GRIZZLY BEAR EMIGRATION AND LAND USE: AN INTERDISCIPLINARY CASE STUDY OF THE GREATER YELLOWSTONE ECOSYSTEM

by

Craig L. Shafer
A Dissertation
Submitted to the
Graduate Faculty
of
George Mason University
in Partial Fulfillment of
The Requirements for the Degree
of
Doctor of Philosophy
Environmental Science and Public Policy

Committee:

____	Dr. E. C. M. Parsons, Dissertation Director
____	Dr. Lee M. Talbot, Committee Member
____	Dr. Thomas L. Lovejoy, Committee Member
____	Dr. James C. Kozlowski, Committee Member
____	Dr. Albert Torzilli, Graduate Program Director
____	Dr. Robert Jonas, Department Chairperson
____	Dr. Timothy L. Born, Associate Dean for Student and Academic Affairs, College of Science
____	Dr. Vikas Chandhoke, Dean, College of Science
Date: __________________________________	Spring Semester 2013 George Mason University Fairfax, VA

Grizzly Bear Emigration and Land Use: An Interdisciplinary Case Study of the Greater Yellowstone Ecosystem

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at George Mason University

by

Craig L. Shafer
Master of Philosophy
George Washington University, 1983
Master of Science
George Washington University, 1979
Bachelor of Science
University of Maryland, 1979

Director: E.C.M. Parsons, Associate Professor
Department of Environmental Science and Policy

Spring Semester 2013
George Mason University
Fairfax, VA

DEDICATION

To My Parents

ACKNOWLEDGEMENTS

I thank my father for instilling in me an appreciation for the American West, for thinking of federal land management as an honorable endeavor and for encouraging me to pursue higher education. I thank my mother for teaching me all about human virtues and practical life wisdom. I thank my sister, Judy Anne Shafer, for critically reading all these draft chapters. I thank Dr. Christine Schonewald for being a sounding board for all my ideas related to this research and for buoying me up during the many times when I was having misgivings about my research question.

I thank my Committee. Specifically, Dr. Edward Parsons for agreeing to take me on as student, for always being there when I needed advise and encouragement and for serving as my Committee Chair; Dr. Lee Talbot for putting up with me during five of his graduate courses and for not dismissing the idea of me pursuing non-traditional research based on a case study approach; Dr. Thomas Lovejoy for agreeing to be on my committee and seeing value in my research interests and authoring so many conservation biology articles that I read for three decades; and Dr. James Kozlowski for teaching me about natural resources law and for counseling me on various pitfalls to avoid in pursing a higher graduate degree. All these people of course read and commented my various research proposals, were available for my oral research presentation, participated in my comprehensive exam, read my draft dissertation chapters, and were there for my defense.

Some other professors at George Mason University had interests much like my own and were a very positive influence on my thinking and education: George Taylor, Rebecca Forkner, and Dann Sklarew. Sharon Bloomquist went well beyond the call of duty to get me through the maze of graduate school forms and other hoops.

I thank the many dedicated and hard-working federal agency staff who took the time to help me find answers, locate data or point me in right direction. For the USFS, I acknowledge Martha Mousel, Judy Warrick and Steve Robinson, Caribou-Targhee NF; Mary Gonzales, Custer NF; Ken Ostrom, Shoshone NF; Leslie Vaeulik, Missoula; Rob Delice, Anchorage; Andrea Rodriquez, GSTC; and Virginia Kelly, Greater Yellowstone Coordinating Committee. For the BLM, I acknowledge Skip Jones, Targhee NF; Tom Williams, Denver; Teri Bakken, Billings; and Larry Neasloney, Cheyenne. For the NPS, I am appreciative of Ann Rodman, Rob Daley and Christine Lake, Greater Yellowstone Network. Special thanks to Lisa Landenburger, USGS and the Interagency Grizzly Bear Study Team (IGBST) for her many hours of counsel and help. I thank Charles Schwartz and Mark Haroldson, also of IGBST, for guidance on GYE grizzly bear distribution data.

Rebecca Shoemaker, IGBST, provided an invaluable literature compilation. I acknowledge the help of Kevin Fry and Jamie Jonkel, Montana Fish, Wildlife and Parks, for insight into grizzly bear movements.

Many people in the private sector also helped me: Dennis Glick, Future West; Brent Brock, Craighead Environmental Research Institute; Ken Wall, Geodata Services, Missoula; John Dibari, Ecologic, Missoula, and Andrea Tovoila, Wildlife Conservation Society, Bozeman.

I also must thank some people I worked with during my federal career who helped me along the way: Dr. Albert G. Green, Jr., NPS Deputy Associate Director for Science and Technology (retired) and Dr. Harry A. Butowksi, NPS Historian and history professor at GMU, for both seeing promise in me pursuing another graduate degree. I also thank Theodore W. Sudia and Frank H. Ugolini for mentoring a young, inexperienced federal government employee.

Very special thanks to Jing Li and Min Sun, then PhD candidates, Department of Geography and Geoinformation Science, George Mason University, for assistance with GIS mapping. That Department's Assistant Professor Matt Rice allowed me to audit his introductory GIS course and guided me in securing such able GIS help.

I thank Katherine Regan, Columbia University Environmental Law Journal editor–in chief, for seeing merit in the article at Appendix 2, to Adrienne Maxwell, a Columbia University law student for editing it, and the many law students there who checked the references. I thank Patrick Redmond, University of New Mexico law school, for encouraging me to finish that article.

I appreciate Neola Cowen of the Department of Geography, George Washington University, for help in preparing Figure 33. I am grateful to Ryan Hitzeroth for his many, many hours of computer tutoring. I thank Sally Evans of George Mason University for direction on dissertation formatting.

I greatly appreciate the work of the Craighead Environmental Research Institute, Missoula. Montana, whose work I have relied on for guidance throughout this research. I simply examined in more detail one small piece of the Northern Rocky Mountains conservation planning undertaking that they have been doing for decades. Such work by Lance Craighead and colleagues has been cited or reproduced herein including many of their maps and figures.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

GRIZZLY BEAR EMIGRATION AND LAND USE: AN INTERDISCIPLINARY CASE STUDY OF THE GREATER YELLOWSTONE ECOSYSTEM

Craig L. Shafer, PhD

George Mason University, 2013

Dissertation Director: Dr. E.C.M Parsons

The Greater Yellowstone Ecosystem (GYE) is the largest tract of wild land remaining in the lower 48 states however its habitat is fragmented by private land development, roads, mining activity and other human activities. The flagship species in the GYE is the grizzly bear (*Ursus arctos horribilis*) which persists here at this southernmost North American latitude. This GYE subpopulation has been isolated from other grizzly bear subpopulations in the United States for around a century. As a result, some scientists have measured a loss of genetic diversity. Retaining or reestablishing usable habitat connectivity between both the GYE and the Northern Continental Divide Ecosystem in Montana and Alberta and the Selway-Bitterroot Ecosystem in Idaho and Montana would help mitigate this genetic loss. Using Geographic Information System analysis, factors that appear to contribute to how far grizzly bears have emigrated from the GYE in northward direction include large centers of human population and one section of interstate highway. The GYE itself is reviewed: history, resources and threats. Available land use planning options (e.g., county, state, federal, wilderness, buffer zones)

are addressed and the more promising conservation options for the GYE are identified. Off-road vehicles and climate change complete the list of treated topics.

CHAPTER 1: INTRODUCTION

"As the heart of the ecosystem, Yellowstone National Park cannot possibly survive unimpaired if the ecological unit of Greater Yellowstone is allowed to disintegrate. What is good for the Greater Yellowstone Ecosystem will be good for Yellowstone National Park."

Reese 1984: 66

Legislation

Yellowstone National Park (now 899,139 ha or 8,991 km^2) was created by the Yellowstone National Park Act in 1872 (17 Stat 32) because of its scenery and geology. The Act sought the preservation of "all timber, mineral deposits, natural curiosities, and wonders within said park." However, protection of its wildlife was not secure. The President signed the Lacy Act of 1894 (28 Stat 73) to "protect the birds and animals in Yellowstone National Park..." The Act prohibited "all hunting or the killing, wounding, or capturing at any time of any bird or wild animal except dangerous animals when it is necessary to prevent them from destroying human life or inflicting an injury." Today the park is still under threat from a variety of external influences.

Habitat Islands

"The Greater Yellowstone Ecosystem is, in effect, a habitat island surrounded by burgeoning human land uses including intensive agriculture, mining, road construction, clearcutting of timber, and other human caused disturbances, that create impenetrable barriers to dispersal of many wildlife and plant species" (Glick et al. 1991:39). These land uses cause habitat fragmentation and loss, judged the most important factor in the loss of biological diversity (Vitousek et al. 1997). In addition, these outside land uses propagate deleterious flows of matter and energy that generate their own environmental stresses on park biota.

The implications of a species residing in a habitat island are very important to their conservation (Shafer 1990). Habitat fragmentation experiments support the hypotheses that species movement and richness are facilitated by corridors and habitat connectivity (Debinski and Holt 2000). Western North American national park area has long been a topic of research and discussion (Newmark 1986, 1987, 1995). Newmark's research documented that some mammalian extirpations in some western North American national parks was correlated with park area. Many have interpreted this work as implicating habitat size and isolation as the reason for these extinctions. Other explanations, namely outside human population density, have surfaced (Parks and Harcourt 2002). The same correlation existed for small West African parks (Harcourt et al. 2001). Wiersma et al.'s (2004) models identified habitat loss as the primary reason for some mammalian extinction in Canadian national parks. One thing is very clear: species that wander out of protected areas around the world suffer mortalities and even park extirpations (Woodruffe and Ginsberg 1998).

People Magnets

Yellowstone National, and indeed protected U.S. landscapes of all types, attracts people (McGranahan 2008). Approximately 16 million annual visits occur on public land in the Greater Yellowstone Ecosystem (GYE) (Greater Yellowstone Coordinating Committee 2006) (Figure 1).

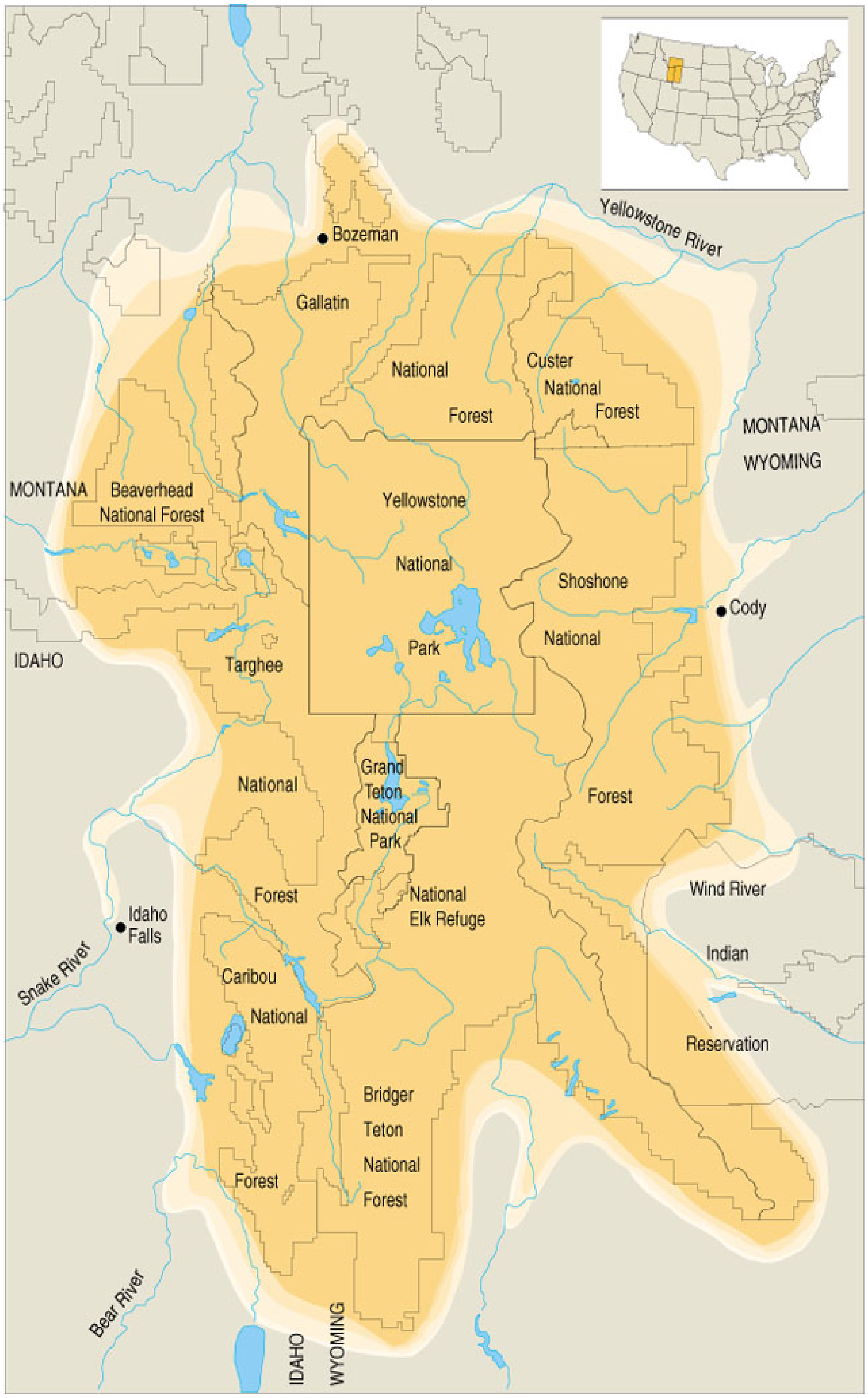


Figure 1. The Greater Yellowstone Ecosystem. (http::// www.wikipedia.org/wiki/File:Greater_Yellowstone_ecosystem_map.jpg)

Many of these people desire to stay and live near these enclaves. This can increase development rates outside some protected area boundaries (McDonald et al. 2007) as documented, for example, at Indiana Dune National Lakeshore, Indiana (Gimmi et al. 2011). Many people wish to live in a pastoral or wilderness setting as often exists near protected areas. However, these people cause environmental impacts. Mapping the global human footprint demands geographic proxies like human population density, settlements, roads and remoteness (Sanderson et al. 2002). This is the same suite of indicators one could use to project adjacent human impacts *to* reserves.

Development Pressures on Protected Areas

Appealing natural landscapes attract development. To provide data to support this assertion, consider the following findings and projections:

- For 57 of the largest U.S. national parks during the 1940s to the present, outside housing density increased 329% which was much higher than the national rate (Davis and Hansen 2011).

- Housing around U.S. national wildlife refuges from 1940s-1990s grew faster than the average national rate for all distances (1-25 km) except during the 1990s (Hamilton et al.)

- From 1940-2000, 28 million housing units were constructed within 50 km of U.S. wilderness areas, national parks and national forests. The housing growth rate in the 1990s within 1 km of these protected areas was greater than the national average (Radeloff et al. 2010).

- During the period from 1970-2030, residential housing development will reduce the amount of buffer zones at the edge of the U.S. core reserves by 11% and the total area of the buffer zones by 22% (Wade and Theobald 2009).

- Scientists predict a total of 17 million housing units within 50 km of national forests, wilderness areas and national parks by 2030: 16 million for national forests, 10 million for wilderness areas, and 3 million for national parks. The number of housing units within 1 km will increase even more rapidly (Radeloff et al. 2010).

Human Population Growth and Federal Land

Counties that contain federal wilderness areas have grown two to three times faster than those without wilderness during the 1970s and 1980s (Rudzitis and Johansen 1991). With the exception of two regions of the United States, counties containing Bureau of Indian Affairs (BIA), Bureau of Land Management (BLM) or US Forest Service (USFS) land produced higher than average human population growth rates. But counties with National Park Service (NPS) land were the only ones which consistently yielded such higher than average human population growth rates nationwide (Frentz et al. 2004). Average percentage human population growth rates in GYE counties with federal land were higher than for counties without it and such rates were highest in the metropolitan West (Frentz et al. 2004).

Economic Drivers

The GYE exhibits natural resource extraction activity on public land that can harm biota in Yellowstone National Park. However, these extraction jobs are not supporting the regional economy as they once did. As of 1994, agriculture, mining, timber harvest, and wood products, and oil and gas development, in total, generated less than eight % of the GYE's economy (Rasker and Glick 1994, cited in Glick and Clark 1998). In the GYE from 1969 to 1992, more than 99% of all new jobs and personal income was not derived from mining, logging, ranching and farming (references in Rasker and Hackman 1996). This comports with broader regional findings. In 2005, only 3% of those employed in the Rocky Mountain region worked in agriculture, forestry, fishing, hunting and mining. In terms of GDP, mining in the Rocky Mountains grew by 25% from 1997-2006, but accounted for only 5% of the region's GDP (Goldstein 2008: 93). The most important economic activity on GYE national forests is recreation (Rasker et al. 1992). In fact, recreation is the most important economic activity on all GYE federal lands (Wilkinson 1992:154).

Outdoor recreation on U.S. public lands, in terms of gross national product, generated $140 billion in 1998 (Laitos and Carr 1999). During 1969-1992, employment and personal income in wilderness counties of northwest Montana increased by 93% and 89%, respectively, while the same factors in resource extractive counties grew by only 15% and 19% (Rasker and Hackman 1996). From 1969-1992, counties with land that had wilderness characteristics (e.g., national parks, wildlife refuges or officially designated federal wilderness) had more employment and real personal income growth than those without wilderness (Rasker and Hackman 1996).

This Research

In spite of lessening amounts of extraction for some resources in the GYE, its biota remains under ecological stress from other sources like private land development. If left without more directed planning, GYE habitat will become increasingly more fragmented. Reiners and Lockwood (2010:11) argued that some scientists believe that "ecology's main task should be to solve actual problems in particular cases..." This research will not seek out general ecological patterns or principles, but rather it will seek more information about the influence of development in the GYE. Put another way, this research might be "judged on its relevance to pragmatic problem solving" (Meijaard and Sheil 2007: 3053, cited in Van Dyke 2008: 439). This approach at learning more about the GYE relies on some aspects of "conservation planning" (sensu Craighead and Convis 2013) as well insights from traditional "land use planning" (sensu Platt 2004) intermixed with some science aspects of conservation biology. As Noss et al. (1997: 207) perceived, "Case studies provide the only way for hypotheses derived from general principles to be tested in any rigorous fashion." In this case, the GYE landscape experiment has been ongoing since 1872.

This study will combine "land change science" (Rindfuss et al. 2004, Turner et al. 2007) coupled with policy analysis. Habitat insularity is a highly interdisciplinary problem that needs more attention (Moslemi et al. 2009) and is best addressed taking an interdisciplinary approach (van Riper et al. 2011). Interdisciplinary research of any kind is a challenge (Tress et al. 2009). Interdisciplinary fact finding and analysis is a task usually not pursued by single-minded disciplinarians.

For the land change science aspect, this study will ask some questions that can be illuminated by Geographic Information System (GIS) technology. For example, have roads/highways and human population centers precluded grizzly bear (*Ursus arctos horribilus*) emigration out of the GYE? This form of mapping could be described as the "human modification" or "human footprint" approach (Sanderson et al. 2002, Leu et al. 2008, Baldwin et al. 2012:275). Does land use influence the emigration of grizzly bears from the GYE? Do official GYE wilderness areas and roadless areas influence the occurrence of roads and mining/oil and gas development activity? These questions and others will be answered in Chapter 14.

For policy analysis, it is recognized that synergisms exist between the scientific, technical, social, economic, legal, organizational, and policy aspects of biological diversity conservation (Clark et al. 1996). Put more simply, they are all interrelated so it becomes hard to discuss one aspect without verging into another. As most conservation biologists now appreciate, “solutions to biological problems lie in social, cultural and economic systems” (Machlis 1992: 161). Meffe and Viederman (1995: 327, quoted in Clark et al. 1996) remarked that “conservation biology...has now matured to encompass economic, legal and political issues.” Even politics cannot be ignored, to the chagrin of some scientists, because “all of federal land management necessarily is political” (Glickman and Coggins 2006: 5-6).

In keeping with its policy analysis aspect, this study will integrate some protected area management insight amidst an enormous array of interdisciplinary facts. “We are drowning information while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely” (Wilson 1998, cited in Hampton and Parker 2011). The need for synthesis is growing in appreciation (Pfirman 2003). As a result of taking a broader look, can we shed light on how to thwart habitat fragmentation in the GYE such as through better land use planning? Incidentally, progressive habitat isolation of the GYE is a wicked problem which “resist[s] being tamed, bounded, or managed by classical problem-solving approaches” (Klein 2004: 4).

In fact, “they are not solved once and forever. They must be continuously managed” (Klein 2004: 5).

As Keiter and Boyce (1991:407) observed, “Yellowstone is the birthplace of the world’s first real experiment with wilderness preservation.” How this experiment will unfold is still an open question.

REFERENCES

Baldwin, R.F., S.E. Reed, B.H. McRae, D.M. Theobold, and R. W. Sutherland. 2012. Connectivity restoration in large landscapes: modeling landscape condition and ecological flows. *Restoration Ecology* 30(4): 274-279.

Clark, T.W., P.C. Paquet and A.P. Curlee. 1996. Special section: large carnivore conservation in the Rocky Mountains of the United States and Canada. *Conservation Biology* 10(4): 936-939.

Craighead, F.L. and C.L. Convis, Jr. (eds) 2013. Conservation Planning: Shaping the Future. ESRI Press, Redlands, California.

Davis, C.R. and A.J. Hansen. 2011. Trajectories in land use change around U.S. National Parks
and challenges and opportunities for management. *Ecological Applications* 21 (8): 3299-3316.

Debinski, D.M. and R.D. Holt. 2000. A survey and overview of habitat fragmentation experiments. *Conservation Biology* 14 (2): 342-355.

Frentz, I.C., F.L. Farmer, J.M. Guldin, and K.G. Smith. 2004. Public lands and population growth. *Society and Natural Resources* 17: 57-68.

Gimmi, U., S.L. Schmidt, T.J. Hawbaker, C. Alcántara, U. Gafvert, and V. Radeloff 2011. Increasing development in the surroundings of U.S. National Park Service holdings jeopardizes park effectiveness. *Journal of Environmental Management* 92: 229-239.

Glick, D., M. Carr and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana.

Glick, D.A. and T.W. Clark. 1998. Overcoming boundaries: the Greater Yellowstone Ecosystem. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 237-256. Island Press, Washington, D.C.

Glickman, R.L. and G.C. Coggins. 2006. Modern Public Land Law in a Nutshell. Thomson West, St. Paul, Minnesota.

Goldstein, B. 2008. Wilderness and Extractive Industries: An Economic Transition in the Rockies. Available at: http://www2.coloradocollege.edu/StateoftheRockies/08ReportCard/ExtractiveIndustries.pdf Accessed December 2011.

Greater Yellowstone Coordinating Committee. 2006. Recreation in the Greater Yellowstone Area: An Interagency Report. Available at: http://fedgycc.org/RecreationintheGreaterYellowstoneArea.pdf. Accessed March 2011.

Hamilton, C.M., V.C. Radeloff, A.M. Pidgeon, P.J. Heglund, W.E. Thogmartin and D.P. Helmes. Housing growth, conservation corridors, and the United States National Wildlife Refuge System (Poster at 24th Annual Congress for Conservation Biology, Edmonton, Alberta, Canada, July 3-7, 2010).

Hampton, S.E. and J.N. Parker. 2011. Collaboration and productivity in scientific synthesis. *BioScience* 61(11): 900-910.

Harcourt, A.H., S.A. Parks, and R. Woodruffe. 2001. Small reserves face a double jeopardy: small size and high surrounding human density. *Biodiversity and Conservation* 10: 1011-1026.

Keiter, R.B. and M.S. Boyce. 1991. Greater Yellowstone's future: ecosystem management in a wilderness environment. In R.B. Keiter and M.S. Boyce (eds), The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage, pp. 379-415. Yale University Press, New Haven.

Klein, J. T. 2004. Interdisciplinarity and complexity: an evolving relationship. *Emergence: Complexity and Organization* 6: 2-10.

Laitos, J.G. and T.A. Carr. 1999. The transformation on public lands. *Ecology Law Quarterly* 26: 140-242).

Leu, M. S.E. Hanser, and S.T. Knick. The human footprint in the West: A large-scale analysis of anthropogenic impacts. *Ecological Applications* 18(5): 119-139.

Machlis, G. E. 1992. The contribution of sociology to biodiversity research and management. *Biological Conservation* 62: 161-170.

McGranahan, D.A. 2008. Landscape influence on recent rural migration in the U.S. *Landscape and Urban Planning* 85: 228-240.

Meffe, G.K. and S. Viederman. 1995. Combining science and policy in conservation biology. *Wildlife Society Bulletin* 23: 327-332.

Meijaard, E. and D. Sheil. 2007. Is wildlife research useful for wildfire conservation in the tropics? A review of Borneo with global implications. *Biodiversity and Conservation* 16: 3053-3065.

Moslemi, J.M., K.A. Capps, M.S. Johnson, J. Maul, P.B. McIntyre, A.M. Melvin, T.M. Vadas, D.M. Vallano, J.M. Watkins, and M. Weiss. 2009. Training tomorrow's environmental problem solvers: an integrative approach to graduate education. *BioScience* 59 (6): 514-521.

Newmark, W.D. 1986. Species-area relationship and its determinants for mammals in western North American national parks. *Biological Journal of the Linnaean Society* 28 (1-2): 83-98.

Newmark, W.D. 1987. A land-bridge island perspective on mammalian extinctions in western North American parks. *Nature* 325: 430-432.

Newmark, W.D. 1995. Extinction of mammal populations in Western North American national parks. *Conservation Biology* 9 (3): 512-526.

Noss, R.F., M.A. O'Connell and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation under the Endangered Species Act. Island Press, Washington, D.C.

Parks, S.A. and A.H. Harcourt. 2002. Reserve size, local human density, and mammalian extinctions in U.S. protected areas. *Conservation Biology* 16 (3): 800-808.

Pfirman, S.L 2003. Complex Environmental Systems: Synthesis for Earth, Life, and Society in the 21st Century: A Report Summarizing a Ten-Year Outlook in Environmental Research and Education for the National Science Foundation National Science Foundation, Washington, D.C.

Platt, R.H. 2004. Land Use and Society: Geography, Law, and Public Policy. Island Press, Washington, D.C.

Radeloff, V.C., S.I. Stewart, T.J. Hawbaker, U. Gimmi, A.M. Pidgeon, C.H. Flather, R.B. Hammer, and D.P. Helmers. 2010. Housing growth in and near United States protected areas limits their conservation value. *Proceedings of the National Academy of Sciences USA* 107 (2): 940-945.

Rasker, R. and D. Glick. 1994. Footloose entrepreneurs: pioneers of the new west? *Illahee Journal for the Northwest Environment* 10: 34-43.

Rasker, R. and A. Hackman. 1996. Economic development and the conservation of large carnivores. *Conservation Biology* 10 (4): 991-1002.

Rasker, R., N. Tirrell, and D. Kloepfer. 1992. The Wealth of Nature: New Economic Realities in the Yellowstone Region. The Wilderness Society, Washington, D.C.

Reese, R. 1984. Greater Yellowstone: The National Park and Adjacent Wildlands. Montana Magazine, Helena, Montana.

Reiners, W.A. and J.A. Lockwood. 2010. Philosophical Foundations for the Practice of Ecology. Cambridge University Press, Cambridge, UK.

Rindfuss, K.H., S.J. Walsh, B.L. Turner II, J. Fox and V. Mishra. 2004. Developing a science of land change: challenges and methodological issues. *Proceedings of the National Academy of Sciences* USA 101 (39): 976-981.

Rudzitis, G. and H.E. Johansen. 1991. How important is wilderness? Results from a United States survey. *Environmental Management* 15: 227-233.

Sanderson, E.W., M. Jaiteh, M.A. Levy, K. H. Redford, A.V. Wannebo, and G. Woolmer. 2002. The human footprint and the last of the wild. *BioScience* 52 (10): 891-904.

Shafer, C.L. 1990. Nature Reserves: Island Theory and Conservation Practice. Smithsonian Institution Press, Washington, D.C.

Tress, B., G. Tress and G. Fry. 2009. Integrative research on environmental and landscape change: PhD students' motivations and challenges. *Journal of Environmental Management* 90: 2921-2929.

Turner, B.L., E.F. Lambin and A. Reenberg. 2007. The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences USA* 104 (52): 20666-20671.

Van Dyke, F. 2008. Conservation Biology: Foundations, Concepts, Applications. 2nd Ed. Springer, New York.

Van Riper III, C., R. Powell, J.W. van Wagtendonk, G. Machlis, R. Gilipeau, C.J. Riper, and E. von Ruschkowski. 2011. Integrated science and interdisciplinary research for parks and protected areas. In S. Weber (ed.), Rethinking Protected Areas in a Changing World: Proceedings of the 2011 George Wright Society Conference on Parks, Protected Areas, and Cultural Sites, pp. 350-355. George Wright Society, Hancock, Michigan.

Virtuosic, P.M. HAD. Mooney, J. Lichens, and B.M. Melville. 1997. Human dominance of Earth's ecosystems. *Science* 25: 277 (5325): 494-499.

Wade, A.A., and D. M. Theobald. 2009. Residential development and encroachment on U.S. protected areas. *Conservation Biology* 24 (1): 151-161.

Wiersma, Y.F., T.D. Nudds and D.H. Rivard. 2004. Models to distinguish the effects of landscape patterns and human population pressures associated with species loss in Canadian national parks. *Landscape Ecology* 19: 773-786.

Wilkinson, C.F. 1992. Crossing the Next Meridian: Land, Water, and the Future of the West. Island Press, Washington D.C.

Wilson, E.O. 1998. Consilience: The Unity of Knowledge. Random House, New York.

Woodruffe, R. and J.R. Ginsberg. 1998. Edge effects and the extinction of populations inside protected areas. *Science* 280(5372): 2126-2128.

CHAPTER 2: CHRONOLOGY OF AWARENESS ABOUT U.S. NATIONAL PARK EXTERNAL THREATS

"It became evident that in order to make our national parks effective wildlife refuges we must cope with the conditions which affect wildlife outside of the parks as well as within them."

Wright and Thompson 1935: 50

Introduction

The progression of national park and protected area external threat awareness in the United States, and to a lesser degree in the world parks' community, will be examined. The primary perceived threats (external and internal) to national parks which were more frequently reported by less-developed countries included unlawful entry, fire, drought, harassment of animals, removal of animals and plants, and conflicting demands imposed on management. In contrast, the perceived threats often reported by more-developed countries included exotic plants, chemical pollution, legal removal of animals, noise pollution, and mining (Machlis and Tichnell 1985:79). These same authors reported that 24% of the reported threats globally were coming exclusively from outside of the protected area (Machlis and Tichnell 1985: 52). My objective is to raise awareness of the history of national park external threat awareness in the United States and at World Protected Area Congresses.

Threats Terminology

As Burgess and Woolmington (1981) note, the concept of threat is highly anthropogenic, a social metaphor used in a biological context. In terms of ecology, threats are "suspected stresses," and "thus threat [is] roughly equal to perceived (and sometimes imagined) stress" (Burgess and Woolmington (1981: 419, quoted in Machlis and Tichnell 1985:10). Determination of threat demands a nonscientific judgment (Rapport and Regier 1980, quoted in Machlis and Tichnell 1985: 11). However, it did not take long until the concept of "threat" was incorporated into mainstream ecological literature (e.g., Wilcove et al. 1998, Evans et al. 2011). Some authors differentiate threats (= sources) from their impacts. "Threats to wilderness [and protected areas in general] are generally defined as change agents that cause impacts on wilderness resource conditions and values--what causes the impacts--not the impacts themselves" (Dawson and Hendee 2008: 353).

Early Omens: 1880s-1920s

When was it realized that influences outside U.S. national park boundaries could have a negative impact on that park's biota? This is difficult to determine. One possibility was during the 1880s when Congress defeated a proposal by railroad and mining interests to build a track through the northern portion of Yellowstone National Park (Bartlett 1989:

309-314, Sellars 1997:15). Another possibility was the threat of logging when the Yellowstone Park Timberland Reserve was created in 1891 “to protect woodlands adjacent to the eastern boundary of Yellowstone National Park” (Glick et al. 1991: 90). Yet another form of external threat includes poachers and looters. The enactment of the National Park Protective Act of 1894 (28 Stat. 73), or Lacey Act, sponsored by Congressman John Lacey, but long pushed for by Senator George Graham Vest, stopped the killing of Yellowstone game and the despoilment of its thermal features (Bartlett 1989: 317).

As early as 1916, Joseph Grinnell and Tracy Storer stressed that exotic species should be kept out of the parks. They also wanted to bar the entry of dogs, cats, cattle and sheep (Grinnell and Storer l916). The next year, E.W. Nelson, Chief of the Biological Survey, complained that range and forage, which sustained Yellowstone National Park’s Rocky Mountain elk (*Cervus elaphus*) population during the winter, was being depleted by domestic livestock ranched beyond the park’s boundary (Nelson 1917).

By 1920, the NPS Director’s Annual Report mentioned problems stemming from development outside park boundaries (Foresta 1984, cited in Buechner et al. 1992). The American Association for the Advancement of Science passed a resolution that same year which “strongly opposes the introduction of nonnative animals and plants into parks...” (American Association for the Advancement of Science 1925:353).

In 1921, Victor Shelford, chairman of a committee of the Ecological Society of America, spoke about external influences impinging on parks: “Even the national parks must be watched and defended against external aggression” (Shelford 1921: 431). Eight years later, Horace Albright, the NPS’s second director, noted development on national park doorsteps as a “pushing of civilization to the very lines of the parks” (Albright 1929: 507).

George Wright and Colleagues: Scientific Park Policy Blooms

George Wright and colleagues, famous NPS biologists of the 1930s, frequently used the terminology “external influences” (Figure 2). For example, “This matter of external influence incessantly acting upon the faunal resources of a national park cannot be overestimated” (Wright and Thompson 1935: 124). To these biologists, external influences included a wide array of stressors: hunting and trapping of furbearers and large carnivores, livestock grazing, logging, exotic species, disease and hybridization between species after translocations. Mining, oil and extraction, and water and geothermal projects, which were to become prominent in later decades, were not mentioned.

Figure 2. George Wright, Ben Thompson and Joseph Dixon (From Emory and Lloyd 2000).

Wright and colleagues noted a number of national parks were suffering from “external influences” (Wright et al. 1933, Wright and Thompson 1935). For example, livestock grazing was a problem in Bryce Canyon National Park, Utah; Grand Canyon National Park, Arizona; Zion National Park, Utah; Glacier National Park, Montana; Yellowstone National Park, Wyoming, Montana and Idaho, Jackson Hole National Monument, Wyoming; Carlsbad Caverns, New Mexico; Lassen Volcanic and Sequoia National Parks, California and Mesa Verde National Park, Colorado. Hunting and trapping occurred in Yosemite National Park, California, Lassen Volcanic and Mesa Verde.

Lumbering was a threat in Grand Canyon, Lassen Volcanic, Sequoia and Yosemite. Development was a concern at Lassen Volcanic. Hunting, trapping or poisoning were mentioned at Zion, Lassen Volcanic, Rocky Mountain National Park, Colorado and Mount McKinley National Park, Alaska.

George Wright and colleagues voices, though anonymous, were unmistakable in a popular brochure published in 1938: "As civilization impinges upon all boundaries of a park, the wildlife may be forced to live under restricted and somewhat unnatural conditions" (American Planning and Civic Association, circa 1938). During the 1930s, the Ecological Society of America recommended buffer zones around national parks mostly to protect large mammals from poaching (Shelford, 1933). The story of George Wright and colleagues as modern conservation biology trailblazers is outlined in Shafer (2001).

The 1940s-1950s: Science on Hold

There was almost a 30-year hiatus of expressed concern until the 1960s which corresponded to the period when NPS support for science ebbed to its lowest point (Sumner 1983). That does not mean that the need for research or biological expertise was not discussed (Sellars 1997: 149-203) but little of substance happened. By the early 1940s, the federal government was measuring a diminishing water flow into Everglades National Park, Florida (Ackerman et al. 1963: appendix 3). By the late 1940s, NPS began opposing the building of Echo Park Dam on the Colorado River which would have flooded Dinosaur National Monument, Colorado and Utah (Sellars 1997).

The 1960s: International Awareness and the Leopold and Robbins Reports

In 1961, the NPS prepared a booklet under the direction of NPS biologist Howard Stagner entitled *Get the Facts and Put Them to Work* (NPS 1961: 2, cited in Sellars 1997). It said that national parks were “rapidly becoming islands.” The first international forum for national park and protected area scientists, managers, administrators and policy makers occurred in June-July, 1962 in Seattle, Washington. This forum--The First World Conference on National Parks--generated 28 park management recommendations (Adams 1964). Recommendation 7 was preceded by the following statement: “Few of the world’s parks are large enough to be in fact self-regulatory ecological units; rather, most are ecological islands subject to the direct or indirect modification by activities and conditions in the surrounding areas” (p. 378). Finally, external park threats captured international attention. Protected areas are defined as “An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of the natural and associated cultural resources, and managed through legal or other effective means” (International Union for the Conservation of Nature and Natural Resources 1994).

The famous “Leopold Report” (Leopold et al. 1963) was completed at the request of Secretary of the Interior Steward Udall. Udall wanted a blue ribbon committee of wildlife experts to evaluate the Service’s wildlife policies. Besides including the First World Conference recommendations, the report provided examples of park issues stemming from influences outside their boundaries, for example, past livestock grazing near the eastern border of Yosemite and Kings Canyon National Parks, California, might have affected the abundance of bighorn sheep (*Ovis canadensis*). The Leopold Report was adopted by NPS in 1964 (see National Park Service 1970b). Udall asked another advisory group to evaluate the Service’s research activities. Their report, called the Robbins Report (Ackerman et al. 1963), also issued in 1963, warned of changes in land use or economic activity outside national park boundaries (p.xiv). The water supply problem at Everglades National Park, Florida, was highlighted. Other external problems included water flow into Carlsbad Caverns National Park, New Mexico, a dam upstream from Mammoth Cave National Park, Kentucky, the decline of glaciers at Glacier National Park, Montana, and exotic plants in Yellowstone National Park, Wyoming, Montana and Idaho. A supplement to an NPS research handbook (National Park Service 1966**:** I-2) declared that external threats and habitat isolation were preceding hand-in-hand: “The national parks are, in essence, ecological islands...these islands are impinged upon by forces resulting from the increasingly intensive use of bordering lands. Among them are fire, forest insect and disease infestation, exotic plant and animal infestation, stream pollution, predator control, overlapping ranges of domestic stock and wildlife, and the like.” This point was dramatically illustrated at Death Valley National Monument, California. During 1968, water levels in the Monument began declining as a result of agricultural irrigation on adjacent private lands threatening the survival of the Devils Hole pupfish (*Cyprinodon diabolis*) (Risser et al. 1992).

Public awareness of external threats was slowly being fostered by NGO reports. In a postscript to the second edition of *Man and Nature in the National Parks* (Darling and Eichhorn 1969: 85), William Edy said, “The point is that we are witnessing an increasing threat to our national parks that comes from outside the area of their authority and control, and which dramatically affects not only their immediate interests but their very existence.” The perception that national parks were becoming “islands of primitive America” was even noted in official NPS 1968 management policy (National Park Service 1970a: 16). The “external influences” terminology surfaced in writings about protected areas internationally (Westoff 1970: 113).

By 1963, the Glen Canyon Dam was constructed on the Colorado River only 20 miles upstream from Grand Canyon National Park, Arizona. That dam permanently altered the river’s water flow and biotic communities (Johnson and Carruthers 1987). Also by the early 1960s, there was an increasing recognition that Everglades National Park, Florida, was being deprived of upstream freshwater inflow (Kushlan 1987).

The 1970s: NGOs Spread the Word

A task force working under the auspices of the Conservation Foundation criticized the NPS in 1972: “generally we believe the Park Service has been much too tardy, timid and reluctant in identifying and challenging external threats to the parks and in aggressively guarding the parks against these threats” (Strong et al. 1972: 84). This task force recommended that the NPS should designate a “park-influence zone” around each park. They even recommended that the U.S. federal government begin national land use planning.

In 1973 the National Parks Centennial Commission issued a progress report recommending that the NPS “investigate and seek to implement mechanisms whereby cooperative efforts and legal constraints and controls may be utilized to assure that development outside of the parks and adjacent to the boundaries is of a character that does not adversely impact the integrity of the parks themselves” (National Park Service 1973:143).

The Second World Conference on National Parks was held in Yellowstone and Grand Teton National Parks, Wyoming, during September 1972. The issue of external influences and progressive park isolation surfaced there. One participant recommended “buffer areas in cases where incompatible development just across the boundary would compromise the integrity of the park" (Nicholson 1974: 36). A management recommendation was that "compatible land-use practices be implemented outside the boundaries of national parks" (Elliott 1974: 448). NPS Director George Hartzog boldly stated "it is highly important that parks should not be treated as isolated reserves, but as integral parts of the complex economic, social, and ecological relationships of the region in which they exist" (Hartzog 1974: 155).

A 1974 inventory of problems suffered by federal parks as a result of activities on adjacent lands was enlightening (Kusler 1974). Based on inquires made of 130 national parks, recreation areas, parkways and historic sites, the following threats were noted: incompatible development, trespass (including ORVs), litter, destruction of scenic beauty, air pollution, water pollution and extraction, noise and others. The author made reasoned recommendations to protect national parks from the effects of incompatible development on bordering private lands.

The year 1978 was a milestone for national parks threatened by outside influences. Redwoods National Park, California, established in 1968, was expanded ten years later due to logging on private lands adjacent to the park's boundary (Hudson 1979). The land cost the government $1.5 billion (Mackintosh 1991).

The National Parks and Conservation Association inventoried problems on adjacent land by querying national park Superintendents. Residential and industrial developments as well as energy extraction were key concerns (National Parks and Conservation Association 1979 a, 1979 b). The report caused Congress to ask NPS to do a "State of the Parks Report" that was completed in 1980. Almost concurrently, the Conservation Foundation conducted a broader survey of multiple federal land management agencies (e.g., U.S. Forest Service, Bureau of Land Management, Fish and Wildlife Service) to ascertain their relationships with their non-federal neighbors. Adjacent land impacts to national parks included diminishing scenery, water diversion, and air pollution (Shands 1979).

State of the Parks Report 1980: Public and Congressional Awakening

American public awareness of national park "external threats" surfaced in 1980. At the request of Congress, NPS completed the first comprehensive survey of threats to the US National Park System (National Park Service 1980). It listed potential threats in seven major categories: air pollution, water quantity/quality, aesthetic degradation, physical removal of resources, exotic species encroachment, visitor physical impacts, and park operations. More than 50 % of the threats came from outside park boundaries. The report stated "Many previously pristine areas today have become surrounded by and exposed to an ever growing array of incompatible and threatening activities on adjacent lands..." (p.34). The common external threats nationwide included industrial and commercial development, urban encroachment, air pollution and roads. More than 75 % of the threats in this 1980 report were deemed insufficiently documented by scientific data. It instigated regional analysis of the report. For example, Reese (1984) perceived the threats posing the greatest danger to the GYE included oil/gas and geothermal exploration and development, mining, logging, hydropower and reclamation projects, resorts, subdivisions and recreational facilities.

The report was unusually candid for a government document. Once Service leaders realized the negative public attention the report was garnering, they downplayed the seriousness of its findings (Sellars 1997). A 1986 Department of the Interior memorandum instructed NPS to drop the term park "threats" and adopt the more benign descriptor "adverse actions" (Zasowsky and Watkins 1994: 47). The report confirmed Sax's (1980: 106) observation: "You cannot build a wall around the parks and close your eyes to what goes on outside them." It also ended what Sax referred to as the agency's "enclave mentality" (Zaslowsky and Watkins 1994: 45). The public was now involved in agency "affairs."

The following year the NPS produced a plan to help mitigate external threats (National Park Service 1981); however, with the exception of an endeavor to train NPS staff in doing specific resources management tasks, these initiatives were terminated after the arrival of President Ronald Reagan's new Secretary of the Interior James Watt (Cahn 1982). During the days of James Watt, NPS was instructed not to deal with or even talk about many resource issues occurring outside park boundaries. Abating external threats was perceived by some special interest groups as an infringement on private land rights and a preclusion of industry's resource extraction opportunities (Shafer 1999a). The Government Accounting Office (1987) noted that most of the specific initiatives set forth by NPS in 1981 had not been achieved. This period of attempted threats' abatement by NPS was documented in detail (Supernaugh 1994). NPS (1988) presented an even more dismal picture than National Park Service (1980) on the degree that park resources were being impacted and their habitat isolated by adjacent human activities.

Beginning in 1982 and ending in 1992, various pieces of legislation were introduced in the U.S. Congress to thwart external threats to national parks (Keiter 1985, Hiscock 1986). None of this legislation became law due to political pressure exerted by special interest groups (Shafer 1999a).

Other 1980s Events: Activity Abounds

The Third World Congress on National Parks took place in Bali, Indonesia in 1982. By this time external threats were recognized as a serious worldwide problem. One recommendation of the Congress called for action to "reduce the external threats to protected areas" (McNeely and Miller 1984: 769). As a follow-up to this Congress, Machlis and Tichnell (1985) conducted a survey of 135 national parks in 49 countries. The results were summarized two years later: "Stage of economic development [sensu developed versus developing countries] emerged as a powerful variable related to type of threat, its location, and the 'core' of common threats faced by national parks" (Machlis and Tichnell 1987: 155).

By the mid-1980s, specific park threats in the 1980 *State of the Parks Report* were publicized by national conservation organizations like the Audubon Society (Elfring 1985, 1986a). This included pesticide application outside of Dinosaur National Monument, Colorado and Utah; mineral extraction, timber harvest, road construction and oil and gas leasing outside of Glacier National Park, Montana; a planned nuclear waste dump outside of Canyonlands National Park, Utah; water diversion outside of Everglades National Park, Florida; and geothermal drilling, oil and gas leasing, and residential development outside of Yellowstone National Park, Wyoming, Idaho, and Montana. The Conservation Foundation (1985) concluded that the most frequently reported threat was development, but they used the term broadly to include urban encroachment, utility infrastructure, mineral exploration, and logging. This NGO also called for "an inventory of cases in which park boundaries need to be expanded to protect the parks from external activities..." (p. 275-276).

When the Subcommittee on Public Lands of the House Interior Committee of Interior and Insular Affairs held hearings on the Greater Yellowstone Ecosystem (GYE) in 1985, Freemuth (1997) inferred that the members were more concerned about external threats to national parks than the actual focus of the hearing: regional ecosystem management. Congress requested the Congressional Research Service study the GYE resulting in a report a year later (Congressional Research Service 1986). By now external threats to the National Park System were receiving attention in some professional journals (Elfring 1986b, Sun 1985). The Chairman of the Subcommittee on National Parks and Recreation, House Committee on Interior and Insular Affairs, asked the Government Accounting Office to prepare a report. The resultant document was critical of progress made by NPS in monitoring, documenting and mitigating threats (Government Accounting Office 1987). Narratives on world parks observed "all manner of dynamic fluxes" moving across park boundaries (Myers 1984: 658, cited in Fall 2002). Progress in modeling the threats issue was underway by park scientists. Schonewald-Cox and Bayless (1986) proposed their "boundary model" based on personal experience with U.S. National Park System external threats. The boundary model focused on boundary permeability and introduced the concept of a generated edge.

Problems in specific units of the National Park System independent of the "threats reports" were themselves gaining public attention. The impacts of the Glen Canyon Dam on Colorado River riparian ecosystems in the Grand Canyon National Park, Arizona, became a concern (National Research Council 1987). From 1979 to 1981, air pollution was being measured in Southwestern units of the National Park System (Ostrov 1982). In the East, an air pollution detection device was established in the early 1980s at Great Smoky Mountains National Park, North Carolina and Tennessee, and monitoring has continued since then (Shaver et al. 1994). NPS began experiments in 1987 to monitor haze in Grand Canyon National Park, Arizona (National Research Council 1990) though attempts to monitor for visibility started in 1978 (Shaver and Malm 1994). Park managers in the 1980s became concerned about private land development moving closer to the boundaries of Saguaro National Monument, Arizona (Shaw 1996).

A 1988 report by the National Parks and Conservation Association (NPCA) stated “The National Park Service should immediately begin an evaluation of lands around parks which have significant potential for adversely affecting park resources....If a park ‘zone of concern’ were established around a park, mapped and well publicized, potential users of these adjacent lands would know beforehand that the rules were somewhat different within the zone” (National Parks and Conservation Association 1988:23).

The NPCA and NPS appointed an independent commission to prepare a report that would update the Leopold Report (Leopold et al. 1963). The resulting Gordon Report (1989) stressed that park Superintendents need to partner with diverse individuals and organizations in order to manage ecosystems that extend beyond park boundaries.

The 1990s: Activity Continues

In 1990, the NPS Director concluded that the largest threats facing US national parks came from outside park boundaries (Ridenour 1990, cited in Buechner et al. 1992). One NPS workshop produced recommendations on how to integrate parks into the larger regional landscape (Dottavio et al. 1990: 69-74). Another report one year later by the NPCA declared that development outside park boundaries was among the five major threats facing the National Park System (National Parks and Conservation Association 1991). J. Kenney (1991), writing in the Association's magazine, listed the most significant external threats to parks: oil and gas exploration and extraction, geothermal exploitation, hard-rock mining and logging on adjacent agency lands, urban encroachment and oil and gas development on state and private lands, and air pollution. John Freemuth (1991), a Boise State University political scientist, examined in detail tar sands development near Canyonlands National Park, Utah, and adjacent to and inside Glen Canyon National Recreation Area, Arizona. Other NGOs (e.g., Natural Resource Defense Council) showcased certain external threats like air pollution, river management and development at Grand Canyon National Park, Arizona; urban smog/acid rain and private land development at Acadia and Shenandoah National Park; uranium mining outside of Arches National Park, Utah; logging, oil/gas leasing, mineral development, and grizzly bear/bison killing next to Yellowstone National Park, Idaho, Montana and

Wyoming; water diversion and potential airport construction outside of Everglades National Park, Florida, channel dredging and wildlife poaching at Cumberland Island National Seashore, Georgia; antiquated upstream sewers, hazardous waste dumps and oil and gas operations at Cuyahoga Valley National Park, Ohio; and mineral exploration and development, hazardous waste spills, aircraft overflights, land development and grazing at Chaco Culture National Historical Park, New Mexico (Buccino et al. 1997). National news media described the situation as "parks in peril" (Satchell 1997). The Natural Resources Defense Council (1999) published a compendium of news media and magazine articles about threats to U.S. national parks.

The working committees that produced *National Parks for the 21st Century: The Vail Agenda* (National Park Service 1991), an outgrowth of National Park Service's 75th Anniversary Symposium, recommended policy guidance in an array of NPS endeavors. The authors were very aware of the need to abate external park threats and plan in a regional context. One year later a respected science committee, commissioned to evaluate the NPS science program, published their conclusions. They were not oblivious to the need for research related to external threats (Risser et al. 1992:16): "Actions outside park boundaries are producing critical changes in ground and surface water, accelerated pest introduction, increasing stream sedimentation, and threatening wildlife populations." By now, magazines like *National Geographic* raised public awareness of external influences to national parks. One article singled out housing construction, proposed highways and dams, and ongoing mining activity as special concern (Mitchell

1994). Government Accounting Office criticism extended into this decade (Government Accounting Office 1994, 1995, 1997).

The Fourth Congress on National Parks and Protected Areas was held in Caracas, Venezuela, in February 1992. One of the recommendations of the Caracas Action Plan was to integrate protected areas into the surrounding region including the possible creation of buffer zones (McNeely 1993).

Awareness Extends to Other U.S. Protected Areas: National Wildlife Refuges and Federal Wilderness Areas

As a result of the *State of Park Report 1980,* other U.S. federal land management agencies began to survey their natural resource problems. U.S. Fish and Wildlife Service (1983) reported that 58% of the problems in national wildlife refuges were external in nature. The draft report copied some of the phraseology from National Park Service (1980) and said "In some cases, this degradation or loss of resource is irreversible. It represents a sacrifice by a public that, for the most part, is unaware that such a price is being paid." This statement was edited out of the final report by Reagan Administration Department of the Interior political appointees. In addition, terms like "threats" and "conflicts" were downgraded to "problems" in the final version to appear less serious to the public (Zaslowsky and Watkins 1994:180-181).

More than a decade later, Cole and Landres (1996) reviewed external threats to officially designated wilderness areas. The threats included exotic species, domestic livestock, water flow disruption, and fire suppression. Other threats were only briefly mentioned: mining, gas and oil drilling, poaching, subsistence hunting and gathering, aerial overflights, and controlling disease and insects. A survey of wilderness managers in 1995 by Kelson and Lilieholm (1997) catalogued 60 different perceived impacts from external sources with the top five being fire, military overflights, exotic plants, air pollution and water pollution.

Climate Change: The Gravest External Threat

The most daunting impact of climate change on protected area biota reached the awareness of scientists in the mid-1980s (Peters and Darling 1985). There was a realization that few reserve biota can shift their latitudinal niche with a warming climate and remain under protective stewardship. By the 1990s, such awareness was gaining more attention (Peters and Lovejoy 1992). Scientific compilations of the entire climate change issue were leased (Houghton et al. 1996, Watson et al. 1996) with updates to follow. There were some early efforts to provide protected area planners guidance in dealing with climate change (e.g., Shafer 1999b). The predictions for species extinctions based on climate change are chilling (Thomas et al., 2003): 15-37% of the species they sampled would be "committed to extinction." The literature on global warming has burgeoned (e.g., Houghton 2005) and is too vast to review here. Dealing with climate change will require more than just corridors between reserves (Kostyack et al. 2011).

The 2000s: Reports by Advisory Boards and Commissions

At the request of the Director of the NPS, the National Park System Advisory Board produced their report *Rethinking the National Parks for the 21st Century* (Franklin et al. 2001). They recommended that the Service "encourage ecological stewardship outside the parks" and that parks should be "linked with other natural areas through wildlife migratory corridors and greenways" (p.17). Years later, the National Parks and Conservation Association convened an independent commission and assigned them the task of creating a 21st century vision for the NPS. The National Parks Second Century Commission (Baker et al. 2009) said "Today many of the most serious threats too our parks come from beyond their borders" (p. 26). They noted that clearcutting on national forest land came right up to the boundary of Olympic National Park, Washington (p. 26), an observation widely recognized (Shafer 1990: 8). They also noted that during the last 20 years in the GYE "Human population has grown by 62%, developed land by 350%" (p. 41). Actually, from 1970 to 1999, the GYE human population increased by 58% and developed land by 350% (Hernández 2004, Gude et al. 2006). In the international arena, the International Union for the Conservation of Nature (IUCN) was advocating that assessments of park management effectiveness include a consideration of development outside their boundaries (Hockings et al. 2000).

The State of America's National Parks, a report prepared by the National Parks and Conservation Foundation and published in 2011 (National Parks and Conservation Association 2011), had a refreshing focus on the need for "landscape conservation." In other words, protecting U.S. national parks requires taking into account things going on in the surrounding region. The report listed activities that disrupted habitat connectivity: roads, logging, mining, residential development and grazing. In order the promote habitat connectivity, one inventive recommendation included Congress and the Administration offering land preservation incentives to private landowners who own land next to a park. Karkkainen (1997:100) indicates that such incentives could include tax penalties/credits and tradable development rights. Another option was park expansion (Shafer 2010).

The Matrix

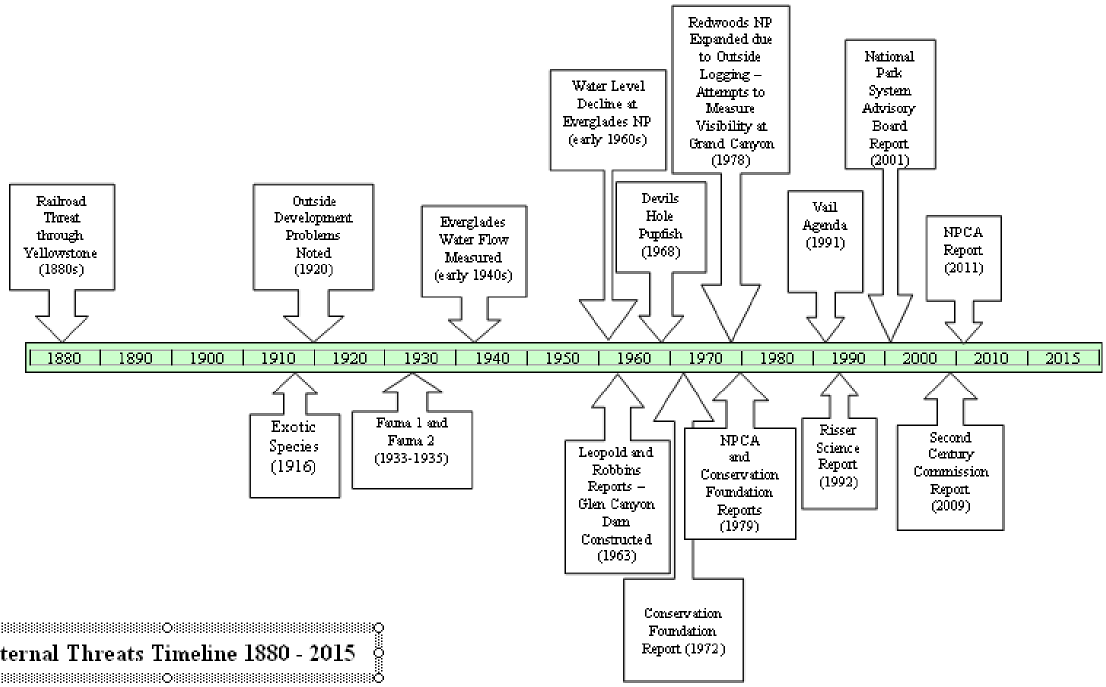
The work of Jansen (1983, 1986) has been viewed by some conservation biologists as the beginning of an awareness of protected area "external threats." Jansen's examples included weedy species in abandoned or cultivated fields invading adjacent reserves. An awareness of external threats actually began more than half a century earlier for U.S. national parks. History can provide important insights for modern ecology and conservation biology (or conservation science) (Meine 1999). Using modern landscape ecology jargon, it facilitated an appreciation of the importance of the "matrix." The matrix is "the most extensive and connected landscape element type present...a landscape element surrounding a patch" (Forman and Godron 1986: 596). For habitat islands, what exists in the matrix has recently been judged just as important as protected area size and habitat isolation for determining species number (Prugh et al. 2008, cited in Triantis and Bhadwat 2011). The matrix can be an impediment for animals to traverse *and* a source of external threats to a reserve. Shafer (1990: 111-116) contrasted area/isolation affects with threats from external influences two decades earlier.

What Does History Tell Us?

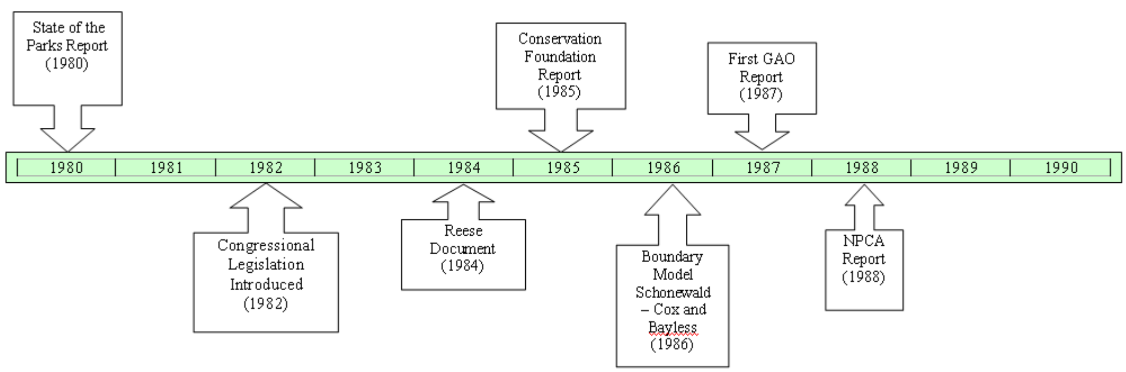
In the United States, a concern about outside development affecting protected areas can be traced back to 1920 (Foresta 1984), however, a general concern about mining, oil/gas extraction, and geothermal projects did not surface until 1979/1980 (National Parks and Conservation Association 1979a, 1979b, National Park Service 1980). Thus the *source* of these external threats expanded over time. The *State of the Park Report 1980* (National Park Service 1980) brought the issue of external threats to the attention of the U.S. public and the Congress. Actions by Congress to help abate external threats to U.S. national parks began in 1982 but stopped in the early 1990s. Science, planning, management and politics will always be unavoidably intertwined when addressing external threats to protected areas. As Harold Eidsvik (cited in Lowry 1998:21) stressed in 1985, "Parks are a creation of the political process." Their management cannot avoid politics (Shafer 2010).

Awareness in the United States after 1980 about outside park boundary concerns coincided with the same insight at the Third World Parks Congress in 1984 (Fall 2002). There was a general awakening in the mid-1970s, and especially by 1980, in the U.S. conservation biology community about the importance of protected area size, habitat isolation and reserve system distribution (Soulé and Wilcox 1980, Frankel and Soulé 1981). A book about nature reserve design, *Nature Reserves: Island Theory and*

Conservation Practice, written by an NPS staff ecologist, surfaced a decade later touting the importance of corridors and buffer zones (Shafer 1990). However, it was not until 2001 that a blue ribbon commission recommended that U.S. national parks be connected by corridors (Franklin et al. 2001). One must ask why such a time lag existed between publishing about the problem by agency staff (e.g. 1990) and the resultant 2006 agency policy on the need for habitat corridors (National Park Service 2006). Until bolstered by a high-level body, NPS does not usually proceed with independent, bold policy initiatives. The political oversight of the George W. Bush Administration also played a role in thwarting initiatives after the turn of the century, like stalling the release of science reports (Shafer 2010). The below charts provide an external threats awareness timeline (Figure 3). This represents one example of national park and protected areas institutional history contributing to the breath of modern conservation biology. This chapter has been published (Appendix 1).



External Threats Timeline 1880 - 2015



External Threats Timeline 1980 - 1990

Figure 3: Timelines

REFERENCES

Adams, A.P. 1964. (Ed). Proceedings of the First World Conference on National Parks. National Park Service, Department of the Interior, Washington, D.C.

