From:	Burgess, Angela
To:	Drizd, Lara
Subject:	Re: GRSG 2015 - Are you still entering things into RefWorks for chapter authors?
Date:	Monday, March 30, 2015 2:44:02 PM
Attachments:	Drought Lit Cited RefWorks 20150330.docx Connelly and Braun 1997.pdf

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And here's the lit cited for the drought chapter, and the PDF of the one citation I couldn't find a link to...

Thanks!

Angela Burgess
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On Mon, Mar 30, 2015 at 1:38 PM, Burgess, Angela <angela_burgess@fws.gov> wrote:

> Oops, forgot to actually attach the list of citations!
>
> **Angela Burgess**
> **Fish and Wildlife Biologist**
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> **134 Union Blvd., Lakewood, Colorado 80228**
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> **angela_burgess@fws.gov**
>
> On Mon, Mar 30, 2015 at 1:37 PM, Burgess, Angela <angela_burgess@fws.gov> wrote:
>
>> Awesome, thanks Lara! I've attached the list for the contaminants chapter - both completely new articles and ones that I found are already in RefWorks but don't have a link (I separated these into 2 different sections). Still waiting to see if I can get a couple of the links to new articles, and several of the articles I couldn't find a PDF online, so I've attached them here.
>> Let me know if you have any questions!
>>
>> And if you realize you can't get to them, just let me know and I'll see what I can do.
>>
>> Thanks again!
>>
>> **Angela Burgess**
>> **Fish and Wildlife Biologist**
>> **Mountain Prairie Region - U.S. Fish and Wildlife Service**
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On Mon, Mar 30, 2015 at 11:42 AM, Drizd, Lara <lara_drizd@fws.gov> wrote:

Hi Angela,

Funny you should ask. I'm working on doing that for Holly's climate change chapter right now. If you've identified your list of references that are not already in RefWorks, I would be happy to enter those for you. It might take a little while like the last time but I'll be sure to get them in there eventually.

On Mon, Mar 30, 2015 at 10:29 AM, Burgess, Angela <angela_burgess@fws.gov> wrote:

Hi Lara,
I'm wrapping up my chapters for the species report and have been working on the citations. For the recreation chapter, I sent you all the information for the citations that weren't in RefWorks, but I was wondering - do you still have time to do that for the citations for my other two chapters? Wanted to check with you before I bombard you, as I'm not sure if you still have time available to do that!

Thanks,
Angela

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Drought Chapter Lit. Cited – RefWorks additions

Citations not currently in RefWorks and links where you can download PDF:

Andreadis, K.M., and D.P. Lettenmaier. 2006. Trends in 20th century drought over the continental United States. Geophysical Research Letters 33:1–4.

http://onlinelibrary.wiley.com/doi/10.1029/2006GL025711/abstract

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.

http://www.fs.fed.us/rm/pubs_other/rmrs_2007_chambers_j001.pdf

Global Climate Change Impacts in the United States. 2009. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson,(eds.). Cambridge University Press. 196 pp.

http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

Knopf, F.L. 1996. Prairie legacies - birds. Pages 135-148 In Samson, F.B. and F.L. Knopf, eds. Prairie Conservation: Preserving North America's Most Endangered Ecosystem. Island Press, Washington, D. C. 330 pp.

http://www.fws.gov/southwest/es/documents/R2ES/LitCited/LPC_2012/Knopf_1996.pdf

Neilson, R.P., J.M. Lenihan, D. Buchelet, and R.J. Drapek. 2005. Climate change implication for sagebrush ecosystems. Transactions of the 70th North American Wildlife and Natural Resources Conference 70:145–159.

http://www.sagestep.org/educational_resources/bibliographies/articles/2005_Neilson_et_al.pdf

Peterson, T.C., R.R. Heim, Jr., R.Hirsch, D.P. Kaiser, H. Brooks, N.S. Diffenbaugh, R.M. Dole, J.P. Giovannettone, K. Guirguis, T.R. Karl, R.W. Katz, K. Kunkel, D. Lettenmaier, G.J. McCabe, C.J. Paciorek, K.R. Ryberg, S.Schubert, V.B.S. Silva, B.C. Stewart, A.V. Vecchia, G.Villarini, R.S. Vose, J.Walsh, M. Wehner, D. Wolock, K.Wolter, C.A. Woodhouse, and D. Wuebbles. 2013. Monitoring and understanding changes in heat waves, cold waves, floods, and droughts in the United States. American Meteorological Society. 94: 821–834.

