Stephen Frederick Stringham, PhD.
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UNIVERSITY DEGREES

PhD **Behavioral and Population Ecology**. Univ. of Tennessee, Knoxville, TN 97996

MSc **Wildlife Management.** Univ. of Alaska, Fairbanks, AK 99701.

BSc **Biological Oceanography.** Humboldt State Univ., Arcata, CA 99521

PROFESSIONAL EXPERIENCE

WildWatch

39200 Alma Ave
Soldotna, AK 99669-0941 USA
907/260-9059

Dates Employed: 01/1972-present
Grade Level: equivalent to GS14
Salary: up to $200 per billable hour
Hours per week: 40-60
Title: President
Supervisor: self

Founded in 1972, WildWatch is an educational services company that began with wildlife viewing tours before expanding into ecological/environmental consulting, scientific and scholarly research, teaching and tutoring, book publication, website and video production. My accomplishments in each of these roles are listed below.

WILDWATCH CONSULTING

* **Consulting to private industry, conservation groups, and other NGOs**
  - Coauthored the Alaska Recreational Management 2010 Operations Plan for campgrounds in Chugach National Forest. I did 95% of the writing and about one third of the planning.
  - Assessed potential impacts on large mammals by logging, ski resort expansion, and construction of a natural gas pipeline
  - Supervised assessment activities by subcontracting consultants – individuals and firms.
  - Assessed and interpreted environmental protection laws relevant to these issues
  - Assessed and critiqued Federal and State natural resource management plans
  - Assessed and critiqued scientific reports and journal publications
  - Assessed and critiqued (D)EISs, EAs, and related documents
  - Preparing prefile testimony which was submitted to Federal or State agencies or commissions.

- o Testified orally as an expert witness in Federal Court and in State administrative hearings
- o Testified before a Congressional subcommittee
- o Coached attorneys for Direct testimony by myself and other allied witnesses and for Cross-examination of opposition witnesses
- o Cross-examined opposition witnesses
- o Prepared media releases; did radio & TV interviews, as well as public talks
- o Assisted *Kinder Magic Software* in design of interactive educational software for K-12 students ("Backyard Bugs" and "Urban Habitats" for 3^{th}-5^{th} graders, and a lesson on black bear biology and management for high school students)

* **Consulting to the Blackfeet Indian Tribe/Nation**

- o Co-founding Director of the Blackfeet Environmental Office
- o Won EPA grants bringing in roughly $400,000 over 2 years
- o Oversaw grant administration.
- o Provided strategic and tactical guidance for 8 staff.
- o Performed or supervised all scientific work.
- o Performed or supervised environmental monitoring, setting water quality standards; pollution prevention; and assessing impacts of pollution;
- o Wrote QA/QC plans, work plans, progress and completion reports, etc;
- o Supervised issuance of Tribal water quality permits and assisted community members in submitting requests for Army Corp. of Engineers 404 permits.
- o Assured adherence to environmental laws through programs in water quality (lakes, wetlands, watersheds), air quality, and land quality (e.g., superfund; underground storage tanks, solid waste disposal).
- o Analyzed federal and state environmental laws
- o Drafted sewage treatment regulations for the Reservation
- o Drafted the Tribe's Aquatic Lands, Riparian Lands, and Surface Waters Protection Act
- o Served as an expert witness in Federal prosecution of industrial polluters.
- o Advised the Tribal Council and Tribal Government offices on potential environmental impacts by development of windpower generation facilities.
- o Advised the Tribal Council and Tribal Government offices on water rights and related water conservation.
- o Served as a liaison between the Tribe and the Soil Conservation Service, U.S. Geological Survey, Environmental Protection Agency, U.S. Fish & Wildlife Service, National Park Service, and other Federal or State agencies, as well as to NGOs such as the Nature Conservancy and the Montana Natural Heritage Program, and with local ranchers and farmers (including Hutterite colonies).
- o Testified on behalf of the Tribe in Congressional hearings.
- o Made regular reports to the Tribal Council; explained environmental issues; assisted the Tribal government in fulfilling many of its objectives; tried to dissuade the Tribal government from using environmental protection measures selectively for political ends.
- o Used official activities, newspaper articles, and other means to prevent organized crime from illegally disposing of toxic pollutants in caves at the headwaters of the Madison Aquifer.
- o Assisted the Tribal forestry office in minimizing environmental impacts by timber harvest, and in negotiating with "traditionalists" to assure protection of sites and environmental "qualities" that were sacred. Liaised with "medicine men" and other traditionalists to integrate environmental protection with traditional values and practices.

- o Promoted the "hotshot" firefighting team
- o Promoted development of environmental and scientific education at the Blackfeet Community College (where I had taught previously).
- o Consulted with municipal (as contrasted to Tribal) leaders on environmental issues.

* **Consulting to Other Native Communities or Organizations**
  - o Sitka Tribe of Alaska and Kake Tribe
  - o Alaska Native Brotherhood (in Sitka and Kake) – of which I was a member

* **Consulting to Non-Native Communities**
  - o Chair, Scientific Advisory Board, BEAR League, at Lake Tahoe in California and Nevada.
  - o Environmental subcommittee of the **Planning Board/Commission** for Underhill, VT.
  - o Advisory Board member, **North American Bear Society**
  - o Board of Directors member, **Alaska Communities Economic Coalition**
  - o **Technical Committee for the cleanup of the Alaska Pulp Co. mill site** in Sitka, AK.
  - o Cooper Landing - on potential impacts of highway construction
  - o Fish & Game Advisory Council, Kenai/Soldotna (1yr advisor, 1 yr member)
  - o Wolverine Creek Management Committee (12 yrs member)
  - o Kenai Peninsula Brown Bear Management Stakeholder Committee (1yr advisor)
  - o Kenai Brown Bear Committee (3 yrs member)
  - o 100+ talks to the general public and to K-12 school classes on environmental conservation and wildlife safety (Alaska, Vermont, New York, Montana)

BEAR COMMUNICATION & COEXISTENCE RESEARCH PROGRAM

Since 1972, I have been studying the ecology and behavior of bears to learn about their communication, aggression, and relationships with people – especially with bear viewers. Publications listed later in resume.

WILDWATCH PRODUCTIONS & PUBLICATIONS

* 2 videos produced
* Hundreds of webpages published (all linked to www.bear-viewing-in-alaska.info)
* 6 books published – 5 of which I also authored

WILDWATCH TOURS

- During the summers of 1986, 1987, 1998-2014, I led over 3000 guests on wildlife viewing tours, most of which focused on bears. Many of these tours were conducted under the auspices of Katmai Coastal Bear Tours or Redoubt Bay Lodge (see pp. 5-6).
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- I am Director of the ***Bear Viewing Association*** – an organization which I founded to promote bear safety and conservation.

TELE-TEACHERS /TELE-TUTORS

- Nature Interpretation and Environmental education: 25 talks during 2008-2014, over 300 talks during career (not including courses taught in colleges or high schools). Subjects included, but not limited to, behavior and ecology of moose, bears and other large mammals; bear safety, moose safety, etc.
- University courses listed later under "Teaching Experience" (12 yrs part time)
- Teaching assistant for high school physiology & anatomy (1 yr part time)
- Volunteer instructor or tutor for high school math & science (5 yrs part time)
- Tutor "special needs" middle- and high-school students in science and math (5 yrs part time)

RECENT INTERMITTENT EMPLOYMENT

Wolverine Leasing LLC - Redoubt Bay Lodge
P.O. Box 8553
Nikiski, AK 99635
907/776-5147

Dates Employed: 06/2013-08/2016
Grade Level: Master Naturalist Guide
Salary: approx. $3000/mo + R&B + tips
Hours per week: 60+
Title: Bear viewing guide
Supervisor: Danny Brewer

* I guided over 2000 bear viewers at Big River Lakes on the Alaska Peninsula.
* I gave talks on bears and bear safety to at least 6000 clients.
* I assisted in other aspects of running the lodge
* When bears were not visible, I entertained clients with stories of my own experiences.

Katmai Coastal Bear Tours
1/800-532-8338

Dates Employed: June-Sept 1998-2014
Grade Level: Master Naturalist Guide
Salary: volunteer
Hours per week: Up to 2 weeks/summer
Title: Bear viewing guide
Supervisor: John Rogers

Most summers since 1998, I have spent up to 2 weeks guiding bear viewers in exchange for transportation to areas where bears are viewed – which allows me to conduct my own studies on bears and to film them. When I guide bear viewers, I teach them about bears and bear safety, as well as about other local wildlife, habitat and ecosystems.

Within the Wild - Redoubt Bay Lodge
2463 Cottonwood St.
Anchorage, AK 99508
907/274-2710

Dates Employed: 06/2004-08/2004
Grade Level: Master Naturalist Guide
Salary: approx. $2,000/mo + R&B
Hours per week: 60+
Title: Bear viewing/fishing guide
Supervisor: Carl Dixon

* I guided ~600 bear viewers and, occasionally, fishermen at Big River Lakes on the Alaska Peninsula.
* I gave talks on bears and bear safety to at least 2000 clients.
* I assisted in other aspects of running the lodge
* When bears were not visible, I entertained clients with stories of my own experiences.
* I initially took this job to help deal with conflicts between fishermen and viewers, in keeping with my role as a member of the Wolverine Creek Management Committee – which is made up of stakeholders (fishing, viewing, air taxi, lodges, etc.).

University of Alaska, Anchorage
Kenai and MatSu campuses

Dates Employed: 01/2002-10/2005
Grade Level: Adjunct Professor
Salary: Up to approx. $10,000/yr
Hours per week: up to 3
Title: Adjunct Professor

Kenai Peninsula College
349820 College Dr.
Soldotna, AK 99669
907/262-0300

Supervisor: Dr. David Wartanbee

MatSu College
907/262-0300
P.O. Box 2889
Palmer, AK 99645
907/745-9729

Supervisor: Dr. Ben Curtis

I taught courses on Alaska's wildlife. For example, one course focused on **bear biology and bear safety;** another covered all of **Alaska's mammals**.

PAST EMPLOYMENT (*in reverse chronological order*)

US Fish & Wildlife Service
Marine Mammals Management
1011 E. Tudor
Anchorage, AK 99518
907/786-7800

Dates Employed: 04/1994-10/1994
Grade Level: GS 7
Salary: ~ $28,000/yr with COLA
Hours per week: 40
Title: Biologist, 0486
Supervisor: Scott Schliebe

* Analyzed laws pertaining to protection of polar bears and their habitat – including the Endangered Species Act, Marine Mammal Protection Act, Coastal Zone Management Act, Outer Continental Shelf Lands Act, and NEPA. In a more cursory fashion, I also studied around 50 other Federal statutes, as well a several State statutes.
* Visited Arctic coastal communities to collect Indigenous knowledge on polar bear habitat use
* Helped develop the Polar Bear Habitat Conservation Strategy
* Developed estimates of "Potential Biological Removal," as required by the Marine Mammal Protection Act.

Blackfeet (Tribal) Community College
Browning, MT 59417-0819

* Taught General Biology, Physiology Wildlife Biology, etc.

Dates Employed: 09/1990-05/1991
Grade Level: Instructor
Salary: Aprox. $36,000/ 9 mo.
Title: Instructor
Supervisor: Will Henderson (deceased)

Salish-Kootenai (Tribal) Comm. College
P.O. Box 117
Pablo, MT 59855

* Taught Wildlife Habitat

Dates Employed: 09/1989-12/1989
Grade Level: Instructor
Salary: Volunteer
Title: Instructor
Supervisor: David Rockwell

State Univ. of New York,
Adirondack Ecological Center
Newcomb, NY 12852
315/470-6798

Dates Employed: 09/1985-08/1986
Grade Level/Title: Post Doctoral Fellow
Salary: ~ $18,000/yr
Hours per week: 40-60
Supervisor: Dr. Wm. Porter

- I coordinated research by ~8 grad students who were working on related projects, but under several different professors. We were attempting to develop **"holistic resource management**" for both wildlife (e.g., coyote, lynx, bobcat, fox, deer, bear, moose, hare, beaver, etc.) and their habitat – i.e., from an ecosystem perspective, and to integrate this with forest management, so as to optimize the combined yield of game, timber and recreation.

- I developed one of the first density-dependent matrix- models for predator-prey relations.

University of Tennessee
Ecology Program
Knoxville, TN 37996

Dates Employed: 01/1978-05/1984 **approx**
Grade Level/Title: Doctoral candidate grad student
Salary: $0
Hours per week: 60+
Supervisor: Dr. Gordon Burghardt

* Collected, reviewed, analyzed and interpreted data on the behavior, ecology, and population dynamics of bears. Wrote and published reports on these results.
* Extensive statistical analysis of data
* Designed and used mathematical and computer models to analyze population dynamics

University of Tennessee
Biology Dept.
Knoxville, TN 37996

Dates Employed: 01/1978-05/1984 **approx**
Grade Level/Title: Instructor
Salary: ?
Hours per week: 20
Supervisor: Drs. David Fox & Ed Clebsch

* Prepared and conducted lectures and labs in general biology (Teaching Assistant) and general ecology (Instructor).

Maryville College
Biology Dept.
Maryville, TN 37801

Dates Employed: 09/1983-11/1983
Grade Level/Title: Instructor
Salary: $700 / mo
Hours per week: 20
Supervisor: Dr. Robert Ramger

* Taught general physiology to upper-class undergraduates (mostly premeds), including both lectures and labs. All but one of my students got into med school that year; the other one got in the next year.

Texas A&M Univ.
Dept. of Wildlife & Fisheries Sciences
College Station, TX 77843

Dates Employed: 01/1976-05/1977
Grade Level/Title: Doctoral candidate grad student
Salary: start $401/mo end $425/mo
Hours per week: 20
Supervisor: Dr. Fritz Walther (retired)

* Taught labs in Mammalogy, Ecology and Animal Behavior
* Conducted research on bear behavioral ecology and population dynamics

Border Grizzly Project
Ursid Research Center
POB 9383
Missoula, MT 59812
406/829-93798

Dates Employed: 06/1976-09/1976
Grade Level: Equivalent to GS 9
Salary: volunteer
Hours per week: 60+
Title: field assistant
Supervisor: Dr. Chas. Jonkel

- Captured, marked and observed black and grizzly/brown bears.

World Fund fur Umwelt Studien &
German Appeal of WWF
Bonn, Germany

Job location: Tirol, Austria

Dates Employed: 09/1973-08/1975
Grade Level: Equivalent to GS 9
Salary: ~$10,000/yr
Hours per week: 80+
Title: Supervising biologist
Supervisor: Dr. Anton Bubenik (deceased)

- Analyzed impacts of trophy hunting on ungulates (chamois, red deer and roe deer) through restoring near-natural ratios of adult males vs. adolescent males and vs. females of all ages. This was one facet of Project Achenkirch – the most comprehensive study of human impacts to the alpine environment ever done in Europe as of the mid-1970's. Our game management scheme was subsequently adopted throughout Austria, certain other parts of Europe, and some parts of North America, including Alaska (Dall sheep and moose).

University of Alaska, Fairbanks

Dates Employed: 05/1970-09/1973
Salary: ~$4,000/yr
Hours per week: 80+
Title: Masters degree grad student

* Researched the behavior and ecology of moose
* Documented mother-calf relations in moose
* Provided baseline data for assessment of how calf survival is affected by death of the mother
* Assisted teaching wildlife courses

U.S. Geological Survey
Menlo Park, CA

Dates Employed: 06/1968-08/1968
Grade Level: GS-5
Hours per week: 40
Title: Field Assistant
Supervisor: Dr. Ed Clifton (ret.)

Explored for along-shore deposits of gold and other precious metals

U.S. Forest Service
Pacific NW Field Station
Berkeley, CA

Dates Employed: 06/1966-08/1966
Grade Level: GS-5
Hours per week: 40+
Supervisor: Dr. Carroll B. Williams

Collected samples of forest insects before and after treatment with an experimental pesticide to kill spruce budworm.

Diablo Valley College and Humboldt State Univ,
4 years as a part-time lab/field assistant in General Biology, Anatomy & Physiology, Marine Biology, Oceanography and Forestry programs. Taught gymnastics (later coached diving at Texas A&M Univ)

TEACHING EXPERIENCE
(11 yrs college, 6 yrs high school part time)

Sept 07 - present	**Tutor** high school science & math to special needs students. Connections Program, Kenai Peninsula Borough School District, Soldotna, AK. Consulting, not employment.
Jan 02 -May 05	**Adjunct Professor**. Bears & Bear Safety; Mammals of Alaska. Univ. of Alaska, Anchorage satellite campuses at MatSu (Palmer, AK. 99645) and Kenai (Soldotna, AK 99669)
Sept. 96 -May 97	**Tutor** high school science and math. Chignik Bay High School. Chignik Bay, AK.
Sept. 95 - May 96	**Adjunct Professor.** Ecology, Applied Ecology, Outdoor Recreation, Outdoor Leadership, Soils, Natural Resource Conservation. Sheldon Jackson College, Sitka, AK (college now defunct).
Sept 94 95	**Instructor** (volunteer) Taught Marine Science 1 semester; tutored math & computer - June skills 2 semesters. Edna Bay High School, Edna Bay, AK.
Sept 90 - Jun 91	**Instructor.** Wildlife and environmental sci., biology and physiology (pre-nursing). Blackfeet Community College, Blackfeet Indian Reservation, Browning, Montana, 59417.
Fall 89	**Adjunct Faculty.** Wildlife habitat. Salish-Kootenai Tribal College, Salish Kootenai Reservation, Pablo, MT 59855.
Fall 83	**Adjunct Faculty**. Pre-med General Physiology. Maryville College, Maryville, TN 37801.
Sep 79 - Dec 80	**Instructor** for General Ecology and TA for General Biology. Biology Dept., Univ. of Tennessee, Knoxville, TN 37996.

Sep 76 -Dec 77 **TA** General Ecology, Animal Behavior, and Mammalogy. Wildlife Dept., Texas A&M University, College Station, TX, 77843.

Sep 64 - Jun 66 **TA** Biology and Physiology. Diablo Valley College Pleasant Hill, CA 94521.

Sep 63 - Jun 64 **TA** Biology and Physiology. Clayton Valley High School, Concord, CA 94521.

Jan 77 - Jun 77 **Coach**: Diving. Texas A&M Univ.

Sep 66 - Jun 69 **Instructor**: Gymnastics. Humboldt State Univ.

COMMUNITY ACTIVITIES

* Member, Kenai Wildlife Committee (Kenai Brown Bear sub-Committee)
* Member, Wolverine Creek Management Committee (a bear viewing site)
* Member, Alaska Native Brotherhood
* Advisory board member, the BEAR League, at Lake Tahoe in California and Nevada.
* Former member, Fish & Game Advisory Council for Kenai/Soldotna (Alaska)
* Former member of and advisor to the Alaska Native Brotherhood on environmental issues.
* Former advisor to the Sitka Tribe of Alaska on environmental issues.
* Former member Board of Directors of the Alaska Communities Economic Coalition
* Advisor to the Stakeholder Committee for conservation of brown bears on the Kenai Peninsula of Alaska
* Former advisor to the Technical Committee for the cleanup of the Alaska Pulp Co. mill site in Sitka, AK.
* Advisor to various conservation groups.

JOB-RELATED TRAINING

2003 USFWS and State of Alaska bear safety courses (taught bear behavior part of the USFWS course; I took these courses mainly to assure that the messages of my own courses were consistent with the government courses and to sharpen my skill with firearms against simulated bear charges.)
1993 EPA Grant Administration
1993 EPA Water Quality Standards
1991 EPA Groundwater Protection

JOB-RELATED SKILLS

Languages: Moderately fluent in German.
Watercraft: Canoe, kayak, skiff, raft.
Terrestrial vehicles: cars, trucks (up to 5 ton), snowmobile, 4-wheeler, mountain bike
Software: Word processing, spreadsheet, database, graphics, mathematical analysis and modeling, video editing, photo editing, etc.
Firearms: rifle, shotgun, pistol
Lab equipment: wide variety
Construction: All standard carpentry tools & equipment, chainsaw
Landscaping: All standard hand tools (axe, shovel, pick-axe, etc.)
Camping under wilderness conditions with negligible impact
Wilderness Living with minimal impact
Misc: still cameras, camcorder, VCR, tape recorder
Wilderness medicine, survival and rescue

JOB-RELATED CERTIFICATIONS AND LICENSES

2010 Training & Coaching Interpreters, Epply Institute
2010 Foundations of Interpretation, Epply Institute
2009 Wilderness First Aid, CPR, Wilderness Medicine Survival (delayed care)
2008 Ham radio license (KL2IP)
2008 Community Emergency Response Team
1999 Emergency Medical Tech. I (First Responder)
1984 Certified Wildlife Biologist (Wildlife Society)
1968 NAUI Scuba diving

PUBLICATIONS

REFEREED

Stringham SF and A. Bryant. 2015. Distance-dependent effectiveness of diversionary bear bait sites. *Human–Wildlife Interactions* **9**: 229–235.

Stringham SF and A. Bryant. 2016. Distance-dependent effectiveness of diversionary bear bait sites: Commentary. Human–Wildlife Interactions **10**: 128–131.

Stringham, S. 2012a. **Salmon fishing by bears and the dawn of cooperative predation.** *J. of Comparative Psychology*. 26(4):329-38. doi: 10.1037/a0028238. Epub 2012 Oct 22

Stringham, S. 2012b. **Managing risk from bears and other potentially lethal wildlife: predictability, accountability, and liability.** *Human-wildlife Interactions* 7(1):5-7.

Stringham, S. 2011. **Aggressive body language of bears and wildlife viewing: a response to Geist** (2011). *Human-wildlife Interactions* 5(2):177-191.

Stringham, S. 1995a. **Is grizzly bear cub mortality rate elevated by aggregation at concentrated food sources?** *Int. Conf. Bear Res. and Manage*. 9(2):205-215.

Stringham, S. 1995b. **Is grizzly bear reproductive rate depressed by aggregations at concentrated food sources?** *Int. Conf. Bear Res. and Manage*. 9(2):216-222.

Stringham, S. 1995c. **Aggregation of bears at food concentrations (ecocenters).** *Int. Conf. Bear Res. and Manage*. 9(2):223-230.

Stringham, S. 1990a. **Black bear reproductive rate relative to body weight in hunted populations.** *Ursus*. 8:425-432.

Stringham, S. 1990b. **Grizzly bear reproductive rate relative to body size.** *Ursus*. 8:433-443.

Stringham, S. 1989. **Consequences of bears eating garbage at dumps: an overview.** *Bear-People Conflicts - Proceedings of a Symposium on Management Strategies (1989).* Northwest Territories Department of Renew. Res. pp. 35-42.

Stringham, S. 1986. **Effects of climate, dump closure, and other factors on Yellowstone grizzly bear litter size.** *Ursus*. 6:33-39.

Stringham, S. 1984. **Responses by grizzly bear population dynamics to certain environmental and biosocial factors**. PhD. Dissertation, U Tennessee, 495 pp.

Stringham, S. 1983. **Roles of adult males in grizzly bear population biology.** *Ursus*. 5:140-151.

Stringham, S. 1980. **Possible impacts of hunting on the grizzly/brown bear (Ursus arctos), a Threatened species**. *Ursus*. 4:337-348.

Stringham, S and A. B. Bubenik. 1975. **Physical condition and survival rates of chamois** (*Rupicapra rupicapra* L.) as a function of maturity-sex class ratios in the population. Implications for ungulate harvest plans. pp. 123-158 in W. Schroder (ed.): *Tagungsbericht: Internationales Gamswild-Treffen*, Institute for Wildforschung und Jagdkunde, Oberammergau, Germany.

Stringham, S and A. B. Bubenik. 1975. **Condition Physique et Taux de Survie du Chamois,** Rupicapra rupicapra L., En Fonction des Classes d'Age et de Sexe de la Population. *Bulletin de l'Office de la Chasse, Etudes Scientifiques et Techniques, Paris*. Special No. 3:199-224.

Stringham, S. 1974. **Mother-offspring relations in moose**. *Naturaliste Can*. 101:325-369.

Wei, Fuwen, G. Yang, J. Hu, & S. Stringham. 2004. **Balancing panda and human needs for bamboo shoots in Mabian Nature Reserve China: Predictions from a logistic-like model.** pp. 201-209 in D. Lindberg (ed), *Panda Conservation*. U. Calif Press.

MAJOR REPORTS -- mainly on behalf of consulting clients, usually as testimony in legal proceedings.

Stringham, S. F. & Bruce McCurtain. 2009. **Annual Operating Plan 2010-2019 for Campgrounds and Other Facilities in Chugach National Forest, Alaska**. Alaska Recreational Management. 266 pp. + attachments

Stringham, S. F. 2006a. **Critique of the USFWS (1999) Draft Habitat-Based Recovery Criteria for the Yellowstone Grizzly Bear.** (30 pp.) [*Update of 1999 testimony to the USFWS*]

____. 2006b. **Are Official Estimates of Yellowstone Grizzly Bear Population Size and Sustainable Mortality Critically Biased by Annual Variation in Thoroughness of Censusing Adult Females with Infant Cub Litters?** (103 pp.) [*Update of testimony submitted in 1998 to the USFWS*]

____. 2006c. **Overview of my Comments on the U.S. Fish & Wildlife Service DPS-Delisting Proposal For Grizzly Bears** (11 pp.) [*Testimony to the USFWS*]

____. 2006d. **Crippling Vagueness of the Delisting / DPS Rule**. (11 pp.) [*Testimony to the USFWS*]

____. 2006e. **Are Yellowstone Grizzly Bears a Distinct Population Segment that is Ready for Delisting?** (25 pp.)

____. 2006f. **Are Delisting Criteria Legal?** (2 pp.)

____. 2006g. **Analysis of Population Trend for Grizzlies** (13 pp.)

____. 2000a. **Estimating Extinction Risk for Grizzly Bears or Other Large Mammals: Is Foley's Model Applicable?** (69 pp.) [*Testimony to the USFWS*]

____. 2000b. **Critique of Boyce (2000) Metapopulation Analysis for the Bitterroot Population.** [Testimony to the USFWS]

____. 2000c. **Critique of the Draft Conservation Strategy for the Grizzly Bear in the Yellowstone Area**. (11 pp.) [*Testimony to the USFWS*]

____. 1999 **Assessing importance of specific habitat areas. [Unpubl. Report to the Kenai Brown Bear Stakeholders Committee**] (3 pp.)

____. 1998a**. Does the Grizzly Bear Recovery Plan Exaggerate Sustainable Loss to Known Human Kills**? (10 pp.) [*Testimony to the USFWS*]

____. 1998b. **How the Grizzly Bear Recovery Plan May Exaggerate Estimates for Total Population Size and Sustainable Loss Extrapolated from Abundance of Adult Females**. (19 pp.) [*Testimony to the USFWS*]

____. 1997a. **Critical Deficiencies in Information-Gathering Under the U.S. Fish & Wildlife Service Grizzly Bear Recovery Plan** (32 pp.) [*Testimony to the USFWS*]

____. 1997b. **Why Abundance of Infant Litters is Not a Reliable Index of Population Size and Sustainable Mortality for Yellowstone Grizzly Bears?** (27 pp.) [*Testimony to the USFWS*]

____. 1996. **Buffered viability management of bear populations: a conceptual model for selecting critical decision thresholds.**

____. 1995a. **A meta-strategy for world bear conservation.**

____. 1995b. **Endangered Species Act – annotated Synopsis**. USFWS report.

____. 1994a. **Legal Protection for Marine Mammals and Habitat**. USFWS report.

____. 1994b. **Legal Basis for Protecting Polar Bear Habitat**. USFWS report.

____. 1994c. **Comments on the Marine Mammal Protection Act**. USFWS report.

____. 1994d. **Outer Continental Shelf Lands Act: annotated Synopsis**. USFWS report.

____. 1994e. **Outer Continental Shelf Lands Act: basis for decisions**. USFWS report.

____. 1988a. **Evolving standards for the legal admissibility and judgment of scientific evidence about the impacts of human activity on bears or their habitat.** Address to the Ninth Eastern Black Bear Workshop. Ontario. April 1988.

____. 1988b. **What are "necessary habitat" and "undue adverse effect on the natural** environment?" An ecologist's view of Vermont Acts 250 (8a) and 248 (b5). Prefile testimony presented in hearings on Champlain (natural gas) Pipeline before the Vermont Public Utilities Board, administrative hearing.

____. 1988c. **Is the Vermont black bear population crashing? Implications of a population reconstruction analysis.** Prefile testimony presented in hearings on Champlain (natural gas) Pipeline before the Vermont Public Utilities Board, administrative hearing.

1986. **Ecosystem perspectives and modeling for Adirondack mammal predator-prey interactions.** 58pp. + 48pp. of appendices.

NATIONAL MAGAZINE AND LOCAL NEWSPAPER ARTICLES.

____. 1992. How many grizzlies is enough: Is the grizzly still Threatened or Endangered? Ursus 1(3) and 1(4):8-10, 13, 23-24.

____. 1993. Trophy bull management: an alternate strategy. Bugle magazine (3):123-126.

____. 2000a. Series of 12 newspaper articles on conservation of grizzly/brown bears on the Kenai Peninsula of Alaska -- related to development of a new Conservation Plan.

____. 2002b. **Opinion** piece for Homer News, Homer, AK.

____. 2002c. **Smokey and Mirrors**. The War Between Science vs. Pseudoscience in grizzly bear conservation. WildEarth Magazine. fall issue.

TECHNICAL BOOKS

Published

____. 2011. **Ghost Grizzlies and Other Rare Bruins: The Art & Adventure of Knowing Wild Bears**. [A field guide for bear viewers.]

____. 2010. **When Bears Whisper, Do You Listen?** [How to cope with non-aggressive bears during close encounters.]

____. 2009. **Alaska Magnum Bear Safety Manual**: [How to avoid unwanted encounters, and how to cope with encounters you can't or won't avoid. This is the only bear safety manual tailored to Alaska conditions, explaining how to kill a bear if necessary, and detailing the "Ten Golden Rules of Bear Viewing.]

____. 2007. **Bear Viewing in Alaska. [**Where, when and how to view bears.]

____. 2002. **Beauty Within the Beast: [**On bear-human relationships.]

____. 1992/2006 **Evolution of Bears: [**An eBook soon to be available to read without cost at www.bear-viewing-in-alaska.info/Evolution_of_Bears/Contents.html]

In preparation

____. 2016 (scheduled). **Bear Aggression**: [How to cope with aggressive bears during close encounters without having to kill the animals.]

____. 2015 (scheduled) **The Language of Bears: Communication is the Key to Coexistence. [**How to interpret the body language and vocalizations of bears.]

EDUCATIONAL NOVELS

______. 2015. **Treasures of the Golden Bear**

VIDEO PRODUCTION

2003. **Grizzlies Among the Glaci**ers. Bear communication and social relationships.

2005. **Wolverine Creek Wildlife Adventures**. Bear predation and social relationships in the vicinity of Wolverine Creek on the Alaska Peninsula.

CONFERENCE PRESENTATIONS

(up to 8 papers presented at each conference; 50+ presentations total)

2016. Chaired the session on bear viewing, International Bear Association annual conference, Anchorage, AK.

2009. *Bear Care Conference,* San Francisco Zoo.

a. Bear behavior & ecology: potential contributions by captive research to testing hypotheses & answering questions generated by field research.
b. Ursid ontogenetic responses to variations in nutrition and adult male abundance.
c. Ursid pelage coloration: Ontogenetic, regional and seasonal variations.
d. Cognitive ethology of ursidae.
e. Ursid ethogram project.
f. Does habituation to humans really render captive bears unfit for release into the wilds?
g. Distinguishing among North American bear species by hand- and foot-prints.
h. Does behavioral maturation continue during hibernation or aestivation? A possible method for distinguishing effects of maturation vs. experience

2013, 2007, 2004, 2001, 1998, 1995, 1992, 1989, 1986, 1983, 1980 *International Conferences on Bear Research and Management*. During the 1980, 1983, 1986, 1992, 1998 and 2001 conferences, I **chaired workshops on population analysis and modeling, on roles of adult males, on bear conservation strategies, and on bear communication and aggression.**

2009. *Bear-Human Conflicts Conference*, Canmore, Alberta. (abstracts submitted)

a. Bear Viewing: *Recreation, Industry and Management*
b. Wildlife Viewing, Habituation, and Attack Risk
c. Ursid Ethograms*: Can They Assist in Assessing Bear Attacks?*
d. How Dangerous Are Bears?
e. Can Aggression Data Alone Provide Valid Estimates of Risk?
f. The Treadwell Syndrome: *Failure to Distinguish Effective Precautions From Superstitions*
g. Do Images of Close Bear Viewing Endanger The Public?
h. The Bear Viewing Association’s Ten Golden Rules

2003. *Carnivore Reproduction and Nutrition* workshop, San Diego Zoo.

1993, 1992, 1991, 1990 *Border grizzly/wolf/puma workshops,* Glacier National Park.

1987 *Black bear and timber wolf habitat symposium,* Hiawatha National Forest, Michigan.

1987 **Chair:** *Northeastern Hardwoods Black Bear Habitat Symposium*, Bridgewater Vermont.

