APPENDIX A

Literature Cited

Hart Mountain National Antelope Refuge Final Bighorn Sheep Management Plan and Environmental Impact Statement

Appendix A. Literature Cited

Aanderud, Z.T., J. Bahr, D.M. Robinson, J. Belnap, T.P. Campbell, R.A. Gill, B. McMillian, and S. St. Clair. 2019. The burning of biocrusts facilitates the emergence of a bare soil community of poorly-connected chemoheterotrophic bacteria with depressed ecosystem services. *Frontiers in Ecology and Evolution* 7:Article 467.

Ackerman, B.B. 1982. Cougar predation and ecological energetics in southern Utah. Thesis, Utah State University, Logan.

Adams, A.W. 1975. *A Brief History of Juniper and Shrub Populations in Southern Oregon*. Wildlife Research Report Number 6. Corvallis, Oregon: Oregon State Wildlife Commission.

Alaska Chapter of the Wildlife Society. 2015. *Reducing Disease Risk to Dall's Sheep and Mountain Goats from Domestic Livestock Position Statement*. Available at: https://wildlife.org/wp-content/uploads/2015/12/Position-Statement-red_disease_risk_statement.pdf. Accessed August 4, 2021.

Albert, D. 2017. Interim summary of activities on Hart Mountain and Sheldon Wildlife Refuges during 2016. Progress Report: Project 3-1383-Research_SHMNWRC-DAA. Unpublished report, made to U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

———. 2018. Interim summary of activities on Hart Mountain and Sheldon Wildlife Refuges during 2017. Progress Report: 14620-17-007-Research_SHMNWRC-DAA. Unpublished report, made to U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

Allen, C.R., L. Gunderson, and A.R. Johnson. 2005. The use of discontinuities and functional groups to assess relative resilience in complex systems. *Ecosystems* 8:958–966.

American Veterinary Medical Association (AVMA). 2020. *AVMA Guidelines for the Euthanasia of Animals*. 2020 edition. Schaumburg, Illinois: American Veterinary Medical Association.

Andelt, W.F., R. Phillips, R. Schmidt, and R.B. Gill. 1999. Trapping furbearers: an overview of biological and social issues surrounding a public policy controversy. *Wildlife Society Bulletin* 27(1):53–64.

Anderson, D.C., K.T. Harper, and S.R. Rushforth. 1982. Recovery of cryptogamic soil crusts from grazing on Utah winter ranges. *Journal of Range Management* 35:355–359.

Andrew, N.G. 1994. Demography and habitat use by desert dwelling mountain sheep in the East Chocolate Mountains, Imperial County, California. Thesis, University of Rhode Island, Kingston.

Andrew, N.G., L.M. Lesicka, and V.C. Bleich. 1997. An improved fence design to protect water sources for native ungulates. *Wildlife Society Bulletin* 25:823–825.

Animal Diversity Web (ADW). 2021. Animal taxon information. Available at: https://animal diversity.org/. Accessed January 3, 2021.

Archer, A.J. 2001. Fire Effects Information System (FEIS), Species: Taeniatherum caput-medusae. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/graminoid/ taecap/all.html. Accessed October 27, 2020.

Arizona Game and Fish Department. 2021. Living with mountain lions. Available at: https://www.az gfd.com/wildlife/livingwith/mountainlions/. Accessed August 4, 2021.

Ashman, D.L., G.C. Christensen, M.L. Hess, G.K. Tsukamoto, and M.S. Wickersham. 1983. *The Mountain Lion in Nevada*. Final study report. Reno, Nevada: Nevada Department of Wildlife. Available at: https://mountainlion.org/us/nv/LIBRARY/NV-R-Ashman-et-al-1983-the-Mountain-Lion-in-Nevada.pdf. Accessed January 17, 2021.

Association of Fish and Wildlife Agencies. 2006. *Best Management Practices for Trapping in the United States*. Available at: https://www.dec.ny.gov/docs/wildlife_pdf/trapbmpsintro.pdf. Accessed August 2, 2021.

Aurell, B.K. Gullett, D. Tabor, and N. Yonker. 2017. Emissions from prescribed burning of timber slash piles in Oregon. *Atmospheric Environment* 150(February 2017):395–406.

Austreng, A.C., P.H. Olin, A. Hummer, J.L. Pierce, M. deGraaff, and S.G. Benner. 2011. Carbon Sequestration in Semi-arid Ecosystems: Potential Benefits of Sagebrush Restoration. *American Geophysical Union, Fall Meeting 2011*, abstract id. B23F-08.

Bahr, J.R. 2013. Exploring post-fire recovery of biocrusts and desert ecosystem services. Thesis, Brigham Young University, Provo, Utah.

Bailey, J.A. 1980. Desert bighorn, forage competition, and zoogeography. *Wildlife Society Bulletin* 8:208–216.

Bailey, V. 1936. *The Mammals and Life Zones of Oregon*. No. 55. U.S. Government Printing Office.

Baker, T.L. 2015. Habitat selection and spatial responses of bighorn sheep to forest canopy in north-central Washington. Thesis, Washington State University, Pullman.

Baker, W.L. 2006. Fire and restoration of sagebrush ecosystems. *Wildlife Society Bulletin* 34:177–185.

———. 2013. Is wildland fire increasing in sagebrush landscapes of the western United States? *Annals of the Association of American Geographers* 103:5–19.

Balch, J.K., B.A. Bradley, C.M. D’Antonio, and J. Gómez-Dans. 2013. Introduced annual grass increases regional fire activity across the arid western USA (1980–2009). *Global Change Biology* 19:173–183.

Ballard, J. 2010. Hart Mountain National Wildlife Refuge intensive riparian habitat evaluation: Phase 3. Great Basin Bird Observatory, Reno, Nevada. Unpublished report, made to Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

Bangs, P.D. 2002. Habitat use by female desert bighorn sheep, Fra Cristobal Mountains, New Mexico. Thesis, University of Arizona, Tucson.

Barrett, H. 2007. *Western Juniper Management: A Field Guide*. Salem, Oregon: Oregon Watershed Enhancement Board. Available at: https://www.oregon.gov/oweb/Documents/Western-Juniper-Management-Field-Guide-2007.pdf. Accessed November 12, 2020.

Barrett, S., D. Havlina, J. Jones, W. Hann, C. Frame, D. Hamilton, K. Schon, T. Demeo, L. Hutter, and J. Menakis. 2010. *Interagency Fire Regime Condition Class (FRCC) Guidebook*. Version 3.0. Boulder, Colorado: The Nature Conservancy; Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. Available at: https://www.landfire.gov/frcc/documents/FRCC_Guidebook_2010_final.pdf. Accessed November 10, 2020.

Bat Conservation International. 2021. Bat profiles. Available at: https://www.batcon.org/about-bats/bat-profiles/. Last accessed January 3, 2021.

Batcheller, G.R., T.A. Decker, D.A. Hamilton, and J.F. Organ. 2000. A vision for the future of furbearer management in the United States. *Wildlife Society Bulletin* 28(4):833–840.

Batchelor, J.L., W.J. Ripple, T.M. Wilson, and L.E. Painter. 2014. Restoration of riparian areas following the removal of cattle in the northwestern Great Basin. *Environmental Management* 55:930–942.

Bates, J.D., R.F. Miller, and T. Svejcar. 2005. Long-term successional trends following western juniper cutting. *Rangeland Ecology and Management* 58:533–541.

Becerra-Absalón, I., M.Á. Muñoz-Martin, G. Montejano, and P. Mateo. 2019. Differences in the cyanobacterial community composition of biocrusts from the drylands of central Mexico. Are there endemic species? *Frontiers in Microbiology* 10:Article 937.

Beck, K.G., K. Zimmerman, J.D. Schardt, J. Stone, R.R. Lukens, S. Reichard, J. Randall, A.A. Cangelosi, D. Cooper, and J.P. Thompson. 2006. Invasive species defined in a policy context: recommendations from the Federal Invasive Species Advisory Committee. *Invasive Plant Science and Management* 1:414–421.

Bedunah, D.J., K.D. Pflug, and T.E. Jones. 2004. Antelope bitterbrush flowering, survival, and regeneration following ponderosa pine forest restoration treatments. In *Seed and Soil Dynamics in Shrubland Ecosystems: Proceeding*s, Laramie, Wyoming, August 12–16 2002, compiled by A.L. Hild, N.L. Shaw, S.E. Meyer, D.T. Booth, and E.D. McArthur, pp. 149–155. Proceedings RMRS-P-31. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Beecham, J.J., C.P. Collins, and T.D. Reynolds. 2007. *Rocky Mountain Bighorn Sheep* (Ovid canadensis)*: A Technical Conservation Assessment*. Rigby, Idaho: U.S. Forest Service, Rocky Mountain Region. Available at: https://www.lib.washington.edu/msd/norestriction/b66890214.pdf. Accessed February 8, 2021.

Behnke, R.J. 1992. *Native Trout of Western North America.* American Fisheries Society Monograph 6. Bethesda, Maryland: American Fisheries Society.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. *Journal of Wildlife Management* 59:228–237.

Belnap, J., J.H. Kaltenecker, R. Rosentreter, J. Williams, S. Leonard, and D. Eldridge. 2001. *Biological Soil Crusts: Ecology and Management*. Technical Reference 1730-2. Denver, Colorado: U.S. Department of the Interior, Bureau of Land Management, National Science and Technology Center, Information and Communications Group.

Belsky, A.J., and J.L. Gelbard. 2000. *Livestock Grazing and Weed Invasions in the Arid West*. Bend, Oregon: Oregon Natural Desert Association.

Bentz, J.A., and P.M. Woodard. 1988. Vegetation characteristics and bighorn sheep use on burned and unburned areas in Alberta. *Wildlife Society Bulletin* 16:186–193.

Berger, J. 1978. Group size, foraging, and antipredator ploys: an analysis of bighorn sheep decisions. *Behavioral Ecology and Sociobiology* 4:91–99.

Beschta, R.L., J.B. Kauffman, D.S. Dobkin, and L.M. Ellsworth. 2014. Long-term livestock grazing alters aspen age structure in the NW Great Basin. *Forest Ecology and Management* 329:30–36.

Besser, T.E., M. Highland, K. Baker, E.F. Cassirer, N.J. Anderson, J.M. Ramsey, K. Mansfield, D.L. Bruning, P. Wolff, J.B. Smith, and J.A. Jenks. 2012. Causes of pneumonia epizootics among bighorn sheep, western United States, 2008–2010. *Emerging Infectious Diseases* 18:406–414.

Beyer, A.C. 2008. Habitat comparisons of historically stable and less stable bighorn sheep populations. Thesis, Montana State University, Bozeman.

Bishop, C.J., G.C. White, D.J. Freddy, B.E. Watkins, and T.R. Stephenson. 2009. Effect of enhanced nutrition on mule deer population rate of change. *Wildlife Monographs* 172:1–28.

Blake, L. 2014. Foraging ecology of cougars in the Pryor Mountains of Wyoming and Montana. Thesis, Utah State University, Logan.

Blake, L.W., and E.M. Gese. 2016. Resource selection by cougars: influence of behavioral state and season. *Journal of Wildlife Management* 80:1205–1217.

Bleich, V.C., R.T. Bowyer, and J.D. Wehausen. 1997. Sexual segregation in mountain sheep: resources or predation? *Wildlife Monographs* 134:1–50.

Bleich, V.C., and S.G. Torres. 1994. 1994 NWS&GC management workshop questionnaire response: California's mountain sheep management program. In *Proceedings of the Ninth Biennial Symposium of the Northern Wild Sheep and Goat Council, 2–6 May 1994, Cranbrook, British Columbia, Canada*, pp. 186–191.

Bleich, V.C., J.D. Wehausen, R.R. Ramey, and J.L. Rechel. 1996. Metapopulation and mountain sheep: implications for conservation. In *Metapopulations and Wildlife Conservation,* edited by D.R. McCullough, pp. 353–373. Washington, D.C.: Island Press.

Block, W.M., L.M. Conner, P.A. Brewer, P. Ford, J. Haufler, A. Litt, R.E. Masters, L.R. Mitchell, and J. Park. 2016. *Effects of Prescribed Fire on Wildlife and Wildlife Habitat in Selected Ecosystems of North America*. Technical Review 16-01. Bethesda, Maryland: The Wildlife Society.

Boyer, R.T., V.C. Bleich, K.M. Stewart, J.T. Whiting, and K.L. Monteith. 2014. Density dependence in ungulates: a review of causes, and concepts with some clarifications. *California Fish and Game* 100:550–572.

Brice, E.M., B.A. Miller, H. Zhang, K. Goldstein, S.N. Zimmer, G.J. Grosklos, P. Belmont, C.G. Flint, J.E. Givens, P.B. Adler, M.W. Brunson, and J.W. Smith. 2020. Impacts of climate change on multiple use management of Bureau of Land Management land in the Intermountain West. *Ecosphere* 11:1–29.

Brodie, J., H. Johnson, M. Mitchell, P. Zager, K. Proffitt, M. Hebblewhite, M. Kauffman, B. Johnson, J. Bissonette, C. Bishop, and J. Gude. 2013. Relative influence of human harvest, carnivores, and weather on adult female elk survival across western North America. *Journal of Applied Ecology* 50:295–305.

Browning, B.M., and G. Monson. 1980. Food. In *The Desert Bighorn: Its Life History, Ecology, and Management*, edited by G. Monson and L. Sumner, pp. 80–99. Tucson: University of Arizona Press.

Broyles, B. 1995. Desert wildlife water developments: questioning use in the southwest. *Wildlife Society Bulletin* 23:663–675.

Brundige, G.C., and T.R. McCabe. 1986. Summer habitat use by bighorn ewes and lambs. In *Proceedings of the 5th Biennial Symposium of the Northern Wild Sheep and Goat Council, 1986*, pp. 408–420.

Buechner, H.K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildlife Monographs* 4:3–174.

Bukowski, B.E., and W.L. Baker. 2013. Historical fire regimes, reconstructed from land-survey data, led to complexity and fluctuation in sagebrush landscapes. *Ecological Applications* 23:546–564.

Bunting, S.C., L.F. Neuenschwander, and G.E. Gruell. 1985. Fire ecology of bitterbrush in the northern Rock Mountains. In *Fire's Effects on Wildlife Habitat – Symposium Proceedings, Missoula, Montana, March 21, 1984*, compiled by J.E. Lotan, and J.K. Brown, pp. 48–57. General Technical Report INT-186. Ogden, Utah: U.S. Forest Service, Intermountain Research Station.

Cahn, M.L., M.M. Conner, O.J. Schmitz, T.R. Stephenson, J.D. Wehausen, and H.E. Johnson. 2011. Disease, population viability, and recovery of endangered Sierra Nevada bighorn sheep. *Journal of Wildlife Management* 75:1753–1766.

Cain III, J.W., R.C. Karsch, E.J. Goldstein, E.M. Rominger, and W.R. Gould. 2019. Survival and cause-specific mortality of desert bighorn sheep lambs. *Journal of Wildlife Management* 83:251–259.

Call, M.W. 1966. A proposed desert bighorn sheep range development project. In *Desert Bighorn Council 1966 Transactions. 6–7 April 1966, Silver City, New Mexico*, pp. 53–58.

Cassaigne, I.G., R.A. Medellin, and J.A.O. Guasco. 2010. Mortality during epizootics in bighorn sheep: effects of initial population size and cause. *Journal of Wildlife Diseases* 46:763–771.

Cassell, B.A., R.M. Scheller, M.S. Lucash, M.D. Hurteau, and E.L. Loudermilk. 2019. Widespread severe wildfires under climate change lead to increased forest homogeneity in dry mixed-conifer forests. *Ecosphere* 10(11):Article e02934.

Cassirer, E.F., K. Manlove, E. Almberg, P. Klamath, M. Cox, P. Wolff, A. Roug, J. Shannon, R. Robinson, R. Harris, B. Gonzales, R. Plowright, P. Hudson, R. Cross, A. Dobson, and T. Besser. 2018. Pneumonia in Bighorn Sheep: Risk and Resilience. *Journal of Wildlife Management* 82:32–45.

Cassirer, E.F., K.R. Manlove, R.K. Plowright, and T.E. Besser. 2017. Evidence of strain-specific immunity to pneumonia in bighorn sheep. *Journal of Wildlife Management* 81:133–143.

Cassirer, F. 2004. *Hells Canyon Bighorn Sheep*. Boise, Idaho: Idaho Department of Fish and Game.

Chambers, J.C., J.L. Beck, S. Campbell, J. Carlson, T.J. Christiansen, K.J. Clause, J.B. Dinkins, K.E. Doherty, K.A. Griffin, D.W. Havlina, K.F. Henke, J.D. Hennig, L.L. Kurth, J.D. Maestas, M. Manning, K.E. Mayer, B.A. Mealor, C. McCarthy, M.A. Perea, and D.A. Pyke. 2016. Using resilience and resistance concepts to manage threats to sagebrush ecosystems, Gunnison sage-grouse, and greater sage-grouse in their eastern range: a strategic multi-scale approach. General technical report RMRS-GTR-356. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Chambers, J.C., B.A. Bradley, C.S. Brown, C. D'Antonio, M.J. Germino, J.B. Grace, S.P. Hardegree, R.F. Miller, and D.A. Pyke. 2014. Resilience to stress and disturbance, and resistance to Bromus tectorum L. invasion in cold desert shrublands of western North America. *Ecosystems* 17:360–375.

Chambers, J.C., M.L. Brooks, M.J. Germino, J.D. Maestas, D.I. Board, M.O. Jones, and B.W. Allred. 2019. Operationalizing resilience and resistance concepts to address invasive grass-fire cycles. F*rontiers in Ecology and Evolution* 7:Article 185.

Chambers, J.C., R.F. Miller, D.I. Board, D.A. Pyke, B.A. Roundy, J.B. Grace, E.W. Schupp, and R.J. Tausch. 2014. Resilience and resistance of sagebrush ecosystems: implications for state and transition models and management treatments. *Rangeland Ecology and Management* 67:440–454.

Chambers, J.C., and M. Pellant. 2008. Climate change impacts on northwestern and intermountain United States rangelands. *Rangelands* 30:29–33.

Chambers, J.C., D.A. Pyke, J.D. Maestas, M. Pellant, C.S. Boyd, S.B. Campbell, S. Espinosa, D.W. Havlina, K.E. Mayer, and A. Wuenschel. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: a strategic multi-scale approach. General technical report RMRS-GTR-326. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Chambers, J.C., B.A. Roundy, R.R. Blank, S.E. Meyer, and A. Whittaker. 2007. What makes Great Basin sagebrush ecosystems invasible by *Bromus tectorum*? *Ecological Monographs* 77:117–145.

Clark, R.G., and E.E. Starkey. 1990. Use of prescribed fire in rangeland ecosystems. In *Natural and Prescribed Fire in the Pacific Northwest Forests*, edited by J.D. Walstad, S.R. Radosevich, and D.V. Sandberg, pp. 81–90. Corvallis: Oregon State University Press.

Clary, W.P., and D.E. Medin. 1999. Riparian zones—the ultimate ecosystems? Proceedings: shrubland ecotones, 12–14 August 1998, Ephraim, Utah. U.S. Forest Service, Rocky Mountain Research Station, Proceedings RMRS-P-11, Ogden, Utah, compiled by E.D. McArthur, W.K. Ostler, and C.L. Wambolt, pp. 49–55.

Collins, G.H. 2016. Seasonal distribution and routes of pronghorn in the northern Great Basin. *Western North American Naturalist* 76:101–112.

———. 2018. Inventory and rapid health assessment of aspen stands on the Sheldon-Hart Mountain National Wildlife Refuge Complex, 2013–2017. Unpublished report, U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

Collins, W.B., and E.F. Becker. 2001. Estimation of horizontal cover. *Journal of Range Management* 54:67–70.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, M. Pyne, M. Reid, K. Schulz, K. Snow, and J. Teague. 2003. *Ecological Systems of the United States: A Working Classification of U.S. Terrestrial Systems*. Arlington, Virginia: NatureServe.

Connelly, J.W., S.T. Knick, M.A. Schroeder, and S.J. Stiver. 2004. Conservation assessment of greater sage-grouse and sagebrush habitats. Unpublished report, Western Association of Fish and Wildlife Agencies, Cheyenne, Wyoming. Available at: https://ir.library.oregon state.edu/concern/technical_reports/ff365b304. Accessed November 5, 2020.

Cooperrider, A.Y., S.A. McCollough, and J.A. Bailey. 1980. Variation in bighorn sheep food habits as measured by fecal analysis. In *Proceedings of the 2nd Biennial Symposium of the Northern Wild Sheep and Goat Council, 23–25 April 1980, Salmon, Idaho*, pp. 29–41.

Cottam, D.F. 1985. Lamb production differences for bighorn sheep on Hart Mountain, Oregon. Thesis, Oregon State University, Corvallis.

Council for Agricultural Science and Technology (CAST). 2008. *Pasteurellosis transmission risks between domestic and wild sheep*. CAST Commentary QTA2008-1. Ames, Iowa: Council for Agricultural Science and Technology.

Council for Environmental Quality (CEQ). 2014. Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews.

Courtemanch, A.B. 2014. Seasonal habitat selection and impacts of backcountry recreation on a formerly migratory bighorn sheep population in northwest Wyoming. Thesis, University of Wyoming, Laramie.

Cox, M.K. 2006. Effects of mineral supplements on California bighorn sheep in northern Nevada. In *Proceedings of the 15th Biennial Symposium of the Northern Wild Sheep and Goat Council, 2–6 April 2006, Kananskis, Alberta, Canada*, pp. 107–120.

Crist, P., L. Wise, J. Kagan, M. Harkness, I. Varley, and P. Comer. 2011. *Vulnerability Assessment and Strategies for the Sheldon National Wildlife Refuge and Hart Mountain National Antelope Refuge Complex*. Boulder, Colorado: NatureServe. Available at: https://www.fws.gov/refuges/whm/pdfs/SheldonHartNWR_RVA_Report.pdf. Accessed February 8, 2021.

D'Antonio, C.M., and M. Thomsen. 2004. Ecological resistance in theory and practice. *Weed Technology* 18:1572–1577.

D'Antonio, C.M., and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. *Annual Review of Ecology and Systematics* 23:63–87.

Davies, G.M., J.D. Bakker, E. Dettweiler-Robinson, P.W. Dunwiddie, S.A. Hall, J. Downs, and J. Evans. 2012. Trajectories of change in sagebrush steppe vegetation communities in relation to multiple wildfires. *Ecological Applications* 22:1562–1577.

Davies, K.W., and J.D. Bates. 2010a. Vegetation characteristics of mountain and Wyoming big sagebrush plant communities in the northern Great Basin. *Rangeland Ecology and Management* 63:461–466.

———. 2010b. Native perennial forb variation between mountain big sagebrush and Wyoming big sagebrush plant communities. *Environmental Management* 46:452–458.

———. 2020. Re-introducing fire in sagebrush steppe experiencing decreased fire frequency: does burning promote spatial and temporal heterogeneity? *International Journal of Wildland Fire* 29:686–695.

Davies, K.W., J.D. Bates, and C.S. Boyd. 2019. Postwildfire seeding to restore native vegetation and limit exotic annuals: an evaluation in juniper-dominated sagebrush steppe. *Restoration Ecology* 27:120–127.

Davies, K.W., J.D. Bates, C.S. Boyd, and A.M. Nafus. 2014. Is fire exclusion in mountain big sagebrush communities prudent? Soil nutrient, plant diversity and arthropod response to burning. International *Journal of Wildland Fire* 23:417–424.

Davies, K.W., J.D. Bates, D.D. Johnson, and A.M. Nafus. 2009. Influence of mowing *Artemisia tridentata* ssp. *wyomingensis* on winter habitat for wildlife. *Environmental Management* 44:84–92.

Davies, K.W., J.D. Bates, and R.F. Miller. 2007. Short-term effects of burning Wyoming big sagebrush steppe in southeast Oregon. *Rangeland Ecology and Management* 60:515–522.

Davies, K.W., C.S. Boyd, J.L. Beck, J.D. Bates, T.J. Svejcar, and M.A. Gregg. 2011. Saving the sagebrush sea: an ecosystem conservation plan for big sagebrush plant communities. *Biological Conservation* 144:2573–2584.

Davies, K.W., R.C. Rios, J.D. Bates, D.D. Johnson, J. Kerby, and C.S. Boyd. 2019. To burn or not to burn: comparing an encroaching conifer for conservation of an imperiled shrub-steppe. *Ecology and Evolution* 9:9137–9148.

Davies, K.W., R.L. Sheley, and J.D. Bates. 2008. Does fall prescribed burning *Artemisia tridentata* steppe promote invasion or resistance to invasion after a recovery period? *Journal of Arid Environments* 72:1076–1085.

DeCesare, N.J., M. Hebblewhite, M. Bradley, K.G. Smith, D. Hervieux, and L. Neufeld. 2012. Estimating ungulate recruitment and growth rates using age ratios. *Journal of Wildlife Management* 76:144–153.

DeCesare, N.J., and D.H. Pletscher. 2004. Bighorn sheep, horizontal visibility, and GIS. In *Proceedings of the 14th Biennial Symposium of the Northern Wild Sheep and Goat Council, 15–22 May 2004, Inside Passage, Alaska*, pp. 181–190.

———. 2006. Movements, connectivity, and resource selection of Rocky Mountain bighorn sheep. *Journal of Mammalogy* 87:531–538.

DeHaan, P., J. Von Bargen, M. Meeuwig, and S. Clements. 2015. *Great Basin Redband Trout Genetic Status Assessment*. Final report. Longview, Washington: U.S. Fish and Wildlife Service, Abernathy Fish Technology Center. April 24.

Demarchi, R.A. 2004. Bighorn sheep. In *Ministry of Water, Land and Air Protection. Accounts and Measures for Managing Identified Wildlife Southern Interior Forest Region*, pp. 391–409. Victoria, Canada: British Columbia Ministry of Water, Land and Air Protection, Biodiversity Branch.

Demarchi, R.A., C.L. Hartwig, and D.A. Demarchi. 2000. *Status of California Bighorn Sheep in British Columbia*. Wildlife Bulletin B-98. Victoria, Canada: British Columbia Ministry of Environment, Lands and Parks, Wildlife Branch.

Deming, O.V. 1961. Bighorn sheep transplants at the Hart Mountain National Antelope Refuge. In *Desert Bighorn Council 1961 Transactions. 4–7 April 1961, Hermosilla, Sonora, Mexico,* pp. 56–67.

Dicus, G.H. 2002. An evaluation of GIS-based habitat models for bighorn sheep winter range in Glacier National Park, Montana. Thesis, University of Montana, Missoula.

Dobkin, D.S. 1994. *Conservation and Management of Neotropical Migrant Landbirds in the Northern Rockies and Great Plains*. Moscow, University of Idaho Press.

Dobkin, D.S., A.C. Rich, and W.H. Pyle. 1998. Habitat and avifaunal recovery from livestock grazing in a riparian meadow system of the northwestern Great Basin. *Conservation Biology* 12:209–221.

Dolan, B.F. 2006. Water developments and desert bighorn sheep: implications for conservation. *Wildlife Society Bulletin* 34:642–646.

Driscoll, C.C., J.G. Driscoll, C. Hazekamp, J.B. Mitton, and J.D. Wehausen. 2015. A tale of two markers: population genetics of Colorado Rocky Mountain bighorn sheep estimated from microsatellite and mitochondrial data. *Journal of Wildlife Management* 79:819–831.

Dunn, W.C. 1996. *Evaluating Bighorn Habitat: A Landscape Approach.* BLM Technical Note 395. Denver, Colorado: U.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center.

Dyer, D., R. O'Beck, and G.L. Noller. 2007. *Plant Guide: Antelope Bitterbrush,* Purshia Tridentate *(Pursh) DC*. Lockeford, California: U.S. Department of Agriculture, National Resources Conservation Service, Plant Materials Center.

Earnst, S.L., D.S. Dobkin, and J.A. Ballard. 2012. Changes in avian and plant communities of aspen woodlands over 12 years after livestock removal in the northwestern Great Basin. *Conservation Biology* 26:862–872.

Eaton, R.L., and K.A. Velander. 1977. Reproduction in the puma: biology, behavior and ontogeny. *The World's Cats Proceedings* 3:45–70.

Ebert, D.W. 1993. Desert bighorn movements and habitat use in relation to the proposed Black Canyon Bridge project: Nevada. Thesis, University of Nevada, Las Vegas.

Eddleman, L.E., P.M. Miller, R.F. Miller, and P.L. Dysart. 1994. Western juniper woodlands (of the Pacific Northwest): science assessment. Unpublished report, U.S. Forest Service and Bureau of Land Management, Interior Columbia Basin Ecosystem Management Project.

Ellsworth, L.M., D.W. Wroblesk, J.B. Kauffman, and S.A. Reis. 2016. Ecosystem resilience is evident 17 years after fire in Wyoming big sagebrush ecosystems. *Ecosphere* 7:1–12.

Enk, T.A. 1999. Population dynamics of bighorn sheep on the Beartooth Wildlife Area, Montana. Dissertation, Montana State University, Bozeman.

Erickson, H J. 2011. Herbaceous and avifauna responses to prescribed fire and grazing timing in a high-elevation sagebrush ecosystem. Thesis, Colorado State University, Fort Collins.

Ernest, H.B., E.S. Rubin, and W.M. Boyce. 2002. Fecal DNA analysis and risk assessment of mountain lion predation of bighorn sheep. *Journal of Wildlife Management* 66:75–85.

Esri. 2020a. ArcGIS Code Sharing, vector ruggedness measure. Available at: codesharing.arcgis.com. Accessed July 30, 2020.

———. 2020b. Area Solar Radiation (ASR). The Spatial Analyst toolbox of ArcGIS 10.7.1. Redlands, California.

Evans, R.D., and J. Belnap. 1999. Long-term consequences of disturbance on nitrogen dynamics in an arid ecosystem. *Ecology* 80:150–160.

Evans, R.D., and J.R. Ehleringer. 1993. A break in the nitrogen cycle in aridlands? Evidence from $\delta^{15}N$ of soils. *Oecologia* 94:314–317.

Falkowski, M.J., J.S. Evans, D.E. Naugle, C.A. Hagen, S.A. Carleton, J.D. Maestas, A.H. Khalyani, A.J. Poznanovic, and A.J. Lawrence. 2017. Mapping tree canopy cover in support of proactive prairie grouse conservation in western North America. *Rangeland Ecology and Management* 70:15–24.

Fecske, D.M., D.J. Thompson, and J.A. Jenks. 2011. Cougar ecology and natural history. In *Managing Cougars in North America*, edited by J.A. Jenks, pp. 15–40. Jack H. Berryman Institute. Logan: Utah State University.

Federal Geographic Data Committee (FGDC). 2008. National vegetation classification standard, version 2. Vegetation Subcommittee, FGDC-STD-005-2008 (Version 2). Reston, Virginia.

Festa-Bianchet, M. 1988. Birthdate and survival in bighorn lambs. *Journal of Zoology* 214(4):653–661.

Festa-Bianchet, M., T. Coulson, J.M. Gaillard, J.T. Hogg, and F. Pelletier. 2006. Stochastic predation events and population persistence in bighorn sheep. *Proceedings of the Royal Society B*. 273:1537–1543.

Fitzgerald, S.A. 2005. Fire ecology of ponderosa pine and the rebuilding of fire-resilient ponderosa pine ecosystems. In *Proceedings of the Symposium on Ponderosa Pine: Issues, Trends, and Management, 18–21 October 2004, Klamath Falls, Oregon*, M.W. Ritchie, D.A. Maguire, and A. Youngblood, technical coordinators, pp. 197–225. Albany, California: U.S. Forest Service, Pacific Southwest Research Station, PSW-GTR-198.

Fleischner, T.L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8:629–644.

Folke, C., S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C.S. Holling. 2004. Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics* 35:557–581.

Forbes, K.M. 2001. Modeling bighorn sheep habitat in northwest Nebraska. Thesis, University of Nebraska, Lincoln.

Forrester, T.D., and H.U. Wittmer. 2013. A review of the population of mule deer and black-tailed deer *Odocoileus hemionus* in North America. *Mammal Review* 43:292–308.

Foster, C.L. 2004. Wild sheep capture guidelines. *Northern Wild Sheep and Goat Council Proceedings* 14:211–282.

Foster, C.L., M. Bennet, and D. Whittaker. 2008. Factors related to poor population performance of California bighorn sheep on Hart Mountain National Antelope Refuge. Abstract only. In *Proceedings of the 16th Biennial Symposium of the Northern Wild Sheep and Goat Council, 27 April1–May 2008, Midway, Utah*, pp. 137.

Foster, C.L., and D.G. Whittaker. 2010. Poor population performance of California Bighorn Sheep on Hart Mountain National Antelope Refuge. In *Proceedings of the 17th Biennial Symposium of the Northern Wild Sheep and Goat Council, 7–11 June 2010, Hood River, Oregon*, pp. 129–137.

Fryer, J.L. 2016. Fire Effects Information System (FEIS), fire regimes of northern Rocky Mountain ponderosa pine communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Northern_RM_ponderosa_pine/all.html. Accessed November 4, 2020.

———. 2017. Fire Effects Information System (FEIS), Ventenata dubia. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/graminoid/vendub/all.html. Accessed October 27, 2020.

Fryxell, J.M., A.R.E Sinclair, and G. Caughley. 2014. *Wildlife Ecology, Conservation, and Management*. 3rd ed. Hoboken, New Jersey: Wiley-Blackwell.

Galliard, J.M., M. Festa-Bianchet, and N.G. Yoccoz. 1998. Population dynamics of large herbivores: variable recruitment with constant adult survival. *Trends in Ecology and Evolution* 13:58–63.

Ganskopp, D., T. Svejcar, F. Taylor, and J. Farstvedt. 2004. Can spring cattle grazing among young bitterbrush stimulate shrub growth? *Journal of Range Management* 57:161–168.

Garrison, H.D., L.M. Shultz, and E.D. McArthur. 2013. Studies of a new hybrid taxon in the Artemisia tridentata complex. *Western North American Naturalist* 73:1–19.

Garton, E.O., A.G. Wells, J.A. Baumgardt, and J.W. Connelly. 2011. Greater sage-grouse population dynamics and probability of persistence. *Studies in Avian Biology* 38:293–381.

Geist, V. 1971. *Mountain Sheep: A Study in Behavior and Evolution*. Chicago, Illinois: University of Chicago Press.

George, J.L., D.J. Marin, P.M. Lukacs, and M.W. Miller. 2008. Epidemic pasteurellosis in a bighorn sheep population coinciding with the appearance of a domestic sheep. *Journal of Wildlife Diseases* 44(2):388–403.

Goldstein, E.J., and E.M. Rominger. 2012. A comparison of mortality rates for desert and Rocky Mountain bighorn sheep under two cougar control regimes. In *Proceedings of the 18th Biennial Symposium of the Northern Wild Sheep and Goat Council, 12–15 March 2012, Kamloops, British Columbia, Canada*, pp. 137–145.

Greene, L. 2010. Short-term effects of wildfire on Sierra Nevada bighorn sheep habitat ecology. Thesis, University of Montana, Missoula.

Greenwood, C.L., S. Goodrich, and J.A. Lytle. 1999. Response of bighorn sheep to pinyon-juniper burning along the Green River corridor, Daggett County, Utah. In P*roceedings: Ecology and Management of Pinyon-Juniper Communities within the Interior West, 15–18 September 1997, Provo, Utah*, compiled by S.B. Monsen, and R. Stevens, pp. 205–209. Proceedings RMRS-P-9. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

Grinnell, G.B. 1928. Mountain sheep. *Journal of Mammalogy* 9:1–9.

Gruell, G.E. 1995. *Historic Role of Fire on Hart Mountain National Antelope Refuge, Oregon, and Sheldon National Wildlife Refuge, Nevada: A Report*. Unpublished report, U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

———. 1999. Historical and modern roles of fire in pinyon-juniper. *Proceedings: Ecology and Management of Pinyon-Juniper Communities within the Interior West, 15–18 September 1997, Provo, Utah*, compiled by S.B. Monsen and R. Stevens, pp. 24–28. Proceedings RMRS-P-9. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

The Guardian. 2021. California relocates mountain lions making a meal of endangered sheep. Available at: https://www.theguardian.com/environment/2021/mar/30/mountain-lions-relocated-bighorn-sheep-california.

Gustavson, T.C., V.T. Holliday, and S.D. Hovorka. 1995. *Origin and Development of Playa Basins, Sources of Recharge to the Ogallala Aquifer, Southern High Plains, Texas and New Mexico*. Report of Investigations No. 229. Austin: University of Texas, Bureau of Economic Geology.

Hansen, M.C. 1982. Status and habitat preference of California bighorn sheep on Sheldon National Wildlife Refuge, Nevada. Thesis, Oregon State University, Corvallis.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 2011. *Bats of the United States and Canada*. Baltimore, Maryland: Johns Hopkins University Press.

Haukos, D.A., and L.M. Smith. 2003. Past and future impacts of wetland regulations on playa ecology in the southern Great Plains. *Wetlands* 23:577–589.

Hayes, C.L., E.S. Rubin, M.C. Jorgensen, R.A. Botta, and W.M. Boyce. 2000. Mountain lion predation of bighorn sheep in the Peninsular Ranges, California. *Journal of Wildlife Management* 64:954–959.

Heinse, L.M., L.H. Hardesty, and R.B. Harris. 2016. Risk of pathogen spillover to bighorn sheep from domestic sheep and goat flocks on private land. *Wildlife Society Bulletin* 40:625–633.

Heisey, D.M., and T.K. Fuller. 1985. Evaluation of survival and cause-specific mortality rates using telemetry data. *Journal of Wildlife Management* 49:668–674.

Heltzel, J.M., and S.L. Earnst. 2006. Factors influencing nest success of songbirds in aspen and willow riparian areas in the Great Basin. *Condor* 108:842–855.

Herbst, D.B. 1996. *Aquatic Invertebrate Biodiversity on the Sheldon National Wildlife Refuge, Nevada*. Mammoth Lakes, California: University of California, Sierra Nevada Aquatic Research Laboratory.

Hogan, P.A. 1990. A review of desert bighorn sheep in the San Andres Mountains, New Mexico. In *Desert Bighorn Council 1990 Transactions. 4–6 April 1990, Hermosillo, Sonora, Mexico*, pp. 14–22.

Holl, S.A. 1982. Evaluation of bighorn sheep habitat. In *Desert Bighorn Council 1982 Transactions. 7–9 April 1982, Borrego Springs, California*, pp. 47–49.

Holling, C.S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4:1–23.

Hopcraft, J.G.C., H. Olff, and A.R.E. Sinclair. 2010. Herbivores, resources and risks: alternating regulation along primary environmental gradients in savannas. *Trends in Ecology and Evolution* 25:119–128.

Hornocker, M.G. 1970. An analysis of mountain lion predation upon mule deer and elk in the Idaho Primitive Area. *Wildlife Monographs* 21:3–39.

Hoskinson, R.L., and J.R. Tester. 1980. Migration behavior of pronghorn in southeastern Idaho. *Journal of Wildlife Management* 44:132–144.

Howard, J.L. 1994. Fire Effects Information System (FEIS), Bromus japonicus (species information webpage). Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/graminoid/brojap/all.html. Accessed October 27, 2020.

Hubbs, C.L., and R.R. Miller. 1948. Part II: the zoological evidence: correlation between fish distribution and hydrographic history in the desert basins of western United States. In *The Great Basin, with an Emphasis on Glacial and Postglacial Times*, E. Blackwelder, C.L. Hubbs, R.R. Miller, and E. Antevs, pp. 17–166. Reprinted from Bulletin of the University of Utah, Vol. 38 Number 20 (Biological Series Vol. 10 Number 7), University of Utah, Salt Lake City. Available at: https://hdl.handle.net/2027/mdp.39015037687459. Accessed October 30, 2020.

Hurley, M.A., J.W. Unsworth, P. Zager, M. Hebblewhite, E.O. Garton, D.M. Montgomery, J.R. Skalski, and C.L. Maycock. 2011. Demographic response of mule deer to experimental reduction of coyotes in mountain lions in southeastern Idaho. *Wildlife Monographs* 178:1–33.

Hurn, S. 2013. Guano Creek fish survey report. Unpublished report, Oregon Department of Fish and Wildlife, Malheur Watershed District, Hines, Oregon.

Ibáñez, I., E.W. Schupp, and J.L. Boettinger. 1999. Successional history of a curl leaf mountain mahogany stand: a hypothesis. In Proceedings: shrubland ecotones, 12–14 August 1998, Ephraim, Utah, compiled by E.D. McArthur, W.K. Ostler, W. Kent, and C.L. Wambolt, pp. 102–107. Proceedings RMRS-P-11. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

Inkley, D.B., M.G. Anderson, A.R. Blaustein, V.R. Burkett, B. Felzer, B. Griffith, J. Price, and T.L. Root. 2004. *Global Climate Change and Wildlife in North America*. Technical Review 04-2. Bethesda, Maryland: The Wildlife Society.

Innes, R.J. 2014. Fire Effects Information System (FEIS). Fire regimes of sparsely vegetated communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Sparsely_vegetated/all.html. Accessed November 4, 2020.

———. 2017. Fire Effects Information System (FEIS). Artemisia tridentata subsp. vaseyana, mountain big sagebrush (species information webpage). Missoula, Montana U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/shrub/arttriv/all.html. Accessed October 7, 2020.

———. 2019a. Fire Effects Information System (FEIS). Fire regimes of Wyoming big sagebrush and basin big sagebrush communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/WY_basin_big_sagebrush/all.html. Accessed October 7, 2020.

———. 2019b. Fire Effects Information System (FEIS). Annotated bibliography of scientific publications on medusahead 2000–2019: relationship with fire and response to fire and other control methods. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: http://www.fs.fed.us/database/feis/plants/graminoid/taecap/annbib/all.html. Accessed October 27, 2020.

Innes, R.J., and K. Zouhar. 2018. Fire Effects Information System (FEIS). Fire regimes of mountain big sagebrush communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/mountain_big_sagebrush/all.html. Accessed October 7, 2020.

Intergovernmental Panel on Climate Change (IPCC). 2018. Summary for policymakers. In *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*. Geneva, Switzerland: World Meteorological Organization.

Interior Redband Conservation Team. 2016. *Conservation Strategy for Interior Redband* (Oncorhynchus mykiss *subsp*.) *in the States of California, Idaho, Montana, Nevada, Oregon and Washington*. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd525054.pdf. Accessed October 30, 2020.

International Association of Fish and Wildlife Agencies. 1997. *Improving animal welfare in U.S. trapping programs: process recommendations and summaries of existing data*. International Association of Fish and Wildlife Agencies (currently Association of Fish and Wildlife Agencies). Washington, D.C.

Iossa, G., C.D. Soulsbury, and S. Harris. 2007. Mammal trapping: a review of animal welfare standards of killing and restraining traps. *Animal Welfare* 16:335–352.

Iriarte, J.A., W. Franklin, W. Johnson, and K. Redford. 1990. Biogeographic variation of food habits and body size of the America puma. *Oecologia* 85:185–190.

Jardine, J.T., and M. Anderson. 1919. *Range Management on the National Forests*. U.S. Department of Agriculture, Bulletin 790. Washington, D.C.: U.S. Department of Agriculture.

Jansen, B.D., and J.A. Jenks. 2012. Birth timing for mountain lions (*Puma concolor*); testing the prey availability hypothesis. *PLoS One* 7:Article e44625.

Johansen, J.R., J. Ashley, and W.R. Rayburn. 1993. Effects of rangefire on soil algal crusts in semiarid shrub-steppe of the Lower Columbia Basin and their subsequent recovery. *Great Basin Naturalist* 53:73–88.

Johansen, J.R., and L.L. St. Clair. 1986. Cryptogamic soil crusts: recovery from grazing near Camp Floyd State Park, Utah. *Great Basin Naturalis*t 46:632–640.

Johansen, J.R., L.L. St. Clair, B.L. Webb, and G.T. Nebeker. 1984. Recovery patterns of cryptogamic soil crusts in desert rangelands following fire disturbance. *Bryologist* 87:238–243.

Johnson, D.D. 2005. The influence of environmental attributes on temporal and structural dynamics of western juniper woodland development and associated fuel loading characteristics. Thesis, Oregon State University, Corvallis.

Johnson, M.L., and L.K. Couch. 1954. Determination of the abundance of cougar. *Journal of Mammalogy* 35:255–256.

Johnson, H.E., M. Hebblewhite, T.R. Stephenson, D.W. German, B.M. Pierce, and V.C. Bleich. 2013. Evaluating apparent competition in limiting the recovery of an endangered ungulate. *Oecologia* 171:295–307.

Johnson, H.E., L.S. Mills, J.D. Wehausen, T.R. Stephenson, and G. Luikart. 2011. Translating effects of inbreeding depression on component vital rates to overall population growth in endangered bighorn sheep. *Conservation Biology* 25:1240–1249.

Johnson, T.L., and D.M. Swift. 2000. A test of a habitat evaluation procedure for Rocky Mountain bighorn sheep. *Restoration Ecology* 8:47–56.

Jones, F.L., G. Hittner, and R. Gard. 1957. Report on a survey of bighorn sheep in the Santa Rosa Mountains, Riverside County. *California Fish and Game* 43:179–191.

Kaltenecker, J.H. 1997. The recovery of microbiotic crusts following post-fire rehabilitation on rangelands of the western Snake River Plain. Dissertation, Boise State University, Idaho.

Kaltenecker, J.H., and M. Wicklow-Howard. 1994. *Microbiotic soil crusts in sagebrush habitats of southern Idaho*. Unpublished contract report, prepared for Eastside Ecosystem Management Project. Available at: https://www.fs.fed.us/r6/icbemp/science/kaltenec.pdf. Accessed February 17, 2021.

Kaltenecker, J.H., M. Wicklow-Howard, and M. Pellant. 1999a. Biological soil crusts: natural barriers to Bromus tectorum L. establishment in the northern Great Basin, USA. In *Proceedings of the VI International Rangeland Congress, Aitkenvale, Queensland, Australia*, edited by D. Eldridge and D. Freudenberger, pp. 109–111.

Kaltenecker, J.H., M.C. Wicklow-Howard, and R. Rosentreter. 1999b. Biological soil crusts in three sagebrush communities recovering from a century of livestock trampling. In *Proceedings: Shrubland Ecotones, 12–14 August 1998, Ephraim, Utah*, *compiled by* E.D. McArthur, W.K. Ostler, W. Kent, and C.L. Wambolt, pp. 222–226. Proceedings RMRS-P-11. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

Kamler, J.F., R.M. Lee, J.C. DeVos, Jr., W.B. Ballard, and H.A. Whitlaw. 2002. Survival and cougar predation of translocated bighorn sheep in Arizona. *Journal of Wildlife Management* 66:1267–1272.

Karsch, R.C., J.W. Cain III, E.M. Rominger, and E.J. Goldstein. 2016. Desert bighorn sheep lambing habitat: parturition, nursery, and predation sites. *Journal of Wildlife Management* 80:1069–1080.

Kauffman, J.B., and D.B. Sapsis. 1989. The natural role of fire in Oregon's high desert. In *Oregon's High Desert: The Last 100 Years*, pp. 15–19. Special Report 841. Corvallis: Oregon State University, Agricultural Experiment Station.

Keane, R.E., J.K. Agee, P. Fulé, J.E. Keeley, C. Key, S.G. Kitchen, R. Miller, and L.A. Schulte. 2008. Ecological effects of large fires on US landscapes: benefit or catastrophe? *International Journal of Wildland Fire* 17:696–712.

Keating, K.A., P J.P. Gogan, J.M. Vore, and L.R. Irby. 2007. A simple solar radiation index for wildlife habitat studies. *Journal of Wildlife Management* 71:1344–1348.

Keeley, J.E. 2009. Fire intensity, fire severity and burn severity: a brief review and suggested usage. *International Journal of Wildland Fire* 18:116–126.

Kelly, L.T., L. Brotons, and M.A. McCarthy. 2017. Putting pyrodiversity to work for animal conservation. *Conservation Biology* 31:952–955.

Keyser, A.R., and A.L. Westerling. 2019. Predicting increasing high severity area burned for three forested regions in the western United States using extreme value theory. *Forest Ecology and Management* 432:694–706.

Kleinhesselink, A.R., and P.B. Adler. 2018. The response of big sagebrush (*Artemisia tridentata*) to interannual climate variation changes across its range. *Ecology* 99:1139–1149.

Knapp, P.A. 1996. Cheatgrass (*Bromus tectorum*) dominance in the Great Basin Desert: history, persistence, and influences to human activities. *Global Environmental Change* 6:37–52.

Knick, S.T., D.S. Dobkin, J.T. Rotenberry, M.A. Schroeder, W.M. Vander Haegen, and C. van Ripper III. 2003. Teetering on the edge or too late? Conservation and research issues for avifauna of sagebrush habitats. *Condor* 105:611–634.

Knick, S.T., A.L. Holmes, and R.F. Miller. 2005. The role of fire in structuring sagebrush habitats and bird communities. *Studies in Avian Biology* 30:63–75.

Knick, S.T., and J.T. Rotenberry. 2002. Effects of habitat fragmentation on passerine birds breeding in intermountain shrubsteppe. *Studies in Avian Biology* 25:130–140.

Knopff, K.H., N.F. Webb, and M.S. Boyce. 2014. Cougar population and range expansion in Alberta during 1991–2010. *Wildlife Society Bulletin* 38:116–121.

Kornet, C.A. 1978. Status and habitat use of California bighorn sheep on Hart Mountain, Oregon. Thesis, Oregon State University, Corvallis.

Landres, P., C. Barns, S. Boutcher, T. Devine, P. Dratch, A. Lindholm, L. Merigliano, N. Roeper, and E. Simpson. 2015. *Keeping it Wild 2: An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System*. General technical report RMRS-GTR-340. Fort Collins, Colorado: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Larkins, A., S. Harju, and D.G. Whittaker. 2018. Pronghorn migration and survival: a statistical analysis of a southeastern Oregon population. In *Proceedings of the Western States and Provinces Twenty-Eight Biennial Pronghorn Workshop: Learning from the Past – Adapting for the Future, 13–15 August 2018, Reno, Nevad*a, edited by B.F. Wakeling and C. Schroeder, pp. 19–28.

Larson, R. 2018. Preliminary results of the 2017 intermittent lacustrine waterbodies project, southcentral Oregon and adjacent areas in California and Nevada. Unpublished report, made to Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

Laundré, J.W., L. Hernández, and S.G. Clark. 2007. Numerical and demographic responses of pumas to changes in prey abundance: testing current predictions. *Journal of Wildlife Management* 71:345–355.

Lawrence, P.K., S. Shanthalingham, R.P. Dassanyake, R. Subramaniam, C.N. Herndon, D.P. Knowles, F.R. Rurangirwa, W.J. Foreyt, G. Wayman, and A.M. Marciel. 2010. Transmission of Mannheimia Haemolytica from domestic sheep (*Ovis aries*) to bighorn sheep (*Ovis canadensis*): unequivocal demonstration with green fluorescent protein-tagged organisms. *Journal of Wildlife Management* 46:706–717.

Leckenby, D.A., D.P. Sheehy, C.H. Nellis, R.J. Scherzinger, I.D. Luman, W. Elmore, J.C. Lemos, L. Doughty, and C.E. Trainer. 1982. *Wildlife Habitats in Managed Rangelands—the Great Basin of Southeastern Oregon: Mule Deer.* General Technical Report PNW-GTR-139. Portland, Oregon: U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams, and others. 1997. Chapter 4: broadscale assessment of aquatic species and habitats. In *An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume III*, T.M. Quigley, and S.J. Arbelbide, technical editors, pp. 1057–1496. General Technical Report PNW-GTR-405. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, and U.S. Department of the Interior, Bureau of Land Management.

Levick, L.R., J. Fonseca, D.C. Goodrich, M. Hernandez, D.J. Semmens, J. Stromberg, R.A. Leidy, M. Scianni, D.P. Guertin, M. Tluczek, and W.G. Kepner. 2008. *The Ecological and Hydrological Significance of Ephemeral and Intermittent Streams in the Arid and Semi-Arid American Southwest*. Washington, D.C.: U.S. Environmental Protection Agency, Office of Research and Development; Tucson, Arizona: U.S. Department of Agriculture, Agricultural Research Station, Southwest Watershed Research Center.

Lindzey, F. 1987. Mountain lion. Wild furbearer management and conservation in North America. *Ontario Ministry of Natural Resources*, Toronto 1150:657–658.

Lindzey, F.G., W.D. Van Sickle, B.B. Ackerman, D. Barnhurst, T.P. Hemker, and S.P. Laing. 1994. Cougar population dynamics in southern Utah. *Journal of Wildlife Management* 58:619–624.

Littell, J.S., D. McKenzie, D.L. Peterson, and A.L. Westerling. 2009. Climate and wildfire area burned in western U.S. ecoprovinces, 1916–2003. *Ecological Applications* 19:1003–1021.

Loehman, R. 2010. *Understanding the Science of Climate Change: Talking Points – Impacts to Arid Lands*. Natural Resource Report NPS/NRPC/NRR- 2010/209. Fort Collins, Colorado: U.S. Department of the Interior, National Park Service.

Logan, K.A., L.L. Irwin, and R. Skinner. 1986. Characteristics of a hunted mountain lion population in Wyoming. *Journal of Wildlife Management* 50:648–654.

Logan, K.A., and L.L. Sweanor. 2001. *Desert Puma: Evolutionary Ecology and Conservation of an Enduring Carnivore*. Washington, D.C.: Island Press.

Lohr, S., J.M. Hudson, M. Koski, and T.A. Whitesel. 2012. Fish and aquatic habitat surveys at Sheldon-Hart Mountain National Wildlife Refuge Complex. Unpublished report, U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Longshore, K. 2017. *Ecology and Conservation of Desert Bighorn Sheep*. Western Ecological Research Center. U.S. Geological Survey.

Lowry, J.H, Jr., R.D. Ramsey, K. Boykin, D. Bradford, P. Comer, S. Falzarano, W. Kepner, J. Kirby, L. Langs, J. Prior-Magee, G. Manis, L. O'Brien, T. Sajwaj, K.A. Thomas, W. Rieth, S. Schrader, D. Schrupp, K. Schulz, B. Thompson, C. Velasquez, C. Wallace, E. Waller, and B. Wolk. 2005. *The Southwest Regional GAP Analysis Project: Final Report on Land Cover Mapping Methods.* Logan, Utah: Remote Sensing/GIS Laboratory, Utah State University.

Mack, R.N. 1986. Alien plant invasions into the Intermountain West: a case history. In *Ecology of Biological Invasions in North America and Hawaii*, edited by H.A. Mooney and J. Drake, editors, pp. 192–213. New York, New York: Springer-Verlag.

Mack, R.N., and J.N. Thompson. 1982. Evolution in steppe with few large, hooved mammals. *American Naturalist* 119:757–773.

Martin, R.E., and C.H. Driver. 1983. Factors affecting antelope bitterbrush reestablishment following fire. In *Proceedings – Research and Management of Bitterbrush and Cliffrose in Western North America, 13–15 April 1982, Salt Lake City, Utah*, compiled by A.R. Tiedemann and K.L. Johnson, pp. 266–279. General Technical Report INT-152. Ogden, Utah: U.S. Forest Service, Intermountain Forest and Range Experimental Station.

Martin, R.E., and D.B. Sapsis. 1992. Fires as agents of biodiversity: pyrodiversity promotes biodiversity. In *Proceedings of the Symposium on Biodiversity of Northwestern California, 28–30 October 1991, Santa Rosa, California*, pp. 150–157. Berkeley: University of California, Division of Agriculture and Natural Resources, Wildland Resources Center.

Masters, R.A., and R.L. Sheley. 2001. Principles and practices for managing rangeland invasive plants. *Journal of Range Management* 54:502–517.

McArthur, E.D. 2000. Sagebrush systematics and distribution. In *Proceedings: Sagebrush Steppe Ecosystems Symposium, 21–23 June 1999, Boise State University, Idaho,* compiled by P.G. Entwistle, A.M. DeBolt, J.H. Kaltenecker, and K. Steenhof, pp. 9–14. U.S. Department of the Interior, Bureau of Land Management Publication BLM/ID/PT-001001+1150, Boise State Office, Idaho.

McArthur, E.D., and S.C. Sanderson. 1999. Ecotones: Introduction, scale, and big sagebrush example. In Proceedings: Shrubland Ecotones, 12–14 August 1998, Ephraim, Utah, compiled by E.D. McArthur, W.K. Ostler, W. Kent, and C.L. Wambolt, pp. 3–8. Proceedings RMRS-P-11. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

McCann, L.J. 1956. Ecology of mountain sheep. *American Midland Naturalist* 56:297–324.

McCarty, C.W., and M.W. Miller. 1998. *Modeling the Population Dynamics of Bighorn Sheep: A Synthesis of Literature*. Colorado Division of Wildlife Special Report No. 73. Denver, Colorado.

McCorquodale, S.M., K.J. Raedeke, and R.D. Taber. 1986. Elk habitat use patterns in the shrub-steppe of Washington. *Journal of Wildlife Management* 50:664–669.

Meeuwig, M.H., and S.P. Clements. 2015. *Temporal Variability in the Distribution and Abundance of a Desert Trout: Implications for Monitoring Design and Population Persistence in Dynamic Stream Environments*. Progress Reports 2015. Salem, Oregon: Oregon Department of Fish and Wildlife, Fish Division.

Messeier, F. 1994. Ungulate population models with predation: a case study with North American moose. *Ecology* 75:478–488.

Middleton, A.D., M.J. Kauffman, D.E. McWhirter, M.D. Jimenez, R.C. Cook, J.G. Cook, S.E. Albeke, H. Sawyer, and P J. White. 2013. Linking anti-predator behaviour to prey demography reveals limited risk effects of an actively hunting large carnivore. *Ecology Letters* 16:1023–1030.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson, and L.E. Eddleman. 2005. *Biology, ecology, and Management of Western Juniper* (Juniperus occidentalis). Technical Bulletin 152. Corvallis, Oregon: Oregon State University, Agricultural Experiment Station.

———. 2007. *Western Juniper Field Guide: Asking the Right Questions to Select Appropriate Management Actions*. U.S. Geological Survey Circular 132. Reston, Virginia: U.S. Geological Survey.

Miller, R.F., J.C. Chambers, L. Evers, C.J. Williams, K.A. Snyder, B.A. Roundy, and F.B. Pierson. 2019. *The Ecology, History, Ecohydrology, and Management of Pinyon and Juniper Woodlands in the Great Basin and Northern Colorado Plateau of the Western United States*. General Technical Report RMRS-GTR-403. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Miller, R.F., J.C. Chambers, and M. Pellant. 2014. *A Field Guide for Selecting the Most Appropriate Treatment in Sagebrush and Pinon-Juniper Ecosystems in the Great Basin.* General Technical Report RMRS-GTR-322-rev. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

———. 2015. *A Field Guide for Rapid Assessment of Post-wildfire Recovery Potential in Sagebrush and Piñon-Juniper Ecosystems in the Great Basin: Evaluating Resilience to Disturbance and Resistance to Invasive Annual Grasses and Predicting Vegetation Response*. General Technical Report RMRS-GTR-338. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Miller, R.F., J.C. Chambers, D.A. Pyke, F.B. Pierson, and C.J. Williams. 2013. *A Review of Fire Effects on Vegetation and Soils in the Great Basin region: RESPONSE and Ecological Site Characteristics*. General Technical Report RMRS-GTR-308. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Miller, R.F., S.T. Knick, D.A. Pyke, C.W. Meinke, S.E. Hanser, M.J. Wisdom, and A.L. Hild. 2011. Characteristics of sagebrush habitats and limitations to long-term conservation. In *Greater Sage-Grouse: Ecology and Conservation of a Landscape Species and its Habitats,* edited by S.T. Knick, and J.W. Connelly, pp. 145–184. *Studies in Avian Biology*, Volume 38.Berkeley: University of California Press.

Miller, R.F., and J.A. Rose. 1995. Historic expansion of *Juniperus occidentalis* (western juniper) in southeastern Oregon. *Great Basin Naturalist* 55:37–45.

———. 1999. Fire history and western juniper encroachment in sagebrush steppe. *Journal of Range Management* 52:550–559.

Miller, R.F., T.J. Svejcar, and J.A. Rose. 2000. Impacts of western juniper on plant community composition and structure. *Journal of Range Management* 53:574–585.

Miller, R.F., R.J. Tausch, E.D. McArthur, D.D. Johnson, and S.C. Sanderson. 2008. *Age Structure and Expansion of Piñon-Juniper Woodlands: A Regional Perspective in the Intermountain West*. Research Paper RMRS-RP-69. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Missoula Fire Sciences Laboratory (MFSL). 2012a. Fire Effects Information System (FEIS)., Information from LANDFIRE on fire regimes of Columbia Plateau grasslands and steppe communities. U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/CP_grass_steppe/all.html. Accessed November 4, 2020.

———. 2012b. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of mixed dwarf sagebrush communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/Mixed_dwarf_sagebrush/all.html. Accessed October 7, 2020.

———. 2012c. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of northern Rocky Mountain montane shrubland communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Northern_RM_shrub/all.html. Accessed November 4, 2020.

———. 2012d. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of Great Basin desert grassland communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/GB_desert_grass/all.html. Accessed November 4, 2020.

———. 2012e. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of northwestern high-elevation grassland communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/NW_high_elevation_grass/all.html. Accessed November 4, 2020.

———. 2012f. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of southern Rocky Mountain high-elevation grasslands. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Southern_RM_high_elevation_grass/all.html. Accessed November 4, 2020.

———. 2012g. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of southern Rocky Mountain ponderosa pine communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: http://www.fs.fed.us/database/feis/fire_regimes/Southern_RM_ponderosa_pine/all.html. Accessed February 7, 2021.

———. 2012h. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of mountain-mahogany communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Mountainmahogany/all.html. Accessed November 4, 2020.

———. 2012i. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of Great Basin quaking aspen communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/GB_quaking_aspen/all.html. Accessed November 4, 2020.

———. 2012j. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of northern Rocky Mountain quaking aspen communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/Northern_RM_quaking_aspen/all.html. Accessed November 4, 2020.

———. 2012k. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of southern Rocky Mountain quaking aspen communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/Southern_RM_quaking_aspen/all.html. Accessed November 4, 2020.

———. 2012l. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of greasewood shrubland communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Greasewood_shrub/all.html. Accessed November 4, 2020.

———. 2012m. Fire Effects Information System (FEIS). Information from LANDFIRE on fire regimes of saltbush shrubland communities. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: www.fs.fed.us/database/feis/fire_regimes/Saltbush_shrub/all.html. Accessed October 7, 2020.

Monteith, K.L., V.C. Bleich, T.R. Stephenson, B.M. Pierce, M.M. Conner, J.G. Kie, and R.T. Bowyer. 2014. Life-history characteristics of mule deer: effects of nutrition in a variable environment. *Wildlife Monographs* 186:1–62.

Mooring, M.S., T.A. Fitzpatrick, T.T. Nishihara, and D.D. Reisig. 2004. Vigilance, predation risk, and the allee effect in desert bighorn sheep. *Journal of Wildlife Management* 68:519–532.

Morgan, P., C.C. Hardy, T.W. Swetnam, M.G. Rollins, and D.G. Long. 2001. Mapping fire regimes across time and space: understanding coarse and fine-scale fire patterns. *International Journal of Wildland Fire* 10:329–342.

Morris, L.R., and R.J. Rowe. 2014. Historical land use and altered habitats in the Great Basin. *Journal of Mammalogy* 95:1144–1156.

Muir, J. 2018. Hart Mountain Bighorn Sheep Population Model. On file, Oregon Department of Fish and Wildlife, Lakeview, Oregon.

———. 2020. Personal communication concerning bighorn sheep movement between ranges near or on Hart Mountain National Antelope Refuge. Lakeview Oregon: Sheldon-Hart Mountain National Wildlife Refuge Complex.

Muir, J., and D. Whittaker, 2020. Personal communication concerning guzzler installation and operation on Hart Mountain NAR. Sheldon-Hart Mountain NWR Complex. Lakeview, Oregon.

Murphy, S.K., and J.L. Fryer. 2019. Fire Effects Information System (FEIS). Fire regimes of juniper communities in the Columbia and northern Great basins. Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/fire_regimes/Columbia_GB_juniper/all.html. Accessed October 7, 2020.

Murray, R.B. 1983. Response of bitterbrush to burning and spraying in southeastern Idaho. In *Proceedings – Research and Management of Bitterbrush and Cliffrose in Western North America, 13–15 April 1982, Salt Lake City, Utah,* compiled by A.R. Tiedemann and K.L. Johnson, pp. 142–152. General Technical Report INT-152. Ogden, Utah: U.S. Forest Service, Intermountain Forest and Range Experimental Station.

National Oceanic and Atmospheric Administration. 2020. Summary of Monthly Normals 1981–2010, Hart Mountain Refuge, OR US. Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals. Last accessed December 22, 2020.

National Wildfire Coordinating Group (NWCG). 2001. *Smoke Management Guide for Prescribed Fire*. PMS 420-2 NFES 1279.

The Nature Conservancy (TNC), U.S. Forest Service (USFS), and U.S. Department of the Interior (DOI). 2006. *LANDFIRE Vegetation Dynamics Modeling Manual*. Version 4.1. Boulder, Colorado: The Nature Conservancy. Available at: https://www.conservationgateway.org/ConservationPractices/FireLandscapes/LANDFIRE/Documents/Modeling_Manual_v4.1.2006.pdf. Accessed November 10, 2020.

NatureServe. 2020. NatureServe Explorer. Arlington, Virginia: NatureServe. Available at: https://explorer.natureserve.org/. Last accessed October 6, 2020.

North, M.P., and M.D. Hurteau. 2011. High-severity wildfire effects on carbon stocks and emissions in fuels treated and untreated forest. *Forest Ecology and Management* 261:1115–1120.

Norton, J.B., T.A. Monaco, J.M. Norton, D.A. Johnson, and T.A. Jones. 2004. Cheatgrass invasion alters soil morphology and organic matter dynamics in big sagebrush-steppe rangelands. In *Seed and Soil Dynamics in Shrubland Ecosystems: Proceedings, 12–16 August 2002, Laramie, Wyoming,* compiled by A.L. Hild, N.L. Shaw, S.E. Meyer, D.T. Booth, and E.D. McArthur, pp. 57–63. Proceedings RMRS-P-31. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

O'Shea, T.J., P.M. Cryan, and M.A. Bogan. 2018. United States bat species: a synthesis. *Proceedings of the California Academy of Sciences*, 28 September 2018, Series 4, Vol. 65, Supplement I. San Francisco, California.

Ohmart, R.D. 1996. Historical and present impacts of livestock grazing on fish and wildlife resources in western riparian habitats. In *Rangeland Wildlife*, edited by P.R. Krausman, pp. 246–274. Denver, Colorado: Society for Range Management.

Oldemeyer, J.L., W.J. Barmore, and D.L. Gilbert. 1971. Winter ecology of bighorn sheep in Yellowstone National Park. *Journal of Wildlife Management* 35:257–269.

Olson, B.E. 1999. Impacts of noxious weeds on ecologic and economic systems. In *Biology and Management of Noxious Rangeland Weeds*, edited by R.L. Sheley and J.K. Petroff, pp. 4–18. Corvallis: Oregon State University Press.

Olson, Z.H., D.G. Whittaker, and O.E. Rhodes, Jr. 2013. Translocation history and genetic diversity in reintroduced bighorn sheep. *Journal of Wildlife Management* 77:1553–1563.

Ordiz, A., R. Bischof, and J.E. Swenson. 2013. Saving large carnivores, but losing the apex predator? *Biological Conservation* 168:128–133.

Oregon Department of Environmental Quality (ODEQ). 2019. *Oregon Air Quality Annual Report: 2018*. Portland, Oregon: Oregon Department of Environmental Quality. Available at: https://oraqi.deq.state.or.us/Pagesfiles/2018AQAnnualReport.pdf. Accessed March 11, 2021.

———. 2020. *Oregon's 2018/2020 Integrated Report of Impaired Waters*. Portland, Oregon: Oregon Department of Environmental Quality. Available at: https://www.oregon.gov/deq/wq/Pages/epaApprovedIR.aspx. Accessed March 11, 2021.

Oregon Department of Fish and Wildlife (ODFW). 2003. *Oregon's Bighorn Sheep and Rocky Mountain Goat Management Plan*. Salem, Oregon: Oregon Department of Fish and Wildlife.

———. 2005a. *2005 Oregon Native Fish Status Report: Volume I: Species Management Unit Summaries*. Salem, Oregon: Oregon Department of Fish and Wildlife, Fish Division.

———. 2005b. *2005 Oregon Native Fish Status Report: Volume II: Assessment Methods and Population Results*. Salem, Oregon: Oregon Department of Fish and Wildlife, Fish Division.

———. 2011. *Greater Sage-Grouse Conservation Assessment and Strategy for Oregon: A Plan to Maintain and Enhance Populations and Habitat*. Salem, Oregon: Oregon Department of Fish and Wildlife.

———. 2015. *Malheur Lakes and Catlow Valley Redband Trout Conservation Plan*. Public Review Draft. May 12, 2015. Salem, Oregon: Oregon Department of Fish and Wildlife, Fish Division. Available at: https://www.dfw.state.or.us/fish/crp/docs/Public%20Draft%20MLCV%20Redband%20Cons%20Plan%205-11-15.pdf. Accessed March 11, 2021.

———. 2016. *Oregon Conservation Strategy*. Salem, Oregon: Oregon Department of Fish and Wildlife.

———. 2017. *Oregon Cougar Management Plan*. Salem, Oregon: Oregon Department of Fish and Wildlife.

———. 2020. Hart Mountain 2019 bighorn sheep capture progress report. Unpublished report, made to Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

———. 2021. Steens Mountain Cougar Target Area. Unpublished document and notes. On file, Oregon Department of Fish and Wildlife, Oregon.

Osterkamp, W.R., and W.W. Wood. 1987. Playa-lake basins on the Southern High Plains of Texas and New Mexico: part 1: hydrologic geomorphic, and geologic evidence for their development. *Geological Society of America Bulletin* 99:215–223.

Pallister, G.L. 1974. The seasonal distribution and range use of bighorn sheep in the Beartooth Mountains, with special reference to the West Rosebud and Stillwater herds. Thesis, Montana State University, Bozeman.

Payer, D.C. 1992. Habitat use and population characteristics of bighorn sheep on Hart Mountain National Antelope Refuge, Oregon. Thesis, Oregon State University, Corvallis.

Payer, D.C., and B.E. Coblentz. 1997. Seasonal variation in California bighorn ram habitat use and group size. *Northwest Science* 71:281–288.

Peek, J.M. 1980. Natural regulation of ungulates (what constitutes a real wilderness)? *Wildlife Society Bulletin* 8:217–227.

Peek, J.M., R.A. Riggs, and J.L. Lauer. 1979. Evaluation of fall burning on bighorn sheep winter range. *Journal of Range Management* 32:430–432.

Pierce, B.M., V.C. Bleich, and R.T. Bowyer. 2000. Social organization of mountain lions: does a land-tenure system regulate population size? *Ecology* 81:1533–1543.

Pilliod, D.S., J.L. Welty, and R.S. Arkle. 2017. Refining the cheatgrass-fire cycle in the Great Basin: precipitation timing and fine fuel composition predict wildfire trends. *Ecology and Evolution* 7:8126–8151.

Poessel, S.A., J.C. Hagar, P.K. Haggerty, and T.E. Katzner. 2020. Removal of cattle grazing correlates with increases in vegetation productivity and in abundance of imperiled breeding birds. *Biological Conservation* 241:1–9.

Prior-Magee, J., K. Thomas, D. Schrupp, D. Osborne, L. O'Brien, W. Kepner, D. Bradford, T. Sajwaj, K. Boykin, D. Ramsey, J. Lowry, and K. Schulz. 2005. Southwest regional GAP analysis project: land cover descriptions. Remote Sensing/GIS Laboratory, Utah State University, Logan.

Prugh, L.R., and S.M. Arthur. 2015. Optional predator management for mountain sheep conservation depends on the strength of mesopredator release. *Oikos* 124:1241–1250.

Raghavan, B., J. Bavananthasivam, A. Kugadas, G.J. Haldorson, and S. Srikumaran. 2017. Effect of vaccination against pneumonia on the survival of bighorn sheep commingled with carrier animals. *Veterinary Microbiology* 203:56–61.

Rau, B.M., R. Tausch, A. Reiner, D.W. Johnson, J.C. Chambers, and R.R. Blank. 2012. Developing a model framework for predicting effects of woody expansion and fire on ecosystem carbon and nitrogen in a pinyon–juniper woodland. *Journal of Arid Environments*, 76:97–104.

Reeves, C.C., Jr., and J.A. Reeves. 1996. The Ogallala Aquifer (of the Southern High Plains). Lubbock, Texas: Estacado Books.

Reid, M.S., K.A. Schulz, P.J. Comer, M.H. Schindel, D.R. Culver, D.A. Sarr, and M.C. Damm. 1999. An alliance level classification of vegetation of the coterminous western United States. Unpublished final report to the University of Idaho Cooperative Fish and Wildlife Research Unit and National Gap Analysis Program, Cooperative Agreement #1434-HQ-97-AG-01779. Boulder, Colorado: The Nature Conservancy, Western Conservation Science Department.

Reisner, M.D., J.B. Grace, D.A. Pyke, and P.S. Doescher. 2013. Conditions favouring *Bromus tectorum* dominance of endangered sagebrush steppe ecosystems. *Journal of Applied Ecology* 50:1039–1049.

Riggs, R.A., and J.M. Peek. 1980. Mountain sheep habitat-use patterns related to post-fire succession. *Journal of Wildlife Management* 44:933–938.

Risenhoover, K.L., and J.A. Bailey. 1980. Visibility: an important factor for an indigenous, low elevation bighorn herd in Colorado. In *Proceedings of the 2nd Biennial Symposium of the Northern Wild Sheep and Goat Council, 23–25 April 1980, Salmon, Idaho*, pp. 18–28.

———. 1985. Foraging ecology of mountain sheep: implications for habitat management. *Journal of Wildlife Management* 49:797–804.

Risenhoover, K.L., J.A. Bailey, and L.A. Wakelyn. 1988. Assessing the Rocky Mountain bighorn sheep management problem. *Journal of Wildlife Management* 16:346–352.

Robinette, W.L., J.S. Gashwiler, and O.W. Morris. 1961. Notes on cougar productivity and life history. *Journal of Mammalogy* 42:204–217.

Robinson, R.W. 2017. Space use, resource selection, and survival of reintroduced bighorn sheep. Dissertation, Brigham Young University, Provo, Utah.

Roemer, G.W., M.E. Gompper, and B. Van Valkenburgh. 2009. The ecological role of mammalian mesocarnivore. *BioScience* 59:165–173.

Rominger, E.M. 2018. The Gordian knot of mountain lion predation and bighorn sheep. *Journal of Wildlife Management* 82:19–31.

Rominger, E.M., H.A. Whitlaw, D.L. Weybright, W.C. Dunn, and W.B. Ballard. 2004. The influence of mountain lion predation on bighorn sheep translocations. *Journal of Wildlife Management* 68:993–999.

Rose, J., and R. Miller. 1998. Monitoring response of mountain big sagebrush and low sagebrush plant communities to burning: annual report from Badger and Catnip burns and Catnip Canyon low sagebrush site. Unpublished report, U.S. Department of Agriculture, Eastern Oregon Agricultural Research Center, Burns, Oregon.

Rosen, L.E., D.P. Walsh, L.L. Wolfe, C.L. Bedwell, and M.W. Miller. 2009. Effects of selenium supplementation and sample storage time on blood indices of selenium status in bighorn sheep. *Journal of Wildlife Diseases* 45:795–801.

Rosenstock, S.S., W.B. Ballard, and J.C. Devos, Jr. 1999. Viewpoint: benefits and impacts of wildlife water developments. *Journal of Range Management* 52:302–311.

Rosenstock, S.S., V.C. Bleich, M.J. Rabe, and C. Reggiardo. 2005. Water quality at wildlife water sources in the Sonoran Desert, United States. *Rangeland Ecology and Management* 58:623–627.

Rosentreter, R., and D.J. Eldridge. 2004. Monitoring rangeland health: using a biological soil crust stability index. In *Seed and Soil Dynamics in Shrubland Ecosystems: Proceedings, 12–16 August 2002, Laramie, Wyoming*, compiled by A.L. Hild, N.L. Shaw, S.E. Meyer, D.T. Booth, and E.D. McArthur, pp. 74–76. Proceedings RMRS-P-31. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Rosentreter, R., and R.G. Kelsey. 1991. Xeric big sagebrush, a new subspecies in the Artemisia tridentata complex. *Journal of Range Management* 44:330–335.

Ross, P.I., M.G. Galkotzky, and M. Festa-Bianchet. 1997. Cougar predation on bighorn sheep in southwestern Alberta during winter. *Canadian Journal of Zoology* 74:771–775.

Ruhl, C.Q., and E.M. Rominger. 2015. Status of desert sheep in New Mexico, 2013–2014. In *Desert Bighorn Council 2015 Transactions. 14–17 April 2015, Borrego Springs, California*, pp. 45–48.

Sage Grouse Initiative (SGI). 2017. Resource map webpage. Available at: https://map.sagegrouse initiative.com/ecosystem/tree-cover. Last accessed September 30, 2020.

Salafsky, N., J. Boshoven, Z. Burivalova, N. Dubois, A. Gomez, A. Johnson, A. Lee, R. Margoulis, J. Morrison, M. Muir, S. Pratt, A. Pullin, D. Salzer, A. Stewart, W.J. Sutherland, and C.F.R. Wordley. 2019. Defining and using evidence in conservation practice. *Conservation Science and Practice* 5(1):e27.

Salwasser, H. 1979. The ecology and management of the Devil’s Garden interstate deer herd and its range. Dissertation, University of California, Berkeley.

Sappington, J.M., K.M. Longshore, and D.B. Thompson. 2007. Quantifying landscape ruggedness for animal habitat analysis: a case study using bighorn sheep in the Mojave Desert. *Journal of Wildlife Management* 71:1419–1426.

Sapsis, D.B. 1990. Ecological effects of spring and fall prescribed burning on basin big sagebrush/Idaho fescue—bluebunch wheatgrass communities. Thesis, Oregon State University, Corvallis.

Sawyer, H., and F. Lindzey. 2002. *A Review of Predation on Bighorn Sheep*. Laramie, Wyoming: Wyoming Fish and Wildlife Cooperative Research Unit.

Sawyer, H., F. Lindzey, and D. McWhirter. 2005. Mule deer and pronghorn migration in western Wyoming. *Wildlife Society Bulletin* 33:1266–1273.

Schaefer, R.J., S.G. Torres, and V.C. Bleich. 2000. Survivorship and cause-specific mortality in sympatric populations of mountain sheep and mule deer. *California Fish and Game* 86:127–135.

Schier, G.A. 1975. *Deterioration of Aspen Clones in the Middle Rocky Mountains*. Research Paper INT-170. Ogden, Utah: U.S. Forest Service, Intermountain Forest and Range Experiment Station.

Schirokauer, D. 1996. The effects of 55 years of vegetative change on bighorn sheep habitat in the Sun River area of Montana. Thesis, University of Montana, Missoula.

Seidensticker, J.C., M.G. Hornocker, W.V. Wiles, and J.P. Messick. 1973. Mountain lion social organization in the Idaho Primitive Area. *Wildlife Monographs* 35:3–60.

Serrouya, R., S. Gilbert, R.S. McNay, B.N. McLellan, D.C. Heard, D.R. Seip, and S. Boutin. 2017. Comparing population growth rates between census and recruitment-mortality models. *Journal of Wildlife Management* 81:297–305.

Shackleton, D.M., C.C. Shank, and B.M. Wikeem. 1999. Natural history of Rocky Mountain and California bighorn sheep. In *Mountain Sheep of North America*, edited by, R. Valdez, and P.R. Krausman, pp. 78–138. Tucson: University of Arizona Press.

Shannon, N.H., R.J. Hudson, V.C. Brink, and W.D. Kitts. 1975. Determinants of spatial distribution of Rocky Mountain bighorn sheep. *Journal of Wildlife Management* 39:387–401.

Sharp, J.M., Jr. 2007. *A Glossary of Hydrological Terms*. Austin: University of Texas, Jackson School of Geosciences, Department of Geological Sciences.

Shaver, F.A., A.P. Rose, R.F. Steele, and A.E. Adams. 1905. *An Illustrated History of Central Oregon: Embracing Wasco, Sherman, Gilliam, Wheeler, Crook, Lake and Klamath Counties, State of Oregon*. Spokane, Washington: Western Historical Publishing Company.

Shillinger, J.E. 1937. Disease relationship of domestic stock and wildlife. In *Transactions of the Second North American Wildlife Conference,* pp. 298–302. St. Louis, Missouri.

Sikes, R.S., and the Animal Care and Use Committee of the American Society of Mammalogists. 2016. 2016 guidelines of the American Society of Mammalogists for the use of wild mammals in research and education. *Journal of Mammalogy* 3(97):663–688.

Simpson, N.O., K.M. Stewart, and V.C. Bleich. 2011. What have we learned about water developments for wildlife? Not enough! *California Fish and Game* 97:190–209.

Sinclair, A.R.E., and C.J. Krebs. 2002. Complex numerical responses to top-down and bottom-up processes in vertebrate populations. *Philosophical Transactions of the Royal Society* 357:1221–1231.

Sinclair, A.R.E., R.P. Pech, C.R. Dickman, D. Hik, P. Mahon, and A. E. Newsome. 1998. Predicting effects of predation on conservation of endangered prey. *Conservation Biology* 12:564–575.

Singer, F.J., C.M. Papouchis, and K.K. Symonds. 2000. Translocations as a tool for restoring populations of bighorn sheep. *Restoration Ecology* 8:6–13.

Sittler, K.L., K.L. Parker, and M.P. Gillingham. 2019. Vegetation and prescribed fire: implications for Stone's sheep and elk. *Journal of Wildlife Management* 83:393–409.

Smith, T.S., J.T. Flinders, and D.S. Winn. 1991. A habitat evaluation procedure for Rocky Mountain bighorn sheep in the intermountain west. *Great Basin Naturalist* 51:205–225.

Smith, T.S., P.J. Hardin, and J.T. Flinders. 1999. Response of bighorn sheep to clear-cut logging and prescribed burning. *Wildlife Society Bulletin* 27:840–845.

Snyder, K.A., L. Evers, J.C. Chambers, J. Dunham, J.B. Bradford, and M.E. Loik. 2019. Effects of changing climate on the hydrological cycle in cold desert ecosystems of the Great Basin and Columbia Plateau. *Rangeland Ecology and Management* 72:1–12.

Soulard, C.E., and M. Rigge. 2020. Application of empirical land-cover changes to construct climate change scenarios in federally managed lands. *Remote Sensing* 12:Article 2360.

Spitz, D.B., D.A. Clark, M.J. Wisdom, M.M. Rowland, B.K. Johnson, R.A. Long, and T. Levi. 2018. Fire history influences large-herbivore behavior at circadian, seasonal, and successional scales. *Ecological Applications* 28:2082–2091.

Stebbins, G.L. 1981. Coevolution of grasses and herbivores. *Annals of the Missouri Botanical Garden* 68:75–86.

Steinberg, P.D. 2002. Fire Effects Information System (FEIS). Artemisia arbuscula, low sagebrush (species information webpage). Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/shrub/artarb/all.html. Accessed October 7, 2020.

Stewart, G., and A.C. Hull. 1949. Cheatgrass (*Bromus tectorum* L.) – an ecological intruder in southern Idaho. *Ecology* 30:58–74.

Stine, P., P. Hessburg, T. Spies, M. Kramer, C.J. Fettig, A. Hansen, J. Lehmkuhl, K. O'Hara, K. Polivka, P. Singleton, S. Charnley, A. Merschel, and R. White. 2014. *The Ecology and Management of Moist Mixed-Conifer Forests in Eastern Oregon and Washington: A Synthesis of the Relevant Biophysical Science and Implications for Future Land Management*. General Technical Report PNW-GTR-897. Portland, Oregon: U.S. Forest Service, Pacific Northwest Research Station.

Suring, L.H., M.M. Rowland, M.J. Wisdom, L. Schueck, and C.W. Meinke. 2005a. Vegetation communities. In *Habitat Threats in the Sagebrush Ecosystem: Methods of Regional Assessment and Applications in the Great Basin*, edited by M.J. Wisdom, M.M. Rowland, and L.H. Suring, pp. 94–113. Lawrence, Kansas: Alliance Communications Group.

Suring, L.H., M.J. Wisdom, R J. Tausch, R.F. Miller, M.M. Rowland, L. Schueck, and C.W. Meinke. 2005b. Modeling threats to sagebrush and other shrubland communities. In *Habitat Threats in the Sagebrush Ecosystem: Methods of Regional Assessment and Applications in the Great Basin*, edited by M.J. Wisdom, M.M. Rowland, and L.H. Suring, pp. 114–149. Lawrence, Kansas: Alliance Communications Group.

Sweanor, L.L., K.A. Logan, and M.G. Hornocker. 2000. Cougar dispersal patterns, metapopulation dynamics, and conservation. *Conservation Biology* 14:798–808.

Sweanor, P.Y., M. Gudorf, and F.J. Singer. 1996. Application of a GIS-based bighorn sheep habitat model in Rocky Mountain region national parks. In *Proceedings of the 10th Biennial Symposium of the Northern Wild Sheep and Goat Council, 29 April–3 May 1996, Silverthorne, Colorado*, pp. 118–125.

Tagestad, J.D. 2010. *Analysis and Mapping of Vegetation and Habitat for the Hart Mountain National Antelope Refuge*. PNNL-19437. Richland, Washington: Pacific Northwest National Laboratory.

Tanner, J.T. 1975. The stability and the intrinsic growth rates of prey and predator populations. *Ecology* 56:855–867.

Temple, S.A., and J.A. Wiens. 1989. Bird populations and environmental changes: can birds be bio-indicators? *American Birds* 43:260–270.

Theberge, J.B., and D.A. Gauthier. 1985. Models of wolf-ungulate relationships: when is wolf control justified? *Wildlife Society Bulletin* 13:449–458.

Thorson, T.D., S.A. Bryce, D.A. Lammers, A.J. Woods, J.M. Omernik, J. Kagan, D.E. Pater, and J. Comstock. 2003. Ecoregions of Oregon (map poster). Scale 1:1,350,000. Reston, Virginia: U.S. Geological Survey.

Tilton, M.E., and E.E. Willard. 1982. Winter habitat selection by mountain sheep. *Journal of Wildlife Management* 46:359–366.

Tirmenstein, D. 1999. Fire Effects Information System (FEIS), Artemisia tridentata subsp. tridentata, basin big sagebrush (species information webpage). Missoula, Montana: U.S. Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory. Available at: https://www.fs.fed.us/database/feis/plants/shrub/arttrit/all.html. Accessed October 7, 2020.

Trombulak, S.C., and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. *Conservation Biology* 14:18–30.

Turner, J.C., and R.A. Weaver. 1980. Water. In *The Desert Bighorn, its Life History, Ecology, and Management*, edited by G. Monson and L. Sumner, pp. 100–112. Tucson: University of Arizona Press.

U.S. Department of Agriculture (USDA). 2015. *Wildlife Services Directive 3.101 – Interfacing with Business and Establishing Cooperative Programs*.

U.S. Department of Commerce Census Bureau. 2019. QuickFacts Census Available at: https://www.census.gov/quickfacts/fact/table/US/PST045219. Last accessed December 22, 2020.

U.S. Environmental Protection Agency (EPA). 2020. Ecoregion information, maps, and GIS data. Corvallis, Oregon: U.S. Environmental Protection Agency, Western Ecology Division. Available at: https://www.epa.gov/eco-research/ecoregions. Accessed December 21, 2020.

———. 2021a. Enforcement and Compliance History Online (ECHO), Facility Search – Enforcement and Compliance Data. Available at: https://echo.epa.gov/facilities/facility-search. Accessed March 11, 2021.

———. 2021b. Greenhouse Gas Equivalencies Calculator. Available at: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator. Accessed July 2021.

U.S. Fish and Wildlife Service (Service). 1995. *Lahontan Cutthroat Trout* (Oncorhynchus clarki henshawi) *Recovery Plan*. Portland, Oregon: U.S. Fish and Wildlife Service, Region 1 (Pacific Region).

———. 2009. *Limiting Mountain Lion Predation on Desert Bighorn Sheep on the Kofa National Wildlife Refuge Final Environmental Assessment.*

———. 2014. *NEPA for National Wildlife Refuges: A Handbook*. U.S. Fish and Wildlife Service.

———. 2015. *Sheldon-Hart Mountain National Wildlife Refuge Complex Wildland Fire Management Plan*. Unpublished, reviewed annually, and amended, as necessary. Lakeview, Oregon: U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex.

———. 2016. *Region 1: U.S. Fish and Wildlife Service Pacific Region Policy on Minimizing the Introduction of Invasive Species by Service Activities*. Available at: https://ecos.fws.gov/ServCat/Reference/Profile/105555. Accessed January 2, 2021.

———. 2019a. Hart Mountain golden eagle nest data from Frank Isaacs. Lakeview, Oregon: Sheldon-Hart Mountain NWR Complex.

———. 2019b. *The Economic Contributions of Recreational Visitation at Hart Mountain National Antelope Refuge*. Falls Church, Virginia: U.S. Fish and Wildlife Service, Division of Economics.

———. 2020a. Hart Mountain bighorn sheep files. Lakeview, Oregon: Sheldon-Hart Mountain NWR Complex.

———. 2020b. Hart Mountain bighorn sheep capture study files. Lakeview, Oregon: Sheldon-Hart Mountain NWR Complex.

U.S. Fish and Wildlife Service (Service) and Utah State University (USU). 2018. Invasive plant inventory and early detection prioritization tool. Version 4.0. Sacramento, California: U.S. Fish and Wildlife Service, National Wildlife Refuge System, Pacific Southwest Region, Inventory and Monitoring Program. February.

U.S. Geological Survey (USGS). 2019. *Interim Spring Study Report at Hart Mountain NAR*. Lakeview, Oregon: Hart Mountain National Antelope Refuge.

———. 2020. Letter on Hart Mountain bighorn sheep health screenings. Unpublished report, made to Sheldon-Hart Mountain National Wildlife Refuge Complex, Lakeview, Oregon.

U.S. National Vegetation Classification (USNVC). 2019. United States National Vegetation Classification Database. Version 2.03. Washington, D.C.: Federal Geographic Data Committee, Vegetation Subcommittee. Available at: http://usnvc.org/explore-classification/. Last accessed October 6, 2020.

Van Auken, O.W. 2000. Shrub invasions of North American semiarid grasslands. *Annual Review of Ecology and Systematics* 31:197–215.

Van Dyke, W.A. 1978. Population characteristics and habitat utilization of bighorn sheep, Steens Mountain, Oregon. Thesis, Oregon State University, Corvallis.

Van Dyke, W.A., A. Sands, J. Yoakum, A. Polenz, and J. Blaisdell. 1983. *Wildlife Habitats in Managed Rangelands—the Great Basin of Southeastern Oregon—Bighorn Sheep*. General Technical Report PNW-GTR-159. Portland, Oregon: U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station.

Villapique, J.T., B.M. Pierce, V.C. Bleich, and R.T. Bowyer. 2011. Diet of Cougars following a decline in a population of mule deer: lack of evidence for switching prey. *Southwestern Naturalist* 56:187–192.

Voget, K. 1983. *Status Report: California Bighorn Sheep on Hart Mountain National Antelope Refuge, Oregon*. Lakeview, Oregon: U.S. Fish and Wildlife Service.

Vucetich, J.A., D.W. Smith, and D.R. Stahler. 2005. Influence of harvest, climate and wolf predation on Yellowstone elk, 1961–2004. *Oikos* 111:259–270.

Wagner, G.D., and J.M. Peek. 2006. Bighorn sheep diet selection and forage quality in central Idaho. *Northwest Science* 80:246–258.

Waichler, W.S., R.F. Miller, and P.S. Doescher. 2001. Community characteristics of old-growth western juniper woodlands. *Journal of Range Management* 54:518–527.

Wakelyn, L.A. 1987. Changing habitat conditions on bighorn sheep ranges in Colorado. *Journal of Wildlife Management* 51:904–912.

Wall, T.G., R.F. Miller, and T.J. Svejcar. 2001. Juniper encroachment into aspen in the northwest Great Basin. *Journal of Range Management* 54:691–698.

Walsh, D.P, G.C. White, T.E. Remington, and D.C. Bowden. 2004. Evaluation of the lek-count index for greater sage-grouse. *Wildlife Society Bulletin* 32:56–68.

Ward, J.P., and S.H. Anderson. 1988. Influences of cliffs on wildlife communities in southcentral Wyoming. *Journal of Wildlife Management* 52:673–678.

Wehausen, J.D. 1996. Effect of mountain lion predation on bighorn sheep in the Sierra Nevada and Granite Mountains of California. *Wildlife Society Bulletin* 24:471–479.

Wehausen, J.D., and R.R. Ramey II. 2000. Cranial morphometric and evolutionary relationships in the northern range of *Ovis canadensis*. *Journal of Mammalogy* 81:145–161.

Wehausen, J.D., R.R. Ramey II, and S.T. Kelley. 2011. Domestic sheep, bighorn sheep, and respiratory disease: a review of experimental evidence. *California Fish and Game* 97(1):7–24.

Weller, T.J., P.M. Cryan, and T.T. O'Shea. 2009. Broadening the focus of bat conservation and research in the USA for the 21st century. *Endangered Species Research* 8:129–145.

West, N.E. 1979. Basic synecological relationships of sagebrush-dominated lands in the Great Basin and the Colorado Plateau. In *The Sagebrush Ecosystem: A Symposium*, April 1978, pp. 33–41. Logan: Utah State University.

———. 1983. Great Basin–Colorado Plateau sagebrush semi-desert and Western intermountain sagebrush steppe. In *Ecosystems of the World: Temperate Deserts and Semi-deserts*, edited by N.E. West, pp. 331–374. Volume 5. Amsterdam, Netherlands: Elsevier Science.

———. 2000. Synecology and disturbance regimes of sagebrush steppe ecosystems. In *Proceedings: Sagebrush Steppe Ecosystem Symposium*, compiled and edited by P.G. Entwistle, A.M. DeBolt, J.H. Kaltenecker, and K. Steenhof, pp. 15–26. Boise, Idaho: U.S. Department of the Interior, Bureau of Land Management.

West, N.E., and J.A. Young. 2000. Intermountain valleys and lower mountain slopes. In *North American Terrestrial Vegetation*, edited by M.G. Barbour and W.D. Billings, pp. 255–284. 2nd ed. Cambridge, United Kingdom: Cambridge University Press.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 313:940–943.

Wheaton, J.M., S.N. Bennett, N. Bouwes, J.D. Maestas, and S.M. Shahverdian. 2019. Low-tech process-based restoration of riverscapes: design manual. Version 1.0. Logan, Utah: Utah State University Restoration Consortium.

White, G.C., and K.P. Burnam. 1999. Program MARK: survival estimation from populations of marked animals. *Bird Study* 46 (supplement):S120-S139.

White, G.C., and B.C. Lubow. 2002. Fitting population models to multiple sources of observed data. *Journal of Wildlife Management* 66:300–309.

White, H.B., E. Boggess, C. Brown, J. Butfiloski, T. Decker, J. Erb, M. Fall, D. Hamilton, T. Hiller, G. Hubert Jr., M. Lovallo, J. Olson, and N. Roberts. 2021. Best management practices for trapping furbearers in the United States. *Wildlife Monographs* 1(207):3–59.

White, H.B., T. Decker, M.J. O'Brien, J.F. Organ, and N.M. Roberts. 2015. Trapping and furbearer management in North American wildlife conservation. International Journal of Environmental Studies 5(72):756–769.

White, P.J., T.L. Davies, K.K. Barnowe-Meyer, R.L. Crabtree, and R.A. Garrott. 2007. Partial migration and philopatry of Yellowstone pronghorn. *Biological Conservation* 135:502–510.

White, P.J., and R.A. Garrott. 2005. Northern Yellowstone elk after wolf restoration. *Wildlife Society Bulletin* 33:942–955.

Whiting, J.C., V.C. Bleich, R.T. Bowyer, and R.T. Larsen. 2012. Chapter 4: Water availability and bighorn sheep: life-history characteristics and persistence of populations. In *Advances in Environmental Research*, edited by J.A. Daniels, pp. 127–158. Vol 21. New York, New York: Nova Science Publishers, Inc.

Whiting, J.C., R.T. Bowyer, and J.T. Flinders. 2009a. Annual use of water sources by reintroduced Rocky Mountain bighorn sheep *Ovis canadensis*: effects of season and drought. *Acta Theriologica* 54:127–136.

———. 2009b. Diel use of water by reintroduced bighorn sheep. *Western North American Naturalist* 69:407–412.

Whittaker, D.G., S.D. Ostermann, and W.M. Boyce. 2004. Genetic variability of reintroduced California bighorn sheep in Oregon. *Journal of Wildlife Management* 68:850–859.

Weise, Christa, Ph.D. 2021. Former Refuge Manager, Kofa National Wildlife Refuge. Personal communication on the *Environmental Assessment Limiting Mountain Lion Predation on Desert Bighorn Sheep on the Kofa National Wildlife Refuge* and the success of the project.

Wielgus, R.B., D.E. Morrison, H.S. Cooley, and B. Maletzke. 2013. Effects of male trophy hunting on female carnivore population growth and persistence. *Biological Conservation* 167:69–75.

Wilckens, D.T., J.B. Smith, S.A. Tucker, D.J. Thompson, and J.A. Jenks. 2016. Mountain lion feeding behavior in the Missouri Badlands of North Dakota. *Journal of Mammalogy* 92:373–385.

Wild Sheep Working Group (WSWG). 2012. Recommendations for domestic sheep and goat management in wild sheep habitat. Boise, Idaho: Western Association of Fish and Wildlife Agencies. Available at: https://wafwa.org/wpdm-package/recommendations-for-domestic-sheep-and-goat-management-in-wild-sheep-habitat-2/. Accessed January 17, 2021.

Wildlife Action Plan Team. 2013. Nevada Wildlife Action Plan. Reno, Nevada: Nevada Department of Wildlife. Available at: http://www.ndow.org/Nevada_Wildlife/Conservation/Nevada_Wildlife_Action_Plan/. Accessed February 11, 2021.

The Wildlife Society. 2020. TWS and AAWV joint issue statement: domestic sheep and goats disease transmission risk to wild sheep. Available at: https://wildlife.org/tws-and-aawv-joint-issue-statement-domestic-sheep-and-goats-disease-transmission-risk-to-wild-sheep/. Accessed August 2, 2021.

Williams, B.K., R.C. Szaro, and C.D. Shaprio. 2009. Adaptive Management: The U.S. Department of Interior Technical Guide. Washington D.C.: U.S. Department of the Interior.

Williams, J.E., and C.E. Bond. 1981. A new subspecies of Tui chub (Osteichthyes: Cyprinidae) from Guano Basin, Nevada and Oregon. *Southwestern Naturalist* 26:223–230.

Wilson, B.R. 2014. Evaluating the effects of wildfire in piñon-juniper woodlands on bighorn sheep habitat and vegetation composition. Thesis, Colorado State University, Fort Collins.

Wilson, L.O. 1968. Distribution and ecology of the desert bighorn sheep in southeastern Utah. Thesis, Utah State University, Logan.

Wilson, L.O., J. Blaisdell, G. Welsh, R. Weaver, R. Brigham, W. Kelly, J. Yoakum, M. Hinks, J. Turner, and J. DeForge. 1980. Desert bighorn habitat requirements and management recommendations. In *Desert Bighorn Council 1980 Transactions. 9–11 April 1980, St. George, Utah*, pp. 1–7.

Wilson, W.E., and J.E. Moore, eds. 1998. *Glossary of Hydrology*. Alexandria, Virginia: American Geological Institute.

Winward, A.H. 1991. A renewed commitment to management of sagebrush grasslands. In *Management in the Sagebrush-Steppe*, pp. 2–7. Special Report 880. Corvallis, Oregon: Oregon State University, Agricultural Experiment Station.

Wright, Clinton S. 2015. Piled fuels biomass and emissions calculator. U.S. Forest Service, Pacific Northwest Research Station. Portland, Oregon. Available at: https://depts.washington.edu/nwfire/piles/. Accessed August 4, 2021.

Wright, G.J., R.O. Peterson, D.W. Smith, and T.O. Lemke. 2006. Selection of northern Yellowstone elk by gray wolves and hunters. *Journal of Wildlife Management* 70:1070–1078.

Wright, J.M., and J.C. Chambers. 2002. Restoring riparian meadows currently dominated by Artemisia using alternative state concepts—above-ground vegetation response. *Applied Vegetation Science* 5:237–246.

Yenson, D.L. 1981. The 1900 invasion of alien plants into southern Idaho. *Great Basin Naturalist* 41:176–183.

Young, J.A., R.A. Evans, and J. Major. 1972. Alien plants in the Great Basin. *Journal of Range Management* 25:194–201.

Zeedyk, B., and V. Clothier. 2009. *Let the Water do the Work: Induced Meandering, an Evolving Method for Restoring Incised Channels.* Santa Fe, New Mexico: Quivira Coalition; and White River Junction, Vermont: Chelsea Green Publishing.

Zeigenfuss, L.C., F.J. Singer, M.A. Gudorf. 2000. Test of a modified habitat suitability model for bighorn sheep. *Restoration Ecology* 8:38–46.

Zouhar, K. 2003. Fire Effects Information System (FEIS). Bromus tectorum. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available at: https://www.fs.fed.us/database/feis/plants/graminoid/brotec/all.html. Accessed October 27, 2020.

Zouhar, K., J.K. Smith, S. Sutherland, and M.L. Brooks. 2008. *Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants*. General Technical Report RMRS-GTR-42-volume 6. Ogden, Utah: U.S. Forest Service, Rocky Mountain Research Station.

APPENDIX B

Relevant Federal and State Laws

Relevant Federal and State Laws

The following Federal and State laws are relevant to the actions considered in this EIS:

National Wildlife Refuge System Administration Act

The U.S. Fish and Wildlife Service, an agency within the Department of Interior, is the principal Federal agency responsible for conserving, protecting, and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Service manages the 95- million-acre National Wildlife Refuge System, which encompasses 568 national wildlife refuges.

Refuges are guided by various Federal laws and executive orders, Service policies, and international treaties. Fundamental are the mission and goals of the National Wildlife Refuge System (NWRS or Refuge System) and the designated purposes of the refuge unit as described in establishing legislation, executive orders, or other documents establishing, authorizing, or expanding a refuge. The purpose(s) for which a refuge was established represents its highest priority for resource management and conservation in addition to fulfilling the Refuge System Mission. The purpose(s) must form the basis for planning and management decisions on units of the NWRS. In accordance with the NWRSAA, as amended, "The purposes of a refuge are specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit."

Key concepts and guidance of the Refuge System derive from the National Wildlife Refuge System Administration Act of 1966 as amended (16 U.S.C. 668dd-668ee), the Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4), as amended, Title 50 of the Code of Federal Regulations, and the Fish and Wildlife Service Manual. The National Wildlife Refuge System Administration Act is implemented through regulations covering the National Wildlife Refuge System, published in Title 50, subchapter C of the Code of Federal Regulations. These regulations govern general administration of units of the Refuge System.

National Wildlife Refuge System Improvement Act

The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57) amends the National Wildlife Refuge System Administration Act of 1966 in a manner that provides an "Organic Act" for the Refuge System.

It was passed to ensure that the Refuge System is managed as a national system of related lands, waters, and interests for the protection and conservation of our Nation's wildlife resources. The only system of Federal lands devoted specifically to wildlife, the National Wildlife Refuge System is a network of diverse and strategically located habitats.

The passage of this Act gave guidance to the Secretary of the Interior for the overall management of the Refuge System. The Act's main components include:

- a strong and singular wildlife conservation Mission for the Refuge System;

- a requirement that the Secretary of the Interior maintain the biological integrity, diversity and environmental health of the Refuge System;
- a new process for determining compatible uses on refuges;
- a recognition that wildlife-dependent recreational uses involving hunting, fishing, wildlife observation and photography, and environmental education and interpretation, when determined to be compatible, are legitimate and appropriate public uses of the Refuge System;
- that these compatible wildlife-dependent recreational uses are the priority general public uses of the Refuge System; and
- a requirement for preparing a comprehensive conservation plan for each refuge.

U.S. Fish and Wildlife Service Mission

The mission of the Service is "working with others, to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people." National natural resources entrusted to the Service for conservation and protection include migratory birds, endangered and threatened species, inter-jurisdictional fish, wetlands, and certain marine mammals. The Service also manages national fish hatcheries, enforces Federal wildlife laws and international treaties on importing and exporting wildlife, assists with state fish and wildlife programs, and helps other countries develop wildlife conservation programs.

National Wildlife Refuge System

The National Wildlife Refuge System is the world's largest network of public lands and waters set aside specifically for conserving wildlife and protecting ecosystems. From its inception in 1903, the Refuge System has grown to encompass 568 national wildlife refuges in all 50 states, and waterfowl production areas in 10 states, covering more than 95 million acres of public lands.

The mission of the Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans" (National Wildlife Refuge System Administration Act of 1966, as amended)(16 U.S.C. 668dd-668ee).

Wildlife conservation is the fundamental mission of the Refuge System. The goals of the National Wildlife Refuge System, as articulated in the Mission Goals and Purposes Policy (601 FW 1) are to:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and inter-jurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.

- Conserve those ecosystems, plant communities, wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

The NWRSAA, as amended, also legally mandates the maintenance, and where feasible, restoration of biological integrity, diversity, and environmental health (biological integrity) on the established refuge within the NWRS. Biological integrity essentially equates to native fish, wildlife, plants, and the processes that support them (601 FW 3).

Fish and Wildlife Coordination Act

The Act of March 10, 1934, authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with Federal and State agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.

National Environmental Policy Act (NEPA).

NEPA requires that Federal actions be evaluated for environmental impacts, that these impacts be considered by the decision maker(s) prior to implementation, and that the public be informed. This EIS has been prepared in compliance with NEPA (42 USC Section 4231, et seq.,); the President's CEQ Regulations, (40 CFR Section 1500 – 1508); Executive Order 13807; and Secretarial Order 3355.

Animal Damage Control Act

Animal Damage Control Act of March 2, 1931, (46 Stat. 1468) provided broad authority for investigation, demonstrations and control of mammalian predators, rodents and birds. Public Law 99-19, approved December 19, 1985, (99 Stat 1185) transferred administration of the Act from the Secretary of the Interior to the Secretary of Agriculture. Pub. L. 102-190(Div. A, title III, Sec. 348, Dec. 5, 1991, 105 Stat. 1348).