http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-12-00066.1

Strzepek, K., G. Yohe, J. Neumann, and B. Boehlert. 2010. Characterizing changes in drought risk for the United States from climate change. Environmental Research Letters 5: 1–9.

http://iopscience.iop.org/1748-9326/5/4/044012

Walsh, J., D. Wuebbles, K. Hayhoe, J. Kossin, K. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner, J. Willis, D. Anderson, S. Doney, R. Feely, P. Hennon, V. Kaharin, T. Knutson,

F. Landerer, T. Lenton, J. Kennedy, and R. Somerville. 2014. Ch. 2: Our changing climate. Pp. 19–67 in J.M. Melillo, T.C. Richmond, and G.W. Yohe (editors). Climate change impacts in the United States: the third national climate assessment, U.S. Global Change Research Program.

http://s3.amazonaws.com/nca2014/low/NCA3_Full_Report_02_Our_Changing_Climate_LowRes.pdf?download=1

Woodhouse, C.A., and J.T. Overpeck. 1998. 2000 years of drought variability in the central United States. Bulletin of the American Meterological Society. 79:2693–2714.

http://www.eahcp.org/documents/1998_WoodhouseOverpeck_DroughtVariability.pdf

Citations currently in RefWorks but currently lacking links where you can download PDF (and the appropriate link to add):

Milton, S.J., R.J. Dean, M.A. du Plessis, and W.R. Siegfried. 1994. A conceptual model of arid rangeland degradation. BioScience 44:70–76.

http://www.jstor.org/stable/1312204?seq=1#page_scan_tab_contents

Hanf, J.M., P.A. Schmidt, E.B. Groshens. 1994. Sage grouse in the high desert of central Oregon: Results of a study, 1988–1993. U.S. Department of the Interior, Bureau of Land Management, Prineville District. 84 pp.

http://www.biodiversitylibrary.org/bibliography/59897#/summary

Connelly, J.W. and C.E. Braun. 1997. A review of long-term changes in sage grouse populations in western North America. Wildlife Biology 3:1–23.

Comment [AB1]: Couldn't find link – attached PDF to email.

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FAX TRANSMITTAL

# of pages ▶ 23

To Chris Warren

Dept./Agency

Fax #

From Jeff Hood

Phone #

Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

A review of long-term changes in sage grouse populations in western North America

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Key words: *Artemisia, Centrocercus urophasianus, habitat, North America, population decline, sage grouse*

Running head: Changes in sage grouse populations

A review of long-term changes in sage grouse populations in western North America

John W. Connelly & Clait E. Braun

Connelly, J. W. & Braun, C.E. 1997: A review of long-term changes in sage grouse populations in western North America. - Wildl. Biol. 3:000-000.
229-234

Available data indicate that sage grouse (*Centrocercus urophasianus*) have declined throughout their range. This species presently occurs in 11 U.S. states and 2 Canadian provinces. In 9 states having long-term data, breeding populations have declined by 17 to 47% ($\bar{x}$ = 33%) from the long-term average. Six states have long-term information on sage grouse production. In 5 of these states, production has declined by 10 to 51% ($\bar{x}$ = 25%) From the long-term average. Habitat deterioration, loss, and fragmentation have reduced the quantity and quality of nesting and early brood-rearing habitat causing population declines. We discuss those factors that appear largely responsible for changes in habitats and, ultimately, sage grouse populations over

wide areas of western N.A. and suggest hypotheses that could be tested to provide better insight into sage grouse population declines. Once these changes are better understood, conservation strategies that address protection and rehabilitation of sagebrush (*Artemisia* spp.) rangelands should be developed and implemented in each state and province to halt the decline of sage grouse and initiate recovery.