1987 *Bear-people conflicts conference*. Yellowknife, Canada.

1987, 1983, 1982, 1981, 1980 *Animal Behavior Society* international conferences.
I **assisted in hosting the 1981 conference**. In 1987, **I organized a symposium** on *"Adult male mammals ... Implications for theory and management.*

1986 *Animal Behavior Society,* northeastern regional meeting,

1986 *American Society of Mammalogists.*

1988, 1984. *Eastern Black Bear Workshop*

1984 *Barrett Memorial Lecture Series: Symposium on Mathematical Ecology*

1982, 1981, 1980. *Society for the Sigma Xi.*

1974 *Gamstagung* (Internat. Conf. on ecology and management on chamois), Germany.

1973 *International Symposium on Ecology and Behavior of Moose,* Quebec.

GRANTS

Obtained from EPA for the Blackfeet Tribe when I directed their Environmental Office

$113,000 Wetlands grant
$ 79,000 Multimedia grant
$ 15,000 Solid waste disposal planning grant
$ 88,000 Clean Water Act (106) grant
$ 50,000 Clean Water Act (106) grant
$ 47,000 Clean Lakes (314) grant

Recent Grants from NGOs

Jane Perlmutter Memorial Fund
Earth Justice Legal Defense Fund
Sierra Club Legal Defense fund
Sierra Club Foundation
Wild Forever
Natural Resource Defense Council

PROFESSIONAL REFERENCES

Consulting Clients and Others

Kenai Peninsula

Dianne Owen, former Operations Manager. Alaska Recreational Management, 3705 Arctic Blvd, #2337 Anchorage, AK 99503. Phone 601/649-4696 *dianne1001@gmail.com*

Roland Maw, Director, United Cook Inlet Driftnet Association, Soldotna, AK 99669 *rmaw@ucida.org* 43961 K-Beach Road, Suite E . *Soldotna*, *Alaska* 99669. (907) 260-9436 . fax (907) 260-9438. Former Operations Superintendent for AK Division of Parks & Outdoor Rec.

Joe Kashi, Attorney at Law, *kashi@alaska.net*. 398-0480 (cell) 260-7732 (Office)

Andrea Brooks, former Manager, Redoubt Bay Lodge. Brooks12andrea@yahoo.com

Outside Alaska

Dr. Val Geist, P.O. Box 1294 Port Alberni, British Columbia, V9Y 7M2 Ph./Fax 250/723-7436 (colleague of nearly 30 years) *geistvr@cedar.alberni.net*

Louisa Willcox, Director. Natural Resources Defense Council. P.O. Box 70, Livingston, MT 59047. 406/581-3839 email *LLwillcox@aol.com* (Long-term consulting client).

Susan Morse, Program Director, Keeping Track. Wolf Run, 55a Bently Lane, Jericho, VT 05465. Ph 082/899-2023 (colleague and occasional subcontractor for over 20 yrs)

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DRAFT 9/30/16 Not for citation without author permission

RH: Hunting Yellowstone Grizzly Bears

Would Hunting Yellowstone Grizzly Bears Reduce Risk of Attacks on People or Livestock?

Stephen F. Stringham, Bear Viewing Association. 39200 Alma Ave, Soldotna, AK 99669

Abstract: While Listed as Threatened under the Endangered Species Act, grizzly bears (*Ursus arctos*) in the Greater Yellowstone Ecosystem have increased in abundance and distribution beyond national park boundaries. Despite evidence that long term viability has not yet been restored, the population has met concrete Recovery objectives, so termination of ESA protection is pending. This would allow major increases in human impacts, including harvest for trophies, to reduce grizzly abundance outside parks, and to intensify fear of humans, anthropophobia. Intensifying anthropophobia might minimize risk to humans if most attacks were offensive. However, nearly all serious or fatal attacks are defensive, due to excessive anthropophobia, not to its lack. Hunting Yellowstone grizzlies is likely to increase, not decrease danger to humans, including not only hunters, but "innocent bystanders" who pose no threat to bears. True recovery will not been achieved until viability can be assured for the foreseeable future even after Delisting.

In A Nutshell

- To the extent that attacks on humans are defensive, risk can be reduced by winning the animals' trust– teaching them locations and conditions where humans will not harass or harm them.
- To the extent that attacks are offensive, risk can be countered by enhancing respect for humans and by minimizing situations that invite aggression, e.g., attraction to human foods.

- Adding sport hunting to the already high human-induced grizzly bear mortality rate in the Greater Yellowstone Ecosystem is likely to elevate attack risk and jeopardize their longterm viability, warranting relisting biologically, whether or not it is feasible politically.

Keywords: Attack risk, delisting, Endangered Species Act, fear of humans, Greater Yellowstone Ecosystem, grizzly bear, habituation, hunting, national park, *Ursus arctos*.

Delisting a Threatened Species

Grizzly bears (*Ursus arctos*) living south of Canada were among the first large mammals classified as Threatened under the 1973 Endangered Species Act (ESA). They have been protected from hunting ever since, as one of the most charismatic, flagship species on this continent. Since then, grizzlies in the Greater Yellowstone Ecosystem (GYE) have roughly tripled in number and geographic distribution, including habitat far beyond the boundaries of Yellowstone and Grand Tetons National Parks (Servheen 2013, Haroldson et al. 2016.) Accordingly, the U.S. Fish & Wildlife Service (USFWS) judges that the population has Recovered and is ready for an end to ESA protection, i.e., for being Delisted. This decision accords with official Recovery criteria that are empirical and measureable (USFWS 2016). Yet they have no definite correlation with the theoretical criterion of achieving long term population viability – i.e., minimizing risk of Threat or Endangerment over the foreseeable future, as implied by the ESA (Clegg et al. 1995). Scheduled Delisting in coming months could allow enough increase in human impacts to reverse gains made under Threatened status (Mattson 2016).

Human-Bear Conflicts

One reason for concern is the rise in human-bear conflicts, especially outside of national park boundaries, which has accompanied the rise in bear numbers and distribution (DeBolt et al. 2016, Frey & Smith 2016, Gunther et al. 2016, Hendricks et al. 2016; Wilmot 2016). The grizzly population has allegedly exceeded the "political carrying capacity" of its peri-park habitat, according to rhetoric expressing and enflaming concern by a cadre of local residents about potential danger to humans and livestock. That is overriding nationwide and international concern for welfare of GYE grizzlies.

Benefits of Habituation

Problems created by increasing size and distribution of the grizzly population have allegedly been exacerbated by large scale bear viewing, especially in habitats adjacent to roads, mainly within the national parks, or within the Rockerfeller Memorial Parkway corridor connecting the parks. Habitats near humans and roads are usually avoided by adult male grizzlies, thereby providing a refuge from adult male aggression for subadults and mothers with cubs (Mattson et al. 1992). Bears thusly forced into proximity of benign humans sometimes trust people enough to largely ignore them as the bears live in frontcountry habitat much as they would live in more remote habitat– neither seeking people and their artifacts, nor avoiding them by a wide margin. Developing neutrality towards humans can be referred to as "neutralizing habituation" (N-habituation) – by contrast to other degrees and forms of habituation (see Herrero et al. 2005; Smith et al. 2005; Stringham 2010; Geist 2011). To the extent that this increases bear utilization of habitat near humans or roads, it raises the realized ecological carrying capacity of the GYE for bears (Herrero et al. 2005; Smith et al. 2005).

Potential Downsides of Habituation

Nevertheless, critics condemn habituation as dangerously unnatural, in part because it increases risk of close bear-human encounters, during which people might conflict with bears over food, or accidentally provoke bear defensiveness. This is exemplified by conflicts which have involved highly N-habituated bears such as matriarch #399 and her clan. They frequent habitat near roads in Grand Tetons National Park and the Rockerfeller Memorial Parkway, where they have been easily and safely viewed by countless people from around the world, who contribute tens of millions of dollars annually to local communities (Masica 2016; Gunther et al. 2016). Yet, despite this matriarch's unusually high tolerance for humans near roads, she mauled one man who surprised her elsewhere while she and her cubs were feasting on a wapiti carcass (*Cervus elaphus*, NPS 2007).

Hunting Bears Without Hunting Them

One alleged means of minimizing N-habituation is sport hunting. Supposedly, the boldest bears will fall prey, and the survivors will be too afraid to approach humans, livestock or other property. However, even while protected by the ESA, most subadult and adult grizzlies that die each year are killed because of predation on livestock or from more direct conflict with a human, for instance when a bear challenges a hunter for a big game carcass or its gut pile (DeBolt et al. 2016, Frey & Smith 2016, Gunther et al. 2016, Hendricks et al. 2016; Wilmot 2016). Or grizzlies respond defensively when surprised by a stalking wapiti hunter.

What Dead Bears Don't Learn

So it is likely that anything bears can learn from being hunted is already being learned. There is no evidence that adding sport harvest will teach surviving bears anything new. Nor is there evidence that whatever survivors learn outside of Parks is being transferred to bears that live solely within Park boundaries. On the contrary, most migration by bears is from inside Parks to outside habitat, and this trend is only likely to increase as bear density outside parks shrinks (Mattson 2016). There is no scientific basis for claiming that adding a sport harvest of grizzly bears outside Yellowstone and Grand Tetons National Parks will be make surviving grizzlies more wary or less dangerous to humans, livestock or property.

Recreation or Decimation?

Nevertheless, once ESA protection is lost, trophy hunting of GYE grizzlies outside national park boundaries will become legal in each of the three adjacent states: Wyoming, Montana and Idaho (e.g., MFWP 2016, USFWS 2016). How many bears will be killed, how soon, remains to be seen In 2015, shortly after Florida's black bears lost ESA protection, trophy hunters killed about 10% of the population (>300 bears) during the first weekend of hunting season (FWC 2016:Table 1). Although grizzlies cannot withstand as much hunting pressure as black bears, total mortality limits for GYE would be about 10% for all age-sex classes except adult males, for whom the limit would be 22%, based on current estimates of around 750 grizzlies in the entire GYE (USFWS 2016:Table 2). Worse, the vast majority of GYE grizzlies would be harvested outside Park boundaries, where the effective harvest rate could be double the population-level figures. That could vastly exceed immigration from Parks and decimate grizzly numbers in surrounding areas of the GYE – not by accident.

Questionable Strategy

It stands to reason that livestock predation and other forms of conflict with humans by wild carnivores can be minimized by reducing carnivore density. However, there is a surprising lack of empirical data showing that anything short of predator holocaust can achieve that goal (Orians et al. 1997). After reviewing the literature on predator control in North America and Europe, Treves et al. (2016) found little reliable evidence that increased harvests of coyotes (*Canis latrans*), wolves (*C. lupus*), cougars (*Puma concolor*), or bears (*Ursus arctos* or *U. americanus*) substantially reduced livestock predation. Nor does it reduce other kinds of conflict between black bears and humans (Treves et al. 2010; Obbard et al. 2014).

Backlash Effect

Sometimes just the reverse happens, as has been well known for decades among predator control officers (Randall, pers. commun.). One reason stems from predator social dynamics. Adults limit the number of conspecifics and sometimes allospecifics with which they share habitat. Adults tend to be relatively skilled at capturing wild prey and avoiding conflicts with humans, in part by not preying on livestock. When such adults are killed, their home ranges tend to be taken over by adolescents that are less skilled at predation on wild game and at coexisting with humans.

Alternative Strategies

Given that most grizzly predation on livestock is done by adult males (Mattson 2016), one might expect trophy hunters to be targeting the same class of bears troubling ranchers. However, a more effective strategy would be hunting the specific bears killing cattle. Even that should be minimized if adequate livestock protection can be achieved using non-lethal tactics such as (a) reducing livestock vulnerability (Treves et al. 2016), (b) aversively conditioning bears, or (c) providing bears with an alternative food source to counter shortages of wild foods (Stringham & Bryant 2015, 2016). One driver of livestock predation by grizzlies in the GYE is the rapidly diminishing supply of seed-producing whitebark pine trees (*Pinus albicaulis*) due to climatic warming and pathogens; that exacerbates earlier loss of most cutthroat trout (*Oncorhynchus clarkii*) and diminishing supplies of wapiti as prey or carrion – i.e., three of the population's four major sources of protein and lipid, aside from livestock (Mattson 2016).

Aversively conditioned bears can survive long enough to learn how to coexist with humans and transmit this knowledge to other bears; harvested bears can't. Bears chased by free-running hounds may learn greater fear of hounds; but does this teach them anything about coexisting with humans? Bears stalked by trained bear dogs leashed to a human handler (IGBST 2016) are likely to learn more.

Even a single human persistently following a bear can increase its respect toward humans (Stringham 2010, Geist 2011). A recent study in Sweden found that after brown bears were closely approached by a human on foot, although not necessarily within sight of the bear, the bears shifted their activity peaks from daytime to nighttime – a tactic commonly used by prey to avoid diurnal predators (Ordiz et al. 2013).

Just as important as educating bears is educating humans about bears so that perceptions about risk are more realistic – countering exaggerating propaganda by livestock owners and sport hunters – and about how to minimize risks (see Johansson et al. 2016).

Grizzlies in the Night

There is no evidence that bears becoming more nocturnal reduces risk to humans or livestock; on the contrary, if it reduces efficiency of foraging on other foods (e.g., nuts, berries or rodents), it might increase predation on livestock. Most predation on humans occurs at night; and nighttime activities by bears can increase risk of surprise encounters, for instance when bears forage near campsites or settlements. Fear of humans is often dominated by fear of other bears (see Mattson et al. 1992) and/or by attraction to anthropogenic foods such as garbage or carcasses of harvested ungulates. Numerous other factors also govern how much distance a bear tries to maintain from people and their artifacts.

Conclusions

Even if hunting were to decrease likelihood of human-bear encounters, that would occur at the cost of higher attack risk per encounter due to intensifying distrust. Most assaults and attacks by brown/grizzly bears, as well as most assaults by black bears, are triggered by fear of being harmed by humans. Serious or fatal injuries are also inflicted on humans who are perceived as rivals for carrion which a brown bear has claimed. The incident involving matriarch #399 is a case in point. Those assaults and attacks are not offensive but defensive (Herrero 1985, Herrero & Higgins 1999, 2003) – the result of too much fear, not too little. Hunting tends to make matters worse, both by further alienating bears, and by exposing hunters to defensive attack. Hunters are among the most common targets of brown/grizzly aggression (Herrero 1985, Herrero & Higgins 1999, 2003; Mattson 2016). Bear viewers that don't crowd or threaten a grizzly are almost never injured; nor do they have to harm bears to assure their own safety. If human safety is a primary goal of managing bears outside of Yellowstone and Grand Tetons National Parks, then this would be better promoted by reducing human aggression than by increasing it – i.e., by enhancing trust, non-violently enhancing respect for humans, and educating the public about actual risks and how to minimize them.

Acknowledgements

This assessment was conducted under the auspices of WildWatch. For additional information in flaws in evidence that Yellowstone grizzlies have truly Recovered to long term viability, consult comments by David Mattson and Louisa Willcox at www.allgrizzly.org, and www.grizzlytimes.org. Dick Randall was a predator control office based in Rock Springs, Wyoming for many years. In 1969-70, we had several long talks about his experiences, including the backlash effects of harvesting adult coyotes, which were soon replaced by youngsters that were less skilled at coexisting with humans.

References Cited

Clegg MT, BrownGM Jr., Brown WmY, Fink WL, Harte J, Houck OA, Lynch M, Maguire LA, Murphy DD, O'Brien PY, Pickett STA, Pulliam HR, Ralls K, Simpson BB, Sparrowe RD, Steadman DW, Sweeney JM. 1995. Science and the Endangered Species Act. National Academy Press, Washington D.C.

DeBolt B, Turnbull Z, Ellsbury L, Boyce M, Bales K, Stephens S, Lasseter D, Nielsen C, and Thompson D. 2016. Human-grizzly bear conflicts in Wyoming. Pages 79-85 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana, USA.

Frey KA. and Smith J. 2016. Human-grizzly bear conflicts in Montana. Pages 73-78 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana.

FWC (Florida Wildlife Commission). 2016. 2015 Florida black bear hunt summary report. http://myfwc.com/bear.

Geist V. 1978. Life strategies, human evolution, and environmental design. Springer-Verlag, New York, New York.

Geist V. 2011. Response to Rogers and Mansfield (2011) and Stringham (2011). *Human–Wildlife Interactions* **5:** 192–196.

Gunther KA, Wyman T, and Reinertson E. 2016. Human-Grizzly Bear Conflicts in Yellowstone National Park. Pages 66-70 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana.

Haroldson MA, Dickinson C, and Bjornlie DD. 2016. Bear modeling and population trend. Pages 5–27 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana.

Hendricks C. 2016. Human-grizzly bear conflicts in Idaho. Pages 71-72 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana.

Herrero S. 1985. Bear attacks: their causes and avoidance. Lyons and Buford. New York, NY.

Herrero S, and Higgins A. 1999. Human injures inflicted by bears in British Columbia 1960–1997. *Ursus* **11**: 209–218.

Herrero S and A. Higgins 2003. Human injuries inflicted by bears in Alberta 1960–1998. *Ursus* **14**: 44–54.

Herrero S, Higgins A, Cardoza J, Hajduk LI, and Smith T. 2011. Fatal Attacks by American black bear on People: 1900–2009. Journal of Wildlife Management **75**: 596–603.

Herrero S, Smith T, DeBruyn T, Gunther K, and Matt C. 2005. Brown bear habituation to people – safety, risks, and benefits. *From the field: Wildlife Society Bulletin* **33**: 362-373.

Johansson M, Ferreira IA, Støen OG, Frank J and Flykt A, 2016. Targeting human fear of large carnivores — Many ideas but few known effects. *Biological Conservation* **201**: 261–269.

MFWP (Montana Fish, Wildlife, and Parks). 2016. Greater Yellowstone Ecosystem Grizzly Bear Hunting Regulation Framework – Proposal. fwp.mt.gov/hunting/publicComments/2016/ GYEGrizzly BearHunting.html. Viewed 10 June 2016

Masica SE. 2016. Memo from the Intermountain Regional Director of the National Park Service to the Director of the U.S. Fish & Wildlife Service. 10 May 2016. Memo: NPS Review of GYE GB CS and PR) 051016.

Mattson DR. 2016. Comments on the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA); Federal Register 81(48): 13174-13227, and Related Materials. Comments submitted to the US Fish & Wildlife Service, 5 May 2016.

NPS (National Park Service, Grand Tetons National Park). 2007. News release, 14 June 2007,

Obbard ME., Howe EJ, Wall LL, Allison B, Black R, Davis P, Dix-Gibson L, Gatt M, and Hall MN. 2014. Relationships among food availability, harvest, and human–bear conflict at landscape scales in Ontario, Canada. *Ursus* **25**: 98-110. http://dx.doi.org/10.2192/URSUS-D-13-00018.1

Orians, GH, Cochran PA, Duffield JW, Fuller TK, Gutierrez RJ, Hanemann WM, James FC, Kareiva P, Kellert SR, Klein D, McLellan BN, Oleon PD, Yaska G. 1997. Wolves, Bears and Their Prey in Alaska. National Academy Press, Washington D.C.

Smith T, Herrero S, and DeBruyn T. 2005. Alaskan brown bears, humans, and habituation. *Ursus* **16**: 1-10.

Stringham SF. 2010. When Bears Whisper, Do You Listen? Negotiating Close Encounters With Wild Bruins. WildWatch. Soldotna, AK.

Stringham SF and Bryant A. 2015. Distance-dependent effectiveness of diversionary bear bait sites. *Human–Wildlife Interactions* **9**: 229–235, Stringham SF and Bryant A. 2016. Distance-dependent effectiveness of diversionary bear bait sites: Commentary. Human–Wildlife Interactions **10**: 128–131,

Treves A, Kapp KJ, and MacFarland DM. 2010. American black bear nuisance complaints and hunter take. *Ursus* 21: 30–42.

Treves A, Krofel M, and McManus J. 2016. Predator control should not be a shot in the dark. *Frontiers in Ecology and the Environment.* **14**: 380-388. doi 10.1002/fee.1312

USFWS (US Fish and Wildlife Service). 2016. FINAL DRAFT, Draft 2016 Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Ecosystem. pdf available at http://ecos.fws.gov/ecp0/pub/sepciesRecovery.jsp?sort=1. Viewed 22 Sept. 2016.

Wilmot K. 2016. Human-grizzly bear conflicts in Grand Teton National Park. Page 65 in: van Mannen F, Haroldson MA and Karabensh BE (Eds). Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2015. U.S. Geological Survey, Bozeman, Montana.

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1 October 2016
Additional Comments by
Stephen F. Stringham, PhD

On the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA);
Federal Register 81(48): 13174-13227, Docket FWS-R6-ES-2016-0042 and Related Materials

On 30 September 2016, I submitted a cover letter and 3 attachments as the first installment of my comments on proposed delisting of the Yellowstone grizzly bear (Tracking #1k0-8s7c-klty) Those 4 attachments are listed below.

Part 1 (30 September 2016) Attachments:
a.Stringham pre-publication peer review of vanMannen et al 2015 - Part 1.pdf

b.Stringham pre-publication peer review of vanMannen et al 2015 - Part 2.pdf

c.Habituation & Hunting Yellowstone Grizzlies 2016-9-30.pdf "Would Hunting Yellowstone Grizzly Bears Reduce Risk of Attacks on People or Livestock?"

I also included by reference all comments which I submitted to the FWS for proposed delisting of the Yellowstone grizzly in 2006. Three of my 2006 documents are attached here. Much of the material therein is still relevant to the 2016 delisting proposal. Also included here is a copy of my professional resume.

Parts 2-4 (1 October 2016) Attachments
Part 2.Flaws in a Core Argument of the 2006 FWS Delisting Rule
Part 3.2006 Comments on Keating's Chao2 Method of Extrapolating from Counts of Females With COY To Estimate Total Females With COY
Part 4.What is the Yellowstone DPS and HOW MANY GRIZZLY POPULATIONS ARE WITHIN THE pDPS?
Stringham resume

Sincerely,
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30 September 2016

Comments by
Stephen F. Stringham, PhD

On the

US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered

Species Act (ESA); Federal Register 81(48): 13174-13227, Docket FWS–R6–ES–2016–0042

and Related Materials

This package of materials constitutes my review of the Rule and related materials (hereafter the Rule) issued by the US Fish & Wildlife Service (FWS) covering a proposal to remove grizzly bears in the Grater Yellowstone Ecosystem (GYE) from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA). The Rule itself was published in the Federal Register 81(48): 13174-13227; I obtained additional related materials from the Service's web site under Docket no. FWs-R6-ES-2016-0042: FXES111309000000C6-156-FF09E42000. These additional materials include the draft 2016 Conservation Strategy plus appendices (hereafter the CS) and the draft Grizzly Bear Recovery Plan Supplement: Revised Demographic Criteria (hereafter the RP).

Given that these materials encompass nearly 700 pages and that I only recently was able to set time aside to respond, most of my response consists of documents which I prepared in the past for (a) responding to the 2006 delisting proposal, or (b) critiquing publications by the IGBST. Despite the decade-long interval, the current versions of the Rule and CS have sufficient similarity to the 2006 versions that most of the comments I made then still apply and are included herein by reference. Copies are attached.

Qualifications

Although I began my career as a marine ecologist (BSc Biological Oceanography), since 1970 I have researched the ecology and behavior of terrestrial wildlife (MSc Wildlife Management, PhD Ecology). Among my specialties are roles of adult males in the population ecology of bears and ungulates; population dynamics; population modeling; mother-offspring relations and behavioral ontogeny; communication; tool use; direct bear-human interactions; bear viewing; and Native American indigenous science and resource management. Most of my professional life has been spent as an independent consultant. Most of the reports I produced were proprietary information; so few were published. Occasionally during those 4 decades, I have held short term positions with various universities and government agencies. For example, I was a member of the polar bear management team in the Office of Marine Mammals Management of the US Fish & Wildlife Service in Anchorage, Alaska. As a consultant, I have been called upon numerous times to critique wildlife management plans produced by state or federal agency personnel. This included critiques concerning Yellowstone grizzly bears, Nevada black bears, and Florida black bears – all of which were protected from hunting for decades. The two black bear populations have already been subjected to renewed hunting. The same is proposed for the Yellowstone grizzly population.

Peer Review

Quoting from Dr. David Mattson's Introduction in his May 2016 comments on the delisting Rule (Rule) and Conservation Strategy (CS): "The IGBST operates under the auspices and authority of the US Geological Survey (USGS). In its various policy documents, the USGS makes many claims regarding the efficacies of peer review, including the assertion that 'peer review … insures the scientific quality of USGS information' (USGS Manual, 502.4, Fundamental Science Practices) and 'peer review, as cornerstone of scientific practice, validates and ensures the quality of published USGS science' (USGS Manual, 502.3, Fundamental Science Practices)."

The wording of the Rule and CS, implies that those documents, as well as the published studies they cite, have passed stringent peer review without exposure of any serious flaws. That is only partly true. The true part is that the cited papers passed reviews by *some* of the handful of peers who were selected by journal editors. Some, but *not all*.

Editors often base selection of reviewers on suggestions by the authors as to which reviewers would be welcomed and which not. That might be sufficient to assure that the studies are worth publishing as a means of presenting them to the larger scientific community for their scrutiny and edification; but it is far from a guarantee of reliability. It is only results which can also survive post-publication scrutiny which can be considered reliable by the standards of the day. It is the latter process in which we are now engaged. Unwillingness of the IGBST and FWS to make public the vast majority of information gathered by the IGBST drastically limits the ability of peer reviewers to identify and cure weaknesses in the IGBST studies. I hope that the FWS will delay Delisting the Yellowstone Ecosystem grizzly bear until thorough post-publication peer review has been completed. Meanwhile, I trust that the FWS will thus consider all current reviews, both pre- and post-publication, with the utmost care and objectivity to assure fulfilling all ESA requirements in the spirit as well as in the letter of that law.

Density Dependence vs. Food Supply

I was selected by the editors of the Journal of Wildlife Management to review the vanMannen et al. (2015) draft manuscript comparing the relative effects on vital rates by so-called density dependence vs. the abundance of whitebark pine, a major food source for Yellowstone grizzlies. Presumably, I was selected because I had previously published a study on the same subject -- the relative effects of density dependence vs. food supply on the Yellowstone grizzly population – for an earlier period (Stringham 1983, 1985, 1986).

My study analyzed data collected by the Craighead research team during 1959-70, plus some from later years by the Knight team. I found that 94% of variance in a reproductive rate index (combining litter size, number of females whelping each year, etc) was statistically accounted for by adult male abundance. Likewise, the rate of each birth cohort's recruitment from the year of birth to adulthood was almost as tightly correlated with adult male abundance. By contrast, vital rates were only weakly correlated with my index of food supply.

This led to a widespread perception among fellow wildlife biologists that I believed density effects outweighed those of food supply. It was on this basis that John Craighead disagreed with my analysis in his 1995 book, where he argued that food supply and human-caused mortality were the dominant controlling factors. Although Craighead tried to explain away my results, he offered no alternative explanation for why vital rates were so tightly correlated with adult male abundance. That neglect might be overlooked had correlations between adult male abundance vs. vital rates been weak; but they were some of the strongest reported for any large mammal in the wildlife literature. Neglecting those relationships neglects important clues into bear population ecology – clues that may or not be relevant to the Yellowstone population after closure of garbage dumps, but which are strongly relevant to populations which forage on other concentrated food sources such as salmon or whale carrion.

What John Craighead and others misunderstood is that I did not regard density as the primary controlling factor, but nutrition status, which was governed by both food supply and food competition. Those are related to per capita food supply (total food supply divided by total population size F/N), yet strongly weighted towards the dominant competitors – adult males (F/AdM), then secondarily adult females, with least weigh being given to cubs (F/C). Furthermore, variation in adult male abundance during the Craighead era was likely due less to variation in the number of males in the population, than to the number seen at garbage dumps, where most censusing took place, and where the females foraged whose reproductive rates they monitored most closely.

Whereas the number of adult females at dumps was relatively constant from year to year (in keeping with their small home range sizes), the number of adult males varied 3-fold. I theorized that abundance of adult males at dumps was inversely related to supply of native foods – avoiding dumps, and thus human proximity, when native food supply allowed that. My theory was based on a similar pattern of behavior by brown bears on salmon streams in Alaska. It has subsequently been verified for both dumps and salmon stream in several populations of both grizzly/brown and black bears.

In short, during the Craighead era, effects of variation in native food supply could not be separated from those of annual variation in number of adult males counted. I have long hoped that biologists working in the Yellowstone Ecosystem would find some evidence in the rings of whitebark pine of how often they produced heavy nut crops during 1959-70, as well as indicators (e.g., precipitation) for supplies of other foods during that era so that effects of density could be distinguished from those of food supply at that time, in addition to the following decades when bears no longer fed at dumps.

I thus began reading the vanMannen et al. (2015) manuscript with great interest. That quickly turned to rising concern about the authors' conclusion that vital rates were not linked to abundance of whitebark pine, despite a wealth of earlier research showing a strong link. Whereas data showing a link had been derived from on-the-ground observations, fecal analyses, and other empirical evidence, vanMannen et al.'s data were derived from satellite imagery – a method known to have high potential for error. When I spoke with a forester (who wished to remain anonymous) who had independently used satellite imagery to monitor whitebark pine trees, she found imagery indicators of presence/absence were only about 50% accurate. Error rate was highest in habitat where whitebark pine was heavily interspersed with lodgepole pine – the kind of habitat where the nuts are harvested most efficiently by red squirrels and stored in middens where they are most cost-effectively harvested by grizzly bears. . Abundance and behavior of red squirrels need to be addressed better by the IGBST, given that grizzly bears can efficiently harvest pinenuts only from squirrel middens,

I was concerned that the satellite imagery data had not been verified by ground-truthing. The authors provided no data showing the percentage of times that imagery indicated the presence or absence of whitebark pine, when that was verified by on-ground observations; or vice versa. Note that when the Craighead team pioneered satellite image based mapping of grizzly habitat, they did extensive ground-truthing research. Without proof that vanMannen et al.'s satellite data were in fact strongly related to actual abundance, the lack of correlation between the imagery "data" vs. vital rates could not be considered evidence of lack of correlation between actual whitebark pine tree abundance vs. vital rates. That conclusion was reinforced when I later contacted Dr. David Mattson who noted that the vanMannen et al. map of WBP locations excluded more than half the sites where feeding on pine nuts had been documented "on the ground."

Tree abundance doesn't necessarily correlate well with abundance of nuts harvestable by bears. For example, when I studied black bear foraging on beechnuts in New York's Adirondack Park, nut production varied widely from year to year. So the effects of changing tree abundance (e.g., due to logging) may not be detectable until several nut production cycles have passed, which can take 1-2 decades

Furthermore, stressed trees tend to produce unusually large nut crops as though shifting their emphasis from long term survival to short term reproduction. Anthropomorphically, it was as if the trees recognize that they might be doomed, and thus put the majority of their metabolic resources into producing offspring. Over the period of at least one decade, effects of declining tree abundance can be masked by a transient "last gasp" increase in nut production. This appears to have also happened with whitebark pine in the GYE.

Nut availability to bears need not be tightly correlated even with nut production by trees, at least over the short term. For example, when there were two consecutive years of high beechnut production, during the second year a large percentage of nuts were unavailable to bears due to nut infestation by insects and fungi. Whether that is also true for whitebark pinenuts isn't known to me. .

In my critique of the VanMannen et al. (2015) paper I produced a flowchart indicating these and other relationships which should be included in an analytical model for analyzing effects of declining whitebark pine tree abundance (Figure 1). Few of these relationships were assessed by the IGBST, and the statistical models they used where not necessarily appropriate for this purpose. Those statistical models are fundamentally linear, whereas actual causal relationships may not be. For example, if vital rates are governed by per capita food supply VR = f(F/N), this relationship is not necessarily revealed by a regression model if the form of VR = f_1(F) – f_2(N).