Albright, H.M. 1929. Our national parks as wild life sanctuaries. *American Forests and Forest Life* 35: 505-507, 536.

Ackerman, E.A., M. Bates, S.A. Cain, F.F. Darling, J.M. Fogg, Jr., T. Gill, J.M. Gillson, E.R. Hall, C.L. Hubbs, and W. J. Robbins. 1963. A Report by the Advisory Committee to the National Park Service on Research. National Academy of Sciences-National Research Council, Washington, D.C.

American Association for the Advancement of Science. 1925. A Resolution Bearing on the Introduction of Non-Native Plants and Animals into the National Parks of the United States. In G.B. Grinnell and C. Sheldon (eds), Hunting and Conservation: The Book of the Boone and Crockett Club, p. 353. Yale University Press, New Haven, Connecticut.

American Planning and Civic Association. circa 1938. Portfolio on the National Park and Monument System. Part II: Conservation of Nature. American Civic Association, Washington, D.C.

Baker, H. H., Jr., Johnston, J.B., Bilmes, L., Blanchard, J.J., Chen, M., Colwell, R., Earle, S., Fahey, J., Faustinos, B., Fazio, V., Jr., Finney, C., Galvin, D.P., Hinojosa, M., Jewell, S., Knowles, T., Lockhart, S.H., Long, G., McPherson, J., Nash, G.B., Senge, P.M., Shanley, D.A., West, W.R., Jr., Wheatley, M., and E.O. Wilson. 2009. Advancing the National Park Idea: National Parks Second Century Commission Report. National Parks and Conservation Association, Washington, D.C.

Bartlett, R.A. 1989. Yellowstone: A Wilderness Besieged. University of Arizona Press, Tucson.

Buccino, S., C. Clusen, E. Norton, and J. Wald. 1997. Reclaiming Our Heritage: What We Need to Do to Preserve America's National Parks. Natural Resources Defense Council, New York.

Buechner, M., C. Schonewald-Cox, R. Sauvajot, and B.A. Wilcox. 1992. Cross-boundary issues for national parks: what works "on the ground." *Environmental Management* 16 (6): 799-809.

Burgess, J.S. and E. Woolmington. 1981. Threat and stress in the Clarence River Estuary of northern South Wales. *Human Ecology* 9(4): 419-431.

Cahn, R. 1982. Quelling the storm: what will it take. *The Christian Science Monitor*, June 18, pp. 1-6.

Cole, D.N. and P.B. Landres. 1996. Threats to wilderness ecosystems: impacts And research needs. *Ecological Applications* 6 (1): 168-184.

Congressional Research Service. 1986. Oversight Hearing before the Subcommittee on Public Lands and the Subcommittee on National Parks and Recreation of the Committee on Interior and Insular Affairs, House of Representatives, 99th Congress. First Session on Greater Yellowstone Ecosystem held in Washington D.C., October 1985. Serial No. 99-18.

Conservation Foundation. 1985. National Parks for a New Generation: Visions, Realities, and Prospects. The Conservation Foundation, Washington, D.C.

Darling, F.F. and N.D. Eichhorn. 1969. Man and Nature in the National Parks: Reflections on Policy. The Conservation Foundation, Washington, D.C.

Dawson, C.P. and J.C. Hendee. 2008. Wilderness Management: Stewardship and Protection of Resources and Values. 4th Ed. Fulcrum Publishing, Golden, Colorado.

Dottavio, F.D., P.F. Brussard and J.D. McCrone (eds). 1990. Protecting Biological Diversity in the National Parks: Workshop Recommendations. Transactions and Proceedings Series No. 9. National Park Service, Department of the Interior, Washington, D.C.

Elfring, C. 1985. Wildlife and the National Park Service. In A.S. Eno and R.L. Di Silvestro (eds), Audubon Wildlife Report 1985, pp. 280-304. The National Audubon Society, New York.

Elfring, C. 1986a. Wildlife and the National Park Service. In A.S. Eno, R.L. Di Silvestro and W.J. Chandler (eds), Audubon Wildlife Report 1986, pp. 463-494. The National Audubon Society, New York.

Elfring, C. 1986b. U.S. parks at a crossroads. *BioScience* 36: 301-304.

Elliott, H.E. 1974 (ed). Second World Conference on National Parks. IUCN, Morges, Switzerland.

Emory, J, and P. W. Lloyd. 2000. George Melendez Wright 1904-1936: a voice on the wing. *The George Wright Forum* 17(4): 14-45.

Evans, M.C., J.E. Watson, R.A. Fuller, O. Venter, S.C. Bennett, P.R. Marsack, and H.P. Possingham. 2011. The spatial distribution of threats to species in Australia. *BioScience* 61 (4): 281-289.

Fall, J. 2002. Divide and rule: constructing human boundaries in "boundless nature." *GeoJournal* 58: 243-251.

Foresta, R. A. 1984. America's National Parks and Their Keepers. Johns Hopkins University Press, Baltimore.

Forman, R.T.T. and M. Godron. 1986. Landscape Ecology. John Wiley and Sons, New York.

Frankel, O.H. and M.E. Soulé. 1981. Conservation and Evolution. Cambridge University Press, London.

Franklin, J.H., R.S. Chandler, M.L. Brown, S.A. Earle, J.M. Gonzales, C.R. Jordan, S.M. Malcolm, G.P. Nabhan, M.W. Ridder, S. Selengut, P. Westbrook and T.B. Williams. 2001. Rethinking the National Parks for the 21st Century. National Geographic Society, Washington, D.C.

Freemuth, J.C. 1991. Islands under Siege: National Parks and the Politics of External Threats. University of Kansas, Lawrence.

Freemuth, L. 1997. Ecosystem management and its place in the National Park Service. *Denver University Law Review* 74: 697-727.

Glick, D., M. Carr, and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana.

Gordon, J.C. chairman. National Parks: From Vignettes to Global View. National Park Service, Washington, D.C.

Government Accounting Office. 1987. Parks and Recreation: Limited Progress Made in Documenting and Mitigating Threats to Parks. GAO/RECD-87-36.

Government Accounting Office. 1994. National Park Service: Activities Outside Park Borders Have Caused Damage to Resources and Will Likely Cause More. GAO/RCED-94-59.

Government Accounting Office. 1995. National Parks: Difficult Choices Need to be Made about the Future of the Parks. GAO/RCED-95-238.

Government Accounting Office. 1997. National Parks: National Park Service Needs Better Information to Preserve and Protect Resources. GAO/RCED-97-76.

Grinnell, J. and T.L. Storer. 1916. Animal life as an asset of national parks. *Science* 44: 375-380.

Gude, P.H., A.J. Hansen, R. Rasker, and B. Maxwell. 2006. Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77: 131-151.

Hartzog, G.B. Jr. 1974. Management considerations for optimal development and protection of national park resources. In H. Elliott (ed), Second World Conference on National Parks, pp. 155-161. IUCN, Morges, Switzerland.

Hernández, P.C. 2004. Rural residential development in the Greater Yellowstone Ecosystem: rates, drivers, and alterative future scenarios. MS Thesis. Montana State University, Bozeman, Montana.

Hiscock, J.W. 1986. Protecting national park system buffer zones: existing and proposed authority. *Journal of Energy Law and Policy* 7: 35-94.

Hockings, M., S. Stolton, and N. Dudley. 2000. Evaluating Effectiveness: A Framework for Assessing the Management of Protected Areas. IUCN, Gland, Switzerland.

Houghton, J., 2005. Global warming. *Reports on Progress in Physics* 68: 1343-1403. doi:10.1088/0034-4885/68/6/R02

Houghton, J.T., M. Filho, B.A. Callander, N. Harris, A. Kattenburg, and K. Maskell (eds). 1996. Climate Change 1995-The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, London.

Hudson, D., 1979. Sierra Club vs. Department of the Interior: the fight to preserve the Redwood National Park. *Ecology Law Quarterly* 7: 781-859.

International Union for the Conservation of Nature and Natural Resources. 1994. Guidelines for Protected Area Categories. IUCN Commission on National Parks and Protected Areas with assistance of the World Conservation Monitoring Center, Gland, Switzerland.

Janzen, D.H. 1983. No park is an island: increase in interference from outside as park size decreases. *Oikos* 41: 402-410.

Janzen, D.H. 1986. The eternal external threat. In M. Soulé (ed), Conservation Biology: The Science of Scarcity and Diversity, pp. 286-303. Sinauer Associates, Sunderland, Massachusetts.

Johnson, R.R., and Carothers, S.W., 1987. External threats: the dilemma of resource management on the Colorado River, Grand Canyon National Park, USA. *Environmental Management* 11(1): 99-107.

Karkkainen, B.C. 1997. Biodiversity and land. *Cornell Law Review* 83: 1-104.

Keiter, R.B. 1985. On protecting the national parks from the external threats dilemma. *Land and Water Law Review* 20(2):355-420.

Kelson, A.R. and R.J. Lilieholm. 1997. The influence of adjacent land activities on wilderness resources: U.S. wilderness manager perceptions. *International Journal of Wilderness* 3(1), 25-28.

Kenney, J., 1991. Beyond park boundaries. *National Parks* 66(7/8), 20-25.

Kostyack, J., J.L. Lawler, D.D. Goble, J.D. Olden, and J.M. Scott. 2011. Beyond reserves and corridors: policy solutions to facilitate the movement of plants and animals in a changing climate. *BioScience* 61(9):713-719.

Kushlan, J.A., 1987. External threats and internal management: the hydrological regulation of the Everglades, Florida, USA. *Environmental Management* 11(1): 109-119.

Kusler, J.A. 1974. Public/Private Parks and Management of Private Lands for Park Protection. Institute for Environmental Studies Report No. 16, University of Wisconsin, Madison.

Leopold, A.S., S.A. Cain, C.M. Cottam, I. N. Gabrielson and T.M. Kimball. 1963. Wildlife management in the national parks: advisory board on wildlife management appointed by the Secretary of the Interior. *Transactions of the North American Wildlife and Natural Resources Conference* 28: 29-44.

Lowry, W. R. 1998. Preserving Public Lands for the Future: The Politics of Intergenerational Goods. Georgetown University Press, Washington, D.C.

Machlis, G.E. and D.L. Tichnell. 1985. The State of the World's Parks: An International Assessment for Resource Management, Policy and Research. Westview Press, Boulder, Colorado.

Machlis, G.E. and D.L. Tichnell. 1987. Economic development and threats to national parks: a preliminary analysis. *Environmental Conservation* 14(2): 151-156.

Mackintosh, B. 1991. The National Parks: Shaping the System. National Park Service, Department of the Interior, Washington, D.C.

McNeely, J. (ed) 1993. Parks for Life: Report of the IVth World Congress on National Parks and Protected Areas. IUCN, Gland, Switzerland.

McNeely, J.A. and K.R. Miller. 1984. Recommendations of the World National Parks Congress. In J.A. McNeely and K.R. Miller (eds), National Parks, Conservation, and Development: The Role of Protected Areas in Sustaining Society, pp.765-776. Smithsonian Institution Press, Washington, D.C.

Meine, C., 1999. It's about time: conservation biology and history. *Conservation Biology* 13: 1-3.

Mitchell, J.G. 1994. Our national parks. *National Geographic* 186: 2-55.

Myers, N. 1984. Eternal values for the parks movement and the Monday morning world. In J.A. McNeely and K.R. Miller (eds), National Parks, Conservation and Development: The Role of Protected Areas in Sustaining Society, pp. 656-660. Smithsonian Institution Press, Washington, D.C.

National Park Service. 1961. Get the Fact and Put Them to Work. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 1966. Natural Science Research Handbook. National Park Service, Department of the Interior, Washington, D.C.

National Park Service, 1970a. Administrative Policies for the National Parks and National Monuments of Scientific Interest (Natural Area Category). US Government Printing Office, Washington, D.C.

National Park Service, 1970b. Memorandum from the Secretary of the Interior to the Director of the National Park Service, July 10, 1964. In Administrative Policies for the National Parks and National Monuments of Scientific Significance (Natural Area Category), pp. 76-80. US Government Printing Office, Washington, D.C.

National Park Service. 1973. Preserving a Heritage: Final Report to the President and Congress of the National Parks Centennial Commission. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 1980. State of the Parks 1980: A Report to the Congress. National Park Service, U.S. Department of the Interior, Washington, D.C.

National Park Service. 1981. State of the Parks: A Report to the Congress on a Servicewide Strategy for Prevention and Mitigation of Natural and Cultural Resources Management Problems. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 1988. Natural Resource Assessment and Action Program. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 1991. National Parks for the Twenty-first Century: The Vail Agenda. Report and Recommendations to the Director of the National Park Service from the Steering Committee of the 75th Anniversary Symposium. Chelsia Green Publishing Company, Post Mills, Vermont.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

National Parks and Conservation Association. 1979a. NPCA adjacent lands survey: no park is an island. *National Parks and Conservation Association Magazine* 53(3): 4-9.

National Parks and Conservation Association. 1979b. NPCA adjacent lands survey: part II. *National Parks and Conservation Association Magazine* 53 (4):4-7.

National Parks and Conservation Association. 1988. Investing in Park Futures. The National Park System Plan: A Blueprint for Tomorrow. Executive Summary. National Parks and Conservation Association, Washington, D.C.

National Parks and Conservation Association. 1991. A Race Against Time: Five Threats Endangering America's National Parks and Solutions to Avert Them. National Parks and Conservation Association, Washington, D.C.

National Parks and Conservation Association. 2011. The State of America's National Parks. Center for Park Research, National Parks and Conservation Association, Fort Collins, Colorado.

National Research Council. 1987. River and Dam Management: A Review of the Bureau of Reclamation's Glen Canyon Environmental Studies. National Academy Press, Washington, D.C.

National Research Council. 1990. Haze in the Grand Canyon: An Evaluation of the Winter Haze Intensive Tracer Experiment. National Academy Press, Washington, D.C.

Natural Resources Defense Council. 1999. Parks for Tomorrow: News and Commentary About the Problems Confronting America's National Parks. Natural Resources Defense Council, New York.

Nelson, E.W. 1917. The Yellowstone and the game supply. Proceedings of the National Parks Conference, pp. 200-204. Government Printing Office, Washington, D.C.

Nicholson, E.M. 1974. What is wrong with the national park movement. In H. E. Elliott (ed), Second World Conference in National Parks, pp. 32-37. IUCN, Morges, Switzerland.

Ostrov, J., 1982. Visibility protection under the Clean Air Act: preserving scenic and parkland areas in the Southwest. *Ecology Law Quarterly* 10: 397-454.

Peters, R.L. and J.D.S. Darling.1985. The greenhouse effect and nature reserves. *BioScience* 35: 707-717.

Prugh, L.R., K.E. Hodges, A.R.E. Sinclair, and J.S. Brashares. 2008. Effect of habitat area and isolation on fragmented animal populations. *Proceedings of the National Academy of Sciences, USA* 105: 20770-20775.

Peters, R.L. and T.E. Lovejoy (eds) 1992. Global Warming and Biological Diversity, Yale University Press, New Haven.

Rapport, D.J. and H.A. Regier. 1980. An ecological approach to environmental information. *Ambio* 9(1): 22-27.

Reese, R. 1984. Greater Yellowstone: The National Park and Adjacent Wildlands. Montana Magazine, Helena, Montana.

Ridenour, J.M. 1990. The director's report: working with our neighbors. *Courier* 35:1.

Risser, P.G. et al. 1992. Science and the National Parks. National Academy Press, Washington, D.C.

Sax, J.L. 1980. Mountains without Handrails: Reflections on the National Parks. University of Michigan Press, Ann Arbor.

Satchell, M. 1997. Parks in peril. *U.S. News and World Report* 123(3) pp. 22-29.

Sax, J.L. 1980. Mountains Without Handrails: Reflections on the National Parks. University of Michigan Press, Ann Arbor.

Schonewald-Cox, C.M. and J.W. Bayless. 1986. The boundary model: a geographic analysis of design and conservation of nature reserves. *Biological Conservation* 38: 305-322.

Sellars, R.W. 1997. Preserving Nature in the National Parks: A History. Yale University Press, New Haven.

Shafer, C.L. 1990. Nature Reserves: Island Theory and Conservation Practice. Smithsonian Institution Press, Washington, D.C.

Shafer, C.L. 1999a. US national park buffer zones: historical, scientific, social, and legal aspects. *Environmental Management* 23 (1): 49-73.

Shafer, C.L. 1999b. Reserve planning to protect biological diversity: some basic elements. *Landscape and Urban Planning* 44 (1999): 123-153.

Shafer, C.L. 2001. Conservation biology trailblazers: George Wright, Ben Thompson, and Joseph Dixon. *Conservation Biology* 15 (2): 332-344.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal land. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Shands, W.E. 1979. Federal Resource Lands and Their Neighbors. Conservation Foundation, Washington, D.C.

Shaver, C. and C. Malm. 1996. Air quality at the Grand Canyon. In W.L. Halvorson and G. E. Davis (eds), Science and Ecosystem Management in the National Parks, pp. 229-250.
University of Arizona Press, Tucson.

Shaver, C. L., K.A. Tonnessen, and T.G. Maniero. 1994. Clearing the air at Great Smoky Mountains National Park. *Ecological Applications* 4(4): 690-701.

Shaw, W.W. 1996. Urban encroachment at Saguaro National Monument. In W.L. Halvorson and G.E. Davis (eds), Science and Ecosystem Management in the National Parks, pp. 184-200. University of Arizona Press, Tucson.

Shelford, V.E. 1921. National parks. Science 77: 281-282.

Shelford, V.E. 1933. The preservation of natural biotic communities. Ecology 14 (2): 240-245.

Soulé, M.E. and B. Wilcox (eds.) 1980. Conservation Biology: An Evolutionary-Ecological Perspective. Sinauer Associates, Sunderland, Massachusetts, 395 pp.

Strong A.L., Durning M.B., Foster C.H.W,, Rowntree R., Schulman S.J., Stoddard C.H. 1972. The National Park System: Ways and Means. In: The Conservation Foundation (ed.) National Parks for the Future. The Conservation Foundation, Washington, D.C., pp. 75-114

Sumner, L. 1983. Biological research and management: a history. The George Wright Forum 3: 3-27.

Sun, M. 1985. Host of problems threaten national parks. Science 228: 1413-1414.

Supernaugh, W.R., Jr. 1994. An Assessment of Progress Between 1980 and 1992 in Responding to Threats to the National Park System. M.S. Thesis, Slippery Rock University, Pennsylvania.

Thomas, C. D. et al. 2003. Extinction risk from climate change. *Nature* 427: 145-148.

Triantis, K.A. and B.A Bhagwat. 2011. Applied island biogeography. In R.J. Ladle and R.J. Whittaker (eds.), Conservation Biogeography, pp. 190-223. Wiley-Blackwell, Oxford, UK.

U.S. Fish and Wildlife Service. 1983. Report on Resource Problems on National Wildlife Refuges, National Fish Hatcheries, Research Centers. U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C.

Watson, R.T., M.C. Zinyowera, and R.H. Moss (eds) 1996. Climate Change 1995-Impacts, Adaptation, and Mitigation of Climate Change: Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, London.

Westoff, V. 1970. New criteria for nature reserves. *New Scientist* 16: 108-113.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48: 607-615.

Wright, G.M., J.S. Dixon and B.H. Thompson. 1933. Fauna and Flora of the National Parks of the United States: A Preliminary Survey of Faunal Relations in National Parks. Fauna Series No. 1. Government Printing Office, Washington, D.C.

Wright, G.M. and B.H. Thompson. 1935. Fauna of the National Parks of the United States. Fauna Series No. 2. U.S. Government Printing Office, Washington, D.C.

Zaslowsky, D. and T.H. Watkins. 1994. These American Lands: Parks, Wilderness, and the Public Lands. Island Press, Washington, D.C.

CHAPTER 3: THE GREATER YELLOWSTONE ECOSYSTEM: HISTORY, DESCRIPTION AND THREATS

"The future of Yellowstone Park and its broader ecosystem will continue to be in doubt."

Varley 1988: 223

The Park and Forests: Early History

Yellowstone National Park was created in 1872 (Pritchard 1999). During the 1890s, the Congress and the public viewed parks and forests as much the same (Turner 2000). The first tract of protected United States federal forest, dubbed the Yellowstone Park Timber Land Reserve, was established in 1891 directly east and south of Yellowstone (Figure 4).

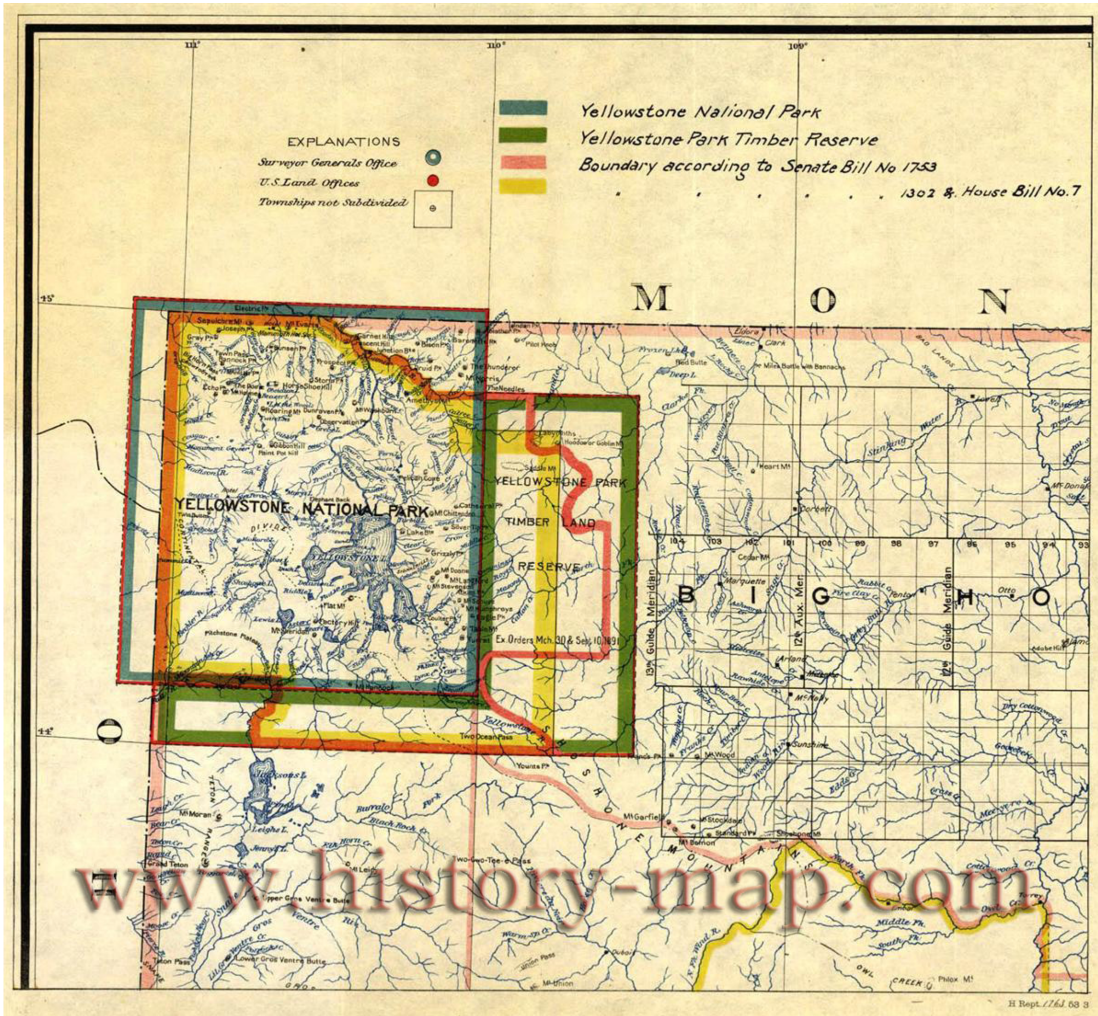


Figure 4. Early map of Yellowstone National Park. This map shows the relationship between the first boundary of Yellowstone National Park (blue) and the Yellowstone Timber Land Reserve (green). From National Park Service. (http://www.history-map-.com/picture/003/Yellowstone-boundaries-National-Park.htm)

This was a result of the 1891 Forest Reserve Amendment to the General Revision Act (16 U.S.C. §§471) which allowed the creation of "forest reserves" from public land. Guidance on forest management came with the USFS Organic Administration Act of

1897 (16 U.S.C. §§473-478, 479-482 and 551). The Reserve included lands that today are known as the Shoshone, Bridger-Teton and Targhee National Forests (US Forest Service/National Park Service 1987). However, the terminology "national forest" did not arise until 1907. The creation of the Yellowstone Park Timber Land Reserve provided more protection for Yellowstone's migratory ungulates and the Reserve corresponded to land proposed for addition to the park during the previous decade by Philip Henry Sheridan, George Bird Grinnell, Charles Sargent and others (Bartlett 1989, Carr 1998, Schullery 2004). Efforts to add the Reserve to the park did not succeed (Culpin 1992, cited in Carr 1998). Some historians contend that the creation of Yellowstone National Park was unopposed by extraction industries because it was viewed as worthless land for mining, grazing and logging (Runte 2010).

Park Boundary Modifications

The 1884 bill introduced by Senator George Graham Vest, which sought to expand the park's boundary to provide more range for game animals and to protect the upper watersheds of rivers, failed to be enacted. Another bill failed again in 1892 (Bartlett 1989: 312-314). There were other members of Congress during that period that saw no value in government reserves and wanted the park abolished or divided into 160-acre tracts and sold (Bartlett 1889: 315). The first boundary modification to Yellowstone National Park began in 1929. After successful negotiations between the NPS and the Wyoming Game Commission, the newly created eastern boundary followed mountain ridges adding 78 mi^2 of USFS land to the park (Pritchard 1999). In 1932, most of the park's eastern boundary, and a small part of the western end of its northern boundary, were realigned to correspond to drainage divides or accommodate winter range for elk (*Cervus elaphus*) (Schullery 2004, Yellowstone National Park 2011). For a graphic description of various proposed and enacted Yellowstone National Park boundary modifications, see Marcus et al. 2012:11). As George Wright and colleagues later argued, "As a natural barrier, a mountain crest is better than a valley or stream... (Wright et al. 1933: 38). Also during 1929, NPS was seeking boundary extensions for Sequoia, Bryce Canyon, Zion, Rocky Mountain, and Glacier national parks (Sellars 1997).

Wright (1985) identified reasons for U.S. park boundary expansion and one was to minimize conflicts with humans. This reason was a focus of one private conservation organization which recommended that NPS identify parks in need of boundary expansions to protect against external threats (Conservation Foundation 1985: 275-276). The National Parks and Conservation Association (1988) recommended almost 200 boundary adjustments for the National Park System, many for ecological reasons.

Description of the Ecosystem

The area of the Greater Yellowstone Ecosystem (GYE) (sometimes called Greater Yellowstone Area) was first delineated by Craighead (1977) as representing continuous critical habitat for the grizzly bear. Since then, the size of the GYE varied based on the source: 14 million ha (Corn and Gorte 1986), 18 million ha (Glick et al. 1991), 26 million ha (Noss et al. 2001) and 36 million ha (Gude et al. 2006). Using 14 million acres as the GYE delimitation, more than 92 % of the land is in federal ownership (Corn and Gorte 1986). The federal agencies have given the GYE *de facto* recognition (Keiter 1989). Although the concept of "greater ecosystems" has gained attention in recent decades (Grumbine 1990), the parameters of the concept are yet to be defined (Andelman and Fagan 2000). The GYE, using the 18 million acre spatial definition of Glick et al. (1991) (Figure 5), contains two national parks (Yellowstone and Grand Teton), one national parkway (John D. Rockefeller Memorial Parkway), parts of six national forests (Bridger-Teton, Shoshone, Caribou-Targhee, Gallatin, Custer, and Beaverhead-Deerlodge), three units of the National Wildlife Refuge System (National Elk Refuge, Red Rock Lakes NWR, and Gray's Lake NWR), one Indian Reservation (Wind River), BLM, Bureau of Reclamation, state, municipal, and private lands in Wyoming, Montana and Idaho.

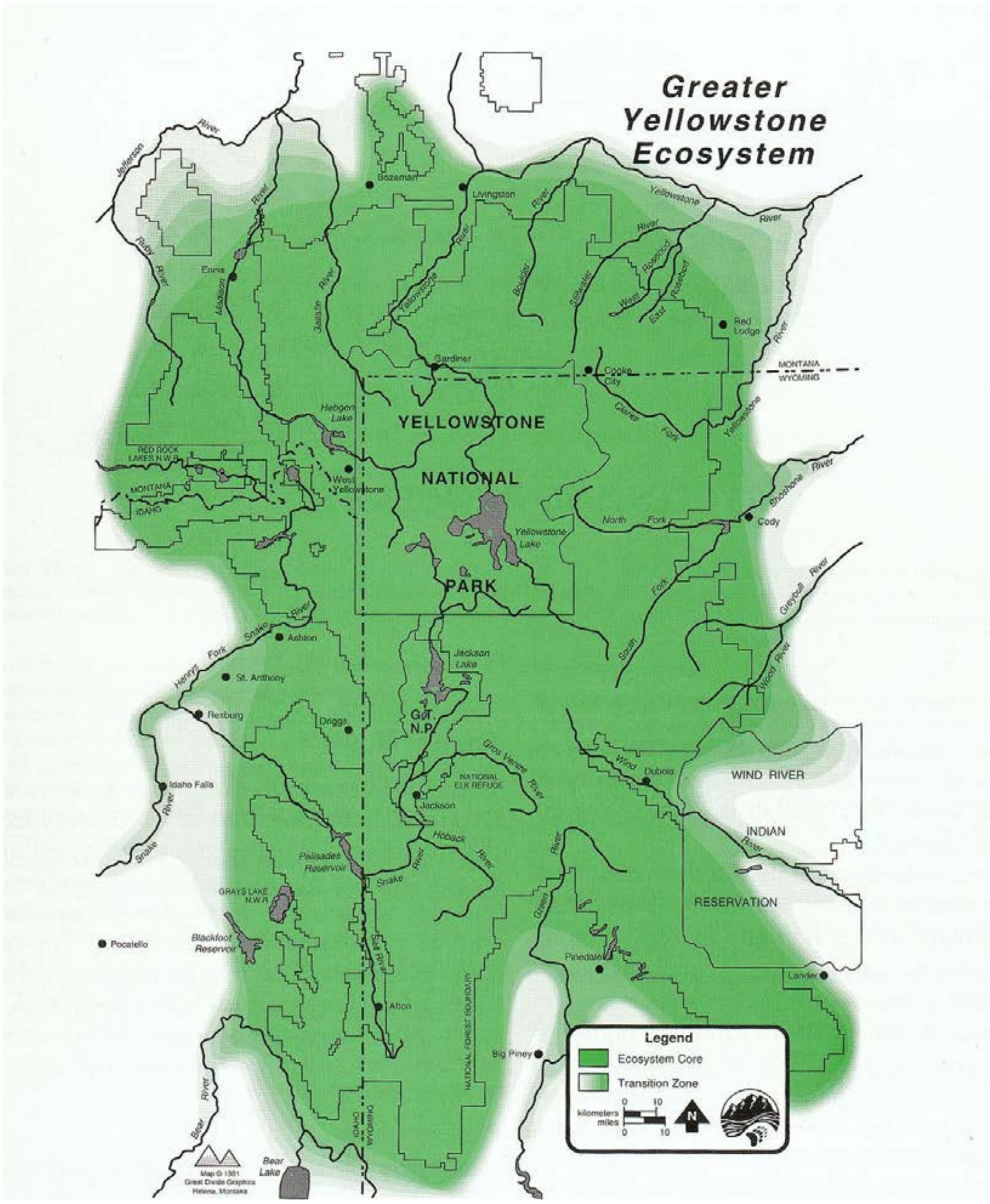


Figure 5. The Greater Yellowstone Ecosystem. From Glick et al. (1991).

The GYE is administered by 28 different federal, state and local government agencies (Clark and Harvey 1990). However, the federal government represents the dominant organizational management entity (Burroughs and Clark 1995). If one adopts a GYE socio-economic delimitation being about 36 million acres so that the area of 20 counties surrounding the park are included, land ownership percentages follow: private 32%, USFS 32%, BLM 19%, national parks 7%, tribal lands 5%, and state lands, wildlife refuges, and other federal lands 5%. Such a patchwork of ownership has created an enormous land management dilemma. “Today there remains no common approach to land management and no single entity empowered to assess the larger ecological ramifications of concurrent development activities within the Ecosystem” (Glick et al. 1991: 98). There were over 370,000 permanent residents (2.54 persons/km^2) as of 2000 (Gude et al. 2006). Land uses in the GYE are diverse (see Patten 1991) but the one which is key to this investigation are roads. Jones et al. (2009) perceived that resource extraction, agriculture and residential development were the top threats to GYE. All of these activities require roads. The GYE is one of the fastest growing areas in the nation (Gude et al. 2006). The entire GYE had been described as an “ecological island” (Barbee and Varley 1985, Varley 1988).

Superlatives of the Ecosystem

The GYE is “one of the largest, essentially intact, wild ecosystems remaining in the earth’s temperate zone” (Reese 1984:9, Varley 1988: 218, Greater Yellowstone Coalition 1990:2, cited in Pritchard 1999). Others are willing to grant such superlative status only in terms of the continental United States (Debinski et al. 1999) or the lower 48 states

(Camenzind 1985; Gosnell et al. 2006; Fishbein 1997:24). According to Sanjayan et al. (2012), the Crown/Yellowstone temperate coniferous forest is only one of 23 areas worldwide that had “intact faunal assemblages.” Yellowstone superlatives include the largest concentrations of mammals in the lower 48 states; one of the largest concentrations of elk in North America; one of the few sanctuaries for the grizzly bear in the lower 48 states; home of rare and endangered species; the only place where wild buffalo (*Bison bison*) still persist since the prehistoric period; the largest lake in North America above the 7,000 foot elevation; circumscribes the headwaters of the Yellowstone, Snake and Green Rivers which in turn feed hundreds of streams that represent the highest concentration of trout fisheries in the lower 48 states; harbors the largest, most diverse and most intact assemblage of geothermal features on the planet; represents one of the last wild tracts where natural processes and disturbances of large magnitude manifest under the influence of minimal human manipulation; and may offer the highest concentration of high–quality outdoor recreation opportunities in the country (Glick et al. 1991, Yellowstone National Park 2011). Its resources have been documented elsewhere (Corn and Gorte 1986). Congressional oversight hearings were held on the GYE in 1985 (Congressional Research Service 1986). Congress asked that a useful aggregation document be prepared to aid GYE (US Forest Service/National Park Service 1987).

Threats to Biological Diversity

In the United States, habitat elimination and degradation appear to be the most significant threats to biological diversity (Wilcove et al. 1998). Wilcove and colleagues categorized habitat destruction activity as follows: agriculture; livestock grazing; mining, oil and gas and geothermal exploration and development; logging; infrastructure development; road construction, military activities; outdoor recreation; ORVs; water development; dams and impoundments; pollutants; land conversion for development; and disruption of fire ecology. All of these activities have occurred in the GYE. Therefore, land use is the key reason for biological diversity changes in terrestrial ecosystems (Sala et al. 2000, McKinney 2002). All three stages of economic development can be seen in the GYE: agricultural, industrial and information/communication (Huston 2005). Chase (1987: 424) though the seriousness of external threats to the park had been exaggerated. This review may dispel that idea.

National Park Service (1980) identified various external threats to Yellowstone National Park. They included oil and gas exploration and development, logging, mining, geothermal energy development, hydrological power and reclamation projects, resorts and subdivisions. As Reese (1984: 8) noted, “Some of man’s activities on surrounding national forest, state and private lands, though politically apart from Yellowstone, pose severe threats to the wildlife, water, air, thermal features and other aspects of the park itself.” The Greater Yellowstone Coalition (1984), which Reece headed, identified some of the same GYE threats and others: mining, oil and gas exploration, dams, roads, snowmobile trails, ski resorts, timber sales, and garbage dump removal. The specific problematic management issues have been identified since the 1980s. Greater Yellowstone Coalition (1986) was an update. Mapping the global human footprint, including around protected areas, demands geographic proxies like human population density, settlements, roads and remoteness (Sanderson et al. 2002). We shall now examine the most significant threats to the GY**E**.

Human Population Growth

Using the Glick et al. (1991) GYE ecosystem delineation, there are around 425,000 people living in the GYE with a population density of 2.93 people/km^2 (Hansen 2010). The counties surrounding Yellowstone National Park are amongst the fastest growing in the United States (Rasker and Hansen 2000). In fact, they are growing faster than 78% of all U.S. counties (Hansen et al. 2002). During the period of 1970-1999, the GYE had a 58% increase in human population (Gude et al. 2006). That human population is expected to increase by around 15,000 residents from 2000 to 2020 (Wyoming Department of Administration and Information 2005, cited in US Fish and Wildlife Service 2007). On a worldwide basis, human populations outside protected areas are one factor that correlates with diminished species diversity inside them (Parks and Harcourt 2002, Harcourt et al. 2001).

Private Homes

The construction of rural homes has been the primary form of land use change in the GYE (Rasker and Hansen 2000) (Figure 6).

Figure 6. Private vacation home next to the Yellowstone River in the Greater Yellowstone Ecosystem (http://www.yellowstonevacationhomes.net)

From 1950 to 1999, the number of rural homes bordering federal land in the GYE expanded by 302% (9,942 to 39,944 homes) (Gude et al. 2006). Over the shorter time period of 1970-1999, the GYE had a 350% increase in rural lands which support exurban housing (Gude et al. 2006). From 1970-1997, the number of rural homes in the Montana and Wyoming portion of the GYE increased 402% (Hansen et al. 2002). Halvorson and Davis (1996: 339) argued that “long-term data sets are politically powerful.” Development data spanning only 30 years is powerful as well. In light of the above, U.S. Fish and Wildlife Service (2007:14919) made a surprising statement: “human population growth on private lands is not likely to endanger the Yellowstone [grizzly bear] DPS [distinct population segment] in all or a significant portion of its range in the foreseeable future.” Most of the new homes constructed in Gallatin County, Montana, were in prime wildlife habitat (Glick and Haggerty 2000). More than 50% of all U.S. federally listed rare and endangered species are in decline due to urbanization (Czech et al. 2000). Private land is for sale all over the GYE (Figures 7a,b).

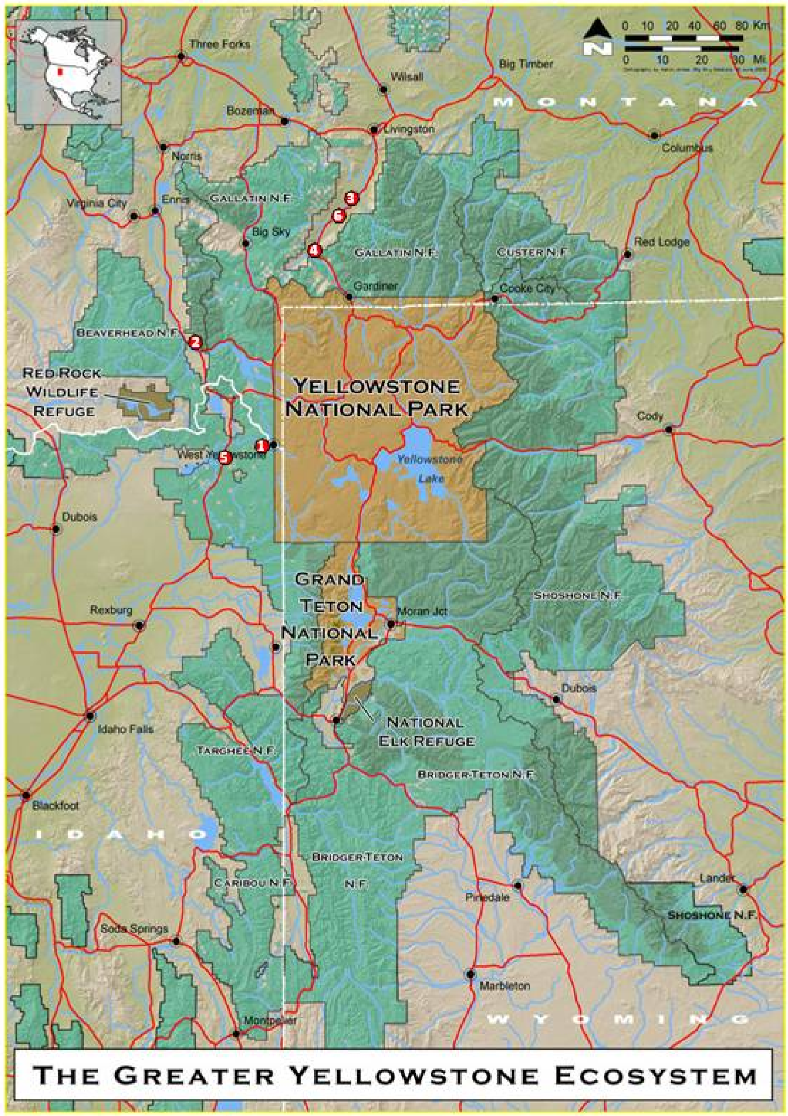


Figure 7a. Locations of some private land for sale in the GYE as of 8-2012.

1 2

3 4

5 6

Figure 7b. Private land for sale located on Figure 7a.

Resort Development

Major ski resorts in the GYE include the Teton Village near Jackson Hole, Wyoming, the Grand Targhee on the Pacific side of the Teton Mountains, and both the Big Sky and Ski Yellowstone resorts just west of Bozeman, Montana (Reese 1984). The Big Sky resort (Figure 8) is located on Lone Mountain in the Gallatin National Forest about 15 miles from the northwestern border of Yellowstone National Park. Another resort, Ski Yellowstone (also called the Yellowstone Club) sits right next to Big Sky on Pioneer and Andesite Mountains. Ski Yellowstone was an invitation only club for millionaires but filed for bankruptcy in November 2008. The land came from the USFS based on a land swap. Like any development, these ski resorts have environmental impacts such as habitat fragmentation, soil erosion and exotic plant species introduction (Tsuyuzaki 1990). Their creation on USFS lands remains controversial (Briggs 2000). There are 134 ski resorts on USFS lands (Hudson 2006).

Figure 8. Big Sky Ski Resort, Gallatin County, Montana. (http:www.visitmt.com/dhski/trail/maps/BIG_SKY_RESORT_EASTERN.jpg)

Roads

Over 7,500 miles of roads reportedly existed on federal lands in the GYE (Glick et al. 1991:113) (Figure 9). The road system in the Targhee National Forest is the densest

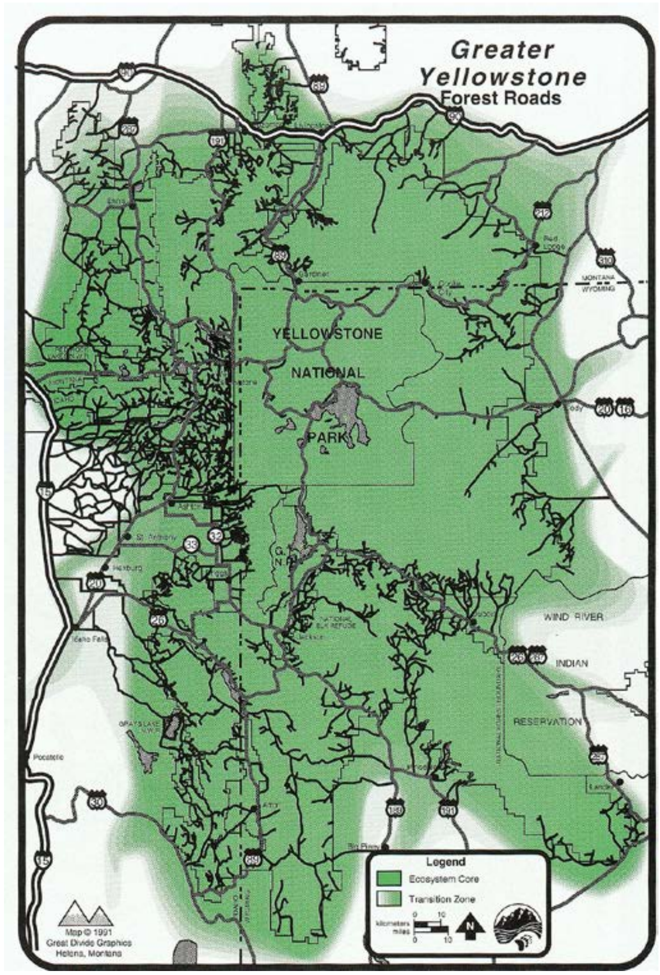


Figure 9. Forest roads, existing and planned, in the Greater Yellowstone Ecosystem as of 1987. From Glick et al. (1991).

in the U.S. National Forest System (Glick et al. 1991:38). However, road construction declined in the mid-1990s. In fact, from 1986 to 2002, more than 1,000 miles of roads in GYE national forests were eliminated (US Forest Service 2006, cited in US Fish and Wildlife Service 2007). Figure 10 illustrates road closure/decommissioning on the Caribou-Targhee- National Forests.

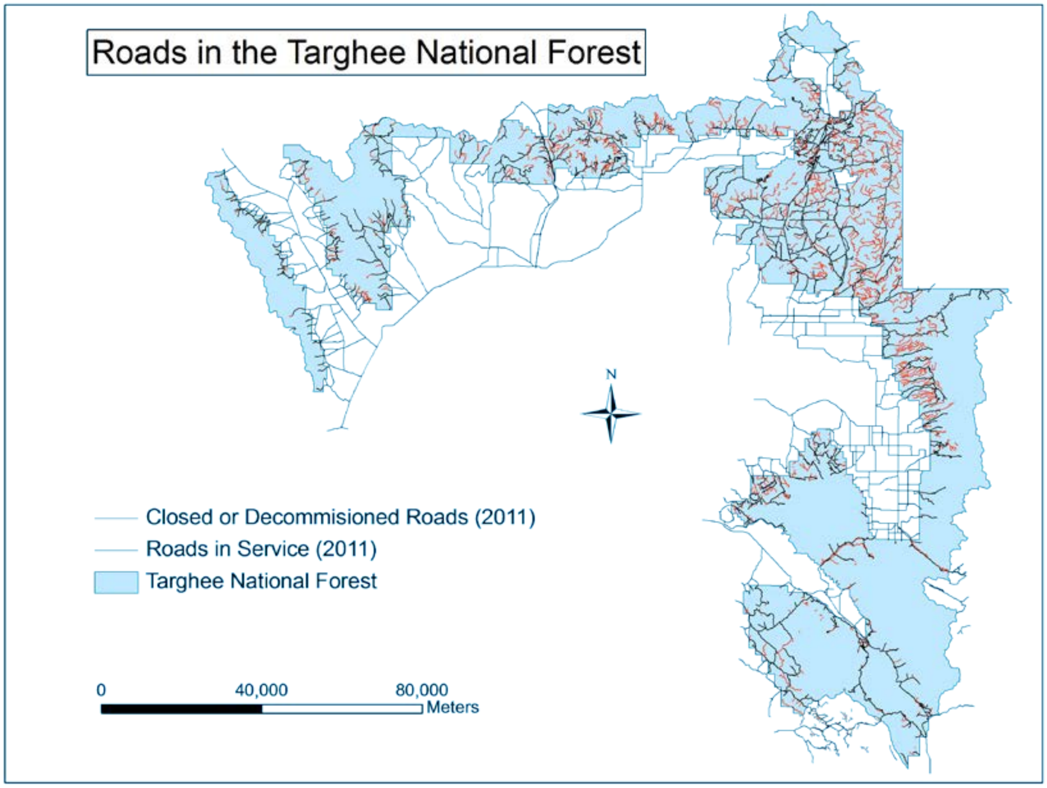


Figure 10. Road closures in Targhee National Forest, Idaho. Source for roads: Targhee National Forest 2011.

The USFS is reportedly the "world's most prolific road builder, with a road system that now spans more than 375,000 miles (Bechtold et al. 1996). More specifically, the Service has a 600,300 km (373,000 mile) road system on 193 million acres (77.8 million ha) (Coghlan and Sowa 1998, cited in Forman et al. 2003). Roads have numerous negative ecological impacts (Forman and Alexander 1998, Trombulak and Frissell 2000, Spellerberg 1998, Gucinski et al. 2001). This study follows the rationale of American Wildlands (2006: 12): "Road density acts as an indicator of the amount of anthropogenic disturbance." According to Theobald et al. (2000), around 80 % of Rocky Mountain forest is within three km of private land.

Logging

Until the 1950s, the national forests were managed in large part to preserve wilderness (Hocker 1979). Logging was common in most U.S. national forests from 1960-1990 (Parmenter et al. 2003). BLM's timber harvest in the 1990s was only 10% of that harvested on national forests (Laitos and Carr 1999).

The USFS derived its multiple use mandate from the Multiple-Use, Sustained-Yield Act (MUSYA) of 1960 (16 U.S.C. §§ 528-531). The BLM derived its multiple use mandate from the Federal Land Policy and Management Act (FLPMA) of 1976 (43 U.S.C. §§ 1701-1784).

Large-scale commercial logging in the GYE was much more widespread during the 1970s and 1980s (Figure 11). It amounted to 12 billion board feet by the mid-1960s but declined to less than 2 billion board feet during the 1990s (Laitos and Carr 1999). Four billion board feet of timber was cut from the GYE since the 1960s (Glick and Clark 1998).

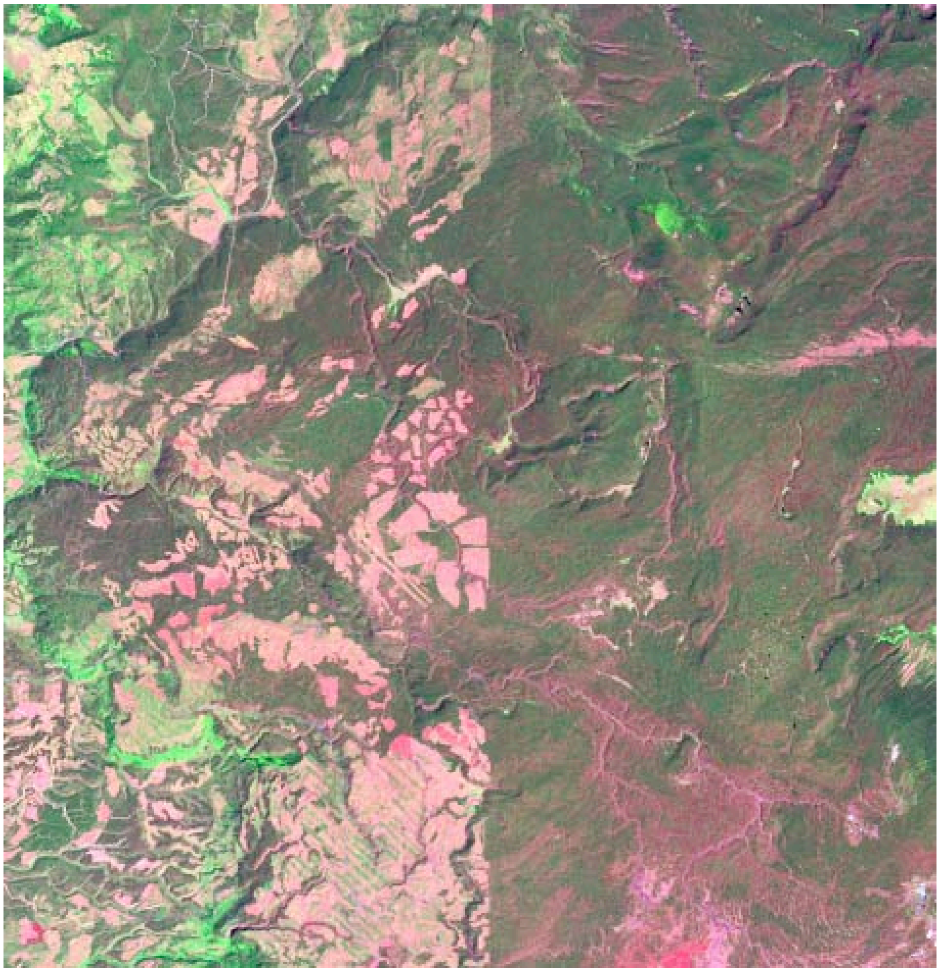


Figure 11. Logging on the Targhee National Forest (pink blocks) up to the western boundary of Yellowstone National Park. Landsat image July 13, 1999. From Earth Observatory, NASA (http://earth.rice.edu/MTPE/bio/biospheretopics/forestapps/ynp-log.htm)

Congress sometimes demands that the USFS over-harvest its timber (Goldstein 1992).

Even salvage logging has deleterious impacts to a forest (Lindenmayer and Noss 2006).

Logging and roads go hand in hand.

In terms of the grizzly bear, clearcutting reduces the amount of habitat for bears (McLellan and Shackleton 1989). The bears prefer not to cross clearcuts or other large habitat openings (Noss et al. 1996, Nielson et al. 2004). Given the above, the following statement in US Forest Service (2006: 259) is perplexing: “changes in the distribution and quantity and quality of cover are not necessarily detrimental to grizzly bears.” Nielson et al. (2008) suggests that roads are a more important factor for grizzly bear survival than how a forest is harvested. Timber harvesting is not permitted in 78 % of USFS lands inside the grizzly bear Primary Conservation Area (PCA) because of either wilderness designations or because the management area does not allow logging (US Forest Service 2006). Within the PCA, the Targhee National Forest has the most land suitable for timber harvest. Logging there was recently about 100 acres per year (US Forest Service 2006: 153). The most deleterious past logging activity in the GYE is described in Chapter 4.

Water Project Development

As of 1991, there were 18 existing major water projects in the GYE and another 17 proposed (Glick et al. 1991: 111). Dams can negatively impact river ecosystems (Stanford and Ward 1979) with a resultant diminished overall integrity (Figure 12).

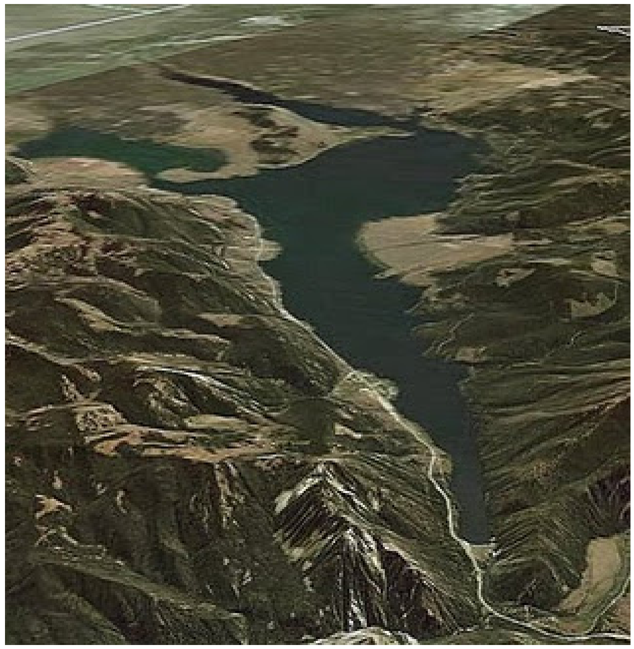


Figure 12. The Hebgen Lake Dam (lower right) was built on the Madison River in 1913. The dam was damaged by an earthquake in 1959 and then improved. It is located just outside the western boundary of Yellowstone National Park on the Gallatin National Forest near Twin Forks, Montana. The old dam’s ability to continue to function is now a concern (http://flyfishyellowstone.blogspot.com/2008_09_01_archive_html).

For example, dams can eliminate spring runoff and interfere with the formation of gravel bars and braided channels (Glick et al. 1991:106). The Jackson Lake Dam on the Snake River in Grand Teton National Park lowered the magnitude and frequency of floods, prompted channel migration, and changed vegetation and wildlife habitat (Marston et al. 2005). Dams also obstruct the movement of fish (Liermann et al. 2012). There has been controversy for decades over removing the four dams on the Lower Snake River (Lavinge 2005).

About 100 dams existed in national forest wilderness as of 1987 (Dawson and Hendee 2008: 366-368). The Greater Yellowstone Coordinating Committee has a plan to manage the GYE watershed. A report they sponsored remarks that “water may very well be the most valuable natural resource in the Greater Yellowstone Area” (Greater Yellowstone Area Hydrology Subcommittee 2006:2).

Grazing, Bears and Ranches

As of 1991, there were about 200,000 cattle, sheep and horses grazing on public lands in the GYE (Glick et al. 1991:113). Nearly 50 % of the GYE public lands at that time were leased for grazing (Glick et al. 1991:104). This includes grazing in wilderness areas. But this situation creates competition for forage between wildlife and livestock and conflicts between ranchers and grizzly bears (Glick 1995).

Grazing has multiple negative impacts to an ecosystem (McClaran 2000). It is generally prohibited in NPS units unless preexisting rights occur or other conditions prevail (National Park Service 2006). However, grazing is an important and longstanding use allowed on USFS and BLM land.

The federal agencies can attempt to phase out grazing rights (Kerr 1998). For privately owned inholdings, whether for grazing or not, USFS and BLM can perform land exchanges in order to create more ecologically functional park boundaries (Anderson

1979, Beaudoin 2000). Agencies or NGOs can also purchase easements or development rights (Loomis 2002: 526-528) (Figures 13, 14).

Figure 13. The Squaw Basin portion of the Blackrock/Spread Creek grazing allotment found east Grand Teton National Park in the Bridger Teton National Forest. The 87,500 acre allotment was retired in 2003 (http://www.forwolves.org/ralph/grizzrpt-old.htm).

Figure 14. Sheep grazing on the Absaroka-Beartooth Wilderness, Gallatin National Forest, Montana and Wyoming. From (http://www.kued.org/?area=pressreleases&action-details&id=OKky)

As of 2003, there were 70 active cattle allotments and seven active sheep allotments inside the GYE grizzly bear PCA (US Forest Service 2006: 117). Approximately 300,000 acres in 22 grazing allotments in prime GYE grizzly bear habitat has thus far been retired (Western Alliance for Nature 2010). As of 2006, only two active sheep allotments remained in the PCA, both in the Targhee National Forest (US Forest Service 2006, cited in US Fish and Wildlife Service 2007). There are, however, many sheep grazing allotments outside the PCA in the Bridger-Teton and Targhee national forests (US Fish and Wildlife Service 2007:14913). Surprisingly, US Fish and Wildlife Service (2007:

14886) thought eliminating existing grazing allotments was not necessary to maintain the current “recovered” status of the grizzly bear.

From 1992-2004, there were 478 documented human-grizzly bear conflicts related to livestock on GYE national forests. However, reportedly only 10 % of documented grizzly bear deaths since 1975 have been related to livestock (US Forest Service 2006: 92). However, in the Primary Conservation Area (PCA), 30 % of sheep allotments active in 2003 had documented grizzly bear conflicts and for 24 % of the cattle allotments (US Forest Service 2006: 346). From 1992-2004, 45 % of grizzly bear/human conflicts occurred on private lands (US Forest Service 2006: 259).

A study of ten GYE counties (but excluding extensive resort development or urban development) revealed that from 1990-2001, 1,479,046 acres of ranchland changed hands as a result of 582 land sales of 400 acres or more (Gosnell et al. 2006). The land purchasers included amenity buyer 43%, traditional ranchers 25%, investors 12%, and conservation organizations 2%. Contrary to popular perception, large ranchland tracts tended to remain intact (Gosnell et al. 2006). However, ranching does have negative ecological impacts (Fleischner 1994).

The national forests in the GYE contain thousands of acres of inholdings as a result of mining patents, homesteading laws and railroad grants (Greater Yellowstone Coordinating Committee 2008: 2-3). Such inholdings may allow not only for grazing but for mining and oil and gas extraction.

Mining

There are two ways that minerals from federal lands can be acquired: claims and leases. Locatable or “hardrock” minerals are available to the public by authority of the Mining Act of 1872 (17 Stat. 91, 30 U.S.C. 21 et seq.) via claims.   Leases are used for other minerals, including most energy resources (e.g., oil, gas, coal, phosphates, and geothermal) by authority of the Mineral Leasing Act of 1920 (30 U.S.C. §§ 181 et seq.). This act declared that fuel and fertilizer minerals (i.e., oil, gas, coal, shale oil, and four fertilizer minerals) would no longer be “locatable” but rather could be leased. Leasing provides the government with more flexibility than location (Corn and Gorte 1986, Glickman and Coggins 2006).

Mineral Location

The GYE has a long history of locatable hardrock mining going back to the late 1800s. Such activity has since declined (US Forest Service 2006: 206). As of 1987, there were 12, 816 mining claims on federal lands in the GYE but 69 % were inactive (US Forest Service/National Park Service 1987:5-27). As of 1984, the USFS indicated that there were more than 2,300 mining claims in the North Absaroka and Washakie wildernesses and 380 claims in the Absaroka-Beartooth wilderness (Reese 1984). As of 2006, there were 1,354 mining claims in the GYE’s grizzly bear Primary Conservation Area (US Forest Service 2006, cited in Fish and Wildlife Service 2007). Some of these mining locations have been mapped (Figure 15).