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Concern about the status of sage grouse populations was first raised in the early 1900's (Hornady 1916). During the 1920's and 1930's sage grouse were generally declining throughout the species' range (Gabrielson & Jewett 1940, Rush 1942, Patterson 1952:12, Autenrieth 1981). However, population increases were reported in the late 1940's and 1950's (Patterson 1952:15, Edminster 1954, Autenrieth 1981). Additional population declines were reported in the 1960's and 1970's (Wallestad 1975a, Swensen

et al. 1987), associated with sagebrush loss due to herbicide or mechanical treatment. More recently, concern has again been expressed regarding declines in sage grouse populations throughout much of the species' range (Dobkin 1995).

Unfortunately, most information on the status and population trends of sage grouse relate to relatively small areas (e.g., a portion of a state) (Braun 1995), and to monitoring effects of land use treatments (Wallestad 1975*b*, Connelly et al. 1994). To our knowledge, no one has examined the status and population trends of this species over most or all of its range. Therefore, this paper synthesizes information on sage grouse populations and qualitatively assesses trends. We also suggest explanations for these trends and hypotheses that should be tested to allow a better understanding of sage grouse and those factors that limit this species.

Methods

All states and provinces that presently or historically supported sage grouse were contacted for information on distribution, abundance, and population trends. Additional information on fire and other sagebrush manipulation practices were obtained by reviewing state and federal land management agency records in southeastern Idaho (Crowley & Connelly 1996).

Nine U.S. states and 1 Canadian province provided long-term data on breeding populations. These data were obtained by

monitoring spring lek attendance (Jenni & Hartzler 1978, Beck & Braun 1980) using methods established by the Western States Sage Grouse Technical Committee (Autenrieth et al. 1982). Seven states provided data on production obtained from juvenile:adult hen ratios in the harvest. These ratios were calculated by assigning sex and age to wings of harvested birds collected from hunters (Eng 1955, Autenrieth et al. 1982).

Although these data were collected across the range of sage grouse, not all populations were sampled. However, in all states represented, data were collected on the same grouse populations in a similar fashion over many years (i.e., 12 - >30 years).

Distribution and abundance

Historically, sage grouse occurred in at least 15 states and 3 provinces (Fig. 1). Presently, this species is found in 11 states and 2 provinces. In 6 of the 11 states and both provinces, sage grouse populations could generally considered at risk because of long-term declines and fragmented habitats.

Breeding population trends

We obtained breeding population data from 9 states and 1 province (Table 1). Seven states provided data on breeding populations that spanned >30 years and 3 states had monitoring data that extended >40 years. All states and provinces that had data on breeding populations indicated that population size was

declining. A comparison of long-term averages (through 1984) to data collected over the last 10 years indicates that breeding populations declined from 17 to 47% with a rangewide average of -33% (Table 1). States historically having the largest sage grouse populations (Colorado, Idaho, Montana, Oregon, Wyoming) declined an average of 30%. States and provinces with smaller populations (Alberta, North Dakota, South Dakota, Utah, Washington) declined an average of 37%.

Production trends

Seven states provided data on juvenile production (the ratio of juveniles to adult females in the fall). Because of small samples in the harvest, data from North Dakota were not used in our analysis. Four of the six states provided production data that spanned >30 years (Table 2). A comparison of long-term averages (through 1984) to data collected over the last 10 years indicates that sage grouse production declined in 5 of 6 states by 10 to 51%. Production in Utah remained virtually unchanged from the long-term average (Table 2). Rangewide, the average decline in juvenile recruitment was 25%.

Factors responsible for changes

Sage grouse population declines have been attributed to many factors including predation (Batterson & Morse 1948, Autenrieth 1981, Willis et al. 1993), pesticides (Blus et al. 1989), sagebrush removal (Swensen et al. 1987), herbicide application to

sagebrush rangelands (Wallestad 1975a, 1975*b*), hunting (Zunino 1987), and fire (Connelly et al. 1994, Fischer 1994). However, sage grouse populations have experienced widespread declines especially since the early to mid-1980's. Therefore, factors causing recent range-wide declines should be widespread. Adult survival and nest success rates have varied but do not indicate predation is a major problem throughout the range of sage grouse (Connelly et al. 1993, Zablan 1993, Connelly et al. 1994, Sveum 1995), unless nesting habitat is in poor condition (Gregg 1991). Similarly, some grouse populations that have declined are not hunted or are subject to relatively low exploitation (Wallestad 1975a, Braun & Beck 1985, Braun 1995). Herbicide use has declined on public rangelands since the 1970's (Braun 1987) and pesticides have only been identified as a problem in Idaho (Blus et al. 1989). Livestock grazing, weather patterns, and fire are the only known factors occurring throughout most of the range of sage grouse that could be related to widespread population declines by causing habitat deterioration, loss or fragmentation.