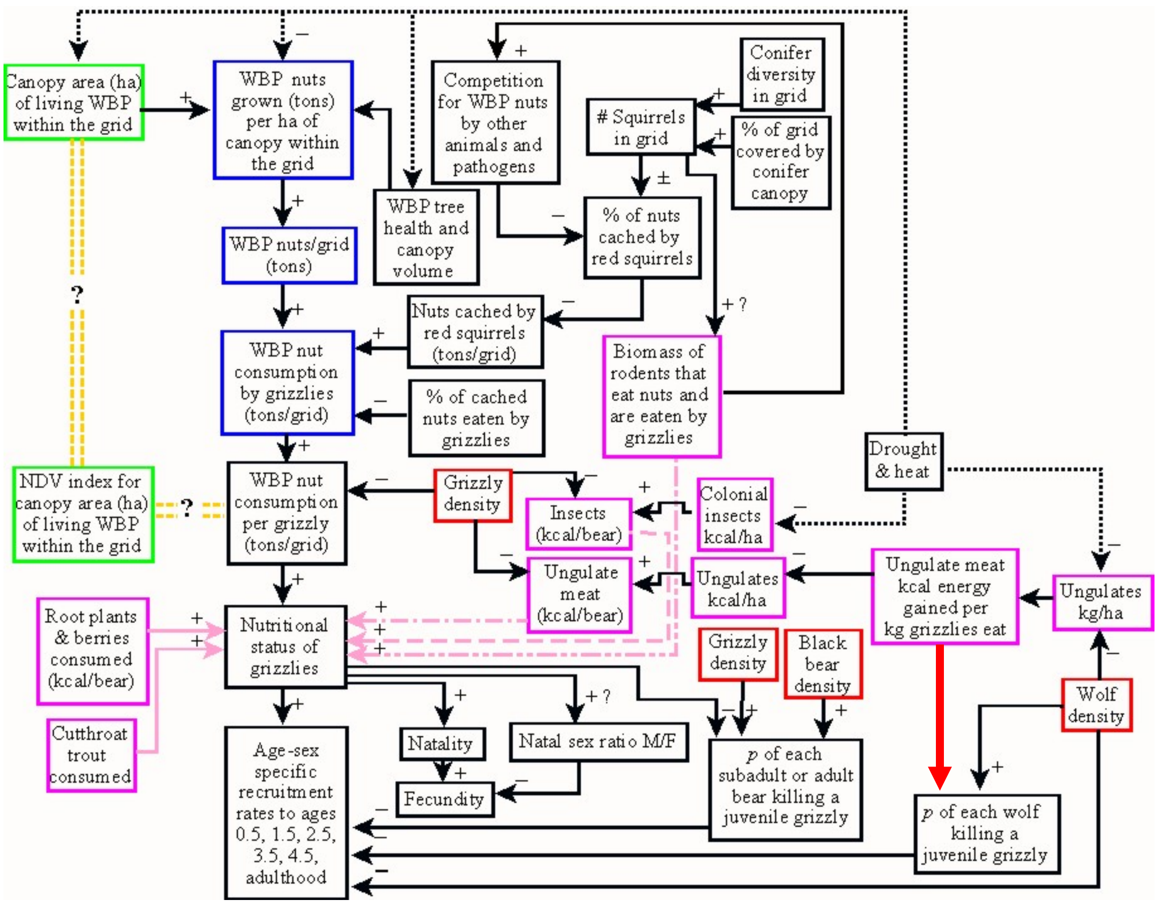

Figure 1. **Factors governing the relationship between the area of WBP canopy cover within each grid cell vs. vital rates for bears inhabiting the cell**. The green boxes represent actual vs. indexed canopy areas (ha) of live WBP trees. How tightly these are correlated is not yet known. Unless it is high, any lack of correlation between the WBP index vs. vital rates is meaningless. The symbol "*p*" in boxes at the lower right signifies probability. All of these relationships, expect perhaps natal sex ratio vs. nutrition, have been documented for bears and have been shown to be influential under at least some (ill-defined) circumstances. So the fact that the authors may lack data to measure their influence in this case does not justify them ignoring those influences when they interpret the correlation, or lack thereof, between their WBP index vs. vital rates. "+" and "-" signs refer to direction of correlation. "±" sign indicates variable or non-linear relationship. Pink boxes refer to alternate food sources.

Methods of estimating population density were also questionable, as was giving equal weight to all age-sex classes – e.g., equating the impact of X cubs with impact of X adult males.

Last but not least, none of the models or analyses were described in enough detail to allow replication by independent scientists – thereby violating one of the basic tenets of sound science.

I judged that these and other flaws would have to be corrected before vanMannen et al.'s results would be reliable enough to be published. Although the editor initially required that vanMannen et al address my concerns, the authors' replies were superficial. The paper was finally published without criticall improvements, and without any convincing argument as to why those corrections were not needed.

That decision by the editors was apparently less a matter of science than of politics. This is not the first time that the JWM has published questionable research that favored exposing an animal population to increased harvest followed a long period when hunting was forbidden.

Heuristic Peer Review

So long as the goal of peer review is vetting papers for any potential errors, the most heuristic reviews are likely to come from devil's advocates, so long as their comments are limited to scientific critique, not to professional rivalry or personal clashes. Yet some of the most qualified peers have been systematically excluded from the pre-publication review process

David Mattson – a former member of the IGBST under Richard Knight -- is arguably the most qualified reviewer, due both to (a) his prior membership on the research team and his later critiques of the continuing research, and (b) his overall expertise as a wildlife ecologist. Yet, he has not been given an opportunity to review any of the IGBST papers prior to publication, presumably because his earlier analyses, even while a member of the Knight team, revealed so many critical weaknesses in the ongoing research. Instead of recognizing the value of his insights, and using them to dramatically upgrade the Yellowstone studies, he was forced off the team and has been systematically marginalized.

Those actions would be reprehensible even if due only to the usual academic infighting, where scientists compete with one another for prestige. But the agenda driving exclusion of Mattson and other critics was due less to professional rivalry than due to the determination by certain FWS employees and legislators to delist the Yellowstone grizzly as soon as possible. Indeed, whereas the Endangered Species Act identifies Recovery as the goal on ESA protection, the Grizzly Bear Recovery Plan identified delisting as the goal. This is comparable to a health insurance company identifying the goal of medical treatment as discharging patients – whereas a physician's goal is healing patients. Whereas the Grizzly Bear Recovery Coordinator Chris Servheen functioned as though he worked for an insurance company, Mattson, I and numerous other critics functioned more like physicians, trying to assure sufficient Recovery prior to discharge that the patient isn't likely to relapse over the foreseeable future – which is implicitly the criterion of true Recovery under the ESA.

I have read the vast majority of Mattson's critiques, including his May 2016 comments on the Rule and CS. I have found all of them without exception, to be of the highest professional technical quality and objectivity. Indeed, it is amazing the insights he has been able to draw from the IGBST data, despite all the limitations of those data.

It should be obvious to any critical reader of Mattson's critiques that he should have been appointed as a member of the IGBST decades ago so that he could help design research and critique it on an ongoing basis, rather than only being allowed to comment post-publication. Even now, he should be given full access to all IGBST data, and all help needed from the IGBST to review and reanalyze those data, and then to integrate all findings to date and derive reliable projections of how the Yellowstone population is likely to fare over the foreseeable future if vs. if not delisted, under a broad spectrum of probable futures.

Use of remote sensing to monitor landscape scale characteristics of grizzly habitat, as attempted by vanMannen et al. is essential. But all ground-truthing, like all population models, need empirical verification. Fulfilling all of those foundational studies, should be the basis of designing future monitoring plans to assure that any excessive human impacts or other causes of population stress are prevented or reversed before long term viability is jeopardized.

Meanwhile, Mattson and others have already revealed enough evidence to prove that the Yellowstone population is far from ready for delisting. First, the population appears to be declining even while still under ESA protection. Second, there is little likelihood that this downward trend will not be accelerated by the added impacts allowable after delisting. Among the most immediate and devastating impacts on grizzlies living outside of the Parks would be hunting bears as trophies or to prevent livestock predation. Even if the total proposed harvests would potentially be sustainable if spread more-or-less evenly over the entire occupied habitat, taking those same numbers of bears from just areas outside the Parks would quickly reduce abundance of bears in those peri-park habitats. Yet the IGBST has not provided meaningful projections of how that is likely to impact viability of the population. This and all other potentially major sources of impact need to be considered in projections of the population's future. Assessing risks "over the foreseeable future" of extirpation -- and, implicitly of Endangerment and Threat -- is implicitly a fundamental component of the Recovery process as specified by the ESA – even if it is seldom enforced.

I recommend that further consideration of delisting be postponed until the Mattson et al. results are submitted, then subjected to thorough pre- and post-publication peer review.

Mattson provides evidence that the grizzly population is declining, due in part to excessive human-caused mortality – for instance due to livestock protection or to people hunting elk or black bear. Adding sport harvest to this could soon increase to the point that it would jeopardize viability of the grizzly population. The CS does not provide adequate protection against over-harvest, much less appropriately address cumulative effects of all kinds of human-caused mortality, "natural" mortality (i.e., mortality where the coup de grace is inflicted by nature, even if nature has been modified by humans – e.g., climate change).

Contrary to prevailing propaganda, the way to show that the ESA works is by achieving true Recovery, not just going through the motions, as the FWS would be doing if it delists the Yellowstone grizzly on the basis of existing IGBST research and conclusions.

Sincerely,

Stephen F. Stringham, PhD
Director

Attachments:

1. Stringham pre-publication peer review of vanMannen et al 2015 - Part 1.pdf

2. Stringham pre-publication peer review of vanMannen et al 2015 - Part 2.pdf

3. Habituation & Hunting Yellowstone Grizzlies 2016-9-30.pdf “Would Hunting Yellowstone Grizzly Bears Reduce Risk of Attacks on People or Livestock?”

4. I also include by reference all comments which I submitted to the FWS for proposed delisting of the Yellowstone grizzly in 2006.

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1 October 2016

Part 2 of Comments by
Stephen F. Stringham, PhD

On the

US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered

Species Act (ESA); Federal Register 81(48): 13174-13227, Docket FWS–R6–ES–2016–0042

and Related Materials

Flaws in a Core Argument of the 2006 FWS Delisting Rule

1. **Demographics**:
   a. The population grew by at least 2-fold since listing.

   b. Growth was fastest from the mid- to late 1980's until present – at least 5-7% per year.

   c. Extensive growth is also evident by increasing dispersions of bears throughout most suitable habitat and unsuitable edge habitat.

2. **Habitat**
   a. 1988-98 was a decade when habitat quality and extent were relatively stable, at least within "suitable" habitat.

   b. After delisting, net habitat changes within "suitable" habitat will remain near 0.

   c. If habitat quality and extent remain stable, the bear population can continue growing for the foreseeable future, at least until forced to level off as the habitat becomes saturated. There is no reason to expect population size to decline, barring catastrophes for which FWS, USFS and state agencies cannot plan and manage.

3. **Management**
   a. ***Historical:*** Growth of the population is attributable almost entirely to better management practices such as closure of logging roads on National Forests, garbage disposal, livestock carcass disposal, etc. By comparison, any effects on vital rates by transient variations in supply of foods such as pine nuts or due to forest fires have been trivial.

   b. ***Future***:
      * Changes in supplies of pinenuts, moths, trout and ungulate meat will occur whether or not the population is delisted. So, even if declines in those foods were to have substantial impact in the future, continued protection under the ESA would not do anything that cannot be done without ESA protection to mitigate impacts.

      * Bears are highly adaptable omnivores which can shift to alternative food sources. Supplies of nuts, trout, moths, and ungulate meat are likely to change slowly enough that the bears can fully adapt with negligible impact to vital rates or population size.

      * In the event that the grizzly population starts declining – perhaps due to random variation in habitat or demography, or to environmental catastrophes – protective measures can be increased, as a last resort by relisting.

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Rebuttal

* **Cumulative uncertainty:** There is uncertainty in FWS estimates for rates of reproduction and survival, and numerous possible driving variables. Combining all these factors in models of population dynamics compounds uncertainty. Yet, FWS provides no clear idea of how cumulative uncertainty is carried over into final uncertainty figures for results such as estimated population size or growth rate. In some cases, one might expect variance to be so great that 95% confidence bounds would run from 0 to numbers so large that they are biologically untenable. Yet, there is little or no indication of so much net uncertainty in any of the parameters addressed by FWS.

1. **Demography**
   a. ***Population growth*** Evidence of substantial growth is weak due to uncertainties and directional biases in methods and thus in data.
      * *Counting Female-&-cubs (= Fcc) families:*
        o Sightability of bears has increased markedly – possibly enough to account for all apparent increase in population size.
        o Errors in identifying unique Fcc
          - Mistaking black bears for grizzly bears
          - Mistaking multiple counts of the same Fcc families for counts of multiple families.

        In the past, many allegedly unduplicated sightings of Fcc were attributed to observers of questionable skill. To what extent is that still true?
      * *Dispersion:* Number of Bear Management Units where Fcc are documented Increasing dispersion of bears into peripheral habitat is not necessarily due to increased numbers of bears in the population as a whole, but perhaps to:
        o Bears relocating away from large areas of core habitat that burned (e.g., in 1988)
        o Years without much hunting pressure may have increased tolerance of bears for encountering people or our spoor – which are presumably most common on the periphery of the population's range.

   b. ***Dispersion:*** Number of Bear Management Units where Fcc are documented Increasing dispersion of bears into peripheral habitat is not necessarily an indication of improved population health or viability – especially in those parts of peripheral habitat where mortality exceeds reproduction.
      * If any given number of bears N is concentrated in a relatively small ears (e.g., YNP) or dispersed over a relatively large areas (e.g., the entire GYE), this may have some effect on vital rates and on viability. Some effects could be indicative of improved population health, whereas others could indicate declining health. Without further information, it would be hard to identify whether benefits outweigh detriments.

- Greater dispersal of N bears across a larger, more varied area of habitat should
  . reduce vulnerability of the population to localized food shortages or localized catastrophes such as forest fires or droughts or wind/ice storms.
  . Make more habitat and food available and known to grizzlies, thereby increasing realized carrying capacity.
- Greater use of peripheral habitat may increase vulnerability to conflict with humans or our artifacts, increased exposure to hunters, or other causes of increased human-related mortality.

c. ***Reproductive Rate:***

* The number of cubs produced by a female in her lifetime depends on her age at first whelping, interval between whelpings, size of her litters, and survival rate for her cubs between birth and adulthood.

* Likewise, total cub production by a population depends on the number of females whelping each year, and on size of their litters. FWS uses only litter production rate (the so-called *unduplicated* count of Fcc families) to estimate population size and growth rate. It is not clear that litter size is taken into account.

* If we know a minimum count for number of females whelping each year, as well as sizes for most of those litters, we can count a minimum number of cubs for the year.

* The FWS has not provided a definitive analysis of how these reproductive parameters are correlated to – much less controlled by – supplies of particular foods (e.g., whitebark pinenuts) or of food supply or nutrition status in general, for instance as indicated by age-gender-specific percent body fat, total body weight, lean body weight, or lean tissue weight,

* At best, FWS has addressed variations in reproductive parameters by finding the average value and variance for each parameter, then using the mean and variance in modeling of population dynamics.

  They might argue that one does not need to track changes in food supply vs. reproductive rate; for food supply varies randomly, and randomness can be introduced directly into calculations by letting the demographic model sample from a random distribution for each reproductive parameter.

  In response, one might question whether the various reproductive parameters co-vary, and if so whether they do so in a linear manner or in a non-liner manner – as found by Stringham (1985).

One might also argue that some changes in food supply are not random, or simply so chaotic that they appear random, but show documented or predictable trends – as in the case of declining abundance of whitebark pine trees.

d. ***Mortality Rate***

* *Rate:* There are likewise major problems in determining mortality rate, not only for individual age-gender classes, but for the population as a whole.

* *Causation*: FWS has not provided up-to-date information on the number of bears dying of known vs. unknown causes, what each known-cause was, age-gender of each bear, when it died, or where it died.

- o We need to know not only the geographic location of death, but also simultaneous geographic locations of factors associated with mortality risk, including
  - Cover in which a bear can remain hidden or through which it can escape
  - Attractants (e.g., garbage, livestock feed, pet feed, wild bird feed, etc.)
  - Roads, clearcuts, or other areas where bears might be particularly vulnerable to vehicles, hunters, etc.
  - Industrial activities which might be encountered by bears, leading to a human perception that the bear must be killed to assure human safety and property security.
  - Attractive natural foods or other attractive habitat features in the area where each bear died
  - Food scarcity in more isolated habitat (e.g., scarcity of whitebark pine nuts and/or moths)
- o How have these contributing factors varied from season to season and year to year, so that their correlations with mortality rate can be tracked.
- o How are these contributing factors likely to change over the foreseeable future, with or without delisting?
- o Would the benefits of continued listing outweigh the costs?

* *Source-Sink Dynamics*:

- o FWS projections of potential population growth over the next decade (Harris et al. 2005) were based on ~20 previous years of data, from which they derived mean and variance figures for each vital rate. These were done for the population as a whole, without taking into account
  - Transfer between “management classes” of bears such as habituated vs. non-habituated, or “problem” vs. “non-problem bears,” or any other measure of each bear’s likelihood of dying from anthropogenic causes.
  - Migration between geographic zones between whihc mortality risk differed substantially. Although analyses by Schwartz et al. (2005) identify three geographic zones and provide differential analyses of

vital rates by zone, these zonal effects were not addressed in population projections by Harris et al. 2005.

* *Time-lags*: It is not clear that FWS adequately addresses length of time-lags between anthropogenic influences and their effects on demography (e.g., on vital rates). For example, the impact of logging a specific area might not be felt until the year(s) when that particular area became especially important to the bears – e.g., if it was refuge habitat that was vital during droughts, but little-used otherwise.

e. ***Migration Rate***
   * The rate at which bears of each age-gender class move between areas within "suitable" habitat, or especially between "suitable" vs. "unsuitable edge" habitat vs. unsuitable non-habitat" are valuable to know, for reasons other than calculating source-sink dynamics.

f. ***Viability:***
   * *Risk of extinction*
   * *Risk of endangerment* (inviability)

2. **Habitat - General Features**

a. Why limit consideration to the years 1989-98? Is 1989 the beginning year, because it follows the 1988 fires? Why stop at 1989; why not continue through 2005? Has the habitat gotten substantially worse since 1998?

b. Specifically, which features of the habitat were stable during 1988-98?

c. Since 1975, on an annual basis, what changes have been documented in:
   * Miles of roads and acres logged both increased.

   * What were the whitebark pine nut crops doing each year?

   * Variation in moth abundance and availability

   * Numbers of people penetrating into grizzly habitat and living on its periphery

   * Habitat use by bears changed, in part due to fires in core habitat

   * Vegetative succession in logged areas

d. What has been done to assess relationships between habitat features and vital rates? Over what time lags have such relationships been tested? Obviously, some habitat changes could have had immediate impacts on vital rates; but other impacts may not show up for years, perhaps even decades.

3. **Habitat - Specific Features**

a. ***Whitebark Pine Nuts***

- *Decline in abundance of whitebark pine trees*. This would not necessarily have led to a decrease in abundance of whitebark pine nuts, given that stressed trees may be most productive shortly before they die. The trees are being stressed by climatic warming, bark beetle and blister rust.
  - what data are there on abundance of pine nuts/cones each year?
  - how has nut availability been affected by red squirrel abundance, etc.?
- *Post-fire vegetation succession in the core of YNP* – which may have
  - decreased the amount of food available on the burns
  - decreased the amount of cover on burns, thereby lessening their use by bears
  - many burned areas are so large that they may receive much use than would the same acreage in smaller patches.
- *Changes in supplies of or availability of other prime foods*

b. ***Cut-throat Trout***

- *Historical Abundance:* how has their abundance changed since the grizzly was listed?
- *Future abundance:* How is their abundance likely to change over the foreseeable future?
  - Abundance of lake trout: is it likely to change?
    - If current efforts to reduce lake trout populations continue
    - If current efforts decline
    - Vulnerability of lake trout to disease
  - Vulnerability of cutthroat trout to lake trout: is it likely to change?
  - Vulnerability of cutthroat trout to pathogens
  - If abundance of lake trout remains stable, how would this affect abundance of cutthroats?
    - How much has the cutthroat population declined since lake trout were introduced into Yellowstone Lake? How much of the decline is attributable to lake trout rather than to other factors?
    - If cutthroats are likely to decline over the foreseeable future, how fast? How soon is this likely to limit the amount eaten by bears; how severely?
- *Utilization by grizzlies*:
  - Apparently, utilization is low, but increasing
  - What is limiting their usage: knowledge of where the fish are or how to catch them profitably?
  - What could be done to foster grizzly usage? [making fish more vulnerable]?
- *Access by grizzlies*:
  - General: How has grizzly access to the fish changed in areas where they are most easily caught?
  - Specific: How has access by Fcc changed – e.g., due to increasing use by boars grizzlies, by black bears, or even by wolves?

c. ***Army Cutworm Moths***
   - *Historical Abundance:* how has their abundance changed since the grizzly was listed?
   - *Future abundance:* How is their abundance likely to change over the foreseeable future?
   - *Utilization by grizzlies*:
     - Apparently, utilization is low, but increasing
     - What is limiting their usage: knowledge of where the moths are or how to catch them profitably?
     - What could be done to foster grizzly usage?
   - *Access by grizzlies*:

d. ***Ungulate Meat***
   - *Abundance:*
     - *Historical:* how has the abundance of live ungulates of each species changed since the grizzly was listed? How has their abundance changed relative to:
       - Predation by bears
       - Predation by wolves
       - Winter severity
       - Pathogens
       - Loss of (access to) winter habitat outside YNP.
     - *Future:* How is their abundance likely to change over the foreseeable future?
       - Predation by bears
       - Predation by wolves
       - Winter severity
       - Pathogens
         - Pathogens that kill the wild ungulates *in situ*
         - Pathogens (e.g., *Brucellosis*) that could infect livestock, leading to preventative slaughter of ungulates
       - Loss of (access to) winter habitat outside YNP.
   - *Access by grizzlies*:
     - *Historical*
       - Predation of live ungulates (mainly calves/fawns)
       - Scavenging carcasses of animals killed by wolves or puma
       - Scavenging carcasses of winter-killed
         - Competition for those carcasses by wolves, coyotes, birds, etc.
     - *Future*
   - *Utilization by grizzlies*:
     - *Historical*
       - Apparently, utilization is low, but increasing
       - What is limiting their usage: knowledge of where the moths are or how to catch them profitably?
       - What could be done to foster grizzly usage?
     - *Future*

e. **Cover:** for hiding in place (e.g., while foraging or resting) or for fleeing

f. **Habitat Security and Isolation from People**: Now and in the foreseeable future?
   * Within YNP
   * In "suitable" habitat outside YNP
   * In "unsuitable" edge habitat outside YNP
     o Encroachment by roads, logging, mining, and other development closer to habitat that is currently secure
     o Encroachment by hunters
     o How will logging, etc. here affect trees (e.g., transmission of disease) in "suitable" habitat?
   • In non-habitat outside YNP

g. **Denning Habitat and Access to It**: Now and in the foreseeable future?
   * Two recent papers by the Schwartz team address denning. They may contain relevant information on human disturbance of denning, etc.

h. **Habitat Integrity vs. Fragmentation**: Now and in the foreseeable future?
   * How fast is fragmentation occurring? Where has it increased enough to reduce use of specific areas as travel routes by grizzlies? To which habitat are these bears losing access?
   * How fast are unsuitable-edge habitat and non-habitat increasing within the GYUA?

3. **Management**

a. ***Historical***: FWS has provided no evidence to verify its allegation that most growth of the YGP is due to improved management of habitat and especially in terms of reduce bear-human conflict.
   * What statistical analyses has FWS done demonstrating that variations in grizzly mortality rates are more closely correlated with annual variations in management than with annual variations in whitebark pine abundance?
   * What analyses has FWS done that rates of bear-human conflict and of bear mortality are lower now (e.g., during 1989-98 or 1989-2005), on a per bear basis, than they were prior to that time? To be meaningful, such an analysis should be tiered to provide separate analyses:
     o across the whole population
     o within each management zone
     o within each bear management unit
     o related to distance at which each bear died from each major kind of hazard and cause of death

b. ***Future:*** If critical habitat features, such as supplies of the most important sources of meat, are worsening,
   * how quickly is this occurring?
   * even if most of the change is beyond our control (e.g., die-off of whitebark pine), it might be possible to mitigate the impacts of losing that food and of

consequence increase in exposure to people, by acting pro-actively to reduce exposure –

- e.g., restricting human access to specified habitat during shortages of the critical foods.
- restricting human impacts in specified habitat at those times, and until the population has recovered.

Although the CS refers to adaptive management, it is not clear that the measures would be adequate even if implemented; and it is even less sure that there are the economic resources and political will to implement.

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Species Act (ESA); Federal Register 81(48): 13174-13227, Docket FWS–R6–ES–2016–0042

and Related Materials

2006 Comments on Keating's Chao2 Method of Extrapolating from Counts of Females With COY To Estimate Total Females With COY

It is my understanding that Keating's Chao2 method was supposed to compensate for variation in sightability of bears during extrapolation from the number of mother-cub (#FCOY) families observed to estimate the total number present.

To better understand how that worked, I tested for correlation between raw counts of #FCOY families vs. total estimated #FCOY using Keating's Chao2 extrapolation method.

I tested that using 2 data sets

1) Keating et al. (2002, Table 5). For the period 1986-2001, they list (a) total observed litters ($_{Obs}$), (b) random counts of #FCOY, and (c) "second order sample coverage estimates per Lee & Chao (1994) $_{SC2}$

2) Mortality Workshop: For the period 1999-2004, they list (a) observed count, and (b) Chao2.

Results

1. **For the years covered in both data sets (1999-2001), the data do not agree between those two sources for either (a) observed count) or (b) Chao2. Strange or worrisome. This should be explained by the IGBST.**

2. For the Keating et al. data:

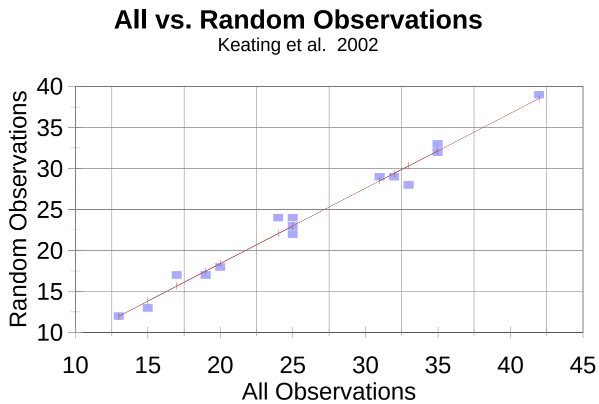
Year	All obs N(obs)	Random Obs	Chao2 N(SC2)
1986	25	24	31.9
1987	13	12	19.5
1988	19	17	21.5
1989	15	13	20.2
1990	25	22	25.5
1991	24	24	34.5
1992	25	23	47.6
1993	19	17	21.8
1994	20	18	25.5
1995	17	17	54.9
1996	33	28	41.4
1997	31	29	41.3
1998	35	33	40.9
1999	32	29	35.7
2000	35	32	59.7
2001	42	39	54.6

a. There is a correlation of r^2=98.2% between "all observations" vs. "random observations" with no consistent bias between these two methods. Why such a tight correlation? What does "random observations" refer to?

b.

<u>Obs vs. Random</u>

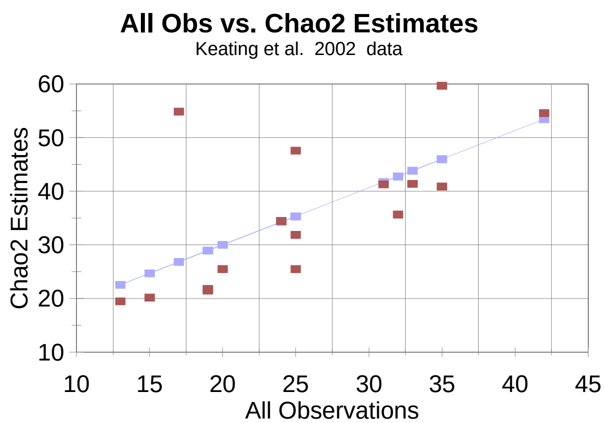
Y intercept	0.095
Slope	0.916
Std Err of Y Int.	1.0549
Std Err of Slope	.0.0327
R Squared	**0.982**
No. of Observations	16
Degrees of Freedom	14



b. For the relationship between "all observations" vs. extrapolations via Chao2

<u>Obs. vs. Chao2 Extrapolations</u>

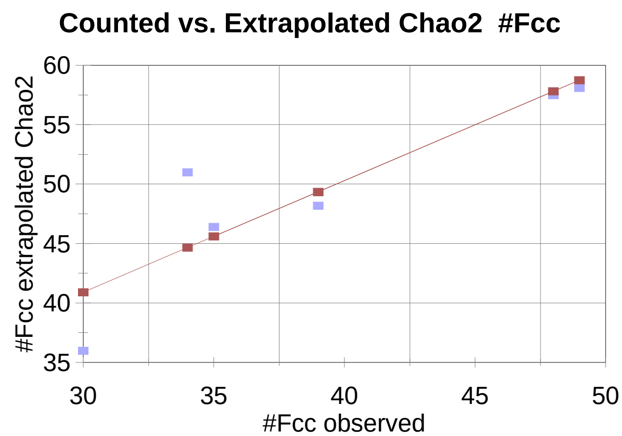
Y intercept	8.73
Slope	0.0655
Std Err of Y Int	10.27
Std Err of Slope	0.319
R Squared	**0.444**
No. of Observations	16
Degrees of Freedom	14



3. By contrast, There is a correlation of r^2=80.0% using the Mortality Workshop data between Counted vs. extrapolated numbers of Fcc.

Year	#Fcc counted	#Fcc extrapolated	
1999	30	36	40.9
2000	34	51	44.66
2001	39	48.2	49.36
2002	49	58.1	58.76
2003	35	46.4	45.6
2004	48	57.5	57.82

Obs vs. Chao2 Extrapolated #Fcc	
Y Intercept	12.8
X Coefficient(s)	0.939
Std Err of Y Int	4.08
Std Err of Coef.	0.235
R Squared	**0.800**
No. of Observations	6
Degrees of Freedom	4



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The Workshop report does not explain how it ended us with different figures for both raw counts and Chao2 extrapolations than Keating et al. derived.

If the Workshop figures represented an updated version of the Keating et al. approach, this would suggest that the Keating method produced very little adjustment of data for sightability or anything else.

However, if one looks at just the Keating et al. figures, the Chao2 estimates involve a great deal of adjustment of the raw data. Whether that adequately accounts for variation in sightability is unclear.

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1 October 2016

Part 4 of Comments by
Stephen F. Stringham, PhD

On the

US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered

Species Act (ESA); Federal Register 81(48): 13174-13227, Docket FWS–R6–ES–2016–0042

and Related Materials

This note, submitted to the FWS in 2006, continues my effort to make logical sense of FWS statements and arguments, and to relate bureaucratic and legal terms to biological realities, so that logic and science can be used to (a) verify or refute FWS claims, or to (b) test for adherence to or violation of the ESA.

WHAT IS THE YELLOWSTONE *DPS?*

BACKGROUND

The geographic range of the Yellowstone grizzly population (YGP) includes not only Yellowstone National Park, but part of the larger area commonly known as the Greater Yellowstone Area.

The GYA contains lands in relatively natural condition which can serve as grizzly habitat – areas with the physical and ecological properties needed by bears. Habitat may include some areas which have been temporarily so degraded – e.g., by logging – that they currently have negligible value to grizzly bears; but substantial value can potentially be recovered through natural succession of the ecosystem, with or without human assistance (e.g., road closure).

The GYA also contains, or is adjacent to, areas of non-habitat such as human communities and campgrounds, highways, mined areas, or agricultural lands. Non-habitat neither has nor is likely to have the features of habitat within the foreseeable future.

Habitat adjacent to non-habitat is called *edge* habitat (*sensu* Lande 1988, Yahner 1988, Mills 1995). Some areas of edge habitat may not provide substantial resources of food or shelter. Nevertheless, such areas may be invaluable for travel between areas of better habitat or as a buffer between core-habitat and non-habitat. This is illustrated schematically in **Fig. 1**.