The Animal Damage Control Act of March 2, 1931 (46 Stat. 1468; 7 U.S.C. 8351-352) states:

"The Secretary of Agriculture may conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program….

The Act was amended in 1987 (Act of December 22, 1987 (101 Stat. 1329-331, 7 U.S.C. 8353) to further provide:

On or after December 22, 1987, the Secretary of Agriculture is authorized, except for urban rodent control, to conduct activities and to enter into agreements with state, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under such agreement into the appropriation accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities."

United States Department of Agriculture – Animal and Plant Health Inspection Service - Wildlife Services provides federal professional leadership and expertise to resolve wildlife conflicts to help create a balance that allows people and wildlife to coexist. Wildlife Services applies and recommends a cohesive integrated approach, which incorporates biological, economic, environmental, legal and other information into a transparent wildlife damage management decision-making process, and includes many methods for managing wildlife damage, including non-lethal and lethal options. The agency is funded by Congressional appropriations and by funds provided by governmental, commercial, private, and other entities that enter into an agreement with Wildlife Services for assistance.

Migratory Bird Treaty Act.

The Migratory Bird Treaty Act provides the Service regulatory authority to protect species of birds that migrate outside the United States. All cooperating agencies coordinate with the Service on migratory bird issues.

Migratory birds would not be affected by this proposal except in an unlikely event of non-target capture or lead poisoning from scavenging on predators shot with lead containing ammunition. Any impact on a migratory bird would be reported to the Service, Migratory Bird Management Office.

National Historic Preservation Act (NHPA) of 1966, as amended.

The NHPA requires Federal agencies to: 1) evaluate the effects of any Federal undertaking on cultural resources, 2) consult with the State Historic Preservation Office regarding the value and management of specific cultural, archaeological and historic resources, and 3) consult with appropriate American Indian tribes to determine whether they have concerns for traditional cultural resources in areas of these Federal undertakings. Actions associated with juniper management would be evaluated under the NHPA.

Wilderness Act of 1964

Congress passed the 1964 Wilderness Act in order to preserve and protect certain lands "in their natural condition" and thus "secure for present and future generations the benefits of wilderness.". The Act recognized the value of preserving "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Congress therefore directed that designated wilderness areas "shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."

In 1972 the President proposed that Congress designate 16,462 acres of Poker Jim Ridge as a Wilderness Area under the 1964 Wilderness Act. This proposal has never been acted upon, but it is Service policy that all proposed wilderness areas, including the Poker Jim Ridge Proposed Wilderness Area be managed consistent with policy and guidance for designated wilderness until further action is taken by Congress. Generally, activities that conflict with wilderness values, such as permanent artificial structures and roads, use of mechanized tools and equipment, and commercial uses are prohibited in wilderness areas unless there is an approved Minimum Requirements Analysis (MRA) decision authorizing a specific action.

Relevant State Laws and Regulations

ODFW - Wildlife Policy (ORS 496.012). It is the policy of the State of Oregon that wildlife be managed to prevent serious depletion of any indigenous species and to provide the optimum recreational and aesthetic benefits for present and future generations of the State. Included in this wildlife policy is maintaining all species of wildlife at optimum levels.

Measure 18 of 1994 and ORS 498.164. A 1994 ballot measure (Measure 18) eliminated the public use of dogs for cougar hunting. However, Measure 18 specifically maintained provisions that allow employees of county, state, and federal agencies to use dogs while acting in their official capacities.

ODFW Cougar Management Plan Content and Purpose: (1) The 2017 Oregon Cougar Management Plan establishes state policy and direction for Oregon's cougar management program. The 2017 Plan replaces previous plans. Chapters III (Cougar Management Objectives), IV (Adaptive Management, Appendix B (Cougar Incident Response Guidelines), Appendix C (Captive Cougar Kitten Guidelines), Appendix I: (Glossary – Definition of Terms), and Appendix M (Process for Development and Selection of Cougar Target Areas) of that 2017 Plan are incorporated here by reference as administrative rule. The 2017 Plan also serves as an informational and historical document for the Department.

Categories of Wildlife and Legal Take

ORS §498.012: Taking wildlife causing damage, posing public health risk or that is public nuisance: Cougar, bobcat, red fox, and black bear can be taken on private land at any time without a permit if the individual animal is causing damage, is a public nuisance, or poses a public health risk. Any person can take these species on private land as long as they have written permission from the landowner. However, no person shall take at a time and under a circumstance when such taking is taking is prohibited by the State fish and Wildlife Commission, any game mammal or nongame species unless the person first obtain a permit from the commission. No permit is required for taking of cougar, bobcat, red fox, or bear; but must have in possession written authority from the landowner or lawful occupant of the land.

HB 2971: enacted by the 2007 Legislative Assembly, which authorized appointment of agents, subject to the ODFW's direction and control, to assist ODFW in its official duties by pursuing black bear and/or cougar with dogs. These rules authorize two classes of agents:

(1) volunteer agents; and

(2) private contractors hired by the Department on personal services contracts — for responding to specific conflict or management actions consistent with the Oregon cougar and bear management plans and/or to work on specific research projects.

ORS §610.105: Landowners or their agent can control predatory animals in good faith by using lawful poison, traps, or other appropriate or effective means.

OAR 635-043-0085: Any person authorized to alleviate wildlife damage pursuant to ORS 498.136 may hunt designated wildlife from a motor propelled vehicle, except while in motion or on any public road or highway.

Use of Pursuit Dogs and Artificial Light

ORS §498.164: Dogs and bait cannot be used to hunt or pursue black bears or cougars, except for county, state, or federal agencies in their official capacities. This rule does not apply to black bears or cougars taken under ORS §498.012.

OAR 635-043-0090: Any person hunting bobcat, raccoon, or opossum may hunt with an artificial light not attached or operated from a motor-propelled vehicle. Any person authorized to alleviate wildlife damage pursuant to ORS 498.142 may use artificial light in manner prescribed by a permit.

Use of Traps, Snares and Other Capture Devices

ORS §498.172: Traps set for predatory animals must be checked on a regular basis. Furbearer traps set during the regulated furbearer season must be checked at least once during a 48-hour period.

OAR 635-050-0045: The law limits foothold trap size and sets use parameters, such as a minimum trap check of 48 hours for furbearers and unprotected mammals. Additionally, any killing traps and snares must be checked at least once every 30 days, restraining traps and snares at least once every 76 hours, and at least once every 7 days for predatory animals damaging land, livestock, or agricultural or forest crops.

OAR 635-050-0045:

(9) It is unlawful for any person to trap for furbearers, predatory animals or unprotected mammals using:

(a) A steel foothold trap with a jaw spread greater than 9 inches.

(b) A No. 3 or larger foothold trap or any foothold trap with an inside jaw spread at dog greater than 6” not having a jaw spacing of at least 3/16 of one inch when the trap is sprung (measurement excludes pads on padded jaw traps) and when the trap is placed in a manner that is not capable of drowning a trapped animal.

(c) The flesh of any game bird, game fish, game mammal for trap bait.

(d) Any killing trap having a jaw spread of 9 inches or more in any land set.

(e) Any killing trap having a jaw spread of 7.5 inches or more but less than 9 inches, in a land set on public lands, at a distance greater than 50 feet from a permanent water source or a seasonal water source when water is present except when authorized by the Oregon Department of Fish and Wildlife.

(f) Any toothed trap, or trap with a protuberance on the facing edge of the jaws that is intended to hold the animal (except pads on padded jaw traps).

(g) Or possessing the branded traps or snares of another unless in possession of written permission from the person to whom the brand is registered.

(h) Sight bait within 15 feet of any foothold trap set for carnivores.

OAR 635-050-0047: Sets limits on where traps and snares can be set on public lands, unless otherwise authorized by ODFW

No traps or snares may be set on land:

(1) Within 50 feet of any public trail; within 300 feet of any trailhead that is designated and maintained as such by the public land management agency and is accessible to vehicular traffic; within 300 feet of any public campground or picnic area designated and maintained as such by the public land management agency on the most current official map of the agency.

Protecting Human Safety

ORS §498.166: Bears or cougars posing a threat to human safety or structures can be taken and immediately reported to ODFW, who will order disposal of the animal.

ORS §498.166: Bears or cougars posing threat to human safety:

A person may take a cougar or a bear that poses a threat to human safety, and immediately report the taking to a person authorized to enforce the wildlife laws and shall dispose of the animal in such a manner as the State Fish and Wildlife Commission directs.

A threat involves the following behaviors: aggressive actions directed toward a person or persons, including but not limited to charging, false charging, teeth popping and snarling; breaking into or attempting to break into a residence; attacking a pet or domestic animal; loss of wariness of humans, displayed through repeated sightings of the animal during the day near a permanent structure, permanent corral or mobile dwelling used by humans at an agricultural, timber management, ranching, or construction site.

OAR 635-043-0051: ODFW staff or their agents (including WS-Oregon) may take or harass wildlife as necessary for protection against a threat to human safety, protection of land or property from damage (among other reasons).

Carcass Disposal and Report of Take

OAR 635-002-0009: Disposition of Bear and Cougar Killed Posing a Threat to Human Safety: Black bear or cougar taken as a threat to human safety shall be disposed of in the following manner: carcass, hide, gall bladder, and female reproductive tract shall be delivered to a location determined by ODFW; edible portions shall be disposed of per OAR 635-002-0007 for black bear and per OAR 635-002-0010 for cougar.

OAR 635-002-0010: Disposal of Inedible Wildlife: Carcasses of wildlife except black bear can be donated to public and charitable institutions, provided the receiving entity does not sell the meat; donated to low income people or those with medical conditions as long as the receiver eats the meat at their place of residence; donated to wildlife rehabilitators to feed animals in rehabilitation; or donated to rendering plants, pet food manufacturers, or disposed of by ODFW personnel.

OAR 635-002-0012: Disposal of Wildlife or Wildlife Parts: Any wildlife or part not specifically directed elsewhere by ODFW shall be disposed of per ODFW determination, with priority for scientific, enforcement, or educational purposes.

APPENDIX C

Maps

Figure C-1. Location of Hart Mountain NAR.

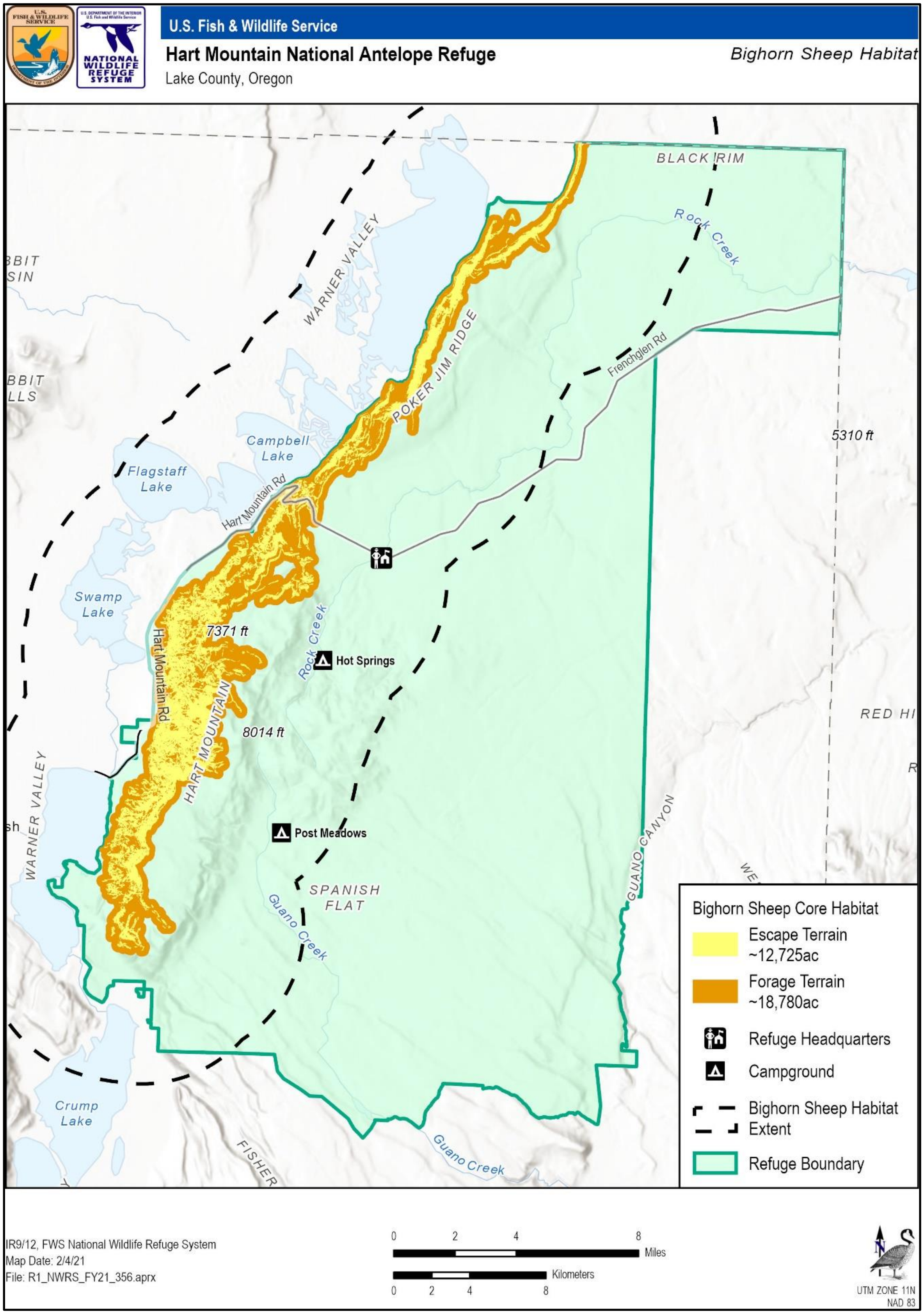


Figure C-2. Modeled core bighorn sheep habitats on Hart Mountain NAR.

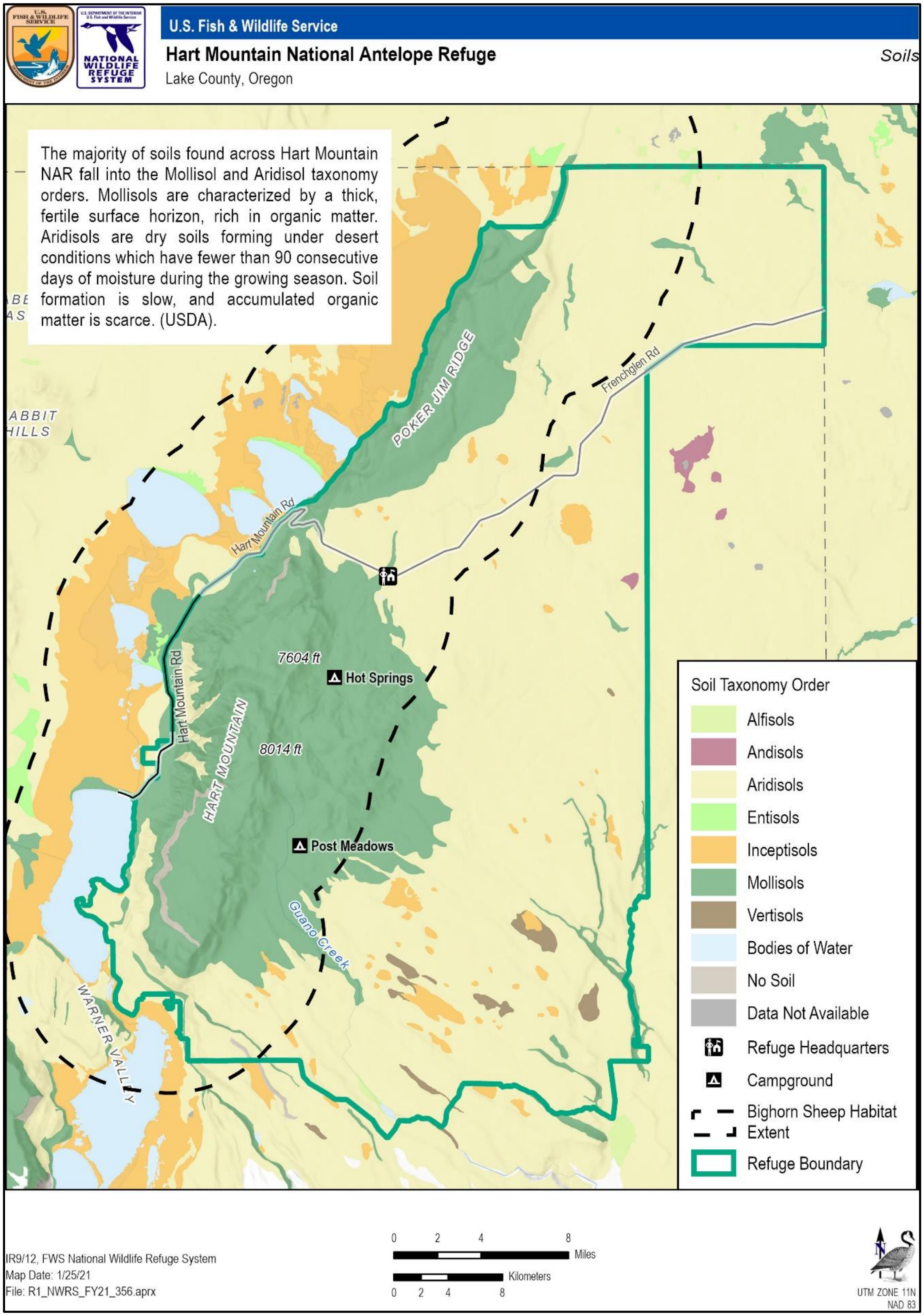


Figure C-3. Soil taxonomic orders of Hart Mountain NAR and Refuge bighorn sheep habitats.

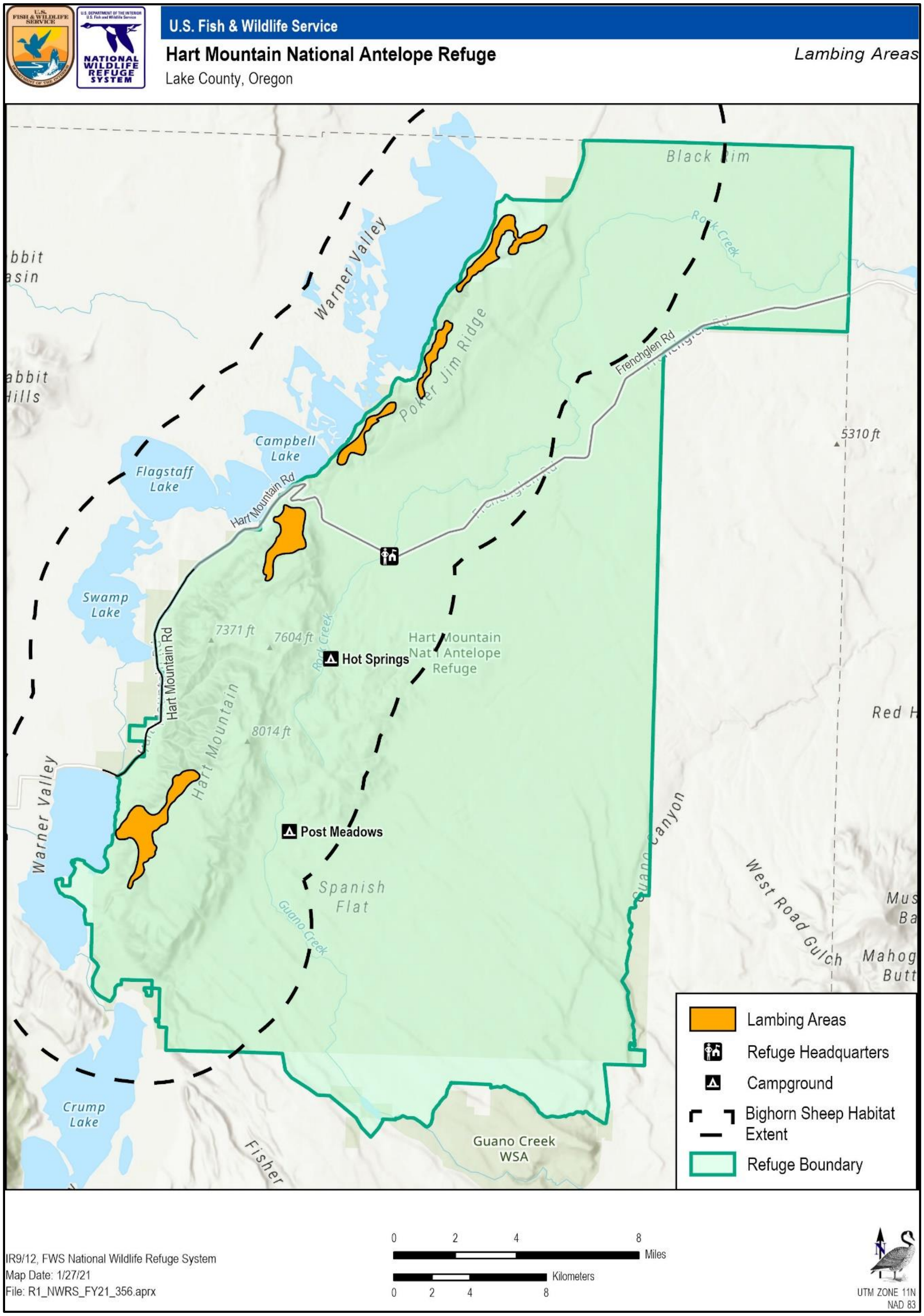


Figure C-4. Identified bighorn sheep lambing areas within Hart Mountain NAR.

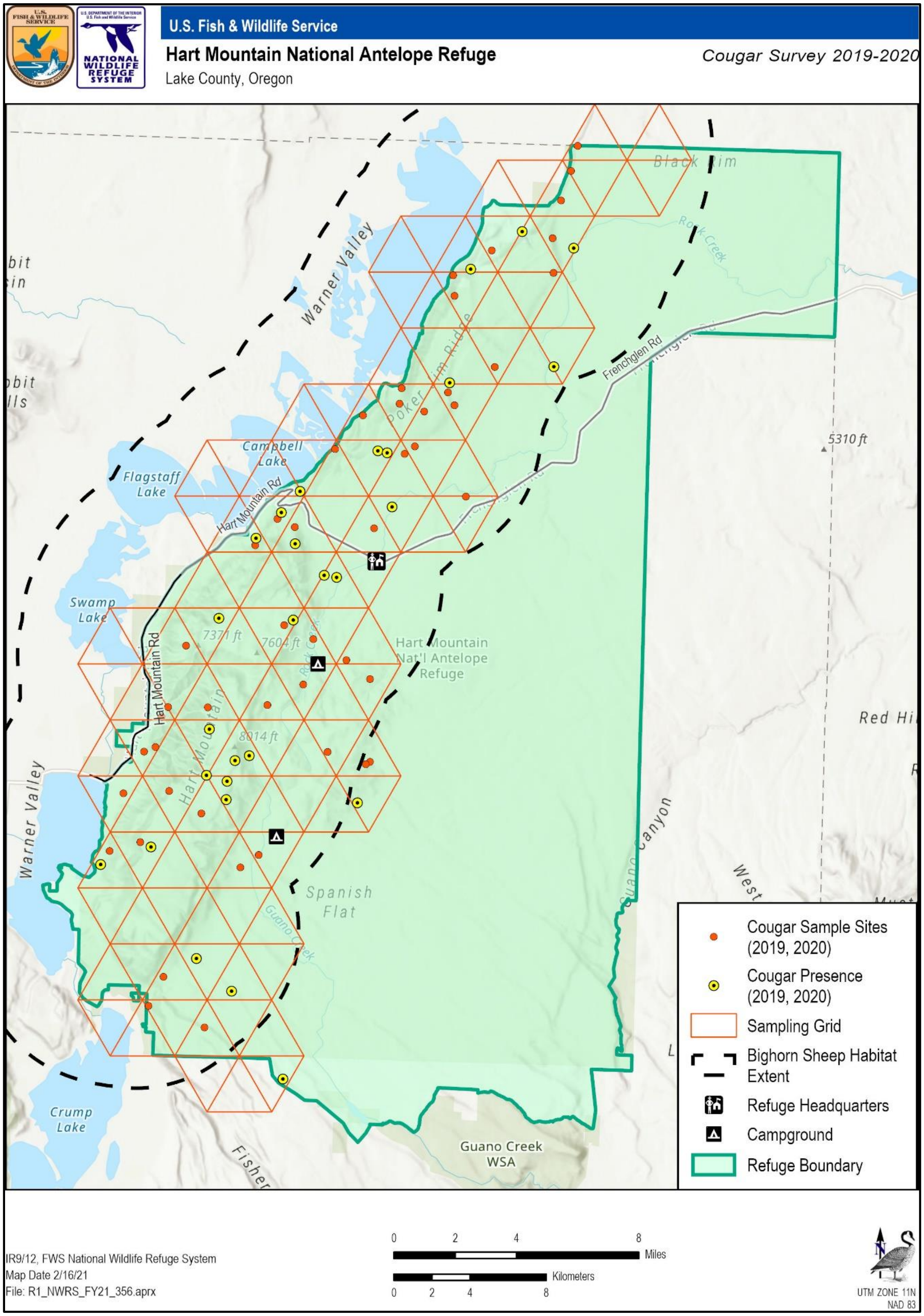


Figure C-5. Sampling grid, sampling sites, and locations of detected cougars from sampling surveys conducted on Hart Mountain NAR in 2019–2020.

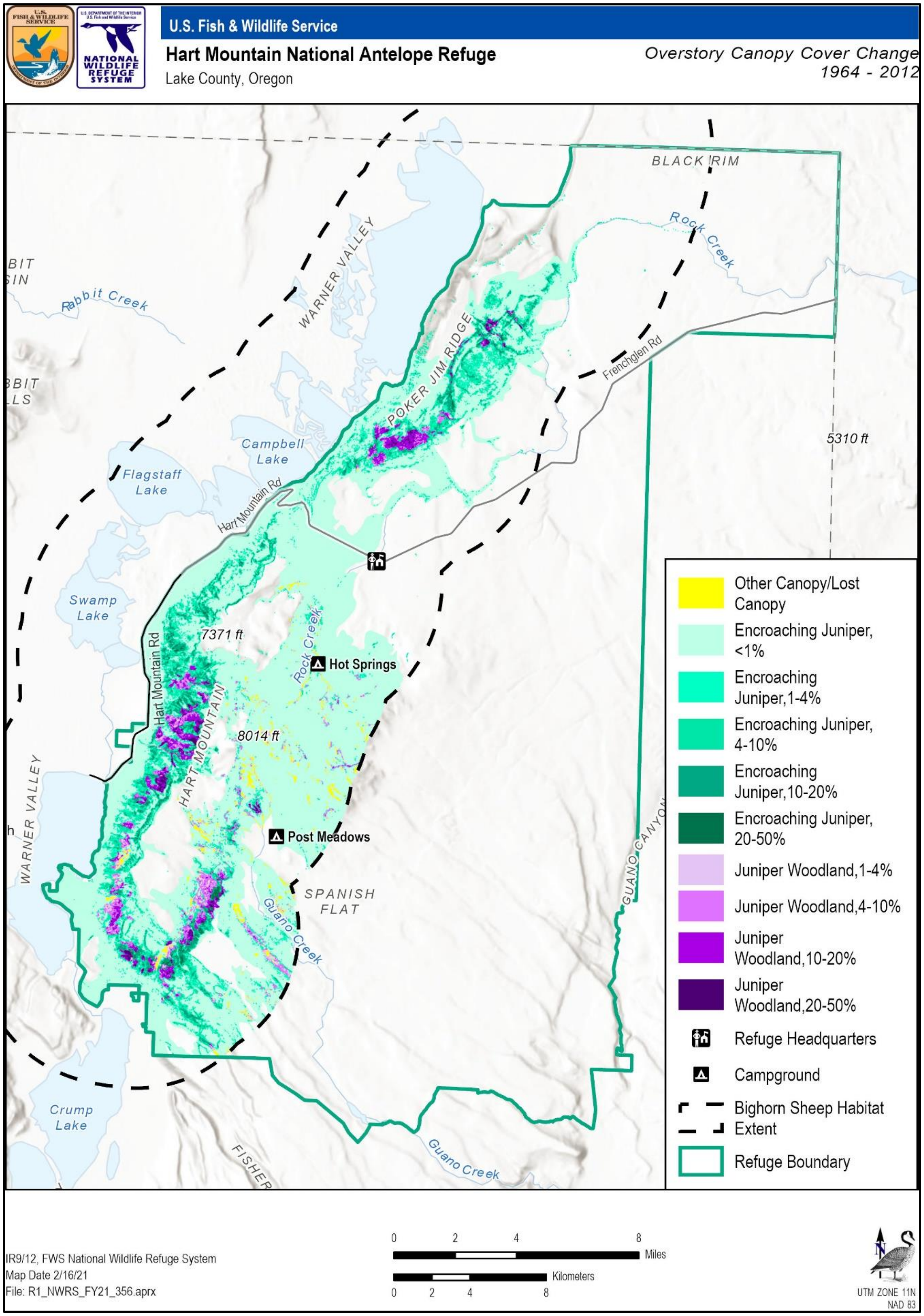


Figure C-6. Changes in overstory canopy cover on Hart Mountain NAR between 1964 and 2012, showing areas of juniper encroachment within shrub-steppe habitats.

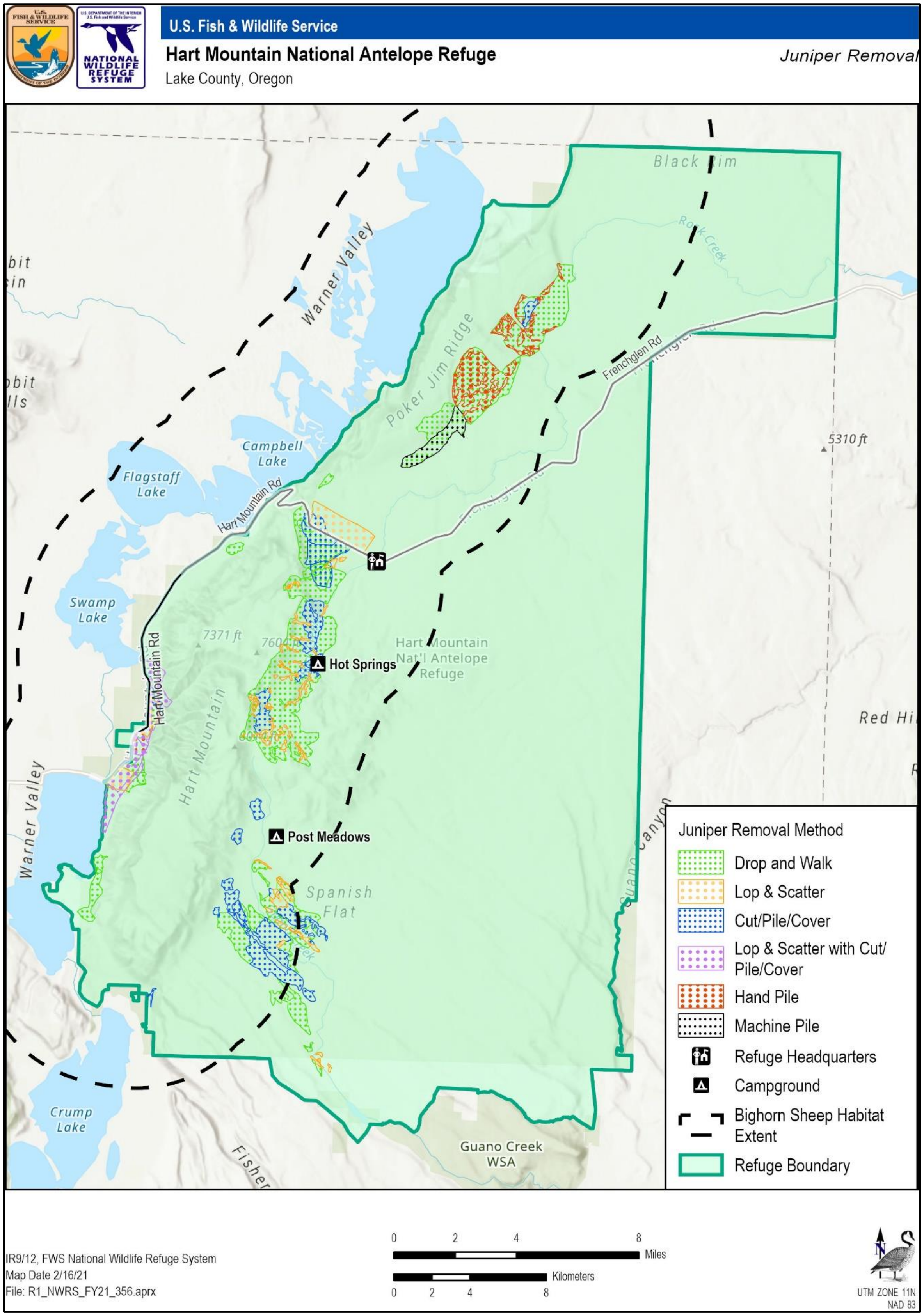


Figure C-7. Project areas and methods for removal of encroaching juniper on Hart Mountain NAR undertaken between 2001 and 2020.

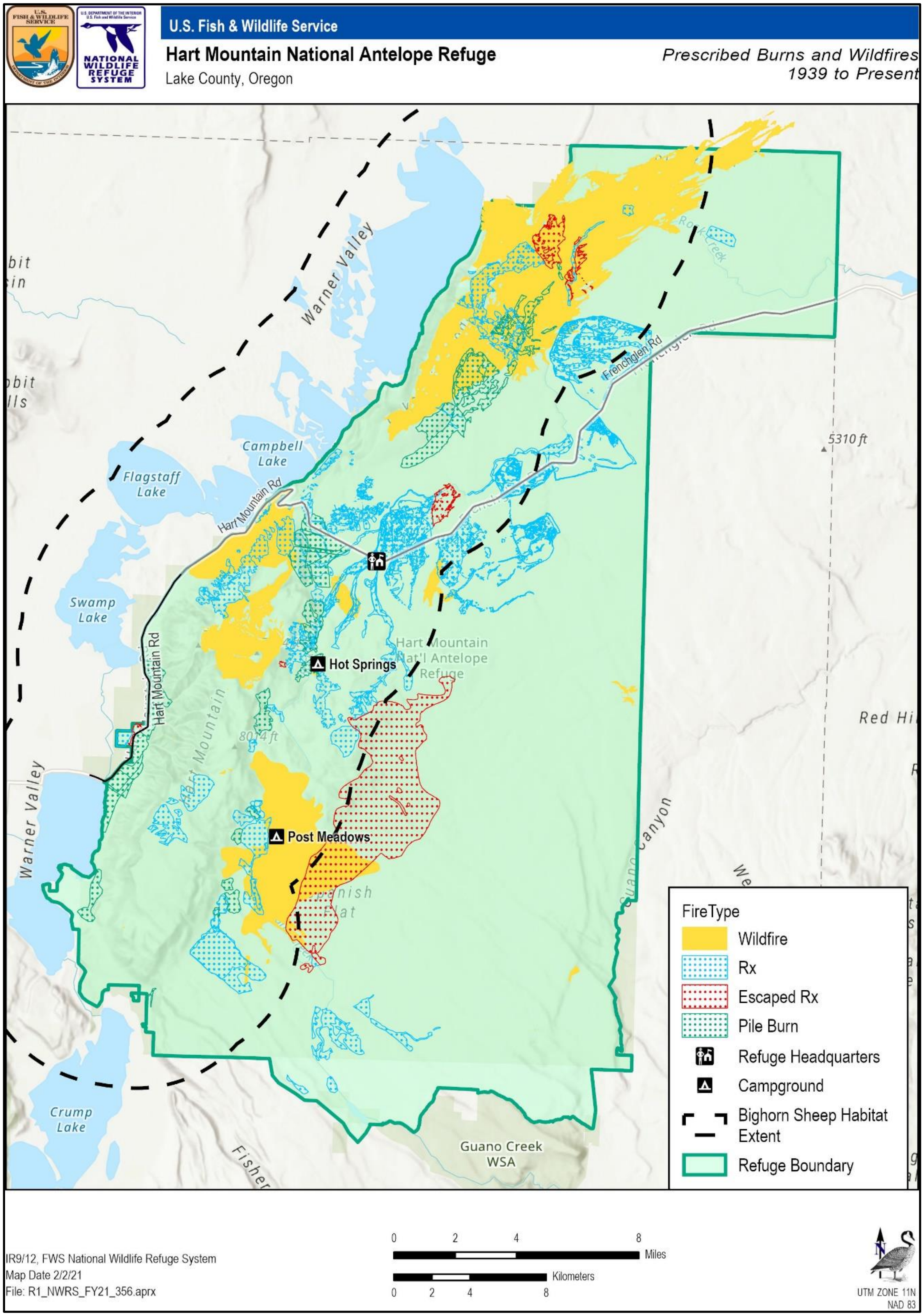


Figure C-8. Fire history on Hart Mountain NAR since 1939, identified by general fire type.

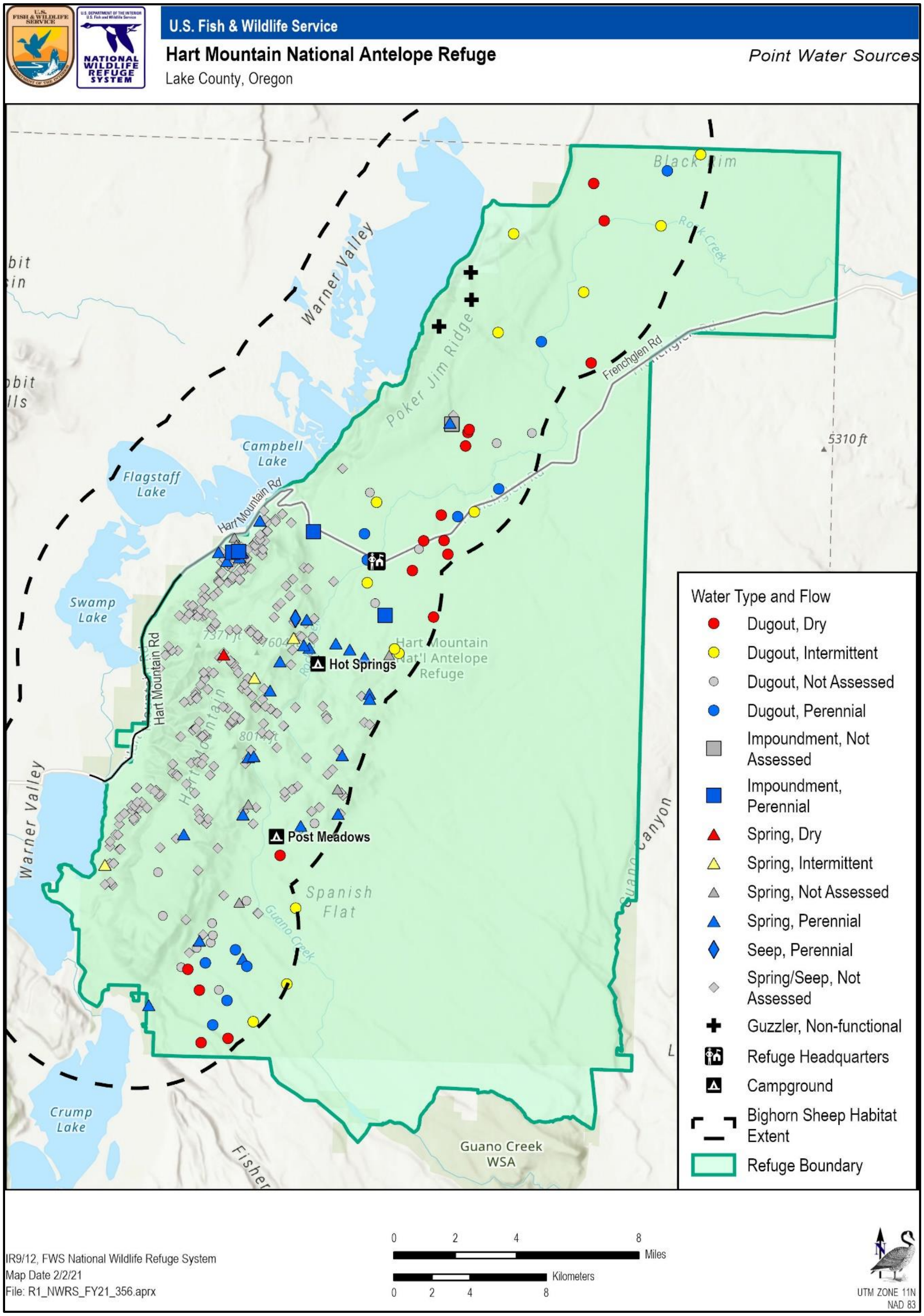


Figure C-9. Potential point sources of water, identified by duration where known, within bighorn sheep habitats on Hart Mountain NAR.

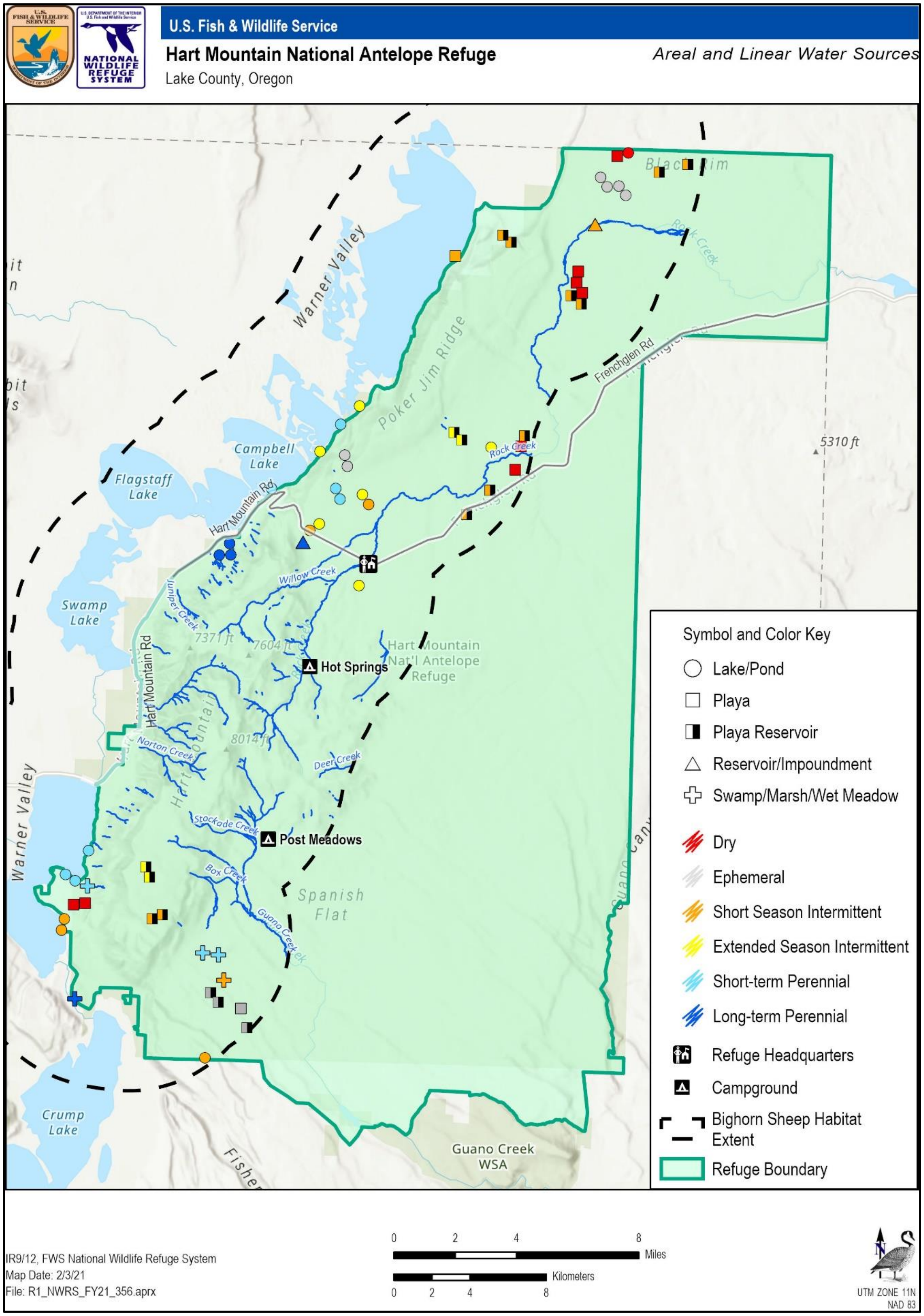


Figure C-10. Other potential sources of water, identified by duration where known, within bighorn sheep habitats on Hart Mountain NAR.

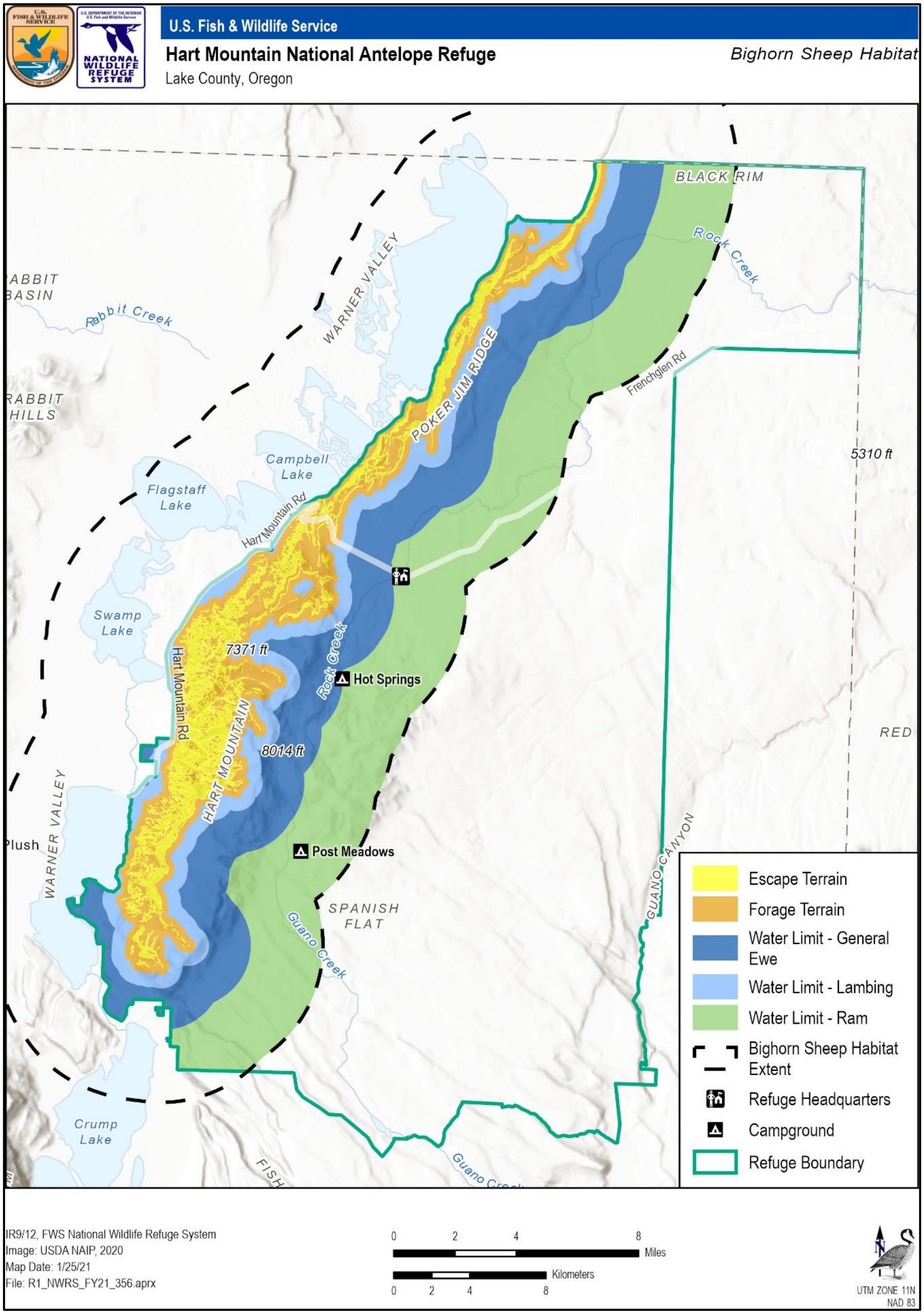


Figure C-11. Modeled bighorn sheep habitats within Hart Mountain NAR.

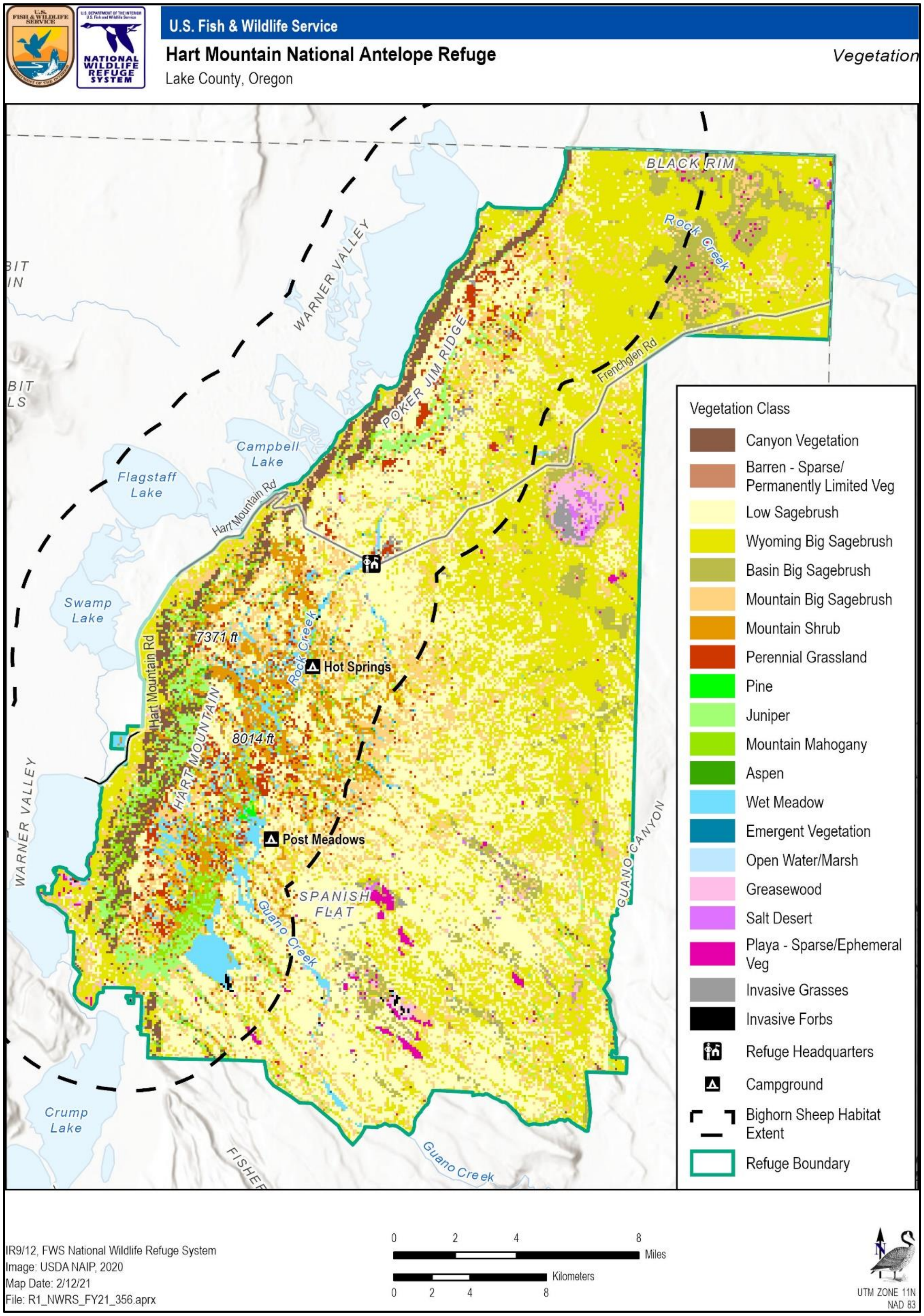


Figure C-12. Vegetation cover types within Hart Mountain NAR and Refuge bighorn sheep habitats.

APPENDIX D

Hart Mountain National Antelope Refuge
Integrated Pest Management Program

Hart Mountain National Antelope Refuge
Final Bighorn Sheep Management Plan and Environmental Impact Statement

Appendix D. Hart Mountain National Antelope Refuge Integrated Pest Management Program

1.0 Background

Integrated Pest Management (IPM) is an interdisciplinary approach utilizing methods to prevent, eliminate, contain, and/or control pest species in concert with other management activities on refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is also a scientifically based, adaptive management process where available scientific information and best professional judgment of the refuge staff as well as other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 CFR 46.145, adaptive management would be particularly relevant where long-term impacts may be uncertain and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, would be selected that are feasible, efficacious, and most protective of non-target resources, including native species (fish, wildlife, and plants), and Service personnel, Service authorized agents, volunteers, and the public. Staff time and available funding would be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as strategies (see Section 2.2.3 and 2.3 of this Bighorn Sheep [BHS] Management Plan/EIS) in an adaptive management context to achieve refuge resource objectives. In order to satisfy requirements for IPM planning as identified in the Director's Memo (dated September 9, 2004) entitled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into this BHS Management Plan:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this Appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to refuge biological resources and environmental quality in accordance with effects analyses presented in Section 4.0 (Environmental Consequences) of this BHS Management Plan/EIS. Only pesticide uses that likely would cause minor, temporary, or localized effects to refuge biological resources and environmental quality with appropriate BMPs, where necessary, would be allowed for use on the refuge.

This Appendix does not describe the more detailed process to evaluate potential effects associated with aerial applications of pesticides. However, the basic framework to assess potential effects to refuge biological resources and environmental quality from aerial application of pesticides would be similar to the process described in this Appendix for ground-based treatments of other pesticides.

2.0 Pest Management Laws and Policies

In accordance with Service policy 569 FW 1 (Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System can be controlled to ensure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on federal (refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 USC 668dd-668ee);
- Plant Protection Act of 2000 (7 USC 7701 *et seq*.);
- Noxious Weed Control and Eradication Act of 2004 (7 USC 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act of 1996 (7 USC 136-136y);
- National Invasive Species Act of 1996 (16 USC 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 USC 4701);
- Food Quality Protection Act of 1996 (7 USC 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112;
- Executive Order 13751; and
- Animal Damage Control Act of 1931 (7 USC 426-426c, 46 Stat. 1468).

Pests are defined as "…living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" from Department policy 517 DM 1 (Integrated Pest Management Policy). Similarly, 569 FW 1 defines pests as "…invasive plants and introduced or native organisms, that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." Policy 517 DM 1 also defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this BHS Management Plan/EIS, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests (vertebrate or invertebrate) on the refuge would conserve and protect the nation's fish, wildlife, and plant resources as well as maintain environmental quality. From 569 FW 1, animal or plant species, which are considered pests, may be managed if the following criteria are met:

- Threat to human health and wellbeing or private property, the acceptable level of damage by the pest has been exceeded, or State or local government has designated the pest as noxious;
- Detrimental to resource objectives as specified in a refuge resource management plan (e.g., comprehensive conservation plan, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the refuge was established.

The specific justifications for pest management activities on the refuge are the following:

- Protect human health and well-being;
- Prevent substantial damage to important to refuge resources;
- Protect newly introduced or re-establish native species;
- Control non-native (exotic) species in order to support existence for populations of native species;
- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy 620 FW 1 (Habitat Management Plans), there are additional management directives regarding invasive species found on the refuge:

- "We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere."
- "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct refuge habitat management activities to prevent, control, or eradicate invasive species..."

Animal species damaging/destroying federal property and/or detrimental to the management program of a refuge may be controlled as described in 50 CFR 31.14 (Official Animal Control Operations). For example, the incidental removal of beaver damaging refuge infrastructure (e.g., clogging with subsequent damaging of water control structures) and/or negatively affecting habitats (e.g., removing woody species from existing or restored riparian) managed on refuge lands may be conducted without a pest control proposal. We recognize beavers are native species and most of their activities or refuge lands represent a natural process beneficial for maintaining wetland habitats. Exotic nutria, whose denning and burrowing activities in wetland dikes causes cave-ins and breaches, can be controlled using the most effective techniques considering site-specific factors without a pest control proposal. Along with the loss of quality wetland habitats associated with breaching of impoundments, the safety of refuge staffs and public (e.g. auto tour routes) driving on structurally compromised levees and dikes can be threaten by sudden and unexpected cave-ins.

Trespass and feral animals also may be controlled on refuge lands. Based upon 50 CFR 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing or molesting humans or wildlife may be disposed of in the interest of public safety and protection of the wildlife. Feral animals should be disposed by the most humane method(s) available and in accordance with relevant Service directives (including Executive Order 11643). Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species will only be made after securing State approval (50 CFR 30.11 [Donation and Loan of Wildlife Specimens]**).** Surplus wildlife specimens may be sold alive or butchered, dressed and processed subject to federal and state laws and regulations (50 CFR 30.12 [Sale of Wildlife Specimens]**).**

3.0 Strategies

To fully embrace IPM as identified in 569 FW 1, the following strategies, where applicable, would be carefully considered on the refuge for each pest species:

- **Prevention.** This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the established pests to un-infested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used determine if current management activities on a refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention.

  Prevention may include source reduction, using pathogen-free or weed-free seeds or fill; exclusion methods (e.g., barriers) and/or sanitation methods (e.g., wash stations) to prevent re-introductions by various mechanisms including vehicles, personnel, livestock, and horses. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new satellite pest populations. Prevention would require consideration of the scale and scope of land management activities that may promote pest establishment within un-infested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason for prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

  The following would be methods to prevent the introduction and/or spread of pests on refuge lands:
    - Before beginning ground-disturbing activities (e.g., disking, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on-site or within reasonably expected potential invasion vicinity. Where possible, the refuge staff would begin project activities in un-infested areas before working in pest-infested areas.
    - The refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict to those periods when spread of seed or propagules of invasive plants would be least likely.
    - The refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned of pests. Where possible, the refuge staff would clean equipment before entering lands at on-refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of

the project area that will remain on roadways. Seeds and plant parts of pest plants would need to be collected, where practical. The refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.

- The refuge staff would clean all equipment, before leaving the project site, if operating in areas infested with pests. The refuge staff would determine the need for, and when appropriate, identify sanitation sites where equipment can be cleaned.
- Refuge staffs, their authorized agents, and refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly discarding of them (e.g., incinerating).
- The refuge staff would evaluate options, including closure, to restrict the traffic on sites with on-going restoration of desired vegetation. The refuge staff would revegetate disturbed soil (except travel ways on surfaced projects) to optimize plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. The refuge staff would use native material, where appropriate and feasible. The refuge staff would use certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.
- The refuge staff would provide information, training, and appropriate pest identification materials to permit holders and recreational visitors. The refuge staff would educate them about pest identification, biology, impacts, and effective prevention measures.
- The refuge staff would require grazing permittees to utilize preventative measures for their livestock while on refuge lands.
- The refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within refuge lands.
- The refuge staff would consider invasive plants in planning for road maintenance activities.
- The refuge staff would restrict off-road travel to designated routes.

The following would be methods to prevent the introduction and/or spread of pests into refuge waters:

- The refuge staff would inspect boats (including air boats), trailers, and other boating equipment. Where possible, the refuge staff would remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, the refuge staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site. If possible, the refuge staff would wash and dry boats, downriggers, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch.
- Where feasible, the refuge staff would maintain a l00-foot buffer of aquatic pest-free clearance around boat launches and docks or quarantine areas when cleaning around culverts, canals, or irrigation sites. Where possible, the refuge staff would inspect and clean equipment before moving to new sites or one project area to another.

These prevention methods to minimize/eliminate the introduction and/or spread of pests were taken verbatim or slightly modified from Appendix E of USFS (2005).

- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tool (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/disking, cutting, swathing, grinding, sheering, girdling, mowing, and mulching of the pest plants. These treatments can also include prescribed burning and/or flaming with propane torches, to facilitate revegetation, increase herbicide efficacy, remove litter to assist in emergence of desirable species, and/or remove or sterilize seed banks dominated by pest species.

  For animal species, Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based upon 50 CFR 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a "balanced conservation program" in accordance with federal or state laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the state.

  Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plant's root system. Although some mechanical tools (e.g., disking, plowing) may damage root systems, they may stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species (e.g., Canada thistle). In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

  Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be a very effective technique to control perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment only.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest, or manipulating species compositions to facilitate competition of native plants. Cultural methods would include water-level manipulation, mulching, winter cover crops, changing planting dates to minimize pest impact, trap/barrier crops, moisture management, addition of beneficial insect habitat, reducing clutter, proper trash disposal, planting or seeding desirable species to shade or out-compete invasive plants, applying fertilizer to enhance desirable vegetation, and other habitat alterations.

- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or out compete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

Biological control has advantages as well as disadvantages. Benefits would include reducing pesticide usage, host specificity for target pests, long-term self-perpetuating control, low cost/acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts will develop resistance to agents. Disadvantages would include the following: limited availability of agents from their native lands, the dependence of control on target species density, slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood; whereas, others are only partially understood or not at all.

Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent population level or survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) would tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agents search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters would include diseases, invertebrates (insects, mollusks), vertebrates and invasive plants (the most common group). Often it is assumed that biological control would address many if not most of these pest problems. There are several well-documented success stories of biological control of invasive weed species in the Pacific Northwest including Mediterranean sage, St. Johnswort (Klamath weed), and tansy ragwort. Emerging success stories include Dalmatian toadflax, diffuse knapweed, leafy spurge, purple loosestrife, and yellow star-thistle. However, historically, each new introduction of a biological control agent in the United States has only about a 30% success rate (Coombs et al. 2004). Refer to Coombs et al. (2004) for the status of biological control agents for invasive plants in the Pacific Northwest.

Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Hasan and Ayres 1990, Center et al. 1997).

The refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by USEPA under FIFRA, most biological control agents are regulated by the US Department of Agriculture (USDA) Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts, have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another state. Form 526 may be obtained by writing:

USDA-APHIS-PPQ
Biological Assessment and Taxonomic Support
4700 River Road, Unit 113
Riverdale, MD 20737

or

through the internet at:
https://www.aphis.usda.gov/aphis/resources/forms/ct_ppq_forms.

The Service strongly supports the development, and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and non-indigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds (USDA-PPQ Form 526 USDA-APHIS-PPQ, Biological Assessment and Taxonomic Support, 4700 River Road, Unit 113, Riverdale, MD 20737) to release specific biological control agents in a state and/or county. Furthermore, certification regarding the biological control agent's identity (genus, specific epithet, sub-species and variety) and purity (e.g., parasite free, pathogen free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to USFWS 7 RM 8 (Exotic Species Introduction and Management). In addition, the refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds as ratified by delegates to the X International Symposium on Biological Control of Weeds, Bozeman, MT, July 9, 1999 (Balciunas and Coombs 2004). This code identifies the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, non-target species and the environment.

Biological control agents formulated as pesticide products and registered by the USEPA (e.g., *Bti*) are also subject to PUP review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

NEPA documents regarding biological and other environmental effects of biological control agents prepared by another federal agency, where the scope is relevant to evaluation of releases on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, US Forest Service, National Park Service, US Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 CFR 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of its populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to utilize best management practices (BMPs) to reduce/eliminate potential effects to non-target species, sensitive habitats, and potential to contaminate surface and groundwater. All pesticide usage (pesticide, target species, application rate, and method of application) would comply with the applicable federal (FIFRA) and state regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on refuge lands and waters, pesticide use proposals (PUPs) would be prepared and approved in accordance with 569 FW 1. PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on the refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service's intranet (https://systems.fws.gov/pups; accessed 14 December 2020). Only Service employees would be authorized to access PUP records for a refuge in this database.

  Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to non-target areas and degradation of surface and groundwater quality. Where possible, target-specific equipment (e.g., backpack sprayer, wiper) would be used to treat target pests. Other target-specific equipment to apply pesticides would include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed wing or helicopter) would only be used where access is difficult (remoteness) and/or the size/distribution of infestations precludes practical use of ground-based methods.

Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and non-chemical controls also are highly effective, where practical, because pesticide-resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on a refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environment quality (soils, surface water, and groundwater) as well as least potential effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on refuge lands in the context of an IPM approach.

- **Habitat restoration/maintenance.** Restoration and/or proper maintenance of refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Masters et al. 1996, Masters and Shelly 2001, Brooks et al. 2004). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

4.0 Priorities for Treatments

For many refuges, the magnitude (number, distribution, and sizes of infestations) of pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests in the refuge, it would be essential to prioritize treatment of infestations. Highest priority treatments would be focused on early detection and rapid response to eliminate infestations of new pests, if possible. This would be especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated refuge purpose(s), NWRS resources of concern (federally listed species, migratory birds, selected marine mammals, and inter-jurisdictional fish), and native species for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously un-infested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established, source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success. The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found treating fewer populations that are sources represents an effective long-term strategy to reduce of total number of invasive populations and decreasing meta-population growth rates.

Although state-listed noxious weeds would always of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, cheatgrass may not be listed by a state as noxious, but it can greatly alter fire regimes in shrub steppe habitats resulting in large monotypic stands that displace native bunch grasses, forbs, and shrubs. Pest control would likely require a multi-year commitment from the refuge staff. Essential to the long-term success of pest management would be pre- and post-treatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

5.0 Best Management Practices (BMPs)

BMPs can minimize or eliminate possible effects associated with pesticide usage to non-target species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of Interior Pesticide Use Policy (517 DM 1) and the Service Integrated Pest Management policy (569 FW 1), the use of applicable BMPs (where feasible) also would likely ensure that pesticide uses may not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in 50 CFR part 402.

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and utilized, where feasible, based upon target- and site-specific factors and time-specific environmental conditions. Although not listed below, the most important BMP to eliminate/reduce potential impacts to non-target resources would be an IPM approach to prevent, control, eradicate, and contain pests.

5.1 Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple rinsed and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make-up water in the sprayer tank and applied to treatment areas.
- The refuge staff would triple rinse and recycle (where feasible) pesticide containers.

- All unused pesticides would be properly discarded at a local “safe send” collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health, fish, and wildlife and prevent soil and water contaminant.
- The refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in the refuge spill response plan.

5.2 Applying Pesticides

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate, state or BLM certification to safely and effectively conduct these activities on refuge lands and waters.
- The refuge staff would comply with all federal, state, and local pesticide use laws and regulations as well as Departmental, Service, and NWRS pesticide-related policies. For example, the refuge staff would use application equipment and apply rates for the specific pest(s) identified on the pesticide label as required under FIFRA.
- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators would review the labels, SDSs, and Pesticide Use Proposal (PUPs) for each pesticide, determining the target pest, appropriate mix rate(s), PPE, and other requirements listed on the pesticide label.
- A 1-foot no-spray buffer from the water’s edge would be used, where applicable and where it does not detrimentally influence effective control of pest species.
- Use low-impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) rather than broadcast foliar applications (e.g., boom sprayer, other larger tank wand applications), where practical.
- Use low-volume rather than high-volume foliar applications where low-impact methods above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.
- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average<7mph and preferably 3 to 5 mph) and consistent direction wind conditions with moderate temperatures (typically <85^{o} F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions) that can cause large-scale herbicide drift to non-target areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.

- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30% forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.
- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a non-toxic dye to aid in identifying target area treated as well as potential over spray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with cropland and facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment set up and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. The refuge staff would only apply adjacent to sensitive areas when the wind is blowing the opposite direction.
- Applicators would utilize scouting for early detection of pests to eliminate unnecessary pesticide applications.
- The refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.
- Application equipment (e.g., sprayer, ATV, tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to un-infested areas.

6.0 Safety

6.1 Personal Protective Equipment

All applicators would wear the specific personal protective equipment (PPE) identified on the pesticide label. The appropriate PPE will be worn at all times during handling, mixing, and applying. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or an NIOSH-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing and disposing of pesticide containers will be consistent with label requirements, USEPA and OSHA requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

6.2 Notification

The restricted entry interval (REI) is the time period required after the application at which point someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the refuge. Where required by the label and/or state-specific regulations, sites would also be posted on its perimeter and at other likely locations of entry. The refuge staff would also notify appropriate private property owners of an intended application, including any private individuals who have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

6.3 Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel would be medically monitoring if one or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); use pesticides in a manner considered “frequent pesticide use”; or use pesticides in a manner that requires a respirator (see 242 FW 14 for respirator use requirements). In 242 FW7.7A, “**Frequent Pesticide Use** means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period.” Under some circumstances, individuals may be medically monitored who use pesticides infrequently (see section 7.7), experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2. This decision would consider the individual’s health and fitness level, the pesticide’s specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators (e.g., cooperative farmers) and other authorized agents (e.g., state and county employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at refuge expense) of appropriate refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

6.4 Certification and Supervision of Pesticide Applicators

Appropriate refuge staff or approved volunteers handling, mixing, and/or applying or directly supervising others engaged in pesticide use activities would be trained and state or federally (BLM) licensed to apply pesticides to refuge lands or waters. In accordance with 242 FW7.18A and 569 FW 1.10B, certification is required to apply restricted use pesticides based upon USEPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. The certification requirement would be for a commercial or private applicator depending upon the state. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of herbicides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the refuge office.

6.5 Record Keeping

6.5.1 Labels and material safety data sheets

Pesticide labels and safety data sheets (SDSs) would be maintained at the refuge pesticide storage building and/or shop, with copies in the mixing area. These documents also would be carried by field applicators, where possible. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links (URLs) to pesticide labels and SDSs, and/or the Complex maintains a "master list" of approved pesticides, along with digital copies of labels, supplemental labels, and SDSs, with website links as available, all of which are reviewed annually and updated as necessary (these are available on the Complex network drive: S:\BiologicalProgram\Invasives [*current as of 14 December 2020*]).

6.5.2 Pesticide use proposals (PUPs)

A PUP would be prepared for each proposed pesticide use associated with annual pest management on refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with Service guidelines (Director's memo [December 12, 2007]), a refuge staff may receive up to five-year approvals for Washington Office and field reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary. For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or a habitat management plant (HMP) if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

PUPs would be created, approved or disapproved, and stored as records in the Pesticide Use Proposal System (PUPS), which is centralized database on the Service's intranet (https://systems.fws.gov/pups; accessed 14 December 2020). Only Service employees can access PUP records in this database.

6.5.3 Pesticide usage

In accordance with 569 FW 1, the refuge Project Leader would be required to maintain records of all pesticides annually applied on lands or waters under refuge jurisdiction. This would encompass pesticides applied by other federal agencies, state and county governments, non-government applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, dessicants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs. or gallons)
- Total amount of active ingredient(s) used (lbs.)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pre- and post-treatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation-density, % cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a geo-referenced data management system (e.g., Refuge Lands GIS) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 CFR 46.145.

7.0 Evaluating Pesticide Use Proposals

Pesticides would only be used on refuge lands for habitat management as well as croplands/facilities maintenance after approval of a PUP. In general, proposed pesticide uses on refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and non-listed species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments as well as characteristics of environmental fate and potential to degrade environmental quality for pesticides would be documented in Chemical Profiles (see Section 7.5). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section 4.0) for habitat management and cropland/facilities maintenance on refuge lands that would potentially have minor, temporary, or localized effects on refuge biological and environmental quality (threshold values not exceeded) would be approved.

7.1 Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide(s) proposed for use on refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazard, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision-making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 CFR Part 1502.22. Protocols for ecological risk assessment of pesticide uses on the refuge were developed through research and established by the USEPA (2004). Assumptions for these risk assessments are presented in Section 6.2.3.

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the USEPA to meet regulatory requirements under FIFRA. These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be utilized for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in Section 7.5.

Table 1. Ecotoxicity tests used to evaluate potential effects to birds, fish, and mammals to establish toxicity endpoints for risk quotient calculations.

Species Group	Exposure	Measurement endpoint
Bird	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1]
Fish	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[2]
Mammal	Acute	Oral Lethal Dose (LD_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[3]

[1]Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).

[2]Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.
[3]Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

7.2 Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on the refuge to cause direct adverse effects to fish and wildlife would be evaluated using USEPA's Ecological Risk Assessment Process (USEPA 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration [EEC] and toxicological endpoints [e.g., LC_{50} and oral LD_{50}]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates for managing units of the NWRS. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effect (Table 1).

$$RQ = EEC/Toxicological\ Endpoint$$

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by U.S. Environmental Protection Agency (Urban et al. 1998 [Table 2]). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the refuge: acute-listed species, acute-non-listed species, chronic-listed species, and chronic-non-listed species.

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC_{50} and LD_{50} tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Table 2. Presumption of unacceptable risk for birds, fish, and mammals (Urban et al. 1998).

Risk Presumption		Level of Concern	
		Listed Species	Non-listed Species
Acute	Birds	0.1	0.5
	Fish	0.05	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0

	Fish	1.0	1.0
	Mammals	1.0	1.0

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973 (16 USC 1531-1544, 87 Stat. 884, as amended-Public Law 93-205). For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to non-listed species would consider effects at the population level. A RQ<LOC would indicate the proposed pesticide use "may affect, not likely to adversely affect" individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (non-listed species) for each taxonomic group (Table 2). In contrast, an RQ>LOC would indicate a "may affect, likely to adversely affect" for listed species and it would also pose unacceptable ecological risk for adverse effects to non-listed species.

7.2.1 Environmental exposure

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides which would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as non-target vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (e.g., leaching) (Baker et al. 1992, EXTOXNET 1993, Ramsay et al. 1995, Buttler et al. 1998, Pope et al. 1999). Pesticides which would be injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but it does indicate movement of pesticides in the environment is very complex with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but it also may involve transportation of pesticides over long distances (Barry and Walters 2004, Woods 2004).

7.2.1.1 Terrestrial exposure

The ECC for exposure to terrestrial wildlife would be quantified using an USEPA screening-level approach (USEPA 2004). This screening-level approach is not affected by product formulation because it evaluates pesticide active ingredient(s). This approach would vary depending upon the proposed pesticide application method: spray or granular.

7.2.1.1.1 Terrestrial-spray application

For spray applications, exposure would be determined using the Kenaga nomogram method (Pfleeger et al. 1996, USEPA 2004, USEPA 2005) through the USEPA's Terrestrial Residue Exposure model (T-REX) version 1.5 (USEPA 2012). To estimate the maximum (initial) pesticide residue on short grass (<20 cm tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds active ingredient [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 ppm per lb. ai/acre) for worst-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et. al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table 3) would be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kenaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

Table 3. Average body weight of selected terrestrial wildlife species frequently used in research to establish toxicological endpoints (Dunning 1984).

Species	**Body Weight (kg)**
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Common grackle	0.114
Japanese quail	0.178
Bobwhite quail	0.178
Rat	0.200
Rock dove (aka pigeon)	0.542
Mammal (1000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

7.2.1.1.2 Terrestrial – granular application

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units which birds or mammals might ingest accidentally with food items or intentionally as in the case of some bird species actively seeking and picking up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of active ingredient (ai) exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate LD_{50} value multiplied by the surrogate's body weight (Table 3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100% of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but they are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15% of the applied granules remain available to wildlife. It would be assumed that only 1% of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area (LD_{50}/ft^2) for comparison to USEPA Level of Concerns (Urban et al. 1998). The T-REX version 1.5 (USEPA 2012) contains a submodel which automates Kenaga exposure calculations for granular pesticides and treated seed.

The following formulas will be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1% granules, bait, or seed remain unincorporated.

mg ai/ft.^{2} = [(lbs. product/acre)(% ai)(453,580 mg/lbs.)(1% exposed))] / {[(43,560 ft.^{2}/acre)/(row spacing (ft.))] / (row spacing (ft.)}

or

mg ai/ft^2 = [(lbs. product/1000 ft. row)(% ai)(1000 ft row)(453,580 mg/lb.)(1% exposed)

EEC = [(mg ai/ft.^{2})(% of pesticide biologically available)]

- Incorporated banded treatments assume that 15% of granules, bait, and seeds are unincorporated.

mg ai/ft.^{2} = [(lbs. product/1000 row ft.)(% ai)(453,580 mg/lb.)(1-% incorporated)] / (1,000 ft.)(band width (ft.))

EEC = [(mg ai/ft.^{2})(% of pesticide biologically available)]

- Broadcast treatment without incorporation assumes 100% of granules, bait, seeds are unincorporated.

mg ai/ft.^{2} = [(lbs. product/acre)(% ai)(453,590 mg/lb.)] / (43,560 ft.^{2}/acre)

$$EEC = [(mg\ ai/ft.^2)(\%\ of\ pesticide\ biologically\ available)]$$

Where:

- *% of pesticide biologically available = 100% without species specific ingestion rates*

- *Conversion for calculating mg ai/ft.*^{2} *using ounces: 453,580 mg/lb. /16 = 28,349 mg/oz.*

The following equation would be used to calculate an RQ based on the EEC calculated by one of the above equations. The EEC would divided by the surrogate LD_{50} toxicological endpoint multiplied by the body weight (Table 3) of the surrogate.

$$RQ = EEC / [LD_{50}\ (mg/kg) * body\ weight\ (kg)]$$

As with other risk assessments, an RQ>LOC would be a presumption of unacceptable ecological risk. An RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

7.2.1.2 Aquatic exposure

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands (especially those cultivated by cooperative farmers for economic return from crop yields) and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the refuge. In addition, pesticide applications may be done <25 feet of the high water mark of aquatic habitats for habitat management treatments; whereas, no-spray buffers (≥25 feet) would be used for croplands/facilities maintenance treatments.

7.2.1.2.1 Habitat treatments

For the worst-case exposure scenario to non-target aquatic habitats, EECs (Table 4) would be would be derived from Urban and Cook (1986) that assumes an intentional overspray to an entire, non-target water body (1-foot depth) from a treatment <25 feet from the high water mark using the max application rate (acid basis [see above]). However, use of BMPs for applying pesticides (see Section 4.2) would likely minimize/eliminate potential drift to non-target aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100% overspray (RQ>LOC), then the proposed pesticide use may be disapproved or the PUP would be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms (RQ=LOC).

Table 4. Estimated Environmental Concentrations (ppb) of pesticides in aquatic habitats (1 foot depth) immediately after direct application (Urban and Cook 1986).

Lbs./acre	EEC (ppb)
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1103.5
4.00	1471.4
5.00	1839
6.00	2207
7.00	2575
8.00	2943
9.00	3311
10.00	3678

7.2.1.2.2 Cropland/facilities maintenance treatments

Field drift studies conducted by the Spray Drift Task Force, which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT® computer model was created to satisfy USEPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. Several versions of the computer model have been developed (i.e., v2.01 through v2.1.1). The Spray Drift Task Force AgDRIFT® model version 2.1.1 (Teske et al. 2001, Teske et al. 2002,) would be used to derive EECs resulting from drift of pesticides to refuge aquatic resources from ground-based pesticide applications >25 feet from the high water mark. The Spray Drift Task Force AgDRIFT® model is publicly available at https://www.epa.gov/sites/production/files/2015-07/agdrift_2.1.1.zip (accessed 14 December 2020).

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: max application rate (acid basis [see above]), low boom (20 inches), fine to medium droplet size, EPA-defined wetland, and a ≥25-foot distance (buffer) from treated area to water.

7.2.2 Use of information on effects of biological control agents, pesticides, degradates, and adjuvants

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on refuge lands, would be reviewed. Possible source agencies for such NEPA documents would include the Bureau of Land Management, US Forest Service, National Park Service, US Department of Agriculture-Animal and Plant Health Inspection Service, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference (40 CFR 1502.21) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in 43 CFR 46.135, the Service would specifically incorporate through reference ecological risk assessments prepared by the US Forest Service (https://www.fs.usda.gov/detail/r6/forest-grasslandhealth/invasivespecies/?cid=stelprdb5302157; accessed 14 December 2020) and Bureau of Land Management (https://www.blm.gov/programs/natural-resources/weeds-and-invasives/vegetative-peis; accessed 14 December 2020). These risk assessments and associated documentation also are available in total with the administrative record for the Final Environmental Impact Statement entitled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (USFS 2005), *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS* (BLM 2007), and *Vegetation Treatments Using Aminopyralid, Fluroxypyr, and Rimsulfuron on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Impact Statement* (BLM 2016). In accordance with 43 CRF 46.120(d), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the US Forest Service would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl

- Triclopyr
- Nonylphenol polyethylate (NPE) based surfactants

As a basis for completing "Chemical Profiles" for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated with pesticide degradates and adjuvants prepared by the Bureau of Land Management would be incorporated by reference:

- Aminopyralid
- Bromacil
- Chlorsulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Fluroxypyr
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Rimsulfuron
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants (*Appendix D – Evaluation of risks from degradates, polyoxyethylene-amine (POEA) and R-11, and endocrine disrupting chemicals*)

7.2.3 Assumptions for ecological risk assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with utilization of the USEPA's (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether or not they may lead to recommendations that are risk neutral, underestimate, or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.
- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Non-target organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (USEPA 2004). As a result, this conservative approach may lead to an overestimation of risk characterization from pesticide exposure.

- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. However, sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity for mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data is selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data will not be limited to the species previously listed as common surrogates.
- The Kenaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kenaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide, length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data is usually not available for inclusion into risk assessments. Without time response data it is difficult to determine the concentration which elicited a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimate of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimate of risk. TWAs may be used for chronic risk assessments, but they will be applied judiciously considering the potential for an underestimate or overestimate of risk. For example, the number of days exposure exceeds a Level of Concern may influence the suitability of a pesticide use. The greater the number of days the EEC exceeds the Level of Concern translates into greater the ecological risk. This is a qualitative assessment, and is subject to reviewer's expertise in ecological risk assessment and tolerance for risk.
- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure

duration needed to elicit a toxicological response. Pesticides, which do not bioaccumulate, may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs will require justification and it will not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.

- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as bi-phasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, these data are often not available and it can be misleading particularly if the compound is prone to "wash-off". Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of refuge lands would be utilized, if available.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (USEPA 2004).
- Exposure through incidental ingestion of pesticide contaminated soil is not considered in the USEPA risk assessment protocols. Research suggests <15% of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kenaga nomogram indicates incidental soil ingestion will not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.
- Exposure through inhalation of pesticides is not considered in the USEPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The Driver et al. (1990) reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1% of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible

spray drop size distribution for ground pesticide applications is restricted to ASAE medium or coarser drop size distribution.

- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post application, and it would pertain to those pesticides with a high vapor pressure. The USEPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.
- The effect from exposure to dusts contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1990, Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, except dermal toxicity values are common for some mammals used as human surrogates (rats and mice). The USEPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the USEPA for assessing dermal exposure to pesticides, they will be considered for incorporation into pesticide assessment protocols.
- Exposure to a pesticide may occur from consuming surface water, dew or other water on treated surfaces. Water soluble pesticides have the potential to dissolve in surface runoff and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soils types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The USEPA is actively developing protocols to quantify drinking water exposures from puddles and dew. If and when protocols are formally established by the USEPA for assessing exposure to pesticides through drinking water, these protocols will be incorporated into pesticide risk assessment protocols.
- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of spills represent a potential underestimate of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the state in which they apply pesticides. Certification training includes the safe storage, transport, handling,

and mixing of pesticides; equipment calibration; and proper application with annual continuing education.

- The USEPA relies on Fletcher (1994) for setting the assumed pesticide residues in wildlife dietary items. The USEPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify". Fletcher's (1994) research suggests that the pesticide active ingredient residue assumptions used by the USEPA represent a 95th percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates USEPA residue assumptions for short grass was not exceeded. Baehr and Habig (2000) compared USEPA residue assumptions with distributions of measured pesticide residues for the USEPA's UTAB database. Overall residue selection level will tend to overestimate risk characterization. This is particularly evident when wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole above-ground plant material, but others will preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species specific knowledge regarding foraging behavior characterizing ecological risk other than in general terms is not possible.
- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC_{50} or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.
- There are several other assumptions that can affect non-target species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic and biotic factors) and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are usually characterized in the published literature in only a general manner limiting their value in the risk assessment process.
- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However, the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of

wildlife may result in an under- or over-estimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.

- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occurs at lower levels for many newer pesticides compared with older more persistent bioaccumulative compounds. Pesticides with RQs close to the listed species level of concern, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for the potential to concentrate pesticide through the evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.
- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event, analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of invertebrate life-cycle or fish-early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the USEPA relies on chronic exposure toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on

several undefined variables, risk associated with chronic exposure may in some situations underestimate risk and overestimate risk in others.

- There are several other factors that can affect non-target species not considered in the risk assessment process. These would include the following: possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure, adverse abiotic [not pesticides] and biotic factors), and sub-lethal effects such as behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are not routinely assessed by regulatory agencies. Therefore, information on the factors is not extensive limiting their value for the risk assessment process. As this type of information becomes available, it would be included, either quantitatively or qualitatively, in this risk assessment process.
- USEPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same within an organism. Currently, USEPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

7.3 Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or it is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier (such as clay in which the active ingredient is impregnated on the clay particle in dry formulations). For example, if isopropyl alcohol would be used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of all inert ingredients must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The USEPA (September 1997) issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term “other ingredients” for “inert ingredients” in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on non-target organisms and, therefore, are not necessarily inert. Whether referred to as “inerts” or “other ingredients,” these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA categorizes regulated inert ingredients into the following four lists (https://www.epa.gov/pesticide-registration/inert-ingredients-overview-and-guidance; accessed 14 December 2020):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally-occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on SDSs or published data.

Comprehensively assessing potential effects to non-target fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the USFS (2005) found that mixtures of pesticides used in land (forest) management likely would not cause additive or synergistic effects to non-target species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (Wilbur et al. 2001). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources such as the following:

- TOMES (a proprietary toxicological database including USEPA's IRIS, the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- USEPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
- Safety Data Sheets (SDSs) from pesticide suppliers.
- Other sources such as the Farm Chemicals Handbook.

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredient(s).

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult.

For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides would represent a source of uncertainty for assessing risk.

A USEPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action would be common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for two or more pesticides applied as a mixture should be completely reviewed, where products with the least potential for negative effects would be selected for use on the refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides and the USEPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

7.4 Determining Effects to Soil and Water Quality

The approval process for pesticide uses would consider potential to degrade water quality on and off refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from runoff or wind;
- Dissolve in water that can be subjected to runoff or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient (K_{oc}), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996). Half-life data is usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time (DT_{50}). It represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, half-life describes the rate for degradation only. As for half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation time is the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-life is the most common persistence data cited in published literature. If field or foliar dissipation data is not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism will be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et al. 1996) is expressed as the soil adsorption coefficient (K_{oc}). The soil adsorption coefficient is measured as micrograms of pesticide per gram of soil (μg/g) that can range from near zero to the thousands. Pesticides with higher K_{oc} values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water (mg/L or parts per million [ppm]). Pesticide with solubility <0.1 ppm are virtually insoluble in water, 100-1000 ppm are moderately soluble, and >10,000 ppm highly soluble (USGS 2000). As pesticide solubility increases, there would be greater potential for off-site movement.

The Groundwater Ubiquity Score (GUS) is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It utilizes soil persistence and adsorption coefficients in the following formula.

$$GUS = \log_{10}(t_{½}) \times [4 - \log_{10}(K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS <0.1 would considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 would be low, 2.0-3.0 would be moderate, 3.0-4.0 would be high, and >4.0 would have a very high potential to move toward groundwater.

Water solubility describes the amount of pesticide dissolving in a specific quantity of water, where it is usually measured as mg/L or ppm. Solubility is useful as a comparative measure because pesticides with higher values are more likely to move by runoff or leaching. GUS, water solubility, $t_{½}$, and K_{oc} values are available for selected pesticides from the OSU Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm (accessed 10 December 2020). Many of the values in this database were derived from the SCS/ARS/CES Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse textured soils (e.g., high sand content) have a larger pore size and they are generally more permeable than fine textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller the pore size would lower the likelihood and rate water that would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well-developed soil structure have looser, more aggregated, structure that would be less likely to be compacted. Both characteristics would allow for less restricted flow of water through the soil profile resulting in greater infiltration.
- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.
- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.
- Soil pH would influence chemical reactions that occur in the soil which in turn determines whether or not a pesticide will degrade, rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate best management practices (see below) would be used in an IPM framework to treat pests while minimizing effects to non-target biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through runoff and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker et al. 1992). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which it is persists. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

7.5 Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure which would be affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with $I<10$ would have a low potential to volatilize; whereas, pesticides with $I>1,000$ would have a high potential to volatilize (EXTOXNET 1996).

Vapor pressure values for pesticides are usually available in the pesticide product SDS or the USDA Agricultural Research Service (ARS) pesticide database.

7.6 Preparing a Chemical Profile

The following instructions would be used by Service personnel to complete Chemical Profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with USEPA. All information fields under each category (e.g., Toxicological Endpoints, Environmental Fate) would be completed for a Chemical Profile. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete Chemical Profiles. Each entry of scientific information would be shown with applicable references.

Completed Chemical Profiles would provide a structured decision-making process utilizing quantitative assessment/screening tools with threshold values (where appropriate) that would be used to evaluate potential biological and other environmental effects to refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to refuges. Where the "worst-case scenario" likely would only result in minor, temporary, and localized effects to listed and non-listed species with appropriate BMPs (see Section 5.0), the proposed pesticide's use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a Chemical Profile. In some cases, the Chemical Profile would include a lower application rate than the maximum labeled rate in order to protect refuge resources. As necessary, Chemical Profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed Chemical Profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on refuge lands. In general, PUPs would be approved for pesticides with Chemical Profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

Date: Service personnel would record the date when the Chemical Profile is completed or updated. Chemical Profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated, as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

Trade Name(s): Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

Common chemical name(s): Service personnel would record the common name(s) listed on the pesticide label or safety data sheet (SDS) for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the SDS, Section 2: Composition/ Information on Ingredients. A Chemical Profile is completed for each active ingredient.

Pesticide Type: Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, desiccant, fungicide, fumigant, growth regulator, insecticide, piscicide, or rodenticide.

EPA Registration Number(s): This number (EPA Reg. No.) appears on the title page of the label and SDS, Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number that is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

Pesticide Class: Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

CAS (Chemical Abstract Service) Number: This number is often located in the second section (Composition/Information on Ingredients) of the SDS. The SDS table listing components usually contains this number immediately prior to or following the % composition.

Other Ingredients: From the most recent SDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation not listed as an active ingredient that are described as toxic or hazardous, or regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), Occupational Safety and Health Administration (OSHA), State Right-to-Know, or other listed authorities. These are usually found in SDS sections titled “Hazardous Identifications”, “Exposure Control/Personal Protection”, and “Regulatory Information”. If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the Chemical Profile by trade name. SDS(s) may be obtained from the manufacturer, manufacturer’s website or from a professional on-line database such as that maintained by Crop Data Management Systems, Inc. (see list below).

Toxicological Endpoints

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for a particular taxonomic group, then “No data available is references” would be recorded as the data entry. Throughout the Chemical Profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

Mammalian LD_{50}: For test species in the scientific literature, Service personnel would record available data for oral lethal dose (LD_{50}) in mg/kg-bw (body weight) or ppm-bw. Most common test species in scientific literature are the rat and mouse. The lowest LD_{50} value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table 1 in Section 7.1).

Mammalian LC_{50}: For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species in scientific literature are the rat and mouse. The lowest LC_{50} value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Mammalian Reproduction: For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], No Observed Adverse Effect Concentration [NOAEC]) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, new born weight). Most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Avian LD_{50}: For test species available in the scientific literature, Service personnel would record values for oral lethal dose (LD_{50}) in mg/kg-bw or ppm-bw. Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD_{50} value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Avian LC_{50}: For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC_{50} value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Avian Reproduction: For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). Most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, NOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Fish LC_{50}: For test freshwater or marine species listed in the scientific literature, Service personnel would record a LC_{50} in ppm or mg/L. Most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC_{50} value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table 1 in Section 7.1).

Fish Early Life Stage (ELS)/Life Cycle: For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, LOAEC) in ppm for test procedure(s) (e.g., early life cycle, life cycle). Most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table 1 in Section 7.1).

Other: For test invertebrate as well as non-vascular and vascular plant species available in the scientific literature, Service personnel would record LC_{50}, LD_{50}, LOEC, LOEL, NOAEC, NOAEL, or EC_{50} (environmental concentration) values in ppm or mg/L. Most common test invertebrate species available in scientific literature are the honey bee and the water flea (*Daphnia magna*). Green algae (*Selenastrum capricornutum*) and pondweed (*Lemna minor*) are frequently available test species for aquatic non-vascular and vascular plants, respectively.

Ecological Incident Reports: After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The USEPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various federal and state agencies and non-government organizations. Information included in an incident report is date and location of the incident, type and magnitude of effects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

Environmental Fate

Water Solubility: Service personnel would record values for water solubility (S_w), which describes the amount of pesticide that dissolves in a known quantity of water. S_w is expressed as mg/L (ppm). Pesticide S_w values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1000 ppm, highly soluble >10,000 ppm (USGS 2000). As pesticide S_w increases, there would be greater potential to degrade water quality through runoff and leaching.

S_w would be used to evaluate potential for bioaccumulation in aquatic species [see **Octanol-Water Partition Coefficient (K_{ow})** below].

Soil Mobility: Service personnel would record available values for soil adsorption coefficient (K_{oc} [μg/g]). It provides a measure of a chemical's mobility and leaching potential in soil. K_{oc} values are directly proportional to organic content, clay content, and surface area of the soil. K_{oc} data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

K_{oc} values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

Soil Persistence: Service personnel would record values for soil half-life ($t_{½}$), which represents the length of time (days) required for 50% of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the $t_{½}$ value, soil persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et. al. 1996).

Threshold for Approving PUPs:

If soil $t_{½}$ ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.
If soil $t_{½}$ >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to minimize potential surface runoff and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil $t_{½}$ values would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below).

Soil Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade and move from a treated site; whereas, soil $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies compared to soil $t_{½}$, which is derived in a laboratory. However, soil $t_{½}$ is the most common persistence data available in the published literature. If field dissipation data is not available, soil half-life data would be used in a Chemical Profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the DT_{50} value, environmental persistence in the soil also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for Approving PUPs:

If soil $DT_{50} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If soil $DT_{50} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to minimize potential surface runoff and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil DT_{50} values (preferred over soil $t_{½}$) would be used in evaluating the potential to degrade groundwater by leaching (see **Potential to Move to Groundwater** below), if available.

Aquatic Persistence: Service personnel would record values for aquatic $t_{½}$, which represents the length of time required for 50% of the deposited pesticide to degrade (completely or partially) in water. Based upon the $t_{½}$ value, aquatic persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

Threshold for Approving PUPs:

If aquatic $t_{½} \leq 100$ days, then a PUP would be approved without additional BMPs to protect water quality.
If aquatic $t_{½} > 100$ days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to minimize potential surface runoff and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Aquatic Dissipation: Dissipation time (DT_{50}) represents the time required for 50% of the deposited pesticide to degrade or move (dissipate); whereas, aquatic $t_{½}$ describes the rate for degradation only. As for $t_{½}$, units of dissipation time are usually expressed in days. Based upon the DT_{50} value, environmental persistence in aquatic habitats also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for Approving PUPs:

If aquatic DT_{50} ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.
If aquatic DT_{50} >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to minimize potential surface runoff and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Potential to Move to Groundwater: Groundwater Ubiquity Score (GUS) = $\log_{10}$(soil t ½) x [4 – $\log_{10}(K_{oc})$]. If a DT_{50} value is available, it would be used rather than a t ½ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential<1.0, low - 1.0 to 2.0, moderate - 2.0 to 3.0, high - 3.0 to 4.0, or very high>4.0.

Threshold for Approving PUPs:

If GUS ≤4.0, then a PUP would be approved without additional BMPs to protect water quality.
If GUS >4.0, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to minimize potential surface runoff and leaching that can degrade water quality:*

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the ground water table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Volatilization: Pesticides may volatilize (evaporate) from soil and plant surfaces and move off-target into the atmosphere. The potential for a pesticide to volatilize is a function of its vapor pressure that is affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these values easier to compare, vapor pressure would be recorded by Service personnel in exponential form (I x 10^{-7}), where I represents a vapor pressure index. In general, pesticides with I<10 would have low potential to volatilize; whereas, pesticides with I >1,000 would have a high potential to volatilize (EXTOXNET 1996). Vapor pressure values for pesticides are usually available in the pesticide product SDS or the USDA Agricultural Research Service (ARS) pesticide database (see **References**).

Threshold for Approving PUPs:

If I ≤1,000, then a PUP would be approved without additional BMPs to minimize drift and protect air quality.
If I >1,000, then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to reduce volatilization and potential to drift and degrade air quality:*

- *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
- *Apply the large-diameter droplets possible for spray treatments.*
- *Avoid spraying when air temperatures >85°F.*
- *Use the lowest spray height possible above target canopy.*
- *Where identified on the pesticide label, soil incorporate pesticide as soon as possible during or after application.*

Octanol-Water Partition Coefficient (K_{ow}): The octanol-water partition coefficient (K_{ow}) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, K_{ow} would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If K_{ow} >1,000 or S_w<1 mg/L and soil $t_{½}$>30 days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (USGS 2000).

Threshold for Approving PUPs:

If there is not a high potential for a pesticide to bioaccumulate in aquatic species, then the PUP would be approved.
If there is a high potential to bioaccumulate in aquatic species (K_{ow}>1,000 or S_w<1 mg/L and soil $t_{½}$>30 days), then the PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Bioaccumulation/Bioconcentration: The physiological process where pesticide concentrations in tissue would increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low – 0 to 300, moderate – 300 to 1,000, or high >1,000 (Calabrese and Baldwin 1993).

Threshold for Approving PUPs:

If BAF or BCF≤1,000, then a PUP would be approved without additional BMPs.
If BAF or BCF>1,000, then a PUP would not approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Worst-Case Ecological Risk Assessment

Max Application Rates (acid equivalent): Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a Chemical Profile. These rates would be found in Table CP.1 under the column heading "Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis)". This table would be prepared for a Chemical Profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

EECs: An estimated environmental concentration (ECC) represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an USEPA screening-level approach (USEPA 2004). For each max application rate [see description under **Max Application Rates (acid equivalent)**], Service personnel would record 2 EEC values in a Chemical Profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see description for data entry under **Presumption of Unacceptable Risk/Risk Quotients**, which is the next field for a Chemical Profile.

Presumption of Unacceptable Risk/Risk Quotients: Service personnel would calculate and record acute and chronic risk quotients (RQs) for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a Chemical Profile would represent the worst-case assessment for ecological risk. See Section 7.2 for discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish and the EEC would be derived from Urban and Cook (1986) assuming 100% overspray to an entire 1-foot deep water body using the max application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish and an EEC would be derived from the aquatic assessment in AgDRIFT® model version 2.1 under Tier I ground-based application with the following input variables: max application rate (acid basis [see above]), low boom (20 inches), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section 7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the "short grass" food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kenaga nomogram method through the USEPA's T-REX version 1.5.

T-REX input variables would include the following: max application rate (acid basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section 7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with Levels of Concern (LOCs) established by USEPA (see Table 2 in Section 7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (T&E) species and non-listed species. See Section 7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

Threshold for approving PUPs:

If RQs ≤ LOCs, then a PUP would be approved without additional BMPs.
If RQs > LOCs, then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the **Specific Best Management Practices (BMPs) section** *to reduce potential risk to non-listed or listed species:*

- *Lower application rate and/or fewer number of applications so RQs ≤ LOCs*
- *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25 feet so RQs ≤ LOCs.*

Justification for Use: Service personnel would describe the reason for using the pesticide based control of specific pests or groups of pests. In most cases, the pesticide label will provide the appropriate information regarding control of pests to describe in the section.

Specific Best Management Practices (BMPs): Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to non-target species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a Chemical Profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to refuge resources and/or degradation of environmental quality is outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section 4.0 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

References: Service personnel would record scientific resources used to provide data/information for a chemical profile. Use the number sequence to uniquely reference data in a chemical profile.

The following on-line data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. < http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods >. Accessed 11 December 2020.

2. ECOTOX database. Office of Pesticide Programs, US Environmental Protection Agency, Washington, DC. < http://cfpub.epa.gov/ecotox/ >. Accessed 14 December 2020.

3. Extension Toxicology Network (EXTOXNET), Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University and University of Idaho through Oregon State University, Corvallis, Oregon. < http://extoxnet.orst.edu/pips/ghindex.html >. Accessed 11 December 2020.

4. FAO specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, Food and Agriculture Organization, United Nations. < http://www.fao.org/agriculture/crops/thematic-sitemap/theme/pests/jmps/ps-new/en/ >. Accessed 11 December 2020.

5. Human health and ecological risk assessments, pesticide-use risk assessments and worksheets. Pesticide Management and Coordination, Forest Health Protection, U.S. Department of Agriculture, US Forest Service. < https://www.fs.fed.us/foresthealth/protecting-forest/integrated-pest-management/pesticide-management/pesticide-risk-assessments.shtml >. Accessed 11 December 2020.

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. < http://www.kellysolutions.com/clemson/pesticides/pesticideindex.asp >. Accessed 11 December 2020.

7. Pesticide Fact Sheets. National Pesticide Information Center. < http://npic.orst.edu/npicfact.htm >. Accessed 11 December 2020.

8. Pesticide product labels and material safety data sheets. Crop Data Management Systems, Inc. (CDMS) or multiple websites maintained by agrichemical companies. < http://www.cdms.net/Label-Database >. Accessed 14 December 2020.

9. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. < http://oda.state.or.us/dbs/pest_productsL2K/search.lasso >. Accessed 14 December 2020.

10. Specific Chemical Fact Sheet – New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. U.S Environmental Protection Agency, Washington, DC. < https://www.epa.gov/ingredients-used-pesticide-products/brief-overviews-about-individual-pesticides > and < https://iaspub.epa.gov/apex/pesticides/f?p=CHEMICALSEARCH:1:0::NO:1:: >. Accessed 14 December 2020.

11. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. < https://www.invasive.org/gist/handbook.html >. Accessed 14 December 2020.

12. Wildlife Contaminants Online. U.S. Geological Survey, Department of Interior, Washington, D.C. < http://www.pwrc.usgs.gov/contaminants-online/ >. Accessed 14 December 2020.

Chemical Profile

Date:			
Trade Name(s):		**Common Chemical Name(s):**	
Pesticide Type:		**EPA Registration Number:**	
Pesticide Class:		**CAS Number:**	
Other Ingredients:			

Toxicological Endpoints

Mammalian LD_{50}:	
Mammalian LC_{50}:	
Mammalian Reproduction:	
Avian LD_{50}:	
Avian LC_{50}:	
Avian Reproduction:	
Fish LC_{50}:	
Fish ELS/Life Cycle:	
Other:	

Ecological Incident Reports

Environmental Fate

Water solubility (S_w):	
Soil Mobility (K_{oc}):	
Soil Persistence ($t_{½}$):	
Soil Dissipation (DT_{50}):	
Aquatic Persistence ($t_{½}$):	
Aquatic Dissipation (DT_{50}):	
Potential to Move to Groundwater (GUS score):	
Volatilization (mm Hg):	
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Biocentration:	**BAF:`** **BCF:**

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** **Croplands/Facilities Maintenance:**
EECs	**Terrestrial (Habitat Management):** **Terrestrial (Croplands/Facilities Maintenance):** **Aquatic (Habitat Management):** **Aquatic (Croplands/Facilities Maintenance):**

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Non-listed Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]

	Mammals	[1]	[1]
	Fish	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Non-listed Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Justification for Use:	
Specific Best Management Practices (BMPs):	
References:	

Table CP.1 Pesticide Name

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate - Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

[a] From each label for a pesticide identified in pesticide use proposals (PUPs), Service personnel would record application information associated with possible/known uses on Service lands.

[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

8.0 References

Baehr, C. H., and C. Habig. 2000. Statistical evaluation of the UTAB database for use in terrestrial non-target organism risk assessment. Presented at 10th Symposium on Environmental Toxicology and Risk Assessment, American Society of Testing and Materials, 10-12 April 2000, Toronto, Ontario, Canada.

Baker, J., E. Adcock, and G. Miller. 1992. Understanding and reducing pesticide losses. Pages 151-161 *in* Proceedings of the 1992 Crop Production and Protection Conference, 3 December 1992, Ames, Iowa. Iowa State University, USA.

Balciunas, J. K., and E. Coombs. 2004. International code of best practices for classical biological control of weeds. Pages 130-136 *in* E. M. Coombs, J. K. Clark, G. L. Piper, and A. F. Cofrancesco Jr., editors. Biological control of invasive plants in the U.S. First edition. Oregon State University Press, Corvallis, USA.

Barry, T., and J. Walters. 2004. Characterization of propanil prune foliage residues as related to propanil use patterns in the Sacramento Valley, CA. Pages 184-198 *in* C. Ramsay, A. Hewitt, H. Thistle, C. Hoffman, R. Wold, and T. Wolf, editors. Proceedings of the International Conference on Pesticide Application for Drift Management, 27-29 October 2004, Waikoloa, Hawaii.

Battaglin, W. A., E. M. Thurman, S. J. Kalkhoff, and S. D. Porter. 2003. Herbicides and transformation products in surface waters of the Midwestern United States. Journal of the American Water Resources Association 39:743-756.

Beyer, W. N., E. E. Connor, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. Journal of Wildlife Management 58:375-382.

Brooks, M. L., C. M. D'Antonio, D. M. Richardson, J. B. Grace, J. E. Keeley, J. M. DiTomaso, R. J. Hobbs, M. Pellant, and D. Pyke. 2004. Effects of invasive alien plants on fire regimes. BioScience 54:677-688.

Bureau of Land Management [BLM]. 2007. Vegetation treatments using herbicides on Bureau of Land Management lands in 17 western states programmatic environmental impact statement. U.S. Department of the Interior, Bureau of Land Management, Washington D.C., USA.

Bureau of Land Management [BLM]. 2016. Vegetation treatments using aminopyralid, fluroxypyr, and rimsulfuron on Bureau of Land Management lands in 17 western states programmatic environmental impact statement. U.S. Department of the Interior, Bureau of Land Management, Washington, D.C., USA.