Livestock Grazing

Livestock grazing management is a highly complex issue because it varies temporally and spatially. Moreover, grazing patterns and use of habitats are highly dependent on weather conditions (Vallentine 1990:310). Thus, there is little direct

evidence linking grazing practices to sage grouse population levels. However, grass height and cover influence sage grouse nest site selection and success (Wakkinen 1990, Gregg 1991, DeLong 1993). Thus, indirect evidence suggests that grazing management practices resulting in removal of a relatively large proportion of herbaceous growth during the breeding season may have negative impacts on sage grouse populations (Dobkin 1995). More information is needed on the relationship of livestock grazing to sage grouse production and quality of breeding habitat. Controlled field experiments should be designed to evaluate the relationship of grazing pressure (i.e., disturbance and removal of herbaceous matter) to sage grouse nest success and juvenile survival.

Weather

Patterson (1952:68) reported that drought during the 1930's coincided with declining sage grouse populations throughout much of the species' range. A prolonged drought occurred over much of western North America from the mid-1980's to the early 1990's (Fischer 1994, Hanf et al. 1994). From 1990 to 1992, mean precipitation along the eastern part of the Snake River Plain in Idaho was 22% below the long term average (Fischer 1994). Similarly, Hanf et al. (1994) reported that precipitation in sage grouse habitat of central Oregon was less than the historical average and related low precipitation to declining sage grouse populations. Hanf et al. (1994) suggested drought impacted

grouse populations by reducing herbaceous cover at nests and reducing the quantity and quality of food available for grouse during the spring. Fischer et al. (1996) identified a decrease in insect populations (i.e., chick food) during drought. Thus, drought may negatively affect populations by decreasing the quality of breeding habitat. We suggest that states or provinces with relatively extensive data (i.e. ≥15 years) on sage grouse production examine the relationship between weather conditions and production. Natural Resource agencies should also consider establishing permanent transects in important sage grouse breeding habitats to assess the influence of weather on forb and insect production.

Fire

Prior to and during the drought, from the mid-1980's to the early 1990's, many thousands of hectares of sagebrush rangeland were burned by wild fire or prescribed fire. Little information was readily available on total area burned within the range of sage grouse over the last 40-50 years. However, data on fire in southeastern Idaho indicated an increasing frequency of wild fires and prescribed burns (Table 3). The total area burned on the Upper Snake River Plain of southeastern Idaho increased by >2,000% between 1959 and 1989 (Table 3). Moreover, of the 59,895 ha of sagebrush burned during the 1980's, 61% was attributed to wild fires. Of all wild fires for which a cause could be determined from 1950 to 1994 (N = 123), 76% were caused by man

(Crowley & Connelly 1996). The amount and frequency of fire in sagebrush rangelands of southeastern Idaho may not be typical of all sage grouse habitat. However, at this time there is no evidence to suggest that similar patterns did not occur throughout large portions of the species' range and anecdotal reports indicate fire was a widespread phenomenon in other parts of southern Idaho, Oregon, Colorado and Nevada during the 1980's (Dobkin 1995, A. R. Sands, pers. commun.). Fire not only eliminates potential winter and nest habitat (Robertson 1991, Fischer 1994) but also reduces insects (Fischer et al. 1996), an important food for chicks in early brood rearing habitat (Johnson & Boyce 1990). Further, big sagebrush (*A. tridentata*) does not resprout following fire. Thus, re-establishment of sagebrush stands suitable for sage grouse nesting and winter habitat will generally take 15 to 30 years (Peterson 1995). Fire may negatively impact sage grouse populations by eliminating or fragmenting relatively large blocks of wintering or nesting habitat. A careful analysis of sage grouse population trends and fire frequency and extent throughout sage grouse range is needed to better understand the role of fire in fragmenting sagebrush habitats and affecting sage grouse populations. Although tightly controlled and replicated experiments are not generally possible (Fischer 1994), data on fire frequency and extent can be obtained from state and federal resource agencies. When combined with

data on sage grouse populations, general inferences can be drawn with respect to the effect of fire on sage grouse.