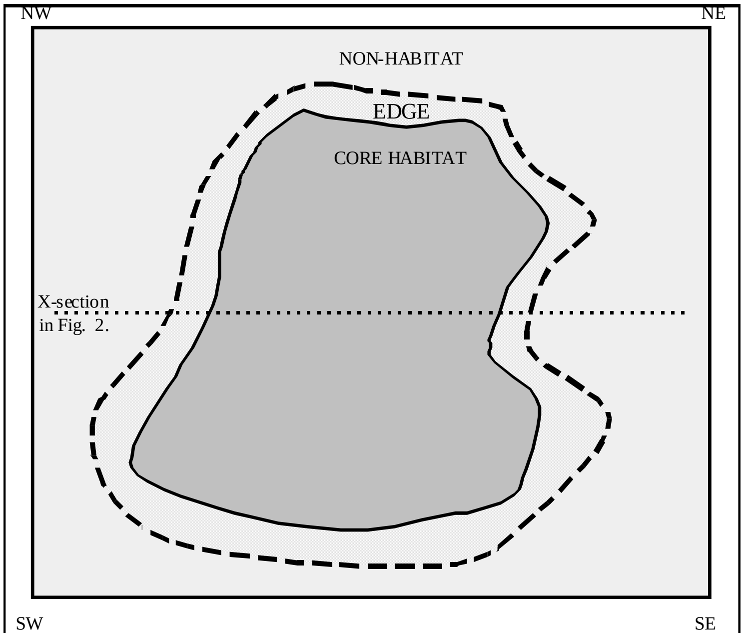

Fig. 1. **Overhead view of a hypothetical area, showing non-habitat as well as edge and core habitat for grizzlies.**

Edge habitat tends to be less secure than more remote *core* habitat. For it is along the edges that bears most commonly encounter and conflict with people, property and livestock. Indeed, it is in edge habitat and adjacent non-habitat that most adult and subadult grizzlies are eventually killed due to conflicts or to running afoul of artificial hazards (e.g., vehicular collisions or possibly toxic pollutants). In this case, much or all edge habitat may constitute a population sink, as is illustrated schematically in **Fig. 2.**

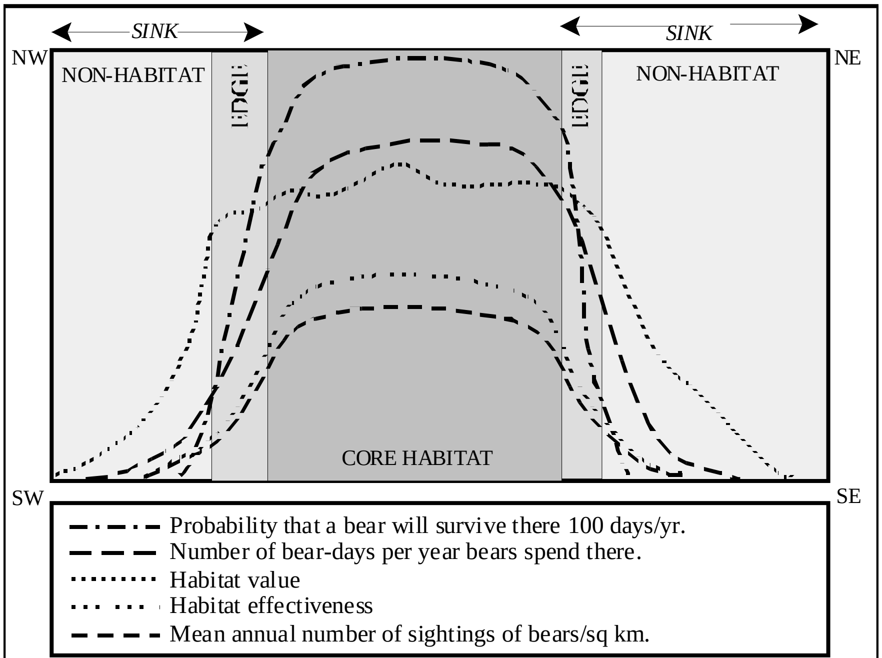

Fig. 2. **East-West cross-section through the hypothetical area**. showing how critical parameters vary between those zones. In this hypothetical case, both edge habitat and non-habitat are population sinks.

KNOWN OR ANTICIPATED ARGUMENTS BY FWS FOR *DPS* DESIGNATION

The GYA completely encompasses the YGP along with enough secure habitat to assure that the YGP can remain viable over the foreseeable future. Furthermore, no grizzlies are known to inhabit land adjacent to the GYA, within over 130 km (80 miles) in any direction.

1. Hence, boundaries of the DPS can appropriately be equated with boundaries of the Greater Yellowstone Area.

2. The highways that bound the GYA are likely to prevent a significant number of bears from moving in or out of the GYA and thus to prevent significant interbreeding between bears inside vs. outside the GYA. Hence, any bears beyond those highways would not be part of the YGP, even were some grizzlies to reach that area.

Bears could move in and out of theGYA only if

a. they could move across the highways
   * either risking collision with a vehicle, or
   * traveling along safe corridors (e.g., over- or underpasses) that do not yet exist; or
   * if transplanted by people.

b. At this time, there is no plan to build such corridors, if only because of cost and doubt that they would work; nor is there a plan to transplant bears outside the GYA – although there is a plan to *import* bears to maintain genetic diversity. That is sufficient biological rational to justify equating boundaries of GYA with those of the proposed DPS (pDPS).

3. The *Policy* for DPS designation does not mean that the exact boundaries of a DPS have to be governed by sound biological principles, but merely that the DPS boundaries *encompass* any boundaries that could theoretically be drawn according to sound biological principles. So long as

   a. no bears reasonably encompassed within the pDPS are left out of the GYA, and

   b. no habitat needed to assure sustained viability is excluded from the GYA . Hence, selecting boundaries of convenience is in no way disadvantageous to the imperiled species. And it in no way violates the *Policy*.

4. Both edge habitat and non-habitat are *unsuitable* for occupation by grizzlies due to resultant conflicts with people – for instance aggression towards people or damage to property or livestock – often leading to the death of the bear. Although edge habitat may support occupancy by individual bears, it cannot support even one viable population, by contrast to *suitable* habitat which **can** support viable populations.

REBUTTAL

I. DPS: Animals or Land?

1. According to the ESA *(3)(15):* s*pecies* "includes any subspecies of [animal or plant] and any distinct population segment of any species of vertebrate ... which interbreeds when mature."

   A DPS, therefore is a group of animals. Although the area(s) of habitat it occupies can, in principle, be mapped, the DPS itself is not a land area.

2. Nevertheless, the map provided in the rule (p. 69,863) erroneously represents proposed boundaries of the pDPS as though the pDPS were that area of land. For purposes of clarity, I will therefore distinguish between the pDPS as an interbreeding group of bears vs. the geographic area encompassing the pDPS – i.e., the GYA .

3. Given that DPS classification of the YGP has only been proposed, not granted, and that alleged geographic and demographic boundaries to the pDPS are *extremely vague*, this document will avoid referring to the YGP, or any portion thereof, in a manner that would imply that DPS designation is warranted.

II. HABITAT SUITABILITY

The FWS mapped areas which it designated as *suitable* vs. *unsuitable* habitat – a distinction based on vulnerability of bears to being killed by people. Yet, the rule fails to identify

1. which areas of *unsuitable* habitat are edge habitat vs. non-habitat.

2. which areas of *suitable* habitat, if any, are edge habitat.

3. which areas of either *core* or *edge* habitat, or *suitable* or *unsuitable* habitat, are needed to sustain viability of the Yellowstone grizzly population over the foreseeable future, or how much risk of inviability is likely to be affected by pending changes in habitat – due for instance to logging, roading, petrochemical development or mining.

4. **"Suitable" defined**: FWS (p.69,866) states that "*Suitable* habitat provides food, seasonal foraging opportunities, cover, denning areas, and security. We have defined *suitable* habitat for grizzly bears as having three characteristics – (1) being of adequate habitat quality and quantity to support grizzly bear reproduction and survival; (2) contiguous with the current distribution of Yellowstone grizzly bears such that natural re-colonization is possible; and (3) having low mortality risk as indicated through reasonable and manageable levels of grizzly bear/human conflicts."
   a. The first criterion is unclear. What does it mean by "support ... survival?" Given that the vast majority of subadult and adult grizzly bears in the population die from human causes (vehicular collisions, gunshot, etc.), *suitable* habitat is obviously not sufficient to keep members of a viable population from traveling or dispersing into *unsuitable* habitat.

   b. The third criterion is confusing. What "levels of grizzly bear/human conflicts does the FWS designate as "reasonable and manageable"?

   Put differently, what levels and kinds of management to minimize conflicts does the FWS consider "reasonable and manageable"? Please answer for each of the following kinds of management:

   * Public information and education
   * Installation of bear-proof garbage containers or electric fences to protect garbage, bee hives, livestock forage, livestock, or crops;

* Live-trapping and removal of nuisance bears
* Aversive conditioning of intrusive bears

c. Is the FWS trying to say something equivalent to:
   * Habitat is *unsuitable* anywhere that reasonable levels of bear/human conflict precautions do not suffice to prevent the death of a substantial fraction of bears entering this area.
   * An index of *unsuitability* is the number of bear/human conflicts or of bears involved in such conflicts. An *unsuitable* area is any area
     o reporting more than some threshold number of conflicts, or
     o resembling an areas with excessive conflicts.

5. "**Unsuitable" defined**: "*Unsuitable* habitat consists of those areas within the [GYA] that cannot support viable populations of grizzly bears."

a. This criterion of *unsuitability* is <u>illogical</u> given that it stipulates failure to support multiple populations, rather than just "a population" – the YGP.

b. FWS admits that grizzly bears currently use habitat far outside the PCA, and even outside *suitable* habitat. But how far is not revealed.

   * The FWS states (p.69,870) "The records of grizzly bears in these *unsuitable* habitat areas are generally due to recorded grizzly bear/human conflicts or to transient animals. These *unsuitable* habitat areas do not permit grizzly bear reproduction or survival because bears that repeatedly come into conflict with humans or livestock are usually either relocated or removed from these areas."

     o FWS provides no information on how the *unsuitable* habitat was searched to determine how many bears are present there during any given period or season, or how long each of those bears stayed there – even for radio-collared bears, to say nothing of other grizzly bears. How many person-hours were devoted to searches in unsuitable vs. suitable habitat? How many adult females or other bears were radio-collared in each zone? During which years and seasons? By what methods? What differences are there in observer effort, methods, technology, or sightability in *suitable* vs. *unsuitable* habitat? How were counts of bears in *unsuitable* habitat adjusted to compensate for such differences?

     o FWS provides no evidence that bears observed in *unsuitable* habitat were mere transients rather than residents. FWS does not even define "transient" or explain how transients are distinguished from residents. How long does a bear have to remain in *unsuitable* habitat before it ceases being a transient and becomes classified as a resident?

     o FWS provides no map of where bears died relative to

a. boundaries of unsuitable habitat
b. what FWS designates as the (proposed) 'range' of viable populations.
c. normal home ranges of the bears that died

Given that most adult and subadult grizzlies are eventually killed by people, presumably most bears in this population visit *unsuitable* habitat at some time in their lives. At what point does any bear cease being a member of a viable population – when it enters *unsuitable* habitat?

- o FWS provides no evidence that while in *unsuitable* habitat, grizzlies do not mate, give birth, or rear cubs.
  At best, FWS implies that any such reproduction is moot, given that bears which reproduce there and their cubs are especially likely to have conflicts there with humans or livestock, leading quickly to their deaths. But it provides no evidence supporting that assertion.
  For example, of all bears which have been observed within *unsuitable* habitat, how many (number and percentage) have *not* come into conflict with humans or livestock, and how many have survived for one or more years? If FWS is merely stating that this is "sink" habitat – where deaths exceed births, it should state this.

* FWS provides no site-specific natality and mortality data and other information to verify which areas are substantial "*population sinks*" (*sensu* Knight et al. 1988, Pease & Mattson 1999)

* This dearth of public information makes it impossible for the public to assess appropriateness of the FWS decisions on which habitat to classify as *suitable* or *unsuitable*, as well as importance of the *unsuitable* habitat to bears.

c. The rule fails to distinguish on a map between *unsuitable* habitat which cannot meet the needs of grizzly bears due to factors other than mortality risk vs. lands where mortality risk is not the decisive factor.
   * The rule refers repeatedly to Cumulative Effects Analysis, one component of which is distinguishing the "value" and "effectiveness" of each area of habitat (p.69,882).
   - o "<u>Habitat value</u> is a relative measure of the average net digestible energy potentially available to bears in a [management] subunit during each season. Habitat value is primarily a function of vegetation and major foods ..."
   - o "<u>Habitat effectiveness</u> is that part of the energy potentially derived from the area that is available to bears given their response to humans ... More specifically, habitat effectiveness is a function of relative value coefficients of human activities, such as location, duration, and intensity of use for motorized access routes, non-motorized access routes, developed sites, and front- and back-country dispersed uses."

- * The rule does not map either *suitable* or *unsuitable* habitat in a way that would allow the public to distinguish
  - o either the *value* or the *effectiveness* of both classes of habitat on any scale, much less on a scale fine enough to distinguish features such as small livestock allotments.
  - o values for the *human dimension* of effectiveness, distinct from habitat value.
  - o which areas of *unsuitable* edge habitat could potentially be reclaimed as *suitable* habitat – for instance by cancelling livestock allotments. Indeed, which, if any livestock allotments are *valuable*?

6. Habitat Importance

a. ***Nutrition & Refuge***: FWS addresses the importance of habitat in terms of the food (nutrients and energy) it supplies, as measured by *value*. But it does not address how the importance of each BMU or each food varies annually (e.g., between years that are wet vs. dry, or when pinenuts are abundant vs. scarce). Even habitat that has low *value* or receives little use during normal years could be vital during weather/climate extremes (e.g., drought, late spring frosts). Such *refuge habitat* is not discussed or mapped by FWS.

b. ***Mortality risk****:* FWS also distinguishes habitat according to mortality risk, implying that *unsuitable* habitat – apparently including edge habitat – is a population sink, and thus of negligible value to bears.

c. ***Buffering****:* FWS does not address importance of *unsuitable* edge habitat as a buffer between the YGP and humanity. Even lands that are of little *value* can be important if they are sufficiently protected from human degradation or intrusion to provide essential isolation to grizzly bears.

d. ***Travel Corridors***. FWS does not reveal the importance of any, much less all areas of low value *unsuitable* habitat, as travel corridors between areas of *valuable* habitat.

Any land which is important to grizzly bears for buffering or travel is, by definition, important to the support of those bears. The FWS has provided no evidence that *unsuitable* edge habitat is not important for the support of bears – including bears that do not otherwise venture outside of suitable habitat – or to the entire pDPS.

That dearth of information prevents the public from assessing

a. how any such edge habitat would likely fare over the foreseeable future, with vs. without after delisting.
b. how proposed post-delisting management of edge habitat could jeopardize sustained viability of the Yellowstone grizzly.

7. Habitat Stability or Change over the Foreseeable Future

a. FWS defines “foreseeable future” as 100 years, in accordance with common usage initiated by Schaffer (1983) for viability analysis.

b. One century is also similar in magnitude to a single “forest rotation,” which is a common planning period for management of national forests, and thus an appropriate duration for planning management of the large portion of grizzly habitat lying within national forests. However, 2 full rotations would be better, given that the effects of any rotation may not be completely manifest for years afterwards; and successive rotations will occur in different environments caused by soil scarification, burning, erosion, climate change, and other events during and after the first timber harvest.

c. Unfortunately, the rule’s sole geographic map (p.69,863) fails to include boundaries of the National Parks and Forests within the GYA. This omission impedes the public’s ability to project likely changes in suitability of habitat over the foreseeable future, and thus to verify validity of Conservation Strategy or of FWS claims that the YGP has recovered.

d. FWS claims that plans for future management of suitable habitat will attempt to maintain the same average conditions in the future as prevailed in the decade after 1988 – a period when habitat conditions within the GYA were supposedly stable. It does not explain in sufficient detail which characteristics of either *suitable* or *unsuitable* edge habitat were stable during that period vs. other characteristics which were not stable. Nor does FWS discuss the habitat characteristics that were unstable during earlier or later years. The public is thus left to wonder whether the base period began in 1989 because fires during 1988 caused much greater changes in suitable habitat than have occurred subsequently.

   Indeed, FWS neglects to describe how the 1988 fires affected either suitable or unsuitable habitat, and how ecological succession has affected value of the burned lands since 1989.
   If succession in the burned lands has involved major changes in habitat value during the base period, that contradict FWS claims that habitat was stable during that period.
   FWS does not address how such changes might have contributed to alleged growth of the YGP since 1988. Indeed, FWS neglects to address how any habitat factors (e.g., supplies of whitebark pine nuts or increasing utilization of cutworm moths) might have affected population growth. Instead, FWS attributes all growth of the population to improved management practices, including allegedly preventing further net human-degradation of habitat.

   Yet, FWS acknowledges the effects of variation in abundance of whitebark pinenuts (and possibly other foods) on rate of human-caused mortality, and possibly on cub production and survivorship unrelated to human hazards.

These contradictions and omissions in the rule deny the public their right to verify that the YGP has been restored to long-term viability, or that proposed management practices can sustain population size at near current levels, much less sustain viability, over the foreseeable future.

III. ALTERNATIVE APPROACH TO SOURCE-SINK ANALYSIS

1. **Zone vs. Behavior**: The FWS approaches grizzly conservation according to the arbitrary assumption that mortality risk and population dynamics are best analyzed and managed from the perspective of geographic zones (Schwartz et al. 2005), as though the fate (death risk, reproductive rate, etc.) of each grizzly depends so heavily on:
   a. which zone it is located in during any given day or season,
   that analysis can ignore:
   b. behavior of that particular bear – for instance on whether it is habituated or food-conditioned, or whether it is knowledgeable about living near people or foraging on key foods (e.g., whitebark pinenuts or cutthroat trout)
   c. Judging from the findings of Pease & Mattson (1999), the FWS assumption is invalid. Although location strongly affects risk of human conflict, this does not justify ignoring the additional major factors identified by Pease & Mattson (1999).
   d. Neither the rule nor Schwartz et al. (2005) adequately address "migration" of bears between management zones or management classes during source-sink analysis.
   e. Results by Pease & Mattson suggest that their method produces lower, possibly more realistic estimates of population "growth" rate; and linking vital rates to habitat characteristics should allow much greater predictability. Given that the whole conservation strategy of the FWS is based on source-sink analysis, this analysis should be approached from all scientifically-reasonable angles, not from just one angle that was selected arbitrarily (or perhaps to achieve a predetermined result supportive of delisting). Neglecting to consider all angles is a serious defect of the rule.

IV. THE FWS HAS ***<u>NOT</u>*** UNAMBIGUOUSLY IDENTIFIED A DISTINCT POPULATION SEGMENT

FWS discussions of demographic and geographic boundaries of the pDPS, the YGP, and their range are so ambiguous, and at times illogical, that these failings prevent the public from independently verifying:

* whether the YGP is still threatened "in all or a significant portion of its [current] range."
* whether any allegedly *unsuitable* habitat outside the designated "range" is important for sustained viability of the YGP.

BOUNDARIES AND RANGE OF THE pDPS

Equating the GYA with the geographic distribution of the pDPS is invalid because these pDPS boundaries were not selected according to sound biological principles, in accordance with the *Notice of Policy*. Neither geographic nor demographic boundaries of the YGP, or any distinct segment thereof, have been mapped or otherwise identified by FWS.

1. **Range Defined**

a. The FWS states that: "For the purposes of this proposed rule, the 'range' of this grizzly bear DPS is the area within the DPS boundaries where viable populations of the species now exist."

b. That usage of the term "range" is logically contradictory to the ESA which defines an *endangered* species as "a species which is [already] in danger of extinction throughout all or a significant portion of its **range** ...."
Using the FWS definition of range, one obtains the self-contradictory definition of *an endangered species [as] one in danger of extinction where ever its populations are* ***viable*** *– i.e., in negligible danger of extinction*. That is, of course, exactly opposite to what the ESA intends.

Logically, the actual endangerment definition intends that "range" refer to all of the area where the species has been observed in the recent past and where it is likely to be observed again, barring catastrophic natural events or human intervention.

2. **Present Range**

The ESA also uses the term "range" in a number of other definitions and clauses, including but not necessarily limited to the following: [each instance is presented in bold face and underscore]

(3)(5) Critical Habitat:

(i) *"the specific areas within the geographical area occupied by the species, at the* time it is listed ... on which are found those physical or biological features
(I) essential to the conservation of the species and
(II) which may require special management considerations or protection; and

(ii) specific areas outside the geographical **range** occupied by the species at the time it is listed ... that ... are essential for the conservation of the species."

(3)(19) A *Threatened* species is "any species which is likely to become an Endangered species within the foreseeable future throughout all or a significant portion of its **range**."
(10)(j)(2)(A): The Secretary may authorize the *release* (and the related *transportation*) of any population (including eggs, propagules, or *individual*s) of [an E/T] species outside the current **range** of such species if ... such release will further the conservation of such species."

3. **Historic Range**

In all of the above definitions or clauses, "range" refers to the current geographic distribution of the "species," as does the FWS rule.

Nevertheless, listing and delisting decisions are supposed to address not only extent of the present range, but whatever past reduction in range contributed to imperilment of the species, as well as potential future reduction in range that would affect risk of endangerment over the foreseeable future.
(4)(b)(1)(A) These classification decisions will be made by the Secretary on the following basis: Conducting a review of the status of the species by obtaining available scientific and commercial data.
(4)(1) As the basis for listing, delisting, or reclassifying a species, the *ESA* mandates determination of whether any or all of five sets of factors have caused threat or endangerment to the species of concern:
"(A) the present or threatened destruction, modification, or curtailment of its habitat or **range**;

It is not clear at what point in history the Yellowstone population – i.e., the population of which Yellowstone area bears are the remnant – ceased to interbreed with bears in at least one other population within the North American metapopulation. So size of the Yellowstone population's range at the time of separation can only be estimated roughly, at best. However, the rule cites historical records dating from after said separation, showing that range of the Yellowstone grizzly population then was much larger than it is now – indeed far larger than the GYA.

4. **Range of a Sustainably Viable Population**
Extent of the "range" of the Yellowstone grizzly should ultimately be defined not in terms of current or even past distribution of this subpopulation, but by the extent of the habitat needed to *link this subpopulation with one or more other subpopulations,* so as to assure sufficient **genetic diversity** to prevent inbreeding depression over the foreseeable future.

5. **How heavily does an area have to be used by a species to be within its range?**
   a. Although rare sightings of a species are not always encompassed within designations of the species' range, inclusion normally takes only a few repeated sightings. For example,
      * Colorado was part of the range of the grizzly until a few decades ago.
      * A "new" species of louse was recently discovered on the Kenai Peninsula of Alaska – the first sighting of this species in the western hemisphere. The Kenai Peninsula is now described as being within its range.
      * So too, a single specimen of another species of insect was discovered here which is previously unknown to science. The Kenai Peninsula is its only known range. (J. Morton, Senior Wildlife Biologist, Kenai National Wildlife Refuge, personal communication.)
   b. The FWS proposal to limit the "range" of the pDPS to the geographic distribution of viable [sub]populations of the YGP implies that only a segment of the YGP "belongs to" the pDPS and is encompassed within its "range." This raises two major problems:

* *Distribution*: The rule does not map geographic distribution of
- o the pDPS, which obviously does not encompass the whole GYA. Indeed, FWS states that the viable populations do not even occupy all *suitable* habitat, much less any *unsuitable* habitat.
- o any, much less all viable [sub]populations.

* *Membership*: The rule provides no basis for distinguishing which
- [sub]population any given bear belongs to
- bears are members of a viable population vs. which are not. (bears belonging to a viable population are herein referred to as *core bears*; those that do not are termed *peripheral* bears.

6. **Adaptive Management and Population Support**: For the purposes of the 1993 Grizzly Bear Recovery Plan, FWS defined the Recovery Zone "as an area large enough and of sufficient habitat quality to support a recovered grizzly bear population ....." (rule p.69,857).

   a. ***Is Management Really Adaptive?*:** The extent of that area was determined before FWS had sufficient data or had done sufficient computer simulations to even roughly calculate how many bears and how much habitat, to say nothing of which habitat, would be required for sustained viability of the population. Yet, more than two decades of subsequent research have led to no change whatsoever in those boundaries. This leaves readers with no basis for believing that said boundaries where determined according to biological criteria, rather than political or bureaucratic criteria.

   b. ***Support***: What is meant by "support" of a population? Contributing to its sustenance, or sufficient to be the sole source of sustenance?

7. **Existence and Occupancy of Range or Habitat**
"For the purposes of this proposed rule, the 'range' of this grizzly bear [p]DPS is the area within the pDPS boundaries where viable populations of the species now exist."

   In this and other sentences, the rule refers to areas, range or habitat where grizzly bears *exist* or which they *occupy*. What does that mean?

   a. **Existence:** What does "exist" mean? Is existence synonymous with "use." Does said "range" encompass all land where any grizzly bear is known to have been at any time while the species has been listed – where at least one bear has been seen or where any spoor (e.g., footprints or hair) was found?

   b. **Occupancy**: Is "existence" synonymous with "occupancy" (or residence)? When the FWS refers to an area being "occupied" by bears, what does that mean? What frequency or duration or type of use constitutes occupancy? Is area identified as being occupied by grizzly bears determined by all evidence of bear use (sightings, spoor, etc.) or only on evidence of use by certain bears, for instance on sow-cub families or only radio-collared families?

8. **Current Distribution of Bears**: Although FWS mapped "Current Distribution of Bears," what that phrase means was not explained.

   a. ***Current***: How many years are encompassed by "current" – for instance since listing of the species in 1975, or just after 1988 – the beginning of the base period 1989-98 according to which plans for management of habitat conditions have been designed?

   b. ***Distribution vs. range:***

      * Is "distribution of bears" (p.69,863) synonymous with "range" of the pDPS? The FWS rule states: "[b]ecause the grizzly bear occupies all of its range within the pDPS, we conducted the following threats assessment over the entire current range of the grizzly bear ... within the pDPS..." (p.69, 866)

      * Does "distribution"/"range" encompass all sites where grizzly bears or their spoor (e.g., tracks or hair) have been observed – approximately what biologists would call the range of the YGP (*YGP-range*)?

      * Or does "distribution"/"range" encompass only those areas where the presence of bears has been determined by visual sighting or radio-tracking or some other limited variety of evidence?

   c. ***Bears:*** Is distribution limited to only a portion of the areas traveled by bears (e.g., their normal home ranges) or also trips outside their normal home ranges? If so, how are movements within the home range distinguished from trips outside it?

      Does "Bears" encompass the entire YGP or only some segment of the population, such as what FWS alleges are "viable populations." That is, is "Current Distribution of Bears" synonymous with *range* of the pDPS (pDPS-range)?

      What proportion of the roughly 500 bears alleged to be in the YGP are encompassed in the "Current Distribution of Bears"?

      Which bears belong to the pDPS? Throughout much of the rule, the FWS implies that all grizzly bears living within the GYA – i.e., the entire YGP – are included in the pDPS. However, that is contradicted by other statements implying that only those bears which belong to a "viable population" are encompassed within the pDPS.

      The rule neglects to identify any biological criteria for distinguishing *which* viable population – if any – each bear belongs to. Indeed, the rule doesn't even provide geographic or demographic criteria for subdividing the YGP into two or more [sub]populations, or for identifying which of these [sub]populations are viable.

* The rule acknowledges that most adult and subadult bears die by being killed by humans or by accidents with our artifacts (e.g., vehicle collisions). Presumably, most of these deaths occur in edge habitat, or occasionally in non-habitat – which has to be reached by traveling through edge habitat.

* On what basis does the FWS allege that ventures into *unsuitable* habitat are ventures outside the normal home range of these bears? Given that a bear may expand size of its home range or shift its home range directionally (e.g., east, west, north or south) over time, what besides location distinguishes expansions and shifts that cross from *suitable* habitat into *unsuitable* edge habitat vs. those which occur solely within *suitable* habitat? Is there any fundamental behavioral difference in how permanent range expansions within *suitable* habitat differ from those within *unsuitable* habitat? Likewise, is there any way in which transient expansions differ between *suitable* vs. *unsuitable* habitat?

* At what point does the FWS allege that bears which venture into *unsuitable* habitat cease being members of one or more viable populations? Do they cease being members as soon as they enter *unsuitable* edge habitat or non-habitat, then resume being members when they return to *suitable* habitat? How long does a bear have to be in *unsuitable* habitat to cease being a member of a viable population?

9. These and other ambiguities of the rule make it impossible for the public to independently verify
   * whether the YGP is still threatened "in all or a significant portion of its [current] range."
   * whether any allegedly *unsuitable* edge habitat outside the designated DPS-range is important for sustained viability of the YGP.

10 Assessing threat and habitat importance requires kinds of information which the FWS has not made public. A general idea of what we need is provided by the hypothetical maps which follow:

Habitat maps of the GYA might provide either overhead (Fig. 1) or cross-sectional views (Fig. 2) of the topography. Some maps should depict local variation in usage of the landscape by bears – for instance probability of survival, days per year of bear use, or sightings of bears per year – as well as habitat characteristics such as *value* and *effectiveness* vary among locations (Fig. 2).

Other maps should show

a. distribution of bears over the landscape – for instance by drawing isohabs representing cumulative percentages of bear usage as concentric "rings" – for instance at the 25%, 50%, 75%, 95% and 100% isohabs,

b. how distribution changes as conditions change – for instance contrasting years that were wet vs. dry (Figures 3 vs. 4) or when nuts were abundant vs. scarce – over recent decades, as well as

c. how distribution might change if habitat degradation continues unabated for the foreseeable future, (a) gradually turning edge habitat into non-habitat, and (b) degrading former edge habitat into non-habitat. To illustrate the concepts, hypothetical examples are provided in Figs. 1-5. This is the type of mapped information that the public needs in order to verify whether the grizzly bear is likely to become endangered (inviable) in the foreseeable future.

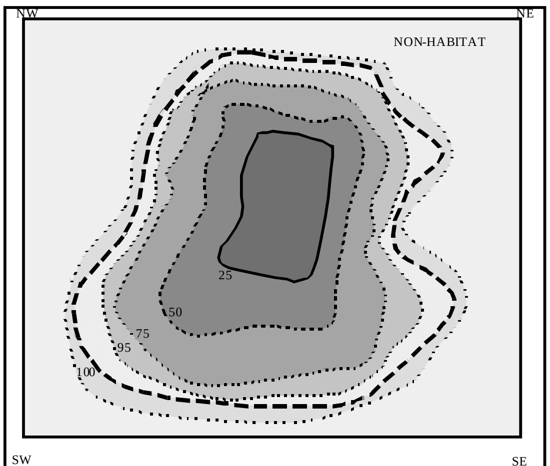

Fig. 3. **Percentage of time spent by grizzly bears in each part of the range during a typical wet year 1988-present.**

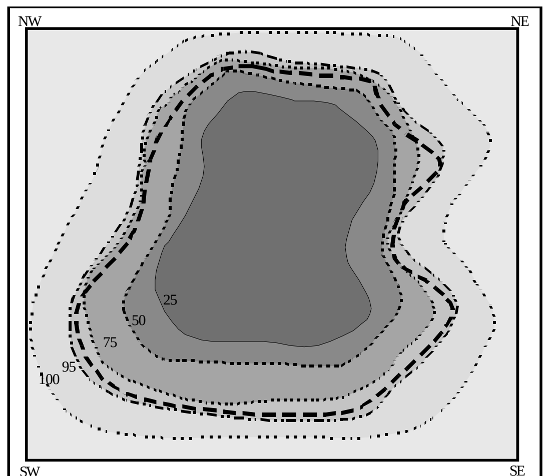

Fig. 4. **Percentage of time spent by grizzly bears in each part of the range during a typical drought year 1988 present.**

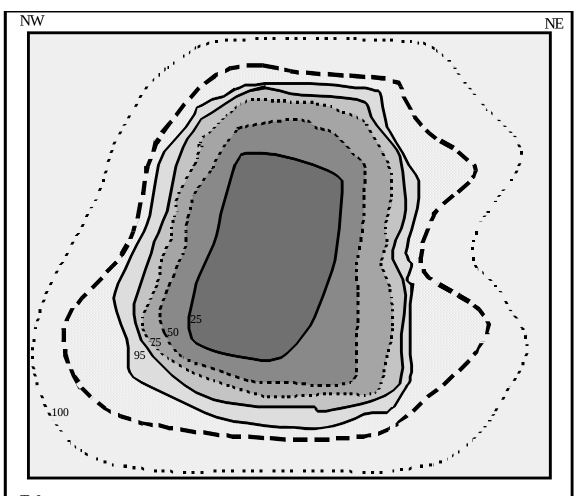

Fig. 5. **Percentage of the average day, Xyears later, that rizzly bears spent in each part of the range , during a typical drought year.**

It is not evident that the FWS has produced any map providing more than a few of these critical kinds of information, or something equivalent.

11 Extension or Shrinkage of the pDPS-Range

a. Whenever a grizzly with its own home range core inside the pDPS-range extends the periphery of its own home range into the pDPS-range, does this extend the boundary of the pDPS-range?

b. If members of a viable population were to all withdraw from the margins of the pDPS-range – for instance due to disturbance from humans, a forest fire, or a temporary food shortage there – would that automatically be considered as shrinkage of the core habitat and reduce its protection from human impact?

12 Threat Assessment Within Core Habitat

The FWS rule states: "[b]ecause the grizzly bear occupies all of its range within the pDPS, we conducted the following threats assessment over the entire current range of the grizzly bear ... within the pDPS..." (p. 69, 866)

That so-called justification is circular "reasoning," as becomes obvious when one replaces the word "range" with its definition. The phrase translates as: *Because viable populations of the grizzly bear occupy all of the land they occupy within the pDPS, we conducted the following threats assessment over the entire area they occupy within the pDPS.*

The fact that the grizzlies occupies all of the land they occupy does not mean or justify anything.

Ignoring the illogical justification, couldn't the FWS statement be accurately rephrased as: *Threats assessment was conducted over the entire core habitat ... within the pDPS"*

13 Threat Assessment in Edge Habitat

a. Although the FWS states that threats assessment was also carried out "throughout all *suitable* habitat within the" GYA, it does not clearly distinguish results of the assessments in core vs. *suitable* edge habitat. And apparently no assessment was done in any *unsuitable* edge habitat.

b. That is, FWS apparently ignores threats to and fate of grizzlies in at least some edge habitat. Given that *peripheral* bears do not belong to a viable population, by definition, those in both *suitable* and *unsuitable* habitat are at high risk of extinction. Do they constitute a significant segment of the YGP? Does their range encompass a significant segment of the range of the entire YGP? If so, one must question whether peripheral bears warrant classification as endangered?

HOW MANY GRIZZLY POPULATIONS WITHIN THE pDPS?