Buttler, T., W. Martinkovic, and O. N. Nesheim. 1998. Factors influencing pesticide movement to ground water. University of Florida, Cooperative Extension Service Publication PI-2, Gainesville, USA.

Calabrese, E. J., and L. A. Baldwin. 1993. Performing ecological risk assessments. Lewis Publishers, Chelsea, Michigan, USA.

Center, T. D., J. H. Frank, J.H., and F. A. Dray Jr. 1997. Biological Control. Pages 245-263 *in* D. Simberloff, D. C. Schmitz, and T. C. Brown, editors. Strangers in paradise: impact and management of nonindigenous species in Florida. Island Press, Washington, D.C., USA.

Cox, R. D., and V. J. Anderson. 2004. Increasing native diversity of cheatgrass-dominated rangeland through assisted succession. Journal of Range Management 57:203-210.

Coombs, E. M., J. K Clark, G. L. Piper, and A. F. Cofrancesco Jr., editors. 2004. Biological control of invasive plants in the United States. Oregon State University Press, Corvallis, USA.

Driver, C. J., M. W. Ligotke, P. Van Voris, B. D. McVeety, B. J. Greenspan, and D. B. Brown. 1991. Routes of uptake and their relative contribution to the toxicologic response of northern bobwhite (*Colinus virginianus*) to an organophosphate pesticide. Environmental Toxicology and Chemistry 10:21-33.

Driver, C., L. Smith, J. Briant, P. Voris, and P. Buchholz. 1990. Laboratory test methods of exposure to microbial pest control agents by the respiratory route to nontarget avian species. U.S. Environmental Protection Agency, Environmental Research Laboratory, Publication EPA/600/3-90/070, Corvallis, Oregon, USA.

Dunning Jr., J. B. 1984. Body weights of 686 species of North American birds. Western Bird Banding Association Monograph No. 1, Phoenix, Arizona, USA.

Extension Toxicology Network [EXTOXNET]. 1993. Pesticide information project. Movement of pesticides in the environment. <http://extoxnet.orst.edu/tibs/movement.htm>. Accessed 10 December 2020.

Extension Toxicology Network [EXTOXNET]. 1996. Pesticide Information Profiles (PIPs). <http://extoxnet.orst.edu/pips/ghindex.html>. Accessed 10 December 2020.

Fletcher, J. S., J. E. Nellessen, and T. G. Pfleeger. 1994. Literature review and evaluation of the EPA food-chain (Kenaga) nomogram, an instrument for estimating pesticide residues on plants. Environmental Toxicology and Chemistry 13:1383-1391.

Hasan, S., and P. G. Ayres. 1990. The control of weeds through fungi: principles and prospects. Tansley Review 23:201-222.

Huddleston, J. H. 1996. How soil properties affect groundwater vulnerability to pesticide contamination. Oregon State University Extension Service, Publication EM 8559, Corvallis, USA.

Kerle, E. A., J. J. Jenkins, P. A. Vogue. 1996. Understanding pesticide persistence and mobility for groundwater and surface water protection. Oregon State University Extension Service, Publication EM 8561, Corvallis, USA.

Masters, R. A., S. J. Nissen, R. E. Gaussoin, D. D. Beran, and R. N. Stougaard. 1996. Imidazolinone herbicides improve restoration of Great Plains grasslands. Weed Technology 10:392-403.

Masters, R. A., and R. L. Sheley. 2001. Principles and practices for managing rangeland invasive plants. Journal of Range Management 54:502-517.

Maxwell, B. D., E. Lehnhoff, and L. J. Rew. 2009. The rationale for monitoring invasive plant populations as a crucial step for management. Invasive Plant Science and Management 2:1-9.

Mineau, P., B. T. Collins, and A. Baril. 1996. On the use of scaling factors to improve interspecies extrapolation of acute toxicity in birds. Regulatory Toxicology and Pharmacology 24:24-29.

Moody, M. E., and R. N. Mack. 1988. Controlling the spread of plant invasions: the importance of nascent foci. Journal of Applied Ecology 25:1009-1021.

Morse, L. E., J. M. Randall, N. Benton, R. Hiebert, and S. Lu. 2004. An invasive species assessment protocol: evaluating non-native plants for their impact on biodiversity. Version 1. NatureServe, Arlington, Virginia, USA. <https://www.natureserve.org/sites/default/files/publications/files/invasive_species_assessment_protocol.pdf >. Accessed 10 December 2020.

Mullin, B. H., L. W. Anderson, J. M. DiTomaso, R. E. Eplee, and K. D. Getsinger. 2000. Invasive plant species. Council for Agricultural Science and Technology Issue Paper 13, Ames, Iowa, USA. <https://www.cast-science.org/wp-content/uploads/2018/12/nnpl_ip.pdf>. Accessed 10 December 2020.

Pfleeger, T. G., R. Hayes, H. Ratsch, C. Wickliff, and A. Fong. 1996. Field evaluation of the EPA (Kenaga) nomogram, a method for estimating wildlife exposure to pesticide residues on plants. Environmental Toxicology and Chemistry 15:535-543.

Pope, R., J. DeWitt, and J. Ellerhoff. 1999. Pesticide movement: what farmers need to know. Iowa State University Extension Publication PAT 36, Iowa State University Extension and Outreach, Ames, and Iowa Department of Agriculture and Land Stewardship, Des Moines, USA.

Ramsay, C. A., C. G. Cogger, and C. B. McConnell. 1995. Protecting groundwater from pesticide contamination. Washington State University Extension Publication EB1644, Washington State University Extension, Pullman, USA.

Spray Drift Task Force [SDTF]. 2003. A summary of chemigation application studies. Stewart Agricultural Research Services, Macon, Missouri, USA.

Teske, M. E., S. L. Bird, D. M. Esterly, T. B. Curbishley, S. L. Ray, and S. G. Perry. 2002. AgDRIFT®: a model for estimating near-field spray drift from aerial applications. Environmental Toxicology and Chemistry 21:659-671.

Teske, M. E., S. L. Bird, D.M. Esterly, S. L. Ray, and S. G. Perry. 2001. A user's guide for AgDRIFT® 2.0: a tiered approach for the assessment of spray drift of pesticides. Report 01-01. Continuum Dynamics, Ewing, New Jersey, USA.

United States Environmental Protection Agency [USEPA]. 2004. Overview of the ecological risk assessment process in the Office of Pesticide Programs, U.S. Environmental Protection Agency: endangered and threatened species effects determinations. U.S. Environmental Protection Agency, Office of Pesticide Programs, and U.S. Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Washington, D.C., USA.

United States Environmental Protection Agency [USEPA]. 2005. Ecological risk assessment for pesticides: technical overview [website]. <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/ecological-risk-assessment-pesticides-technical>. Accessed 10 December 2020.

United States Environmental Protection Agency [USEPA]. 2012. T-REX version 1.5 user's guide for calculating pesticide residues on avian and mammalian food items: user's guide T-REX version 1.5 (Terrestrial Residue EXposure model). U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate and Effects Division, Washington, D.C., USA. <https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/t-rex-version-15-users-guide-calculating-pesticide>. Accessed 10 December 2020.

United States Forest Service [USFS]. 2005. Pacific Northwest region invasive plant program: preventing and managing invasive plants final environmental impact statement. U.S. Forest Service, Pacific Northwest Region, Portland, Oregon, USA.

United States Geological Survey [USGS]. 2000. Pesticides in stream sediment and aquatic biota: current understanding of distribution and major influences. U.S. Geological Survey, National Water-Quality Assessment, Fact Sheet 092-00, Sacramento, California, USA.

Urban, D. J., and N. J. Cook. 1986. Hazard evaluation division standard evaluation procedure: ecological risk assessment. U.S. Environmental Protection Agency, Office of Pesticide Programs, Publication EPA-540/9-85-001, Washington, D.C., USA.

Urban, D., T. Steeger, and E. Odenkirchen. 1998. A comparative analysis of ecological risks from pesticides and their uses: background, methodology and case study. U.S. Environmental Protection Agency, Office of Pesticide Programs, Environmental Fate & Effects Division, Washington, D.C., USA.

Wauchope, R. D., T. M. Buttler, A. G. Hornsby, P. M. Augustijn-Beckers, and J. P. Burt. 1992. The SCS/ARS/CES pesticide properties database for environmental decision-making. Reviews of Environmental Contamination and Toxicology 123:1-155.

Wilbur, S., H. Hansen, H. Pohl, J. Colman, and W. Stiteler. 2001. Guidance manual for the assessment of joint toxic action of chemical mixtures. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Toxicology, Atlanta, Georgia, USA. <https://hdl.handle.net/2027/mdp.39015052671503>. Accessed 11 December 2020.

Woods, N. 2004. Australian developments in spray drift management. C. Ramsey, A. Hewitt, H. Thistle, C. Hoffman, R. Wolf, and T. Wolf. Proceedings of the International Conference on Pesticide Application for Drift Management, 27-29 October 2004, Waikoloa, Hawaii. Washington State University Extension, Pullman, USA.

APPENDIX E

Practices to Minimize the Introduction of Invasive Species by Service Activities

The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The U.S. Fish and Wildlife Service has made every effort to ensure that the information in this document is accessible. If you have any problems accessing information, please contact the Hart Mountain National Antelope Refuge at Sheldon-Hart@fws.gov or (540) 947-3315.

Hart Mountain National Antelope Refuge Draft Bighorn Sheep Management Plan and Environmental Impact Statement

Appendix E. Practices to Minimize the Introduction of Invasive Species by Service Activities

Sheldon-Hart Mountain National Wildlife Refuge Complex

Within the NWRS, invasive species are collectively the single greatest threat to native plants, fish, and wildlife, with the potential to degrade entire ecosystems (USFWS 2003, USGAO 2008). Stopping the introduction and spread of new invasive species infestations is the most cost-effective approach to reducing this damage.

USFWS Region One employees carry out, fund, and authorize an extensive range of field activities that have the potential to spread invasive species. The tools, equipment, vehicles, animals, clothing, boots, and project materials moved between worksites can become potential vectors for the spread of invasive species. Prevention is a key aspect of invasive species management.

Sheldon-Hart Complex's Prevention Practices are organized according to the Seven Critical Elements presented in the USFWS Pacific Region's *Policy on Minimizing the Introduction of Invasive Species by Service Activities* (Prevention Policy). The staff of Sheldon Hart Complex NWR seeks to implement the following prevention practices to systematically minimize the risk of spreading invasive species. The appendices provide additional prevention practices and resources to assist with implementation of prevention practices.

Effective implementation of prevention practices requires a process of continuous learning. Each situation has different needs, constraints, and resources. Managers should use best professional judgement and provide alternate guidance when unique conditions warrant. Last, while prevention is the ideal method to address invasive species, it is also necessary for the Pacific Region to invest in early detection, rapid response, and long-term control in order to minimize harm.

The **Invasive Species Prevention Lead** for this refuge complex is Joelle Fournier (*current as of December 2020*). This position will help with the interpretation, implementation, and evaluation of the Invasive Species Prevention Policy and aid in dissemination of training materials and technical guidance and providing assistance, when feasible.

Table of Contents

Critical Elements

1. Risk evaluation

Conducting a thorough pre-activity assessment will help to identify which tasks can spread invasive species. For field activities with uncertain risk of invasive species introduction, the Invasive Species Pre-Activity Risk Assessment method will be conducted and prevention practices developed for the activity. This risk evaluation method can be applied to activities conducted by refuge management, biology, fire, maintenance or visitor services. Pacific Region National Wildlife Refuge System Invasive Species Pre-Activity Risk Assessment worksheet can be found in Appendix X2-A.

2. Low-risk sources of materials

Use of pest-free or low-risk sources of plants, mulch, wood, animal feed, or other materials brought to a field site or Service-owned property. *Clean transporting equipment prior to new load; consider using a liner if applicable. Consider tracking pads as a means to remove soil from equipment. If tracking pads are used they need to be thoroughly cleaned.*

Construction/building materials

- □ Inspect construction/building materials and associated shipping/storage containers to ensure that they are not harboring invasive species, including wood-boring insects before accepting delivery. Treat as necessary.
- □ Monitor areas where materials have been used for evidence of new invasive species introduction. *A monitoring framework & schedule should be developed in advance of specific project material needs. Most monitoring guidelines suggest quarterly inspection for 2 years. This can be modified as necessary.*

Hay and other animal feed

Comprehensive information on weed free forage, including list of noxious weed species and how to add a species to the list: *https://naisma.org/programs/purchase-weed-free-products/ (accessed 14 December 2020).* Information on Weed Free Forage Program including Map of Providers for states in accordance with North American Weed Free Forage (NAWFF) standards: https://www.oregon.gov/oda/programs/MarketAccess/ShippingPoint/Pages/WeedFreeForage.aspx (accessed 14 December 2020).

- □ Feeding operations should occur in established feed sites to reduce the potential introduction of invasive species to other areas.
- □ Survey feed sites frequently for new introductions, and treat accordingly. Monitor areas where materials were used, for evidence of invasive species germination.

Plants

- □ Do not plant or introduce prohibited or regulated invasive species or other listed invasive species as listed on relevant state or regional sites.
- □ When possible, use locally-sourced materials that would not present any invasive species risks not already found extensively at the activity site.

- □ Inspect nursery stock (including plants, seeds, sod) before accepting delivery and planting. *Inspect storage containers and soil for invasive species hitch-hiking in potting soil or on root ball; inspect stems, branches and leaves for obvious signs of insects or disease (black, brown, red, or white spots indicating the presence of insects or disease).*
- □ Monitor areas where materials are added for evidence of invasive species germination. *A monitoring framework & schedule should be developed in advance of specific project material needs.*
- □ Plants, seeds, and bulbs necessary for habitat restoration or other purposes should be from sources certified as free of invasive species (including weed seeds) or otherwise evaluated to ensure that they are not harboring invasive species.
  - *Use local seeding guidelines to determine detailed procedures and appropriate mixes. To avoid weed-contamination, a certified seed laboratory needs to test each lot against the all-State noxious weed list to Association of Seed Technologists and Analysts (AOSTA) standards, and provide documentation of the seed inspection test. There are plant species not on State and Federal noxious weed lists that may be considered non-native invasive weeds. Check State and Federal lists to see if any local weeds need to be added prior to testing. Seed lots labeled as certified weed free at time of sale may still contain some weed seed contamination. Non-certified seed should first be tested before use.*
  - *Verify seeds purchased commercially for label stating basic information about content and germination. Seed purchased commercially should have label stating: species; purity (most seed should have no less than 75% pure and preferably over 85% pure); weed seed content (tag should state NO invasive species are present. Only certified weed-free seed should be used. Note that seed is usually certified to be "noxious weed free" and may still contain seeds of wildland invasive plant species not included in noxious weed list); germination of desired seed (germination generally should not be less than 50% for most species, although some shrubs and forbs will have lower percentages).*

Soil and other non-woody fill materials

Soil, rocks, gravel, non-woody and other fill materials needed for habitat restoration, road construction, or other purposes.

- □ When possible, use locally-sourced materials that would not present any invasive species risks not already found extensively at the activity site. Materials obtained in close locality to the work site usually have a lower potential to introduce new invasive species, compared to materials brought in from more distant locations.
- □ Monitor areas where materials were added for evidence of invasive species germination. *A monitoring framework & schedule should be developed in advance of specific project material needs. Most monitoring guidelines suggest quarterly inspection for 2 years. This can be modified as necessary.*

Water

- □ When possible, water transported for fire management, irrigation of newly planted materials, herbicide/pesticide application or other purposes should come from potable

sources, non-invaded water bodies, or be certified to be free of aquatic invasive species.
- □ Do not transport water from infested waters, except by permit. When you must use water from an infested water-body for a management activity, do not drain the water or water that has come in contact with organisms from the infested waters where it can run into another basin, river, or drain system unless it drains to a treatment facility.
- □ Avoid moving water buckets from infested lakes to lakes that are not infested prior to inspection and cleaning. There is no hazard in using water infested with aquatic weeds on terrestrial sites.

Wood (e.g., firewood, logs, large woody debris for habitat restoration, mulch)
- □ When possible, use locally-sourced materials that would not present any invasive species risks not already found extensively at the activity site.
- □ Consider keeping materials on-site to limit transport; chipping, burying or burning where allowed.
- □ Designate an area for dumping woody material if it is infested with invasive species. Consider end source of woody material before disposal (e.g., brush to chip, chip to mulch, bio-fuels)
- □ Be aware of quarantine areas and other restrictions on the movement of materials and remove soil from stumps and trees before transporting.
- □ Monitor both areas where materials were used, and where materials were removed from (if applicable) for evidence of invasive species introduction. *A monitoring framework & schedule should be developed in advance of specific project material needs. Most monitoring guidelines suggest quarterly inspection for 2 years. This can be modified as necessary.*

3. Reduce exposure

Take measures to minimize contact with invasive species at field sites to reduce the potential for unwanted introductions, recognizing that some activities may require contact for control or other purposes.

Clothing selection
- □ Consider purchase of wading gear and boots with the fewest places for organisms and debris to become attached (e.g., one-piece systems with full rubber material and open cleat soles) Mud/rock guards are recommended for all stocking-foot waders to minimize contamination on inside surfaces.

Inventory/mapping
- □ Check each project site for invasive species infestations prior to management activity.
- □ See Appendix X2-B for resources to determine invasive species proximity to refuge.
- □ Employees working in invaded sites should be acquainted with the status and location of known invasive species that occur along trails, roads, riparian zones, or other sites where exposure vulnerability is significant.

Parking

- Avoid parking in patches of invasive species. When unavoidable, clean off soil and vegetation from vehicle when leaving the site.

Planning of work: aquatic

- When working on multiple water bodies, arrange sampling plans to progress from the least to the most likely to be contaminated areas when working within the same water body. When working on different reaches of the same stream, plan to decontaminate whenever equipment crosses a barrier while going upstream.
- Where possible, take reasonable steps to avoid transit through areas of high density, or small isolated populations of invasive species.
- Reduce the amount of plants, sediment, or organisms that are removed from the water into boats or sampling gear; throw any plants, sediment, or fish back into the waterbody they were found.
- Take additional care when working in waters designated as infested with aquatic invasive species. *However, just because a body of water has not been listed as infested does not mean there are no aquatic invasive species there – always come clean, leave clean, no matter the site.*
- Avoid washing and cleaning equipment where material could enter nearby bodies of water. Monitor areas where equipment is washed for invasive plants. Treat new infestations quickly.

Planning of work: land

- Minimize removal of vegetation and soil disturbance during construction, maintenance, and other ground-disturbing activities as invasive plants readily colonize areas of disturbed soil. *Plan to use equipment that minimizes soil and vegetation disturbance where feasible.*
- Monitor and manage invasive species in high exposure/risk areas (storage areas, gravel pits, trails)
- Designate cleaning areas for tools, equipment, vehicles, clothing, boots and gear. *Conduct inspection and removal/decontamination near entry/exit points away from water (at least 30 m away) and drainage areas. Select areas that are easily accessible and preferably have paved or sealed surfaces, and not near waterways or sensitive habitat or species. The cleaning area should be large enough to allow for safe movement of vehicles, equipment and staff.*

Roads

- Avoid driving off road; when driving off-road is necessary, avoid patches of invasive plants, whenever possible.
- Prioritize reducing invasive plant seed production along roadsides (edge to fifteen feet along roadway edge) to reduce seed movement by vehicles.

Timing of work

- Consider pre-treatment of invasive species, and postpone activity until an infestation can be treated. Effective pre-treatment may need to occur prior to soil disturbance.

4. Inspection, Removal, and Decontamination

Inspection is the first step to removal and decontamination practices; vehicles, machinery and gear should be inspected before and after conducting activities where there is potential to introduce invasive species. See Table X2-1 for guidance on when to conduct vehicle/equipment inspections.

Removal and decontamination practices will depend on the activity, equipment and tools being used, whether the equipment is moving off site or entering a high quality area, time of the year, if you are trying to clean mud or dry soil and vegetation, and other considerations. See Table X2-2 for a generic breakdown of risk categories to assist with selecting appropriate removal and decontamination practices.

Table X2-1. Examples of when to conduct inspections on vehicles and equipment.

Inspect before	Moving vehicles out of local area of operations Moving machinery between properties or sites within the same property where invasive species may be present in one area, and not in another Using machinery along roadsides, in ditches, and along watercourses Vehicles using unformed dirt roads, trails or off road conditions Using machinery to transport soil and quarry materials Visiting remote areas where access by vehicles is limited
Inspect after	Operating in areas known to have terrestrial invasive plants or are in high risk areas (e.g., recently disturbed areas near known invaded areas) Transporting materials (e.g., soil, fill) known to contain or has potential to contain invasive species Operating in an area or transporting materials that you are uncertain contain invasive species Rain events. Mud containing seeds can travel long distances, potentially transporting seeds to areas where those species previously did not exist

Table X2-2. Generic breakdown of risk categories.

Risk is highly dependent upon the location, activity, and materials used, and should be assessed prior to conducting activity. *If there are multiple levels of risk identified (e.g., low and moderate), the field crew should take the highest level of precaution (e.g., moderate).

Low Risk	In contact with one water body or field site in a week Frequenting an area near a water body but not entering the water body No documented invasive species in the area and none observed during field operation In contact with more than one field site/week but invasive species known or observed in each area have no risk of spreading at the time of the visit(s) (propagules are not present)
Moderate Risk	In contact with multiple water bodies or field sites in a week In contact with any invasive species infested water body or field site and risk of spread is present (propagules are present)
High Risk	In contact with multiple water bodies or field sites in a single day and the risk of spread is present (propagules present) in one or more sites In contact with both pristine/isolated locations and invasive species infested water bodies or field sites in a given field trip and propagules present in one, or more, locations Visiting rare and imperiled communities or known habitat for threatened and endangered species High risk could be one visit to one infected site depending on the organism and its virulence or likelihood to establish nearby

<u>Terrestrial field gear and equipment</u>

When loaning equipment or vehicles, make an expectation that the equipment is loaned out and returned clean. Materials and waste collected from removal and decontamination process are best destroyed on the cleaning site, when possible. If transporting off-site, place debris, soil, seeds, or invertebrates in plastic bags or totes and dispose in the trash, or incinerate. Do not dispose of material down storm drains.

Low Risk

Before leaving each site, clothing, hats, socks, shoes, gloves, jackets, and other gear should be thoroughly inspected. Particular attention must be given to places where foreign material could become accidentally trapped, such as in the cuffs and folds, closures such as zippers or ties and laces and treads of boots. Pockets and hoods should be turned inside out to remove debris. Upon inspection, use physical removal methods (stiff brush, lint remover, or compressed air) to remove contaminated material (plants, animals, and mud) from personal gear. Make sure to inspect items before visiting new work site to ensure they are free of foreign materials.

Moderate/High Risk

(*Includes Low Risk Category steps and additional step in bold*)

Before leaving each site, clothing, hats, socks, shoes, gloves, jackets, and other gear should be thoroughly inspected. Particular attention must be given to places where foreign material could become accidentally trapped, such as in the cuffs and folds, closures such as zippers or ties and laces and treads of boots. Pockets and hoods should be turned inside out to remove debris. Upon inspection, use physical removal methods (stiff brush, lint remover, or compressed air) to remove contaminated material (plants, animals, and mud) from personal gear.

AND:

Use pressurized hot water or other appropriate chemical decontamination appropriate to conditions (and invasive species risk), and launder washable items after each trip. When scrubbing fabric, be careful to brush with the nap (direction of fabric), as brushing against the nap could cause small seeds to become more embedded. Scrubbing should be followed by a rinse with clean water. Ensure all gear and equipment is completely dry.

OR:

Use dedicated field gear for each site with unique invasive species risks. Dedicated gear does not need to be cleaned or decontaminated after each use if labeled and kept isolated from other equipment to avoid cross-contamination.

Make sure to inspect items before visiting new work site to ensure they are free of foreign materials.

For details on pressurized hot water washer operation and safety precautions, see Appendix X2-D. Additional information on hot water washer safety and proper usage can be found in the owner's/operator manuals for the equipment (pdf's of these are available on the Complex network drive: S:\Property\Equipment [*current as of 14 December 2020*]).

Sensitive Equipment (Sondes, hydrolabs, and dataloggers)

Low, Moderate, and High Risk

Clean and sanitize sensitive equipment every time it has been exposed to substrates that may harbor invasive species. Dataloggers and similar equipment should be thoroughly rinsed after every exposure to potentially infested land areas using potable water or other similar purified water. Always consult the operating manual for the equipment to determine the manufacturer's recommendation for cleaning.

Terrestrial vehicles

When loaning equipment or vehicles, make an expectation that the equipment is loaned out clean and returned clean. For equipment such as water trucks that may be exposed to aquatic invasive species, trucks should be disinfected with bleach solution before conducting work in a new area. Materials and waste collected from removal and decontamination process are best destroyed on the cleaning site, when possible. If transporting off-site, place debris, soil, seeds, or invertebrates in plastic bags or totes and dispose in the trash, or incinerate. Do not dispose of material down storm drains.

<u>Rubber-tired vehicles (trucks, cars, trailers, ATV, UTV, motorbikes)</u>

Diagrams have been provided with key areas to inspect and clean on a variety of rubber-tired terrestrial vehicles (see Appendix X2-C, "Rubber-tired Vehicles").

Common BMP's, Regardless of Risk

Low Risk

Before leaving each site, visually inspect interior and exterior of the vehicle and remove plants, animals, and mud.

- □ Interior of vehicles: use rubber/plastic floor mats if possible, as carpet-type mats are harder to clean.
- □ Exterior of vehicles: clean from top of vehicle and work down to the bottom, knock off all large clods of dirt using a stiff-bristled brush or other appropriate tools.

Particular attention given to places where foreign material could become accidentally trapped, such as in cracks and crevices in upper surface and panels, in undercarriages, and in the treads of tires, rims, fender wells, spare tire mounting area, bumpers, front and rear quarter panels, around and behind grills, bottom of radiator vent openings, brake mechanisms, transmission, stabilizer bar, shock absorbers, front and rear axles, beds, suspension units, exhaust systems, light casings and mirrors. Interior areas like beneath seats and floor mats, upholstery, beneath foot pedals, and inside folds of gear shift cover.

Moderate Risk

Before leaving each site, visually inspect interior and exterior of the vehicle and remove plants, animals, and mud.

- □ Interior of vehicles: use rubber/plastic floor mats if possible, as carpet-type mats are harder to clean. **Sweep, vacuum, or use compressed air (on-site only).**
- □ Exterior of vehicles: clean from top of vehicle and work down to the bottom, knock off all large clods of dirt, **scrape or brush soil and debris from exterior surfaces**. Remove any guards, covers or plates that are easy to remove.

Particular attention given to places where foreign material could become accidentally trapped, such as in cracks and crevices in upper surface and panels, in undercarriages, and in the treads of tires, rims, fender wells, spare tire mounting area, bumpers, front and rear quarter panels, around and behind grills, bottom of radiator vent openings, brake mechanisms, transmission, stabilizer bar, shock absorbers, front and rear axles, beds, suspension units, exhaust systems, light casings and mirrors. Interior areas like beneath seats and floor mats, upholstery, beneath foot pedals, and inside folds of gear shift cover.

Heavy equipment

Examples of heavy equipment: off-road, rubber-tired, and tracked equipment, including excavators, dozers, graders, skidders, log trucks, dump trucks, loaders, feller bunchers, timber processors, mowers, and other equipment such as farm implements, construction mats, or Marsh Masters® (when decontaminating a Marsh Master® or other equipment that has substantial contact with water, the removal and decontamination practices within "watercraft and associated gear" may be applicable in addition to heavy equipment). Diagrams have been provided with key areas to inspect and clean on a variety of heavy equipment likely to be used, both tracked and rubber-tired (see Appendix X2-C, "Heavy Equipment – Tracked" and "Heavy Equipment – Rubber-tired").

Heavy equipment that stays on roads has a low risk of spreading invasive species. Whenever possible, park on a paved lot or in an area mowed or maintained with little or no vegetation to minimize contact with plant materials, soils, and water. This will reduce the likelihood of invasive species hitching a ride on your vehicle. When loaning equipment or vehicles, make an expectation that the equipment is loaned out clean and returned clean.

Low Risk

Clean interior of vehicles. Sweeping, vacuuming, or using compressed air. Use rubber/plastic floor mats if possible, as carpet-type mats are harder to clean.

Exterior of vehicles: knock off all large clods of dirt; scrape or brush soil and debris from exterior surfaces; an additional option is to use a leaf blower to remove vegetative debris.

Particular attention given to places where foreign material could become accidentally trapped, such as in cracks and crevices in upper surface and panels, in undercarriages, and in the treads of tires, tracks, bumpers, front and rear quarter panels, around and behind grills, ladders or steps, bottom of radiator vent openings, brake mechanisms, transmission, stabilizer bar, shock absorbers, front and rear axles, beds, suspension units, exhaust systems, light casings, buckets and blades, within slashing, mulching and ripping equipment. Interior areas like beneath seats and floor mats, beneath foot pedals, and inside folds of gear shift cover.

Water-based field gear and equipment

Water Body Sampling Gear

Nets (e.g., fyke, trap, gill, hoop, or dip) and other equipment that has direct contact with the water from the water body sampled. When loaning equipment, make an expectation that the equipment is loaned out clean and returned clean.

Common BMP's, Regardless of Risk

Soak nets and equipment (and any tools used for cleaning) with one of the following after leaving the site:

- Bleach solution (120 mL bleach to 19 liters of water). Thoroughly spray or soak equipment. Contact time should be at least 10 minutes. Rinse with clean water. When sampling for veligers (e.g., zebra or quagga mussel larvae), be sure to use a vinegar spray or soak (100%) for 20 minutes. This will prevent false positives at the next sampling location.
- Virkon® Aquatic. Soak for 20 minutes. Spray solution so surface is thoroughly exposed to disinfectant.
- Expose equipment for 10 seconds at 140°F/60°C with pressurized hot water.

For details on pressurized hot water washer operation and safety precautions, see Appendix X2-D. Additional information on hot water washer safety and proper usage can be found in the owner's/operator manuals for the equipment (pdf's of these are available on the Complex network drive: S:\Property\Equipment [*current as of 14 December 2020*]).

When applying chemical disinfection methods, consider safety in every step. Read the Material Safety Data Sheet or Safety Data Sheet and product labels for chemicals being used (e.g., Virkon®, bleach, and Formula 409®) and follow instructions to avoid inhalation and eye/skin irritation problems. Wear chemical splash goggles, gloves, and an apron to prevent contact with eyes or skin. Spray downwind (i.e., don't stand downwind when spraying).

Low Risk

*Immediately after leaving the water body, c*lean by hand picking or scrubbing attached sediment, plants, or debris from sampling nets and other equipment. If low risk practices cannot be done in the field, gear should be placed in a plastic bag or tote for transportation to a decontamination site. Rinse all surface areas with potable water, including any cleaning tools used. If potable water is not available, mix in a 3-5 gallon bucket or collapsible container, liquid chlorine bleach to achieve a 20-ppm active ingredient solution (mix to 30 ppm if water is noticeably discolored). Wait 10 minutes before using. Rinse equipment in location that will not drain back into the water body, to avoid contamination and potential damage to organisms. Follow all manufacturer's suggestions for chemical handling and wear proper protective gear. Dry thoroughly (≥2 days, if possible), preferably in the sun, before using gear in a different body of water.

Moderate Risk

Immediately after leaving the water body, clean by hand picking or scrubbing attached sediment, plants, or debris from sampling nets and other equipment. If low risk practices cannot be done in the field, gear should be placed in a plastic bag or tote for transportation to a decontamination site.

Rinse all surface areas with potable water, if possible. Hang equipment in a way that facilitates drying. Dry thoroughly (≥*5 days*, if possible), preferably in the sun. Inspect before using gear in a different body of water.

<u>Waders, Boots, and Other Field Equipment</u>

When loaning equipment, make an expectation that the equipment is loaned out clean and returned clean.

Common BMP's, Regardless of Risk

Wash and dry clothing (including field vest, etc.) before using in a different water body and field site, if possible. Wash footwear in sink or boot wash station in field offices before using in a different water body or field site.

Clean or soak other equipment such as shovels, knives, augers, etc., with one of the following options:

- □ Bleach solution (120 mL bleach to 19 liters of water). Apply by spraying or use a sponge so surface is thoroughly exposed to the bleach solution. Contact time should be at least 10 minutes. *When sampling for veligers (zebra or quagga mussel larvae), be sure to use a vinegar spray or soak (100%) for 20 minutes. This will prevent false positives at the next sampling location*
- □ Virkon® Aquatic. Soak for 20 minutes. Spray solution so surface is thoroughly exposed to disinfectant.
- □ Formula 409®. Spray 100% Formula 409 with a contact time of 10 minutes.

When applying chemical disinfection methods, consider safety in every step. Read the Material Safety Data Sheet or Safety Data Sheet and product labels for chemicals being used (e.g., Virkon®, bleach, and Formula 409®) and follow instructions to avoid inhalation and eye/skin irritation problems. Wear chemical splash goggles, gloves, and an apron to prevent contact with eyes or skin. Spray downwind.

Low Risk

Separate all individual components such as insoles, socks, booties, ankle guards and laces. Wash all components separately.

- □ By hand: before leaving a site, remove all sediment, plants, or debris from boots, waders, clothing, shovels, knives, and other field gear.
- □ Brushing: use a boot brush or pick to remove clods of dirt from boot or wader treads. If there is a nap to clothing material, brushing with the nap will remove plant material and seeds rather than embed it further.
- □ Adhesive roller: use an adhesive roller over all fabric clothing and footwear to remove small or embedded seed and plant material. Bag used adhesive sheets and dispose of in trash.

Rinse all surface areas with potable water, if possible. Hang items in a manner that facilitates drying. Dry thoroughly (≥2 days, if possible), preferably in the sun. Inspect before using gear in a different water body.

Moderate Risk

Separate all individual components such as insoles, socks, booties, ankle guards and laces. Wash all components separately.

- □ By hand: before leaving a site, remove all sediment, plants, or debris from boots, waders, clothing, shovels, knives, and other field gear. Look for adult mussels and feel by hand for very small juvenile mussels (an immature life stage) attached to anything that has made contact with water.
- □ Brushing: use a boot brush or pick to remove clods of dirt from boot or wader treads. If there is a nap to clothing material, brushing with the nap will remove plant material and seeds rather than embed it further.
- □ Adhesive roller: use an adhesive roller over all fabric clothing and footwear to remove small or embedded seed and plant material. Bag used adhesive sheets and dispose of in trash.

Rinse all surface areas with potable water, if possible. Hang items in a manner that facilitates drying. Dry thoroughly (≥2 days, if possible), preferably in the sun. Inspect items before using in a different water body.

Sensitive Equipment (Sondes, hydrolabs, and dataloggers)

Low, Moderate, and High Risk

Clean and sanitize sensitive equipment every time it has been exposed to substrates that may harbor invasive species. Dataloggers and similar equipment should be thoroughly rinsed after every exposure to potentially infested land areas using potable water or other similar purified water. Always consult the operating manual for the equipment to determine the manufacturer's recommendation for cleaning.

Watercraft Decontamination

Unless an activity has been determined to have no risk of introducing invasive species, one or more of the following actions should be taken (a) before going into the field, (b) before moving between field sites, and (c) before or upon return from field site:

Boats, Trailers, and Motors

When loaning equipment or vehicles, make an expectation that the equipment is loaned out clean and returned clean.

Common BMP's, Regardless of Risk

Clean all surfaces, live wells, and bilges with one of the following (when using either bleach or Virkon® Aquatic, make sure the boat is away from the water body to reduce the chance of the disinfection solution going into surface waters). Decontamination sites shall be located where risk is adequately managed to reasonably avoid the potential for runoff of waters or by-products into storm drains, groundwater, waterways, or wetlands. All decontamination will take place only in compliance with all applicable federal, state and local laws and rules and regulations including obtaining any permits that may be required.

- □ Bleach solution (120 mL bleach to 19 liters of water). Apply by spraying or use a sponge so surface is thoroughly exposed to the bleach solution. Contact time should be at least 10 minutes. Rinse with clean water. *When sampling for veligers (zebra or quagga mussel larvae), be sure to use a vinegar spray or soak (100%) for 20 minutes. This will prevent false positives at the next sampling location*
- □ Virkon® Aquatic (20 grams of Virkon® powder to 1 liter of water). Spray solution so surface is thoroughly exposed to disinfectant. Leave the solution on for 20 minutes. Rinse with clean water
- □ Use a hot water pressure washer with exposure time of a minimum of 10 seconds at 140°F/60°C to kill most AIS. Longer application is necessary for mature animals, up to 10-minutes for large clusters of mussels. Care must be given to avoid damaging equipment such as fragile surfaces, electronic components, electrical wiring, and certain mechanized equipment. Care must be exercised to not remove decals, paint or labels from any surface.

For details on pressurized hot water washer operation and safety precautions, see Appendix D. Additional information on hot water washer safety and proper usage can be found in the owner's/operator manuals for the equipment (pdf's of these are available on the Complex network drive: S:\Property\Equipment [*current as of 14 December 2020*]).

When applying chemical disinfection methods, consider safety in every step. Read the Material Safety Data Sheet or Safety Data Sheet and product labels for chemicals being used (e.g., Virkon®, bleach, and Formula 409®) and follow instructions to avoid inhalation and eye/skin irritation problems. Wear chemical splash goggles, gloves, and an apron to prevent contact with eyes or skin. Spray downwind.

Low Risk

Clean by hand picking or scrubbing with a stiff-bristled brush, any attached sediment, plants, or debris from boats, motors, and trailers before leaving access area. Drain water from bilges, pumps, and live wells at the ramp before leaving. Dispel water from motor by turning over engine. Rinse all surface areas with potable water, if possible. Dry thoroughly before using in a different body of water. Inspect items before using in a different water body.

Moderate Risk

Clean by hand picking or scrubbing with a stiff-bristled brush, any attached sediment, plants, or debris from boats, motors, and trailers before leaving access area.

Drain water from bilges, pumps, and live wells at the ramp before leaving. Dispel water from motor by turning over engine. Rinse all surface areas with potable water, if possible. Dry thoroughly before using in a different body of water. Inspect items before using in a different water body.

5. Drain water

Water from a site, collected in equipment or samplers, should be drained before leaving as it could introduce aquatic invasive species.

- □ Before leaving an aquatic sampling, work site or boat launch, drain water from all equipment onto dry land. *Items such as samplers, hoses, buckets, coolers, turbidity curtains, tanks, or water-retaining components of boats such as motors (lower-end units and motor cooling systems), live wells, bilge, pumps, or transom wells. Empty water out of kayaks, canoes, rafts, etc. Flush areas that can't be seen with clean water until the rinse water is clean and debris-free.*
- □ Drain plugs, bailers, valves, or other devices for draining water must be removed or open while transporting water-related equipment on a public road.
- □ Wring out any wet gear.

6. Movement of animals

General

- □ Adhere to existing Service protocols for controlling pathogens, parasites and toxins that cause disease when moving animals and discharging water or other media associated with movement, when applicable. *For example, 713FW 5: Special Case Aquatic Animal Movements and Controlled Propagation Programs (https://www.fws.gov/policy/713fw5.html, accessed 14 December 2020); refer to USFWS (2016), Appendix 2, for other related protocols.*
- □ Before disposing of water used to transport animals, treat with ethyl or isopropyl alcohol or drain on land where water will not enter surface water.
- □ Inspect outside of storage containers, cages, or other materials for visible presence of invasive species

Horse camps, trails and boarding facilities

- □ Designate areas for the storage of horse feed, bedding, and manure.
- □ Encourage stock users to feed animals weed-free feed and avoid grazing in weed-infested areas 72 hours prior to entering new location. *Information on weed-free forage found at https://naisma.org/programs/purchase-weed-free-products/ (accessed 14 December 2020) (see also "Low risk sources of materials, Hay and other animal feed", above)*

7. Reducing Invasive Species Introductions by Visitors

Provide information

- □ At key locations on Service lands and facilities, and via the internet or other electronic means as warranted, provide information that helps visitors understand the impacts of invasive species and how they can minimize introductions through simple methods.
- □ When appropriate, incorporate widely-used invasive species outreach messages or graphics. Examples of these include:
  - o "Stop Aquatic Hitchhikers!" campaign (https://stopaquatichitchhikers.org/; accessed 14 December 2020).
    - *Basics of "Clean, Drain, Dry" for recreationists (https://stopaquatichitchhikers.org/prevention/#clean-drain-dry; accessed 14 December 2020);*
  - o "Don't Move Firewood" campaign (https://www.dontmovefirewood.org/; accessed 14 December 2020).
    - Firewood maps (https://www.dontmovefirewood.org/map/; accessed 14 December 2020), provide information on firewood rules, regulations, recommendations, and pests of concern for the United States and Canada, as well as resource links.
    - Downloadable posters and kid's coloring pages (https://www.dontmovefirewood.org/resource-library/; accessed 14 December 2020).
  - o "Don't Let It Loose!" campaign (https://www.dontletitloose.com/; accessed 14 December 2020), has general information, map with local "Don't Let It Loose!" information.
  - o "Play Clean Go: Stop Invasive Species In Your Tracks" outreach campaign (https://www.playcleango.org/help-stop-invasive-species-with-playcleango; accessed 14 December 2020), provides basics of invasive species and prevention, primarily related to outdoor recreation.
- □ Provide information about known on-site invasive species that helps visitors understand how to avoid inadvertent contact that could lead to introduction of those species to uninvaded areas.

Activity-specific prevention

The below categories are single-page prevention fliers that would be appropriate for posting to assist the public with invasive species prevention practices awareness.

[ATV and other rubber-tired vehicles (on land)]

[Hunters]

[Motorized boaters]

[Non-motorized boaters]

8. Additional activities

Brush pile stacking and burning

- □ Pile woody material on already disturbed site. Make pile as tall and narrow as possible to reduce ground disturbance.
- □ Control any known populations of invasive species on site.
- □ Allow piles to cure for at least six months before burning.
- □ Monitor for invasive species after treatment.

Fire breaks (mowing)

Intentional movement of equipment (mower, brush and chainsaws) between areas:

- □ Use brush to sweep materials off saws.
- □ Remove chain from chain saws to clean out clutch and clean out saw carrier.
- □ Clean Velcro® areas and straps on Kevlar® chaps.
- □ Remove all loose soil and vegetation from mower deck and blade area.

Mowing

Preventing seed dispersal is crucial for preventing the spread of many invasive species. Mowing should be carefully considered to ensure that invasive species will not actually be spread by the practice.

- □ Mow areas with invasive species prior to flowering or at the very early flowering stages to minimize the spread of maturing seed. Do not mow plants after they have started to develop seeds.
- □ Prioritize roads/trails/areas that are either heavily infested with invasive plants or near sensitive habitat areas and prioritize mowing schedule for these.
- □ Set mower height sufficient to minimize soil disturbance.

Portable pumps

Examples of pumping equipment: portable pumps and suction hoses or any equipment that draws water from a water body, such as that used in water level management and fire operations.

- □ Avoid moving water from one waterbody to another. *Any equipment that draws water from one water body should not be drained into another water body without careful consideration of the likelihood of moving invasive species and their impacts.*

Low Risk

Scrape or brush soil and debris from exterior surfaces.

Prescribed burning

- ◻ Survey site before burning. The presence of invasives should be addressed in the burn plan.
- ◻ Minimize fire lines, use natural barriers
- ◻ Time burns to coincide with life cycle of weeds/invasives to burn weeds before they produce seeds
- ◻ Reduce burn frequency on sites that are susceptible to sterilization; allow piles to dry so that burn speed is rapid and intensity is low. Several cooler burns in spring may be better than hot burns that can reduce duff and leave soil bare
- ◻ Be prepared to conduct post burn treatment if invasive species seeds are stimulated to germinate
- ◻ Monitor after the burn and treat any invasive species (such as resprouts and germination).

Seeding/seed harvest

Intentionally moving equipment (harvesters, spreaders, mower, brush and chain saws):

- ◻ Use brush or leaf blow to clean broadcast spreader or drill.
- ◻ Use brush or leaf blower to clean seed stripper.
- ◻ Remove shoes or boots and dump out seeds.
- ◻ Remove all seeds from clothing using brush.

Wildfire camps

- ◻ Identify potential cleaning stations for those entering and leaving these areas.
- ◻ Identify water sources infested and uninfested with aquatic and terrestrial invasive plants. Map acceptable and contaminated water sources and ensure this information is available to resource advisors and fire personnel.
- ◻ Integrate equipment cleaning BMPs into planning for fire management activities.

Appendix X2-A. Pacific Region National Wildlife Refuge System Invasive Species Pre-Activity Risk Assessment

*Adapted from Pre-Activity Assessment included within Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers, California Invasive Plant Council, 2012.

1. **<u>Conduct a site assessment</u>**
   - □ List invasive species found in route to and within project sites, paying careful attention at likely introduction sites such as roadsides, trailheads, staging areas, boat launches, and other disturbed areas. (*Include as much detail as necessary to assess introduction/spread risk*.)

Species (common name)	Location (exact, when possible), density, dispersal mechanisms, impacts, other relevant information

   - □ List priority management areas or sensitive habitats within project area

Priority area/sensitive habitat	Location within project area

2. **<u>Describe each activity to determine:</u>**

- □ Location(s) of the activity:

- □ Location(s) of access routes:

- □ Timing for the activity:

- □ Tools and equipment to be used:

- □ Materials to be moved, imported or exported:

- □ Expected alteration of existing vegetation and soil:

- □ Other considerations:

3. List the sequence of tasks that are included in the activity and which can be altered to reduce the risk of invasive species introduction/spread based on:

- □ Task location:

    - □ Is there a location for this task with less potential to spread invasive species?

- ☐ Can access routes be changed to avoid traveling through invasive species populations?

- ☐ If materials are being moved, is there a better location for materials to be stored?

- ☐ Other task location considerations:

☐ <u>Task timing:</u>

- ☐ Can the task be performed in a different time (earlier/later in the season) or in a different sequence (e.g. spraying herbicide after mowing)?

- ☐ Can invasive species populations be treated before project tasks commence to reduce the introduction or spread of invasive species propagules?

- ☐ Other task timing considerations:

☐ <u>Task method(s):</u>

- ☐ Is there a different method of performing the task that can reduce the risk of introduction and spread?

- ◻ Could using different tools/equipment/materials reduce the risk of introduction and spread?

- ◻ Are weed-free materials available?

- ◻ Other task method considerations:

4. <u>Select appropriate prevention guidelines or develop new guidelines to address the risks of introduction and spread of invasive species for this activity.</u> ***<u>(Include each below.)</u>***

Appendix X2-B. Resources for determining invasive species proximity to refuge

Region-wide

- Early Detection and Distribution MAPping System (https://www.eddmaps.org/; accessed 15 December 2020). Provides point locations by species, and distribution data at the State and County level.
- USDA Natural Resources Conservation Service PLANTS Database (https://plants.sc.egov.usda.gov/java/; accessed 15 December 2020) allows user to track plants occurrence in individual counties throughout 49 states. Also available through the PLANTS database:
  - Users can determine whether a plant is invasive by referring to the Invasive and Noxious Weeds page (https://plants.usda.gov/java/noxiousDriver; accessed 15 December 2020);
  - Federal Noxious Weed List (introduced, invasive, noxious plants): https://plants.usda.gov/java/noxious?rptType=Federal (accessed 15 December 2020);
  - Oregon Noxious Weed List (introduced, invasive, noxious plants): https://plants.usda.gov/java/noxious?rptType=State&statefips=41 (accessed 15 December 2020);
  - Nevada Noxious Weed List (introduced, invasive, noxious plants): https://plants.usda.gov/java/noxious?rptType=State&statefips=32 (accessed 15 December 2020);
  - California Noxious Weed List (introduced, invasive, noxious plants): https://plants.usda.gov/java/noxious?rptType=State&statefips=06 (accessed 15 December 2020).
- USGS Nonindigenous Aquatic Species database (does not include pathogens): https://nas.er.usgs.gov/ (accessed 15 December 2020):
  - US Forest Service AIS distribution: Pacific Northwest Region (OR, WA) https://www.fs.fed.us/r6/fire/aquatic-invasive-species/ (accessed 15 December 2020). Subset of data from USGS NAS, broken down by watershed for priority AIS.

State-specific: Oregon

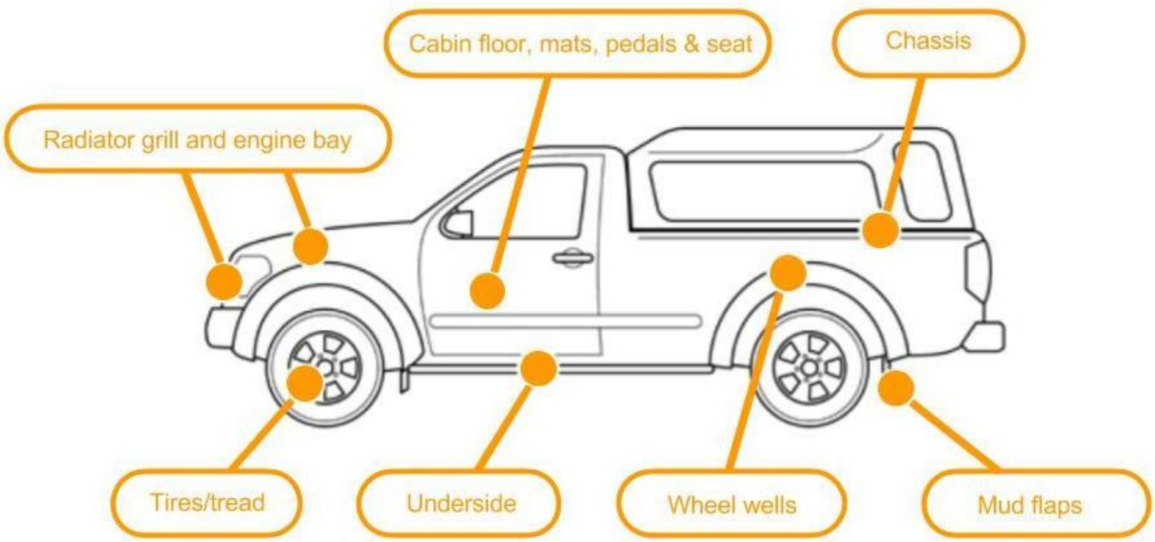
- WeedMapper: spatial information on the distribution of noxious weeds listed by the Oregon Department of Agriculture (ODA):
  - Program description, documentation, and links: https://www.oregon.gov/oda/programs/Weeds/Pages/WeedMapper.aspx (accessed 15 December 2020);
  - Spatial data and maps: https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=54e9b0eaacb34bc4a146a33faa9f8966 (accessed 15 December 2020).
- Oregon Cooperative Weed Management Areas: to assess and collaboratively manage "nearby invaders" (https://www.oregon.gov/ODA/programs/Weeds/Pages/CWMA.aspx; assessed 15 December 2020).
- Oregon iMapInvasives: an online GIS-based invasives species data management program, led by NatureServe at the national/international level (of which Oregon iMapInvasives is part):

    - Program overview, documentation, and links: https://sites.google.com/site/orimapresources/ (accessed 15 December 2020);
    - Spatial data and maps: https://imapinvasives.natureserve.org/imap/services/page/map.html (accessed 15 December 2020);
    - Login for adding/downloading data (creation of free iMapInvasives account required): https://imapinvasives.natureserve.org/imap/login.jsp (accessed 15 December 2020).
- Oregon Invasive Species Council: https://www.oregoninvasivespeciescouncil.org/ (accessed 15 December 2020).

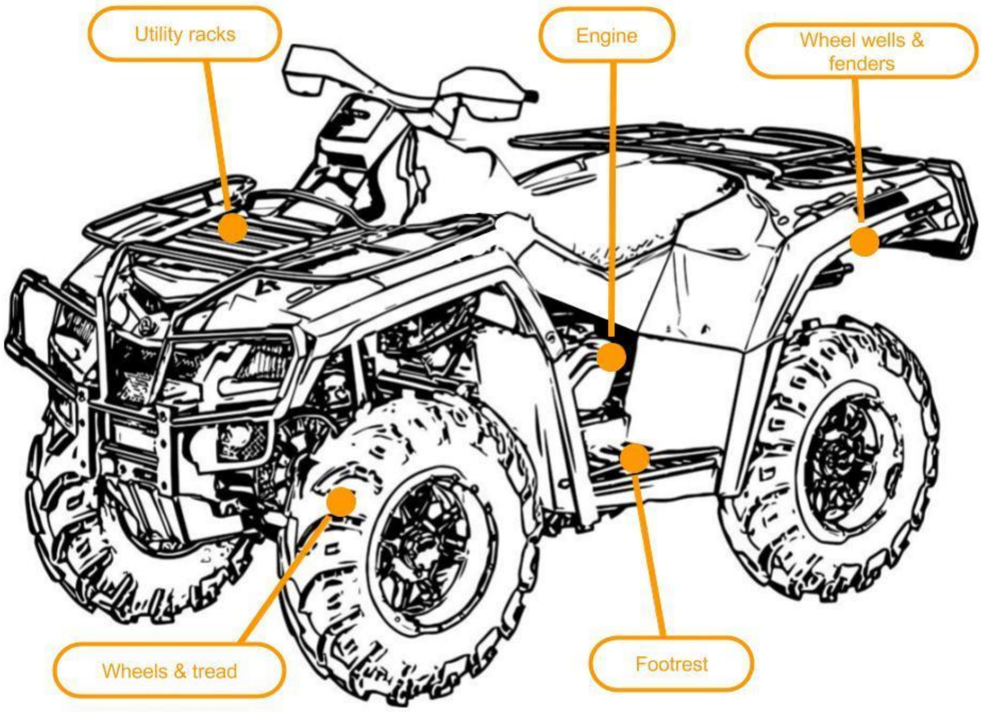
Appendix X2-C. Diagrams and checklists for inspection/decontamination of vehicles and heavy machinery.

Diagrams courtesy of Ontario Invasive Plant Council (Halloran et al. 2013).

<u>Rubber-tired Vehicles</u>

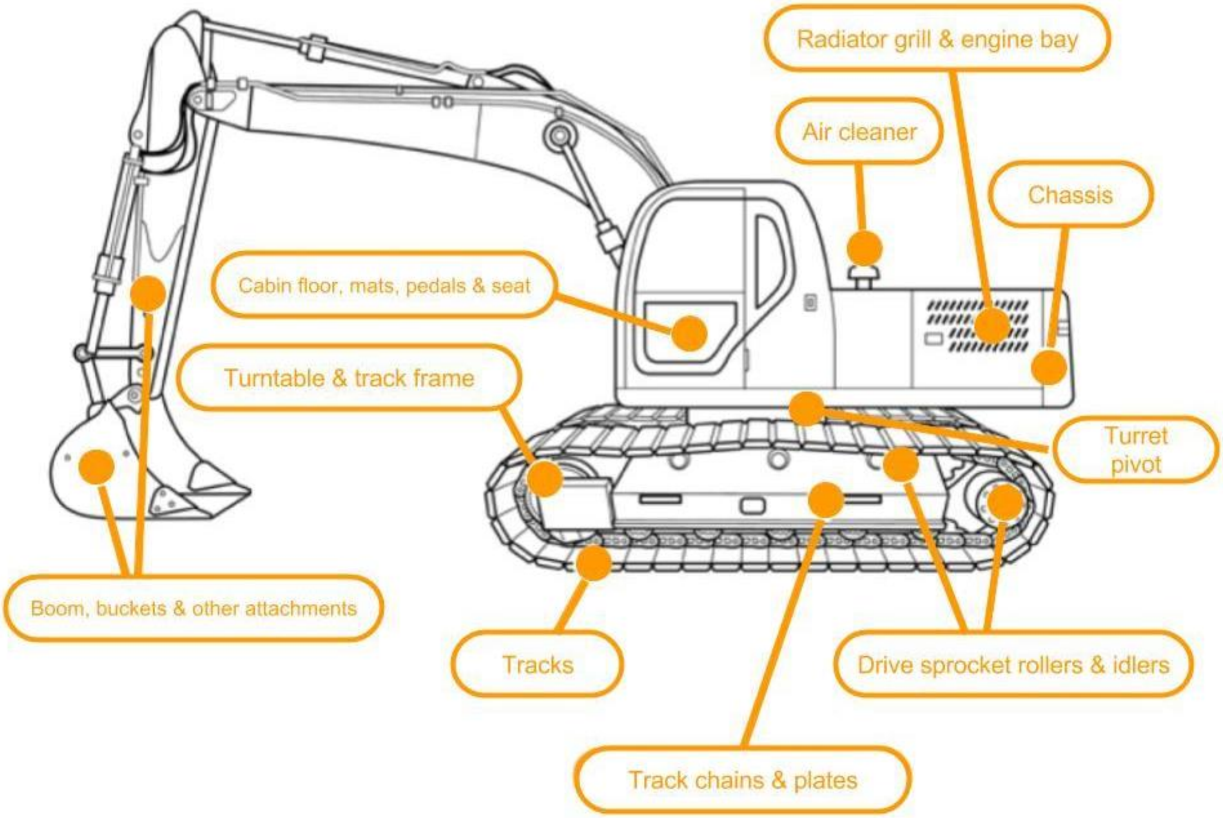


Cabin	Floor, mats, pedals, seats	
Engine	Radiators, engine bay, grill	
Body	Underside, chassis, crevices, ledges, bumper bars	
Wheels	All wheels including spare, wheel wells, mud flaps	
Truck bed	Floor, canopy (if applicable)	

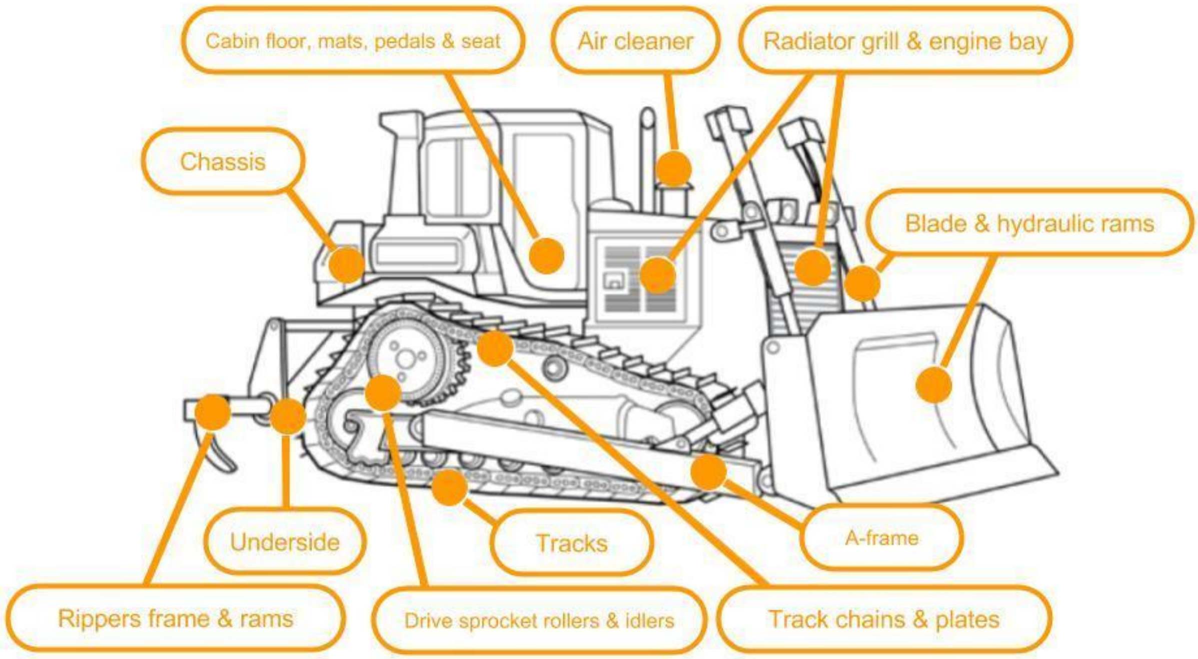


Body	Underside, crevices, ledges, footrest, skid plates	
Racks	Front & rear utility racks	
Wheels	All wheels, wheel wells, arm guards, & mud flaps	
Engine	Engine compartments, exhaust, radiators	

<u>Heavy Equipment – Tracked</u> (*such as Excavator and Bulldozer*)

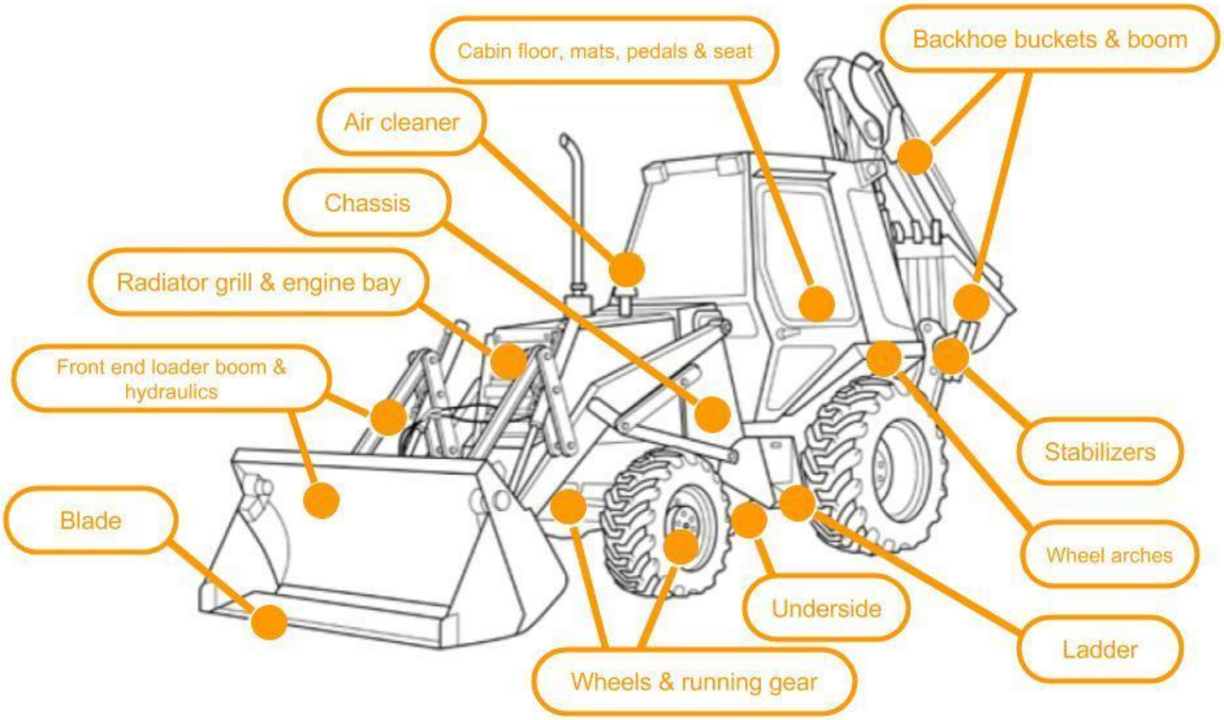


Cabin	Floor, mats, pedals, seats	
Engine	Radiators, engine bay, grill, air cleaner	
Tracks	Tracks, track frame, drive sprocket rollers, idlers	
Body plates	Plates of cabin	
Body	Ledges, channels	
Boom	Boom, bucket, other attachments as applicable	
Turret pivot		



Cabin	Floor, mats, pedals, seats	
Engine	Radiators, engine bay, grill, air cleaner	
Tracks	Tracks, track frame, drive sprocket rollers, idlers	
Body plates	Belly plates, rear plates	
Body	Ledges, channels	
Blade	Pivot points, hydraulic rams, a-frame	
Ripper	Ripper frame, ripper points	

Heavy Equipment – Rubber-tired (*such as Backhoe*)



Cabin	Floor, mats, pedals, seats, ladder	
Engine	Radiators, engine bay, grill, air cleaner	
Wheels	All wheels, wheel arches, guards	
Front end loader	Blade, hydraulics, booms	
Backhoe	Buckets, boom, hydraulics, stabilizers	

Appendix X2-D. Standard Operating Procedure for High Pressure Washer Use

All employees using the portable pressure washer must be trained in safe operation of the equipment and familiar with all controls. Untrained personnel are not permitted to operate this equipment. Owner's manual should be kept with the washer and read by all persons who will operate the equipment.

<u>**Before Each Use**</u>

1. Check equipment
    a. Check/add pump oil-verify oil level is half way up the sight glass
2. Check the engine oil level and add oil as needed
    a. Use recommended oil type for your engine and expected ambient conditions. See owner's manual for additional information.
3. Inspect spray system
    a. Inspect for damage and/or leaks before use. Check hoses, fittings, wand, trigger gun and connections for signs of wear, cracks, looseness, or leaks. Replace as needed. Check and clean nozzle and inlet filter. See owner's manual for maintenance details.
    b. Never use your finger to check for leaks. Never operate machine with damaged or missing hoses/parts. Do not start pressure washer until repairs have been completed.
4. Inspect fuel system
    a. Always inspect (engine and burner) fuel systems & check for leaks before starting pressure washer. Inspect fuel system looking for signs of leaks or deterioration, spongy fuel hose, loose connections, missing or loose fuel hose clamps, damaged gasoline tank, or defective gasoline shut-off valve.
5. Perform other scheduled maintenance as needed
    a. Refer to the owner's manual "Maintenance and Repair" section.
6. Select Suitable Outdoor Worksite
    a. **Outdoor use only**, and at least 20 feet from all building windows and air intakes
    b. **Do not locate and use the pressure washer in the presence of flammable vapors, dust, gases, or other potentially combustible materials**. Burner is an open flame, which can ignite airborne dusts and flammable vapors. Operate only where open flame or torch is permitted.
    c. Usage of this washer **requires adequate, unobstructed ventilation airflow**. Proper combustion can only be obtained when there is a sufficient supply of oxygen available for the amount of fuel being burned. Cooling ventilation is required to prevent overheating of the pressure washer and possible fire.
    d. **The exhaust gas from your pressure washer is extremely hot and can cause combustible materials to catch on fire.** Make sure both the engine exhaust and burner exhaust are at least 7 feet from all combustible materials and structures during operation. Keep a fire extinguisher rated "ABC" nearby; keep it properly charged and be familiar with its use
    e. **The pressure washer should be positioned on a firm, level (less than 3 degree slope), heat-resistant surface with good drainage and a nearby water supply.**

Ensure that the pressure washer sits level and will not slide or shift during operation. If applicable, block the pressure washer's wheels to prevent movement. Surface should be heat resistant if you will be using the burner for heated spray.

   f. **Wash water effluent must not enter state waters**, therefore the power washing operations must be located in a flat gravel area where water will seep into the ground without ponding.

7. Add fuels
   a. Check the gasoline tank level. If needed, fill tank.
   b. If you are planning to use heated water, fill burner fuel tank with appropriate fuel (see owner's manual for specifics)

<u>Operation:</u>

1. Connect hoses, water supply and spray nozzle. Ensure water supply is steady and capable of flowing at rate (20%) above rated flow of pump if using tap water. Water should be clean, debris can cause excess pump wear and reduce performance.
2. Attach high pressure hose to the pressure washer's water outlet. See owner's manual for details on coupler device usage and component specifications.
3. Select appropriate spray nozzle for the job. Generally, wider the spray angle of the nozzle, the lower the spray pressure produced. Use low pressure when applying approved chemicals with the pressure washer.
4. Attach nozzle to the spray gun. First depressurize hose line by squeezing the spray gun trigger while engine is off. Install the nozzle and check connection by pulling. It will rotate but stay in place if installed correctly.
5. Put on personal protective gear. Wear waterproof, thermally insulated gloves, safety glasses with side and top protection, face protection, and protective clothing when operating the machine. If spraying pressure washer specific chemicals, wear a respirator mask to avoid inhalation of vapors if directed on the chemical label. Wear non-slip, protective footwear. Use of pressure washer can create puddles and slippery surfaces. Wear footwear capable of maintaining a good grip on wet surfaces.
6. Prime water supply. Never run the pump without water supply connected and primed. See owner's manual for specific process based on water source used.
7. Start engine. Engage safety latch on spray gun and follow the instructions in the Engine Manual for starting.
8. Turn on burner for hot spray. Make sure vicinity is free of flammable vapors and fuel in the burner fuel tank. Make sure engine throttle is all the way open, turn heat switch on and adjust thermostat to the desired temperature.
9. High pressure spray. Clear cleaning area of all persons. Hold spray gun firmly with two hands and a sturdy stance. Wash from the bottom to the top, using side-to-side motions. This washes away heavy dirt and allows detergent to soak as you work toward the top.
   a. Use width of spray pattern to wash a wide path. Overlap spray paths for complete coverage.
   b. Nozzle should be 12-24 inches from work, closer for packed dirt areas.
   c. Small parts should be washed in a basket so the pressure does not push them away. Larger, lightweight parts should be clamped down.
   d. To reduce pressure, turn unloader know counterclockwise.

e. If temporarily interrupting spraying, rotate trigger safety latch downward to locked position.
f. Always turn off the engine and activate spray gun trigger to relieve system pressure when the sprayer is unattended or disconnecting hoses, installing/cleaning nozzles, or servicing the pump.

10. Stopping. Turn heat switch to OFF and run cold water through the coil for at least 3 minutes while spraying. Turn engine OFF. Turn water supply OFF. Actuate spray gun trigger to relieve system pressure. Remove nozzle from spray gun. Turn gasoline line valve to the OFF position. Cool engine at least 5 minutes before storing.

Important Safety Instructions:

Conditions for use:

- **Know how to stop.** Be thoroughly familiar with proper use of the equipment and all controls and connections. Know how to stop the pressure washer and depressurize system quickly if needed.
- **Instruct all operators**. The pressure washer's owner must instruct all operators and potential renters in safe set-up and operation. Do not allow anyone to operate the pressure washer who has not read the Owner's Manual and been instructed on its safe use.
- **Adult control only**. Only trained adults should set up and operate the pressure washer.
- **Under the influence**. Never operate, or let anyone else operate, the pressure washer while fatigued or under the influence of alcohol, drugs, or medication.
- **Safety equipment/controls in place**. Do not operate the pressure washer unless all safety covers, guards, and barriers are in place and in good working order, and all controls are properly adjusted for safe operation.
- **Damaged**. Do not operate the pressure washer with damaged, missing, or broken parts. Never attempt to repair a high pressure hose or component. Always replace it with a part that is rated at or above the pressure rating of the machine.
- **Modifications**. Do not modify the pressure washer in any way or deactivate any safety device. Do not change or add to fuel tank, fuel lines, or exhaust system. Modifications can result in hazards related to carbon monoxide poisoning, fuel leaks, fire, explosion or other serious safety hazards, and will also void the warranty.

During Use:

- **Stay alert.** Watch what you are doing at all times.
- **Clear work area.** Clear the work area of all bystanders. Keep children and pets away.
- **Keep spray away from electrical wiring**. Spray contact with electrical wiring will likely result in severe electrical shock or electrocution.
- **Hot exhaust/parts**. Stay clear of engine and burner exhausts. Never touch hot engine muffler, burner/heating coil, or other hot surfaces. All are very hot and will burn you.
- **Do not direct spray at this machine.** Do not attempt to clean this machine with its own spray. Engine damage will result. Cleaning should be done with a damp sponge with the engine OFF.
- **Let engine cool** at least two minutes before refueling.

- **Avoid inhalation of exhaust.** This product emits CO and chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.
- **Never pull by hose**. Do not move this machine by pulling on the hose. Hose or connections could fail and result in catastrophic high pressure release of fluid as well as hose whipping.
- **Avoid sharp objects**. Keep hose away from sharp objects. Bursting hoses may cause injury.
- **No load bearing**. Do not use the pump to support other items of equipment that impose unacceptable loads on the pump. Do not attempt to use this machine as a prop.
- **Lock trigger safety latch when not spraying**. Spray gun is equipped with a built-in trigger safety latch to guard against accidental trigger release. Rotate safety latch to the locked position when not spraying.
- **Leaving unattended**. Always turn off the pressure washer and relieve system pressure before leaving the sprayer unattended.

Emergency Response:

- **Seek medical aid for suspected injection injury**. If injured by high-pressure fluid, no matter how small the wound is, see a doctor at once. A typical injection injury may be a small puncture wound that does not look serious. However, severe infection or reaction can result if proper medical treatment is not administered immediately.
- **Seek medical aid for suspected carbon monoxide poisoning**. The running engine gives off carbon monoxide, a poisonous gas that can kill you. If you start to feel sick, dizzy, or weak while using the pressure washer, shut off the engine and get to fresh air RIGHT AWAY. See a doctor.

Appendix X2-E. References

Cal-IPC. 2012. Preventing the spread of invasive plants: best management practices for land managers. Third edition. California Invasive Plant Council, Berkeley, USA. < https://www.cal-ipc.org/docs/bmps/dd9jwo1ml8vttq9527zjhek99qr/BMPLandManager.pdf>. Accessed 15 December 2020.

Clark, J. 2003. Invasive plant prevention guidelines. Center for Invasive Plant Management, Bozeman, Montana, USA. <https://winapps.umt.edu/winapps/media2/wilderness/toolboxes/documents/invasive/CIPM_prevention_guide.pdf>. Accessed 15 December 2020.

DiVittorio, J., M. Grodowitz, J. Snow, and T. Manross. 2012. Inspection and cleaning manual for equipment and vehicles to prevent the spread of invasive species. U.S. Department of the Interior, Bureau of Reclamation, Technical Memorandum No. 86-68220-07-05, Denver, Colorado, USA. <https://www.usbr.gov/mussels/prevention/docs/EquipmentInspectionandCleaningManual2012.pdf>. Accessed 15 December 2020.

Halloran, J., H. Anderson, and D. Tassie. 2013. Clean equipment protocol for industry: inspecting and cleaning equipment for the purposes of invasive species prevention. Peterborough Stewardship Council and Ontario Invasive Plant Council, Peterborough, Ontario, Canada. <https://www.ontarioinvasiveplants.ca/wp-content/uploads/2016/07/Clean-Equipment-Protocol_June2016_D3_WEB-1.pdf> Accessed 15 December 2020.

Kenai Peninsula Cooperative Weed Management Area. 2013. Preventing the spread of invasive species: prevention guidelines for field research. Kenai Peninsula Cooperative Weed Management Area, Homer, Alaska, USA. <http://www.kenaiweeds.org/user_images/Prevention%20Guidelines.pdf>. Accessed 15 December 2020.

Michigan Department of Natural Resources. 2015. DNR wildlife division guidelines for decontamination. Michigan Department of Natural Resources, Wildlife Division, Lansing, USA. <http://www.michigandnr.com/FTP/forestry/Forest%20Certification%20Audit%20Documents%202015/Forest%20Certification%20Auditor%20Master%20CD%20File/Management%20Plans%20and%20Guidelines/DNR%20Guidelines/Wildlife%20Division%20guidance%20for%20decontamination_FINAL_June2015.docx>. Accessed 15 October 2020.

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed control methods handbook: tools & techniques for use in natural areas. The Nature Conservancy, Wildland Invasive Species Team. <https://www.invasive.org/gist/products/handbook/methods-handbook.pdf>. Accessed 15 December 2020.

Tweit, B., A. Pleus, D. Heimer, M. Hayes, C. Klein, J. Kerwin, J. Schultz, L. Phillips, B. Hebner, A. Hoffmann, M. Schmuck, S. Kelsey, and R. McDaniel. 2012. Invasive species management protocols. Version 2. Washington Department of Fish and Wildlife, Invasive Species Management Committee, Publication 01490, Olympia, USA. <https://wdfw.wa.gov/sites/default/files/publications/01490/wdfw01490.pdf>. Accessed 15 October 2020.

U.S. Fish and Wildlife Service [USFWS]. 2003. The national strategy for management of invasive species. U.S. Fish and Wildlife Service, National Wildlife Refuge System, Washington, D.C., USA. <https://www.fws.gov/invasives/pdfs/nationalstrategyfinalrevised05-04.pdf>. Accessed 15 December 2020.

U.S. Fish and Wildlife Service [USFWS]. 2016. Region 1: U.S. Fish and Wildlife Service Pacific Region Policy on minimizing the introduction of invasive species by Service activities. <https://ecos.fws.gov/ServCat/Reference/Profile/105555>. Accessed 14 December 2020.

U.S. Government Accountability Office [USGAO]. 2008. Wildlife refuges: changes in funding, staffing, and other factors create concerns about future sustainability. U.S. Government Accountability Office, Report GAO-08-797, Washington, D.C., USA. <https://www.gao.gov/assets/290/281400.pdf>. Accessed 15 December 2020.

Wisconsin Department of Natural Resources [WI-DNR]. 2018. Best management practices for boat, gear and equipment decontamination. Wisconsin Department of Natural Resources, Bureau of Water Quality, Madison, USA. <https://dnr.wisconsin.gov/sites/default/files/topic/Invasives/BMPs%20for%20Decontamination_2018-2-6.pdf>. Accessed 15 December 2020.

APPENDIX F

Minimum Requirements Analysis for Management Actions within Proposed Poker Jim Ridge Wilderness

ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER

MINIMUM REQUIREMENTS DECISION GUIDE

WORKBOOK

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

-- The Wilderness Act of 1964

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 1: Determination

Determine if Administrative Action is Necessary

Description of the Situation

What is the situation that may prompt administrative action?

Biologists working at the Hart Mountain National Wildlife Refuge have identified a need for information about the ecology of bighorn sheep within the refuge, including the proposed Poker Jim Wilderness Area. The 17,464 acre Poker Jim Wilderness Area encompasses the northern portion of Hart Mountain commonly referred to as Poker Jim Ridge and is situated north of the Frenchglen Road between Rock Creek and the Warner Valley. Terrain is formed by a geologic fault-thrust of the basalt formation resulting in a steep rocky west facing escarpment culminating with a table-top formation which gradually slopes off to the east. Habitats are primarily low sagebrush steppe with scattered areas of mountain sagebrush steppe habitat and more rocky areas dominated by juniper woodland habitat. Habitats along Poker Jim Ridge are considered important for California bighorn sheep, mule deer, for pronghorn in summer, and for Greater sage-grouse. Based on aerial monitoring and because bighorn sheep are susceptible to respiratory disease, notably pneumonia, which often results in subsequent die-off and poor juvenile recruitment, refuge biologists and Oregon Department of Fish and Wildlife (ODFW) have become concerned about the bighorn sheep population.

Options Outside of Wilderness

Can action be taken outside of wilderness that adequately addresses the situation?

☐ YES

☑ NO

EXPLAIN & COMPLETE STEP 1 OF THE MRDG

Explain:

Bighorn sheep inhabit habitats across the western portion of the Hart Mountain Refuge, with a significant portion of the population occuring within the proposed Poker Jim Ridge proposed wilderness. The lands surrounding the refuge are of mixed ownership and do not provide habitat for bighorn sheep. Consequently, while action to acquire information about the population and disease will be conducted in non-wilderness portions of the Refuge, these actions cannot be taken entirely outside of the proposed wilderness. Collaring and sampling sheep across the Refuge is required to meet project objectives.

Criteria for Determining Necessity

Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that ***requires*** *action? Cite law and section.*

☐ YES ☑ NO

Explain:

There are no valid existing rights or special provisions that require action to be taken.

B. Requirements of Other Legislation

Is action necessary to meet the requirements of <u>other federal laws</u>? Cite law and section.

☑ YES ☐ NO

Explain:

The National Wildlife Refuge Administration Act of 1966 (16 U.S.C.§668dd, as amended) specifies that biological integrity, diversity, and environmental health of the National Wildlife Refuge System shall be ensured. Maintaining a healthy and viable bighorn sheep population is important to maintaining the biological integrity, diversity and environmental health of Hart Mountain Antelope Refuge and the Proposed Poker Jim Wilderness. Given recent declines in bighorn sheep the Refuge needs to conduct bighorn sheep monitoring in the proposed Poker Jim Wilderness Area.

C. Wilderness Character

Is action necessary to preserve one or more of the five qualities of wilderness character?

UNTRAMMELED

☐ YES ☑ NO

Explain:

Actions are not neccessary to preserve the untrammeled wilderness quality.

UNDEVELOPED

☐ YES ☑ NO

Explain:

Actions are not neccessary to preserve the undeveloped wilderness quality.

NATURAL

☑ YES ☐ NO

Explain:

The proposed actions are needed to ensure a healthy, viable population of bighorn sheep over the long-term and thereby preserve a critically important component of the natural quality of the Proposed Poker Jim Ridge proposed wilderness and a symbol of Refuge. Understanding disease issues, movements, habitat and causes of population decline are critical to the management of Bighorn sheep on the Refuge. Bighorn sheep are particularly susceptible to respiratory disease which can result in rapid population decline. By conducting the analysis now to understand the prevalence of disease and the specific strains of pathogens present in the population, informed decisions can be made about whether or not further management actions are necessary and, if so, more proactive, wilderness-compatible management actions can be developed to preserve this species as a natural component of this proposed wilderness area.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the solitude or primitive and unconfined recreation wilderness quality.

OTHER FEATURES OF VALUE

☐ YES ☑ NO

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Step 1 Determination

Is administrative action *<u>necessary</u>* *in wilderness?*

Criteria for Determining Necessity	Summary Responses
A. Existing Rights or Special Provisions	Action IS NOT necessary to meet this criterion.
B. Requirements of Other Legislation	Action IS necessary to meet this criterion.
C. Wilderness Character	
Untrammeled	Action IS NOT necessary to meet this criterion.
Undeveloped	Action IS NOT necessary to meet this criterion.
Natural	Action IS necessary to meet this criterion.
Solitude/Primitive/Unconfined	Action IS NOT necessary to meet this criterion.

Other Features of Value — Action IS NOT necessary to meet this criterion.

Is administrative action necessary in wilderness?

☑ YES — **EXPLAIN & PROCEED TO STEP 2 OF THE MRDG**

☐ NO

Explain:

Action is necessary to allow the gathering of information about the bighorn sheep population disease issues and habitat in wilderness. The bighorn sheep is a native species to the refuge and an iconic part of the natural conditions of the wilderness to be protected. Previous studies have indicated that over a three year period no marked individuals left the refuge. Suitable habitat for bighorn sheep in this area exists within the refuge and approximately 35% of the habitat is within the wilderness area. The information to be gained is needed to provide a baseline and also to help address questions of any future need for management to ensure a healthy viable population over the long-term.

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2

Determine the Minimum Activity

Other Direction

*Is there "special provisions" language in legislation (or other Congressional direction) that explicitly **allows** consideration of a use otherwise prohibited by Section 4(c)?*

AND/OR

Has the issue been addressed in agency policy, management plans, species recovery plans, or agreements with other agencies or partners?

☑ YES

DESCRIBE OTHER DIRECTION

☐ NO

Describe Other Direction:

Proposed handling of bighorn sheep would primarily occur between January 1st and February 28th to avoid disruption of lamb/ kid birth and development, and decrease the possibility of heat stress and mortality to captured animals. This time frame reduces potential conflict with wilderness visitors in the busy summer season. FWS and ODFW has determined that to effectively understand what is causing this herd to underperform, collecting biological samples as well as GPS radio collaring are needed. The minimum number of animals studied for an effective sample has been determined to be 25 bighorn sheep.

Time Constraints

What, if any, are the time constraints that may affect the action?

Components of the Action

What are the discrete components or phases of the action?

Component X	*Example: Transportation of personnel to the project site*
Component 1	Transportation of personnel to and from capture site
Component 2	Capturing method
Component 3	Health and disease monitoring
Component 4	Population monitoring
Component 5	
Component 6	
Component 7	
Component 8	
Component 9	

Proceed to the alternatives.

Refer to the **MRDG Instructions** regarding alternatives and the effects to each of the comparison criteria.

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 1: No Action

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

The No Action alternative for a Minimum Requirements Analysis is to take no management action. This differs from a No Action alternative under the National Environmental Policy Act (NEPA) in that under NEPA, the no action alternative is the continuation of current management practices. The No Action Alternative serves as a baseline to compare the effects of the action alternatives to wilderness character. No capture, collaring or disease monitoring would be conducted in the wilderness. Annual aerial counts would remain the only means of determining: health and status of individual animals and identifying population trends.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	No transportation of personnel to and from capture site
2	Capturing method	No capturing of animals
3	Health and disease monitoring	No processing and biological sampling of animals
4	Population monitoring	Annual helicopter surveys
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel to and from capture site	☐	☐	☑
2	No capturing of animals	☐	☐	☑
3	No processing and biological sampling of animals	☐	☐	☑
4	Annual helicopter surveys	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

No action would have no effect to untrammeled quality. Continuing annual aerial surveys is the only action under this alternative, and is not a trammeling action.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel to and from capture site	☐	☐	☑

2	No capturing of animals	☐	☐	☑
3	No processing and biological sampling of animals	☐	☐	☑
4	Annual helicopter surveys	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

There would be no effect to the undeveloped character from the no action alternative

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel to and from capture site	☐	☐	☑
2	No capturing of animals	☐	☐	☑
3	No processing and biological sampling of animals	☐	☑	☐

4	Annual helicopter surveys	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Natural Total Rating			**-1**	

Explain:

If no action is taken, there is legitimate concern that bighorn sheep population would continue to decline and this important aspect of the natural quality of wilderness could be impacted or even extirpated over the long-term. The population of the bighorn sheep within the proposed wilderness area may continue to be stable but below the refuge population objective or the population could decline rapidly due to disease spread. While no domestic sheep are permitted on the surrounding BLM administered lands, or within the project area, some potential for disease transmission from domestic sheep to bighorn sheep still exists due to the presence of domestic sheep on private land or outside the project area. Transmission of disease to bighorn sheep inside the wilderness area from individuals that have interacted with domestic animals is a primary concern without direct monitoring and sampling of individual sheep, we will continue to have no information regarding disease in the bighorn sheep population or movements and herd dynamics, consequently whether or not the underperformance of these herds is a natural process or if it is being caused by disease from domestic livestock or something else would not be understood. If no action is taken, the effect to the natural character could range from minor to catastrophic (loss of the herd) with potential significant and long-duration effects.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel to and from capture site	☐	☐	☑
2	No capturing of animals	☐	☐	☑
3	No processing and biological sampling of animals	☐	☐	☑
4	Annual helicopter surveys	☐	☐	☑
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating		0		

Explain:

If no action is taken there would not be any effect on the ability of wilderness visitors to find solitude or recreate in the wilderness area. However, if the bighorn sheep population declines due to unknown disease issues, the opportunity for popular wilderness recreational activities (bighorn sheep observation, photography, hunting) may be lost.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel to and from capture site	☐	☐	☑
2	No capturing of animals	☐	☐	☑
3	No processing and biological sampling of animals	☐	☐	☑
4	Annual helicopter surveys	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 1

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	-1
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**-1**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 2: Net Trapping Using Ground Crews Only

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

This alternative would use no Wilderness Act section 4c prohibited tools and consists of using porters and/or stock to support activities. The maximum number of crew per site is 15. Eighteen porters or 7 stock within the proposed wilderness would be required and estimated stay is 16 days. Helicopter will do reconnaissance to locate areas where bighorn sheep occupy the area to identify highest potential trap locations in each wilderness. Highest potential sites are prioritized and trap site spike camp(s) location is determined. Trap crew (3 people) hike into location. Material are transported by stock or porters to trap location which includes: bait (300Ibs of apple mash), and spike camp equipment and supplies to highest potential pre-net test area and to a spike camp location. Stock and porters may stay overnight, but will leave wilderness area after delivery of equipment and materials. Pre-test area suitability- Trap crew sets out bait (300lbs of apple mash) to attract animals. If pre-net test area draws in desired number of animals in up to 3 days Spike camp set up in a location that will not affect net test operations. Trap area determined - Trap crew will call in additional trap crew (2 people). Stock or porters will haul in spike camp supplies, additional bait (300Ibs of apple mash) and a trap-net that includes: 6 steel poles, stakes, 60'X60' net, 2-12volt batteries, associated cables and pulleys (600Ibs). Trap setup - Expanded crew will set up the trap with bait and monitor. Trap release- It generally takes 7 days or more for animals to get accustomed to trap and for human scent to dissipate. (Note: Porters may be required to haul in more bait, if bait is needed) When survey quota of animals stay under trap an additional crew of 10 (number is based on 5 animals with a ratio of 2 people per animal) people will be called in to assist the night before trap release day. Stock or porters will be required to bring in processing supplies and equipment. On trap release day morning, spotter signals for trap release when number of animals are within net area. Support crew and trap crew converge on netted animals and subdue. Processing- Crew will do blood work and collar animals. Once processing is complete animals will be released. Trap removal - Crew will remove trap and associated materials and ready for transport by stock or porters to a new location. These steps are repeated for each capture site. An estimated two sites will be needed for within the wilderness area to capture and process the required number of animals.

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	Personnel will travel to and from capture site by foot or stock
2	Capturing method	Stock supported trap net crew
3	Health and disease monitoring	Processing and biological sampling of animals
4	Population monitoring	GPS radio collars
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by foot or stock	☐	☐	☑
2	Stock supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

Capturing and collaring bighorn sheep is an intentional action that manipulates "the earth and its community of life" inside a proposed wilderness.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by foot or stock	☐	☐	☑

2	Stock supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Undeveloped Total Rating			**-2**	

Explain:

The trap pen and GPS radio collars are installations that represent visible evidence of human activity, which degrades the undeveloped wilderness quality. The presense of the trap pens would be temporary.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by foot or stock	☐	☐	☑
2	Stock supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☑	☐	☐

		Positive	Negative	No Effect
4	GPS radio collars	☑	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		2	1	NE
Natural Total Rating			**1**	

Explain:

By helping to ensure a healthy viable bighorn sheep population, two components would have positive effects to Natural quality. Processing and biological sampling of animals: Drawing blood samples will provide USFWS and ODFW the opportunity to understand what is causing poor herd performance. This is potentially very important information for preservation of bighorn sheep in the wilderness area. Understanding the potential for disease spread between bighorn sheep, monitoring and maintaining meaningful data regarding current health status, survival, and causes of mortality will inform future management actions and potentially have long term positive effects to the natural quality of wilderness character. Similarly, data obtained from GPS radio collars will allow USFWS and ODFW to track movements which will help inform the understanding of the potential for spread of as well as provide information about year-round habitat use and movement/migration patterns. Data from animals that die (transmit a mortality signal) will provide important information on specific cause of death. Positive effects to natural quality could range from minimal to substantial and long lasting. The introduction of a large quantity of apple mash could potentially attract bears, or other species with subsequent negative effects from habituated bears.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by foot or stock	☐	☑	☐
2	Stock supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-3**	

Explain:

Two components of this action have negative effects to the solitude and unconfined recreation quality of wilderness character.
Transporting personnel to and from capture site via helicopter would have a negative effect on solitude and the sense of isolation from the sounds and sights of modern civilization. The trap pen and capture of animals along with the presence of collared bighorn sheep has a potential negative effect if observed by wilderness visitors. The sights and sounds of the actual operation of netting, capturing, and processing the animals could be very intense, though the effect would be of short duration.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by foot or stock	☐	☐	☑
2	Stock supported trap net crew	☐	☐	☑
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 2

Wilderness Character	
Untrammeled	-2
Undeveloped	-2
Natural	1
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-6**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 3: Helicopter Net Gunning / One Time Capture / GPS Collaring

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

This alternative would include a onetime capture of sheep followed by monitoring GPS collars both within and outside the proposed wilderness. Captures would occur primarily in January or February to avoid disruption of lamb/ kid birth and development and decrease the possibility of heat stress and mortality to captured animals as well as minimize conflicts with hunting and other recreational activities. Helicopter net-gunning would be used to capture and transport sheep, in groups to a site outside the proposed wilderness (base camp). Once an animal is net-gunned from the helicopter, the helicopter touches down to off-load one to two people to restrain the animal (hobble, blindfold, and place into transport bag). At base camp, biological samples for disease sampling and GPS radio collaring would occur. In order to capture animals, it is anticipated an estimated 10 landings with approximately 2-3 hours of flight time would occur in the proposed wilderness area. Additional landings may occur to pick up nets if a net is shot and misses a target animal (less ten percent of shots), but landings would be kept to a minimum. Multiple captures would occur with the objective to capture a representative sample based on group size and distribution of animals. Once the sample quota is reached, helicopter operations would cease. The GPS radio collars would allow 24 hour remote monitoring of collared sheep. Upon the death of a collared animal, the GPS collars would transmit a mortality signal. Dead animals and collars would be retrieved on foot to allow the determinate cause of death.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	Personnel will travel to and from capture site by helicopter
2	Capturing method	Helicopter/net gunning/landing
3	Health and disease monitoring	Processing and biological sampling of animals
4	Population monitoring	GPS radio collars
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☑
2	Helicopter/net gunning/landing	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

Capturing and collaring bighorn sheep is an intentional action that manipulates "the earth and its community of life" inside a proposed wilderness. Animals would be captured by shooting a net from a helicopter and then personnel would secure the net. Captured sheep would be fitted with a GPS radio collar. Thes are trammeling actions as human intervention occurs to capture and manipulate the animals. Capturing animals is a high intensity trammeling, but of short duration. Collars would remain on the animals for a longer period.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☑	☐

2	Helicopter/net gunning/landing	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Undeveloped Total Rating			-3	

Explain:

Three components of the action have a negative effect to the undeveloped quality. Personnel will be transported using a helicopter and net-gunn bighorn sheep from a helicopter, requires the helicopter to touch down to off-load one to two people to restrain the animal. There is an estimated 10 landings over 1 day. The presence of a helicopter is an intense effect to the undeveloped quality, though the duration is short and not permanent. Affixing GPS radio collars affect the undeveloped quality because they are scientific installations that represent visible evidence of human activity. A small percent of the population would have radio collars, thus the effect would be low intensity and of moderate duration.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☑
2	Helicopter/net gunning/landing	☐	☐	☑
3	Processing and biological sampling of animals	☑	☐	☐

4	GPS radio collars	☑	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		2	0	NE
Natural Total Rating			**2**	

Explain:

By helping to ensure a healthy viable bighorn sheep population, two components would have positive effects to Natural character. Processing and biological sampling of animals: Drawing blood samples will provide USFWS and ODFW the opportunity to understand what is causing poor herd performance. This is potentially very important information for preservation of bighorn sheep in the wilderness area. Understanding the potential for disease spread between bighorn sheep, monitoring and maintaining meaningful data regarding current health status, survival, and causes of mortality will inform future management actions and potentially have long term positive effects to the natural quality of wilderness character. GPS radio collars: Similarly, data obtained from radio collars will allow USFWS and ODFW to track movements which will help inform the understanding of the potential for spread of as well as provide information about year-round habitat use and movement/migration patterns. Data from animals that die (transmit a mortality signal) will provide important information on specific cause of death. Positive effects to natural quality could range from minimal to substantial and long lasting.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☑	☐
2	Helicopter/net gunning/landing	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-3**	

Explain:

Three components of this action have negative effects to the solitude and unconfined recreation quality of wilderness character.
The sights and sounds of crews being transported by a helicopter within the proposed wildernes would have a negative effect on solitude and the sense of isolation from the sounds and sights of modern civilization. In addition to the presence and landing of helicopters, the net gunning and capture of animals has a negative effect if observed by wilderness visitors. The sights and sounds of the actual operation of capturing and processing the animals could be very intense, though the effect would be of short duration. The presence of collared bighorn sheep has a potential negative effect if observed by wilderness visitors.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☐
2	Helicopter/net gunning/landing	☐	☐	☐
3	Processing and biological sampling of animals	☐	☐	☐
4	GPS radio collars	☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 3

Wilderness Character	
Untrammeled	-2
Undeveloped	-3
Natural	2
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-6**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 4: Trap Netting with Helicopter Support

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

This alternative consists of using a helicopter to support trap-net activities. (Approximate total number of flights 12-14 for 1 site in proposed wilderness area, personnel 15). Helicopter will do reconnaissance to locate areas where bighorn sheep occupy to identify highest potential trap locations in the wilderness. Highest potential sites are prioritized and trap site spike camp(s) location is determined. Trap crew transported by a helicopter to trap location which includes: trap crew (3 people), bait, and spike camp equipment and supplies to highest potential pre-net test area and to a spike camp location. Pre-test area suitability-Trap crew sets out bait (300lbs of apple mash) to attract animals. If pre-net test area draws in desired number of animals in up to 3 days then a spike camp is set up in a location that will not affect net test operations. Trap area determined -Trap crew will call in a helicopter to transport addition trap crew (2 people), spike camp supplies, additional bait and a trap-net that includes: 6 steel poles, stakes, 60'X60' net, 2-12volt batteries, associated cables and pulleys (600lbs). Trap setup -Expanded crew will set up the trap with bait and monitor. Trap release -It generally takes 7 days or more for animals to get accustomed to trap and for human scent to dissipate. (Note: another helicopter fight may be required to provide more bait if trap bait is needed) When needed survey quota of animals stay under trap an additional crew (2 people to one animal ratio) people will be called in to assist the night before trap release day. Three flights will be required to bring in processing crew and equipment. On trap release day morning, spotter signals for trap release when number of animals are within net area. Support crew and trap crew converge on netted animals and subdue. Processing-Crew will do disease sampling and collar animals. Once processing is complete animals will be released. Trap removal -Crew will remove trap and associated materials and ready for transport by a helicopter. Assuming that 4 people and equipment can be transported at a time with an additional flight to haul out trap, the number of flights could be 7 or more. Optimal time would be 9 days of trap operations per suitable site with a minimum of 1 site within the wilderness area. An estimated 2 sites will be needed to capture and process the required number of animals.

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	Personnel will travel to and from capture site by helicopter
2	Capturing method	Helicopter supported trap net crew
3	Health and disease monitoring	Processing and biological sampling of animals
4	Population monitoring	GPS radio collars
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☑
2	Helicopter supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

Capturing and collaring bighorn sheep is an intentional action that manipulates “the earth and its community of life” inside a proposed wilderness. Baiting and trapping animals and fitting them with GPS radio collard are trammeling actions as human intervention occurs to capture and manipulate the animals. Capturing animals is a high intensity trammeling, but of short duration. Collars would remain on the animals for a longer period.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☑	☐

2	Helicopter supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Undeveloped Total Rating			**-3**	

Explain:

Three components of the action affect the undeveloped quality. Transportation to and from capture site, use of helicopters to support the trap net crew, and affixing GPS radio collars. There will be an estimated 12-14 landings over the period of time required to capture a sufficient number of animals. Compared to alternative 3 the intensity is slightly more with a longer duration. Affixing GPS radio collars affects the undeveloped quality because they are scientific installations that represent visible evidence of human activity. A small percent of the population would have radio collars, thus the effect would be low intensity and of moderate duration.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☑
2	Helicopter supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☑	☐	☐

4	GPS radio collars	☑	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		2	1	NE
Natural Total Rating			**1**	

Explain:

Positive effects to natural quality would be nearly identical to Alternative three. However this is a less effective capture technique so the requisite number of animals may take multiple sites to study. Because multiple animals are captured together there could be more injury and a higher chance for mortality. Additionally, the introduction of a large quantity of apple mash could potentially attract bears, or other species with subsequent negative effects from habituated bears.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☑	☐
2	Helicopter supported trap net crew	☐	☑	☐
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☑	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			-3	

Explain:

Effects are similar to alternative three, however because of the longer term presence of base camps and trap structure, the effect will be of moderate duration. Wilderness visitors are more likely to encounter and notice the activities since the camp and trap structures will be in place for at least 7 days for each site.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel will travel to and from capture site by helicopter	☐	☐	☑
2	Helicopter supported trap net crew	☐	☐	☑
3	Processing and biological sampling of animals	☐	☐	☑
4	GPS radio collars	☐	☐	☑
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 4

Wilderness Character	
Untrammeled	-2
Undeveloped	-3
Natural	1
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-7**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 5:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	
2	Capturing method	
3	Health and disease monitoring	
4	Population monitoring	
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 5

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 6:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	
2	Capturing method	
3	Health and disease monitoring	
4	Population monitoring	
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating		0		

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 6

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 7:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	
2	Capturing method	
3	Health and disease monitoring	
4	Population monitoring	
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 7

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives

Alternative 8:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from capture site	
2	Capturing method	
3	Health and disease monitoring	
4	Population monitoring	
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Summary Ratings for Alternative 8

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed

What alternatives were considered but not analyzed? Why were they not analyzed?

1) Chemical immobilization using dart gun: This Alternative was not analyzed further due to the high risk of increased injury or mortality to animals.
2) Net gunning from helicopter with reduced landings: This alternative was not analyzed further because the number of estimated landings needed to capture the necessary 20 bighorn sheep to produce sufficient data for the study has already been minimized in alternative 3 . Net gunning in and of itself is considered a landing since materials are being dropped and the nature of aerial net capture requires personnel to be on site as soon as the animal is captured to avoid potential injury and over-stress.
3) Obtain data via animals harvested within the wilderness areas: This alternative would obtain blood samples from animals that have been harvested in the project area. Using only harvested animals does not allow for monitoring animals overtime or determining movement patterns and habitat use. Sampling would not be distributed across the unit and would be biased towards males. ODFW has halted bighorn sheep hunting at the Refuge, so this option is not viable.

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Alternative Comparison

Alternative 1: No Action

Alternative 2: Net Trapping Using Ground Crews Only

Alternative 3: Helicopter Net Gunning / One Time Capture / GPS Collaring

Alternative 4: Trap Netting with Helicopter Support

Wilderness Character	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	2	0	2	0	2
Undeveloped	0	0	0	2	0	3	0	3
Natural	0	1	2	1	2	0	2	1
Solitude/Primitive/Unconfined	0	0	0	3	0	3	0	3
Other Features of Value	0	0	0	0	0	0	0	0
Totals	0	1	2	8	2	8	2	9
Wilderness Character Rating	-1		-6		-6		-7	

Alternative 5:

Alternative 6:

Alternative 7:

Alternative 8:

Wilderness Character	Alternative 5		Alternative 6		Alternative 7		Alternative 8	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	0	0	0	0	0
Undeveloped	0	0	0	0	0	0	0	0
Natural	0	0	0	0	0	0	0	0
Solitude/Primitive/Unconfined	0	0	0	0	0	0	0	0
Other Features of Value	0	0	0	0	0	0	0	0

Totals	0	0	0	0	0	0	0	0
Wilderness Character Rating	**0**		**0**		**0**		**0**	

Project Title: Bighorn Sheep Capture & Monitoring

MRDG Step 2: Determination

Refer to the **MRDG Instructions** before identifying the selected alternative and explaining the rationale for the selection.

Selected Alternative

- ☐ Alternative 1: No Action
- ☐ Alternative 2: Net Trapping Using Ground Crews Only
- ☑ Alternative 3: Helicopter Net Gunning / One Time Capture / GPS Collaring
- ☐ Alternative 4: Trap Netting with Helicopter Support
- ☐ Alternative 5:
- ☐ Alternative 6:
- ☐ Alternative 7:
- ☐ Alternative 8:

Explain Rationale for Selection:

In determining the minimum activity, the potential long term negative effects of the no action alternative on the natural quality are weighed against the short term effects of the action alternatives on the Untrammeled, Undeveloped, and Solitude or Primitive and Unconfined Recreation qualities. Even though numerous short term effects were identified in the action alternatives, the potential long term effect of bighorn sheep being lost in the proposed Wilderness is considered a greater impact to Wilderness character.

In comparing the action alternatives, it is necessary to weigh the intensity and duration of effects to Wilderness Character. Alternatives 3 and 4 have a more intense effect to both the undeveloped and solitude qualities due to the use of helicopters. Alternative 2 and 4 have a longer term effect to the natural and solitude qualities due to the need for a long term base camp and trap structures as well as the need to repeat the process until the necessary number of animals are captured and processed. Alternative 4 produces a combination of intense and longer term effects to wilderness character so is not recommended.

When comparing Alternative 3 and 4, the intensity of motorized equipment (an estimated 10 helicopter landings over 1 day) is weighed against the longer term effects of base camps and trap structures in place over a week at a time for each capture site (likely 2 sites). Additionally because the baiting and capture method used in alternatives 2 and 4 is less effective and may lead to more injury or mortality to animals as well as creating a potential food attractant for bears and other wildlife, there could be negative effects to the natural quality.

If more space is needed, continue on the next page…

Explain Rationale for Selection, Continued:

Considering all aspects of each alternative and positive/ negative effects to wilderness character, Alternative 3 is the minimum necessary action to preserve wilderness character while minimizing negative effects. This alternative has the best chance to provide the necessary information to preserve the natural quality of wilderness character. Though there are short term intense effects from the use of helicopters and actions to capture and process animals, these are not long lasting.

Describe Monitoring & Reporting Requirements:

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity?

Prohibited Use	Quantity
☐ Mechanical Transport:	
☐ Motorized Equipment:	
☐ Motor Vehicles:	
☐ Motorboats:	
☑ Landing of Aircraft:	Approximately 10 landings for the capture of bighorn sheep
☐ Temporary Roads:	
☐ Structures:	
☐ Installations:	

Record and report any authorizations of Wilderness Act Section 4(c) prohibited uses according to agency policies or guidance.

Refer to agency policies for the following signature authorities:

Prepared	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Approved	Name	Position	
	Signature		Date

ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER

MINIMUM REQUIREMENTS DECISION GUIDE

WORKBOOK

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

-- The Wilderness Act of 1964

Project Title: Bighorn Sheep and Water Resources

MRDG Step 1: Determination

Determine if Administrative Action is Necessary

Description of the Situation

What is the situation that may prompt administrative action?

The 17,464 acre Proposed Poker Jim Wilderness Area encompasses the northern portion of Hart Mountain commonly referred to as Poker Jim Ridge and is situated northwest of the Frenchglen Road between Rock Creek and the Warner Valley. Terrain is formed by a geologic fault-thrust of the basalt formation resulting in a steep rocky west facing escarpment culminating with a table-top formation which gradually slopes off to the east. Habitats are primarily low sagebrush steppe with scattered areas of mountain sagebrush steppe habitat and more rocky areas dominated by juniper woodland habitat. Habitats along Poker Jim Ridge are considered important for California bighorn sheep, mule deer, for pronghorn in summer, and for Greater sage-grouse. As water decreases in the Poker Jim area, including the wilderness area, bighorn sheep travel to other areas to access water. This movement increases their time in areas with no escape cover, thereby putting them at risk of predation. To provide supplemental water for bighorn sheep and other wildlife, three permanent water guzzlers were previously constructed and are located within the proposed Poker Jim Wilderness Area. Two guzzlers were damaged when a wildlfire swept through Poker Jim Ridge in 2019. All three are currently non-functioning.

Options Outside of Wilderness

Can action be taken outside of wilderness that adequately addresses the situation?