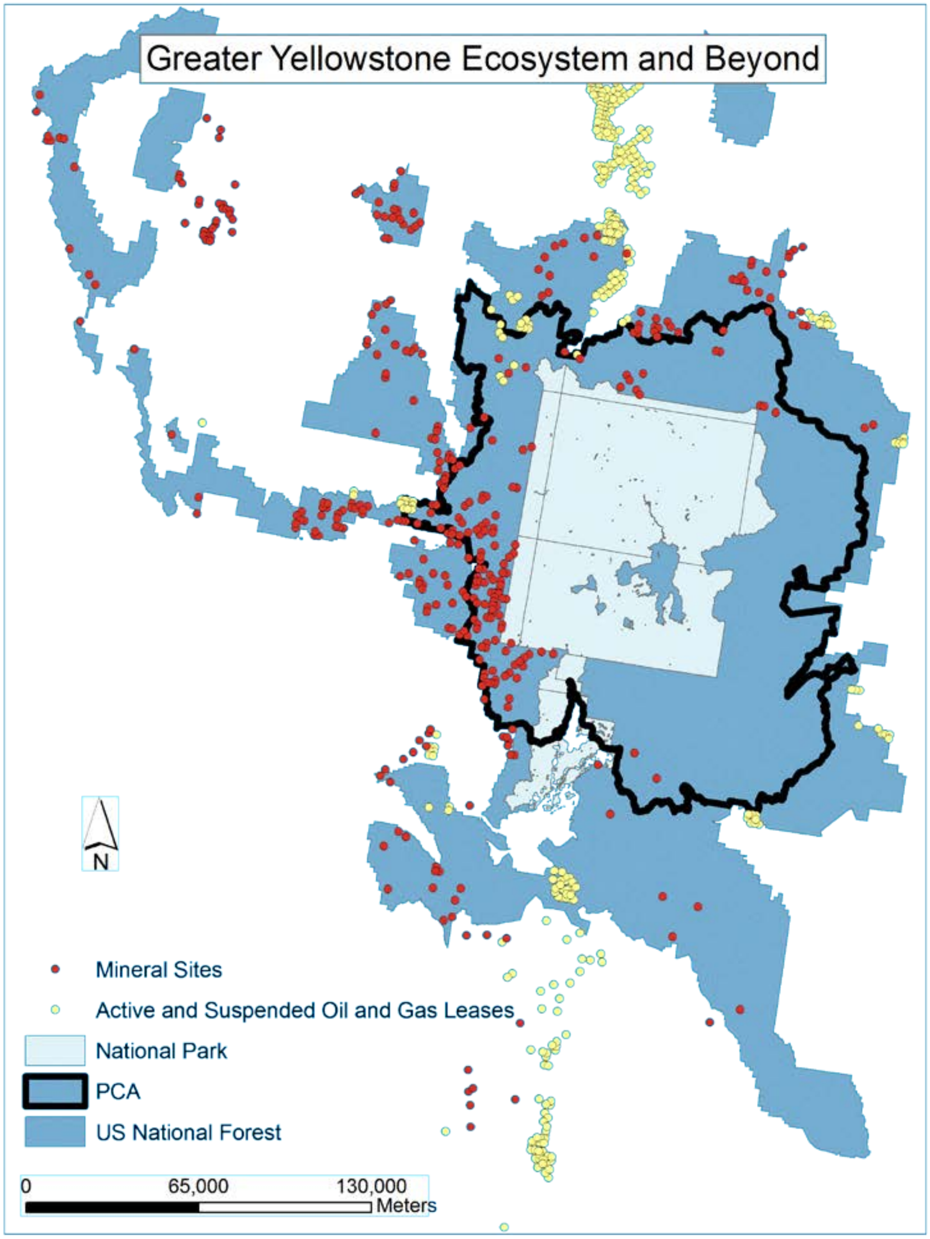


Figure 15. Locations of mineral sites and active or suspended oil and gas leases in the GYE including inside the PCA. Source for mineral/oil and gas data: USFS (2006). Source for PCA: US Fish and Wildlife Service.

According to a BLM official, “The BLM does not have the authority to deny a mining claim” (Corn and Gorte 1986: 75). The current greatest mining threat in the GYE is for phosphate (Figure 16).

Figure 16. Phosphate mine on the Blackfoot River in the Targhee-Caribou National Forest. From Ecoflight (http:www.ecoflight.org.issues/gallery/Idaho-Blackfoot-River---Phosphate/?img=4)

The key minerals sought include gold and silver, but others that have been mined include chromium, copper, iron, lead, molybdenum, nickel, platinum, tungsten and zinc. The key areas with potential for exploitation include the Absaroka, Gros Ventre, Salt River and

Caribou Ranges. Non-metal mining includes talc in the Beaverhead National Forest, travertine and asbestos in the Gallatin National Forest and rock salt in the Caribou National Forest (Corn and Gorte 1986:102). One famous GYE hardrock mining activity is described in Chapter 4.

Mineral Leasing

The 1980s Situation

According to US Forest Service/National Park Service (1987: 5-27), there were 2,071,800 million acres of land in the GYE leased for oil and gas, or with pending leases. According to Corn and Gorte (1986: 71-72), the BLM reported 398 existing leases in Idaho, with 75 more pending and 6,600 leases in Wyoming, with 40 pending. The USFS reported 158 leases in the Gallatin National Forest and 169 leases in the Beaverhead National Forest. There were 18 producing wells, 9 other active drilling sites and 38 abandoned wells in the Bridger-Teton NF. According to Reese (1984), there were 1, 600 oil and gas leases covering 2.3 million acres on the Bridger-Teton National Forest, 75 % of the Targhee National Forest was leased or under lease application, and ½ million acres of the Washakie Wilderness was under lease application, as was 20,000 acres in the Absaroka-Beartooth Wilderness. According to Glick (1991: 110), as of 1987, 200 oil and gas wells were drilled, 6,000,000 acres of national forest was open to leasing, and there were 7,000 pending leases mostly on the Bridger-Teton National Forest. According to US Forest Service/National Park Service (1987:5-28), about 40 % of federal land in the GYE was open to leasing but with varying restrictions.

The USFS waived their “no surface occupancy” stipulation to allow oil and gas drilling outside of Grand Teton National Park, Wyoming (Keiter 1989). Against NPS protests, the USFS dropped its “no-leasing buffer zone next to national parks” stipulation that applied to the Bridger-Teton National Forest and allowed an oil well to be drilled next to Yellowstone on the Shoshone National Forest (Keiter 1989). Hocker (1979: 389) thought oil and gas development was the greatest single threat to Yellowstone National Park. It was the most controversial federal land use in the GYE (Corn and Gorte 1986: 79). As of 1986, the areas in the GYE with high oil and gas potential included the eastern edge of the Shoshone National Forest, the Wyoming and Salt River Ranges (Figure 17), the Snake River Valley in Idaho and the Henry’s Lake Area. The majority of oil and gas drilling took place on the Bridger-Teton National Forest (Corn and Gorte 1986:99).

Figure 17. Gas drilling on Riley Ridge, Bridger National Forest, Wyoming. From Western Wild (http://www.westernwild.org/drilling-the-greater-yellowstone)

In May 1982, the DOI approved an application to drill for gas in the Gros Ventre wilderness located in the GYE's Bridger-Teton National Forest. When it became clear that the DOI intended to issue an oil and gas lease for the GYE's Washakie wilderness, protest followed (Cwik 1983). However, the DOI has a right to prohibit the development of an oil or gas lease if it determines that it will result in unacceptable environmental degradation (Axline 1983). The USFS has been accused of not complying with the National Environmental Policy Act (42 U.S.C. §§ 4321-4331) and the National Forest

Management Act (16 U.S.C. §§1600-1614) when leasing oil and gas rights (Sierra Club 1986).

The 2000s Situation

Only about 150 wells have been drilled in the Bridger-Teton National Forest (US Forest Service 2006:211). In the six GYE national forests, there were 90 active leases (US Forest Service 2006:209). However, there were reportedly only 14 *active* oil and gas wells in the Bridger-Teton National Forest, all in the Wyoming Range (US Forest Service 2006, cited US Fish and Wildlife Service 2007). All active leases will be honored (US Forest Service 2006: 213). BLM lands in the Upper Green River Valley, near Pinedale, Wyoming, have the highest density of oil and gas wells in the GYE (Figures 18 and 19). The threat of the USFS authorizing more natural gas development on the Bridger-Teton National Forest continues (Madison 2011).

Figure 18. Oil and gas wells in the Jonah Field near Pinedale, Wyoming. From Ecoflight (http://ecoflight.org/issues/gallery/Wyoming-Pinedale-Anticline-and-Jonah/?img=7)

Figure 19. Oil and gas well on the Pinedale Anticline, near Pinedale, Wyoming. (http://www.earthpulsedaily.net/epd-past/environmental-and-social-impacts-of-oil-and-gas)

The USFS has the right to withdraw lands from oil and gas exploration and extraction. About 45 % of the GYE national forests are closed to such development. Even if such formal action is not taken, a “no surface occupancy restriction” can constitute a *de facto* withdrawal. The BLM is the agency with the actual authority to issue and cancel leases on USFS lands (Leal et al. 1990). However, as BLM Director Burford testified, “the Forest Service has veto power [on leasing], and they are the ones that say whether or not we can lease in lands which have been made national forests out of the public domain” (Hocker 1979: 397). One ongoing and controversial GYE oil and gas extraction activity is described in Chapter 4.

The negative aspects of oil and development includes habitat destruction from the construction of drill pads and roads, the possible flow of toxic mud into streams, noise and the influx of people (Glick et al. 1991:103-104). More impacts are described by Noble (1982).

Wilderness and Mining

National forest wilderness areas are withdrawn from mineral leasing and hardrock and material mining. However, Federal agencies cannot deny access to valid claims, even those in wilderness, but they can regulate extraction methodologies (Thompson 1996). The agencies have the power to approve or disapprove the mining "plan of operations" as well as how access is achieved (Hubbard et al. 1998). In spite of such agency discretionary power, mining has occurred in some official federal wilderness areas (Gorte 2010). Claims for mining and leases for oil and gas cluster next to the GYE wilderness boundary (Figure 20).

During the tenure of Secretary of the Interior James Watt (1981-1983), the Department of the Interior (DOI) offered 1000 leases in wilderness and potential wilderness sites (Cwik 1983). This happened because the Wilderness Act of 1964 (16 U.S.C. §§ 1131 et seq.) allowed for the leasing of oil, gas and minerals until December 31, 1983, with the approval of the Secretary of the Interior. Watt took advantage of this waning opportunity.

In fact, the public was so outraged that Congress prohibited the USFS from processing permits during FY 1983 (Zaslowski and Watkins 1994: 216-218).

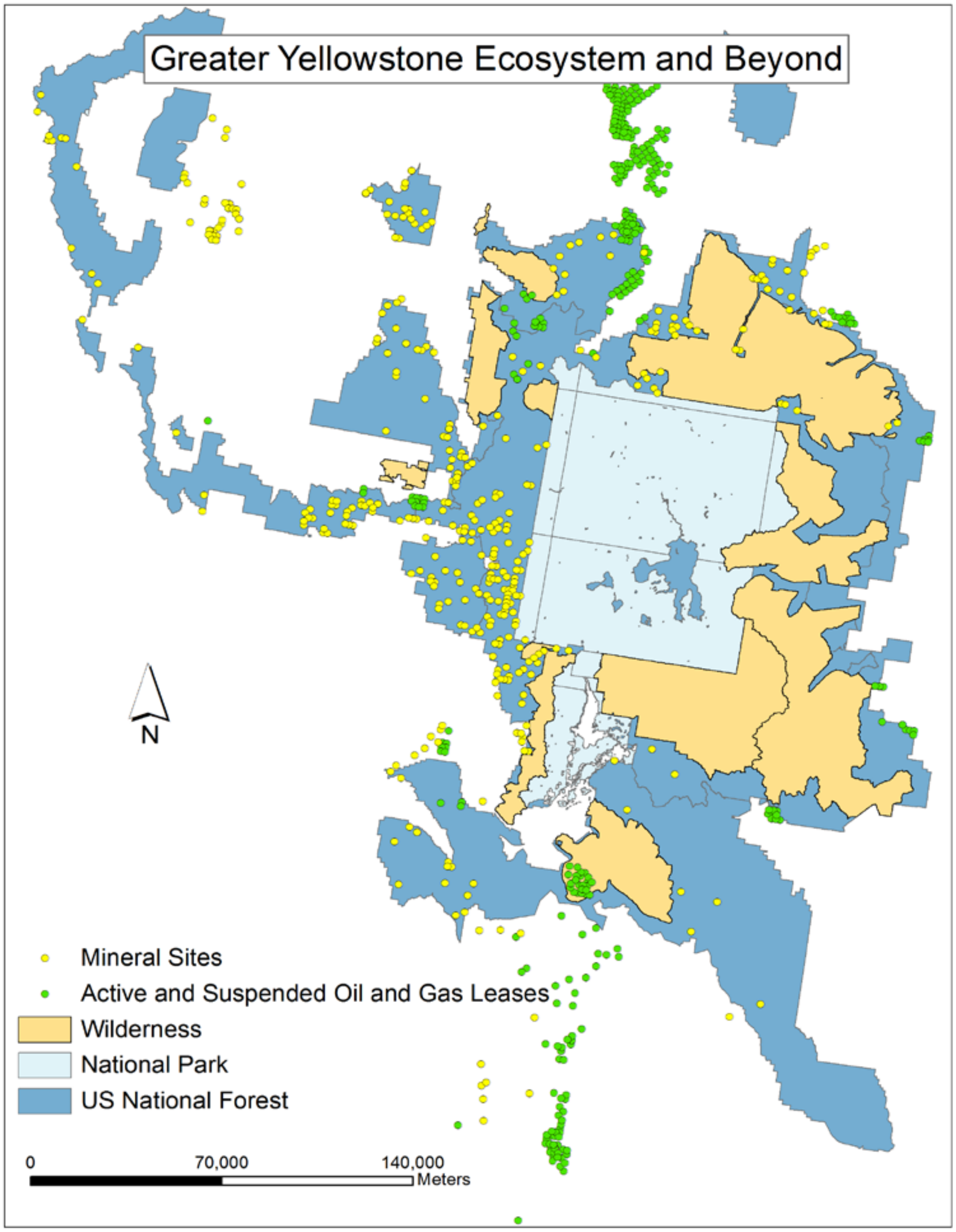


Figure 20. Mineral sites and active or suspended oil and gas leases abut the GYE wilderness boundary as of 2006. Source for wilderness: University of Montana. Source for mining/oil and gas data: US Forest Service (2006).

Section 4(d) (3) of the Wilderness Act of 1964 addresses mining in wilderness. Some key points follow (Dawson and Hendee 2008: 96-104):

-Mining and mineral leasing on claims established on USFS lands before passage of the Wilderness Act most likely will persist indefinitely.

-Mining and mineral leasing claims could continue to be created on USFS lands until December 31, 1983.

-After January 1, 1984, minerals on USFS lands were withdrawn from extraction though they were still subject to valid existing rights.

-The Secretary of Agriculture was instructed to promulgate "reasonable regulations" to allow owners to access such mining properties.

However, as of 1984, little hardrock mining had actually occurred in wilderness and the agencies rarely issued a lease (Glickman and Coggins 2006: 367). Exploratory drilling is allowed in wilderness (Bieg 1983). Events surrounding the New World Mine in the Gallatin National Forest during the 1990s caused one commentator to call for additional reform of the General Mining Law of 1872 (30 U.S.C. §§ 22-42) (Ekey 1997). This old law also provides a miner with "extra-lateral rights" (i.e., the miner can drill laterally beneath his claim) if the claim is located on national forest land or wilderness (Ziemer 1998).

Units of the National Park System are different but also similar. In national parks and monuments (and every type of unit except for five national recreation areas), new mining claims cannot be established. Congress can specify in a park's enabling legislation that mining can occur but NPS can still specify how exploration, extraction and transportation will be conducted (Loomis 2002: 481-482). However, if preexisting private mining claims, mineral leases, or mineral rights exist, mineral development can proceed as long as permanent damage to the park resources does not occur (National Park Service 2006).

Geothermal Development

The largest functional geothermal basin in the world exists in the GYE with its more than 300 geysers and 10,000 thermal features. There are three Known Geothermal Resource Areas (KGRA) there include the Yellowstone KGRA, the Island Park KGRA, and the Corwin Springs KGRA (Glick et al. 1991). As of 1987, in the Island Park KGRA, more than 70 industrial and utility companies applied for leases on 70,000 acres of the Targhee National Forest (Reese 1984). According to Dodd (1988), as of 1986, 107 lease applications covering 175,000 acres had been received for this KGRA. In response to these proposals to lease portions of the Targhee National Forest for geothermal power extraction, an environmental impact statement released by the USFS admitted that it was not known whether there were underground connections between the proposed drill site and the park's geysers (Runte 2010: 229). This provided the USFS with no basis for an informed decision as to whether or not to lease. No leases were ever approved.

The Geothermal Steam Act of 1970 (30 U.S.C. §§ 1001 et seq.) authorized the Secretary of the Interior to grant leases on some federal lands but did not contain language which clearly required the protection of natural resources from exploitation damage. The Act excluded national parks, national refuges and national recreation areas but not wilderness (Glickman and Coggins 2006: 196). However, the Act was amended in 1984 which stopped geothermal development in the Island Park KGRA, only 20 km from Yellowstone National Park's western boundary in the Targhee National Forest, but left the state and private lands in the Corwin Springs KGRA open to development, just 8 km from the park's boundary, A 1988 amendment to the Geothermal Steam Act placed a moratorium on development at Corwin Springs and gave the Secretary of the Interior the power to deny geothermal steam applications. The Old Faithful Protection Act of 1995 would have provided the park with additional protection but it never became law (Steingisser and Marcus 2009).

Much like oil and gas exploration and exploitation, geothermal drilling requires drill pads and roads. There are examples in United States and around the world where geothermal exploitation resulted in the demise of a geyser basin. It is therefore not an unfounded fear that geothermal drilling outside of Yellowstone National Park could cause the termination of some geyser activity inside the park (Reese 1984).   One specific GYE geothermal mining threat is described in Chapter 4.

REFERENCES

American Wildlands. 2006. Regional Habitat Connectivity Analysis: Crown of the Continent Ecosystem. Available at: http://www.mtnforum.org/sites/default/files/pub/1665.pdf Accessed June 2012.

Andelman, S. J., and W. F. Fagan. 2000. Umbrella and flagships: efficient conservation surrogates or expensive mistakes? *Proceedings of the National Academy of Sciences* (USA) 97: 5954-5959.

Anderson, F.R. 1979. Public land exchanges, sales, and purchases under the Federal Land Policy and Management Act of 1976. *Utah Law Review* 1979: 657-676.

Axline, M.D. 1983. Private rights to public oil and gas. *Idaho Law Review* 19: 505-552.

Barbee, R.D. and J.D. Varley. 1985. The paradox of repeating error: Yellowstone National Park from 1872 to biosphere reserve and beyond. *George Wright Forum* 4 (3): 1-4.

Bartlett, R.A. 1989. Nature's Yellowstone. University of Arizona Press, Tucson.

Beaudoin, R.M. 2000. Federal ownership and management of America's lands through land exchanges. *Great Plains Natural Resources Journal* 4: 229-260.

Bechtold, T., D. Havlick, and K. Stockmann. 1996. Analysis of road densities in selected brown bear management units in the Northern Rockies. Available at: http://proceedings.esri.com/library/userconf/proc96/to450/pap413/p413.html. Accessed November 2010.

Bieg, J.P. 1983. Montana grizzly bears protest exploratory drilling in wilderness area. *Natural Resources Journal* 23: 467-478.

Briggs, J. 2000. Ski resorts and national forests: rethinking Forest Service management practices for recreational use. *Boston College Environmental Affairs Law Review* 78: 79-118.

Burroughs, R.H. and T.W. Clark. 1995. Ecosystem management: a comparison of Greater Yellowstone and Georges Bank. *Environmental Management* 19(5): 649-663.

Camenzind, F.J. 1985. Yellowstone ecosystem. *Park Science* 5(2): 12-14.

Carr, E. 1998. Wilderness by Design: Landscape Architecture and the National Park Service. University of Nebraska Press, Lincoln.

Chase, A. 1987. Playing God in Yellowstone: The Destruction of America's First National Park. Harcourt Brace Jovanovich, San Diego, California.

Clark, T.W. and A.H. Harvey. 1990. The Greater Yellowstone Ecosystem policy arena. *Society and Natural Resources* 3: 281-284.

Coghlan, G. and R. Sowa. 1998. National Forest Road System and Use. USDA Forest Service, Washington, D.C.

Conservation Foundation. 1985. National Parks for a New Generation: Visions, Realities, and Prospects. The Conservation Foundation, Washington, D.C.

Corn, L.M. and R.W. Gorte. 1986. Yellowstone: Ecosystem, Resources, and Management. Congressional Research Service RS 86-1087 ENR.

Craighead, J.J. 1977. A Delineation of Critical Grizzly Bear Habitat in the Yellowstone Region. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula.

Culpin, M.S. 1992. Yellowstone and its borders: a significant influence toward the creation of the first forest reserve. In H.K. Steen (ed), The Origins of the National Forests, pp. 276-283. The Forest History Society, Durham, North Carolina.

Cwik, L.J. 1983. Oil and gas leasing on wilderness lands: the Federal Land Policy and Management Act, the Wilderness Act, and the Unites States Department of the Interior, 1981-1983. *Environmental Law* 14: 585-616.

Czech, B., P.R. Krausman, and P.K. Devers. 2000. Economic associations among causes of species endangerment in the United States. *BioScience* 50: 593-601.

Dawson, C.P. and J.C. Hendee. 2008. Wilderness Management: Stewardship and Protection of Resources and Values. 4$^{th\ Ed}$. Fulcrum Publishing, Golden, Colorado.

Debinski, D.M., K. Kindscher and M.E. Jakubauskas. 1999. A remote sensing and GIS-based model of habitats and biodiversity in the Greater Yellowstone Ecosystem. *International Journal of Remote Sensing* 20 (17): 3281-3291.

Dodd, E.M. 1988. The Geothermal Steam Act: unlocking its protective provisions. In D.J. Simon (ed), Our Common Lands: Defending the National Parks, pp. 425-443. Island Press, Washington, D.C.

Ekey, R. 1997. The New World Agreement: A call for reform of the 1872 Mining Law. *Public Land and Resources Law Review* 18: 151-164.

Fishbein, S.L. 1997. Yellowstone Country: The Enduring Wonder. National Geographic Society, Washington, D.C.
Fleischner, T. L. 1994. Ecological costs of livestock grazing in western North America. *Conservation Biology* 8: 629-644.

Forman, R.T.T., and L.E. Alexander. 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 29: 207-231.

Forman, R.T.T. et al. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C.

Glick, D.A. 1995. Greater Yellowstone tomorrow: charting a course for a Greater Yellowstone forever. In R.E. Saunier and R.A. Meganck (eds), Conservation of Biodiversity and the New Regional Planning, pp. 101-111. Organization of American States, Washington, D.C. and IUCN, Morges, Switzerland.

Glick, D. and M. Haggerty. 2000. Land use planning in Greater Yellowstone: is it making the grade? Greater Yellowstone Report (winter).
.
Glick, D., M. Carr and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana

Glick, D.A. and T.W. Clark. 1998. Overcoming boundaries: the Greater Yellowstone Ecosystem. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 237-256. Island Press, Washington, D.C.

Glickman, R.L. and G.C. Coggins. 2006. Modern Public Land Law in a Nutshell. Thomson West, St. Paul, Minnesota.

Goldstein, B. 1992. The struggle over ecosystem management at Yellowstone. *BioScience* 42 (3): 183-187.

Gorte, R.W. 2010. Wilderness: Overview and Statistics. Congressional Research Service RL 31447.

Gosnell, H., J.H. Haggerty and W.R. Travis. 2006. Ranchland ownership change in the Greater Yellowstone Ecosystem, 1990-2001: implications for conservation. *Society and Natural Resources* 19(8): 743-758.

Greater Yellowstone Area Hydrology Subcommittee. 2006. Watershed Management in the Greater Yellowstone Area: An Interagency Strategy. Available at: http://fedgycc.org/

documents/6YA_water_strategy-06update_001.pdf Accessed March 2011.

Greater Yellowstone Coalition. 1984. Greater Yellowstone Challenges 1984: An Inventory of Management Issues and Development Projects in the Greater Yellowstone. Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana, 112 pp.

Greater Yellowstone Coalition. 1986. Greater Yellowstone Challenges 1984: An Inventory of Management Issues and Development Projects in the Greater Yellowstone. Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana, 217 pp.

Grumbine, E. 1990. Protecting biological diversity through the greater ecosystem concept. *Natural Areas Journal* 10(3): 114-120.

Gude, P.H., A.J. Hansen, R. Rasker, and B. Maxwell. 2006. Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77: 131-151.

Guzinski, H., M.J. Furniss, R.R. Ziemer, and M.H. Brookes. 2001. Forest Roads: A Synthesis of Scientific Information. General Technical Report PNW-GTR-509. U.S. Forest Service, U.S. Department of Agriculture, Pacific Northwest Research Station, Portland, Oregon, 103 pp.

Halvorson, W.L. and G.E. Davis. 1996. Lessons learned from a century of applying research results to management of national parks. In W.L. Halvorson and G.E. Davis (eds), Science and Ecosystem Management in the National Parks, pp. 334-344. University of Arizona Press, Tucson.

Hansen, A.J. 2010. Thinking big about the Greater Yellowstone. In J. Johnson (ed), Knowing Yellowstone: Science in America's First National Park, pp. 2-15. Rowan and Littlefield, Lanham, Maryland.

Hansen, A.J., R. Rasker, B. Maxwell, J. J. Rotella, A. Wright, U. Langner, W. Cohen, R. Lawrence and J. Johnson. 2002. Ecology and socioeconomics in the new west: a case study from Greater Yellowstone. *BioScience* 52: 151-168.

Harcourt, A.H., S.A. Parks, and R. Woodroffe. 2001. Human density as an influence on species-area relationships: double jeopardy for small African reserves? *Biodiversity and Conservation* 10: 1011-1026.

Hocker, P.M. 1979. Yellowstone: the region is greater than the sum of its parks. *Sierra* 64 (4): 8-12.

Hubbard, K.D., M. Nixon and J.A. Smith. 1998. The Wilderness Act's impact on mining activities: policy versus practice. *Denver University Law Review* 76: 591-609.

Hudson, S. 2006. Ski resorts: enjoyment versus environmental responsibility-does there have to be a choice? In I. M. Herremans (ed), Cases in Sustainable Tourism: An Experimental Approach to Making Decisions, pp. 123-143. Haworth Hospitality Press, Binghamton, New York.

Huston, M.A. 2005. The three phases of land-use change: implications for biodiversity. *Ecological Applications* 15 (6): 1864-1878.

Jones, D.A., A.J. Hansen, K. Bly, K. Doherty, J.P. Verschuyl, J.I. Paugh, R. Carle, and S.J. Story. 2009. Monitoring, land use and cover around parks: a conceptual approach. *Remote Sensing of the Environment* 113: 1346-1356.

Keiter, R.L. 1989. Taking account of the ecosystem on the public domain: law and ecology in the Greater Yellowstone Region. *University of Colorado Law Review* 60: 923-1007.

Kerr, A. 1998. The voluntary retirement option for federal public land grazing permittees. *Rangelands* 20 (5): 26-29.

Laitos, J.G. and T.A. Carr. 1999. The transformation on public lands. *Ecology Law Quarterly* 26: 140-242).

Lavinge, P.M. 2005. Essay: Dam(n) how times have changed. *William and Mary Environmental Law and Policy Review* 29 (2): 451-480.

Leal, D., G. Black and J.A. Baden. 1990. Oil and gas development. In J.A. Baden and D. Leal (eds), The Yellowstone Primer: Land and Resource Management in the Greater Yellowstone Ecosystem, pp. 117-136. Pacific Research Institute for Public Policy, San Francisco, California.

Liermann, C.R., C. Nilsson, J. Robertson and R.Y. Ng. 2012. Implications of dam obstruction for global freshwater fish diversity. *BioScience* 62(6): 539-548.

Lindenmayer, D.B. and R.F. Noss. 2006. Salvage logging: ecosystem processes, and biodiversity conservation. *Conservation Biology* 20(4): 949-958.

Loomis, J.B. 2002. Integrated Public Lands Management: Principles and Applications to National Forests, Parks, Wildlife Refuges, and BLM Lands. 2nd Ed. Columbia University Press, New York.

Madison, D. 2011. Drilling in Greater Yellowstone: massive outcry erupts over well pads in wildlife areas. Available at: http://wilderness.org/content/drilling-greater-yellowstone-massive-outcry-erupts-over-well-pads-wildlife-areas Accessed April 2011.

Marcus, W.A., J.F. Meacham, A.W. Rodman A.Y. Steingisser, S. Allan and R. West (eds) 2012. Atlas of Yellowstone. University of California Press, Berkeley.

Marston, R.A., J.D. Mills, D.R. Wrazien, B. Bassett and D.K. Splinter. 2005. Effects of Jackson Lake Dam on the Snake River and its floodplain, Grand Teton National Park, Wyoming, USA. *Geomorphology* 71: 79-98.

McClaran, M.P. 2000. Improving livestock management in wilderness. In D.N. Cole, S.F. McCool, W.T. Borrie, and J. O' Loughlin (comps), Wilderness Science in a Time of Change Conference-Volume 5: Wilderness Ecosystems, Threats, and Management. Proceedings RMRS-P-15-VOL-5. Rocky Mountain Research Station, U.S. Forest Service, Department of Agriculture, Ogden, Utah.

McKinney, M.L. 2002. Urbanization, biodiversity, and conservation. *BioScience* 52: 883-890.

McLellan, B.L. and D.M. Shackleton. 1989. Immediate reactions of grizzly bears to human activities. *Wildlife Society Bulletin* 17: 269-274.

National Parks and Conservation Association. 1988. Investing in Park Futures. The National Park System Plan: A Blueprint for Tomorrow. Executive Summary. National Parks and Conservation Association, Washington, D.C.

National Park Service. 1980. State of the Parks 1980: A Report to the Congress. National Park Service, U.S. Department of the Interior, Washington, D.C.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

Nielson, S.E., M.S. Boyce, and G.B. Stenhouse. 2004. Grizzly bears and forestry: I. Selection of clearcuts in west-central Alberta, Canada. *Forest Ecology and Management* 1: 51-65.

Nielson, S.E., G.B. Stenhouse, H.L. Beyer, F. Huettmann, and M.S. Boyce. 2008. Can natural disturbance-based forestry rescue a declining population of grizzly bears? *Biological Conservation* 141: 2193-2207.

Noble, H. 1982. Oil and gas leasing on public lands: NEPA gets lost in the shuffle. *Harvard Environmental Law Review* 6: 117-158.

Noss, R.F., H.B. Quigley, M.G. Hornocker, T. Merrill, and P.C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology* 10 (4): 949-963.

Noss, R., G. Wuerthner, K. Vance-Borland, and C. Carol. 2001. A Biological Assessment of the Greater Yellowstone Ecosystem. Conservation Sciences, Corvallis, Oregon.

Parks, S.A. and A.H. Harcourt. 2002. Reserve size, local human density, and mammalian extinctions in US protected areas. *Conservation Biology* 16: 800-808.

Parmenter, A.W., A. Hansen, R.E. Kennedy, W. Cohen, U. Langner, R. Lawrence, B. Maxwell, A. Gallant, and R. Aspinall. 2003. Land use and land cover change in the Greater Yellowstone Ecosystem: 1975-1995. *Ecological Applications* 13(3): 687-703.

Patten, D.T. 1991. Human impacts in the Greater Yellowstone Ecosystem: evaluating sustainability goals and eco-redevelopment. *Conservation Biology* 5(3): 405-411.

Pritchard, J.A. 1999. Preserving Yellowstone's Natural Conditions: Science and the Perception of Nature. University of Nebraska Press, Lincoln.

Rasker, R. and A. Hansen. 2000. Natural amenities and population growth in the Greater Yellowstone Region. *Human Ecology Review* 7 (2): 30-40.

Reese, R. 1984. Greater Yellowstone: The National Park and Adjacent Lands. Montana Magazine, Helena, Montana.

Runte, A. 2010. National Parks: The American Experience. 4th Ed. University of Nebraska Press, Lincoln.

Sala, O.E., F.S. Chapin III, J.J. Armesto, R. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L.F. Huenneke, R.B. Jackson, A. Kinzig, R. Leemans, D. Lodge, H.A. Mooney, M. Oesterheld, N.L. Poff, M.T. Sykes, B.H.Walker, M. Walker, and D.H. Wall. 2000. Global biodiversity scenarios for the year 2100. *Science* 287: 1770-1774.

Sanderson, E.W., M. Jaiteh, M.A. Levy, K. H. Redford, A.V. Wannebo, and G. Woolmer. 2002. The human footprint and the last of the wild. *BioScience* 52 (10): 891-904.

Sanjayan, M., L.H. Samberg, T. Boucher, and J. Newby. 2012. Intact faunal assemblages in the modern era. *Conservation Biology* 26 (4): 724-730.

Schullery, P. 2004. Searching for Yellowstone: Ecology and Wonder in the Last Wilderness. Montana Historical Society Press, Helena, Montana.

Sellars, R.W. 1997. Preserving Nature in the National Parks: A History. Yale University Press, New Haven.

Sierra Club. 1986. Yellowstone Under Siege: Oil and Gas Leasing in the Greater Yellowstone Region. Sierra Club, San Francisco, 28 pp.

Spellerburg, I. F. 1998. Ecological effects of roads and traffic: a literature review. *Global Ecology and Biogeography Letters* 7: 317-333.

Stanford, J.A. and J.V. Ward. 1979. Stream regulation in North America. In J.V. Ward and J.A. Stanford (eds), The Ecology of Regulated Streams, pp. 215-236. Plenum Press, New York.

Steingisser, A. and A.M. Marcus. 2009. Human impacts on geyser basins. *Yellowstone Science* 17 (1): 7-18.

Theobald, D.M., N.T. Hobbs, T. Bearly, J.A. Zack, T. Shenk, and W.E. Riebsame. 2000. Incorporating biological information in local land-use decision making: designing a system for conservation planning. *Landscape Ecology* 15: 35-45.

Thompson, D.A. 1996. Mining in National Parks and Wilderness Areas: Policy, Rules, Activity. Congressional Research Service Report 96-161. Available at: http://digitallibrary.unt.edu/ark;/67531/metacrs353/m1/1/ high_res_d/... Accessed 11/2010.

Tsuyuzaki, S. 1990. Species composition and soil erosion on a ski area in Hokkaido, Japan. *Environmental Conservation* 14: 203-207.

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

Turner, J.M. 2000. Charting American environmentalism's early (intellectual) geography, 1890-1920. *Wild Earth* 10 (2): 18-25.

US Fish and Wildlife Service. 2007. Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife; 90-Day Finding on a Petition To List as Endangered the Yellowstone Distinct Population Segment of Grizzly Bears. *Federal Register*, Vol. 72, No. 60, March 29, 2007, pp. 14866-14938.

US Forest Service. 2006. Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests. Final Environmental Impact Statement. US Forest Service, Department of Agriculture, Washington, D.C.

US Forest Service and National Park Service. 1987. An Aggregation of National Park and National Forest Service Management Plans. Prepared under the direction of the

Greater Yellowstone Coordinating Committee. US Forest Service and US National Park Service.

Varley, J.D. 1988. Managing Yellowstone National Park into the twenty-first century: the park as an aquarium. In J.K. Agee and D.R. Johnson (eds), Ecosystem Management for Parks and Wilderness, pp. 216-225. University of Washington Press, Seattle.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. *BioScience* 48: 607-615.

Wright, G.M., J.S. Dixon and B.H. Thompson. 1933. Fauna and Flora of the National Parks of the United States: A Preliminary Survey of Faunal Relations in National Parks. Fauna Series No. 1. Government Printing Office, Washington, D.C.

Wright, R.G. 1985. Principles of new park–area planning as applied to the Wrangell-St. Elias region of Alaska. *Environmental Conservation* 12: 59-66.

Wyoming Department of Administration and Information, Economic Analysis Division. 2005. Population for Wyoming Counties, Cities and Towns: 2000 to 2020. Available at: eadiv.state.wy.us.

Yellowstone National Park. 2011. Yellowstone Resources and Issues. Division of Interpretation, Mammoth Hot Springs, Wyoming. Available at: www.nps.gov/yell Accessed April 2011.

Zaslowski, D. and T.H. Watkins. 1994. These American Lands: Parks, Wilderness, and the Public Lands. Island Press, Washington, D.C.

Ziemer, L.S. 1998. The 1872 Mining Law and the 20th century collide: a rediscovery of limits on mining rights in wilderness areas and national forests. *Environmental Law* 28: 145-168.

CHAPTER 4: SITE SPECIFIC EXAMPLES OF BEYOND BOUNDARY DEVELOPMENT THREATS

"Today, with their surrounding buffer zones gradually disappearing, many of these parks are experiencing significant and widespread adverse effects of external encroachment."

NPS 1980: viii

Yellowstone National Park has faced a diverse barrage of external threats to its biological integrity to which there are few easy solutions. We shall examine some threat situations to the Greater Yellowstone Ecosystem (GYE) and elsewhere, to see what forms of action resulted in threat diminishment or resolution.

Threats in the GYE

Urbanization and Private Homes

Up until the 1990s, over one million acres of the GYE's three million acres of private land was subdivided (Glick et al. 1991). According to Glick and Freese (2004), the future of biodiversity in the GYE hinges on the future of its remaining private lands. The amount and distribution of private lands in the GYE exacerbates the goal of ecosystem management (Figure 21).

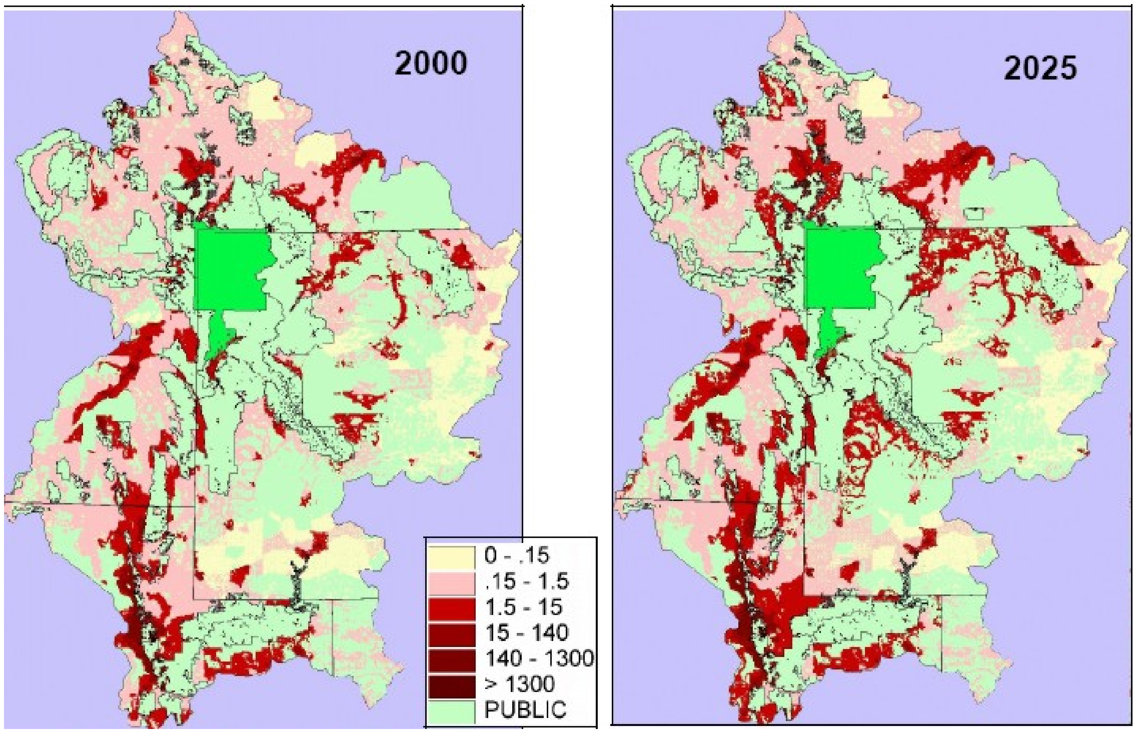


Figure 21. Human population density in the Greater Yellowstone Ecosystem is greatest on private land (dark red). This delimitation of the Ecosystem is defined by Gude et al. (2006) and includes 20 counties and 36 million acres. Data from Theobald (2000). Figure from Noss et al. (2001) at (http://www.conservationplanninginstitute.org/files/gyc_exec_summ.pdf)

Compas (2007) studied private land use planning in Gallatin County, Montana, and concluded that any shift in development patterns has been mostly in the design of the development itself rather than where development occurs in the county. Compas also identified places in the GYE where future growth was most likely the highest (Figure 22). According to Gude et al. (2006:148), “15 of the 20 GYE counties have no county–wide zoning plan, and 4 GYE counties have no full-time planners on staff.” The NPS rarely waded into these issues and only when development was within 2 km of the park and affected a species like Rocky Mountain elk (*Cervus elaphus*) or grizzly bear (Compas 2007).

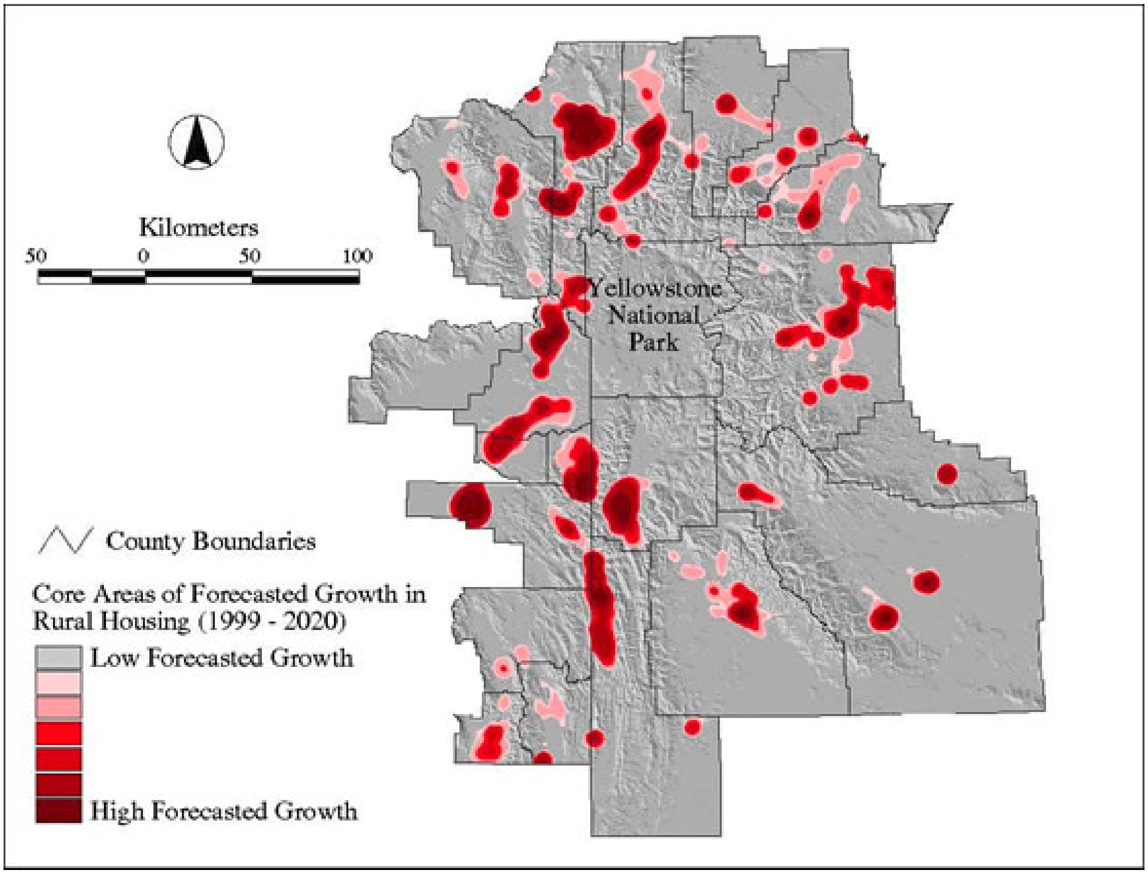


Figure 22. Projected growth of rural housing in the Greater Yellowstone Ecosystem. From Compas (2007).

“There is no ‘magic bullet’ for ameliorating the adverse impacts of development” (Johnson 2001:9) but *effective* local planning controls, like zoning, could do much to protect nearby parks and reserves. Some land conservation successes are undeniable. Up to July 2004, over 450,000 acres of GYE private land (which is 5 % of the total private land) had been conserved using easements (US Forest Service 2006:260). The Nature Conservancy indicates the figure is 500,000 acres (Anonymous 2011). The town of Jackson is one of the larger urban areas in the GYE (Figure 23).

Figure 23. The town of Jackson, Wyoming. From Ecoflight (http://ecoflight.org/issues/gallery/Wyoming-Jackson---Urban-Planning/?img=3)

Logging

In the Targhee National Forest, one of six national forests in the GYE, 38% of its forest was logged during 1950-1990 (A. Hansen, unpublished data, cited in Parmenter et al. 2003). From 1961 to 1989, timber harvest on the Targhee increased by 645% compared to only 24% for the other six GYE national forests (Glick et al. 1991: 115). The Targhee was logged due to an insect infestation (Figure 24). This timber harvest rationale began a 30-year, one billion board-feet logging program that created 3,600 miles of roads and motorized trails (Walder 1999). The logging peaked in 1978 at 107.4 million board-feet, ranged from 46-84 million board-feet until 1990, dropped to 21 million board-feet by 1992, and by the late 1990s declined to less than 10 million board-feet (Walder 1999).

Figure 24. A view during 1984 of the Madison Plateau of the Targhee National Forest about three miles west of Yellowstone National Park's western boundary (From Reese 1984).

A 1980s Targhee National Forest Plan acknowledged that logging would affect Situation I grizzly bear habitat (Reese 1984: 77). Such logging and roading was correlated with the grizzly bear almost disappearing from the Targhee (Willcox 1995). Pritchard (1999:260) reported that, as of 1987, the Greater Yellowstone Coalition thought logging represented the greatest threat to the bear. The USFS's "Recovery Area" for the grizzly bear included the Targhee (Merrill and Mattson 2003).

A lawsuit filed by NGOs claimed that clearcutting on the Targhee reduced grizzly bear habitat and was not in compliance with the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) (Keiter and Boyce 1991). This was compounded by the fact that the Targhee was the only national forest in grizzly bear territory that lacked road standards (Willcox 1995). During the late 1980s and early 1990s, NGOs started appealing USFS timber sales scheduled for the Targhee (Maughan 1997). From 1992-1993, the USFS closed 1,245 miles of its roads in that forest. By 1997, the agency prohibited clear-cutting and ORVs in 59,000 acres of grizzly bear "secure areas" (Wilkinson 1999). Thus logging on the Targhee National Forest was halted as a result of litigation over "threatened" grizzly bear habitat as a result protection afforded by the Endangered Species Act.

Hardrock Mining

Located on the Gallatin National Forest north of Yellowstone National Park, mining has occurred in the New World Mining District for over a century (Willcox 1995). A Superfund site on that District leached chemicals into the park. During the 1990s, gold mining was planned on the District but of far greater scale than before (Willcox 1995). This 1990s gold mining site was just 1.7 km outside the northern boundary of the park (Humphries 1996, Dykstra 1997, Ferre 1995, Nimmo et al. 1998, Lockhart 1997) (Figures 25 and 26). To stop this initiative, President Clinton brokered a land exchange along with other assets worth $65 million. The deal involved a $22.5 million trust fund to clean up the mining mess. The effort was finally concluded when 1,426 acres of remaining underground rights sold for $9 million during 2009-2010 (Repanshek 2010).

Figure 25. Henderson Mountain, Gallatin National Forest, the location of the once proposed New World mining project. This proposed mine was within the New World Mining District which witnessed mining for a century. From Ecoflight. (http://switchboard.nrdc.org/blogs/willcox/bruce_gordon_ecoflight_and_the_htm

Figure 26. Mining waste flowing from the New World Mining District in 2001. From US Geological Survey (http://pubs.usgs.gov/wri/wr10042611/htdocs/coverjpg.htm)

Geothermal Exploitation

The Church Universal and Triumphant purchased a 120,000 acre ranch on the northern border of Yellowstone National Park in 1981 (Figure 27). They planned to use underground hot water reserves at LaDuke Hot Springs, just ten miles north of the Park's Mammoth Geyser Basin. However, there was concern that such pumping might jeopardize Mammoth Springs and possibly other hot springs in the park (Ness 1988, Barrick 2009). Keiter (1993) describes Congressional attempts to deal with this issue through legislation. Specifically, H.R. 1137, the Lost Creek Land Exchange Act of 1994, authorized the Secretary of Agriculture (DOA) to acquire lands or interests in lands owned by the Church. By 1998/1998, portions of the Royal Teton Ranch were controlled by the DOA through land sale and easements (Barrick 2009). The church gave up its rights in 1999 to tap into the geothermal energy source. By 2006, an agreement was signed that curtailed the Ranch's use of geothermal energy and permitted ungulates to graze on their property (Barrick 2009).

Figure 27. Church Universal and Triumphant near Corwin Springs, Montana.
(http://cache.daylife.com/imageserve/04YM6hnb5xd2x/610x.jpg)

Oil and Gas Exploration and Extraction

One of the most contentious GYE controversies was the potential expansion of oil drilling platforms in the Jonas Field and the Pinedale Anticline near Pinedale, Wyoming (Mitchell 2005). The Upper Green River Valley is the winter home for more than 100,000 big game animals (Berger 2004). It is also the largest block of public land winter range in the GYE (Thompson et al. 2004).

The Pinedale Anticline is 56.3 km (35 miles) long and 9.7 km (6 miles) wide and forms a natural corridor between the Wind River and Wyoming Ranges. In terms of area, the Anticline is 798 km^2 (308 mi^2) (Sawyer et al. 2002). The Anticline is one of the richest known oil and gas deposits in the nation. Eighty percent of the land and 83% of the minerals are owned by the BLM (Sawyer et al. 2002). According to a company that has been drilling the Anticline for 40 years, it contains 20 trillion cubic feet of natural gas, enough to supply the entire United States for one year (Mitchell 2005). Prior to the 1990s, there were 30 active wells on the Anticline but by the 2000s there were 662 wells on 348 well pads. One BLM alternative identified in their 2000 Final Environmental Impact Statement was to allow another 4,400 wells to be drilled there (Wyoming Outdoor Council et al. 2007).

The fate of the Pinedale Anticline is not encouraging if one observes what transpired at the 30,000 acre Jonah Field just to its south, one of the largest U.S. onshore gas field discoveries in the later half of the 20th century (Figure 28). In the five years prior to 2004, 468 wells were drilled, and in the process, 14% of the 116.5 km^2 area was bulldozed for well-pads, roads pipelines, and production facilities (Shogren 2004). The wildlife impacts of all this proposed and ongoing development are not well understood (Sawyer et al. 2004).

Figure 28. Jonah Field near Pinedale, Wyoming. From Ecoflight (http://ecoflight.org/issues/gallery/Wyoming-Pinedale-Anticline-and-Jonah/?img=9)

President George W. Bush's Executive Order #13212 of May 2001 said agencies shall "expedite review of permits or take other actions as necessary to accelerate the completion on energy-related projects" (Berger 2003). By 2002, some 1990s environmental safeguards in place for oil and gas exploration on BLM lands were lifted. Companies like Questar, Ultra and Shell were granted higher well densities, year-round operations, and relaxed pollutant limits (Glick 2007). The Energy Policy Act of 2005 (42 U.S.C. §§ 13201 et seq.) exempted energy companies from many environmental laws. New regulations stemming from the Act speeded up the application process with "categorical exclusions" (Glick 2008). By 2004, there were 2,200 wells pumping in the Upper Green River Valley (Maffly 2003). From 2001-2007, BLM approved 33,000 applications for drilling permits in the Rocky Mountain region (Glick 2008). However, the Obama administration has pledged to give lease applications on the Pinedale Anticline, Jonas Field, and elsewhere a more thorough environmental review (Daly 2010).

A small band of pronghorn antelope (*Antilocapra americana*) is intertwined with the Upper Green River Valley and its oil and gas extraction. Despite subdivisions, fences, roads, oil and gas development, pipelines, and other obstacles, this band of about 200 animals still travels from their summer home in Grand Teton National Park to their historic winter range in the Upper Green River Valley (Figure 29) and further south in the Red Desert. In so doing, they wind their way through oil and gas development

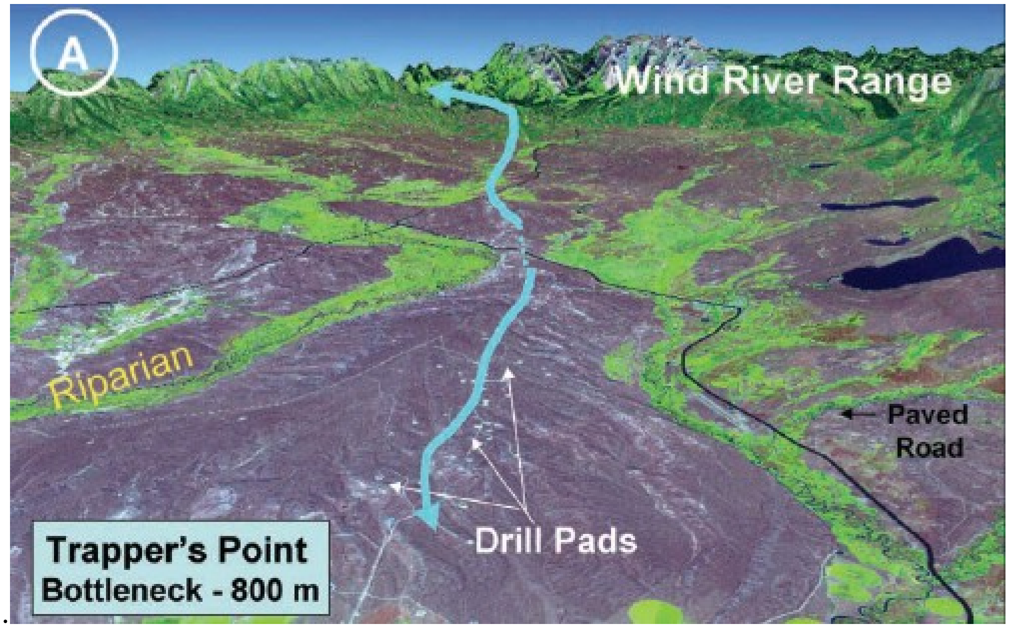


Figure 29. Trapper's Point bottleneck for pronghorn antelope migration (From Berger 2004)

in the Pinedale Anticline and the Jonah Field. This pronghorn corridor issue has come to the attention of the American public via articles in popular magazines (e.g., Mitchell 2005; Glick 2007, 2008; Kemper 2008) and the National Geographic Society Television Series "Great Migrations" which aired in 2011. The projected impacts of this drilling on the sagebrush-dominated biotic communities are considerable (Thompson et al. 2004).

The Western Governor's Association unanimously approved a resolution (07-01) entitled *Protecting Wildlife Corridors and Crucial Habitat in the West*. It also instructed the Association to "identify key wildlife migration corridors and crucial habitats in the West and make recommendations on needed policy options for preserving those landscapes."

By June 2008, the Association adopted a report entitled *Western Governor's Association Wildlife Corridor Initiative* (Anonymous 2008).

Government officials for Grand Teton NP, the National Elk Refuge in Jackson Hole, and the Bridger-Teton National Forest signed a symbolic letter in early February, 2008, agreeing to cooperate in preserving this long-trekking migratory pronghorn herd. BLM, however, who owns 90% of the land along the migratory corridor, did not participate in the signing (Hatch 2008). On May 31, 2008, the Forest Supervisor of Bridger-Teton National Forest signed an amendment to a forest management plan agreeing to protect 45 miles of pronghorn corridor that it manages (Hamilton 2008).

The Wyoming Range and Legacy Act of 2007 (S. 2229) was signed into law as part of the Omnibus Public Land Management Act of 2009 (123 Stat. 991-1456; P.L. 111-11). It withdrew 1.2 million acres in the Wyoming Range, within the Bridger-Teton National Forest, from oil and gas leasing and encouraged private land owners to voluntarily sell their leases (Anonymous 2009). On October 5, 2012, 58,000 remaining acres in the Wyoming Range were protected from drilling (Anonymous 2012). There was internal talk within the Obama administration about making the Red Desert a national monument (Casimiro 2010) and this actually happened.

To sum up, the NGO community concerned with the Upper Green River Valley did many things that were positive: they organized, they instigated national publicity, they met with diverse interest groups, they helped write planning documents, they contacted state and federal agencies, they challenged oil and gas leases, they helped inform the scientific community, they enlisted the support of the Western Governor's Association, and they secured funds from the Department of the Interior. However, the problem is not over.

Threats Nationally

Logging: Redwoods National Park, California

Redwoods National Park, California, was established in 1968 but only the lower reaches of several watersheds were included within its park boundary. At this time, logging on adjacent private lands was causing sediment to flow into the park. Congress in 1978 expanded the park boundary by 40,000 acres which incorporated more of its watershed area within its confines (Crabtree 1975, Agee 1980) (Figure 30). This legislation, incidentally, gave NPS the responsibility to deal with external threats but not the authority (Keiter 1989). Private land secured in 1968 (58,000 acres) plus the 1978 additions (30,000 acres) cost the government $1.5 billion (Mackintosh 1991). The removal of logging roads and other landscape restoration activities have succeeded in creating a more aesthetically pleasing park landscape (Havlick 2006).

Figure 30. Logged landscape approximately 0.25 miles outside the boundary of Redwoods National Park, California, in 1975. The treeline in the background was the park boundary at that time. The park boundary was expanded in 1978 to subsume this logged area. Photo by National Park Service. From Shafer (1994).

Resort Building: Mineral King, California

Mineral King is a 7.5 mile long glacial valley in the southern portion of California's Sierra Nevada Mountains. The valley is the location of one of the most famous examples of conflict between the US Forest Service and environmentalists. In the 1960s, the Walt Disney Company proposed to build a ski resort in the valley. As the size of the proposed resort expanded, the development project was opposed by the Sierra Club. When public opposition to the development plan grew, Congress added the valley to Yosemite National Park in 1978 (Bryson 1972, Sax 1973).

Agriculture: Everglades National Park, Florida

Everglades National Park, Florida, was authorized in 1934 and established in 1947. Since that time, the park as been severely influenced by insufficient freshwater inflow (Kushlan 1979, 1987). This was caused by water being diverted for irrigation by the sugar industry, urban development and flood control (Harwell et al. 1996, Gunderson et al. 1995). In 2000, the U.S. Congress agreed to fund a multi-billion dollar Comprehensive Everglades Restoration Plan (Ansson 2000) but implementation has been problematic. The George W. Bush Administration removed Everglades National Park from UNESCO's List of World Heritage in Danger in 2007 (Lowry 2009) but under the Obama administration it was put back on that List in July 2010. Also see Zaslowsky and Watkins (1994) and Balint et al. (2011: 34-42).

Commercial Development: Zion National Park, Utah

A commercial developer, World Odyssey Inc., planned to build a giant seven-story movie theatre and retail complex next to the south entrance of Zion National Park, Utah, consisting of an 80-room motel, spa, pool, gift shops, lounge and restaurant plus and parking space for 275 automobiles. A later modified plan would accommodate 5,000 square feet of retail shops and 169 automobiles. Environmentalists complained that the complex would create a visual obstruction that would bother park campers staying at the park's Watchman Campground. The development would also reportedly create more traffic, noise, litter, and air and light pollution. The town of Springvale wanted the development because of its economic benefits (Giesser 1993). The Springvale Town Council granted their approval to begin construction during May 1991 (Anonymous 1991a). Environmentalists went to court to stop the development during August 1991 (Anonymous 1991b). NPS unfortunately did not take legal action to stop the development. The complex was built regardless of NPS's wishes. Giesser (1993) argued that NPS could have fought this development by invoking a public nuisance action under federal common law or state law.

Conclusion

As the above examples illustrate, experience in the GYE and elsewhere has proven that some approaches work for mitigating external threats: stopping private land development (by buying easements), stopping logging and roading (by using litigation), stopping hardrock mining (through land exchange and purchase), reducing or stopping oil and gas exploration and development (via legislation), stopping grazing (by phase out and purchase), stopping geothermal exploration and development (through legislation and persuasion), and halting resort development (by adding land to a park, exchanging land, or preventing the US Forest Service from granting resort permits). For mining, other management solutions can be employed including regulating access, non-approval of a plan of operations and withdrawal of future exploration opportunities.

REFERENCES

Agee, J.K. 1980. Issues and impacts of Redwoods National Park expansion. *Environmental Management* 4 (5): 407-423

Anonymous. 1991a. Giant-screen theatre outside Zion National Park Okd. *Los Angeles Times*, May 25. Available at: http://articles.latimes.com/1991-05-25/mn-2038_1_zion-national-park Accessed November 2010.

Anonymous. 1991b. Lawsuit seeks to stop theatre outside park. *New York Times* August 22. Available at: http://www.nytimes.com/1991/08/22/us/lawsuit-seeks-to-stop-theatre-outside-park.html Accessed November 2010.

Anonymous. 2008. Western Governor's Association Wildlife Corridor Initiative. Available at: http://www.westgov.org/wga_reports.htm. Accessed October 2008.

Anonymous. 2009. The Wyoming Range Legacy Act: Chronology of a Great Success. Available at: http://www.wyomingoutdoorcouncil.org/html/press-room/pdfs/Newsletters/2009Summer-FL.pdf. Accessed February 2011.

Anonymous. 2011. Conservation easements: conservation easements across large landscapes. Available at: http://www.nature.org/aboutus/privatelandconservation/conservationeasements/easement-across-landscapes.xml Accessed August 2011.

Anonymous. 2012. Wyoming Range: No drilling in Hoback! Available at: http://www.greateryellowstone.org/issues/lands/Feature.php?id=57. Accessed October 2012.

Ansson, R.J. Jr. 2000. Protecting and preserving our national parks: the Everglades National Park Restoration Project. *Virginia Environmental Law Journal* 19: 121-159.

Balint, P.J., R.E. Steward, A. Desai, and L.C. Walters. 2011. Wicked Environmental Problems: Managing Uncertainty and Conflict. Island Press, Washington, D.C.

Barrick, K.A. 2009. Protecting the geyser basins of Yellowstone National Park: toward a new national policy for a vulnerable environmental resource. *Environmental Management* 45 (1): 192-202.

Berger, J. 2003. Is it acceptable to let a species go extinct in a national park? *Conservation Biology* 17(5): 1451-1454.

Berger, J. 2004. The last mile: how to sustain long-distance migration in mammals. *Conservation Biology* 18 (2): 320-331.

Bryson, W.D. 1972. Mineral King: a study in Forest Service decision making. *Ecology Law Quarterly* 2: 493-531.

Casimiro, S. 2010. 14 New Monuments Considered by Obama Administration. Available at: http://wwwadventure-journal.com/2010/02/14-new-national-monuments-considered-by-obama-adminstration/ Accessed February 2011.

Compas, E.D. 2007. 'The Next Best Place': Private Land Planning at Yellowstone's Periphery. PhD Dissertation, University of Wisconsin, Madison.

Crabtree, T.J. 1975. The redwoods: to preserve and protect. *Environmental Law* 5: 283-310.

Daly, M. 2010. Ken Salazar announces tougher oil and gas regulations. Available at: http://www.huffingtonpost.com/2010/01/06/oil-and-gas-leases-ken-sa_n_413556.html Accessed February 2011.