1. **“Population” vs. “populations.”**
   a. In some places, it refers to there being a single Yellowstone grizzly population. For example, FWS defined the Recovery Zone (and thus the PCA) “as an area large enough and of sufficient habitat quality to support a recovered grizzly bear population .....” (p.69,857).

   b. In other places, FWS refers to multiple populations within the pDPS. For example:
      * FWS defined the ‘range’ of this grizzly bear pDPS [as] the area within the [GYA] where viable populations of the species now exist.” (p.69,866)

      * FWS considers *suitable* habitat to be “the area within the [GYA] where viable populations of the species now exist or are capable of being supported in the foreseeable future.” (p.69,869)

      * FWS defines *unsuitable* habitat as being unable to support viable populations of grizzly bears. (p.69,866)

   These are but a few of the phrases in which the FWS implies that there is not just one grizzly population but multiple populations within the pDPS. Yet, the FWS has provided no evidence or even discussion citing evidence, that the Yellowstone population is subdivided into multiple populations, or even distinct subpopulations.

   c. Is the FWS is merely implying that the “range” can be subdivided into a number of geographic zones – e.g., Bear Management Units” – each of which is known to be used by grizzly bears, and that each such zone within the “range” is large enough to support a minimally viable population (e.g., one with under 5% risk of extinction over the next century, *sensu* **Shaffer** 1983)? If so, then this should be stated unambiguously, and the geographic boundaries of each zone should be presented on a map, and an explanation given of how those boundaries were determined.

   d. If FWS is instead merely saying that enough bears live within the “range” to constitute at least two minimally viable populations, then this should be stated unambiguously, and the number of such populations specified.

   e. FWS should state whether its usage of the term “population” is
      * Merely a loose practice referring to whatever bears happen to be within specific geographic zones at any given time. If so, then each of these “groups” would be more appropriately called a “subpopulation.”
      * A rigorous demographic usage? If so, FWS should answer these questions:

- o Is the "range" is naturally subdivided into two or more geographic zones between which there is much less interchange of genes or of individual bears than occurs within each zone?
- o Is the grizzly population is socially subdivided into two or more groups between which there is much less interchange of genes or of individual bears than occurs within each group?

2. **Viable populations**

a. FWS also claims that "populations" within the "range" of the pDPS are all viable, whereas those outside the range are inviable. Yet no evidence is presented or cited explaining how viability has been determined for even one of these "populations." Nor has FWS defined its use of "viability" – other than implying (p.89,866) that its use is consistent with standard scientific usage (e.g., Boyce 1995, Saether et al. 1998; Boyce et al. 2001) in assessing viability over a 100 year time horizon.

b. FWS does not

* state whether it is referring to probability of at least X members of each "population" being alive 100 years later,

- o The concept of "minimum viable population size" was created by (Shaffer 1983). MVPS referred to the minimum number of bears a population would have to contain now in order to have a 95% chance of still having 1 member a century later.
- o However, there is nothing but convention which makes the endpoint of analysis X=1 bear. POTENTIALLY DECISIVE POINT:

  If FWS were to stipulate that, unless a group of bears has at least X members, then that group would be too small or scattered to be considered a population or population segment for the purposes of the ESA,

  then one might respond that the same criterion must be applied to definitions of viability. If there must be at least X bears that interbreed for a group of bears to be considered a population, then viability analysis should not analyze how long it takes a population to decline to 0, or how many bears we need now to assure that at least 1 bear still lives Y years form now, as is commonly assumed by viability analysts, including Mark Boyce. Rather, the endpoint of viability analysis should be decline of the population to X bears that would be likely to interbreed.

or whether FWS is instead referring to some other measure of *population persistence*.

* which probability threshold (e.g., 5% risk of extinction) it uses

* the "population dynamics" model utilized to make its calculations. For example,

- o is its model density-dependent or independent? If density-dependent, does it employ

-the relationships discovered by Stringham (1980, 1983, 1985, 1986) between adult abundance vs. vital rates?
-the method devised by Boyce (19__)? **[metapop? Bitterroot)**
-the model proposed by Taylor 1995?

- o Does the FWS's model address variations over the foreseeable future in equilibrium population size or in habitat carrying capacity, and if so how? Does its model take into account changes in habitat which can be foreseen over the next century (e.g., in accordance with the draft Habitat-Based Recovery or draft Conservation Strategy and its linked Forest Plans), with vs. without delisting?

Given that viability over the foreseeable future is the ESA's crux for deciding whether recovery has been achieved, this is a glaring omission, arguably one sufficient to invalidate the rule.

4. *Peripheral* bears – those which do not belong to a viable population must
   * belong to one or more inviable populations or population segments; or
   * be too few in number to constitute a population or segment thereof.
   * be so widely scattered that they don't interbreed with one another or with bears in one /of the viable populations.

   Which, if any of these criteria, are the basis on which *peripheral* bears were actually identified? What other criteria were used? Are they logically consistent with FWS arguments?

5. For clarity in my own usage of terms, I will designate that all bears within the pDPS belong to a single population, although this population might be viewed as consisting of multiple *subpopulations*.

   a. What game is FWS playing? **I suspect they are setting the stage for writing off all bears and habitat outside YNP – not merely outside the PCA.**

   b. If they define the pDPS as the unit of bears whose conservation status is being decided – still threatened vs. now recovered – does this mean that extinction of the subpopulations does not matter, except to the extent it affects viability of the whole pDPS?

   c. Given implications of the term "viability" and calculations indicating minimum necessary effective population sizes to sustain viability, a multiplicity of subpopulations that are independently viable is a very controversial claim. Does it place a burden of proof on them to identify each such subpopulation and to demonstrate its long-term viability – for instance, that logging, etc. won't endanger them?
   d. If they get away with characterizing each subpopulation as a separate population, and each of these populations as viable, then the group of "populations" could be

characterized as a metapopulation, whose calculated viability would be higher than for a single population of the same cumulative size. (See Boyce's metapopulation analysis in the DEIS for reintroduction of grizzly bears to the Bitterroots.)

6. Recall that the population's core habitat is centered on YNP, and that edge habitat approaches highways, communities and areas of industrial resource extraction: No matter how large the population or its core habitat, its edge habitat will always be a sink, and any peripheral subpopulation(s) will always be imperiled.

   a. Will this edge habitat be a "significant" portion of the GYA or of the YGP's range? It appears that nearly all the land outside YNP will become a serious population sink within the foreseeable future. This is a very large portion of the habitat within the PCA.

   b. Will peripheral bears constitute a "significant" portion of the whole YGP?

   c. Will fate of peripheral bears affect viability of core area bears?

   d. Assuming any bear B spends part of its time near the center of the GYA, how much of B's time is spent in edge habitat? The greater the percentage of time spent in edge habitat, the more vulnerable a bear would tend to be to hazards typical of the periphery – bear-human conflict.

      We would expect home ranges to be largest for adult males, making them disproportionately likely to encompass some edge habitat in their ranges, and thus to heighten their vulnerability to human hazards.

   e. What is the probability that B's core range will shift from core habitat to edge habitat,
      and how fast is it likely to shift? We would except the rate of shift to be highest for subadult males and young adult males, likewise making them disproportionately vulnerable to human hazards – perhaps even more so than adult males, since young males are forced into areas avoided by adult males (e.g., near people), and are less knowledgeable in how to cope in the vicinity of humans.

REFERENCES CITED

Shaffer 1983
Stringham 1980, 1983, 1985, 1986
McCullough 1981, 1983
Taylor 1995
Knight et al. 1988,
Pease & Mattson 1999
Lande 1988, Yahner 1988, Mills 1995).
Schwartz et al. 2005

DENSITY DEPENDENCE, WHITEBARK PINE DECLINE, AND CHANGING VITAL RATES OF YELLOWSTONE GRIZZLY BEARS

Introduction

The introductory paragraph of this paper (L **59-71**) is unnecessary. It should be replaced with a statement that goes directly to the heart of the key management issue (which presumably justifies funding for the authors' research): **Is the Yellowstone grizzly bear population resilient enough to avoid endangerment over the foreseeable future if it is *vs*. is not delisted?** Then the authors should explain how this paper is relevant to the delisting decision – addressing points covered in the following paragraphs.

a. There is moderately strong (although not unequivocal) evidence that the size of the population is now large enough and possibly genetically diverse enough to avoid endangerment over the foreseeable future if current environmental conditions persist.

   That is the essential rationalization for the USFWS's decision in 2006 to delist the Yellowstone grizzly – i.e., to upgrade its status from "Threatened" to "Recovered" in accordance with the Endangered Species Act.

b. However, despite that scientific rationalization, coupled with powerful political justifications for delisting, the Federal Court revoked delisting, arguing that the USFWS had not met its scientific burden of proof of "Recovery." In particular, the USFWS had not
   - explained why vital rates have declined over the past decade or so;
   - shown that the declining vital rates are is not due to ongoing habitat degradation;
   - shown that the combination of ongoing and highly-probable future habitat degradation would not cause population size and vital rates to decline fast enough and far enough to endanger this population within the foreseeable future even if it remains listed;
   - shown how much that degradation would be accelerated and deepened by loss of those protections dependent on Threatened status to minimize impacts from logging, mining, geothermal development, real estate development, the livestock and ski industries, and other forms of recreation including sport hunting of grizzlies.

c. One of the best-documented forms of habitat degradation is ongoing loss of major foods, including seeds of whitebark and limber pines (*Pinus flexilis*), exacerbated by potential reductions in army cutworm moths, ungulate carrion, and cutthroat trout. From a management perspective, therefore, it is essential to assess the effect of declining whitebark pine (WBP), and of other potentially critical foods. For example, how is the decline in vital rates correlated with the decline in whitebark pine tree abundance; how does that compare with other influences on vital rates such as rising population density?

The authors attempt to answer the latter pair of questions through a series of nested computer models. Before any model's output can be trusted, it needs to pass two tests: (a) Validity, appropriateness and adequacy of the data. (b) Validity of the models themselves. It's not clear that either of those tests is passed by this paper. Furthermore, most of its calculations are "blackbox," such that they cannot be replicated or otherwise verified by colleagues. To overcome that limitation, details on calculations should be provided as supplementary materials for storage in the JWM archive or in a federal archive accessible through the web by any interested party.

The 2006 delisting/relisting fiasco is said to have cost government agencies and the business community many million dollars, and exacerbated skepticism about the whole recovery/delisting process. It is essential that the next round of deliberations rest on a nearly unequivocal scientific foundation. Presumably, the authors have sufficient data and expertise to meet that standard; but they have not yet achieved that in this paper. Its weaknesses virtually guarantee that it would become a subject of litigation by whichever parties disagree with the official decision to delist or not to delist. *My review is intended to help the authors improve their paper to the point that it can withstand even the most rigorous critique.*

Hypotheses Tested

The primary hypotheses were that the observed declines in vital rates during recent years were partly functions of (a) rising population density and (b) declining WBP tree abundance. Implicit is the notion that whichever influence was most strongly correlated with vital rates had the strongest impact on those rates.

Methods

The authors identify several factors in addition to indices of vital rates, population density and whitebark pine abundance. They state (L234) "We assigned covariate values to the encounter histories of individually marked bears based on spatiotemporal indices of whitebark pine decline and grizzly bear density and time trend."

A clearer way of stating this might be: *For each encounter with a marked bear, we recorded the corresponding spatio-temporal index values for whitebark pine abundance and grizzly population density.* The authors should explain the differences between a "spatiotemporal" index vs. a "density and time trend index.

Derivation of the density index is too obscure to be replicated by independent researchers. For example: "The density index in a given year was the sum of proportional overlap of all lifetime activity ranges present during that year, as calculated for 14- x 14-km grid cells." (**L 241**) A fuller explanation should be provided in the Supplementary Materials.

Further discussion of modeling in this paper is postponed until L402 of this review. Meanwhile, let us address this issue in qualitative biological terms: (a) Food Supply, (b) Carrying Capacity and Population Density, and (c) Per Capita Food Supply and Nutritional Status.

BIOLOGY

Food Supply Issues that the Authors Should Address

Before any conclusion is drawn about the relative effects of population density vs. whitebark pine nut availability on vital rates and dynamics of the Yellowstone grizzly bear population, maps should be provided showing distributions of healthy vs. “sick” WBP, overlain with locations of the particular bears addressed in this study. Also, the following questions should be answered:

a. To what extent can observed declines in vital rates be attributed to a decline in nutritional status? What indices of nutritional status were assessed? How?

b. If nutritional status has declined, which nutrients have been in short supply: protein, energy or something else?

c. Which other potentially limiting nutrients, if any, have been provided by whitebark pinenuts?

d. To what extent can shortages of whitebark pinenuts in the diets of bears be attributed to declining abundance of whitebark pine trees? How tightly does abundance of nuts in the diet correlate with
   - Total abundances of nuts
   - abundance of trees in each size range (measured at DBH, canopy area or volume)
   - nuts per tree of each size range
   - nuts or trees per hectare
   - hectares of healthy WBP tree canopies with a bear’s home range
   - abundance of squirrels that cache nuts

   In the long term, one would expect tight correlations. But they might not show up over the short term. Over how long a period was each of these correlations measured? A correlation which is tight over a period of 2+ decades; would not necessarily be detected over the period covered by this paper.

e. How often do whitebark pine trees produce heavy crops? How many years of data would be necessary to document the effects of nut abundance on vital rates for the population as a whole vs. for subsections of the ecosystem or grizzly population?

f. To what extent can abundances of pinenuts in the diets of sampled grizzly bears be attributed to activities (e.g., competition for these nuts) by:
   - Other grizzly bears or black bears
   - Smaller mammals, especially squirrels
   - Birds, insects, model and fungi

g. To what extent can shortages of WB pinenuts in the diets of bears be attributed to high availability of other – perhaps more preferred -- foods (e.g. limber pinenuts, berries, prey or carrion)? (Preference, in this sense, encompasses not only palatability, but profitability). How commonly is availability of those other foods high enough to compensate for reduced consumption of whitebark pine nuts? In some hardwood species, nut production can be a response to stress, especially if a tree is dying. Could the effect of declining annual WB pinenut abundance be partly masked by more nut production per dying tree?

h. Conversely, what alternative food sources (e.g., limber pinenuts or huckleberries) provide some of the same limiting nutrients provided by WB pinenuts? Where, when, in what abundance, and how profitably or securely? How often and severely do these other food sources fail? How important would WB pinenuts be during such failures?

Even in habitats where nuts are highly abundant only once every several years, they can be critical to long-term health of a bear population, as has been observed with beechnuts in New England and surrounding states.

i. To the extent that declines in vital rates cannot be attributed to a decline in nutritional status, to what extent can the decline in vital rates be attributed to other influences by rising population density (e.g., infanticide or chronic stress)?

j. What factors other than nutritional status or nutrition-unrelated density factors [e.g., infanticide or chronic stress] might reduce vital rates in areas where WB pinenuts have been scarce?

So far, the authors have only begun to answer the questions listed above. Additional points they should address more fully include:

a. In the Yellowstone Ecosystem, the primary sources of lipid and carbohydrates are army cutworm moths, nuts of whitebark and limber pines, various berry species, and some subterranean plant tissues (e.g.., tubers) CARRION AND PREY

b. Moths and whitebark pine are found primarily at isolated high-altitude sites. Abundances of these foods tend to draw bears away from areas where encounters and conflicts with humans are more likely. (Where, relative to altitude and park boundaries, are limber pine most common? How do fluctuations in their abundance affect bear-human conflicts?)

c. Abundances of both these pine species are declining and might be virtually eliminated due to the combined effects of climatic warming, drought, blister rust, and bark beetle. Making matters worse, loss of those trees could send ripple effects through the ecosystem, impacting other plants upon which bears depend. For example, some berry-producers (e.g., *Ribes* spp.) and rodents eaten by grizzlies allegedly depend on food or microhabitats provided by limber pines. Army cutworm moths may also be in jeopardy by climatic warming and pesticides. Synergistic effects should not be ignored.

d. It is thus essential to quantify likely impact by the ongoing or potential declines in all major food supplies on nutritional status, vital rates, population size, and bear-human conflicts.

e. Where it is possible to show a strong correlation between vital rates vs. an environmental factor (e.g., food supply or population density), one can reasonably infer that this reflects strong influence by that factor. However, the converse is not necessarily true.

- For example, low sensitivity by vital rates when mast supplies are very low or very high would not preclude high sensitivity when mast supply is intermediate (Figure 1). Which ranges of mast supply (i.e., sectors of this curve) and of nutritional status were documented by the authors? Whereas the index of WBP decline varied from -0.38 to 0, only 18% of that total range was represented by the bears sampled (see line 446 of this review). Was that 18% in the range of WBP values where sensitivity is very high or very low?

- Strength of correlation between vital rats vs. pinenuts depends upon
  - o the amount of variation in nut supply over time or space,
  - o the amount of impact on vital rates per unit change in nut supply.
  - o noisiness of the data.

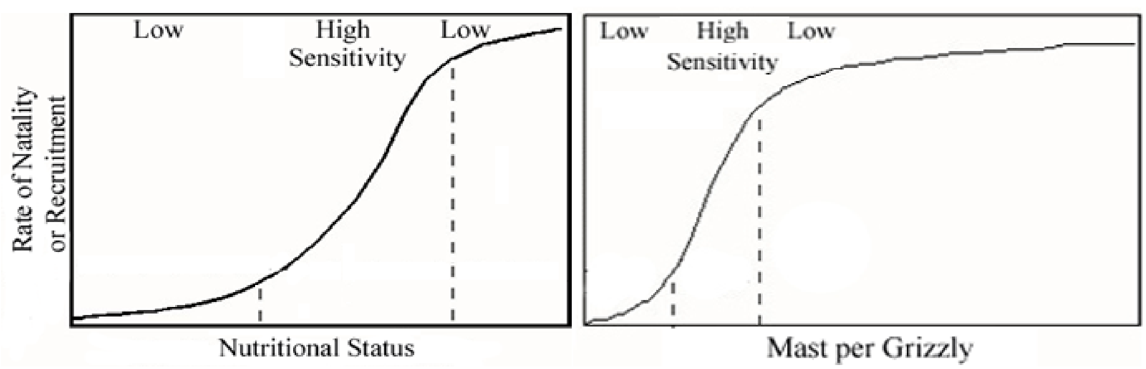

Figure 1. **Relationships between vital rates vs. nutritional status or vs. per capita mast supply** (schematic).
a. If *mean* grizzly density did not change, then a curve of similar shape to Vital *Rates vs. Mast/Grizzly* would exist for *Vital Rates vs. Total Mast Supply,* with the influence by variations in grizzly density tending to appear as *random noise* around the curve – much as Stringham (1984) found for vital rates vs. an index of food supply during the 1959-80 era.
b. However, a *trend* in population density could alter or mask the vital rate vs. per capita food supply relationship. And variations in other foods could mask the effects of whitebark pine mast per bear.

- Lack of a strong correlation could be due either to:
  - o small variation in nut supply during the study for the bears sampled
  - o low sensitivity per unit variation in nut supply over the observed range of supply.
  - o masking effects by variations in other foods (e.g., limber pine nuts, berries, tubers, ungulate prey and carrion, moths, or cutthroat trout), or
  - o masking by variation in profitability with which bears harvest nuts from squirrel caches, which might in turn depend on abundance of squirrels to

harvest and cache nuts, density of nuts produced per hectare, and competition for nuts by black bears, other mammals, birds, and mold.

- masking effects by variations in non-food influences (e.g., logging, mining, ungulate hunting, pollution) on vital rates.
- the index of WBP nut abundance being (?) poorly correlated with WBP tree abundance
- nut abundance in trees being (?) irrelevant to bears. For example, is what matters to bears total nut abundance in trees, or total abundance that bears can profitably harvest from squirrel middens (Figure 2), which might depend less on total abundance of nuts in trees then on how concentrated the trees are geographically, on the abundance of squirrels, or on loss of nuts to competitors or weather.

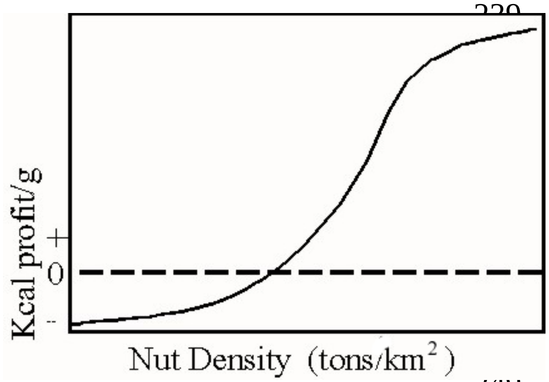

Figure 2. **Profitability (Kcal profit per gram of nuts) of foraging on nuts as a function of whitebark pinenut density** (schematic).

- The mere fact that the conventional index of nut abundance was correlated with vital rates and human conflicts when compared from year to year in the past, does not prove that it will also be revealing when comparisons are made between locations over a shorter time span. Correlations that exist at one scale of analysis often disappear when data are subdivided, causing a decline in signal-to-noise ratio.

f. Even a strong influence by mast supply might be distorted or masked by intervening variables – for instance alternate foods. The critical issue, from both academic and conservation perspectives, is not whether alternative foods might temporarily buffer a declining supply of white-bark pinenuts, but whether a long-term decline in nuts tends to produce a long-term decline in vital rates – which might be detectable only if the intervening influences can be factored out. Factoring might require finding a biochemical signal in the tissue of bears which indicates how much of their lipid, calorie or protein intake comes from whitebark pinenuts, and how that fraction varies with supplies of nuts and other foods. What do fecal analyses for nut fragments or biochemical markers show about consumption of pinenuts?

g. Some foods are more profitable than others. Likewise, there can be variation in profitability among sources of each food, or over time for any given source. Hence, even were food competition constant, nutritional status would not necessarily be highly correlated with food supply. Put differently, assessing effects of declining food supply can require measuring intervening influences on harvest-profitability.

- To help tease apart these various influences, one should measure nutritional status, including lipid storage, of each age-sex class, and if possible measure amounts of stored lipid derived from whitebark pine nuts.

- Variation in WBP abundance considered in this paper should be contrasted with variation in abundance analyzed by Mattson et al.. Did these authors use the same index of nut abundance which has shown high correlations with vital rates in the past?

h. It is not enough to test for relationships between vital rates vs. mast supply currently or one year previously. Longer time lags and multi-year effects should also be investigated. Based on the Craighead's data on these bears, Stringham (1983, 1984) demonstrated strong correlations between conditions during the 2 years of a cohort's gestation and infancy vs. recruitment rates to each subsequent age until adulthood (i.e., time lags up to 5.5 yrs). The conditions he assessed were abundances of adults, especially males, and an index of food supply, for the subpopulation of Yellowstone grizzlies that fed regularly at garbage dumps from 1959-68. If only after dump closer, similar relationships might have existed for the whole population between vital rates vs. supplies of natural foods, including pinenuts. Were one to contrast cohorts conceived or born during years of peak vs. negligible pinenut production, one might well find evidence of a strong influence by nut abundance – evidence which might not be revealed by the kind of tests reported in this paper. I find no evidence that this possibility was assessed by the authors.

i. Declines in food supply need to be considered in context with cumulative past, current and future impacts from other influences, including stress from human disturbance.

j. Noisiness of data also needs to be assessed. For example: After noting that vital rates were more strongly correlated with adult male abundance than with an index of food supply during the 1959-80 era, Stringham (1984) formulated two hypotheses:
- adult male abundance had more impact than food supply;
- the higher correlation with adult male abundance might be an artifact of having more noise in the index of food supply than in the data on population age-sex structure.

So too in this case, one must question relative noisiness of data on population density vs. WBP tree abundance, especially if one considers not just the abundance of nuts produced, but also availability of those nuts to bears and how profitably they can be harvested.

Carrying Capacity and Population Density

1. The authors' introductory statements in paragraph 2 about density dependence should also be clarified and provide a fuller review of the literature, especially the seminal points made by McCullough (1981), Stringham (1983, 1984, 1986), Taylor et al. (1994), and Craighead et al. (1995). For example:

- **L80-82**: "Miller et al. (2003) indicated that differences in body mass among Alaskan brown bear populations were most parsimoniously explained by each population's proximity to *carrying capacity* rather than by differences in their *habitat quality*." (my italics).
- **L86-88:** Miller et al. (2003) suggested that variation in cub survival and litter size were mostly influenced by proximity to carrying capacity, with some additional influence from environmental variation and stochastic events."

2. The above pair of statements regarding Miller (2003) imply that differences in "carrying capacity" are synonymous with measurable differences in "habitat quality" – e.g., differences in supplies of one or more major foods. Also implied is that differences in carrying capacity are synonymous with differences in equilibrium density – as assumed in the Verhulst-Pearl logistic model – according to which narrowing proximity between N_i and N_K implies that as N_i rises, and/or N_K declines, the difference between per capita natality minus mortality (*b-d*) would shrink towards 0. Trying to equate those concepts with one another raises questions about both logical consistency and empirical methodology. How are habitat quality and equilibrium density measured in the field? How tightly are these variables correlated? If habitat quality rises by X%, would equilibrium density also rise by X%? Which factors (e.g., carrying capacity or food supply) are included or excluded under "environmental variation" or stochasticity? Without answers to these questions, the Miller (2003) citations and others in this paragraph are too nebulous to be meaningful.

3. Theoretically, if "carrying capacity" = "equilibrium density," and if the density at which natality balances mortality were constant, then one could estimate that balance point by extrapolating from numerous sets of data points for observed rates of natality and mortality vs. population density. However, in the real world where the supply of major foods (e.g, pinenuts) fluctuates widely from year to year, the relationships between vital rates vs. population density could also fluctuate widely. So how could one actually estimate equilibrium density; and how does one distinguish whether an equilibrium actually exists rather than a trend? How could one distinguish a declining multi-year mean difference between natality vs. mortality from a declining equilibrium?

Whatever their utility for theorization, are the concepts of "equilibrium density" and "carrying capacity" anything more than convenient but arguably obsolete fictions?

Per Capita Food Supply and Nutritional Status

1. **Per Capita Food:** I suggest rephrasing the statements by Miller and the other references in accordance with the following points: Correlations between body mass or vital rates vs. total food supply tend to be weaker than those vs. proximity to equilibrium density. That can be more elegantly expressed as *food supply per bear* – a measure encompassing both food supply and the number of bears competing for it (Stringham 1984). By contrast to "carrying capacity" or "equilibrium density," pinenut supply per bear could actually be measured from year to year and place to place.*

2. **Population "density**" is a nebulous term, given that all age-sex classes are lumped together, and age-sex ratios vary over time and space. Obviously, each bear tends to have a far greater impact on vital rates once it is an adult than it did as a cub. Given that competitive abilities and per capita food consumption vary with age and sex, tighter correlations with vital rates might be obtained by calculating metric tons of mast per 100 kg of bear biomass. Or, considering that cubs tend to have a higher basal metabolic rate than adults, one might find even tighter correlations between vital rates vs. megacalories of energetic profit per hectare relative to the cumulative BMR of bears per hectare.

* Findings by Stringham (1984) were based primarily on (the Craighead data) for bears which regularly fed at garbage dumps, and thus represented only localized density dependence. Findings on that subpopulation cannot be directly extrapolated to dynamics of the entire population at that time, contrary to what McCullough attempted to do (using faulty statistical methods). However, localized density dependence on a small scale can exist anywhere/when numerous bears father to forage and socialize – even now.

3. Interspecific competition also varies over time and space.

4. Analysis of supplies per bear is one way of integrating information on population size or density with that on food/nutrient/energy supply. One should then test how closely per capita food/nutrient/energy supply is related to other indices of nutritional status, including age-sex-season specific body size (weight, girth, etc.).

5. Issues of density dependence can then contrast resource competition against other influences by density, such as infanticide. All this should be done as part of a cumulative effects analysis.

MODELING

As noted earlier, this paper is mainly an exercise in computer modeling. Speaking as an experienced modeler: Before any outputs can be trusted, they need to pass two tests: (a) Validity, appropriateness and adequacy of the data. (b) Validity of the models themselves. It's not clear that either of those tests is passed by this paper.

Validity, Appropriateness, and Adequacy of Data

1) The first pitfall of modeling -- "garbage in, garbage out" – does not seem to be a major problem here regarding vital rates and population density. The authors have

made reasonable efforts to assess these variables for the population as a whole, and then to estimate local variation for the bears included in this study. Nevertheless, one must question how thoroughly outputs from each of these local variation models has been verified empirically with any mammals, much less with bears? Without such verification, this whole study is a house of cards – i.e., layers untested assumptions built upon other untested assumptions.

2) Furthermore, there is high risk of "garbage in, garbage out" regarding whitebark pine abundance.
   - Even *if* the satellite data on land area coverage by healthy vs. unhealthy WBP *trees* are valid, the authors provide no information on confidence intervals based on ground-truthing.
   - Nor do they provide any evidence that this is an appropriate metric for assessing impact of WBP *nut* abundance on vital rates of grizzly bears. For example, they provide no evidence of a tight correlation between the numbers of hectares covered by WBP trees vs. amount of nutritional profit that grizzly bears derive from foraging on WBP nuts.
   - Effects of WBP abundance are based on imagery starting in year 2000. But how far back in time have WBP trees been seriously impacted by bark beetles, blister rust or drought? How far back has this been affecting nut abundance and quality or their availability and profitability to grizzly bears? Does assessing WBP only from 2000 onwards mask WBP effects on grizzly bear vital rates?

3. The authors provide no data on supplies of other foods which could mask or distort effects of WBP nut consumption on grizzly bear vital rates.

4. They provide no data on nutritional status, or on an index of status such as body size, for the specific bears upon which this analysis is based.

5. Their analyses do not encompass any obvious awareness that relationships apparent at one scale of time and space might not be apparent at larger or smaller scales.

   - For example, a negative correlation between abundance of whitebark pine nuts vs. incidents of bear-human conflicts that is apparent across many years for the ecosystem as a whole wouldn't necessarily show up over shorter periods or smaller areas.

   - The same might be true for vital rates vs. population density and vs. WBP tree abundance. Whereas the population density index (**Line 255**) showed considerable variation among individual bears (mean 13.9, SD = 5.6, range = 0 – 29.2, the range for sampled individuals (**L 258**) was only 8.9 to 16.4 – i.e., 26% of the full range observed. Likewise, their WBP index ranged from -0.38 to 0, whereas the index for sampled bears ranged from only -0.07 to 0 – i.e., 18% of the full range. The relatively lower variation in WBP (26% vs. 18%) alone might account for its looser relationship with vital rates – as explained on lines 200-256 of this review.

Model Validity

Concerning the models used by these authors to assess relative impacts on vital rates by population density and WBP abundance, further question arises concerning semantic validity, robustness, and cumulative decline in signal-top-noise ratio.

1) *Semantics*: How well do the assumptions underlying each model match the specific real world situations being modeled?

- Program MARK is widely accepted as a major step forward in our collective ability to assess population dynamics. It seems appropriate for estimating survivorship and transition among reproductive states in many cases. Yet, one might question how well its assumptions are met by data on *this* population.

- **Line 227**: "Because fecundity is correlated with age, our base model included a quadradic covariate for age (age + age^2) of individual females for the N to C transition …" This would be better rephrased as: "Fecundity is lower for young and old adult females than for those in their prime – a relationship closely fit by a quadradic curve (age + age^2). … [This is one of numerous examples of how the paper could be markedly improved by translating more of the text from geekspeak into biological phraseology.]

2) *Cumulative decline in signal-to-noise ratio*: Whereas the basic idea of selecting among models according to AIC scores is sound, the "data" themselves are so noisy that differences in goodness of fit among the competing models might be nothing more than artifact. Each step of this analysis, from estimation of vital rates, population density, and WBP abundance, on through tests for strength of relationships among those variables, has some level of uncertainty. As a general rule, combining variables tends to magnify uncertainty. As one takes successive steps in modeling, uncertainty can rise geometrically. This analysis includes so many steps that one would expect extremely wide CI around the final measures for relative strength of relationships between vital rates vs. population density or vs. WBP abundance. Without further information, one must question whether the *difference* in strengths of those two relationships are themselves statistically significant. The authors do not reveal how they coped with this issue of cumulative uncertainty.

3) *Robustness*: The authors do not provide any test for robustness of their conclusions. Do tiny variations in input figures cause tiny variations in output; or do they produce disproportionately large, chaotic variations in output *(= Butterfly effect)*? For example, how would small variations in input affect which of the statistical models for survivorship or reproduction (e.g., sigmoidal vs. splined) provides the highest AIC values? How would they affect relative strength of relationships between vital rates vs. population density or vs. WBP abundance? Put differently, how much would relative strengths of these relationships be altered by using different starting values within the CIs –not the 50% percentile estimates, but perhaps the 40^{th} or 60^{th} percentile estimates for vital rates, population density, or WBP abundance?

4) *Models for survivorship and reproduction*: Why not also test the fits of simple asymptotic, logarithmic, or other geometric models, particularly those predicted by basic theory or previous studies on bears or other wildlife (e.g., see Stringham 1984)?

5) The models used to combine variables are all basically linear (see Table 1). The effect of each variable is added to the effects of the other variables. Adding variables this way is useful for minimizing multiplicative growth in uncertainty. However, that approach does not necessarily reflect biological reality. For example, the relationship between population density vs. WBP tree abundance might be better captured as WBP tree coverage per bear. (see Stringham 1984) – as an index of nut supply per bear.