☐ YES

☑ NO

EXPLAIN & COMPLETE STEP 1 OF THE MRDG

Explain:

The bighorn sheep population on the Refuge mainly occupies the Poker Jim Ridge area, including the proposed wilderness area, during the spring and summer months. A study in 1997 showed that bighorn ram movements shifted with water availability, from Rock Creek to Petroglyph Lake as water decreased, both in the Poker Jim Ridge area. In addition, water availability can exert a high factor on the seasonal distrubtion of rams (Payer and Coblentz 1997). While bighorn sheep do use other areas of the Refuge, the Poker Jim Ridge and proposed wilderness area are the most important area due to escape coverage

Criteria for Determining Necessity

Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that ***requires*** *action? Cite law and section.*

☐ YES ☑ NO

Explain:

There are no valid existing rights or special provisions that require action to be taken.

B. Requirements of Other Legislation

Is action necessary to meet the requirements of *<u>other federal laws</u>*? *Cite law and section.*

☑ YES ☐ NO

Explain:

The National Wildlife Refuge Administration Act of 1966 (16 U.S.C.§668dd, as amended) specifies that biological integrity, diversity, and environmental health of the National Wildlife Refuge System shall be ensured. Maintaining a healthy and viable bighorn sheep population is important to maintaining the biological integrity, diversity and environmental health of Hart Mountain National Antelope Refuge and the Proposed Poker Jim Wilderness. Given recent declines in bighorn sheep, the Refuge is looking into the impacts that are affecting the bighorn sheep population. The bighorn sheep population occupy the proposed Poker Jim Wilderness Area. This area also does not have a reliable source of water and water guzzlers were installed in previous years to ensure that the bighorn sheep population had a constant source of water.

C. Wilderness Character

Is action necessary to preserve one or more of the five qualities of wilderness character?

UNTRAMMELED

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the untrammeled wilderness quality.

UNDEVELOPED

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the undeveloped wilderness quality.

NATURAL

☑ YES ☐ NO

Explain:

Bighorn sheep are a critical component of the natural quality of the Poker Jim Ridge proposed wilderness and a symbol of the Refuge. Understanding and addressing predation issues, water sources, habitat, and other causes of bighorn sheep population decline are critical to the management of the Refuge.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the solitude or primitive and unconfined recreation wilderness quality.

OTHER FEATURES OF VALUE

☐ YES ☑ NO

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Step 1 Determination

Is administrative action <u>necessary</u> in wilderness?

Criteria for Determining Necessity	Summary Responses
A. Existing Rights or Special Provisions	Action IS NOT necessary to meet this criterion.
B. Requirements of Other Legislation	Action IS necessary to meet this criterion.
C. Wilderness Character	
Untrammeled	Action IS NOT necessary to meet this criterion.
Undeveloped	Action IS NOT necessary to meet this criterion.
Natural	Action IS necessary to meet this criterion.
Solitude/Primitive/Unconfined	Action IS NOT necessary to meet this criterion.

Other Features of Value | Action IS NOT necessary to meet this criterion.

Is administrative action necessary in wilderness?

☑ YES

EXPLAIN & PROCEED TO STEP 2 OF THE MRDG

☐ NO

Explain:

Action is necessary to preserve the bighorn sheep on Hart Mountain. The bighorn sheep is a native species to the Refuge and an iconic part of the natural quality of the proposed wilderness to be protected. Previous studies have shown that bighorn sheep travel outside of areas with escape cover, exposing them to predators, so they can access water. Poker Jim plays a big role in the bighorn sheep population on the Refuge due to the habitat and terrain.

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2

Determine the Minimum Activity

Other Direction

Is there "special provisions" language in legislation (or other Congressional direction) that explicitly ***allows*** *consideration of a use otherwise prohibited by Section 4(c)?*

AND/OR

Has the issue been addressed in agency policy, management plans, species recovery plans, or agreements with other agencies or partners?

☐ YES

☐ NO

Describe Other Direction:

Bighorn sheep (*Ovis canadensis*), an iconic species native to Oregon and the Refuge, were extirpated in Oregon by 1912. The species was successfully re-introduced in 1954 when 20 sheep were translocated to the Refuge. Since then, the Refuge and Oregon Department of Fish and Wildlife (ODFW) staff have conducted cooperative annual surveys to estimate population trends and measure demographic parameters including number of sheep, lamb recruitment, and ram size/age class. Bighorn sheep numbers have declined since the mid-1980s and the last three years represent the most significant declines, 149 (2017) to 100 (2018) to 68 (2019). The Refuge is currently writing a Bighorn Sheep Management Plan to address the decline and future management of bighorn sheep.

Time Constraints
What, if any, are the time constraints that may affect the action?

No constraints, the installation would be permanent installation.

Components of the Action
What are the discrete components or phases of the action?

Component X	*Example: Transportation of personnel to the project site*
Component 1	Transportation of personnel
Component 2	Delivery and installation method
Component 3	Condition of site after project
Component 4	
Component 5	
Component 6	
Component 7	
Component 8	
Component 9	

Proceed to the alternatives.

Refer to the **MRDG Instructions** regarding alternatives and the effects to each of the comparison criteria.

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 1: No Action

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

The No Action alternative for a Minimum Requirements Analysis is to take no manageent action. This differs from a No Action alternative under the National Environmental Policy Act (NEPA) in that under NEPA, the no action alternative is the continuation of current management practices. No action would be taken to maintain the three existing guzzlers. The guzzlers would remain in place to degrade over time.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnel would not be transported.
2	Delivery and installation method	No actions taken to repair guzzlers.
3	Condition of site after project	Guzzlers remain in state of disrepair.
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	No actions taken to repair guzzlers.	☑	☐	☐
3	Guzzlers remain in state of disrepair.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	0	NE
Untrammeled Total Rating			**1**	

Explain:

Not taking a management action preserves the untrammeled wilderness quality.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑

2	No actions taken to repair guzzlers.	☐	☐	☑
3	Guzzlers remain in state of disrepair.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Undeveloped Total Rating			**-1**	

Explain:

Three guzzlers would remain as permanent installations within the proposed wilderness.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	No actions taken to repair guzzlers.	☐	☑	☐
3	Guzzlers remain in state of disrepair.	☐	☐	☑

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Natural Total Rating			**-1**	

Explain:

As water decreases in the Poker Jim Ridge across the year, including the proposed wilderness area, bighorn sheep must travel to other areas of the Refuge to access water. This movement increases their time in areas with no escape cover, thereby putting them at risk of predation. The bighorn sheep population on the Refuge has declined by greater than 50% since 2017 and is now at a potentially unsustainable popluation level. Any increased risk of predation exacerbates the situation.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	No actions taken to repair guzzlers.	☐	☐	☑
3	Guzzlers remain in state of disrepair.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

Taking no action would have no effect to the solitude or primitive and unconfined wilderness quality.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	No actions taken to repair guzzlers.	☐	☐	☑
3	Guzzlers remain in state of disrepair.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Summary Ratings for Alternative 1

Wilderness Character	
Untrammeled	1
Undeveloped	-1
Natural	-1
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**-1**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 2: Maintain Guzzlers Using Non-Mechanized and Non-Motorized Tools

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

All maintenance of guzzlers within the proposed wilderness would be conducted using non-mechanzied and non-motorized tools and equipment. Access and transport of tools, equipment, and materials would be by foot or other non-mechanized and non-motorized means. Under this alternative, periodic monitoring and minor maintenance would be completed by a single person or small crews of four to six people within a single day. Large items such as catchment basins and water tanks would be repaired on-site. Materials used for maintenance and replacement would be selected and/or modified to blend with the surrounding terrain. The most noticeable element of guzzlers are their metal roofs. Replacement roofing would be painted camouflage/natural colors to better blend with the ground.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wilderness.
2	Delivery and installation method	Personnel woud carry and install all materials by hand using non-motorized and non mechanized equipment
3	Condition of site after project	Three water guzzlers provide water to wildlife.
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Personnel woud carry and install all materials by hand using non-motorized and non mechanize	☐	☑	☐
3	Three water guzzlers provide water to wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

A trammeling action intentionally manipulates "the earth and its community of life" inside a wilderness. Maintaining existing water guzzlers would be a negative impact on this quality. Providing and maintaining water guzzlers is an action that controls or manipulates components or processes of ecological systems.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑

2	Personnel woud carry and install all materials by hand using non-motorized and non mechanize	☐	☐	☑
3	Three water guzzlers provide water to wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Undeveloped Total Rating			**-1**	

Explain:

Water guzzlers would affect the undeveloped quality because they are permanent installations that represent visible evidence of human activity. However, only a small percent of wilderness area would have these installations. Thus, the effect would be low intensity.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Personnel woud carry and install all materials by hand using non-motorized and non mechanize	☐	☐	☑
3	Three water guzzlers provide water to wildlife.	☑	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	0	NE
Natural Total Rating			**1**	

Explain:

By helping to ensure a healthy and viable bighorn sheep population, the maintenance of water guzzlers would result in long-term positive effects to the natural quality. Bighorn sheep have declined greater than 50% since 2017, 149 in 2017 to 68 in 2019 and is now at a potentially unsustainable popluation level. Providing water in specific areas within the wilderness will create an advantage for the bighorn sheep. Currently, they have to travel further from their home range for water, putting them at a higher risk of predation. Affects to natural quality would range from minimal (increase water availability) to substantial and long lasting (increase bighorn sheep population). Maintenance of guzzlers using materials that blend with the surrounding landscape would somewhat reduce the unnatural appearance of guzzlers

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☑	☐
2	Personnel woud carry and install all materials by hand using non-motorized and non mechanize	☐	☑	☐
3	Three water guzzlers provide water to wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-3**	

Explain:

Encounters with, or the presence of, field crews and signs of modern civilization degrade this quality. However, these impacts would be short-term, minor effects due to the low visitor use of the proposed wilderness area and the low likelihood of a vistor seeing a crew or finding a guzzler site. Reduced visibility of guzzlers should imporve opportunities for primitive recreation.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Personnel woud carry and install all materials by hand using non-motorized and non mechanize	☐	☐	☑
3	Three water guzzlers provide water to wildlife.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Summary Ratings for Alternative 2

Wilderness Character	
Untrammeled	-2
Undeveloped	-1
Natural	1
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-5**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 3: Maintain Guzzlers Using Low Level Helicopters

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Under this alternative, routine sites visits for monitoring to assess condition and maintenance needs for guzzlers would be conducted either on foot, by horseback or by low level helicopter overflight (without landing). A single trip on foot, by horseback or by helicopter overflight to each guzzler would likely occur every three to five years, but no more than once per year. Minor maintenance of guzzlers within proposed wilderness would be conducted using non-mechanized and non-motorized tools and equipment. Access and transport of tools, equipment, and materials for routine and minor maintenance would be foot, horseback, pack stock or other non-mechanized and non-motorized means. The transportation of sheet metal, catchments, water tanks or other large items needed for major maintenance or repairs and not typically transported by pack stock or backpack would be conducted by helicopter. Helicopters would be used to transport suspended loads of materials. At each site where materials are to be flown in, the items being replaced would be prepared in advance to be hauled out on the return trip. In this way, helicopter use would maximize efficiency, and the number of people and amount of time required for maintenance would be minimized. Except in the case of emergency or for pilot safey, this alternative would not require the landing of aircraft within the proposed wilderness areas; personnel and work crews would not be transported by helicopter. Helicopter use is anticipated to occur at each guzzler once every 10 years. Work would normally be completed using primitive tools consistent with the principles of wilderness management. Under this alternative, battery powered hand tools may be permitted when it is determined that such uses would reduce the number of days required to complete maintenance and repairs within the proposed wilderness area and that such use would minimize impacts to wilderness solitude and undeveloped character from reduced presence of work crews. However, such uses would not be permitted for convenience, comfort or only negligible benefits to efficiency for conducting maintenance repairs. Water tanks used for guzzlers are typically buried and would need to be excavated for replacement.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnnel would travel by foot or horeseback.
2	Delivery and installation method	Delivery of smaller items would be via foot and larger items would be via low level helicopter. Installation woud be completed using primative tools and battery powered tools.
3	Condition of site after project	Three water guzzlers provide water for wildlife.
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnnel would travel by foot or horeseback.	☐	☐	☑
2	Delivery of smaller items would be via foot and larger items would be via low level helicopter. In	☐	☑	☐
3	Three water guzzlers provide water for wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

A trammeling action intentionally manipulates "the earth and its community of life" inside a wilderness. Providing and maintaining water guzzlers is an action that controls or manipulates components or processes of ecological systems. Helicopter overflights and the presence of crews working up to six days within the same general location are expected to alter wildlife behavior and habitat use until maintenance is completed. Maintaining existing water guzzlers would be a negative impact to the untrammeled wilderness quality.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnnel would travel by foot or horeseback.	☐	☐	☑

2	Delivery of smaller items would be via foot and larger items would be via low level helicopter. In	☐	☑	☐
3	Three water guzzlers provide water for wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Undeveloped Total Rating			**-2**	

Explain:

Battery-powered hand tools would only be used for major maintenance and repairs where the use of hand tools is impracticable and would reduce the number of days needed for work crews in the field, resulting in slightly less adverse impact to undeveloped wilderness character. However, the use of power tools, mechanical transport, and landing of aircraft are all negatvie effects.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnnel would travel by foot or horeseback.	☐	☐	☑
2	Delivery of smaller items would be via foot and larger items would be via low level helicopter. In	☐	☑	☐
3	Three water guzzlers provide water for wildlife.	☑	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	1	NE
Natural Total Rating			0	

Explain:

By helping to ensure a healthy and viable bighorn sheep population, the installation of water guzzlers would result in long-term positive effects to the Natural character. Bighorn sheep have declined greater than 50% since 2017, 149 in 2017 to 68 in 2019 and is now at a potentially unsustainable popluation level. Providing water in specific areas within the wilderness would create an advantage for the bighorn sheep. Currently, they have to travel further from their home range for water, putting them at a higher risk of predation. Affects to natural quality would range from minimal (increase water availability) to substantial and long lasting (increase bighorn sheep population).
Maintenance of guzzlers using materials that blend with the surrounding landscape would somewhat reduce the unnatural appearance of guzzlers. Access by work crews on foot or by horseback would occur approximately once every 10 years and would result in some tramping of vegetation. However, impacts from such use are expected to be negligible and not observable or measurable after one growing season.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnnel would travel by foot or horeseback.	☐	☑	☐
2	Delivery of smaller items would be via foot and larger items would be via low level helicopter. In	☐	☑	☐
3	Three water guzzlers provide water for wildlife.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating		**-3**		

Explain:

Encounters with, or the presence of, field crews and signs of modern civilization degrade this quality. However, these impacts would be short-term, minor effects due to the low visitor use of the proposed wilderness area and the low likelihood of a vistor seeing a crew or finding a guzzler site. Reduced visibility of guzzlers should imporve opportunities for primitive recreation.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnnel would travel by foot or horeseback.	☐	☐	☑
2	Delivery of smaller items would be via foot and larger items would be via low level helicopter. In	☐	☐	☑
3	Three water guzzlers provide water for wildlife.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 3

Wilderness Character	
Untrammeled	-2
Undeveloped	-2
Natural	0
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-7**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 4:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Delivery and installation method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 4

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 5:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Delivery and installation method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 5

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 6:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Delivery and installation method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 6

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 7:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Delivery and installation method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 7

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives

Alternative 8:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Delivery and installation method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating		**0**		

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 8

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed
What alternatives were considered but not analyzed? Why were they not analyzed?

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Alternative Comparison

Alternative 1: No Action

Alternative 2: Maintain Guzzlers Using Non-Mechanized and Non-Motorized Tools

Alternative 3: Maintain Guzzlers Using Low Level Helicopters

Alternative 4:

Wilderness Character	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	1	0	0	2	0	2	0	0
Undeveloped	0	1	0	1	0	2	0	0
Natural	0	1	1	0	1	1	0	0
Solitude/Primitive/Unconfined	0	0	0	3	0	3	0	0
Other Features of Value	0	0	0	0	0	0	0	0
Totals	1	2	1	6	1	8	0	0
Wilderness Character Rating	**-1**		**-5**		**-7**		**0**	

Alternative 5:

Alternative 6:

Alternative 7:

Alternative 8:

Wilderness Character	Alternative 5		Alternative 6		Alternative 7		Alternative 8	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	0	0	0	0	0
Undeveloped	0	0	0	0	0	0	0	0
Natural	0	0	0	0	0	0	0	0
Solitude/Primitive/Unconfined	0	0	0	0	0	0	0	0
Other Features of Value	0	0	0	0	0	0	0	0

Totals	0	0	0	0	0	0	0	0
Wilderness Character Rating	**0**		**0**		**0**		**0**	

Project Title: Bighorn Sheep and Water Resources

MRDG Step 2: Determination

Refer to the **MRDG Instructions** before identifying the selected alternative and explaining the rationale for the selection.

Selected Alternative

- ☐ Alternative 1: No Action
- ☐ Alternative 2: Maintain Guzzlers Using Non-Mechanized and Non-Motorized Tools
- ☑ Alternative 3: Maintain Guzzlers Using Low Level Helicopters
- ☐ Alternative 4:
- ☐ Alternative 5:
- ☐ Alternative 6:
- ☐ Alternative 7:
- ☐ Alternative 8:

Explain Rationale for Selection:

Even though short term effects were identified in the action alternatives, the potential long term effect of bighorn sheep being lost in the proposed Wilderness is considered a greater impact to Wilderness character. Alternative 2 would use the tools and techniques that have the least impact on natural conditions while achieving management objectives. Impacts to wilderness solitude are greater under Alternative 3 than Alternative 2, which uses primitive tools, due to helicopter overflights from monitoring and the use of helicopters, but landing would not be required and impacts to solitude would be short term and less intrusive over long term. Alternative 2 would be less intrusive than Alternative 3 but due to the steep, rough, and rocky terrain where most guzzlers are located, Alternative 2 would not be able to transport large materials required for major maintenance or repairs in order to accomplish maintenance of all guzzlers, including replacement of large water tanks or sheet metal. In the 1994 Hart Mountain NAR CMP, it states that the Refuge would maintain the exisiting water guzzlers so removing them or letting them degrade is not consistent with current management goals. Alternative 3 provides the tools and techniques needed to accomplish the objectives in a safe manner. Due to the steep, rough, and rocky terrain, Alternative 2 will not be able to accomplish the objectives, but with the various options listed in Alternative 3, the water guzzlers would provide an immediate and long-term benefit to bighorn sheep.

If more space is needed, continue on the next page…

Explain Rationale for Selection, Continued:

Describe Monitoring & Reporting Requirements:

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity?

	Prohibited Use	Quantity
☑	Mechanical Transport:	1 heliocopter
☑	Motorized Equipment:	Power tools and equipment.
☐	Motor Vehicles:	
☐	Motorboats:	
☐	Landing of Aircraft:	
☐	Temporary Roads:	
☐	Structures:	
☐	Installations:	

Record and report any authorizations of Wilderness Act Section 4(c) prohibited uses according to agency policies or guidance.

Refer to agency policies for the following signature authorities:

Prepared	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Approved	Name	Position	
	Signature		Date

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MINIMUM REQUIREMENTS DECISION GUIDE

WORKBOOK

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

-- The Wilderness Act of 1964

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 1: Determination

Determine if Administrative Action is Necessary

Description of the Situation

What is the situation that may prompt administrative action?

Western juniper is a native species, but its expansion into sagebrush-steppe habitats as a result of continued long-term fire suppression and overgrazing for more than 100 years has severely degraded these habitats and as a result has adversely impacted priority wildlife species and the purposes of Hart Mountain NAR. These habitat changes are important to bighorn sheep for two reasons. First, they require an open environment with good visibility of their surroundings in order to avoid predators. As trees encroach into sheep habitat, visibility decreases and predators like cougars have an easier time killing sheep, driving up the mortality rate. Second, as trees expand in area, forb and grass species that sheep depend on for forage decline. This problem is exacerbated when combined with increases in invasive plants including cheatgrass - another issue that can be seen across the Great Basin.

Options Outside of Wilderness

Can action be taken outside of wilderness that adequately addresses the situation?

☐ YES

☑ NO

EXPLAIN & COMPLETE STEP 1 OF THE MRDG

Explain:

Western juniper has expanded into sagebrush-steppe habitats as a result of fire suppression. This has resulted in an impact to wildlife species and degredation to habitat. Western juniper that needs to be addressed is located solely within the proposed Poker Jim Wilderness Area.

Criteria for Determining Necessity

Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

*Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that **requires** action? Cite law and section.*

☐ YES ☑ NO

Explain:

There are no valid existing rights or special provisions of wilderness legislation that require action.

B. Requirements of Other Legislation

Is action necessary to meet the requirements of <u>other federal laws</u>? Cite law and section.

☑ YES ☐ NO

Explain:

The National Wildlife Refuge Administration Act of 1966 (16 U.S.C.§668dd, as amended) specifies that biological integrity, diversity, and environmental health of the National Wildlife Refuge System shall be ensured. Maintaining a healthy and viable bighorn sheep population is important to maintaining the biological integrity, diversity and environmental health of Hart Mountain Antelope Refuge and the Proposed Poker Jim Wilderness. Given recent declines in bighorn sheep, potentially driven in part by western juniper encroachment, the Refuge needs to conduct habitat work in the proposed Poker Jim Wilderness Area.

C. Wilderness Character

Is action necessary to preserve one or more of the five qualities of wilderness character?

UNTRAMMELED

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the untrammeled wilderness quality.

UNDEVELOPED

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the undeveloped wilderness quality.

NATURAL

☑ YES ☐ NO

Explain:

The expansion of western juniper into bighorn sheep habitat

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☑ NO

Explain:

Actions are not necessary to preserve the solitude or primitive and unconfined recreation wilderness quality.

OTHER FEATURES OF VALUE

☐ YES ☑ NO

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Step 1 Determination

Is administrative action necessary in wilderness?

Criteria for Determining Necessity	Summary Responses
A. Existing Rights or Special Provisions	Action IS NOT necessary to meet this criterion.
B. Requirements of Other Legislation	Action IS necessary to meet this criterion.
C. Wilderness Character	
Untrammeled	Action IS NOT necessary to meet this criterion.
Undeveloped	Action IS NOT necessary to meet this criterion.
Natural	Action IS necessary to meet this criterion.
Solitude/Primitive/Unconfined	Action IS NOT necessary to meet this criterion.

Other Features of Value — Action IS NOT necessary to meet this criterion.

Is administrative action necessary in wilderness?

☑ YES — **EXPLAIN & PROCEED TO STEP 2 OF THE MRDG**

☐ NO

Explain:

Action is necessary to prevent the further spread of western juniper. Suitable habitat for bighorn sheep in this area exists within the Refuge and approximately 35% of the habitat within the wilderness area. Bighorn sheep, and other wildlife, in the proposed Poker Jim Wilderness area depend on the habitat and water resouces that are within the area.

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2

Determine the Minimum Activity

Other Direction

*Is there "special provisions" language in legislation (or other Congressional direction) that explicitly **allows** consideration of a use otherwise prohibited by Section 4(c)?*

AND/OR

Has the issue been addressed in agency policy, management plans, species recovery plans, or agreements with other agencies or partners?

☐ YES

☐ NO

Describe Other Direction:

Bighorn sheep (*Oviscanadensis*), an iconic species native to Oregon and the Refuge, were extirpated in Oregon by 1912. The species was successfully re-introduced in 1954 when 20 sheep were translocated to the Refuge. Since then, the Refuge and Oregon Department of Fish and Wildlife (ODFW) staff have conducted cooperative annual surveys to estimate population trends and measure demographic parameters including number of sheep, lamb recruitment, and ram size/age class. Bighorn sheep numbers have declined since the mid-1980s and the last three years represent the most significant declines, 149 (2017) to 100 (2018) to 68 (2019). The Refuge is currently writing a Bighorn Sheep Management Plan to address the decline and future management of bighorn sheep.

Time Constraints

What, if any, are the time constraints that may affect the action?

Components of the Action

What are the discrete components or phases of the action?

Component X	*Example: Transportation of personnel to the project site*
Component 1	Transportation of personnel
Component 2	Removal method
Component 3	Condition of site after project
Component 4	
Component 5	
Component 6	
Component 7	
Component 8	
Component 9	

Proceed to the alternatives.

Refer to the **MRDG Instructions** regarding alternatives and the effects to each of the comparison criteria.

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 1: No Action: no western juniper mnagement

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

The No Action alternative for a Minimum Requirements Analysis is to take no manageent action. This differs from a No Action alternative under the National Environmental Policy Act (NEPA) in that under NEPA, the no action alternative is the continuation of current management practices. Under this alternative, no western juniper would be removed within the Poker Jim Ridge proposed wilderness.

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnel would not be transported.
2	Removal method	Western juniper would not be removed.
3	Condition of site after project	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	Western juniper would not be removed.	☑	☐	☐
3	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	0	NE
Untrammeled Total Rating		**1**		

Explain:

Taking no action means the area remains untrammeled.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑

2	Western juniper would not be removed.	☐	☐	☑
3	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

The undeveloped quality would be unaffected by taking no action.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	Western juniper would not be removed.	☐	☑	☐
3	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.	☐	☑	☐

		Positive	Negative	No Effect
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Natural Total Rating			**-2**	

Explain:

Western juniper would continue to encroach into bighorn sheep habitat, reducing the sheep's horizontal sight distance and provding increased cover for bighorn sheep predators.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	Western juniper would not be removed.	☐	☐	☑
3	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating		0		

Explain:

Not taking an action would not affect solitudue or primitiave and unconfined recreation.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would not be transported.	☐	☐	☑
2	Western juniper would not be removed.	☐	☐	☑
3	Western juniper remains on landscape and contiues to encroach into bighorn sheep habitat.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Summary Ratings for Alternative 1

Wilderness Character	
Untrammeled	1
Undeveloped	0
Natural	-2
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**-1**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 2: Non-mechanized and non-motorized

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Control of expanding juniper would be completed using a combination of chemical herbicides and cutting with primitive hand tools. Access and transport of tools and equipment would be by foot, horseback, pack stock or other non-mechanized and non-motorized means.

Chemical control would be single tree application of approved herbicides as liquid concentrate through an applicator gun or a spray applied to the foliage with a backpack sprayer. These methods would be used most often where juniper are suffciently small and occur at low density (less than 10 trees per acre) where carrying hand tools would be more cumbersome and cutting through small fine branches and more flexible stems would be more difficult and time consuming. Cutting, felling, limbing, piling, and burning of juniper would be conducted using non-motorized tools and equipment. Work crews using crosscut saws, axes, pruning saws, limbing shears, drip torches, and other primitives hand tools would remove or thin juniper. Burning of felled trees and limp piles would take place during typically cooler and wetter winter months.

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wilderness. Tools may be be carried by foot or pack stock.
2	Removal method	Removal with non-motorized and non-mechanized tools and equipment.
3	Condition of site after project	Longer time frame, more people, potenitally larger juniper left.
4		
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Removal with non-motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Longer time frame, more people, potenitally larger juniper left.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Untrammeled Total Rating			**-2**	

Explain:

Removal and/or cutting juniper is considered an action that controls or manipulates components or processes of ecological systems and is a trammeling action. The presence of work crews in the area over a longer period of time is expected to alter wildlife behavior and habitat use. Over the long term as native perennial grasses, forbs, and shrubs become re-established, it is expected that several wildlife species absent from these areas over the past several decades would return.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑

2	Removal with non-motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Longer time frame, more people, potenitally larger juniper left.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Undeveloped Total Rating			**-2**	

Explain:

The presence of cut stems and burn piles would be a negative impact to the undeveloped quality of wilderness

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Removal with non-motorized and non-mechanized tools and equipment.	☑	☐	☐
3	Longer time frame, more people, potenitally larger juniper left.	☐	☑	☐

		Positive	Negative	No Effect
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	1	NE
Natural Total Rating			0	

Explain:

Where juniper is treating using herbicide, the few trees killed would be left standing and would appear to have died naturally. Higher amounts of herbicide needed to kill larger trees could also kill nearby shrubs, which would have a negative impact on the natural quality. However, the removal of the juniper trees would allow natural regeneration of shrubs and forbs, increasing the natural quality of the area. In addition, natural water sources may be enhanced by controlling encroaching juniper in the watershed, increasing water storage capacity and availability, and reducing vertical cover used by bighorn sheep predators

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☑	☐
2	Removal with non-motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Longer time frame, more people, potenitally larger juniper left.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			-3	

Explain:

The use of hand tools would have little or no impact on opportunities for primitive recreation. However, the appearance of juniper stumps within the proposed wilderness area would serve as a reminder of human activity and intrusion and would negatively impact opportunities for solitude over the long term. Recreation use is estimated to be low in the proposed wilderness area so the overall impacts to solitude or primitive and unconfined recreation would affect few people. The presence of work crews over a longer time frame would negatively affect this quality.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Removal with non-motorized and non-mechanized tools and equipment.	☐	☐	☑
3	Longer time frame, more people, potenitally larger juniper left.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Other features of value have not been identified for the Poker Jim Ridge proposed wilderness.

Summary Ratings for Alternative 2

Wilderness Character	
Untrammeled	-2
Undeveloped	-2
Natural	0
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-7**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 3: Motorized and Non-Motorized

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Cutting, felling, limbing, piling, and burning of juniper within the proposed wilderness would be conducted using both motorized and non-motorized tools and equipment. Transport of tools and equipment would be by motorized vehicle to the boundary of the proposed wilderness area and then they would be transported by foot. Work crews would also be traveling by foot or horseback.
Chemical control would be single tree application of approved herbicides as liquid concentrate through an applicator gun or a spray applied to the foliage with a backpack sprayer. These methods would be used most often where juniper are suffciently small and occur at low density (less than 10 trees per acre) where carrying hand tools would be more cumbersome and cutting through small fine branches and more flexible stems would be more difficult and time consuming. Work crews using chainsaws, motorized pruning saws, limbing shears, drip torches, and other hand tools would remove or thin juniper. Burning of felled trees and limp piles would take place during typically cooler and wetter winter months.

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wilderness. Tools may be be carried by foot or pack stock.
2	Removal method	Removal with motorized and non-mechanized tools and equipment.
3	Condition of site after project	Shorter time frame, more people, more juniper removed.
4		
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Removal with motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Shorter time frame, more people, more juniper removed.	☐	☐	☑
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Untrammeled Total Rating			**-1**	

Explain:

Removal and/or cutting of juniper is an action that controls or manipulates components or processes of ecological systems.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑

2	Removal with motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Shorter time frame, more people, more juniper removed.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Undeveloped Total Rating			**-2**	

Explain:

The use of motorized tools and equipment has a short term negative quality. In addition, the imprint of "man's work" being noticeable for some time.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☑
2	Removal with motorized and non-mechanized tools and equipment.	☑	☐	☐
3	Shorter time frame, more people, more juniper removed.	☐	☐	☑

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	0	NE
Natural Total Rating			**1**	

Explain:

The removal of the juniper trees would allow natural regeneration of shrubs and forbs, increasing the natural quality of the area. In addition, natural water sources may be enhanced by controlling encroaching juniper in the watershed, increasing water storage capacity and availability, and reducing vertical cover used by bighorn sheep predators. Bighorn sheep sometimes have to travel long distances for reliable water sources, putting them at risk of predation. Reducing juniper in bighorn sheep habitat would reduce the amount of distance bighorn sheep would need to travel, as well as reduce their exposure to predators.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☑	☐
2	Removal with motorized and non-mechanized tools and equipment.	☐	☑	☐
3	Shorter time frame, more people, more juniper removed.	☐	☑	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	3	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-3**	

Explain:

Opportunities for solitude would be directly affected by the presence of work crews and the sounds of chainsaws and other motorized equipment. The noise impacts to wilderness solitude under this alternative would be more intense and would affect a larger area than larger work crews using hand tools. The use of motorized hand tools and equipment would detract from opportunities for primitive recreation. However, the appearance of juniper stumps within the proposed wilderness area would serve as a reminder of human activity and intrusion and would negatively impact opportunities for solitude over the long term. However, the recreation use is estimated to be very low and as a result, impacts to solitude and primitive recreation would affect few people.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Personnel would travel by foot, leaving motorized vehicles on roads outside of the proposed wil	☐	☐	☐
2	Removal with motorized and non-mechanized tools and equipment.	☐	☐	☐
3	Shorter time frame, more people, more juniper removed.	☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 3

Wilderness Character	
Untrammeled	-1
Undeveloped	-2
Natural	1
Solitude or Primitive & Unconfined Recreation	-3
Other Features of Value	0
Wilderness Character Summary Rating	**-5**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 4:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Removal method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating		**0**		

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Summary Ratings for Alternative 4

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 5:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Removal method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Summary Ratings for Alternative 5

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 6:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Removal method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 6

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 7:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Removal method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 7

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives

Alternative 8:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel	
2	Removal method	
3	Condition of site after project	
4		
5		
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative	Positive	Negative	No Effect

X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐

2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐

4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐

6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐

8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Summary Ratings for Alternative 8

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed
What alternatives were considered but not analyzed? Why were they not analyzed?

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Alternative Comparison

Alternative 1: No Action: no western juniper mnagement

Alternative 2: Non-mechanized and non-motorized

Alternative 3: Motorized and Non-Motorized

Alternative 4:

Wilderness Character	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	1	0	0	2	0	1	0	0
Undeveloped	0	0	0	2	0	2	0	0
Natural	0	2	1	1	1	0	0	0
Solitude/Primitive/Unconfined	0	0	0	3	0	3	0	0
Other Features of Value	0	0	0	0	0	0	0	0
Totals	1	2	1	8	1	6	0	0
Wilderness Character Rating	-1		-7		-5		0	

Alternative 5:

Alternative 6:

Alternative 7:

Alternative 8:

Wilderness Character	Alternative 5		Alternative 6		Alternative 7		Alternative 8	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	0	0	0	0	0
Undeveloped	0	0	0	0	0	0	0	0
Natural	0	0	0	0	0	0	0	0
Solitude/Primitive/Unconfined	0	0	0	0	0	0	0	0
Other Features of Value	0	0	0	0	0	0	0	0

Totals	0	0	0	0	0	0	0	0
Wilderness Character Rating	**0**		**0**		**0**		**0**	

Project Title: Reducing Western Juniper in Bighorn Sheep Habitat

MRDG Step 2: Determination

Refer to the **MRDG Instructions** before identifying the selected alternative and explaining the rationale for the selection.

Selected Alternative

☐ Alternative 1: No Action: no western juniper mnagement

☐ Alternative 2: Non-mechanized and non-motorized

☐ Alternative 3: Motorized and Non-Motorized

☐ Alternative 4:

☐ Alternative 5:

☐ Alternative 6:

☐ Alternative 7:

☐ Alternative 8:

Explain Rationale for Selection:

If more space is needed, continue on the next page…

Explain Rationale for Selection, Continued:

Describe Monitoring & Reporting Requirements:

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity?

Prohibited Use	Quantity
☐ Mechanical Transport:	
☐ Motorized Equipment:	
☐ Motor Vehicles:	
☐ Motorboats:	
☐ Landing of Aircraft:	
☐ Temporary Roads:	
☐ Structures:	
☐ Installations:	

Record and report any authorizations of Wilderness Act Section 4(c) prohibited uses according to agency policies or guidance.

Refer to agency policies for the following signature authorities:

Prepared	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Approved	Name	Position	
	Signature		Date

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MINIMUM REQUIREMENTS DECISION GUIDE

WORKBOOK

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

-- The Wilderness Act of 1964

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 1: Determination

Determine if Administrative Action is Necessary

Description of the Situation

What is the situation that may prompt administrative action?

The Proposed Poker Jim Wilderness Area encompasses the northern portion of Hart Mountain commonly referred to as Poker Jim Ridge and is situated north of the Frenchglen Road between Rock Creek and the Warner Valley. Terrain is formed by a geologic fault-thrust of the basalt formation resulting in a steep rocky west facing escarpment culminating with a tabletop formation, which gradually slopes off to the east. The steep west-facing escarpment encompasses approximately half of the bighorn sheep habitat on Poker Jim Ridge comprising 8,264 acres of the 16,462-acre proposed wilderness. The escarpment provides critically important escape and lambing habitat. Since 2017, the bighorn sheep herd has declined by almost 70 percent to a potentially unsustainable population level and is at risk of extirpation. Cougar predation of bighorn sheep has been documented on the escarpment.

Options Outside of Wilderness

Can action be taken outside of wilderness that adequately addresses the situation?

☐ YES

☑ NO

EXPLAIN & COMPLETE STEP 1 OF THE MRDG

Explain:

Bighorn sheep inhabit habitats across the western portion of the Hart Mountain Refuge, with a significant portion of the population occuring within the proposed Poker Jim Ridge proposed wilderness. The escarpment is inside the boundary of the proposed wilderness. The lands surrounding the refuge are of mixed ownership and do not provide habitat for bighorn sheep.

Criteria for Determining Necessity

Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that ***requires*** *action? Cite law and section.*

☐ YES ☑ NO

Explain:

There are no valid existing rights or special provisions that require action to be taken.

B. Requirements of Other Legislation

Is action necessary to meet the requirements of <u>other federal laws</u>? Cite law and section.

☑ YES ☐ NO

Explain:

The National Wildlife Refuge Administration Act of 1966 (16 U.S.C.§668dd, as amended) specifies that biological integrity, diversity, and environmental health of the National Wildlife Refuge System shall be ensured. Maintaining a healthy and viable bighorn sheep population is important to maintaining the biological integrity, diversity and environmental health of Hart Mountain Antelope Refuge and the Proposed Poker Jim Wilderness. Given recent declines in bighorn sheep on Poker Jim Ridge action is needed to restore the biological integrity, diversity, and environmental health of Poker Jim Ridge.

C. Wilderness Character

Is action necessary to preserve one or more of the five qualities of wilderness character?

UNTRAMMELED

☐ YES ☑ NO

Explain:

Actions are not neccessary to preserve the untrammeled wilderness quality.

UNDEVELOPED

☐ YES ☑ NO

Explain:

Actions are not neccessary to preserve the undeveloped wilderness quality.

NATURAL

☑ YES ☐ NO

Explain:

Actions are needed to ensure a healthy, viable bighorn sheep population over the long-term and thereby preserve a critically important component of the natural quality of the Proposed Poker Jim Ridge Wilderness and an iconic symbol of Refuge. Managing habitat and causes of the population decline are critical to the successful management of bighorn sheep on the Refuge.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☑ NO

Explain:

Actions are not neccessary to preserve the solitude or primitive and unconfined recreation wilderness quality.

OTHER FEATURES OF VALUE

☐ YES ☑ NO

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Step 1 Determination

Is administrative action *<u>necessary</u>* *in wilderness?*

Criteria for Determining Necessity	Summary Responses
A. Existing Rights or Special Provisions	Action IS NOT necessary to meet this criterion.
B. Requirements of Other Legislation	Action IS necessary to meet this criterion.
C. Wilderness Character	
Untrammeled	Action IS NOT necessary to meet this criterion.
Undeveloped	Action IS NOT necessary to meet this criterion.
Natural	Action IS necessary to meet this criterion.
Solitude/Primitive/Unconfined	Action IS NOT necessary to meet this criterion.

Other Features of Value — Action IS NOT necessary to meet this criterion.

Is administrative action necessary in wilderness?

☑ YES — **EXPLAIN & PROCEED TO STEP 2 OF THE MRDG**

☐ NO

Explain:

Maintaining a healthy and viable bighorn sheep population is critically important to maintaining the natural quality of wilderness character and the biological integrity, diversity and environmental health of Hart Mountain Antelope Refuge and the proposed Poker Jim Wilderness.

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2

Determine the Minimum Activity

Other Direction

*Is there "special provisions" language in legislation (or other Congressional direction) that explicitly **allows** consideration of a use otherwise prohibited by Section 4(c)?*

AND/OR

Has the issue been addressed in agency policy, management plans, species recovery plans, or agreements with other agencies or partners?

☐ YES

☑ NO

SKIP AHEAD TO TIME CONSTRAINTS BELOW

Describe Other Direction:

Time Constraints
What, if any, are the time constraints that may affect the action?

Components of the Action
What are the discrete components or phases of the action?

Component X	*Example: Transportation of personnel to the project site*
Component 1	Transportation of personnel to and from PJR escarpment
Component 2	Tools used
Component 3	Administrative removal of cougars
Component 4	Monitoring
Component 5	Site condition upon completion
Component 6	
Component 7	
Component 8	
Component 9	

Proceed to the alternatives.

Refer to the **MRDG Instructions** regarding alternatives and the effects to each of the comparison criteria.

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 1: No Action

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

The No Action alternative for a Minimum Requirements Analysis is to take no management action. This differs from a No Action alternative under the National Environmental Policy Act (NEPA) in that under NEPA, the no action alternative is the continuation of current management practices. The No Action Alternative serves as a baseline to compare the effects of the action alternatives to wilderness character. No population management actions would be employed. Annual aerial counts would remain the only means of determining: health and status of individual animals and identifying population trends.

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	No transportation of personnel
2	Tools used	No tools used
3	Administrative removal of cougars	No administrative removal of cougars
4	Monitoring	No monitoring conducting
5	Site condition upon completion	Site undisturbed
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel	☐	☐	☑
2	No tools used	☐	☐	☑
3	No administrative removal of cougars	☐	☐	☑
4	No monitoring conducting	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

Not taking an action does not affect the untrammeled quality.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1	No transportation of personnel	☐	☐	☑
2	No tools used	☐	☐	☑
3	No administrative removal of cougars	☐	☐	☑
4	No monitoring conducting	☐	☐	☑
5	Site undisturbed	☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

Not taking an action does not affect the undeveloped quality.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel	☐	☐	☑
2	No tools used	☐	☐	☑

3	No administrative removal of cougars	☐	☑	☐
4	No monitoring conducting	☐	☐	☑
5	Site undisturbed	☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Natural Total Rating			**-1**	

Explain:

If no action is taken, there is legitimate concern that bighorn sheep population would continue to decline due to predation pressure and this important aspect of the natural quality of wilderness could be impacted or even extirpated over the long-term.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel	☐	☐	☐
2	No tools used	☐	☐	☐
3	No administrative removal of cougars	☐	☐	☐
4	No monitoring conducting	☐	☐	☐

5	Site undisturbed	☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

If no action is taken there would not be any effect on the ability of wilderness visitors to find solitude or recreate in the wilderness area. However, if the bighorn sheep population continues to decline the opportunity for popular wilderness recreational activities (bighorn sheep observation, photography, hunting) may be lost.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	No transportation of personnel	☐	☐	☑
2	No tools used	☐	☐	☑
3	No administrative removal of cougars	☐	☐	☑
4	No monitoring conducting	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 1

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	-1
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**-1**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 2: Cougar Management Using No Wilderness Act Section 4(C) prohibited tools

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Under this alternative, the administrative removal of cougars from the PJR escarpment would employ professional, highly skilled cougar trackers that use sign, sighting, calling, and specialized methods to locate, track, and remove targeted cougars in as humane a manner as practicable. A primary method to be used would be specially trained hounds to trail and locate specific individual cougars, which would then be euthanized by gunshot. In some cases, the cougar would be immobilized by lethal injection. Hounds are preferred because this is typically the most effective and selective method of capturing cougars with the lowest potential to affect nontarget animals. Removals would be conducted from August 1 to March 31, concurrent with existing Refuge hunting seasons and when conditions are likely to be more successful. Authorized agents could include Service, ODFW, or USDA APHIS–Wildlife Services personnel, or professional houndsmen, trackers, or trappers under contract or agreement with the Service or ODFW. All authorized agents would be required to follow approved SOPs and Best Management Practices (BMPs) detailed in the Service's bighorn sheep management plan. The Service would follow American Veterinary Medical Association (AVMA) recommendations and guidelines for the euthanasia of animals (AVMA 2020).

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	Only foot traffic allowed with PJR
2	Tools used	Firearms, hounds
3	Administrative removal of cougars	Cougars administratively removed from the escarpment
4	Monitoring	No monitoring is required
5	Site condition upon completion	Site undisturbed
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Firearms, hounds	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☑	☐
4	No monitoring is required	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Untrammeled Total Rating			**-1**	

Explain:

The administrative removal of cougars is an intentional action that manipulates "the earth and its community of life" inside a proposed wilderness.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1	Only foot traffic allowed with PJR	☐	☐	☑
2	Firearms, hounds	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	No monitoring is required	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

The administrative removal of cougars not employing Wilderness Act Section 4 (C) prohibited tools would have no effect to the PJR undeveloped quality.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Firearms, hounds	☐	☑	☐

3	Cougars administratively removed from the escarpment	☐	☐	☑
4	No monitoring is required	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Natural Total Rating			**-1**	

Explain:

While using highly skilled cougar trackers/hunters is the Service's preferred method to administratively remove cougars and will be employed on gentler slopes within PJR, this method is not appropriate for the rugged and steep terrain of the PJR escarpment. It would not be effective, practical, or safe for hunters and hounds to traverse the steep slopes of the escarpment.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☑	☐
2	Firearms, hounds	☐	☑	☐
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	No monitoring is required	☐	☐	☑

5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-2**	

Explain:

Two components of this action negatively affect a visitor's ability to experience solitude: encountering personnel and the act of carrying out the administrative removal of cougars. This may affect a visitor's sennse of isolation and also due to the sounds and sights of modern civilization as the hunt occurs. the quality by the may have a negative effect on solitude and the sense of isolation due to the sounds and sights of modern civilization. A visitor's ability to experience unconfined recreation should not be impacted.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Firearms, hounds	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	No monitoring is required	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 2

Wilderness Character	
Untrammeled	-1
Undeveloped	0
Natural	-1
Solitude or Primitive & Unconfined Recreation	-2
Other Features of Value	0
Wilderness Character Summary Rating	**-4**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 3: Cougar Management Using Snares

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Under this alternative, the Service would use foothold and neck snares to carry out administrative removals of cougars on the Poker Jim Ridge escarpment due to the impracticality of hunting along the steep escarpment. Effectiveness of snares depend greatly on the skill and expertise of the trapper, but can be highly selective to minimize unintentional captures. Snares can be set to kill cougars or hold them alive for shooting. A leg snare set is made on game trails frequented by cougars and stones or sticks are used to direct foot placement over the tigger. Neck snares intended to live capture cougars are typically placed with the bottom loop 14 inches off the ground and a loop diameter of 18-20 inches. Foothold snares with stops set at the appropriate size for the target species (and to avoid non-target species capture) appear to have an acceptable effect on animal welfare, with little mortality of target species. When neck snares are set correctly as a restraint (not as a kill trap), using a stop on the cable, serious injuries are relatively uncommon, although the risk of mortality may be higher than with foothold snares. Both foot and neck restraint snares can capture non-target species, with risk of mortality. Adding a breakaway snare lock, snare stops, and appropriate pan tension can minimize capture of non-target species and reduce the risk of holding a non-target animal. All snares would be monitored within 48 hour intervals, which requires multiple trips to the escarpmeent. Up to 20 snares will be set to cover 8,000 acres of the escarpment. The Service would follow American Veterinary Medical Association (AVMA) recommendations and guidelines for the euthanasia of animals (AVMA 2020).

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	Only foot traffic allowed with PJR
2	Tools used	Foothold and neck snares
3	Administrative removal of cougars	Cougars administratively removed from the escarpment
4	Monitoring	Monitor all snares within 48 hour intervals
5	Site condition upon completion	Site undisturbed
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Foothold and neck snares	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☑	☐
4	Monitor all snares within 48 hour intervals	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Untrammeled Total Rating			**-1**	

Explain:

The administrative removal of cougars is an intentional action that manipulates “the earth and its community of life” inside a proposed wilderness.

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1	Only foot traffic allowed with PJR	☐	☐	☑
2	Foothold and neck snares	☐	☑	☐
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	Monitor all snares within 48 hour intervals	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	1	NE
Undeveloped Total Rating			-1	

Explain:

Foothold and neck snares are considered temporary installations, which are Wilderness Act Section 4 (C) prohibited tools. Foothold and neck snares remaining in the wilderness as the management plan is in effect diminishes the undeveloped quality of the proposed PJR Wilderness.

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Foothold and neck snares	☐	☐	☑

3	Cougars administratively removed from the escarpment	☑	☐	☐
4	Monitor all snares within 48 hour intervals	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		1	0	NE
Natural Total Rating			**1**	

Explain:

Maintaining a healthy and viable bighorn sheep population is critically important to maintaining the natural quality of wilderness character and the biological integrity, diversity and environmental health of Hart Mountain Antelope Refuge and the Proposed Poker Jim Wilderness. Cougar predation is the leading cause of bighorn sheep mortality. The only safe and effective way to carry out removals on the steep and rugged escarpment is to employ snares. The effectiveness of snares depends greatly on the skill and expertise of the trapper, but can be highly selective to minimize unintentional captures.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☑	☐
2	Foothold and neck snares	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	Monitor all snares within 48 hour intervals	☐	☑	☐

5	Site undisturbed	☐	☐	☑
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	2	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**-2**	

Explain:

Encountering personnel as they travel to and from the escarpment to install, monitor, and remove snares may have a negative effect on a visitor’s ability to experience solitude and the sense of isolation. A visitor's ability to experience unconfined recreation should not be impacted.

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1	Only foot traffic allowed with PJR	☐	☐	☑
2	Foothold and neck snares	☐	☐	☑
3	Cougars administratively removed from the escarpment	☐	☐	☑
4	Monitor all snares within 48 hour intervals	☐	☐	☑
5	Site undisturbed	☐	☐	☑
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Other features of value have not been identified for the proposed Poker Jim Ridge wilderness.

Summary Ratings for Alternative 3

Wilderness Character	
Untrammeled	-1
Undeveloped	-1
Natural	1
Solitude or Primitive & Unconfined Recreation	-2
Other Features of Value	0
Wilderness Character Summary Rating	**-3**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 4:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	
2	Tools used	
3	Administrative removal of cougars	
4	Monitoring	
5	Site condition upon completion	
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			0	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐

3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐

5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 4

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 5:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	
2	Tools used	
3	Administrative removal of cougars	
4	Monitoring	
5	Site condition upon completion	
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐

3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐

5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			**0**	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 5

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 6:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	
2	Tools used	
3	Administrative removal of cougars	
4	Monitoring	
5	Site condition upon completion	
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐

3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			**0**	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐

5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating		**0**		

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating		**0**		

Explain:

Summary Ratings for Alternative 6

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 7:

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities
How will each of the components of the action be performed under this alternative?

Component of the Action		Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	
2	Tools used	
3	Administrative removal of cougars	
4	Monitoring	
5	Site condition upon completion	
6		
7		
8		
9		

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			**0**	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐

3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐

5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating		**0**		

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 7

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives

Alternative 8:

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Component Activities

How will each of the components of the action be performed under this alternative?

	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to and from PJR escarpment	
2	Tools used	
3	Administrative removal of cougars	
4	Monitoring	
5	Site condition upon completion	
6		
7		
8		
9		

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Untrammeled Total Rating			**0**	

Explain:

UNDEVELOPED

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑

1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Undeveloped Total Rating			0	

Explain:

NATURAL

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐

3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Natural Total Rating			0	

Explain:

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐

5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Solitude or Primitive & Unconfined Recreation Total Rating			0	

Explain:

OTHER FEATURES OF VALUE

Component Activity for this Alternative		Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☑
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐

7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐
Totals		0	0	NE
Other Features of Value Total Rating			**0**	

Explain:

Summary Ratings for Alternative 8

Wilderness Character	
Untrammeled	0
Undeveloped	0
Natural	0
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	0
Wilderness Character Summary Rating	**0**

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed
What alternatives were considered but not analyzed? Why were they not analyzed?

The use of box traps was considered but not analyzed. Box traps would only be considered if the other management techniques prove to be ineffective.

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Alternative Comparison

Alternative 1: No Action

Alternative 2: Cougar Management Using No Wilderness Act Section 4(C) prohibited tools

Alternative 3: Cougar Management Using Snares

Alternative 4:

Wilderness Character	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	1	0	1	0	0
Undeveloped	0	0	0	0	0	1	0	0
Natural	0	1	0	1	1	0	0	0
Solitude/Primitive/Unconfined	0	0	0	2	0	2	0	0
Other Features of Value	0	0	0	0	0	0	0	0
Totals	0	1	0	4	1	4	0	0
Wilderness Character Rating	-1		-4		-3		0	

Alternative 5:

Alternative 6:

Alternative 7:

Alternative 8:

Wilderness Character	Alternative 5		Alternative 6		Alternative 7		Alternative 8	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Untrammeled	0	0	0	0	0	0	0	0
Undeveloped	0	0	0	0	0	0	0	0
Natural	0	0	0	0	0	0	0	0
Solitude/Primitive/Unconfined	0	0	0	0	0	0	0	0

Other Features of Value	0	0	0	0	0	0	0	0
Totals	0	0	0	0	0	0	0	0
Wilderness Character Rating	**0**		**0**		**0**		**0**	

Project Title: Cougar Management on the Poker Jim Ridge Escarpmant

MRDG Step 2: Determination

Refer to the **MRDG Instructions** before identifying the selected alternative and explaining the rationale for the selection.

Selected Alternative

- ☐ Alternative 1: No Action
- ☐ Alternative 2: Cougar Management Using No Wilderness Act Section 4(C) prohibited tools
- ☑ Alternative 3: Cougar Management Using Snares
- ☐ Alternative 4:
- ☐ Alternative 5:
- ☐ Alternative 6:
- ☐ Alternative 7:
- ☐ Alternative 8:

Explain Rationale for Selection:

Maintaining a healthy and viable bighorn sheep population is critically important to maintaining the natural quality Poker Jim Ridge and the biological integrity, diversity and environmental health of Hart Mountain National Antelope Refuge. As the population has experienced serious recent declines attributable to cougar predation, the need for action is clear. Allowing cougar hunting as the only means to administratively remove cougars from the Poker Jim Ridge escarpment would be unsafe and largely ineffective at reducing cougar predation pressure on bighorn sheep. The only safe and effective way to carry out removals on the steep and rugged escarpment is to employ snares. Use of snares can be effective as well as selective to minimize unintentional captures.

If more space is needed, continue on the next page…

Explain Rationale for Selection, Continued:

Describe Monitoring & Reporting Requirements:

Monitor all snares within 48-hour intervals. PLEASE ADD

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity?

Prohibited Use	Quantity
☐ Mechanical Transport:	
☐ Motorized Equipment:	
☐ Motor Vehicles:	
☐ Motorboats:	
☐ Landing of Aircraft:	
☐ Temporary Roads:	
☐ Structures:	
☑ Installations:	20

Record and report any authorizations of Wilderness Act Section 4(c) prohibited uses according to agency policies or guidance.

Refer to agency policies for the following signature authorities:

Prepared	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Recommended	Name	Position	
	Signature		Date
Approved	Name	Position	
	Signature		Date

APPENDIX G

Taxonomy of Species Identified in the Management Plan and Environmental Impact Statement

Hart Mountain National Antelope Refuge
Draft Bighorn Sheep Management Plan and
Environmental Impact Statement

Appendix G. Taxonomy of Species Identified in the |Management Plan and Environmental Impact Statement

The following list identifies the taxonomy of species identified in the Draft Bighorn Sheep Management Plan and Environmental Impact Statement. This should not be viewed as a complete species list for the Refuge. Taxonomy presented in this list is based on that provided by the Integrated Taxonomic Information System (ITIS; http://www.itis.gov) within the identified Taxonomic Serial Number (TSN) entries, except where otherwise indicated.

Class	**Order**	**Family**	***Scientific Name***	**Common Name(s)**	**ITIS TSN**	**Native Status**
Mammalia (Mammals)						
	Artiodactyla (Cloven-hoofed Ungulates)					
		Antilocapridae (Pronghorns)				
			Antilocapra americana	Pronghorn	180717	Native
		Bovidae (Cattle, Goats, Sheep)				
			Ovis canadensis	Bighorn sheep	180711	Native
			Ovis canadensis ssp. *californiana*	California bighorn sheep	898802	Native
			Ovis canadensis ssp. *canadensis*	Rocky Mountain bighorn sheep	898801	Native (not present)
			Ovis canadensis ssp. *mexicana*	Desert bighorn sheep	898804	Native (not present)
			Ovis canadensis ssp. *sierrae*	Sierra Nevada bighorn sheep	898931	Native (not present)
		Cervidae (Deer, Elk, Moose)				
			Cervus elaphus ssp. *canadensis*	Elk North American elk Wapiti	898519	Native
			Odocoileus hemionus	Mule deer	180698	Native
	Carnivora (Carnivores)					
		Canidae (Canines)				
			Canis latrans	Coyote Wile E.	180599	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Urocyon cinereoargenteus	Gray fox	180609	Native (not present)
		Felidae (Felines)				
			Lynx rufus	Bobcat	180582	Native
			Puma concolor	Cougar Mountain lion Puma	552479	Native
		Mephitidae (Skunks)				
			Mephitis mephitis	Striped skunk	180562	Native
			Spilogale putorius	Spotted skunk	180570	Native
		Mustelidae (Mustelids)				
			Lontra canadensis	River otter North American river otter	180549	Native
			Mustela erminea	Ermine Short-tailed weasel	180555	Native
			Mustela frenata	Long-tailed weasel	180556	Native
			Taxidea taxus	American badger Badger	180565	Native
		Procyonidae (Raccoons)				
			Procyon lotor	Raccoon Northern raccoon Common raccoon	180575	Native
		Ursidae (Bears)				
			Ursus arctos	Grizzly bear Brown bear	180543	Native (not present)
	Chiroptera (Bats)					
		Molossidae (Free-tailed Bats)				
			Nyctinomops macrotis	Big free-tailed bat	180086	Native (not present)
			Tadarida brasiliensis	Mexican free-tailed bat	180088	Native (not present)
		Vespertilionidae (Vesper Bats)				
			Antrozous pallidus	Pallid bat	180006	Native
			Corynorhinus townsendii	Townsend's big-eared bat	203452	Native
			Eptesicus fuscus	Big brown bat	180008	Native
			Eptesicus fuscus ssp. *bernardinus*	Big brown bat	948383	Native
			Euderma maculatum	Spotted bat	180010	Native (not present)
			Lasionycteris noctivagans	Silver-haired bat	180014	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Lasiurus blossevillii	Western red bat	552512	Native (not present)
			Lasiurus cinereus	Hoary bat	180017	Native
			Myotis californicus	California myotis	179991	Native
			Myotis californicus ssp. *californicus*	California myotis	947705	Native
			Myotis ciliolabrum	Western small-footed myotis	179994	Native
			Myotis evotis	Long-eared myotis	179995	Native
			Myotis lucifugus	Little brown myotis	179988	Native
			Myotis lucifugus ssp. *carissima*	Little brown myotis	948587	Native
			Myotis melanorhinus	Dark-nosed small-footed myotis	946251	Native (not present)
			Myotis thysanodes	Fringed myotis	180002	Native
			Myotis volans	Long-legged myotis	179990	Native
			Myotis volans ssp. interior	Long-legged myotis	948629	Native
			Myotis yumanensis	Yuma myotis	180004	Native
			Myotis yumanensis ssp. *sociabilis*	Yuma myotis	948635	Native
			Parastrellus hesperus	Canyon bat Western pipistrelle	947298	Native
	Lagomorpha (Rabbits, Hares, Pikas)					
		Leporidae (Hares, Rabbits)				
			Brachylagus idahoensis	Pygmy rabbit	552521	Native
			Lepus californicus	Black-tailed jackrabbit	180115	Native
			Lepus townsendii	White-tailed jackrabbit	180118	Native
			Sylvilagus nuttallii	Mountain cottontail Nuttall's cottontail	180126	Native
		Ochotonidae (Pikas)				
			Ochotona princeps	American pika Rock rabbit Whistling hare	180109	Native
	Rodentia (Rodents)					
		Cricetidae (Voles, Mice, New World Rats)				
			Lemmiscus curtatus	Sagebrush vole	552490	Native
			Microtus montanus	Montane vole	180310	Native
			Neotoma cinerea	Bushy-tailed woodrat	180371	Native
			Neotoma lepida	Desert woodrat	180374	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Ondatra zibethicus	Muskrat Muskbeaver	180318	Native
			Onychomys leucogaster	Northern grasshopper mouse	180382	Native
		Erethizontidae (Porcupines)				
			Erethizon dorsatus	Porcupine North American porcupine	825295	Native
		Heteromyidae (Kangaroo mice/rats, Pocket mice)				
			Microdipodops megacephalus	Dark kangaroo mouse	180252	Native
			Perognathus parvus	Great Basin pocket mouse	180269	Native
		Sciuridae (Squirrels, Marmots, Chipmunks)				
			Ammospermophilus leucurus	White-tailed antelope ground squirrel	180181	Native
			Callospermophilus lateralis	Golden-mantled ground squirrel	930305	Native
			Marmota flaviventris	Yellow-bellied marmot	180140	Native
			Tamias amoenus	Yellow pine chipmunk	180190	Native
			Tamias minimus	Least chipmunk	180195	Native
			Urocitellus beldingi	Belding's ground squirrel	930315	Native
	Soricomorpha (Shrews, Moles)					
		Soricidae (Shrews)				
			Sorex merriami	Merriam's shrew	179949	Native
			Sorex palustris	Water shrew	179933	Native
			Sorex preblei	Preble's shrew	179954	Native
			Sorex vagrans	Vagrant shrew Wandering shrew	179932	Native
Aves (Birds)						
	Accipitriformes (Hawks, Eagles)					
		Accipitridae (Eagles, Hawks, Kites)				
			Aquila chrysaetos	Golden eagle	175407	Native
			Buteo lagopus	Rough-legged hawk	175373	Native
			Buteo regalis	Ferruginous hawk	175377	Native
			Buteo swainsoni	Swainson's hawk	175367	Native
			Circus cyaneus	Northern harrier	175430	Native
			Haliaeetus leucocephalus	Bald eagle	175420	Native
	Anseriformes (Ducks, Geese)					

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
		Anatidea (Ducks, Geese, Swans)				
			Anas acuta	Northern pintail	175074	Native
			Anas clypeata	Northern shoveler	175096	Native
			Anas crecca ssp. *carolinensis*	Green-winged teal	175084	Native
			Anas cyanoptera	Cinnamon teal	175089	Native
			Anas discors	Blue-winged teal	175086	Native
			Anas platyrhynchos	Mallard	175063	Native
			Anas strepera	Gadwall	175073	Native
			Aythya americana	Redhead	175125	Native
			Aythya valisineria	Canvasback	175129	Native
			Branta canadensis	Canada goose	174999	Native
			Oxyura jamaicensis	Ruddy duck	175175	Native
	Apodiformes (Swifts, Hummingbirds)					
		Trochilidae (Hummingbirds)				
			Selasphorus platycercus	Broad-tailed hummingbird	178038	Native
			Selasphorus rufus	Rufous hummingbird	178040	Native
			Stellula calliope	Calliope hummingbird	178048	Native
	Charadriiformes (Gulls, Shorebirds)					
		Charadriidae (Plovers)				
			Charadrius nivosus	Snowy plover	824030	Native
			Charadrius vociferus	Killdeer	176520	Native
		Laridae (Gulls, Terns, Skimmers)				
			Chlidonias niger	Black tern	176959	Native
			Sterna forsteri	Forster's tern	176887	Native
		Recurvirostridae (Stilts, Avocets)				
			Himantopus mexicanus	Black-necked stilt	176726	Native
			Recurvirostra americana	American avocet	176721	Native
		Scolopacidae (Sandpipers)				
			Actitis macularius	Spotted sandpiper	726049	Native
			Calidris mauri	Western sandpiper	176668	Native
			Calidris minutilla	Least sandpiper	176656	Native
			Gallinago gallinago	Common snipe	176700	Native
			Numenius americanus	Long-billed curlew	176593	Native
			Phalaropus tricolor	Wilson's phalarope	176736	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Tringa flavipes	Lesser yellowlegs	176620	Native
			Tringa melanoleuca	Greater yellowlegs	176619	Native
			Tringa semipalmata	Willet	824147	Native
			Tringa solitaria	Solitary sandpiper	176615	Native
	Falconiformes (Falcons)					
		Falconidae (Falcons)				
			Falco sparverius	American kestrel	175622	Native
	Galliformes (Gallinaceous Birds/Fowl)					
		Odontophoridae (New World Quail)				
			Callipepla californica	California quail	175876	Native
			Oreortyx pictus	Mountain quail	175893	Native
		Phasianidae (Pheasant)				
			Alectoris chukar	Chukar Chukar partridge	175908	Introduced
			Centrocercus urophasianus	Greater sage-grouse	175855	Native
	Gruiformes (Cranes, Rails)					
		Gruidae (Cranes)				
			Grus canadensis	Sandhill crane	176177	Native
		Rallidae (Rails)				
			Porzana carolina	Sora	176242	Native
			Rallus limicola	Virginia rail	176221	Native
	Passeriformes (Perching Birds)					
		Cardinalidae (Cardinals)				
			Passerina amoena	Lazuli bunting	179151	Native
		Emberizidae (American Sparrows)				
			Artemisiospiza belli	Sage sparrow	997724	Native
			Passerculus sandwichensis	Savannah sparrow	179314	Native
			Passerella iliaca	Fox sparrow	179464	Native
			Pooecetes gramineus	Vesper sparrow	179366	Native
			Spizella breweri	Brewer's sparrow	179440	Native
		Fringillidae (Finches)				
			Haemorhous cassinii	Cassin's finch	997804	Native
		Hirundinidae (Swallows)				
			Tachycineta bicolor	Tree swallow	178431	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
		Icteridae (New World Blackbirds)				
			Agelaius phoeniceus	Red-winged blackbird	179045	Native
			Dolichonyx oryzivorus	Bobolink	179032	Native
			Euphagus cyanocephalus	Brewer's blackbird	179094	Native
			Icterus galbula	Northern oriole	179083	Native
			Sturnella neglecta	Western meadowlark	179039	Native
		Laniidae (Skrikes)				
			Lanius ludovicianus	Loggerhead shrike	178515	Native
		Mimidae (Mimids)				
			Oreoscoptes montanus	Sage thrasher	178654	Native
		Parulidae (New World Warblers)				
			Geothlypis tolmiei	MacGillivray's warbler	950023	Native
			Leiothlypis celata	Orange-crowned warbler	950015	Native
			Setophaga petechia	Yellow warbler	950039	Native
		Polioptilidae (Gnatcatchers)				
			Polioptile caerulea	Blue-gray gnatcatcher	179853	Native
		Turdidae (Thrushes)				
			Catharus ustulatus	Swainson's thrush	179788	Native
			Sialia mexicana	Western bluebird	179806	Native
		Tyrannidae (Tyrant Flycatchers)				
			Empidonax oberholseri	Dusky flycatcher	178346	Native
			Myiarchus cinerascens	Ash-throated flycatcher	178316	Native
		Vireonidae (Vireos)				
			Vireo gilvus	Warbling vireo	179023	Native
	Pelecaniformes (Pelicans, Herons, Ibis)					
		Ardeidae (Herons)				
			Botaurus lentiginosus	American bittern	174856	Native
			Nycticorax nycticorax	Black-crowned night heron	174832	Native
	Piciformes (Woodpeckers)					
		Picidae (Woodpeckers)				
			Colaptes auratus	Northern flicker	178154	Native
			Melanerpes lewis	Lewis' woodpecker	178196	Native
	Podicipediformes (Grebes)					
		Podicipedidae (Grebes)				

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Aechmophorus clarkii	Clark's grebe	554027	Native
			Aechmophorus occidentalis	Western grebe	174503	Native
			Podiceps auritus	Horned grebe	174482	Native
			Podiceps nigricollis	Eared grebe	174485	Native
			Podilymbus podiceps	Pied-billed grebe	174505	Native
	Strigiformes (Owls)					
		Strigidae (Typical Owls)				
			Asio flammeus	Short-eared owl	177935	Native
			Megascops kennicottii	Western screech owl	686659	Native
	Suliformes (Cormorants)					
		Phalacrocoracidae (Cormorants)				
			Phalacrocorax auritus	Double-crested cormorant	174717	Native
Amphibia (Amphibians)						
	Anura (Frogs, Toads)					
		Bufonidae (Toads)				
			Anaxyrus boreas	Western toad	773513	Native
		Hylidae (New World Treefrogs)				
			Pseudacris regilla	Pacific chorus frog Pacific treefrog	207313	Native
		Ranidae (True Frogs)				
			Rana pretiosa	Oregon spotted frog	173458	Native
		Scaphiopodidae (American Spadefoots)				
			Spea intermontana	Great Basin spadefoot	206991	Native
	Caudata (Salamanders)					
		Ambystomatidae (Mole Salamanders)				
			Ambystoma macrodactylum	Long-toed salamander	173601	Native
Reptilia (Reptiles)						
	Squamata (Lizards and Snakes)					
		Colubridae (Typical Snakes)				
			Coluber constrictor ssp. *mormon*	Western racer Western yellow-bellied racer	209197	Native
			Coluber taeniatus	Striped whipsnake	1082077	Native
		Iguanidae (Iguanids)				
			Sceloporus graciosus ssp. *graciosus*	Northern sagebrush lizard	208742	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Sceloporus occidentalis	Western fence lizard	173875	Native
			Uta stansburiana	Side-blotched lizard	173956	Native
		Phrynosomatidae (North American Spiny Lizards)				
			Phrynosoma douglasii	Pygmy short-horned lizard	564567	Native
			Phrynosoma platyrhinos	Desert horned lizard	173943	Native
Teleostei (Teolost Ray-finned Fishes)						
	Cypriniformes (Minnows, Suckers)					
		Catostomidae (Suckers)				
			Catostomus warnerensis	Warner sucker	163915	Native
		Cyprinidae (Carps and Minnows)				
			Siphateles bicolor	Tui chub	913989	Native
			Siphateles bicolor ssp. [1]	Catlow tui chub [1] Catlow Tui chub subspecies group [1]	<none>[1]	Native [1]
			Siphateles bicolor ssp. *eurysoma*	Sheldon tui chub	914010	Native
	Salmoniformes (Salmonids)					
		Salmonidae (Trouts, Salmons)				
			Oncorhynchus clarki ssp. *alvordensis*	Alvord cutthroat trout	<none>	Extinct
			Oncorhynchus clarkii	Cutthroat trout	161983	Native
			Oncorhynchus clarkii ssp. *henshawi*	Lahontan cutthroat trout	201902	Native
			Oncorhynchus clarkii x mykiss	Cuttbow (Cutthroat x Rainbow hybrid)	<none>	Hybrid
			Oncorhynchus mykiss	Rainbow trout	161989	Introduced [2]
			Oncorhynchus mykiss ssp. [1,3]	Redband trout [1,3] Great Basin redband trout [1,3]	<none>[1,3]	Native [1,3]
			Oncorhynchus mykiss ssp. [1,3]	Catlow redband [1,3] Great Basin redband trout (Catlow Valley SMU population segment)[1,3]	<none>[1,3]	Native [1,3]
Mollicutes (Soft Skin Bacteria)						
	Mycoplasmatales					
		Mycoplasmataceae				
			Mycoplasma ovipneumoniae	<no common name> (aka, *M. ovi.*)	963950	Infectious
Magnoliopsida (Flowering Plants)						
	Alismatales					
		Araceae (Arums)				
			Lemna	Duckweed	42588	Native

Class	Order	Family	Scientific Name	Common Name(s)	ITIS TSN	Native Status
		Potamogetonaceae (Pondweeds)				
			Potamogeton	Pondweed	39005	Native
	Apiales					
		Apiaceae (Carrots)				
			Lomatium	Biscuitroot Desert-parsley Indianroot	29677	Native
	Asparagales					
		Amaryllidaceae (Amaryllis)				
			Allium	Wild onion	42634	Native
		Asparagaceae (Asparagus)				
			Camassia quamash	Camas Common camas Small camas	42883	Native
		Iridaceae (Iris)				
			Iris missouriensis	Wild iris Rocky Mountain iris Western blue flag	43221	Native
	Asterales					
		Asteraceae (Sunflowers)				
			Achillea millefolium	Yarrow Common yarrow Western yarrow	35423	Native
			Artemisia	Sagebrush Wormwood Sagewort	35431	Native
			Artemisia arbuscula	Low sagebrush Little sagebrush	35449	Native
			Artemisia cana	Silver sagebrush	35454	Native
			Artemisia nova	Black sagebrush	500971	Native
			Artemisia tridentata	Big sagebrush	35498	Native
			Artemisia tridentata ssp. *tridentata*	Basin big sagebrush	35499	Native
			Artemisia tridentata ssp. *vaseyana*	Mountain big sagebrush	183740	Native
			Artemisia tridentata ssp. *wyomingensis*	Wyoming big sagebrush	183741	Native
			Artemisia tridentata ssp. *X bonnevillensis* [4]	Bonneville big sagebrush [4]	<none> [4]	Native [4]
			Artemisia tridnetata ssp. *Xericensis* [5]	Xeric big sagebrush [5]	524887 [5]	Native [5]

Class	Order	Family	Scientific Name	Common Name(s)	ITIS TSN	Native Status
			Balsamorhiza	Balsamroot	36806	Native
			Balsamorhiza sagittata	Arrowleaf balsamroot	36818	Native
			Carduus nutans	Musk thistle Nodding thistle	35787	Invasive
			Chrysothamnus	Rabbitbrush	37048	Native
			Chrysothamnus humilis	Truckee rabbitbrush	37053	Native
			Chrysothamnus viscidiflorus	Green rabbitbrush Yellow rabbitbrush	37090	Native
			Crepis	Hawksbeard	37168	Native
			Ericameria	Goldenbush Rabbitbrush	37323	Native
			Ericameria nauseosa	Gray rabbitbrush Rubber rabbitbrush	507594	Native
			Ericameria suffruticosa	Singlehead goldenbush Bighead goldenbush	502372	Native
			Erigeron	Daisy Fleabane	35803	Native
			Gnaphalium palustre	Western marsh cudweed Lowland cudweed Marsh everlasting	36709	Native
			Onopordum acanthium	Scotch thistle Scotch cottonthistle	38140	Invasive
			Picrothamnus desertorum	Bud sagebrush	519062	Native
			Rhaponticum repens	Russian knapweed Hardheads	780495	Invasive
			Solidago	Goldenrod	36223	Native
			Tetradymia	Horsebrush	38491	Native
		Campanulaceae (Bellflower)				
			Downingia	Calicoflower	34551	Native
	Boraginales					
		Boraginaceae (Borage or Forget-Me-Not)				
			Mertensia	Bluebells	31660	Native
	Brassicales					
		Brassicaceae (Mustards)				
			Anelsonia eurycarpa	Daggerpod	23037	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Boechera cobrensis	Sagebrush rockcress	823028	Native
			Descurainia pinnata	Western tansymustard	22826	Native
			Descurainia sophia	Pinnate tansymustard Flixweed Herb sophia	22843	Invasive
			Lepidium latifolium	Perennial pepperweed	503379	Invasive
			Lepidium perfoliatum	Clasping pepperweed	22974	Invasive
			Phoenicaulis cheiranthoides	Wallflower	23266	Native
			Polyctenium fremontii	Desert combleaf Fremont's combleaf	23287	Native
			Sisymbrium altissimum	Tall tumblemustard Jim Hill mustard Tumble mustard	23312	Invasive
	Caryophyllales					
		Amaranthaceae (Amaranth)				
			Atriplex canescens	Fourwing saltbush	20518	Native (not present)
			Atriplex confertifolia	Shadscale saltbush Spiny saltbush	20519	Native
			Atriplex gardneri var. *falcata*	Sickle saltbush	192244	Native
			Bassia hyssopifolia	Fivehorn smotherweed	20588	Invasive
			Grayia spinosa	Spiny hopsage	20690	Native
			Halogeton glomeratus	Saltlover Halogeton	20692	Invasive
			Kochia scoparia	Common kochia Kochia Burningbush	20696	Invasive
			Krascheninnikovia lanata	Winterfat	503290	Native
			Salsola	Russian thistle Tumbleweed	20654	Invasive
		Polygonaceae (Buckwheats)				
			Eriogonum	Buckwheat	21054	Native
			Eriogonum crosbyae [6]	Crosby's buckwheat [6]	195635 [6]	Native (not present) [6]
			Eriogonum cusickii [7]	Cusick's buckwheat [7]	21107 [7]	Native [7]
			Eriogonum ovalifolium	Cushion buckwheat Ovalleaf eriogonum	21212	Native
			Eriogonum prociduum [7]	Prostrate buckwheat [7]	21226 [7]	Native [7]

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Polygonum	Knotweed	20847	Native
		Sarcobataceae (Greasewoods)				
			Sarcobatus vermiculatus	Black greasewood	20707	Native
	Cornales					
		Cornaceae (Dogwoods)				
			Cornus sericea	Red-osier dogwood	501637	Native
	Dipsacales					
		Adoxaceae (Moschatel)				
			Sambucus nigra	Elderberry	35324	Native
			Sambucus nigra ssp. *canadensis*	American black elderberry Common elderberry	525079	Native
			Sambucus nigra ssp. *cerulea*	Blue elderberry Blue elder	525080	Native
		Caprifoliaceae (Honeysuckles)				
			Symphoricarpos	Snowberry	35330	Native
			Symphoricarpos oreophilus	Mountain snowberry Whortleleaf snowberry	35338	Native
	Ericales					
		Polemoniaceae (Phlox)				
			Phlox	Phlox	30897	Native
	Fabales					
		Fabaceae (Legumes)				
			Astragalus	Milkvetch Locoweed	25392	Native
			Lupinus	Lupine	25916	Native
			Melilotus officinalis	Yellow sweetclover	26150	Invasive
			Trifolium	Clover	26204	Native
	Lamiales					
		Lamiaceae (Mint)				
			Salvia aethiopis	Mediterranean sage	32696	Invasive
		Plantaginaceae (Plantains)				
			Penstemon	Penstemon Beardtongue	33665	Native
	Malpighiales					

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
		Salicaceae (Willow)				
			Populus tremuloides	Quaking aspen Aspen	195773	Native
			Salix	Willow	22476	Native
	Myrtales					
		Onagraceae (Willowherb or Evening Primrose)				
			Camissonia	Suncup Evening primrose	27462	Native
	Poales					
		Cyperaceae (Sedges)				
			Carex	Sedge	39369	Native
			Eleocharis	Spikerush	40010	Native
			Schoenoplectus	Bulrush Threesquare	500920	Native
			Scirpus	Bulrush	40225	Native
		Juncaceae (Rushes)				
			Juncus	Rush	39220	Native
		Poaceae (Grasses)				
			Achnatherum hymenoides	Indian ricegrass	507943	Native
			Achnatherum thurberianum	Thurber's needlegrass	507961	Native
			Bromus arvensis	Field brome	40494	Invasive
			Bromus japonicus	Japanese brome	40479	Invasive
			Bromus rubens	Red brome	40518	Invasive
			Bromus tectorum	Cheatgrass Downy brome	40524	Invasive
			Calamagrostis canadensis var. *canadensis*	Bluejoint Big reedgrass	527004	Native
			Calamagrostis rubescens	Pinegrass	40540	Native (not present)
			Distichlis spicata	Saltgrass Desert saltgrass Inland saltgrass	40662	Native
			Elymus elymoides	Squirreltail Bottlebrush squirreltail Western bottlebrush grass	502264	Native
			Festuca idahoensis	Idaho fescue	40816	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Hesperostipa comata	Needle and thread	507974	Native
			Hordeum brachyantherum	Meadow barley	40875	Native
			Koeleria macrantha	Prairie junegrass	503284	Native
			Leymus cinereus	Great Basin wildrye Basin wildrye	503433	Native
			Phalaris arundinacea	Reed canarygrass	41335	Invasive
			Poa	Bluegrass	41074	Native & Invasive
			Poa bulbosa	Bulbous bluegrass	41116	Invasive
			Poa secunda	Sandberg's bluegrass	41103	Native
			Pseudoroegneria spicata	Bluebunch wheatgrass	504637	Native
			Taeniatherum caput-medusae	Medusahead	42203	Invasive
			Ventenata dubia	Ventenata North Africa grass	42259	Invasive
		Typhaceae (Cattail)				
			Typha	Cattail	42324	Native
			Typha latifolia	Broadleaf cattail Common cattail	42326	Native
	Ranunculales					
		Berberidaceae (Barberry)				
			Berberis aquifolium	Oregon grape	18816	Native
		Ranunculaceae (Buttercups)				
			Ranunculus aquatilis	Water crowfoot	18581	Native
	Rosales					
		Rosaceae (Rose)				
			Amelanchier	Serviceberry	25108	Native
			Amelanchier alnifolia	Serviceberry	25109	Native
			Cercocarpus ledifolius	Curl-leaf mountain mahogany	25134	Native
			Dasiphora fruticosa	Shrubby cinquefoil	836659	Native
			Holodiscus discolor	Oceanspray Creambush	25177	Native
			Ivesia rhypara var. *rhypara* [6]	Grimy mousetail [6] Grimy Ivesia [6]	195888 [6]	Native (not present) [6]
			Prunus virginiana	Chokecherry	24806	Native
			Prunus virginiana var. *demissa*	Western chokecherry	529893	Native

Class	Order	Family	*Scientific Name*	Common Name(s)	ITIS TSN	Native Status
			Purshia tridentata	Antelope bitterbrush Bitterbrush	25290	Native
			Rosa	Wild rose	24807	Native
			Rosa woodsii ssp. *ultramontana*	Wood's rose	526557	Native
	Saxifragales					
		Grossulariaceae (Gooseberries)				
			Ribes	Currant	24448	Native
			Ribes aureum	Golden currant	24452	Native
			Ribes cereum	Wax currant	24457	Native
			Ribes hudsonianum	Northern black currant	24471	Native
			Ribes inerme var. *inerme*	Whitestem gooseberry	530056	Native
			Ribes lacustre	Prickly currant	24476	Native
Pinopsida (Conifers)						
	Pinales					
		Cupressaceae (Cypress, Redwoods)				
			Juniperus	Juniper	18047	Native
			Juniperus occidentalis	Western juniper	194855	Native
		Pinaceae (Pines)				
			Abies concolor	White fir	181826	Native
			Pinus ponderosa	Ponderosa pine	183365	Native
Polypodiopsida (Leptosporangiate Ferns)						
	Equisetales					
		Equisetaceae (Horsetails)				
			Equisetum	Horsetail	17148	Native

[1] not yet formally recognized as a separate subspecies, though has been commonly identified and described as such
[2] native to Oregon, but not to Hart Mountain National Antelope Refuge
[3] considered genetically distinct from rainbow trout
[4] not universally accepted as a subspecies; considered a stable hybrid of mountain big sagebrush and Wyoming big sagebrush
[5] not universally accepted as a subspecies; considered a stable hybrid of basin big sagebrush and mountain big sagebrush
[6] State Threatened species (Oregon); Federal Species of Concern
[7] State Candidate species (Oregon)

APPENDIX H

Photographs

Figure H-1. Rock Creek and Rock Meadow on Hart Mountain NAR.


Figure H-2. Spring brook on Hart Mountain NAR.

Figure H-3. Spring and seep complex on Hart Mountain NAR.

Figure H-4. Dugout on Barry Knoll waterhole on Hart Mountain NAR.

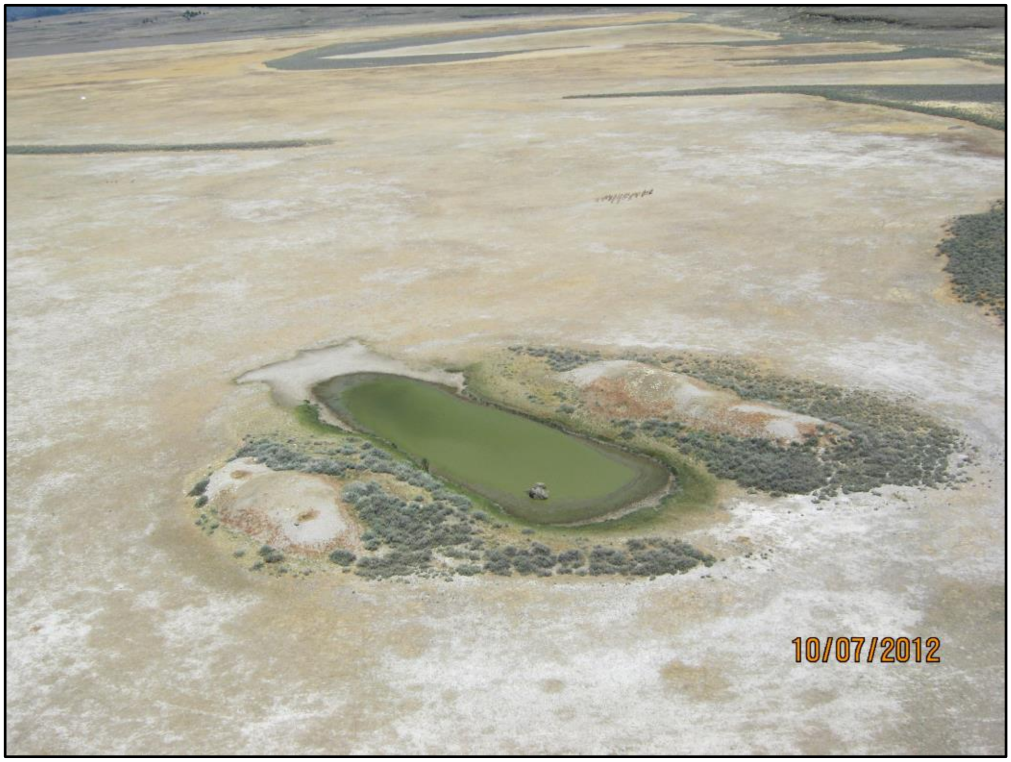

Figure H-5. Playa reservoir with pronghorn on Hart Mountain NAR.

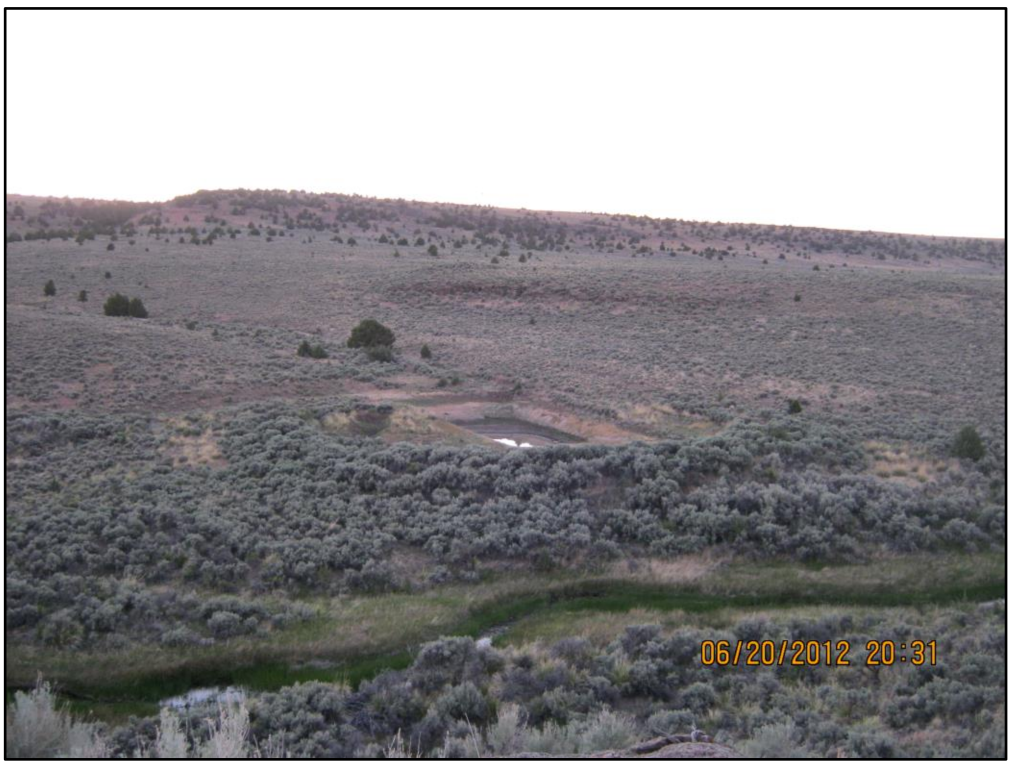

Figure H-6. Impoundment on Rock Creek, Hart Mountain NAR.

Figure H-7. Guzzler apron that catches water and directs it to storage tanks on Hart Mountain NAR.

Figure H-8. Guzzler tanks and trough on Hart Mountain NAR.

Figure H-9. Guzzler tanks and trough on Hart Mountain NAR.

Figure H-10. Hart Mountain NAR bighorn sheep lambing area.

Figure H-11. Lambing area on Poker Jim Ridge, Hart Mountain NAR.

Figure H-12. Bighorn sheep neck trauma caused by cougar on Hart Mountain NAR.

Figure H-13. Bighorn sheep cougar kill and caching on Hart Mountain NAR.

Figure H-14. Cougars with identifying ear notches and scar features.

Figure H-15. Cougars with identifying lumps and scars features.

Figure H-16. Hart Mountain in 1937 with very little juniper expansion.

Figure H-17. Hart Mountain in 2019 with significant juniper expansion.

Figure H-18. Hart Mountain juniper encroachment.

Figure H-19. Hart Mountain juniper encroachment with understory intact.

Figure H-20. Hart Mountain woodland.

Figure H-21. Hart Mountain woodland with little understory remaining.

APPENDIX I

Health Screening Letters, Reports, and Summary

The Section 508 amendment of the Rehabilitation Act of 1973 requires that the information in federal documents be accessible to individuals with disabilities. The U.S. Fish and Wildlife Service has made every effort to ensure that the information in this document is accessible. If you have any problems accessing information, please contact the Hart Mountain National Antelope Refuge at Sheldon-Hart@fws.gov or (540) 947-3315.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sheldon – Hart Mountain National Wildlife Refuge Complex
Post Office Box 111
Lakeview, Oregon 97630

October 16, 2019

Paul Cross
Northern Rocky Mountain Science Center
U.S. Geological Survey
2327 University Way, Suite 2
Bozeman, MT 59715

Dear Dr. Cross:

The California bighorn sheep herd on Hart Mountain National Antelope Refuge in southeastern Oregon has declined by greater than 50% over the past two years. In addition, the number of lambs counted during aerial surveys conducted in July of 2018 and 2019 also declined to around 22 lambs:100 ewes, with 10 of the 19 lambs observed in 2018 (but none, 0 of 10, in 2019) being noticeably smaller than expected relative to lambs seen during past surveys.

In order to GPS-collar, monitor movements, and track adult survival, in cooperation with Refuge staff, the Oregon Department of Fish and Wildlife captured and obtained health-screening samples from 21 sheep in January 2019. The ODFW Wildlife Heath and Population Laboratory analyzed the health screening samples and submitted tonsillar swabs and blood serum for diagnostic tests to both Oregon State University and Washington Animal Disease Diagnostics Laboratory in Pullman, Washington to be screened for a number of pathogens known to be associated with bighorn sheep. To ensure a thorough and defensible interpretation of the health screening results, we are requesting your peer review of the enclosed summary report.

Thank you in advance for your assistance. Please direct any questions you may have to Jon Muir, District Wildlife Biologist, ODFW (541-947-2950, jonathan.d.muir@state.or.us), John Owens, Wildlife Biologist, Sheldon-Hart Mountain NWRC (541-947-3315, ext. 226, john_owens@fws.gov), or directly to Dr. Julia Burco, Wildlife Veterinarian, Wildlife Heath and Population Laboratory, ODFW (541-757-5233, julia.d.burco@state.or.us).

Sincerely,

John W. Kasbohm, Ph.D.
Project Leader
Sheldon-Hart Mountain NWRC

Jon Muir
District Wildlife Biologist
Oregon Department of Fish and Wildlife

Enclosed: Burco, J.B. 2019. Summary of Health Surveillance of California Bighorn Sheep—Hart Mountain 2019. Oregon Department of Fish and Wildlife, Wildlife Health and Population Laboratory.

OREGON DEPARTMENT OF FISH & WILDLIFE

♦ MEMORANDUM ♦

Date: August 15th, 2019

To: Jon Muir

From: Wildlife Health and Population Laboratory

Subject: Summary of health surveillance of California bighorn sheep –Hart Mountain 2019

The purpose of this memo is to summarize the disease and health parameters determined from 21 California bighorn sheep sampled at Hart Mountain in January of 2019.

Of the 21 sheep sampled there were two acute capture –related mortalities but a full set of health samples were still collected and necropsies were performed.

One pathogen of great importance to the health of bighorn sheep herds is *Mycoplasma ovipneumonia* (M.ovi), a bacteria that has been associated with acute pneumonia mortality events as well as poor recruitment in future years. There was no evidence of mucopurulent nasal discharge in any of the animals handled and all nasal swabs were negative on PCR M.ovi, indicating there was no active shedding of the bacteria. In addition, these animals had their blood serum tested for exposure to the bacteria by looking for antibodies. These results were also negative, indicating that there has not been a recent infection in this herd.

The presence of other respiratory Pasteurellacea bacteria were also evaluated through collection of tonsillar swabs. Pasteurella have been isolated from a number bighorn respiratory outbreaks in live and dead sheep but the role of these organisms as primary pathogens is controversial. The presence of a hemolytic strain indicates that the organism has the potential to be more virulent than non-hemolytic strains. Various isolates were identified in this herd and have been banked at the Washington State Diagnostic Laboratory in Pullman. Interpretation of these results should be done with caution and in combination with historic data, data from other neighboring herds and other pathogens. Isolates here are similar to cultures we have had in other healthy herds around the state. Consequently the clinical condition of the sheep handled, negative M. ovi status and absence of a consistent organism being spread in all sheep does not raise any major alarms in this herd.

In addition to respiratory pathogens, other diseases of significance to domestics and wildlife were also evaluated. Bluetongue virus and Epizootic Hemorrhagic Disease virus are a couple of viruses that can be spread by the biting midge, Culicoides spp. Clinical signs may include swollen tongue, salivation, lethargy, and painful feet. Bluetongue has been identified as the causative agent of larger bighorn sheep and pronghorn mortality events infrequently in the west. Often the lethality and severity of the outbreak depends on serotype (and virulence) of the virus in addition to previous exposure. Epizootic hemorrhagic disease can cause similar clinical signs. Often these viruses can be found circulating in domestic cattle and sheep in the area as well, but it does not always result in mortalities or clinical signs in either the domestics or wildlife. Established testing protocols for these two closely-related viruses often cross-react so a positive BT result usually yields a positive EHD result as well. Animals are unlikely to be infected with both viruses concurrently. The following table lists the prevalence of positive antibody results (indicating exposure, not necessarily active infection) to BTV in Oregon bighorn sheep herds. It is certainly not uncommon to have some sheep showing exposure to BTV as it is relatively common on the landscape. In 2018, we confirmed two positive mortalities due to BTV, one via fresh tissues on a collared animal (Sheepheads) and another off of bone marrow collected several days after mortality from a collared animal (Rattlesnake canyon). This was confirmed to be BTV-serovar 17. There were also a handful of other collared sheep found in the surrounding area near creek bottoms suggestive of an acute mortality event. Mortalities were also being observed in mule deer in the surrounding area. Since the virus and dead animals were identified, this was likely a true outbreak resulting in mortality in the area. Conversely, with a low prevalence of antibodies to BT and no reports of finding dead animals in the area, the probability of BT having any major population effects in this Hart Mountain population are low and very speculative. Future confirmations of mortalities due to BTV can be obtained from fresh dead tissues or on a long bone such as a femur up to 4 months after death.

Bluetongue prevalence in Oregon bighorn sheep

Year	Location	Prevalence (% of popn exposed)
2019	Hart Mountain	2/21 = 9.5%
2019	Coleman Rim	1/10 = 10%
2019	Pueblos	0/20 = 0%
2019	Steens	3/20 = 15%
2018	Deschutes, John Day, Potomas, Trout Creek, Bowden Hills, Rattlesnake	0/80 = 0%
2017	Sheepsheads, Rattlesnake, Trout creeks, Rattlesnake, Leslie Gulch	8/57 = 14%

2016	I-84, Rattlesnake, Lookout Mountain, Owyhee, Blue Mtn, Ten-mile, Trout Creeks	7/86 = 8.1%

Other disease/ health findings

Selenium deficiency
42% (9/21) of the Hart Mountain sampled sheep appear to be Selenium deficient based on domestic livestock values (minimum of 50 ng/ml). Low selenium is a common occurrence across much of Oregon. Potential effects of low selenium include a lower immune function or white muscle disease which can result in heart problems and stiff muscles.

Leptospirosis
There was evidence of exposure to various serovars of leptospirosis, a bacteria that is spread in urine. The most common serovars were L. bratislava (usually maintained in pigs and horses) and L. ictiohaemorrhagie (maintained in rats). Serology values less than 1:600 indicate these animals do not have active infections. These low positive titers are fairly common across livestock and many or our wildlife species. There have been no large mortality events associated with leptospirosis in bighorn but occasionally severe infections can cause problems for individual animals.

Summary

In summary, there were no dramatic health findings in our screening tests on Hart Mountain bighorn sheep captured in January of 2019. Certainly continued monitoring of the herd performance (lamb ratios, etc.) will be useful to direct management. On the disease front, further investigation of population level disease impacts outside those already screened for will require fresh tissues and samples delivered to the lab on any mortalities that are identified. As noted, the known hemorrhagic diseases may be detected form bone marrow samples that may be obtained from any older (possibly uncollared animals) mortalities.

Please feel free to contact me if you have any questions.

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Species	ID #	Sex	Location	Release site	Pregnancy Status	OD Value (High recheck 0.15-0.21; Pregnant OD>0.21)	Age (L=0)	Eartag w/ color & R/L	Collar tag w/ color
Bighorn	CABS-6644	M	Hart	On-site			3	56	82686
Bighorn	CABS-6645	M	Hart	On-site			2	57	82687
Bighorn	CABS-6646	M	Hart	On-site			3	58	82688
Bighorn	CABS-6647	M	Hart	On-site			2	59	82689
Bighorn	CABS-6648	M	Hart	On-site			6	60	82690
Bighorn	CABS-6684	F	Hart	On-site	pregnant			66	82676
Bighorn	CABS-6685	F	Hart	On-site	pregnant		3	67	82677
Bighorn	CABS-6686	F	Hart	On-site	pregnant		4	68	82691
Bighorn	CABS-6687	F	Hart	On-site	pregnant		2	69	82692
Bighorn	CABS-6688	F	Hart	On-site	pregnant		7	70	82693
Bighorn	CABS-6699	F	Hart	On-site	pregnant		4	71	82694
Bighorn	CABS-6700	F	Hart	On-site	pregnant		4	72	82695
Bighorn	CABS-6701	F	Hart	On-site	open		6	73	82696
Bighorn	CABS-6702	M	Hart	On-site			5	74	82697
Bighorn	CABS-6703	M	Hart	On-site			6	75	81981
Bighorn	CABS-6704	M	Hart	On-site			3	76	81982
Bighorn	CABS-6705	M	Hart	On-site			4	77	81983
Bighorn	CABS-6707	M	Hart	On-site			5	79	81985
Bighorn	CABS-6708	M	Hart	On-site			4	80	81986
Bighorn	CABS-6719	F	Hart	On-site	pregnant		3		
Bighorn	CABS-6720	M	Hart	On-site			2		

Species	ID #	Radio SN	Radio FREQ	Time in	Time out	Temp sequence horn to box in ˚F	Pulse	Resp	SQ Inj.	Swab (Nasal/Tonsilar)	Fecal	Blood	DNA	Capture method
Bighorn	CABS-6644		151.68			103.1, 102.8				X		X	x	Net-gun
Bighorn	CABS-6645		151.68			103.7, 103.4				X		X	x	Net-gun
Bighorn	CABS-6646		151.68			105.6, 104				X		X	x	Net-gun
Bighorn	CABS-6647		151.68			102.2, 105.6, 104				X		X	x	Net-gun
Bighorn	CABS-6648		151.68			102.5, 103.9, 103.8				X		X	x	Net-gun
Bighorn	CABS-6684		167.231							X		X	x	Net-gun
Bighorn	CABS-6685		167.244			107.1, 106.6, 104.5				X		X	x	Net-gun
Bighorn	CABS-6686		167.081			102.5, 102.5				X		X	x	Net-gun
Bighorn	CABS-6687		167.094			105.6, 106.2, 105.1				X		X	x	Net-gun
Bighorn	CABS-6688		167.106			106.3, 105.5, 105.1				X		X	x	Net-gun
Bighorn	CABS-6699		167.119			105, 104.4, 104				X		X	x	Net-gun
Bighorn	CABS-6700		167.131			104.9, 106, 105.4				X		X	x	Net-gun
Bighorn	CABS-6701		167.144			104.7, 103.9, 103.5				X		X	x	Net-gun
Bighorn	CABS-6702		167.156			102.4, 101.6				X		X	x	Net-gun
Bighorn	CABS-6703		167.006			104.8, 104.2				X		X	x	Net-gun
Bighorn	CABS-6704		167.019			102.7, 102.7, 104.3				X		X	x	Net-gun
Bighorn	CABS-6705		167.031			104.7, 102.6				X		X	x	Net-gun
Bighorn	CABS-6707		167.056			103.4, 102.2				X		X	x	Net-gun
Bighorn	CABS-6708		167.069			104.8, 106.2, 105.5				X		X	x	Net-gun
Bighorn	CABS-6719									X		X	x	Net-gun
Bighorn	CABS-6720									X		X	x	Net-gun

Species	ID #	Date	Sedatives	Comments	M. ovi PCR	M. ovi Elisa	%I	*Bibersteinia trehalosi*	*Pasteurella sp.*	*Mannheimia ruminalis*
Bighorn	CABS-6644	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	0.12	X		X (Beta-hemolytic)
Bighorn	CABS-6645	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-4.384			X (1 colony)
Bighorn	CABS-6646	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-3.604			X (Beta-hemolytic)
Bighorn	CABS-6647	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-7.628			X
Bighorn	CABS-6648	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	0.901	X		X (Beta-hemolytic)
Bighorn	CABS-6684	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-8.402			
Bighorn	CABS-6685	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-20.935	X		X (1 colony - Beta-hemolytic)
Bighorn	CABS-6686	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-15.27	X		X (Beta-hemolytic)
Bighorn	CABS-6687	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-6.986	X		X
Bighorn	CABS-6688	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-5.782			X (Beta-hemolytic)
Bighorn	CABS-6699	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-0.684	X		X (Both)
Bighorn	CABS-6700	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-14.775	X		
Bighorn	CABS-6701	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-14.562	X (Both)		X
Bighorn	CABS-6702	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-10.88	X (Both)		X
Bighorn	CABS-6703	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	2.289	X		
Bighorn	CABS-6704	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	1.015	X		
Bighorn	CABS-6705	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	6.184	X (Both)		X (Beta-hemolytic)
Bighorn	CABS-6707	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	2.785	X		X
Bighorn	CABS-6708	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	7.316	X (Both)		
Bighorn	CABS-6719	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	1.511			swa
Bighorn	CABS-6720	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-7.553			swa

Species	ID #	*M. haemolytica*	*M. glucosida*	*Trueperella pyogenes*	*No pasteurella isolated*	Baermann (lungworms)	Johnes PCR
Bighorn	CABS-6644					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6645					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6646					Lungworm larvae present, Muellerius spp observed.	
Bighorn	CABS-6647	X				Insufficient sample	
Bighorn	CABS-6648					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6684				X	Insufficient sample	
Bighorn	CABS-6685					No Lungworm larvae observed	
Bighorn	CABS-6686					Insufficient sample	
Bighorn	CABS-6687		X (Beta-hemolytic)			Lungworm larvae present, Muellerius spp observed.	
Bighorn	CABS-6688					Insufficient sample	
Bighorn	CABS-6699					Insufficient sample	
Bighorn	CABS-6700	X				Insufficient sample	
Bighorn	CABS-6701					Insufficient sample	
Bighorn	CABS-6702					Insufficient sample	
Bighorn	CABS-6703			X		No Lungworm larvae observed	
Bighorn	CABS-6704		X (Beta-hemolytic)			Insufficient sample	
Bighorn	CABS-6705					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6707					Insufficient sample	
Bighorn	CABS-6708					Insufficient sample	
Bighorn	CABS-6719	b not taken- mortality				No Lungworm larvae observed	
Bighorn	CABS-6720	b not taken- mortality				No Lungworm larvae observed	

Species	ID #	Fecal Flotation	WB (Se)-ng/mL	Serum Se (ng/mL)	Serum Co (ng/mL)	Serum Cu (ug/mL)	Serum Fe (ug/dL)	Serum Mn (ng/mL)	Serum Mo (ng/mL)
Bighorn	CABS-6644		107	182	0.76	0.64	178	3.2	11.1
Bighorn	CABS-6645		35	24	1.2	0.57	167	5.7	34.5
Bighorn	CABS-6646		30	25	0.43	0.6	179	2.4	5.4
Bighorn	CABS-6647		37	22	2.78	0.77	213	5.2	56.3
Bighorn	CABS-6648		30	31	0.83	0.62	127	3.5	63
Bighorn	CABS-6684		39	17	0.66	0.66	123	6.3	17.2
Bighorn	CABS-6685		194	333	0.77	0.54	188	3.2	16.1
Bighorn	CABS-6686		56	26	1.14	0.76	214	1.7	79.1
Bighorn	CABS-6687		31	16	0.96	0.63	178	3.5	19.3
Bighorn	CABS-6688		34	19	0.89	0.68	238	2.6	33
Bighorn	CABS-6699		56	25	0.73	0.78	317	1.8	85.6
Bighorn	CABS-6700		56	25	0.97	0.84	243	3.2	56
Bighorn	CABS-6701		96	21	0.56	0.66	161	4	54.9
Bighorn	CABS-6702		33	64	0.51	0.62	142	3.9	25.4
Bighorn	CABS-6703		71	33	0.78	0.71	144	3	51.5
Bighorn	CABS-6704		73	34	0.51	0.62	164	4.4	47.7
Bighorn	CABS-6705		67	21	0.67	0.7	185	5.4	49.3
Bighorn	CABS-6707		65	27	0.69	0.69	144	4.9	84.8
Bighorn	CABS-6708		55	29	0.67	0.7	195	3.6	65.6
Bighorn	CABS-6719		34	19	0.8	0.77	252	5.5	32.3
Bighorn	CABS-6720		64	32	0.59	0.72	156	9.1	35.9

Species	ID #	Serum Zn (ug/mL)	L. bratislava	L.canicola	L. grippo	L. hardjo	L. ictero	L. pomona	Bluetongue	EHD	BRSV (SN)	Brucella
Bighorn	CABS-6644	0.93	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6645	0.84	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6646	0.88	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6647	0.74	1:100	Neg	1:100	Neg	1:200	1:400	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6648	0.72	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6684	0.85	1:200	1:100	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6685	0.61	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6686	0.59	1:200	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6687	0.59	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6688	0.51	1:200	Neg	Neg	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6699	0.51	1:200	Neg	1:200	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6700	0.64	1:200	Neg	Neg	Neg	1:100	Neg	Positive	Negative	Neg @1:4	Negative
Bighorn	CABS-6701	0.77	1:100	Neg	1:200	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6702	0.71	1:100	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6703	0.77	1:100	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6704	0.56	1:100	Neg	1:200	Neg	1:100	Neg	Positive	Positive	Neg @1:4	Negative
Bighorn	CABS-6705	0.58	1:200	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6707	0.64	1:100	Neg	1:100	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6708	0.61	1:200	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6719	0.83	1:100	Neg	Neg	Neg	1:100	1:100	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6720	0.69	1:200	Neg	1:200	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative

Species	ID #	BVD-2 (SN)	BVD-1 (SN)	CAE	IBR	PI-3 (HI)	CK (U/L, rr=50-150)		Mortality
Bighorn	CABS-6644	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6645	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6646	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6647	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6648	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:32			
Bighorn	CABS-6684	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			
Bighorn	CABS-6685	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6686	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6687	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6688	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6699	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6700	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6701	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6702	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/10/19- cougar predation
Bighorn	CABS-6703	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/6/19- cougar predation
Bighorn	CABS-6704	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/25/19 - cougar predation
Bighorn	CABS-6705	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6707	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/11/19 - cougar predation
Bighorn	CABS-6708	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			
Bighorn	CABS-6719	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			Fractured C2 vertebrae at time of capture
Bighorn	CABS-6720	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			Acute capture mortality

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Case#: 2019-1337
Report Date: 02/28/19

Submittal Date: 01/31/19	Species: Bighorn Sheep	Age:
Owner: Oregon Dept of Fish & Wil	Subspecies: California Bighorn Sheep	Sex:

Final Report:

Bacteriology- Reported on 02/28/19 Authorized by Claire Burbick, Section Head

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6639	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6640	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6641	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6641	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6641	Swab Tonsil	Moderate	Non-hemolytic Mannheimia sp.
CABS-6642	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6642	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6643	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6643	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6643	Swab Tonsil	Few	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6644	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6644	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6645	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated.			
CABS-6646	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6647	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6647	Swab Tonsil	Few	Mannheimia haemolytica

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6648	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6648	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6649	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6650	Swab Tonsil	No Pasteurella isolated.	
CABS-6651	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated.			
CABS-6651	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			
CABS-6652	Swab Tonsil	Few	Non-hemolytic M. haemolytica
Result Comment: Non-hemolytic			
CABS-6652	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6652	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6653	Swab Tonsil	See comment.	Pasteurella sp.
Result Comment: One colony isolated.			
CABS-6653	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6654	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6654	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6654	Swab Tonsil	Few	Trueperella pyogenes
CABS-6655	Swab Tonsil	No Pasteurella isolated.	
CABS-6656	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6656	Swab Tonsil	See comment.	Mannheimia glucosida
Result Comment: One colony isolated. Beta-hemolytic			
CABS-6657	Swab Tonsil	No Pasteurella isolated.	
CABS-6658	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6659	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6660	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6660	Swab Tonsil	Moderate	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6661	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6661	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6662	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6663	Swab Tonsil	No Pasteurella isolated.	
CABS-6664	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6665	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			
CABS-6666	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6667	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6668	Swab Tonsil	No Pasteurella isolated.	
CABS-6669	Swab Tonsil	No Pasteurella isolated.	
CABS-6670	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			
CABS-6670	Swab Tonsil	Few	Trueperella pyogenes
CABS-6671	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated.			
CABS-6672	Swab Tonsil	No Pasteurella isolated.	
CABS-6672	Swab Tonsil	Few	Trueperella pyogenes
CABS-6673	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6673	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6674	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6674	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6675	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6676	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6677	Swab Tonsil	See comment.	Mannheimia haemolytica
Result Comment: One colony isolated.			
CABS-6678	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated. Beta-hemolytic			
CABS-6679	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6679	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6680	Swab Tonsil	No Pasteurella isolated.	
CABS-6681	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6682	Swab Tonsil	No Pasteurella isolated.	
CABS-6683	Swab Tonsil	No Pasteurella isolated.	
CABS-6684	Swab Tonsil	No Pasteurella isolated.	
CABS-6685	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated. Beta-hemolytic			
CABS-6685	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6686	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6686	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6687	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6687	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6687	Swab Tonsil	Moderate	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6688	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6689	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6689	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6689	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6690	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6690	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6690	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6691	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6691	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6691	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6692	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6692	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6692	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6693	Swab Tonsil	Moderate	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6693	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6693	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6694	Swab Tonsil	Moderate	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6694	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6695	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6695	Swab Tonsil	Few	Mannheimia haemolytica
Result Comment: Non-hemolytic			
CABS-6696	Swab Tonsil	Moderate	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6697	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6697	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6697	Swab Tonsil	Few	Non-hemolytic Mannheimia sp.
CABS-6697	Swab Tonsil	Moderate	Mannheimia glucosida
CABS-6698	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6698	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6699	Swab Tonsil	Moderate	Mannheimia ruminalis
Result Comment: Beta-hemolytic and non-hemolytic colony types present.			
CABS-6699	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6700	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6700	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6701	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6701	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6701	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6702	Swab Tonsil	Few	Mannheimia ruminalis

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6702	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6702	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6703	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6703	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6704	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6704	Swab Tonsil	Few	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6705	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6705	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6705	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6707	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6707	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6708	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6708	Swab Tonsil	Few	Bibersteinia trehalosi

Aerobic Culture test comment: In addition, mixed bacterial growth is present and is consistent with normal mucosal flora.