Dykstra, P. 1997. Defining the mother lode: Yellowstone National Park v. the New World Mine. *Ecology Law Quarterly* 24: 300-321.

Ferre, J.A. 1995. Forest Service regulations governing mining: ecosystem preservation versus economically feasible mining in the national forests. *Journal of Energy, Natural Resources and Environmental Law* 15: 351-383.

Giesser, J.L. 1993. Comment: The National Park Service and external development: addressing park boundary-area threats through public nuisance. *Boston College Environmental Affairs Law Review* 20: 761-809.

Glick, D. 2007. End of the road? *Smithsonian Magazine*: January.

Glick, D. 2008. Putting the "public" back in public lands. *National Wildlife* October/ November: 24-30.

Glick, D., M. Carr and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana.

Glick, D., and C. Freese. 2004. Yellowstone: a 130-year experiment in integrated conservation and development. In T.O. McShane and M.P. Wells (eds), Getting Biodiversity Projects to Work, pp. 124-153. Columbia University Press, New York.

Gude, P.H., A.J. Hansen, R. Rasker, and B. Maxwell. 2006. Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77: 131-151.

Gunderson, L.H., S.S. Light and C.S. Holling. 1995. Lessons from the Everglades. *BioScience Supplement* 45: S66-S73.

Hamilton, C. 2008. Decision Notice and Finding of No Significant Impact: Pronghorn Migration Corridor Forest Plan Amendment. Available at: http://www.fs.us/r4/btnf/projects/2008/pronghorn/PronghornDN.pdf. Accessed September 2008.

Harwell, M.A., J.F. Long, A.M. Bartuska, J.H. Gentile, C.C. Harwell, V. Myers, and J.C. Ogden. 1996. Ecosystem management to achieve ecological sustainability: the case of South Florida. *Environmental Management* 20(4): 497-521.

Hatch, C. 2008. Preserving the pronghorn corridor into Jackson Hole. *Jackson Hole News & Guide*, February 6. Available at: http://www.jacksonholenews.com/article.php?art_id2711. Accessed September 2008.

Havlick, D. 2006. Removing roads: the redwoods experience. *Conservation* 3 (4): 28-33.

Humphries, M. 1996. New World Gold Mine and Yellowstone National Park. Congressional Research Service 96-669 ENR.

Johnson, V.K. 2001. Trends in rural residential development in the Greater Yellowstone Ecosystem since the listing of the grizzly bear, 1975-1998. *Yellowstone Science* Spring: 2-9.

Keiter, R.L. 1989. Taking account of the ecosystem on the public domain: law and ecology in the Greater Yellowstone Region. *University of Colorado Law Review* 60: 923-1007.

Keiter, R.B. 1993. The Old Faithful Protection Act: Congress, national park ecosystems, and private property rights. *Public Land Law Review* 14: 5-39.

Keiter, R.B. and M.S. Boyce. 1991. Greater Yellowstone's future: ecosystem management in a wilderness environment. In R.B. Keiter and M.S. Boyce (eds), The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage, pp. 379-415. Yale University Press, New Haven.

Kemper, S. 2008. Perilous journeys. *National Wildlife* October-November: 42-50.

Kushlan, J.A. 1979. Design and management of continental wildlife reserves: lessons from the Everglades. *Biological Conservation* 15: 281-290.

Kushlan, J.A. 1987. External threats and internal management: the hydrological regulation of the Everglades, Florida, USA. *Environmental Management* 11(1): 109-119.

Leopold, A. 1935. Game Management. Scribner's Sons, New York.

Lockhart, W.J. 1997. External threats to our national parks: an argument for substantive protection. *Stanford Environmental Law Journal* 6: 3- 73.

Lowry, W.R. 2009. Repairing Paradise: The Restoration of Nature in America's National Parks. Brookings Institution Press, Washington, D.C.

Mackintosh, B. 1991. The National Parks: Shaping the System. U.S. Government Printing Office, Washington, D.C.

Maffly, B. 2003. Where the antelope (and the oil companies) play. *High Country News*, August 18.

Maughan, R. 1997. History of the Targhee timber salvage program. Available at: http://ww.forwolves.org/ralph/targhst.htm. Accessed September 2010.

Merrill, T. and D.J. Mattson. 2003. The extent and location of habitat biophysically suitable for grizzly bears in the Yellowstone region. *Ursus* 14: 171-187.

Mitchell, J.G. 2005. All fired up. *National Geographic* 208(1):92-113.

National Park Service. 1980. State of the Parks 1980: A Report to the Congress. National Park Service, U.S. Department of the Interior, Washington, D.C.

Ness, D. 1988. Protection of the geothermal resource of Yellowstone National Park-a case study. *Public Land Law Review* 9: 145-157.

Nimmo, D.R., M.J. Willcox, T.D. Lafrancois, P.L. Chapman, S.F. Brinkman, and J.C. Greene. 1998. Effects of metal mining and milling on boundary waters of Yellowstone National Park, USA. *Environmental Management* 22(6): 913-926.

Parmenter, A.W., A. Hansen, R.E. Kennedy, W. Cohen, U. Langner, R. Lawrence, B. Maxwell, A. Gallant, and R. Aspinall. 2003. Land use and land cover change in the Greater Yellowstone Ecosystem: 1975-1995. *Ecological Applications* 13(3): 687-703.

Pritchard, J.A. 1999. Preserving Yellowstone's Natural Conditions: Science and the Perception of Nature. University of Nebraska Press, Lincoln.

Reese, R. 1984. Greater Yellowstone: The National Park and Adjacent Wildlands. Montana Magazine, Helena, Montana.

Repanshek, K. 2010. Land deal closes the book on the New World Mine proposed on Yellowstone National Park's doorstep. Available at: http://www.nationalparktraveler.com/2010/land-deal-closes-book-new-world-mine-pro... Accessed February 2011.

Sawyer, H., F. Lindzey, D. McWhirter, and K. Andrews. 2002. Potential effects of oil and gas development on mule deer and pronghorn populations in western Wyoming. *Transactions of the North American Wildlife and Natural Resources Conference* 67: 350-365.

Sawyer, H., R. Nielson, L. McDonald, and D. Strickland. 2004. Sublette mule deer study (Phase II): Long-term monitoring plan to assess potential impacts of energy development on mule deer in the Pinedale Anticline project area. Annual Report. Available at: http://www.west-inc.com/reports/papa_2004_report.pdf. Accessed 9-5-2008.

Sax, J.L. 1973. Standing to sue: a critical review of the Mineral King decision. *Natural Resources Journal* 13: 76-88.

Shafer, C.L. 1994. Beyond park boundaries. In E.A. Cook and H.N. van Lier (eds), Landscape Planning and Ecological Networks, pp. 201-223. Elsevier Science, Amsterdam.

Shogren, E. 2004. Wildlife, gas fields squeeze into a key migratory corridor. *Los Angeles Times.* February 29. Available at: http://www.articles.latimes.com/2004/feb/29/nation/na-drill29. Accessed September 2008.

Thompson, J.L., T.S. Schaub, N.W. Culver and P.C. Aengst. 2004. Wildlife at a crossroads: energy development in western Wyoming. In A.Wondrak Biel (ed), Greater Yellowstone Public Lands: A Century of Discovery, Hard Lessons, and Bright Prospects, pp. 198-217. Proceedings of the 8th Biennial Scientific Conference on the Greater Yellowstone Ecosystem, October 17-19, 2005, Mammoth Hot Springs Hotel, Yellowstone National Park. Yellowstone Center for Resources, Yellowstone National Park. Available at: http://www.greateryellowstonescience.org/sites/default/files/references/8thConf_Thompson_et_al.pdf Accessed July 2011.

Theobald, D. M. 2000. Fragmentation by inholdings and exurban development. In R. L. Knight, F W. Smith, S. W. Buskirk, W. H. Romme, and W. L. Baker (eds), Forest Fragmentation in the Southern Rocky Mountains, pp. 155-174. University Press of Colorado. Boulder.

Thompson, J.L., T.S. Schaub, N.W. Culver and P.C. Aengst. 2004. Wildlife at a crossroads: energy development in western Wyoming. In A.Wondrak Biel (ed), Greater Yellowstone Public Lands: A Century of Discovery, Hard Lessons, and Bright Prospects, pp. 198-217. Proceedings of the 8th Biennial Scientific Conference on the Greater Yellowstone Ecosystem, October 17-19, 2005, Mammoth Hot Springs Hotel, Yellowstone National Park. Yellowstone Center for Resources, Yellowstone National Park. Available at: http://www.greateryellowstonescience.org/sites/default/files/references/8thConf_Thompson_et_al.pdf Accessed July 2011.

US Forest Service. 2006. Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests. Final Environmental Impact Statement. US Forest Service, Department of Agriculture, Washington, D.C.

Walder, B. 1999. Hand-wringing and thumb-twiddling: Wither the moratorium? The Road-RIPorter January/February. Available at: www.wildlandscpr.org/files/iploads/RIPorter/rr_v4-1.pdf Accessed September 2010.

Wilkinson, T. 1999. The Forest Service sets off into uncharted territory. *High Country News*, November 8. Available at: http://lobby.la.psu.edu/068_Roads_in_National_Forests/ Organizational_Statements/BRC/... Accessed September 2010.

Willcox, L. 1995. The Yellowstone experience. *BioScience Supplement* 45(6): S79-S83.

Wyoming Outdoor Council et al. 2007. Comments on the Draft Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project. Available at: http://www.wyomingoutdoorcouncil.org/html/what_we_do/air_quality?pdfs/Draft%20PASEIS%20Comments.pdf Accessed July 2011.

Zaslowsky, D. and T.H. Watkins. 1994. These American Lands: Parks, Wilderness, and the Public Lands. Island Press, Washington, D.C.

CHAPTER 5: LAND USE PLANNING

"We have confidence that, because of their mutual concern, such activities [harmful land use] in the vicinity of the public lands will be appropriately regulated by state and local authorities in close cooperation with the Federal agencies."

Public Land Law Review Commission 1970: 82

Introduction

According to Primm and Clark (1996: 157), the central question in the Greater Yellowstone Ecosystem (GYE) policy debate is a scientific one: "how do we manage our wild areas in light of all the demands and encroachments civilization makes upon them?" The influx of new residents to the periphery of natural areas creates governance challenges if we were to maintain the integrity of the reserves (Kretser et al. 2009). Shafer (2010) identified a systematic approach to improve biological diversity conservation in U.S. national parks by increasing effective park size, reducing external threats, and improving habitat connectivity. Let us review some basic land use planning notions and then some specific potential tools.

Land use planning is now a discipline (Platt 2004) and its practice remains a contentious topic in the United States (Diamond and Noonan 1996). It is based on one common sense assumption: "A penny of conservation prevention is worth a pound of restoration cure" (Weber 2004:3). From an ecological perspective, its purpose was expressed by Forman (2001: vi): "creating a mesh of nature and people where both thrive over the long term." Travis (2007:4) expressed a pessimistic view, "Traditional land use planning has done little to mitigate the negative effects of rapid western growth..." New approaches to land use planning are needed to achieve more reductions in biological diversity losses. The following characterization does not have to always prevail: "Plans are only as good as the action they lead to. Too many plans are long on content and short on delivery" (Davey 1998: 41). Some government agencies write lengthy plans but do not get to the implementation stage. The plan becomes the work product rather than representing only the tool to guide subsequent work. Today, there is increasing discussion about how to do large landscape conservation (McKinney et al. 2010). Land use planning and conservation biology have different roots (Nassauer 2006).

Many land planning decisions in the United States are made with little concern about their ecological impacts (Dale et al. 2000). Professional land use planners need to be cognizant of biological diversity concerns (Beatty 2000). Some western U.S. counties will rely on biodiversity data for planning decisions only if it is available and usable (Theobald et al. 2000). Concepts in conservation biology, the applied science whose goal is to preserve biological diversity, have been offered as planning guidance in science journals and books (e.g., Shafer 1990, Noss et at. 1997, Peck 1998, Soulé 1991).

“We must appeal for an integrated approach, a broader incorporation of disciplines in planning, if what we want to protect what is to be protected” (Olindo 1989:251). Few planners, managers, scientists, or resource specialists would disagree with this viewpoint. However, to achieve integration, the planning literature suggests that four principles are required: holism, interconnectedness, goal-orientedness, and a strategic outlook (Margerum 1997). But Margerum concludes there is difficulty in translating such principles into practice. Activities that reportedly will help achieve such translation include public participation, stakeholder involvement, interorganizational coordination and conflict resolution (Margerum 1997). The details of various land protection approaches can seem overwhelming but can be boiled into four basic categories: acquisition, zoning, other regulation and easements (Wilkosz 2010: 110).

Approaches

National Planning

According to Babbitt (2005), the late Senator Henry Jackson introduced the Land Use Policy and Planning Assistance Act. This action occurred on January 29, 1970 and was titled S.3354 (Daly 1996). It passed the Senate in 1972 and 1973, while the companion

House bill was defeated in 1974 (Babbitt 2005). The bill intended to create a grants program that would fund the states to create state land use plans (Daly 1996). According to Reilly (1971), the President introduced a similar bill called the National Land Use Policy Act of 1971 (S 992 and HR 4332). Daly (1996) describes the differences between Senator Jackson's and the Administration's proposed legislation. None of this legislation ever became law, and as Babbitt (2005) points outs, Congress has not yet revisited the subject. Babbitt does describe activities during his administration that nevertheless involved land use planning. Note that S. 3354 intended that states assure that incompatible land use did not damage nearby federal land like national parks and wildlife refuges (Daly 1996). Senator Jackson's own words are worth repeating (Daly 1996: 36):

> To a very great extent, all environmental management decisions are intimately related to land use decisions. All environmental problems are outgrowths of land use patterns. The collective land use decisions which the nation makes in the future will dictate our success in environmental management; and the land use decisions of today will shape the environment future generations will enjoy.

Some conservation biologists argue that the United States still needs national land use planning (Baldwin and Trombulak 2007). Unfortunately, the time has not yet arrived (Kayden 2000). Just as the federal government was responsible for so many positive initiatives to both develop and conserve the West (Udall 1964), should this same body play a major role in thwarting the continued fragmentation of the GYE? When dealing with the "commons," freedom can spell disaster for the environment. "Ruin is the destination toward which all men rush, each pursuing his own interest in a society that believes in the freedom of the commons. Freedom in the commons brings ruin to all" (Hardin 1968: 1244).

State Planning

As Keiter (1993:33) explained, "Congress ordinarily has not relied upon state law to protect national park resources." Any authority that allows local governments to make land use decisions usually stems from state enabling laws. It is expressed in the form of zoning and growth management laws (Breggin and George 2003). In *Kelo vs. New London (04-108) 545 U.S. 469 (2005)*, the Supreme Court conceded that regional planning is a state issue.

Although State governments have the authority to protect land through public trust and wildlife trust doctrines, in practice their clout is limited (Wilkosz 2010: 65). Schneebeck (1986) concluded that Wyoming state legislation is insufficient to deal with the dangers facing the GYE grizzly bear. Even if this situation changed, Schneebeck continued, the States have limited jurisdiction over what happens on federal property. Furthermore, Schneebeck thought a local response by itself would not work. Sometimes coordination with the states is essential. In order to begin a policy of preventing bison from wandering out of Yellowstone National Park, even though the adjacent property was a national forest, the park was forced to sign "boundary control agreements" with the three adjoining states (Yellowstone National Park 1997).

The states are getting involved in land use planning. The Western Governor's Association unanimously approved a resolution (07-01) entitled *Protecting Wildlife Corridors and Crucial Habitat in the West*. The resolution also instructed the Association to "identify key wildlife migration corridors and crucial habitats in the West and make recommendations on needed policy options for preserving those landscapes." By June 2008, the Association adopted a report entitled *Western Governor's Association Wildlife Corridor Initiative* (Anonymous 2008). Other states have been involved in land use planning activities (Callies 1994).

Regional Planning

"At present, there is little comprehensive regional or area planning" concluded the Public Land Law Review Commission (1970: 64) more than 40 years ago. They recommended that regional commissions be created. "Regional commissions created to facilitate continuous joint participation in land use planning would bring stand and local planning and zoning for private and non-Federal public lands into a continuum with Federal land use planning, on a regional scale. Although such an arrangement would not assure genuine integration of planning for different classes of Federal lands in the region as long as their regional administration remains organizationally separated, the regional commission arrangement would at least provide a single point of contact for states..." (p. 64). The existing Greater Yellowstone Coordinating Committee (federal, created in

1960) and the Greater Yellowstone Coalition (private, created in 1983) are not regional commissions.

Good regional planning in this country is very rare (Platt 2004). McKinstry et al. (2006:941) reminded us about the effectiveness of the approach taken upon creation of Adirondacks Forest Reserve in 1885. Today, the state regulates development and the Adirondack Park Agency reviews and approves some regional development projects and local land use plans. More information is available about the Forest Reserve in Porter et al. (2009). Managing by “nature districts” has been suggested by Elmendorf (2003). Bioregional planning has been discussed (Brunckhorst 2000) but how to do it for the GYE is not an easy question to answer.

County and Municipal Planning

The federal government has not embraced land use planning because it has long viewed such activity, especially private land regulation, as the domain of states and local governments (Karkkainen 1997: 57). Zoning spread to the county level after World War II (Kuperberg 1978). Every county bordering Yellowstone National Park has a comprehensive land use plan (Glick 1999) but not all GYE communities have one (Glick and Alexander 2000). This does not mean such plans are good, enforceable, or even followed. Sometimes counties fail to follow their own land use plans. For example, when the county commissioners of Gallatin County, Montana, approved development along the western border of Yellowstone National Park, the Greater Yellowstone Coalition took them to court because their activities seemed oblivious to the welfare of park biota (Travis 2007). Private land development would be better controlled with county zoning. County planning is conducted largely in isolation from what other counties are doing (Hernandez 2004). Private land in and next to the town of Jackson, nicely situated near the National Elk Refuge in Jackson, Wyoming, can sell for 1 million dollars per acre (Chadwick 2000). According to Gude et al. (2006:148), "15 of the 20 GYE counties have no county–wide zoning plan, and 4 GYE counties have no full-time planners on staff." Compas (2012) explains how some NGOs are becoming effective in influencing county development decisions in Gallatin County, Montana. As Gude et al. (2007:1016) explained, "Existing growth management policies will provide minimal protection to biodiversity in the GYE."

Probst et al. (1990:173) said, "Using a variety of development management techniques, local governments, depending on state enabling authority, usually can regulate most major aspects of projects on private land that might affect a national park." They go on to outline techniques. They also point out that some parks like Cape Cod National Seashore, Massachusetts, have the "legal authority to review and approve local plans that regulate private development." Wilkosz (2010) reviews federal, state and local land use protection options. Few U.S. national parks have followed the lead of Rocky Mountain National Park, Colorado, which hired one staff person to work solely on adjacent land issues (Gamble 1999). One problem is that municipal and county governments often lobby against state planning, or any legislation that facilitates regional cooperation, because it results in less local control (Travis 2007). Wallace (1999) offers ideas on how to influence county and municipal land use decisions that may affect a protected area. The NPS can offer planning assistance to local communities, especially gateway cities, to help them create a plan. This little known service might go a long way towards linking local communities to park resources. Probst and Rosen (1997) suggest how park Superintendents can form effective partnerships with surrounding human communities. There are two types of local zoning that would most benefit national parks: “corridor” zoning and “concentric” zoning (Wilkosz 2010: 221).

The Public Land Law Review Commission (1970:82) seemed optimistic about the prospects for regulating outside-boundary land uses that caused harm to public lands: “We have confidence that, because of their mutual concern, such activities in the vicinity of the public lands will be appropriately regulated by state and local authorities in close cooperation with the Federal agencies.” What has happened since then begs the question of whether such optimism was warranted. The Commission also said, “If cooperation is not prompt and successful, the agencies should be empowered to take direct action in furtherance of the preservation of the public land environment” (p. 82).

Land Management Agency Planning

As Coggins (1990) explained, Congress did not require any federal agency to perform systemwide planning for U.S. national forests until 1974 when the Forest and Rangeland Renewable Resources Planning Act (16 U.S.C. 1601 et seq.) was passed. The subsequent National Forest Management Act of 1976 (16 U.S.C. 472a et seq.) required the USFS to include the interested public in any planning activity (Wagner 2006) parroting the intent of the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.). BLM is required to produce plans as a result of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.). The US Forest Service and BLM plans are legally binding, while those of NPS and USFWS are not (Coggins 1990). The USFS is required to coordinate its forest planning with local governments but it retains authority to make the final decisions (Hart 1995).

Land use planning conducted by the BLM, the USFS and NPS is fundamentally different from that done by urban and regional political entities. The key to the success of an agency's plan is "the degree to which it meets the goals of the agency, to be sure, but it is also the degree to which it achieves an acceptable political balancing of contending group demands" (Culhane and Friesema 1979: 73-74). The decentralized nature of planning in some federal land management agencies creates additional political balancing oversight. "Different resource interests have different degrees of access to the central, regional, and field units. What seems to be emerging...is a system of multiple vetoes over positive agency decisions" (Culhane and Friesema 1979: 73-74). However, things may be changing for landscape level thinking. One facet of the USFS's new *Open Space Conservation Strategy* is to "acquire and exchange lands within National Forest System boundaries to reduce islands and fingers of urban development within wildlands" (US Forest Service 2007).

There was a 1987 initiative of NPS Director William Mott to support studies to evaluate how park resources are affected by development activities on adjacent, nonpark lands. The task force was led by Dr. Christine Schonewald-Cox who produced an NPS plan (Schonewald-Cox 1987). In spite of the plan's foresight, implementation was short-lived. It was NPS Director William Mott, incidentally, who called for the development of a regional plan for managing the GYE in 1985 (Clark and Zaunbrecker 1987).

The land use patterns in the GYE may be suitable for an ideal biosphere reserve according to Barbee and Varley (1985): Yellowstone, Grand Teton, the Parkway and USFS wilderness areas would be the core, the seasonal wildlife ranges and the Island Park Geothermal Resource Area would be the buffer zone and the multiple use national forest land and private lands would be the transition area. One point seems paramount: "A network of linked habitats that maintains effective connectivity to populations and ecological processes is unlikely to be achieved by ad hoc reservation and restoration of linkages in response to an ongoing series of development proposals" (Bennett 2003: 153).

Ecosystem Management and the Vision Document

A Leopold Committee (Leopold et al. 1968) recommended that the "ecosystem" be the basis for managing national wildlife refuges. Van Dyne (1969), a scientist, and Caldwell (1970), a policy analyst, also advocated the ecosystem concept as the basis for land management. However, the notion of "ecosystem management" surfaced later (e.g., Christensen et al. 1996). While there is no widely accepted definition of ecosystem management, its basic concerns include being mindful of the following: managing using an ecosystem perspective, looking beyond political and administrative boundaries, managing for the entire suite of biological diversity, data collection, monitoring, adaptive management, interagency cooperation, institutional change, humans as part of nature and values (Grumbine 1994, cited in Olheiser 1997). It has generated a large literature but most of the controversy is not about science (Lackey 1998).

Ecosystem management has been embraced as the new hope for managing large landscapes (e.g., Sexton et al. 1999). It was adopted in principle by 18 U.S. federal land management agencies (Morrissey et al. 1994). The key land management agencies, including NPS, USFS, USFWS and BLM, signed a Memorandum of Understanding in 1995 that said they would promote ecosystem management (Federal Interagency Ecosystem Management Task Force 1995). While the Clinton Administration tried to promote ecosystem management (Frampton 1996), Congress never embraced the concept. Each agency went on to define the concept differently (Haeuber 1996). Ecosystem management has its critics in academia and elsewhere. For example, Stanley (1995: 260), a biologist, claimed its assumptions were “presumptuous or false.” Coggins, a lawyer (1995:1, quoted in Laitos and Carr 1999), said “No amount of semantic refining can change the fact that ‘ecosystem management’ will always be an arbitrary, artificial, and amorphous concept.” Clark and Minta (1994:11), natural resource policy analysts, maintained its concepts at that time consisted of “nebulous imagery and ideology” (Clark and Minta 1994: 11). Fitzsimmons (1996), a geographer, disputed the notion of potential management because he felt the ecosystem concept was too vague**.** In spite of such critics and concerns, the majority of academics and practitioners see positive aspects to ecosystem management (Clark and Minta 1994: 56-63). Textbooks extol the approach (Meffe et al. 2002). Butler and Koontz (2005) conclude that the USFS has implemented many ecosystem management principles. Yaffe et al. (1996, cited on Van Dyke 2008) documented that the success or failure of ecosystem management at 105 project locations was based on the expected outcomes. For example, 74% reported success at communication and cooperation while only 14 % reported success at increasing trust and respect. Shafer (2010) briefly highlighted the benefits of ecosystem management. As Freemuth (1997:719) reminded us, “ecosystem management is a public policy idea.”

Recognition that coordination is needed for the Yellowstone area is not new. As early as 1917, Henry S. Graves, Chief of the USFS, “want[ed]to be see more effective coordination of other plans between the forests and the park" (Graves 1917: 192). Yellowstone National Park, after the creation of the Greater Yellowstone Coordinating Committee, has been experimenting with regional scale management since the 1960s (Clark et al. 1991). One valid criticism of ecosystem management in the GYE follows: "How could 'ecosystem management' work if the park is not an ecosystem?" (Chase 1987: 42). The fact that Yellowstone National Park does not contain enough space for its migratory ungulates, for example, has been recognized since 1882 (Craighead 1991: 32). While some critics maintain that the legal framework for ecosystem management does not exist (Coggins 1995), Keiter et al. (1999) argued that existing law contains considerable authority in the interim. Canada and the United States do lack the legislative authority to create terrestrial protected area networks which require functional land connections (Vásáserhelyi and Thomas 2006). However, it is far from clear whether ecosystem management can cure the ills of the GYE (Goldstein 1992).

One exception to implementation of toothless laws is the Endangered Species Act (ESA) of 1973 (7 U.S.C. § 136, 16 U.S.C. §1531 et seq.). ESA stipulations can control land use on private land. As Edgar (1998:496) explained, "grizzly bear management under the ESA does not effectuate a Fifth Amendment taking under the Lucas test [*Lucas vs. South Carolina Coastal Commission (1992)*]." One downside of the ESA implementation in the GYE is that no critical habitat designation for the grizzly bear has ever occurred. Critical habitat designation was discretionary in 1973 but was required by the 1982 amendment. This amendment did not demand retroactive designations but made them possible if the Secretary of the Interior so desired (Sellers 1994). Due largely to political opposition, the USFWS never finalized critical habitat designation for the GYE grizzly bear.

The Greater Yellowstone Ecosystem "Vision Document" has been treated at length elsewhere (Freemuth and Cawley 1998, Litchman and Clark 1994, Clark and Harvey 1990). However, the reason for the demise of the Vision Document needs to be made clearer. The Wyoming legislature passed a resolution in 1991 demanding that the Yellowstone "Vision Document" be withdrawn. Their objections to the document were clearly stated in their resolution: "[the] Vision document will create a de facto Yellowstone National Park management philosophy on adjacent forests, diminishing or totally excluding multiple use activities" [H.R.J. Res. 16, 51st Leg. Gen. Sess. (Wyo. 1991), quoted in Freemuth 1997]. Industry was opposed to restricting multiple use on adjacent GYE national forests. "In the wake of its failure," remarked Lynch et al. (2008: 831), "there has been little to replace it as far as a guiding vision for the region."

Even though the Wyoming delegation sank the Vision Document, Olheiser (1997: 651, 646) still believed ecosystem management might still stand a chance in Wyoming "because it creates a dialogue between people with very different goals and interests." However, he said politicians "are more likely to support a management approach that leaves the private property rights of their constituency intact." We have been slow to recognize that conservation is politics (Redford 2011: 1073).

The Vision Document was an exercise in trying to do ecosystem management. It failed for political reasons. Yellowstone National Park has become a "crucible for formulating and testing preservation policies, making it both an international model as well as a symbolic battleground over competing park management philosophies" (Keiter 1996: 653). Ecosystem management is one such new philosophy.

Schonewald-Cox et al. (1992) reviewed a plethora of suggested approaches to encourage beyond reserve boundary management for U.S. national parks. One of the largest challenges of ecosystem management is multiple ownerships (Sample 1994, Breckinridge 1994). Integrating private land into preservation oriented regional planning remains our "stiffest challenge" (Keiter 1998: 338).

When managing "commons resources" like the Jackson Hole, Wyoming, elk herd, Clark (2001) argues that one impediment is the absence of a "commons institution" to manage the herd. The same principle holds for the GYE grizzly bear. The Greater Yellowstone Coordinating Committee coordinates federal agencies but has no clout to enforce favored policies for those agencies. When private and state land enters the ownership mix, the governance issue becomes even more complicated. A land use planning toolkit has already been developed for the GYE (Greater Yellowstone Coordinating Committee 2008).

Northern Rockies Ecosystem Protection Act

The Northern Rockies Ecosystem Protection Act (NREPA) has been introduced in Congress four times since 1994. It was introduced in the 111th Congress during May 2009 as H.R. 980. It was again reintroduced as HR 1187 in 2013. The bill would create more wilderness areas out of existing USFS roadless areas in Idaho, Montana, Oregon, Washington and Wyoming. It would designate more wild and scenic rivers. It would recover landscapes through road elimination and revegetation. It would connect large federal tracts of land with biological corridors. It would reduce federal subsidies offered to the logging industry, and at the same time, create jobs needed to rehabilitate degraded habitat. No private land would be affected. The early thinking behind the legislation is found in Bader (1991, 1999). A 2009 NGO press release touted the legislation (Anonymous 2009). If NREPA becomes law, there will be new wilderness areas and semi-linking corridors in the form of federal land stepping stones (Figure 31).

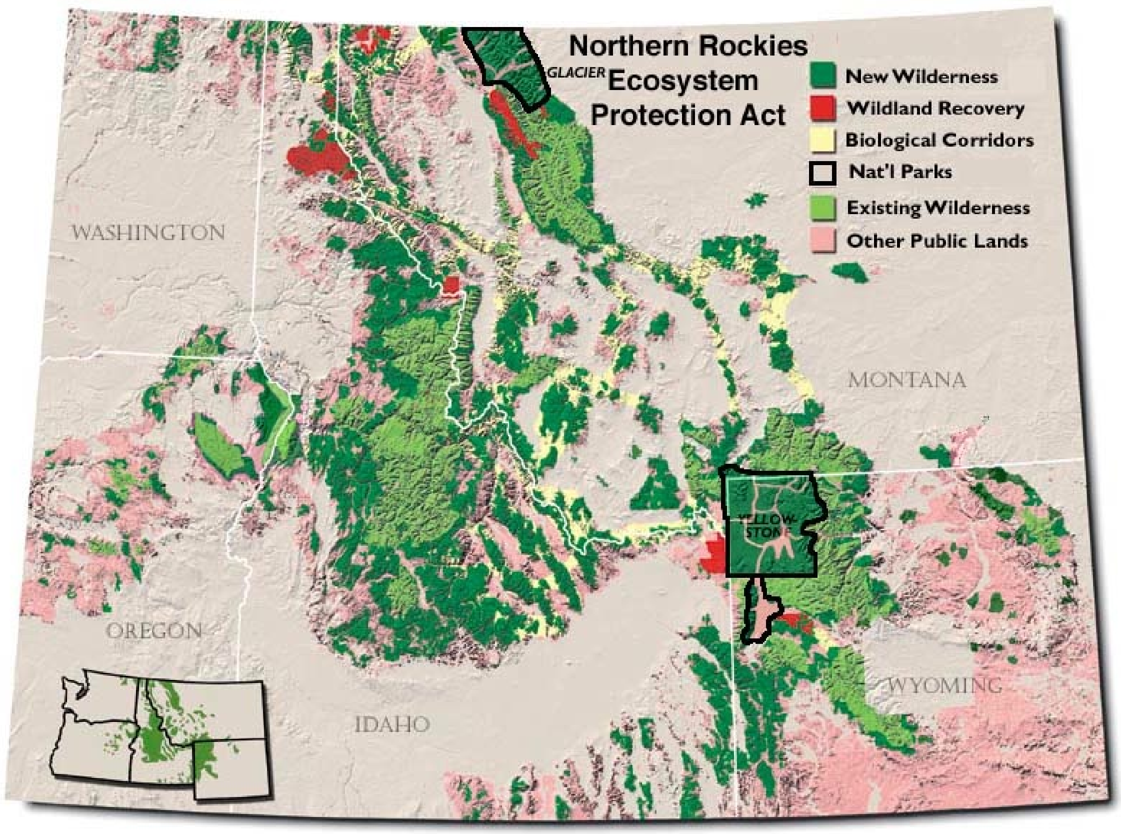


Figure 31. The biological corridor goals of NREPA are in yellow. From Alliance for the Wild Rockies (http://www.wildrockiesalliance.org/assets/nrepaMaps/nrepaImagemap.shtml)

SOME KEY TOOLS

Beyond-Boundary NPS Authority

As Franklin et al. (2001: 9) observed, "[there is] a mismatch between demand that park units be protected and the tools available when the threats to park resources and values are increasingly coming from outside unit boundaries." Does NPS have the authority to deal with this issue. The best short answer is nobody knows for sure.

Based on a survey of U.S. national park and monument Superintendents, almost two-thirds reported that development on adjacent private land was either a "significant issue" or "one of the most significant issues" facing their protected area (Ryder 1997). Sax (1976) referred to U.S. national parks as "helpless giants" due to a park Superintendent's inability to control land use on adjacent private lands. Since then, the legal aspects of dealing with external threats to national parks have been treated by many legal scholars. Keiter (1985) and Lockhart (1997) represent comprehensive reviews. Keiter often argued that NPS has ample authority to deal with external threats on some land ownerships but not the authority to regulate private lands (Keiter 1985, 1996). Mantell's (1990:240) insight on this issue follows: "The extent of park service powers regarding activities on lands outside park boundaries that affect park resources has not been fully tested. Although several relevant court decisions have some important language about the need to protect resources, they do not establish how park service powers will be defined judicially in any particular case." But park Superintendents are almost universally unaware or uneducated about all their authorities. They feel helpless when attempting to deal with some external threats. When they seek advice, they are usually cautioned not to rely on any unclear or controversial authorities. DOI Solicitors avoid the issue (Lockhart 1997). "Congress seldom exercises [its power to control external threats], the land agencies seldom claim it, and the Department of Justice seldom asserts it in federal land litigation" (Coggins and Glickman 2007: 3:4). Regardless of potential untapped authority, to make matters worse, NPS sometimes does not object when development is planned outside a park boundary. One example includes oil and gas leasing on the Flathead National Forest next to Glacier National Park, Montana, during the 1980s (Sax and Keiter 1988: 192).

Threats coming from private land represent the most difficult situation to deal with. In fact, the creation of Indiana Dunes National Lakeshore, Indiana, appears to have "attracted" development outside its boundaries (Gimmi et al. 2011). Giesser (1993) argued that NPS could bring a public nuisance action under federal common law to stop development projects on private lands near the entrance to Zion National Park, Utah (see Chapter 4). The House of Representatives once attempted to give NPS the authority to thwart threats to geothermal resources within 15 miles of Yellowstone National Park's boundary (Keiter 1993).

Whether a U.S. national park or monument Superintendent did something to thwart deleterious adjacent land use depended on their orientation, type of NPS unit, severity of the problem, support from elsewhere in the agency, and support from local conservation organizations (Ryder 1997). Congress needs to address the confusion surrounding authority to thwart external threats to wilderness areas and national parks. For state and private lands, Glickman and Coggins 1999: 410) maintained "Congress could clear up the judicial confusion by enunciating that agencies with jurisdiction over official wilderness are authorized to regulate activity on adjacent state or private land whose development or use may threaten wilderness character." However, they are unlikely to do so given the private lands "takings clause" of the Fifth Amendment of the U.S. Constitution. That takings clause has been extended to state and local governments as a result of the Fourteenth Amendment. A famous U.S. Supreme Court decision upheld the takings protection when a municipal government overreached its authority (Freis and Reyniak 1996).

Exchanges and Easements

The USFS and BLM can perform land exchanges in order to create more ecologically functional park boundaries (Anderson 1979, Beaudoin 2000). For example, the Gallatin National Forest in Montana made a land trade with a private landowner to secure an inholding that was close to the boundary of Yellowstone National Park (Hansen 2006). However, securing the 100,000 acres from the timber company required two

Congressional bills to facilitate the transfer (Keiter 2001: 315-316). Recommendation #124 of the Public Land Law Review Commission (1970:16) was "General land exchange authority should be used primarily to block up existing Federal holdings..." Unlike NPS (see Gorte and Vincent 2007: 7), the USFS and BLM can exchange federal lands for state or private property. The Federal Land Policy and Management Act of 1976 (43 U.S.C. §§ 1701 et seq.) explained some of the rules of land exchanges, amended by the Federal Land Exchange Facilitation Act of 1988 (43 U.S.C. §§ 1716)

For privately owned property, federal agencies can purchase easements or development rights (Loomis 2002: 526-528). The easement tool is discussed in Gustanski and Squires (2000), Baldwin (1997), Bray (2010), McLaughlin (2001) and elsewhere. In order to create large landscape permeability, the easement may be the most reliable tool of all though some risks are beginning to surface (Colburn 2007). Easements can allow for "working landscapes" (i.e., ranching, forestry, and farming) and even some subdivision (Rissman et al. 2006). Other tools are listed in Neudecker et al. (2011:224): "transfer of development rights, leases, zoning, purchase of leaseback or sellback arrangements, management agreements, bargain sales, transfers in trust, statutory easements and scenic easements, community ownership or grassbanks and other mechanisms that partition equity in land." One likely truism warrants repeating: "Private landowners and many state agencies will voluntarily engage in planning by ecological units only when they find it at least as financially beneficial as their current land management practices" (Loomis 2002: 538). And a final prediction is worth highlighting: "In most regions collecting enough land to join existing reserves together into metareserves (as conservation biology recommends) will come, if at all, from the private sector" (Colburn 2007: 275). This conforms to Van Dyke's (2008: 68) view that "Habitat and species conservation can be successful in landscape context only if private landowners are involved and motivated partners." One way to motivate them is to offer incentives (Eisner et al. 1995).

Federal Land Annexation

Shafer (2010) outlined the option of annexing adjacent federal lands to expand the boundaries of U.S. national parks. As Director George Hartzog (1989:17) explained, "In the past, when parks were threatened with adverse uses outside their boundaries, the boundary was extended to include the troubled area and then purchased." As of 1960, 30% of the National Park System had been derived from USFS lands (Dana and Fairfax 1979, cited in Grumbine 1991). Yet only rarely has this approach been presented as an overall strategy (e.g., Carle 2000). However, fairness demands noting that progress in abating many external threats to Glacier National Park, Montana, stemming from proposed activities on adjacent national forests, was achieved without any changes in administrative boundaries (Sax and Keiter 2006) This idea has been expanded upon and published (see Appendix 2).

Private Property Purchase

Using 18 million acres to delimit the GYE, 25 % is private land (Gosnell et al. 2006). However, if one jumps to the 36 million acre delimitation (all 20 counties), private land represents 32 % (Gude et al. 2006). Private land is often key to preserving species and ecosystems. Most large landscapes often cannot avoid containing small tracts of private land. Looking at the American Midwest, for example, the checkerboard land ownership pattern so readily observed from the air was a result of a rectilinear land survey system required by the Land Ordinance of 1785. Within each township, the Ordinance also gave some federal land sections to the states and the railroads. The pattern was the same in the Rocky Mountain West. From a transboundary management perspective, the resulting quilt-like ownership pattern could easily be described as a "map from hell" (Nie 2008: 257) which represents more of a conservation challenge than areas in the country with more federal land (Wilkosz 2010). Land consolidation is a logical solution. As Nie (2008:253) pointed out, "enlarging and/or consolidating the public estate can ameliorate the scarcity and intermixed ownership drivers of conflict."

Concerns

Private Land Rights

In regard to the GYE, "No one, it seems, wants to tackle the issue of threats to the park (or ecosystem) that arise on private lands" (Varley 1988: 222). Corroborating this viewpoint in terms of potential national land use planning, Baldwin and Trombulak (2007) said, "The single most important obstacle will be private property rights." "In certain instances, regulation of external threats will be politically impossible or legally difficult because of the effects it would have on the property rights of neighboring landowners" (Glickman 2009: 879). As Little (1987) speculated, the GYE federal agencies would likely lose if they got into a battle of protecting resources at the expense of property rights. Private lands are crucial in biological diversity planning given the fact that known habitat of over one-third of all listed threatened and endangered species in the United States is confined to private land (Bean and Wilcove 1997). The greatest threat to the grizzly bear is reportedly development on private lands (Knight et al. 1999).

Inholdings

Although the focus here is outside of protected area boundaries, after a park in created, preexisting land use inside its boundaries is a critical determinant in how smoothly future park management will go. Management of land inside protected area boundaries is a challenge by itself. For example, Yellowstone National Park, created in 1872, was established before miners, loggers, farmers and ranchers laid claims to this land. As a result, park managers did not have to deal with private land or preexisting rights within the park's boundaries. By way of contrast, Mojave National Preserve, California, created in 1994, represents the antithesis of Yellowstone because of all of the Congressionally created headaches (=inholdings) that future park managers must deal with. Sorting out the morass of preexisting land rights at Mojave may not be accomplished for decades, if ever (Dilsaver and Wyckoff 2005).

The NPS policy on private inholdings in national parks was set forth in 1918: "There are many private inholdings in the national parks, and many of these seriously hamper the administration of these reservations. All of them should be eliminated as far as is practicable..." (National Park Service 1970: 69). Horace Albright, the Service's second Director, believed inholdings were one of the "greatest problems" and a "distinct menace to good administration" (Sellars 1997: 66). Wright and Thompson (1935: 100) echoed Albright's view in the mid-1930s: "A second vital contingency of wildlife restoration is the eradication of private inholdings within the parks." Director George Hartzog was blunt in 1967: "Inholdings are the worm in the apple..." (Zaslowsky and Watkins 1994: 45). A Presidential Commission as late as 1973 recommended the acquisition of inholdings (National Park Service 1973). Since then, the policy has mellowed (NPS 2006). As of April 2007, the NPS estimated that more than 11,000 tracts in the System, totaling 656,694 ha, needed to be purchased for the security of the parks (reference in

Shafer 2010). Without government purchase, these inholdings can be developed, mined, or logged. The national forests in the GYE contain thousands of acres of inholdings as a result of mining patents, homesteading laws and railroad grants (Greater Yellowstone Coordinating Committee 2008: 2-3).

Afterthoughts

As Noss et al. (1997: 98) observed, "The political obstacles to local, regional, state, and federal cooperation in land-use and conservation planning are daunting." Indeed, "nature protection by definition is a social and political process" (Brechin et al. 2002:42). Game management is largely people management (Leopold 1935). Fiske (1990) extended this idea to natural resource management. It also holds for managing regions like the GYE.

The overall trends in population and development growth in the United States is beyond debate. As of 1992, 1/3 of the conterminous United States was classified as human-dominated (26 million km^2). This amount expanded by 80,800 $km^{2\ by}$ 2001 and is predicted to expand by 82,100 km^2 by 2030 (Theobald 2010). The question is how do we keep this growth away from protected area boundaries and connect protected areas? As Glick and Clark (1998: 253) stated, "Effective cross-boundary resource management in the GYE still is in its infancy." However, managing the matrix adjacent to protected areas cannot be ignored (Franklin and Lindenmayer 2009, Prugh et al. 2008). For some large mammals with habitat in our national parks, the creation of viable populations will demand unprecedented amounts of cooperation and legal reform (Grumbine 1990). Grumbine suggests a very unlikely but very real need: “Biologists, politicians, industry representatives, citizens, and philosophers are going to have to work together” (p. 132). Federal agencies must reach out to states and local governments to secure their cooperation. States and local governments have a range of regulatory tools, incentive-based tools and land acquisition approaches to choose from (Haeuber and Hobbs 2001: 269). We can learn from suggestions offered for Mesoamerican countries: Wallace et al. (2003) suggested technical and financial assistance for stabilizing land use in protected area buffer zones, land owner incentives for creating habitat corridors, and more.

An integrated overall regional planning strategy is needed and maybe another system of governance (Brunner et al. 2002). The issue of governance is discussed in Lemos and Agrawal (2006). One of the foremost obstacles to ecosystem management is institutional (Imperial 1999). Powell (2010) offers some useful generalizations about governing large landscapes. However, exactly what that new governance system should be for the GYE, especially in light of existing institutional arrangements, represents a challenge for another author.

The current guidance offered to international audiences on how to create protected area system plans (Davey 1998) is vague on *outside* boundary planning. That is also the case for guidance offered on bioregional planning (e.g., Miller 1996). Guidelines proposed to reduce conflicts between national parks in developing countries and their surrounding human communities (Hough 1988) may be equally applicable to developed countries.

According to Hansen (2009), a comprehensive assessment of logging in the GYE has not been conducted, nor for any other land uses either. This situation prohibits the USFS from planning on a GYE-wide basis but rather creates six independent national forest chiefdoms. As of 1989, the USFS had reportedly not stopped consumptive resource harvest on any national forest that borders a national park or wilderness area (Keiter 1989). This changed in the 1990s (see Chapter 4 logging example).

Guercio and Duane (2009: 355) remarked, “there are no quick and easy solutions to the complex legal, cultural, economical, and political problem of managing predator habitat at an ecoregional scale.” Heisel (1998: 251) argues “Direct government regulation and ownership is the only method of effectively manifesting the public values assigned to biodiversity.” Keiter (2001:348), on the other hand, concludes there is no sense in “trying to craft a single ‘magic bullet’ biodiversity law, we might better off with a patchwork of federal, state, and local law...” Although land use planners might prefer otherwise, “Land use planning is not, and cannot, be a purely rational technocratic and scientific exercise” (Wilson 1997: 465). Lovejoy (1992: xviii) remarked, “But landscapes are already so modified that there are limited opportunities for augmenting dispersal by designing corridors.” We should be asking whether or not the GYE is now so developed as to preclude natural movement to the Northern Continental Divide Ecosystem or the Selway Bitterroot-Ecosystem in Idaho by the grizzly bear.

REFERENCES

Anderson, F.R. 1979. Public land exchanges, sales, and purchases under the Federal Land Policy and Management Ac of 1976. *Utah Law Review* 1979: 657-676.

Anonymous. 2008. Western Governor's Association Wildlife Corridor Initiative. Available at: http://www.westgov.org/wga_reports.htm. Accessed 10-2008.

Anonymous. 2011. NREPA introduced in the 111th Congress. Available at: http://www.wildrockiesalliance.org/issues/nrepa/ Accessed August 2011.

Babbitt, B. 2005. Cities in the Wilderness: A New Vision for Land Use in America. Island Press, Washington, D.C.

Bader, M. 1991. The Northern Rockies Ecosystem Protection Act: a citizen plan for wildlands management. *Western Wildlands* 17(2): 22-28.

Bader, M. 1999. NREPA: ecology meets politics in the Northern Rockies. *Wild Earth* 8(4): 78-80.

Baldwin, B.W. 1997. Conservation easements: a viable tool to land protection. *Land and Water Law Review* 32: 89-123.

Baldwin, R.F. and S.C. Trombulak. 2007. Losing the dark: a case for a national policy on land conservation. *Conservation Biology* 12 (5): 1133-1134.

Barbee, R.D. and J.D. Varley. 1985. The paradox of repeating error: Yellowstone National Park from 1872 to biosphere reserve and beyond. *George Wright Forum* 4(3): 1-4.

Bean, M.J. and D.S. Wilcove. 1997. The private land problem. *Conservation Biology* 11 (1): 1-2.

Beatty, T. 2000. Preserving biodiversity: challenges for planners. *Journal of the American Planning Association* 66(1): 5-20.

Beaudoin, R.M. 2000. Federal ownership and management of America's lands through land exchanges. *Great Plains Natural Resources Journal* 4: 229-260.

Bennett, A.F. 2003. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK.

Bray, Z. 2010. Reconciling development and natural resource beauty: the promise and dilemma of conservation easements. *Harvard Environmental Law Review* 34: 119-177.

Brechin, S.R., P.R. Wilshusen, C.L. Fortwangler, and P.C. West. 2002. Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as a social and political process. *Society and Natural Resources* 15: 41-64.

Breckinridge, L.P. 1994. Reweaving the landscape: the institutional challenges of ecosystem management for lands in private ownership. *Vermont Law Review* 19: 363-422.

Breggin, L. and S. George. 2003. Planning for biodiversity: sources of authority in state land use laws. *Virginia Environmental Law Journal* 22: 81-121.

Brunckhorst, D.J. 2000. Bioregional Planning: Resource Management Beyond the New Millennium. Routledge, London.

Brunner, R.D., C.H. Colburn, C.M. Cromley, R.A. Klein and E.A. Olson. 2002. Finding Common Ground: Governance and Natural Resources in the American West. Yale University Press, New Haven.

Butler, K.F. and T.M. Koontz. 2005. Theory into practice: implementing ecosystem management objectives in the USDA Forest Service. *Environmental Management* 35(2): 138-150.

Caldwell, L.K. 1970. The ecosystem as a criterion for land policy. *Natural Resources Journal* 10: 203-221.

Callies, D. 1994. The quiet revolution revisited: a quarter century of progress. *The Urban Lawyer* 26: 197-213.

Carle, D. 2000. Reformation through amputation: expanding national parks by shrinking national forests. *Wild Earth* 10 (2): 39-44.

Chadwick, D.H. 2000. Yellowstone toYukon. National Geographic Society, Washington, D.C.

Chase, A. 1987. Playing God in Yellowstone: The Destruction of America's First National Park. Harcourt Brace Jovanovich, San Diego, California.

Christensen, N.L., A.M. Bartuska, J.H. Brown, S. Carpenter, D. D'Antonio, R. Francis, J.F.Franklin, J.A. MacMahon, R.F. Noss, D.J. Parsons, C.H. Peterson, M.G. Turner, and R.B. Woodmansee. 1996. The Report of the Ecological Society of America Committee on the Scientific Basis for Ecosystem Management. *Ecological Applications* 6: 665-691.

Clark, T.W. 2001. Wildlife resources: the elk of Jackson Hole, Wyoming. In J. Burger, E. Ostrom, R.B. Norgaard, D. Policansky and B.D. Goldstein (eds), Protecting the Commons: A Framework for Resources Management in the Americas, pp. 91-108. Island Press, Washington, D.C.

Clark, T.W. and D. Zaunbrecker. 1987. The Greater Yellowstone Ecosystem: the ecosystem concept in natural resource policy and management. *Renewable Resources Journal* Summer: 8-16.

Clark, T.W. and A.H. Harvey. 1990. The Greater Yellowstone Ecosystem policy arena. *Society and Natural Resources* 3: 281-284.

Clark, T.M. and S.C. Minta. 1994. Greater Yellowstone's Future: Prospects for Ecosystem Science, Management, and Policy. Homestead Publishing, Moose, Wyoming.

Clark, T.W., E.D. Amento, D.G. Whittemore, and A.H. Harvey. 1991. Policy and programs for ecosystem management in the Greater Yellowstone Ecosystem: an analysis. *Conservation Biology* 5: 412-422.

Coggins, G.C. 1990. The developing law of land use planning on the federal lands. *University of Colorado Law Review* 61: 307-353.

Coggins, G.C. 1995. Legal problems and powers inherent in ecosystem management. *Natural Resources and Environmental Issues* 5: 36-41. Available at: http://digitalcommons.usu.edu/nrei. Accessed June 2010.

Coggins, G.C. and R.L. Glickman. 2007. Public Natural Resources Law, 2nd Ed. Environmental Law Series.

Colburn, J. 2007. Bioregional conservation may mean taking habitat. *Environmental Law* 37: 249-300.

Compas, E. 2012. "Retooling" for the New West: environmental NGOs, planning, and governance regimes. *Society and Natural Resources* 25: 883-899.

Craighead, J.J. 1991. Yellowstone in transition. In R.B. Keiter and M.S. Boyce (eds), The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage, pp. 27-39. Yale University Press, New Haven.

Culhane, P.J. and H.P. Friesema. 1979. Land use planning for the public lands. *Natural Resources Journal* 19: 43-74.

Dale, V.H., S. Brown, R.A. Haeuber, N.T. Hobbs, N. Huntly, R.J. Naiman, W.E. Riesbame, M.G. Turner, and T.J. Valone. 2000. Ecological principles and guidelines for managing the use of land. *Ecological Applications* 10 (1): 639-670.

Daly, J.E. 1996. A glimpse of the past-a vision for the future: Senator Henry M. Jackson and national land-use legislation. *The Urban Lawyer* 28: 7-39.

Dana, S.T. and S. Fairfax. 1979. Forest and Range Policy. McGraw-Hill, New York.

Davey, A.G. 1998. National System Planning for Protected Areas. IUCN, Gland, Switzerland and Cambridge, UK.

Diamond, H.L. and P.F. Noonan. 1996. Land Use in America. Island Press, Washington, D.C.

Dilsaver, L. M. and W. Wyckoff. 2005. The political geography of national parks. *Pacific Historical Review* 74 (2): 237-266.

Edgar, D.W. 1998. Yellowstone to Yukon: can it ever become reality? *UMKC Law Review* 67: 111-143.

Eisner, T., J. Lubchenco, E.O. Wilson, D.S. Wilcove and M. J. Bean. 1995. Building a scientifically sound policy for protecting endangered species. *Science* 269: 1231-1232.

Elmendorf, C.S. 2003. Ideas, incentives, gifts, and governance: toward conservation stewardship of private land, in cultural and psychological perspective. *University of Illinois Law Review* 2003: 423-505.

Federal Interagency Ecosystem Management Task Force. 1995. Memorandum of Understanding to Foster the Ecosystem Approach. December 15, Washington, D.C.

Fiske, S.J. 1990. Resource management as people management: anthropology and renewable resources. *Renewable Resources Journal* Winter: 16-20.

Fitzsimmons, A.K. 2006. Sound policy or smoke and mirrors: does ecosystem management make sense? *Journal of the American Water Resources Association* 32 (2): 217-227.

Forman, R.T.T. 2001. Forward. In V.H. Dale and R.A. Haeuber (eds), Applying Ecological Principles to Land Management, pp. v-vii. Springer-Verlag, New York.

Frampton, G. 1996. Ecosystem management in the Clinton Administration. *Duke Environmental Law and Policy Forum* 7: 39-48.

Franklin, R. and D.B. Lindenmayer. 2009. Importance of matrix habitats in maintaining biodiversity. *Proceedings of the National Academy of Sciences, USA* 106-349-350.

Franklin, J.H., R.S. Chandler, M.L. Brown, S.A. Earle, J.M. Gonzales, C.R. Jordan, S.M. Malcom, G.P. Nubhan, M.W. Ridder, S. Selengut, P. Westerbrook and T.B. Williams. 2001. Rethinking the National Parks for the 21st Century. National Geographic Society, Washington, D.C.

Freemuth, J. and R M. Cawley. 1998. Science, expertise and the public: the politics of ecosystem management in the Greater Yellowstone Ecosystem. *Landscape and Urban Planning* 40: 211-219.

Freemuth, L. 1997. Ecosystem management and its place in the National Park Service. *Denver University Law Review* 74: 697-727.

Freis, J.H., Jr. and S.V. Reyniak 1996. Putting takings back into the Fifth Amendment: land use planning after *Dolan v. City of Tigard. Columbia Journal of Environmental Law* 21: 103-174.

Gamble, L.H. 1999. Venturing beyond our boundaries: Rocky Mountain National Park's involvement in adjacent land use issues. In D. Harmon (ed), On the Frontiers of Conservation: Proceedings of the Tenth Conference on Research and Resource Management in Parks and on Public Lands, pp. 429-431. The George Wright Society, Hancock, Michigan.

Giesser, J.L. 1993. The National Park Service and external development: addressing park boundary-area threats through public nuisance. *Boston College Environmental Affairs Law Review* 20: 761-809.

Gimmi, U., S.L. Schmidt, T.J. Hawbaker, C. Alcántara, U. Gafvert, and V. Radeloff. 2011. Increasing development in the surroundings of U.S. National Park Service holdings jeopardizes park effectiveness. *Journal of Environmental Management* 92: 229-239.

Glick, D. 1999. Removing the blinders: a call for National Park Service involvement in regional development issues. In D. Harmon (ed), On the Frontiers of Conservation: Proceedings of the Tenth Conference on Research and Resource Management in Parks and on Public Lands, pp. 437-441. The George Wright Society, Hancock, Michigan.

Glick, D. and B. Alexander. 2000. Development by default, not design: Yellowstone National Park and the Greater Yellowstone Ecosystem. In G.E. Machlis and D.R. Field (eds), National Parks and Rural Development: Practice and Policy in the United States, pp. 181-205. Island Press, Washington D.C.

Glick, D.A. and T.W. Clark. 1998. Overcoming boundaries: the Greater Yellowstone Ecosystem. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 237-256. Island Press, Washington, D.C.

Glickman, R.L. and G.C. Coggins. 1999. Wilderness in context. *Denver University Law Review* 76: 383-411.

Glickman, R.L. 2009. Ecosystem resilience to disruptions linked to global climate change: an adaptive approach to federal land management: *Nebraska Law Review* 87: 833-1096.

Goldstein, B.E. 1992. Can ecosystem management turn an administrative patchwork into a Greater Yellowstone Ecosystem? *Northwest Environmental Journal* 8: 285-324.

Gorte, R.W. and C.H. Vincent. 2007. Federal Land Ownership: Current Acquisition and Disposal Authorities. Congressional Research Service RL 34273.

Gosnell, H., J.H. Haggerty and W.R. Travis. 2006. Ranchland ownership change in the Greater Yellowstone Ecosystem, 1990-2001: implications for conservation. *Society and Natural Resources* 19(8): 743-758.

Graves, H.S. 1917. National forest and national parks in wild-life conservation. In Proceedings of the National Park Conference, pp. 187-192. U.S. Government Printing Office, Washington, D.C.

Greater Yellowstone Coordinating Committee. 2008. A Toolkit to Protect the Integrity of the Greater Yellowstone Area Landscapes. Available at: http://www.fedgycc.org/ Accessed January 2011.

Grumbine, E. 1990. Viable populations, reserve size, and federal lands management: a critique. *Conservation Biology* 4 (2): 127-134.

Grumbine, E. 1991. Cooperation or conflict? Interagency relationships and the future of biodiversity for US parks and forests. *Environmental Management* 15 (1): 27-37.

Grumbine, E. 1994. What is ecosystem management? *Conservation Biology* 8: 27-38.

Gude, P.H., A.J. Hansen, R. Rasker, and B. Maxwell. 2006. Rates and drivers of rural residential development in the Greater Yellowstone. *Landscape and Urban Planning* 77: 131-151.

Gude, P.H., A.J. Andrews, and D. Jones. 2007. Biodiversity consequences of alternative future land use scenarios in Greater Yellowstone. *Ecological Applications* 17(4): 1004-1018.

Guercio, L.D. and T.P. Duane. 2009. Grizzly bears, gray wolves, and federalism, oh my! The role of the Endangered Species Act in de facto ecosystem-based management in the Greater Glacier Region of Northwest Montana. *Journal of Environmental Law and Litigation* 24: 285-366.

Gustanksi, J.A. and R. H. Squires. 2000. Protecting the land: Conservation Easements Past, Present and Future. Island Press, Washington, D.C.

Haeuber, R. 1996. Setting the environmental policy agenda: the case of ecosystem management. *Natural Resources Journal* 36: 1-28.

Haeuber, R. and N.T. Hobbs. 2001. Many small decisions: incorporating ecological knowledge in land-use decisions in the United States. In V.H. Dale and R.A. Haeuber (eds), Applying Ecological Knowledge to Land Management, pp. 255-275. Springer-Verlag, New York.

Hansen, A. 2006. Yellowstone Bioregional Assessment: Understanding the Ecology and Land Use of Greater Yellowstone Ecosystem. Technical Report # 2, Landscape Biodiversity Lab, Montana State University, Bozeman.

Hansen, A.J. 2009. Species and habitat most at risk in Greater Yellowstone. *Yellowstone Science* 17 (3): 27-36.

Hardin, G. 1968. The tragedy of the commons. *Science* 162:1243-1248.

Hart, J.W. 1995. National forest planning: an opportunity for local governments to influence federal land use. *Public Land and Resources Law Review* 16: 137-161.

Hartzog, G.B. 1989. Remarks of George B. Hartzog, Jr. at the Fifth Triennial Conference of the George Wright Society, Tucson, Arizona-November 14-18, 1988. *The George Wright Forum* 6 (1): 16-24.

Heisel, J. 1998. Biodiversity and federal land ownership: mapping a strategy for the future. *Ecology Law Quarterly* 25: 229-312.

Hernandez, P.C. 2004. Rural residential development in the Greater Yellowstone: rates, drivers, and alternative future scenarios. MS Thesis, Montana State University, Bozeman, Montana.

Hough, J.L. 1988. Obstacles to effective management of conflicts between national parks and surrounding human communities in developing countries. *Environmental Conservation* 15 (2): 129-136.

Imperial, M.T. 1999. Institutional analysis and ecosystem-based management: the institutional analysis and development framework. *Environmental Management* 24(4): 449-465.

Karkkainen, B.C. 1997. Biodiversity and land. *Cornell Law Review* 83: 1-104.

Kayden, J.S. 2000. National land use planning in America: something whose time has never come. *Washington University Journal of Law and Policy* 2000 (3): 445-472.

Keiter, R.B. 1985. On protecting the national parks from the external threats dilemma. *Land and Water Law Review* 20 (2):355-420.

Keiter, R.L. 1989. Taking account of the ecosystem on the public domain: law and ecology in the Greater Yellowstone Region. *University of Colorado Law Review* 60: 923-1007.

Keiter, R.B. 1993. The Old Faithful Protection Act: Congress, national park ecosystems, and private property rights. *Public Land Law Review* 14: 5-39.

Keiter, R.B. 1996. Preserving nature in the national parks: law, policy, and science in a dynamic environment. *Denver University Law Review* 649-695.

Keiter, R.B. 1998. Ecosystems and the law: toward an integrated approach. *Ecological Applications* 8: 332-341.

Keiter, R.B. 2001. Biodiversity conservation and the intermixed ownership problem: from nature reserves to collaborative processes. *Idaho Law Review* 38: 301-323.