This paper appears to be a classic case of hubris which fails to distinguish models from reality. In particular, consider the authors' conclusion that:
(**L359**) "*Decline in cub survival … was associated more strongly with increasing grizzly bear density than reduced availability of whitebark pine*."

A more accurate statement of the results would be: *Decline in our index of cub survival … was associated more strongly with the increase in our index of grizzly bear density than with our index for geographic coverage of the land by whitebark pine trees. However, until validity of our methods is proven, one cannot conclude that these results reflect real-world differences in the impacts of rising population density or declining whitebark pine tree abundance.*

This more exact phrasing would help readers keep in mind that the difference in strengths of relationship might lie more in differing levels of validity of the indices, than in what was indexed, and of the potentially low correlation – at this scale – between land area covered by WBP trees vs. nut availability. Furthermore, all AIC values or other measures for strength of relationship should incorporate all uncertainties in all the variables addressed, and in all calculations made. If the differences in strength of relationship for vital rates vs. population density and vs. WBP abundance are indeed non-significant, when ALL uncertainty is accounted for, that should be admitted.

REFERENCES CITED

Craighead et al. 1995. (see Ref list in the paper)

McCullough, D. R. 1971. Population dynamics of the Yellowstone grizzly. Pp. 173-196 *in* C. W. Fowler and T. D. Smith, *eds*. Dynamics of large mammal populations. John Wiley & Sons. New York, NY.

Stringham, S. 1983. **Roles of adult males in grizzly bear population biology.** *Ursus.* 5:140-151.

Stringham, S. 1984. **Responses by grizzly bear population dynamics to certain environmental and biosocial factors**. PhD. Dissertation, U Tennessee, 495 pp.

Stringham, S. 1986. **Effects of climate, dump closure, and other factors on Yellowstone grizzly bear litter size.** *Ursus*. 6:33-39.

Taylor et al. 1994. (see Ref list in the paper)

Density Dependence, Whitebark Pine Decline, and Changing Vital Rates of Yellowstone Grizzly Bears JWM-14-0247.R1

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2ND review 13 April 2015

SUMMARY OF COMMENTS TO THE AUTHORS

The purpose of this analysis is to assess the degrees to which recent slowing in population growth and decline in certain underlying vital rates can be attributable to rising population density vs. decline in whitebark pine (WBP) nut supply. WBP is a primary source of dietary energy for grizzly bears, and has previously been shown to be highly correlated with rates of reproduction and recruitment.

The authors' conceptual approach is (a) deriving an index for both population density and WBP for each bear whose history of reproduction and survival is known, and following those relationships for up to 30 years. In their response to my initial review, they made a statement that should be included [in clearer phrasing] early in their paper: "Our spatio-temporal index of whitebark pine decline allows us to actually examine the potential effect of decline in nut abundance on subsections of the population. We are, in fact, asking, whether those bears most affected by whitebark pine decline (i.e. those with a lot of whitebark pine in their range and a lot of impact) are exhibiting the most profound change in vital rates. This is possible because we are weighting the index by the proportion of habitat in each bear's activity range."

This is potentially the most sophisticated analysis of population dynamics yet done for bears and one of the most sophisticated for any carnivore. Nevertheless, for that potential to be fulfilled, and for this paper to be publishable, fundamental weaknesses in its execution and description must be addressed. Therein lies the difference between mediocrity and greatness.

1) *Background*: Previous studies by current and former members of the Interagency Grizzly Bear Study Team (IGBST), dating back to Mattson et al. (1992) have demonstrated strong causal relationships between whitebark pine (WBP) nut supply vs. vital rates. Nuts can be consumed by bears only if they are being produced by trees. So there is widespread concern that progressive loss of WBP trees in the ecosystem is greatly reducing nut supply to bears, which would be expected to impair vital rates. Hence, concurrent declines in certain vital rates, and slowing of population growth have been attributed to loss of WBP trees, and/or to [alleged] growth in size of the Yellowstone grizzly population during those same years. Rising density would have potentially increased competition for pine nuts and other foods, and possibly inflicted other aversive impacts on vital rates, such as (a) intensified physiological distress from social strife, sexually-selected infanticide, or cannibalism, as well as (b) heightened vulnerability to predation on juveniles by wolves, and (c) increased killing of bears by hunters and livestock stewards.

2) I have numerous questions about derivation of the density index. These are listed later. I suspect all can readily be answered by the authors, and that the basic method is sound – an ultra-sophisticed form of population reconstruction.

Nevertheless, I am not quite sure what to make of their statement that:
"We validated the density index using data from standardized observation flights conducted twice annually by IGBST since 1998 in 28 Bear Observation Areas (BOAs). All independent-aged bears (≥2 years old) were counted individually. For females with offspring we only counted the mother. Using BOAs as the sampling unit, we calculated correlation coefficients to test if bear observation rates were positively associated with the density index."
My unease rises from evidence that the population size estimates developed from standardized observation flights are biased by changes in flight durations and in sightability of bears due to increased foraging in open terrain at high altitude for moths and at low altitude in burned areas for plant foods – a concern that extends back decades and is no way specific to the current IGBST team.

The most recent challenges to validity of the flight-based counts were made by Doaks and Culter (2013, 2014). Notwithstanding the rebuttal by van Mannen et al. (2014), something about this controversy should accompany the above statement about validating the density index used in this paper.

3) The authors have no measure of WBP nut supply. So they have used the surrogate index of "horizontal" area of land surface covered by WBP canopy.

Fundamental Flaw: They estimate that area through satellite imagery. Yet they provide no measure of accuracy of the estimate – no measure of how well strength of the reflectance signature indicative of WBP matches actual WBP abundance in each pixel. They provide no information on likelihood that WBP canopy will be mistaken for canopy of other confers, or vice versa. So there is no confidence interval associated with the WBP index values for each grid cell or for each bear.

When I pointed this out in my initial review, they responded:
"That is correct, we do not have confidence intervals for this index. This is no different than not having a confidence interval for an individual covariate such as age, a covariate that has been used without consideration of aging errors in hundreds of papers."

This is a surprisingly disingenuous statement from researchers so qualified in most respects. Ground-truthing has been considered an essential prerequisite for using sat imagery for assessment of grizzly bear habitat dating back to the pioneering studies by the Craighead team. Indeed, assessing methodological error and incorporating it into analyses is fundamental to most "hard" science.

Regarding their analogy to age data: Since when has accuracy of age determination been ignored? Were that not important we would assess age by eye rather than by going to all the trouble and expense of capturing bears, removing a premolar, and sectioning it to count annual rings.

Of course, age is often used as a driving variable in regression analyses, without any measure of uncertainty being attached. This corresponds to the common practice of ignoring uncertainty in most driving variables – at least in the sense of ignoring the assumption underlying (minimum-variance or least-squares) regression that the driving variable is measured without error. However, this is justified by each statistical method's assumption that any error in the independent variable is negligible. When, in fact, there is appreciable uncertainty, those "Type I" forms of regression are technically inappropriate. One should allegedly use "Type II" regression – one form of which is Principle Component analysis.

Whether the form of modeling done by these authors is Type I or Type II is unclear. But the fact remains that unless there is negligible error in distinguishing WBP from other tree species, the whole analysis regarding WBP is garbage that all the sophisticated analyses cannot turn into gold. The same would apply if researchers could not distinguish grizzly bears from black bears or males from females. Surely, there must be some way they can measure reliability of their index.

The authors go on to respond: "Additionally, we note that use of confidence intervals would be applied at the pixel level and any variation in pixel values would be usurped by the fact that we summarized pixel values across the lifetime activity range into a single value for each year a bear was included in the sample." I question the accuracy of this statement. Suppose that the sat imagery cannot distinguish between WBP versus lodgepole pine or subalpine fir under at least some lighting conditions. How would those errors disappear in the manner they suggest?

Until the authors can provide empirical evidence quantifying the reliability of their imagery, the paper will not warrant publication.

4) In their response to my initial review, the authors stated (p. 5) "…the relative strength of association [by WBP-Index vs. N-Index] with changing vital rates [VRs] would be indicative of [which] factors [WBP or N] that may be acting more strongly on a particular population." [bracketed info added by me]

My initial review explained the hazard of that assumption, namely because the strength of association is also influenced by noisiness of data, by relative amount of variation in each variable, and by sensitivity of VR to each unit variation in WBPI vs. NI.

Their current draft reports that individual bears experienced densities ranging from 0 to 29.2 (mean 13.9, SD = 5.6; canopy coverage declines ranged from 0 down to -0.38; mean = -0.022, SD = 0.050. Those correspond to %SDs of 40% for NI and 227% for WBPI.

For further information the authors referred readers to Figure S3. Unfortunately, I was not able to download that Figure. Although it is labeled as being about 25 MB in size, after 4 hrs of downloading and reaching 400 MB in size, the download was still not complete. Apparently the file is corrupted.

In any event the issue of relative variance seems to have been adequately addressed. But that is not yet true for relative accuracy and noisiness of data on WBPI vs. NI. That is absolutely critical to credibility of this paper.

5) Had their results for each vital rate (VR_i) relative to their WBPI and NI been expressed in an equation of the form

$$VR_i = f_1(WBPI) - f_2(NI) + (covariates)$$

data for the ranges of both WBPI and NI could have been used to assess the relative amounts of change in VR attributable to WBPI and NI for any given combination of changes in WBPI and NI, either to test for consistency with past observations or to predict future impacts of continued change in WBPI or NI.

If the “true” coefficient F_1 for WBPI is relatively weak, such that it takes a lot more change in WBI than in NI to change VR by a given amount, the WBI “signal” is likely to be obscured by noise, producing an low reliability estimate f_1, as indicated by wide CI and low partial correlation coefficient – which the authors did not reveal for WBI or NI for any of their statistical models.

In any event, the authors did not express their findings in the above form, creating doubt about validity of their conclusion that WBP decline has had negligible effect on vital rates.

6) As noted in my initial review**:** Had the WBPI been strongly correlated with one or more vital rates, that might have been interpreted as indirect evidence that the WBPI is indeed highly correlated with actual abundance of WBP canopy cover. However, the apparent lack of correlation between any WBPI vs. *any* vital rate adds to skepticism about validity of the WBP index.

Furthermore, I stated: “Where it is possible to show a strong correlation between vital rates vs. an environmental factor (e.g., food supply or population density), one can reasonably infer that this reflects strong influence by that factor. However, the converse is not necessarily true.”

The authors responded.
“We appreciate this point, however, we designed our study to assess whether there was more support for an association of changes in vital rates with a major change in a high-calorie resource versus changes in bear density and simply found more support for the latter effect. We were extremely careful not to suggest a cause and effect and made it clear to the reader that we observed “associations”.

Granted, one can always say that statistical analysis reveals just associations, not cause and effect. However, readers commonly interpret statistical results as if they did represent cause and effect. So this distinction should be stated in the Discussion, lest readers miss that point earlier in the paper.

The authors’ response to my initial review stated: Our primary food resource of interest was whitebark pine because managers wanted to know whether this resource alone could be associated with the observed slowing of population growth. Our hypothesis was that if whitebark pine is a critical food resource for grizzly bears, the substantial decline of whitebark pine would show a relationship with changing vital rates.

I would be surprised if many managers really want to know about associations, rather than about causation. Managers typically want to be able to anticipate how a population will respond with vs. without any given management action – e.g., whether decline of the whitebark pine tree resource is likely to jeopardize viability of this population over the foreseeable future, with vs. without continued management by the federal government vs. by the states. They also want to be able to anticipate potential population responses to sport harvest if delisting occurs. Hence, managers need to be told unambiguously that the results of this paper do not help them answer those questions. They should not be mislead or have to guess. Strangely, the current version of the paper doesn't even address the whitebark pine decline issue in its "Management Implications" despite the fact that financial support for this research has been justified by the needs of managers.

I cannot agree with the authors' apparent abdication of responsibility implied by their rebuttal statement: "How managers intend to use the information from our ms. is entirely their decision."

7) In their response to my initial review, the authors state:
"The data available on beetle kill indicates considerable cumulative tree mortality over the last decade, therefore it is a logical conclusion that nut availability has declined, especially where tree mortality is highest. Even if trees produced large crops just before dying, this burst of nut production could not persist." … "We used our index of whitebark pine impact as a surrogate measure of change and assumed that a change from live to dead whitebark pine canopy cover (based on NDVI) would reflect a change in availability of pine seeds."

Agreed. As noted earlier, it makes sense at first glance to evaluate the impact of declining WBP tree abundance by measuring loss of WBP canopy cover, which should be related to nut production capacity – although capacity is probably more closely linked to canopy volume than to "horizontal" canopy area – and thus to nuts supply available to bears. For nuts can be available only if live trees are producing them. If one considers a wide enough range of WBP tree abundance, there has to be a positive correlation with nut production and nut supply available to bears.

If much of the effect by declining WBP abundance was exerted at intermediate abundances, then this effect might have been obscured by intervening factors such as variation in the percent of each nut crop that was actually consumed by bears – which would have been a function of the percent of each nut crop that was stored by red squirrels in middens where they could be usurped by bears.

Indeed, there is abundant evidence contradicting the assumption of a strong correlation between WBP canopy area vs. nut availability to bears, which I summarize in my detailed comments.

Hence, even if the WBPI were 100% accurate, it would likely not be strongly correlated with grizzly consumption of nuts, and thus with vital rates, even if nuts were each bear's primary source of energy.
My comments on this in my initial review evoked protests by the authors that:

a) "Since grizzly bears are reliant on red squirrels to obtain whitebark pine seeds, we see grizzly bears as their competitors, rather than vice versa. We do not dismiss the role that other species mentioned here may play in competing for this resource. Our study is not a diet study nor a habitat study; these issues are not relevant with regard to our central research hypothesis."

b) "These are interesting questions but not relevant to the central research questions we addressed in our study. Some of these questions require an entirely different and new study because the data do not exist to answer these questions. Furthermore, we are trying to make inference about a population that exists over >50,000 square km. Thus, it would be nearly impossible to quantify nut availability on the scale this reviewer is suggesting, and we have made no attempt to do so."

c) "the approach for scientific inquiry as suggested by this reviewer is quite different from ours. Whereas we appreciate the idealism behind the comments from this reviewer, in the end we have to work within the confines of studying a species and ecosystem that do not lend themselves to collection of the type of detailed data the reviewer suggests, at least not at the ecosystem level. The central thread of the comments is nutrition-based and that is a fundamental difference with our approach."

d) "Few studies can document these detailed ecological relationships, particularly for species like grizzly bears. This is one reason why our research hypothesis was not based on determining the relationship between vital rates and variation in whitebark pine seed yield over space and time."

e) The reviewer is essentially asking to conduct the "mother of all analyses". These suggestion are beyond the scope of the research questions we are asking.

My apology to the authors for not being clearer – which was partly a result of not fully understanding their method due to the thick curtain of geek speak obscuring their message. I appreciate them parting the curtain at several more points in the current draft so that their basic method is clearer.

In any event, I do not suggest that their "Results" cover all those points, but rather than their "Discussion" must do so. Their Results at least superficially contradict prior studies by their own team (current and former members) on the importance of WBP seeds in the diet of grizzly bears, strongly influencing rates of reproduction, mortality, and population growth. Accordingly, this paper will add more confusion than insight unless it accounts for these discrepancies from the two different scales of analysis. Their Discussion should address these contradictions and try to explain them by identifying several alternative hypotheses and testing each as well as possible with new and old findings. Or, if the discrepancies cannot yet be explained, that should be stated, not left for the reader to guess at. In any event, I think that it is well within the scope of available information to proceed with stating and testing alternative hypotheses to explain the discrepancies. For example:

Hypothesis 1: The WBP index is not correlated with actual WBP abundance strongly enough to reveal any relationship between actual WBP abundance vs. vital rates.

Hypothesis 2: There is a strong relationship between abundances of WBP vs. vital rates; but it is clearly detectable, through the "noise" of intervening factors, only if one compares order-of-magnitude differences in WBP abundance. Among these intervening factors are variations in seed production from year to year, and variations in the percent of seeds produced which are available to bears.

Hypothesis 3: There is a strong relationship between abundances of WBP vs. vital rates, but an even stronger relationship between population density vs. vital rates.

Hypothesis 4: Lack of correlation between WBP index vs. vital rates represents a lack of correlation between abundance of WBP seeds available to bears vs. vital rates.

DETAILED COMMENTS TO AUTHORS

The issue of density dependence in large mammal populations is important, and addressing this in bear populations has been vastly under-represented in the literature. One reason is that most bear populations are subject to such high anthropogenic morality that they never become dense enough for density effects to be recognizable on a broad geographic scale – although they have previously been documented on a more localized scale for this same population (e.g., McCullough 1982, Stringham 1983, 1985). Hence, new information, particularly on the Yellowstone ecosystem – with its unparalleled longitudinal research history – is particularly welcome. This paper has the potential to be an important addition to the literature.

Clearly, the IGBST authors put considerable effort into writing the initial draft, and commendable effort into revising it in response to reviewer comments. There is no bear research team more talented, better funded, or better equipped. Hence, one expects their work to set standards to which other teams can aspire. Hopefully, they can quickly fix this paper's critical flaws so that it will warrant publication.

Statistical Inference

On p. 4, the IGBST authors state: "…when individual-level data on resource loss and population density are available, the relative strength of association with changing vital rates would be indicative of factors that may be acting more strongly on a particular population." My first review of this paper pointed out limitations to validity of that approach. In brief, strength of association depends on (a) relative amounts of variation in WBP abundance vs. population density, and on (b) relative amount of change in vital rates per unit changes in resource supply vs. in population density, as well as on (c) relative noisiness of the data on WBP vs. density. I used the author's own data to show that the relative variation was lower for the WBP index than for the density index; that alone would have tended to produce weaker correlations with WBP than with density. There also appears to be at least an order of magnitude greater amount of noise in the WBP index than in the density index. That too would have tended to minimize correlation between vital rates vs. WBP. The authors have not adjusted their findings accordingly, or even acknowledged that this could bias their findings.

This paper suffers also from a lack of clear explanation of how cumulative uncertainties were handled. There are many steps to the analysis, each with its own range of uncertainty. From the material submitted by these authors, I cannot tell how they avoided generating so much uncertainty in their final model tests that the CI don't range from 0 to infinity.

Models, Hypotheses and Empirical Reality

My initial review described the paper as an exercise in modeling. This impression stems from the seemingly weak connections between empirical reality vs. this study's indices and models. The authors responded with the statement that "(we presume this implies mathematical models) when in fact we used a statistical approach to test the hypotheses."

They also disagreed with my characterization of their analysis as hypothesis built upon hypothesis – apparently thinking that the only hypotheses in their analysis were those that they labeled as hypotheses.

Granted, statistical analysis yielded statistical models for the relative importance of population density vs. whitebark pine abundance. However, their WBP data are also results of modeling, not direct empirical measurements. Variation in each index from one grid cell to the next modeled variation in numbers of bears and in canopy cover by WBP trees within the cells. The link between each index value and the empirical reality it allegedly represents is an "assumption" if it is not being tested, or an "hypothesis" if it is being tested. I will rephrase my point to say that the analysis rests on critical assumptions whose validity has not been demonstrated.

> *"If you are addicted to models, at least do not believe them until all the assumptions can be tested (Bradley 1982) and their predictions verified. There is no such thing in population dynamics as a 'reasonable assumption' without data."* (Krebs 1995:9).

Ideally, the authors can provide enough additional detail to render that concern moot.

The IGBST authors also disagreed with my statement that model outputs are just sophisticated hypotheses. My meaning is that the output of a statistical comparison of alternate models is just a matter of comparing how well each of them describes past events. But the ultimate test is how well each predicts future events. The most predictive model is not necessarily the most parsimonious model or the one with the best AIC score according to historical data.

Statistical analysis is no substitute for thinking through the biology and understanding what statistical analysis does vs. does not reveal. In this case, what do their findings predict about the impact on bears by continued loss of WBP? Is a simple extrapolation of "no effect" reasonable? Over what amount of WBP loss? Over how long a time-span? Over how much change in intervening variables such as abundances of ungulate meat and army cutworm moths? Other lines of evidence suggest that loss of WBP will have a tremendous impact on vital rates and population viability – which is why this paper needs to be fully rigorous before publication.

Whitebark Pine Index

What does It Measure, and How Exactly?

1. The IGBST authors state (p.5) that: "One hypothesis for the slowing of population growth is based on substantial decline of an annually variable, high-calorie fall food source for grizzly bears, seeds of whitebark pine (*Pinus albicaulis*). Previous studies have demonstrated associations between whitebark pine cone production and survival of independent bears (Haroldson et al. 2006), fecundity (number of female cubs/ breeding-age female/yr; Mattson et al. 1992, Schwartz et al. 2006a), movements (Blanchard and Knight 1991), and frequency of management actions (Mattson et al. 1992, Blanchard and Knight 1995, Gunther et al. 2004). Starting in the early 2000s, whitebark pine experienced widespread mortality primarily from mountain pine beetle (*Dendroctonus ponderosae*) infestations and, to a lesser degree, from fire and white pine blister rust (*Cronartium ribicola*) infection (Gibson 2007)."

2. Given the unfeasibility of documenting whitebark pine [WBP] production of cones and seeds across the whole portion of the ecosystem addressed in this study, they have instead used a surrogate of production – or at least of potential production capacity: a WBP index. Unfortunately, just how the index was created, and how appropriate it is are unclear.

3. The authors state (p. 14): "no annual data existed to derive an individual covariate of whitebark pine decline. Therefore we developed a spatially explicit, annual index of whitebark pine impact due to tree mortality." What kind of individual – an individual bear, a WBP tree or an individual grid cell? What is "an individual covariate of whitebark pine decline?"

4. (p.14): … "Normalized Difference Vegetation Index (NDVI) data derived from MODIS satellite imagery (250– x 250-m grid cells) have been used effectively to model insect induced tree morality …" Does this translate to "MODIS satellite imagery (250– x 250-m grid cells) can be used to distinguish living trees from dead ones, specifically those killed by insects, when the imagery is processed by Normalized Difference Vegetation Index (NDVI) software."
   a) How was grid cell size of 250 m x 250 m selected? Is this a function of the satellite's resolution or of something else? For instance, is this a convenient area for analyzing bear density?

   b) What is the pixel size (in m^2) for the satellite imagery? How many pixels are there per grid cell? Does it yield just one WBP value per grid cell, or a separate WBP value for each pixel, which are then added or averaged across the cell?

5. (p. 14) "Our analysis extent followed a whitebark pine distribution map (Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee 2011), which included mixed and pure stands." What is an "analysis extent"?

I was not able to download the authors' 25 MB map of WBP values. However, I have another map, attached below. How closely does their map agree with this one? Are all differences intentional, due to different designs. Or do some represent measurement error?

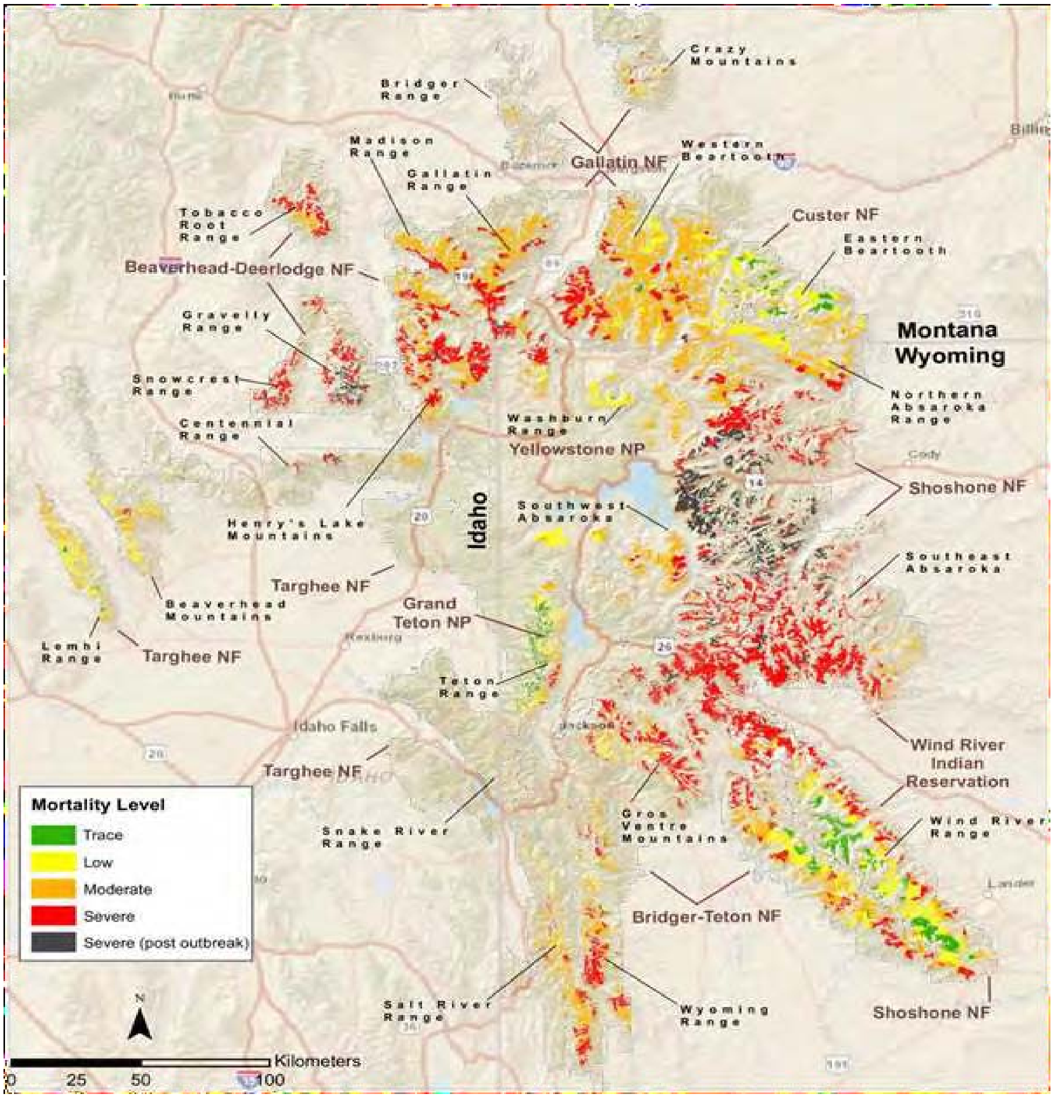


Figure 1. Whitebark pine mortality in and around the Greater Yellowstone Ecosytem.

6) (p.15) "Within mapped whitebark pine, we selected pixels with ≥50% canopy cover"' What was the pixel size – 250 m x 250 m? Was each cell a single pixel or a composite of pixels? If it is a composite, is the reflectance value for each grid cell an average, a sum, or some other index of the values for the individual pixels?

7) How was the "reflectance value" of each grid cell determined?

8) What *is* a reflectance value? Is it a "spectral fingerprint", and if so is the spectrum limited to visible light, or does it also encompass IR and/or UV?

9) How distinct is the reflectance/absorption signature of whitebark pine vs. other vegetative species – e.g., lodgepole pine, Engelmann spruce and subalpine fir? What is the probability of mistaking each species for the other?

10) How does the live-WBP signature differ according to lighting conditions, cloudiness, phonological stage of the vegetation, and other factors? How are these effects incorporated into confidence intervals?

11) What are the confidence intervals for each pixel and each grid cell? How does width of the CI vary along with strength of the signal from each cell? Is the relationship linear or geometric?

12) What does the WBP index for each cell represent? Does the imagery count individual trees or just % of each cell covered by WBP canopy or just total strength of a given spectral fingerprint for each pixel or grid cell?

13) How does the live-WBP signature differ according to lighting conditions, cloudiness, phonological stage of the vegetation, and other factors? For example, how much variance was there among different scans of the same grid cell or pixel over the course of each year, and from year to year? How much of that variance can be attributed to measurement error?

14) How are these effects incorporated into confidence intervals? How are those CIs propagated through successive calculations, such that precision and accuracy of the final index values are not exaggerated?

15) The authors state that they used 2000 as the baseline year, and that the WBP index had to remain stable or decline thereafter. The authors also state that they use demographic and bear location data extending back to 1975. Does this mean that they extrapolated the baseline WBP index for each cell from 2000 back to 1975?

16) The paper is still too full of geek speak, as noted in my first review. Taking another example:

    (p.13) "We spatially reconstructed individual bears' extent of use, as represented in a lifetime activity range, and temporally extruded these activity ranges each year from the age of independence (≥2 years of age) through the known or estimated year of death."
    What is "temporally extruding an activity range"? Does this mean that you extrapolated from what was known about each bear's activity range to estimate size of its range during earlier years for which you lack data on that bear? If so, what were the confidence intervals for each estimate, on average?

17) (p. 15): The authors state: "we used 5 composite scenes (16-days each; late July through mid-October) to calculate a weighted mean annual value of NDVI for each grid cell. We weighted each pixel using the 16-bit binary coded Quality Assurance (QA) science data sets (SDS) included in the MODIS products (Solano et al. 2010). Using the Vegetation Indices (VI) pixel reliability parameter (bits 2–5 of the QA-SDS dataset), we converted the 11 classes of binary data to an interval-scaled (range = 1–11) weighting factor for each pixel in each composite scene. Because our primary interest was to detect mortality of whitebark pine rather than inter-annual variation in

reflectance from other sources (e.g., precipitation), we used a robust piecewise constant signal denoising algorithm (Little and Jones 2011) to reduce annual variation."

Although they have listed these quality assurance procedures, they have not quantified effectiveness of these procedures, much less reliability of the WBPI figures, or how reliability was assessed.

Once CIs have been measured, either cell by cell, or for the entire study area, those uncertainties need to be propagated through all subsequent analyses so that CIs of the final outputs are not unrealistically narrow. Was this done? How?

18) The weaker the correlation between the WBP index vs. actual abundance of WBP, the less relevant any weakness in the correlation between the WBP index vs. vital rates.

19) Nevertheless, even if the WBP index were perfectly correlated with WBP abundance, that would be no guarantee that WBP abundance itself is tightly correlated with the amount of WBP seeds consumed by bears, due to the intervening effects of numerous other variables (Figure 2). One must constantly beware of Type II errors with regard to both statistical significance and biological relevance. Put differently, statistical power is not the only measure of risk of rejecting valid hypotheses on the basis of significance tests.

20) Certainly, the authors are correct that bears can consume seeds only so long as live WBP trees are producing them; and a large decline in numbers of live WBP trees in any given grid must be accompanied by some decline in seed production if one looks over a long enough time interval. Likewise, geographic variation in numbers of WBP trees or in the area of WBP tree canopy is presumably accompanied by variation in seed production. In other words, if the abundance is live trees is much greater at one time or site than another, the abundance of seeds potentially available to bears is also likely to be greater, respectively. But tightness of this correlation at the levels of difference allegedly measured by the WBP index is not necessarily high.

By way of analogy, suppose that a science student was to measure variation in carbon dioxide content in classrooms within a school during winter when all windows were closed -- some rooms containing only a few people, others of which were packed. Suppose the student's measure of impact by CO_2 content was how rapidly the people are breathing – assuming that breathing rate would be directly related to CO_2 content. In any classrooms I've ever been in, no matter how packed, or how poor the ventilation, no one sits around gasping for breath. Presumably, our student would observe the same thing – potentially leading to the conclusion that CO_2 content has no impact on breathing rate. However, you and I know that is untrue. The student wouldn't see people gasping because the CO_2 content wasn't high enough, despite the range of CO_2 levels among the various rooms.

In a somewhat analogous way, not finding a correlation between WBP index values vs. vital rates could be due to not assessing a wide enough range of values.

The narrower the range of WBP values compared, the more likely that the relationship between WBP abundance vs. vital rates is obscured by intervening variables.

21) The IGBST authors rebutted my original comments about the need to interpret lack of correlation between vital rates vs. their WBP index in terms of how WBP actually affect bears. They state: "Whereas we appreciate the idealism behind the comments from this reviewer, in the end we have to work within the confines of studying a species and ecosystem that do not lend themselves to collection of the type of detailed data the reviewer suggests, at least not at the ecosystem level. The central thread of the comments is nutrition-based and that is a fundamental difference with our approach. The data necessary to address the wide variety of ideas, concepts, and new lines of inquiry suggested by this reviewer simply do not exist (it would take substantial funding dollars and 10-20 years to accomplish what the reviewer is suggesting) and many are not directly relevant to the research questions we were asking."

22) I did not judge this paper unpublishable in its original or current form because it lacked data on all the other variables (see Figure 2), but because the authors did not acknowledge (a) the roles of these intervening variables, and (b) that until they are accounted for quantitatively, any lack of correlation between the WBP index vs. vital rates reveals nothing about the relative influence of WBP on vital rates. I suggest that they include a flowchart comparable to Figure 2.

23) My point cannot validly be dismissed on the basis that my approach is nutritional, whereas theirs is not. For nutrition is the primarily link between WBP abundance and vital rates. They imply that one does not need to document the links in order to test for correlation. That is valid. But one does need to document the links in order to interpret strength of correlation, especially weak or negligible correlation. The authors assume that if WBP abundance had as much influence on vital rates as density does, vital rates would be as strongly correlated with their index of WBP abundance as with their density index,. By contrast, I question why one would expect to be able to distinguish the influence of WBP abundance until the masking effects of these other variables are removed?