Previously reported results:

Molecular Diagnostics- Last reported on 02/05/19 Authorized by Daniel Bradway, Lab Manager

PCR-Mycoplasma ovipneumoniae : SOP-MD-38

Animal	Specimen	Result
CABS-6639	Nasal swab	Not detected
CABS-6640	Nasal swab	Not detected
CABS-6641	Nasal swab	Not detected
CABS-6642	Nasal swab	Not detected
CABS-6643	Nasal swab	Not detected
CABS-6644	Nasal swab	Not detected
CABS-6645	Nasal swab	Not detected
CABS-6646	Nasal swab	Not detected
CABS-6647	Nasal swab	Not detected
CABS-6648	Nasal swab	Not detected
CABS-6649	Nasal swab	Not detected
CABS-6650	Nasal swab	Not detected
CABS-6651	Nasal swab	Not detected
CABS-6652	Nasal swab	Not detected
CABS-6653	Nasal swab	Not detected
CABS-6654	Nasal swab	Not detected
CABS-6655	Nasal swab	Not detected
CABS-6656	Nasal swab	Not detected
CABS-6657	Nasal swab	Not detected
CABS-6658	Nasal swab	Not detected
CABS-6659	Nasal swab	Not detected

PCR-Mycoplasma ovipneumoniae : SOP-MD-38

Animal	Specimen	Result
CABS-6660	Nasal swab	Not detected
CABS-6661	Nasal swab	Not detected
CABS-6662	Nasal swab	Not detected
CABS-6663	Nasal swab	Not detected
CABS-6664	Nasal swab	Not detected
CABS-6665	Nasal swab	Not detected
CABS-6666	Nasal swab	Not detected
CABS-6667	Nasal swab	Not detected
CABS-6668	Nasal swab	Not detected
CABS-6669	Nasal swab	Not detected
CABS-6670	Nasal swab	Not detected
CABS-6671	Nasal swab	Not detected
CABS-6672	Nasal swab	Not detected
CABS-6673	Nasal swab	Not detected
CABS-6674	Nasal swab	Not detected
CABS-6675	Nasal swab	Not detected
CABS-6676	Nasal swab	Not detected
CABS-6677	Nasal swab	Not detected
CABS-6678	Nasal swab	Not detected
CABS-6679	Nasal swab	Not detected
CABS-6680	Nasal swab	Not detected
CABS-6681	Nasal swab	Not detected
CABS-6682	Nasal swab	Not detected
CABS-6683	Nasal swab	Not detected
CABS-6684	Nasal swab	Not detected
CABS-6685	Nasal swab	Not detected
CABS-6686	Nasal swab	Not detected
CABS-6687	Nasal swab	Not detected
CABS-6688	Nasal swab	Not detected
CABS-6689	Nasal swab	Not detected
CABS-6690	Nasal swab	Not detected
CABS-6691	Nasal swab	Not detected
CABS-6692	Nasal swab	Not detected
CABS-6693	Nasal swab	Not detected
CABS-6694	Nasal swab	Not detected
CABS-6695	Nasal swab	Not detected
CABS-6696	Nasal swab	Not detected
CABS-6697	Nasal swab	Not detected
CABS-6698	Nasal swab	Not detected
CABS-6699	Nasal swab	Not detected
CABS-6700	Nasal swab	Not detected
CABS-6701	Nasal swab	Not detected
CABS-6702	Nasal swab	Not detected
CABS-6703	Nasal swab	Not detected
CABS-6704	Nasal swab	Not detected
CABS-6705	Nasal swab	Not detected
CABS-6707	Nasal swab	Not detected
CABS-6708	Nasal swab	Not detected
CABS-6719	Nasal swab	Not detected
CABS-6720	Nasal swab	Not detected

PCR-Mycoplasma ovipneumoniae test comment: This assay detects Mycoplasma ovipneumoniae with high sensitivity (ability to detect true positives) and specificity (ability to detect true negatives) based on WADDL validation studies The assay has a sensitivity of 100% [300/300] versus a published standard PCR (McAuliffe, et. al. 2003. Detection of Mycoplasma ovipneumoniae in Pasteurella-vaccinated sheep flocks with respiratory disease in England. Vet. Rec. 153:687-688), with specificity of >98.7% [1388/1419] in sheep, bighorn sheep, and goats using this same standard PCR followed by sequencing as a gold standard. Confirmatory testing and strain typing by DNA sequencing is available if desired. Culture is available at WADDL to detect other species of Mycoplasma if desired. Fees for culture are available on our website. [Intedeterminate results may be caused by sampling or transport issues, low level of shedding at time of collection, PCR inhibitors such as dirt, or in rare cases, cross-reacting Mycoplasma species.]

Serology- Last reported on 02/08/19 Authorized by James Evermann, Section Head

M. ovipneumoniae by ELISA

Specimen	Animal	% I	Result
1 A Blood Serum	CABS-6639	4.505	Not detected
2 A Blood Serum	CABS-6640	3.724	Not detected
3 A Blood Serum	CABS-6641	-6.306	Not detected
4 A Blood Serum	CABS-6642	-2.583	Not detected
5 A Blood Serum	CABS-6643	-17.658	Not detected
6 A Blood Serum	CABS-6644	0.120	Not detected
7 A Blood Serum	CABS-6645	-4.384	Not detected
8 A Blood Serum	CABS-6646	-3.604	Not detected
9 A Blood Serum	CABS-6647	-7.628	Not detected
10 A Blood Serum	CABS-6648	0.901	Not detected
11 A Blood Serum	CABS-6649	-25.225	Not detected
12 A Blood Serum	CABS-6650	-14.895	Not detected
13 A Blood Serum	CABS-6651	-4.565	Not detected
14 A Blood Serum	CABS-6652	8.468	Not detected
15 A Blood Serum	CABS-6653	21.441	Not detected
16 A Blood Serum	CABS-6654	-7.928	Not detected
17 A Blood Serum	CABS-6655	-92.235	Not detected
18 A Blood Serum	CABS-6656	3.210	Not detected
19 A Blood Serum	CABS-6657	-4.791	Not detected
20 A Blood Serum	CABS-6658	-11.801	Not detected
21 A Blood Serum	CABS-6659	-1.322	Not detected
22 A Blood Serum	CABS-6660	-8.827	Not detected
23 A Blood Serum	CABS-6661	-14.987	Not detected
24 A Blood Serum	CABS-6662	-11.730	Not detected
25 A Blood Serum	CABS-6663	-0.330	Not detected
26 A Blood Serum	CABS-6664	-19.873	Not detected
27 A Blood Serum	CABS-6665	-24.900	Not detected
28 A Blood Serum	CABS-6666	-13.429	Not detected
29 A Blood Serum	CABS-6667	3.493	Not detected
30 A Blood Serum	CABS-6668	-9.677	Not detected
31 A Blood Serum	CABS-6669	4.272	Not detected
32 A Blood Serum	CABS-6670	3.564	Not detected
33 A Blood Serum	CABS-6671	0.519	Not detected
34 A Blood Serum	CABS-6672	-1.392	Not detected
35 A Blood Serum	CABS-6673	-17.890	Not detected
36 A Blood Serum	CABS-6674	-11.659	Not detected
37 A Blood Serum	CABS-6675	0.378	Not detected

M. ovipneumoniae by ELISA

Specimen	Animal	% I	Result
38 A Blood Serum	CABS-6676	-3.021	Not detected
39 A Blood Serum	CABS-6677	-20.793	Not detected
40 A Blood Serum	CABS-6678	0.873	Not detected
41 A Blood Serum	CABS-6679	-2.879	Not detected
42 A Blood Serum	CABS-6680	-1.534	Not detected
43 A Blood Serum	CABS-6681	15.247	Not detected
44 A Blood Serum	CABS-6682	-10.668	Not detected
45 A Blood Serum	CABS-6683	1.298	Not detected
46 A Blood Serum	CABS-6684	-8.402	Not detected
47 A Blood Serum	CABS-6685	-20.935	Not detected
48 A Blood Serum	CABS-6686	-15.270	Not detected
49 A Blood Serum	CABS-6687	-6.986	Not detected
50 A Blood Serum	CABS-6688	-5.782	Not detected
51 A Blood Serum	CABS-6689	-27.378	Not detected
52 A Blood Serum	CABS-6690	-12.226	Not detected
53 A Blood Serum	CABS-6691	4.272	Not detected
54 A Blood Serum	CABS-6692	-0.968	Not detected
55 A Blood Serum	CABS-6693	2.785	Not detected
56 A Blood Serum	CABS-6694	-2.101	Not detected
57 A Blood Serum	CABS-6695	-3.941	Not detected
58 A Blood Serum	CABS-6696	-0.543	Not detected
59 A Blood Serum	CABS-6697	-19.023	Not detected
60 A Blood Serum	CABS-6698	-4.579	Not detected
61 A Blood Serum	CABS-6699	-0.684	Not detected
62 A Blood Serum	CABS-6700	-14.775	Not detected
63 A Blood Serum	CABS-6701	-14.562	Not detected
64 A Blood Serum	CABS-6702	-10.880	Not detected
65 A Blood Serum	CABS-6703	2.289	Not detected
66 A Blood Serum	CABS-6704	1.015	Not detected
67 A Blood Serum	CABS-6705	6.184	Not detected
68 A Blood Serum	CABS-6707	2.785	Not detected
69 A Blood Serum	CABS-6708	7.316	Not detected
70 A Blood Serum	CABS-6719	1.511	Not detected
71 A Blood Serum	CABS-6720	-7.553	Not detected

Serology Test interpretation comments:

Mycoplasma ovipneumoniae cELISA : SOP-SERO-45

% I <40%: Antibody not detected.

% I >50%: Antibody detected at levels consistent with previous exposure or current infection with *Mycoplasma ovipneumoniae.*

% I 40% to 50%: Antibody detection indeterminate to establishment of correlation with *Mycoplasma ovipneumoniae* infection.

The 50% cutoff represents 3 standard deviations from the mean of bighorn sheep from defined negative sheep (99% confidence interval). Using the 50% cutoff the performance of the cELISA with reference standards is as follows: Agreement = 95.4%, Diagnostic specificity = 99.3%, and Diagnostic sensitivity = 88%. The 40% cutoff represents 2 standard deviations from the mean of defined negative sheep (95% confidence interval). Using the 40% cutoff the performance of the cELISA for individual animals with reference standards is as follows: Agreement = 95.8%, Diagnostic specificity = 98.6%, and Diagnostic sensitivity = 90.7%. However, the test is designed for classifying populations, not individuals. Typically, populations not exposed to *M. ovipneumoniae* will have <1% of animals with 'detected' antibody, whereas exposed populations will have 30-100% of animals with 'detected' antibody.

The Mycoplasma ovipneumoniae cELISA has been validated for Bighorn sheep and domestic sheep only.

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Northern Rocky Mountain Science Center
2327 University Way, Suite 2
Bozeman, Montana 59715

Dear John Kasbohm and Jon Muir,

In October 2019 you requested a review of the health status information of the bighorn sheep at Hart Mountain National Antelope Refuge. Dr. Walsh and I have reviewed the disease testing results and summary report provided by Dr. Julia Burco at the Wildlife Health and Population Laboratory with the Oregon Department of Fish and Wildlife (Appendix 1). In addition, we reviewed your long-term population monitoring data (Appendix 2), the 2019 capture locations (Appendix 3), and conducted a phone-call interview to answer several follow-up questions.

The long-term population monitoring shows a recent decline of the population from the observed count of 149 bighorn sheep in 2107 to 68 in 2019. This decline is coincident with lower lamb:ewe ratios of 22-23 lambs per ewe, which is lower than the historic average of 46 lambs per

with disease issues, specifically *Mycoplasma ovipneumoniae* (*M. ovi*.; Cassirer et al 2017). The disease testing results from January 2019 indicate however, that all 21 captured sheep were negative for *M. ovi*. on both the PCR and serology tests. Given this level of sampling effort and an estimated population size of 86 individuals in 2019, there is a 95% probability that the prevalence of *M. ovi*. shedding individuals and the *M. ovi*. seroprevalence in the population are ≤ 11%. This low, potentially latent prevalence and lack of any positives, particularly on serology, suggests that the population was unlikely to have been exposed within the last two years to *M. ovi*. (Cassirer et al. 2017). For comparison, in 9 bighorn sheep herds with known respiratory disease problems, *M. ovi*. seroprevalence was high (≥ 28%), whereas within 9 healthy herds (i.e., no known respiratory disease symptoms) no serologic evidence for *M. ovi*. infection was detected (Besser et al. 2008). Similarly, 91% of herds across western North America that were classified as healthy exhibited no serologic exposure to *M. ovi*. (Besser et al. 2013) as is the case at Hart Mountain. There are cases where *M. ovi*. has caused an all-age die-off, but then stochastically disappeared from the population (Coggins and Matthews 1992, Jorgensen et al. 1997). However, one would expect the population to still test positive for previous exposure on serological tests, which is not the case here.

The disease testing results also indicated potential exposure to *Mannheimia haemolytica* and *Bibersteinia trehalosi* (Appendices 1 and 4), both of which have been associated with bighorn sheep pneumonia in laboratory trials but are not consistently associated with die-offs in the field in the absence of *M. ovi*. (Besser et al. 2013). Current models of the etiology of respiratory disease in bighorn sheep postulate that bacteria in the *Pasteurellaceae* family serve as secondary invaders of bighorn respiratory tracts and cause pneumonia after *M. ovi*. has inhibited the normal bronchociliary clearance mechanisms (Besser et al. 2013). Therefore, the presence of animals carrying *Pasteurellaceae* is not considered indicative of respiratory disease issues. Additionally, these organisms have been isolated from the Hart Mountain Herd prior to the previous two years when populations were larger (Appendix 4), and similar bacteria have been detected in other bighorn herds in Oregon that are considered healthy (Appendix 1). Lungworm larvae were also detected, however lungworms are commonly found in many bighorn sheep populations and are not strongly associated with bighorn sheep population declines (Besser et al 2013).

There are several other factors to consider in assessing the respiratory disease risks faced by a bighorn sheep population. First, are there nearby domestic sheep and goat flocks or grazing allotments? Second, are there potential movements into Hart Mountain from neighboring bighorn sheep herds that are potential disease risks. Based upon our phone conversation with local managers, it appears both these risks are low in the region. Continued monitoring of any domestic sheep and goats in the region as well as neighboring bighorn sheep populations will help detect potential respiratory disease risk factors for future disease introductions. In addition, our understanding is that there is unlikely to be sub-structuring in this bighorn sheep population, such that it is unlikely that one segment of the population may have been exposed to *M. ovi*., but not sampled during the 2019 captures and unnoticed during a putative outbreak. Additionally, the locations of captures appear to be well distributed across the herd's range (Appendix 3), supporting this assertion.

Bighorn sheep herd health may also be affected by other diseases besides respiratory disease. These include Bluetongue virus and Epizootic Hemorrhagic Disease virus that can cause mortality in bighorn sheep herds. Serologic evidence of limited exposure to these viruses was found in 9.5% of the animals sampled at Hart Mountain. These viruses were detected in other Oregon herds via serologic testing as well as investigation of mortalities; however, no mortalities attributed to these viruses were reported in bighorn sheep or other species within or in the vicinity of Hart Mountain including in any of the 21 marked bighorn sheep (Appendix 1). Therefore, although these viral diseases cannot be ruled out as potentially impacting the Hart Mountain herd, it seems unlikely that they caused any significant population declines while remaining undetected. Similarly, despite testing for a variety of other diseases including: bovine respiratory syncytial virus, bovine viral diarrhea, brucella and parainfluenza virus 3, there was little serologic evidence that these pathogens/diseases are likely having a significant impact on this herd at the present time (Appendix 1).

Taken together the evidence currently suggests that *M. ovi* or other common diseases do not appear to be currently inhibiting the population growth of bighorn sheep at Hart Mountain. This begs the question—what other factors could be driving the declines over the last few years? We have a few potential directions for you to consider going forward, although they are beyond the scope of our disease evaluation and would require additional efforts and resources that may not be feasible or available.

In many ungulate populations, changes to adult survival have the largest effect on population growth, but are less variable relative to recruitment (Gaillard et al 1998). However, Johnson et al. (2010) found that the most important vital rates varied by location and time for Sierra Nevada bighorn sheep. Therefore, investigating both adult and lamb mortalities quickly to determine the cause of death would be valuable. This information in combination with the timing of lamb mortality can be suggestive of potential *M. ovi.* issues. For example, within the Hells Canyon region, lamb mortalities associated with *M. ovi.* have tended to peak around 1-2 months after the birth pulse (Cassirer et al. 2013). Moreover, being able to identify the proximate cause of death, is also valuable in understanding the drivers of recent low lamb recruitment. It is noteworthy that 4 of the 19 collared bighorn sheep were killed by cougars, which is suggestive that cougar predation and reductions in adult survival may be playing an important role in this population. However, it is possible that some predation mortality may be facilitated by disease (e.g. Smith et al 2014) or reflect habitat quality issues. Therefore, in addition to cause-specific mortality information, data on body condition and pregnancy rates should be collected to help tease apart the various potential factors limiting population performance. Finally, additional disease testing over time and documenting symptomatic individuals, or the absence of symptoms, would continue to increase our confidence that *M. ovi.* is not playing a role and provide assurance new pathogen introductions have not occurred.

In conclusion, it is clear based on the evidence presented and follow-up conversations we have had with managers at Hart Mountain National Wildlife Refuge and Oregon Department of Wildlife that the Hart Mountain bighorn sheep herd has been declining for several decades and much more rapidly in the last few years. Based on our evaluation of the data, there does not appear to be a clear association of this decline with respiratory disease or other common diseases observed in this species. Continued monitoring and potentially additional investigations into bighorn herd health and mortality causes may be needed to identify the most significant driver(s) of the population performance of this herd.

Sincerely,

PAUL CROSS Digitally signed by PAUL CROSS Date: 2020.01.20 11:30:46 -07'00'

Paul C. Cross, PhD.

USGS Research Scientist

Northern Rocky Mountain Science Center

DANIEL WALSH Digitally signed by DANIEL WALSH Date: 2020.01.07 10:40:23 -06'00'

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References:

Besser, TE, EF Cassirer, K Potter, J VanderSchalie, A Fischer, DP. Knowles, DR Herndon, FR Rurangirwa, GC Weiser, Subramaniam Srikumaran. 2008. *J. of Clinical Microbiology* 46 (2) 423-430.

Besser, TE, EF Cassirer, MA Highland, P Wolff, A Justice-Allen, K Mansfield, MA Davis and W Foreyt. 2013 Bighorn sheep pneumonia: Sorting out the cause of a polymicrobial disease. *Prev. Vet. Med.* **108**, 85-93.

Brewer CE, VC Bleich, JA Foster, T Hosch-Hebdon, DE McWhirter, EM Rominger, MW Wagner and BP Wiedmann. 2014. Bighorn Sheep: Conservation Challenges and Management Strategies for the 21st Century. Wild Sheep Working Group, Western Association of Fish and Wildlife Agencies, Cheyenne, Wyoming, USA.

Cassirer, EF, KR Manlove, ES Almberg, PL Kamath, M Cox, P Wolff, A Roug, J Shannon, R Robinson, RB Harris, et al. 2017 Pneumonia in bighorn sheep: Risk and resilience. *J. of Wildlife Management*.

Cassirer, EF, RK Plowright, KR Manlove, PC Cross, AP Dobson, KA Potter, PJ Hudson and A White 2013 Spatio-temporal dynamics of pneumonia in bighorn sheep. *J. Anim. Ecol.* **82**, 518-528.

Coggins, V. L. and P. E. Matthews. 1988. The Lostine Rocky Mountain bighorn sheep die-off and domestic sheep. *Biennial Symposium Northern Wild Sheep and Goat Council* **6**: 57– 64.

Dassanayake, RP, S Shanthalingam, R Subramaniam, CN Herndon, J Bavananthasivam, GJ Haldorson, WJ Foreyt, JF Evermann, LM Herrmann-Hoesing, DP Knowles, et al. 2013 Role of bibersteinia trehalosi, respiratory syncytial virus, and parainfluenza-3 virus in bighorn sheep pneumonia. *Vet. Microbiol.* **162**, 166-172.

Gaillard JM, M Festa-Bianchet and NG Yoccoz 1998. Population dynamics of large herbivores: Variable recruitment with constant adult survival. *Trends Ecol. Evol.* **13**, 58-63.

Johnson HE, LS Mills LS, TR Stephenson, and JD Wehausen 2010 Population-specific vital rate contributions influence management of an endangered ungulate. *Ecol. Appl.* **20**, 1753-1765.

Jorgenson, JT, M Festa-Bianchet, J Gaillard, and WD Wishart. 1997. Effects of age, sex, disease and density on survival of bighorn sheep. *Ecology* 78: 1019-1032.

Smith JB, JA Jenks, TW Grovenburg, and RW Klaver 2014. Disease and predation: Sorting out causes of a bighorn sheep (*Ovis canadensis*) decline. *PLoS One* **9**, e88271.

Peek, JM 1980. Natural regulation of ungulates (what constitutes a real wilderness?). *Wildlife Society Bulletin* 8: 217—227.

Appendix 1: 2019 Disease testing results for Hart Mountain Bighorn sheep provided by the Oregon Department of Fish and Wildlife

OREGON DEPARTMENT OF FISH & WILDLIFE

♦ MEMORANDUM ♦

Date: August 15th, 2019

To: Jon Muir

From: Wildlife Health and Population Laboratory

Subject: Summary of health surveillance of California bighorn sheep –Hart Mountain 2019

The purpose of this memo is to summarize the disease and health parameters determined from 21 California bighorn sheep sampled at Hart Mountain in January of 2019.

Of the 21 sheep sampled there were two acute capture –related mortalities but a full set of health samples were still collected and necropsies were performed.

One pathogen of great importance to the health of bighorn sheep herds is *Mycoplasma ovipneumonia* (M.ovi), a bacteria that has been associated with acute pneumonia mortality events as well as poor recruitment in future years. There was no evidence of mucopurulent nasal discharge in any of the animals handled and all nasal swabs were negative on PCR M.ovi, indicating there was no active shedding of the bacteria. In addition, these animals had their blood serum tested for exposure to the bacteria by looking for antibodies. These results were also negative, indicating that there has not been a recent infection in this herd.

The presence of other respiratory Pasteurellacea bacteria were also evaluated through collection of tonsillar swabs. Pasteurella have been isolated from a number bighorn respiratory outbreaks in live and dead sheep but the role of these organisms as primary pathogens is controversial. The presence of a hemolytic strain indicates that the organism has the potential to be more virulent than non-hemolytic strains. Various isolates were identified in this herd and have been banked at the Washington State Diagnostic Laboratory in Pullman. Interpretation of these results should be done with caution and in combination with historic data, data from other neighboring herds and other pathogens. Isolates here are similar to cultures we have had in other healthy herds around the state. Consequently the clinical condition of the sheep handled, negative M. ovi status and absence of a consistent organism being spread in all sheep does not raise any major alarms in this herd.

In addition to respiratory pathogens, other diseases of significance to domestics and wildlife were also evaluated. Bluetongue virus and Epizootic Hemorrhagic Disease virus are a couple of viruses that can be spread by the biting midge, Culicoides spp. Clinical signs may include swollen tongue, salivation, lethargy, and painful feet. Bluetongue has been identified as the causative agent of larger bighorn sheep and pronghorn mortality events infrequently in the west. Often the lethality and severity of the outbreak depends on serotype (and virulence) of the virus in addition to previous exposure. Epizootic hemorrhagic disease can cause similar clinical signs. Often these viruses can be found circulating in domestic cattle and sheep in the area as well, but it does not always result in mortalities or clinical signs in either the domestics or wildlife. Established testing protocols for these two closely-related viruses often cross-react so a positive BT result usually yields a positive EHD result as well. Animals are unlikely to be infected with both viruses concurrently. The following table lists the prevalence of positive antibody results (indicating exposure, not necessarily active infection) to BTV in Oregon bighorn sheep herds. It is certainly not uncommon to have some sheep showing exposure to BTV as it is relatively common on the landscape. In 2018, we confirmed two positive mortalities due to BTV, one via fresh tissues on a collared animal (Sheepheads) and another off of bone marrow collected several days after mortality from a collared animal (Rattlesnake canyon). This was confirmed to be BTV-serovar 17. There were also a handful of other collared sheep found in the surrounding area near creek bottoms suggestive of an acute mortality event. Mortalities were also being observed in mule deer in the surrounding area. Since the virus and dead animals were identified, this was likely a true outbreak resulting in mortality in the area. Conversely, with a low prevalence of antibodies to BT and no reports of finding dead animals in the area, the probability of BT having any major population effects in this Hart Mountain population are low and very speculative. Future confirmations of mortalities due to BTV can be obtained from fresh dead tissues or on a long bone such as a femur up to 4 months after death.

Bluetongue prevalence in Oregon bighorn sheep

Year	Location	Prevalence (% of popn exposed)
2019	Hart Mountain	2/21 = 9.5%
2019	Coleman Rim	1/10 = 10%
2019	Pueblos	0/20 = 0%
2019	Steens	3/20 = 15%
2018	Deschutes, John Day, Potomas, Trout Creek, Bowden Hills, Rattlesnake	0/80 = 0%
2017	Sheepsheads, Rattlesnake, Trout creeks, Rattlesnake, Leslie Gulch	8/57 = 14%

2016	I-84, Rattlesnake, Lookout Mountain, Owyhee, Blue Mtn, Ten-mile, Trout Creeks	7/86 = 8.1%

Other disease/ health findings

Selenium deficiency
42% (9/21) of the Hart Mountain sampled sheep appear to be Selenium deficient based on domestic livestock values (minimum of 50 ng/ml). Low selenium is a common occurrence across much of Oregon. Potential effects of low selenium include a lower immune function or white muscle disease which can result in heart problems and stiff muscles.

Leptospirosis
There was evidence of exposure to various serovars of leptospirosis, a bacteria that is spread in urine. The most common serovars were L. bratislava (usually maintained in pigs and horses) and L. ictiohaemorrhagie (maintained in rats). Serology values less than 1:600 indicate these animals do not have active infections. These low positive titers are fairly common across livestock and many or our wildlife species. There have been no large mortality events associated with leptospirosis in bighorn but occasionally severe infections can cause problems for individual animals.

Summary

In summary, there were no dramatic health findings in our screening tests on Hart Mountain bighorn sheep captured in January of 2019. Certainly continued monitoring of the herd performance (lamb ratios, etc.) will be useful to direct management. On the disease front, further investigation of population level disease impacts outside those already screened for will require fresh tissues and samples delivered to the lab on any mortalities that are identified. As noted, the known hemorrhagic diseases may be detected form bone marrow samples that may be obtained from any older (possibly uncollared animals) mortalities.

Please feel free to contact me if you have any questions.

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Species	ID #	Sex	Location	Release site	Pregnancy Status	OD Value (High recheck 0.15-0.21; Pregnant OD>0.21)	Age (L=0)	Eartag w/ color & R/L	Collar tag w/ color
Bighorn	CABS-6644	M	Hart	On-site			3	56	82686
Bighorn	CABS-6645	M	Hart	On-site			2	57	82687
Bighorn	CABS-6646	M	Hart	On-site			3	58	82688
Bighorn	CABS-6647	M	Hart	On-site			2	59	82689
Bighorn	CABS-6648	M	Hart	On-site			6	60	82690
Bighorn	CABS-6684	F	Hart	On-site	pregnant			66	82676
Bighorn	CABS-6685	F	Hart	On-site	pregnant		3	67	82677
Bighorn	CABS-6686	F	Hart	On-site	pregnant		4	68	82691
Bighorn	CABS-6687	F	Hart	On-site	pregnant		2	69	82692
Bighorn	CABS-6688	F	Hart	On-site	pregnant		7	70	82693
Bighorn	CABS-6699	F	Hart	On-site	pregnant		4	71	82694
Bighorn	CABS-6700	F	Hart	On-site	pregnant		4	72	82695
Bighorn	CABS-6701	F	Hart	On-site	open		6	73	82696
Bighorn	CABS-6702	M	Hart	On-site			5	74	82697
Bighorn	CABS-6703	M	Hart	On-site			6	75	81981
Bighorn	CABS-6704	M	Hart	On-site			3	76	81982
Bighorn	CABS-6705	M	Hart	On-site			4	77	81983
Bighorn	CABS-6707	M	Hart	On-site			5	79	81985
Bighorn	CABS-6708	M	Hart	On-site			4	80	81986
Bighorn	CABS-6719	F	Hart	On-site	pregnant		3		
Bighorn	CABS-6720	M	Hart	On-site			2		

Species	ID #	Radio SN	Radio FREQ	Time in	Time out	Temp sequence horn to box in ˚F	Pulse	Resp	SQ Inj.	Swab (Nasal/Tonsilar)	Fecal	Blood	DNA	Capture method
Bighorn	CABS-6644		151.68			103.1, 102.8				X		X	x	Net-gun
Bighorn	CABS-6645		151.68			103.7, 103.4				X		X	x	Net-gun
Bighorn	CABS-6646		151.68			105.6, 104				X		X	x	Net-gun
Bighorn	CABS-6647		151.68			102.2, 105.6, 104				X		X	x	Net-gun
Bighorn	CABS-6648		151.68			102.5, 103.9, 103.8				X		X	x	Net-gun
Bighorn	CABS-6684		167.231							X		X	x	Net-gun
Bighorn	CABS-6685		167.244			107.1, 106.6, 104.5				X		X	x	Net-gun
Bighorn	CABS-6686		167.081			102.5, 102.5				X		X	x	Net-gun
Bighorn	CABS-6687		167.094			105.6, 106.2, 105.1				X		X	x	Net-gun
Bighorn	CABS-6688		167.106			106.3, 105.5, 105.1				X		X	x	Net-gun
Bighorn	CABS-6699		167.119			105, 104.4, 104				X		X	x	Net-gun
Bighorn	CABS-6700		167.131			104.9, 106, 105.4				X		X	x	Net-gun
Bighorn	CABS-6701		167.144			104.7, 103.9, 103.5				X		X	x	Net-gun
Bighorn	CABS-6702		167.156			102.4, 101.6				X		X	x	Net-gun
Bighorn	CABS-6703		167.006			104.8, 104.2				X		X	x	Net-gun
Bighorn	CABS-6704		167.019			102.7, 102.7, 104.3				X		X	x	Net-gun
Bighorn	CABS-6705		167.031			104.7, 102.6				X		X	x	Net-gun
Bighorn	CABS-6707		167.056			103.4, 102.2				X		X	x	Net-gun
Bighorn	CABS-6708		167.069			104.8, 106.2, 105.5				X		X	x	Net-gun
Bighorn	CABS-6719									X		X	x	Net-gun
Bighorn	CABS-6720									X		X	x	Net-gun

Species	ID #	Date	Sedatives	Comments	M. ovi PCR	M. ovi Elisa	%I	*Bibersteinia trehalosi*	*Pasteurella sp.*	*Mannheimia ruminalis*
Bighorn	CABS-6644	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	0.12	X		X (Beta-hemolytic)
Bighorn	CABS-6645	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-4.384			X (1 colony)
Bighorn	CABS-6646	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-3.604			X (Beta-hemolytic)
Bighorn	CABS-6647	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-7.628			X
Bighorn	CABS-6648	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	0.901	X		X (Beta-hemolytic)
Bighorn	CABS-6684	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-8.402			
Bighorn	CABS-6685	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-20.935	X		X (1 colony - Beta-hemolytic)
Bighorn	CABS-6686	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-15.27	X		X (Beta-hemolytic)
Bighorn	CABS-6687	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-6.986	X		X
Bighorn	CABS-6688	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-5.782			X (Beta-hemolytic)
Bighorn	CABS-6699	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-0.684	X		X (Both)
Bighorn	CABS-6700	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-14.775	X		
Bighorn	CABS-6701	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	-14.562	X (Both)		X
Bighorn	CABS-6702	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-10.88	X (Both)		X
Bighorn	CABS-6703	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	2.289	X		
Bighorn	CABS-6704	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	1.015	X		
Bighorn	CABS-6705	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	6.184	X (Both)		X (Beta-hemolytic)
Bighorn	CABS-6707	1/23/2019	Midazolam (10-15 mg IV)		ND	ND	2.785	X		X
Bighorn	CABS-6708	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	7.316	X (Both)		
Bighorn	CABS-6719	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	1.511			swa
Bighorn	CABS-6720	1/22/2019	Midazolam (10-15 mg IV)		ND	ND	-7.553			swa

Species	ID #	*M. haemolytica*	*M. glucosida*	*Trueperella pyogenes*	*No pasteurella isolated*	Baermann (lungworms)	Johnes PCR
Bighorn	CABS-6644					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6645					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6646					Lungworm larvae present, Muellerius spp observed.	
Bighorn	CABS-6647	X				Insufficient sample	
Bighorn	CABS-6648					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6684				X	Insufficient sample	
Bighorn	CABS-6685					No Lungworm larvae observed	
Bighorn	CABS-6686					Insufficient sample	
Bighorn	CABS-6687		X (Beta-hemolytic)			Lungworm larvae present, Muellerius spp observed.	
Bighorn	CABS-6688					Insufficient sample	
Bighorn	CABS-6699					Insufficient sample	
Bighorn	CABS-6700	X				Insufficient sample	
Bighorn	CABS-6701					Insufficient sample	
Bighorn	CABS-6702					Insufficient sample	
Bighorn	CABS-6703			X		No Lungworm larvae observed	
Bighorn	CABS-6704		X (Beta-hemolytic)			Insufficient sample	
Bighorn	CABS-6705					Lungworm larvae present, Dictyocaulus spp observed	
Bighorn	CABS-6707					Insufficient sample	
Bighorn	CABS-6708					Insufficient sample	
Bighorn	CABS-6719	b not taken- mortality				No Lungworm larvae observed	
Bighorn	CABS-6720	b not taken- mortality				No Lungworm larvae observed	

Species	ID #	Fecal Flotation	WB (Se)-ng/mL	Serum Se (ng/mL)	Serum Co (ng/mL)	Serum Cu (ug/mL)	Serum Fe (ug/dL)	Serum Mn (ng/mL)	Serum Mo (ng/mL)
Bighorn	CABS-6644		107	182	0.76	0.64	178	3.2	11.1
Bighorn	CABS-6645		35	24	1.2	0.57	167	5.7	34.5
Bighorn	CABS-6646		30	25	0.43	0.6	179	2.4	5.4
Bighorn	CABS-6647		37	22	2.78	0.77	213	5.2	56.3
Bighorn	CABS-6648		30	31	0.83	0.62	127	3.5	63
Bighorn	CABS-6684		39	17	0.66	0.66	123	6.3	17.2
Bighorn	CABS-6685		194	333	0.77	0.54	188	3.2	16.1
Bighorn	CABS-6686		56	26	1.14	0.76	214	1.7	79.1
Bighorn	CABS-6687		31	16	0.96	0.63	178	3.5	19.3
Bighorn	CABS-6688		34	19	0.89	0.68	238	2.6	33
Bighorn	CABS-6699		56	25	0.73	0.78	317	1.8	85.6
Bighorn	CABS-6700		56	25	0.97	0.84	243	3.2	56
Bighorn	CABS-6701		96	21	0.56	0.66	161	4	54.9
Bighorn	CABS-6702		33	64	0.51	0.62	142	3.9	25.4
Bighorn	CABS-6703		71	33	0.78	0.71	144	3	51.5
Bighorn	CABS-6704		73	34	0.51	0.62	164	4.4	47.7
Bighorn	CABS-6705		67	21	0.67	0.7	185	5.4	49.3
Bighorn	CABS-6707		65	27	0.69	0.69	144	4.9	84.8
Bighorn	CABS-6708		55	29	0.67	0.7	195	3.6	65.6
Bighorn	CABS-6719		34	19	0.8	0.77	252	5.5	32.3
Bighorn	CABS-6720		64	32	0.59	0.72	156	9.1	35.9

Species	ID #	Serum Zn (ug/mL)	L. bratislava	L.canicola	L. grippo	L. hardjo	L. ictero	L. pomona	Bluetongue	EHD	BRSV (SN)	Brucella
Bighorn	CABS-6644	0.93	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6645	0.84	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6646	0.88	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6647	0.74	1:100	Neg	1:100	Neg	1:200	1:400	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6648	0.72	1:100	Neg	Neg	Neg	Neg	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6684	0.85	1:200	1:100	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6685	0.61	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6686	0.59	1:200	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6687	0.59	1:100	Neg	Neg	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6688	0.51	1:200	Neg	Neg	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6699	0.51	1:200	Neg	1:200	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6700	0.64	1:200	Neg	Neg	Neg	1:100	Neg	Positive	Negative	Neg @1:4	Negative
Bighorn	CABS-6701	0.77	1:100	Neg	1:200	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6702	0.71	1:100	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6703	0.77	1:100	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6704	0.56	1:100	Neg	1:200	Neg	1:100	Neg	Positive	Positive	Neg @1:4	Negative
Bighorn	CABS-6705	0.58	1:200	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6707	0.64	1:100	Neg	1:100	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6708	0.61	1:200	Neg	1:100	Neg	1:100	Neg	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6719	0.83	1:100	Neg	Neg	Neg	1:100	1:100	Negative	Negative	Neg @1:4	Negative
Bighorn	CABS-6720	0.69	1:200	Neg	1:200	Neg	1:200	Neg	Negative	Negative	Neg @1:4	Negative

Species	ID #	BVD-2 (SN)	BVD-1 (SN)	CAE	IBR	PI-3 (HI)	CK (U/L, rr=50-150)		Mortality
Bighorn	CABS-6644	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6645	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6646	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6647	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6648	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:32			
Bighorn	CABS-6684	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			
Bighorn	CABS-6685	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6686	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			
Bighorn	CABS-6687	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6688	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6699	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6700	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6701	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6702	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/10/19- cougar predation
Bighorn	CABS-6703	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/6/19- cougar predation
Bighorn	CABS-6704	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/25/19 - cougar predation
Bighorn	CABS-6705	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			
Bighorn	CABS-6707	Neg @ 1:4	Neg @ 1:4		Neg @1:4	Neg @ 1:8			2/11/19 - cougar predation
Bighorn	CABS-6708	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			
Bighorn	CABS-6719	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:8			Fractured C2 vertebrae at time of capture
Bighorn	CABS-6720	Neg @ 1:4	Neg @ 1:4		Neg @1:4	1:16			Acute capture mortality

Washington Animal Disease Diagnostic Lab

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Dr. Julia Burco
Oregon Dept of Fish & Wil
7118 NE Vandenberg Ave

Corvallis, OR 97330

Case#: 2019-1337
Report Date: 02/28/19

Submittal Date: 01/31/19
Owner: Oregon Dept of Fish & Wil

Species: Bighorn Sheep
Subspecies: California Bighorn Sheep

Age:
Sex:

Final Report:

Bacteriology- Reported on 02/28/19 Authorized by Claire Burbick, Section Head

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6639	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6640	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6641	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6641	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6641	Swab Tonsil	Moderate	Non-hemolytic Mannheimia sp.
CABS-6642	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6642	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6643	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6643	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6643	Swab Tonsil	Few	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6644	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6644	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6645	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated.			
CABS-6646	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6647	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6647	Swab Tonsil	Few	Mannheimia haemolytica

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6648	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6648	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6649	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6650	Swab Tonsil	No Pasteurella isolated.	
CABS-6651	Swab Tonsil	See comment.	Mannheimia ruminalis
Result Comment: One colony isolated.			
CABS-6651	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			
CABS-6652	Swab Tonsil	Few	Non-hemolytic M. haemolytica
Result Comment: Non-hemolytic			
CABS-6652	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6652	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6653	Swab Tonsil	See comment.	Pasteurella sp.
Result Comment: One colony isolated.			
CABS-6653	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6654	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Both beta-hemolytic and non-hemolytic colony types present.			
CABS-6654	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6654	Swab Tonsil	Few	Trueperella pyogenes
CABS-6655	Swab Tonsil	No Pasteurella isolated.	
CABS-6656	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6656	Swab Tonsil	See comment.	Mannheimia glucosida
Result Comment: One colony isolated. Beta-hemolytic			
CABS-6657	Swab Tonsil	No Pasteurella isolated.	
CABS-6658	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6659	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6660	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6660	Swab Tonsil	Moderate	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6661	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6661	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6662	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6663	Swab Tonsil	No Pasteurella isolated.	
CABS-6664	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6665	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			
CABS-6666	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6667	Swab Tonsil	See comment.	Bibersteinia trehalosi
Result Comment: One colony isolated.			

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6668	Swab Tonsil	No Pasteurella isolated.	
CABS-6669	Swab Tonsil	No Pasteurella isolated.	
CABS-6670	Swab Tonsil	See comment.	Bibersteinia trehalosi
	Result Comment: One colony isolated.		
CABS-6670	Swab Tonsil	Few	Trueperella pyogenes
CABS-6671	Swab Tonsil	See comment.	Mannheimia ruminalis
	Result Comment: One colony isolated.		
CABS-6672	Swab Tonsil	No Pasteurella isolated.	
CABS-6672	Swab Tonsil	Few	Trueperella pyogenes
CABS-6673	Swab Tonsil	Few	Mannheimia ruminalis
	Result Comment: Beta-hemolytic		
CABS-6673	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6674	Swab Tonsil	Few	Mannheimia ruminalis
	Result Comment: Beta-hemolytic		
CABS-6674	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6675	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6676	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6677	Swab Tonsil	See comment.	Mannheimia haemolytica
	Result Comment: One colony isolated.		
CABS-6678	Swab Tonsil	See comment.	Mannheimia ruminalis
	Result Comment: One colony isolated. Beta-hemolytic		
CABS-6679	Swab Tonsil	Few	Mannheimia ruminalis
	Result Comment: Beta-hemolytic		
CABS-6679	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6680	Swab Tonsil	No Pasteurella isolated.	
CABS-6681	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6682	Swab Tonsil	No Pasteurella isolated.	
CABS-6683	Swab Tonsil	No Pasteurella isolated.	
CABS-6684	Swab Tonsil	No Pasteurella isolated.	
CABS-6685	Swab Tonsil	See comment.	Mannheimia ruminalis
	Result Comment: One colony isolated. Beta-hemolytic		
CABS-6685	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6686	Swab Tonsil	Few	Mannheimia ruminalis
	Result Comment: Beta-hemolytic		
CABS-6686	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6687	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6687	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6687	Swab Tonsil	Moderate	Mannheimia glucosida
	Result Comment: Beta-hemolytic		
CABS-6688	Swab Tonsil	Few	Mannheimia ruminalis
	Result Comment: Beta-hemolytic		

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6689	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6689	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6689	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6690	Swab Tonsil	Few	Mannheimia ruminalis

Result Comment: Beta-hemolytic

Animal	Specimen	Result	Isolate
CABS-6690	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6690	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6691	Swab Tonsil	Few	Mannheimia ruminalis

Result Comment: Both beta-hemolytic and non-hemolytic colony types present.

Animal	Specimen	Result	Isolate
CABS-6691	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6691	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6692	Swab Tonsil	Moderate	Mannheimia ruminalis
CABS-6692	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6692	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6693	Swab Tonsil	Moderate	Mannheimia ruminalis

Result Comment: Beta-hemolytic

Animal	Specimen	Result	Isolate
CABS-6693	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6693	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6694	Swab Tonsil	Moderate	Mannheimia ruminalis

Result Comment: Both beta-hemolytic and non-hemolytic colony types present.

Animal	Specimen	Result	Isolate
CABS-6694	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6695	Swab Tonsil	Few	Mannheimia ruminalis

Result Comment: Both beta-hemolytic and non-hemolytic colony types present.

Animal	Specimen	Result	Isolate
CABS-6695	Swab Tonsil	Few	Mannheimia haemolytica

Result Comment: Non-hemolytic

Animal	Specimen	Result	Isolate
CABS-6696	Swab Tonsil	Moderate	Mannheimia ruminalis

Result Comment: Both beta-hemolytic and non-hemolytic colony types present.

Animal	Specimen	Result	Isolate
CABS-6697	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6697	Swab Tonsil	Few	Mannheimia ruminalis

Result Comment: Beta-hemolytic

Animal	Specimen	Result	Isolate
CABS-6697	Swab Tonsil	Few	Non-hemolytic Mannheimia sp.
CABS-6697	Swab Tonsil	Moderate	Mannheimia glucosida
CABS-6698	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6698	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6699	Swab Tonsil	Moderate	Mannheimia ruminalis

Result Comment: Beta-hemolytic and non-hemolytic colony types present.

Animal	Specimen	Result	Isolate
CABS-6699	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6700	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6700	Swab Tonsil	Few	Mannheimia haemolytica
CABS-6701	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6701	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6701	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6702	Swab Tonsil	Few	Mannheimia ruminalis

Aerobic Culture : SOP-BACT-2

Animal	Specimen	Result	Isolate
CABS-6702	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6702	Swab Tonsil	Moderate	Beta hemolytic B. trehalosi
CABS-6703	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6703	Swab Tonsil	Moderate	Trueperella pyogenes
CABS-6704	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6704	Swab Tonsil	Few	Mannheimia glucosida
Result Comment: Beta-hemolytic			
CABS-6705	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6705	Swab Tonsil	Few	Mannheimia ruminalis
Result Comment: Beta-hemolytic			
CABS-6705	Swab Tonsil	Moderate	Bibersteinia trehalosi
CABS-6707	Swab Tonsil	Few	Mannheimia ruminalis
CABS-6707	Swab Tonsil	Few	Bibersteinia trehalosi
CABS-6708	Swab Tonsil	Few	Beta hemolytic B. trehalosi
CABS-6708	Swab Tonsil	Few	Bibersteinia trehalosi

Aerobic Culture test comment: In addition, mixed bacterial growth is present and is consistent with normal mucosal flora.

Previously reported results:

Molecular Diagnostics- Last reported on 02/05/19 Authorized by Daniel Bradway, Lab Manager

PCR-Mycoplasma ovipneumoniae : SOP-MD-38

Animal	Specimen	Result
CABS-6639	Nasal swab	Not detected
CABS-6640	Nasal swab	Not detected
CABS-6641	Nasal swab	Not detected
CABS-6642	Nasal swab	Not detected
CABS-6643	Nasal swab	Not detected
CABS-6644	Nasal swab	Not detected
CABS-6645	Nasal swab	Not detected
CABS-6646	Nasal swab	Not detected
CABS-6647	Nasal swab	Not detected
CABS-6648	Nasal swab	Not detected
CABS-6649	Nasal swab	Not detected
CABS-6650	Nasal swab	Not detected
CABS-6651	Nasal swab	Not detected
CABS-6652	Nasal swab	Not detected
CABS-6653	Nasal swab	Not detected
CABS-6654	Nasal swab	Not detected
CABS-6655	Nasal swab	Not detected
CABS-6656	Nasal swab	Not detected
CABS-6657	Nasal swab	Not detected
CABS-6658	Nasal swab	Not detected
CABS-6659	Nasal swab	Not detected

PCR-Mycoplasma ovipneumoniae : SOP-MD-38

Animal	Specimen	Result
CABS-6660	Nasal swab	Not detected
CABS-6661	Nasal swab	Not detected
CABS-6662	Nasal swab	Not detected
CABS-6663	Nasal swab	Not detected
CABS-6664	Nasal swab	Not detected
CABS-6665	Nasal swab	Not detected
CABS-6666	Nasal swab	Not detected
CABS-6667	Nasal swab	Not detected
CABS-6668	Nasal swab	Not detected
CABS-6669	Nasal swab	Not detected
CABS-6670	Nasal swab	Not detected
CABS-6671	Nasal swab	Not detected
CABS-6672	Nasal swab	Not detected
CABS-6673	Nasal swab	Not detected
CABS-6674	Nasal swab	Not detected
CABS-6675	Nasal swab	Not detected
CABS-6676	Nasal swab	Not detected
CABS-6677	Nasal swab	Not detected
CABS-6678	Nasal swab	Not detected
CABS-6679	Nasal swab	Not detected
CABS-6680	Nasal swab	Not detected
CABS-6681	Nasal swab	Not detected
CABS-6682	Nasal swab	Not detected
CABS-6683	Nasal swab	Not detected
CABS-6684	Nasal swab	Not detected
CABS-6685	Nasal swab	Not detected
CABS-6686	Nasal swab	Not detected
CABS-6687	Nasal swab	Not detected
CABS-6688	Nasal swab	Not detected
CABS-6689	Nasal swab	Not detected
CABS-6690	Nasal swab	Not detected
CABS-6691	Nasal swab	Not detected
CABS-6692	Nasal swab	Not detected
CABS-6693	Nasal swab	Not detected
CABS-6694	Nasal swab	Not detected
CABS-6695	Nasal swab	Not detected
CABS-6696	Nasal swab	Not detected
CABS-6697	Nasal swab	Not detected
CABS-6698	Nasal swab	Not detected
CABS-6699	Nasal swab	Not detected
CABS-6700	Nasal swab	Not detected
CABS-6701	Nasal swab	Not detected
CABS-6702	Nasal swab	Not detected
CABS-6703	Nasal swab	Not detected
CABS-6704	Nasal swab	Not detected
CABS-6705	Nasal swab	Not detected
CABS-6707	Nasal swab	Not detected
CABS-6708	Nasal swab	Not detected
CABS-6719	Nasal swab	Not detected
CABS-6720	Nasal swab	Not detected

PCR-Mycoplasma ovipneumoniae test comment: This assay detects Mycoplasma ovipneumoniae with high sensitivity (ability to detect true positives) and specificity (ability to detect true negatives) based on WADDL validation studies The assay has a sensitivity of 100% [300/300] versus a published standard PCR (McAuliffe, et. al. 2003. Detection of Mycoplasma ovipneumoniae in Pasteurella-vaccinated sheep flocks with respiratory disease in England. Vet. Rec. 153:687-688), with specificity of >98.7% [1388/1419] in sheep, bighorn sheep, and goats using this same standard PCR followed by sequencing as a gold standard. Confirmatory testing and strain typing by DNA sequencing is available if desired. Culture is available at WADDL to detect other species of Mycoplasma if desired. Fees for culture are available on our website. [Intederminate results may be caused by sampling or transport issues, low level of shedding at time of collection, PCR inhibitors such as dirt, or in rare cases, cross-reacting Mycoplasma species.]

Serology- Last reported on 02/08/19 Authorized by James Evermann, Section Head

M. ovipneumoniae by ELISA

Specimen	Animal	% I	Result
1 A Blood Serum	CABS-6639	4.505	Not detected
2 A Blood Serum	CABS-6640	3.724	Not detected
3 A Blood Serum	CABS-6641	-6.306	Not detected
4 A Blood Serum	CABS-6642	-2.583	Not detected
5 A Blood Serum	CABS-6643	-17.658	Not detected
6 A Blood Serum	CABS-6644	0.120	Not detected
7 A Blood Serum	CABS-6645	-4.384	Not detected
8 A Blood Serum	CABS-6646	-3.604	Not detected
9 A Blood Serum	CABS-6647	-7.628	Not detected
10 A Blood Serum	CABS-6648	0.901	Not detected
11 A Blood Serum	CABS-6649	-25.225	Not detected
12 A Blood Serum	CABS-6650	-14.895	Not detected
13 A Blood Serum	CABS-6651	-4.565	Not detected
14 A Blood Serum	CABS-6652	8.468	Not detected
15 A Blood Serum	CABS-6653	21.441	Not detected
16 A Blood Serum	CABS-6654	-7.928	Not detected
17 A Blood Serum	CABS-6655	-92.235	Not detected
18 A Blood Serum	CABS-6656	3.210	Not detected
19 A Blood Serum	CABS-6657	-4.791	Not detected
20 A Blood Serum	CABS-6658	-11.801	Not detected
21 A Blood Serum	CABS-6659	-1.322	Not detected
22 A Blood Serum	CABS-6660	-8.827	Not detected
23 A Blood Serum	CABS-6661	-14.987	Not detected
24 A Blood Serum	CABS-6662	-11.730	Not detected
25 A Blood Serum	CABS-6663	-0.330	Not detected
26 A Blood Serum	CABS-6664	-19.873	Not detected
27 A Blood Serum	CABS-6665	-24.900	Not detected
28 A Blood Serum	CABS-6666	-13.429	Not detected
29 A Blood Serum	CABS-6667	3.493	Not detected
30 A Blood Serum	CABS-6668	-9.677	Not detected
31 A Blood Serum	CABS-6669	4.272	Not detected
32 A Blood Serum	CABS-6670	3.564	Not detected
33 A Blood Serum	CABS-6671	0.519	Not detected
34 A Blood Serum	CABS-6672	-1.392	Not detected
35 A Blood Serum	CABS-6673	-17.890	Not detected
36 A Blood Serum	CABS-6674	-11.659	Not detected
37 A Blood Serum	CABS-6675	0.378	Not detected

M. ovipneumoniae by ELISA

Specimen	Animal	% I	Result
38 A Blood Serum	CABS-6676	-3.021	Not detected
39 A Blood Serum	CABS-6677	-20.793	Not detected
40 A Blood Serum	CABS-6678	0.873	Not detected
41 A Blood Serum	CABS-6679	-2.879	Not detected
42 A Blood Serum	CABS-6680	-1.534	Not detected
43 A Blood Serum	CABS-6681	15.247	Not detected
44 A Blood Serum	CABS-6682	-10.668	Not detected
45 A Blood Serum	CABS-6683	1.298	Not detected
46 A Blood Serum	CABS-6684	-8.402	Not detected
47 A Blood Serum	CABS-6685	-20.935	Not detected
48 A Blood Serum	CABS-6686	-15.270	Not detected
49 A Blood Serum	CABS-6687	-6.986	Not detected
50 A Blood Serum	CABS-6688	-5.782	Not detected
51 A Blood Serum	CABS-6689	-27.378	Not detected
52 A Blood Serum	CABS-6690	-12.226	Not detected
53 A Blood Serum	CABS-6691	4.272	Not detected
54 A Blood Serum	CABS-6692	-0.968	Not detected
55 A Blood Serum	CABS-6693	2.785	Not detected
56 A Blood Serum	CABS-6694	-2.101	Not detected
57 A Blood Serum	CABS-6695	-3.941	Not detected
58 A Blood Serum	CABS-6696	-0.543	Not detected
59 A Blood Serum	CABS-6697	-19.023	Not detected
60 A Blood Serum	CABS-6698	-4.579	Not detected
61 A Blood Serum	CABS-6699	-0.684	Not detected
62 A Blood Serum	CABS-6700	-14.775	Not detected
63 A Blood Serum	CABS-6701	-14.562	Not detected
64 A Blood Serum	CABS-6702	-10.880	Not detected
65 A Blood Serum	CABS-6703	2.289	Not detected
66 A Blood Serum	CABS-6704	1.015	Not detected
67 A Blood Serum	CABS-6705	6.184	Not detected
68 A Blood Serum	CABS-6707	2.785	Not detected
69 A Blood Serum	CABS-6708	7.316	Not detected
70 A Blood Serum	CABS-6719	1.511	Not detected
71 A Blood Serum	CABS-6720	-7.553	Not detected

Serology Test interpretation comments:

Mycoplasma ovipneumoniae cELISA : SOP-SERO-45

% I <40%: Antibody not detected.

% I >50%: Antibody detected at levels consistent with previous exposure or current infection with *Mycoplasma ovipneumoniae.*

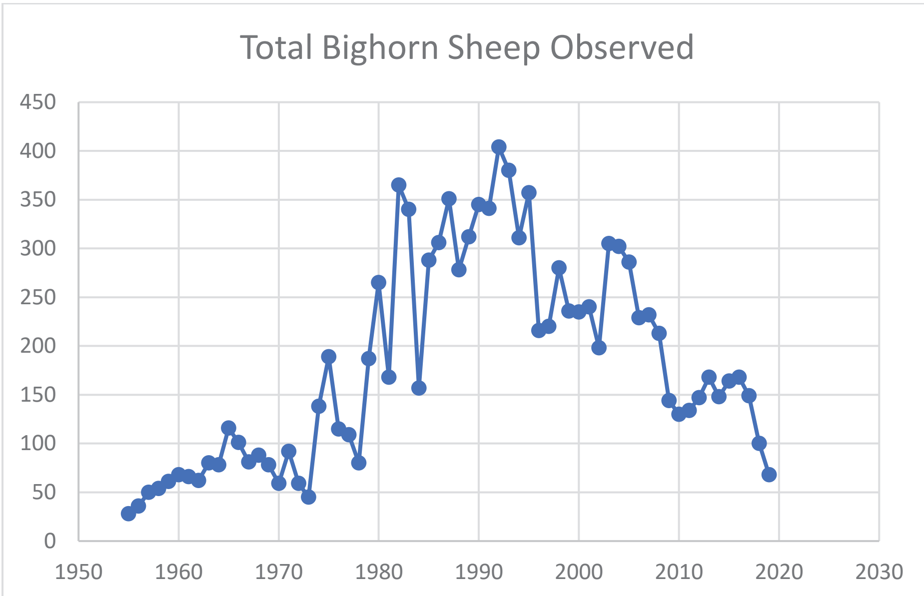
% I 40% to 50%: Antibody detection indeterminate to establishment of correlation with *Mycoplasma ovipneumoniae* infection.

The 50% cutoff represents 3 standard deviations from the mean of bighorn sheep from defined negative sheep (99% confidence interval). Using the 50% cutoff the performance of the cELISA with reference standards is as follows: Agreement = 95.4%, Diagnostic specificity = 99.3%, and Diagnostic sensitivity = 88%. The 40% cutoff represents 2 standard deviations from the mean of defined negative sheep (95% confidence interval). Using the 40% cutoff the performance of the cELISA for individual animals with reference standards is as follows: Agreement = 95.8%, Diagnostic specificity = 98.6%, and Diagnostic sensitivity = 90.7%. However, the test is designed for classifying populations, not individuals. Typically, populations not exposed to *M. ovipneumoniae* will have <1% of animals with 'detected' antibody, whereas exposed populations will have 30-100% of animals with 'detected' antibody.

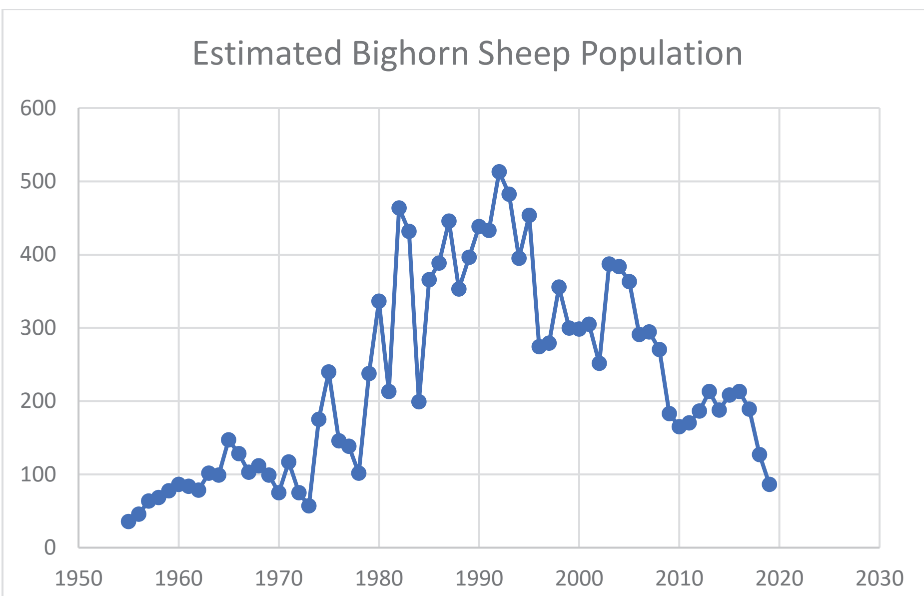
The Mycoplasma ovipneumoniae cELISA has been validated for Bighorn sheep and domestic sheep only.

Appendix 2: Long-term population monitoring data provided by the USFWS Hart Mountain National Wildlife Refuge

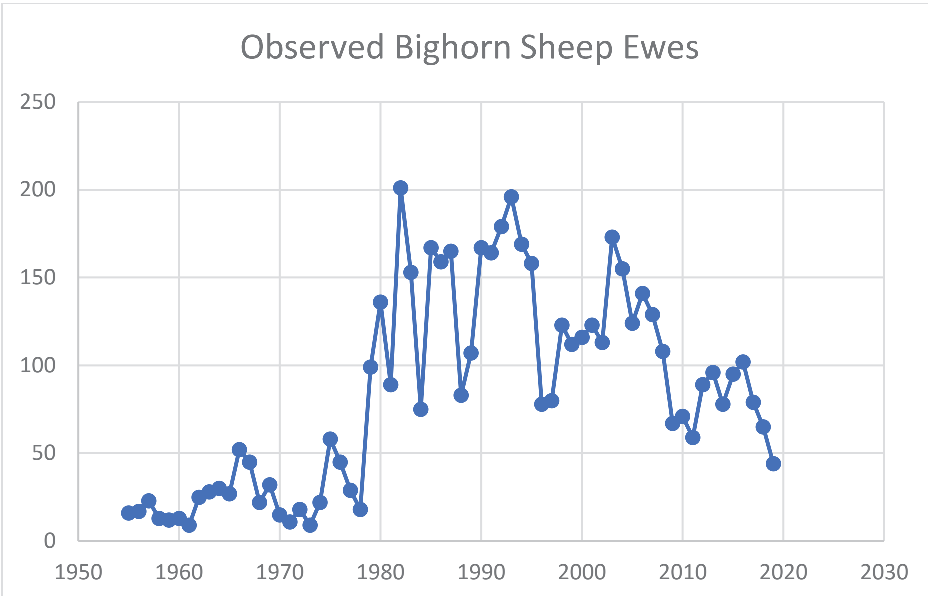
a) Total number of bighorn sheep observed during annual surveys at Hart Mountain National Wildlife Refuge, 1955—2019.



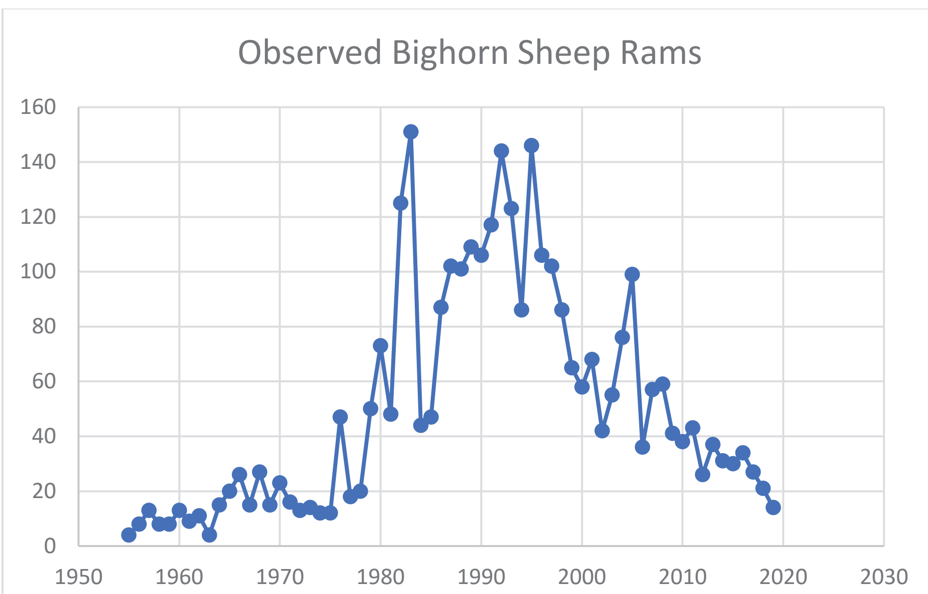
b) Estimated population size of bighorn sheep based on annual surveys at Hart Mountain National Wildlife Refuge, 1955—2019.



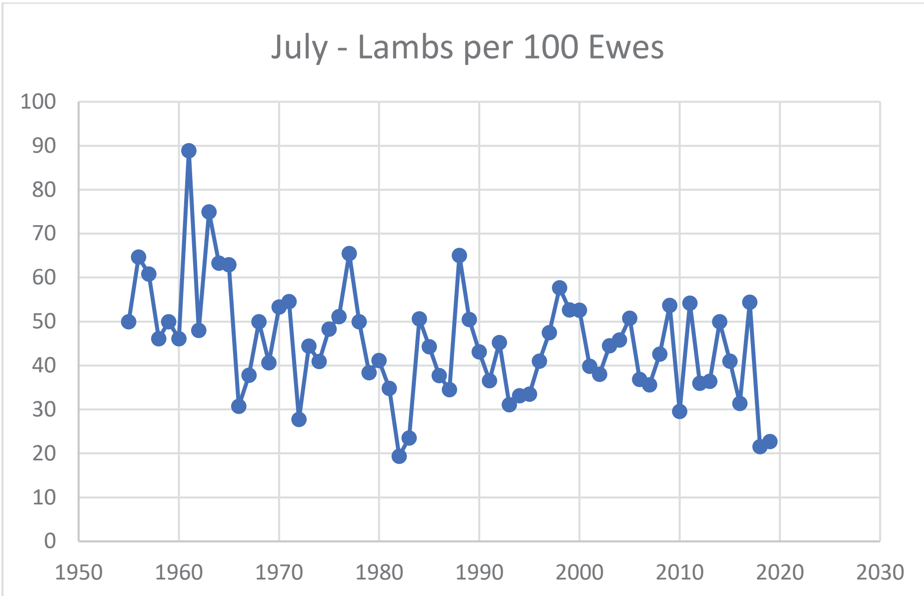
c) Number of bighorn sheep ewes observed during annual surveys at Hart Mountain National Wildlife Refuge, 1955—2019.



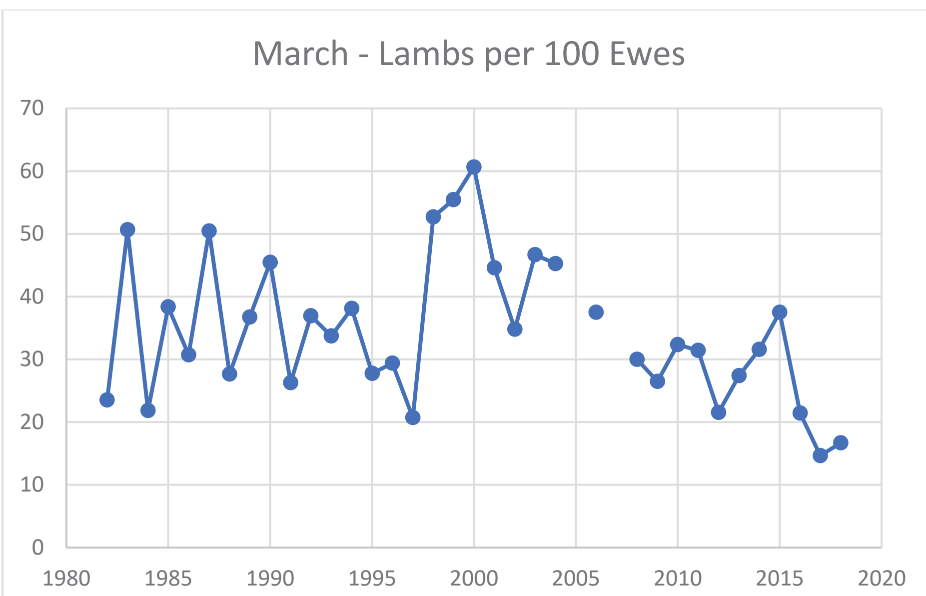
d) Number of bighorn sheep rams observed during annual surveys at Hart Mountain National Wildlife Refuge, 1955—2019.



e) Lamb:ewe ratios observed in July during annual surveys of bighorn sheep at Hart Mountain National Wildlife Refuge, 1955—2019.



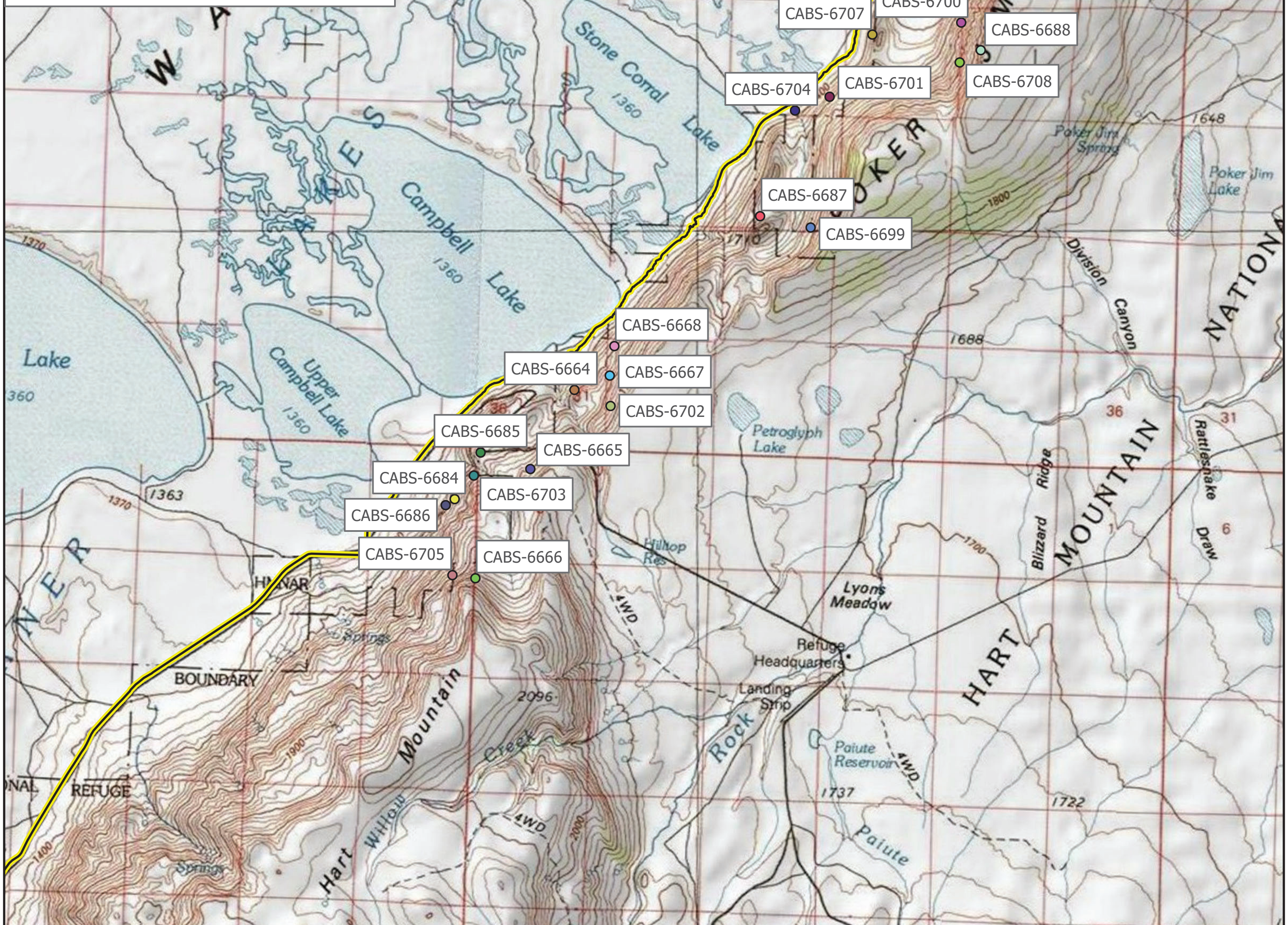
f) Lamb:ewe ratios observed in March during annual surveys of bighorn sheep at Hart Mountain National Wildlife Refuge, 1955—2019.



Appendix 3: 2019 Capture locations of Bighorn sheep in Hart Mountain National Wildlife Refuge.

Hart Mountain National Antelope Refuge 2019 January Bighorn Sheep Capture. Disease sampling locations, first GPS location following release from capture

CABS-**** (individual sample) locations from deployment of collars, no actual location of the capture event but these locations represent release of the animals to the best of our knowledge.



CaptureLocation	DeployedLocation	CollarType	Collar Functioning?	CollarID	Frequency	EarTag	Gender	AccessionNumber	CaptureDate
HMR	North Mountain	GPS	Mort	82671	167.169	61	Ewe	CABS-6664	01/22/2019
HMR	North Mountain	GPS		82672	167.181	62	Ewe	CABS-6665	01/22/2019
HMR	North Mountain	GPS		82673	167.194	63	Ewe	CABS-6666	01/22/2019
HMR	North Mountain	GPS		82674	167.206	64	Ewe	CABS-6667	01/22/2019
HMR	North Mountain	GPS		82675	167.219	65	Ewe	CABS-6668	01/22/2019
HMR	North Mountain	GPS		82676	167.231	66	Ewe	CABS-6684	01/22/2019
HMR	North Mountain	GPS	Mort	82677	167.244	67	Ewe	CABS-6685	01/22/2019
HMR	Poker Jim	GPS	malfunction 01/28/19	82691	167.081	68	Ewe	CABS-6686	01/22/2019
HMR	Poker Jim	GPS		82692	167.094	69	Ewe	CABS-6687	01/23/2019
HMR	Poker Jim	GPS		82693	167.106	70	Ewe	CABS-6688	01/23/2019
HMR	Poker Jim	GPS		82694	167.119	71	Ewe	CABS-6699	01/23/2019
HMR	Poker Jim	GPS		82695	167.131	72	Ewe	CABS-6700	01/23/2019
HMR	North Mountain	GPS		82696	167.144	73	Ewe	CABS-6701	01/23/2019
HMR	Poker Jim	GPS	Mort	82697	167.156	74	Ram	CABS-6702	01/22/2019
HMR	Poker Jim	GPS	Mort	81981	167.006	75	Ram	CABS-6703	01/22/2019
HMR	Poker Jim	GPS	Mort	81982	167.019	76	Ram	CABS-6704	01/23/2019
HMR	Poker Jim	GPS		81983	167.031	77	Ram	CABS-6705	01/22/2019
HMR		GPS	Not Deployed	81984	167.044	78		CABS-6706	
HMR	Poker Jim	GPS	Mort	81985	167.056	79	Ram	CABS-6707	01/23/2019
HMR	Poker Jim	GPS	Mort	81986	167.069	80	Ram	CABS-6708	01/23/2019

Appendix 4: 2001 Bighorn sheep disease testing results Hart Mountain National Wildlife Refuge

University of Idaho
Animal and Veterinary Science Department
Caine Veterinary Teaching Center
WOI Regional Program
1020 E. Homedale Rd.
Caldwell, ID 83607
Telephone: 208-454-8657
Fax: 208-454-8659
E-mail: cvtc@uidaho.edu

February 28, 2001

Mr. Craig Foster
Oregon Department of Fish and Wildlife
P.O. Box 1214
Lakeview, Oregon 97630

Dear Craig,

Enclosed is a table containing data from cultures of bighorn sheep pharyngeal swab samples delivered to the Caine Center February 1st by Dr. Mark Drew. The samples were from sheep captured from the Hart Mountain herd on January 30 and 31. The CVTC Accession No. assigned to these samples is 01-201.

Please contact Dr. Glen Weiser or me if you have any questions regarding this report.

Sincerely,

Alton C. S. Ward

Alton C. S. Ward, PhD

enclosure

Bacteriology culture results for pharyngeal swab samples submitted to the University of Idaho Caine Veterinary Teaching Center February 1, 2001 collected from bighorn captured from Hart Mountain herd on January 30 and 31.

Sample Identification [1]	Bacteria Isolated	*Pasteurella* Biovariant [2]		CVTC Isolate Number
51 ET 4332	*Pasteurella trehalosi*	2	(nh)	01-201-1
52 ET 4345	*Pasteurella trehalosi*	2	(nh)	01-201-11
	Pasteurella haemolytica	10	(nh)	01-201-12
	Pasteurella haemolytica	$11^{\alpha\beta}$	(β)	01-201-13
53 ET 4341	*Pasteurella trehalosi*	2	(nh)	01-201-21
54 ET 4330	*Pasteurella trehalosi*	2	(nh)	01-201-31
55 ET 4340	*Pasteurella haemolytica*	7^{D}	(β)	01-201-41
56 ET 4331	*Pasteurella haemolytica*	10	(nh)	01-201-51
57 ET 4334	*Pasteurella trehalosi*	2	(nh)	01-201-61
	Pasteurella haemolytica	$U^{\alpha BX}$	(nh)	01-201-62
58 ET 4343	*Pasteurella trehalosi*	2	(nh)	01-201-71
59 ET 4344	*Pasteurella trehalosi*	2	(β)	01-201-81
60 ET 4326	*Pasteurella trehalosi*	2	(nh)	01-201-91
61 ET 4336	*Pasteurella trehalosi*	2	(nh)	01-201-101
62 ET 4337	*Pasteurella trehalosi*	2	(nh)	01-201-111
63 ET 4329	*Pasteurella trehalosi*	2	(nh)	01-201-121
	Pasteurella haemolytica	$U^{\alpha\beta RX}$	(nh)	01-201-122
64 ET 4338	*Pasteurella trehalosi*	2	(nh)	01-201-131
65 ET 4333	*Pasteurella trehalosi*	2	(nh)	01-201-141
	Pasteurella haemolytica	10	(nh)	01-201-142
107 ET 4342	*Pasteurella trehalosi*	2	(nh)	01-201-151
Lung Sample	Non-*Pasteurella* species in low numbers			Not preserved

1 Animal identification numbers on record sheets are followed by the ear tag (ET) number recorded for each animal.

2 Notations in brackets indicate reactions of each isolate when grown on agar containing 5% sheep blood, ie. (nh) = isolate did not produce hemolysis and (β) = isolate produced beta-hemolysis on blood agar.

APPENDIX J

U.S. Fish and Wildlife Service Socioeconomic Profile

U.S. Fish and Wildlife Service Socioeconomic Profile

Hart Mountain National Antelope Refuge

Selected Location(s):

Census Tract 9601, Lake County

Comparison Location:

United States

Produced by
Headwaters Economics'
Economic Profile System (EPS)
https://headwaterseconomics.org/eps
February 18, 2021

Headwaters Economics is an independent, nonprofit research group. Its mission is to improve community development and land management decisions.

Headwaters Economics provides original and effective research to help people and organizations develop solutions to some of the most urgent and important issues that communities face.

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.

The U.S. Fish and Wildlife Service is involved in the management of more than 855 million acres of land, including lands that are co-managed or held through easement or other agreements.

U.S. Fish and Wildlife Service Socioeconomic Profile

U.S. Fish and Wildlife Service Socioeconomic Profiles provide an overview of the demographic and economic conditions for counties near FWS management units.

This profile uses indicators most relevant to public land management from reliable, published Federal government data sources, and presents data and definitions as reported from the cited data sources. The profile has a variety of uses including serving as a socioeconomic baseline for National Environment Policy Act (NEPA) analyses, facilitating community engagement, and for simply learning about a region. This profile does not replace local knowledge. Better data may be available from local sources.

For additional reports, try these other tools by Headwaters Economics:

Populations at Risk

Populations at risk are more likely to experience adverse social, health, and economic outcomes due to their race, age, gender, poverty status, and other socioeconomic measures.

Free and easy-to-use
Quickly create reports of current socioeconomic data in convenient formats, including Excel and PDF.

Available nation-wide
Build reports for geographies from states to census tracts. Aggregate multiple geographies into custom study areas.

Updated continuously
Make use of reliable, published government data. The Populations at Risk report always shows the latest available data and trends.

headwaterseconomics.org/par

Economic Profile System

The Economic Profile System (EPS) generates reports on a range of topics including local economics, demographics, and income sources while providing historic context and trends.

Free and easy-to-use
Like Populations at Risk, EPS is free, updated continuously, and easy-to-use.

Integrates federal data sources
Access data from many sources, including the Census, Bureaus of Economic Analysis, Labor Statistics, and others.

Widely used
For more than a decade, EPS has been used by researchers, economic developers, grant writers, elected officials, cities, planners, federal agencies, reporters, and others.

headwaterseconomics.org/eps

USFWS Socioeconomic Profile

Hart Mountain National Antelope Refuge

Table of Contents

Click the links above for quick access to report sections.

USFWS Socioeconomic Profile

Hart Mountain National Antelope Refuge

Age & Sex

	Census Tract 9601, Lake County	United States
Total Population, 2018*	2,753	322,903,030
Under 5 years	139	19,836,850
5 to 9 years	133	20,311,494
10 to 14 years	147	20,817,419
15 to 19 years	84	21,204,226
20 to 34 years	346	66,854,946
35 to 49 years	307	61,591,089
50 to 64 years	742	63,048,425
65 to 84 years	829	43,033,098
85 years and over	26	6,205,483
Total Female	1,338	163,918,840
Total Male	1,415	158,984,190

Change in Median Age, 2010*-2018*

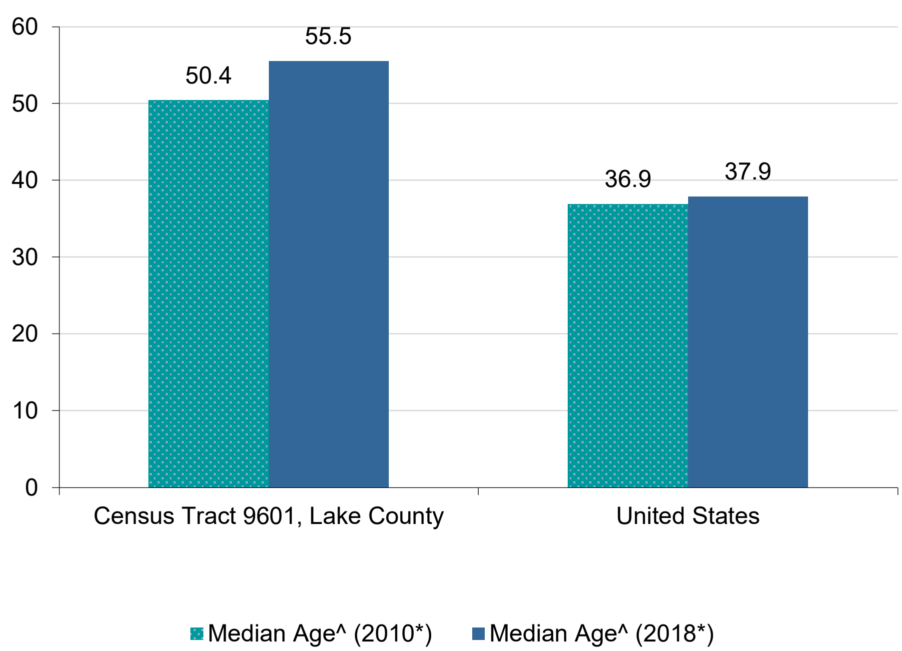
Median Age^ (2018*)	55.5	37.9
Median Age^ (2010*)	50.4	36.9
Change in Median Age^ (2010 to 2018*)	5.1	1.0

^ Median age is not available for metro/non-metro or regional aggregations.

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Median Age, 2010* & 2018*

- From 2010* to 2018* , the median age estimate increased the most in Census Tract 9601, Lake County (50.4 to 55.5) and increased the least in United States (36.9 to 37.9).



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018; 2010 represents 2006-2010.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Age & Sex

What do we measure on this page?

This page describes population distribution by age and sex,[1] and the change in median age.

Median Age: The age that divides the population into two numerically equal groups (half the people are younger than this age and half are older).

Why is it important?

Age is a basic demographic characteristic that intersects other social characteristics such as marital status and education, and economic characteristics such as labor force participation. Age is a critical element in determining federal funding. Changes in the age composition of a population can signify future social and economic trends.

Different locations have different age distributions. For example, in counties with a large number of retirees, the age distribution may be skewed toward categories 65 years and older.[2] In counties with universities, the age distribution will be skewed toward 18- to 29-year-olds. In many counties, the largest segment of the population is the Baby Boomer generation (people born between 1946 and 1964).

The change in median age is one indicator of whether the population has gotten older or younger.[3] In general, the U.S. population is growing older. In many states the median age is over 40 years old and more than four out of every five counties were older in 2018 than in 2010.

Additional Resources

The Orton Family Foundation's Community Network Analysis Tool uses information about who lives, works, and plays in your community to identify how best to reach people. The tool prepares you for achieving broad engagement and participation of diverse audiences throughout your city or town: http://www.orton.org/wp-content/uploads/2017/03/community-network-analysis-tool.pdf.

Refuges with a minimum of 50,000 annual visits can compare demographic data for their area with demographic data collected from refuge visitors. To learn more about the National Wildlife Refuge Visitor Survey and access refuge survey results, see: https://u.osu.edu/dietsch.29/

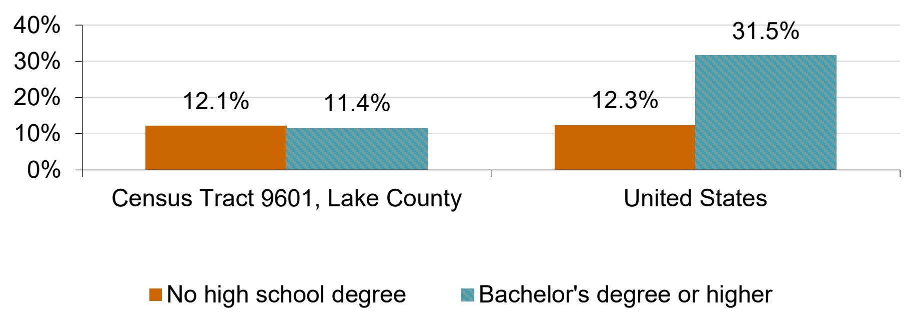
CHANGES IN BOUNDARIES: Data describing change over time can be misleading when geographic boundaries have changed.
The Census provides documentation about changes in boundaries at this site: www.census.gov/geo/reference/boundary-changes.html

Education

	Census Tract 9601, Lake County	United States
Total Population 25 yrs or older, 2018*	2,186	218,446,071
No high school degree	˙265	26,948,057
High school graduate	1,921	191,498,014
Associates degree	˙133	18,338,323
Bachelor's degree or higher	˙250	68,867,051
Graduate or professional	˙69	26,396,124
Percent of Total		
No high school degree	˙12.1%	12.3%
High school graduate	87.9%	87.7%
Associates degree	˙6.1%	8.4%
Bachelor's degree or higher	˙11.4%	31.5%
Graduate or professional	˙3.2%	12.1%

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Educational Attainment, 2018*



	Census Tract 9601, Lake County	United States
Total Population over 3 years old, 2018*	2,662	311,230,839
Enrolled in school:	˙341	81,415,106
Enrolled in nursery school, preschool	˙˙**28**	4,947,516
Enrolled in kindergarten	˙˙**19**	4,083,735
Enrolled in grade 1 to grade 4	˙89	16,263,019
Enrolled in grade 5 to grade 8	˙91	16,544,964
Enrolled in grade 9 to grade 12	˙76	17,004,975
Enrolled in college	˙˙**38**	22,570,897
Not enrolled in school	2,321	229,815,733
Percent of Total		
Enrolled in school:	˙12.8%	26.2%
Enrolled in nursery school, preschool	˙˙**1.1%**	1.6%
Enrolled in kindergarten	˙˙**0.7%**	1.3%
Enrolled in grade 1 to grade 4	˙3.3%	5.2%
Enrolled in grade 5 to grade 8	˙3.4%	5.3%
Enrolled in grade 9 to grade 12	˙2.9%	5.5%
Enrolled in college	˙˙**1.4%**	7.3%
Not enrolled in school	87.2%	73.8%

* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Education

What do we measure on this page?

This page describes levels of educational attainment and school enrollment.

Educational Attainment: The level of education completed by people 25 years and over in terms of the highest degree or the highest level of schooling completed.

School Enrollment: The U.S. Census Bureau's American Community Survey (ACS) defines people as enrolled in school if they were attending a public or private school or college at any time during the three months prior to taking the survey. People enrolled in vocational courses (such as business, technical, secretarial, trade, or correspondence courses) are not included in ACS school enrollment counts.

Why is it important?

Education is one of the most important indicators of the potential for economic success, and lack of education is closely linked to poverty. Studies show that areas with a higher-than-average-educated workforce grow faster, have higher incomes, and suffer less during economic downturns than other areas.[4, 5] In 2017, the Bureau of Labor Statistics reported that the higher the rate of educational achievement, the lower the unemployment rate and the higher the wages.6

Understanding differences in education levels can highlight whether certain people might be disproportionately impacted by policies, plans, and management actions, and can inform communication and outreach efforts.

School enrollment can be an important indicator of the level of access to education, a community's potential for economic growth, and the number of dependents in a community that are not of working age. Some government agencies also use this information for funding allocations.

Additional Resources

For tables with school enrollment by detailed levels, and access to versions by race and ethnicity, see: https://censusreporter.org/tables/B14007/.

USFWS Socioeconomic Profile

Hart Mountain National Antelope Refuge

Language

	Census Tract 9601, Lake County	United States
Population 5 yrs or older, 2018*	2,614	303,066,180
Speak only English	2,494	237,956,495
Speak a language other than English	˙120	65,109,685
Spanish or Spanish Creole	¨**95**	40,256,297
Other Indo-European languages	¨**3**	11,014,379
Asian and Pacific Island languages	¨**22**	10,570,681
Other languages	¨**0**	3,207,613
Speak English less than "very well"	¨**42**	25,647,781

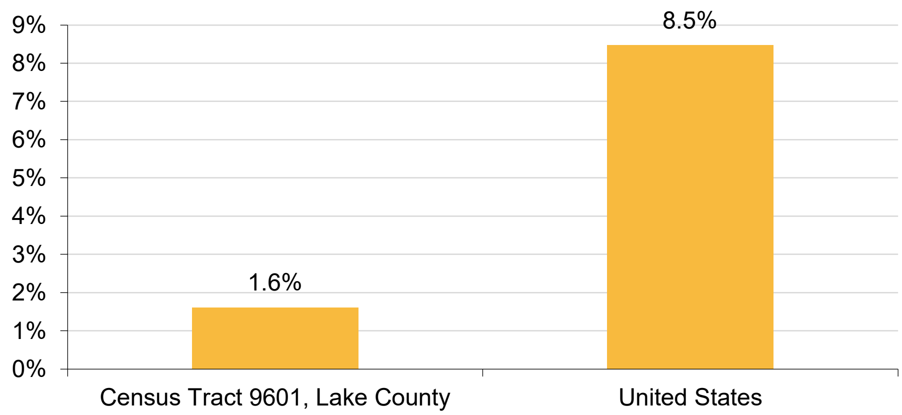
Percent of Total

	Census Tract 9601, Lake County	United States
Speak only English	95.4%	78.5%
Speak a language other than English	˙4.6%	21.5%
Spanish or Spanish Creole	¨**3.6%**	13.3%
Other Indo-European languages	¨**0.1%**	3.6%
Asian and Pacific Island languages	¨**0.8%**	3.5%
Other languages	¨**0.0%**	1.1%
Speak English less than "very well"	¨**1.6%**	8.5%

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Percent of Population that 'Speaks English Less Than Very Well', 2018*

- In the 2014-2018 period, United States had the highest estimated percent of people that spoke English less than 'very well' (8.5%), and Census Tract 9601, Lake County had the lowest (1.6%).



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Language

What do we measure on this page?

This page measures the primary language people speak at home.

Language Spoken at Home: The language used by the population five years and older at home, either "English only" or a non-English language which is used in addition to English or in place of English.

Why is it important?

If a significant portion of the population is classified as speaking English "less than very well," public outreach, meetings, plans, and implementation may need to be conducted in multiple languages. Community leaders and policy makers should be prepared to use interpreters of languages other than English to communicate effectively with diverse publics.

Additional Resources

For a detailed breakdown of languages spoken at home, see: https://censusreporter.org/tables/C16001/.

USFWS Socioeconomic Profile

Hart Mountain National Antelope Refuge

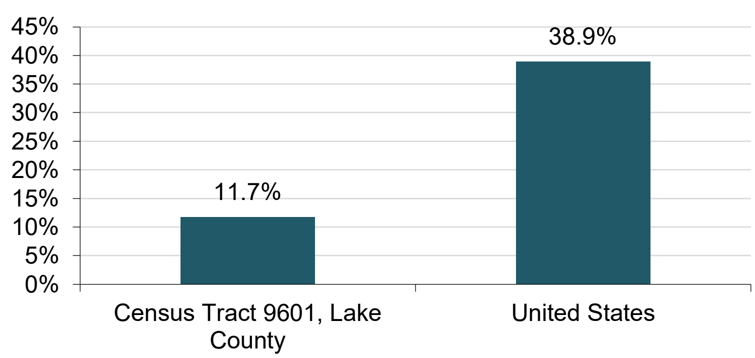
Race & Ethnicity

Race and Ethnicity, 2018*	Census Tract 9601, Lake County	United States
Total Population	2,753	322,903,030
White alone	2,648	234,904,818
Black or African American alone	¨0	40,916,113
American Indian alone	¨43	2,699,073
Asian alone	¨45	17,574,550
Native Hawaii & Other Pacific Is. alone	¨0	582,718
Some other race alone	¨0	15,789,961
Two or more races	¨17	10,435,797
Hispanic or Latino (of any race)	243	57,517,935
Not Hispanic or Latino	2,510	265,385,095
Not Hispanic & White alone	2,430	197,181,177
Total Minority Population	323	125,721,853
Percent of Total		
White alone	96.2%	72.7%
Black or African American alone	¨0.0%	12.7%
American Indian alone	¨1.6%	0.8%
Asian alone	¨1.6%	5.4%
Native Hawaii & Other Pacific Is. alone	¨0.0%	0.2%
Some other race alone	¨0.0%	4.9%
Two or more races	¨0.6%	3.2%
Hispanic or Latino (of any race)	˙8.8%	17.8%
Not Hispanic or Latino	91.2%	82.2%
Not Hispanic & White alone	88.3%	61.1%
Total Minority Population	11.7%	38.9%

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Minority Population, Percent of Total, 2018*

- United States has the largest share of people of color (38.9%).



* ACS 5-year estimates used. The 2018 estimate is based on data collected between 2014 and 2018.

Data sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Race & Ethnicity

What do we measure on this page?

This section reports the size of populations by racial and ethnic groups as reported by the U.S. Census Bureau's American Community Survey (ACS) five-year estimates. The U.S. Census Bureau defines race and ethnicity independently:

Race: Respondents can self-identify as "White," "Black or African American," "American Indian and Alaska Native,[7]" "Asian," and "Native Hawaiian or Other Pacific Islander."

Some Other Race: This includes all other responses not included above. Respondents providing write-in entries—such as multiracial, mixed, interracial, or a Hispanic/Latino group (for example, Mexican, Puerto Rican, or Cuban)—in the "Some other race" write-in space are included in this category.

Two or More Races: This includes people who either checked two or more race response check boxes, provided multiple write-in responses, or submitted some combination of check boxes and write-in responses.

Ethnicity: Respondents identify themselves as either Hispanic or Latino, or Not Hispanic or Latino. The terms Hispanic and Latino are generally used to denote people living in the United States with cultural ties to Latin America or other Spanish speaking countries. Individuals self-identifying as having a Hispanic, Latino, or Spanish heritage can do so by selecting from categories listed on the Census questionnaire: "Mexican, Mexican American, or Chicano," "Puerto Rican," "Cuban," or "other Spanish, Hispanic, or Latino." People who identify as being of Spanish, Hispanic, or Latino culture can be of any race or combination of races.

Minority: A minority individual is defined as a person whose race is not White or a person who is Hispanic or Latino (or both). Thus the "Total Minority Population" is calculated by subtracting those who identify as both "Not Hispanic or Latino" and "White alone" from "Total Population."

Why is this important?

Different groups of people may value and use public lands in different ways. They may also experience different barriers and opportunities to access public lands and natural resource management decision-making processes. Understanding the various values, beliefs, and attitudes of minority populations living in an area is important to public land managers working to meet the needs of the public, or when evaluating potentially adverse impacts on a population. Furthermore, research has demonstrated that minority populations have a higher likelihood of being exposed to health and environmental risks than non-minority populations.

The Council on Environmental Quality (CEQ) guidance on Environmental Justice states that minority EJ populations are considered to be present when (a) the minority population of the affected area exceeds 50%, or (b) the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (typically the state).

While these data help identify the presence of a minority population, further outreach and analysis is required to understand values, beliefs, and attitudes of groups, and determine potential impacts of management decisions on local populations.

Income

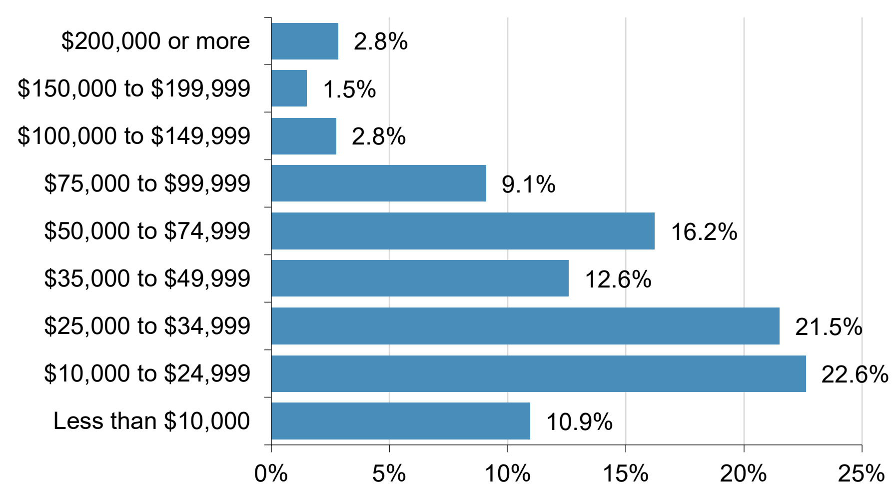
	Census Tract 9601, Lake County	United States
Per Capita Income (2018 $s)	$22,149	$32,621
Median Household Income^ (2018 $s)	$32,119	$60,293
Total Households, 2018*	1,344	119,730,128
Less than $10,000	˙147	7,584,305
$10,000 to $24,999	˙304	16,654,012
$25,000 to $34,999	289	11,117,434
$35,000 to $49,999	˙169	15,124,821
$50,000 to $74,999	˙218	20,910,222
$75,000 to $99,999	˙122	14,937,330
$100,000 to $149,999	˙37	17,533,125
$150,000 to $199,999	**¨20**	7,513,313
$200,000 or more	**¨38**	8,355,566
Gini Coefficient^	0.44	0.48
Percent of Total		
Less than $10,000	˙0	6.3%
$10,000 to $24,999	˙0	13.9%
$25,000 to $34,999	˙0	9.3%
$35,000 to $49,999	˙0	12.6%
$50,000 to $74,999	˙16.2%	17.5%
$75,000 to $99,999	˙9.1%	12.5%
$100,000 to $149,999	˙2.8%	14.6%
$150,000 to $199,999	**¨1.5%**	6.3%
$200,000 or more	**¨2.8%**	7.0%

^ Median Household Income and Gini Coefficient are not available for metro/non-metro or regional aggregations.

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Household Income Distribution, Tract 9601, Lake County, OR, 2018*

- In the 2014-2018 period, the income category in the Tract 9601, Lake County, OR with the most households was $10,000 to $24,999 (22.6% of households). The income category with the fewest households was $150,000 to $199,999 (1.5% of households).



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Income

What do we measure on this page?

This page describes per capita income and the distribution of household income.

Per Capita Income: Total personal income divided by total population of an area.[8]

Household: All the people who occupy a housing unit as their usual place of residence.

Gini Coefficient: A summary value of the inequality of income distribution. A value of 0 represents perfect equality and a value of 1 represents perfect inequality. The lower the Gini coefficient, the more equal the income distribution.

The per capita income shown on this page is from the U.S. Census Bureau. The U.S. Census Bureau and Bureau of Economic Analysis (BEA) define income differently and derive the estimates using different techniques.[9]

Why is it important?

One important consideration of proposed policies and management actions is whether low-income populations could experience disproportionately adverse effects as a result. Analyzing income differences within and between locations helps to highlight areas where the population, or a sub-population, may be experiencing economic hardship.