Management Implications

A large body of data exists on sage grouse populations and habitat requirements throughout much of the species' range. However, this information does not seem sufficient to fully explain recent sage grouse population declines. The major factor occurring throughout sage grouse range is loss or degradation of brood habitat (Dobkin 1995). Thus, based on available data throughout the species' range and documented habitat changes in Idaho, we suggest the decline may be due to low juvenile survival caused by decreasing quantity and quality of early brood rearing habitat. Similarly, Peterson & Silvy (1994, 1996) indicated that reproductive success, as measured by juvenile to adult ratios, was related to declining populations of Attwater's prairie chicken (*Tympanuchus cupido attwateri*). Bergerud (1988) also suggested that reproductive success was sufficient to account for yearly changes in grouse numbers regardless of habitat availability, predation, or winter severity. Drought and fire may be the primary agents causing a decline in brood rearing habitat for sage grouse. Moreover, an unfavourable situation due to drought and an increase in wild fire may have been made worse in many areas by vigorous prescribed burning programs implemented by land management

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agencies during the 1980's.

Fire was historically rare in many (Winward 1984), or perhaps most (Braun 1987), sagebrush habitats occupied by sage grouse and these contentions are supported by the fact that most sagebrush species are fire intolerant (Winward 1984, Peterson 1995). We strongly disagree with Winward's (1991) call for an intensive prescribed fire program in sagebrush habitats because of the increased frequency of wild fire (Dobkin 1995, Crowley & Connelly 1996) and the detrimental effects such a program would likely have on sage grouse and other sagebrush obligate species. Instead, we recommend that each state and province with sage grouse populations inventory their current sagebrush habitats and assess the trends of these habitats. Relating changes in sage grouse populations (especially production) to weather patterns, fire frequency and extent would provide evidence to support or refute our hypothesis regarding the cause of sage grouse population declines. We also suggest that each state and province develop a conservation strategy that addresses sage grouse population and habitat trends, prescribed burning and other sagebrush management practices, and appropriate conservation measures during drought conditions.

We caution that most sage grouse populations have relatively low annual turnover (Zablan 1993, Connelly et al. 1994) and reproductive rates (Eng 1963, Connelly et al. 1993, 1994). Thus, population recovery may be relatively slow even if environmental

and habitat conditions improve.

Acknowledgements - we thank members of the Western States Sage and Columbian Sharp-tailed Grouse Workshop for sharing data and insights on sage grouse populations and habitats. This manuscript was improved by reviews of R. J. Gutierrez, R. L. Eng, and two anonymous referees. This is a contribution from Idaho Federal Aid in Wildlife Restoration Project W-160-R and Colorado Federal Aid in Wildlife Restoration Project W-167-R.

References

Autenrieth, R. E. 1981: Sage grouse management in Idaho. - Idaho Department of Fish and Game Wildlife Bulletin 9, Boise, 238 pp.

Autenrieth, R. E., Molini, W. & Braun, C. E. 1982: Sage grouse management practices. - Western States Sage Grouse Committee Technical Bulletin 1. Twin Falls, Idaho, 42 pp.

Batterson, W. M. & Morse, W. B. 1948: Oregon sage grouse. - Oregon Fauna Series 1. Oregon Game Commission, Portland, 29 pp.

Beck, T. D. I. & Braun C.E. 1980: The strutting ground count: variation, traditionalism, management, and needs. - Proceedings Western Association of State Game and Fish Commissioners 60: 558-566.

Bergerud, A. T. 1988: Increasing the numbers of grouse. - In Bergerud, A. T. & Gratson, M. W. (eds.); Adaptive strategies and population ecology of northern grouse. University of Minnesota Press, Minneapolis, pp. 686-731.

Blus, L. J., Staley, C. S., Henny, C. J., Pendleton, G. W., Craig, T. H., Craig, E. H. & Halford D. K. 1989: Effects of organophosphorus insecticides on sage grouse in southeastern Idaho. - Journal of Wildlife Management 53: 1139-1146.