Keiter, R.B., T. Boling, and L. Milkman. 1999. Legal perspectives on ecosystem management: legitimizing a new federal land management policy. In W.T. Sexton, A.J. Malk, R.C. Szaro and N.C. Johnson (eds), Ecological Stewardship: A Common Reference for Ecosystem Management, pp. 9-41. Elsevier Science, Oxford, UK.

Knight, R.R., B.M. Blanchard, and P. Schullery. 1999. Yellowstone bears. In T.W.Clark, A.P. Curlee, S.C. Minta and P.M. Kareiva (eds), Carnivores in Ecosystems: The Yellowstone Experience, pp. 51-76. Yale University Press, New Haven.

Kretzer, H.E., J.A. Hilty, M.J. Glennon, J.F. Burrell, Z.P. Smith, and B.A. Knuth. 2009. Challenges in governance and land management on the exurban/wilderness frontier in the USA. In K. Anderson, M. Lehtola, E. Eklund, and P. Salmi (eds), Beyond the Rural-Urban Divide: Cross–Continental Perspectives on the Differentiated Countryside and its Regulation (Research in Rural Sociology and Development, Volume 14), pp. 277-304. Emerald, Bingley, UK.

Kuperberg, J. 1978. Reforming private land use practices. In H.P. Brokaw (ed), Wildlife in America, pp. 442-453. U.S. Government Printing Office, Washington, D.C.

Lackey, R.T. 1998. Ecosystem management: paradigms and prattle, people and prizes. *Renewable Resources Journal* 16 (1): 8-13.

Laitos, J.G. and T.A. Carr. 1999. The transformation on public lands. *Ecology Law Quarterly* 26: 140-242).

Lemos, M.C. and A. Agrawal. 2006. Environmental governance. *Annual Review of Environment and Resources* 31: 297-325.

Leopold, A.S., C.M. Cottam, I. Cowan, I. N. Gabrielson, and T.L. Kimball. 1968. The National Wildlife Refuge System, Report of the Advisory Committee on Wildlife Management. U.S. Fish and Wildlife Service, Department of the Interior, Washington, D.C.

Litchman, P. and T.M. Clark. 1994. Rethinking the “vision” exercise in the Greater Yellowstone Ecosystem. *Society and Natural Resources* 7 (5): 459-478.

Little, C. E. 1987. The challenge of Greater Yellowstone. *Wilderness* 51 (179): 18-56.

Lockhart, W.J. 1997. External threats to our national parks: an argument for substantive protection. *Stanford Environmental Law Journal* 6: 3-73.

Loomis, J.B. 2002. Integrated Public Lands Management: Principles and Applications to National Forests, Parks, Wildlife Refuges, and BLM Lands. 2nd Ed. Columbia University Press, New York.

Lovejoy, T.E. 1992. Preface. In R.L. Peters and T.E. Lovejoy (eds), Global Warming and Biological Diversity, pp. xviii-xix. Yale University Press, New Haven.

Lynch, H.J., S. Hodge, C. Albert, and M. Dunham. 2008. The Greater Yellowstone Ecosystem: challenges for regional ecosystem management. *Environmental Management* 41: 820-833.

Mantell, M.A. 1990. Frontier issues. In M.A. Mantell (ed), Managing National Park System Resources: A Handbook on Legal Duties, Opportunities, and Tools, pp. 235-253. The Conservation Foundation, Washington, D.C.

Margerum, R.D. 1997. Integrated approaches to environmental planning and management. *Journal of Planning Literature* 11(4): 459-475.

McKinney, M.. L. Scarlett and D. Kemmis. 2010. Large Landscape Conservation: A Strategic Framework for Policy and Action. Lincoln Institute of Land Policy, Cambridge, Massachusetts. Available at: http:// cnrep.org/documents/montana_policy_reports/LLC_Strategic_Framework_Final_pdf Accessed June 2012.

McKinstry, R.B., Jr., J. McElfish, M. Jacobson and D.J. Hay. 2006. Legal tools that provide direct protection for elements of biodiversity. *Widener Law Journal* 16: 909-945.

McLaughlin, N. 2011. The role of land trusts in biodiversity conservation on private lands. *Idaho Law Review* 38:453-465.

Meffe, G., L. Nielson, R.L. Knight and D. Schenborn. 2002. Ecosystem Management: Adaptive, Community-Based Conservation. Island Press, Washington, D.C.

Miller, K. 1996. Balancing the Scales: Guidelines for Increasing Biodiversity's Chances through Bioregional Planning. World Resources Institute, Washington, D.C.

Morrissey, W.A., J.A. Zinn and M.L.Corn. 1994. Ecosystem management: federal agency activities. Congressional Research Service 94-339 ENR.

National Park Service. 1970. Memorandum from the Secretary of the Interior to the Director of the National Park Service, July 10, 1964. In Administrative Policies for the

National Parks and National Monuments of Scientific Significance (Natural Area Category), pp. 76-80. US Government Printing Office, Washington, D.C.

National Park Service. 1973. Preserving a Heritage: Final Report to the President and Congress of the National Parks Centennial Commission. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

Neudecker, G.A., A.L. Duvall, and J.W. Stutzman. 2011. Community-based landscape conservation: a roadmap for the future. In D.E. Naugle (ed), Energy Development and Wildlife Conservation in Western North America, pp. 211-230. Island Press, Washington, D.C.

Nassauer, J.I. 2006. Landscape planning and conservation biology: systems thinking revisited. *Conservation Biology* 20 (3): 677-678.

Nie, M. 2008. The Governance of Western Public Lands: Mapping its Present and Future. University Press of Kansas, Lawrence.

Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation under the Endangered Species Act. Island Press, Washington, D.C.

Olheiser, S.L. 1997. Cooperative ecosystem management: can an ecosystem approach succeed in Wyoming? *Land and Water Law Review* 32: 629-653.

Olindo, P. 1989. Overview: a planner's perspective. In D. Western and M.C. Pearl (eds), Conservation for the Twenty-first Century, pp. 251-253. Oxford University Press, New York.

Peck, S. 1998. Planning for Biodiversity: Issues and Examples. Island Press, Washington, D.C.

Platt, R.H. 2004. Land Use and Society: Geography, Law, and Public Policy. Island Press, Washington, D.C.

Porter, W.F., J.D. Erickson and R.S. Whaley. 2009. The Great Experiment in Conservation: Voices from the Adirondack Park. Syracuse University Press, Syracuse, New York.

Powell, R.B. 2010. Developing institutions to overcome governance barriers to ecoregional conservation. In S.C. Trombulak and R.F. Baldwin (eds), Landscape-scale Conservation Planning, pp. 53-66. Springer, Netherlands.

Primm, S.A. and T.W. Clark. 1996. Making sense of the policy process for carnivore conservation. *Conservation Biology* 10 (4): 1036-1045.

Probst, C.L., D. Merriam, and C.J. Duerksen. 1990. Local governments and park resources. In M.A. Mantell (ed), Managing National Park Resources: A Handbook on Legal Duties, Opportunities, and Tools, pp. 171-209. The Conservation Foundation, Washington, D.C.

Probst, L. and L. Rosen. 1997. National Parks and Their Neighbors: Lessons from the Field on Building Partnerships with Local Communities. The Sonoran Institute, Tucson, Arizona, 16 pp.

Prugh, L.R., K.E. Hodges, R.E. Sinclair and J.S. Brashares. 2008. Effect of habitat area and isolation on fragmented animal populations. *Proceedings of the National Academy of Sciences, USA* 105: 20770-20775.

Public Land Law Review Commission. 1970. One Third of the Nation's Land: A Report to the President and to the Congress by the Public Land Law Review Commission. U.S. Government Printing Office, Washington, D.C.

Redford, K.H. 2011. Special section: the futures of conservation. *Conservation Biology* 25 (6): 1072-1074.

Reilly, W. K.1971. National land use policy: the President's proposal. *Transactions of the Thirty-sixth North American Wildlife and Natural Resources Conference*: 82-89.

Rissman, A.R., L. Lozier, T. Comendant, P. Kareiva, J.M. Kiesecker, M.B. Shaw and A.M. Merenlender. 2007. Conservation easements: biodiversity protection and private use. *Conservation Biology* 21 (3): 709-718.

Ryder, S. 1997. National parks and the politics of adjacent land use: a survey of Superintendents. In D. Harmon (ed), Making Protection Work: Proceedings of the 9th Conference on Research and Resource Management in Parks and on Public Lands, pp. 335-342. The George Wright Society, Hancock Michigan.

Sample, V.A. 1994. Building partnerships for ecosystem management on mixed owner landscapes. *Journal of Forestry* 92 (8): 41-44.

Sax, J.L. 1976. Helpless giants: the national parks and the regulation of private lands.

Michigan Law Review 75: 239-274.

Sax, J.L. and R.B. Keiter. 1988. Glacier National Park and its neighbors: a study of federal inter-agency cooperation. In D.J. Simon (ed), Our Common Lands: Defending the National Parks, pp. 175-240. Island Press, Washington, D.C.

Sax, J.L. and R.B. Keiter. 2006. The realities of regional resources management: Glacier National Park and its neighbors revisited. *Ecology Law Quarterly* 33**:** 233-312.

Schneebeck, R. 1986. State participation in federal policy making for the Yellowstone Ecosystem: a meaningful solution or business as usual? *Land and Water Review* 21(2):397-416.

Schonewald-Cox, C.M. chairperson. 1987. Report to the Director on the Role of the National Park Service in Protecting Biological Diversity. NPS/CPSU Ecology Institute, University of California, Davis.

Schonewald-Cox, C., M. Buechner, R. Sauvajot, and B.A. Wilcox. 1992. Cross-boundary management between national parks and surrounding lands: a review and discussion. *Environmental Management* 16 (2): 273-282.

Sellars, R.W. 1997. Preserving Nature in the National Parks: A History. Yale University Press, New Haven.

Sellers, S.L. 1994. Grizzly state of the Endangered Species Act: an analysis of the ESA's effectiveness in conserving the Yellowstone grizzly bear population. *Land and Water* Conservation Review 29: 467-503.

Sexton, W.T., A.J. Malk, R.C. Szaro and N.C. Johnson (eds) 1999. Ecological Stewardship: A Common Reference for Ecosystem Management Vol. I-III. Elsevier Science, Oxford, UK.

Shafer, C.L. 1990. Nature Reserves: Island Theory and Conservation Practice. Smithsonian Institution Press, Washington, D.C.

Shafer, C.L. 1999. US national park buffer zones: historical, scientific, social, and legal aspects. *Environmental Management* 23 (1): 49-73.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal lands. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Soulé, M.E. 1991. Land use planning and wildlife maintenance: guidelines for conserving wildlife in an urban landscape. *Journal of the American Planning Association* 57(3): 313-323.

Stanley, T.R., Jr. 1995. Ecosystem management and the arrogance of humanism. *Conservation Biology* 9(2): 255-262.

Theobold, D.M. 2000. Fragmentation by inholdings and exurban development. In R.L. Knight, F.W. Smith, S.W. Buskirk, W.H. Romme, and W.L.Baker (eds), Forest Fragmentation in the Southern Rocky Mountains, pp. 155-174. University of Colorado Press, Niwot, Colorado.

Theobald, D.M. 2010. Estimating natural landscape changes from 1992 to 2030 in the conterminous United States. *Landscape Ecology* 25: 999-1011.

Travis, W.R. 2007. New Geographies of the American West: Land Use and Changing Patterns of Place. Island Press, Washington, D.C.

Udall, S.L. 1964. The West and its public lands: aid or obstacle to progress? *Natural Resources Journal* 4 (1): 1-16.

US Forest Service. 2007. Forest Service Open Space Conservation Strategy: Cooperating Across Boundaries to Sustain Working and Natural Landscapes. FS-889. U.S. Government Printing Office, Washington, D.C., 16 pp.

Van Dyke, F. 2008. Conservation Biology: Foundations, Concepts, Applications. Springer, New York.

Van Dyne, G.M. ed. 1969. The Ecosystem Concept in Natural Resource Management. Academic Press, New York.

Varley, J.D. 1988. Managing Yellowstone National Park into the twenty-first century: the park as an aquarium. In J.K. Agee and D.R. Johnson (eds), Ecosystem Management for Parks and Wilderness, pp. 216-225. University of Washington Press, Seattle.

Vásárhelyi, C. and V.G. Thomas. 2006. Evaluating the capacity of Canadian and American legislation to implement terrestrial protected areas networks. *Environmental Science and Policy* 9(1): 46-54.

Wagner, F.H. 2006. Yellowstone's Destabilized Ecosystem: Elk Effects, Science, and Policy Conflicts. Oxford University Press, Oxford, UK.

Wallace, G.N. 1999. Influencing land use decisions on lands adjacent to your park or protected area. In D. Harmon (ed), On the Frontiers of Conservation: Proceedings of the Tenth Conference on Research and Resource Management in Parks and on Public Lands, pp. 446-451. The George Wright Society, Hancock, Michigan.

Wallace, G.N., J.R. Barborak and C. MacFarland. 2003. Land use planning and regulation in and around protected areas: a study of best practices and capacity building needs in Mexico and Central America. Paper delivered September 2003 at the Vth World Parks Congress, Durban, South Africa. Available at: warnercnr.colostate.edu/docs/hdnr/cpamt/landuseplanning_durban.pdf/ Accessed November 2012.

Weber, B. 2004. The arrogance of America's designer ark. *Conservation Biology* 18(1): 1-3.

Wilkosz, J.M. 2010. Linking the Landscape: Legal and Policy Tools to Promote Connected Habitat in Fragmented Landscapes. MS Thesis. University of Illinois, Urban-Champaign.

Wilson, M.A. 1997. The wolf in Yellowstone: science, symbol, or politics? Deconstructing the conflict between environmentalism and wise use. *Society and Natural Resources* 10(5): 453-468.

Wright, G.M. and B.H. Thompson. 1935. Fauna of the National Parks of the United States. Fauna Series No. 2. U.S. Government Printing Office, Washington, D.C.

Yaffe, S.L., A.F. Phillips, I.C. Frentz, P.W. Hardy, S.M. Malecki and B.E. Thorpe. 1996. Ecosystem Management in the United States: An Assessment of Current Experience. Island Press, Washington, D.C.

Yellowstone National Park. 1997. Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem. National Park Service, Mammoth Hot Springs, Yellowstone National Park, Wyoming.

Zaslowsky, D. and T.H. Watkins. 1994. These American Lands: Parks, Wilderness, and the Public Lands. Island Press, Washington, D.C.

CHAPTER 6: WILDERNESS AREAS

"Nine-tenths of Yellowstone is still-and we hope it always will be-an everlasting wilderness."

Albright and Taylor 1928

Early Policy

"Yellowstone today is an icon of the wilderness movement" (Meyer 1996: 19). This author points out that the park had been valued for its wilderness character from the outset. During 1928, Horace Albright, second director of the National Park Service (NPS) was seeking a middle-of-the-road policy for development in national parks. For the wilderness purist constituency there would be no roads in some sections of a park, however, for the automobile tourist constituency there would be good roads in other parts (Miles 2009). A subsequent NPS Director, Arno Cammerer, continued Albright's compromise by arguing that some concentrated development was needed to preserve wilderness in parks (Cammerer 1936, cited in Miles 2009. Both the NPS and USFS opposed wilderness legislation introduced in the 1950s (Rohlf and Hannold 1988). Sellars (2000) provides a critique of the NPS wilderness program. For an overview of the Wilderness Act, see Gorte (1994). To access its legislative history, see Craig et al. (2010).

Wilderness Act

The Wilderness Act of 1964 (16 U.S.C. §§ 1131-1136) was passed as a result of political compromise. It banned permanent roads and commercial enterprises but lands remained "subject to existing private rights" [16 U.S.C. §1133(c)] on public lands except BLM lands. Preexisting mining claims and leases (if they existed prior to 1964 or were created before January 1, 1984) could be exploited in wilderness though subject to agency "reasonable stipulations" [16 U.S.C. §1133(d) (3)]. If the grazing predated wilderness designation, livestock grazing could continue also subject to agency "reasonable regulations" [16 U.S.C. § 1133(d) (4)] (from Glickman and Coggins 1999). It also allowed the President to authorize water and power development, including road construction [16 U.S.C. § 1133 (d) (4)], control of fire and pests [16 U.S.C. § 1133 (d) (1)], and the use of motorboat and aircraft if such use was already established [16 U.S.C. § 1133 (d) (1)] (from Rohlf and Hannold 1988, Gorte 1998). Since the Wilderness Act was passed in 1964, up until 2009, there have been 172 other public laws that have designated or affected wilderness (Dawson et al. 2010; also see Alexander and Johnson 2012). The types of wilderness "exceptions" allowed by these laws have been summarized (Anonymous 2011, based on Gorte 1998).

Leshy (2005: 2-3) summarized the Act's above exceptions in more user friendly language. The most important compromises included "(a) giving the President open–ended authority to approve reservoirs and other water works, power projects, transmission lines, and 'other facilities needed in the public interest, including the road construction and maintenance essential to development and use thereof ' in the national forest wilderness areas; (b) giving hardrock mining companies a twenty-year window to stake new mining claims—any of which could turn into open pit mines—in national forest wilderness areas; (c) giving the Secretary of the Interior a twenty-year window to issue new oil and gas, coal, and other kinds of mineral leases in national forest wilderness areas; and (d) allowing livestock grazing to continue where already established, subject to reasonable regulation."

Despite the Wilderness Act's compromises for commercial mining interests, "in practicality the Act severely restricted hard-rock mining activities on wilderness areas within national forests" (Hubbard et al. 1998: 599). Leshy (2005: 3) concluded "The gamble turned out well. Although grazing has continued, there have been no water projects and almost no mineral development in wilderness areas." After December 31, 1983, Congress elected not to gamble. Many wilderness areas were withdrawn from being bound by the mining laws (Cwik 1983, cited in Edwards 1986: 108).

Section 603 of the Federal Land Policy and Management Act (FLPMA) (43 U.S.C. 1701 et seq.) requires non-impairment of proposed wilderness areas. Nevertheless, a 1981 Wyoming District Court came to the startling conclusion that FLPMA mandates that oil and gas development continue uninfluenced by the non-impairment standard (while mining, timbering and grazing are not exempt from that same standard) (Corbett 1982).

As passage of the Wilderness Act confirms, there was considerable Congressional sympathy for not insisting that wilderness with incompatible land use be banned completely from wilderness. As one Senate committee report (Senate Report 98-465) later argued, certain activities in wilderness should not be prevented because they can still be seen or heard from inside wilderness (Dawson and Hendee 2008: 148-149). Nevertheless, federal wilderness has grown from 54 areas comprising 9.1 million acres in 1964 to more than 790 areas comprising 109 million acres as of 2010 (Dawson et al. 2010; also see Gorte 2011).

As of 1987, 9 % of wilderness managers said they had active surface or subsurface mining claims (or the maintenance of them) on their wilderness areas; 1% of wilderness managers indicated there were active oil and natural gas wells in operation in their wilderness areas; grazing occurred on about one-third of wilderness areas (excluding Alaska); about 100 dams existed in national forest wilderness; while logging was allowed on only one wilderness area (Dawson and Hendee 2008: 366-368).

GYE Wilderness

Almost 50 % of GYE national forests are managed as federal wilderness under a preservation philosophy, though hunting is allowed (Figure 32). By way of contrast,

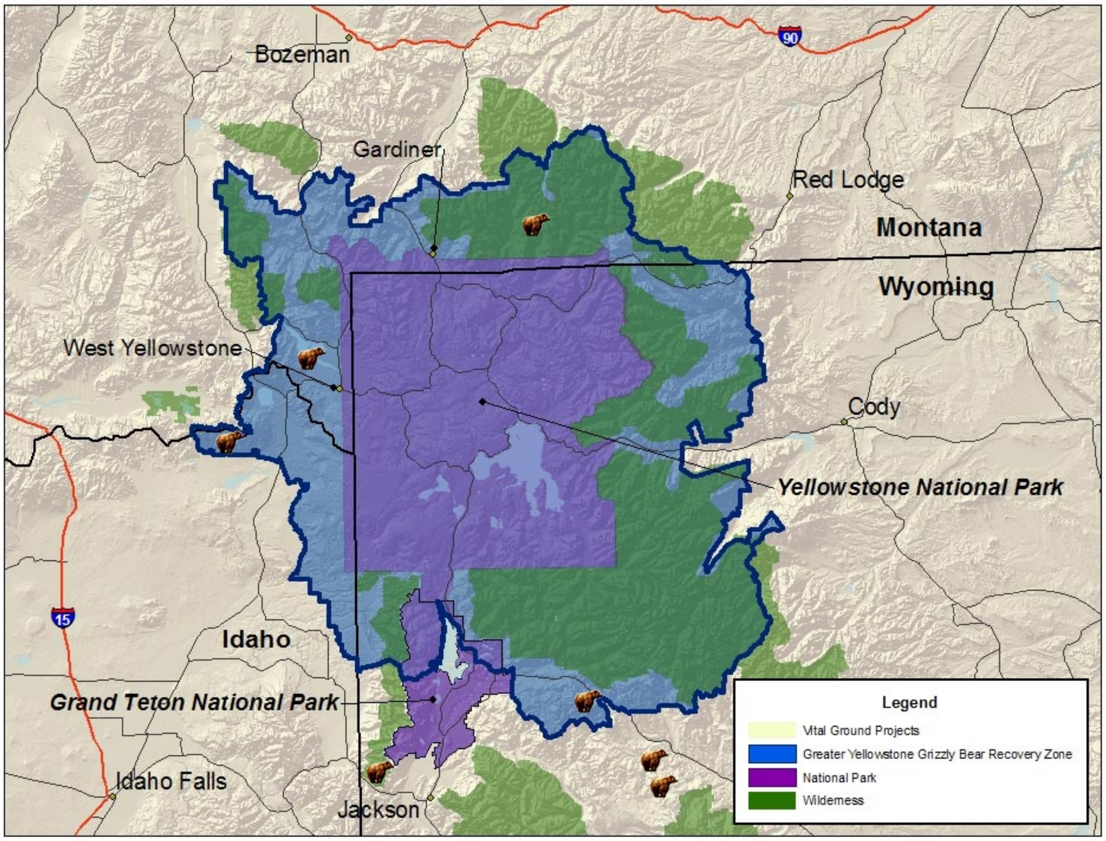


Figure 32. USFS wilderness areas (in green) in the Greater Yellowstone Ecosystem. From Vital Ground (http://www.vitalground.org/Greater_Yellowstone_Ecosystem)

the national forest non-wilderness tracts in the GYE are managed under a multiple-use philosophy where timber harvesting, grazing and motorized recreation is often permitted

(Keiter and Froelicher 1993). Using a GYE area of 24,000 km^2, official wilderness constitutes 8,600 km^2 with 22,783 km^2 of “suitable habitat” for the grizzly bear outside the PCA (US Fish and Wildlife Service 2011: 73). Ironically, grizzly bear mortality in a USFS wilderness area in Montana was greater than in a nearby USFS non-wilderness (Mace and Waller 1998, cited in Noss et al. 1999). Allin (1987) thought that NPS had been more aggressive than USFS in preventing wilderness resource degradation using law enforcement and engineering approaches. About 18% of USFS holdings nationwide are official wilderness (Cole 2003).

In 1972, the Secretary of Interior recommended 2,016,181 acres of Yellowstone National Park as wilderness, about 90% of the park, but Congress never acted on that recommendation (Yellowstone National Park 2011). Some other national parks also lack wilderness designation like Grand Canyon National Park, Arizona (Jacques and Ostergren 2006).

Threats to Wilderness

Threats to wilderness (and by extension national parks) include fragmentation and habitat isolation; commercial and public recreational use; livestock grazing; nonnative species; administrative access, facilities, and intrusive management; adjacent management and use; inholdings; mining; wildland fire suppression; air quality; water projects and water quality; advanced technology; motorized and mechanical equipment trespass and legal use; aircraft noise and airspace reservations; urbanization and encroaching development; global climate change; legislation that designates new wilderness areas with compromised wilderness conditions; and lack of political and financial support for wilderness protection and management. These identified threats can affect air, aquatic systems, rock/landforms, soils, vegetation, animals, ecosystems/landscapes, cultural resources and wilderness experiences (Dawson and Hendee 2008: 339). Testing is needed for biotic impacts to protected areas based on activity in their buffer zones. For example, one anonymous author said “The wilderness area surrounding Yellowstone and Glacier might be big enough to act of buffers” (Anonymous n.d.). Thinking of buffer zones in terms of ecological impacts, we do not know how far lateral fluxes extend into a wilderness area (Figure 33).

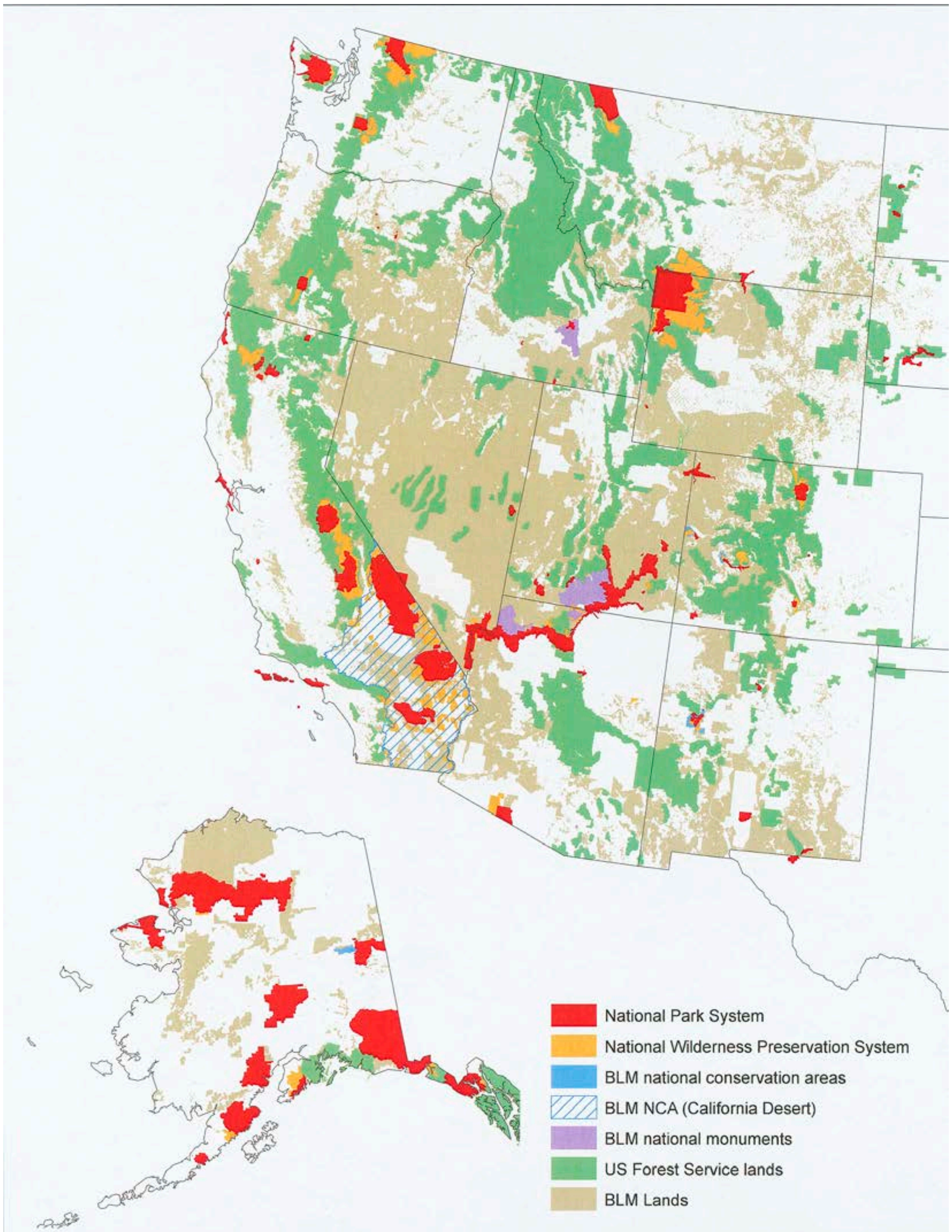


Figure 33. The distribution of wilderness areas adjacent to western units of the National Park System as of 2006 (Assistance provide by George Washington University Department of Geography).

Highest Use

Aldo Leopold (1921:78) once indicated that wilderness might be the "highest use" that one could assign to a U.S. national forest. After the Wilderness Act of 1964 became law, the common American perception of wilderness was expressed by Weber (2004:2): "The U.S. Wilderness Act brought larger landscapes and even higher standards [when compared to national parks] into the fold of protected areas." Keiter (1985) also viewed official wilderness as the highest form of U.S. federal land protection. So did Wallace Stegner: "If the national park idea is...the best idea American ever had, wilderness preservation is the highest refinement of that idea" (Stegner 1998: 131). However, this may not be the case in every instance (Shafer 2010). Existing land rights are such that mining, oil and gas extraction and grazing can occur in GYE national forest wilderness and non-wilderness (Shafer 2010). However, the reality is that mining has rarely occurred inside a wilderness GYE boundary, but see Chapter 4. Congress essentially said that having inholdings in wilderness was not incompatible with the wilderness concept (Foote 1973). But inholdings do occur in wilderness.

Wilderness designation is not the best tool preserve biological diversity. The values that may factor into wilderness selection worldwide include scenery, history, geology, open space, and primitive recreation. Sarkar (1999) argued that wilderness and biodiversity conservation are different goals that should not be sought after simultaneously. Taking a different position, Harrison (2005) thought wilderness and biological diversity conservation need not be incompatible.

U.S. Invention

According to Cronon (1995), wilderness is not a natural condition but a social construction of the late 19th century United States. It is a foreign concept to many other countries such as Latin America (Gómez-Pompa and Kaus 1992) and Africa (Adams and McShane 1992). "The Western concept of preservation by segregation is alien to societies evicted from their traditional homes and denied use of animals and plants within newly created reserves" (Western et al. 1989: 304-305).

Based on observations in tropical countries, humans there were viewed as an integral part of nature (Guha 1989, 1997). The western view of wilderness had its own ideology (Callicott and Nelson, 1998). That ideology had puritanical roots (Callicott and Ybara 2008) and was a United States invention (Sarkar 1999). The United States Wilderness Act (16 U.S.C. 1131 et seq.) defined wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain..."

Today we realize that Native Americans were responsible for fashioning the natural landscape for centuries by using tools like fire (Williams 2000). There was no such thing as a pristine America unaltered by human hands (Denevan 1992). Accommodating native people in U.S. National Park System units did not happen until the Alaska Native Claims Settlement Act of 1971 (16 U.S.C. 3101 et seq.) In other parts of the world (e.g., Amazon forests, African savanna, Northern European tundra and polar areas, and Australian outback), man has influenced the landscape for millennia (Posey 1999).

Is Industry the Culprit?

The loss of our wilderness areas in the American West is due to a great number of factors. Robert F. Kennedy, Jr. (2007:190) saw the situation from a black and white perspective. To him, our wilderness heritage is being lost "Because the governments of both Canada and the United States are dominated by large corporations that are driven to maximize short-term profits at the expense of the interests of future generations. Massive governmental subsidies to energy, lumber, mining and agribusiness companies-with some of the largest subsidies in the West-are driving the destruction of the last remaining wild places..."

REFERENCES

Adams, W.M. and T.O. McShane. 1992. The Myth of Wild Africa: Conservation Without Illusion. University of California Press, Berkeley.

Albright, H.M. and F.J. Taylor. 1928. The everlasting wilderness. *Saturday Evening Post* 201 (September 29): 28, 63, 66, 68.

Alexander, K. and S.L. Johnson. 2012. Wilderness: Legislation and Issues in the 112th Congress. Congressional Research Service R41610.

Allin, C.W. 1987. Park Service vs. Forest Service: exploring the differences in wilderness management. *Policy Studies Review* 7(2): 385-394.

Anonymous, n.d. Ecological threats to the parks. *Different Drummer*. Available at: http:www.ti.org.ddrummer.html. Accessed June 2011.

Anonymous, 2011. Congressional Research Service: wilderness laws: prohibited and permitted uses. Available at: http://www.wilderness.net/index.cfm?fuse=NWPS&sec=legiscrs. Accessed July 2011.

Callicott, J.B. and M.P. Nelson (eds) 1998. The Great New Wilderness Debate. University of Georgia Press, Athens.

Callicott, J.B. and Ybarra, S. 2008. Puritan origins of the American wilderness movement. In C.J. Cleveland (ed) Encyclopedia of Earth (Environmental Information Coalition, National Council for Science and the Environment, Washington D.C.). Available at: http://www. eoearth.org/article/Puritan_origins_of_the American_wildrness_movement Accessed January 2009.

Cammerer, A. 1936. Standards and policies in national parks. *American Planning and Civic Annual*: 13-20.

Cole, D.N. 2003. Agency policy and the resolution of wilderness stewardship dilemmas. *The George Wright Forum* 20 (3): 26-33.

Corbett, H.E. 1982. PUBLIC LANDS – Oil and Gas Leasing in Proposed Wilderness- The Wyoming District Court's Interpretation of Section 603 of the Federal Land Policy and Management Act of 1976-Rocky Mountain Oil and Gas Association v. Andrus, 500 F. Supp. 1338 (D. Wyo. 1980), appeal docketed, No. 81-1040 (10th Cir. Jan. 5, 1981). *Land and Water Law Review* 17: 487-508.

Cronon, W. 1995. The trouble with wilderness; or getting back to the wrong nature. In W. Cronon (ed), Uncommon Ground, pp. 69-90. W.W. Norton, New York.

Craig, D.R., P. Landres and L.Yung. 2010. Improving wilderness stewardship through searchable databases of U.S. legislative history and special provisions. *International Journal of Wilderness* 16 (2): 27-31.

Cwik, L.J. 1983. Oil and gas leasing on wilderness lands: the Federal Land Policy and Management Act, the Wilderness Act, and the Unites States Department of the Interior, 1981-1983. *Environmental Law* 14: 585-616.

Dawson, C.P. and J.C. Hendee. 2008. Wilderness Management: Stewardship and Protection of Resources and Values. 4th Ed. Fulcrum, Golden, Colorado.

Dawson, C.P., B. Probst, and J.C. Hendee. 2010. Special provisions of wilderness legislation in the United States, 1964 to 2009. *International Journal of Wilderness* 16(2): 32-34.

Denevan, W.M. 1992. The pristine myth: the landscape of the Americas in 1492. *Annals of the American Geographer* 82(3): 369-385.

Edwards, G.W. 1986. Keeping wilderness areas wild: legal tools for management. *Virginia Journal of Natural Resources Law* 6: 101-141.

Foote, J. P. 1973. Wilderness--a question of purity. *Environmental Law* 3: 255-266.

Glickman, R.L. and G.C. Coggins. 1999. Wilderness in context. *Denver University Law Review* 76: 383-411.

Gómez-Pompa, A. and A. Kaus. 1992. Taming the wilderness myth. *BioScience* 42 (4): 271-279.

Gorte, R.W. 1994. Wilderness: overview and statistics. Congressional Research Service Report 94-976.

Gorte, R.W. 1998. Wilderness Laws: Prohibited and Permitted Uses. Congressional Research Service Report 98-848.

Gorte, R.W. 2011. Wilderness Laws: Statutory Provisions and Permitted and Prohibited

Uses. Congressional Research Service R41649.

Guha, R. 1989. Radical American environmentalism and wilderness preservation: a third world critique. *Environmental Ethics* 2 (1): 71-83.

Guha, R. 1997. The authoritarian biologist and the arrogance of anti-humanism: Wildlife conservation in the third world. *The Ecologist* 27: 14-20.

Harrison, S. 2005. Biodiversity and wilderness: the need for systematic protection of biological diversity. *Journal of Land Resources and Environmental Law* 25: 53-62.

Hubbard, K.D., M. Nixon and J.A. Smith. 1998. The Wilderness Act's impact on mining activities: policy versus practice. *Denver University Law Review* 76: 591-609.

Jacques, P. and D.M. Ostergren. 2006. The end of wilderness: conflict and defeat of wilderness in the Grand Canyon. *Review of Policy Research* 23 (2): 573-586.

Keiter, R.B. 1985. On protecting the national parks from the external threats dilemma. *Land and Water Law Review* 20 (2): 355-420.

Keiter, R.B. and P.H. Froelicher. 1993. Bison, brucellosis, and law in the Greater Yellowstone Ecosystem. *Land and Water Law Review* 28 (1): 1-75.

Kennedy, R.F., Jr. 2007. Epilogue. In Yellowstone to Yukon Freedom to Roam: A Photographic Journey by Florian Schulz. Braided River, Seattle, Washington.

Leopold, A. 1921. The wilderness and its place in forest recreation policy. In S. Flader and J.B. Callicott (eds), The River of the Mother of God and Other Essays, 78-81. University of Wisconsin Press, Madison.

Leshy, J.D. 2005. Contemporary politics of wilderness preservation. *Journal of Land Resources and Environmental Law* 25: 1-13.

Mace, R.R. and J.S. Waller. 1998. Demography and population trend in grizzly bears in the Swan Mountains. *Conservation Biology* 10: 1013-1016.

Meyer, J.L. 1996. The Spirit of Yellowstone: The Cultural Evolution of a National Park. Rowan and Littlefield, Lanham, Maryland.

Miles, J.C. 2009. Wilderness in National Parks: Playground or Preserve. University of Washington Press, Seattle.

Noss, R. F., E. Dinerstein, B. Gilbert, M. Gilpin, B.J. Miller, J. Terborgh, and S. Trombulak. 1999. Core areas: where nature reigns. In M.E. Soulé and J. Terborgh (eds), Continental Conservation: Scientific Foundations of Regional Reserve Networks, pp. 99-128. Island Press, Washington, D.C.

Posey, D.A. (ed). 1999. Cultural and Spiritual Values of Biodiversity. Intermediate Technology Publications and UNEP, Nairobi.

Rohlf, D. and D.L. Hannold. 1988. Managing the balances of nature: the legal framework of wilderness management. *Ecology Law Quarterly* 15: 249-279.

Sarkar, S. 1999. Wilderness preservation and biodiversity conservation-keeping divergent goals distinct. *BioScience* 49(5): 405-412.

Sellars, R.W. 2000. The path not taken: National Park Service wilderness management. *The George Wright Forum* 17 (4): 4-8.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal lands. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Stegner, W. 1998. Marking the Sparrow's Fall. Henry Holt, New York.

Weber, B. 2004. The arrogance of America's designer ark. *Conservation Biology* 18(1): 1-3.

Western, D., M.C. Pearl, S.L. Pimm, B. Walker, I. Atkinson, and D.S. Woodruff. 1989. An agenda for conservation action. In D. Western and M.C. Pearl (eds), Conservation for the Twenty-first Century, pp. 304-323. Oxford University Press, New York.

US Fish and Wildlife Service. 2011. Grizzly Bears (*Ursus arctos horribilis*) 5-Year Review: Summary and Evaluation. Available at: http://www.fws/mountain-prairie/species/mammals/grizzly/Final%205YearReview_August%202011.pdf. Accessed May 2012.

Williams, G.W. 2000. Introduction to aboriginal fire use in North America. *Fire Management Today* 60(3): 8-12.

Yellowstone National Park. 2011. Yellowstone Resources and Issues. Division of Interpretation. Mammoth Hot Springs, Yellowstone National Park. Available at: www.nps.gov/yell Accessed April 2011.

CHAPTER 7: BUFFER ZONES

"We need buffer zones and regional planning."

NPS Director William Mott 1988:32

Buffer Zone Purposes

Buffer zones have been portrayed in an *ecologic* sense especially for industrialized nations (e.g., thwarting outside boundary groundwater withdrawal that could lower the water level in a reserve, Schonewald 1988) and in the *social* sense of benefiting local people especially in developing countries (e.g., providing people with subsidies so they will not harm large mammals that wander out of a protected area, Talbot and Olindo 1990). Our focus here is on the former.

"Buffer zones are among the best–accepted elements of conservation design" (Noss et al. 1997:109) but such blind enthusiasm is based more on presumed effectiveness that empirical data. "There are few studies that test the effectiveness of buffer zones, and most of those have focused on the socioeconomic as opposed to the ecological buffering functions" (Heinen and Mehta 2000: 148 , cited in Diego Martino 2001). The ideal buffer zone for a developed country like the United States would guard against the potential impacts of mining, oil and gas extraction, logging, geothermal exploration, water development projects, commercial resorts and private home building. These threat *sources* create *stresses* like pollution, noise, surface water diversion, groundwater depletion, habitat fragmentation, influx of exotic species, poaching, and more. Unfortunately, this is an unrealistic expectation for any buffer zone (Shafer 1999).

Brief History of U.S. Buffer Zone Advocacy

Buffer zones have been recommended for U.S. national parks since the 1930s and thus represent a long-standing management tool that was/is perceived to be effective in protecting a core protected area (Shelford 1933a, Wright et al. 1933). More specifically, Wright and colleagues viewed buffer zones as being necessary to thwart "external influences" such as timbering, road development, and exotic species. The zones were to be off-limits to trapping furbearing animals, controlling predators (with exceptions), hunting rare species, sheep grazing and cultivation (Wright et al., 1933; Wright and Thompson, 1935). Shelford (1933a), on behalf of the Ecological Society of America, recommended buffer zones around first class reserves (like most national parks) to allow more room for wide-ranging mammals. He also thought protected area buffer zones could accommodate development (e.g., timber production, livestock grazing), recreation, experimental research, protection against fire and disease and thwart the invasion of exotic species (Shelford 1933b,c).

Former NPS Director Conrad Wirth in 1961 (1962:29) asked whether buffer zones "should be part of the park, or should we leave their development and management to other public agencies, such as the Forest Service or a state agency, or to private enterprise?" If they are part of the park, it decreases the park's effective size. Leopold et al. (1963) recommended that some parks be buffered with adjacent national recreation areas where hunting is allowed. "Perhaps only through compromises of this sort will the park system be rounded out" (p. 103). There was an attempt by Senator Barry Goldwater in 1975 to create a buffer zone around Grand Canyon National Park, Arizona, but when environmentalists insisted on the buffer zone being inside the park, the effort ceased (Lowry 1998:80). Former NPS Director William Mott (1988), drafted by Shafer, called for the creation of buffer zones around U.S. national parks. Coggins (1990) assumed that official wilderness areas adjacent to national parks would serve as buffer zones. Large core areas surrounded by buffer zones are likely only possible in parts of the western United States (Wade et al. 2011).

US National Park Buffer Zones

The creation of buffer zones for US national parks has been achieved at some locations in various ways. For example, the Everglades National Park and Expansion Act of 1989 (16 U.S.C. §410) authorized the purchase of 107,000 acres next to the park's eastern boundary to serve as a "buffer" against urban encroachment (Zaslowksy and Watkins 1994: 50). However, this buffer area became part of the park itself. When El Malpais

National Monument, New Mexico, was created in 1987, Congress created a BLM managed “national conservation area” bordering much of its boundary. In this case, the park buffer zone was administered by a sister agency. The NPS has created buffer zones around some units by securing easements for scenic vistas (e.g., the Blue Ridge Parkway, Virginia and North Carolina). A buffer zone and a scenic vista achieve many of the same goals (Camp et al. 1997).

Biosphere Reserves

Four decades after Shelford, the reason for buffer zones articulated both similar and different rationale. The United Nations Environmental, Scientific and Cultural Organization (UNESCO) Man and the Biosphere (MAB) Program was initiated in 1971, an outgrowth of the 1968 Biosphere Conference. One of the 12 major research themes was Project 8: Biosphere Reserves. Before MAB became operational in 1976, there were some expert panels that drafted guidelines on how to select biosphere reserves. Buffer zones and transition areas for biosphere reserves were intended to shield the core from man's activities, allow more space for wide-ranging mammals and larger population species for rare species, education, tourism, and manipulative research (United Nations Environmental, Scientific and Cultural Organization 1974). But the concept also included an additional factor. There was a realization that preservation, especially in developing countries, may not succeed unless the needs of local people were considered (Dasmann 1988). Hence the biosphere model allowed for indigenous people in the buffer zone or transition area (Figure 34). Whether motivated by MAB or not, observations around the world witnessed tropical developing countries emphasizing accommodating indigenous people in buffer zones (MacKinnon et al. 1986, Oldfield 1988, Sayer 1991).

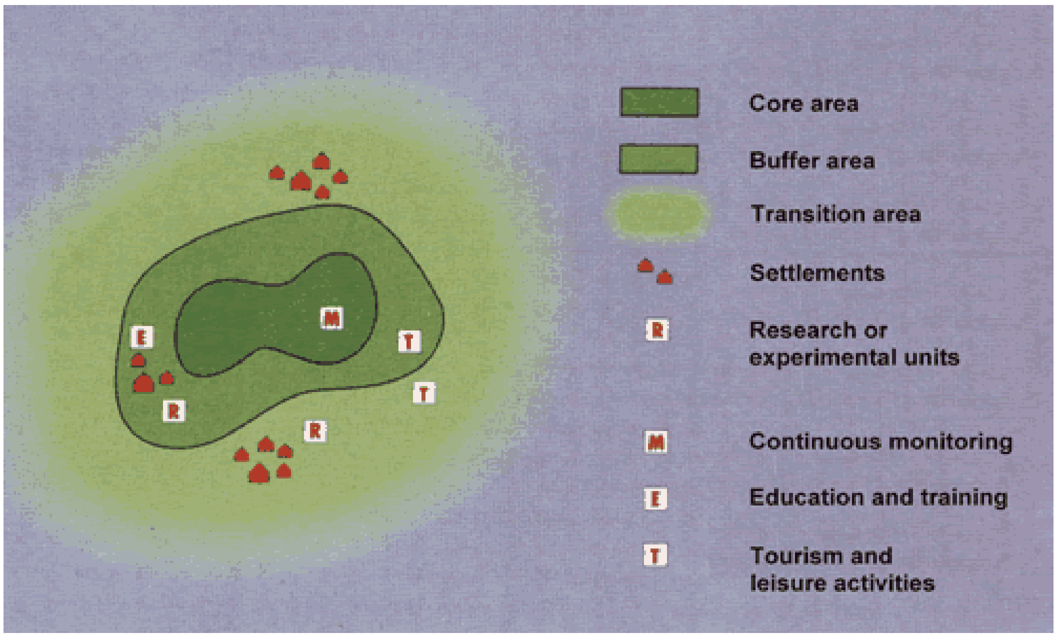


Figure 34. The zoning scheme of the idealized biosphere reserve. (http://www.biosphere-vosages-pfaelzerwald.org/_uk/html/mab/fonctionnement_zonage_htm)

In most instances, biosphere reserves were labels on top of existing reserves. Surrounding land use often precludes a manager from turning that area into a model biosphere reserve in terms of spatial configuration (Hough 1988). What happens in a buffer zone is usually outside of the reserve manager's authority (Newmark and Hough 2000).

Yellowstone National Park was designated a biosphere reserve in 1976. However, the designation did not conform to the biosphere reserve spatial model. The Yellowstone “biosphere reserve” encompassed only the national park and none of the adjacent land. In other words, there was an official core area but no official buffer zone or transition area. This practice extended to all national parks. biosphere reserves of that time except for one (Shafer 1999, Bradybaugh 1996). The reason for designating only U.S. national parks as biosphere reserve core areas, minus the essential buffer and transition areas was political.

The national uproar that ensued after NPS and USFS issued the 1990 GYE “Vision Document” illustrates how industry derailed efforts perceived as precluding consumptive use on national forests next to Yellowstone National Park (Shafer 1999, 2010). Another larger uproar occurred in the mid-1990s when U.S. biosphere reserves and world heritage sites were unfairly perceived as a United Nation’s infringement on U.S. sovereignty (Machado 1998, Shafer 2004: 165-166).

Boundary Lines and Fluxes

Forces generated by human activity may cross an imaginary line, a park boundary. "Fixed boundaries define the limits of where the Park Service may implement regulatory authorities and enforce federal law" (National Parks and Conservation Association 1974: 74). A boundary is a non-physical one-dimensional entity though we may mark it with posts, wire, rails, or signs which are an expression of the sociological "generated edge" (Schonewald-Cox and Bayless 1986). Some forces or entities moving across a protected area boundary have been described as "lateral fluxes" (Reiners and Driese 2001) but have received little treatment in ecology. Reiners and Driese (2001) note that there is as yet no conceptual framework in ecology to address such spatial phenomena. The movement of fluxes across landscapes is a much needed new area of research (Wu and Hobbs 2002). In more lay terminology, these lateral fluxes have been referred to as the "spillover effect" (Karkkainen 1997: 98). Documenting the environmental impact of such fluxes goes to a very core issue of ecological science. "The challenge for ecosystem scientists and managers is to scientifically relate cause and effect when the cause and effect relationship is spatial" (Boyd 2008:12).

Buffer Zone Definition and Design

Diego Martino (2001) correctly pointed out that there is not yet an accepted definition of buffer zone in terms of its presumed ecological impact filtering function. This begs the question of why scientists and protected area managers have been so slow creating a good definition. It may be because the notion has thus far evaded adequate conceptualization. One can rather easily articulate the goal of an effective buffer zone: it increases the width of a protected area so that the conditions of exterior and interior habitats are similar. A buffer zone is *not* land adjacent to a reserve (sensu Defries et al. 2005, Zaccarelli et al. 2008) where land use restrictions may or may not exist. Simply calling something a buffer zone does not dictate that it buffers anything.

As Groom et al. (1999: 192) pointed out, "buffers have not been a traditional conservation element in North America." They go on to say, "Presently there is no systematic approach to designing buffer areas. The characteristics of each buffer zone depend on what they are buffering [and] the current and probable future uses in the zone..." (Groom et al. 1999: 186). Kelly and Rotenberry (1993) made a plea that buffer zone guesswork needs to be replaced with buffer zone science. Without buffer zones, inevitable encroachment on the reserve occurs (Gascon et al. 2000).

Buffer zones are therefore a set of societal rules, not as a physical band of land. However, one must first know what influences one seeks to buffer against. Otherwise, the creation of a buffer zone may entail treating existing symptoms instead of first identifying the real or potential problem. Often there is no authority to create the rules needed for a buffer zone. Buffer zones may often represent *a priori* rather than *a posteriori* land use planning tools. Most buffer zones could represent more aspiration than reality. Some advice is worth repeating: “Buffer zones are rarely a panacea” (Groom et al. 1999: 185). However, “In general, the greater the difference in management goals on either side of a border, the greater the need for, and width of, a buffer zone” (Landres et al. 1998:59).

Reserve Area and Corridors

U.S. national park area has long been a topic of research and discussion (Newmark 1986, 1987, 1995). Newmark’s research documented that some mammalian extinctions in some North American national parks were correlated with park area. Other interpretations of the potential reasons for these extinctions have surfaced (Parks and Harcourt 2002). However, this long-term interest in U.S. national park area has not been the case for protected area buffer zones.

According to Noss et al. (1996: 957), the following hypothesis as it applies to large mammals has not been well evaluated empirically: “buffer zones will help protect sensitive species from frequent contacts with people and provide supplemental habitat." Boitani et al. (2007) asserted that the buffer zone/corridor network model proposed by Noss and Harris (1986), which has now gained international adoption (e.g., World Wildlife Fund 2006), still remains a working hypothesis. As Cooperrider et al. (2001:59) said, "Neither do we know how effective such an approach can be in resolving conflicting human demands on the regional landscape." An examination of the empirical evidence supporting the corridor strategy has received much attention, and as a result, discussion and field application have burgeoned (Hilty et al. 2006, Crooks and Sanjayan 2006). In contrast, any empirical evidence supporting the buffer zone strategy to thwart human generated edges and lateral fluxes is hard to locate. Furthermore, one buffer zone prescription may not suffice for a whole protected area boundary (Ambrose and Bratton 1993).

US Social Stigma

Buffer zones have a social stigma in the United States. For example, Anderson (1988) presents the argument that imposing park buffer zones on states or private landowners would likely represent a "compensatory regulatory taking" and thus an improper use of federal authority. Karkhainen (1997: 103, 92), however, argues that "So long as the government permits viable economic uses on private lands in these outer concentric zones, the takings doctrine should not pose any problems to this scheme." Karkkainen also indicates "the status of takings jurisprudence and its implications for biodiversity conservation policy remain highly unsettled." This legal scholar recommended the core/buffer zone concept as the bedrock approach for biological diversity conservation (Karkkainen 1997:100). This approach demands that land use adjacent to a protected area be regulated.

Wilderness Buffer Zones

After the USFS began instituting a *de facto* buffer zone policy for official wilderness on national forest land, Congress removed such discretionary agency authority (Kelson 1998). Congress made its views known about buffer zones being created adjacent to wilderness clear in the Endangered American Wilderness Act of 1978 (16 U.S.C. 1131 et seq.). Federal land buffer zones around USFS wilderness were precluded in almost every state wilderness act passed since 1984 (Kelson 1998). The New Mexico Wilderness Act of 1980 was the first to prohibit buffer zones around wilderness areas, and the prohibition was adopted later for the Oregon Wilderness Act, Washington Wilderness Act, Arizona Wilderness Act, Utah Wilderness Act, Arkansas Wilderness Act, Wyoming Wilderness Act, Pennsylvania Wilderness Act, and Michigan Wilderness Act (Dawson and Hendee 2009: 192, 149). The boiler-plate language used in federal legislation prohibiting buffer zones is provided in Hubbard et al. (1998: 605). The official policy of both the USFS and BLM is that buffer zones will not be allowed next to wilderness (Hubbard et al. 1998).

Roadless Area Buffer Zones

Roadless areas may not have been intended as buffer zones for national parks but, like wilderness areas, they can serve that purpose (Figures 35 and 36).

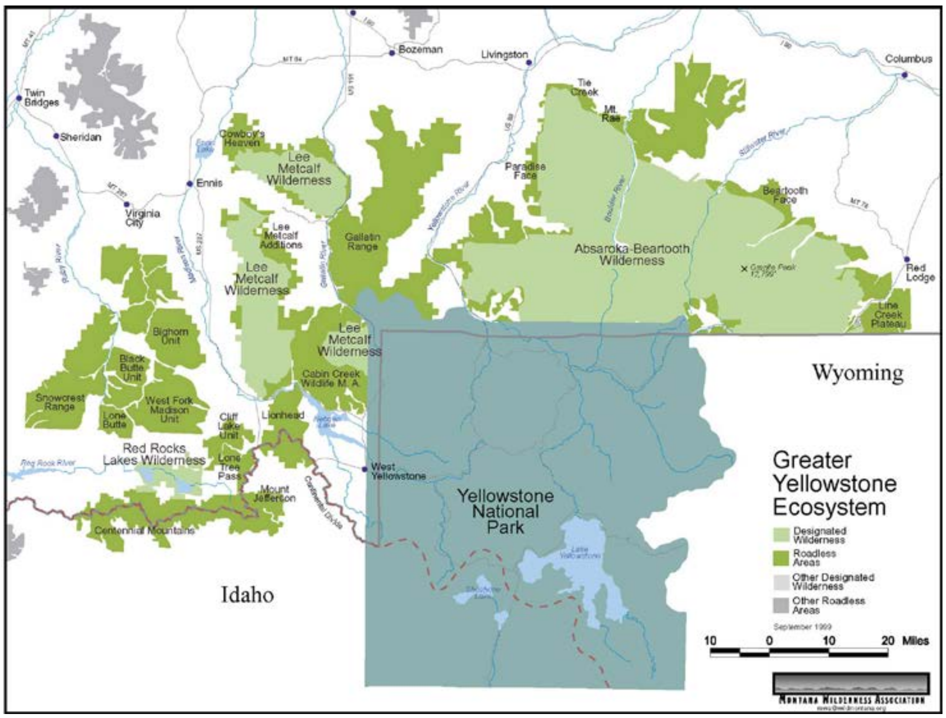


Figure 35. Montana wilderness and roadless areas near Yellowstone National Park. From Wild Montana (http://wwwwildmontana.org./resources/maps/roadless.php)

Figure 36. Windy Pass in the Gallatin Divide Roadless Area, Gallatin National Forest, Montana. Some mountain peaks in the background are in Yellowstone National Park. From Native Forest Network (http://www.nativeforest.org/campaigns/last_refuge_/gallatin_range.htm)

The USFS Final Rule for roadless areas was published in the *Federal Register* during early January 2001 and the agency adopted it on January 12, 2001. The rule prohibited road building and timber cutting on 58.5 million acres of inventoried USFS roadless areas (with exceptions), or about 1/3 of U.S. National Forest System. After a bitter decade-long battle initiated by the George W. Bush Administration, on October 21, 2011, the U.S. Tenth Court of Appeals ruled that 49 of the 58.5 million acres were protected under the rule (*Wyoming v. US Dep't of Agriculture (USDA) 661 F. 3d 1209 (2011).* The rule did not close any existing road or trail, permitted access to private property, honored existing leases or permits for minerals or oil and gas, ski areas and logging rights, and allowed new roads for fire-fighting. Timber already sold could be logged. In September 2012, the U.S. Supreme Court would not hear an appeal of the 2001 roadless rule by the state of Wyoming, the mining industry and others. However, the upheld rule allowed Idaho to remove all roadless protections from its 300,000 acres in the GYE. Roadless areas are not administrative wilderness because some uses disallowed in wilderness areas are acceptable in roadless areas (e.g., ORVs) (Baldwin 2002). The distribution of roadless areas and wilderness areas in Montana is found in Figure 37.

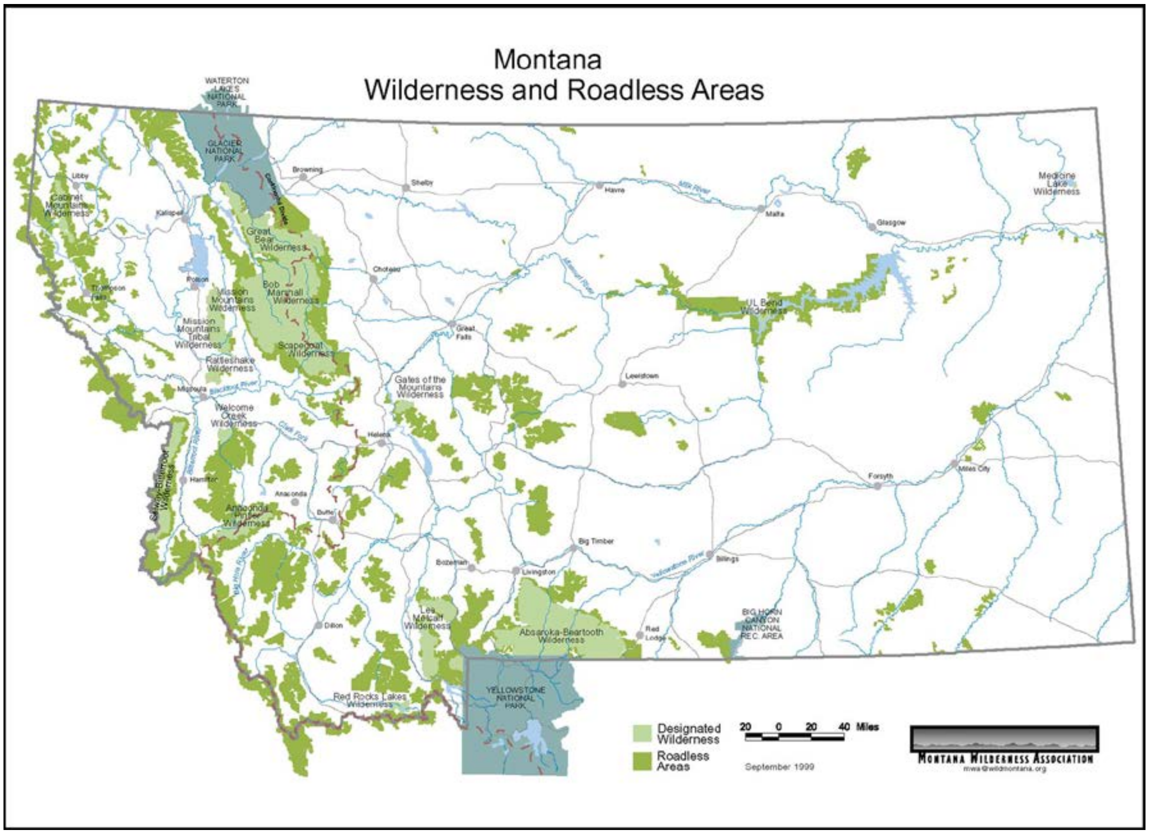


Figure 37. Roadless areas and wilderness areas in Montana. Montana Wilderness Association (http://www.wildmontana.org/resources/maps/roadless.php).

For a history of USFS roadless area policy, see Hoyt (2001), Glickman (2004), and Turner (2006). Roadless area protection will enhance the preservation of biological diversity in the U.S. (Crist et al. 2005, Loucks et al. 2003, DeVelice and Martin 2001). According to DeVelice and Martin (2001), 35% of inventoried roadless areas are next to existing wilderness areas. Roadless areas in the Klamath-Siskiyou Ecoregion of Oregon contributed to overall regional connectivity as well as representation and the protection of rare species (Strittholt and DellaSala 2001).

Yet another form of buffer zone can exist in the form of congressionally designated “special designations” on federal lands. An example of such a designation if the USFS’s 36,703 acre Cabin Creek Special Management Area, Gallatin National Forest, that lies between two Montana wilderness areas (McKnight 1987).

Buffer Zones or Fortresses

In industrial nations, erecting a barrier between a protected areas and encroaching civilization might be a wise prescription to keep out unwanted influences. According to Groom et al. (1999), erecting an impermeable barrier may in some cases be needed. The problem with this solution is the barrier might also thwart the immigration and emigration of some park carnivores and herbivores. This is a biocentric conflict. If we erect impenetrable barriers, we might later appreciate Hales’ (1989: 142) warning: “Because we believed that our walls would protect parks, we are now at risk of finding them to be prisons rather than fortresses.”

Other Countries

The U.S. experience with protected area buffer zones is not the same as in some developing countries. The initiative taken by some of these countries in creating protected area buffer zones is inspiring. For example, in 1996 His Magesty's Government of Nepal created a 750 km^2 enforceable buffer zone created around the country's 932 km^2 Royal Chitwan National Park (Heinen and Mehta 2000). Such a buffer zone is larger than Crater Lake National Park, Oregon.

REFERENCES

Ambrose, J.P. and S.P. Bratton. 1993. Trends in landscape heterogeneity along the borders of Great Smoky Mountains National Park. *Conservation Biology* 4: 135-143.

Anderson, F.R. 1979. Public land exchanges, sales, and purchases under the Federal Land Policy and Management Act of 1976. *Utah Law Review* 1979: 657-676.