The distribution of income is related to important aspects of economic well-being. Large numbers of households in the lower end of income distribution indicate economic hardship. A bulge in the middle can be interpreted as the size of the middle class. A figure that shows a proportionally large number of households at both extremes indicates a location characterized by “haves” and "have-nots.”[10]

Income distribution has always been a central concern of economic theory and economic policy. Classical economists were mainly concerned with the distribution of income among the main factors of production: land, labor, and capital. Modern economists have also addressed this issue but have been more concerned with the distribution of income across individuals and households.[11]

According to the U.S. Census Bureau, the long-term trend shows increasing income inequality. Workers at the top of the wage distribution have experienced real wage[12] gains, while those at the bottom have experienced real wage losses. Researchers cite changes in the labor market—for example, shifts in demand for labor on the basis of education and skill—as the primary reason. Changes in household composition are also a factor. The U.S. Census Bureau notes that divorces, marital separations, births out of wedlock, and the increasing age at first marriage have led to a shift away from married-couple households to single-parent families and nonfamily households. Because non-married-couple households tend to have lower income and less equally distributed income than other types of households, changes in household composition have been associated with growing income inequality.[13]

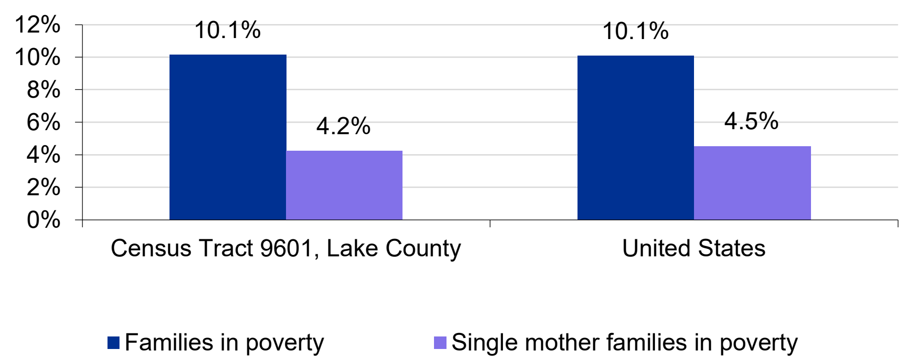
Families in Poverty

	Census Tract 9601, Lake County	United States
Total families for whom poverty status is determined, 2018*	849	78,697,103
Families in poverty	86	7,930,699
Families with children in poverty	**44**	5,909,657
Single mother families in poverty	**36**	3,563,666
Percent of Total, 2018*		
Families in poverty	10.1%	10.1%
Families with children in poverty	**5.2%**	7.5%
Single mother families in poverty	**4.2%**	4.5%
Change in Percentage Points, 2010*-2018*		
For example, if the value is 3% in 2010* and 4.5% in 2018*, the reported change in percentage points is 1.5.		
Families in poverty	-4.0	0.0
Families with children in poverty	-4.0	-0.4
Single mother families in poverty	-0.7	-0.3

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

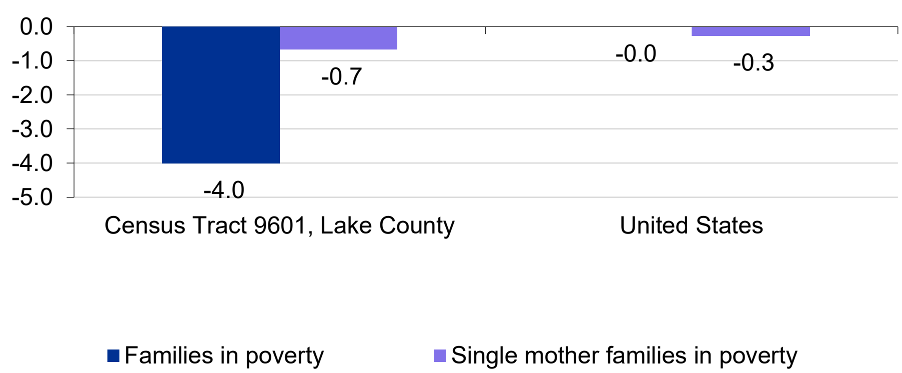
Families in Poverty, Percent of Total, 2018*

- United States has the largest share of single mother families in poverty (4.5%).



Families in Poverty, Change in Percentage Points, 2010*-2018*

- The largest change in the share of single mother familes in poverty occurred in Census Tract 9601, Lake County, which went from 4.9% to 4.2%.



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018; 2010 represents 2006-2010.

CITATION: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Families in Poverty

What do we measure on this page?

This page describes the number of families living below the poverty line, including families with children, single-mother families with children, and other family types for which data are not presented on this page.

The U.S. Census Bureau defines a family as a group of two or more people who reside together and who are related by birth, marriage, or adoption.

The U.S. Census Bureau uses a set of income thresholds that vary by family size and composition to define who is poor. If the total income for a family or an unrelated individual falls below the relevant poverty threshold, then the family or an unrelated individual is classified as being "below the poverty level."

Why is it important?

Families in poverty may lack resources to meet their basic needs. Their challenges cross the spectrum of food, housing, health care, education, vulnerability to natural disasters, and emotional stress.

To save money, families with low incomes often have to make lifestyle compromises such as unhealthy foods, less food, substandard housing, or delayed medical care.[14] Children in poor families, on average, receive fewer years of education compared to children in wealthier families.[15]

Lack of financial resources make families in poverty more vulnerable to natural disasters. This is due to inadequate housing, social exclusion, and an inability to re-locate or evacuate.[16, 17]

Inadequate shelter exposes occupants to increased risk from storms, floods, fire, and temperature extremes.[17] Households with low incomes are more likely to have unhealthy housing such as leaks, mold, or rodents.[18]

Low-income residents are less likely to have adequate property insurance, so they may bear an even greater burden from property damage due to natural hazards.[17]

Living in poverty can lead to a lack of personal control over potentially hazardous situations such as air pollution or flooding. Impoverished families may be less likely to take proactive measures to prevent harm.[16]

Families in poverty may experience barriers to accessing and participating in outdoor recreation and public decision-making processes.

Additional Resources

For data on individuals in poverty, households receiving public assistance, and housing affordability, see https://headwaterseconomics.org/tools/populations-at-risk/.

CHANGES IN BOUNDARIES: Data describing change over time can be misleading when geographic boundaries have changed.
The Census provides documentation about changes in boundaries at this site: www.census.gov/geo/reference/boundary-changes.html

Poverty by Race & Ethnicity

	Census Tract 9601, Lake County	United States
Total Population in Poverty, 2018*	˙443	44,257,979
White alone	˙418	26,730,734
Black or African American alone	¨0	9,490,587
American Indian alone	¨14	673,665
Asian alone	¨0	1,989,768
Native Hawaii & Other Pacific Is. alone	¨0	103,304
Some other race	¨0	3,497,625
Two or more races	¨11	1,772,296
All Ethnicities in Poverty, 2018*		
Hispanic or Latino (of any race)	¨21	11,849,315
Not Hispanic or Latino (of any race)	˙397	19,205,816

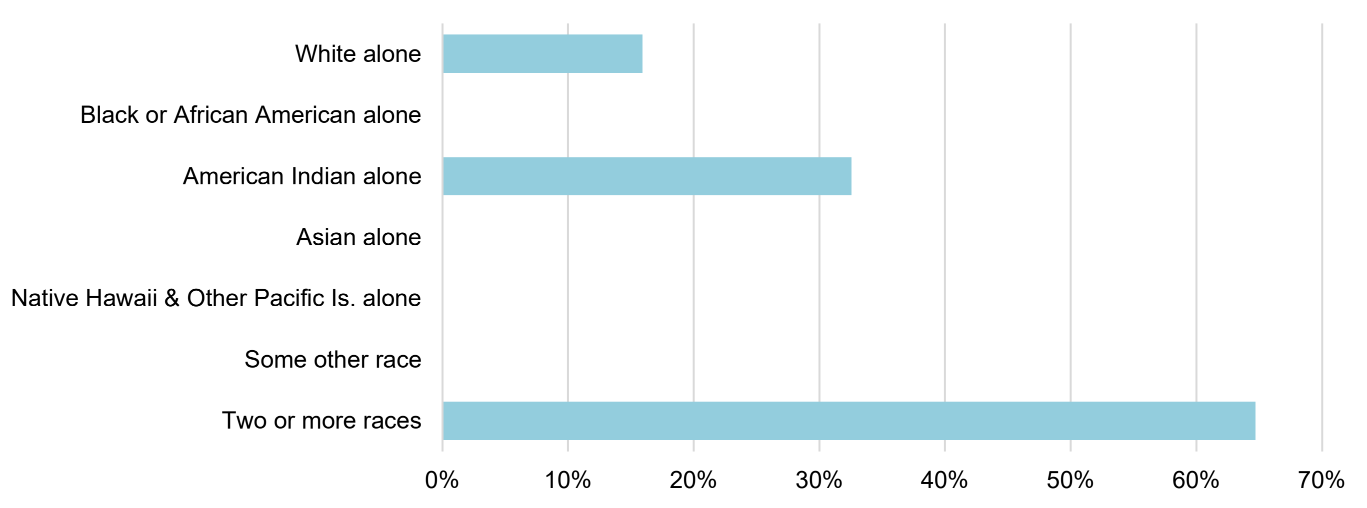
Percent of Total**

	Census Tract 9601, Lake County	United States
White alone	˙15.9%	11.6%
Black or African American alone	na	24.2%
American Indian alone	¨32.6%	25.8%
Asian alone	¨0.0%	11.5%
Native Hawaii & Other Pacific Is. alone	na	18.3%
Some other race	na	22.6%
Two or more races	¨64.7%	17.5%
Hispanic or Latino (of any race)	¨8.9%	21.0%
Not Hispanic or Latino (of any race)	˙16.5%	10.0%

** Poverty prevalence by race and ethnicity is calculated by dividing the number of people by race in poverty by the total population of that race.

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Poverty Prevalence by Race, Percent of Total, 2018*



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Poverty by Race & Ethnicity

What do we measure on this page?

This page describes the number of people living in poverty by race and ethnicity. It also shows the share of all people living in poverty by race and ethnicity, and the share of each race and ethnicity living in poverty.

Race: Race is a self-identification data item in which U.S. Census respondents choose the race or races with which they most closely identify.

Race categories include both racial and national-origin groups. The concept of race is separate from the concept of Hispanic or Latino origin. Percentages for the various race categories add to 100% and should not be combined with the percent Hispanic or Latino.

Ethnicity: There are two minimum categories for ethnicity: Hispanic or Latino, and Not Hispanic or Latino. The federal government considers race and Hispanic origin to be two separate and distinct concepts. Hispanics and Latinos may be of any race.[19]

Poverty: Following the Office of Management and Budget's Directive, the U.S. Census Bureau uses a set of income thresholds that vary by family size and composition to detect who is poor. If the total income for a family or an unrelated individual falls below the relevant poverty threshold, then the family or an unrelated individual is classified as being "below the poverty level."

Poverty thresholds are updated every year by the U.S. Census Bureau to reflect changes in the Consumer Price Index.[20] The poverty thresholds are the same for all parts of the country. They are not adjusted for regional, state, or local variations in the cost of living.[21]

Why is it important?

Disaggregating socioeconomic data by racial groups can unearth problems that are hidden when looking at overall population trends. For example, overall trends in a population may show decreased levels of poverty. However, disaggregating the data may reveal that conditions are not improving for minority racial groups. Proposed policies and activities may need to be analyzed in the context of whether minorities and people who are economically disadvantaged could be disproportionately impacted.[22, 23]

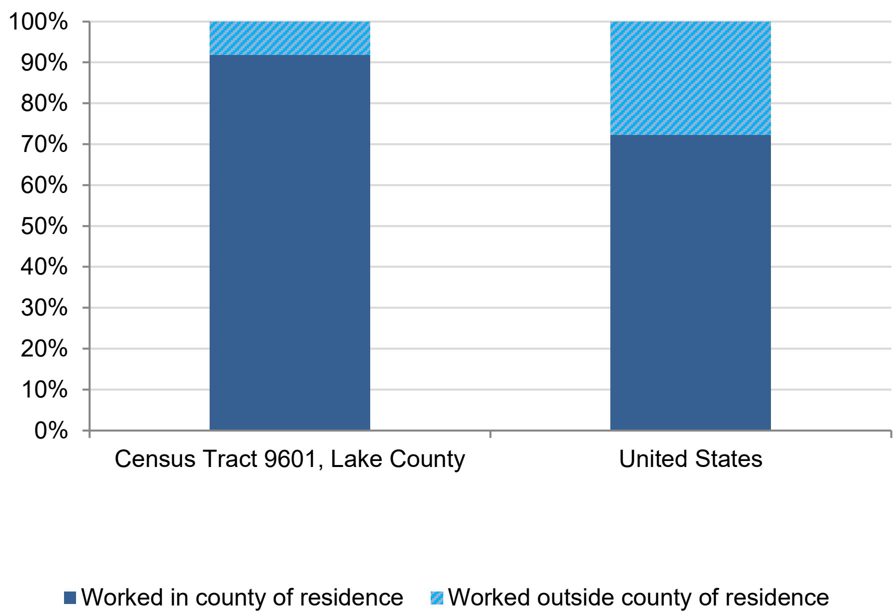
Commuting

	Census Tract 9601, Lake County	United States
Workers 16 years and over, 2018*	1,027	150,571,044
Mean travel time to work (minutes)	˙16	25.3
Percent of Total		
PLACE OF WORK:		
Worked in county of residence	91.9%	72.3%
Worked outside county of residence	¨8.1%	27.7%
TRAVEL TIME TO WORK:		
Less than 10 minutes	˙35.7%	11.8%
10 to 14 minutes	¨5.2%	12.8%
15 to 19 minutes	¨4.1%	14.5%
20 to 24 minutes	¨9.7%	13.8%
25 to 29 minutes	¨0.8%	6.1%
30 to 34 minutes	¨8.0%	13.1%
35 to 39 minutes	¨0.1%	2.9%
40 to 44 minutes	¨1.0%	3.7%
45 to 59 minutes	˙3.1%	7.8%
60 or more minutes	˙8.5%	8.7%

High Reliability: Data with coefficients of variation (CVs) < 12% are in black to indicate that the sampling error is relatively small.
Medium Reliability: Data with CVs between 12 & 40% are in orange to indicate that the values should be interpreted with caution.
Low Reliability: Data with CVs > 40% are displayed in red to indicate that the estimate is considered very unreliable.

Place of Work, 2018*

- In the 2014-2018 period, United States had the highest estimated percent of people that worked outside the county of residence (27.7%), and Census Tract 9601, Lake County had the lowest (8.1%).



* ACS 5-year estimates used. 2018 represents average characteristics from 2014-2018.

Data Sources: U.S. Department of Commerce. 2019. Census Bureau, American Community Survey Office, Washington, D.C.

Commuting

What do we measure on this page?

This page describes workers by place of work and by travel time to work. These data do not include those who work from home.

Why is it important?

The longest commute times tend to occur in larger metro areas or in counties surrounding metro areas. However, fast-growing micropolitan communities or some rural areas, such as resort communities where the cost of living has gone up, are also experiencing long commute times.[24]

Economic development is sometimes affected by commuting in unanticipated ways: strategies aimed at increasing jobs in a community will not necessarily mean jobs for residents. Conversely, creating job opportunities for residents does not always require bringing jobs into that community.

High out-commuting rates can also separate tax revenues from demands for services, which complicates fiscal planning for local governments. "Bedroom communities"—those with high levels of out-commuting—may struggle to provide social services, housing, and water and sewer facilities without an adequate source of business tax revenue. Higher levels and longer distance of commuting likely indicate a housing-job imbalance. This can result from unaffordable housing prices or other residential constraints.[25]

Additional Resources

To explore interactive maps with additional commuting variables, such as the percent of the population that bikes or walks to work, commutes to work by public transportation, or carpools to work, see EPA's EnviroAtlas: https://enviroatlas.epa.gov/enviroatlas/interactivemap/.

Endnotes

1 - The concepts of gender and sex are often confused. U.S. Census Bureau surveys measure sex, very specifically intending to capture a person's biological sex and not gender. Reliable data about the lesbian, gay, bisexual and transgender community are not available nationally. See https://www.census.gov/topics/population/age-and-sex/about.html.

2 - The U.S. Department of Health and Human Services' Administration on Aging has a host of resources about older Americans at https://aoa.acl.gov/.

3 - The U.S. Census Bureau publishes age data estimates for the United States, states, counties, and metropolitan areas. See https://www.census.gov/topics/population/age-and-sex.html.

4 - The Bureau of Labor Statistics shows a tight relationship between employment projections and educational attainment. See https://www.bls.gov/emp/documentation/education-training-system.htm.

5 - Card D. 1999. The Causal Effect of Education on Earnings in Ashenfelter O and Card D, eds., Handbook of Labor Economics, Vol. 3A. New York: Elsevier. Pp. 1801-63.

6 - Employment Projections. 2017. Bureau of Labor Statistics. https://www.bls.gov/emp/chart-unemployment-earnings-education.htm.

7 - For additional data on American Indian and Alaska Native populations, download a demographic report from EPS at https://headwaterseconomics.org/eps.

8 - For a description of the U.S. Census Bureau's ACS definition of per capita income, see https://www.census.gov/quickfacts/fact/note/US/INC910216.

9 - For an explanation of the discrepancies between the U.S. Census Bureau and the Bureau of Economic Analysis, see http://www.incontext.indiana.edu/2003/jan-feb03/details.asp.

10 - For useful remarks and scholarly references on the level and distribution of economic well-being, see Federal Reserve System Chairman Ben S. Bernanke's speech on February 6, 2007: https://www.federalreserve.gov/newsevents/speech/Bernanke20070206a.htm.

11 - For an analysis of trends in the distribution of wealth in the United States, see: Saez E and Zucman G. 2016. Wealth inequality in the United States since 1913: Evidence from capitalized income tax data. The Quarterly Journal of Economics 131(2):519-578.

12 - Real wages are wages adjusted for inflation, i.e., the changes in the prices of goods and services. Real wages better represent an individual's wages in terms of what they can afford to buy with their wages. Real wages are necessary for comparing changes in income over time in a meaningful way.

13 - Income Inequality. U.S. Census Bureau. 2010. https://www.census.gov/topics/income-poverty/income-inequality/about/middle-class.html.

Endnotes (cont.)

14 - County of Los Angeles Public Health. 2013. Health Atlas for the City of Los Angeles. Los Angeles, CA. http://healthyplan.la/wordpress/wp-content/uploads/2013/10/Health-Atlas-for-the-City-of-Los-Angeles-July-2013-FINAL-SMALL.pdf.

15 - North Carolina Institute of Medicine. 2009. Prevention Action Plan. Chapter 11 Socioeconomic Determinants of Health. http://www.nciom.org/publications/?prevention.

16 - Fothergill A and Peek LA. 2004. Poverty and disasters in the United States: A review of recent sociological findings. Natural Hazards 32(1): 89-110.

17 - Wilkinson RG and Marmot MG. 2003. Social determinants of health. Geneva, Switzerland: World Health Organization. http://www.euro.who.int/__data/assets/pdf_file/0005/98438/e81384.pdf.

18 - Centers for Disease Control and Prevention. 2011. CDC Health Disparities and Inequalities Report — United States, 2011. Morbidity and Mortality Weekly Report 60 Suppl. (January 14, 2011). http://www.cdc.gov/mmwr/pdf/other/su6001.pdf.

19 - For a primer on how the Census 2010 handles race and Hispanic origin, see: Humes KR, Jones NA, and Ramirez RR. 2011. Overview of Race and Hispanic Origin. U.S. Census Bureau. https://www.census.gov/prod/cen2010/briefs/c2010br-02.pdf.

20 - For information on the Consumer Price Index, see: https://www.bls.gov/cpi/.

21 - The specific thresholds used for tabulation of income for particular years are shown at https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

22 - The University of Michigan's National Poverty Center hosts a body of research on race and ethnicity as they relate to poverty. See http://npc.umich.edu/research/ethnicity/.

23 - The U.S. Census Bureau briefing on "Poverty Areas" shows that Blacks and Hispanics are disproportionately affected by poverty. "Four times as many Blacks and three times as many Hispanics lived in poverty areas than lived outside them." For more information, see https://www.census.gov/population/socdemo/statbriefs/povarea.html.

24 - See Census commute times data: https://www.census.gov/programs-surveys/acs/data.html.

25 - Aldrich L, Beale C, and Kasse K. 1997. Commuting and the Economic Functions of Small Towns and Places. Rural Development Perspectives 12(3):26-31. https://naldc.nal.usda.gov/download/34577/PDF.

APPENDIX K

Procedures for Inadvertent Archaeological Discoveries for the Hart Mountain National Antelope Refuge Bighorn Sheep Management Plan, U.S. Fish and Wildlife Service

Procedures for
Inadvertent Archaeological Discoveries
for the
Hart Mountain National Antelope Refuge
Bighorn Sheep Management Plan
U.S. Fish and Wildlife Service

Purpose: To outline procedures for the inadvertent discovery of human remains or significant cultural resources identified during implementation of the **Hart Mountain National Antelope Refuge Bighorn Sheep Management Plan.**

Authority
Archeological and Historic Preservation Act of 1974 (16 United States Code [USC] § 469-469c); National Historic Preservation Act of 1966, as amended (16 USC § 470 et seq.); Archaeological Resources Protection Act of 1979, as amended (16 USC § 470aa–470mm); Native American Graves Protection and Repatriation Act (NAGPRA) of 1990 (25 USC § 3001 et seq.); Historic Sites Act of 1935 (49 USC 303); The Protection of Historic Properties (36 Code of Federal Regulations [CFR] Part 800); Curation of Federally-Owned and Administered Archeological Collections (36 CFR Part 79); Protection of Archaeological Resources (43 CFR Part 7); Native American Graves Protection and Repatriation Act Regulations (43 CFR Part 10); and Managing Museum Property (411 DM 1-3).

Procedures

A. The following procedures for handling inadvertent archaeological discoveries shall be adopted for all phases and aspects of work carried out by any U.S. Fish and Wildlife Service (USFWS) personnel or any contractor on the project. Prior to project implementation, the USFWS shall communicate these procedures to contractors, whose superintendent shall notify all crew members through safety briefings or other appropriate meetings. The intent is to avoid or minimize direct or indirect impacts to human remains or archaeological resources that may qualify for inclusion in the National Register of Historic Places.

1. **General Procedures**

The USFWS shall designate at least two points of contact (POC) for inadvertent archaeological discoveries, who shall be contacted immediately upon the unearthing of prehistoric or historic cultural materials, including Native American remains and/r grave goods. The POC shall be an individual capable of making a rapid assessment of the potential significance of any find, capable of assisting in the notification and consultation with other appropriate parties, and capable of developing and implementing a plan of action in consultation with those parties. Implementation of the project will be monitored by professional archaeologist(s), who will be a POC.

2. **Specific Procedures**

a. Ground-disturbing activities shall be immediately stopped when human remains or potentially significant archaeological materials are discovered. Examples include, but are not limited to (a) concentrations of historic artifacts (e.g., bottles, ceramics) or prehistoric artifacts (chipped stone, obsidian, or glass arrow points and other tools, wood fish weirs or lattice panels); (b) culturally altered ash-stained midden soils associated with pre-contact Native American habitation sites; (c) concentrations of fire-altered rock and/or burned or charred organic materials; and (d) historic structure remains such as stone-lined building foundations, wells, or privy pits. Ground-disturbing project activities may continue in other areas that are outside the discovery locale.

b. An "exclusion zone" where unauthorized equipment and personnel are not permitted shall be established (e.g., cordoned/taped off) around the discovery area, plus a reasonable buffer zone established by the contractor's superintendent or authorized representative, or party who made the discovery and initiated these Procedures.

c. The discovery locale shall be secured (e.g., 24-hour surveillance) as directed by the USFWS if considered prudent to avoid further disturbances.

d. The contractor's superintendent, an authorized representative, or party who made the discovery and initiated these procedures, shall be responsible for immediately contacting by telephone the parties listed below to report the find in order to initiate the consultation process:

e. In cases where a known or suspected human burial or skeletal remains are uncovered, the Sheriff's Office, Medical Examiner, or County Coroner, as appropriate, shall be contacted by POC or any party listed in 2(d). In addition, USFWS Zone Law Enforcement Officer will also be contacted. See Section 3 below for further instructions. See Appendix A below for POCs and phone numbers.

f. Ground-disturbing project work at the discovery locality shall be suspended temporarily while USFWS, consulting archaeologists, tribes, and the State Office of Historic Preservation staff consult to evaluate the significance of the find, and if determined eligible for the National Register of Historic Places, develop measures to mitigate adverse effects and arrange for disposition of any archaeological materials removed during the investigations.

g. USFWS employees and agents, including contractors, shall be obligated to protect significant cultural resource discoveries and may be subject to prosecution if applicable state or federal laws are violated. In no event shall unauthorized persons collect artifacts.

h. Any and all inadvertent discoveries shall be considered strictly confidential, with information about their location and nature being disclosed only to those with a need to know. USFWS representatives shall coordinate to respond to any requests by or contacts to the media about a discovery.

3. Inadvertent Discovery of Native American Remains

a. In addition to the steps above, especially 2(d), the following policies and procedures for treatment and disposition of inadvertently discovered Native American remains will apply. These procedures are to simplify and clarify the NAGPRA and promulgated regulations. NAGPRA law and regulation fully apply.

b. Discovery of Native American remains is a very sensitive issue and serious concern of affiliated Native Americans. If human remains are encountered, they shall be treated with dignity and respect. Information about such a discovery shall be held in confidence by all project personnel on a need-to-know basis. The rights of Native Americans, to the extent permitted by federal laws, to practice ceremonial observances on sites, in labs, and around artifacts shall be upheld.

c. To facilitate application of this section, a description of what constitutes burial items, funerary objects, sacred objects, and items of cultural patrimony as defined in NAGPRA may be provided by the tribe(s) to the POCs and archaeologist providing monitoring of construction activities. Information may be provided in a manner of the tribes' choosing. Oral presentation is acceptable. Specific NAGPRA contacts and traditional religious leaders may be designated by tribal chairs.

d. The Sheriff's Office, or designated County Coroner, or Medical Examiner, shall have 2 working days to examine the remains in situ after being notified of the discovery. The purpose of the Sheriff's Office involvement is to determine if inadvertently discovered human remains represent a crime scene or are not of Native American origin. If determined to be a crime scene, then the rest of these procedures do not apply. The Sheriff's Office, in consultation with USFWS Law Enforcement, will determine the next course of action.

e. Immediately upon determination that the human remains are of Native American origin, contact with designated tribal NAGPRA coordinators shall be undertaken by the USFWS archaeologist. Nothing in these procedures is meant to prevent prior contact, if deemed prudent. If possible, contact will be made with the Most Likely Descendant (MLD).

f. Within 3 working days of notification, the tribal NAGPRA coordinator shall provide recommendations to the USFWS for treating, with appropriate dignity, the human remains and any associated grave goods. The recommendation will address the scientific removal analysis of human remains and items associated with Native American burials. The human remains and associated grave offerings may be reburied with appropriate dignity on the property in a location not subject to further subsurface disturbance.

4. Documenting Inadvertent Archaeological Discoveries

a. The contractor's superintendent or authorized representative, or party who made the discovery and initiated these procedures, shall make written notes and digital photographs available to USFWS, describing the date, time, location, and nature of the discovery; the date and time each party was informed about the discovery; and when and how security measures were implemented.

b. USFWS cultural resources team members and project manager shall prepare or authorize the preparation of a summary report that shall include the time and nature of the discovery; who and when parties were notified; outcome of consultations with appropriate agencies and Native American representatives; how, when, and by whom the approved plan of action was carried out; and final disposition of any collected archaeological specimens.

c. The contractor’s superintendent or authorized representative shall record how the discovery downtime affected the immediate and near-term contracted work schedule, for purposes of negotiating contract changes where applicable.

d. Consulting archaeologists and Native American representatives shall maintain daily field notes on the inadvertent discovery.

e. A plan of action and corresponding archaeological evaluation and data-recovery reports shall be authored by professionals who meet the federal criteria for principal investigator archaeologist and reference the *Secretary of the Interior's Standards and Guidelines for Archaeological Documentation* (48 FR 44734-44737).

f. Final disposition of all collected archaeological materials shall be documented in a technical report. Long-term storage of collections may be housed at the facility nearest to the discovery locale that conforms to federal guidelines for curation of archaeological collections (36 CFR 79).

APPENDIX A

Tribal Contacts
Cecil Dick
Chair
Burns Paiute Tribe
100 Pasigo Street
Burns, Oregon 97720-2442

Kevin Townsend
Chairman
Fort Bidwell Indian Community
P.O. Box 129
Fort Bidwell, California 96112

Local Law Enforcement
Lake County Sheriff
513 Center Street
Lakeview, Oregon 97630
O: (541) 947-6027
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USFWS Law Enforcement
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Senior Federal Wildlife Officer
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E: nick_valentine@fws.gov

APPENDIX L

Wild Sheep Capture Guidelines

Bienn. Symp. North. Wild Sheep
and Goat Counc. 14:211-282

Wild Sheep Capture Guidelines

Sponsored by:

Northern Wild Sheep and Goat Council
and
Desert Bighorn Council

Prepared by:
Craig L. Foster
Oregon Department of Fish and Wildlife

January, 2005

[These guidelines are dedicated to all those individuals that have tried to put wild sheep in available habitat, or have tried to keep them there…C.L. Foster]

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WILD SHEEP CAPTURE GUIDELINES

INTRODUCTION

The need for this document was identified at the 2nd North American Wild Sheep Conference (1999). It is intended to provide a set of guidelines for capturing and relocating wild sheep. The document covers capture operations and permit requirements for capturing and importing sheep from other states or Canada. Reasons to catch wild sheep vary from needing to catch one or two individuals that have strayed from their range to catching many individuals for marking, research or transplant. Therefore procedures identified in this document will not apply to every capture or will need modified depending on the situation. The document provides activities or considerations various agencies have used to catch wild sheep. The Northern Wild Sheep and Goat Council (NWSCG) and Desert Bighorn Council (DBC) hope that future capture operations will benefit from these guidelines.

Wild sheep are the only North American species for which the prevention of disease is a constant consideration in management activities. Many aspects of wild sheep disease are poorly understood. For that reason it is important that the recommended health tests identified in the document be completed. If we ever understand the various aspects of disease in wild sheep it will be because those of us that catch sheep collected samples and had them analyzed. If funding is tight collect the samples and store them in case future analysis in needed.

PRE-CAPTURE PROCEDURES

Preparation should start at least 6 months in advance. If the capture site is in another state, or nation permission to capture must be received before any planning starts. The process to secure permission to capture, or clearance for the release site, may take several months to several years to negotiate. After approvals have been secured, the following activities should be reviewed and those applicable, completed. One individual should be assigned to complete these duties. This individual should become the Capture Boss described later in this document.

1.) Select actual capture site(s), number, sex and age of sheep to be caught and method of capture. Compile any historical herd health information for the source herd. If no herd health information exists it may be possible to substitute information from other ungulates in the same herd range as the source herd. This must be done several months in advance to prepare the capture contract (if necessary), select a capture contractor, develop Foundation for North American Wild Sheep (FNAWS) Grant In Aide request or other funding sources, and order radio collars.

2.) Select release sites and the number, sex and age of sheep to be released at each site. Determine ear tag color, type, and size to be used on each release site. Color should be different than colors used on previous releases in the same district/drainage/area in case the sheep do not stay where they are released. Determine radio collar needs. Order radio collars with frequencies assigned to each release site. Make sure frequencies do not overlap with other radio marked species in the area.

3.) Assign a wildlife veterinarian to assist with the capture, transport and release. If the agency completing the capture does not have a wildlife veterinarian on staff, develop a personal service contract with a private practice veterinarian. The veterinarian selected should have experience with large ruminants.

4.) Identify and secure required permits for capture, transport and release.

5.) Determine which samples are to be collected during capture. Decide which tests are required or desired, and how much blood must be taken. Contact the labs you will use and ask them if they require any special handling of samples. On new capture sites, a full complement of tests on each adult sheep is recommended. On capture sites that have a recent sampling history for herd health, less testing (50%) is adequate for collection of herd health data.

6.) Assemble sample kits just prior to capture. Contents of the kits are determined by capture method and selected herd health tests. Coordinate the contents with your veterinarian.

7.) Develop a data record form with details applicable to the project.

8.) Most of us catch sheep in the colder climates of North America when animals are concentrated on winter range. Desert bighorn biologists often catch sheep when temperatures exceed 100^{o}F. Throughout the various sections to follow we will use the term: Hot Climate Considerations for desert bighorn captures or periods of unseasonably warm weather during northern captures. Keep in mind that a period of 65^{o}F weather during a January capture in Oregon when sheep are in winter coat can result in as many heat related stress problems as a 100^{o}F September capture in New Mexico.

9.) Whether you are running a large New Mexico style netgun capture with 50 people or 2 biologists need to clover trap and mark 4 Dall Sheep in the Yukon, plan each step of the capture and handling process. Strive for efficiency and reduced handling time. Capture operations are the glamour duties we all dreamed about when we decided on a wildlife career. There will always be more people that want to help than duties. Don’t let the desires of all those willing helpers compromise the health of the sheep.

10.) The best place for a captured sheep during an operation is in the transport vehicle, away from people. It is easy to get carried away with sampling, treatments or handling. Critically review each planned activity to ensure it is needed and will not substantially increase handling time and animal stress. A certain amount of animal handling is necessary, but unnecessary activities will only compromise the health of captured individuals.

REQUIREMENTS FOR TRANSPORT OF BIGHORN SHEEP FROM MEXICO OR CANADA TO THE U.S.

Requirements for importation of sheep from Mexico or Canada are not terribly complicated, but start the permit process, making phone calls, and working on permit logistics at least 2 months ahead of time. Things start to get busy about 3 weeks ahead of the capture as you are working on trapping and permit logistics. Before starting the permitting process, decide which Port of

Entry will be used, because it will be a factor in some of the permits needed. Establish a good contact within the wildlife agency managing the source herd to help with their export requirements.

U.S. FEDERAL IMPORT PERMITS

U.S. Department of Agriculture,
Animal Plant Health Inspection Service
Veterinary Services, National Center for Import and Export
4700 River Road, Unit 38
Riverdale, MD 20737-1231
Contact person: Betsy Sillers (301) 734-8145
Fax (301) 734-6402

Lead time – approx. 3 weeks, longer if holidays are included. The permit is good for a 14 day period and can be extended.

Submit VS FORM 17-329 Application for import or in transit permit. Forms are available at www.aphis.**usda**.gov

Requirements for U.S. Entry (These will be listed in a letter accompanying your federal import permit and normally include)

1.) Health certification by a veterinarian accredited in the province of origin.

2.) Brucellosis testing. Card test for *B. abortus* and compliment fixation or ELISA for *B. ovis*. The test must be completed before the sheep can cross the border. Can be done at any USDA or Canadian Food Inspection Agency (CFIA) accredited lab. Currently there is no lab in western Canada that can do these tests. You will have to airfreight or fly the samples to an USDA accredited lab. State Department of Agriculture Labs are USDA accredited. Make sure they have a current USDA, APHIS **Controlled Material or Organism permit**, which is shipped with the samples and, required to get animal samples into the country. Most labs that commonly analyze serum will have this permit. If they have the permit you will need a copy to be shipped with the serum. If they do not have the permit request they get one from the USDA, APHIS address shown above. In case of inaccurate results, positives or incompletes, ensure you have a backup plan with the source herd managers and wildlife veterinarian. This is critical to avoid long delays during transport.

3.) Treatment of each animal with ivermectin or one of the benzimidazoles, fenbendazole, oxfendazole, and albendazole.

U.S. Fish and Wildlife Declaration for Importation or Exportation of Fish and Wildlife: Form 3-177.

Fill out and leave at port for USFWS Wildlife Inspector along with Provincial Sundry Permit (Canada).

Contact person will depend on the Port of Entry you choose. Ask the Port Veterinarian for the name and contact number of the Wildlife Inspector. Contact the Wildlife inspector before the capture to start the 3-177 permit process. Forms are available at http://permits.fws.gov

Entry at a port not approved for importation of wildlife will require a **USFWS Port Exemption Permit** (good for 2 years). The USFWS can also require that you work through a border broker if it is considered you are making a "formal entry" vs. an "informal entry". This is up to the discretion of the USFWS and the Port Director. They will not recommend a broker but can tell you which broker handles most of the animal imports at that port.

CANADIAN CERTIFICATES OR PERMITS

Health Certificate

Issued by a veterinarian certified in the province of origin. Required by USDA to get sheep across the border. You must work with a Canadian veterinarian to fulfill this requirement. The Canadian Food Inspection Agency (CFIA) will require negative Brucellosis test results before they counter-sign the permit. The Provincial Wildlife Veterinarian will have the certificate counter-signed by a CFIA port veterinarian.

Provincial Export (or Sundry) Permit

Permit issued by the Provincial Wildlife Agency giving you the sheep. Required by USFWS. Obtain this at the end of the capture from the local wildlife agency biologist.

STATE PERMITS

State Department of Agriculture Requirements – variable

Some agencies may require tuberculosis testing. No case of tuberculosis has ever been documented in free-ranging wild sheep, and the federal government and many states have dropped this requirement. Contact the State Veterinarian, Department of Agriculture for the state in which you will release. If the State Veterinarian has no experience with wild sheep, provide references or documentation on health issues including a list of the standard disease tests you are planning to complete. Western wildlife agencies have agreed to a testing protocol proposed by the Western Association of Fish and Wildlife Agencies, Western Wildlife Health Cooperative (WWHC), which should relax prior requirements.

OTHER IMPORTANT CONTACTS/CONSIDERATIONS

Port Veterinarian – Contact the USDA veterinarian at the Port of Entry to be used and ask them about any requirements. They usually are on duty during normal working hours, so make special arrangements for entries during non-business hours. Also notify the CFIA port veterinarian.

US Customs, Port Authority – Before the capture contact the Port Directors office and ask for specific information needed. When leaving the capture site call the Port and tell them the estimated arrival time. There will be an entry fee. Set up the billing for this cost before the capture. No pictures are allowed of an U.S. Port of Entry. Tell your media people to not take pictures of sheep crossing the border.

Contact the wildlife agency for every state or province through which sheep will be transported. They may require a through-state transportation permit.

No vaccine or other "biologicals" or prescription drugs can be brought into Canada. A Canadian veterinarian will have to buy the needed medications and have them for you at the capture site. Leave any leftovers in Canada. Check with the U.S. Port Veterinarian to see if medications needed for the return trip can be left at the Port.

If importing bighorn from another state, skip all references to federal requirements in this section. It will still be necessary to coordinate with the receiving states department of agriculture.

ANIMAL HEALTH AND STANDARD TESTING

VITAL SIGNS FOR WILD SHEEP

When handling wild sheep, vital signs (Table 1) should be monitored so that proper treatment can be given at an early stage when an animal becomes stressed. Exercise and handling will elevate all these values and higher ambient temperatures will aggravate them further.

Take pulse and respiration for 6 seconds and multiply by 10. This will not give an exact pulse but it will be close enough to determine critical problems. Pulse and respiration have wide fluctuations during the restraint period but are generally less than the stressed levels. Checking gum color and capillary refill is a very good way to monitor blood pressure and shock. Any handling will cause pulse and respiration to be above normal. Therefore temperature and gum color are the best measure of shockiness. A veterinarian should monitor gum color and make decisions on treatments for shock. Restrained sheep will usually have temperatures in the stressed range. The most important consideration is to have at least two temperatures that are descending and below the extreme range.

MEDICATIONS, VACCINES AND TREATMENTS

There are no field medication or treatment protocols that can effectively treat many of the complications seen with field captures. The best protocol is to use the most effective capture method; one that causes the least stress, takes the shortest time, and results in the least physiological changes in the animal. Reliance on drugs or treatments instead of the most appropriate capture method can result in increased handling times, stressed sheep and a higher incidence of complications.

The use of specific treatment or prophylactic medications on wild sheep should only be performed after consultation with a veterinarian experienced with wildlife and specifically with wild sheep. Selection of medications and protocols can be controversial and opinions vary on their effectiveness. Pre-project planning with experienced personnel is strongly advised to discuss the most appropriate protocols suitable for the specific situations associated with the project. Treatment protocols have three objectives; to protect wild sheep from the stress of capture, to aid individual sheep when released into a new environment and to treat emergency situations as they arise. The project veterinarian will select which routine or emergency treatments are advisable and may prefer specific products used and dosages.

Automated syringes (syringe guns) - A syringe gun with a 16 or 18 gauge 1-inch needle can substantially increase handling efficiency, especially if the drug used is thick in consistency. Needles should be changed between each individual. Keep in mind that many of the suggested medications freeze easily or do not flow well in cold temperatures. Syringe guns should be kept warm between uses.

ROUTINE TREATMENTS

1. WATER

Wild sheep commonly have elevated body temperatures following capture that involves chasing and during processing periods. Hyperthermia (body temperature > 107 F/41 C) is the most common complication noted during capture events and, if uncorrected, will have serious physiological, even fatal consequences. Cold water rubbed into the haircoat may help reduce body temperature. Water most effective if rubbed into the neck, belly, under the legs, and to the mammary area.

HOT CLIMATE CONSIDERATIONS:
Mix ½ gallon of isopropyl alcohol per 5 gallons of water to increase the evaporative cooling effect. Horns are believed to dissipate heat. Applying 100% isopropyl alcohol with a spray bottle to the horns may help overall reduce body temperature.

In hot climates it may be prudent to direct capture crews to apply water and take a baseline temperature before transport of sheep to base camp/processing site. If transport is directly after capture, this is not necessary. However, if sheep are restrained for 10 or more minutes before transport, a temperature should be taken, recorded and water applied. The crew should write the temperature on the horn with a permanent marker and then notify the pilot of sheep with critical temperatures so they are the first treated at base camp.

2. ANTHELMINTIC.

An injectable broad-spectrum anthelmintic (dewormer) can be chosen that is injectable, has an extended length of action, is highly effective against ecto and endo parasites and is larvicidal. Although sheep populations can carry a large variety and high number of parasite species, the translocation of animals with reduced parasite loads may prevent the transmission of organisms to the new habitat and can give individual translocated animals an advantage. There is no evidence that any anthelmintic can remove all parasites with a single dose, however some have been documented to reduce overall numbers to some degree and reduce larval lungworm shedding. Prior screening of source and recipient herds for parasites can ensure specific knowledge of the parasites that can be potentially transferred with the translocation. These drugs do not generally thicken in cold weather.

3. SELINIUM/VITAMIN E

Combination injectable preparations are frequently given as a treatment and prophylaxis for capture myopathy and to supplement low selenium levels found in many wild sheep ranges. Although there is no evidence that treatment at the time of capture is beneficial or protective, it is unlikely to cause harm and may be of long term benefit to animals with low or marginal selenium levels. These drugs do not generally thicken in cold weather.

4. ANTIBIOTICS

Long acting injectable preparations of penicillin or oxytetracycline are frequently given as treatment for capture related injuries and in order to prevent the development of pneumonia in stressed animals during and following transport. Although there is no guarantee that effective antibiotic levels are reached and that the antibiotics used will be effective against the organisms present, many wildlife workers feel that there is little harm done with the use of antibiotics. Single antibiotic doses are unlikely to result in the development of antibiotic resistant bacteria; however this is of increasing environmental concern. Since wild sheep are so highly sensitive to stress and pneumonia this may be considered a valid treatment.

5. CLOSTRIDIUM BACTERIN (7 or 8 WAY)

Clostridial infections of muscle tissue have been diagnosed in translocated sheep. Clostridial bacterins are given to domestic ruminants to prevent diseases such as tetanus, blackleg and gastrointestinal overgrowths. However, vaccinations are generally poorly effective in animals under stress and require booster injections for full protection. Many projects do not routinely use bacterins for these reasons.

EMERGENCY TREATMENTS

Animals may require treatment for shock, hyperthermia, acute or subacute muscle damage or myopathy, trauma or other conditions recognized following capture or combinations of these conditions. Common symptoms may include high (hyperthermia) or low (hypothermia) temperatures, increased or decreased heart rate, increased or decreased respiratory rate with varying quality of respiratory depth, increased capillary refill time and pale or blue mucous membranes. Other symptoms are dependent on the body system involved.

The earlier treatment can be initiated the more likely abnormal symptoms can be reversed, however field treatment is often not successful. Emergency treatments should attempt to stabilize animals and should only be given under the direction and supervision of a licensed veterinarian.

1. OXYGEN

Many physiological responses that occur during capture result in complications that will benefit from supplemental oxygen. Oxygen administered via a nasal cannula at a rate of 5 + liters per minute can be very beneficial and is especially advised in critical care and emergency situations.

The delivery systems can be a mask held over the nose and mouth, however use of a nasal cannula does not block the mouth or face for other activities.

2. INTRAVENOUS FLUIDS

LACTATED RINGERS SOLUTION: Ringers is used to reduce acidosis and reverse the dehydration brought about by shock, hyperthermia, and other capture stress factors. An IV administration kit will be required for each bag you use.

GLUCOSE (5%) OR DEXTROSE (20%): Given to combat hypoglycemic shock. This condition is usually observed after the sheep have been held in a transport vehicle for several hours. An individual may not be able to exit the transport vehicle and usually has a low body temperature. An IV administration kit will be required for each bag you use. A can of non-diet soda administered orally will work if IV fluids are not available.

3. INJECTABLE SOLUTIONS

SODIUM BICARBONATE: Given to counter severe metabolic acidosis brought on by excessive muscular activity, excitement, chase, and resistance to handling. Usually given in Ringers Solution.

DEXAMETHASONE SP (4mg/ml): Used to treat individuals suffering from acute shock or more severe capture stress. Assists in controlling respiration and heart rate, blood sugar levels and improves general well being. Dex is a steroid and can cause abortion if given in the last trimester of pregnancy.

NON STEROIDAL ANTI-INFLAMMATORY: **(Banamine)**: Used on animals with elevated temperatures not responding to routine cooling treatments. Also used on animals with musculoskeletal injuries or other trauma as an anti-inflammatory and analgesic agent.

4. COLD WATER ENEMA

Used to combat extreme temperatures. An enema bag and application tube designed for humans works very well on wild sheep. The enema tube must be carefully inserted into the anus to keep from tearing the colon.

5. ADDITIONAL EMERGENCY EQUIPMENT

Suture Kit, Ambu bag

HEALTH TESTING REQUIREMENTS

There are two purposes for health testing. First is monitoring health of the source herd and to provide initial information for new releases. A history of exposure to various diseases is invaluable in investigating disease concerns in the future, especially when confronted with an all age die-off. The second reason is political. Certain tests are required for importation or transport of wild sheep. Additionally, potential for disease transmission to livestock or existing wildlife populations is a common concern. Health testing can provide data needed to address that concern.

The WWHC has developed a health testing protocol for wild sheep (Table 2). Table 3 presents additional tests that managers can consider.

The councils recommend the WWHC protocol be completed for any wild sheep capture. Considering the impact of disease to wild sheep herds it is irresponsible for a wildlife agency to plan a capture operation and not complete recommended testing for all adult individuals captured. The only reason to not test all adult sheep captured is if the source herd has a recent history of sampling and therefore pre-existing health information is available. In this case, at least 50% of the captured adults should be tested. For monitoring herd health it is not necessary to sample lambs, however U.S. and some state import permits will require sampling of all sheep captured.

If you are importing sheep from another state/province check with the state veterinarian for the receiving state to see if any additional tests will be required as part of the state import permit. Requirements for additional tests may be based on old information and/or personal biases. Wildlife veterinarians with the WWHC can be very helpful with these discussions, and assist in providing up to date information on wild sheep diseases.

During project planning all desired/required tests need to be identified so the correct type and amount of specimens can be collected at time of capture. Certain tests can be completed at almost any animal health diagnostic lab while others require special labs. Handling procedures vary depending on lab and tests selected. Work with a veterinarian before capture to determine which labs to use and how specimens are to be handled.

BLOOD TAKING/TESTING

It is the responsibility of the capture boss to determine all samples to be collected, amount of blood to be drawn, and proper handling and distribution of samples. Coordination with a veterinarian will make this duty easier. A sample kit for each animal should be prepared before the capture operation begins. Each kit and every blood tube in the kit should be labeled with a sample number which references the year of capture and the animal number (Fig. 1). In 1995

Oregon captured 90 bighorn from 3 different herd ranges, 95-001 was the number of the first sheep caught at the first site and number 95-090 was the number of the last sheep caught at the last site. This sample number is very important since it ties all samples back to the individual animal and its capture records. Sample numbers do not necessarily correspond to ear tag number, so be careful not to confuse the two. An acronym identifying the agency collecting samples should be put on all labels to insure labs handling samples from different states or provinces do not confuse samples.

Size of syringes and needles and number and type of vaccutainers needed will depend on which tests are to be conducted and the amount of serum required for those tests. A syringe should be large enough to draw adequate volume for all test needs with one venipuncture. As a rule, use a 16 ga. x 1.5 in. needle with two 35ml syringes or one 60cc syringe. Use of vaccutainer needles is not recommended because of the volume required. A 60ml draw will usually provide enough whole blood and serum for all tests. Know how much blood is needed and leave the rest in the sheep.

Serum separator tubes (also called tiger tops, red/gray tops or red/black tops) are recommended to simplify serum collection. Usually red top, tiger top and royal blue top vaccutainers are used for serum collection. Purple top and green top vaccutainers are used for whole blood collection. Once blood is drawn and transferred from the syringe to vaccutainers, the tubes should be kept at room temperature (cab of pickup or ice chest with warm water bottles) and allowed to sit a minimum of 2 hours so a blood clot forms. Place vaccutainers in a centrifuge and spin for at least 10 minutes at 2500-3000 rpm to separate serum from the clot. Balance tubes in the centrifuge or breakage will occur. If tubes are not approved for centrifuging, remove the rubber stopper before spinning so they do not break. For convenience spin tubes each evening of the capture at the motel, lab or other facility.

After centrifuging pour off or aspirate serum into serum tubes, which are labeled with the same sample number. Usually the serum from each individual vaccutainer is transferred to a corresponding serum tube however, depending on tests, serum from one vaccutainer can be split into to more than one serum tube. Take care not to pour any solids into the serum tube since this will cause problems with testing. Band the serum tubes for each animal together, place them in a cooler and/or freeze depending on the situation at the capture site. Usually serum samples can be frozen and whole blood samples cannot be frozen. Talk to the labs you are using before capture and make sure you know how each sample should be handled.

PASTEURELLA SAMPLING

In 2000 *Pasteurella haemolytica* was renamed to *Mannheimia haemolytica*. Various serotypes of this bacteria have been implicated as the cause of pneumonia outbreaks in some wild sheep herds, resulting in all age die-offs. The purpose for this test is to support on-going research and to acquire baseline information on the types of *Pasteurella or Mannheimia* bacteria present in a herd, so that in case of a pneumonia outbreak, there is reference information. *Mannheimia hemolytica* and *P. multocida* are the organisms of primary interest. Nasal swabbing is not accurate for bacterial culture, therefore pharyngeal swabbing is necessary.

Originally bacterial samples were taken at the tonsilar crypts using a laryngyscope, speculum and an Accu-culshur swab. Since then research indicates that a general pharyngeal wipe is as effective. A pharyngeal wipe is faster and causes less stress. In 2001 Accu-culshur swabs went out of production. Port-a-cul swabs are now preferred for bacterial recovery. All samples must be marked with the appropriate sample number. There is variation on how different labs want samples handled, and how different swab types should be handled. Check with the lab before the capture operation.

FECAL SAMPLING

Fecal samples are taken to check for gastrointestinal parasites and lungworm larva (*Protostrongylus stilesii* and *P. rushii*) as an indicator of overall lungworm loads and herd health. Usually 10-12 pellets provide an adequate sample. Pellets are extracted with the fingers of a rubber-gloved hand, lubricated with K-Y jelly prior to being inserted into the anus, and packaged in the glove by rolling it off the hand inside out. Write the sample number on the glove or place the glove and pellets in a pre-labeled whirl-pak.

ECTO-PARASITES

Scabies, a skin disease caused by mites (*Psoroptes* spp.) is the most debilitating disease caused by ecto-parasites in wild sheep. Scabies is known to be endemic in many sheep populations in the United States, but is unknown to occur in other locations and Canada. Sheep that have not been previously exposed to the mite or are under stressful conditions appear to be extremely susceptible and can be severely and even fatally affected.

There are several tick species that may be found on wild sheep, depending on the geographical location of the sheep herd. In most cases ticks cause few clinical symptoms, but in some regions they may serve as vectors of infectious organisms. Tick infestations have been associated with mild to severe hair loss in wild sheep during fall and winter months but are usually insignificant.

Each sheep captured should have an examination of the ears and hair coat for mite and tick infestations, focusing specifically inside the ears for mites and in the axillae, groin and under the tail for ticks. Yellowish waxy debris, crusts or flakes inside the ear may be an indication of mites. Animals affected may shake their heads vigorously and there may be localized or generalized hair loss with evidence of self-inflicted trauma. *Psoroptes* mites are microscopic but can be collected by wiping inside the ear with a cotton or Dacron swab and placing the swab in a red top Vaccutainer tube for later evaluation. Mite infestations of the skin are usually obvious but may require diagnostic skin scrapings. Larger ecto-parasites such as ticks can be collected with fingers or forceps and placed in a red top tube or a Whirl-Pak bag for short term transport to a diagnostic laboratory for species identification.

CAPTURE AND HANDLING PROCEDURES

METHODS OF CAPTURE

This section compares the different methods used for capturing wild sheep and considerations for selecting a capture method. Wild sheep captures are inherently expensive. With radio transmitters, capture contracts, sampling and analysis of samples, and transportation of relocated animals, can exceed $1000 per animal relocated. For transplants, initial budget estimates, without personnel costs should assume costs of $1100/animal. It is very important that minimum health testing be completed on all adults captured. If available dollars are tight, cut the budget somewhere other than health testing, or seek additional funding. Mature rams are not recommended for transplant. Rams older than 3 years (larger than ½ curl) usually do not stay with the relocated group and are aggressive in the transport vehicle. Older rams usually stray off, never to be heard from again or show up in areas of non-habitat or close to domestic sheep. There is no physiological or capture stress related reason not to move big rams, but since they are aggressive during transport and usually won't stay with your new herd it is not a good use of available funds or sheep.

Helicopter netgunning, drop nets, linear drive nets, corral traps and chemical immobilization are the common methods used for capturing wild sheep. Each technique has advantages and disadvantages. The objective of any capture should be to capture the desired number of sheep as quickly and efficiently as possible without causing excessive stress to the animals or compromising safety for the capture crew. Detailed planning and selection of the correct technique is important.

Helicopters are used to pursue sheep while net-gunning, drive netting or darting. Because the animals are chased, elevated body temperatures are common. There is a strong correlation between ambient temperature and how long individuals can be chased before body temperatures reach extreme levels. In general chase times should not exceed 3 minutes, however if ambient temperatures exceed 60^{o}F (in the winter) chase times may need to be shortened to about 1 minute. It is important to discuss chase times and stress with the pilot prior to the capture. Monitor body temperatures as the capture proceeds and modify chase times as necessary.

Helicopter net-gunning is the most commonly used capture technique for large numbers of animals. Sheep are captured by shooting a net from a helicopter over individual animals. Captured animals are flown to a base camp in transport bags for processing and transport, or worked at the capture site and released. Depending on the experience of the capture crew, this technique is fast, safe and efficient, and specific age and sex ratios can be selected. The netgun crew is able to go to the sheep rather than try to get the sheep to come to a predetermined spot, and access from the ground is not required. With this technique, an experienced crew working with normal herd densities should be able to deliver 4 sheep/hour. If conditions are good more then 4 sheep/hour is common. One disadvantage to this technique is that it requires a helicopter and there are wild sheep ranges with powerlines, residences or highways that preclude pursuing sheep from the air.

Drop nets are the second most commonly used capture technique. They work very well in areas where helicopter pursuit is restricted, or vehicle access to the capture site is available. Drop nets require adequate ground access for baiting activities and trap/transport vehicles on the day of capture. Drop nets require a large group of sheep that are easy to bait. This technique usually will not work on ranges with conditions that are not severe enough to force the sheep to use bait or with limited access to the trap site. Effective baits used for drop net captures include good quality alfalfa hay, apple pulp and salt. Drop net captures require approximately 1.5 people per sheep expected to be caught in any single drop. Because animals are coming to bait it is hard to select for a specific age/sex ratio in the animals captured. However, surplus animals can be released immediately with little or no harm. It usually takes a minimum of 30 days to get animals hooked on bait and habituated to the net. One major benefit to this technique is animals are restrained the least amount of time.

Linear drive nets were commonly used in the early 1980's but are not used as much today. Drive nets come in 6 X 100 foot sections and six to 12 sections are usually required. Nets are generally placed in a U shape in a shallow draw, and sheep are driven downhill into the nets with a helicopter. A net crew of 12-20 people is required to drive sheep the final distance once they are inside the arms of the U, and restrain sheep once they are tangled in the nets. Once the sheep are captured they are placed in transport bags and flown to a base camp for processing. The advantage of this technique is ground access is not required and nets are mobile, therefore herding time can be shortened substantially compared to a fixed drive trap. Disadvantages are, the technique is less efficient than using a netgun; is requires more helicopter hours for the same number of sheep; it requires a large capture crew; it requires an equally large base camp crew.

Corral trapping is a relatively inexpensive method of capture and requires only a small capture crew. Trap panels need to be 8 feet tall and set up in an angular fashion (Coggins, 1999), or circular with a diameter less than 15 feet so animals cannot get a running start to jump out. Trapped animals can be physically restrained in squeeze or handling chutes for processing, then released or moved directly into the transport vehicle. Corral traps work well in locations with ground access and severe enough conditions so that sheep use the bait (e.g. winter conditions with persistent snow cover or severe summer conditions at water sources). They also work well with herds that are habituated to structures or in locations where the trap can be constructed and left long enough for sheep to habituate.

Clover traps (Taber and Cowan, 1971) normally used for deer have been used to catch sheep or Simmons box traps (Simmons and Robertson, 1970) have been designed for capture of dall sheep or rocky mountain goats. They are most efficient when it is only feasible to catch a few animals at a time or when the limitations of budget or crew size prevent the use of alternative methods. Traps should be checked twice daily.

Chemical immobilization is the least used capture technique for large numbers of sheep. Herd ranges where helicopter darting could be used might also be netgunned. Netgunning has similar result without the time or problems associated with darts, immobilizing drugs, induction and recovery periods. Ground darting in order to capture a single individual or a small number of animals for health testing or radio collaring can be very economical and effective. Ground darting requires conditions where sheep can be approached close enough for an accurate shot, and terrain where immobilized individuals will not injure themselves during the induction period. Chemical immobilization should not be attempted without specialized training and access to suitable pharmaceuticals.

SAFETY

The goal of any capture operation is to catch, handle and release healthy wild sheep. To accomplish these goals safety of the sheep, as well as the capture crew, is critical. Detailed planning is imperative and it is critical to have one person in charge of the project. The "capture boss" needs to visualize each step of the process recording everything needed for the operation from the time the crew first arrives until the last sheep is released.

It is the responsibility of the capture boss to develop a capture plan to ensure sheep are handled as efficiently as possible. Efficient handling reduces the time any one sheep is handled, and thereby reduces stress. Delays in the capture process can usually be attributed to equipment not being at hand when needed, crew members not doing the job assigned, or crew members trying to help where they are not needed. All of these result in longer handling times and more stress to the animals. All talking while handling the sheep needs to be minimized and there is no reason for anyone to raise his or her voice.

Capture crew safety must be a priority. Even the simplest captures where animals are caught, sampled and marked then released at the capture site have safety risks because you are handling a wild animal in steep rocky terrain. Think about potential safety concerns and plan accordingly. Helicopter capture operations pose inherent risks with people working in and around the aircraft. The capture boss needs to identify those individuals with reason to be near the helicopter, educate them on proper conduct, and demand that everyone else stay away.

Most capture operations require the use of many chemicals and needles. Crew members using these needles should be well trained and inform others around the sheep when they are handling drugs or needles. This may be done by simply having the individual with control of the needle say the word "Needle" when approaching someone else on the crew. The other crew member should not move until they can see the individual with the needle or are told the needle is clear. Needle punctures are painful at the very least, and depending on the drug in the syringe, can be life threatening.

The capture boss needs to make sure everyone assigned a duty can complete that duty. This will require a lot of honesty. Capture operations require some crew members to lift and carry animals. Don't assign someone with a bad back to one of the lifting duties. Queasy stomachs at the sight of blood or needles will preclude an individual from directly handling sheep. There are many jobs associated with any capture; ask and make sure everyone can do the assigned job.

In order to complete a safe capture, everyone involved must thoroughly understand how the operation will be laid out, completed, and what is acceptable or unacceptable conduct. The crew needs to meet the afternoon or evening before the capture and assign duties, answer questions and outline how the operation will be completed. Each morning during the operation there should be a 5-minute safety/orientation session to review duties, operation layout, and address concerns. After the days capture operation is completed get some or all crew members together to critique what happened that day and look for ways to improve the operation.

It is easy to get caught up in the urgency of handling animals. With the exception of severe human injury, there is no reason to run or yell while working animals. It is imperative that everyone relax, do the job they are assigned and enjoy the operation.

COMMENTS COMMON TO ALL CAPTURE METHODS

Radio Collars

Because a capture for relocation should target only young rams it is possible to fit radio collars too tight as the rams mature and necks swell during rut. Wild sheep are true horned animals and therefore collar slippage is rarely a problem. However, loose collars may cause abrasion or irritation as animals lower their heads and the radio hits their jaw, especially during combat. Mandibular damage has been caused by collars which are too loose. Biologists working with Rocky Mountain Bighorns in Hells Canyon recommend collar lengths of 22 inches for ewes and 30 inches for rams. Another technique is to fit ewe collars snug with 2 fingers underneath the collar perpendicular to the neck. Fit yearling or two year old ram collars snug with a palm width underneath the collar perpendicular to the neck. Expandable collars can be designed from Kevlar material or with spacers or thread designed to break after a period of time.

Make sure all magnets are removed from all radio collars the night before the capture starts. Leave magnets off until the capture is done. If radio collars will be carried with magnets off inside the helicopter they may cause interference with communications. If you leave the magnets on until the collar is hung on a sheep, put a MAGNET OFF box on your data form as a reminder. The piece of tape that will never rot or break is the one holding a magnet on a radio collar which is on a sheep running away from you.

Color coding collars can be useful for visually identifying individuals. Collar straps can be colored with permanent markers however, the colors will fade in time. Attaching large colored and/or numbered plastic ear tags or attaching other plastic material to the collar gives a good long lasting mark. Collars need to be marked before the capture starts. Once an animal is restrained there is no time for marking collars. It is not always necessary to radio collar all individuals in a transplant. Three to 4 collars per 15 head may be adequate to monitor success of a transplant. The number of individuals collared depends on the research or management question you want answered.

Ear Tags

Many makes and models of ear tags are available. Small plastic or metal ear tags can be put in the ears. Before the capture, make sure you have the proper pliers and replacement needles for the brand of tag purchased. If one purpose for the tag is to visually identify a live individual, placement of the tag becomes important. Tags placed in the ear(s) facing forward are easier to see from the ground. If placed in the ear facing back they are easier to see from the air.

Individuals fitted with radio collars can be identified by putting large plastic tags in the collar and the ears can be left intact. If most observations will be from the air put the tag in the top of the collar. Put a tag on each side of the collar if observations will be from the ground. Even the largest commercial tags are inadequate for identification of individual animals necessary in some research projects. If individual ID is necessary colored plastic strips approximately 15 cm long can be affixed to collars with pop rivets. Any marks need to be on the collars prior to capture starting. There won't be time to attach tags or color mark collars while sheep are being worked.

Communications
The importance of having excellent communication during the capture can not be over stressed. Communications can be as simple as having someone wave a flag when the drop net falls so team members know when to move into position. Or as complicated as setting up satellite phone links so the capture team on the mountain can communicate with base camp or off site personnel. Before the capture set up and test the communication system you think you need. Make sure extra batteries fit the equipment you are using, are available, and are carried as needed. If you use programmable radios have several copies of the frequency list available, and identify those members of the team that know how to program the radio.

Data Records
Record forms should be set up before the capture and have a space to record all the information you will want, after you no longer have physical contact with the animal. At the least records for each animal should include: date captured, species, sex, age, a list of all samples taken, a list of all treatments given, all marks and how or where they were attached, comments as necessary.

Genetic Banking
The councils encourage individuals hankling wild sheep to collect horn or hair samples and bank them for future genetic analysis needs. Idaho has been banking samples for several years and have used them for enforcement needs, to identify specific herd range of and individual, and for identification of paternity or maternity. Horn or hair samples can be stored indefinitely dry at room temperature. At this time horn material is more dependable then hair samples. A small amount of horn material such as the spirals left over after pinning or a piece of horn tip removed with side cutters while the animal is restrained provides abundant genetic material. These samples should be collected for development of a genetic material bank, and would not take the place of live tissue (blood, meat, ear punches) collected to answer a specific research question.

Capture Timing
When to schedule capture operations depends on availability and migration patterns of the source herd, capture technique used, weather conditions and access to the source herd and release site, and personnel availability. Captures of transplants for mature ewes should be scheduled to avoid the last 6 weeks of pregnancy.

Stretchers
Several agencies use stretchers to carry sheep from the drop net or helicopter drop off point through processing and to the transport vehicles. Stretchers may save lower back strains for personnel carrying the sheep.

Weighing

Recording weights of individual sheep may provide useful data, especially if release plans require the use of a helicopter or boat. Without proper planning the process to weigh each animal can significantly increase handling times and compromise animal health. If you must weigh each sheep, use a hanging scale suspended from a large tripod or A-frame and stationed so animals being moved in transport bags or on stretchers can be weighed quickly then moved to a tarp.

Hobbles
Good hobbles are a single strap of well oiled leather or plastic coated nylon with a strong D-ring buckle. Whichever material is selected they should remain pliable when wet and frozen. Hobbles must be easy to put on and take off.

The hind and fore leg on each side of an animal should be hobbled together, rather then hobbling both fore legs and both hind legs. This makes it easier to keep the animal sternal during handling. Keep 12 pairs of hobbles in the capture supplies in case your contractor shows up with sub-standard equipment or an individual comes with hobbles missing.

Blindfolds
Blindfolds must be designed to cover the eyes but leave the mouth and nose open for respiration. Attachment of the blindfold needs to be a simple snap buckle or velcro. It is imperative that blindfolds are easy to put on, will stay on during flight or handling, and easy to remove. Blindfolds can be made from any non-abrasive material. Materials that remain pliable when wet or frozen are preferred. As with hobbles, have 12 blindfolds in your capture equipment.

Tarps
For capture methods that require setting up a specific processing area or base camp, it is good to have canvas tarps to lay the sheep on during processing. Use of tarps keeps the crew from having to work in mud, and clean up between sheep is easier. Tarps act as a focal point in base camp, which results in more efficient processing. Tarps should be staked on the corners. Stakes should be flush to the ground so no one trips. Canvas tarps are preferred over plastic as they are less slippery when wet and more resistant to rotor-wash. New Mexico has taken the tarp concept one step further by placing their sheep on sturdy tables for processing. This keeps capture personnel from having to stoop over sheep during processing.

HOT CLIMATE CONSIDERATION: For captures being completed on hot days in direct sunlight, put a sun shade over your tarps to provide shade for sheep and crew. This will aid in treating elevated body temperatures.

Euthanasia
Any capture operation runs the risk of injuring animals. At times these injuries are severe and euthanasia is the only humane option. The American Veterinary Medical Association (2001) has published euthanasia guidelines. For wild animals the use of a .22 caliber gunshot delivered to the head or neck is approved as a humane euthanasia method. Other approved techniques include use of potassium chloride in association with an anesthetic agent, use of barbituates (Beuthanasia), use of carbon monoxide, and exanguination. The use of potassium chloride without an anesthetic is considered inhumane. Meat from animals euthanized with methods

other than gunshot or exsanguination will not be fit for consumption, and current veterinary recommendation is that carcasses of animals euthanized with barbiturates be burned. Be prepared to complete the process quickly and professionally. If chemical euthanasia is selected know the dosage rates before the capture starts.

Thermometers
Digital thermometers are preferred over glass thermometers, because they are easier to read and less likely to break. Most commercially available digital thermometers are designed for human use and read temperatures up to 108^{o}F. If possible try to find thermometers that read up to 110^{o}F. For animals requiring emergency treatment a continuous read thermometer is very useful. Continuous read thermometers must be calibrated before each capture.

Physical Examination
Each animal captured should have a full physical examination to evaluate their physiological responses, body condition, general health and suitability for translocation as well as for any capture related trauma or complications. Animals demonstrating variations from a previously established standard of health should be evaluated immediately by the project veterinarian.
Body temperature, respiration and heart rates should be recorded on arrival at the site and animals triaged according to these levels. These should be repeated at least once during handling and the appropriate treatments initiated if necessary. Sampling procedures should be performed and medications/treatments administered according to the project protocol. Once the individual protocol is completed and checked, hobbles and blindfold can be removed and the sheep can be released into the field or transport vehicle. It is vital to perform these actions as quickly, quietly and as efficiently as possible in order to reduce handling time and stress.

CAPTURE METHODS

Within this section there is little information describing specific activities required to actually catch a wild sheep. We have attempted to describe considerations needed to restrain, process, transport and release wild sheep. Every capture situation will require modifications therefore the only absolute is that sheep need to be handled as quickly and efficiently as possible for the health of the animal and safety of the crew. How one should actually catch the animal depends on more variables then can be described in this document. Appendix 2 presents a list of individuals experienced with the various facets of wild sheep capture and are willing to give advice.

NET GUN
Nt gun capture is specialized and an experienced capture team that keeps the health of the animals as a priority will be invaluable to your operation. Several private companies are available to provide net gunning services, and most agencies now contract the actual capture to ensure the most experienced are completing this most critical step. This does not mean that an agency should not decide to put together their own capture team, but keep in mind that with experience comes efficiency and most agency personnel don't net gun enough animals in a year to get truly efficient. Find a capture crew with a good reputation and the equipment necessary to provide you a quality job. Write the capture contract with enough detail to ensure both parties know what is expected. The contractor should have enough handlers (3-4) so animals are worked and transported to base camp quickly. Contract capture crews should provide needed equipment to net gun, hobble, blindfold and transport sheep to base camp. Some have the

expertise to collect samples as well. They should have a minimum of 20 nets so they don't run out while used nets are being repacked.

The councils recommend that sheep be transported sternum down to keep the weight of the rumen off the lungs and ensure animals don't regurgitate, then aspirate rumen content. With a helicopter, the best way to transport sheep is hobbled and blindfolded in specialized transport bags slung on a cable under the ship. Sheep can be blindfolded, hobbled and carried inside the helicopter but enough people need to be with the sheep to keep them sternal and guard against a slipped hobble or blindfold causing an accident. Sheep have been slung under the helicopter from their hobbles, sternum-up. For minimal distances this does not seem to have negative physiological effects. Slinging animals by their hobbles has been questioned socially and professionally.

Base Camp Procedure and Set up

Capture of wild sheep fro transport to another location usually requires some type of base camp or processing are, because many sheep are handled in a short period of time. Following is a description of procedures and personnel needs for efficiently operating a base camp.

The Personnel Assignment section and Table 4 identify individuals need for a net gun capture base camp. Figure 2 shows a generic base camp set up. For ease of operation and to keep people from tripping over each other, arrangement of the base camp is important. Tarps need to be close to the vet-supply truck and arranged so that sheep can be brought to and removed from the tarps without restraint teams tripping over each other. Sheep should be placed on the tarps in the same sequence every time. Restraint teams always go to the same tarp. This keeps ear tags, sample collection, and records in the proper sequence. Failure to do this can confuse the recorder and compromise record keeping. Transport vehicles should be located close enough to tarps so sheep can be loaded easily, but not in the pathway of sheep being moved from the helicopter to the tarps. Transport vehicles should be situated away from the generator, social area, or helicopter refueling site to minimize disturbance. Determine the location of the helicopter landing zone and how helicopter should approach. This should be far enough away from the work area that rotor wash does not effect the operation but close enough to minimize the distance sheep must be carried. It is important that the helicopter lands with the same attitude each time, so tail rotor location stays the same. The helicopter coordinator must be alert to changes in wind direction.

Base Camp Etiquette

Talk in whispers or low voice. Do not disturb sheep in transport vehicles and do not congregate around them. Relax, do assigned duties, and pay attention for problems. Suggestions for modifications or changes should be taken to the capture boss. Ask if someone needs help before assisting. If a problem occurs with one of the sheep, go directly to the lead veterinarian. For any other type of problem, go to the capture boss.

Base Camp Function

Prior to the capture the following items are completed. The capture boss determined what samples will be taken and how they should be handled. Capture and release sites were identified and the target number of sheep is known. All sample kits and capture supplies are on hand, properly labeled and ready. The night before the capture the crew got together and had a safety/orientation meeting. At the start of the capture, after base camp is set up and the helicopter has left, conduct a 5-minute safety/orientation session, emphasizing helicopter approach and exit.

Assuming adequate sheep densities, good weather and ferry distances of less then 5 miles, a qualified net gun crew should be able to deliver a minimum of 4 sheep per hour to base camp. When the helicopter returns it usually has 1-4 sheep in bags hanging from the transport hook. The helicopter coordinator goes to the landing zone, and takes them off the hook as the helicopter sets the sheep down. Restraint teams approach as the sheep are being unhooked. Restraint team A carries their sheep to tarp A and starts removing the bag and net, pouring water, and taking temperatures. Restraint teams B through D move a sheep to their respective tarps and do the same. Blood takers, swabbers, medicators and the veterinarian work through the sheep getting samples or giving medications. Ear tagger/radio collar puts in tags but only attaches radio collars after the blood is drawn. Recorder checks to make sure all needed data are written down, all samples collected, and all treatments given. If processing is completed and a sheep does not require additional treatment, the recorder gives approval for the sheep to be loaded. Once approved the restraint team puts their sheep in the transport vehicle. If all the sheep are in good shape this whole process takes about 5 minutes per sheep. During processing the helicopter coordinator services the helicopter with new nets, bags and water (optional). As people complete their assigned duty they go and re-pack nets, or get ready for the next load of sheep. If you are working 4 -5 sheep at a time this process requires 18 to 20 people.

New Mexico has modified the process described above by having all marking, sampling and health monitoring done by a single team per sheep. As described above the sheep are moved from the helicopter to a tarp or table. At that tarp a team gives completes all processing for that sheep, and there is a complete team at each tarp. After processing the animal is moved to the transport vehicle. If you are working 4-5 sheep at a time this process requires about 50 people.

DROP NET

Because a drop net operation usually catches 20-30 sheep at a time, a modification of the net gun base camp system is needed to efficiently work sheep and minimize handling time. Assuming there is vehicle access to the drop site and sheep can be completely worked at the net, it is more efficient to have sample teams go to the sheep rather then moving each animal to a tarp for processing. The goal of healthy sheep is still the same, and depending on the samples you are collecting 20-30 sheep should be processed and loaded in 30-40 minutes. Each sheep is worked as soon as it is freed from the net, then moved to the transport vehicle and loaded. The Personnel Assignment section and Table 4 identify duties needed for a drop net capture.

Some drop net captures occur in areas without vehicle access (e.g. wilderness). In these cases sheep are cleared from the net, hobbled, blindfolded and slung in transport bags to a base camp for processing. A crew of approximately the same number of people as sheep expected to be caught in any single drop will be needed at the net. Select a drop net site which includes helicopter hook-up access.

Procedure and Set-up

Selection of the site for the drop net is dependent on having access for baiting and enough room to station capture and transport vehicles near the net for processing. Feed baits such as alfalfa hay or apple pulp require daily monitoring and re-supply. Salt baits do not have to be checked as often. Depending on conditions sheep may need to be baited for as much as 30 days prior to the capture. Set up the net on site and trip it several times before you want to catch anything to ensure that everything is working.

Figure 3 shows a generic layout for a drop net capture site after the net has fallen and all personnel are on station. The sample kit consists of a gallon zip-lock bag with all injections drawn up in individual syringes and marked whether the injection is given IM or SQ, ear tag, pharyngeal swab, nasal swab, syringe and needle for drawing blood, glove for taking fecal, and vaccutainers. Each zip lock bag and all contents are marked with a sample number, and the ear tag number and color is written on the outside of the zip lock bag. When building the kits keep a separate record of the eartag number and color put in each kit. Have 6-8 plastic buckets with the capture equipment, for carrying and collecting kits. Each sample team will need a tube of K-Y jelly and ear tag pliers. Each handler and net roller needs a pair of hobbles, blindfold and thermometer. It is common to catch unwanted individuals in drop net captures. The entire capture crew needs to know which type (sex/age) of sheep are not wanted so they can be released as soon as possible.

Drop Net Function

Prior to dropping the first net the capture boss must decide the exact location where vehicles will be staged, and where they will move to once the net falls. Drivers must be informed of the staging order and where they should drive. Prior to the drop all personnel except the trap supervisor and net rollers are stationed away from the net. When the correct number and sex/age composition of sheep are under the net the trap supervisor triggers the net release. The net falls and sheep are captured. Net rollers stationed close to the net move to the edges to stop escapes. Handlers move to the net and restrain sheep. Sample teams move the vet truck into place, get sample kits and go to sheep. Transport crews move trailers into place (all magnets are off all radios before the net falls). Capture boss and Lead veterinarian provide assistance as needed. Sheep are hobbled, blindfolded, removed from net, sampled and medicated, collared, moved to trailers and loaded. As sheep are loaded people are free to assist wherever needed. With an average of 25 sheep per capture and only standard animal health sampling, the whole process should take less then an hour from the time the net falls until the last sheep are loaded.

The vet truck contains all veterinary supplies. If an individual becomes stressed or shocky before loading, it is moved to the vet truck where the lead vet can start treatments to stabilize the animal. Spread a tarp at the back of the vet truck in case you need to work an animal.

LINEAR DRIVE NET

Linear drive nets are usually set up in an open U shape across a small drainage so that sheep being driven down hill cannot see the pocketof the net until they are within the wings (Fig. 4). It usually requires about 1200 feet of drive net for an effective trap. If you are catching a small number of sheep without using a helicopter less net is required. Drive net comes in 6'X100' sections. The Personnel Assignment section and Table 4 identify duties needed for a drive net capture. The net crew consists of 4 to 5 people at the end of each wing and approximately 10 people stationed on either side of the pocket. As the helicopter drives sheep toward the net everyone on the net crew lies flat under cover. When sheep pass the ends, individuals stationed there run across the mouth of the trap and drive sheep toward the pocket. When sheep hit the net all crew members restrain, blindfold and hobble an animal. Each crew member should have a thermometer, and water should be stationed near the net to treat high body temperatures while awaiting transport.

Wind direction is extremely important. If the wind is blowing from net crew toward approaching sheep, capture attempts often fail. When purchased net sections are usually white. They can be dyed earth tones if captures will primarily occur without snow. If snow conditions at the capture site are uncertain a mix of white and brown nets are required. If trapping on snow use brown nets for the wings and white nets for the pocket, so it doesn't appear that there is a barrier to escape. If trapping on bare ground use the brown nets for the pocket. Once sheep are restrained they are placed in transport bags and flown to base camp. From that point follow the base camp procedures described in the Net Gun section.

CORRAL TRAP

Corral traps work well if located on a site with road access and severe enough climatic conditions to get sheep to use bait consistently. Corral traps are permanent structures and it may take 2-3 years for sheep to habituate after construction. A squeeze chute or handling chute should be attached to the trap to increase handling efficiency. With a handling chute, 4 people can easily work 10-15 sheep. The most important consideration with corral trapping wild sheep is that the trap needs to be built in irregular angles (Coggins, 1999), or round with a diameter less then 15 feet, so animals do not have enough distance run and jump the trap. Round traps are easier to construct but all sheep captured are constantly harassed while working animals through the handling chute. Traps of irregular shape can be sectioned off and a smaller number of trapped animals can be processed while the remainder are kept separate and un-harassed. The door can be manually tripped if sheep are habituated to humans, or a set trigger and trip wire can be rigged so sheep trip the door. Sampling procedures are the same as other techniques but animals will be restrained in the chute and not hobbled. A sample kit should be built for each individual expected to be captured. Depending on how much sampling needs to be done, blindfolds can help keep animals calm while in the chute. When catching sheep for transplant, build the bottom of the handling chute to the same level as the bottom of the transport vehicle, so animals can easily exit the chute to enter the vehicle.

CHEMICAL IMMOBILIZATION

Chemical immobilization is an appropriate technique for capturing single or small numbers of wild sheep in specific circumstances that allow a close and undisturbed approach. It is not appropriate for the capture of large (>20) numbers of wild sheep from the ground or from a helicopter. The remote delivery of drugs in darts can be an effective tool to selectively capture, mark, collar and/or sample wild sheep in a number of field situations. Care must be taken to avoid accidental darting of nontarget animals. Wildlife professionals considering the chemical immobilization of wild sheep should recognize that this is a difficult species to immobilize in field settings and extra care must be taken to prevent and, if necessary, treat complications that occur as a result of immobilization. It is recommended that wildlife professionals interested in this technique refer to *Chemical Immobilization of Wildlife* (Kreeger et al., 2004), *Chemical Immobilization of Wildlife Course Manual* (CAZWV, Ed. M. R. Woodbury, 1996), other references (Jorgensen et al, 19..) and contact those who are experienced with the field immobilization of wild sheep.

Chemical immobilization should only be performed by personnel who have the appropriate training and experience; specific training and qualifications may be mandatory in certain jurisdictions. At all times the safety of the animal and humans involved in each procedure should be the first priority.

There is no satisfactory single drug or combination of drugs that can be recommended for the immobilization of wild sheep (Kreeger pers. com.). The most reliable combination is a narcotic, carfentanil citrate (Wildnil ®) and an alpha-2 agonist sedative, xylazine hydrochloride. This combination has the advantages of good analgesia, muscle relaxation and reversibility. The narcotic can be reversed with naltrexone for the carfentanil and the sedative can be reversed using yohimbine or tolazoline.

Carfentanil is an extremely concentrated narcotic with a high potential for human toxicity. This drug must only be used by specifically trained and licensed individuals with the appropriate back up support in case of accidental human administration. Narcotics also have the potential for negative effects on the animal such as extended induction/excitatory and recovery periods as well as respiratory depression. These may lead to elevated body temperature as a result of excessive muscle activity. Therefore it is important to monitor body temperature and to be prepared to reverse the drug effects and treat hyperthermia.

Other drug combinations have been used to immobilize wild sheep, including ketamine hydrochloride/xylazine hydrochloride, ketamine/medetomidine and tiletamine hydrochloride:zolazepam (Telazol ®)/xylazine). However, in field settings results with these combinations are not always predictable or dependable. Any animal that is excited or stressed is much more likely to be refractory to chemical immobilization, particularly when using alpha-2 agonists.

The most suitable remote delivery systems (dart rifles) and darts are those that are the most suitable for the field circumstances and cause as little trauma as possible. Generally, those that deliver small volumes of drug with a low pressure propellant are the most desirable. In most cases, 2 -3 ml darts with 1 inch to 1¼ inch needles and metal barbs will be adequate.

Large capture crews are not required when immobilizing sheep. Two individuals have immobilized and processed up to 20 sheep in one day under ideal conditions of sheep feeding at a baited site (Kreeger pers. com). Since chemical immobilization is not generally predictable, pre-capture planning is vital. Only very experienced, thoroughly briefed personnel should be present with the appropriate drugs and supplies for the immobilization and sample collection.

The supplies must include emergency and first aid drugs and equipment with protocols for their use on both humans and animals.

Drug withdrawal times for some of the drugs used in wildlife chemical immobilization are available for domestic species, but these may not be recognized for wild sheep in the local jurisdiction. Investigation of this issue should be made prior to the project and notification of the hunting public is strongly advised if applicable to the sheep population. Animals captured with drugs are not immediately suitable for human consumption and under some legislation may never be legally acceptable for consumption. Wild sheep captured with drugs should be clearly marked with ear tags or collars with contact information included, particularly if capture occurs within 30 days of a hunting season, a time often used when official withdrawal times are not available. Capture crews need to be prepared to apply marks to all individuals immobilized. Marking also insures that all individuals released on site are not re-darted.

Carcasses of animals that die during and within days of immobilization events should be considered contaminated and may be toxic to scavenging animals. Following necropsy examination of the carcass, disposal methods appropriate for the area should be used.

TRANSPORT

The councils recommend that sheep are not transported individually in crates or boxes. Wild sheep are gregarious and will settle down and haul very easily with other animals. The only time aggressive behavior is observed is when sheep are stressed or if larger (>3 yr. old) rams are included in the group. It is recommended that if adult rams are transported, they be segregated from ewes and lambs. This can be accomplished by partitioning trailers or having a separate transport vehicle for rams. Partitions must provide visual obstruction without compromising ventilation.

For transport a conventional 4 horse trailer or a special sheep box on the back of a pickup work very well. A sheep box allows easier access to release sites with poor road conditions, but more sheep can be hauled in a trailer. Transport 10 sheep per approximately 40 square feet (the area of a standard, long/wide box pickup bed), or 20 sheep in most conventional 4 horse trailers. The primary concern is that any transport vehicle has good ventilation especially when the vehicle is not moving, to provide good air exchange, reduced temperatures and humidity. Most captures take place in late fall or winter and animals are in winter coat so cold temperatures are rarely a problem, even if the sheep are wet.

HOT CLIMATE CONSIDERATION: Transport vehicles should be kept in the shade on hot days. If temperatures are excessive it is necessary to drive the vehicle between loads to keep air circulating. Blocks of ice inside the transport vehicle will assist in reducing temperatures. Make sure you have communication between all transport vehicles and base camp if they leave base camp.

If sheep will be held for more than 12 hours during transport, provide good quality alfalfa or grass hay for feed and clean water. Be very selective with the hay used. Several areas have hay quarantines for noxious weed control. Even without quarantines you do not want to introduce weeds to the release site. Make sure the hay is not purchased from a grower that winters domestic sheep on their fields. California introduced contagious ecthyma to a wild sheep herd by using hay from a domestic wintering field. A commercial electrolyte powder in the water will help during long hauls. Use cedar shavings or hay on the floor for bedding material.

Most conventional trailers have a feed bunk in the front of the trailer and this area needs to be blocked with plywood. Other large openings at or below head level to a sheep (breast height for you) should be blocked. If using plywood, Oriented Strand Board or sheet metal to block openings, cut a lot of 4" holes for ventilation and observation ports. If the inside of the trailer is dark sheep cannot be observed and ventilation will not be adequate. Openings above head level should not be blocked, assuming they are small enough so a sheep can't jump through them.

Several states have special sheep boxes or trailers for transport. A sheep box is a cab high canopy with special doors for loading and unloading. They can be made of sheet metal and angle iron, or plywood and dimension lumber. Metal boxes are more aerodynamic and last longer. It is rare for ewes, lambs or young rams to challenge a person inside the transport vehicle. Therefore if an animal has problems it is easier on all concerned to enter the box to administer treatment and not try to remove the animal. Blindfold the animal being treated.

Pickup manufacturers change length and width dimensions of standard long/wide beds with changes in body style. Therefore do not assume a box built to fit one make, model or year of pickup will fit a different make, model or year. Check to make sure boxes fit the transport vehicles early enough to allow for modifications.

RELEASE

Plan the release to occur in daylight so animals have time to get oriented in their new range. Usually it is better to hold sheep overnight and release them in the morning than to release in the dark or at dusk.

HOT CLIMATE CONSIDERATION: During hot weather the risks involved with releasing in the dark must be weighed against holding the animals in a hot trailer over-night. You probably have less risk of mortality releasing in the dark then holding the animals until dawn.

Try to select release sites so animals are moving uphill or downhill as they leave the transport vehicle. This is not mandatory but it will help animals stay together, and up or downhill to escape terrain is a normal escape path for wild sheep. The best releases are to back trucks or trailers into the base of the steep ground and open the door. Unfortunately that is not always possible. If conditions require that sheep be flown into the release site there are 3 options. Option 1 is to hire a large helicopter, hobble and blindfold animals, and lay them on the floor of the helicopter for aerial transport. Twin rotor Chinooks can haul about 20 sheep per trip. Option 2 is to hobble and blindfold sheep, place them in transport bags and haul as an external load under a smaller helicopter. With the proper cable system, a Bell Long Ranger can lift 10 sheep in a single trip. Keep in mind that the amount of weight which can be lifted changes with terrain and weather. The ultimate decision belongs to the pilot. Your job is to know what your sheep weigh. Both options require a crew with as many people as sheep to be released at any one time be stationed at the release site before any sheep are transported. When sheep arrive, the crew should take all the sheep out of the helicopter or transport bags, then hobbles and blindfolds are stripped off as fast as possible so animals are released as close to a single group as possible. Option 3 is to build a specialized flight box which is slung under the helicopter with about 4 sheep per trip. Arizona has built several flight boxes which are kept on a trailer and loaded with sheep as they are processed (Remington and Fuller, 1989). Know the weight of each flight box used. No hobbles or blindfolds are needed. One person must be stationed at the release site prior to transport to release the sheep.

Biologists re-introducing bighorns to Hells Canyon consistently use boats to access release sites. A jet sled or other type of boat with open deck space is best. Sheep are hobbled and blindfolded in the transport vehicle then carried to the boat and laid on the deck. At least 1 person per 2 sheep rides on the boat to keep animals sternal during the trip. The capture boss and boat captains need to calculate load weights to ensure boats are not overloaded, and determine the number of trips or boats needed. Extra people are stationed at the release site to assist with unloading and quickly strip hobbles and blindfolds.

PERSONNEL ASSIGNMENTS AND DUTIES

The focus of this section is capture for transplant, when many sheep will be worked in a short period of time. Capture for marking or sampling a few sheep and release at the capture site requires the same amount of attention to detail but considerably less people. The duties listed are not absolutes. For the various methods of capture each resource agency have their own modifications. The author and editors have stolen from the various duties and activities currently being used in an effort to describe the most efficient methods for capturing and handling wild sheep.

During any type of capture for transplant sheep are caught on the mountain then moved to some type of transport vehicle. Somewhere between the capture site and the transport vehicle it will be necessary to collect samples and attach marks. There are 3 basic methods to complete this step:

1. A base camp is set up and sheep are delivered. The focal point of the base camp are 4 or more tarps and a vet truck with capture supplies. Usually more then one sheep is delivered to base camp at a time, and when delivered they are placed on one of the tarps. Each member of the capture team has a specific duty. Members complete their duty on each animal, moving between animals until all the sampling and marking is completed and sheep are in the transport vehicle.

2. As in method 1 a base camp is set up with tarps as the focal point. Unlike method 1 each tarp has a sample team of 3 to 4 people and when a sheep is delivered to their tarp this team completes all the necessary sampling, health monitoring and marking for the sheep on their tarp. Upon completion the sheep is then moved to the transport vehicle.

3. This method is used for drop net captures. There is no fixed processing area and no tarps used. When the net falls, sheep are worked free of the net and sampled. Assuming you catching about 20 sheep per drop there are 3 sample teams. The sample team consists of

a recorder, blood taker and 1 assistant. The sample team completes all sampling and marking then moves on to the next sheep, repeating the process until all sheep are sampled and marked. After a sheep is processed those individuals designated as handlers and net rollers put the sheep in a transport vehicle.

All duties listed below are needed in each method, however they can be divided among more people then suggested or combined with other duties, depending on the rate animals will be delivered and how many people are desired/available to help. Capture conditions and personal preference will determine which option is used and how it may be modified. An efficient base camp operation will average less than 10 minutes per animal processed. The listed duties are presented assuming you are running an Option 1 base camp. We will try to present considerations for modifying the duties for other options.

For a base camp the number of people needed will vary with objectives of the capture, number of samples being collected, speed with which the animals are expected to be captured, and number of sheep that can be delivered to base camp at any one time. Usually there are more people at base camp than the duties listed. It may not be possible to give everyone a chance to handle a sheep. Keep well being of the animals in mind and be ready to say no. Fewer people than listed will cause the whole operation to run less smooth, increase mistakes, compromise safety and ultimately compromise the welfare of the animals being processed. Personnel numbers identified (Table 4) assume sheep will be delivered to base 4 at a time, and more than 4 sheep/hour will be received. If conditions indicate less then 4 sheep/hour will be received several of these duties can be combined and less people are required. For a drop net operation approximately 1.5 people are required for each sheep expected to be caught in any single drop.

Capture Boss – (Used in all capture methods). One person who is responsible for making sure all the pre-capture preparations occur and running the entire capture operation. At the actual capture this individual will assign duties, assist where needed, and make decisions as they are needed. The capture boss should not have a specific duty, but oversees the entire operation and makes corrections as needed. Any non-medical problems, issues, or concerns that arise during the capture operation are taken to the capture boss. Capture boss decisions are final.

Specific duties include:
- Selects capture method to be used.
- Sets up the capture contract (if necessary) and coordinates with the capture contractor.
- Identifies and orders all supplies needed for capture, sampling, transport and release.
- If captured sheep are to be imported/exported coordinates with the giving/receiving agency to insure all permits are secured and scheduling is completed.
- Selects capture dates and sets up schedule.
- Identifies transport and release methods needed and insures all equipment is available and serviceable.
- Selects capture crew and assigns duties.
- Coordinates any media interest.
- Works with lead veterinarian to secure all needed medications and treatment supplies.
- Selects labs for analysis of samples and finalizes sampling procedures.
- Insures all samples are properly handled and delivered to the labs within the proper time.

- Distributes sampling results to the appropriate biologists and veterinarians.
- Constantly critiques the capture process and identifies improvements.

It is possible for the capture boss to delegate some of these duties, but it is imperative that he/she knows that those delegated duties are being completed in a timely manner and are not causing conflicts with another aspect of the capture. Capture boss duties start a minimum of 4 months before any capture and continue until the final lab results are received and distributed. Depending on the complexity of the capture, 20-30 days before the capture all this planning will become a full time job.

Any single capture operation has a significant number of decisions that must be made during planning and completion. Someone must make those decisions and they cannot be made by committee. A good capture boss asks for a lot of advice throughout the process but it is imperative that their decisions be final. A lengthy decision making process causes unnecessary delays and can results in sheep mortality.

Lead Veterinarian – (Used in net gun, drop net and drive net captures). Primary duty is health and well being of captured sheep. Specific duties include:

- Administers emergency treatments.
- Monitors pulse, respiration and color.
- Completes ultra-sound analysis for pregnancy.
- Selects treatments for stressed animals.
- Recommends changes to procedure as needed.
- Trains individuals giving treatments or taking samples, and assists them when needed.
- Has the final say on all medical related decisions.
- Provides advice to the capture boss.
- Supervises activities of other veterinarians that may be present.

In a drop net capture the lead vet must monitor health for 20-30 sheep at a time rather then the 4-6 sheep processed at once in a base camp. Additional veterinarians are very beneficial, or the lead vet can train one or two biologists to monitor health signs. Drop net captures usually result in lower stress levels because sheep are not run prior to capture. Stress will increase the longer sheep are restrained.

Recorder – (Used in all capture methods). One or more people depending on the type of record form you select. Responsible for recording data during the capture. Specific duties include:

- Record at least 2 temperatures, 1 pulse, and 1 respiration per animal, temperatures must be below the extreme level and descending.
- Notify veterinarian of any problems.
- Checks with team members that all medications have been given, samples taken, ear tags/radio collars are on and recorded correctly.
- Records injuries or anomalies.
- Records any emergency treatments given.
- Gives final approval for a sheep to be moved to the transport vehicle.

Recorders must have the ability to stay focused while multiple sheep are being processed. Some states or provinces use a data form that allows recording information on one page for multiple animals and with this form only one person is needed to record data. Other agencies use one data form per sheep and therefore there is one recorder for each sheep being processed. Both systems work once your capture team is trained.

Restraint Teams – (Used in methods using a base camp). Four teams with 3 people per team. Each team is responsible for moving one sheep from helicopter through processing and to transport vehicles, with several other duties in-between. The team stays with their individual sheep throughout the process. Team members and duties:

- Head Person:
    - With tail person, carries sheep from helicopter to tarp.
    - Removes sling bag and net.
    - Rubs water into the front half of sheep.
    - Positions head for sampling and treatments.
    - Assists with radio collaring.
    - Ages sheep or makes sure it is done and given to recorder.
    - Pays attention that all samples and treatments are completed before sheep is taken off tarp.
    - Advises recorder when sheep is ready to be loaded.
    - With tail person carries sheep from tarp to transport vehicle.

- Tail Person:
    - With head person, carries sheep from helicopter to tarp.
    - Removes sling bag and net.
    - Rubs water into back half of the sheep.
    - Takes rectal temperatures (at least 2) and notifies lead vet if temperatures are extreme.
    - Takes fecal sample and records sample number on fecal glove.
    - Pays attention that all samples and treatments are completed before sheep is taken off tarp.
    - Advises recorder when sheep is ready to be loaded.
    - With head person carries sheep from tarp to transport vehicle.

The procedure for taking temperatures and fecal is to get the first temperature, take the fecal and then take any additional temperatures.

- Water Pourer/Head Restraint:
    - Assists with moving sheep by controlling head and horns. Controlling the head is an important safety concern. If the sheep throws its head back while being carried, the person closest to the neck can take a horn in the face.
    - Pours water on sheep at the request of head or tail person.

- Assist with removing bags, nets, hobbles, and blindfolds; trimming radio collars, etc.
- Finds the lead veterinarian, recorder or other personnel as needed.
- This person is an extra set of hands around each sheep but their activities are controlled by request of the head and tail people.

In an option 2 base camp the head and tail person become part of the sample team and someone else brings the sheep to the tarp for processing then moves it to the transport vehicle after processing.

Blood Taker/Sample Team – (Used in all capture methods). For option 1 you need 2 blood takers. In option 2 there is one sample team per tarp and one member of the team draws blood. Responsible for managing blood kits and using them in order, taking the proper amount of blood, filling all vaccutainers, and properly storing vaccutainers before spinning. For safety, blood takers must notify those people around the sheep that they are coming in with a needle. The lead veterinarian should not be one of the blood takers because of his/her responsibility to monitor health and status of all sheep on the tarps.

In a drop net capture the blood taker becomes one member of a sampling team. Members of the team include the blood taker, one assistant and a recorder. Sample teams move through the sheep as they are cleared from the net. Teams carry their sample kits in one plastic bucket. When a sheep is blindfolded, hobbled and cleared from the net the team takes all samples, gives all medications and affixes ear tags. All samples, used syringes and the record form are put back in the sample bag and the bag is placed in a second plastic bucket carried by the recorder. On a typical drop net capture of 20-30 sheep there should be at least 3 sample teams. Try not to change membership of sample teams during multiple day captures. Once a team works a few sheep they get very efficient. Changing members reduces efficiency and increases stress.

Swabber – (Used in methods using a base camp). One person to take pharyngeal swabs and nasal swabs, mark samples with the correct sample number, and store swab(s) properly for transport to the lab. These samples are not always taken at every capture site every year, so this person could be reassigned to another duty at those sites where no swabs are used. Pharyngeal swabs should be taken for several years in a row at new capture sites until a history is developed, then approximately every 3rd year after a herd history is developed. Nasal swabs are usually required by a state department of agriculture as a condition of the import permit, and are in addition to viral analysis of serum. For option 2 or 3 the sample team will take swabs.

Medicator – (Used in methods using a base camp). Two people, depending on the standard medications selected. One gives wormer and BO-SE and one gives Penicillin and 7-way clostridium vaccine. Medicators need to know dosage rates and the type of injection (IM, SQ), and are responsible for ensuring that guns are cleaned and lubricated as needed during a multiple day capture operation. Medicators need to notify people around the sheep of an incoming needle. For option 2 or 3 the sample team will take swabs.

Pulse/Respiration – (Used in methods using a base camp). One person takes pulse and respiration and gives to the recorder. This duty is optional however, when there are 4 or more sheep being processed it is hard for the veterinarian to keep up with pulse and respiration monitoring, especially if one sheep is stressed. Veterinarian(s) will monitor pulse and respiration as needed, during drop net captures.

Ear Tags/Radio Collars – (Used in all methods of capture). One person for base camp captures and 3 people for drop net captures. Duty it is to affix ear tags and radio collars (base camp), or just radio collars (drop net). This duty should be the biologist receiving sheep for transplant so he/she can make decisions on location of ear tags and which animals will get radio collars. It is important that ear tag numbers are properly recorded with the correct sample number. The person putting on ear tags must keep the recorder informed of which tag went on which sheep. Responsible for removing all magnets from all collars and ensuring that frequencies are recorded correctly.

In a drop net capture, the sample team puts on ear tags. Radio collars can be put on before sheep are moved from the net or near the transport vehicle. Collaring at the net results in sheep only being picked up and carried one time, but it is one more process that must be completed in the middle of sheep, sample teams, handlers and veterinarians. It is imperative that these people know the desired number, sex and age of sheep to be collared. No collars are put on until after the sample team is finished. Because the sample team will have moved on to another sheep prior to collaring these people need to keep a separate record of the ear tag number and color, and collar frequency put on each sheep so that data records can be updated after all sheep are processed.

Another option is after the sample team is done, the sheep is moved from the net area to the transport vehicle. Somewhere along this route the sheep is set down, a radio collar is attached, the collar frequency and ear tag number and sex is recorded on a separate form. Then the sheep is picked up and put in the transport vehicle. If you choose to PIT tag rams the people putting on collars can put in the PIT tag at the same time.

Helicopter Coordinator – One person whose primary responsibility is to unload sheep and maintain communication with the helicopter pilot. It is essential that this person has direct communication with the helicopter. All personnel need to understand that coordination with the helicopter operation goes through this person only. This person is responsible for unhooking sheep for the restraint teams and supplying the helicopter with nets, bags and water. He or she takes the lead on getting people together to repack nets and sling bags.

Media Person. Wild sheep captures are very popular and generate a lot of media interest. One individual should work with any media or public present to ensure they get the information and pictures needed without compromising efficiency or safety. He/she will need information on objectives, techniques and safety measures for the capture.

Load Supervisor/Transport Crew – In base camp operations one person controls transport vehicle door(s), and just before loading removes blindfold. Often one capture site will be worked for more than one release site. Therefore, this person will take the lead on getting sheep into the correct transport vehicles, keep track of sex ratios in different vehicles, and monitors general health of the animals before transport. He/she needs to be advised by the recorder about which sheep were stressed or shocky before they were loaded so he/she knows which individuals to monitor after loading but before transport.

If the release will require use of flight boxes or boats the load supervisor may need to keep a list of ear tag number and weight of each sheep and which box it went in. Loads can then be calculated to ensure that the flight box or boat is not over loaded.

For drop net captures the transport vehicles are staged away from the net then moved into place after the net drops. The transport crew consists of at least one person per vehicle to move them into place and assist handlers with loading. They may have the responsibility of putting on radio collars and recording collar frequency, and ear tag number/color (See Ear Tags/Radio Collars).

Enforcement - There will be operations with individuals present that do not support the capture program. If there is any chance these people will be present, it is very beneficial to have an enforcement officer as a member of the capture crew.

Handlers – (Used in drop net captures). At least one handler is needed for every sheep expected to be caught in any single drop. Depending on their experience with animal restraint handlers may need to work in teams of two people per sheep. Handlers are stationed away from the net. When the net drops they move to the net, select a sheep and put on hobbles and blindfolds through the net. They must be cautious to not get strands of net under the hobbles or blindfolds. Handlers stay with their sheep until all sampling and marking is complete then help load it in the transport vehicle. Each handler should have a thermometer so they can take a rectal temperature while waiting for the sample team. Sheep should be kept sternal prior to loading.

Net Rollers – (Used in drop net captures). Six people are required for a 70-90 ft^2 net. Net rollers need to be experienced at capture and restraint. They are put in the bait truck or stationed close to the net. When the net drops they run to the edges of the net to stop escapes. Once the handlers arrive the net rollers work the net toward the center and assist handlers with removing their sheep. When all the sheep are free of the net and as sample team duties are completed, net rollers help the handlers carry their sheep to the transport vehicle. These people control the flow of sheep from the net to the transport vehicle so bottlenecks do not occur. Net rollers usually have time to age sheep, tell that age to the handler, and the handler gives the age to the recorder.

Net Crew – (Used in linear drive net captures). This group of people set up the drive nets, and blindfold, hobble and place captured sheep in transport bags. Minimum number of people for a net crew is 12. Plan on having at least one person for each sheep expected to be captured in any single drive.

Trap Supervisor – (Used in drop net captures). One individual responsible for baiting and monitoring the drop net prior to capture. Individual informs capture boss of number, sex and age of sheep visiting the net so capture date can be selected, also trips the net on capture day.

Water Pourer – (Used in drop net captures). Because stress increases the longer sheep are restrained, high body temperatures can occur. One or 2 people with 5 gallon water jugs need to move through sheep providing water where needed.

Table 1. Vital Signs for Wild Sheep.

	Normal	Stressed	Extreme
Temperature (F/C)[a]	102/38.5	103+/39.5+	107+/41.5+
Pulse (bpm)[b]	80	130	160
Respiration (rpm)[c]	40	60	75

[a] degrees Farenheit/ degrees Celcius
[b] beats per minute
[c] respiration per minute

Table 2. Recommended Wild Sheep Health Sampling Analyses [a], Western Association of Fish and Wildlife Agencies, Western Wildlife Health Cooperative, 2005.

Test	General Information	Number of Vaccutainers	Serum (ml)
Scabies	Swabbing and examination of ears and/or skin for mites is recommended. Samples should be sent to a veterinary parasitologist. Serology is not considered to be reliable. Health histories of source an recipient herds should be similar with regards to Scabies as naïve animals may be severely affected on exposure.	n/a	n/a
Ticks .	Representative specimens should be collected intact in a container (Vaccutainer) and forwarded to a veterinary parasitologist	n/a	n/a
Contagious Ecthyma (Orf or Soremouth)	Physical examination can usually diagnose active infections. These animals should not be relocated. Health histories of source and recipient herds should be similar with regard to CE as naïve animals may be severely affected on exposure.	n/a	n/a
Serology	Brucellosis (*B. ovis*) Bluetongue/EHD Respiratory-associated viruses: RSV, PI-3, IBR, BVD OPP Anaplasmosis Leptospirosis (5 strains) Malignant Catarrhal Fever Johne's disease (Paratuberculosis)	2-3 (10 ml red or 6 ml tiger top)	8-10

These diseases are among the most commonly assessed in wild sheep. Exposure to some is common in some herds and rare or nonexistent in others. The choice of disease, test used, interpretation of results and disposition of animals should be discussed with local and state/provincial/territorial/federal wildlife and livestock disease experts prior to the project. Some test results may be required by health authorities prior to movement, others may be performed after sheep are released.

Serum Bank	Held frozen for future retrospective use. Useful in disease outbreak situations for herd disease history	1	4
Trace Mineral	Selenium, Copper, Molybdenum, Iron, Manganese and Zinc.	1 (7ml royal blue)	2
	Trace mineral levels may play a significant role in herd immunity of wild sheep, however normal levels are still not well defined.	1 (3ml purple)	whole blood
Pharyngeal	Bacterial culture of the pharynx may identify presence of bacteria of high virulence in a sheep herd. *Mannhaemia.*and *Pasteurella spp* are of particular significance and require a specific type of swab and culture conditions. Port-a-cul swabs and sterile sampling techniques are recommended. The reference lab (Univ. of Idaho Caine Vet. Center) should be contacted prior to shipping. Swabs should be refrigerated and arrive within 48 hours of collection. The absence these bacteria on culture is no guarantee of their absence in the herd, but is considered useful knowledge.	n/a	n/a
Feces	20-30 fresh pellets (10 grams). Flotation for parasite ova and Baermann for larvae. Samples should be sent fresh or frozen to a veterinary parasitologist familiar with wild sheep parasites.	n/a	n/a

[a]- It is strongly recommended to document and share the herd health history of source and receiving sheep herds where translocation is used for sheep management. This should include previous sampling and results, herd demographics, disease outbreaks and other diagnoses. Diseases endemic in sympatric wildlife and domestic species, particularly domestic sheep and goats are of strong interest as well and should also be documented.