Furthermore, nearly all of my "nutritional-related" comments are based on data collected in this ecosystem, by the authors and their predecessors on the IGBST team. The problem is that said data have not been integrated into this particular study. Indeed, this analysis appears to contradict prior studies. Hence the need for full explanation.

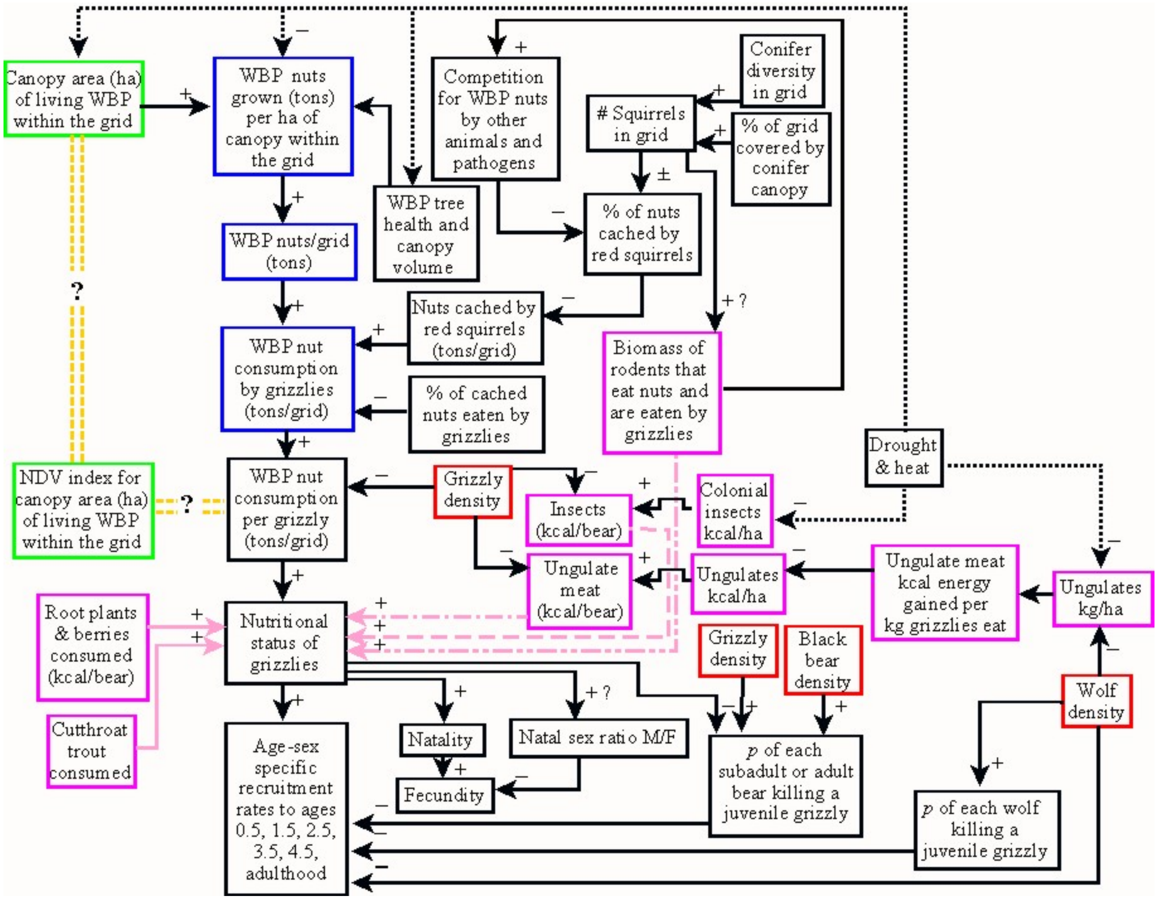


Figure 2. **Factors governing the relationship between the area of WBP canopy cover within each grid cell vs. vital rates for bears inhabiting the cell**. The green boxes represent actual vs. indexed canopy areas (ha) of live WBP trees. How tightly these are correlated is not yet known. Unless it is high, any lack of correlation between the WBP index vs. vital rates is meaningless. The symbol "*p*" in boxes at the lower right signifies probability. All of these relationships, expect perhaps natal sex ratio vs. nutrition, have been documented for bears and have been shown to be influential under at least some (ill-defined) circumstances. So the fact that the authors may lack data to measure their influence in this case does not justify them ignoring those influences when they interpret the correlation, or lack thereof, between their WBP index vs. vital rates. "+" and "-" signs refer to direction of correlation. "±" sign indicates variable or non-linear relationship. Pink boxes refer to alternate food sources.

24) The authors note that density of red squirrels tends to be higher in mixed conifer stands than in pure stands of WBP. This might well affect the percent of the seeds produced that end up in squirrel caches where they are be harvested by grizzly bears. Mattson & Reinhart (1997:30) state that "Densities of active middens were highest in forest types dominated by lodgepole pine … and lowest in forest types dominated by a mix of whitebark and lodgepole pines …".

25) Indeed, both Mattson & Reinhart (1997) and Mattson (2000:41-44) emphasize that bear use of pine seeds is NOT positively correlated with WBP basal area (AKA canopy cover) in any simple way. Use is concentrated in mixed-species stands with

only modest amounts of WBP and also total stand high basal areas. These would be precisely the areas where error in detecting presence (and loss) of WBP would be greatest. Accordingly, the IGBST analysis will be credible only to the extent that they can reliably differential whitebark pine canopies vs. lodgepole pine canopies.

26) According to Mattson, Kendall, & Reinhart (Figure 3), use of pineseeds is related to availability of WBP cones (and thus seeds) in a sigmoidal fashion; likewise use of pine seeds relative to spatial availability (see Mattson 2000, pages 42-44). At the very least these kinds of relations would suggest that any responses by bears WOULD NOT be simple nor linear, and involve many volatile complex interactions with availability of other foods amplified by diet-switching behaviors.

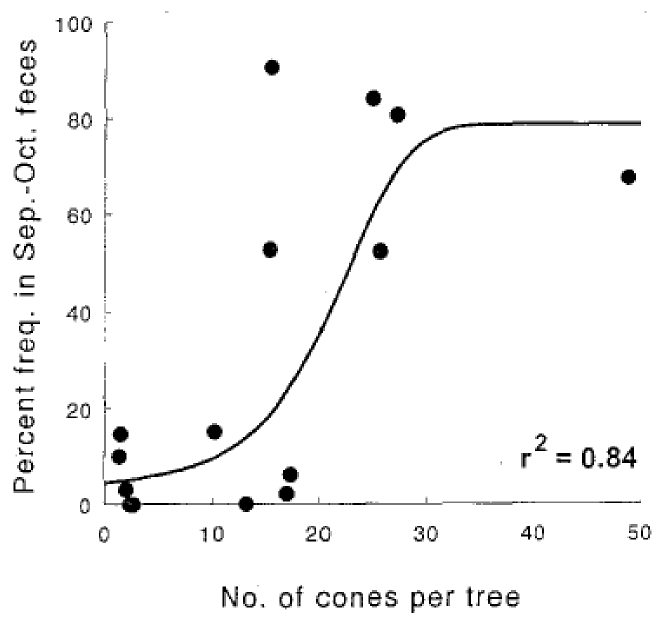
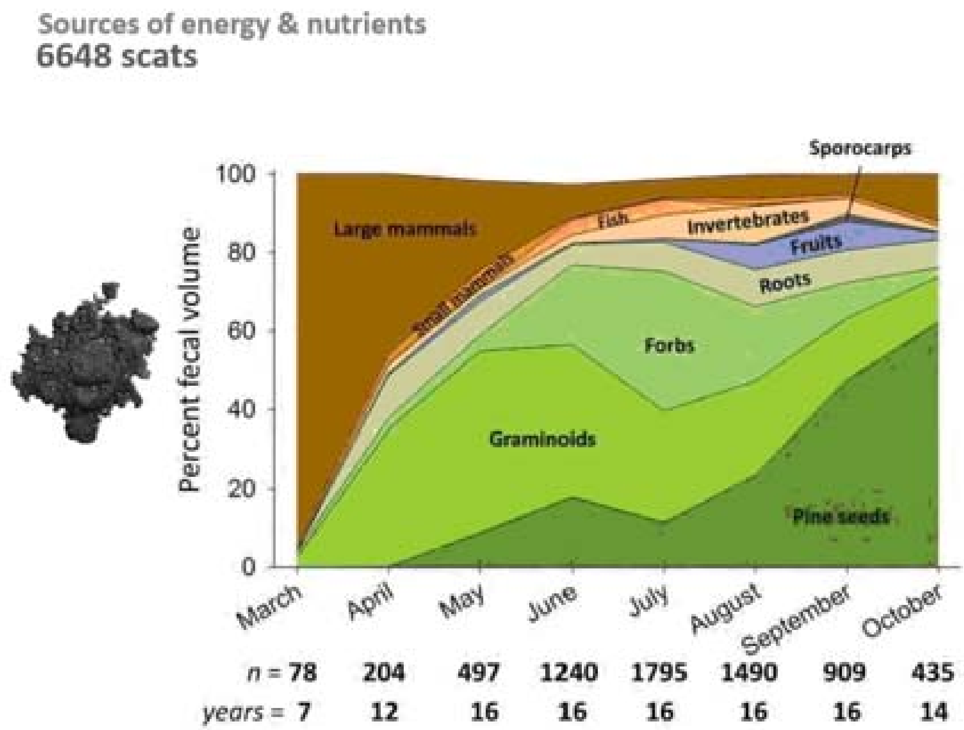


Figure 7-3. Relationship between relative frequency of pine seeds in grizzly bear feces in the Yellowstone ecosystem during September and October and mean number of cones counted per tree on fixed transects in the ecosystem, 1980–1996. Two years were excluded: 1987, because cone counts occurred after many of the cones had already been exploited by seed predators; and 1982, because the sample of bear feces was too small.

27) Vital rates are largely governed by nutritional status, as numerous studies have shown in this and other ecosystems.

28) Research in this ecosystem, dating back to Mattson et al. (1992) and Mattson (2002), clearly shows (a) strong relationships between WBP cone abundance and seed consumption vs. vital rates; as well as (b) the dependence by grizzly bears, especially adult females and juveniles, on WBP seeds as a source of energy – which is commonly the nutrient most strongly limiting natality and recruitment. I have extracted images from one of Mattson's papers and from one of his powerpoints to illustrate my comments. The latter are identified as (c) 2015 D. Mattson.



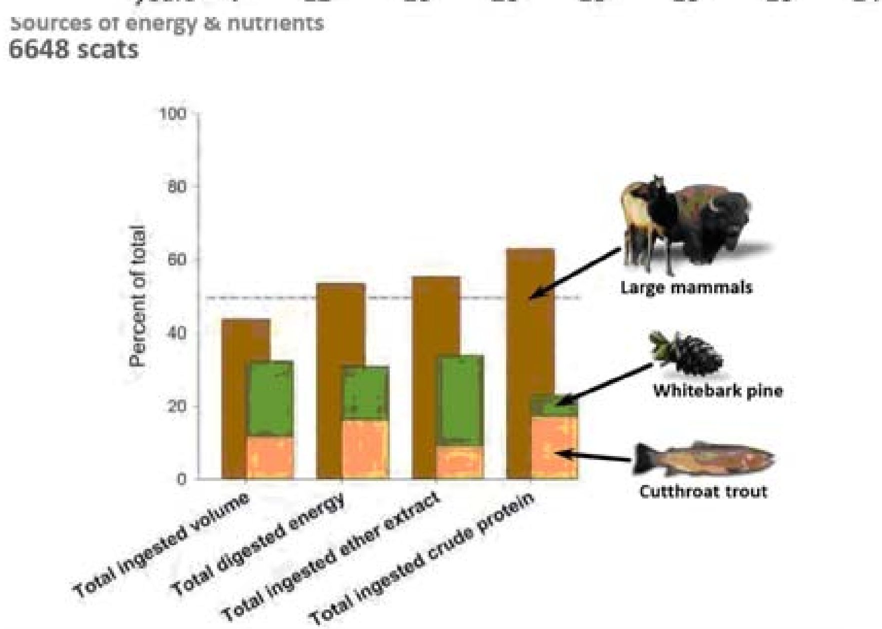


Figure 4. Sources of energy and nutrients for Yellowstone grizzlies © 2015 D. Mattson.

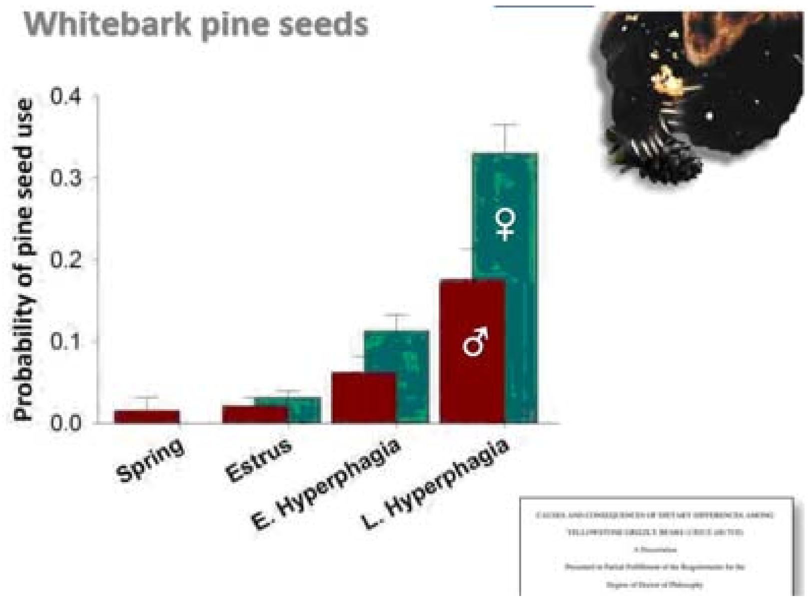


Figure 5. Use of WBP seeds (Mattson 2000; © 2015 D. Mattson).

32) Vital rates tend to be inversely related to WBP seed abundance. During and after years of high seed abundance, rates of reproduction and survival have tended to rise (Figure 6), and population size has tended to increase. During and after years of low seed abundance, the reverse has been true (Figure 7). (Mattson 2000; Felicetti et al. 2003; Pease & Mattson 1999; Schwartz et al. 2006). Lambda also tends to be directly related to nut supply (Figure 8).

Figure 6. Reproductive rate relative to WBP nut abundance © 2015 D. Mattson

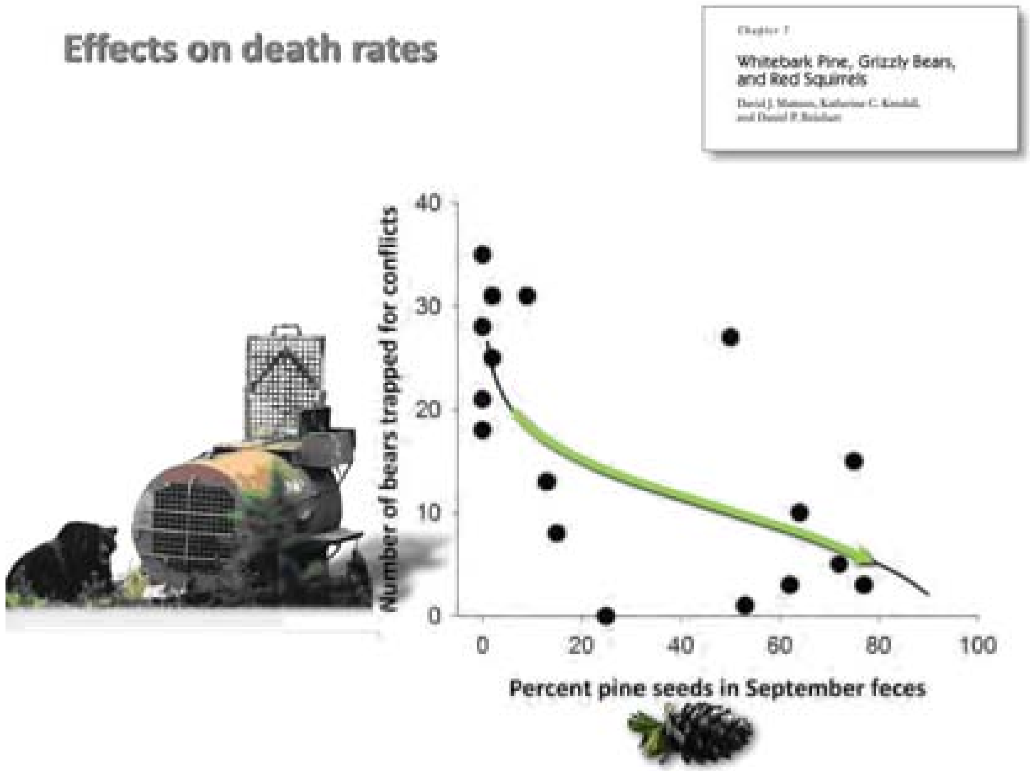


Figure 7. Death rates vs. WBP nut abundance © 2015 D. Mattson

Figure 8. Population growth vs. abundance of WBP nuts. © 2015 D. Mattson

One can thus reasonably assume strong positive correlations between volume of WBP seeds consumed vs. vital rates, especially if one can factor out other influences.

29. The volume of WBP seeds consumed is the amount produced minus the proportion lost to competitors and other factors shown above. The volume of seeds produced depends on volume (not just horizontal area) of the canopy, as well as on tree vigor and other factors. Volume might be estimated from canopy area, if area is indeed what the WBP index was supposed to measure. How would that adjustment affect strength of relationships between vital rates vs. WBP index?

30. As the IGBST has documented, decline in WBP abundance ecosystem-wide has been accompanied by an increasing shift to consumption of ungulate meat from predation (mainly by adult males on elk) and scavenging (mainly of elk and bison, some of whom may have been killed by wolves). On the one hand, in fall, ungulate carcasses may provide as much energy as WBP seeds. But, on the other hand, feeding at a carcass exposes a bear to much greater hazard than foraging on nuts. Cubs are at particular risk (Mattson 2000). This, rather than density per se, might explain declining survivorship by dependent cubs.

31. The IGBST authors have added a statement about wolf predation to their Discussion, dismissing the notion that it is a significant source of cub or yearling mortality. Wolf predation on bear cubs was also largely ignored by Miller et al. (2003) comparing among hunted vs. unhunted bear populations in Alaska. They attributed lower grizzly cub survivorship in Denali and Katmai national parks, than in Black Lakes and another hunted area, to the higher proportions of adult males in the Parks. Yet subsequent observations indicate that adult male grizzly/brown bears kill far fewer

cubs than wolves do, at least within Katmai National Park (Stringham, pers. commun.).

32. As the IGBST has helped document, most of the ecosystem's elk herds have been declining, perhaps due in part to predation by wolves, predation by bears, and a severe several-year drought during the past decade.

Population Density and Vital Rates

1. The authors state (p. 13): "We validated the density index using data from standardized observation flights conducted twice annually by IGBST since 1998 in 28 Bear Observation Areas (BOAs). All independent-aged bears (≥2 years old) were counted individually. For females with offspring we only counted the mother. Using BOAs as the sampling unit, we calculated correlation coefficients to test if bear observation rates were positively associated with the density index. … Assuming that changes in observation rates over time are a product of the number of bears in BOAs, these results support the efficacy of the index to track relative changes in bear density."

2. Whether that method of validation is actually reliable is open to question, given concern that density estimates published elsewhere by this team have raised concern that trends in those estimates have been more a function of trends in (a) sightability of bears and in (b) search effort, than of (c) trends in actual numbers or densities of bears (see Doaks & Cutler 2013, 2014). Sightability has increased due to increased foraging at moth sites (Figure 9) and perhaps in recently burned habitat – both areas where bears are easier to spot. Search effort has increased in the form of more hours spent per year in observation flights, as illustrated here with graphs for the number of adult females with 1st-yr cub litters vs. intensity of observation flights (Figures 10-11).

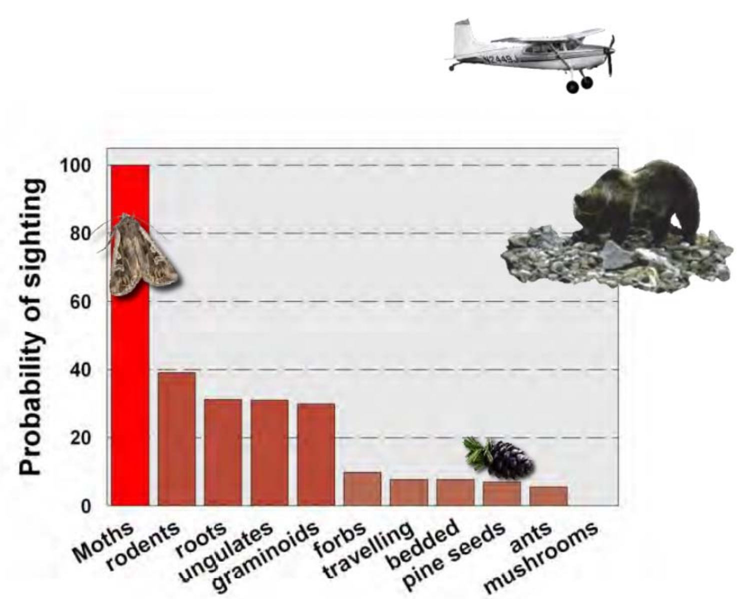


Figure 9. **Relative sightability of bears while feeding on various foods**. © 2015 D. Mattson.

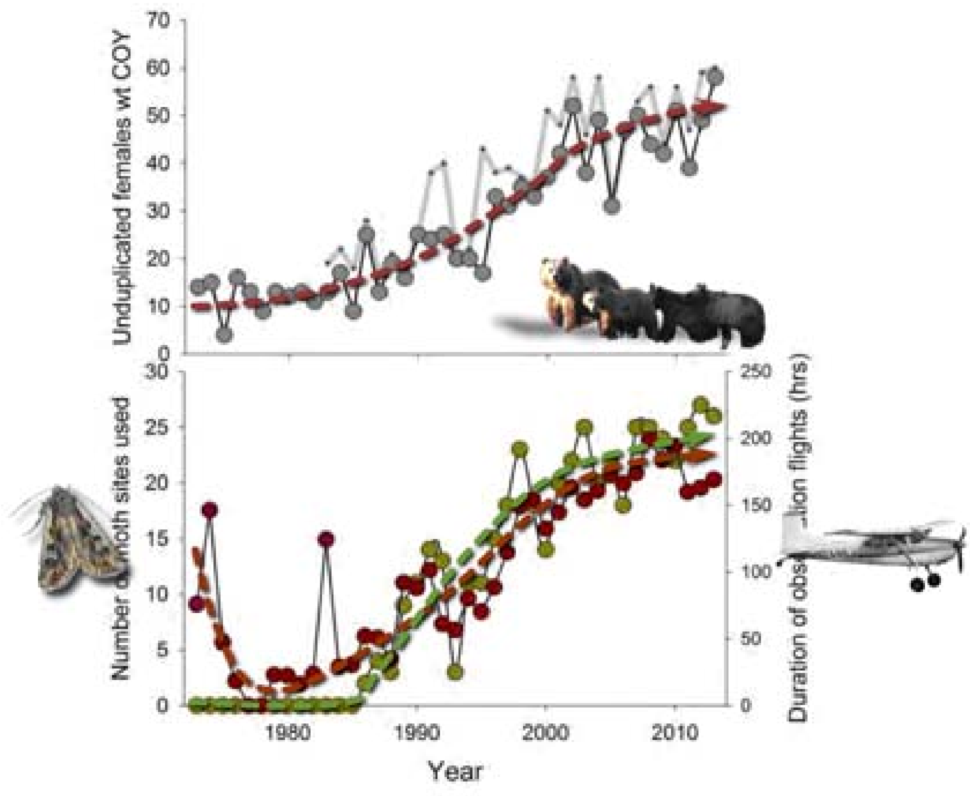


Figure 10. **Count of unduplicated females with COY relative to duration of observation flights, and to increasing sightability of bears due to increased foraging in open habitat, especially while foraging on army cutworm moths**. In the upper diagram, large grey circles represent raw counts; small black dots represent Chao2 adjustments of count data. © 2015 D. Mattson.

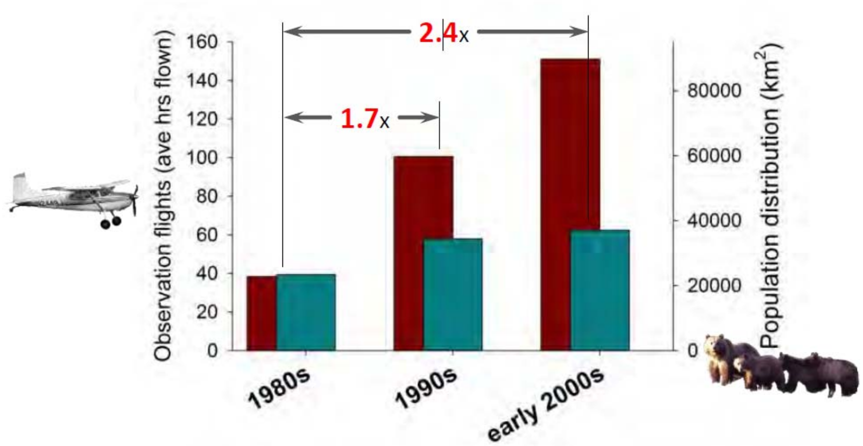


Figure 11. **Relative changes in population distribution (turquoise bars) vs. intensity of observation flights.** The IGBST has stated that longer flight time was necessary to assess increasing distribution of grizzlies. However, given that flight intensity increased far more than bear distribution, did this tend to over-estimate population growth? © 2015 D. Mattson.

3. The authors' description of how they estimated density contains a drop of information on field observations within sea of information about how those field data were manipulated. To anyone not familiar with all of those manipulations – which will likely include the vast majority of readers of the paper in published form -- any certainty about what their density figures mean is quickly lost. So my apology to the authors if I misinterpret.

   As best I can tell, a density value is assigned to each grid cell. That figure is based on the number of bears of ages 2+ years known to have been in that cell at least once. Presence data date back to 1975 and continue forward in time until the last observation of the bear being present. Fair enough.

   An estimate is made of each bear's home range; then the 80 percentile boundary of that range is used as an estimate of core range, whose center is then estimated. An average sized home range, based on the bear's age and sex, is then assigned to the bear.

   The percentage of that range, by area, which falls in each cell which it overlaps, is used to give a density index for that bear for that cell. For example, if a bear A spent 15% of its time in cell X, and bear B spent 50% of its time in cell X, and no other bears spent time there, then the density index value for that cell would be 15% + 50% * 0.65. If there were also 4 other bears, whose percentage usages were 0.40, 0.30, 0.20, and 0.65, the total density index for the cell would be 2.2.

   I suggest that the authors provide examples of their actual calculations, if only in supplementary materials.

4. Do I understand correctly that, aside from the initial capture, and possibly one or more recaptures, virtually all location data for most bears comes from aerial detection, either by eye or radio telemetry? I understand that standardized flights for counting bears were made only twice per year. Is that also true for flights or hikes to document locations?

5. How many times per year during the active season was location sampled? Are the samples distributed evenly over the active season, or clustered during months when WBP nuts are most vs. least heavily consumed by bears?

6. Was the map for each bear's home range based on all of the range it had used over the course of its life, as estimated from all locations documented for that bear? Or was the map of its range altered over time to allow for shifts in activity centers as the bear matured and aged? If a life-time home range is used, was there a trend of increasing home range size as the years passed and more location data were obtained – and as the bear matured and became more dominant?

7. How did you account for the presence of bears which you had not yet captured? Wouldn't failure to do so underestimate density? So too, when data on some known

bears were excluded, did this under-estimate density in the cells overlapping its home range?

8. It appears that your density estimates are minimum figures, and that the extent of under-estimation could vary considerably from one cell to the next. How did you estimate magnitude of uncertainty for each cell, and how was that uncertainty figure integrated into subsequent calculations to determine net uncertainty the final density figure for each cell?

9. Whatever the doubts about estimates for density and bear numbers for the entire ecosystem, this study made its own density estimate for each grid cell. Whether these specific estimates are subject to the same potential biases in search effort is not clear. I again suggest that they provide a few examples of how this calculation was done, using a small subset of their data, as supplementary information. Presumably this could be done in a page or few.

10. Nevertheless, the fact that they found negative correlations between some vital rates vs. their density index suggests that it has some validity.

Vital Rates

1. The Figure S1 legend states. Time trend covariates for vital rate estimation (cub, yearling, and independent survival; and reproductive transition) of grizzly bears in the Greater Yellowstone Ecosystem, USA, 1983–2012. Time trends included a linear trend (T_{lin}), 4 quadratic functions with different starting points (T_{q1983}, T_{q1991}, T_{q1996}, T_{q2001}), 2 sigmoidal trends (T_{sig1} [1995 inflection point], T_{sig2} [2000 inflection point]), 2 time periods (T_{period}; 1983–2001 [period 1] vs. 2002–2012 [period 2]), and no time trend. All values are rescaled to a 0 to 1.0 range.

   What is a "time trend covariate for vital rate estimation"? Are you referring to the pattern of change in each vital rate over time – as represented by the candidate curves shown in this figure?

2. For how many mortalities was the agent of death known? How does the relative frequency of each agent (e.g., anthropogenic vs. intraspecific strife vs. vehicle impact) vary by age-sex class, density, and WBP index?

Density Dependence

1. This paper switches back and forth between size of the population and its density. If geographic range of the population were constant, average density would be perfectly correlated with size. However, given that local densities vary, and the authors are not always referring to the same geographic region within the ecosystem, it would be helpful to readers if they were more specific.

2. This also applies to ancillary data. For example, they report that body fat index for adult females has not declined (a conclusion over which doubt exists). But they do not indicate which females. Are they the same females included in the study reported in this paper? Are they representative of the entire region of habitat addressed by this paper, or do they represent a biased sampling of regions with low or with high per capita food supply?
3. If the population has been declining, or at least not increasing as fast as it has spread out geographically, population density would have declined, on average, across the ecosystem.
4. This occurred at the same time that vital rates have been falling. This should be stated in the introduction. That would set the stage for noting that notwithstanding a decline in average density, local density varies markedly across the ecosystem, as does abundance of WBP. So assessing the effects of WBP abundance vs. density on vital rates must be done locale by locale, rather than as lump sums across the ecosystem.
5. In this paper's introduction, the authors reference Miller et al. (2003) as stating that differences among Alaskan grizzly bear populations in body size and vital rates were most parsimoniously explained by proximity of population size to carrying capacity, rather than by habitat quality [i.e., food supply] per se. Yet they do not take that approach themselves.
6. As noted in my original review, Miller's conclusion is reminiscent of the Verhulst-Pearl logistic model where per capita natality and mortality are governed by proximity of N to K, although it is not absolute but relative proximity i.e., $(K - N)/K$.
7. K in that model is equilibrium density, an abstraction that might exist in nature only where there is a minimum of "stochastic" environmental fluctuation. Granted, if fluctuations occurred around a constant mean, one might calculate a mean K. But in an era of climate change, the mean one obtains depends upon which years one chooses to average. Although one can then refer to a variable or declining equilibrium, that might be just double-talk for non-equilibrium.
8. In any event, K is not equivalent to food supply F, even in cases where F governs K; one cannot expect size or density of a grizzly population to relate to WBP abundance in the same manner as it would allegedly relate to K.
9. Not only are WBP nuts just one kind of food, but food supply is only one of the factors governing K. All other influences on mortality rate also play a role, including infanticide, cannibalism, etc. So although logistic-like models are convenient abstractions for organizing our thoughts about a population, proximity of N to K is not what physically governs vital rates for bears.
10. When Stringham (1984) was faced with this same problem while analyzing density dependence of this same population for 1959-72, he concluded that the key variable is not $(K\text{-}N)/K$ or K/N, but F/N, per capita food supply. Again, even in cases where K is [allegedly] governed entirely by F, K/N would not equate with F/N. This coincides with opinions later voiced by Boutin (1992), Caughley and Gunn (1993), Krebs (1995, 2002), Mduma *et al.* (1999), and Sinclair & Krebs (2002). They suggest that

researchers drop references to *K* and focus on measureable variables such as *F/N* that actually impact vital rates. The authors of this paper might well follow that advice.

11. As Stringham (1984) and his successors also noted, *N* for the population as a whole isn't necessarily the appropriate measure; in some cases, the critical variable is *N* for just adults or perhaps even just adult females or adult males. That was the case in Stringham's analysis, in keeping with abundant evidence that access to food in a bear population can be largely governed by contest competition, in which adult males tend to dominate adult females, who tend to dominate younger bear of both sexes. During the Craighead era, number of adult females in front-country was nearly constant (range 44 – 48 annually), whereas number of adult males in the front-country ranged from 18-55. So variation in adult male abundance – and food supply per adult male -- were the primary drivers of the density dependence at that place and time. Yet this analysis by the IGBST is done in terms of total numbers of bears, encompassing all age-sex classes 2+ years old. Why? Is there evidence that age-sex ratios were relatively constant among grid-cells? How would results differ if only densities of adults, or of just adult males were treated as the driving variable?