Baldwin, P. 2002. The National Forest System Roadless Area Initiative. Congressional Research Service RL 30647.

Boitani, L., A. Falcucci, L. Maiorano, and C. Rondinini. 2007. Ecological networks as conceptual frameworks or operational tools in conservation. *Conservation Biology* 21 (6): 1414-1422.

Boyd, J. 2008. The geography of ecosystem services. *Resources* 170: 10-15.

Bradybaugh, J. 1996. Mammoth Cave biosphere reserve: making a difference in groundwater protection. *Park Science* 16 (3): 12-13.

Camp, R.J., D.T. Sinton and R.L. Knight. 1997. Viewsheds: a complementary management approach to buffer zones. *Wildlife Society Bulletin* 25 (3): 612-615.

Coggins, G.C. 1990. The developing law of land use planning on the federal lands. *University of Colorado Law Review* 61: 307-353.

Cooperrider, A., S. Day, and C. Jacoby. 2001. The bioreserve strategy for conserving biodiversity. In C.L. Convis, Jr. (ed), Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism, pp. 58-63. ESRI Press, Redlands, California.

Crist, M.R., B. Wilmer and G.H. Aplet. 2005. Assessing the value of roadless areas in a conservation reserve strategy: biodiversity and landscape connectivity in the northern Rockies. *Journal of Applied Ecology* 42: 181-191.

Crooks, K.R. and M. Sanjayan (eds) 2006. Connectivity Conservation. Cambridge University Press, UK.

Dasmann, R.F. 1988. Biosphere reserves, buffers, and boundaries. *BioScience* 38: 487-489.

Dawson, C.P. and J.C. Hendee. 2008. Wilderness Management: Stewardship and Protection of Resources and Values. 4th Ed. Fulcrum, Golden, Colorado.

DeVelice, R.L. and J. R. Martin. 2001. Assessing the extent to which roadless areas complement the conservation of biological diversity. *Ecological Applications* 11: 1008-1018.

Diego Martino, M.A. 2001. Buffer zones around protected areas: a brief literature review. Electronic Green Journal, UCLA Library, US Los Angeles. Available at: http://escholarship.org/uc/item/02n4v17n. Accessed September 2010.

Defries, R., A. Hansen, A.C. Newton, and M.C. Hansen. 2005. Increasing isolation of protected areas in tropical forests over the past twenty years. *Ecological Applications* 15: 19-26.

Gascon, C., G.B. Williamson and A.B. da Fonseca. 2000. Receding forest edges and vanishing reserves. *Science* 288 (5470): 1356-1358.

Glickman, R.L. 2004. Traveling in opposite directions: roadless area management under the Clinton and Bush administrations. *Environmental Law* 34: 1145-1208.

Groom, M., D.B. Jensen, R.L. Knight, S. Gatewood, L. Mills, D. Boyd-Heger, L.S. Mills and M.E. Soulé. 1999. Buffer zones: benefits and dangers of compatible stewardship. In M.E. Soulé and J. Terborgh (eds), Continental Conservation: Scientific Foundations of Regional Reserve Networks, pp. 171-197. Island Press, Washington, D.C.

Hales, D. 1989. Changing concepts of national parks. In D. Western and C.C. Pearl (eds), Conservation for the Twenty-first Century, pp. 139-144. Oxford University Press, New York.

Heinen, J. and J. Mehta. 2000. Emerging issues in legal and procedural aspects of buffer zone management with case studies from Nepal. *Journal of Environment and Development* 9 (1): 45-67.

Hilty, J.A., W.Z. Lidicker, Jr. and A.M. Merenlender. 2006. Corridor Ecology: The Science and Practice of Linking Landscapes for Biodiversity Conservation. Island Press, Washington, D.C.

Hough, J. 1988. Biosphere reserves: myth and reality? *Endangered Species Update* 6 (1-2): 1-4.

Hoyt, A.S. 2001. Roadless area conservation: how the “roadless rule” affects America’s forestland. *Tulane Environmental Law Journal* 14: 525-547.

Hubbard, K.D., M. Nixon and J.A. Smith. 1998. The Wilderness Act’s impact on mining activities: policy versus practice. *Denver University Law Review* 76: 591-609.

Karkkainen, B.C. 1997. Biodiversity and land. *Cornell Law Review* 83: 1-104.

Kelly, P.A. and J.T. Rotenberry. 1993. Buffer zones for ecological reserves in California: replacing guesswork with science. In J.E. Keeley (ed). Interface Between Ecology and Land Development in California, pp. 85-91. Southern California Academy of Science, Los Angeles.

Kelson, A.R. 1998. Integrating wilderness within broader landscapes: the U.S. public land experience. *Land Use Policy* 15 (3): 181-189.

Landres, P.B., R.L. Knight, S.T.A. Pickett, and M.L. Cadenasso. 1998. Ecological effects of administrative boundaries. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 39-64. Island Press, Washington, D.C.

Leopold, A.S., S.A. Cain, C.M. Cottam, I. N. Gabrielson and T.M. Kimball. 1963. Wildlife management in the national parks: advisory board on wildlife management appointed by the Secretary of the Interior. In Compilation of the Administrative Policies for the National Parks and National Monuments of Scientific Significance (Natural Area Category). Revised August 1968, printed 1970. U.S. Government Printing Office, Washington, D.C.

Loucks, C., N. Brown, A. Loucks, and K. Cesareo. 2003. USDA Forest Service roadless areas: potential biodiversity conservation reserves. *Conservation Ecology* 7(2): 5. [online] Available at: http://www.consecol.org/vol/7/iss2/art5 Accessed December 2011.

Lowry, W.R. 1998. Preserving Public Lands for the Future: The Politics of Intergenerational Goods. Georgetown University Press, Washington, D.C.

Machado, M. 1998. Mounting opposition to biosphere reserves and world heritage sites in the United States sparked by claims of interference with national sovereignty. *Colorado Journal of International Environmental Law and Policy* 9: 120-129.

MacKinnon, J., K. MacKinnon, G. Child, and J. Thorsell. 1986. Managing Protected Areas in the Tropics. IUCN, Gland, Switzerland.

McKnight, F.B. 1987. The use of “special management areas” as alternatives to wilderness designation or multiple use management of federal public lands. *Public Land Law Review* 8: 61-80.

Mott, W.P. 1988. Looking beyond park boundaries. *Natural Areas Journal* 8:30-32.

National Parks and Conservation Association. 1974. Our Endangered Parks: What You Can Do to Protect our National Heritage. National Parks and Conservation Association, Washington, D.C.

Newmark, W.D. 1986. Species-area relationship and its determinants for mammals in western North American national parks. *Biological Journal of the Linnaean Society* 28 (1-2): 83-98.

Newmark, W.D. 1987. A land-bridge island perspective on mammalian extinctions in western North American parks. *Nature* 325: 430-432.

Newmark, W.D. 1995. Extinction of mammal populations in Western North American national parks. *Conservation Biology* 9 (3): 512-526.

Newmark, W.D. and Hough, J.L. 2000. Conserving wildlife in Africa: integrated conservation and development project and beyond. *BioScience* 50: 585-592.

Noss, R.F. and L.D. Harris 1986. Nodes, networks, and MUMs: preserving diversity at all scales. *Environmental Management* 10: 299-309.

Noss, R.F., H.B. Quigley, M.G. Hornocker, T. Merrill, and P.C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology* 10 (4): 949-963.

Noss, R.F., M.A. O’Connell and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation under the Endangered Species Act. Island Press, Washington, D.C.

Oldfield, S., 1988. Buffer Zone Management in Tropical Moist Forests: Case Studies and Guidelines. IUCN, Gland, Switzerland.

Parks, S.A. and A.H. Harcourt. 2002. Reserve size, local human density, and mammalian extinctions in U.S. protected areas. *Conservation Biology* 16 (3): 800-808.

Reiners, W.A. and K.L. Driese. 2001. The propagation of ecological influences through heterogeneous environmental space. *BioScience* 51 (11): 939-950.

Sayer, J. 1991. Rainforest Buffer Zones: Guidelines for Protected Area Managers. IUCN, Morges, Switzerland.

Schonewald-Cox, C. 1988. Boundaries in the protection of nature reserves. *BioScience* 38(7): 480-486.

Schonewald-Cox, C. and J. Bayless. 1986. The boundary model: a geographical analysis of design and conservation of nature reserves. *Biological Conservation* 38: 305-322.

Shafer, C.L. 1999. US national park buffer zones: historical, scientific, social, and legal aspects. *Environmental Management* 23 (1): 49-73.

Shafer, C.L. 2004. Islands of hope: pursuing the voluntary preservation of America's natural heritage. *Landscape and Urban Planning* 66: 127-171.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal lands. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Shelford, V. E. 1933a. Ecological Society of America: a nature sanctuary plan unanimously adopted by the society, December 28, 1932. *Ecology* 14: 240-245.

Shelford, V.E. 1933b. Nature sanctuaries-a means of saving natural biotic communities. *Science* 77: 281-282.

Shelford, V.E. 1933c. The preservation of natural biotic communities. *Ecology* 24 (2): 240-245.

Strittholt, J.R. and D.A. DellaSala. 2001. Importance of roadless areas in biodiversity conservation in forested ecosystems: case study of the Klamath-Siskiyou Ecoregion of the United States. *Conservation Biology* 15(6): 1742-1754.

Talbot, L.M. and P. Olindo. 1990. Amboseli and Maasai Mara, Kenya. In A. Kiss (ed), Living with Wildlife: Wildlife Resource Management with Local Participation in Africa, pp. 67-74. World Bank Technical Paper No. 30. World Bank, Washington, D.C.

Turner, J.M. 2006. Conservation science and Forest Service policy for roadless areas. *Conservation Biology* 20(3): 713-722.

United Nations Educational, Scientific and Cultural Organization. 1974. Task Force On: Criteria and Guidelines for the Choice and Establishment of Biosphere Reserves. Final Report. Report Series 22. UNESCO, Paris.

Wade, A.A., D.M. Theobald and M. J. Laituri. 2011. A multi-scale assessment of local and contextual threats and potential U.S. protected areas. *Landscape and Urban Planning* 101: 215-227.

Wirth, C. 1962. Memorandum to Secretary of the Interior, October 25, 1961. *National Parks Magazine* 36 (172): 14-15.

World Wildlife Fund. 2006. Joining the Dots: Species and Protected Areas-A Contribution to the Implementation of the CBD Programme of Work on Protected Areas. WWF Global Species Programme, Wien, 94 pp.

Wright, G.M., J.S. Dixon, and B.H. Thompson. 1933. Fauna of the National Parks of the United States: a Preliminary Survey of Faunal Relations in National Parks. Fauna Series No. 1. U.S. Government Printing Office, Washington, D.C.

Wright, G.M. and B.H. Thompson. 1935. Fauna of the National Parks of the United States. Fauna Series No. 2. U.S. Government Printing Office, Washington, D.C.

Wu, J. and R. Hobbs. 2002. Key issues and research priorities in landscape ecology. *Landscape Ecology* 17: 355-365.

Zaccarelli, N., K.H. Riitters, I. Petrosillo, and G. Zurlini. 2008. Indicating disturbance content and context for preserved areas. *Ecological Indicators* 8: 841-853.

Zaslowsky, D. and T.H. Watkins. 1994. These American Lands: Parks, Wilderness, and the Public Lands. Island Press, Washington, D.C.

CHAPTER 8: VALUES, POLICY AND MANAGEMENT

"Actions and decisions may add up to agency policy-but policy that no one has planned."

Majone 1989:160, cited in Primm and Clark 1979

Values

Values are diverse (Rolston 1988) and policy is reflection of values. As Foresta (1984: 261, cited in Wagner et al. 1995) reminded us, "In a democracy, any public organization must ultimately base its goals on society's interests and values." Some scientists may not know that their work or public statements reflect cultural values which can change with time as a society's values change. Freemuth and Cawley (1998: 214) pointed out, "Scientists, and managers who center decisions solely on science, do not have any *special* [emphasis added] position in negotiations over value questions." In other words, value judgments made by scientists should not carry any more weight than judgments made by anyone else in society. However, that does not mean scientists cannot choose to be involved in helping guide an understanding of the consequences of policy options (Wagner et al. 1995: 198-199). However, history illustrates that there has been a long procession of scientists, either interested in U.S. national parks or who worked for NPS, who have not neglected to advocate for policies they thought were in the best interest of park biota (Schullery 2010). The following statement is highly applicable to the U.S. federal government: "[T]he ideal in which the roles of scientist and policy maker are clearly defined, rigidly followed, and perfectly executed is far from reality" (Wilhere 2012:43).

Policy

People perceive of environmental policy in diverse ways. One definition is an overall direction sought by society (e.g., to preserve natural landscapes). To others, actions taken to improve the environment constitute policy. In this case, for example, the Yellowstone Act of 1872 (16 U.S.C. §§21-22) or the creation of the NPS via the Organic Act of 1916 (6 U.S.C. §§1-4) would constitute policy. However, the first definition might view these legislative actions as simply policy *instruments* (Talbot 2008).

The NPS definition of policy is extremely broad and focuses on *management decisions*. "Policy sets the framework and provides direction for all management decisions. This direction may be general or specific; it may prescribe the process through which decisions are made, how an action is to be accomplished, or the results to be achieved" (National Park Service 2006: 4). To add further complexity, NPS also recognizes land management *goals.* One goal, until recently, was the preservation of landscapes as they existed at the time of presettlement. In NPS jargon, therefore, management policy can include overarching goals as well as guidelines to achieve that goal (e.g. controlled burning is encouraged when feasible). The terms policy and goals are used inconsistently in the literature (see Wagner et al. 1995).

Much of the direction found in the most recent NPS policy handbook (National Park Service 2006) is actually management *guidelines*. Such guidelines are typically viewed as not being legally binding, unlike regulations. However, Mappes (2006: 626) points to a court decision where these policies were "binding" though the extent of such is unclear.

Agency policy can be generated from diverse sources (e.g., agency field personnel, conservation organizations, academics, Congress), has various levels (e.g., policy [i.e., management guidance] on culling excess ungulates in parks versus the overall preservation goal stemming from the 1916 NPS Organic Act). It can be technical (e.g., policy on mixing gene pools) or nontechnical (e.g., policy on regional planning).

Care must be taken at arriving at policies especially when we acknowledge that policy can be influenced by external influences. As Starker Leopold's misinterpreted concept of a "vignette of primitive America" illustrates, "[P]olicies themselves, once implemented, take on a life of their own that is not easy to alter" (Lowry 2009:3). Today, the old vignette policy has been supplanted. "The degree to which a park can adequately restore and maintain its natural resources to a desired condition will depend on a variety of factors-such as size, past management events, surrounding land uses, and the availability of resources. Through its planning processes, the Park Service will determine the desired future conditions for each park unit and identify a strategy to achieve them" (National Park Service 2006: 37).

Example: The Yellowstone Fires

The NPS called the 1988 Yellowstone fires the most significant ecological event in U.S. national park history (National Park Service 1988a, cited in Schullery 1989). NPS was later accused by some politicians of allowing one-half of the park's forest to be destroyed (Figures 38, 39). These fires have been attributed by many people to this park's practice of fire suppression. This is arguable. The general public and many scientists do not fully appreciate Yellowstone National Park's fire history and NPS fire policy.

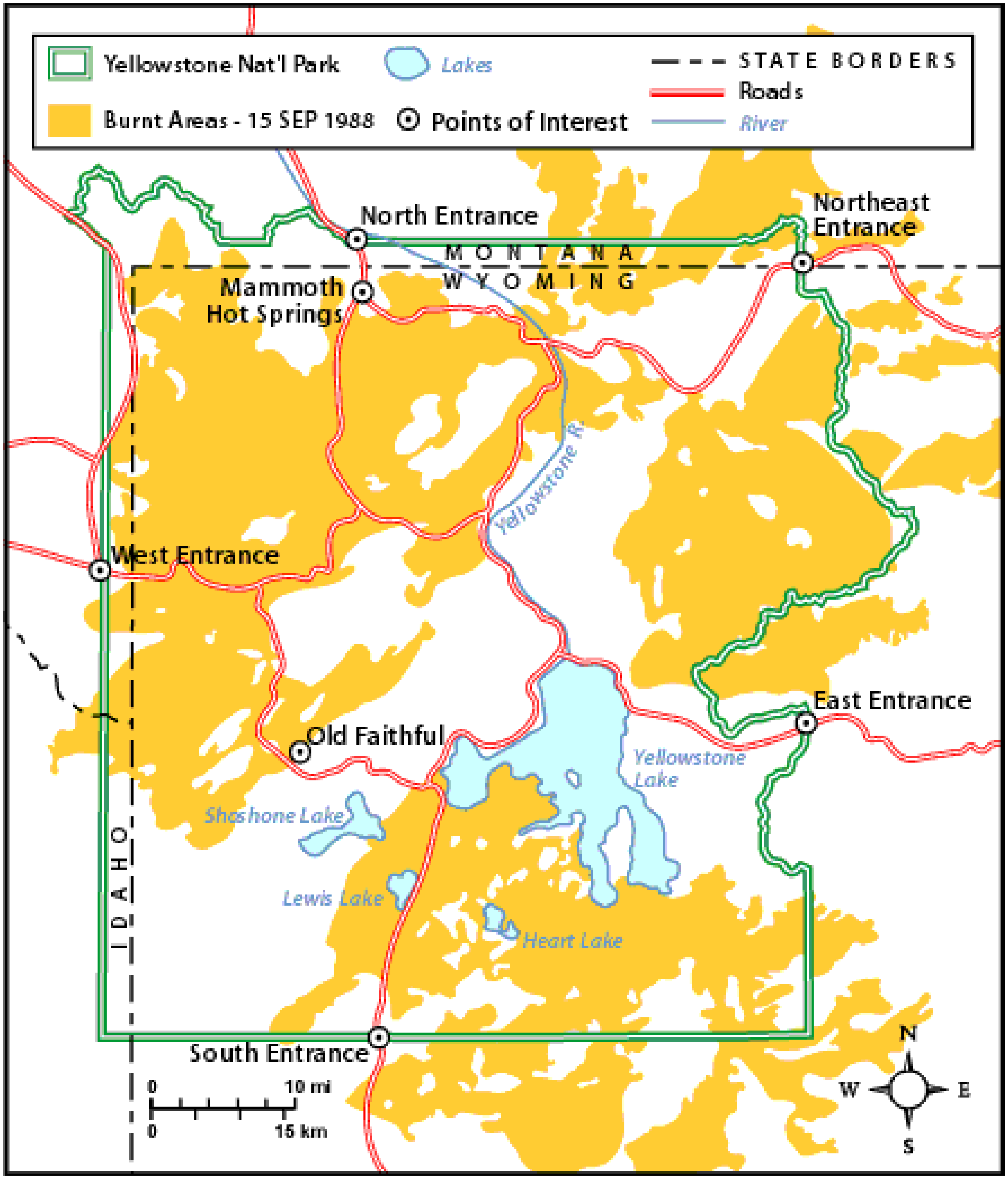


Figure 38. Extent of the Yellowstone fires during the summer of 1988 (http://www.cotf.edu/ete/modules/yellowstone/Ysituation.htm)

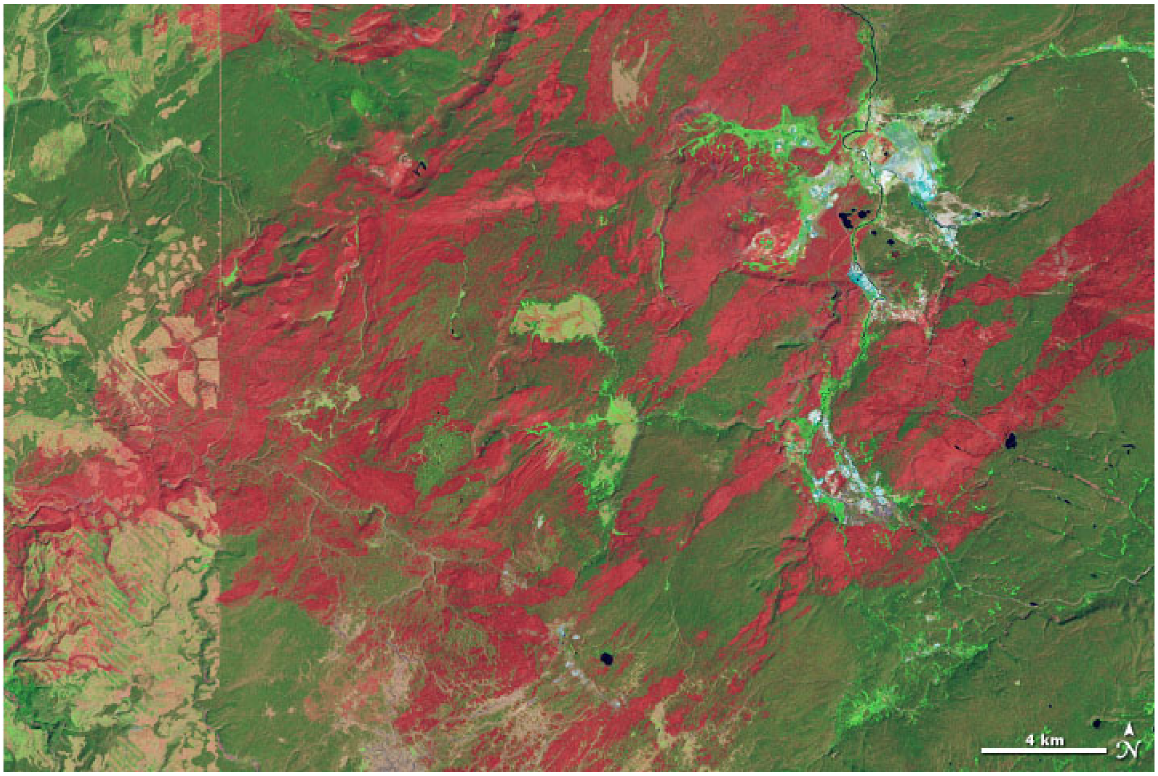


Figure 39. Yellowstone fires on August 2, 1989 from Landsat 5 (http://earthobservatory.nasa.gov/Features/WorldofChange/yellowstone.php)

By using charcoal stratigraphy from Yellowstone National Park's Cygnet Lake, Millspaugh et al. (2000) determined that present fire frequency (2-3 fires/1000 years) has existed for the last 2000 years. Romme and Despain (1989) corroborated this finding using tree ring fire scars and found that a *large* fire occurs in Yellowstone every 300 years.

A policy of fire suppression was in effect in Yellowstone in 1886 but was really not enforced until 1945 (Schullery 1989). However, since 1972, Yellowstone adopted a policy of letting naturally created fires (e.g., lightening strikes) burn in the backcountry unless they threatened infrastructure (Schullery 1989). From 1972-1987, 235 fires were allowed to burn in Yellowstone (Schullery 1989). A 1974 park plan allowed controlled burning but it was rarely used from 1974-1988 (Lowry 1998:84).

The catastrophic Yellowstone fire of 1988 was a result of drought and wind. It burned 45% of the park and 11% of the Greater Yellowstone Ecosystem (Christensen et al. 1989). In fact, there were 248 fire starts in the GYE in 1988 alone (Schullery 1989). According to some Yellowstone researchers, the use of controlled burns in Yellowstone was not considered by park managers because they realized that climate was the key reason for the condition of the park's vegetation (Romme and Despain 1989). It might also have been influenced by a fear of a controlled burn escaping. Klein (2002), a National Academy of Sciences panel that reviewed the condition of Yellowstone's Northern Range at Congressional request, was of the view that the 1988 fire would have happened even if there had been decades of controlled burns. However, without a natural fire regime, Yellowstone National Park will have reduced biological diversity because certain successional plant communities will be absent (Taylor 1973) and so will the associated animals.

It is incorrect to think of Yellowstone National Park's fire policy history as characteristic of all US national parks. Many parks have used controlled burning (e.g., Everglades, Yosemite, and Bandalier). Research in the use of fire occurred at Sequoia National Park in the 1920s and in Everglades National Park in 1953 (Kilgore 2007). Sequoia-Kings National Park was the first park or wilderness to allow a natural fire to burn in its backcountry in 1968 (Kilgore 2007). The policy of prescribed burning (controlled burning) was expressed in NPS's 1968 management policies (National Park Service 1970). The 1972 policy of letting naturally-started fires burn in Yellowstone was extended to 12 other national parks (Schullery 1989). Although many national parks have been treated with controlled burns, the frequency of burning is usually not enough to replicate the natural situation. Therefore, the general public may not understand this policy without agency educational efforts.

Policy and Politics

"National park policy will continue to be decided in the political arena" (Freemuth 1989:36), or stated more precisely, it will always have a political component. It is a "sociopolitical procedure" (Wagner 1999:58). On the other hand, some argue that "political pressure should not drive policy" (Donahue 1997: 54). However, it does. For example, official 1988 NPS management policy (National Park Service 1988b) on park buffer zones was a direct result of Congressional interference (Shafer 1999). NPS thus produces some policy reactively to various events. A much more infamous example was an attempt by George W. Bush administration to completely rewrite the 2001 NPS *Management Policies* (National Park Service 2001). This fiasco is described in Mitchell (2006), Kass (2005) and Sellars (1997/2009: 301-306). But why should politics not interfere? Wagner et al. 1995: 85-86) provided one good reason: “The process malfunctions, however, when one or more of the interest groups exert sufficient pressure to drive ad hoc management decisions that are contrary to established policy, damaging the resources that are the foundation value of the American public’s asset. And it malfunctions when it renders the agency dysfunctional by threatening jobs of Service employees and preventing their acting in the best interests of the resources.”

What scientists and technical experts must ask themselves is whether they object to “wading into the complex and politically charged world of land use policy” (Waller 1988: 400). For those working in federal agencies, such wading is often unavoidable. If they do not wade, those who are less informed will take their place. But NPS upper management often encourages a “stand apart” role of their scientists. The determination of resource “impairment” is now entirely discretionary on the part of the park manager. Impairment is an “impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources and values” (National Park Service 2006: 11). Whether they wish to participate in policy formulation or not, scientists are often relegated to the role of technical advisors.

Land Management

What is management? “Management is defined as any activity directed toward achieving or maintaining a given condition on plant and/or animal populations and/or habitats in accordance with the conservation plan for the area" (Bourliére 1962: 364). Put even more simply, "management is a means, not an end" (Wagner 2006: 333). For example, the key management provision of the NPS Organic Act of 1916 is to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." This directive could be defined as a policy (goal) or a management guideline.

Leopold et al. (1963: 93) recommended that "a reasonable illusion of primitive America could be re-created using the utmost skill, judgment and ecological sensitivity." However, the Robbins Committee, a blue ribbon panel of scientists asked by Secretary Stewart Udall to evaluate the NPS science program, was less confident that such an illusion could be achieved. Although they were "viewing with sympathy the ideal of making a national park a 'vignette of primitive America,'" they were concerned with the "difficulties in even approaching such an ideal. In some instances, because of the paucity of historical records it would be impossible to determine what the condition of a particular park was when the white man first saw it. Changes, some irreversible and current activities, in some instances impossible to control...suggest that the ideal, though admirable may not be fully attainable; yet it is desirable to move in that direction" (Robbins 1963: 20-21). Here we see two groups of advisors not in agreement about the practicality of a management goal, which is a policy position. This leads us to another debate about a related management goal: natural.

Natural as Policy

Natural is in part a value. Sometimes policy setting is not influenced by political pressure but is based on undeveloped thinking. The concept of "natural" has been central to NPS policy since 1872. The Yellowstone Act mandated that the Service would be responsible for issuing regulations for the "preservation, from injury or spoilation, of all timber, mineral deposits, natural curiosities, or wonders, within the park, and their retention in a natural condition" (16 U.S.C. 21-22). The idea has dominated NPS culture ever since (Pritchard 1999). As Cole et al. (2008: 36) observed, "The goal of naturalness has been codified in legislation and protected area policy and built into agency culture." However, 134 years after America's first national park was created, NPS has not defined *natural* without some ambiguity... The most recent policies states that national parks will protect "components and processes in their natural condition." However, it then explains "The term 'natural condition' is used here to describe the condition of resources that would occur in the absence of human dominance of the landscape" (National Park Service 2006:36). This definition is similar to the definition provided by Noss (1995:27): "the condition of a landscape before substantial alteration by modern human activity." However, Yung et al. (2010a: 267) believes "The concept of naturalness does not provide sufficient guidance; it has multiple meanings that are often in conflict" A better standard would be ecological integrity (Huff 1997, Woodley 2010). In lieu of natural, Parks

Canada abandoned adopted ecological integrity in their 1988 park legislation (Parks Canada 2000, 2005).

"Naturalness as the benchmark is neither value free nor logically or practically usable" (Lele and Norgaard 1996:360). Put another way, "This means that any methodological or policy judgment about the naturalness of some ecological process or event is, in part, a categorical value judgment, a value judgment that some 'natural' thing is good" (Shrader-Freschette and McCoy 1993: 104). But the idea of "naturalness" has crept into the thinking of scientists. **"**We are unable to define **'**natural' in a way free of categorical values. We are unable to define it in a way recognized by hypothetico-deductivists as a part of science. Yet, it is part of science" (Shrader-Frechette and McCoy 1993: 103).

In the view of a group of scientists commissioned to conduct a study on NPS wildlife policy, by adhering to natural as an NPS policy goal, "The agency has in our view, set a goal for the parks that is both unknowable and unobtainable" (Wagner et al. 1995: 45). But Yung et al. (2010a: 254-256) argued, "Despite its limitations, we are not suggesting that naturalness be abandoned. Naturalness will continue to provide an important touchstone for protected area conservation ... [but] the goals of wildness, historical fidelity, ecological integrity, and resilience...might be appropriate in some places." Some, but not all, participants in this workshop opted for the abandonment of natural (Cole et al. 2008:50). Even a group of authors consisting of many current and former NPS scientists or natural resource specialists concluded "it is increasingly clear that naturalness is no longer the umbrella under which all protected areas comfortably sit" (Cole et al. 2008: 40).

Many protected areas are not well managed (Harrison 2011). Can intervention cause more naturalness? Put another way, can intervention cause the landscape to show fewer impacts from human influence? Yes. Natural areas need restoration. As Chase (1987:374, 382) argued, "Natural areas are not made less natural by human presence." "What our national parks need...," Chase continued, "is not only protection, by *restoration* (emphasis added)." As for restoration, Dan Janzen (1998:1312) advised, "The question is not so much 'how' but rather 'when,' 'where,' 'how fast,' 'by whom,' 'how much,' and 'who pays for it.'" Janzen is telling us that land managers need to become gardeners. The problem is defining when and how to garden. Intervention to achieve restoration is needed. However, the NPS "concept of naturalness does not provide clarity regarding criteria for thresholds of intervention" (Cole et al. 2008: 43).

How can the internal conflict over "natural" as policy of be resolved? "[N]ew attention needs to be given to the purposes and values of parks and wilderness areas... This is the first order of business," argues Cole et al. (2008: 49). "The key challenge to stewardship of park and wilderness ecosystems is to decide where, when, and how to intervene in physical and biological processes" however "the appropriateness of these strategies can only be evaluated after basic philosophical issues have been resolved" (Cole et al. 2008: 49). "If the purpose of protected areas is to preserve natural conditions, and yet there is no objectively determined condition that can be called natural, the very purpose of protected areas is called into question" (Aplet and Cole: 2010: 18). This leads us into a longstanding debate about one NPS hypothesis and management policy: natural regulation.

Intervention versus Nonintervention

The controversy surrounding the concept of natural regulation, an NPS land management "policy," illustrates how debate over a land management guideline can rise to the level of Congressional attention. Natural regulation as a policy for animal populations in Yellowstone National Park and elsewhere elicited much controversy (Chase 1986, Boyce 1991, 1998, Wagner et al. 1995, Shafer 2000, Klein 2002). The policy of natural regulation is part science and part values (Klein 2002). Pritchard (1999) reviewed the decision-making process that resulted in Yellowstone's 1968 "natural regulation policy" as did Shafer (2000). Although their definition was too tardy to be of much help when most needed, the National Academy of Sciences study proposed an improved definition of natural regulation: "free of direct human manipulation" (Klein 2002:20). The opposite of natural regulation would therefore be management intervention. Protected area managers would be well served if they try to understand these policy debates. Otherwise, they cannot fully explain the underlying basis for their management actions.

George Wright and colleagues recommended intervention: "Time proved that management of some sort would have to be invoked to save certain situations" (Wright et al. 1933: 4). The Leopold Report also advocated intervention *and* made some statements that could have been interpreted as the opposite stance: non-interference. For example, they said "Insofar as possible, control through natural predation should be encouraged" and "the maintenance of naturalness should prevail" (Leopold et al. 1963: 98, 95). Their intervention message, however, was far more obvious: "Reluctance to undertake biotic management can never lead to a realistic presentation of primitive America" (Leopold et al. 1963: 94). Nevertheless, NPS defended its natural regulation policy beginning in 1968 and afterwards. For example, Yellowstone is "a system that has 10,000 years' experience managing itself" (National Park Service 1997: 104). The park championed natural regulation *but* acknowledged that certain other types of intervention did take place: "Such intervention, whether to restore wolves or fight fires or not fight fires or suppress exotic plant invasions, or poison exotic fish and restore native fish, or cull bison, in fact, occurs on a regular basis" (National Park Service 1997: 104). One might conclude from this that Yellowstone National Park viewed itself as implementing management "intervention."

Because of semantic confusion over NPS terminology (i.e., "natural process management" was often used interchangeably with "natural regulation"), Boyce (1991:190) suggested the terminology "ecological process management" instead of "natural process management." Speaking for himself, he argued that ecological process management did not "imply hands-off management, but rather carefully reasoned intervention with a directed goal." (p. 203). This did justify the Yellowstone management activity of that time. This was the same point made by Reese (1984: 22): "The policy of non-interference should not be confused with the policy of no management?" Shafer (2000) noted that natural regulation, originally a Yellowstone research hypothesis, and natural process management, a Servicewide policy, were often confused.

Is the idea of managing for natural processes conceptually useful? As Schrader-Frechette and McCoy (1993: 103) reminded us, "The objects of preservation at places like Yellowstone are now more likely to be, not *climax communities* (emphasis added) as they existed in the past, but the ecological *processes* (emphasis added) that maintain various species, communities, and ecosystems." Wagner et al. (1995: 151) argued "There is no way that the concept of process management, in the casual ways in which it is being used, can be translated into clear directions for park management." More than a decade later he said, "There is no way that the processes can be preserved without preserving the components. Hence, the goal of process management is tantamount to preserving entire ecosystems" (Wagner 2006: 328). Whether or not clear direction can be offered on how to preserve processes, if we preserve processes we are also preserving things but not necessarily states. The National Academy study concluded that some NPS terminology provided welcome flexibility but little guidance: "Management for ecosystem processes remains a challenge for the future, and currently is more a conceptual guide than a prescription for immediate action" (Klein 2002: 124).

Pritchard (1999:281) showed that the “twin traditions concerning the proper role for park managers have coexisted throughout the twentieth century, one emphasizing the necessity of intervention, the other one suggesting that nature will establish its own balance.” The twin traditions were intervention and nonintervention. These twin traditions remain intact. For example, “[T]he Service will allow this evolution to continue-minimally influenced by human actions” but “Biological and physical processes altered in the past by human activities may need to be actively managed to restore them to a natural condition or to maintain the closest approximation of the natural condition when a truly natural system is no longer attainable” (National Park Service 2006: 36-37). This policy was a compromise. However, that said, it still “offers[s] little specific guidance regarding where and when to intervene and how to define desired outcomes” (Yung et al. 2010b: 77). This is the pitfall of using “natural” as policy.

“True natural regulation (i.e., letting nature take its course with no human intervention) has not been possible for more than a century, nor is it likely to become possible in Yellowstone’s foreseeable future” (Klein 2002: 134). NPS policy did evolve in terms of it policy clarity. “Natural change will also be recognized as an integral part of the functioning of natural systems” (National Park Service 2006:36). “[T]he Park Service will determine the desired future conditions for each park unit and identify a strategy to achieve them” (National Park Service 2006: 37). In addition, the confusing terminology like “natural regulation” and “natural process management” were abandoned.

The National Academy study's view on natural regulation in the context of outside human influences demands emphasis: "YNP is an ecological island whose processes are influenced by human activities in the surrounding area. These activities, which strongly influence YNP wildlife, include agriculture, ranching, and hunting. Thus, even if there were no human intervention within YNP, ecological processes there would be profoundly influenced by human activities elsewhere" (Klein 2002:21). This point was made earlier by Shafer (2000). This message was expressed in the simplest terms in 1962: "Management may involve...protection from ...external influences" (Bourliére 1962: 364).

"Policy issues in the GYE are a turbulent confluence of diverging human values, contested science, overlapping jurisdictions, and conflicting problem definitions" (Shanahan and McBeth 2010:144). Today, non-intervention will not suffice as a management guideline for protected areas. "Benign neglect" (Soulé et al. 1979) will only result in the loss of biological diversity. Indeed, Yellowstone has been a "crucible for formulating and testing preservation policies, making it both an international model as well as a symbolic battleground over competing park management philosophies" (Keiter 1996: 653). The scientific community's interest in all aspects protected area management remains strong (e.g., Hansen et al. 2011).

Managing for Conditions vs. Climate Change

Much of the above is now of historical interest. The NPS *Management Policies* now recognize that managing for static temporal conditions is not possible: “Natural change will also be recognized as an integral part of the functioning of natural systems” (National Park Service 2006:36). This policy was framed to counter the longstanding “static museum” management mentality that some accused NPS of adopting subsequent to the Leopold Report (Leopold et al. 1963). Given ongoing climate change, this 2006 policy is not treated enough. Indeed, “climate change means that we no longer manage for a historical reference point, but rather must manage for change” (Chester et al. 2012: 3). NPS must now manage for change which demands rethinking basic mandates (Tweed 2010). NPS must now focus on managing regions to facilitate the movement of protected area biota responding to climate change (see Chapter 11). Indeed, scientists and managers must abandon the static approach to preservation and adopt a dynamic world view (Lovejoy 2005).

REFERENCES

Aplet, G.H. and D.N. Cole. 2010. In D.N. Cole and L. Young (eds), Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Rapid Change, pp. 12-29. Island Press, Washington, D.C.

Bourliére, F. 1962. Management of national parks. In A.B. Adams (ed), First World Conference on National Parks, pp. 364-365. National Park Service, Department of the Interior, Washington, D.C.

Boyce, M.L. 1991. Natural regulation or the control of nature? In R.B. Keiter and M.L. Boyce (eds), The Greater Yellowstone Ecosystem: Redefining America's Wilderness Heritage, pp. 183-208. Yale University Press, New Haven.

Boyce, M.L. 1998. Ecological-process management and ungulates: Yellowstone's conservation paradigm. *Wildlife Society Bulletin* 26: 391-398.

Chase, A. 1986. Playing God in Yellowstone: The Destruction of America's First National Park. Harcourt Brace Jovanovich, San Diego, California.

Chester, C.C., J.A. Hilty and S.C. Trombulak. 2012. Climate change science, impacts, and opportunities. In J.A. Hilty, C.C. Chester and M.S. Cross (eds), Climate and Conservation: Landscape and Seascape Science, Planning, and Action, pp. 3-15. Island Press, Washington, D.C.

Christensen, H.L. et al. 1989. Interpreting the Yellowstone fires of 1988. *BioScience* 39(10): 678-685.

Cole, D.N, L. Yung, E. S. Zavaleta, G.H. Aplet, F S. Chapin III, D.M. Graber, E.S. Higgs, R.J. Hobbs, P.B. Landres, C.I. Millar, D.J. Parsons, J.M. Randall, N.L. Stephenson, K. A. Tonnessen, P.S. White, and S. Woodley. 2008. Naturalness and beyond: protected area stewardship in an era of global environmental change. *The George Wright Forum* 25 (1): 36-56.

Donahue, J. 1997. Wildlife in parks: policy, philosophy, and politics. *The George Wright Forum* 14 (1): 47:55.

Foresta, R.A. 1984. America’s National Parks and Their Keepers. Resources for the Future, Washington, D.C.

Freemuth, J.C. 1989. The national parks: political versus professional determinants of policy. *The George Wright Forum* 6 (3): 26-38.

Freemuth, J. C. and R M. Cawley. 1998. Science, expertise and the public: the politics of ecosystem management in the Greater Yellowstone Ecosystem. *Landscape and Urban Planning* 40: 211-219.

Hansen, A.J., C.R. Davis, N. Piekielek, J. Gross, D.M. Theobald, S. Goetz, F. Melton, and R. DeFries. 2011. Delineating the ecosystems containing protected areas for monitoring and assessment. *BioScience* 61 (5): 363-373.

Harrison, R.D. 2011. Emptying the forest: hunting and the extirpation of wildlife from tropical nature reserves. *BioScience* 61(11): 919-924.

Huff, D. 1997. Wildlife management in America’s national parks: preparing for the next century. *The George Wright Forum* 14 (1): 25-33.

Janzen, D. 1998. Gardinification of wild nature and the human footprint. *Science* 279 (5355):1312-1313.

Kass, M. J. 2005. The National Park Service Management Policies controversy. *Natural Resources and Environment* 20: 68-70.

Keiter, R.B. 1996. Preserving nature in the national parks: law, policy, and science in a dynamic environment. *Denver University Law Review* 649-695.

Kilgore, B.M. 2007. Origin and history of wildland fire use in the U.S. National Park System. *The George Wright Forum* 24(3): 92-122.

Klein, D.R. chair. 2002. Ecological Dynamics on Yellowstone’s Northern Range. National Academy Press, Washington, D.C.

Lele, S. and R.B. Norgaard. 1996. Sustainability and the scientist’s burden. *Conservation Biology* 10: 354-365.

Leopold, A.S., S.A. Cain, C.M. Cottam, I. N. Gabrielson and T.M. Kimball. 1963. Wildlife management in the national parks: advisory board on wildlife management appointed by the Secretary of the Interior. In Compilation of the Administrative Policies for the National Parks and National Monuments of Scientific Significance (Natural Area

Category) Revised August 1968, printed 1970. U.S. Government Printing Office, Washington, D.C.

Lovejoy, T. 2005. Conservation with a changing climate. In T.E. Lovejoy and L. Hannah (eds), Climate Change and Biodiversity, pp. 325-328. Yale University Press, New Haven.

Lowry, W.R. 1998. Preserving Public Lands for the Future: The Politics of Intergenerational Goods. Georgetown University Press, Washington, D.C.

Lowry, W. R. 2009. Repairing Paradise: The Restoration of Nature in America's National Parks. Brookings Institution Press, Washington, D.C.

Majone, G. 1989. Evidence, Argument, and Persuasion in the Policy Process. Yale University, New Haven.

Mappes, H. A. 2006. National parks: for use and "enjoyment" or for "preservation"? and the role of the National Park Service *Management Policies* in that determination. *Iowa Law Review* 92: 601-636.

Millspaugh, S.H., C. Whitlock and P.J. Bartlein. 2000. Variations in fire frequency and climate over the past 17000 yr in central Yellowstone National Park. *Geology* 28: 211-214.

Mitchell, J.G. 2006. Threatened sanctuaries: the state of U.S. parks. *National Geographic* 210 (4): 88-98.

National Park Service. 1970. Compilation of Administrative Policies for the National Parks and National Monuments of Scientific Significance (Natural Area Category) Revised August 1968. U.S. Government Printing Office, Washington. D.C.

National Park Service. 1997. Yellowstone's Northern Range: Complexity and Change in a Wildland Ecosystem. Mammoth Hot Springs, Yellowstone National Park, Wyoming.

National Park Service. 1988a. Special Supplement to *Yellowstone Today*, November 1988. Yellowstone Association, Yellowstone National Park, Wyoming.

National Park Service. 1988b. Management Policies. National Park Service, Department of the Interior, Washington, D.C.

National Park Service. 2001. Management Policies 2001. National Park Service. Department of the Interior, Washington, D.C.

National Park Service. 2006. Management Policies 2006. National Park Service. Department of the Interior, Washington, D.C.

Noss, R. 1995. Maintaining Ecological Integrity in Representative Reserve Networks. World Wildlife Fund, Canada.

Parks Canada Agency. 2000. “Unimpaired for Future Generations”? Vol. II “Setting a New Direction for Canada’s National Parks.” Report of the Panel on the Ecological Integrity of Canada’s National Parks. Parks Canada Agency, Ottawa, Canada.

Parks Canada Agency. 2005. Monitoring and Reporting Ecological Integrity in Canada’s National Parks. Volume I: Guiding Principles. Parks Canada Agency, Ottawa.

Primm, S.A. and T.W. Clark. 1996. Making sense of the policy process for carnivore conservation. *Conservation Biology* 10 (4): 1036-1045.

Pritchard, J.A. 1999. Preserving Yellowstone’s Natural Conditions: Science and the Perception of Nature. University of Nebraska Press, Lincoln.

Reese, R. 1984. Greater Yellowstone: The National Park and Adjacent Lands. Montana Magazine, Helena, Montana.

Robbins, W.K. chairman. 1963. A Report by the Advisory Committee to the National Park Service on Research. National Academy of Sciences-National Research Council, Washington, D.C.

Rolston, H. III. 1988. Human values and natural systems. *Society and Natural Resources* 1(3): 271-283.

Romme, W.H. and D.G. Despain. 1989. Historical perspective on the Yellowstone fires. *BioScience* 39(10): 696-699.

Schullery, P. 1989. The fires and fire policy. *BioScience* 39(10): 686-694.

Schullery, P. 2010. Greater Yellowstone science: past, present, and future. *Yellowstone Science* 18(2): 7-13.

Sellars, R.B. 1997/2009. Preserving Nature in the National Parks: A History; With a New Preface and Epilogue. Yale University Press, New Haven, Connecticut.

Shafer, C.L. 1999. US national park buffer zones: historical, scientific, social, and legal aspects. *Environmental Management* 23 (1): 49-73.

Shafer, C.L. 2000. The Northern Yellowstone elk debate: policy, hypothesis, and implications. *Natural Areas Journal* 20: 342-359.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal lands. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Shanahan, E.A. and M.K. McBeth. 2010. The science of storytelling: policy marketing and wicked problems in the Greater Yellowstone Ecosystem. In J. Johnson (ed), Knowing Yellowstone: Science in America's First National Park, pp. 142-159. Rowan and Littlefield, Lanham, Maryland.

Shrader-Frechette, K.S. and E.D. McCoy. 1993. Method in Ecology: Strategies for Conservation. Cambridge University Press, UK.

Soulé, M.E., B. Wilcox, and C. Holtby. 1979. Benign neglect: a model of faunal collapse in game reserves of East Africa. *Biological Conservation* 15: 259-272.

Talbot, L. M. 2008. Introduction: the quest for environmental sustainability. In L.L. Rockwood, R.E. Stewart, and T. Dietz (eds), Foundations of Environmental Sustainability: The Coevolution of Science and Policy, pp. 3-24. Oxford University Oxford, UK.

Taylor, D.L. 1973. Some ecological implications of forest fire control in Yellowstone National Park, Wyoming. *Ecology* 54 (6): 1394-1396.

Tweed, W.C. 2010. An idea in trouble: thoughts about the future of traditional national parks in the United States. *George Wright Forum* 27(1): 6-13.

Wagner, F.H. 1999. Values, science, and policy: how best to serve national parks. *The George Wright Forum* 16 (3): 52-76.

Wagner, F.H. 2006. Yellowstone's Destabilized Ecosystem: Elk Effects, Science, and Policy Conflicts. Oxford University, UK.

Wagner, F.H., R. Foresta, R.B.Gill, D.R. McCullough, M.R. Pelton, W.F. Porter, and H. Salwasser. 1995. Wildlife Policies in the U.S. National Parks. Island Press, Washington, D.C.

Waller, D.M. 1988. Sharing responsibility for conserving diversity: the complementary roles of conservation biologists and public land agencies. *Conservation Biology* 2 (4): 398-401.

Wilhere, G.F. 2012. Inadvertent advocacy. *Conservation Biology* 26 (1): 39-46.

Woodley, S. 2010. Ecological integrity: a framework for ecosystem-based management. In D.N. Cole and L. Yung (eds), Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Rapid Change, pp. 106-124. Island Press, Washington, D.C.

Wright, G.M., J.S. Dixon and B.H. Thompson. 1933. Fauna and Flora of the National Parks of the United States: A Preliminary Survey of Faunal Relations in National Parks. Fauna Series No. 1. U.S. Government Printing Office, Washington, D.C.

Yung, L., D.N. Cole and R.J. Hobbs. 2010a. A path forward: conserving protected areas in the context of global environmental change. In D.N. Cole and L. Yung (eds) Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Rapid Change, pp. 252-269. Island Press, Washington, D.C.

Yung, L., D.N. Cole, D.M. Graber, D.J. Parsons and K.A. Tonnessen. 2010b. Changing policies and practices: the challenge of managing for naturalness. In D.N. Cole and L. Yung (eds), Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Rapid Change, pp. 67-87. Island Press, Washington, D.C.

CHAPTER 9: GYE GRIZZLY BEARS

"When we save Greater Yellowstone, we save the grizzly--and if we can save the grizzly, we have come a long way toward saving Greater Yellowstone."

Glick et al. 1991:70

Distribution and Abundance

Before European settlement, the range of the brown bear (*Ursus arctos*) extended over the western half of the continental United States, central Mexico, western Canada, and most of Alaska (Mattson et al. 1995) (Figure 40). The abundance of the bear in the western contiguous United States at that time was thought to be around 50,000 individuals (Servheen et al. 1999). By the 1930s its range in North America had been reduced to 2 % of its original range (Mattson et al. 1995) and its population size in the United States was also down to around 2%. Today there are five lower-48 United States populations of the grizzly bear (*Ursus arctos horribilis*): the Greater Yellowstone Ecosystem (GYE) (20,000 $km^{2)}$ in northwest Wyoming, eastern Idaho and southwest Montana) with more than 600 bears; the Northern Continental Divide Ecosystem (25,000 km^2 in north central Montana) with more than 1000 bears; the Northern Cascades area

(25,000 km^2 in north central Washington) with less than 20 bears; the Selkirk Mountains area (5,700 km^2 in north Idaho, northeast Washington and southeast British Columbia) ; and the Cabinet-Yaak area (6,700 km^2 in northwest Montana and

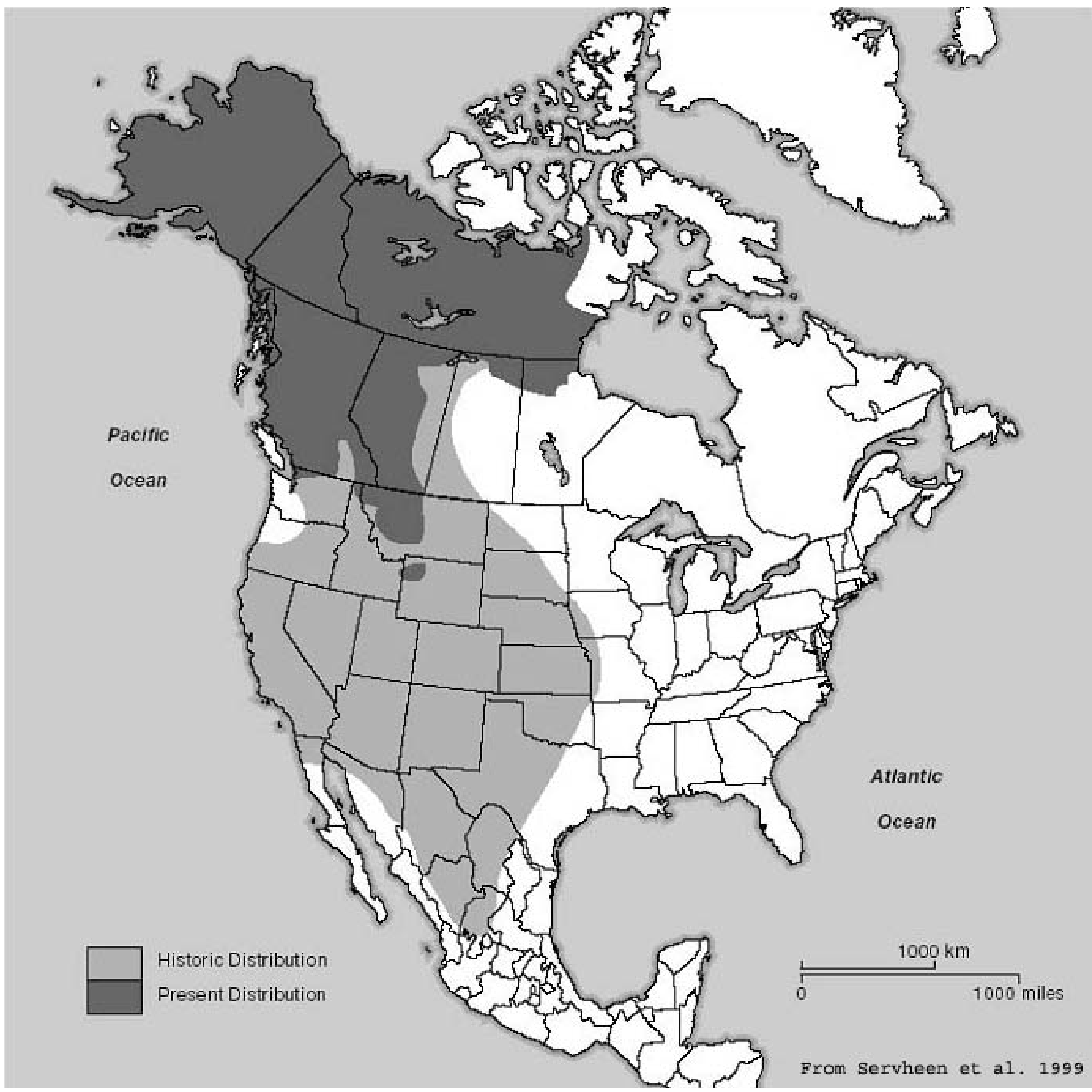


Figure 40. Present and historic distribution of the brown bear in North America. From US Geological Survey (http://www.nrmsc.usgs.gov/research/ncdebeardna_detail.htm)

northern Idaho) with 80-90 bears (US Fish and Wildlife Service 2007a) (Figure 40). The only bear population that is definitely isolated is in the GYE with a strong possibility existing for the Northern Cascades population.

Five Grizzly Bear Populations in the Lower 48 States

Vital Ground Foundation http://www.igbconline.org/html

Figure 41. Remaining grizzly bear populations in the lower 48 states. Based on 2011-2012 USFWS data. From Vital Ground Foundation with modification (http://www.vitalground.org/PopulationMap)

Grizzly Bears as Indicators

If human presence does not interfere, then “Yellowstone belongs to the grizzly bear” (Sutton and Sutton 1972: 110). The grizzly bear is one component of the GYE’s mammalian fauna that has a demonstrated aversion to human presence (Mattson 1990). It can also serve as a barometer for the effectiveness of protected area management (Mattson 1996a, Peterson 2000). In fact, as a result of the National Forest Management Act of 1976 (U.S.C. §§1600-1614), the USFS recognizes the bear as “indicator species” with regulations at 36 CFR 219.19 (a) (1) (Corn and Gorte 1986: 46). The grizzly bears in Yellowstone National Park avoid roads and developments (Mattson et al. 1987). Roads are part of industrial extraction infrastructure and thus are bear deterrents (McLellan and Shackleton 1988, McLellan 1990). Further distant in Canada, the grizzly bear avoided the secondary landscape affects of seismic cutlines in Alberta (Linke et al. 2005). Schwartz et al. (2010a) concluded that bear mortality in the GYE was most highly correlated with road density, number of homes and site development. The bear is one species very sensitive to habitat fragmentation (Crooks 2002). It can also serve as a flagship and umbrella species (Mills 2007). However, not every taxon will fall under the grizzly bear’s umbrella (e.g., reptiles Noss et al. 1996).

Primary Conservation Area and Beyond

The official grizzly bear “recovery zone,” renamed “Primary Conservation Area” (PCA) in 2000, encompasses 9,209 mi^2 (5,983,760 acres or 23,853 km^2) (Interagency Conservation Strategy Team 2007) (Figure 42). Its configuration has not changed since 1993 (Interagency Conservation Strategy Team 2007). The recovery zone is defined as “an area ... [that] would be large enough and of sufficient habitat quality to support a recovered grizzly bear population” (US Forest Service 2006: 2). Another definition in the interagency *Grizzly Bear Conservation Strategy* is “a secure area for grizzly bears, with population and habitat conditions maintained to ensure a recovered population is maintained for the foreseeable future and to allow bears to continue to expand outside...” (Interagency Conservation Strategy Team 2007:6). A *Conservation Strategy* was first developed in 1993 and was reportedly based on the “best available science” (US Forest Service 2006: 294, 298).

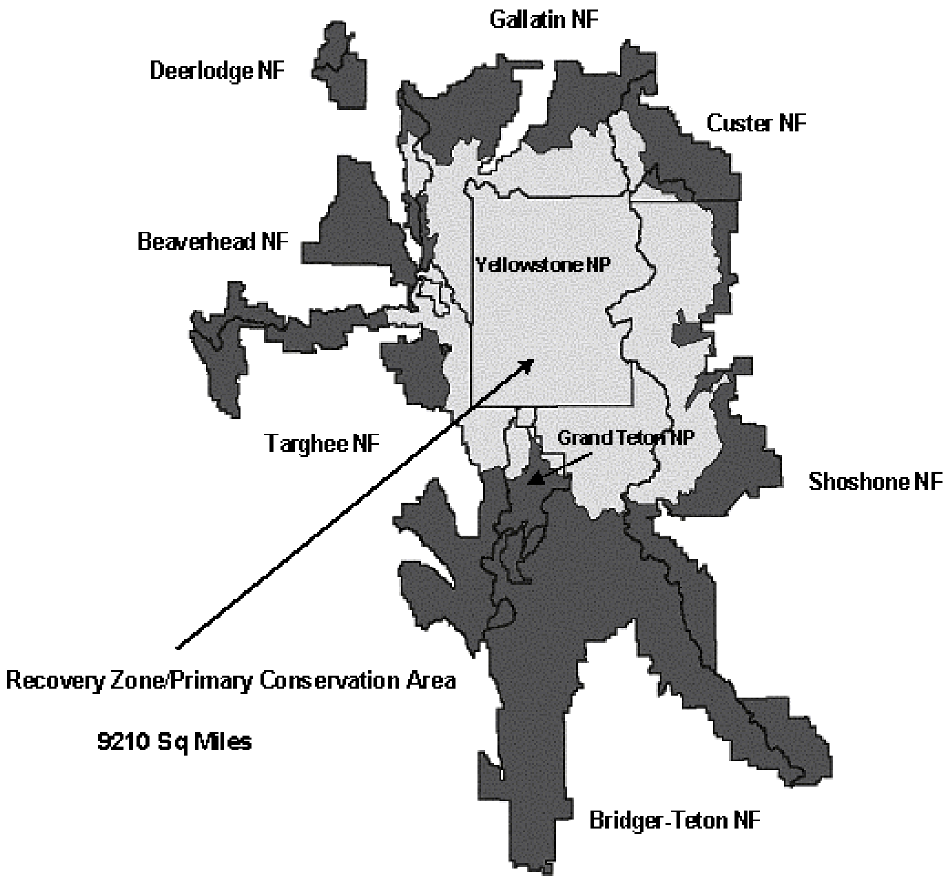


Figure 42. Greater Yellowstone Ecosystem Primary Conservation Area in light gray. From Moody et al. (2002) (http://gf.state.wy.us/wildlife/wildlife_management/grizzfinal.htm)

The PCA is divided up into 15 Bear Management Areas (Schwartz and Gunther 2006) as in Figure 43.

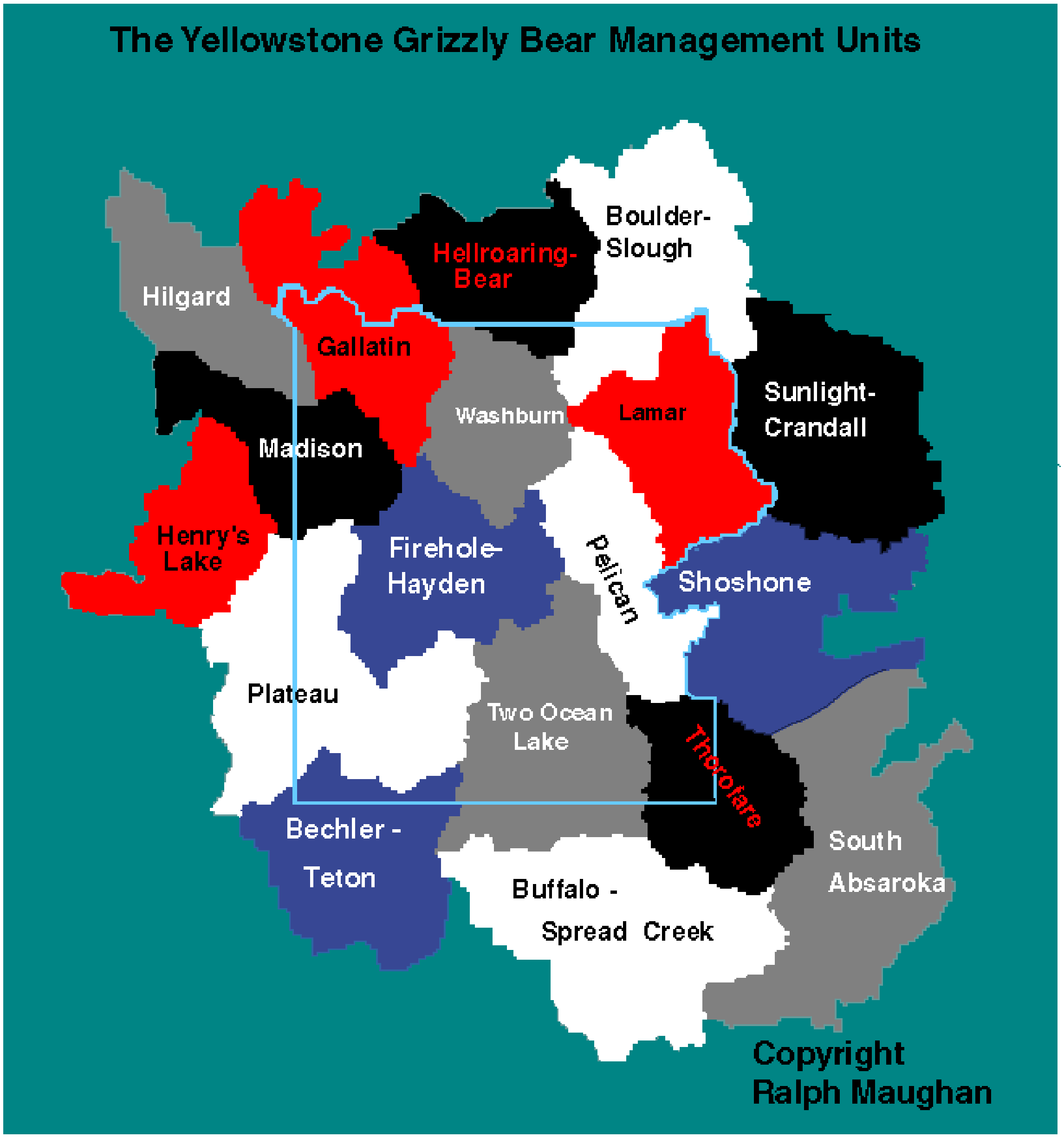


Figure 43. Grizzly bear management units in the Greater Yellowstone Ecosystem (http://forwolves.org/ralph/bmu/htm)

About 98% of the PCA consists of federal lands (Schwartz and Gunther 2006) and the remaining 2 % is private (US Forest Service 2006: 259). National forests account for

58.5 %t and national parks 39.4 % of the PCA (US Forest Service 2006: 64). Surface occupancy is permitted in just 3 % of USFS lands in the PCA (US Forest Service 2006:74). Within the PCA, all forests restrict motorized access to designed routes except for 2.4 % of the Targhee National Forest and 8.3 % of the Bridger-Teton National Forest (US Forest Service 2006: 29). It is the “goal of the habitat management agencies to maintain or improve habitat conditions existing as of 1998, as measured within each subunit of the PCA, while maintaining options for management of resource activities at approximately the same level as existed in 1998” (Interagency Conservation Strategy Team 2007: 7).