Table 3. Optional Health Tests for Wild Sheep.

Test	General Information	Number of Vaccutainers	Serum (ml)
Pregnancy	Use a 7ml red, tiger or blue vaccutainer or use some serum from one of the standard tests. Pregnant Specific Protien-B (PSPB) or Progestrone level test to check for pregnancy. Need only send samples from adult females. For PSPB: Dr. Garth Sasser, BioTracking, 105 E 2nd St. #2, Moscow, ID, 83843. (208) 882-9736. www.biotracking.com Most labs can test for Progestrone. If your capture is later in the pregnancy period, and you have access to a trans-abdominal ultra sound you can determine pregnancy during handling. Do not use a rectal probe ultra sound.	1	1-2
Nasal Swab	For virus isolation. PI-3, IBR, RSV, BRSV.	-	-
Blood	Hematology/ CBC (3ml purple top)	-	-
	Clinical biochemistry (10 ml red or tiger top)	1	4-5
Genetic Analysis	Genetic analysis can be done from hair, tissue or whole blood. Collect blood in 7ml green or purple top vaccutainer. It is very important that you ask the lab how they want samples collected and how much sample they want. Other DNA work, such as NRAMP analysis May require specific samples. Contact the research biologist for sample instructions.	1	3-4

Table 4. Personnel Assignments for Wild Sheep Capture Methods.

Assignment	Net Gun	Drop Net	Linear Drive Net	Corral Trap	Chemical Immobilization
Capture Boss	X	X	X	X	X
Lead Veterinarian	X	X	X		
Recorder	X	Xa	X	X	X
Restraint Team	X		X		
Blood Taker/Sample Team	X	X	X		
Swabber	X		X		
Medicator	X		X		
Pulse/Respiration	X		X		
Ear Tags/Radio Collars	X	Xb	X		
Heicopter Coordinator	X		X		
Media Person	X	X	X	X	X
Load Supervisor/Transport Crew	Xc	Xd	Xc		
Enforcement	Xe	Xe	Xe	Xe	Xe
Handler		X			
Net Roller		X			
Net Crew			X		
Trap Supervisor		X			
Water Pourer		X			

a Member of sample team

b Ear tags are put on by sample team

c Load Supervisor

d Transport Crew

e Optional

Figure 1. Example of label for wild sheep samples
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ODFW[a] **95**[b]**-001**[c]

[a] Acronym which identifies agency submitting sample
[b] Year of capture
[c] Sample number

Figure 2. Wild sheep capture base camp

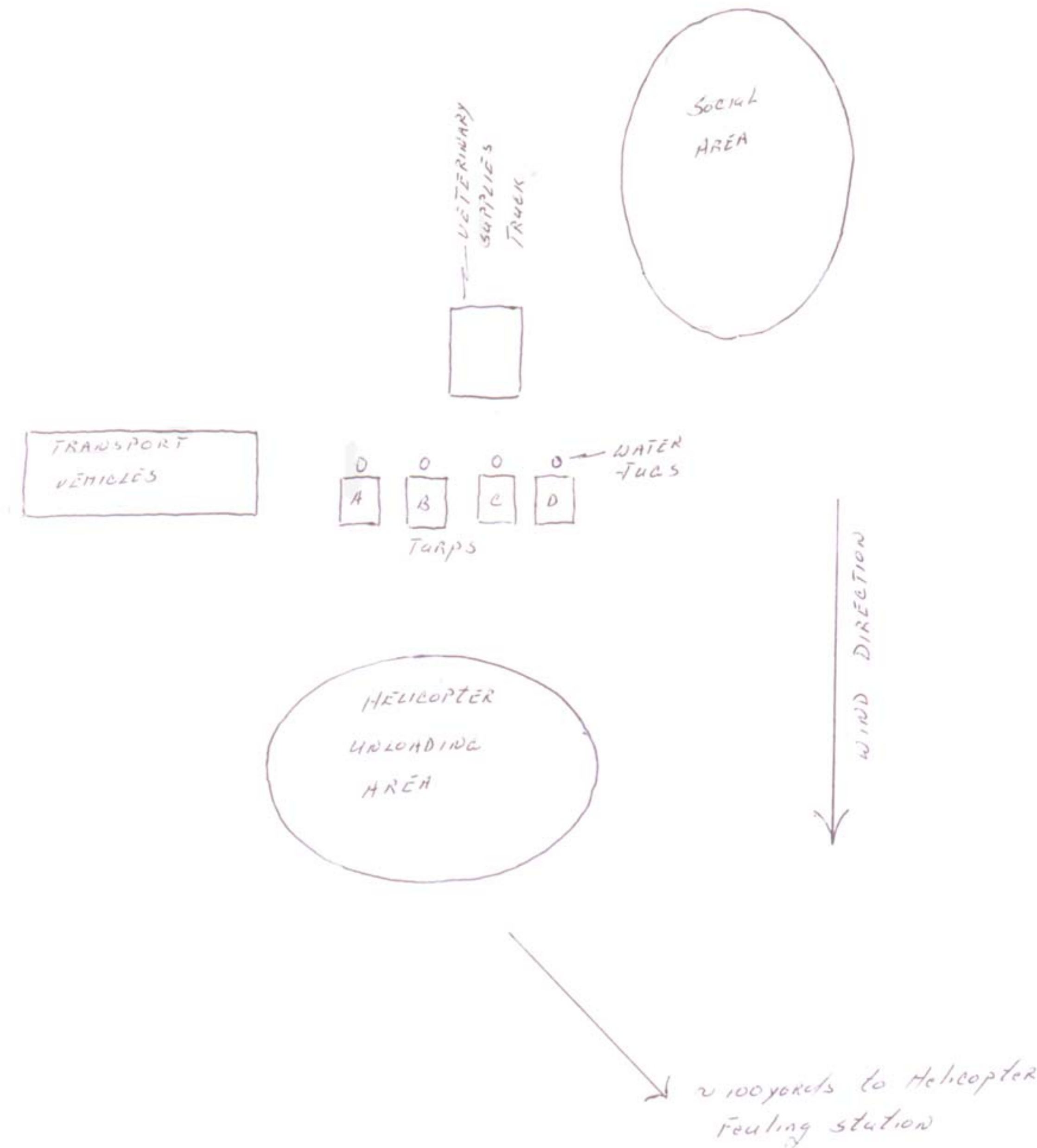


Figure 3. Wild sheep capture drop net layout. Diagram depicts period after net has fallen with all vehicles and personnel in place.

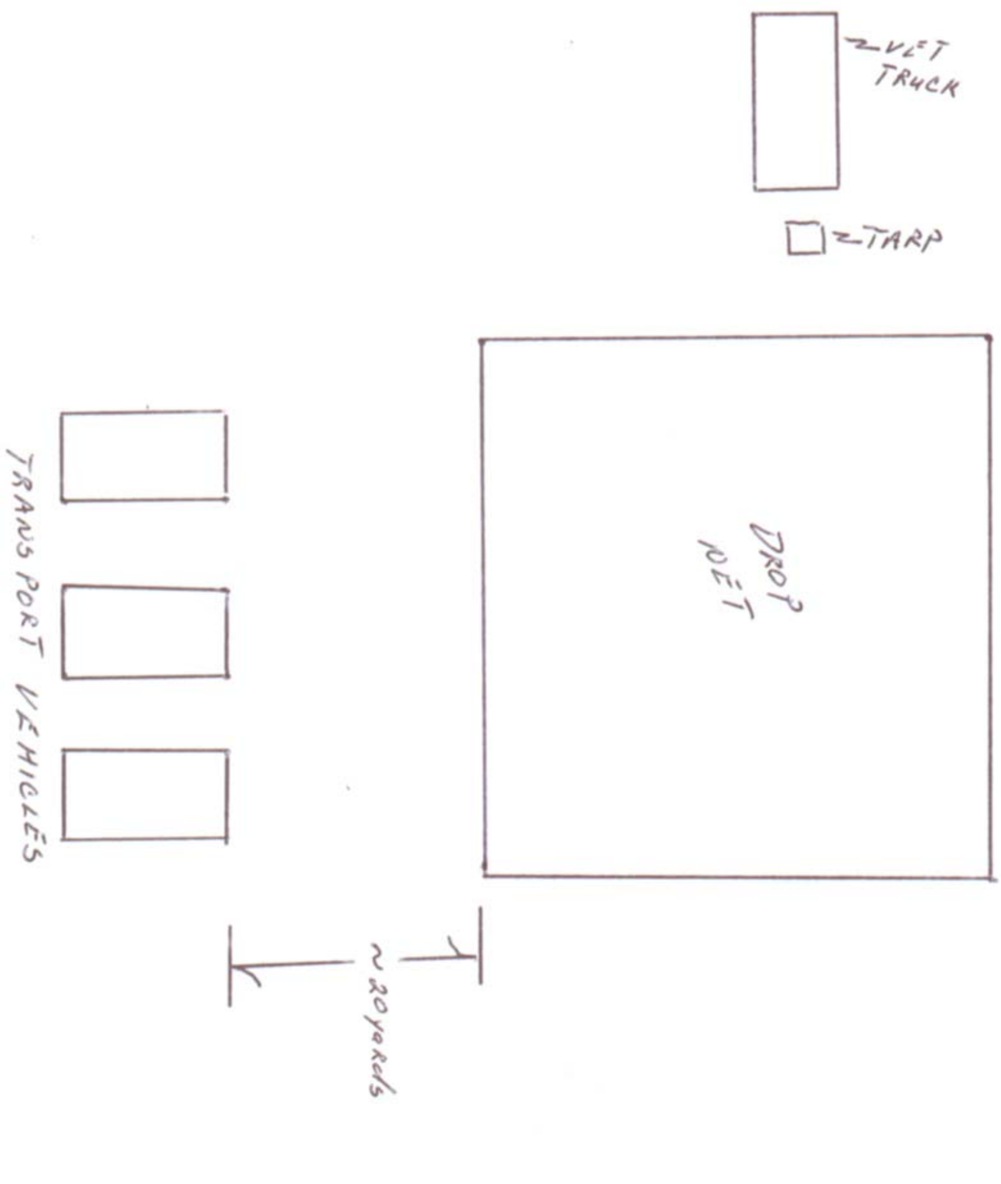
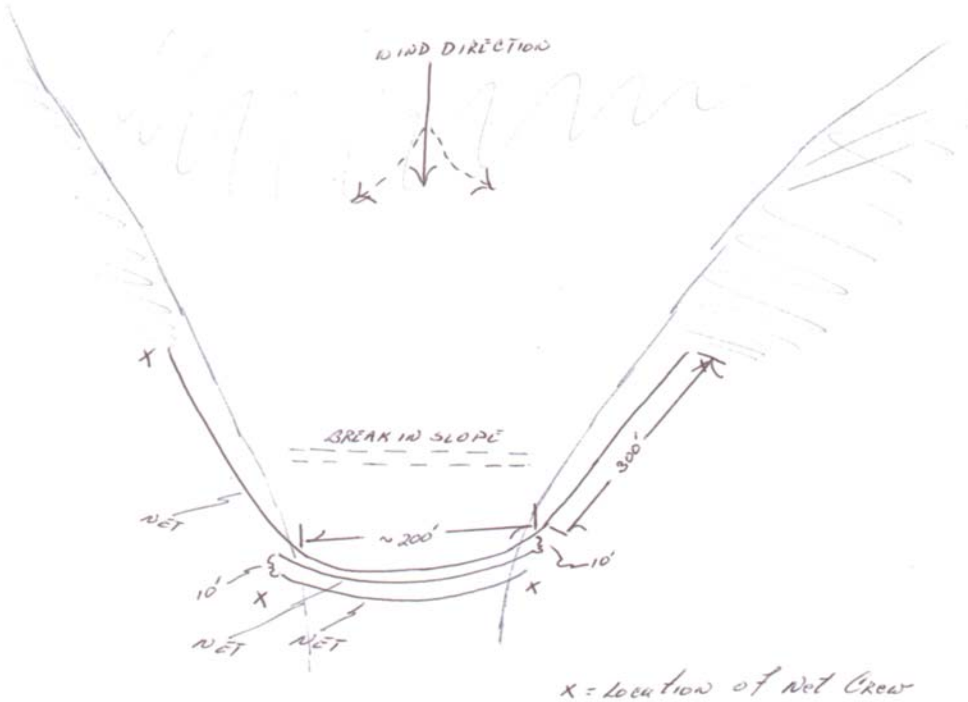
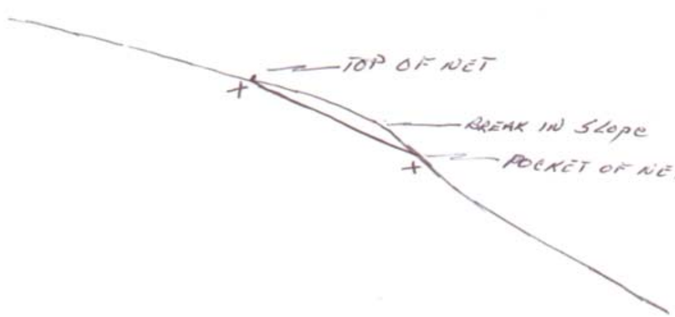


Figure 4. Wild sheep capture linear drive net.





LITERATURE CITED

Coggins, V.L., 1999. Oregon's corral type bighorn trap. Proceedings, 2nd N. Am. Wild Sheep Conf. Reno, NV. 249-251.

Kreeger, T.J., 1999. Handbook of wildlife chemical immobilization. Wildlife Pharmaceuticals, Inc. Fort Collins, CO. 342pp.

Remington, R. and A. Fuller. 1989. Capture and transplant techniques. in: Desert bighorn sheep in Arizona. R.M. Lee (ed). Arizona Game and Fish, Phoenix. pg. 195-197.

Simmons, N.M. and J.R. Robertson. 1970. Progress and problems - marking and counting Dall sheep in the Mackenzie Mountains, Northwest Territories. Proc. N. Wild Sheep and Goat Counc.:3:5-19.

Taber, R.D., I. McT. Cowan. 1971. Capturing and marking wild animals. In Wildlife Management Techniques. 3rd edition. Giles, R.H. Jr.(ed). The Wildlife Society, Washington, DC. pg: 282-286.

_______. 1999. 2nd N. Am. Wild Sheep Conference. Reno, NV, April 6-9. Transaction published by the Northern Wild Sheep and Goat Council and Desert Bighorn Council.

_______. 2001. Report of the AVMA panel on euthanasia. JAVMA, 218:5. 675-696.

APPENDIX 1

EQUIPMENT LIST

General Supplies

- Blindfolds (12 or more)
- Canvas Tarps (4) with 40dd spikes and ½ inch fender washers (4 per tarp)
- Clip Board and Record Forms
- Extra Radio Collar Supplies: attachment hardware, nuts, nut drivers
- Heavy Shears (for trimming radio collars)
- Hobbles (12 pair or more)
- Paper Towels
- Parachute cord, super glue, duct tape
- Plastic Bags: (assorted sizes) zip locks, whirl-packs, large garbage bags
- Plastic Buckets (6-12)
- Push Broom
- Scrub Brushes
- Sharpie Markers (20 black, 20 red), Pencils
- Stretchers
- 5 gallon water jugs (6 minimum)

Medical Supplies

- Bandage Material
- Disposable examination gloves
- Enema tube and funnel
- K-Y Jelly (6 tubes)
- Lactated Ringers solution, 5% Dextrose solution, IV drip kits
- Oxygen bottle with regulator and plastic tube or face mask delivery system
- Tackle Box containing extra syringes (3,6,10,35 cc) and needles (18 &16 ga.) (1 &1.5")
- Tackle Box containing extra ear tags, pliers and replacement needles
- Stethoscope(s)
- Surgical Instruments: hemostat, scalpels, needles
- Surgical scissors and Serrated Scissors
- Suture Kit
- Swabs: Pharyngeal, Viral, Common
- Vaccutainers: a small assortment of extras in case of breakage
- Wound Medication: anti-bacterial spray, blood clotting powder, tamed iodine solution

Sample Kit Contents

- Large syringe(s) (2-35ml or 1 60ml)
- 16ga.X1.5" needle
- Vaccutainers (number and type depends on tests selected)
    - 2-3 Tiger top (10ml)
    - 1 Royal blue top (7ml)
    - 1 Purple top (3ml)

    - 1 Green top (7ml)
- May also include:
    - Ear tags
    - Individual syringes and needles for medications
    - Examination Glove
    - Record Form
    - Swabs: Pharyngeal, Viral, Ear

Medication Supplies

- Ice chest or Insulated box
- Medications (options include: Banamine, BO-SE, Clostridium Vaccine, Penecillin, Oxytetracycline, Wormer, Dexamethasone, Sodium Bicarbonate)
- Syringe Guns: (2-3), soap and small test tube brush , glycerin lube

Necropsy Kit

- Skinning knife, scalpels, boning knife
- Sharpening stone/steel
- 10% Formalin
- ziplock bags and whirl pack backs
- specimen bottles
- scrub brush
- anti bacterial soap

Blood Processing Equipment

- Centrifuge
- Ice chest with ice packs for holding serum, biological specimens, purple & green vaccutainers, swabs.
- Ice chest with warm packs for holding tiger top and royal blue vaccutainers
- Test tube racks (5), with large enough openings to hold a 10ml vaccutainer

APPENDIX 2

CONTACT PERSONNEL

Following is a list of people that have experience in various forms of trapping and transplanting wild sheep. They were instrumental in developing this document. They may not have all the answers to all your questions, but if you contact them they will be able to refer you to someone that does.

Frances Cassirer, Hells Canyon Initiative Coordinator, Idaho Fish & Game, 1540 Warner Ave., Lewiston, ID, 83501. (208) 799-5010. Email: cassirer@idfg.state.id.us Import, Drop Net, Net Gun, Animal Health, Rocky Mountain Bighorns.

Vic Coggins, District Wildlife Biologist, Oregon Department of Fish and Wildlife, 65495 Alder Slope Rd, Enterprise, OR, 97828. (541) 426-3279. Email: coggins@oregontrail.net Corral Trapping, Animal Health, Rocky Mountain Bighorns.

Mark Drew, Veterinarian, Idaho Fish and Game, Wildlife Health Lab, 16569 S. 10th Ave. Caldwell, ID, 83605. (208) 327-7070. Email: mdrew@idfg.state.id.us Lead Veterinarian, WWHC member.

Bill Dunn, Program Leader, New Mexico Dept. of Fish and Game, POB 25115, Santa Fe, NM, 87504. Phone(505) 827-9927, Email: wcdunn@state.nm.us Desert Bighorn.

Marco Festa-Bianchet, Professor, Departement de biologie, Universite de Sherbrooke, Sherbrooke, Quebec, J1K2R1, Canada. Box Traps, Thin Horns.

Craig Foster, District Wildlife Biologist, Oregon Department of Fish and Wildlife, POB 1214, Lakeview, OR, 97630. (541) 947-2950. Email: Craig.l.foster@state.or.us. Capture planning and implementation, California Bighorns.

Kevin Hurley, Wildlife Biologist, Executive Director Northern Wild Sheep and Goat Council, Wyoming Game & Fish Department, 2820 State Hwy 120, Cody, WY, 82414. (307)-527-7125. Email: Kevin.Hurley@wgf.state.wy.us Drop Net, Net Gun, Chemical Immobilization, Rocky Mountain Bighorn.

Emily Jenkins, Veterinarian, Western College of Veterinary Medicine, Univ. Saskatchewan, 52 Campus Drive, Saskatoon, SK, Canada, S7N 5B4. (306) 966-7246. Email: Emily.jenkins@usask.ca Thin Horns.

Susan Kutz, Veterinarian, Western College of Veterinary Medicine, Univ. Saskatchewan, 52 Campus Drive, Saskatoon, SK, Canada, S7N 5B4. (306) 966-7242. Email: susan.kutz@usask.ca Thin horns

Terry Kreeger, Veterinarian, Wyoming Game & Fish, Sybille Wildlife Research Unit, 2362 Hwy 34, Wheatland, WY, 82201. (307) 322-2571. Email: Terry.Kreeger@wgf.state.wy.us Chemical Immobilization, Lead Veterinarian.

Ray Lee, Foundation for North American Wild Sheep, 720 Allen Ave, Cody, WY, 82414, (307) 527-6261 Email: rlee@fnaws.org Desert Bighorn, Capture and Import.

Leon Pielstick, Veterinarian, Harney County Veterinary Clinic, 1050 Crane Blvd. Burns, OR, 97720 (541) 573-6450. Email: leonandsusan@centurytel.net Lead Veterinarian.

Eric Rominger, Professor, Department of Fisheries and Wildlife Science, University of New Mexico, PO Box 704, Santa Fe, NM, 87504. (505) 660-0038. Email: erominger@msn.com Capture planning, Desert Bighorn, Rocky Mt. Bighorn.

Helen Schwantje, Veterinarian, Wildlife Branch, BC Enviroment, POB 9374, STN PROV GOV, Victoria, BC, Canada, V8W 9M4. (250) 953-4285. Email: Helen.Schwantje@gems2.gov.bc.ca Import/Export, Lead Veterinarian, WWHC member, All Wild Sheep.

Walt VanDyke, District Wildlife Biologist, Oregon Department of Fish and Wildlife, 3814 Clark Blvd., Ontario, OR, 97914. (541) 889-6975. Email: Walt.A.VanDyke@state.or.us California Bighorns.

APPENDIX 3

BLOOD SAMPLE COLLECTION AND PROCESSING FACT SHEET

BC Wildlife, Helen Schwantje, DVM

INTRODUCTION:

Animal handling for any reason can put the animal, as well as handlers, at risk. The collection of as much information as possible, while properly handling the animal, supports the project justification, economics and science. If done correctly, the sample collection can be fast and safe for all, and produce information valuable to both the individual project and overall population management.

The collection of serum and genetic material for banking is recommended, as a minimum, whenever an animal is handled. Banking can be coordinated through Dr. Helen Schwantje, Wildlife Veterinarian for the Wildlife Branch. There may also be a standard series of samples appropriate for the species, project and useful to other cooperative studies. Consultation with the project leader and Dr. Schwantje prior to animal handling, regarding recommended samples and techniques is advised.

BEFORE THE PROJECT:

Before samples are collected in the field, the project leader should be clear <u>what information is required</u> from the samples, what type of sample is needed, how they should be collected, processed, preserved and stored. Individual animal kits with the appropriate materials can then be prepared beforehand. For example, numbered ziplock plastic bags with all needed supplies previously labeled are useful and easy to transport.

A data sheet should be prepared prior to the field work, including a checklist for samples, to ensure collections are completed in the field before animal release. The sheet can include animal history, and include location, number, species, sex and age of animals, reaction to handling, and other appropriate data.

SAMPLES:

BLOOD

Blood is one of the most common samples collected from wild animals and can be used to determine physiological condition, disease exposure and genetic profiles. **Blood is fragile**. Proper collection, handling, processing and storage are critical to assure good quality samples, or the effort and sample is wasted. Improper treatment of blood samples will result in the inability to perform tests or inaccurate results. The type of sample handling and storage will vary with the sample purpose, whether for serum chemistry, hematology, serology, microbiology, virology, trace elements, toxicology or genetics.

Generally, blood is collected into sterile glass tubes, manufactured with or without a preservative (Vacutainer®), and kept refrigerated and protected from freezing, excessive heat and strong sunlight.

Blood has two basic components: solids, including red and white cells, and liquid or serum, containing a number of measurable compounds. Blood solids drawn from the body will clot, unless treated with an anticoagulant. Serum is the clear liquid left after blood clot formation and retraction. Clot formation is best accomplished at room temperature for 6 to 12 hours, but it can occur much faster.

Serum should be separated from other blood components as soon as possible for most laboratory analyses, but this may vary. Centrifugation is used to complete the separation and maximize the harvesting of serum. A pipette or 3 ml syringe with a 1 1/2" needle can be used to draw off the serum. A different pipette/syringe with needle must be used for each sample to avoid contamination.

If no centrifuge is available, serum can be aspirated, or poured off, taking care that the clot is not disturbed. This may be a delicate procedure. Some tubes (serum separator tubes or SST tubes) contain a gel which separates the clot from serum after centrifuging, allowing easy separation by pouring off the serum. If separation of serum and cells does not occur, blood cells break down after about 24 hours and the leakage of pigments (hemolysis) can destroy the quality of samples. Hemolysis also occurs with rough handling of blood, shaking of tubes, use of too small a needle, repeated puncturing of the blood vessel, bacterial contamination and extremes of heat and cold.

Separated serum not analyzed immediately should be placed into new glass tubes (3 ml size saves space), labeled properly or numbered corresponding to the data sheet and frozen. Tubes should not be overfilled as the liquid will expand and push the stopper off when frozen.

BLOOD COLLECTION EQUIPMENT:

Two systems are commonly used to withdraw blood. They are the Vacutainer® double ended needles and plastic cuffs or disposable plastic syringes and needles. Both utilize Vacutainer® glass tubes.

Vacutainer® double ended needles are screwed into a plastic cuff. One end of the needle is inserted into the vein, while the glass blood tube is inserted onto the other end. The needles used may be small bore (20 gauge) and these can damage red cells. Larger needles are available, however, it may be difficult to collect large volumes or multiple tubes of blood with this system, especially with active, physically restrained animals under field conditions. The needles are easily dislodged with animal movement. Blood can freeze in narrow bore needles before entering the tube during cold weather.

Syringes of various sizes (6, 12, 20, 35 or 60 ml) with large bore (16 or 18 gauge) needles attached, have advantages in some situations, particularly when multiple tubes of blood are required. Blood is drawn into the syringe, then transferred to Vacutainer® tubes. Some samplers use flexible extension tubes that link the needle in the vein to the syringe and allow movement of the animal without dislodging the needle from the vein.

Vacutainer® tubes have colour coded rubber stoppers, depending on the content. They are red for no anticoagulant, red/black for separator gel (SST), purple for EDTA anticoagulant, green for heparin, etc. There are three sizes; 3 ml, 7 ml and 10 ml.

All blood collection equipment must be sterile and disposable. Used needles, syringes and tubes should be disposed of in appropriate water proof, puncture proof containers according to safety policies.

BLOOD COLLECTION TECHNIQUE:

The sampler must be familiar with the anatomy of the species to be collected from and the preferred sites for blood collection. For many species, the jugular vein is the largest and most superficial vein. For bears, big cats and some other carnivores, the femoral vein in the groin, or saphenous vein in the hind leg is covered with thinner skin, less hair and farther from teeth and claws, so may be the preferred site. Alcohol can be used to flatten hair, outline the vein and clean the surface of debris. Correct positioning, firm but gentle holding off of the vein and lack of movement of the animal will ease collection. Practice is mandatory for expertise to develop. Please contact someone familiar with this technique (experienced biologist, local veterinarian) for training before attempting it in the field.

Since veins are a low pressure system, blood pressure must be created by holding off the vein at a location between the site to be punctured by the needle and the heart. Holding off the vein in this manner is necessary to see and enter veins. For example, on the neck, the jugular vein is usually accessed at a mid neck position, using thumb or fist pressure below this position to allow the jugular to stand out. For the foreleg, the cephalic vein is accessed on the upper front surface of the foreleg with a tourniquet or assistant's hand holding the vein off at the elbow level.

When the sampler is ready to collect blood, the vein is located and held off. If using a syringe, the plunger should be checked for free movement and any air expelled from the syringe. The needle cover of either type of needle is removed and the needle turned so that the bevel, or slanted opening, is facing up. The vein is visualized or palpated with the finger, and the needle is inserted through the skin at a slight angle (20 - 30 degrees), either directly over the vein or parallel to it. Entry into the vein is confirmed by blood appearing in the hub of the needle. The needle is advanced slightly into the vein, maintaining the plastic cuff or syringe parallel to the skin surface, to avoid pushing the needle through the other wall of the vein. Gentle pressure is used to either advance the vacuum tube onto the double ended needle within the cuff of the Vacutainer® system, or gentle pressure on the syringe plunger will withdraw the desired quantity of blood. To prevent excessive bleeding, finger pressure should be maintained on the puncture site for several minutes after needle withdrawal and release of pressure. Bleeding can be pronounced when using large bore needles.

BLOOD HANDLING:

Blood is pulled into tubes by vacuum pressure when using the Vacutainer® system. They should not overfill by this technique. When using syringe and needle systems, the needle and filled syringe is removed from the animal, the needle removed from the syringe, the stopper removed from the tube and blood gently expressed into the tube along the inside wall. Tubes should be filled approximately 3/4 full, so that rubber stoppers can be properly replaced. Alternatively, the needle can be inserted through the tube stopper for vacuum fill. It must be noted that excessive turbulence of blood can damage blood cells, so allow the vacuum to pull the blood into the tube rather than pushing it in.

If multiple syringes are used to collect larger quantities of blood, the needle is gently pulled away from, or turned off the syringe tip, the syringe handed to an assistant to decant into tubes, and a new syringe attached to the needle, still in the animal's vein. This can be a delicate procedure and vein access may be lost if excess handler or animal movement is present.

Blood collected in anticoagulant tubes (purple and green tops, usually) is used for the examination of cells or genetic evaluations. Fill these tubes first to avoid clotting. Immediately after collection into these tubes, the blood and anticoagulant should be **mixed gently** by rocking the tube from side to side 4 to 5 times. It should then be kept as still as possible and refrigerated until required. In some situations, these tubes can be frozen for storage. Consult with the laboratory, researcher or Dr. Schwantje first.

Blood collected for serum separation (red or red/black tops) should be kept upright, as still as possible for 6 to 12 hours (1/2 hour minimum) to allow clotting, then spun for serum separation as soon as possible, finally the serum should be frozen for storage.

Please call Dr. Helen Schwantje (250-953-4285) with any questions regarding this fact sheet.

BIGHORN SHEEP HERD HEALTH SCREENING AND SAMPLING PROTOCOL

PHYSICAL EXAM:

Age - estimated years Sex

Weight - estimated

Health comments:

IDENTIFICATION:

Eartag #s Right   Left

Radiocollar frequency # (if used)

PHARYNGEAL SWABS:

BACTERIOLOGY - Accuculture swabs preferred, attention for Pasteurella spp., save cultures for biotyping

BLOOD SAMPLES:

SERUM - 10 ml red top vacutainer X 2 or 3

- **SEROLOGY** - routine screen for Brucella ovis, BRSV, PI-3, BVD, BT,   Scabies ...plus/- for export testing if applicable

- **CHEM SCREEN** - if desired

- **BANK** - extra serum

SERUM - 7 ml blue vacutainer X 1

-**TRACE MINERALS**

WHOLE BLOOD - 10 ml heparin(green vacutainer) or 7 ml EDTA(purple vacutainer) X 2 (depending on involved lab)

- **GENETICS** analysis (for **NRAMP, MICROSATELLITES**)

- **CBC** - if desired

- **BANK**

******BLOOD MINIMUM: - 2 X 10 ml red top tubes, plus**

- 1 X 7 ml purple top tube or 2 X 3 ml purple top tubes

OTHER SAMPLES:

HAIR FOLLICLES

- 20 hair roots for genetic banking, store dry in paper envelope,   freeze (check with lab involved)

FECES

- **FLOATATION** + **BAERMANN** - fresh, store chilled

- consider **JOHNE'S** if warranted

EXTERNAL PARASITES

- if any, save in alcohol

- check **EARS** for mites by swabbing deeply, store chilled

TREATMENT - advised as minimum

- **VITAMIN E/SE**

- **IVERMECTIN** (or other larvicidal)

- **ANTIBIOTIC** (long acting tetracylcline)

APPENDIX 4

Examples of Data Record Forms

BIGHORN SHEEP TRANSPLANT RECORDS – ODFW

PAGE ______
OF ______

EARTAG COLOR: ______
LOCATION: ______ DATES: ______ CAPTURE METHOD: ______ RELEASE SITES: ______

ID NO	SEX	L=0 AGE	L - EARTAG - R		RADIO SN/FREQ	DEX D, 2D	ULTRA SOUND (Y/N)	TIME	TEMP SEQUENCE HORN TO BOX	PULSE	RESP	COMMENTS

NOTES: ______

BIGHORN SHEEP CAPTURE FORM – HELLS CANYON

Capture date____________ Time__________ Herd_______________

Sex			**Age**		
Color Tag#			**Color Tag side**		
Radiocollar color			**Radiocollar freq.**		
Condition Withers Ribs Hips/Rump					
Horn basal circ. L			**Horn basal circ. R**		
LEFT HORN			**RIGHT HORN**		
Year	**Length (cm)**	**Circumference (cm)**	**Year**	**Length (cm)**	**Circumference (cm)**
1			**1**		
2			**2**		
3			**3**		
4			**4**		
5			**5**		
6			**6**		
7			**7**		
Time		**Temperature**	**Time**		**Temperature**
3 cc Ivermectin SC		**5-7 cc LA-200 IM**			**2-3 cc BOSE IM/SC**
Red top		**Blue top**	**Green top**		**Purple top**
Pharyngeal		**Fecal**	**Ear swab**		

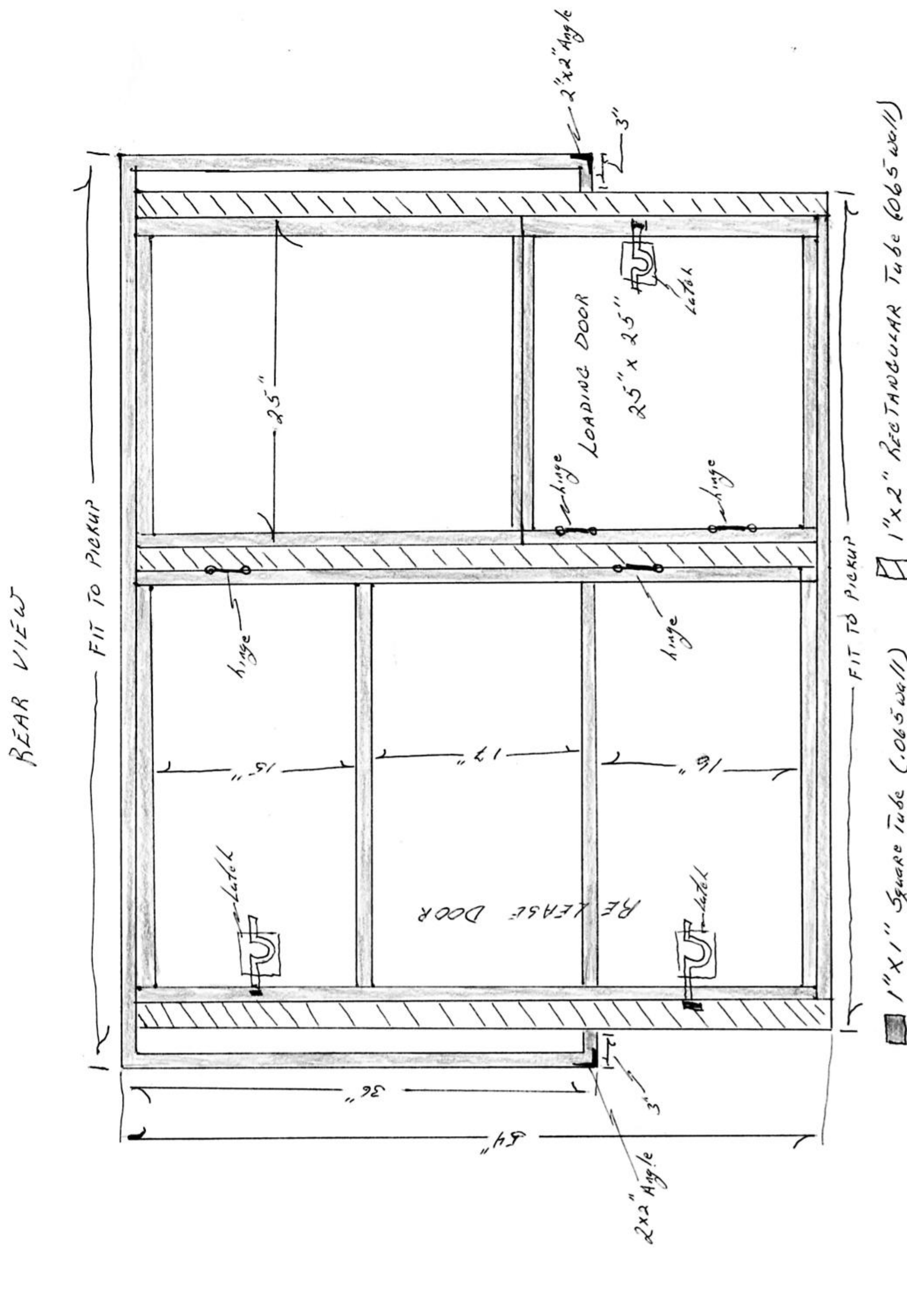
APPENDIX 5
Plans – Oregon Sheep Transport Box

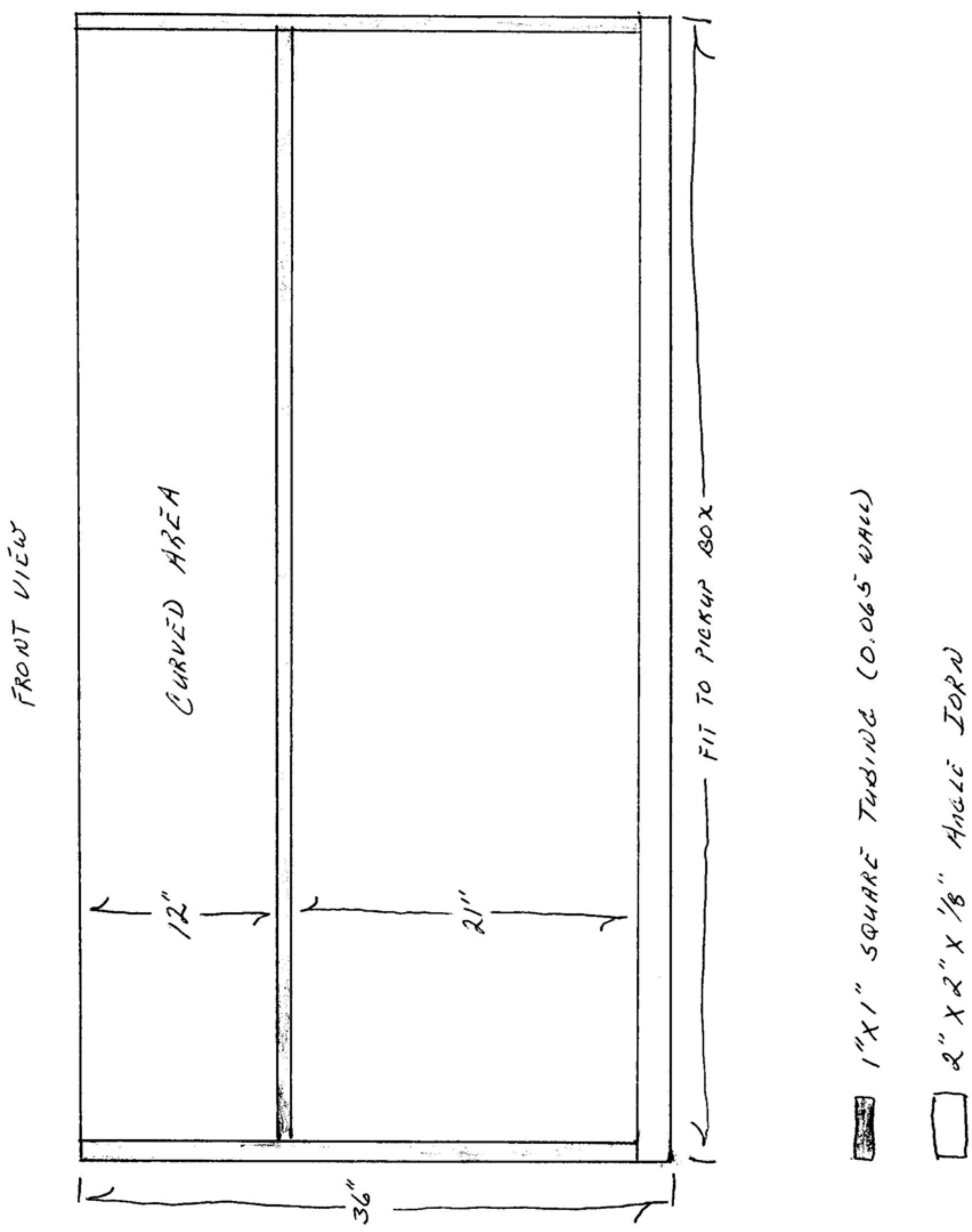
Additional Specifications:

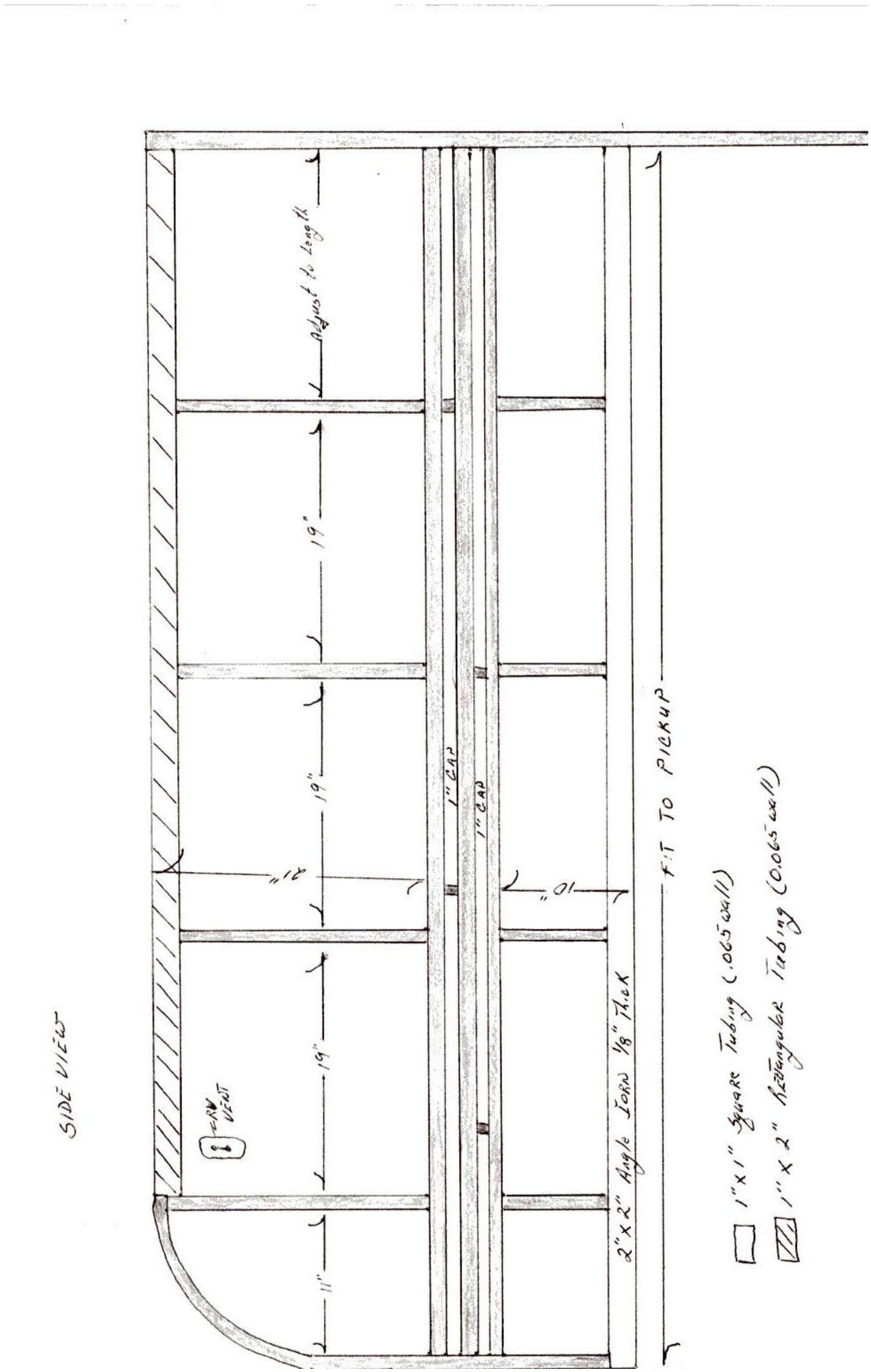
- Exterior Siding – coiled aluminum semi roofing (0.040 thick). Available from Reynolds Aluminum, Portland, OR (503)-283-4705. Seams only on corners and edges. Fastened on with large head 3/16" aluminum pop rivets or aluminum aircraft rivets. 4" spacing between rivets on flats. 3" spacing between rivets on edges and corners.

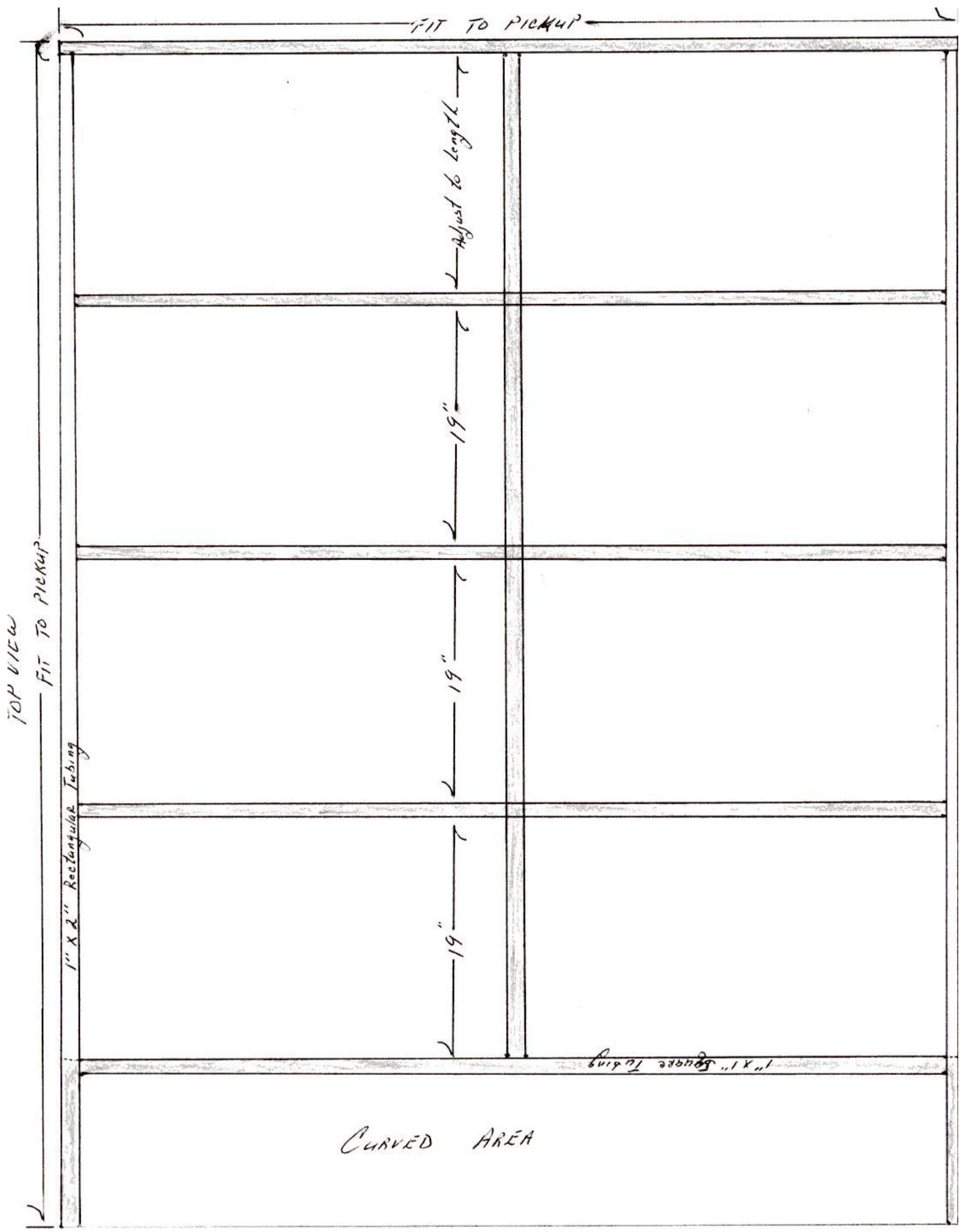
- Curved Front – 1" square tubing (any wall thickness) with 12" radius bend. Custom order from Carl-Built Inc., Manteca, CA, (209)-239-9100. Or any other vendor that has the ability to fabricate the radius in box tubing.

- Molding or Trim Strips on all exposed exterior siding edges.


REAR VIEW
FIT TO PICKUP
FIT TO PICKUP
25"
LOADING DOOR
25" x 25"
Latch
hinge
hinge
hinge
hinge
15"
17"
16"
RELEASE DOOR
Latch
Latch
36"
64"
3"
3"
2"x2" Angle
2x2" Angle
1"x1" Square Tube (.065 wall)
1"x2" RECTANGULAR Tube (.065 wall)

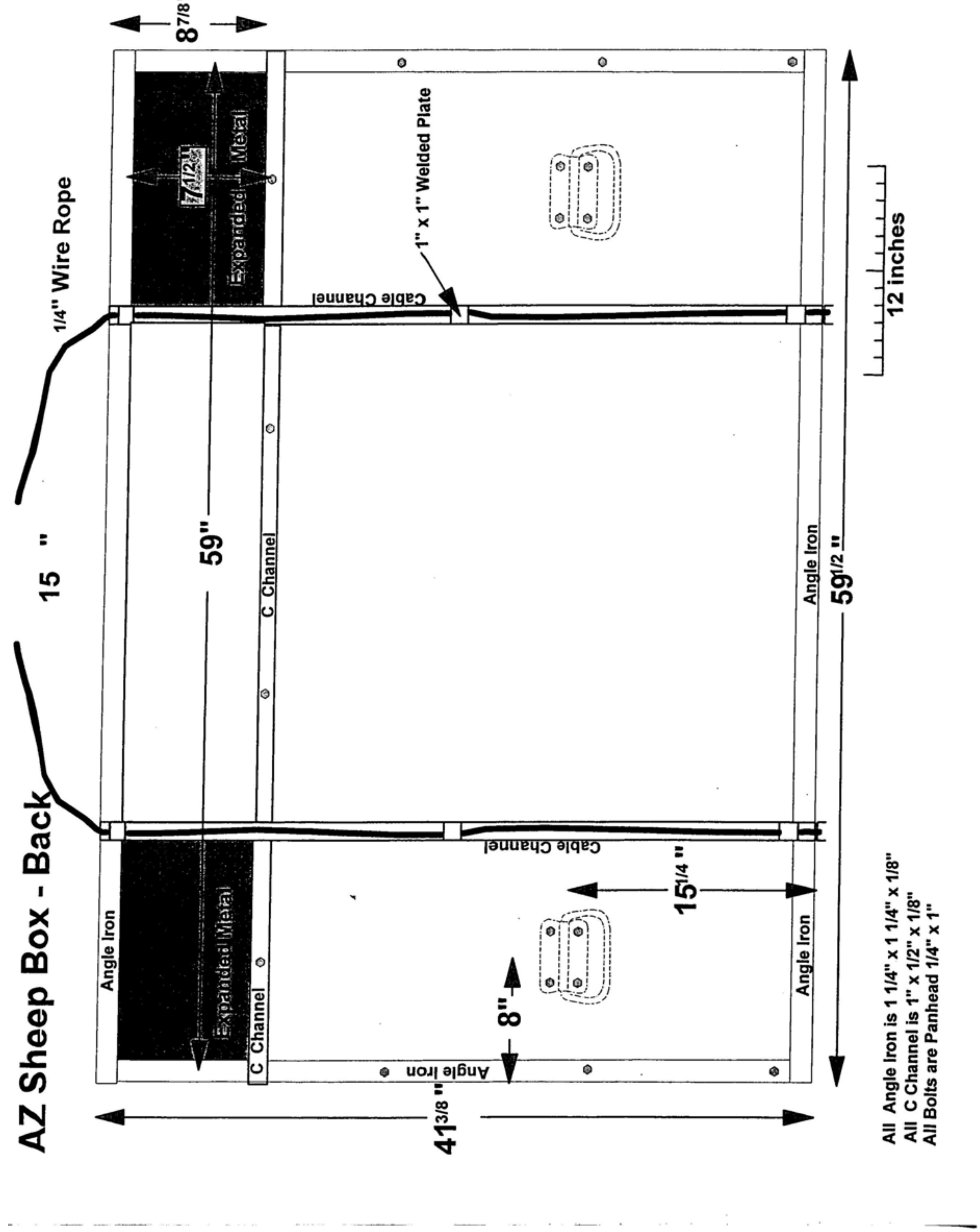

FRONT VIEW
CURVED AREA
12"
21"
36"
FIT TO PICKUP BOX
1"X1" SQUARE TUBING (0.065" WALL)
2"X2"X1/8" ANGLE IRON


SIDE VIEW
RV VENT
Adjust to Length
19"
19"
19"
11"
21"
10"
1" CAP
1" CAP
FIT TO PICKUP
2"x2" Angle Iorn 1/8" Thick
1"x1" Square Tubing (.065 wall)
1" x 2" Rectangular Tubing (0.065 wall)

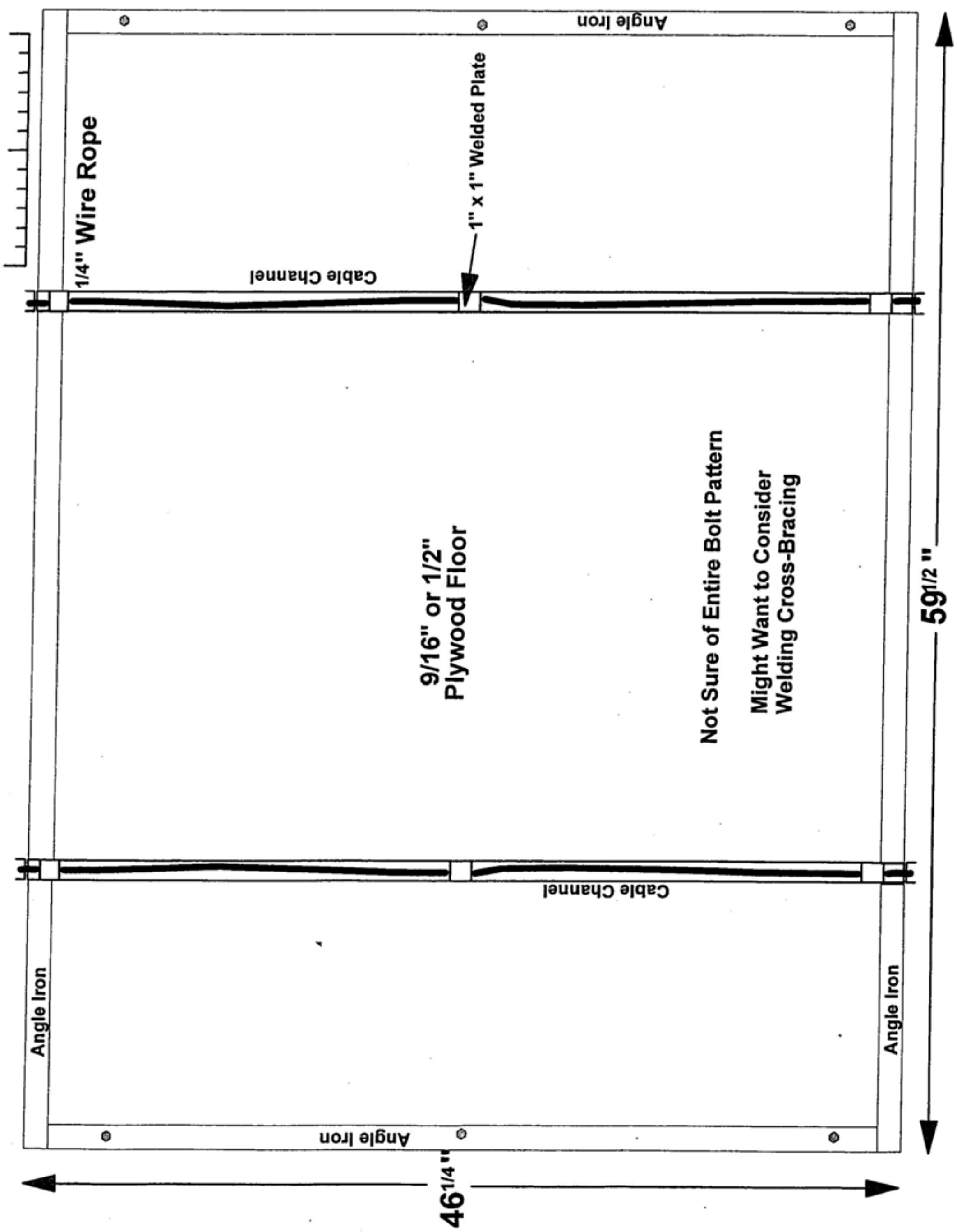

FIT TO PICKUP
Adjust to Length
19"
19"
19"
TOP VIEW
FIT TO PICKUP
1" X 2" Rectangular Tubing
1" X 1" Square Tubing
CURVED AREA

APPENDIX 6

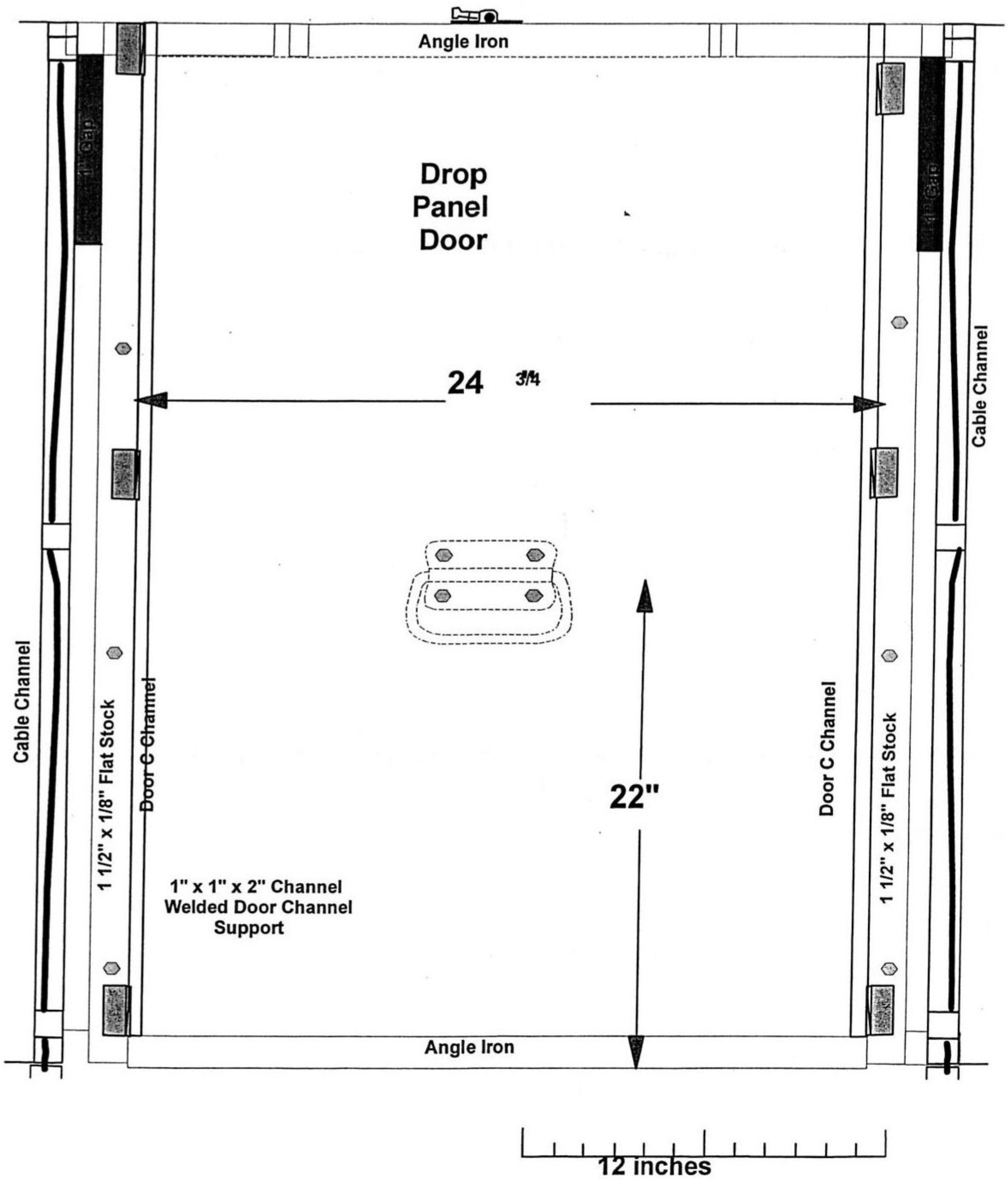
Plans – Arizona flight box



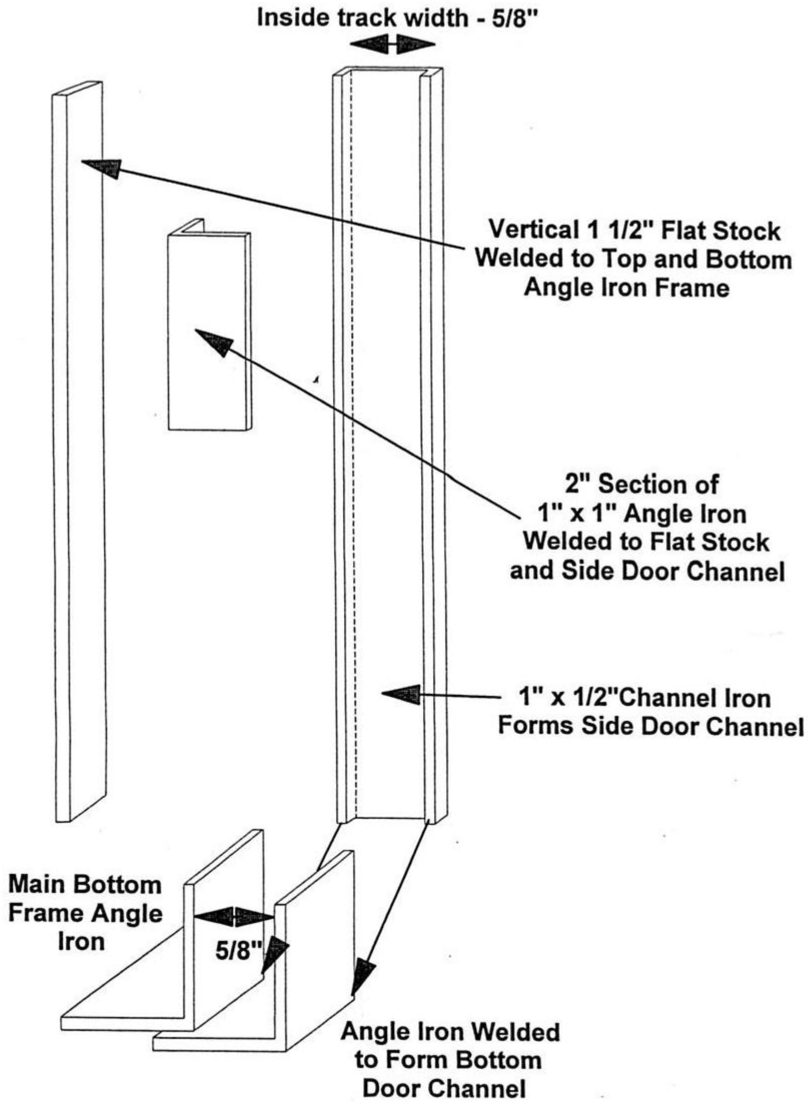
AZ Sheep Box - Bottom

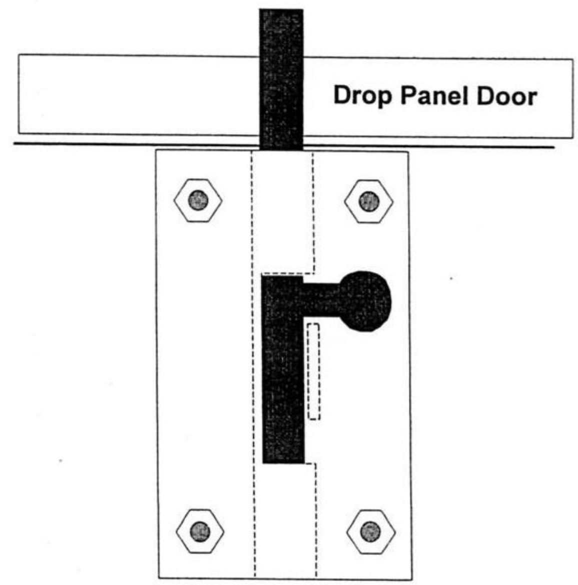


AZ Sheep Box - Door

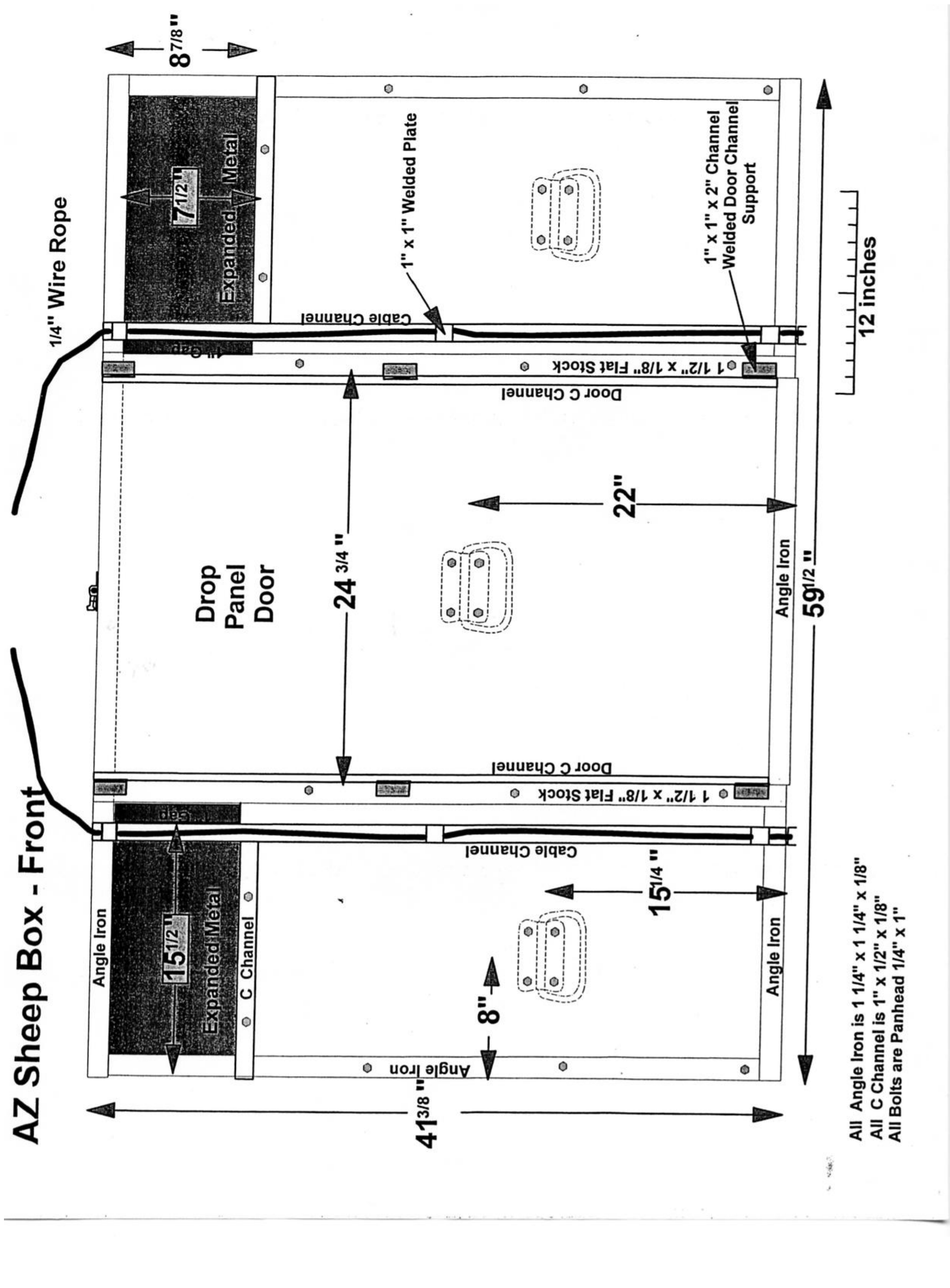


AZ Box - Door Details

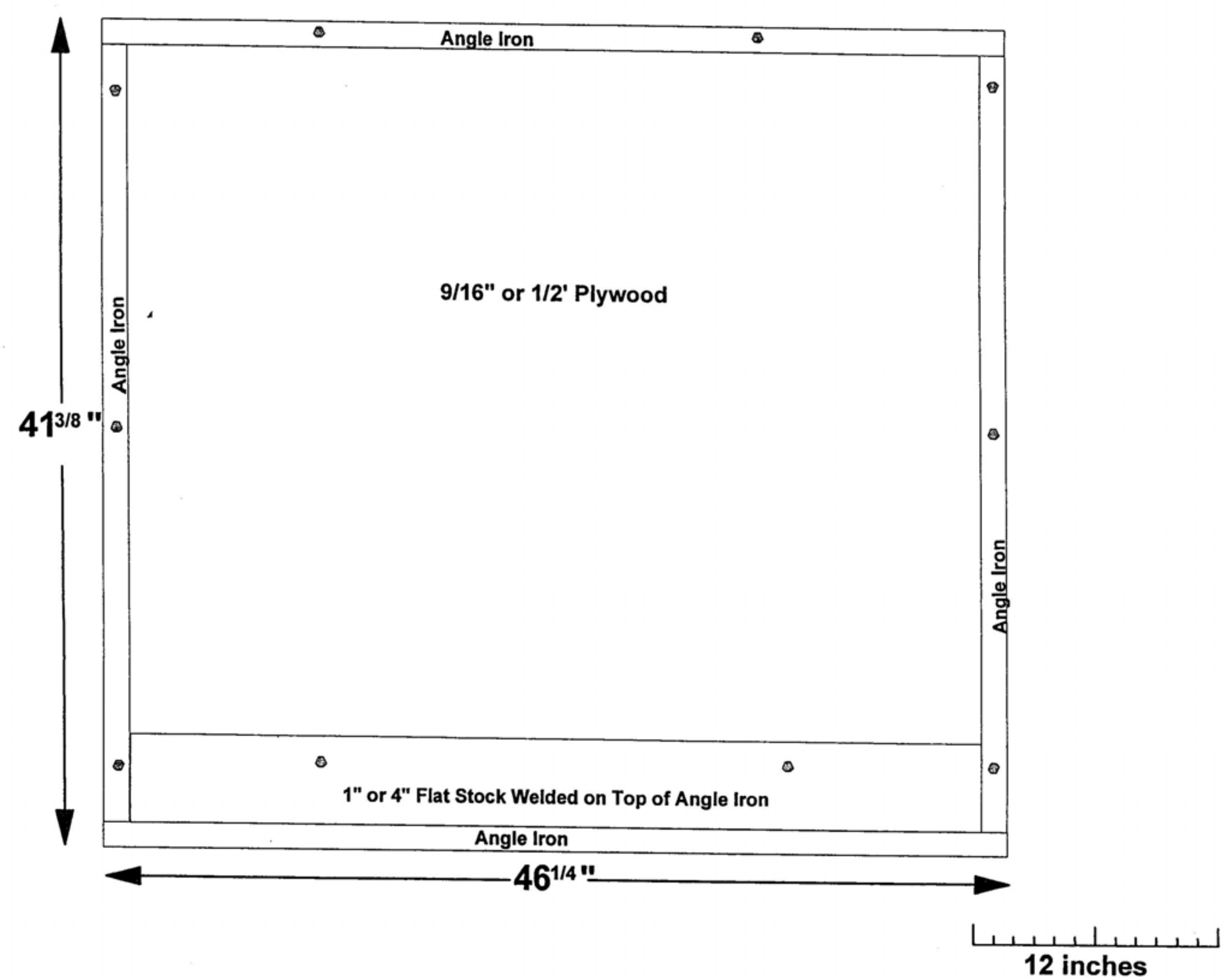




Top-Mounted Door Latch

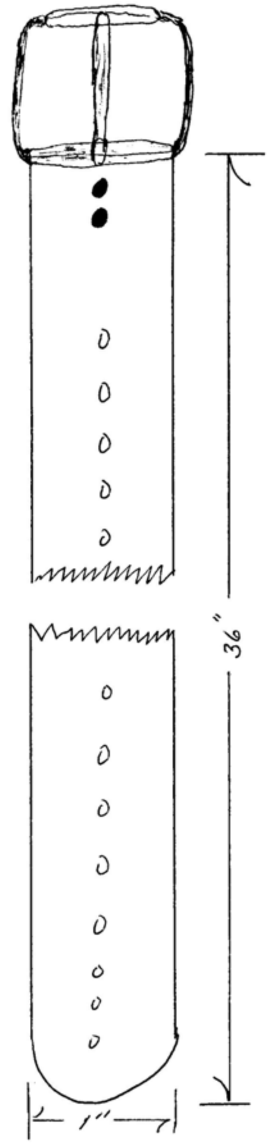

AZ Sheep Box - Front
1/4" Wire Rope
8 7/8"
7 1/2"
Expanded Metal
1" x 1" Welded Plate
1" x 1" x 2" Channel Welded Door Channel Support
12 inches
Cable Channel
1" Gap
1 1/2" x 1/8" Flat Stock
Door C Channel
Drop Panel Door
24 3/4"
22"
Angle Iron
59 1/2"
Door C Channel
1 1/2" x 1/8" Flat Stock
1" Gap
Cable Channel
15 1/4"
Angle Iron
15 1/2"
Expanded Metal
C Channel
Angle Iron
8"
Angle Iron
41 3/8"
All Angle Iron is 1 1/4" x 1 1/4" x 1/8"
All C Channel is 1" x 1/2" x 1/8"
All Bolts are Panhead 1/4" x 1"

AZ Sheep Box - Side



APPENDIX 7

Design – Hobbles

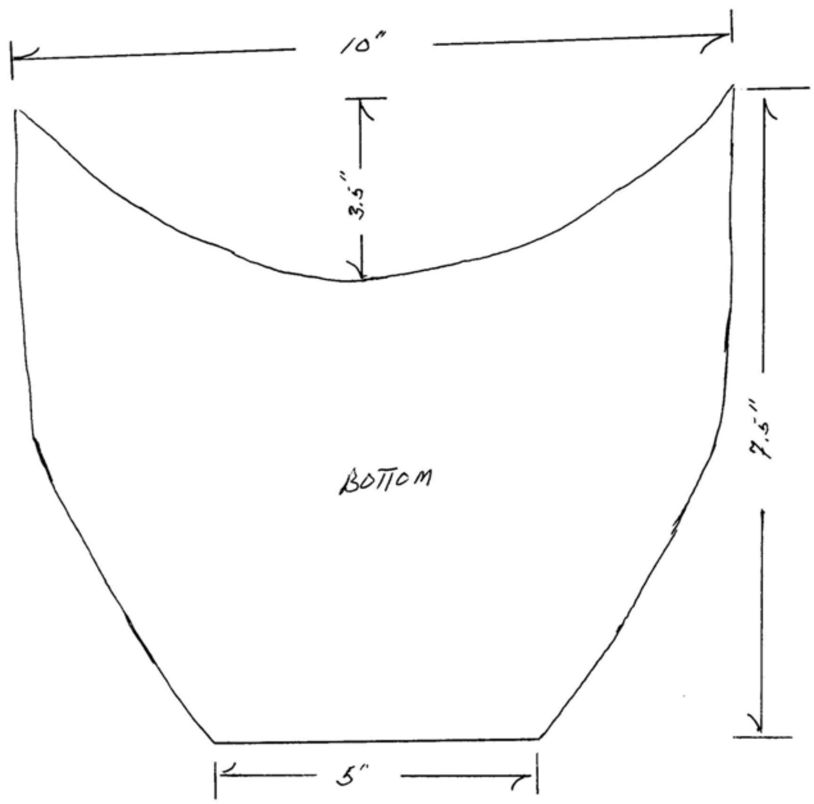


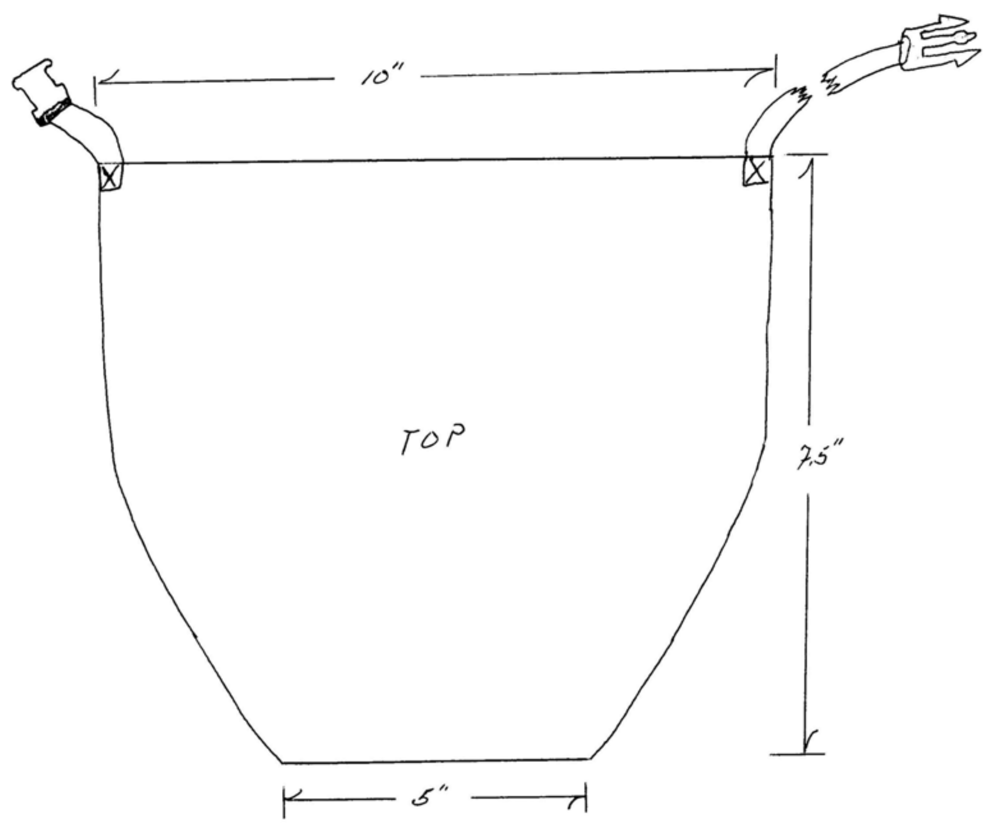
- Material: Well Oiled Leather or
  Biothane

APPENDIX 8
Design – Blindfold

Descriptive Information:

1. Material is denim or nylon
2. Straps are ½ or ¾ inches wide nylon webbing
3. Nylon quick release buckle sized to nylon webbing. Webbing strap on long end is 15 inches
4. Measurements shown are finished size

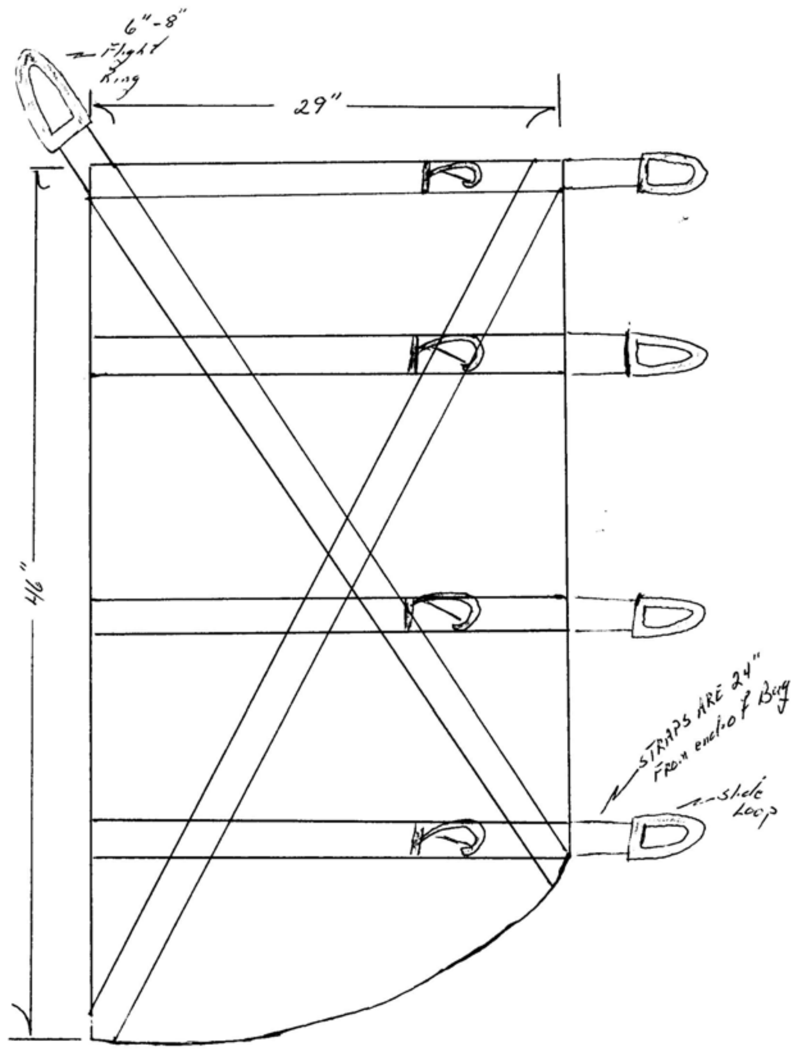



10"
TOP
7.5"
5"

APPENDIX 9
Design – Transport Bag

Descriptive Information:

1. Body of Bag made from heavy duty nylon mesh
2. Support and Flight Straps are 3” nylon webbing
3. Aircraft quality buckles and flight ring
4. Measurements shown are finished size



APPENDIX M

List of Preparers

Hart Mountain National Antelope Refuge
Final Bighorn Sheep Management Plan and Environmental Impact Statement

Appendix M. List of Preparers

Name	Position	Location
Shannon Ludwig	Project Leader	Sheldon-Hart Mountain National Wildlife Refuge (NWR) Complex
Kevin Goldie	Wildlife Habitat Biologist	Sheldon-Hart Mountain NWR Complex
Bill Bridgeland	Wildlife Biologist	Bridgeland Consulting, Retired U.S. Fish and Wildlife Service Wildlife Biologist
Jon Muir	District Wildlife Biologist	Oregon Department of Fish and Wildlife
Don Whittaker	Wildlife Biologist, Ungulate Coordinator	Oregon Department of Fish and Wildlife
Kevin Christensen	Deputy State Director	USDA – APHIS – Wildlife Services
Shane Koyle	District Supervisor	USDA – APHIS – Wildlife Services
Erica Wells	Environmental Coordinator	USDA – APHIS – Wildlife Services
Liz Cruz	Geographer/GIS Analyst	U.S. Fish and Wildlife Service
Kendra Maty	Geographer/GIS Analyst	U.S. Fish and Wildlife Service
Kevin O’Hara	Conservation Planner	U.S. Fish and Wildlife Service
Rebecca Clow	Conservation Planner	U.S. Fish and Wildlife Service
Kendal Morris	Conservation Planner	U.S. Fish and Wildlife Service
Rebecca Frager	Wildlife Refuge Specialist	Sheldon-Hart Mountain NWR Complex
John Kasbohm	Project Leader	Sheldon-Hart Mountain NWR Complex, 2011–2020
Danielle Fujii-Doe	Refuge Manager	Hart Mountain National Antelope Refuge, 2019–2020
John Owens	Wildlife Biologist	Sheldon-Hart Mountain NWR Complex, 2019–2020
Kevin Kilbride	Inventory and Monitoring Coordinator	U.S. Fish and Wildlife Service
Laurel Kullerud	Wildlife Refuge Specialist	Sheldon-Hart Mountain NWR Complex, 2015-2020
Dan Haas	Visitor Services Manager	Mid-Columbia River NWR Complex

APPENDIX N

Response to Public Comments

Hart Mountain National Antelope Refuge Final Bighorn Sheep Management Plan and Environmental Impact Statement

Appendix N. Comments Received During Public/Agency Review Period and U.S. Fish and Wildlife Service Responses

The comment period for the *Draft Hart Mountain National Antelope Refuge Bighorn Sheep Management Plan and Environmental Impact Statement* (Draft BHS Management Plan/EIS) consisted of a formal comment period for 45 days upon release of the draft EIS on April 30, 2021. The U.S. Fish and Wildlife Service (Service) received 205 comment submissions representing 18 organizations and one agency during the notice of availability public comment period between April 30, 2021, and June 14, 2021.

Comments received focused on significant issues identified through public scoping and on the alternatives developed through public input. A large proportion of comments focused on respondents' opinions toward one or more alternatives presented in the Draft BHS Management Plan/EIS for cougar control and bighorn sheep habitat management. Where the opinion expressed provided some level of detail or was based on real or perceived fact, the Service has provided a response. Where the comment expressed solely an opinion and was not supported by any assertion, the Service did not respond to the comment other than to thank the writers for expressing their opinions and thoughts.

Comments received were grouped into 10 categories based upon consideration in the Draft BHS Management Plan/EIS. These categories are: Support Alternative D (Service's Preferred Alternative), Oppose Alternative D (Service's Preferred Alternative), Bighorn Sheep Biology and Population Dynamics, Bighorn Sheep Reintroduction, Cougar Biology/Lethal Control, Habitat Management, Ecosystem and Trophic Effects, National Environmental Policy Act (NEPA) Process and Policy, Ethical Concerns, and Other. Comments as presented in this appendix have been paraphrased from the originals, and in some cases consolidated with others where the Service's response is the same.

Support Alternative D (Service's Preferred Alternative)

Comment 1. Multiple comments expressed support for the Service's Preferred Alternative (Alternative D, Comprehensive Integrated Management).

Thank you for your comments.

Comment 2. Multiple comments expressed support for lethal removal of cougars and predators proposed in Alternatives C and D.

Thank you for your comments.

Comment 3. Several comments expressed support for habitat management actions proposed in Alternatives B and D, including juniper removal and prescribed fire.

Thank you for support of the Service's view that bighorn sheep habitat improvement will address the population decline and is necessary to reach the goal of a sustainable herd. The addition of temporary cougar removal within bighorn sheep habitat is only intended to reduce predation mortality and prevent the herd from extirpation. As stated in the Draft BHS Management Plan/EIS, surveys over the last 3 years represent a 70% bighorn sheep population decline. Data collected over the last 20 years and across multiple collaring events have documented cougars as the significant and primary predator accounting for 60% to 70% of all adult bighorn sheep mortalities on the Hart Mountain National Antelope Refuge (Hart Mountain NAR, Refuge) (Section 3.3.1.14). Action is needed to address the rapidly declining sheep numbers that place the herd at significant risk of extirpation from the Refuge in the next few years if these trends continue. The Preferred Alternative (D) is a combination of management actions proposed in Alternatives B and C in which all management actions proposed in Alternatives B and C will be implemented. Section 2.5.1 and Section 2.5.2 describe specific goals, objectives, and strategies identified to support bighorn sheep integrated management. An integrated management approach is preferred considering complex interactions between habitat features and demographic factors that ultimately determine sustainability. For example, predation risk is determined not only by the number of predators present, but also by their efficiency at successful hunting, which is directly related to the structure of the habitat insofar as it provides ambush cover for the predator or visibility and escape opportunity for the prey. In the short term, improving survivorship by mitigating mortality sources is needed to reverse the bighorn sheep population decline and minimize the imminent risk of extirpation. Over the long term, management to optimize bighorn sheep habitat on the Refuge would ensure that the herd has the resources necessary to be sustainable and resilient to the environmental stressors to which it would inevitably be subjected. This alternative provides a full range of management strategies to adaptively manage the bighorn sheep herd over time and would address the need to take action in a timely manner while providing time to identify and correct habitat issues that may take decades to resolve.

Oppose Alternative D (Service's Preferred Alternative)

Comment 4. Several comments expressed opposition to lethal predator control and a preference for prioritizing habitat management and using cougar relocation. Some comments stated that predators should not be removed for the benefit of ranchers.

The Draft BHS Management Plan/EIS emphasizes and prioritizes habitat improvement as the long-term solution to the bighorn sheep population decline. However, given the current low bighorn sheep numbers, the current level of predation mortality cannot be sustained while waiting for habitat response to treatments without a high risk of bighorn sheep extirpation. Lethal cougar control is the only feasible method of immediately and effectively reducing cougar predation for the following reasons: 1) live trapping and relocating offending individuals is precluded by Oregon Department of Fish and Wildlife (ODFW) policy due to the lack of suitable release sites (cougars are widespread in the state and already occupy most suitable habitat); 2) humane considerations of the likely fate of relocated individuals (displaced cougars will be driven out of established territories, and either forced into marginal habitat or to attempt to return to their home territory); and 3) the potential to create other human-wildlife conflicts at the release sites. As stated in Section 2.3.3 of the Draft BHS Management Plan/EIS, the cougar removal proposal is limited to target only animals in bighorn sheep habitat and will be temporary until the sheep can build their numbers to a sustainable level. Cougar removal is not designed to reduce livestock depredation given that domestic livestock are prohibited on the Refuge.

Comment 89: A number of comments expressed opposition to the Preferred Alternative (Alternative D, Comprehensive Integrated Management). These comments expressed opposition to "single species management" for bighorn sheep, and the implementation of management actions that will reduce native biodiversity.

Thank you for your comments. Chapter 4 of the Draft BHS Management Plan/EIS evaluated potential effects on the physical components of the ecosystem, as well as effects on the plant and animal biological components that may result from the proposed action.

Comment 5. One comment expressed opposition to juniper removal.

Thank you for your comment.

Comment 6. A number of comments expressed support for Alternative B (Bighorn Sheep Habitat Improvement).

Thank you for your comments.

Bighorn Sheep Biology and Population Dynamics

Comment 7. Many comments expressed concern regarding the uncertainty about the cause of the bighorn sheep decline on the Refuge. The comments state that the Draft BHS Management Plan/EIS does not definitively link juniper expansion or cougar predation to the decline in bighorn sheep numbers and that it is important to address these information gaps before a predator control program is implemented.

The Service recognizes the uncertainty around the specific proximal causes of the recent bighorn sheep population decline and has developed the alternatives to address the most likely factors based on current available science and considerable site-specific information described in Sections 1.2, 2.3.3, 3.3.1.11, and 3.3.1.14, and sound, well-established wildlife management and population biology principles.

As managers in the real world faced with trying to solve a problem with imperfect knowledge of the causes, the Refuge will support natural resource management and conservation of refuge biological diversity through an iterative process that involves establishing desired outcomes with regard to the situation, taking management action to achieve desired outcomes, conducting monitoring to evaluate the effectiveness of those actions, and then determining subsequent management direction considering available scientific information. Specifically, as clarified in Sections 2.3.2, 2.3.3.2, and 2.3.4, the Refuge would develop an inventory and monitoring plan (IMP) to include annual bighorn sheep population surveys and habitat surveys that would assess and monitor effectiveness and efficacy of management actions in achieving bighorn sheep population performance. The Refuge and ODFW would convene every 6 years to assess all strategies and management actions implemented to meet habitat objectives and the bighorn sheep population performance and management action threshold objective. If it were determined during these reviews that habitat objectives or performance measures and the management action threshold were not likely to be met, then the Refuge would identify what has been learned through implementation and develop appropriate adjustments to the management actions.

Waiting for the years of study that would be required to obtain complete understanding of all the processes that caused the current situation and implications of the proposed management response carries a very high risk that the bighorn sheep will be extirpated, which is contrary to the Service's Biological Integrity, Diversity, and Environmental Health (BIDEH) policy, and would have potentially serious negative environmental and ecological effects.

Comment 8. Two comments stated that the historical decline of bighorn sheep is not shown to be related to habitat degradation or predators. The commenters stated that bighorn sheep continued to decline during periods of aggressive juniper treatments and no cougar predation was observed during the same period.

Contrary to the commenter's claims, the slow decline of the bighorn sheep population before cougar predation supports the proposal that habitat degradation occurring at that time is the root cause of the decline. The juniper removal program initiated in 2015 was intended to improve greater sage-grouse and pronghorn habitat and was, therefore, mostly done outside sheep range and did not substantially benefit them. There is also no reason to expect the decline to be linear and perfectly correlated with changes in the habitat features because other factors such as drought cycles and sheep social and demographic dynamics can interact to confound any direct correlation. For example, the sheep might tolerate (not show a population response) a steady decline in habitat quality for years until a prolonged drought reveals the loss of resilience and causes breeding failure. As cougars became more abundant in the region, their effect on the small sheep population became more profound as demonstrated through two separate bighorn sheep collaring studies from 2004 to 2007 and 2019 to 2021(Sections 3.3.1.4 and 3.3.1.14). We refer the commenter to Chapter 2, and particularly Section 2.3, for a detailed explanation of the rationale for the proposed management approach.

Comment 9. One comment suggested that the Service consider mineral supplementation to address selenium deficiencies in the bighorn sheep population.

See Draft BHS Management Plan/EIS Section 3.3.1.17 for an extensive discussion of potential selenium deficiency. As explained, all criteria for healthy selenium levels in sheep are based on domestic sheep, and the fact that bighorn sheep is a native species that thrived in selenium-deficient landscapes for centuries is compelling evidence that wild bighorn have adapted to these conditions without artificial supplements.

Comment 10. A few comments stated that all contributing factors should be considered when evaluating bighorn sheep decline. Comments suggested that cougar-specific mortality should be considered in context with all other factors causing bighorn sheep decline.

The Draft BHS Management Plan/EIS enumerates and considers multiple factors in Section 3.3.1 that could be contributing to the decline, including habitat condition, predation, water availability, disease, and other factors. Although Section 3.3.1 appropriately looks at individual factors, it does consider the individual factors in context with others. As an example, the section on habitat (Section 3.3.1.5) discusses connections between habitat factors such as escape terrain, vegetative structure, and predation risk; and proximity of forage areas to escape terrain, visibility, and predation risk. Additionally, in Sections 3.3.1 and 3.3.1.5, the connection of water availability to escape and lambing terrain is detailed as a potential limiting factor on Poker Jim Ridge. Disease was closely examined, and selenium and genetics were evaluated and discussed, but none were found to be a cause in the bighorn sheep population decline. Finally, 3.3.1.11 and 3.3.1.14 detail cause-specific cougar predation affecting the bighorn sheep population. The Preferred Alternative addresses the contributing factors and offers the best chance for the bighorn sheep herd to recover.

Comment 11. A few comments questioned the minimum viable bighorn sheep population number used in the Draft BHS Management Plan/EIS. Some comments questioned why disease was factored into the minimum viable population number (raising the suggested number to 170 from 125) when disease is shown to be uncommon in the population. One commenter suggested a minimum population goal should be set at 1,000 individuals.

The minimum viable population number was discussed in Section 1.3.1 to illustrate how this concept for large mammal populations is considered in the peer-reviewed scientific literature, and that the current population on the Refuge is well below the theoretical minimum, and thus in jeopardy. As stated, 170 is not a minimum viable population objective but a reasonable estimate of how large the herd should be (assuming it meets the other performance criteria for birth rate, survivability, and growth) in order to sustainably tolerate some predation pressure from cougars and other environmental factors and justify the ending of cougar removal. This reasonable estimate, or threshold, is based on both ungulate biology literature and the history of the Refuge herd, which has declined (due to poor population performance) recently in spite of experiencing population spikes near 170 in 2013 and 2016. Therefore, the population threshold was conservatively set at 170 bighorn sheep in combination with the population performance criteria.

There is no indication that disease has played a significant role in the observed recent decline of the bighorn sheep population, and there is no evidence that serious diseases are present. However, there are many documented cases of diseases such as pneumonia suddenly infecting and resulting in significant mortality in local populations. It is therefore prudent that the management plan includes ongoing disease monitoring and a plan of action should serious disease be detected in the future. Disease was only factored into the minimum viable population number based upon peer-reviewed literature and the *potential* for disease to enter the population.

The suggestion by one commenter that based on Traill et al. 2010, the minimum population goal should be set at 1,000 is unreasonable because there is no indication that the population was ever that high, or that even if all of Hart Mountain was ideal bighorn sheep habitat, it could support that many bighorns. Indeed, if 1,000 individuals were necessary for a sustainable population, few, if any, bighorn sheep populations throughout their entire range could be considered sustainable in spite of their long-term persistence and current apparent health.

Comment 12. One comment stated that the bighorn sheep population action thresholds in the Draft BHS Management Plan/EIS are not taking normal population fluctuations and long-term predator prey dynamics into account.

The Service recognizes the dynamic nature of predator-prey relationships and interactions with other ecological factors. No management decisions about cougar removals under the proposed plan will be made based on a single year's conditions or measurements. As discussed in Section 1.3.1, population size or trends as standalone measures are proven to be insufficient as a base for management goals or objectives because environmental stressors and management actions do not affect population size directly; rather, they directly affect the vital rates of the population, and through vital rates, affect the population size and population trend. Vital rates such as population growth, adult survival, and lamb to adult ratios are measurable rates that can be derived from surveys and field data to determine population performance.

As discussed in Section 3.3.1.10, vital rates provide valuable information, but there is still some uncertainty built into conclusions drawn from them. Using 3-year averages of vital rates compensates to some degree for annual variability. Uncertainty is further reduced when multiple vital rates are monitored simultaneously, each contributing unique information that can be combined for a more holistic view of the population status.

As stated in Section 2.5.2, Objective 2.1, all criteria used as management triggers are based on 3-year averages to allow for natural annual variations and avoid misinterpretation of trends. Furthermore, continued monitoring of vital rates and other criteria after any decision to change management direction will permit reconsideration of any decision.

Comment 13. Two comments asked for clarification on how the population objectives will be used to implement action and why the population objectives were chosen. One of the commenters asked if the criteria would need to be met for 3 years, and how the running average would be calculated.

The Service made clear distinctions between management action thresholds and population objectives in Section 2.3.3.1 and no additional information was provided in the comment to alter the analysis. The Draft BHS Management Plan/EIS does not define a set population objective, but it has established a management action threshold, which is a minimum number of bighorn sheep that must be present on the landscape to initiate or suspend management strategies, as discussed in Section 2.5.2. The 170 number is referred to as the management action threshold to set it apart from a population objective. As discussed in Section 1.3.1, population size or trends as standalone measures are proven to be insufficient as a base for management goals or objectives because environmental stressors and management actions do not affect population size directly; rather, they directly affect the vital rates of the population, and through vital rates, affect the population size and population trend. Vital rates such as population growth, adult survival, and lamb to adult ratios are measurable rates that can be derived from surveys and field data to determine population performance.

As discussed in Section 3.3.1.10, vital rates provide valuable information, but there is still some uncertainty built into conclusions drawn from them. Using 3-year averages of vital rates compensates to some degree for annual variability. Uncertainty is further reduced when multiple vital rates are monitored simultaneously, each contributing unique information that can be combined for a more holistic view of the population status. These three vital rates taken together are sufficient to indicate whether the population is responding to management actions as intended. The addition of an estimate or index of population size (e.g., 170 observed animals averaged for 3 consecutive years) that can serve as a management action threshold would establish the minimum necessary for the population to achieve sustainability over a long period of time, ensure that management actions are not prematurely ended, and validate strategies taken to ensure population performance measures are sufficiently met. Using this suite of indicators of the population performance will minimize the chance that the cougar removal program would be suspended prematurely and then be reinstated if the criteria fail to be met again as the cougar population recovers.

As discussed in 2.3.3.1, lethal control of cougars would be conducted only when all four of the following conditions exist: the 3-year moving average of the bighorn sheep population growth rate is <1.0, the 3-year moving average of annual adult survival is <80%, the 3-year moving average of lamb to adult ratio at recruitment age is <30:100, and the bighorn sheep population is below a 3-year moving average of 170 observed animals. The use of 3-year averages would not necessarily require that a vital rate would need to meet the minimum measures for 3 successive years; rather the average of the most recent 3 years' vital rate values met the measures. This way, if the most recent value greatly exceeded the measure, it could potentially compensate for a value below the measure in a previous year and bring the average up to the measure (e.g., 2022 lamb:adult ratio = 18:100, 2023 lamb:adult ratio = 22:100, and 2024 lamb:adult ratio = 20:100). The resulting 3-year average lamb:adult ratio = ((18+22+20)/300)*100 or 20 lambs:100 adults. Administrative cougar removal would be suspended after all population performance measures and management action threshold are met for a 3-year moving average, but it could be reinstated if all the measures fall back below the thresholds.

Using all three population performance measures and management action threshold as decision criteria verifies response in the bighorn sheep population and prevents prematurely starting or stopping cougar control. Cougar control will not be suspended until all bighorn sheep population performance and management action threshold criteria are met, signifying the population is reaching sustainable levels and will be resilient to normal environmental conditions. Conversely, cougar control will only be initiated if all population performance measures and management action threshold fall below performance criteria indicating the bighorn sheep population is trending toward unsustainable levels.

Comment 14. One comment stated that the Refuge should consider bighorn sheep immigration and emigration as a factor in population decline.

Although emigration from Hart Mountain has not been observed and is not suspected by ODFW because of lack of evidence, the Service acknowledges that some undetected movement by some individuals is possible. The Service addressed this topic in Section 3.3.1.7 and pointed out two separate collaring studies in 2010 and 2019 that did not document bighorn sheep emigrating from the Refuge. In addition, ODFW has not documented previously unaccounted for bighorn sheep populations near or around the Refuge during annual aerial surveys, which suggests that bighorn sheep on the Refuge are not emigrating.

Comment 15. One comment expressed concern that management for a transplanted species, bighorn sheep, will harm other species within the habitat that cannot be transplanted.

Hart Mountain NAR was established for the purpose of conserving pronghorn and other wildlife species, including bighorn sheep and cougars, which are native to Oregon and the Refuge. The highest priority for resource management and conservation comes from an individual refuge's establishing purpose. The purpose must form the basis for planning and management decisions on units of the National Wildlife Refuge System (Refuge System). The National Wildlife Refuge System Administrative Act (NWRSAA) states that the purposes of a refuge are "specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit." The NWRSAA, as amended, also legally mandates the maintenance, and where feasible, restoration of biological integrity, diversity, and environmental health on an established refuge within the Refuge System (16 USC 668dd). Biological integrity is the "biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities" (601 FW 3). The Refuge must be managed for the purpose for which it was established and for biological diversity and integrity, which includes managing for native plant and animal communities.

The California bighorn sheep, an iconic species native to Oregon and Hart Mountain NAR, was extirpated from the state by 1912. The species was successfully reintroduced in 1954 when 20 bighorn sheep were translocated to the Refuge. The loss of the Refuge bighorn sheep population would represent a disturbance to historical ecological interactions between a native species (bighorn sheep) and other species, in contradiction to the Service's BIDEH policy. The loss of bighorn sheep would ultimately be detrimental to associated predator populations over the long term, as well as to ecological processes. The alternatives presented in the Draft BHS Management Plan/EIS do include bighorn sheep habitat improvement actions that will have minor detrimental effects on species that benefit from juniper expansion, increased dominance of invasive plant species, and increased frequency/intensity of fires, but these are species that are not in any danger of decline because these ecological processes are widespread in the region. The proposed management actions are designed to have no significant negative effects on other declining species in need of conservation (for example, greater sage-grouse and pygmy rabbit) through measures such as avoiding soil or vegetation disturbance in healthy, intact old-growth juniper woodlands and sagebrush communities; avoiding damage to soil crusts; improving water retention; avoiding disturbance in occupied pygmy rabbit habitat; aggressively restoring disturbed soils; and conducting fieldwork outside of songbird breeding season. Any harm to other native species, as detailed in Chapter 4, will be temporary and minimal enough to permit quick recovery. No species would be lost as a result of implementing the alternatives, except likely bighorn sheep under the No Action Alternative (Alternative A).

Comment 16. One comment stated that the full array of adverse cumulative effects should be assessed, including the stress to bighorn sheep caused by military plane overflights.

The effects of the proposed alternatives on bighorn sheep are analyzed and presented in Section 4.3.1. Cumulative effects of the proposed action are presented in Section 4.7.2 and analyze cumulative effects of the proposed actions on cougars, bighorn sheep, and bighorn sheep habitat. Although Hart Mountain airspace is used for military overflights, military overflights have shown to have little effect on bighorn sheep behavior (Krausman et al. 1998).

Comment 17. One comment stated that if bighorn sheep were extirpated from the Refuge, there would be no adverse consequences to the ecosystem or the flora and fauna of the Refuge.

The Service strongly disagrees that the bighorn sheep have no ecological role to play on the Refuge. Their important roles in the community include providing food for predators and scavengers, and maintaining plant diversity with their foraging habits that benefit pollinators and other herbivores. Their ability to occupy steep and rugged terrain that few other species can exploit adds to the overall productivity of the landscape. The Refuge must manage for the purpose for which it was established and to maintain biological diversity and integrity, which includes managing for native plant and animal communities. The California bighorn sheep, an iconic species native to Oregon and Hart Mountain NAR, was extirpated from the state by 1912. The species was successfully reintroduced in 1954 when 20 bighorn sheep were translocated to the Refuge. The loss of the Refuge bighorn sheep population would represent a disturbance to historical ecological interactions between a species native to the Refuge (bighorn sheep) and other species, in contradiction to the Service's BIDEH policy. The loss of bighorn sheep would ultimately be detrimental to associated predator and scavenger populations over the long term, undermining the Refuge's biological integrity. Furthermore, if bighorn were extirpated from the Refuge, reintroduction would be costly, and it would not be prudent if the causes of extirpation were not addressed.

Comment 18. A few comments suggested that recreational hunting of bighorn sheep should be prohibited on the Refuge.

Under the NWRSAA, as amended, hunting is considered an appropriate wildlife-dependent use of National Wildlife Refuges and is to be facilitated where compatible. Hunting for bighorn sheep is permitted on Hart Mountain NAR, in line with state seasons and regulations. ODFW sets limits on numbers of tags issued for bighorn sheep management units based on population size and objectives in its BHS Management Plan. Currently, ODFW has suspended the bighorn sheep hunt for the management unit that includes Hart Mountain NAR and is issuing no tags due to the Refuge's extremely low bighorn sheep population.

Comment 19. One comment noted that predator control does not address the underlying reasons for bighorn sheep decline. The comment stated that the literature shows that bighorn sheep populations are in decline due to hunting, disease from domestic sheep, resource competition from livestock, and loss of habitat.