12. Multivariate analysis which models vital rates as linear functions of *N* and *F* – i.e., where *N* and *F* are combined by addition or subtraction – is the classical approach.

    For example, regarding litter size: C/L = a*F – b*N

    However, as suggested by Stringham (1984), a biologically more relevant approach might be regressing vital rates on F/N: e.g., C/L = c*F/N.

    Just as the two equations are not mathematically equivalent, their implications for the relative impacts by nutritional status vs. social strife or other density effects would differ

13. Stringham did not have an absolute measure of any food supply, but he did have a relative measure of garbage supply and an index of natural food supply. That natural food index was not justified with the rigor I have suggested is critical for the IGBST authors' WBP index; nevertheless, it was a good predictor of litter size, as its originator Harold Picton first demonstrated. Biological interpretation of Stringham's combination of garbage supply and the Picton index was even murkier. Yet it proved an even better predictor of vital rates. Even tighter correlations were found between vital rates vs. food supply per adult or per adult male.

    Accordingly, the IGBST authors of this paper might test for a correlation between vital rates vs. WBP/N, and use different N's: all age-sex classes; all adults; just adult males, etc.

14. Density per se exerts no influence on reproductive rate. Reproduction is influenced by nutritional status, which is in turn governed by food intake, which is governed in some way by per capita food supply. That in turn depends on both number of bears – especially adult male grizzlies – [as well as on other species] competing for the food, and on the amount of food for which they are competing.

15. Nor does density per se influence mortality rates. Mortality rate can be affected by F/N so low that hunger drives one bear to prey on another, or that makes a bear

critically vulnerable to being preyed upon, whether by another bear or a wolf or puma.

16. If F differs by $\pm$ X% from one time period to another, or from one grid cell to another, whereas N varies by $\pm$ Y%, if X% > Y%, then F will have the most influence on F/N. However, were one to chose a different pair of times or cells to compare, the relative influence by F and N on F/N could be reversed.

    In a comparable manner, the relative influence on nutritional status, and thus on vital rates by differences in density and in WBP nut consumption between any two times or grid cells can vary on a case by case basis. Likewise, even if the variation in density between grid cells in this study had more influence on vital rates than did variation in WBP between cells, this would NOT prove that the increase in density over the past decade(s) had more influence on vital rates than did the decline in WBP tree abundance and productivity.

17. Bears compete for food through both scramble and interference rivalry. Social strife can affect rates of both reproduction and recruitment from infancy to all subsequent ages, at least to adulthood (e.g., Stringham 1984). If adult females with cubs are indeed compensating for declining WBP supply by eating more meat, they are shifting from a food that can be obtained with little risk for cubs to a food with high risk for cubs. Risk rises from aggression by other grizzlies, black bears, wolves, and perhaps pumas. Although a coyote or fox is unlikely to kill a grizzly cub, a small canid's attempt to scavenge can provoke cubs to chase it away from the carcass, and thus inadvertently away from the mother bear, thereby exposing the cubs to other predators – as has been observed in Alaska. A mother attempting to protect her cub against an adult male may be injured or killed, whereupon she may be eaten. Indeed, some males may use aggression against a cub to facilitate predation on the mother.

18. Geographic expansion of the population, combined with increasing reliance on ungulate meat, has been accompanied by increasing conflicts with hunters, despite declining numbers of elk hunters in the ecosystem. It has also increased killing of grizzly bears to protect livestock. Overall, the percent of the population being killed by humans has been rising as WBP seed supply has been declining ecosystem-wide.

19. Historically in this ecosystem, at least since closure of garbage dumps in and around the park, adult males have relied less on pine seeds and more on ungulate meat than have adult females. So declining abundance of WBP is likely to have more impact on adult females and cubs than on adult males. How many years will be required for this shift to be maximized remains unclear.

20. Whichever method is used to estimate bear density, interpretation must ultimately rely on addressing actual mechanisms of influence, be that changes in per capita food supply, increased vulnerability to predation, etc. Both of these latter two mechanisms can be intensified by either or both rising numbers of bears or declining food supply. If this is indeed how rising density is affecting vital rates, then one could not conclude that declining WBP abundance has negligible impact on vital rates.

Discussion

Interpreting the negligible correlation between WBP index vs. vital rates

The Discussion should summarize prior studies on the importance of WBP to Yellowstone grizzlies and explain why this study at least superficially contradicts those studies. When Schwartz et al. (2006) found a weaker correlation between vital rates vs. WBP seed abundance than reported by Mattson (2000), they acknowledged that this might be due to using a cruder index of nut abundance. Yet even the Schwartz et al. index was far less "crude" than using WBP tree abundance, much less an index thereof based on satellite imagery.

I suggest discussing the contradiction in terms of competing hypotheses such as the 4 listed below. Then evidence pro and con each hypothesis can be summarized – somewhat along these lines, followed by predictions deduced from each hypothesis, and evidence pro and con each hypothesis or prediction. For example, what effects would rising density have that declining WBP abundance would not?

Hypothesis 1: The WBP index is not correlated with actual WBP abundance strongly enough to reveal any relationship between actual WBP abundance vs. vital rates.

Hypothesis 2: There is a strong relationship between abundances of WBP vs. vital rates; but it is clearly detectable, through the "noise" of intervening variables, only if one compares order-of-magnitude differences in WBP abundance. Among these intervening variables are variations in seed production from year to year, and variations in the percent of seeds produced which are available to bears.

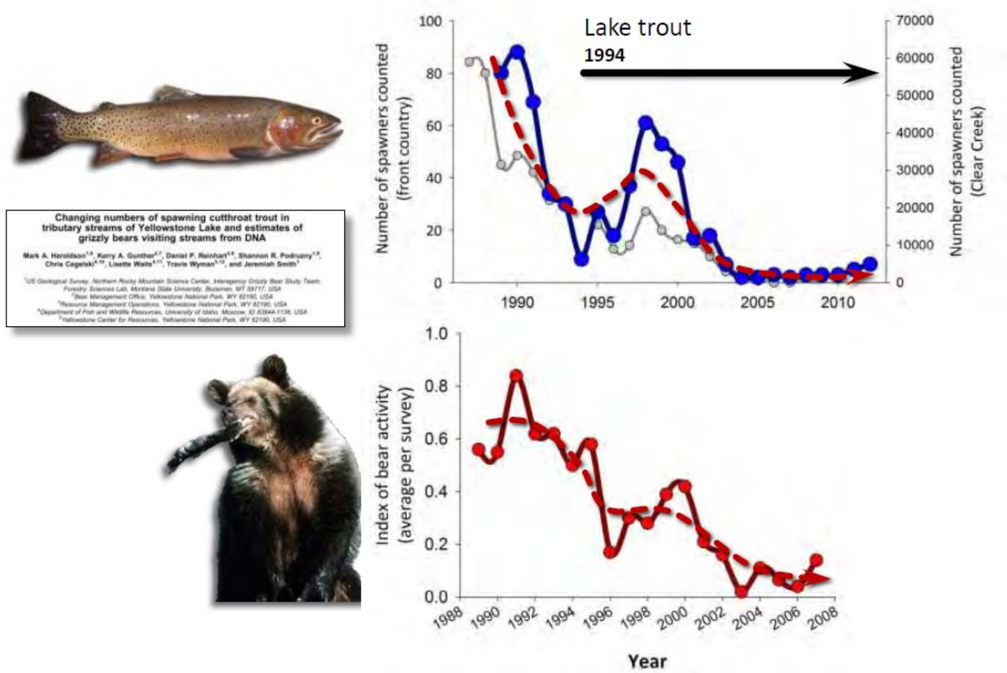
Hypothesis 3: There is a strong relationship between abundances of WBP vs. vital rates, but an even stronger relationship between population density vs. vital rates.

Hypothesis 4: Lack of correlation between WBP index vs. vital rates represents a lack of correlation between abundance of WBP seeds available to bears vs. vital rates.

- On (p. 27) the authors conclude: "current evidence indicates bears showed a functional response to declines in whitebark pine (Costello et al 2014) and cutthroat trout (Fortin et al. 2013), indicating this opportunistic omnivore was able to compensate for the loss of these particular foods."

- Is that an obscure way of saying: Although a strong correlation likely existed in the past, when bears fed heavily on WBP seeds, loss of those seeds has had minimal impact on nutritional status because bears were able to switch to alternative foods.

- If so, the authors might add that, In the past, bears compensated for periodic scarcity of WBP nuts by fishing for cutthroat trout. That is no longer an option for most bears because the trout population has crashed.



- The primary limiting nutrient provided by WBP seeds is energy, in the form of lipid. Two other high-energy foods are army cutworm moths and ungulates. During the course of this study, moth utilization has increased, as have predation and scavenging of ungulates, both wild and domestic.

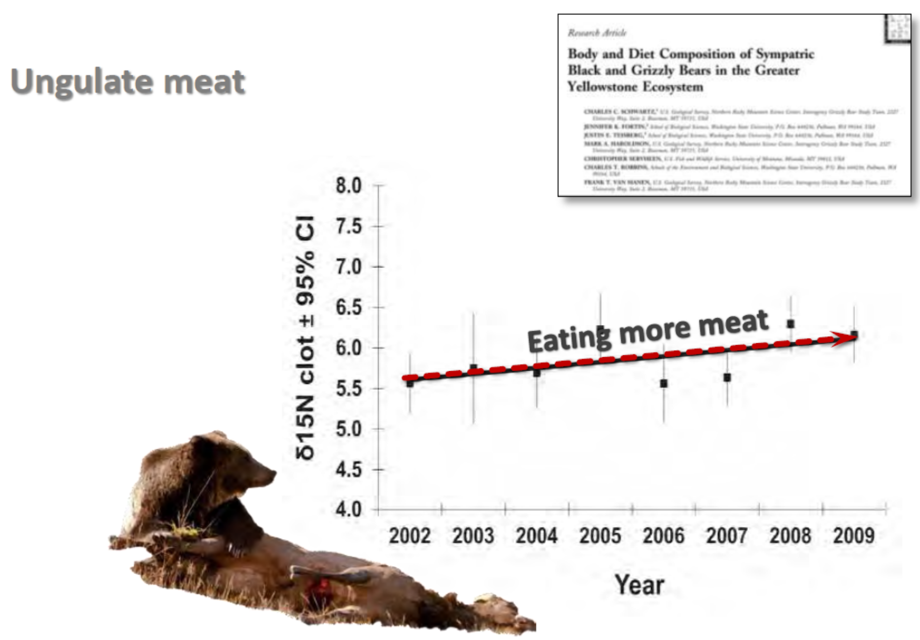


Figure __. **Increased meat consumption since WBP began declining**. © 2015 D. Mattson

Historically, adult males have depended on predation and scavenging more than have adult females, whereas females depended more highly on WBP nuts. Now that nut supply is shrinking, females have become more dependent on meat.

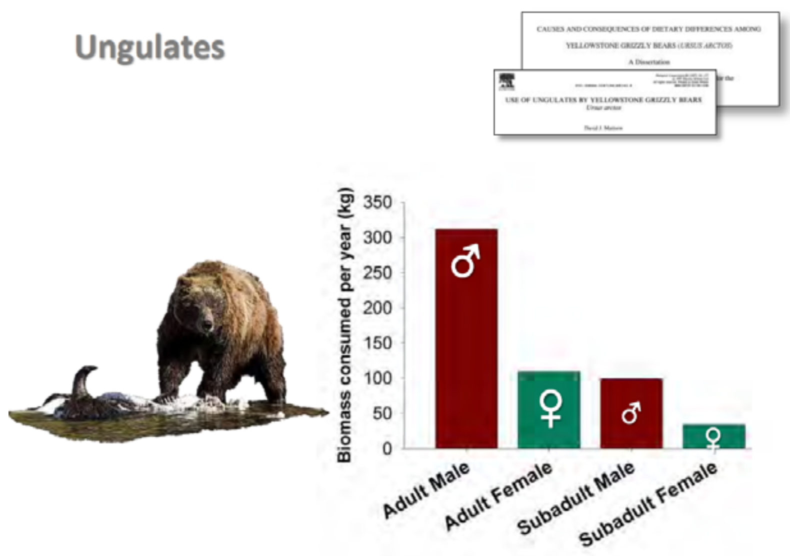


Figure __. **Relative reliance on meat by different age-sex classes of grizzly**. © 2015 D. Mattson

The difference between sexes is particularly great during fall, when bears are most likely to encounter hunters and conflict with them.

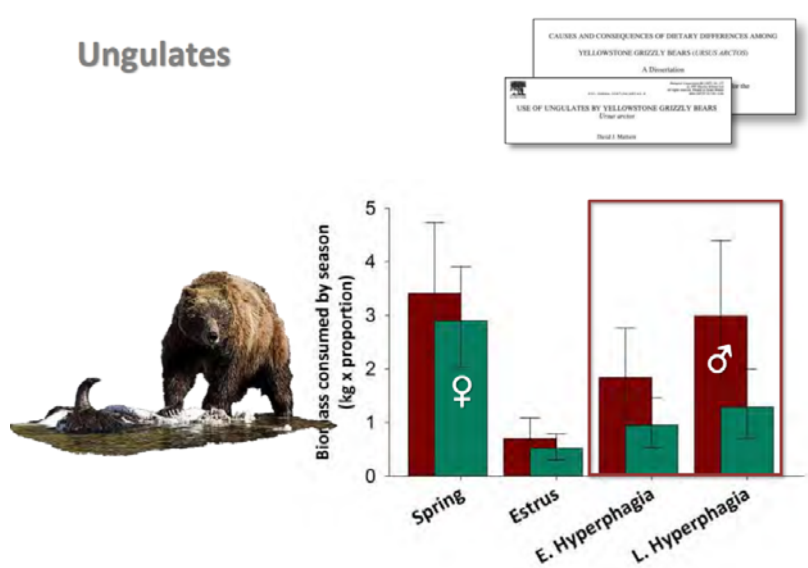


Figure __. **Relative reliance on meat seasonally by each sex of grizzly**. © 2015 D. Mattson

- Foraging on moths may provide a mother bear with roughly as much energy as she previously obtained from nuts, but only the cost of higher risk to her cubs – mainly from other bears that might be cannibalistic. A mother protecting her cubs is at high risk of injury or death. Some adult males prey on cubs and their mothers. Greater reliance on moths could also increase risks to subadults.

- Foraging on ungulates is also hazardous. While feeding on an ungulate carcass, the cubs are at even higher risk than at moth sites. For whereas moth sites are large areas where bears can spread out, a carcass draws competing scavengers to the spot occupied by the mother and cubs. Among the scavengers are not only adult males, but wolves and perhaps the occasional puma. This too could increase risk to subadults.

- These relationships predict that shift from obtaining energy primarily from WBP seeds to moths or especially to meat would be accompanied by an increase in mortality rate for cubs and for subadults, especially singlet subadults.

- Reliance on ungulate meat is likely to also increase risk of being killed by humans, irrespective of a bear's age and sex. Bears hunting elk might have increased encounters with elk hunters, leading to more bears being killed by hunters – as has indeed been documented, despite a steady decline in numbers of elk hunters over the past few decades.

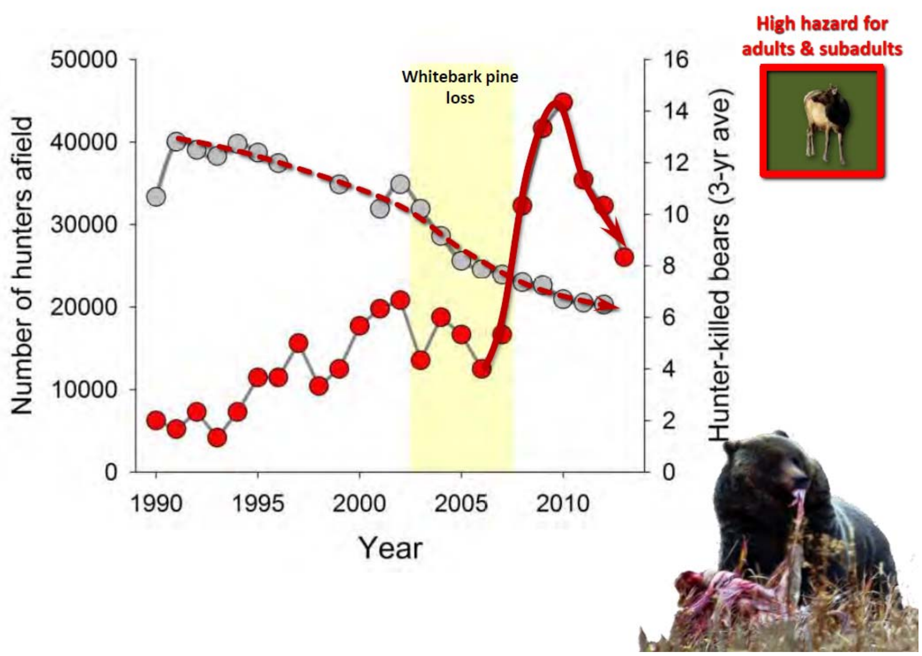


Figure __. Numbers of hunter-killed bears relative to numbers of hunters afield. The decline in hunter numbers is associated with the decline in elk herds and thus in probability of a successful hunt relative to hunt duration.

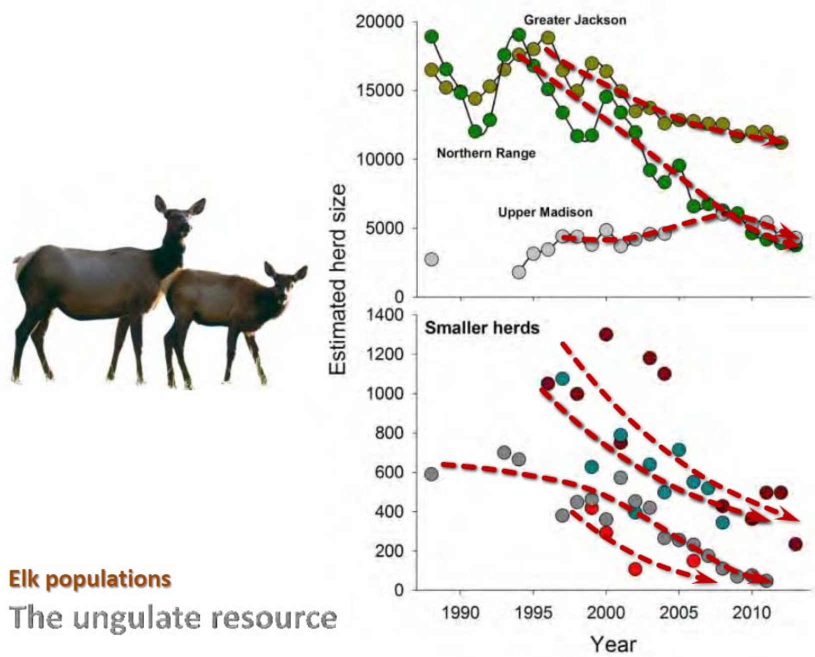


Figure__. **Trends in sizes of the ecosystem's elk herds.**

Bears hunting livestock, or even scavenging dead livestock, are also at higher risk of being killed.

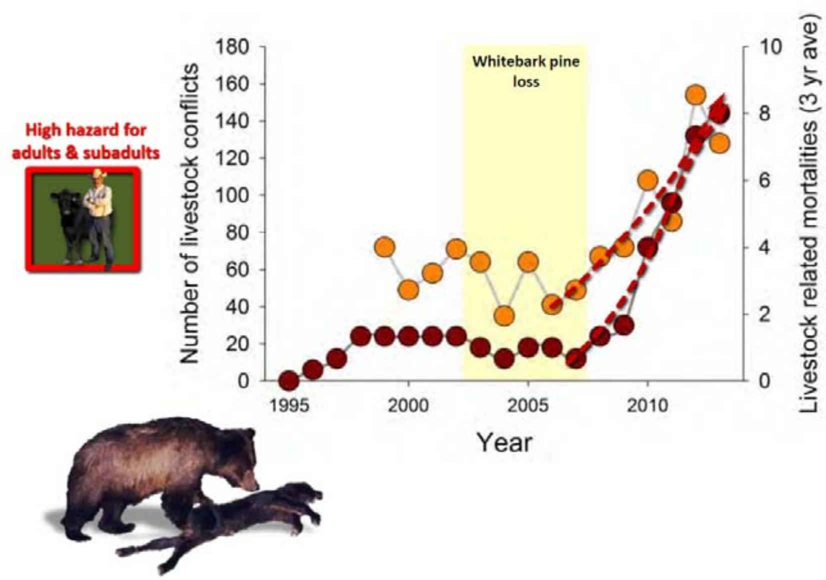


Figure __. **Numbers of livestock conflicts (orange) and of livestock related mortalities (red**). Note that the percent of conflicts ending in mortality seems to have increased since loss of WBP.

- Even if loss of whitebark pine has not resulted in a marked decrease in reproductive rate, it has been associated with a marked increase in mortality rate that is apparently caused by a shift towards reliance on more hazardous food sources, particularly ungulate meat.
- To the extent that rising population density increases food competition, it could also increase reliance on moths and on ungulate meat.
- By what percents has population size increased, and WBP tree abundance declined? If the percentage increase in density outweighs the percentage decrease in WBP, density would presumably have more impact on F/N, and vice versa.
- But rising density can also have effects that declining WBP abundance would not.

Management Implications

- These results suggest that rising population density has impaired certain vital rates. However, the mechanisms through which density has acted remain obscure.
- These results provide no support for the hypothesis that declining abundance of whitebark pine trees accounts for concurrent declines in vital rates. However, this is not equivalent to having evidence that declining vital rates were not partly a function of declining abundance of WBP nuts. For the correlation between the area of WBP tree canopy vs. abundance of WBP nuts can be detected only if the differences in canopy area are very large, perhaps on the scale of an order of magnitude. Effects by smaller differences in WBP canopy area would be obscured by a number of intervening variables.
- The primary effect of rising density is likely to be increased competition for preferred foods such as remaining WBP nuts, army cutworm moths, and ungulate meat.
- Both rising density and declining WBP nut supply could increase reliance on meat, and thus greater exposure to being killed and perhaps eaten by enemies, whether other bears, wolves, or rarely puma.

Which changes are consistent with reduced nutritional status?

Possible effects of declining WBP abundance:

a) Lower nutritional status

b) Switch to alternate foods to maintain status

c) Less time spent in WBP habitat, where risks of encounters and conflicts with humans are low. More time spent where those risks are high.

d) Greater likelihood of preying on or scavenging ungulates, and thus having conflicts with those humans that the bears do encounter.

Any implication that declining WBP nut supply has not jeopardized viability of this population would be disingenuous. By way of analogy, many modern autos are equipped with seatbelts and airbags. If airbags fail during a crash, seatbelts alone might still provide adequate protection during a mild crash. However, this doesn't mean that airbags aren't critical, especially if a seatbelt fails. So too, loss pinenuts might be compensated by other sources so long as the secondary sources are abundant. But when the secondary sources fail, and nuts are no longer available, the population might be in serious trouble.

1. Statements by the authors indicate that they imagine that they are doing pure science for its own sake, and have no responsibility for how their findings are applied by managers. However, the taxpayers and agencies which fund their work are mostly interested in its management implications regarding delisting of the population.

   The authors are correct that the effect of WBP abundance on vital rates was not part of the Court record for relisting of the Yellowstone grizzly by 9th Circuit Court of Appeals. It was merely part of the testimony prepared for the case, but not filed in the end.

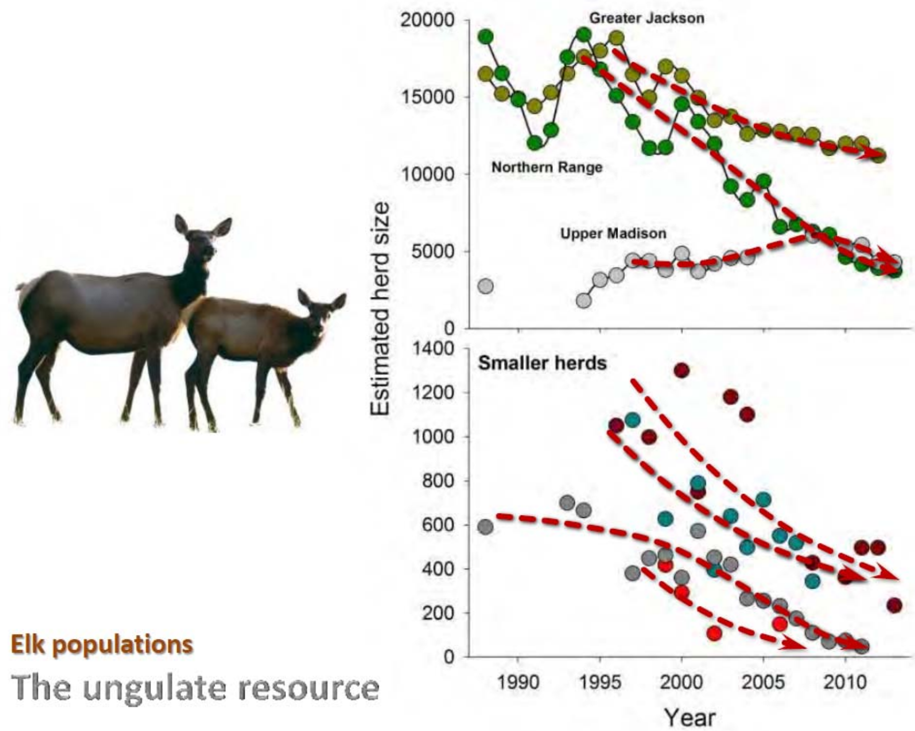
   The authors are also correct that the decline in vital rates was not documented until after the population was relisted. But the decline was predicted in the documents prepared for the hearing, based in part on papers published by Mattson, Schwartz and others of the IGBST. The judge's decision was based on the logical discrepancy between evidence in those papers that WBP is a critical nutrient for grizzly bears in this ecosystem versus the claim made that loss of WBP would not jeopardize viability of the population.

   That exact discrepancy lies at the heart of determining whether this paper is publishable. It cannot be dodged. That these results reveal nothing about the actual influence of WBP abundance on vital rates should be made crystal clear in the "Management Implications." The implications of these findings about the actual role of WBP abundance cannot be assessed until the other variables are documented quantitatively. All that has to be predicated, of course, with documentation of a very high correlation between their index of WBP abundance vs. actual abundance. Otherwise, the analysis is "garbage in, garbage out" – not withstanding the enormous effort made to get the paper as far along as it is, or the expertise of the authors themselves.

2. Although JWM does not allow speculation, the IGBST authors need to find some way of addressing potential impacts by declining WBP abundance on viability of the population. For example, rather than making speculative predictions, they might ask and answer certain questions, such as:

Would a negligible correlation between the WBP index vs. vital rates mean that loss of WBP trees is not likely to jeopardize viability of this population? No. I suggest that their answer to that question include at least the following points.

1. Not only is the shift from WBP to eating more meat a more hazardous way to meet a bear's needs for energy, but the hazard is likely to grow as meat availability shrinks. Most of the ecosystem's elk herds have been on the decline over the past 2 decades.



As this resource shrinks, how will grizzlies compensate now that they can no longer fall back on WBP seeds? The only other food that produces a high energy profit is army cutworm moths. They are potentially vulnerable to both climatic warming at high altitudes, and to pestices.

a. The index itself might not be strongly correlated with actual WBP tree abundance, in which case, lack of correlation is meaningless.

b. Even if the WBP index is valid, it is valid only for the range of variation in the index documented in this study. Continued loss of WBP might be needed before its effects are strong enough to be detectable amid all the effects of other food sources.

c. Even if bears can switch from eating pinenuts to eating meat at this point in history, that may not continue to be the case, given that

* Size of the elk herds are shrinking rapidly.

* Size of the cutthroat trout population has crashed, virtually eliminating that as a backup food.

* Moths continue to be available to bears seasonally; but increased impacts by pesticides or climate change might cripple the moth population too. Foraging on moths increases risk to cubs; foraging on meat increases risk to all age-sex classes, but especially to cubs.

* Berries and roots are are not abundant enough and rich enough in calories to meet bear needs.

Competing bears are not the only hazard; bears eating ungulate meat risk being injured or killed by other wildlife species or by humans – for instance by elk hunters or by ranchers concerned about predation on their cattle. Without whitebark pine nuts to fall back on, to maintain population size or growth when alternative foods are scarce, such scarcity could crash the grizzly population.

Literature Cited

Boutin, S. (1992). Predation and moose population dynamics: a critique. *Journal of Wildlife Management* 56, 1 16-27.

Caughley, G., and Gunn, A. (1993). Dynamics of large herbivores in deserts: kangaroos and caribou. *Oikos* 67,47-55.

Doak, D. F. & K. Cutler. 2013. Re-evaluating evidence for past population trends and predicted dynamics of Yellowstone grizzly bears. *Conservation Letters* 7:312-322.

Doak, D. F. & K. Cutler. 2014. Van Manen *et al.*, Doth Protest too Much: New Analyses of the Yellowstone Grizzly Population Confirm the Need to Reevaluate Past Population Trends. Conservation Letters 7:332-333.

Felicetti, L. A., C. C. Schwartz, R. O. Rye, M. A. Haroldson, K. A. Gunther, D. L. Phillips, and C. T. Robbins. 2003. Use of sulfur and nitrogen stable isotopes to determine the importance of whitebark pine nuts to Yellowstone grizzly bears. *Canadian Journal of Zoology* 81:763–770.

Higgs, M.D., Link, W.A., White, G.C., Haroldson, M.A. & Bjornlie, D.D. (2013). Insights into the latent multinomial model through mark-resight data on female grizzly bears with cubs-of-the-year. *J. Agric. Biol. Environ. Stat.*, **18**:556-577. doi: 10.1007/s13253–013–0148–8.

Krebs, C. J. 1995. Two paradigms of population regulation. *Wildl. Res*. 22:1-10.

Mattson, D. J. Causes and consequences of dietary differences among Yellowstone grizzly bears (*Ursus arctos*). Dissertation, University of Idaho, Moscow, Idaho, USA.

Mduma, S. A. R., Sinclair, A. R. E. & Hilborn, R. 1999 Food regulates the Serengeti wildebeest population: a 40 year record. *J. Anim. Ecol.* **68**, 1101–1122.

Miller, S. D., R. A. Sellers, and J. A. Keay. 2003. Effects of hunting on brown bear cub survival and litter size in Alaska. Ursus 14:130-152.

Peters, R. H. (1991). A Critique for Ecology. Cambridge University Press: Cambridge.

Pease, C. M., & D. J. Mattson. Demography of the Yellowstone grizzly bears. *Ecology* 80:957-975.

Schwartz, C.C., M. A. Haroldson, G.C. White, R.B, Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen. 2006. Temporal, Spatial, and Environmental Influences on the Demographics of Grizzly Bears in the Greater Yellowstone Ecosystem. *Wildlife Monographs.*

Stringham, S. 1984. Responses by grizzly bear population dynamics to certain environmental and biosocial factors. PhD. Dissertation, U Tennessee, 495 pp.

van Manen, F.T., Ebinger, M.R., Haroldson, M.A., *et al*. 2014. Re-evaluation of Yellowstone grizzly bear population dynamics provides false insights: response to Doak & Cutler. *Cons. Lett.*, **7**, 323-331.

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1 October 2016
Additional Comments by
Stephen F. Stringham, PhD

On the US Fish & Wildlife Service proposal to remove grizzly bears in the Yellowstone ecosystem from the list of endangered and threatened wildlife protected under the US Endangered Species Act (ESA);
Federal Register 81(48): 13174-13227, Docket FWS-R6-ES-2016-0042 and Related Materials

On 30 September 2016, I submitted a cover letter and 3 attachments as the first installment of my comments on proposed delisting of the Yellowstone grizzly bear (Tracking #1k0-8s7c-klty) Those 4 attachments are listed below.

Part 1 (30 September 2016) Attachments:
a.Stringham pre-publication peer review of vanMannen et al 2015 - Part 1.pdf

b.Stringham pre-publication peer review of vanMannen et al 2015 - Part 2.pdf

c.Habituation & Hunting Yellowstone Grizzlies 2016-9-30.pdf "Would Hunting Yellowstone Grizzly Bears Reduce Risk of Attacks on People or Livestock?"

I also included by reference all comments which I submitted to the FWS for proposed delisting of the Yellowstone grizzly in 2006. Three of my 2006 documents are attached here. Much of the material therein is still relevant to the 2016 delisting proposal. Also included here is a copy of my professional resume.

Parts 2-4 (1 October 2016) Attachments
Part 2.Flaws in a Core Argument of the 2006 FWS Delisting Rule
Part 3.2006 Comments on Keating's Chao2 Method of Extrapolating from Counts of Females With COY To Estimate Total Females With COY
Part 4.What is the Yellowstone DPS and HOW MANY GRIZZLY POPULATIONS ARE WITHIN THE pDPS?
Stringham resume

Sincerely,
Stephen F. Stringham, PhD, Director