The reason for the 1998 baseline is because at that point in time all grizzly bear demographic recovery goals had been met, with the population increasing and bear range expanding (US Forest Service 2006: 30). In other words, the population has been increasing by 4-7% per year throughout the 1990s while the amount of secure habitat and the extent of developed sites changed little from 1988-1998 (US Fish and Wildlife Service 2007b). A key point is that the PCA is *not* fully protected from all forms of resource extraction. Furthermore, “suitable habitat outside the PCA is under constant threat from development and deforestation” (Kline 2001: 422-423).

Secure habitat in the GYE has reportedly increased over the 17 years prior to 2006 due to decreasing logging and reduction in roads (US Forest Service 2006: 319). In fact, there is reportedly more “secure” habitat outside the PCA than inside it (US Forest Service

2006:315). About 1/3 of the GYE grizzly bear population is estimated to occur *outside* of the PCA on USFS lands (Schwartz et al. 2010a) (Figure 44). Outside the PCA on USFS lands within the range of the GYE Distinct Population Segment, 79 % of suitable grizzly bear habitat consists of official wilderness (6,799 km^2), wilderness study areas (708 km^2),

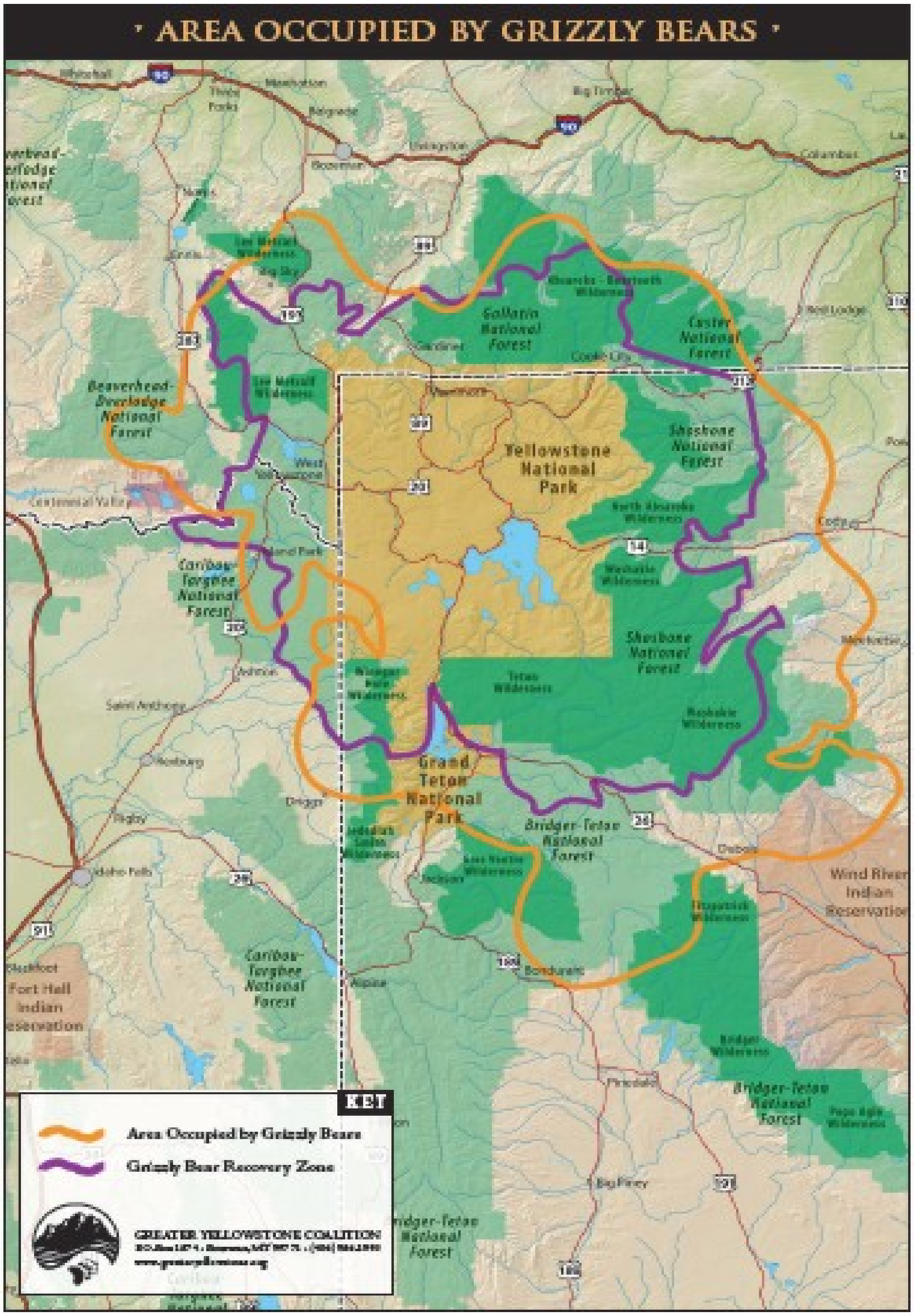


Figure 44. Purple line indicates the extent of the Greater Yellowstone Ecosystem grizzly bear primary conservation area (PCA). Light green represent national forests and dark green are wilderness areas in those national forests. The yellow line indicates that exent of grizzly bear distribution. From Greater Yellowstone Coalition (http://www.greateryellowstone.org/uploads/Grizzly_bear_range.pdf)

or inventoried roadless areas (6,179 km^2) (US Fish and Wildlife Service 2007a:14917). Outside the PCA, the management objective is to "maintain existing resource management and recreational uses and to allow agencies to respond to demonstrated problems with appropriate management actions" (Interagency Conservation Strategy Team 2007: 6). "State grizzly bear management plans, forest plans, and other appropriate planning documents provide specific management direction for the adjacent area outside the PCA" (Interagency Conservation Strategy Team 2007: 14).

Outside the PCA but within the boundary of the DPS (Distinct Population Segment) there is 6,799 km^2 of "suitable habitat" (US Fish and Wildlife Service 2007a: 14879). In other words, using this area demarcation, the bears occupy 68 % of the suitable habitat (US Fish and Wildlife Service 2007a: 14881).

GYE Population Trends and Distribution

The grizzly bear population declined in the 1970s and into the early 1980s (Knight and Eberhardt 1987). The bear's population drop was as a result of human killings perceived to stem from Yellowstone garbage dump closure (Knight and Eberhardt 1985). For example, 229 bears were removed from the GYE from 1967 to 1972 (Knight et al. 1999) which was perceived to be elated to dump closure. During 1971 by itself, from 43 to 48 grizzly bears bear were killed including 18 that had been marked (Pritchard 1999: 246).

During 1980, a panel of scientists estimated the bear population to be between 183-207 (Craighead 1998). But the population increased by 5% per year from 1983-2007 (Harris et al. 2007). Other workers indicate an increase of approximately 4%-7% per year from 1983-2001/2002 (Boyce et al. 2001, Harris et al. 2006**).** There are those, however, that believe the grizzly bear population changed little from 1975-1995 (Pease and Mattson 1999, cited in US Forest Service 2006). According to Schwartz et al. (2002, cited in Haroldson et al. 2008), the bear's range expanded by 11% during the 1980s and an additional 34% during the 1990s. Adult female grizzly bear survival is key to population growth (Eberhardt 1977). Counts are for females with cubs of the year as specified in the 1993 Recovery Plan (US Fish and Wildlife Service 1993, Knight et al. 1995). The goal of the interagency *Grizzly Bear Conservation Strategy* is to "manage the Yellowstone grizzly bear population in the entire GYA at or above 500 total grizzly bears" (Interagency Conservation Strategy Team 2007: 26). The expansion of the GYE grizzly bear population and range between 1979-1981 and 2007-2009 for mothers with cubs, has been mapped (Marcus et al. 2012:148) (Figure 45). According to State of Wyoming biologists, grizzly bears are now turning up far from their expected haunts (Hatch 2011).

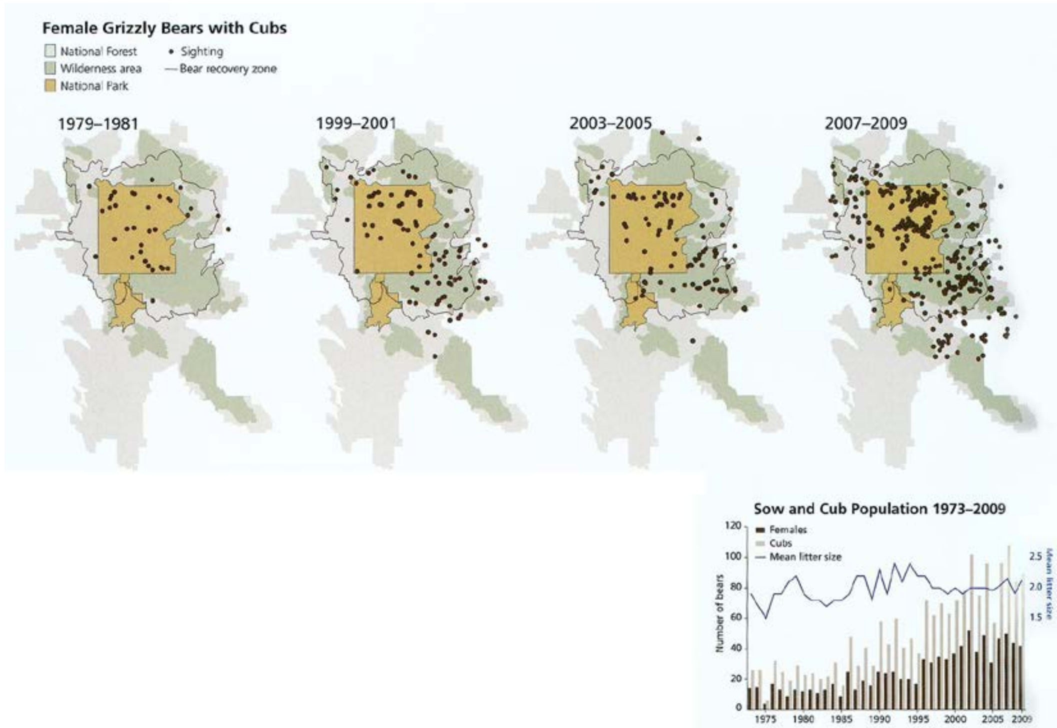


Figure 45. GYE grizzly bear population growth and range expansion based on counts of females with cubs (From Marcus et al. 2012).

Around 51 % of the "suitable" GYE grizzly bear habitat occurs in the PCA along with 84-90 % of females with cubs (Schwartz et al. 2006a). Suitable habitat consists of "areas more than 500 meters from an open or gated motorized access route or helicopter flight line and greater than or equal to 10 acres in size" (US Forest Service 2006: 73). About 71 % of the PCA is considered "long-term" secure (US Forest Service 2006: 74, 334). According to US Fish and Wildlife Service (2007a: 14874), 68% of suitable grizzly bear habitat in the GYE is now occupied but 14,500 km^2 can still be utilized by bears.

Suitable habitat outside the PCA but within the GYE by ownership follows: 83 % federal, 6 % tribal, 1.6 % state, and 9.5 % private (US Fish and Wildlife Service 2007a:14874). There has not been an increase in development in the PCA since 1998 (US Forest Service 2006: 339). Schwartz et al. (2006b) believes grizzly bear carrying capacity has been reached in Yellowstone National Park but not outside it.

Mortalities

During 1974 to 1996, out of 174 grizzly bears radio-collared in the United States and southern Canada which later died, 85-94 % was human-induced deaths (Mattson et al. 1996a). Since the 1970s, between 70-90 % of grizzly bear mortalities in the GYE were caused by humans (Pease and Mattson 1999). Servheen et al. (2004) claimed there were only 12.6 human-caused bear mortalities/year in the GYE from 1980-2002. Specific reasons for bear mortality in the GYE follow: agency removal, 54.2%; self-defense by big-game hunters, 17%; mistaken identity kills by black bear hunters, 8.5%; and malicious killing or poaching, 1.7% (Schwartz et al. 2010b). However, based on the number of grizzly bear mortalities due mostly to elk hunter-related incidents in recent years, the following comment by US Fish and Wildlife Service (2007a: 14892) seems odd: “Because hunting in the Yellowstone ecosystem will be limited, it is unlikely to have an impact on the population dynamics of the Yellowstone ecosystem population.” From 1992-2004, of 814 grizzly bear/human conflicts, 47 % occurred on USFS lands (US Forest Service 2006:86). Looked at through a different lens, the key mortality factors for the grizzly bear in the GYE include bear intolerance, human distribution and presence of firearms (Mattson et al. 1992, 1996b). From 1992-2000, of 995 human–bear conflicts reported, 53% occurred outside the Recovery Zone (Schwartz et al. 2002).

As set forth in 1993 (US Fish and Wildlife Service 1993), the human-caused mortality rate for the grizzly bear in each ecosystem cannot exceed four % of the population based on the most current 3-year sum of females *and* no more than 30 % of this 4 % mortality will consist of females *and* such limits cannot be exceeded for two consecutive years. Willcox (2009) thinks the allowable grizzly bear mortality threshold in the GYE was violated in four of the six years since 2004 (2004-2009). However, according to US Fish and Wildlife Service (2007: 14879-14880), permissible adult female mortality was not exceeded in either 2004 or 2005. Mortalities based on human contact, especially hunters, have been high. During 2008, 48 bears in the GYE died (Moody et al. 2009). The mortality rates for succeeding years follow: 39 (2009), 50 (2010), 44 (2011) and 54 (2012) (Interagency Grizzly Bear Study Team 2013). Willcox (2011) perceived that GYE grizzly bear population growth was “flat” for four years. Haroldson and Van Manen (2012:2) said the GYE grizzly bear population grew from 4-7% per year in the 1980s and 1990s but dropped to 0-2% per year from 2002-2011.

Grizzly Bears and Roads

The effects of roads in this country are pervasive. Forman (2000) estimated that one-fifth of the United States is influenced ecologically by roads. Roads are one indicator of forest fragmentation (Heilman et al. 2002). In a subalpine conifer forest in southern Wyoming, roads caused more fragmentation than clear-cutting (Reed et al. 1996). Land in the U.S. Rocky Mountain region is on average 0.4 miles from a road (Goldstein 2008). Grizzly bears may find road traffic more of a deterrent than road density (Northrop et al. 2012) though two researchers found no correlation between bear proximity and traffic volume (McLellan and Shackelton 1988). Waller and Servheen (2005) insist that both traffic volume and speed are mortality factors.

Grizzly bears prefer not to cross clearcuts or other large habitat openings (Noss et al. 1996, Nielson et al. 2004). Roads are a more important factor for grizzly bear survival than how a forest is harvested (Nielson et al. 2008). Roads and development certainly influence grizzly bear movements in Yellowstone National Park (Mattson et al. 1987). Grizzly bear habitat in the GYE is reportedly underutilized if it is within 2 km of a road (Mattson 1992, cited in Willcox 1998). The affects of roads on bears appear to extend 3 km for primary roads and 1.5 km for secondary roads (Kasworm and Manley 1990, Mattson and Knight 1991, cited in Craighead 2002). The influence of roads on grizzly bears has been observed in other areas of the Northern Rockies (Archibald et al. 1987).

Grizzly bear mortality rate is a function of their proximity to roads. For example, in Northwest Montana from 1967-1986, 48% of non-hunting induced bear deaths were within one mile of a road (Dood et al. 1986, cited in Willcox 1998). Sixty-three percent of known grizzly bear mortalities on the east front of the Rocky Mountains were within 1 km of a road (Aune and Kasworm 1989). Secondary roads were a grizzly bear mortality factor (Mattson and Knight 1991) and roads increase grizzly bear poaching (Mace et al. 1996).

Craighead et al. (1995, cited in Craighead 2002) concluded road densities higher than 1 $km/6.4\ km^2$ are not optimal for grizzly bears. Grizzly bears in the Swan Mountains avoided areas where road density exceeded 6 mi/mi^2 (Mace et al. 1996). For these reasons, this study follows the rationale of American Wildlands (2006: 12): “Road density acts as an indicator of the amount of anthropogenic disturbance.” Decommissioning roads in grizzly bear habitat has been recommended (Mace et al. 1999). Figure 46 provides road density and mineral sites/oil and gas active and suspended leases on USFS lands in the GYE.

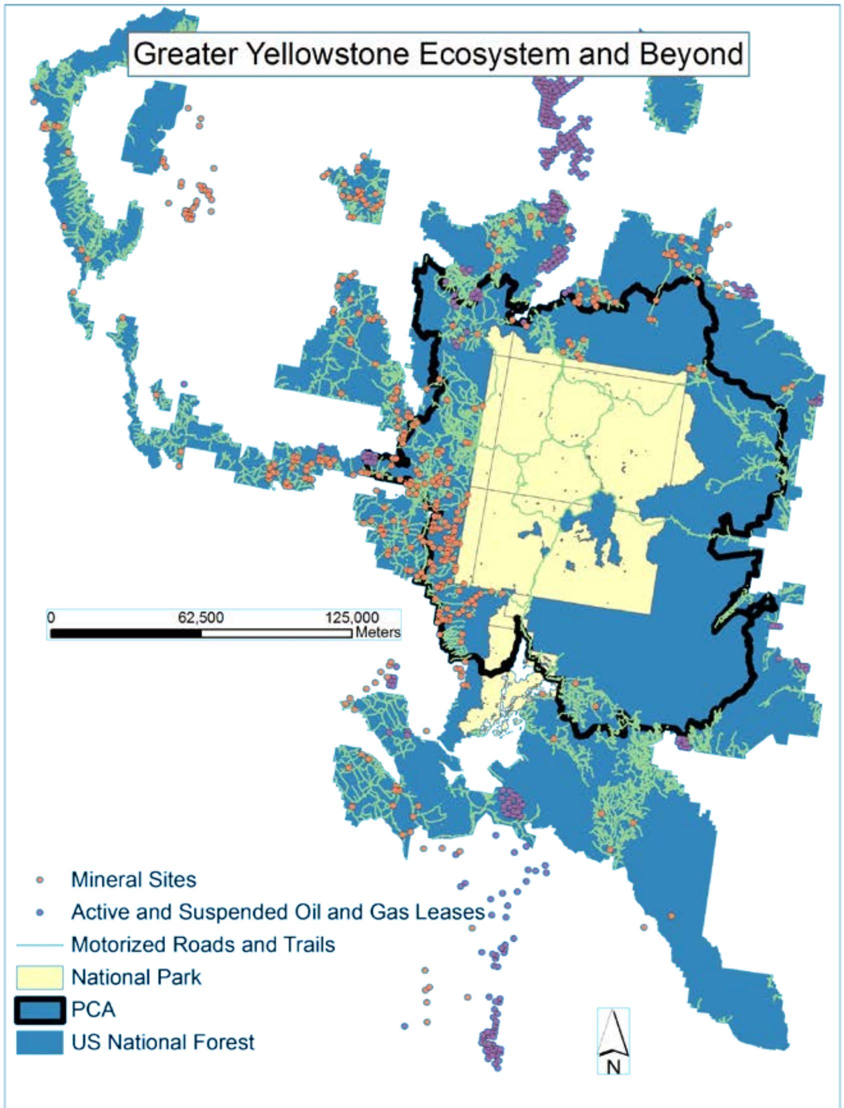


Figure 46. Road density and mineral sites/active/suspended oil and gas leases on national forests including inside the PCA. Source for mining/oil and gas data: US Forest Service (2006). Source for PCA: US Fish and Wildlife Service. Source for roads was USFS as of 2007.

The Grizzly Bear Recovery Plan (US Fish and Wildlife Service 1993: appendix B at 145, cited in Kline 2001) states "the management of roads is the most powerful tool available to balance the needs of bears...with the activities of humans." Corroborating this point, "Of all the covariates we examined, the amount of secure habitat and the density of roads in nonsecure habitat on public lands had the greatest effect on grizzly bear survival" (Schwartz et al. 2010a: 665). One thing is not known: "the exact density and types of roads that are compatible with grizzly persistence in a given area" (Mattson et al. 1996b:1021).

Mining Claims and Oil and Gas Leases

There are 1,354 mining claims in the GYE PCA (US Forest Service 2006, cited in US Fish and Wildlife Service 2007a). There are reportedly no active wells inside or outside the PCA as of 1998 (US Forest Service 2006, cited in US Fish and Wildlife Service 2007a). However, 2006 data show both oil/gas leases and mining claims in the PCA (Figure 45). US Forest Service (2006:349) indicates "The level of potential for oil and gas production is low inside the PCA." There is however potential for more road construction to exploit oil and gas leases especially in the Bridger-Teton National Forest (US Forest Service 2006, cited in US Fish and Wildlife Service 2007a). Still, there are reportedly only 14 active oil and gas wells in the Bridger-Teton National Forest and none of these are in suitable grizzly bear habitat (US Forest Service 2006, cited US Fish and Wildlife Service 2007a). Only 243 km^2 within the PCA allow for surface occupancy of oil and gas rigs and this is less than 4 % of suitable grizzly bear habitat (US Forest Service 2006, cited in US Fish and Wildlife Service 2007a). There are reportedly only eight active leases on about 7,000 acres on USFS land outside the PCA as described under the spatial configuration of Alternative 4 (US Forest Service 2006: 263). Surprisingly, US Fish and Wildlife Service (2007a: 14886) maintained that more control of oil and gas development in the GYE is "not biologically necessary to maintain the recovered status of the Yellowstone grizzly bear." There is no unequivocal data indicating that industrial activity like oil and gas exploration and extraction harms bears except for the associated roads (McLellan 1990). But hunters do use these roads (McLellan 1989). US Fish and Wildlife Service (2007a: 14908) maintained "There has never been any high-density oil and gas development in suitable grizzly habitat in the GYA." However, the "Catch 22" is that the existence of oil and gas wells means the area is not considered "suitable" grizzly bear habitat (US Fish and Wildlife Service 2007a: 14888). There are over 500 "developed sites" on the six national forests in suitable habitat outside the PCA but within the boundaries of the Distinct Population Segment (US Forest Service 2004, cited US Fish and Wildlife Service 2007a: 14918).

Sources and Sinks

> "In many places in the world, the regions adjacent to protected areas have become hot spots of conflict between animals and humans. If such conflicts and the resulting wildlife mortalities could be reduced, these regions would provide important habitat and linkages among protected areas. Minimizing conflicts and mortalities will require either a constant paramilitary presence to control the actions of humans, which is unpalatable and in most cases infeasible, or working with local residents to understand their perspectives and practices and to learn ways of coexisting....If we do not find ways to do better, then populations of carnivores in the protected area of this region will simply act as mortality sinks immediately beyond the margins of these protected areas" (Rutherford and Clark 2005: 267-269).

The above describes the situation for the grizzly bear in the GYE. The concept of a population sink, a location where mortality exceeds fecundity, was suggested by Pullium (1988) as a new aspect of metapopulation theory. Areas outside protected areas may represent sink habitat. Doak (1995) suggested that the source/sink model was pertinent to the GYE. Schwartz et al. (2002) thought one-third of the GYE represented sink habitat. Mark Haroldson, Interagency Grizzly Bear Study Team biologist, posed the issue graphically: “Everywhere they [GYE grizzly bears] go outside of public land there is the urban, human interface. It is a minefield for them.” (quoted in Marris 2011: 152).

Knight et al. (1988) viewed some lands outside Yellowstone National Park as a mortality sink for the grizzly bear. Schwartz et al. (2006b) clarified that grizzly bear survival was highest in the park, declined on federal lands in the surrounding recovery zone and was lowest on public and private lands outside the recovery zone. Bear density outside the Recovery Zone was low (10-14%) by 2006 (Schwartz and Gunther 2006) but they nevertheless viewed land beyond the Recovery Zone (PCA) as a mortality sink. Later modeling efforts revealed that GYE grizzly bear survival was lowest in developed landscapes (Schwartz et al. 2010a). Hansen’s (2009) review of the literature led him to conclude that private land in the GYE were population sinks for the grizzly bear. Noss and Cooperrider (1994) observed that buffer zones on lands managed for multiple use are often mortality sinks. Population density alone may not distinguish a source from a sink (Pulliam and Danielson 1991).

Knight et al. (1999) thought the greatest threat to the GYE grizzly bear was development on private lands. Indeed, the highest mortality for the grizzly bear in the Recovery Zone was on private lands (Schwartz and Gunther 2006).

Reserve Area

There have been many attempts to define how much area a “viable” population of grizzly bears requires. In order to provide for viable populations of gray wolf (*Canis lupus*), grizzly bear, lynx (*Lynx canadensis*), wolverine (*Gulo gulo*) and Rocky Mountain elk (*Cervus elaphus*) for the Yellowstone region, maintain essential ecological and evolutionary processes, contain representative ecosystems and their spatial variation, and withstand environmental perturbations, Noss et al. (2002) calculated that the area needed would be 31.6 million ha, thirty times larger than today’s Yellowstone National Park. This extreme recommendation is understandably hard for land planners, managers and politicians to digest and then act upon.

Disturbance Regimes

Natural disturbance regime considerations contribute to some of this enormous area recommendation. Papers on disturbance regimes have led to reserve area recommendations that seem “unrealistically large” (Angelstam 1992: 56). For example, Shugart (1984) estimated that a protected landscape needs to be 50-100 times larger than the size of the average disturbance patch (e.g., fire) to maintain habitat equilibrium. One important disturbance regime research paper was from work in Minnesota. Baker (1989) observed that the 400,000 ha Boundary Waters Canoe Area of Northern Minnesota was not large enough to maintain a fire-induced steady state disturbance equilibrium (= a stable, fire regulated disturbance mosaic of patches). The work of Romme and Knight (1982) suggested that Yellowstone National Park is not large enough to accommodate its fire disturbance regime. However, minimum viable population size is another component of the Noss et al. (2002) recommendation.

Genetics

Genetic considerations are one aspect of minimum viable population size. Effective population size (N_e) is the breeding population size in contrast to the census population size (N). Metzgar and Bader (1992, cited in Noss et al. 1996) calculated that 129, 500 km^2 would be needed to maintain a N_e (breeding population) of 500 brown bears which would require a census population of 2000 bears. Based on genetics alone, this means that Yellowstone National Park would need to be increased in size more than 14 times. As Noss et al. (1996:106) explained, this would demand around 60 % of the Northern Rocky Mountains region.

Since 1980, a rule of thump for vertebrates is N_e = ¼ of N (see Shafer 1990, 1997). Therefore, to achieve a N_e of 500 brown bears, populations of at least 2000 bears would be required. This thinking continued for quite some time (e.g., Thomas 1990, Reed et al. 2003, cited in Merrill 2005). Such high-end N_es represent what Merrill (2005) calls "evolutionarily robust populations" following the thinking of Franklin (1980). Other authors have called the 50/500 rule “arbitrary and capricious” (Boyce 1997:228). There were some more extreme recommendations for N_e as well. For example, Lande (1995) argued one needs a N_e of 5,000 which translates into a census population of 20,000.

In keeping with most past thinking, US Fish and Wildlife Service (2007a: 14895) said, “many commenters believe that we should set a population objective of 2,000 to 3,000 bears in the GYE or reestablish connectivity among all grizzly bear populations in the Lower 48 States.” However, to the surprise of many, Miller and Waits (2003) offered a very low figure for grizzly bear genetic N_e: ~80 to >100. As a result, the US Forest Service adopted the position that a “viable population” of grizzly bears *already* existed in the GYE (US Forest Service 2006: 68). This estimate of N_e by Miller and Waits is drastically different from some earlier projections for “long-term” genetic effective population size (e.g., Harris and Allendorf 1989, Nunney and Elam 1994).

Genetic Isolation

A decrease in genetic diversity and the genetic divergence of local populations is a common result of habitat fragmentation (Keyghobadi 2007). In small populations, genetic variability is determined mostly by natural selection and genetic drift (Nunney and Campbell 1993). The loss of genetic variation is a result of a decrease in heterozygosity or a decrease in allelic diversity (Avise 1994). The GYE and the NCDE grizzly bear populations are perceived to have been isolated for around a century (Miller and Waits

2003). Haroldson et al. (2010) found no evidence of natural dispersal between the GYE and the Northern Continental Divide Ecosystem. There are genetic differences in the grizzly bear populations of the GYE compared to those populations further north (Paetkau et al. 1997, Miller and Waits 2003) (Table 1). In fact, over a 25 year period, *none* of the 460 radio-collared grizzly bears moved from one of the five major lower 48-US grizzly bear ecosystems to another, a distance varying from 60-384 km (Weaver et al. 1996, based on Servheen pers. comm., cited in Herrero 1998). This analysis must be updated after the discovery of some movement between these recovery areas (US Fish and Wildlife Service 2011: 88). The genetic distinctiveness of grizzly bear subpopulations in the western United States and Canada has now been affirmed (Proctor et al. 2012).

Table 1. Genetic variability within healthy North American brown bear populations based on nuclear DNA microsatellite analysis over 8 loci (data from Paetkau et al. 1997, figure from US Fish and Wildlife Service (2011).

Population	*Alleles*	*Diversity*	*Sample size*
Kodiak Island, Alaska	2.1	26.5%	34
Kluane National Park, Canada	7.4	76.2%	24
East Slope, Alberta, Canada	6.4	65.6%	30
NCDE, Montana, USA	6.8	70.3%	35
Yellowstone, USA	4.4	55.5%	46

Diversity is calculated by $h= (1+/-x_1^{2)\,n} / (n-1)$, *where* x_i *is the frequency of the ith lineage (allele) and n is the population size.*

Miller and Waits (2003) suggested that the GYE grizzly bear population was not in as dire straits genetically as many had assumed. “It is unlikely that genetic factors will have a substantial effect on the viability of the Yellowstone grizzly bear over the next few decades” (Miller and Waits 2003: 4338). This study was instigated by the USFWS. However, Paetkau et al. 1997, cited in Willcox 2004) noted that the grizzly bears in the GYE had lost 15% more of their genetic variability than bears in the Northern Continental Divide Ecosystem. However, Miller and Waits (2003:4338) indicated it had only “declined slightly.”

The USFWS position of “translocation of two or more bears from other ecosystems by 2022 (sic 2020) if genetic analysis shows no movement into the GYE from the NCDE”

(US Forest Service 2006: 311, US Fish and Wildlife Service 2007a: 14926) was based on Miller and Waits (2003) recommendation. These authors said the Yellowstone grizzly bear population had a N_e of 100 bears which reportedly requires a census population of 400 bears. The 4/1 ratio between census and effective population size has been supported for brown bears (Harris and Elmendorf 1989). In response to the USFWS proposal to delist the GYE grizzly bear, 269 concerned scientists signed a March 20, 2006, letter to the agency arguing that the GYE grizzly bear population needed to be 2,000-3,000 individuals (not 400-500) before it could provide for genetic diversity and withstand regional-scale random events (Craighead et al. 2006b). Yellowstone National Park has bought into the logic that GYE grizzly bears are not in any imminent danger genetically: "However, at this time the grizzly bear population in the GYE is not eminently at risk from the deleterious consequences of inbreeding. Thus, the need for gene flow is not urgent" (United Nations Educational, Scientific and Cultural Organization 2011). However, when considering genetic concerns, one must keep in mind that human caused mortality dwarfs genetic factors (Holsinger 1995). Species at the edges of their range like the GYE grizzly bear usually do have special genetic value (Lesica and Allendorf 1995).

According to Noss et al. (1996), adequate reserves need not consist of a single parcel but could be distributed over a wide region as long as such parcels are connected. Since the GYE had long been deemed by many conservation biologists as too small to preserve the genetic diversity of its grizzly bears long term (Craighead et al. 1995), connectivity may be a solution. Approximately 80-130 miles separate the GYE and Northern Continental Divide Ecosystem (US Forest Service 2006: 341).

Seeking Connectivity

There is increasing evidence that animals use habitat corridors to get from place to place (Gilbert-Norton 2010, Beier and Noss 1998). Connectivity must be viewed as a species-specific phenomena for a particular landscape (Merriam 1984). Guidance is being offered on how to plan for corridors and habitat connectivity (Worboys et al. 2010, Aune et al. 2011). We shall look at some potential corridors connecting the GYE to other large blocks of habitat for grizzly bears.

The Craighead Environmental Research Institute created an early version of an ideal reserve design for the Northern Rocky Mountains' grizzly bear (Figure 47). This can be the termed an "ecological network" (sensu Odgam et al. 2001) for the purpose of increasing "habitat connectivity" (sensu Hess and Fischer 2001). However, this ideal is a long way from being achieved. Let us now examine two critical linkages.

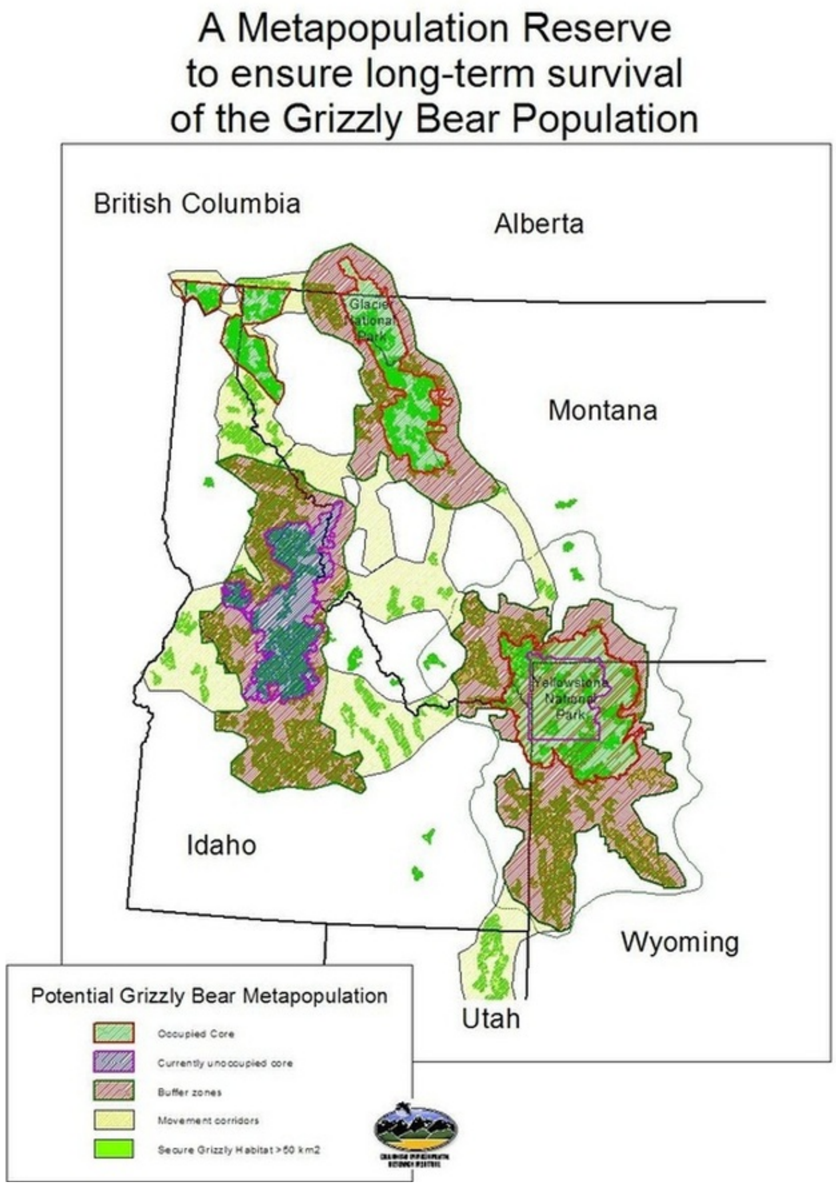


Figure 47. An early version of an idealized reserve design for the grizzly bear in the northern and central Rocky Mountains. Note: the yellow habitat corridors do not yet exist nor do the red areas represent strictly undisturbed habitat. Figure from Craighead Environmental Research Institute.
http://www.craigheadresearchorg/uploads/7/6/9/0/7609832/craighead_gilbert_olenicki_final_comments.pdf

Selway Bitterroot Ecosystem

Merrill et al. (1999) indicated that the nearest large tract to the GYE that would serve as good grizzly bear habitat is the Selway Bitterroot Ecosystem of central Idaho and western Montana. It consists of three wilderness areas: the Selway-Bitterroot (5424 km^2), the Frank Church-River of No Return (9553 km^2) and the Gospel Hump (810 km^2) (Roy et al. 2007). No bears have occupied this area for 25 years (US Fish and Wildlife Service 2007a: 14877) except for one killed by a hunter during September 2007. US Fish and Wildlife Service (2000) determined it to be suitable habitat but the plan for reintroduction was aborted because of controversy (Chadwick 2000: 42-44, Smith 2003). Noss et al. (2002) asserted what many U.S. and Canadian grizzly bear researchers generally recognize: connectivity between the GYE and central Idaho will be lost if current development rates continue for 25 years. Figure 48 illustrates the kinds of physiography between the GYE and the Selway Bitterroot Ecosystem. Work has been done identifying habitat linkages in the High Divide (American Wildlands 2008).

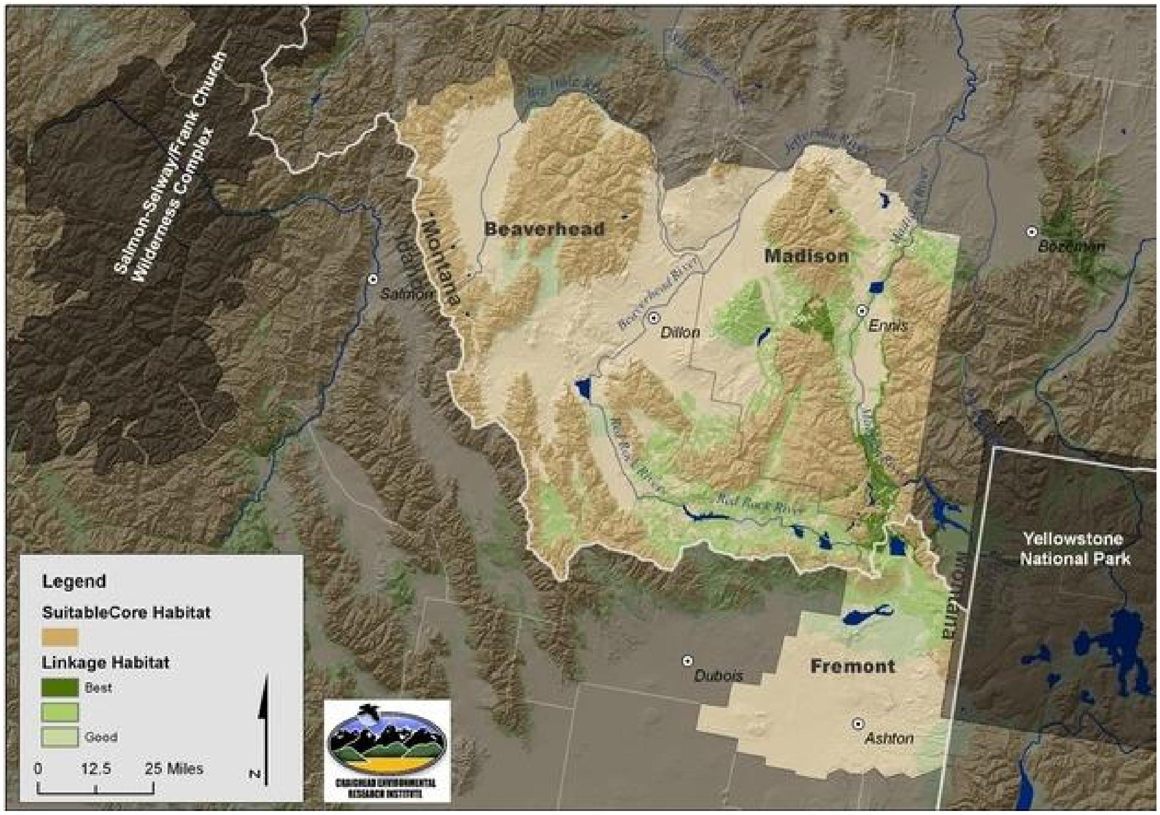
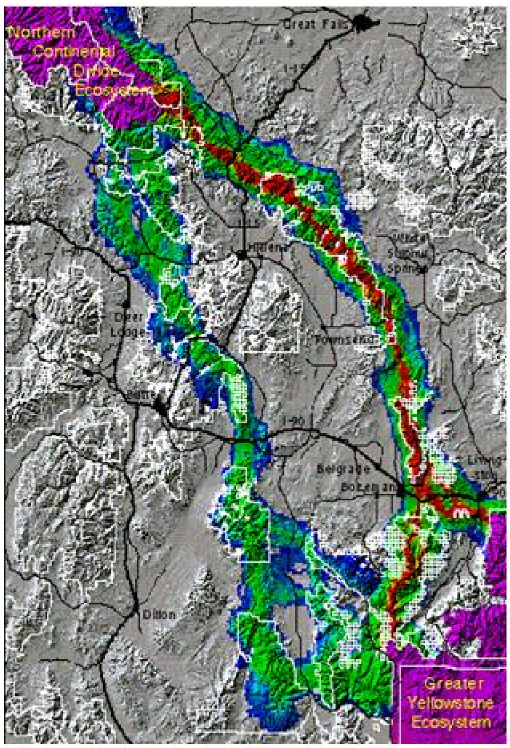


Figure 48. Grizzly bear habitat between the GYE and the Selway-Bitterroot Ecosystem in Idaho and Montana. Craighead Environmental Research Institute (http://www.craigheadresearch.org/high-divide.html)

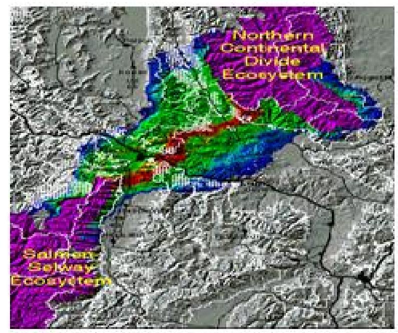
Northern Continental Divide Ecosystem

Servheen et al. (2001) identified potential corridors for the grizzly bear in the Northern Rockies and Picton (1986) found a potential route between the GYE and the Northern Continental Divide Ecosystem (NCDE). Walker and Craighead (1997) relied on "least-cost path" GIS analysis to gain more insight into potential places that would perpetuate or allow grizzly bear habitat connectivity between the GYE and both the NCDE and the

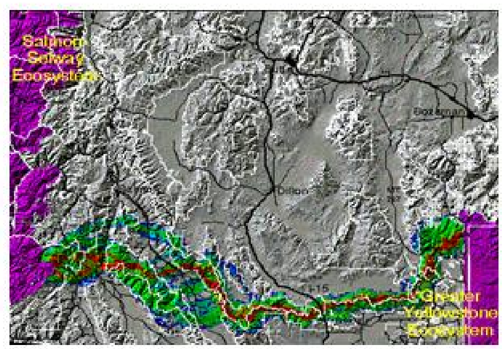
Bitterroot Ecosystem (Figure 49). The key factors in least cost path analysis are habitat suitability, habitat complexity and road density (American Wildlands 2006). Put another way, the technique identifies an animal travel path that requires the least amount of animal movement (Singleton and Lehmkuhl 2001).



http://proceedings.esri.com/library/userconf/proc97/to150/pap116/pap1116.htm



http://proceedings.esri.com/library/userconf/proc97/proc97/to150/pap116/p 116.htm



http://proceedings.esri.com/library/userconf/proc97/to150/pap116/pap116.htm

Figure 49. Mapped potential habitat corridors for grizzly bears. The left figure depicts two potential corridors from the GYE to the NCDE. The right two figures illustrates the corridors necessary to connect the GYE with the Selway-Bitterroot Ecosystem (lower) and that ecosystem with the NCDE (upper). From Walker and Craighead (1997).

The key factors used to identify core areas are habitat quality, road density and forest to edge ratio (Walker and Craighead 1997). Various physiographic features must be traversed along the least-cost pathway (red color band in Figure 50, left side) identified for grizzly bears between the GYE and the NCDE (Craighead et al. 2001). Included in such features is the 28 mile long Bozeman Pass, a mountain pass 13 miles east of Bozeman, Montana (Figure 50). Many more mammals have successfully crossed Interstate 90 after fencing was instituted (Craighead et al. 2010).

Figure 50. Left image is entering Bozeman Pass from the west on Interstate 90. Right image is within Bozeman Pass where the topography flattens out (Photos by author August 2012).

The federal wilderness and roadless areas along this route are certainly not continuous (Figure 51).

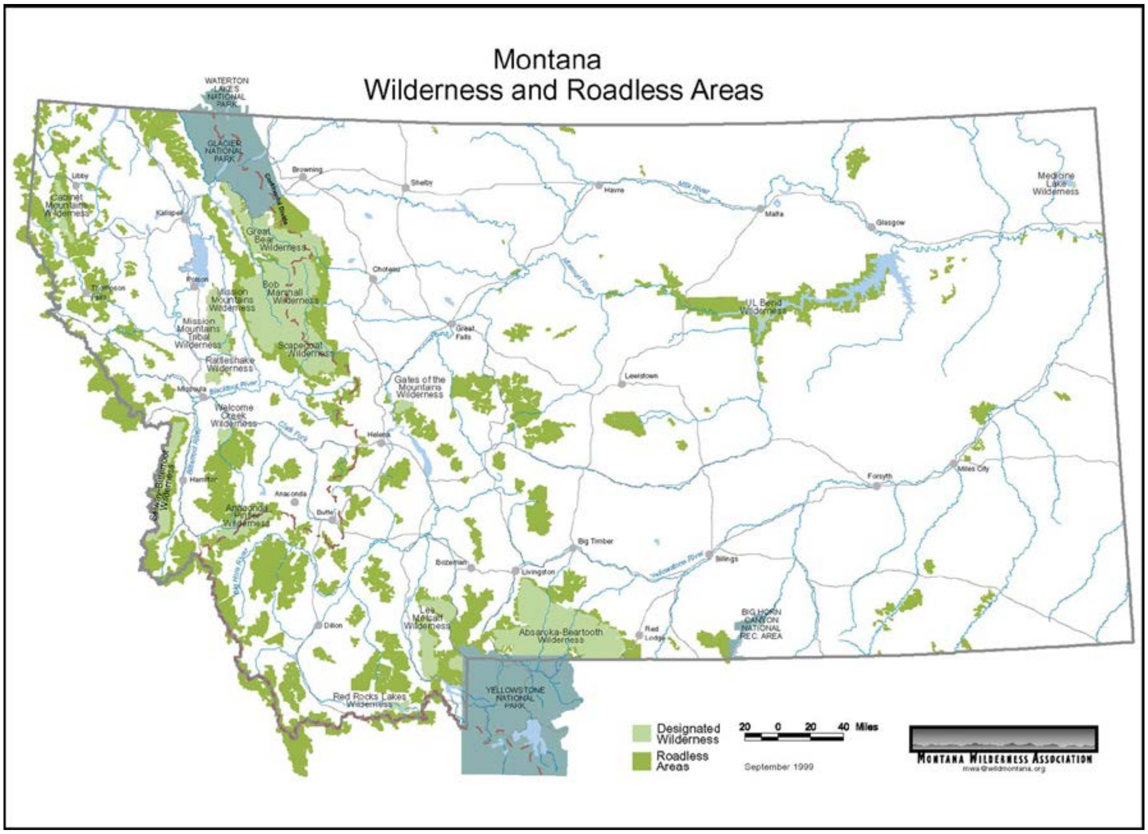


Figure 51. Wilderness and roadless areas between the GYE and the NCDE. Montana Wilderness Association (http://www.wildmontana.org/resources/maps/roadless.php)

Detailed GIS maps of the Bozeman Pass area can be found in Convis (2001: 42, 94). However, one must be mindful that the identification of a least-cost path does not necessarily mean that true habitat connectivity exists (DiBari 2009). The number of mapped roads along the route appears ominous (Figure 52) but the important thing is the type of roads that need to be traversed. Merrill's (2005) view was that this pathway was not yet secure enough for a family of bears. Is there a point where habitat fragmentation by roads makes further survival impossible? We do not know. The critical threshold idea for habitat fragmentation is a research priority (Metzgar and Décamps (1997).

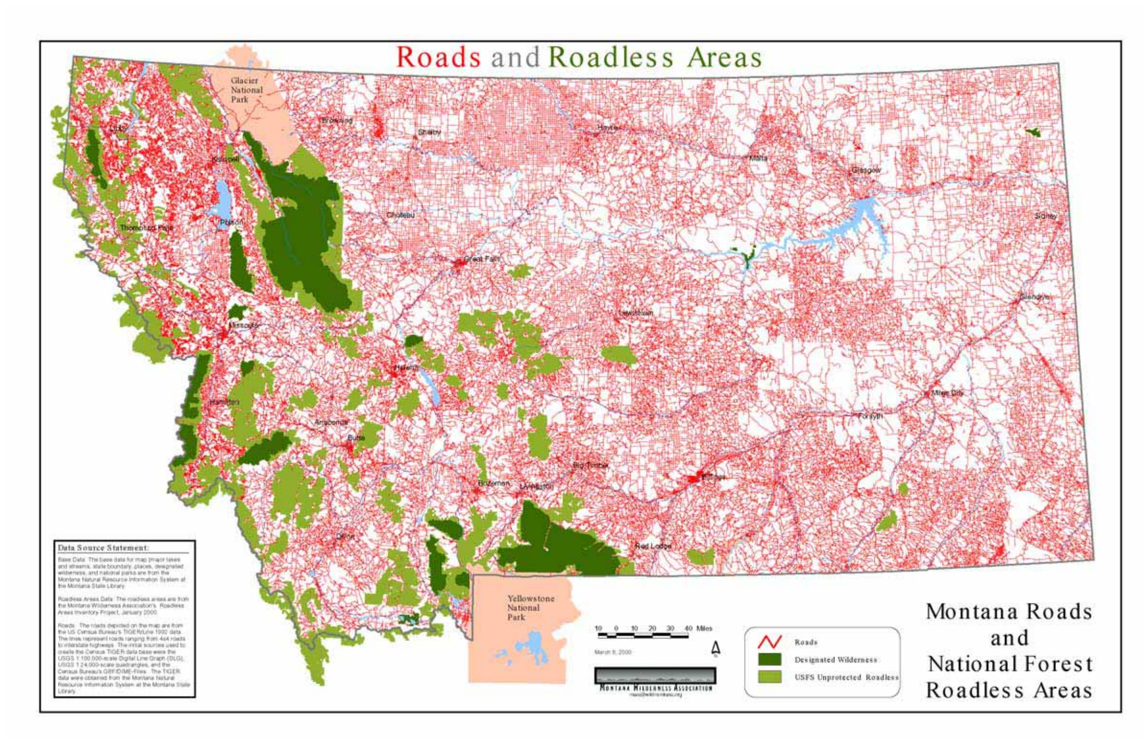


Figure 52. Roads in Montana using TIGER 2000 data. From Montana Wilderness Association (http://www.wildmontana.org/programs/roadless.php)

The High-Divide, an area between the GYE and the Selway-Bitterroot Wilderness Areas, has been looked at carefully by the Craighead Environmental Research Institute. One of their maps follows (Figure 53):

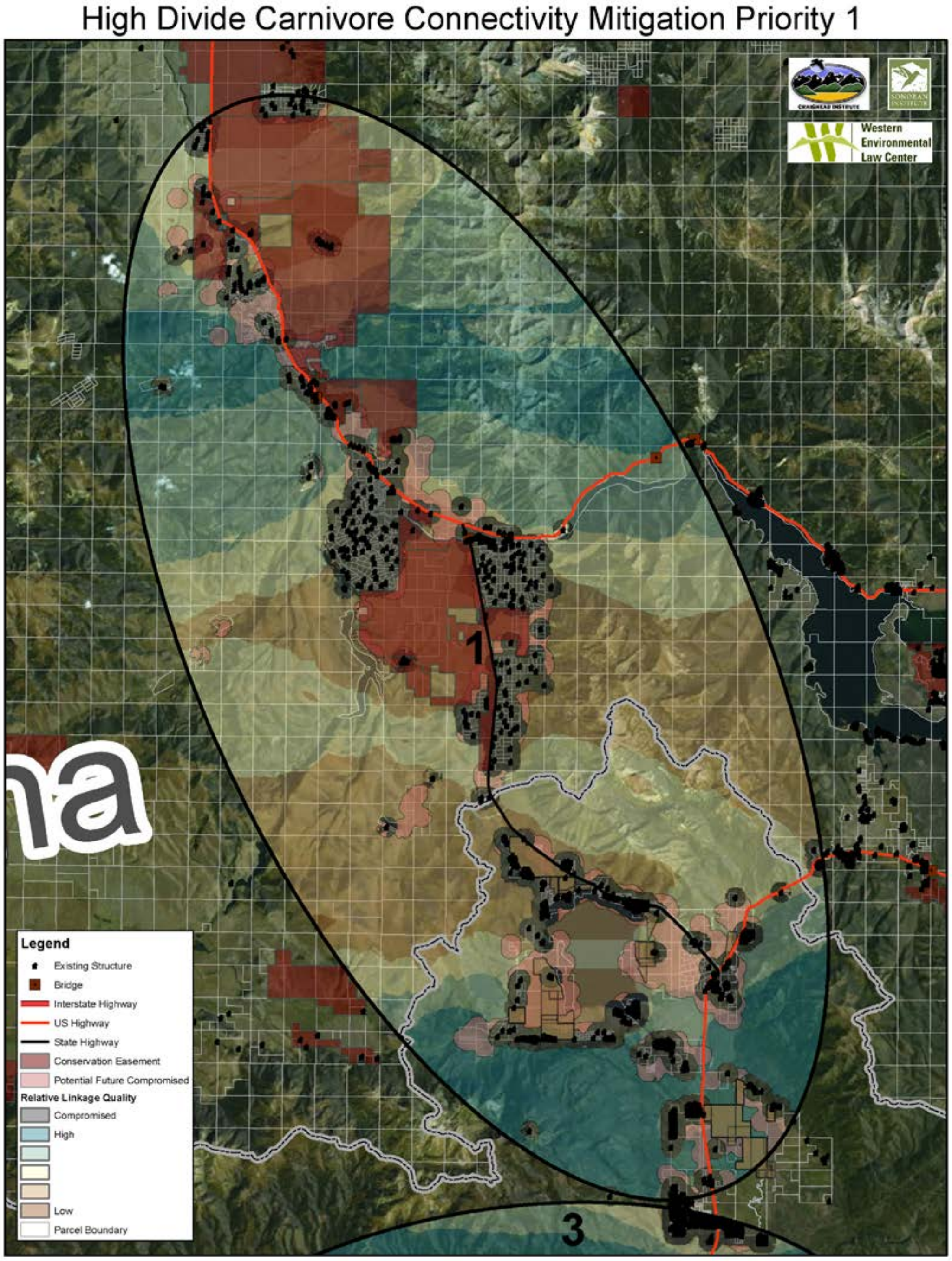


Figure 53. Map of the High Divide area courtesy of Craighead Environmental Research Institute, Bozeman, Montana. This is an example of large-scale mapping done by the Institute which depicts highways, easements, buildings and habitat linkage quality.

Lance Craighead and colleagues' work at identifying least-cost paths has been extended to other focal species in the Canadian Rockies (Craighead and Cross 2005; Craighead et al. 2008, cited in DiBari 2009) and has been applied to other areas in the American West (American Wildlands 2006). The least-cost path approach has been reviewed (Adriaensen et al. 2003, Hargrove et al. 2004; Beier et al. 2009). It has its downsides (Sawyer et al. 2011). There are other approaches at identifying potential habitat linkages (Beier et al. 2008). A linkage zone is not a corridor. Linkage zones can support a carnivore population as seasonal residents (Servheen et al. 2001).

The Interagency Grizzly Bear Study Committee has stated that the long term future of the grizzly bear is dim unless critical corridor connection can be secured, for example, between the GYE and the NCDE (Thompson 2004: 732). See Gore et al. (2001) for linkage habitat prioritization for the Northern Rockies. "Geomorphologic features such as mountain chains, drainage basins, valleys, and floodplains may offer a way to begin corridor design" (Sanderson et al. 2006: 633). The problem is that the low elevation fertile valleys in the GYE contain the most private land and has attracted development (Figures 7a,b).

Grizzly Bears and Highways

Servheen and Shoemaker (2003: 331) stated, "The effects of highways on grizzly bears are largely unknown." However, these bears seem to shy away from highways even more so than simple roads. For example, after monitoring roadkill at Bozeman Pass from January 1, 2001- June 30, 2009, 25 black bears (*Ursus americanus*) were found dead but no grizzly bears (Craighead et al. 2011). After monitoring seven underpasses and three large culverts passing below I-90 between Alberton and St. Regis, Montana, a 35 mile stretch of highway about 200 miles northwest of Bozeman from October 2002-July 2003, only one black bear used these conduits but no grizzly bears (Servheen and Shoemaker 2003). Even after crossing structures were incorporated into the Trans Canada Highway in the Bow Valley, Banff National Park, Alberta, grizzly bear passage was rare (Gibeau and Herrero 1998). Next to moose (*Alces alces*), grizzly bears were the mammal least likely to cross the Trans Canada Highway in the Bow Valley via underpasses, culverts for overpasses over 9 1/2 years of monitoring (Forman et al. 2003: 154). In fact, the Trans Canada Highway has been implicated in causing genetic isolation throughout western Canada (Proctor et al. 2005). One super highway is a known barrier for southern California carnivores (Riley et al. 2006). In Slovenia, brown bears seem to regard one superhighway as their home range boundary but not as an impossible obstacle to cross (Kaczensky et al. 2003). However, North American grizzly bears have crossed Interstate Highway 90 between Missoula and Butte coming from the NCDE. They appear to be moving in the direction of the Selway-Bitterroot Ecosystem, Montana and Idaho.

Social Factors

The unavoidable reality is that any connectivity project has to overcome various social, economic and political considerations (e.g., Morrison and Reynolds 2006). Davidson (2003) explained what NGOs have already done to promote connectivity in the Northern Rockies. The human aspects of connectivity conservation have been highlighted (Saunders et al. 1995). Bennett (2003:148-150) provides a very useful summary of the various considerations needed for optimal habitat connectivity planning. Thompson (2004) treats the legal framework for creating corridors on U.S. public lands. As US Forest Service (2006: 19) makes clear, "Maintenance of linkage zones between ecosystems... if well beyond the authorities of the Forest Service to address." The agency goes on to offer the following truism: "The bottom line is: ensuring occupancy by female grizzly bears between existing bear populations would likely require significant changes in human uses and developments, primarily on private lands" (US Forest Service 2006: 342). Recent modeling (Schwartz et al. 2012) supports the notion that the grizzly bear's future will hinge heavily on how private land in this region is used. Reconnection of some now disjunct grizzly bear populations in the Northern Rocky Mountains, if still possible, will require participation by many levels of government (Primm and Wilson 2004).

US Fish and Wildlife Service (2007a: 14927) explained that the Interagency Grizzly Bear Study Committee "will continue interagency efforts to complete the linkage zone task..." However, they cannot complete the task unless vast amounts of private land are purchased or easements are secured. Documents produced include IGBC Public Lands Wildlife Linkage Taskforce (2004). US Fish and Wildlife Service (2007a:14904) takes a controversial position: "we do not believe isolation is a threat to the Yellowstone grizzly bear population..." It is not a threat if enough bears are periodically translocated each generation (about every ten years) as USFWS plans and as Miller and Waits (2003) advocate. According to Craighead et al. (2006b), one might need to introduce 8 bears each year in order to get 1-2 to breed. However, reintroduction is a poor long term solution. Adams et al. (2011, cited in Hedrick et al. 2011) indicate there are less than 10 well documented cases of genetic rescue (i.e., a population rebounded as a result of the infusion of new genes from a translocation).

Noss and Daly (2006: 608-609) argued that "connectivity between reserves should not be a considered a substitute for the conservation of large core areas. Rather, corridors are an important complement, not an alternative, to the critical strategy of establishing large and multiple reserves." One must ask whether the current political climate in the American West would be more amenable to corridors/connectivity or much larger reserves. Most conservation biologists would at least surely agree with the following: "[Yellowstone] is too small to contain self–regulating populations of large mammals or to support a natural disturbance regime of the size characteristic of the Rocky Mountain region" (Brussard 1991: 10).