Braun, C. E. 1987: Current issues in sage grouse management. - Proceedings of Western Association of Fish and Wildlife Agencies 67: 134-144.

Braun, C. E. 1995: Distribution and status of sage grouse in Colorado. - Prairie Naturalist 27: 1-9.

Braun, C. E., & Beck, T. D. I. 1985: Effects of changes in hunting regulations on sage grouse harvest and populations. - In Beasom, S. L. & Roberson, S. F. (eds.); Game harvest management, Caesar Kleberg Wildlife Research Institute, Kingsville, Texas, pp. 335-343.

Connelly, J. W., Fischer, R. A., Apa, A. D. Reese, K. P. & Wakkinen, W. L. 1993: Renesting by sage grouse in southeastern Idaho. - Condor 95: 1041-1043.

Connelly, J. W., Reese, K. P., Wakkinen, W. L., Robertson, M. D. & Fischer, R. A. 1994: Sage grouse ecology. - Idaho Department of Fish and Game Job Completion Report W-160-R-21, 90pp.

Crowley, C. M. & Connelly, J. W. 1996: Sage grouse population and habitat trends in southeastern Idaho and southwestern Montana. - Unpublished Report, Idaho Department of Fish and Game, Pocatello, 205 pp.

DeLong, A. K. 1993: Relationships between vegetative structure and predation rates of artificial sage grouse nests. - M.S. thesis, Oregon State University, Corvallis, 50 pp.

Dobkin, D. S. 1995: Management and conservation of sage grouse, denominative species for the ecological health of shrubsteppe ecosystems. - U.S.Department of Interior, Bureau of Land Management, Portland, Oregon, 26 pp.

Edminster, F. C. 1954: American game birds of field and forest. - Charles Scribner's Sons, New York, 490 pp.

Eng, R. L. 1955: A method for obtaining sage grouse age and sex ratios from wings. - Journal of Wildlife Management 19: 267-272.

Eng, R. L. 1963: Observations on the breeding biology of male sage grouse. - Journal of Wildlife Management 27: 841-846.

Fischer, R. A. 1994: The effects of prescribed fire on the ecology of migratory sage grouse in southeastern Idaho. - Ph.D. thesis, University of Idaho, Moscow, 150 pp.

Fischer, R. A., Reese, K. P. & Connelly, J. W. 1996: An investigation on fire effects within xeric sage grouse brood habitat. - Journal of Range Management 49: 194-198.

Gabrielson I. N. & Jewett S. G. 1940: Birds of Oregon. - Oregon

State College, Corvallis, 650 pp.

Gregg, M. A. 1991: Use and selection of nesting habitat by sage grouse in Oregon. - M.S. thesis, Oregon State University, Corvallis, 46 pp.

Hanf, J. M., Schmidt, P. A. & Groshens, E. B. 1994: Sage grouse in the high desert of central Oregon: results of a study, 1988-1993. - U.S. Department of Interior, Bureau of Land Management, Series P-SG-01, Prineville, Oregon, 56 pp.

Hornady, W. T. 1916: Save the sage grouse from extinction, a demand from civilization to the western states. - New York Zoological Park Bulletin 5: 179-219.

Jenni, D. A. & Hartzler J. E. 1978: Attendance at a sage grouse lek; implications for spring censuses. - Journal of Wildlife Management 42: 46-52.

Johnson, G. D. & Boyce M. S. 1990: Feeding trials with insects in the diet of sage grouse chicks. Journal of Wildlife Management 54: 89-91.

Patterson, R. L. 1952. The sage grouse in Wyoming. Sage Books, Denver, Colorado, 341 pp.

Peterson, J. G. 1995: Ecological implications of sagebrush manipulation: a literature review. - Montana Fish, Wildlife, and Parks Project W-101-R-2, Helena, 49 pp.

Peterson, M. J. & Silvy N. J. 1994: Spring precipitation and fluctuations in Attwater's prairie chicken numbers: hypotheses revisited. - Journal of Wildlife Management 58:

GSG Administrative Record 2010

222-229.

Peterson, M. J. & Silvy N. J. 1996: Reproductive stages limiting productivity of the endangered Attwater's prairie chicken. - Conservation Biology 10: 1264-1276.