The Service agrees that the bighorn sheep decline over their range in North America is due to multiple factors. However, the Refuge is responsible for managing the Hart Mountain herd, which is subject to specific stressors that may or may not be consistent with other populations. Development of the alternatives involved intensive considerations of the specific issues relevant to the Hart Mountain herd and focused on those that are subject to Refuge management. Hunting is highly regulated and has not been a significant source of mortality, but it is suspended nonetheless; disease has been investigated and is not implicated in the recent decline but will continue to be monitored;

and there are no competing livestock using the Refuge. Loss and/or degradation of habitat is considered the primary cause of the herd decline, making it vulnerable to uncontrolled cougar predation as described in the Draft BHS Management Plan/EIS. The Preferred Alternative is designed to address the specific threats to the continuing existence of the Hart Mountain bighorn sheep herd.

Bighorn Sheep Reintroduction

Comment 20. Many comments suggested that herd augmentation should be considered as an alternative or as part of Alternative D (Comprehensive Integrated Management) to help immediately increase the population numbers.

The Service considered bighorn sheep augmentation in Section 2.3.3.2 of the Draft BHS Management Plan/EIS and it is included in both Alternatives C and D. No additional information was provided in the comments to alter the analysis.

Cougar Biology/Lethal Control

Comment 21. Multiple comments stated that predator control disrupts cougar social structure and risks causing further declines in the Refuge bighorn sheep population. One comment stated, "It is well grounded in science that high male mortality in mountain lions (considered at 35 percent) results in a shift in the sex/age structure of the mountain lion population towards numerous younger, infanticidal, immigrant males (Robinson et al. 2008; Keehner, Wielgus, and Keehner 2015; Keehner, Wielgus, Maletzke, and Swanson 2015)."

The proposed cougar removal described in Alternatives C and D is not intended to eradicate cougars from the Refuge, or on a broad scale. Removal would not target male cougars, but rather target only cougars that are present within the bighorn sheep habitat (the Bighorn Sheep-Cougar Management Zone [BSCMZ]) and therefore likely preying on sheep. Cougars that predominantly prey on other species are not likely to spend much time in bighorn sheep habitat, and therefore are unlikely to be targeted by the removal program. Since both male and female cougars will be removed as they are encountered in the BSCMZ, the effects of skewing the sex ratio as mentioned will be minimized, and any intraspecific mortality will be limited by the small number of cougars that will use the area relative to the entire ODFW's Cougar Management Zone F (Zone F) and will contribute to the goal of reducing predation on the bighorn sheep. See the response to Comment 22 for an explanation of why the cougar removal program is unlikely to result in the segregation of sexes and prey selection reported by the authors cited by the commenter.

Comment 22. A few comments suggested that a study should be conducted to determine the immigration rates of cougars on and around the Refuge. The comments also suggested that the study assess the impact of immigration on prey switching caused by changes in sexually segregated habitat use.

Cougars have not been hunted on the Refuge since it was established, nor have there been significant sources of anthropogenic mortality from other causes such as road strike or wire/fence entanglement, so there is no reason to suspect that there has been an artificially high turnover of resident males resulting in female segregation to avoid infanticidal immigrating males. Cougar hunting and depredation control has occurred elsewhere in Cougar Management Zone F, so if there has been high male turnover, it likely happened off-Refuge and was facilitated by emigration from the Refuge. Further, although some seasonal elevational migration is known to occur by both mule deer and bighorn sheep, the existing elevational range on Hart Mountain does not result in the degree of segregation between the two species that is necessary for the phenomenon reported by Wielgus et al. (2013) where segregated female cougars preferentially prey on the secondary, rarer prey (i.e., bighorn sheep). Therefore, the situation on Hart Mountain is very different from that of the Selkirk Mountains and other areas where the counterintuitive result of removing male cougars leads to increased predation on the rarer prey. See also the response to Comment 21 relating to the non-targeting of male cougars under the proposed plan.

Comment 23. Multiple comments stated that habitat management actions should align with the "native community restoration" approach in the *1994 Hart Mountain National Antelope Refuge Comprehensive Management Plan* (CMP), specifically in relation to mule deer. The comments also stated that restoration actions should benefit mule deer to increase the prey base for cougars.

The Draft BHS Management Plan/EIS and its purpose and goals are entirely consistent with the principles promulgated in the Refuge's CMP, in that the Draft BHS Management Plan/EIS is a response to the urgent conservation need of a member of the native community (bighorn sheep). The analysis of the proposed approach considered impacts on other native species and determined that it avoids unnecessary significant detrimental effects. It is expected that mule deer will benefit by modifications to bighorn sheep habitat because they do share some resources and habitat preferences. However, mule deer range is not centered on escape terrain, as bighorn range is, and therefore mule deer are much more widespread and numerous. There is consensus that mule deer in the region have declined in recent decades, but they are not considered threatened in and around the Refuge, as are bighorn sheep. It is conceivable that successful management that improves mule deer habitat would result in more deer and perhaps lessen the predatory pressure on bighorn sheep, but it is also possible that more deer would support more cougars, and pressure on the sheep would not change. Also, any effort to increase the mule deer population would take many years to have an uncertain effect on bighorn sheep that urgently need help, and it would necessarily be a much larger effort since it would have to affect a significant portion of the much larger mule deer range.

Comment 24. Multiple comments suggested that the Draft BHS Management Plan/EIS consider an alternative that includes cougar management at a landscape scale by assessing and evaluating all cougar populations in ODFW's Cougar Management Zone F.

The Draft BHS Management Plan/EIS considered population-level biology of the cougar removal plan in Sections 3.3.2.4, 3.3.2.8, and 3.3.2.9; and discusses plan effects on the cougar population in Sections 4.3.2.1 and 4.3.2.2. These considerations are based on the fact that direct effects on cougars will only occur in the BSCMZ, which includes a small portion of the regional cougar population relative to the extent of their range over Zone F. The Service acknowledges that it may support a disproportionate segment of the cougar population due to the density of prey and the availability of rugged terrain preferred by cougars, but there are other such concentrations of prey and habitat within the Cougar Management Zone (e.g., Steens Mountain, Warner Mountains, and Beatys Butte). Nonetheless, the number of cougars using the BSCMZ in a given year is likely well under 10% of the Zone F population (12 to 16 out of 300), and the removal program will undoubtedly not be able to remove all the cougars that pass through the area. Although it would be desirable to have the information obtained by a comprehensive study of cougar movements and demographics over the entire Zone F, given the scope and scale of the temporary proposal to remove select cougars, this information is not necessary to conclude that the population-level impact will not be significant in the long term. In addition, the Service only has jurisdictional authority on the Refuge.

Comment 25. Multiple comments stated that the Draft BHS Management Plan/EIS does not fully evaluate the effects of lethal removal of cougars on gender dynamics, sex segregation, and sex ratio of the cougar population on the Refuge.

See the response to Comments 21, 22, and 24 that addresses why the situation on Hart Mountain NAR precludes the phenomenon reported by Wielgus et al. (2013). In summary: the range of elevations existing on the Refuge and the corresponding seasonal movements of bighorn sheep and mule deer do not result in significant or persistent segregation of the prey species. Therefore, there is little or no opportunity for female cougars to segregate by elevation away from immigrant males and prey more exclusively on sheep. In addition, the cougar removal program does not target males over females and will be focused on removal during the fall and winter months (August 1 to March 31, Section 2.3.3) when there are fewer females with dependent young (Section 3.3.2.7). Any removals outside that time will only occur if a cougar kill can be confirmed and the offending cougar can be associated with the kill.

Comment 26. Multiple comments stated that the cougar population estimate used in the Draft BHS Management Plan/EIS is inaccurate and therefore it is impossible to determine an accurate environmental baseline to assess environmental impacts. The comments specifically questioned the inclusion of all age classes in population estimates and inconsistencies between different agencies' population numbers.

The Service used the most current cougar population estimate published by ODFW and no additional information was provided in the comments to alter the analysis in the Draft BHS Management Plan/EIS. Refer to the responses to Comment 24, which explain why more precise size and sex/age ratios of the cougar population of Zone F of the Refuge are not necessary to evaluate the potential impact of the cougar removal program because it targets such a small proportion of the regional population, will not remove all cougars in the BSCMZ, and is temporary.

Comment 27. Two comments stated that the Service does not sufficiently estimate the number of cougars that will be killed under the proposed action.

The Draft BHS Management Plan/EIS discusses the population-level effects of the cougar removal program in Section 4.3.2.1, including describing a worst case scenario of how the unlikely removal of all the cougars that visit the BSCMZ each year might affect the regional population. It explains that the maximum number of cougars that might be removed per year of the program is about 10% of the ODFW annual quota of deaths from all causes in Zone F that could be sustainably tolerated, based on ODFW population model estimates of the Zone F population. Acknowledging that the estimates may be erroneous, they nevertheless are based on the best data available, and there is every indication that the cougar population has remained healthy under current management. The main point is that even if the estimates are off by a factor of three, the actual known deaths in Zone F have remained below 1/3 of the quota and would likely not exceed that amount even if the Refuge cougar removal program managed to remove 12 to 16 cougars per year for the duration of the program because those removals would count toward the quota. This is the basis for the conclusion that the removal program does not reach the scale of impact to the cougar population that would be significant in the long term, even if the population estimates are grossly overstated, and why a more precise estimate would be unlikely to change that conclusion.

Comment 28. Multiple comments stated that the Draft BHS Management Plan/EIS is missing an analysis of the effects of external, off-Refuge conditions on cougar density and population dynamics. The comments noted how habitat differences, prey dynamics, and immigration surrounding the Refuge may impact how the Refuge's cougar population would be impacted by predator control.

The Draft BHS Management Plan/EIS in Section 3.3.2.8 cites the 2017 ODFW Cougar Management Plan's (ODFW 2017) description of cougar distribution in Zone F: "there are areas within Zone F that support more diverse habitats and higher densities of prey, such as the Refuge" relative to the majority of Zone F, which is open grassland and shrubland, mostly supporting livestock and low densities of native prey. Although the Refuge supports a higher than average cougar density, it is by no means unique in Zone F, and most cougars in the region exist outside of the Refuge. If cougar removal from the BSCMZ on the Refuge creates a local “sink” as explained in Section 4.3.2.1, receiving dispersing cougars at a higher rate than before, one probable result would be fewer young cougars from the surrounding areas would be forced into marginal habitat outside the Refuge where they may cause livestock depredation. The prospect raised by the commenter of immigrating cougars overwhelming the removal program, resulting in increased bighorn sheep mortality, seems highly unlikely because the Refuge would respond by increasing cougar removal, and cougar density would be regulated by normal territorial behavior of male cougars.

Comment 29. Multiple comments stated that lethal removal of cougars could extirpate cougars from the Refuge.

See the responses to Comments 24 and 27. Extirpation of cougars on the Refuge, or at any scale, is not part of the Draft BHS Management Plan/EIS, intended or unintended. Also, management by ODFW of Zone F cougars with annual quotas set (and never reached) below 14% of the estimated population addresses the stated concerns about population sustainability. Cougars removed on the BSCMZ portion of the Refuge would be counted toward the annual take quota, so ODFW would limit hunting take if the total human-caused mortality reached the quota. Cougar removal within the BSCMZ would not extirpate cougars from the Refuge, and it may result in cougars avoiding the BSCMZ in favor of other parts of the Refuge where they would not be subject to removal activities.

Comment 30. Several comments stated that cougar population numbers change with prey abundance on a 4-year time lag (Laundré et al. 2007). The comments suggested that the Refuge’s cougar population may be in the midst of this cycle and that predator control would disrupt this natural equilibrium process, causing detrimental impacts to the cougar population.

Laundré et al.’s paper (2007) reports on a study of a cougar population with one main prey species (deer) that experienced a short-term drastic decline, and then a slow recovery. The bighorn sheep on the Refuge are experiencing an ongoing decline due to a dangerously low number, and Hart Mountain cougars prey primarily on mule deer and secondarily on bighorn sheep. Many studies, including reports from Wielgus and colleagues, document cougars depleting the population of a secondary prey while presumably being in equilibrium with the total prey base (i.e., being supported by the primary prey species) (see Section 3.3.2.9 and response to Comment 32 below). In this case, the Service believes cougar predation on the small bighorn sheep population has the potential to result in the extirpation of bighorn sheep on the Refuge, in conflict with the Refuge objective of managing to preserve native biological communities.

Comment 31. Multiple comments suggested that lethal removal of cougars may not decrease cougar population density on the Refuge but would exacerbate threats to bighorn sheep due to increased cougar immigration from other source populations (Robinson et al. 2008).

The Service recognizes that the cougar removal program is unlikely to remove all cougars from the BSCMZ and therefore eliminate cougar-caused mortality to bighorn sheep. The object of the program is to reduce the predation mortality enough to prevent extirpation of the bighorn sheep herd as habitat conditions improve in response to management. The Draft BHS Management Plan/EIS fully acknowledges in several sections the likelihood that cougar immigration will occur and may be accelerated by removal of residents. However, the situation described in Robinson et al. 2008 is significantly different than what is proposed in the context of the Refuge and its surroundings, making the applicability of the authors’ conclusions and recommendations tenuous. For example, the landscape and habitat characteristics were very different, the hunting intensity in and around the study area was different, and the density and distribution of cougars was different; all of which could affect the dynamics of the cougar response. In any case, there will be a time lag between the removal of one cougar and its replacement, and during that time there will be one less cougar taking bighorns. Given that a cougar specializing in bighorn sheep can potentially kill a sheep every week, the time lag can result in significant reduced mortality, as intended. Also, Section 2.3.3.2 of the Draft BHS Management Plan/EIS discusses how the Refuge, in consultation with ODFW, would evaluate the progress and efficacy of management actions relative to bighorn sheep performance measures every 6 years after strategy implementation begins. Section 2.3.3.2 further elaborates that the Refuge will determine if management actions, including cougar control, are trending toward or meeting population performance objectives and will determine if cougar removal will continue based upon population metrics relative to performance measures and management action threshold. If the Refuge determines that thresholds for all performance measures and management action threshold are not likely to be met, the cougar management strategies will be evaluated for adjustment, and could include termination of cougar control and new or adjusted cougar management actions. The Refuge does not intend to continue a demonstrably ineffective program, should that become the case.

To address the point that the removal program might increase predation on declining secondary prey elsewhere, there are no secondary prey elsewhere on the Refuge. Mule deer are the primary prey, with bighorn sheep being secondary. Finally, the proposed removal of cougars from bighorn sheep habitat would be unlikely to cause human and livestock conflicts because there are no livestock on the Refuge, and although human/wildlife interaction can occur, there is no record of cougar conflicts occurring on the Refuge and the chances for such a conflict remain small.

Comment 32. A few comments questioned the use of lethal removal of cougars at Steens Mountain and Warner Cougar Target Area as examples of successful predator control programs. The comments questioned the use of Steens Mountain as an example because the program did not have the desired impact of increasing the mule deer population. The comments also questioned the efficacy of ODFW's cougar control program in the Warner Cougar Target Area in increasing mule deer populations.

The 2006 Oregon Cougar Management Plan created a tool for wildlife managers known as a "cougar target area." This is an area where ODFW staff or agents reduce the cougar population over a 3-year period. Each area has an annual quota, and ODFW staff or agents can remove cougars of any age or sex up until that quota is reached. Cougar reduction programs were initiated at both Steens Mountain Big Game Unit and Warner Big Game Unit to benefit mule deer, cougars' primary prey species, with limited success; however, in both cases there was a documented increase in the respective bighorn sheep herds that corresponded with the cougar removal programs (ODFW unpublished data, 2021). This experience supports the proposed cougar removal plan on Hart Mountain, where cougars supported by their primary prey of mule deer are able to maintain predation pressure on the rarer secondary prey species (bighorn sheep) with the potential to extirpate the bighorn herd because of its small population. ODFW observed an increase in survival of bighorn sheep males and lamb recruitment during the cougar removal period (ODFW unpublished data, 2021) at Warner, which are two of the three population performance measures proposed as criteria for success on the Refuge. Also, in Oregon, a 3-year cougar removal program in the Heppner Unit of Zone F corresponded with an increase of elk calf survival (ODFW, unpublished data, 2021) as intended, which again demonstrates the benefit of cougar removal to a secondary prey species (elk, in this case), as expected in the Hart Mountain situation. Within a few years of stopping the Heppner Unit cougar removal program, calf recruitment declined again. In summary, cougar removal has been shown to be successful at allowing the secondary prey species to recover; see the Rominger (2018) paper citing many examples, and the discussion in Draft BHS Management Plan/EIS Section 3.3.1.14. The text in Section 3.3.1.8 was modified from the Draft BHS Management Plan/EIS to clarify the experiences at Steens Mountain and Warner Cougar Target Area.

Comment 33. A few comments stated that predator control methods, specifically the use of hounds, have detrimental impacts to non-target wildlife and prey species.

Section 2.3.3 Alternative C, discusses the aspects of species population management that are also incorporated in Alternative D. Chapter 4 discusses the potential effects that could or would be likely to occur for cougars and other wildlife species. Table 4.3 summaries the effects for each alternative showing that although some negative effects are likely to occur, they are expected to be of short duration and/or at low intensity.

In the study reported by Grignolio et al. 2011, the researchers looked at the effects of hunting pressure that occurred external to a protected area in Italy and the observed results that the hunting had on wildlife distribution or use (home range) of the protected area. In addition to hunting deer, which showed lower impacts, they also documented the effects from using dogs during swine hunting and rabbit hunting. Unlike the hunting that occurs adjacent to or within Hart Mountain NAR, their swine hunting occurred over 4 months, 3 days a week, with a minimum of 25 hunters, up to 50 hunters in large groups, hunting with many hounds in those groups. The rabbit hunting occurred over 5 days of the week for 2 of the same overlapping months of fall/winter, with minimally one hunter but often more, and up to three hounds per hunter.

The research identified and categorized the habitat inside and outside the protected area. They correlated the movements of radio-collared deer in relation to the hunting activity and found higher densities and movement (home range) of deer in the protected areas during the hunting season. The habitat within the protected area was more diverse and had denser cover. However, they did not evaluate the seasonal movements and use of forage by deer independent of the potential hunting pressure. Although some pressure is likely to be observed, it is hard to conclude how much of the movements were caused by hunting pressure versus seasonal movements to use different forage and cover types.

In Oregon, recreational hunting of cougars with hounds is prohibited. Dogs are used by bird hunters, but neither the type nor behavior of the dogs, nor the number or intensity of the dog use would be comparable to the study mentioned. Without the use of dogs, cougar hunting is much more challenging and hunters who are successful in shooting a cougar most often do so opportunistically while hunting other big game. The use of dogs to pursue cougars that depredate livestock is site specific and occurs over a short period. With the prohibition on using dogs for recreational cougar hunting, and minimal use of dogs to pursue cougars depredating livestock off-Refuge, pressure on cougars from dogs in the Refuge area is not likely to be significant. The proposed use of dogs by professional hunters to pursue cougars in limited portions of Hart Mountain NAR is not comparable to the Grignolio et al. (2011) study in scale or scope. Section 2.3.3 of the Draft BHS Management Plan/EIS identifies measures and standard operating procedures (SOPs) to be implemented to "reduce or eliminate unwanted environmental effects." When used by professionals in accordance with the best management practices (BMPs) outlined in the Draft BHS Management Plan/EIS, the effects of using hounds are expected to be of short duration and low impact.

Comment 34. Two comments stated that the Draft BHS Management Plan/EIS fails to fully examine the effects of mule deer population decline on the cougar and bighorn sheep predator-prey relationship.

The Service recognizes the complexity of the predator-prey relationships on the Refuge in multiple sections of the Draft BHS Management Plan/EIS and is legally committed to manage to conserve the predator-prey relationship. The potential role of mule deer in influencing the decline of the bighorn sheep, and the effects of cougar management on mule deer are discussed in Sections 3.3.2.9, 3.3.4, 4.3.2.2, and 4.3.3. See also the response to Comment 23, which explains why managing to increase the mule deer herd at this time would not adequately address the need and purposes of the bighorn sheep plan.

Comment 35. One comment stated that, "[The Service] claims to install signs at all refuges where trapping occurs [but] the draft plan makes no mention of signage to protect the public from traps placed for mountain lions."

See Section 2.3.3. "Conspicuous, bilingual warning signs alerting people to the presence of traps and snares are placed at major access points when they are set in the field."

Comment 36. Multiple comments suggested that the Draft BHS Management Plan/EIS fails to consider individual cougars specializing in bighorn sheep predation and the targeted removal or relocation of these individuals as a management alternative. Some of the comments questioned the Service's reasoning in the Draft BHS Management Plan/EIS that determined a relocation program was unfeasible.

See Section 2.4.2. Live capture and relocation of cougars occupying Refuge bighorn sheep range is a potential safety issue for people living, working, or recreating in the relocation area and is prohibited under existing ODFW policies. In addition, the survival of cougars that are captured, transported, and released into an unfamiliar area that is likely to be occupied by resident cougars is doubtful. Relocation often ends in the severe injury or death of either the relocated or resident cougar in that territory, or both. In addition, cougars are able to travel great distances in an attempt to return to their home range, raising serious questions about the practicality and effectiveness of relocating cougars.

See Section 2.4.4. Individual cougars can exhibit prey preference even if there are multiple prey species available. Consequently, removing only cougars that prefer taking sheep, while leaving those that prefer other prey such as mule deer, might appear to be the most beneficial to bighorn sheep while minimizing impacts to the cougar population. Certainly, professional hunters would target cougars that that have been confirmed to prey on bighorn sheep when the opportunity arises. But in practice, identifying individual cougars that prey on bighorn sheep would require extensive time and budget resources to capture and GPS collar all cougars that might use bighorn sheep habitats on the Refuge, detect and promptly ground-confirm every collared cougar that may have killed a bighorn sheep, and then track, recapture, and remove the offending cougars. However, it is likely that cougars found in the BSCMZ are preying on bighorn sheep. Given the extremely low population and urgency to retain remaining bighorn sheep, the higher level of predation likely under this strategy could further shift this population to extirpation. Moreover, there exists logistical difficulty due to the rugged and, at times, inaccessible terrain and uncertainty of collaring and recapturing all the cougars using the Refuge bighorn sheep habitat. This strategy was rejected as not addressing the urgency, being impractical, and likely inefficient at reducing predation and, in turn, not achieving bighorn sheep population objectives. Impacts to the cougar population are minimized by only removing cougars found in the BSCMZ. However, after the bighorn sheep population recovers and meets management action threshold and population performance measures, if it then starts to decline again as a result of increased predation, this strategy could be considered if resources are available and there is no urgency to act. We have added targeted cougar removal as an alternative strategy in the Final BHS Management Plan/EIS, Alternatives C and D.

The Service maintains that the evidence of high cougar-specific mortality to the bighorn sheep herd described in Sections 2.3.3, 3.3.1.14, and 3.3.2.9 is compelling. It is certainly possible that certain cougars "specialize" in bighorn sheep. That is the rationale for only targeting cougars present in the BSCMZ, which is centered around prime sheep habitat where such specialists would spend most of their time. The lack of documented cougar predation before 2000 corresponds to the rarity of cougar sightings before that period; the more recently observed prevalence of cougar-specific mortality to sheep corresponds to the increase in cougars in the region during that time. There is no reason to think that, if cougars had been common during the time when the sheep population was much higher, there would not have been sheep specialists then, as well. As stated in the plan, the Refuge implemented two separate bighorn sheep collaring studies that conclusively reported 63.2% and 70% of all reported mortalities were due to cougar predation in Hart Mountain bighorn sheep habitat. Foster and Whittaker (2010) reported cougar predation or probable cougar predation accounted for 63.2% of all mortalities, indicating a shift in the primary source of mortality as compared to previous time spans.

As explained in Sections 2.4 and 3.3.1.11, 10 of the 19 bighorn sheep collared in January 2019 on the Refuge have died. One individual died within 2 weeks of capture, indicating that capture myopathy likely contributed to death. One collared ram was harvested by a hunter during the last year of the state-authorized hunting season, and one collared animal was not recovered after mortality due to terrain limitations. All other mortality is attributed to cougar predation (70% of all mortalities).

Comment 37. One comment stated that, "Management thresholds for lethal removal of cougars on the Refuge are conflated with population objectives and will likely result in a long-term predator control program, contrary to Refuge management goals" and "… the Service should abandon the three population performance measures prescribed for bighorn sheep, and adopt only the population growth rate >1.0. Adopting a minimum population viability number of 125 individuals and a population growth rate >1.0 as management action thresholds would allow the Service to minimize impacts of management to other native species and focus more intensely on management and restoration of bighorn habitat…"

The Service made clear distinctions between management action thresholds and population objectives in Section 2.3.3.1. We feel the description and application of these metrics is adequate, sound, and based upon the most recent ungulate biology. Their implementation will not result in effects beyond those described in the Draft BHS Management Plan/EIS. Conducting "long-term" cougar management is not the goal or intention of the Refuge, as we hope the bighorn sheep population will recover quickly, obviating further cougar removal. However, if the bighorn sheep population is not responding to management actions, including cougar control, the Refuge and ODFW can modify, or discontinue actions, through regular assessment and review, as described in Sections 2.3.2, 2.3.3, and 2.3.4.

As described in Section 2.3.3.1, population size or trends as standalone measures are proven to be insufficient as a base for management goals or objectives because environmental stressors and management actions do not affect population size directly; rather, they directly affect the vital rates of the population, and through vital rates, affect the population size and population trend. Vital rates such as population growth, adult survival, and lamb-to-adult ratios are measurable rates that can be derived from surveys and field data to determine population performance.

As discussed in Section 3.3.1.10, vital rates provide valuable information, but there is still some uncertainty built into conclusions drawn from them. Using 3-year averages of vital rates compensates to some degree for annual variability. Uncertainty is further reduced when multiple vital rates are monitored simultaneously, each contributing unique information that can be combined for a more holistic view of the population status. These three vital rates taken together are sufficient to indicate whether the population is responding to management actions as intended. The addition of an estimate or index of population size (e.g., 170 observed animals averaged for 3 consecutive years) that can serve as a management action threshold would establish the minimum necessary for the population to achieve sustainability over a long period of time, ensure that management actions are not prematurely ended, and validate strategies taken to improve population performance measures are sufficiently met.

As explained in Section 3.3.1.10, the importance of monitoring vital rates such as population growth, annual survivorship, and birth rate complement each other as separate aspects of population performance and together indicate either a declining, stable, or growing population. Section 3.3.1.10 also explained that the use of the three vital rates as performance metrics is preferable to using only the population growth rate because birth rate and annual survival show both population growth and provide an early warning of potential changes to the growth rate. The suggestion by the commenter that we only need growth rate and a minimum population size to evaluate the health of the herd ignores the possibility that a crash in the birth rate or a surge in adult mortality can portend a sharp reversal of a growing population that would only be discovered after the fact if these vital rates are not monitored. Using this suite of indicators of the population performance and management action threshold will minimize the chance that the cougar removal program is suspended prematurely and be repeatedly reinstated if the criteria fail to be met again as the cougar population recovers. Using only an observed population of 170 and growth rate >1.0 as a threshold for suspending cougar removal increases the likelihood of premature suspension of cougar removal before the population would be able to compensate for restored predation levels.

Using all three population performance measures and management action threshold as decision criteria verifies response in the bighorn sheep population and prevents premature and repeated starting or stopping cougar control. Cougar control will not be suspended until all bighorn sheep population performance and management action threshold criteria are met, signifying the population is reaching sustainable levels resilient to normal environmental conditions. Conversely, cougar control will only be initiated if all population performance measures and management action threshold fall below performance criteria indicating the bighorn sheep population is trending toward unsustainable levels. Collectively using the vital rates and management action threshold provide a safeguard against prematurely or repeatedly starting or stopping the cougar control program.

Comment 38. One comment suggested that additional analysis for the implementation of a public cougar hunt be included in the BHS Management Plan/EIS.

This was discussed in Section 2.3.3.1 of the Draft BHS Management Plan/EIS. Once the bighorn sheep population demonstrates an increasing population trend that is above the management action threshold and is meeting the population performance measures, the Service would evaluate implementing a public cougar hunt in coordination with ODFW and according to Service policy. Because there are a number of steps necessary to open a refuge to public hunting (e.g., a hunt plan, environmental analysis, compatibility determination, and public notice in the *Federal Register* with opportunity for public review and comment), it will be a separate planning process.

Comment 39. One comment suggested that Alternative D would have a long-term positive indirect effect on the cougar population because of the re-established bighorn sheep prey herd instead of a long-term negligible effect that the Draft BHS Management Plan/EIS states.

It is certainly possible that the Draft BHS Management Plan/EIS understates the long-term benefits to cougars from a restored and healthy bighorn sheep herd on the Refuge. However, part of the management strategy for improving bighorn sheep habitat is the reduction of ambush cover that makes cougars more efficient hunters of sheep. If successful, decreased success rates for cougars attempting to kill bighorn sheep may result in cougar prey-shifting to other species, thus mitigating the benefit of having more sheep available. These effects are very difficult to predict and quantify. The other consideration is that the Refuge cougars are part of a population extending well beyond the BSCMZ, and even if cougars using that area benefit, it is attenuated over the much larger area used by cougars.

Comment 40. One comment expressed concern that the implementation of predator control on the Refuge would remove a source of baseline ecological data from ecosystems with unmanipulated predator-prey relationships that are becoming rare in the West.

The Service recognizes the importance of intact natural systems to maintain diversity and provide examples of natural processes and is committed to managing refuges with this as a priority. Indeed, it is the probability that such attributes of the Refuge are at risk if bighorn sheep are lost due to the human interference of these processes (e.g., fire suppression) leading to the current predicament that the management plan intends to address. The adoption of the temporary predator control program described in the Draft BHS Management Plan/EIS was incorporated into the Preferred Alternative (D) only after considering all the options available to the Refuge and concluding that it is necessary to prevent extirpation of the Refuge's bighorn sheep herd.

Habitat Management

Comment 41. Two comments expressed concern over the proposed rate of habitat management projects and called for treatment of encroaching juniper at a higher rate than that proposed under the Draft BHS Management Plan/EIS. Several also cite the Refuge's reported treatment totals (acreages) in recent years, up to 2019, as both a target rate and "proof of concept" that increasing the rate of habitat management efforts is feasible.

Treatment rates are determined by a host of external, internal, and intrinsic factors. External factors are those variables beyond the control of the Service, such as funding, contractor availability, and related market forces (such as contractor workload and worker availability). Internal factors include those variables at least partially within the control of the Service, such as personnel availability and project prioritization, administrative access (e.g., seasonal road closures, campground availability, and hunting seasons), and administrative support (e.g., development of specific treatment prescriptions, contracting, and planning and communications). Intrinsic factors are those variables that are naturally limiting to the performance and rate of the treatment, such as weather, phenology, and climatic patterns; topography and physical access restraints; density and size of targeted juniper; ancillary target features (e.g., invasive species presence and frequency, shrub cover and density [especially as it relates to horizontal visibility]); vegetative growth rates; rehabilitative or recovery rates of habitats; and cultural features.

Funding is by far one of the largest factors determining the treatment rate for juniper control. The recent high rates of juniper removal and subsequent follow-up treatments accomplished on the Sheldon National Wildlife Refuge and Hart Mountain NAR were primarily due to significant grant funding received under the U.S. Department of the Interior's Office of Wildland Fire Resilient Landscapes pilot program. This multiyear grant was originally received in 2015 and helped to fund assessments of habitats in 2016 through 2018 and subsequent treatments from 2017 into 2020 (with much of the last of the treatments being funded through supporting [matching] sources rather than through the Resilient Landscapes program itself). Unfortunately, the Resilient Landscapes program and its funding were eliminated and no longer exists as a potential source. A comparable program and funding source has not been created as of this BHS Management Plan/EIS.

As a standard practice, the Service looks for funding sources beyond base allocations (such as grants) to help it accomplish its goals. The Service would continue this practice in implementing the Draft BHS Management Plan/EIS, though successful competition for this funding is not assured. Therefore, the proposed treatment rates are based on base funding allocations only (i.e., realistic target levels given a limited funding resource and other commitments within that funding source, such as those identified in the Sheldon Comprehensive Conservation Plan [Service 2012]). Should a significant funding source again become available, the Service would attempt to increase the juniper treatment rate (and any requisite follow-up treatments) to the extent as would be practicable by that funding source, but within the inherent operative constraints imposed by the intrinsic, internal, and external constraints to the project, such as the need to conduct assessments, develop prescriptions, contract labor, and conduct treatments and any requisite follow-up efforts within the bounds of the weather and topography.

Comment 42. Two comments expressed concern of a lack of detail for habitat treatments other than juniper removal, such as invasive species control and sagebrush treatments.

Habitat treatments are inherently responsive to conditions on the ground using many metrics that cannot be modeled using remote sensing data. Boundaries of some treatments (such as using prescribed fire to set late successional shrub communities back to earlier successional stages, or control and rehabilitation of invaded habitats) would necessarily be tailored to conditions present in the project area at the time of the project. Many of these conditions, such as fuel load, vegetative continuity, and seed production (and subsequent seed bank changes), change from year to year with stochastic events (e.g., weather). As such, specific treatment areas cannot be identified nor enumerated until in-field assessments are completed, and future follow-up treatments cannot be quantified until habitat maps are updated and subsequent in-field assessments are completed, again to be responsive to conditions on the ground.

Since specific project boundaries cannot be predetermined, the Service instead identifies potential management triggers to be evaluated through in-field assessments, as specified in the Draft BHS Management Plan/EIS in Section 2.5.1. Based in part on the Service's institutional knowledge of Refuge habitats, as well as on external, internal, and intrinsic factors inherent in conducting treatments, the Service then further estimates the approximate upper-limit (acres) of shrublands that may receive treatments each year to restore and/or maintain bighorn sheep core habitats and access corridors.

Additional clarification was provided in 2.3.2 where assessment and monitoring would be conducted annually throughout implementation of the habitat management strategies to inform and guide future habitat actions. The Refuge, in consultation with ODFW, would evaluate the progress and efficacy of habitat management actions relative to bighorn sheep habitat objectives every 6 years after implementation begins to determine if habitat management actions are trending toward or meeting habitat objectives and to determine if changes in habitat management actions are warranted. If 6-year generational monitoring suggests bighorn sheep habitat objectives are not likely to be met, the Refuge will develop appropriate adjustments to management actions. Adjustments to management actions could include amending habitat characteristics or management strategies implemented to meet objectives.

Comment 43. Several comments expressed concern about a lack of detail for water resource assessments and potential treatments. Several also recommended a high rate of implementation of potential management actions to restore water features (i.e., within 1 year of approval of the Final BHS Management Plan/EIS).

Water resources were discussed in the Draft BHS Management Plan/EIS in Sections 3.2.3 and 4.2.4, including discussion and analysis related to habitat improvement. Under the Preferred Alternative, the Service will assess the condition and function of artificial water sources, restore and maintain their function and features, and manage sites for their native condition (Section 2.5.1). The Service agrees that conducting assessments and implementing requisite (responsive) management actions should be conducted as soon as is practicable following completion of the Final BHS Management Plan/EIS, not only for the benefit of bighorn sheep, but also just as a matter of course for responsible resource management. However, establishing a definitive timeline for these actions is not feasible nor realistic. As with other habitat management actions, actual implementation rates for both assessment and treatment are determined by a host of external, internal, and intrinsic factors; however, Section 2.5.1 has been edited to clarify that these actions will be undertaken as soon as practicable and as necessary.

Management prescriptions for water features must be individually tailored to conditions and issues present for each water feature, prescriptions that cannot be predetermined. Under the proposed management plan, assessments would be completed as soon as possible and practicable, with the majority occurring as part of the assessment process for other habitat variables. Actual treatment rates and requisite actions would be determined largely based on the results of these assessments as they occur, as well as on staff and budget constraints, but would be completed as soon as possible and practicable. Given the likelihood that follow-up management efforts will be required to ensure that objectives of any treatment prescription are met, especially given the inherent ephemeral and stochastic nature of hydrologic features in the desert environment, a specific treatment rate cannot (and should not) be established. For example, it may not be possible to determine the function of a given artificial water source (such as a dugout) until several years' worth of weather cycles have passed due to the inherently stochastic nature of weather and water availability (such as is caused by drought). Wildlife use of water sources may also be cyclic, and it may take several years of observations to be able to detect these patterns, and subsequently to determine the relative value (or lack thereof) of a given water feature. Additionally, management efforts undertaken on one or multiple water sources may alter these use patterns at other water sources, thereby potentially changing the treatment needs and prescriptions at as yet untreated water sources, as well as at previously treated water sources. As such, management of water sources will necessarily be an iterative process, with some actions taking place in short order, and others taking more time to recognize and/or develop before being undertaken.

Comment 44. One comment stated that juniper removal may have unintended consequences, such as increasing spread of invasive plants, increasing sight-distance for greater sage-grouse predators, or herbicide contamination.

"Unintended consequences" is potentially true of any management action taken in furtherance of a resource goal. It is also potentially true of any action *not* taken. Uncertainty is inherent in natural resources management. As stated in Sections 1.2, 1.3, and 3.3.1.5, the Draft BHS Management Plan/EIS identifies and assesses the issue, and Section 2.3.2 articulates specific and measurable resource management objectives associated with bighorn sheep conservation and habitat management to meet their life-history requirement. Section 2.3.2 in the Draft BHS Management Plan/EIS also identifies assessment and monitoring that would be conducted annually throughout implementation of the habitat management strategies to inform and guide future habitat actions. Refuge surveys, including bighorn sheep population and habitat surveys, within its forthcoming IMP (see 701 FW 2) would assess management action response and progress toward achieving the objectives.

As described in the Draft BHS Management Plan/EIS (Sections 3.4.4.2 and 3.5.2), prescriptions for juniper removal are created using in-field observations of metrics identified by Miller, Bates et al. (2005, 2007) and Miller, Chambers et al. (2014, 2015); Chambers, Bradley et al. (2014); Chambers, Miller et al. (2014); Chambers, Pyke et al. (2014); Chambers et al. (2016); and others. These metrics and prescriptions consider, among other things, the resistance and resilience of a given area to invasive annual grasses. These actions are taken as part of an integrated management response in much the same way that invasive species control is conducted using concepts of integrated pest management (IPM). Prescriptions and actions are tailored to actual conditions present on the ground as determined by in-field site assessment, as well as to the *potentials* of a given site or area (such as invisibility or potential for natural recovery). These conditions and potentials dictate the prescription details and can lead to the need for increased efforts and responses to achieve a desired goal (or goals). This can also include the option to not treat a given site or area in the first place.

In general, greater sage-grouse do not use juniper areas and do not use juniper as hiding cover. In fact, greater sage-grouse select for areas that already have high sight distances, and they have been found to avoid areas with as little as four stems per acre of juniper. Therefore, removal of juniper will not increase sight-distance for greater sage-grouse predators since greater sage-grouse generally avoid areas of juniper. In fact, it is likely that removal of encroaching juniper will benefit greater sage-grouse by restoring the sight conditions to those preferred by greater sage-grouse, thereby functionally increasing the available habitat for the species. Furthermore, by removing perching opportunities for avian predators, the likelihood of predation on greater sage-grouse would be reduced.

Herbicide use is usually necessary to combat invasive plants on a landscape scale, to include control of invasive annual grasses and forbs. Invasive annuals are widespread on Hart Mountain NAR, albeit generally at a low to very low frequency. As described in multiple places within the 1994 CMP and especially in the Draft BHS Management Plan/EIS, an integrated approach to control of invasive species is used on the Refuge. Under this IPM approach, when necessary, herbicides are used at the lowest effective rate and their use is tailored to site conditions, goals of the effort, and with appropriate antecedent and/or follow-up efforts as necessary/appropriate. See also the response to Comments 99, 102, 103.

Comment 45. One comment stated that "Habitat management should follow a 'native community restoration' approach, as described in the 1994 CMP Final Environmental Impact Statement ("FEIS"), including identifying, analyzing and developing additional management actions to address habitat constraints for bighorn and alternative prey populations—especially mule deer—that are part of the complex predator-prey dynamic the plan is attempting to address."

Habitat management proposed in the Draft BHS Management Plan/EIS is consistent with the goals and objectives described in the 1994 CMP and FEIS, and with the "native community restoration" approach described in that document. The proposed habitat management efforts emphasize restoration and maintenance of native shrubland habitats and water features by addressing two of the related primary limitations identified in that document (i.e., excessively high shrub and juniper cover and the related lack of periodic fires in fire-adapted environments, and degraded streams and water features).

Comment 46. One comment suggested that more detailed information on habitat and vegetation communities is needed to fully evaluate the impacts of the proposed actions. Specifically, the comments stated that more information is needed on old growth vegetation communities, past treatments, wildfire, juniper growth, native vegetation communities, effects of human development, and bighorn sheep migration patterns.

As described throughout the Draft BHS Management Plan/EIS, we would protect and maintain old-growth juniper, juniper woodlands, mountain mahogany woodlands, and similar habitats. Juniper removal under this plan would occur where juniper has encroached shrubland habitats within the Core Bighorn Sheep Habitats (Section 2.5.1; Figure C-6 in Appendix C) and as necessary to protect and provide access corridors to critical water features (Figure C-2 and Figure C-11 in Appendix C). Specific treatment prescriptions would be based on in-field assessments and metrics identified in Section 2.5.1 and by reference in this section and in Section 3.5.2. Juniper removal would not occur in old-growth juniper woodlands. Past treatments are discussed in Section 3.4.4.2, summarized in Table 3.12, and shown in Figure C-7 in Appendix C.

Fire history on the Refuge and within bighorn sheep habitats, including wildfire, prescribed fire, escaped prescribed fire, and pile burning fire categories, is discussed in Section 3.5.3, summarized in Table 3.14, and shown in Figure C-8 in Appendix C. Native vegetation communities are discussed in depth throughout Section 3.4, summarized in Table 3.4, and shown in Figure C-12 in Appendix C (see also response to Comment 48).

Human developments on the Refuge within bighorn sheep habitats are overviewed in Section 3.6.2, and the effects of these developments are discussed Section 4.5.2 and summarized in Table 4.6.

As was identified in the Draft BHS Management Plan/EIS (Section 3.3.1.7), the bighorn sheep on Hart Mountain NAR have never been observed to, nor are they believed to, migrate. Rather, they adjust their use patterns within the core bighorn sheep habitats and water limit areas in response to changes in forage, water availability, and snow cover. While these movements are often seasonal in nature and responsive to changes in the environment, they are not truly migratory, as they generally only move around within this one identified general use area and expand or contract their use patterns within this area.

Comment 47. One comment stated that the Draft BHS Management Plan/EIS should evaluate the effects of herbicide use specifically in relation to sensitive wildlife, sagebrush habitat, water, and soil.

Herbicide use on National Wildlife Refuges is consistent with the Service's IPM policy (569 FW 1). Herbicides used, timing, application rates, and techniques are dependent on specific conditions on the ground (e.g., presence of invasive annual grasses and/or invasive forbs) and purpose of treatment(s) at the time of the treatment. Herbicide use is conducted through the Pesticide Use Proposal (PUP) system, as identified in the Draft BHS Management Plan/EIS (Section 2.2.3) and described in Appendix D (Sections 3, 5.2, 6.5.2, and 7.0). PUPs require site-specific analysis, evaluation of chemical profiles, and evaluation of likely environmental effects. Based on scientific information and analyses documented in chemical profiles for PUPs, pesticides allowed for use on refuge lands would be of relatively low risk to non-target organisms as a result of low toxicity or short persistence in the environment. Ecological risk assessments and chemical profiles are developed, reviewed, and updated as necessary by Service personnel and are evaluated as part of the annual PUP process. Potential effects on listed and non-listed species, as well as to ecological conditions of the intended treatment area(s), are also evaluated as part of this annual PUP process. The use of herbicides and the PUP process is outlined in the 1994 CMP and FEIS; the current proposal does not change but provides focus for the actions described there.

Comment 48. One comment stated that "removal of Cougars . . . is highly likely to result in serious unintended consequences for riparian, aspen, bitterbrush and other plants critically important to a host of wildlife" and that the "EIS is deficient in effective mitigation and minimization for a host of wildlife whose habitats will be destroyed."

As stated in Sections 1.1, 1.2, 1.3, 4.3.1, 4.3.2, 4.3.2.1, and 4.3.2.2 of the Draft BHS Management Plan/EIS and responses to Comments 19, 20, 25, 28, 31, 34, and 35, the Service discusses, analyzes, and is committed to preserving intact natural communities that include apex predators and the ecological services they provide. The cougar removal program is not intended, nor will it be permitted, to eliminate cougars from the Refuge or surrounding areas. It recognizes the power of an apex predator to affect its prey populations, and cascading effects on other species, and addresses the need to limit that power temporarily and within a defined geographic area for the benefit of the bighorn sheep. The loss of bighorn sheep would also have cascading effects on the Hart Mountain community. The intended effect of the cougar removals is to lessen the mortality rate of a vulnerable population of sheep until they can respond to habitat improvements and the population becomes large and resilient enough to tolerate natural predation by cougars and other predators. It cannot, and will not eliminate cougar predation, because the program is designed to be limited in scope to target cougars in bighorn habitat. Direct and indirect effects on plant and animal species were analyzed in Sections 4.3 and 4.4 of the Draft BHS Management Plan/EIS. However, the profound trophic cascade effects resulting from apex predators disappearing from or being reintroduced to otherwise natural systems are not considered in more detail in the Draft BHS Management Plan/EIS because elimination of cougars will not occur under the proposed plan, and the intended suppression of cougar predation in a limited area will be temporary, and its effects reversible when the cougar removal stops.

The comment is an inaccurate characterization of proposed habitat management within the Draft BHS Management Plan/EIS. The plan emphasizes the maintenance, rehabilitation, and/or restoration of existing shrub-steppe habitats and their function(s) within identified bighorn sheep habitats, not conversion or destruction of habitat. As was identified and discussed in multiple sections (Sections 2.5.1, 3.3.1.5, 3.4, 3.5, and 4.4) of the Draft BHS Management Plan/EIS, species that use or are dependent on shrub habitats would likely benefit from these efforts. While it is true there would likely be localized shifts in use and value as some efforts are undertaken, such as reduction in shrub cover to increase horizontal visibility for bighorn sheep (i.e., shifting these areas to earlier vegetative seral stages, and the inherent time lag as these areas adapt to the management efforts undertaken), but species dependent on these habitats would likely ultimately benefit from these proposed management efforts. Species dependent on juniper woodland habitats and on old growth would likely not be affected as these vegetative communities and characteristics would be maintained and protected under the proposed efforts. Species that use juniper-encroached communities would see reduction in this habitat characteristic, but not elimination of it as not all areas are likely accessible for management efforts nor are all of these areas on the Refuge proposed for treatment under this management plan. Regardless, given the nature of these vegetative communities of inherently being in a state of flux, most species that use these areas are more "generalist" in their habitat uses and requirements. This means they are not typically reliant on this community type, but rather they simply use these areas to a greater degree than do other species as they are more readily adaptable in their habitat use than more specialized or habitat-dependent species (such as greater sage-grouse, sage thrasher, or northern sagebrush lizard in sagebrush habitats, or silver-haired bats, northern saw-whet owls, flammulated owls, and a handful of migratory songbirds in old growth trees and woodlands). No additional information was provided in the comment to alter the analysis of the Draft BHS Management Plan/EIS.

Comment 49. One comment suggested that the proposed vegetation treatments would harm various ecosystems and wildlife including sagebrush, juniper woodlands, migratory birds, and microbiotic crusts. The comment also expressed concern that the proposed vegetation treatments would increase wildfire risk from increased presence of invasive cheatgrass and the removal of juniper trees.

The Draft BHS Management Plan/EIS describes vegetation communities within the Refuge and core bighorn sheep habitat areas, as well as habitat management actions that would be conducted within core sheep habitat that would increase sight distance for bighorn, reduce cover for predators, and improve overall habitat quality. We propose removing juniper that is encroaching into sagebrush habitat, use of low-intensity prescribed fire to promote the growth of forage species for bighorn and other wildlife, and use of herbicide, where necessary, to control introduced annual grasses such as cheatgrass. Existing high-quality forest and shrubland communities (e.g., juniper forest and mountain mahogany) would be maintained. Overall, these actions would reduce both risk of high-intensity wildfire and cheatgrass prevalence.

The Service used three data sources to geospatially identify and describe shrubland and woodland communities, as well as changes in overstory canopy cover on Hart Mountain NAR since 1964 (the earliest geospatially rectified imagery data available). These are summarized throughout Section 3.4, quantified in Tables 3.4 and 3.11, and visualized in Appendix C, Figures C-6 and C-12. One must look at the constituting components of the communities, the functions these play within the community types, and the historical conditions of these areas (to the degree possible with limited historical data), rather than on any one characteristic by itself. The vast majority of the areas on the Refuge with a juniper presence are not juniper woodlands, but rather are other vegetative community types that are being degraded by an invasive presence (in this case the juniper itself). For the purposes of management of the Refuge's resources, and of the BHS Management Plan, juniper woodlands are those areas that historically were identified and functioned as woodlands, primarily by the presence and dominance of old growth trees or with a degree of in-fill of younger age trees, and where the understory shrubland and grass/forb communities had/have shifted to those common to woodlands rather than shrublands. However, it is not simply the presence of the old growth trees or the denser in-fill of younger age trees that identify these areas as woodlands. There is significant overlap in species compositions between shrubland and woodland communities, but their relative presence, cover, structure, and ecological functions typically differ greatly. In short, simply because an area has juniper trees does not necessarily make these areas juniper woodlands and savannas.

The Draft BHS Management Plan/EIS repeatedly stated that juniper woodlands and old growth juniper would be protected and maintained. Only encroaching juniper within shrubland and related riparian communities within bighorn sheep habitats would be removed to improve sight distance (i.e., horizontal visibility) and to improve and maintain foraging and other habitat conditions for bighorn sheep.

Bighorn sheep primarily use sight to detect and avoid predators (see Section 3.3.1.5). As such, bighorn sheep tend to avoid areas of overstory canopy, as well as areas of limited horizontal visibility. Rams and lambless ewes will occasionally use overstory canopy cover, primarily as thermal cover or to escape (perceived) overhead threats, but this use is generally limited to more visually open understory areas and isolated larger trees, such as old growth, rather than the denser woodlands. Ewes with lambs tend to actively avoid overstory canopy cover, favoring steeper and interconnected terrains with greater visibility. Overstory canopy, especially that with poor horizontal visibility, can function as a barrier to ewes with lambs, as can areas of shrubs with limited horizontal visibility; the latter are barriers for all bighorn sheep when they are greater than 328 feet wide (100 meters).

As identified in the Draft BHS Management Plan/EIS (Section 3.4.4.2), the Service has conducted juniper removal on the Refuge since the early 1990s to reduce of fuel loads, improve the resiliency of these shrubland habitats to the potential degrading effects of large wildfires, and to rehabilitate or restore areas that have been identified as historically important greater sage-grouse habitats. The vast majority of these treatments occurred in encroached shrublands and associated riparian areas. The proposed treatments under the Draft BHS Management Plan are in core bighorn sheep habitats (escape and forage terrain) and in access corridors for important water features within the identified bighorn sheep water limits.

Management actions, such as prescribed fire or removal of encroaching juniper, do not inherently cause cheatgrass and other invasive annuals to appear in an area. Should these species become apparent or increase after a management action is undertaken, it is because they were already present and the management prescription was insufficient to control them, not because the action itself caused them to be present. Prevention practices (Appendix E in Draft BHS Management Plan/EIS) and early detection and rapid response strategies (Appendix D, Section 3.0 in Draft BHS Management Plan/EIS) are designed to prevent establishment of cheatgrass and invasive annuals. Further, it has been demonstrated on Hart Mountain NAR that even habitats of generally inherently lower resistance and resilience (such as Wyoming big sagebrush communities) still have significant resilience to dominance by invasive annual grasses in the long term in the wake of disturbance in the wake of disturbance when compared to similar cover types off-Refuge, elsewhere in the northern Great Basin, at least to those found in lesser condition and/or with more stressors (Ellsworth et al. 2016).

Biological soil crusts (microbiotic crusts) are considered in the Draft BHS Management Plan/EIS in Sections 3.4.8 and 4.4.6. Most shrub-steppe communities are fire-adapted to varying degrees, and the biological soil crust component of these communities is no exception. As with the vegetative components of these communities, soil crusts demonstrate successional stages within the post-fire recovery process. Treatments that mimic natural fire regimes do not generally cause degradation of biological soil crusts although they will “regress” to earlier successional stages. As identified in the Draft BHS Management Plan/EIS, typical causes of degradation include prolonged and excessive trampling (such as from high rates of grazing), alterations to the fire regime (primarily through shifting to high-intensity, long residency, and short-interval fires), changes in plant communities and in-filling of interspaces (such as by juniper on the landscape scale and introduced annual grasses at the site scale), and alterations to the hydrology (primarily through climate change and alterations of the plant communities and water sources). Actions proposed in the Draft BHS Management Plan/EIS may cause localized disturbance and/or short-term successional changes in the biological soil crust communities, but as a whole should not degrade them. The Draft BHS Management Plan/EIS is not proposing to introduce fire regimes that were not historically present, but rather to replicate natural low-intensity fire regimes where in-field assessments indicate it is necessary within bighorn sheep habitats to meet objectives for bighorn sheep. Treatment prescriptions for both juniper removal and prescribed fire efforts, including any requisite follow-up actions, would be developed from these in-field assessments.

Although not explicit, active restoration of sagebrush in areas burned by wildfire is inherent in both the 1994 CMP (following Upland Habitat Management objective) and in the Draft BHS Management Plan/EIS (following 2.5.1 habitat objectives). That is, where the impacts of a given wildfire are sufficient to degrade the sagebrush habitat beyond its ability to naturally recover, or that will limit or eliminate the function of the sagebrush habitat for a focal species (such as eliminating sagebrush cover in an area for a protracted period of time where maintaining sagebrush cover is the intended management purpose of that given area), then restoration of the sagebrush would be implemented in that area to achieve management goals. However, it should be noted that there is no place where the natural recovery of sagebrush is unlikely, or is unlikely in a timeline commensurate with the management purposes of Hart Mountain NAR. Not all areas affected by wildfire or prescribed burns require restoration. Much of these areas will likely recover on their own or with minimal management input; the burned area represents an earlier successional stage rather than being “degraded.” Moreover, a mosaic of varying successional stages within the shrubland habitats is beneficial to the health of the ecosystem and to the resistance and resilience of these communities.

In general, the Service has not conducted removal or thinning within juniper woodlands. Rather, encroaching juniper within shrubland communities have been targeted. Juniper woodlands on Poker Jim Ridge were burned in the 2019 Poker Fire, although the impacts and extent of the loss of juniper is still being determined. It often takes several years for initially sub-lethal fire impacts to juniper to be visible, and given the remoteness and difficulty in access, as well as the size of the fire area, this determination must primarily be made using remote imagery. However, like most other shrub-steppe community types, juniper woodlands are fire adapted. Loss of trees to wildfire does not necessarily mean the community is degraded, merely that it has been “reset” to an earlier seral stage. Given the proven fecundity of juniper on Hart Mountain NAR, reforestation efforts in the burned juniper woodlands would be unnecessary and a low-priority use of limited management capacity. However, burned area emergency response treatments are in progress within selected areas of the Poker Fire perimeter to help promote native species recovery (i.e., to combat invasive annual grasses), though the majority of the recovery is reliant on the resistance and resilience of the native ecosystem.

Comment 50. One comment requested that the proposed prescribed burning follow Clean Air act requirements including: “1. Commit to working with the Oregon Department of Forestry (ODF) and the Oregon Department of Environmental Quality (ODEQ) to develop burn plans for smoke management. 2. Discuss mitigation measures to protect sensitive receptors/populations … 3. Provide an overview of the smoke management program that would be followed to avoid both on-site and off-site public health impacts and potential ambient air quality exceedances.”

Prescribed fire Plans are written and approved for each project prior to implementation in accordance with the *Interagency Standards for Fire Aviation Operations* (National Interagency Fire Center 2021) and *Interagency Prescribed Fire Planning and Implementations Procedures Guide* (PMS 84; National Wildfire Coordinating Group 2017), and Sheldon-Hart Mountain NWR Complex Fire Management Plan (revised 2021; Service 2021), as was referenced in the Draft BHS Management Plan/EIS (page 3-67). Prescribed fire program activities are coordinated with local air authorities to ensure compliance with regulations supported by smoke management guidelines and the Clean Air Act.

Comment 51. One comment requested that the final Plan/EIS follow the Clean Water Act water quality recommendations including: "1. Discuss how the FWS will work with ODEQ to ensure compliance with water quality standards, including what mitigation measures will be implemented to restore waterbodies where WQS are exceeded, 2. Disclose if coordination with U.S. Army Corps of Engineers for 404 permitting is required based on anticipated disturbance to wetlands; 3. Clarify efforts to buffer waterbodies from herbicide treatment. EPA recommends that the Final EIS clarify the scientific basis for how buffers were determined and how monitoring will be conducted to inform the FWS if the buffers should be widened. EPA notes that where possible, it is preferrable to maximize mechanical methods and minimize use of herbicides, 4. Discuss the impacts of prescribed fire on water quality, including information about proximity of burn pile sites to waterbodies. EPA notes that burning may impact the mobilization of metals, thus negatively impacting water quality if burning occurs in areas containing drainages."

The Service will coordinate with both ODEQ and the U.S. Army Corps of Engineers to ensure regulatory compliance prior to working within waters of the U.S. or riparian areas identified in the Draft BHS Management Plan/EIS. Water resources are detailed in Sections 3.2.3.1 and 3.2.3.2, and 3.2.3.4. Information on water quality, including Rock Creek, which is the only known impaired (temperature) body of water in the Refuge, is discussed in Section 3.2.4. It is expected that strategies identified in Section 2.5.1 will improve overall watershed function and water quality (see Table 4.1) and address water quality impairments.

The Service will follow all applicable laws and regulations regarding herbicide use. Buffer areas for areas treated with herbicides are set based on label-identified minimums and on conditions present in the targeted project area at the time of application and are identified as part of and within the PUPs process (see response to Comment 93). Fire is a natural part of the ecosystems proposed for treatment within the Draft BHS Management Plan/EIS. The Service is not proposing to introduce a novel disturbance in conducting prescribed fires. Rather, the Service is proposing to use prescribed fire to mimic historic natural low-intensity fire to achieve seral stages or habitat conditions that benefit bighorn sheep.

Ecosystem and Trophic Effects

Comment 52. Several comments expressed concern that the removal of a keystone species and apex predator such as cougars will have compounding negative effects on interconnected trophic relationships, biological diversity, ecosystem function, and resilience of the Refuge landscape to disturbance.

As stated in Sections 1.1, 1.2, 1.3, 4.3.1, 4.3.2, 4.3.2.1, and 4.3.2.2 of the Draft BHS Management Plan/EIS and responses to Comments 19, 20, 25, 28, 31, 34, and 35, the Service discusses, analyzes, and is committed to preserving intact natural communities that include apex predators and the ecological services they provide. The cougar removal program is not intended, nor will it be permitted, to eliminate cougars from the Refuge or surrounding areas. It recognizes the power of an apex predator to affect its prey populations, and cascading effects on other species, and addresses the need to limit that power temporarily and within a defined geographic area for the benefit of the bighorn sheep. The loss of bighorn sheep would also have cascading effects on the Hart Mountain community. The intended effect of the cougar removals is to lessen the mortality rate of a vulnerable population of sheep until they can respond to habitat improvements, and the population becomes large and resilient enough to tolerate natural predation by cougars and other predators. It cannot, and will not, eliminate cougar predation because the program is designed to be limited in scope to target cougars in bighorn habitat. Direct and indirect effects on plant and animal species were analyzed in Sections 4.3 and 4.4 of the Draft BHS Management Plan/EIS. However, the profound trophic cascade effects resulting from apex predators disappearing from or being reintroduced to otherwise natural systems are not considered in more detail in the Draft BHS Management Plan/EIS because elimination of cougars will not occur under the proposed plan, and the intended suppression of cougar predation in a limited area will be temporary, and its effects reversible when the cougar removal stops.

Comment 53. One comment suggested that an alternative include the restoration of various native predators to the Refuge habitat beyond cougars.

The restoration of long-extirpated predators such as wolves and grizzly bears is beyond the scope of the Draft BHS Management Plan/EIS, and it is beyond the ability of the Refuge to solely support such populations. Should the state and other federal and private landowners decide to promote a feasible plan to do this, the Service would consider what role the Refuge might play in such plans.

Comment 54. One comment suggested that the plan analyze the decline in pronghorn population on the Refuge and how the causes of this decline might relate to the bighorn sheep decline.

The Refuge addresses pronghorn management priorities in the 1994 CMP and in coordination with ODFW and has considered the potential relationships between this plan and pronghorn management (Sections 3.3.4 and 4.3.4). The scope of the bighorn sheep plan was limited to address the immediate problem of the bighorn sheep herd decline, but where the ranges of the two species overlap, habitat improvements meant to benefit bighorn sheep will also benefit pronghorn.

Comment 55. One comment suggested that removal of cougars would lead to an increase in mesopredators and then the Refuge would need to control coyotes.

The Draft BHS Management Plan/EIS considered the effects of cougar removal on mesopredator populations in Section 4.3.2.2 and 4.3.5, acknowledging that there could be an increase in coyote and bobcat populations. The Draft BHS Management Plan/EIS is focused on recovering bighorn sheep by improving habitat conditions in the mid- to long term and by reducing predation mortality caused by cougars in the short term. The relationship between the cougars, habitat, prey, and other mesopredators is extremely complex. However, the analysis determined that any effects in relation to mesopredator release are likely to be negligible to minor in the long term, especially when administrative removal of cougars is suspended. It is unlikely that removing a small number of cougars from the BSCMZ would be likely to result in a significant increase in the coyote population.

Comment 56. Two comments suggested that the Draft BHS Management Plan/EIS evaluate the impacts of the proposed actions to greater sage-grouse including discussing applicable greater sage-grouse resource management plans. A comment also stated that the plan should provide information on the trends of greater sage-grouse and lek population numbers within the region.

The status and management of the Refuge population of the greater sage-grouse is described in Section 3.3.5, and the effects of the proposed Draft BHS Management Plan/EIS on greater sage-grouse is discussed in Section 4.3.6.2 and summarized in Table 4.4. Greater sage-grouse are subject to their own management plan on the Refuge (CMP) and beyond the Refuge (*Oregon Sage-Grouse Action Plan,* ODFW [Sage-Grouse Conservation Partnership 2015]; *Greater Sage-Grouse Conservation Assessment and Strategy for Oregon* [Hagen 2011]). The objectives and strategies in the Draft BHS Management Plan/EIS do not conflict with those of the greater sage-grouse management plans. The plan restricts disturbance to any greater sage-grouse lek grounds, and habitat improvement actions that result in more healthy sagebrush stands will benefit greater sage-grouse. Because the effects on greater sage-grouse are relatively minor, actions completed in this bighorn sheep plan will have a minor effect on the wide ranging area of greater sage-grouse habitat covered under ODFW's *Oregon Sage-Grouse Action Plan*, BLM's *Greater Sage-Grouse Conservation Assessment and Strategy for Oregon*, and BLM's *Lakeview Resource Management Plan and Record of Decision* (DOI 2003). BLM resource management plans are land use plans focused on the specific BLM area or district and are used to identify multiple uses such as oil, gas, grazing, and recreation and have little bearing on this BHS management plan.

NEPA Process and Policy

Comment 57. One comment stated that the analysis and decision-making in the draft plan are arbitrary and capricious and violate federal law.

No decision has been made. Council on Environmental Quality (CEQ) regulations were followed in developing the Draft BHS Management Plan/EIS. A decision is not final until the record of decision (ROD) is signed following public review and comment on the Draft BHS Management Plan/EIS, and a 30-day waiting period following the publication of the notice of availability of the final EIS in the *Federal Register*.

Comment 58. One comment stated that the draft plan has not undergone proper review.

Per CEQ regulations, the Draft BHS Management Plan/EIS was released for public review and comment period for 45 days.

Comment 59. A few comments stated that the Draft BHS Management Plan/EIS is in violation of NWRSAA because the plan did not examine direct, indirect, and cumulative effects. The comments also stated that NEPA "requires the Service to collect and present readily obtainable information, which in turn is prerequisite to a reasoned decision."

The Service examined direct, indirect, and cumulative effects in compliance with CEQ regulations. The Draft BHS Management Plan/EIS was based on readily available information from published research, ODFW, and refuge-specific research.

Comment 60. A few comments stated that the plan is not in accordance with the 1994 CMP because it states that wildlife populations should be managed primarily through habitat management and that predator management should be considered a last resort.

The Draft BHS Management Plan/EIS is in accordance with the 1994 CMP. We agree that where possible, we manage habitat to provide optimal conditions for a wide array of wildlife species, and managing specific wildlife populations is emphasized less, and that predator control should be used as a last resort. In Sections 2.3.2, 2.5.1, and 3.3.1.5, we repeatedly emphasize habitat improvement with the goal of making the bighorn sheep population resilient to natural cougar predation (and other stressors) so cougar management becomes unnecessary. However, the predation issues causing the bighorn sheep population decline cannot be addressed by managing habitat alone (Section 2.3.4) and managing the bighorn sheep population falls under the exception pointed out in Alternative D, 2. Wildlife Population Management in the CMP. As stated in the CMP in Alternative D, 2. Wildlife Population Management, Predator Control, "Predator control may be used if a wildlife species is shown to be at risk due to a high rate of predation, and other measures are not feasible or timely. Predator control would only be used as a temporary solution." As stated in the Draft BHS Management Plan/EIS in Sections 1.2, 2.3.3, 3.3.1.11, and 3.3.1.14, the best available data indicate that cougar predation is the primary source of recent bighorn sheep mortality and population decline at Hart Mountain NAR. In addition, as stated in Chapter 1 and Sections 1.2 and 2.3.3, the rate of decline and population size put the population at risk of extirpation without immediate management intervention that includes cougar control to reduce predation mortality. Lastly, as stated in Sections 2.3.3 and 2.3.3.1, cougar control is intended to be temporary and will only be used when the population performance measures and management action threshold are not met.

Comment 61. A few comments mentioned that the plan fails to consider a reasonable range of alternatives required under NEPA. One comment suggested that the following alternatives should have been considered: 1) Sheep Specialist Alternative: Targeting removal of cougars following a depredation event; 2) Geographic Predator Control Alternative: Targeting removal of cougars by geographic zone; 3) Mule Deer Management Alternative: Developing a comprehensive assessment, evaluation and restoration plan for mule deer habitat, as an integral part of addressing bighorn sheep population concerns and management; and 4) Herd Augmentation Alternative: Increasing bighorn sheep population numbers through population augmentation.

Only a "reasonable range" of alternatives need to be analyzed. CEQ regulation at 40 Code of Federal Regulations (CFR) 1502.16 states "Reasonable alternatives means a reasonable range of alternatives that are technically and economically feasible, meet the purpose and need for the proposed action, and, where applicable, meet the goals of the applicant." CEQ's *Memorandum to Agencies: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations* (CEQ 1986) explains that "What constitutes a reasonable range of alternatives depends on the nature of the proposal and the facts in each case." The Service believes that the alternatives presented in the Draft BHS Management Plan/EIS constitute a reasonable range of alternatives given the nature of the proposal and the facts presented. The Draft BHS Management Plan/EIS either has incorporated all of the commenter's proposed management strategies into the alternatives or considered and rejected these strategies for the reasons given in the Draft BHS Management Plan/EIS and these responses to comments.

Specifically: 1. Sheep Specialist Alternative: See Section 2.4.4 of the Draft BHS Management Plan/EIS and response to Comment 36. We have added targeted cougar removal as an alternative strategy in Alternatives C and D in the Final BHS Management Plan/EIS. Note that the commenter's citation of the Catalina Mountains of Arizona bighorn sheep reintroduction project where offending cougars were identified using collared sheep, rather than collared cougars to detect and respond to predation events is not pertinent to the Hart Mountain situation. The vast majority of the Catalina sheep were collared because they had been captured elsewhere and released, so most deaths could be detected and investigated to determine cause. The Refuge herd is free-ranging in rugged terrain, and the collaring of even a small portion of the herd is a dangerous and difficult endeavor for both humans and sheep. Moreover, the likelihood of capturing all, or most, of the Hart Mountain bighorn sheep herd is small and could result in many unintended capture deaths.

Obviously, the deaths of un-collared animals usually go undetected, and, if the goal is to document cougar predation on sheep, it is more feasible to collar the fewer number of cougars in the area than a majority of the sheep. A more relevant case is that of the Kofa National Wildlife Refuge in Arizona where a wild bighorn sheep herd was declining rapidly largely due to cougar predation, and confirmed cougar kills were facilitated by collared cougars. This is the model the Service proposes for future management, when there may be time and resources for a more comprehensive cougar collaring program.

2. Geographic Predator Control Alternative: This is the strategy proposed in Alternatives C and D in the Draft BHS Management Plan/EIS. Only cougars found within the BSCMZ are targeted for removal based on the high probability that cougars spending much time there are or will be preying on bighorn sheep. The more fine-grained geographic approach described by one commenter, where cougars are targeted based on being found in some subcategory of bighorn sheep habitat (e.g., lambing habitat) at the time the sheep are using it is not feasible at Hart Mountain due to the scale and configuration of these subcategories relative to the normal home range of cougars. Specifically, any cougar using bighorn sheep habitat would routinely range outside of sheep habitat, not to mention the habitat subcategory, within short time frames, and associating a cougar with a habitat category would be arbitrary due to the fact that the transition from one category to another may be mere feet. Also, the focus of bighorn sheep on escape terrain in all seasons, which is essentially inaccessible to humans and hounds, would preclude detection and removal of cougars while they are in that terrain. The proposal to limit removal of cougars to those found in the BSCMZ is the appropriate geographical resolution to target cougars likely to prey on sheep.

3. Mule Deer Management Alternative: While it is reasonable to hypothesize that the decline in mule deer has contributed to increased predation on bighorn sheep, it does not follow that focused management to improve mule deer habitat would be an effective way to address the immediate need to preserve the bighorn herd, and therefore qualifies as an alternative that could, in itself, reasonably address the purpose and need of the proposed action. This is because mule deer are already much more numerous than bighorn sheep and there is no basis for setting a measurable objective for the mule deer population that would alleviate the predation pressure on the bighorn sheep, especially in the time frame necessary to address the current rate of bighorn sheep decline. It is also possible that more mule deer would support more cougars and actually result in an increase of the predation on bighorn sheep. Also, mule deer range on the Refuge extends well beyond that of the sheep, and to have a significant effect on the deer population would necessitate a much more extensive and costly program, with a corresponding delay in its implementation and effects. Finally, bighorn sheep habitat improvements described under Alternatives B and D would also benefit mule deer to some degree and might intensify the overlap of these two species and result in less bighorn sheep predation as more mule deer occupy bighorn range.

4. Herd Augmentation Alternative: This strategy is included in Alternatives C and D in the Draft BHS Management Plan/EIS. Population augmentation is widely recognized as a wildlife management tool to supplement an ungulate herd at risk of extirpation, replace an extirpated herd, increase herd size, extend herd range, or increase genetic diversity. However, augmentation would have a low chance of success as a stand-alone measure to address the bighorn sheep population decline until the reasons and issues for the population decline are addressed and/or resolved. Translocating bighorn sheep from an outside source into a new area causes stress on the animals and the chance for their survival success will be greatly reduced if predation mortality and habitat issues remain limiting factors within the area and on the existing population. Translocated animals are naïve and unfamiliar with new surroundings and will require time to adapt to new habitat and range. This makes a strong case to preserve and recover the existing source herd as the remaining bighorn sheep have adapted to habitat conditions within Hart Mountain. Implementing augmentation would likely fail under Alternative A without addressing the high predation mortality or habitat issues. Implementing augmentation under Alternative B would not be practical as the urgent predation issue would not be resolved, and the source herd would likely become extirpated by the time long-term habitat management actions had an effect on mitigating predation mortality. However, under that Alternative B scenario, augmentation would be considered re-introduction. Under Alternatives C and D, augmentation would be used to supplement the population once the primary causes of the decline (predation mortality and degraded habitat) have been addressed, and over the long term if unoccupied habitat in good condition is documented.

Comment 62. Two comments suggested that the plan fails to take a "hard look" at the following items: 1) impacts of lethal removal of cougars on the cougar population before action is taken; 2) underlying drivers of bighorn sheep decline and the drivers' effects on the environmental baselines; and 3) environmental consequences of the action before the action is taken.

See Sections 3.3.1.4, 3.3.1.11, 3.3.1.14, and Chapter 4 in the Draft BHS Management Plan/EIS and see the responses to Comments 2, 59, 19, 4, 15, 19, 20, 25, 42, 40, 39, and 41. In summary, the Draft BHS Management Plan/EIS does take a hard look at all these concerns and uses the available information to analyze potential effects on environmental and ecological components of the entire system. The Service is confident that the alternatives presented are reasonable and comprehensive responses to the problem of bighorn sheep population decline, and that they are adequately analyzed. Where there is uncertainty about causes, effects, and processes, that uncertainty is acknowledged and mitigated by plan flexibility and an adaptive approach that will reveal unintended and undesirable effects of plan implementation before they are irreversible.

Comment 63. A few comments stated that, "The draft plan lacks sufficient analysis of the direct, indirect and cumulative impacts of mountain lion removal on the Refuge ecosystem."

The Draft BHS Management Plan/EIS analyzes the effects of each of the four alternatives in relation to cougar removal in Sections 4.3.2, 4.3.2.1, and 4.3.2.2, as well as in Table 4.3. In addition, see responses to Comments 19–21, 23–29, 37, and 44.

Comment 64. Two comments suggested that the plan must consider how traps and snares may harm bald and golden eagles, as required by the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act.

Section 2.3.3 includes a discussion of measures and SOPs and BMPs to be implemented to "reduce or eliminate unwanted environmental effects" of cougar control proposed under Alternatives C and D on non-target species. The implementation of the measures and SOPs are intended to minimize the risk or avoid the capture of all non-target species, which include threatened and endangered species and golden or bald eagles. We have clarified this in Section 4.3.6.1 of the Final BHS Management Plan/EIS.

Comment 65. Many comments suggested that the plan should follow the BIDEH policy and the Refuge System mission. The comments suggested that the removal of cougars and trapping undermines the Refuge mandate to maintain BIDEH.

The proposed action complies with BIDEH and the NWRS mission, as discussed in Chapter 1 of the Draft BHS Management Plan/EIS. The Draft BHS Management Plan/EIS explicitly acknowledges the Refuge's obligation to conform with all Service policies, directives, and regulations, specifically including BIDEH, in the development of alternatives that meet the Refuge's purposes and needs described in Sections 1.1, 1.2, and 1.3, 2.3.2, 2.3.3, 2.3.3.1, and 2.3.4. Maintenance of ecological processes and biodiversity is the underlying goal of the proposed action, specifically preservation of the bighorn sheep herd and all the ecological process supported by bighorn sheep, including their role as prey for predators and scavengers.

The reintroduction of bighorn sheep to the Refuge conformed to the "restoration, when feasible" clause of the BIDEH regulation, and the Refuge does not consider their loss a trivial matter. The assertion by the commenters that the Refuge is essentially eradicating one species (cougar) to maintain another (bighorn sheep) is without merit because nothing in the proposed alternatives postulates the elimination of cougars, or advocates "extreme predator removal" that would result in a violation of the mandate to conserve biodiversity. The cougar removal plan is specifically targeted to cougars in the BSCMZ that are likely to be preying on bighorns and will therefore have a minor effect on the larger cougar population dynamics, and is temporary.

Comment 66. Two comments suggested that the Service follow BIDEH policy to analyze the effects of management actions on the larger landscape outside of the Refuge within ODFW Cougar Management Zone F.

See responses to Comments 15, 19, 20, 23, 24, 26, 37, 30, 39, and 41. The proposed action complies with BIDEH and the NWRS mission, as discussed in Chapter 1 of the Draft BHS Management Plan/EIS. The Draft BHS Management Plan/EIS explicitly acknowledges the Refuge's obligation to conform with all Service policies, directives, and regulations, specifically including BIDEH, in the development of the alternatives that proposed to meet the Refuge's purposes and needs described in Sections 1.1, 1.2, and 1.3, 2.3.2, 2.3.3, 2.3.3.1, 2.3.4, and analyzed in Sections 4.3.2, 4.3.2.1, and 4.3.2.2.

Comment 67. Two comments suggested that the Service must "prove" cougar predation is the cause of bighorn sheep decline to implement predator control in accordance with the CMP.

The cougar removal program does conform to the CMP because the Draft BHS Management Plan/EIS presents compelling evidence that it is necessary to conserve a "species (shown) to be at risk to a high rate of predation, and other measures are not feasible or timely" (CMP). The plan is designed to be an immediate and urgent measure to prevent extirpation of the sheep herd, and temporary until the herd can tolerate "normal" levels of natural predation, while the root cause of the recent decline (habitat degradation) is addressed. The CMP and other Service policies do not require irrefutable proof that the predation level is an additive mortality factor that could result in extirpation because that would require tracking the decline beyond the point of no return. Rather, we present available evidence that, in the context of applicable scientific knowledge, strongly indicates the threat of extirpation.

The Service believes that sufficient evidence is presented in the Draft BHS Management Plan/EIS to justify the limited cougar removal plan, as detailed in Sections 1.2, 3.3.1.11, and 3.3.1.14 of the Draft BHS Management Plan/EIS. Surveys over the past 3 years represent a 70% bighorn sheep population decline. Data collected over the past 20 years and across multiple collaring events have documented cougars as the significant and primary predator accounting for 60% to 70% of all adult bighorn sheep mortalities on the Refuge. Urgent action is needed to address the rapidly declining sheep numbers that place the herd at significant risk of extirpation from the Refuge in the next few years if these trends continue.

Comment 68. One comment stated that the plan outlines predator control for a longer than temporary time period (6 years) and this contradicts the Refuge's CMP.

The cougar removal program will end based on clearly stated demographic criteria being met (specified bighorn sheep population growth rate, adult survivorship, birth rate, and population size), or the demonstration that the cougar removal program is not effective at aiding the bighorn sheep recovery after 6 years of effort (Section 2.3.3.1). This is not a proposal to conduct an indefinite cougar removal program, nor is that the Service's intent. Therefore, the proposed cougar removal program is in conformance with the CMP.

Comment 69. Two comments stated that the authorization of a public hunt for cougars would conflict with the Refuge's CMP.

Under the National Wildlife Administration Act, as amended, hunting is considered an appropriate wildlife-dependent use, and it is to be facilitated where compatible. Once the bighorn sheep population demonstrates an increasing population trend that is above the management action threshold and is meeting the population performance measures, the Service would evaluate implementing a public cougar hunt in coordination with ODFW. Although statewide hunter success rate is only 1% to 2%, hunting pressure could replace reliance on administrative removals in the future, after the cougar density in the BSCMZ has been reduced and bighorn sheep population performance measures are met. We believe that a public cougar hunt would not result in significantly reducing cougar predation on bighorn sheep in the short term and would not meet the Service's purpose and need in the Draft BHS Management Plan/EIS. Therefore, cougar hunting was not included as a strategy in this plan. In the future, a public cougar hunt may be considered under a separate planning process to formally open the Refuge to sport hunting of cougar.

Comment 70. One comment stated that the comment period for the Draft BHS Management Plan/EIS was not listed for the standard 45 days in the *Federal Register* notice.

The *Federal Register* notice of availability published on April 30, 2021, allowed a 45-day public comment period for the Draft BHS Management Plan/EIS ending on June 14, 2021 (86 FR 22963, EIS No. 20210045). That comment period was 45 days per CEQ regulations. Regrettably, the Draft BHS Management Plan/EIS included the wrong ending date for receiving comments. The project's website included the correct date. The Service accepted comments for the entire 45-day period. We regret the error.

Comment 71. One comment stated that the Service has the responsibility to address mule deer decline under U.S. Department of the Interior policy, including Secretarial Order 3362, Improving Habitat Quality in Western Big-Game Winter Range and Migration Corridors.

The Service continues to support and follow Secretarial Orders (SOs), including SO 3362. Addressing mule deer decline is outside the scope of the Draft BHS Management Plan/EIS. However, a number of actions under the Draft BHS Management Plan/EIS (see Section 4.3.3) would be expected to benefit mule deer, thus supporting SO 3362.

Comment 72. Two comments suggested that the Draft BHS Management Plan/EIS does not adequately address climate change impacts, mitigation, climate benefits, or greenhouse gas emissions in accordance with Executive Order 13990, Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis, and Secretarial Order 3395, Department Wide Approach to the Climate Crisis and Restoring Transparency and Integrity to the Decision-Making Process.

The Draft BHS Management Plan/EIS addresses climate change impacts and greenhouse gas emissions in Section 4.7.3. The Service has revised Section 4.7.3. of the Draft BHS Management Plan/EIS to further address climate impacts including quantifying greenhouse gas emissions related to slash pile burning using the Piled Fuels Biomass and Emissions Calculator developed by the U.S. Forest Service, Pacific Northwest Research Station (Wright 2015).

Comment 73. One comment stated that the proposed actions on Poker Jim Ridge are at odds with the Wilderness Act.

Poker Jim Ridge has not been designated by Congress as wilderness but has been proposed as wilderness by the president. Under Service policy, proposed wilderness is managed as designated wilderness (610 FW 1.5(T)). We completed a Minimum Requirements Analysis (Appendix F) for all proposed uses of Wilderness Act Section 4(C) prohibited tools, which included the use of GPS collars on bighorn sheep, the use of helicopters in the capture and transportation of bighorn sheep, the use of power tools (e.g., chainsaws and motorized pruning saws) in removing western juniper from bighorn sheep habitat, and snares on the Poker Jim Ridge escarpment. No other Wilderness Act Section 4(C) tools are required for other aspects of the management plan. The MRAs concluded that action in the proposed wilderness is necessary for the conservation of bighorn sheep. In *Wilderness Watch v. U.S. Fish & Wildlife Serv.*, 629 F. 3d 1024, 1039 (9th Cir. 2010), the Court found that conservation of bighorn sheep is consistent with the purposes of the Wilderness Act.

Comment 74. One comment stated that the Refuge needs a new CMP before implementing the proposed actions because the actions have the potential to adversely impact species habitats and population viability over a large area.

The 1994 CMP represents the Refuge's current management direction and will be revised. As further explained in our responses to comments 23, 45, 60, 67, 68, and 69, the alternatives considered in the Draft BHS Management Plan/EIS are consistent with the CMP. In all step-down management plans linked to the CMP, including the Draft BHS Management Plan/EIS, we analyze the reasonably foreseeable effects on species, populations, and habitat on both Refuge and regional scales as we did with the CMP. Mitigation measures proposed in the plan limit the scale of adverse impacts.

Comment 75. One comment suggested that baseline studies need to be conducted for all Refuge resources to conduct a complete EIS analysis.

The CEQ's NEPA regulations explicitly provide that agencies do not need to undertake new scientific and technical research to inform their analyses (40 CFR 1502.22). Chapter 3 of the Draft BHS Management Plan/EIS describes the affected environment, including most of the specific resources identified in the comment, references available scientific information, and discusses the impacts in proportion to the significance of the action (40 CFR 1502.2). Chapter 3 (Affected Environment) discusses information relevant to and commensurate with the importance of the actions, with less important material summarized, consolidated, or simply referenced (40 CFR 1502.15). The description of the affected environment is appropriate to the proposed action and adequate to analyze the effects of the alternatives; additional baseline studies are not "essential to a reasoned choice" and are not required; however, regarding any unknown information required to implement management actions (e.g., juniper treatment), appropriate surveys and assessments will be identified in the Refuge's upcoming IMP.

Comment 76. One comment suggested that the proposed alternative does not fulfill the Refuge mandate because the proposed action is "sacrificing huge habitat areas" and harming juniper forest species.

The Service disagrees with the assertion that we are "sacrificing" huge habitat areas. The intent is to restore natural conditions to sagebrush and grassland areas that are being invaded by western juniper, a condition common to much of the Intermountain West. Old growth juniper forests are and will continue to be protected.

Comment 77. One comment recommended that the Service continue to consult with state agencies and tribal governments and continue public involvement in the remainder of the planning process "especially in areas where communities with environmental justice concerns are impacted."

The Service agrees to continue consultation with state agencies and tribes. We do not anticipate any environmental justice impacts related to implementing the Preferred Alternative.

Ethical Concerns

Comment 78. Many comments suggested that the plan fails to evaluate the negative impacts of traps and snares on non-target and target wildlife including animal suffering, possible non-target wildlife death, and potential harm to people and pets.

Section 2.3.3 includes a discussion of BMPs and SOPs to be implemented to "reduce or eliminate unwanted environmental effects" of cougar removal strategies under Alternatives C and D, including traps and snares, to non-target wildlife. The implementation of the BMPs and SOPs are intended to minimize the risk to, or avoid the capture of, all non-target species, and to minimize effects from those activities.

The BMPs and SOPs discussed in the Draft BHS Management Plan/EIS include provisions of following state laws related to trapping, and methodology to set traps in a way and manner to minimize the chance of capturing non-target species and or reducing harm to animals that are restrained. These practices are often referred to as BMPs. White et al. (2021) describe BMPs as "a method to improve an activity or set of activities by developing recommendations based on sound scientific information, while maintaining practicability." The developed BMP guidelines and research are based on the most extensive study of animal traps ever conducted in the United States, as well as scientific research and professional experience regarding currently available traps and trapping technologies. Trapping BMPs identify both techniques and trap types that address the welfare of trapped animals and allow for the efficient, selective, safe, and practical capture of furbearers. Trapping BMPs are intended to be a practical tool for recreational trappers, wildlife biologists, and wildlife agencies interested in improved traps and trapping practices. BMPs include technical recommendations from expert trappers and biologists, as well as a list of specifications of traps and/or trap types that meet or exceed BMP criteria. BMPs provide options, allowing for discretion and decision making in the field when trapping furbearers in various regions of the United States. They do not present a single choice that can or must be applied in all cases.

Humaneness of traps is improved by using different trap types and design and by trapping practices that minimize animal injury and suffering and increase trap selectivity. BMPs include equipment specifications, the knowledge of the person using the equipment, and how the equipment is set up (with accessories) and then deployed in the field. Although specific traps are tested, the characteristics of the traps are identified and described as features that, either by themselves or when incorporated with other practices and the experience of the applicator, improve animal welfare and increase trappers' efficiency and selectivity.

Using BMP-compliant tools and methodologies, experienced and professional wildlife managers are able to deploy tools is a selective way to target specific animals or group of animals while minimizing effects on non-target species. When professionally applied, the effects are likely to be of short duration and low impact. Chapter 4 discusses the potential effects that could or likely to occur for cougars and other wildlife species. Table 4.3 summaries the effects for each alternative showing that although some effects are likely to occur, they are expected to be of short durations and/or at low intensity.

Comment 79. One comment suggested that bighorn sheep tracking practices such as helicopters and radio collars are distressing to bighorn sheep, and the Service should avoid these practices to minimize stress.

The Service considers the monitoring of bighorn sheep populations essential for their management and recovery. The Hart Mountain bighorn sheep herd is monitored by collecting data on population size, recruitment, survival, movement, and herd health. Due to the rugged terrain that bighorn sheep inhabit and the limited ground access to escape habitat, helicopter surveys are an effective survey method. Helicopter surveys are conducted two times per year and are completed within a 5-hour sampling period. However, observational data provided by helicopter surveys cannot provide important information about habitat usage and individual survivorship that tracking and monitoring radio-collared sheep provide, and such information is critical to evaluate the status of the herd and the efficacy of management actions. The Service and ODFW recognize the risks and tradeoffs associated with capturing and radio-collaring bighorn sheep and follow widely accepted SOPs (Appendix L of the Draft BHS Management Plan/EIS) to mitigate those risks. In every case, a careful analysis of the value of the information gained by collaring versus the risk to the animals and agency personnel is conducted, and collaring is only approved when the risks are warranted. The plan includes radio-collaring of 25 to 35 adults (Section 2.5.2), depending on the estimated population size and logistic limitations, as a minimum representative sample of the population to confidently extrapolate findings to the entire herd.

Comment 80. A few comments stated that cougar removal, especially trapping, is inhumane.

See response to Comment 78. The Service's employees and those who will conduct work under the Draft BHS Management Plan/EIS are concerned about animal welfare. The Service is aware that some members of the public oppose certain wildlife management techniques, especially trapping, on the grounds that they are inhumane. The preferred methods of cougar control would be those that provide a quick kill (shooting). Leghold traps would be used only if hunting and snares are not effective in providing the needed level of control. Wildlife professional organizations (e.g., The Association of Fish and Wildlife Agencies and The Wildlife Society) recognize that traps and snares are effective for management use (Association of Fish and Wildlife Agencies 2006; The Wildlife Society 2020). Personnel authorized to trap cougars on the Refuge will use approved equipment, be trained in the use of that equipment, and follow SOPs, BMPs, policy, and laws and regulations to ensure that trapping is conducted as humanely as possible.

Other

Comment 81. Two comments suggested that adaptive management should be conducted to assess and evaluate the effects of management. The comments also stated that the plan omits aspects of an iterative adaptive management approach linking monitoring to a structured decision-making process.

The purpose for the proposed actions analyzed in this Draft BHS Management Plan/EIS is to restore a sustainable herd of bighorn sheep on the Refuge. The bighorn sheep herd has declined by almost 70% since 2017 to a potentially unsustainable population level and is at risk of extirpation without management intervention. This Draft BHS Management Plan/EIS analyzes the foreseeable effects on the human environment as a result of four possible management alternatives. The alternatives reflect the urgency to implement short-term management actions that are based on the best available science, in combination with mid- to long-term management and monitoring. The plan contains four alternatives: continuing current management, a habitat management focus, a predator control focus, and a preferred alternative, which is a combination of habitat management and predator control. Alternative D: Comprehensive Integrated Management, is the Service's Preferred Alternative. It is a combination of management actions proposed in Alternatives B and C. An integrated management approach is preferred considering the complex interactions between habitat features and demographic factors that ultimately determine sustainability.

An adaptive management approach, as defined in the Adaptive Management DOI Technical Guide (Williams et al. 2009), is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a "trial and error" process, but rather emphasizes learning from management outcomes. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Conclusively, adaptive management is a learning and evidence-based process to improve management decisions.

The Draft BHS Management Plan/EIS articulates specific and measurable management objectives associated with bighorn sheep conservation and specific adaptive management provisions have been incorporated into the alternatives. Refuge surveys, which will be described in the Refuge's forthcoming IMP, would assess progress toward achieving these objectives. In preparing the IMP, the Refuge will identify current and needed surveys, enter surveys and associated metadata into PRIMR (Priority and Review of Inventory and Monitoring Activities on Refuges), and select and priority surveys needed to document response of wildlife and plant communities to management actions.

The Draft BHS Management Plan/EIS identifies and assesses the bighorn sheep issues and articulates specific and measurable resource management objectives associated with bighorn sheep conservation and habitat management. The Draft BHS Management Plan/EIS also identifies management actions that would be followed by monitoring to evaluate the effectiveness of those actions. Monitoring and evaluating would lead to subsequent management direction considering what was learned through management action implementation and available scientific information. As stated in Section 2.3.4, principles of adaptive management implemented in Alternatives B and C would be implemented as part of Alternative D. The process would be informed by refuge surveys, including bighorn sheep habitat surveys, survival monitoring, and population and composition surveys. The Refuge will develop an IMP that will include bighorn sheep population and habitat surveys used to assess bighorn population response to management actions and progress toward achieving management objectives. The Refuge and ODFW would evaluate the progress and efficacy of management actions relative to bighorn sheep performance measures and management action threshold every 6 years after strategy implementation begins to determine if habitat and population management actions, including cougar control, are trending toward or meeting performance objectives. If it is determined during the 6-year generational reviews that habitat objectives or performance thresholds are not likely to be met, the Refuge and ODFW will identify what has been learned through implementation and develop adjustments to the management actions. Adjustments to the management actions could include new, adjusted, or terminated strategies identified in 2.5.1 and 2.5.2. Alternative D provides a full range of management strategies to adaptively manage the bighorn sheep herd over time. These strategies would address the need to take action in a timely manner while providing time to identify and correct habitat issues that may take decades to resolve.

Comment 82. One comment suggested that the Draft BHS Management Plan/EIS evaluate the effects of the proposed actions on pygmy rabbits and their habitat. The comment also states that rabbit hemorrhagic disease should be addressed.

Effects on pygmy rabbits were assessed as part of the Draft BHS Management Plan/EIS (Sections 3.3.4 and 4.3.6.4, Table 4.4). No colonies are known in the core bighorn sheep habitat areas (escape and forage terrains). A few colonies are known in the big sagebrush habitats within the general ewe and ram water limit buffers. Pygmy rabbit habitat and known colonies on the refuge are known to extend well beyond bighorn sheep range. Specific colony sites are considered sensitive and as such would not be depicted on habitat maps included in the Draft BHS Management Plan/EIS. Any groundwork for improvement of bighorn sheep habitat would avoid pygmy rabbit colonies to prevent direct negative impacts. Juniper removal to benefit bighorn sheep would also benefit pygmy rabbits, which prefer sagebrush cover types.

The effect of rabbit hemorrhagic disease on rabbits in the west is outside the scope of the Draft BHS Management Plan/EIS.

Comment 83. One comment questioned if the trees cut on the Refuge would be used as fuel in the controversial Red Rock biodiesel plant. In addition, the commenter claims "This proposal to burn juniper and other forested vegetation in some kind of explosive mix with natural gas from the Ruby pipeline will result in large-scale forested loss across the region, and such impacts add foreseeable deforestation acreages must be assessed under cumulative effects."

The nearest section of Ruby Pipeline is approximately 48 miles from the southern border of Hart Mountain NAR. All prescribed fire projects require an authorized prescribed fire plan that carefully identifies all hazards and avoidance sites, including oil, gas, and electric transmission. Encroaching juniper trees cut as part of sagebrush restoration will be either cut and dropped, lopped and scattered, or piled and burned. The Draft BHS Management Plan/EIS does not identify juniper to be used as fuel for a biodiesel plant.

Comment 84. One comment suggested that the Draft BHS Management Plan/EIS evaluate the effects of cattle grazing on adjacent land in transmitting disease to bighorn sheep.

Cattle are not known to transmit disease to bighorn sheep and there is little overlap in areas where bighorn sheep and cattle can be seasonally present.

Comment 85. One comment stated that pack goats should be prohibited on the Refuge because of the risk of disease transmission to bighorn sheep.

Pack goats are not authorized for use at Hart Mountain NAR. A compatibility determination must be developed to determine if the use (pack goats) is compatible with (would not materially interfere with or detract from) Refuge and Refuge System purposes.

Comment 86. Two comments stated that recreational pack goats should remain allowed on the Refuge because there is no evidence of domestic pack goats transmitting disease to wild sheep.

Pack goats are not authorized for use at Hart Mountain NAR. A Compatibility Determination must be developed to determine if the use (pack goats) is compatible with (would not materially interfere with or detract from) Refuge and Refuge System purposes.

Comment 87. One comment stated that killing of cougars is not supported by the majority of Americans and that non-consumptive wildlife recreation users (e.g., wildlife observation, photography, etc.) are increasing in the population compared to hunters.

The Service actively supports and promotes all compatible priority wildlife-dependent public uses, including hunting, fishing, wildlife observation, wildlife photography, environmental education, and interpretation, on National Wildlife Refuges.

Comment 88. One comment requested that the plan follow adaptive management with regard to pest management actions and recommended the following: "1. Define what resources are included in this plan. For instance, it would be helpful for the Final EIS to include specific resources that will be monitored (e.g., Rock Creek) and what thresholds exist to reevaluate the actions (e.g., turbidity exceedance); 2. Include a monitoring framework that addresses effectiveness monitoring of vegetation treatments; 3. Include pre- and post-treatment monitoring of representative water resources. …; 4. Disclose lessons learned from past practices in developing similar projects, combined with the need to account for new challenges, such as climate change, to help inform the design and management of the currently proposed project."

An adaptive management approach, as defined in the Adaptive Management DOI Technical Guide (Williams et al. 2009), adaptive management, is a decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a "trial and error" process, but rather emphasizes learning from management outcomes. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Conclusively, adaptive management is a learning and evidence-based process to improve management decisions.

As was identified in the Draft BHS Management Plan/EIS (Section 2.2.4), the Service is in the process of developing an IMP as a step-down plan to the CMP, in accordance with 602 FW 4 and 701 FW 2. This IMP is being developed concurrently with the IMP for Sheldon National Wildlife Refuge (a step-down plan to the Sheldon CCP). Refuge surveys, which will be described in the Refuge's forthcoming IMP, would assess progress toward achieving these objectives. In preparing the IMP, the Refuge will identify current and needed surveys, enter surveys and associated metadata into PRIMR (Priority and Review of Inventory and Monitoring Activities on Refuges), and select and priority surveys needed to document response of wildlife and plant communities to management actions.

The Draft BHS Management Plan/EIS identifies and assesses the bighorn sheep issues and articulates specific and measurable resource management objectives associated with bighorn sheep conservation and habitat management to meet their life-history requirements. The Draft BHS Management Plan/EIS also identifies management actions that would be followed by monitoring to evaluate the effectiveness of those actions. Monitoring and evaluation would lead to subsequent management direction considering what was learned through management action implementation and available scientific information. As stated in Section 2.3.4, principles of adaptive management implemented in Alternatives B and C would be implemented as part of Alternative D. The process will be informed by refuge surveys, including bighorn sheep habitat surveys, survival monitoring, and population and composition surveys. The Refuge will develop an IMP that will include bighorn sheep population and habitat surveys used to assess bighorn population response to management actions and progress toward achieving management objectives. The Refuge and ODFW would evaluate the progress and efficacy of management actions relative to bighorn sheep performance measures and management action threshold every 6 years after strategy implementation begins to determine if habitat and population management actions, including cougar control, are trending toward or meeting performance objectives. If it is determined during the 6-year generational reviews that habitat objectives or performance thresholds are not likely to be met, the Refuge and ODFW will identify what has been learned through implementation and develop adjustments to the management actions. Adjustments to the management actions could include new, adjusted, or terminated strategies identified in 2.5.1 and 2.5.2.

Literature Cited

Association of Fish and Wildlife Agencies. 2006. *Best Management Practices for Trapping in the United States*. Available at: https://www.dec.ny.gov/docs/wildlife_pdf/trapbmpsintro.pdf. Accessed August 2, 2021.

Chambers, J.C., J.L. Beck, S. Campbell, J. Carlson, T.J. Christiansen, K.J. Clause, J.B. Dinkins, K.E. Doherty, K.A. Griffin, D.W. Havlina, K.F. Henke, J.D. Hennig, L.L. Kurth, J.D. Maestas, M. Manning, K.E. Mayer, B.A. Mealor, C. McCarthy, M.A. Perea, and D.A. Pyke. 2016. Using resilience and resistance concepts to manage threats to sagebrush ecosystems, Gunnison sage-grouse, and greater sage-grouse in their eastern range: a strategic multi-scale approach. General technical report RMRS-GTR-356. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Chambers, J.C., B.A. Bradley, C.S. Brown, C. D'Antonio, M.J. Germino, J.B. Grace, S.P. Hardegree, R.F. Miller, and D.A. Pyke. 2014. Resilience to stress and disturbance, and resistance to Bromus tectorum L. invasion in cold desert shrublands of western North America. *Ecosystems* 17:360–375.

Chambers, J.C., R.F. Miller, D.I. Board, D.A. Pyke, B.A. Roundy, J.B. Grace, E.W. Schupp, and R.J. Tausch. 2014. Resilience and resistance of sagebrush ecosystems: implications for state and transition models and management treatments. *Rangeland Ecology and Management* 67:440–454.

Chambers, J.C., D.A. Pyke, J.D. Maestas, M. Pellant, C.S. Boyd, S.B. Campbell, S. Espinosa, D.W. Havlina, K.E. Mayer, and A. Wuenschel. 2014. Using resistance and resilience concepts to reduce impacts of invasive annual grasses and altered fire regimes on the sagebrush ecosystem and greater sage-grouse: a strategic multi-scale approach. General technical report RMRS-GTR-326. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

Council on Environmental Quality (CEQ). 1986. Memorandum to Agencies: Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations. 40 CFR Parts 1500–1508. Washington D.C.

———. 2020. National Environmental Policy Act Implementing Regulations. 40 CFR Parts 1500–1508. Washington D.C.

Department of the Interior (DOI). 2003. Lakeview Resource Management Plan and Record of Decision. Bureau of Land Management Lakeview Resource Area. Lakeview, Oregon.

Ellsworth, L.M., D.W. Wroblesk, J.B. Kauffman, and S.A. Reis. 2016. Ecosystem resilience is evident 17 years after fire in Wyoming big sagebrush ecosystems. *Ecosphere* 7:1–12.

Foster, C.L., and D.G. Whittaker. 2010. Poor population performance of California Bighorn Sheep on Hart Mountain National Antelope Refuge. In *Proceedings of the 17th Biennial Symposium of the Northern Wild Sheep and Goat Council, 7–11 June 2010, Hood River, Oregon,* pp. 129–137.

Grignolio, S., E. Merli, P. Bongi, S. Ciuti, M. Apollonio. 2011. Effects of hunting with hounds on a non-target species living on the edge of a protected area. *Biological Conservation* 144:641–649.

Hagen, C. 2011. Greater sage-grouse conservation assessment and strategy for Oregon: a plan to maintain and enhance populations and habitat. Oregon Department of Fish and Wildlife. Available at: https://ir.library.oregonstate.edu/concern/technical_reports/5999n853x. Accessed August 6, 2021.

Keehner, J.R., R.B. Wielgus, and A.M. Keehner. 2015. Effects of male targeted harvest regimes on prey switching by female mountain lions: implications for apparent competition on declining secondary prey. *Biological Conservation* 192:101–108.

Keehner, J.R., R.B. Wielgus, B.T. Maletzke, and M.E. Swanson. 2015. Effects of male targeted harvest regime on sexual segregation in mountain lion. *Biological Conservation* 192(4):42–47.

Krausman, P., M. Wallace, C. Hayes, and D. DeYoung. 1998. Effects of jet aircraft on mountain sheep. *Journal of Wildlife Management* 62(4):1246–1254.

Laundré, J.W., L. Hernández, and S.G. Clark. 2007. Numerical and demographic responses of pumas to changes in prey abundance: testing current predictions. *Journal of Wildlife Management* 71:345–355.

Miller, R.F., J.D. Bates, T.J. Svejcar, F.B. Pierson, and L.E. Eddleman. 2005. *Biology, ecology, and Management of Western Juniper* (Juniperus occidentalis). Technical Bulletin 152. Corvallis, Oregon: Oregon State University, Agricultural Experiment Station.

———. 2007. *Western Juniper Field Guide: Asking the Right Questions to Select Appropriate Management Actions*. U.S. Geological Survey Circular 132. Reston, Virginia: U.S. Geological Survey.

Miller, R.F., J.C. Chambers, and M. Pellant. 2014. *A Field Guide for Selecting the Most Appropriate Treatment in Sagebrush and Pinon-Juniper Ecosystems in the Great Basin.* General Technical Report RMRS-GTR-322-rev. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

———. 2015. *A Field Guide for Rapid Assessment of Post-wildfire Recovery Potential in Sagebrush and Piñon-Juniper Ecosystems in the Great Basin: Evaluating Resilience to Disturbance and Resistance to Invasive Annual Grasses and Predicting Vegetation Response*. General Technical Report RMRS-GTR-338. Fort Collins, Colorado: U.S. Forest Service, Rocky Mountain Research Station.

National Interagency Fire Center. 2021 Interagency Standards for Fire and Fire Aviation Operations. National Interagency Fire Center, Boise, Idaho

National Wildfire Coordinating Group. 2017. Interagency Prescribed Fire Planning and Implementation Procedures Guide (PMS 84). Available at: https://www.nwcg.gov/sites/default/files/publications/pms484.pdf. Accessed August 4, 2021.

Oregon Department of Fish and Wildlife (ODFW). 2017. *Oregon Cougar Management Plan*. Salem, Oregon: Oregon Department of Fish and Wildlife.

———. 2021. Steens Mountain Cougar Target Area. Unpublished document and notes. On file, Oregon Department of Fish and Wildlife, Oregon.

Robinson, H.S., R.B. Wielgus, H.S. Cooley, and S.W. Cooley. 2008. Sink populations in carnivore management: cougar demography and immigration in a hunted population. *Ecological Applications* 4(18):1028–1037.

Rominger, E.M. 2018. The Gordian knot of mountain lion predation and bighorn sheep. *Journal of Wildlife Management* 82:19–31.

Sage-Grouse Conservation Partnership. 2015. The Oregon Sage-Grouse Action Plan. Governor's Natural Resources Office. Salem, Oregon. Available at: http://oregonexplorer.info/content/oregon-sage-grouseaction-plan?topic=203&ptopic=179. Accessed August 4, 2021.

Traill, L. B.W. Brook, R.R. Frankham Corey, J.A. Bradshaw. 2010. Pragmatic population viability targets in a rapidly changing world. *Biological Conservation* 1(43):28-34.

U.S. Fish and Wildlife Service (Service). 2012. Sheldon National Wildlife Refuge Final Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service, Sheldon-Hart Mountain National Wildlife Refuge Complex. Lakeview, Oregon.

———. 2021. Sheldon-Hart Mountain National Wildlife Refuge Complex Fire Management Plan. Sheldon-Hart Mountain National Wildlife Refuge Complex. Lakeview, Oregon.

White, H.B., E. Boggess, C. Brown, J. Butfiloski, T. Decker, J. Erb, M. Fall, D. Hamilton, T. Hiller, G. Hubert Jr., M. Lovallo, J. Olson, and N. Roberts. 2021. Best management practices for trapping furbearers in the United States. *Wildlife Monographs* 1(207):3–59.

Wielgus, R.B., D.E. Morrison, H.S. Cooley, and B. Maletzke. 2013. Effects of male trophy hunting on female carnivore population growth and persistence. *Biological Conservation* 167:69–75.

The Wildlife Society. 2020. TWS and AAWV joint issue statement: domestic sheep and goats disease transmission risk to wild sheep. Available at: https://wildlife.org/tws-and-aawv-joint-issue-statement-domestic-sheep-and-goats-disease-transmission-risk-to-wild-sheep/. Accessed August 2, 2021.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. Adaptive Management: The U.S. Department of Interior Technical Guide. Washington D.C.: U.S. Department of the Interior.

Wright, Clinton S. 2015. Piled fuels biomass and emissions calculator. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon. Available at: https://depts.washington.edu/nwfire/piles/. Accessed August 2, 2021.