Robertson, M. D. 1991: Winter ecology of migratory sage grouse and associated effects of prescribed fire in southeastern Idaho. - M.S. thesis, University of Idaho, Moscow, 87 pp.

Rush, W. M. 1942: Wildlife of Idaho. - Caxton Printers Limited, Caldwell, Idaho, 299 pp.

Sveum, C. M. 1995: Habitat selection by sage grouse hens during the breeding season in south-central Washington. - M.S. thesis, Oregon State University, Corvallis, 86 pp.

Swensen, J. E., Simmons, C. A. & Eustace C. D. 1987: Decrease of sage grouse *Centrocercus urophasianus* after ploughing of sagebrush steppe. - Biological Conservation 41: 125-132.

Vallentine, J. F. 1990: Grazing management. - Academic Press Incorporated, San Diego, California, 533 pp.

Wakkinen, W. L. 1990: Nest site characteristics and spring-summer movements of migratory sage grouse in southeastern Idaho. - M.S. thesis, University of Idaho, Moscow, 57 pp.

Wallestad, R. O. 1975*a*: Life history and habitat requirements of sage grouse in central Montana. - Montana Department of Fish and Game, Helena, 65 pp.

Wallestad, R. O. 1975*b*: Male sage grouse response to sagebrush

treatment. - Journal of Wildlife Management 39: 482-484.

Willis, M. J., Keister, Jr., G. P., Immel, D. A., Jones, D. M., Powell, R. M. & Durbin, K. R. 1993: Sage grouse in Oregon. - Oregon Department of Fish and Wildlife, Wildlife Research Report 15, Portland, 56 pp.

Winward, A. H. 1984: Fire in the sagebrush-grass ecosystem--the ecological setting. - In Sanders, K. & Durham, J. (eds.); Rangeland fire effects, a symposium. U.S.Department of Interior Bureau of Land Management, Boise, Idaho, pp. 2-6.

Winward, A. H. 1991: Management in the sagebrush steppe. - Oregon Agricultural Experiment Station, Special Report 880, Oregon State University, Corvallis, 7 pp.

Zablan, M. A. 1993: Evaluation of sage grouse banding program in North Park, Colorado. - M.S. thesis, Colorado State University, Fort Collins, 59 pp.

Zunino, G. W. 1987: Harvest effect on sage grouse densities in northwest Nevada. - M. S. thesis, University of Nevada, Reno.

Table 1. Changes in sage grouse breeding populations in western North America.

	Males/lek				
	Long-term		>1985		
State/Province	$\bar{x}$	N[a]	$\bar{x}$	N[a]	Change (%)
Alberta	17	10	11	6	-38
Colorado	39	27	27	11	-31
Idaho	33	34	20	11	-40
Montana					
Eastern	33	4	23	10	-30
Southwestern	42	22	29	9	-32
North Dakota	17	31	12	10	-27
Oregon	30	38	21	12	-30
South Dakota	18	13	10	9	-45
Utah	23	26	16	8	-30
Washington	23	21	12	10	-47
Wyoming	36	26	30	10	-17
Average	28	23	19	10	-33

[a]Number of years censused.

Table 2. Changes in sage grouse production in western North America.

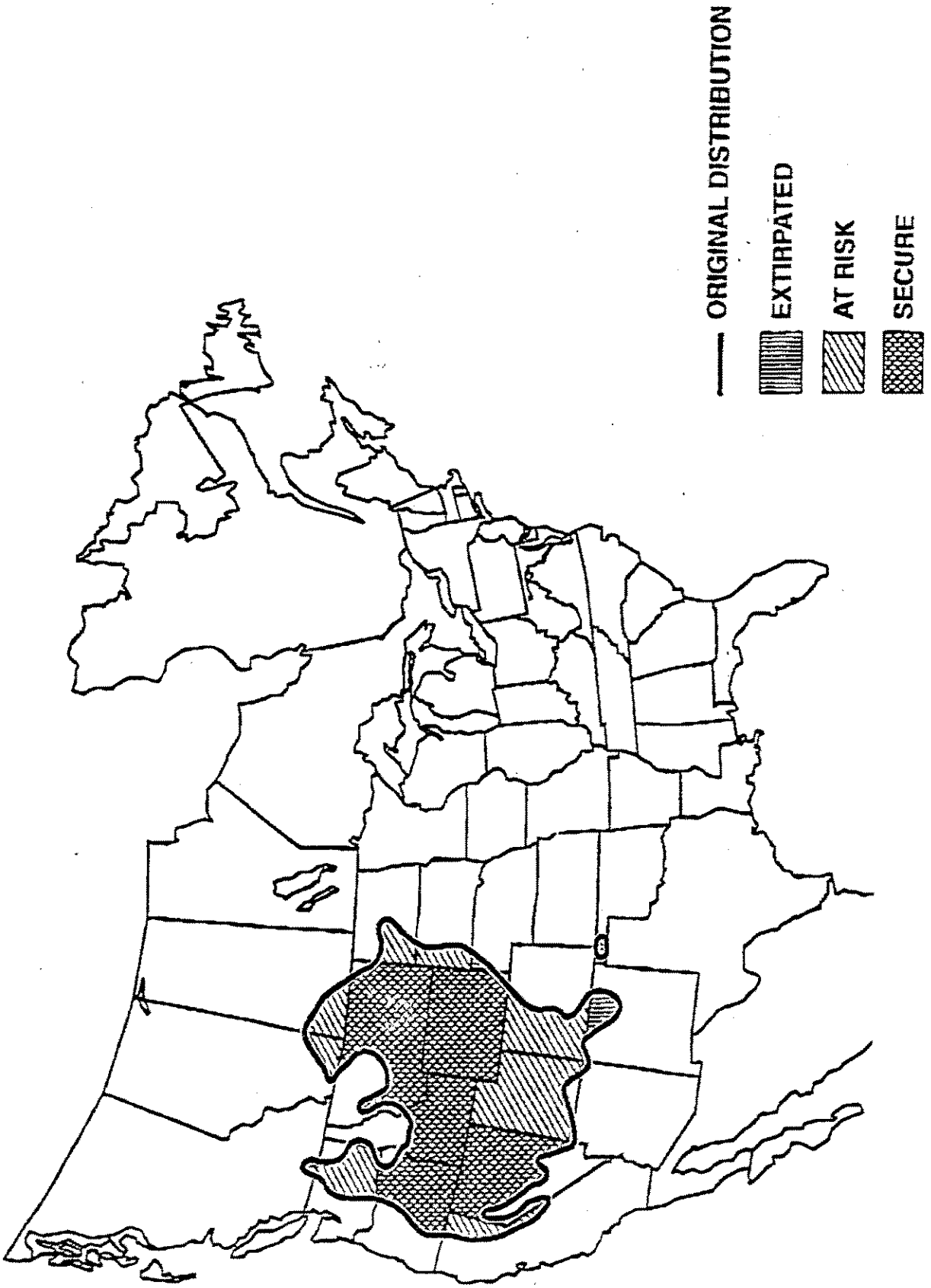
	Chicks/hen				
	Long-term		>1985		
State	$\bar{x}$	N[a]	$\bar{x}$	N[a]	Change (%)
Colorado	1.40	22	1.26	11	-10
Idaho	2.96	25	2.05	10	-31
Montana	2.51	23	2.08	8	-17
Oregon	2.46	34	1.21	11	-51
Utah	2.16	12	2.19	8	+ 1
Wyoming	2.46	7	1.65	10	-33
Average	2.33	21	1.74	10	-25

[a]Number of years censused.

Table 3. Occurrence (ha burned) of fire in sagebrush rangeland on the Upper Snake River Plain of southeastern Idaho, 1950-94.

Years	Wild Fire	Prescribed Fire	Totals
1950-59	2,523	291	2,814
1960-69	18,129	32	18,161
1970-79	19,135	3,297	22,432
1980-89	36,590	23,305	59,895
1990-94	3,887	9,519	13,406
Totals	80,264	36,444	116,708

Figure 1. Distribution and status of sage grouse in North America. Populations have been extirpated in Arizona, British Columbia, New Mexico, and Oklahoma.


ORIGINAL DISTRIBUTION
EXTIRPATED
AT RISK
SECURE