The Endangered Species Act

The Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.), or ESA, is a federal land management law that can affect what happens on private and state lands (Houck 1996: 974). This is because Section 9 of the Act prohibits the "taking" of a listed species. The Act defines *take* as "harass, harm, pursue," "wound" or "kill." The Secretary of the Interior's characterization of "harm" included "significant habitat modification or degradation where it actually kills or injures wildlife." In 1995, the U.S. Supreme Court (in *Babbitt v. Sweet Home Chapter for a Great Oregon 515 U.S. 687,692 (1995)* upheld the Secretary of the Interior's characterization of harm as including habitat destruction. In addition, Section 7 of the Act gives the USFWS veto power over any federal action that might "jeopardize" a listed species. It reportedly trumps other agency governing mandates (Keiter 1989). The ESA is one of the most powerful tools we have to preserve species and their habitat on public or private lands (Keiter 1985). Glickman and Coggins (2006: 272) regard it as "probably the most stringent wildlife law in the world."

The grizzly bear was listed as a threatened species in 1975 in the lower 48 states in 1975 (40 *Federal Register* 31734-31736, July 28, 1975). Section 7 of the Act bans activities that would "jeopardize the continued existence" of a species. Logging is a good example of a use that can place a species like the grizzly bear in jeopardy. Wilkinson (1998) asserted that logging on the Targhee National Forest was in violation of the ESA. Logging occurred there in the late 1970s and into the early 1990s. As a result of successful litigation over Sections 7 and 9 of the Act, this national forest closed 300 miles of roads (Willcox 2004). This result was due to the Sierra Club and several other NGOs suing the USFS and then reaching a negotiated settlement (Kline 2001: 417).

Another court case involving mining and grizzly bears had a less favorable conservation outcome. In *Cabinet Mountains v. Peterson*, 685 *F.2d 678, 222 U.S. App. D.C. 228 (D.C. Cir. 1982*), the court did not side with the NGO who objected to the USFS's approval of hardrock mining activity in grizzly bear habitat. Since the USFS followed the USFWS's recommendations to mitigate adverse effects, the court decided that the USFS did not need to prepare an environmental impact statement and the mining proceeded (Glickman and Coggins 2006:303-304).

Delisting

When the grizzly bear was listed as threatened in 1975, its population in the GYE was estimated at between 136-312 bears (Cowan et al. 1974, Craighead et al. 1974, McCullough 1981). However, by 2005, the USFWS announced that the Yellowstone Distinct Population Segment "recovered" and proposed to delist the bear. The US Fish and Wildlife Service (2007a: 14936) maintained that "the Yellowstone grizzly bear DPS is recovered and no longer needs the Act's definition of threatened or endangered." A complete list of public comments and agency responses on the proposed rule can be found at USFWS (2007a). The comments provided by Craighead et al. (2006a) on the proposed rule are especially noteworthy. For an NGO alternative to delisting, see Willcox (2004).

The USFWS delisted the Yellowstone Distinct Population Segment on April 30, 2007 (US Fish and Wildlife Service 2007a). However, a federal district court judge on September 21, 2009 ordered the USFWS to restore the bear's threatened status (*Greater Yellowstone Coalition, Inc. vs. Christopher Servheen, United States District Court for the District of Montana, Missoula Division, CV 07-134-M-DWM* [*2009*]). District Judge Donald W. Molloy concluded "The final rule in this case does not demonstrate that the Conservation Strategy and state plans are adequate regulatory mechanisms to maintain a recovered grizzly bear population....In addition, the record fails to support the Service's conclusion that whitebark pine declines do not pose a threat to the Yellowstone grizzly bear DPS [Distinct Population Segment]" (*Greater Yellowstone Coalition, Inc. vs. Christopher Servheen* at p.45). As for the genetic issue, which was a plaintiff argument, the judge said "the Court must defer to the agency's area of expertise in estimating an adequate population size because the Service has provided a reasonable explanation or its conclusions" (*Greater Yellowstone Coalition v. Christopher Servheen* at p. 33). The USFWS challenged the Court's September 21, 2009, decision to relist. On November 22, 2011, the U.S. 9th Circuit Court of Appeals Judge Richard Tallman and two other judges upheld the 2009 relisting decision. They criticized the USFWS for taking a “damn-the-torpedoes” approach to delisting. Erickson (2012) reviews the legal decision.

Nevertheless, the ESA has benefited the grizzly bear in Yellowstone National Park. Examples include the phase out of some camping opportunities near Fishing Bridge, reductions in logging and roading in the Gallatin and Targhee National Forests, and stopping a new ski resort from being constructed near Hebgen Lake (Willcox 2004). One must also recognize the positive role the Act has played in ecosystem management (see Chapter 5). After doing a case study of the Greater Glacier Ecosystem, Guercio and Duane (2009:298) said “The aggregate and cumulative effect of a series of individual agency and landowner decisions in the shadow of the ESA constitute a form of ecosystem management. In effect, the ESA becomes the organizing tool for managing human activities in a way that addresses the cumulative, aggregate consequences of those activities across jurisdictional boundaries at the ecosystem scale.” “Success or failure of grizzly bear restoration is viewed by many as the final testament of the Endangered Species Act” (Schwartz 2007: 228).

Critical Habitat

Wilkosz (2010: 70) complained about the ESA’s “inability to protect habitat.” Is this a valid criticism? Section 4 of the ESA requires designation of critical habitat. One of the first attempts to identify critical habitat for the GYE grizzly bear was done by Craighead in 1977 (Craighead 1980). However, the grizzly bear is a listed species that never received any critical habitat designations. There reportedly was a 1982 USFWS authored unpublished paper on critical habitat for the GYE grizzly bear (cited in Clark and Zaunbrecher 1987). The USFWS reportedly held more public hearings for grizzly bear critical habitat designation than for any other species (Primm and Murray 2005:110).

Since critical habitat designation was not required until the 1982 amendments to the ESA, Kuehl (1993) perceives that the USFWS was not required to produce critical habitat designations for a species listed prior to 1978. Kuehl believes that political objections to critical habitat designation for the grizzly bear must have been a significant influence for the USFWS to utilize this loophole (Kuehl 1993). Chase (1987:423) perceived that the USFWS met with so much opposition in the late 1970s to designating critical habitat for the grizzly bear that the agency ceased to continue the process. A zoning scheme was substituted for critical habitat (Primm and Murray 2005). That scheme consisted of five zones MS I-V (Servheen 1993). According to Clark and Minta (1994), the substitution of a zoning scheme for critical habitat designations was a poor tradeoff.

The Endangered Species Act (16 U.S.C. § 1531-1534) requires designation of critical habitat to the “maximum extent prudent and determinable.” Thompson (2004: 737-738) provides additional insight into this murky area of critical habitat designations. Also see Yagerman (1990: 829-838). The law itself provides an excuse for not designating critical habitat. “The Secretary may exclude any area from critical habitat if he determines that the benefits of such exclusion outweigh the benefits of specifying such area as part of critical habitat...” (16 U.S.C. § 1531-1534). Put simply, the government can simply elect not to establish critical habitat for a species due to potential local economic deprivation (Colburn 2011: 626).

The reality is that critical habitat is rarely designated when a species is listed. For example, from 1979-1991 more than 400 species were listed but only 73 had critical habitat designations (Noss et al. 1997: 45). In some cases, the courts have required the USFWS to designate critical habitat for a listed species (Musgrave 2009: 146-147). By 2000, only 10 % of listed species had critical habitat designations but, as a result of litigation, this jumped to 37 % by 2005 (Nie 2008:67).

Agency Accommodations

According to Cromley (2000:173), “the policy problem in dealing with conflicts between humans and bears is really a problem of managing people’s expectations about how resources shared by humans and bears are allocated and how conflicts over those resources are resolved.” As of 1991, 25 % of the GYE’s occupied grizzly bear habitat was open to logging, oil and gas development, livestock grazing and developed recreational sites (Clark et al. 1991). In some cases, USFS has tried to accommodate the needs of the grizzly bear. For example, the Shoshone and Custer National Forests by 1989 made important grizzly bear habitat unavailable for mineral and oil and gas exploration (Keiter 1989). As a result of litigation by NGOs, the USFS closed 1,245 miles of roads in the Targhee National Forest from 1992-1993. And by 1997, the agency prohibited clear-cutting and off-road vehicles in 59,000 acres of the Target's grizzly bear "secure areas" (Wilkinson 1999).

In spite of recent GYE grizzly bear population increases and range expansion, Kline (2001:426) realized the ultimate importance of enforcement authority: "Without enforcement authority, the CS [Grizzly Bear Conservation Strategy] could all too easily become a paper tiger touting grizzly bear recovery measures as cold reality sees the grizzly bear slipping into oblivion..." "Success in maintaining the GYE will be measured, in part, by our success in managing the Yellowstone grizzly" (Clark et al. 1991: 417).

Afterthoughts

Do the words of John F. Kennedy, Jr., portray the true situation: "The last few grizzly bears [are] hanging on by a thread in the Lower 48 and Alberta" (Kennedy: 190)? That thread consists of 600 bears in the GYE as of 2010 (Anonymous 2011). How to save the GYE grizzly bear is a topic too broad for this discussion. However, for some practical recommendations offered almost three decades ago, see Sudia (1986).

This much we know. Unless natural habitat corridors can be secured between the GYE and the NCDE, or the Bitterroot Ecosystem after bears are reintroduced there, keeping the GYE grizzly bear population from loosing genetic diversity will require periodic translocations into the GYE indefinitely.   This issue of whether a reduction in consumptive land use can reduce large mammal mortality is a question being pondered worldwide (Leader-Williams and Hutton 2003).

REFERENCES

Adams, J. R., L. M. Vuccetich, P. R. Hedrick, R. O. Peterson, and J.A. Vucetich. 2011. Genomic sweep and potential genetic rescue during limiting environmental conditions in an isolated wolf population. *Proceedings Royal Society London B* DOI:10.1098/rspb.2011.0261.

Adriaensen, A., J.P. Chardon, G. DeBlust, E. Swinnen, S. Villalba, H. Gulinck, and E. Matthysen. 2003. The application of 'least cost' modeling as a functional landscape model. *Landscape and Urban Planning* 64: 233-247.

American Wildlands. 2006. Regional Habitat Connectivity Analysis: Crown of the Continent Ecosystem. Available at: http://www.mtnforum.org/sites/default/files/pub/1665.pdf Accessed June 2012.

American Wildlands. 2008. The High Divide. American Wildlands, Bozeman, Montana Available at: http://www.montanas4wildlife.org/pdfs/PLA_HighDivide_AWL.pdf Accessed February 2013.

Angelstam, P.1992. Conservation of communities-the importance of: edges, surroundings and landscape mosaic structure. In L. Hansson (ed). Ecological Principles of Nature Conservation, pp. 9-70. Elsevier Applied Science, London.

Anonymous. 2011. Grizzly bears: resource brief. Available at: http://www.greater yellowstonescience.org/download_product/3512/0 Accessed October 2011.

Archibald, W.R., R. Ellis and A.N. Hamilton. 1987. Responses of grizzly bears to logging truck traffic in the Kimsquit River valley, British Columbia. *International Conference on Bear Research and Management* 7: 251-257.

Aune, K. and W. Kasworm. 1989. Final Report East Front Grizzly Bear Study. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Aune, K., P. Beier, J. Hilty and F. Shilling. 2011. Assessment and Planning for Ecological Connectivity: A Practical Guide. Wildlife Conservation Society, Bozeman, Montana.

Avise, J.C. 1994. Molecular Markers, Natural History and Evolution. Chapman Hall, New York.

Baker, W.L. 1989. Landscape ecology and nature reserve design in the Boundary Waters Canoe Area, Minnesota. *Ecology* 70: 23-35.

Beier, P., D.R. Majka, and W.D. Spencer. 2008. Forks in the road: choices in procedures for designing wildland linkages. *Conservation Biology* 22(4): 836-851.

Beier, P., R. Majka and S.L. Newell. 2009. Uncertainty analysis of least-cost modeling for designing wildlife linkages. *Ecological Applications* 19(8):2067-2077.

Beier, P. and R.F. Noss. 1998. Do habitat corridors provide connectivity? *Conservation Biology* 12(6): 1241-1252.

Bennett, A.F. 2003. Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK.

Boyce, M.S. 1997. Population viability analysis: adaptive management for threatened and endangered species. In M.S. Boyce and A. Haney (eds.), Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources, pp. 226-336. Yale University Press, New Haven.

Boyce, M.S., B.M. Blanchard, R.R. Knight, and C. Servheen. 2001. Population viability for grizzly bear: a critical review. Interagency Association for Bear Research and Management Monograph Series 34.

Brussard, P.F. 1991. The role of ecology in biological conservation. *Ecological Applications* 1(1): 6-12.

Chadwick, D.H. 2000. Yellowstone to Yukon. National Geographic Society, Washington, D.C.

Chase, A. 1987. Playing God in Yellowstone: The Destruction of America’s First National Park. Harcourt Brace Jovanovich, San Diego, California.

Clark, T.W., E.D. Amento, D.G. Whittemore, and A.H. Harvey. 1991. Policy and programs for ecosystem management in the Greater Yellowstone Ecosystem: an analysis. *Conservation Biology* 5: 412-422.

Clark, T.M. and S.C. Minta. 1994. Greater Yellowstone’s Future: Prospects for Ecosystem Science, Management, and Policy. Homestead Publishing, Moose, Wyoming.

Clark, T.W. and D. Zaunbrecker. 1987. The Greater Yellowstone Ecosystem: the ecosystem concept in natural resource policy and management. *Renewable Resources Journal* Summer: 8-16.

Colburn, J. 2011. Habitat reserve problem-solving: desperately seeking sophisticated intermediaries. *Environmental Law* 41: 619-654.

Convis, C.L. (ed.) 2001. Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism. Environmental Systems Research Institute, Redlands, California.

Corn, L.M. and R.W.Gorte. 1986. Yellowstone: Ecosystem, Resources, and Management. Congressional Research Service RS 86-1087 ENR.

Cowan, I. McT., D.G. Chapman, R.S. Hoffmann, D.R. McCullough, G.A. Swanson, and R.B. Weedon. 1974. Report of the Committee on the Yellowstone Grizzlies. National Academy of Sciences Report, Washington, D.C.

Craighead, F.L. 2002. Wildlife-related road impacts in the Yellowstone to Yukon Region. Available at: http://www.transwildalliance.org/resources/20088417200.pdf . Accessed March 2011.

Craighead, J.J. 1980. A proposed delineation of critical grizzly bear habitat in the Yellowstone region. Presented at the Fourth International Conference on Bear Research and Management, Kalispell, Montana, February, 1977. Bear Biology Association Monograph Series No. 1.

Craighead, J.J. 1998. Status of the Yellowstone grizzly bear population: has it recovered, should it be delisted? *Ursus* 10: 597-602.

Craighead, J.J., J.S. Summer, and J.A. Mitchell. 1995. The Grizzly Bears of Yellowstone: Their Ecology and Management, 1959-1992. Island Press, Washington, D.C.

Craighead, J.J., J. Varley and F.C. Craighead. 1974. A Population Analysis of the Yellowstone Grizzly Bears. Montana Forest and Conservation Experiment Station, Bulletin 40. School of Forestry, University of Montana, Missoula, Montana.

Craighead, A. C., E. A. Roberts, and F.L. Craighead. 2001. Bozeman pass wildlife linkage and highway safety study. In Proceedings of the International Conference on Ecology and Transportation, pp. 405-422. Center for Transportation and the Environment, North Carolina State University, Raleigh, North Carolina.

Craighead, L., B. Gilbert, and T. Olenicki. 2006a. Comments submitted to the U.S. Fish and Wildlife Service regarding delisting of the Yellowstone grizzly bear DPS, *Federal*

Register, Vol. 70, No. 221 (November 17, 2005), 69853-69884. Available at: http://craigheadresearch.org/education/index.php?cmd=ifws Accessed July 2011.

Craighead et al. 2006b. Group letter to Dr. Christopher Servheen, Grizzly Bear Recovery Coordinator, U.S. Fish and Wildlife Service (March 20, 2006). Available at: http://www.grizlybear.org/education/index.php?cmd=issl Accessed August 2009.

Craighead, L. and B. Cross. 2005. Identifying core habitat and connectivity for focal species in the Interior Cedar-Hemlock forest of North America to complete a conservation area design. In: A. Watson, J. Sproull and L. Dean (eds), Eighth World Wilderness Congress Symposium, September 30-October 6, 2005, Anchorage, Alaska, pp. 281-296. Proceedings RMRS-P-49, USDA Forest Service, Rocky Mountain Station, Fort Collins, Colorado.

Craighead, L., T. Olenicki, B. Brock and J. Williams. 2008. A Conservation Area Design for the Inland Temperate Rainforest of North America. BC's Inland Rainforest-Conservation and Community Conference Proceedings, May 21-23, 2008, Prince George, British Columbia, Canada. Available at: http://wetbelt.unbc.ca/2008-conference-Craighead-Conservation-Area-Design.html

Craighead, L., A. Craighead, L. Oechsli, and A. Kociolek. 2010. Bozeman Pass fencing and wildlife monitoring. Available at: http:// www.mdt.mt.gov/res...cts/env/boz_wildlife.shtm Accessed November 2012.

Craighead, L.A., F.L. Craighead and L. Oechcli. 2011. Bozeman Pass post fencing wildife monitoring. FH-10-006/8173 http://www.westerntransportationinstitute.org/documents/reports/426899-Final-Report-pdf Accessed February 2013.

Cromley, C.M. 2000. The killing of grizzly bear 209: identifying norms for grizzly bear management. In T.M. Clark, A.R. Willard and C.M. Cromley (eds), Foundations of Natural Resources Policy and Management, pp. 173-220. Yale University Press, New Haven.

Crooks, K.R. 2002. Relative sensitivities of mammalian carnivores to habitat fragmentation. *Conservation Biology* 16: 488-502.

Davidson, D.K. 2003. Innovative partnerships that address highway impacts to wildlife habitat connectivity in the Northern Rockies. In C.L. Irwin, P. Garrett and K.P. McDermott (eds), Proceedings of the 2003 International Conference on Ecology and Transportation, pp. 195-203. Center for Transportation and Environment, North Carolina State University, Raleigh, North Carolina. Available at: http://www.escholarship.org/uc/item/13h1p3f3 Accessed June 2011.

DiBari, J. 2009. Using boundary-detection methods to assess conservation corridors. *Journal of Conservation Planning* 5: 15-27.

Doak, D.F. 1995. Source-sink models and the problem of habitat degradation: general models and applications to the Yellowstone grizzly bear. *Conservation Biology* 9: 370-379.

Dood, A., R.D. Brannon and R.D. Mace. 1986. Final Programmatic Environmental Impact Statement, the Grizzly Bear in Northwest Montana. Montana Department of Fish, Wildlife and Parks, Helena, Montana.

Eberhardt, L.L. 1977. Optimal policies for conservation of large mammals. *Environmental Conservation* 4: 206-212.

Erickson, A.B. 2012. Grizzly bear recovery, whitebark pine, and adequate regulatory mechanisms under the Endangered Species Act. *Environmental Law* 42: 943-975.

Forman, R.T.T. 2000. Estimate of the area affected ecologically by the road system in the United States. *Conservation Biology* 14 (1): 31-35.

Forman, R.T.T. et al. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C.

Franklin, I.R. 1980. Evolutionary change in small populations. In M.E. Soulé and B.A. Wilcox (eds), Conservation Biology: An Evolutionary-Ecological Perspective, pp. 135-149. Sinauer, Sunderland, Massachusetts.

Gibeau, M. and S. Herrero. 1998. Roads, rails, and grizzly bears in the Bow Valley, Alberta. In: G. Evink et al. (eds), Proceedings of the International Conference on Ecology and Transportation, FL-ER-69098. Florida Department of Transportation, Tallahassee.

Gilbert-Norton, L., R. Wilson, J.R. Stevens and K.H. Beard. 2010. A metapopulation analytic review of corridor effectiveness. *Conservation Biology* 24(3): 660-668.

Glick, D., M. Carr and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana.

Glickman, R.L. and G.C. Coggins. 2006. Modern Public Land Law in a Nutshell. Thomson West, St. Paul, Minnesota.

Goldstein, B. 2008. Wilderness and Extractive Industries: An Economic Transition in the Rockies. Available at: http://www2.coloradocollege.edu/StateoftheRockies/08ReportCard/ExtractiveIndustries.pdf Accessed December 2011.

Gore, J.F., J.J. Claar and B. Ruedinger. 2001. Why did the bear cross the road? It didn't. Available at: escholarship.org/uc/item/5p76c45#page-1-8. Accessed November 2012.

Guercio, L.D. and T.P. Duane. 2009. Grizzly bears, gray wolves, and federalism, oh my! The role of the Endangered Species Act in de facto ecosystem-based management in the Greater Glacier Region of Northwest Montana. *Journal of Environmental Law and Litigation* 24: 285-366.

Hansen, A. 2009. Contribution of source-sink theory to protected area science. Available at: http://www.homepage.montana.edu/~hansen/bio515_09/readings/lec8/hansen.2010.doc Accessed November 2010.

Hargrove, W.W., F.M. Hoffman and R.A. Efroymson. 2004. A practical map-analysis tool for detecting potential dispersal corridors. *Landscape Ecology* 20: 361-373.

Haroldson, M.A., C.C. Schwartz, and Kerry A. Gunther. 2008. Grizzly bears in the Greater Yellowstone Ecosystem: from garbage, controversy, and decline to recovery. *Yellowstone Science* 16(2): 13-24.

Haroldson, M.A., C.C. Schwartz, K.C. Kendall, K.A.Gunther, D.S. Moody, K. Frey and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus* 21 (1): 1-13.

Haroldson, M.A. and Van Manen. 2012. Introduction. In: F.T. van Manen, M.A. Haroldson and K. West (eds). Yellowstone Grizzly Bear Investigations: Annual Report of the Interagency Grizzly Bear Study Team 2011, pp. 1-3. U.S. Geological Survey, Bozeman, Montana.

Harris, R.B. and F.W. Allendorf. 1989. Genetically effective population size of large mammals: an assessment. *Conservation Biology* 3(2): 181-191.

Harris, R.B., C.C. Schwartz, M.A. Haroldson, and G.C. White. 2006. Trajectory of the Yellowstone grizzly bear population under possible future survival rates. In C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem, pp. 44-54. *Wildlife Monographs* 161.

Harris, R.B., G.C. White, C.C. Schwartz, and M.A. Haroldson. 2007. Population growth of Yellowstone grizzlies: uncertainty, correlation, and future monitoring. *Ursus* 18(2): 167-177.

Hatch, C. 2011. Grizzly bears making homes far from Yellowstone: conservationists say core habitat areas need to be larger. Jackson Hole News & Guide Available at: www.jhnewsandguide.com/article.php?art_id=7479 Accessed January 2013

Hedrick, P.W., J.R. Adams, and J.A. Vucetich. 2011. Reevaluating and broadening the definition of genetic rescue. *Conservation Biology* 25 (6):1069-1070.

Heilman, G.E., J.R. Strittholt, N.C. Slosser, and D.A. Dellasala. 2002. Forest fragmentation of the conterminous United States: assessing forest intactness through road density and spatial characteristics. *BioScience* 52: 411-422.

Herrero, S. 1998. Defining grizzly bear habitat in the Yellowstone to Yukon. In A. Harvey (ed), A Sense of Place: Issues, Attitudes and Resources in the Yellowstone to Yukon Ecoregion, pp.103-111. Yellowstone to Yukon Conservation Initiative, Canmore, Alberta, Canada. Available at: http://www.y2y.net/data/1/rec.docs/661 A-Sense_of_Place,_the_Y2Y.Atlas Accessed April 2011.

Hess, G.R. and R.A. Fischer. 2001. Communicating clearly about conservation corridors. *Landscape and Urban Planning* 55: 195-208.

Holsinger, K.E. 1995. Population biology for policy makers. *BioScience* 45: S10-S12.

Houck, O.A. 1996. On the law of biodiversity and ecosystem management. *Minnesota Law Review* 81: 869-979.

Interagency Grizzly Bear Committee Public Lands Wildlife Linkage Taskforce. 2004. Identifying and Managing Wildlife Linkage Approach Areas on Public Lands. A Report to the IGBC. Missoula, Montana, 44 pp.

Interagency Conservation Strategy Team 2007. Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area. March 2007. Available at: http://www.fws.gov/mountain-prairie/species/mammals/grizzly/Final_Conservation_Strategy.pdf Accessed April 2011.

Interagency Grizzly Bear Study Team. 2013. Interagency Grizzly Bear Mortality Data Base. Available at: http://nrmsc.usgs.gov/science/igbst/mort Accessed March 2013.

Kaczensky, P., F. Knaper, B. Krze, M. Jonozovic, M. Adamic, and H. Gossow. 2003. The impact of high speed, high volume traffic axes on brown bears in Slovenia. *Biological Conservation* 111(2): 191-204.

Kasworm, W.F. and T.L. Manley. 1990. Road and trail influences on grizzly bears and black bears in Northwest Montana. In Bears: Their Biology and Management, Vol. 8, pp. 79-84. International Association for Bear Research and Management.

Keiter, R.B. 1985. On protecting the national parks from the external threats dilemma. *Land and Water Law Review* 20 (2):355-420.

Keiter, R.L. 1989. Taking account of the ecosystem on the public domain: law and ecology in the Greater Yellowstone Region. *University of Colorado Law Review* 60: 923-1007.

Kennedy, R.F., Jr. 2007. Epilogue. In Yellowstone to Yukon: Freedom to Roam-A Photographic Journey by Florian Schulz. Braided River, Seattle, Washington.

Keyghobadi, N. 2007. The genetic implications of habitat fragmentation for animals. *Canadian Journal of Zoology* 85: 1049-1064.

Kline, P. 2001. Grizzly bear blues: a case study of the Endangered Species Act's delisting process and recovery plan requirements. *Environmental Law* 31: 371-432.

Knight, R.R. and L.L. Eberhardt. 1985. Population dynamics of Yellowstone grizzly bears. *Ecology* 66(2): 323-334.

Knight, R.R. and L.L. Eberhardt. 1987. Prospects for Yellowstone grizzly bears. *International Conference on Bear Research and Management* 7: 45-50.

Knight, R.R., B.M. Blanchard, and L.L. Eberhardt. 1988. Mortality patterns and population sinks for Yellowstone grizzly bears, 1973-1985. *Wildlife Society Bulletin* 16: 121-125.

Knight, R.R., B.M. Blanchard, and L.L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year. *Wildlife Society Bulletin* 23(2): 245-248.

Knight, R.R., B.M. Blanchard, and P. Schullery. 1999. Yellowstone bears. In T.W.Clark, A.P. Curlee, S.C. Minta and P.M. Kareiva (eds), Carnivores in Ecosystems: The Yellowstone Experience, pp. 51-76. Yale University Press, New Haven.

Kuehl, B.L. 1993. Conservation obligations under the Endangered Species Act: a case study of the Yellowstone grizzly bear. *University of Colorado Law Review* 64: 607-643.

Lande, R. 1995. Mutation and conservation. *Conservation Biology* 9: 782-791.

Leader-Williams, N. and J.M. Hutton. 2005. Does extractive use provide opportunities to offset conflicts between people and wildlife. In R. Woodroffe, S. Thirgood, and A. Rabinowitz. (eds), People and Wildlife: Conflict or Coexistence?, pp. 140-161. Cambridge University Press, Cambridge, UK.

Lesica, P. and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation. *Conservation Biology* 9:753-760.

Linke, J., S.E. Franklin, F. Huettmann, and G.B. Stenhouse. 2005. Seismic cutlines, changing landscape metrics and grizzly bear landscape use in Alberta. *Landscape Ecology* 20(7): 811-826.

Mace, R.D., J.S. Waller, T.L. Manley, L.J. Lyon and H. Zuuring. 1996. Relationships among grizzly bears, roads and habitat in the Swan Mountains, Montana. *Journal of Applied Ecology* 33 (6): 1395-1404.

Mace, R.D., J.S. Waller, T.L. Manley, K. Ake, and W.T. Willinger. 1999. Landscape evaluation of grizzly bear habitat in western Montana. *Conservation Biology* 13(2): 367-377.

Marcus, W.A., J.F. Meacham, A.W. Rodman A.Y. Steingisser, S. Allan and R. West (eds) 2012. Atlas of Yellowstone. University of California Press, Berkeley.

Marris, E. 2011. Conservation biology: the end of the wild. *Nature* 469: 150-152.

Mattson, D.J. 1990. Human impacts on bear habitat use. *International Conference on Bear Research and Management* 8: 33-56.

Mattson, D.J. 1992. Conversion Factors for Standardized Calculations of Roads and Trail Densities: Yellowstone Grizzly Bears. Interagency Grizzly Bear Study Team, Forest Sciences Labs, Montana State University, Bozeman, Montana.

Mattson, D.J. 1996. Wilderness-dependent wildlife: the large and the carnivorous. *International Journal of Wilderness* 3 (4): 34-38.

Mattson, D.J. and R.R. Knight. 1991. Effects of access on human-caused mortality of Yellowstone grizzly bears. Interagency Grizzly Bear Study Team Report, National Park Service, U.S. Department of the Interior, 13 pp.

Mattson, D.J., B.M. Blanchard and R. Knight. 1992. Yellowstone grizzly bear mortality, human habituation, and whitebark pine seed crops. *Journal of Wildlife Management* 56: 432-442.

Mattson, D.J., S. Herrero, R.G. Wright, and C. M. Pease. 1996a. Designing and managing protected areas for grizzly bears: how much is enough? In R.G. Wright and J. Lemons (eds), National Parks and Protected Areas: Their Role in Environmental Protection, pp. 133-164. Blackwell Science, Cambridge, Massachusetts.

Mattson, D.J., S. Herrero, R.G. Wright and C.M. Pease. 1996b. Science and management of Rocky Mountain grizzly bears. *Conservation Biology* 10 (4): 1013-1025.

Mattson, D.J., R.R. Knight and B.M. Blanchard. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. *International Conference on Bear Research and Management* 7: 259-273.

Mattson, D.J., R.G. Wright, K.C. Kendall, and C.J. Martinka. 1995. Grizzly bears. In E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.J. Mac (eds), Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems, pp. 103-105. U.S. Department of the Interior, National Biological Service, Washington, D.C.

McCullough, D.R. 1981. Population dynamics of the Yellowstone grizzly bears. In C.W. Fowler and T.D. Smith (eds), Dynamics of Large Mammal Populations, pp. 173-196. John Wiley and Sons, New York.

McLellan, B.N. and D.M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behavior, habitat use and demography. *Journal of Applied Ecology* 25 (2): 451-460.

McLellan, B.N. 1989. Dynamics of a grizzly bear population during a period of industrial extraction. II. Mortality rates and causes of death. *Canadian Journal of Zoology* 67:1861-1864.

McLellan, B.N. 1990. Relationship of human industrial activity and grizzly bears. *International Conference on Bear Research and Management* 8:57-64.

Merrill, T., D.J. Mattson, R.G. Wright, and H.B. Quigley. 1999. Defining landscapes suitable for restoration of grizzly bears *Ursus arctos* in Idaho. *Biological Conservation* 87(2): 231-248.

Merrill, T. 2005. Grizzly Bear Conservation in the Yellowstone to Yukon Region. Yellowstone to Yukon Conservation Initiative, Technical Report No. 6. Available at: http://www.y2y.net/data/1/rec_docs/507_Merrill_grizzly_conservation_in _y2y.pdf Accessed October 2011.

Merriam, G. 1984. Connectivity: a fundamental ecological characteristic of landscape pattern. In J. Brandt and P. Agger (eds), Proceedings of the First International Seminar on Methodology Landscape Ecological Research and Planning Vol. 1, pp. 5-15. Roskilde, Denmark.

Metzgar, L.H. and M. Bader. 1992. Large mammal predators in the northern Rockies: grizzly bears and their habitat. *Northwest Environmental Journal* 8(1): 231-233.

Metzgar, J. and H. Décamps. 1997. The structural connectivity threshold: an hypothesis in conservation biology at the landscape scale. *Acta Œcologica* 18 (1): 1-12.

Miller, C.R. and L.P. Waits. 2003. The history of effective population size and genetic diversity in the Yellowstone grizzly (*Ursus arctos*): implications for conservation. *Proceedings of the National Academy of Sciences*, *USA* 100 (7): 4334-4339.

Mills, L.S. 2007. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell, Malden, Massachusetts.

Moody, D., D. Hammer, M. Bruscino, D. Bjornlie, R. Grogan and B. Debolt. 2002. Wyoming Grizzly Bear Management Plan. Wyoming Game and Fish Department, Cheyenne, Wyoming.

Moody, D.S., K. Frey and D. Meints. 2009. Trends in elk hunter numbers within the Primary Conservation Area plus the 10-mile perimeter area. In C.C. Schwartz and M.A. Haroldson (eds), Yellowstone Grizzly Bear Investigations: Annual Report of the Interagency Grizzly Bear Study Team, p. 39. U.S. Geological Survey, Bozeman, Montana.

Morrison, S.A. and M.D. Reynolds. 2006. Where to draw the line: integrating feasibility into connectivity planning. In K.R. Crooks and M. Sanjayan (eds), Connectivity Conservation, pp. 536-554. Cambridge University Press, UK.

Musgrave, R.S. 2009. Legal trends in fish and wildlife policy. In M.J. Manfredo, J.L. Vaske, P.J. Brown, D.J. Decker, and E.A. Duke (eds), Wildlife and Society: The Science of Human Dimensions, pp. 145-160. Island Press, Washington, D.C.

Nie, M. 2008. The Governance of Western Public Lands: Mapping its Present and Future. University Press of Kansas, Lawrence.

Nielson, S.E., M.S. Boyce, and G.B. Stenhouse. 2004. Grizzly bears and forestry: I. Selection of clearcuts in west-central Alberta, Canada. *Forest Ecology and Management* 1: 51-65.

Nielson, S.E., G.B. Stenhouse, H.L. Beyer, F. Huettmann, and M.S. Boyce. 2008. Can natural disturbance-based forestry rescue a declining population of grizzly bears? *Biological Conservation* 141: 2193-2207.

Northrop, J.M., J.Pitt, T.B. Muhly, G.B. Stenhouse, M. Musiani, and M.S. Boyce. 2012. Vehicle traffic shapes grizzly bear behaviour on multiple-use landscape. *Journal of Applied Ecology* 49(5): 1159-1167.

Noss, R.F., C. Carroll, K. Vance-Borland, and G. Wuerthner. 2002. A multicriteria assessment of the irreplaceability and vulnerability of sites in the Greater Yellowstone Ecosystem. *Conservation Biology* 16: 895-908.

Noss, R.F. and A.Y. Cooperrider. 1994. Saving Nature’s Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D.C.

Noss, R.F., M.A. O’Connell and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation under the Endangered Species Act. Island Press, Washington, D.C.

Noss, R. F. and K. M. Daly. 2006. Incorporating connectivity into broad-scale conservation planning. In K.R. Crooks and M. Sanjayan (eds), Connectivity Conservation, pp. 587-619. Cambridge University Press, Cambridge, UK.

Noss, R.F., H.B. Quigley, M.G. Hornocker, T. Merrill, and P.C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology* 10 (4): 949-963.

Nunney, L. and K. Campbell. 1993. Assessing minimum viable population size: demography meets population genetics. *Trends in Ecology and Evolution* 8 (7): 234-239.

Nunney, L. and D.R. Elam. 1994. Estimating effective population size of conserved populations. *Conservation Biology* 8(1): 175-184.

Opdam, P.E., E. Steingröver and S. van Rooij. 2001. Ecological networks: a spatial concept for multi-actor planning of sustainable landscapes. *Landscape and Urban Planning* 75:322-332.

Paetkau, D., L.P. Waits, P.L. Clarkson, L. Craighead, and C. Strobeck. 1997. An empirical evaluation of genetic distance statistics using microsatellite data from bear (Ursidae) populations. *Genetics* 147: 1943-1957.

Pease, C. M. and D. J. Mattson. 1999. Demography of the Yellowstone grizzly bears. *Ecology* 80 (3): 957-975.

Peterson, D. 2000. Grizzly bears as a filter for human use management in Canadian Rocky Mountain national parks. In S.F. McCool and D.N. Cole (eds), Wilderness Science in a Time of Change Conference, Vol. 5, pp. 354-361. USDA Forest Service Proceedings RMRS-P-15, VOL-5, Rocky Mountain Field Station, US Forest Service, Ogden, Utah.

Picton, H. 1986. A possible link between Yellowstone and Glacier grizzly bear populations. *International Conference on Bear Research and Management* 6: 7-10.

Primm, S. and K. Murray. 2005. Grizzly bear recovery: living with success? In T.W. Clark, M. B. Rutherford, and D. Casey (eds), Coexisting with Large Carnivores: Lessons from the Greater Yellowstone, pp. 99-137. Island Press, Washington, D.C.

Primm, S.A. and S.M. Wilson. 2004. Re-connecting grizzly bear populations: Prospects for participatory projects. *Ursus* 15 (1): 104-114.

Pritchard, J.A. 1999. Preserving Yellowstone's Natural Conditions: Science and the Perception of Nature. University of Nebraska Press, Lincoln.

Proctor, M.F., B.N. McLellan, C. Strobeck and R.M.R. Barclay. 2005. Genetic analysis reveals demographic fragmentation of grizzly bears yielding vulnerably small populations. *Proceedings of the Royal Society B* 272 doi:10.1098/rspb.2005.3246.

Proctor, M.F. et al. 2012. Population fragmentation and inter-ecosystem movements of grizzly bears in Western Canada and the Northern United States. *Wildlife Monographs* 180: 1-46.

Pulliam, H.R. 1988. Sources, sinks, and population regulation. *American Naturalist* 132: 652-661.

Pulliam, H.R. and B.J. Danielson. 1991. Sources, sinks, and habitat selection: a landscape perspective on population dynamics. *American Naturalist* 137: S50-S66.

Reed, D.H., J.J. O'Grady, B.W. Brook, J.D. Ballou and R. Frankham. 2003. Estimates of minimum viable population sizes of vertebrates and factors influencing those estimates. *Biological Conservation* 113: 23-34.

Reed, R.A., J. Johnson-Barnard and W.L. Baker. 1996. Contribution of roads to forest fragmentation in the Rocky Mountains. *Conservation Biology* 10(4): 1098-1106.

Riley, S.P.D., J.P. Pollinger, R.M. Sauvajot, E.C. York, C. Bromley, T.K. Fuller, and R.K. Wayne. 2006. A southern California freeway is a physical and social barrier to gene flow in carnivores. *Molecular Ecology* 15: 1733-1741.

Roy, J., C. Servheen, W. Kasworm, and J. Waller. 2007. Restoration of grizzly bears to the Bitterroot Wilderness: the EIS approach. In D.S. Maehr, R.F. Noss and J.L. Larkin (eds), Large Mammal Restoration: Ecological and Sociological Challenges in the 21st Century, pp. 205-224. Island Press, Washington, D.C.

Rutherford, M.B. and T.W. Clark. 2005. Coexisting with large carnivores: lessons from Greater Yellowstone. In T.W. Clark, M.B. Rutherford and D. Casey (eds), Coexisting with Large Carnivores: Lessons from Greater Yellowstone, pp. 254-270. Island Press, Washington, D.C.

Sanderson, E.W., G.A.B. Da Fonseca, C. Galindo-Leal, K. Alger, V.H. Inchausty, K. Morrison, and A. Rylands. 2006. Escaping the minimalist trap: design and implementation of large-scale biodiversity corridors. In K. R. Crooks and M. Sanjayan (eds), Connectivity Conservation, pp. 620-648. Cambridge University Press, UK.

Saunders, D.A., J. L. Craig, and E. M. Mattiske (eds) 1995. Nature Conservation Vol. 4, The Role of Networks. Surrey Beatty and Sons, Chipping Norton, NSW, Australia.

Sawyer, S.C., C.W. Epps and J.S. Brashares. 2011. Placing linkages among fragmented habitats: do least-cost models reflect how animals use landscapes? *Journal of Applied Ecology* 48: 668-678.

Schwartz, C.C. 2007. Case 3. The paradigm of grizzly bear restoration in North America. In D.S. Maehr, R.F. Noss and J.L. Larkin (eds), Large Mammal Restoration: Ecological and Sociological Challenges of the 21st Century, pp. 225-229. Island Press, Washington, D.C.

Schwartz, C.C. and K. Gunther. 2006. Grizzly bear management in Yellowstone National Park: the heart of recovery in the Yellowstone ecosystem. In D.R. McCullough, K. Kaji and M. Yamanaka (eds), Wildlife in Shiretoko and Yellowstone National Parks: Lessons in Wildlife Conservation from Two World Heritage Sites, pp. 232-238. Shiretoko Nature Foundation, Hokaido, Japan. Available at: http://www.nrmsc.usgs.gov/files/norock/products/Schwartz_Gunther.pdf Accessed May 2011.

Schwartz, C.C., M. M. Haroldson, K.A. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990-2000. *Ursus* 13: 203-212.

Schwartz, C.C., M.A. Haroldson, K.A. Gunther and D. Moody. 2006a. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. *Ursus* 17: 63-66.

Schwartz, C.C., R.B. Harris and M.A. Haroldson. 2006b. Impacts of spatial and environmental heterogeneity on grizzly bear demographics in the Greater Yellowstone Ecosystem: a source-sink dynamic with management consequences. In C.C. Schwartz, M.A. Haroldson, G.C. White, R.B. Harris, S. Cherry, K.A. Keating, D. Moody, and C. Servheen, authors. Temporal, spatial, and environmental influences on the demographics of grizzly bears in the Greater Yellowstone Ecosystem, pp. 57-67. *Wildlife Monographs* No. 161.

Schwartz, C.C., M.A. Haroldson, and G.C. White. 2010a. Hazards affecting grizzly bear survival in the Greater Yellowstone Ecosystem. *Journal of Wildlife Management* 74(4): 654-667.

Schwartz, C.C., M.A. Haroldson and K.A. Gunther. 2010b. Understanding Grizzlies: Science of the Interagency Grizzly Bear Study Team, pp. 50-63. Rowan and Littlefield, Lanham, Maryland.

Schwartz, C. C., P.H. Gude, L. Landenburger, M.A. Haroldson, and S. Podruzny. 2012. Impacts of rural development on Yellowstone wildlife: linking grizzly bear *Ursus arctos* demographics with projected residential growth. *Wildlife Biology* 18 (3): 246-257.

Servheen, C. 1993. Grizzly Bear Recovery Plan. U.S. Fish and Wildlife Service, Missoula, Montana.

Servheen, C., S. Herrero, and B. Peyton. 1999. Bears: Status, Survey and Conservation Action Plan. IUCN, Morges, Switzerland.

Servheen, C., J. S. Walker, and P. Sanderstrom. 2001. Identification and management of linkage zones for grizzly bears between the large blocks of public land in the Northern Rocky Mountains. In Proceedings of International Conference on Ecology and Transportation 161-179. Center for Transportation and the Environment, North Carolina State University, Raleigh, North Carolina. Available at: http://wwwigbconline.org/ServheenWallerSandstrom2003.pdf Accessed July 2011.

Servheen, C. and R. Shoemaker. 2003. A sampling of wildlife use in relation to structure variables for bridges and culverts under I-90 between Alberton and St. Regis, Montana. In: C.L. Irwin, P. Garrett and K.P. McDermott (eds), Proceedings of the 2003 International Conference on Ecology and Transportation, pp. 331-341. North Carolina

State University, Raleigh.   Available at: http://escholarship.org/uc/item/4tt86932
Accessed February 2013.

Servheen et al. 2004. Yellowstone Mortality and Conflicts Reduction Report. Presented to the Yellowstone Subcommittee (YES), April 7, 2004.

Shafer, C.L. 1990. Nature Reserves: Island Theory and Conservation Practice. Smithsonian Institution Press, Washington, D.C.

Shafer, C.L. 1997. Terrestrial nature reserve design at the urban/rural interface. In M.W. Schwartz (ed), Conservation in Highly Fragmented Landscapes, pp. 345-378. Chapman and Hall, New York.

Shugart, H.H. 1984. A Theory of Forest Dynamics. Springer-Verlag, New York.

Singleton, P.H. and J.F. Lehmkuhl. 2001. Using weighted distance and least-cost corridor analysis to evaluate regional-scale carnivore habitat connectivity in Washington. In C.L. Irwin and K.P. McDermott (eds.), Proceedings of the 2001 International Conference on Ecology and Transportation. Center for Transportation and Environment, North Carolina State University, Raleigh, North Carolina
http://wwwescholarship.org/uc/item/1526536d6

Smith, R.R. 2003. Unbearable? Bitterroot grizzly bear reintroduction and the George W. Bush administration. *Golden Gate Law Review* 33(3): 385-417.

Sutton, A, and M. Sutton. 1972. Yellowstone: A Century of the Wilderness Idea. Macmillan, New York.

Thomas, C.D. 1990. What do real population dynamics tell us about minimum viable population sizes. *Conservation Biology* 4: 342-327.

Thompson, M.R. 2004. Keeping the door open: protecting biological corridors with existing federal statutes. *Environmental Law* 34: 703-742.

United Nations Educational, Scientific and Cultural Organization. 2011. State Party's Report on the State of Conservation of its Property
Inscribed on the World Heritage List. Available at:
www.parkplanning.nps.gov/document.cfm?park ID=111& projectID=39938&document ID=44881 Accesssed January 2013.

US Fish and Wildlife Service. 1993. Grizzly Bear Recovery Plan. US Fish and Wildlife Service, Missoula, Montana, 181 pp.

US Fish and Wildlife Service. 2000. Grizzly Bear Recovery in the Bitterroot. Final Environmental Impact Statement March 2000. Available at: http://www.fws.gov/mountain-prairie/species/mammals/grizzly/FEIS2000/index.htm Accessed December 2011.

US Fish and Wildlife Service. 2007a. Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife; 90-Day Finding on a Petition To List as Endangered the Yellowstone Distinct Population Segment of Grizzly Bears. *Federal Register*, Vol. 72, No. 60, March 29, 2007, 14866-14938.

US Fish and Wildlife Service. 2007b. Questions and Answers: Removal of the Yellowstone Ecosystem Population of Grizzly Bears from the List of Threatened and Endangered Species.
Available at: http://www.fws.gov/mountain-prairie/species/mammals/grizzly/delstingQandA.pdf Accessed October 2011.

US Fish and Wildlife Service. 2011. Grizzly Bears (*Ursus arctos horribilis*) 5-Year Review: Summary and Evaluation. Available at: http://www.fws/mountain-prairie/species/mammals/grizzly/Final%205YearReview_August%202011.pdf. Accessed May 2012.

US Forest Service. 2004. Forest Plan Amendments for Grizzly Bear Conservation for the Greater Yellowstone Area National Forests Draft Environmental Impact Statement. USDA Forest Service, Cody, Wyoming.

US Forest Service. 2006. Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests. Final Environmental Impact Statement. US Forest Service, Department of Agriculture, Washington, D.C.

Walker, R. and L. Craighead. 1997. Analyzing wildlife movement corridors in Montana using GIS. Available at: http://www.proceedings.csri.com/library/userconf/proc97/proc97/to 150/pap116/p116.htm. Accessed February 2011.

Waller, J.S. and C. Servheen. 2005. Effects of transportation infrastructure on grizzly bears in Northwestern Montana. *Journal of Wildlife Management* 69(3): 985-1000.

Warboys, G.L., W.L. Francis and M. Lockwood. 2010. Connectivity Conservation: A Global Guide. Earthscan, London.

Weaver, J.L., P.C. Paquet, and L.F. Ruggiero. 1996. Resilience and conservation of large carnivores in the Rocky Mountains. *Conservation Biology* 10 (4): 964-976.

Wilkinson, T. 1998. Grizzly fate. *National Parks* Nov/Dec: 30-33.

Wilkinson, T. 1999. The Forest Service sets off into uncharted territory. *High Country News*, November 8. Available at: http://lobby.la.psu.edu/068_Roads_in_National_Forests/ Organizational_Statements/BRC/... Accessed September 2010.

Wilkosz, J.M. 2010. Linking the Landscape: Legal and Policy Tools to Promote Connected Habitat in Fragmented Landscapes. MS Thesis. University of Illinois, Urban-Champaign.

Willcox, L. 1998. Roads kill: Grizzly bears and the effects of human access. Available at: http://www.wildlandscpr.org/node/268. Accessed September 2010.

Willcox, L. 2004. An Alternative Path to Grizzly Bear Recovery in the Lower 48 States. Natural Resources Defense Council, Washington, D.C. Available at: www.nrdc.org/wildlife/animals/grizzlyrecovery/grizzlyrecovery.pdf. Accessed September 2010.

Willcox, L. 2009. Grizzly bears: taking stock of 2009, and a bear prayer for 2010. Available at: http://switchboard.nrdc.org/blogs/1willcox/grizzly_bears_taking_stock_of. html. Accessed December 2010.

Willcox, L. 2011. Bear-ly scientific: why Yellowstone grizzly policy runs counter to Obama's commitment to scientific integrity. Available at: http://switchboard.nrdc.org/blogs/lwillcox/bear-ly_scientific_why_yellows.html Accessed August 2011.

Yagerman, K.S. 1990. Protecting critical habitat under the federal Endangered Species Act. *Environmental Law* 20: 811-855.

CHAPTER 10: OFF-ROAD VEHICLES

"The fourth greatest issue [for U.S. national forests] is unmanaged recreation."

Dale Bosworth, Chief, US Forest Service 2003

Outdoor Recreation

Approximately 16 million visits occur in the Greater Yellowstone Ecosystem (GYE) each year, and 90% is between April and December (Greater Yellowstone Coordinating Committee Interagency Working Group 2006). According to Clark and Minta (1994), the GYE is a test case as to whether the rival interests of preservation and some forms of recreation can both be accommodated. Off-road vehicle (ORV) use is one of the most difficult recreational uses to blend with preservation. ORVs in the national forests are growing but are dwarfed by activities like hiking or walking. The Targhee, Gallatin, Bridger–Teton and Shoshone National Forests provide 84% of the GYE's "semi-primitive motorized [recreation] opportunities." In the Targhee National Forest alone, 65% of its land is set aside for motorized recreation (Greater Yellowstone Coordinating Committee Interagency Working Group 2006). Some roads in the Targhee are specified for "four-wheelers" and others are for trucks (Figures 54). Despite the George W. Bush administration efforts to open national parks like Yellowstone to general ORV use (Sellars 1997/2009: epilogue), today that park only has to contend with winter snowmobiles.

Figure 54. The road in the upper picture is for trucks. The road in the lower picture is for "4-wheelers" and not trucks (Photos by the author August 2010).

ORV Mandates

The use of ORVs on federal lands is governed by two Executive Orders. Executive Order 11644 (Off-Road Vehicles on Public Lands- February 8, 1977) defined ORVs as "any motorized vehicle designed for or capable of cross-country travel in or immediately over land, water, snow, ice, marsh, swampland, or other natural terrain." The Order was designed "to ensure that use of off-road vehicles on public lands will be controlled and directed so as to protect the resources...to promote the safety of all users... and to minimize conflicts among the various uses of those lands." The follow–up Executive Order 11989 (Off-Road Vehicles On Public Lands-May 24, 1977) specified closure of land if ORVs caused "considerable adverse effects." By 1995, the U.S. government investigative body determined that agency compliance with these executive orders was variable (Government Accounting Office 1995).

ORV Impacts

ORVs are just one way outdoor recreation activity can negatively impact wild land (Knight and Gutzwiller 1995). For example, both lizard species number and abundance on California sand dunes (Luckenbach and Bury 1983) and coastal bird and turtle breeding success on Atlantic beaches (Melvin et al. 1994, Hosier et al. 1981) were diminished by ORV traffic. ORV impacts reportedly include soil erosion and compaction, air and water pollution, increased stream sedimentation, the spread of invasive plants, vegetation damage and disturbance to wildlife (Ouren et al. 2007). These vehicles are noisy (Havlick 2002). Higgins and Knight (2008) provide a readable account for a general audience about ORVs in the Gallatin National Forest. Roads (e.g., asphalt, gravel and dirt) and ORV lanes may differ in composition and size; however, lessons learned from general road use might be heeded when looking at ORV use. More information exists for the ecological impacts of roads (e.g., Forman and Alexander 1998, Trombulak and Frissell 2000, Spellerberg 1998, Gucinski et al. 2001) than for the specific impacts of ORVs. Snowmobiles, one type of ORV, will not be treated here (see Yochim 1998, Dustin and Schneider 2005).

NPS Mandates and Use

The Yellowstone Act of 1872 (30 U.S.C. §§ 21-33) specified that the Secretary of the Interior would provide for the "preservation, from injury and spoliation, all of the timber, mineral deposits, natural curiosities, or wonders, within the park, and their retention in their natural condition." The NPS Organic Act of 1916 (16 U.S.C. §§ 1-18f) said that the purpose of the parks was to "conserve the scenery and the natural and historic objects and the wild life therein an to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." This 1916 purpose was reinforced by the NPS General Authorities Act of 1970 (16 U.S.C.

§§1a-1 et seq.) and the Redwoods National Park Expansion Act of 1978 (16 U.S.C. §§1, 1a-1)

The 1916 *unimpaired* specification is the foundational law for U.S. national park management. Whether a resource is being impaired is left to the professional judgment of the park Superintendent (National Park Service 2006: 11). Impacts are not equivalent to impairments (National Park Service 2006: 12). The long perceived dual mission the NPS, preservation and public enjoyment, was further clarified in this policy manual: “when there is a conflict between conserving resources and values and providing for the enjoyment of them, conservation is predominant” (National Park Service 2006: 11).

ORV routes in the National Park System may only be designated in national recreation areas, national seashores, national lakeshores, and national preserves by special regulation. Only 12 NPS units are open to ORVs (Calvert et al. 2011). “Recreational activities and other uses that would impair a park’s resources, values, or purposes cannot be allowed” (National Park Service 2006: 98). Furthermore, “Service-wide regulations addressing aircraft use, off-road bicycling, hang gliding, off-road vehicle use, personal watercraft, and snowmobiling require that special, park-specific regulations be developed before these uses may be allowed in parks” (National Park Service 2006: 101). Snowmobile use in Alaska is governed by the two mentioned executive orders and by the Alaska National Interest Land Conservation Act of 1980 (16 U.S.C. 410hh-3233, 43 U.S.C. 1602-1784).

USFS Mandates and Use

The key legislation governing ORV use in our national forests includes the Multiple-Use Sustained Yield Act of 1960 (16 U.S.C. 528 et seq.), the Forest and Rangeland Renewable Resources Research Act of 1974 (16 U.S.C. 1601 et seq.) and the National Forest Management Act of 1976 (16 U.S.C. 472a et seq.). The USFS has been criticized in the past for not adequately addressing ORV impacts in their ORV management documents (Bleich 1988).

The agency allows ORV use on approximately 300,000 miles of roads and 25% of its 123,000 miles of trails. The agency estimates there are another 60,000 miles of illegal ORV trails on their lands (Yankoviak 2000). Other researchers estimated 96, 500 km of “non-system roads” or “ghost roads” that are not part of the USFS road inventory (reference in Forman et al. 2003: 40).

Recent USFS rules for ORVs are found at *Federal Register* Vol. 70, No. 216, Wed. November 9, 2005 at 68264. It specifies that ORV travel is restricted to designated routes and traffic management is at the discretion of the individual Forest Supervisor. These 2005 regulations did not cover snowmobiles. The 2005 policy is mostly positive but one observer pointed out downsides (Yankoviak 2000). Specifics can be found at http://www.fs.fed.us/recreation/programs/ohv. For some history about USFS and BLM managing ORVs, consult Adams and McCool (2009).

NGOs perceived that ORVs were disturbing grizzly bears on the Gallatin National Forest and threatened to sue the USFS (Anonymous 1999). The Gallatin National Forest produced an ORV plan (US Forest Service 2005). As a result of the new 2005 policy, the Forest will close the following areas, once open to ORVs: 50% of its roads, 40% of its trails, and another 320,000 acres to snowmobiles (Knight 2008) (Figure 55).

Figure 55. Four-wheeler in the Gallatin National Forest in 2003 (From Higgins and Knight 2008).

Road Reduction

From 1986-2002 there has been a net reduction of 1,000 miles of roads in the six GYE national forests. These roads are both inside and outside the PCA (US Forest Service 2006, cited in US Fish and Wildlife Service (2007: 14901). This *net reduction* still included 400 miles of newly constructed roads (US Forest Service 2006: 81). This action was responsible for a nearly 9 % increase in secure habitat within the PCA and a 3 % reduction in secure habitat outside the PCA (US Forest Service 2006: 339). Inside the PCA, there was an average reduction of roads at rate of 59.9 km per year over the same period (US Forest Service 2006, cited in US Fish and Wildlife Service 2007:14908). Outside the PCA, there was an average reduction of 40.5 miles per year over the same time frame (US Forest Service 2006: 200). There are more opportunities to decommission roads outside of the PCA (US Forest Service 2006: 334). “Grizzly bear habitat security is primarily achieved by managing motorized access...” (US Fish and Wildlife Service (2011: 33).

REFERENCES

Adams, J.C. and S.F. McCool. 2009. Finite recreation opportunities: the Forest Service, the Bureau of Land Management, and off-road vehicle management. *Natural Resources Journal* 49: 45-116.

Anonymous. 1999. Unregulated Off Road Vehicle Use Hammering Grizzly Bear Habitat on the Gallatin National Forest. Available at: http://earthjustice.org/news/press/1999/unregulated-off-road-vehicle-use-hammering-grizzly-bear-habitat-on-the-gallatin-national-forest Accessed May 2012.

Bleich, J.L. 1988. Chrome on the range: off-road vehicles on public lands. *Ecology* Law *Quarterly* 15: 159-188.

Bosworth, D. 2003. We need a new national debate. Available at: http://www.fs.fed.us/news/2003/speeches/07/bosworth.shtml Accessed May 2012.

Calvert, K., C.H. Hardy and R.W. Gorte. 2011. Recreation on Federal Lands. Congressional Research Service RL 33525.

Clark, T.W. and S.C. Minta. 1994. Greater Yellowstone's Future: Prospects for Ecosystem Science, Management, and Policy. Homestead Publishing, Moose, Wyoming.

Dustin, D.L. and I.E. Schneider. 2005. The science of politics/the politics of science: examining the snowmobile controversy in Yellowstone National Park. *Environmental Management* 34(6): 761-767.

Forman. R.T.T. and L. E. Alexander. 1998. Roads and their major ecological effects. *Annual Review of Ecology and Systematics* 8: 629-644.

Forman, R.T.T. 2003 et al. Road Ecology: Science and Solutions. Island Press, Washington, D.C.

Government Accounting Office. 1995. Off-Road Vehicle Use on Federal Lands. GAO/RCED-95-209.

Greater Yellowstone Coordinating Committee Interagency Working Group. 2006. Recreation in the Greater Yellowstone Area Interagency Report. Available at: http://fedgycc.org/Recreationin theGreaterYellowstoneArea.pdf Accessed June 2012.

Gucinski, H., M.H. Brooks, M.J. Furniss, and R.R. Ziemer. 2001. Forest Roads: A Synthesis of Scientific Information. U.S. Department of Agriculture, U.S. Forest Service, General Technical Report PNW-GTR-509, Portland, Oregon.

Havlick, D.G. 2002. No Place Distant: Roads and Motorized Trails on America's Public Lands. Island Press, Washington, D.C.

Higgins, M. and P. Knight. 2008. Motorizing Yellowstone: An Investigative Report on the Off Road Vehicle Use within the Gallatin National Forest. Available at: http://www.sierracluborg/lewisandclark/atv.pdf Accessed May 2012.

Hosier, P., M. Kochlar and V. Thayer. 1981. Off-road vehicle and pedestrian track effects on the sea-approach of hatchling loggerhead turtles. *Environmental Conservation* 8(2): 158-161.

Knight, P. 2008. The Gallatin National Forest Travel Plan: Effective Plan or Paper Tiger? Available at: http://www.sierraclub.org/committees/recreationissues/downloads/2008-06-gallatinreport.pdf Accessed May 2012.

Knight, R.L. and K.J. Gutzwiller (eds) 1995. Wildlife and Recreationists: Coexistence through Management and Research. Island Press, Washington, D.C.

Luckenbach, R.A. and R.B. Bury. 1983. Effects of off-road vehicles on the biota of Algodones Dunes, Imperial County, California. *Journal of Applied Ecology* 20: 265-286.

Melvin, S.M., A Hecht and C.R. Griffin. 1994. Piping plover mortalities caused by off-road vehicles on Atlantic Coast beaches. *Wildlife Society Bulletin* 22: 409-414.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

Ouren, D.S., C. Haas, C.P. Melcher, S.C. Stewart, P.D. Ponds, P.D., N.R. Sexton, L. Burris, T. Fancher, and Z.N. Bowen. 2007. Environmental Effects of Off-Highway Vehicles on Bureau of Land Management Lands: A Literature Synthesis, Annotated Bibliographies, Extensive Bibliographies, and Internet Resources: U.S. Geological Survey, Open-File Report 2007-1353.

Sellars, R.W. 1997/2009. Preserving Nature in the National Parks: A History. Yale University Press, New Haven.

Spellerberg, I. F. 1998. Ecological effects of roads and traffic: a literature review. *Global Ecology and Biogeography Letters* 7(5): 317-333.

Trombulak, S.C. and C.A. Frisell. 2000. Review of ecological effects of roads on terrestrial and aquatic ecosystems. *Conservation Biology* 14(1): 18-30.

US Fish and Wildlife Service. 2007. Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife; 90-Day Finding on a Petition To List as Endangered the Yellowstone Distinct Population Segment of Grizzly Bears. *Federal Register*, Vol. 72, No. 60, March 29, 2007, 14866-14938.

US Forest Service. 2005. Gallatin National Forest Travel Management Plan, Gallatin, Madison, Park, Sweetgrass, and Carbon Counties, Montana. US Forest Service Report No. 050231.

US Forest Service. 2006. Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests. Final Environmental Impact Statement. US Forest Service, Department of Agriculture, Washington, D.C.

Yankoviak, B.M. 2000. Off-road Vehicle Policy on USDA National Forests: Evaluating User Conflicts and Travel Management. MS Thesis, James Madison University. Available at:
http://wwwitrr.umt.edu/research05/Brenda's %20 Thesis.pdf Accessed May 2012.

Yochim, M.J. 1998. The development of snowmobile policy in Yellowstone National Park. *Yellowstone Science* Spring: 1-10.

CHAPTER 11: CLIMATE CHANGE

"The climate change induced by anthropogenic releases of CO_2 is likely to be the most fascinating global geophysical experiment that man will ever conduct."

James Hansen et al. 1981: 966

Introduction

The predicted effects of future climate change on biological diversity were addressed two decades ago (Peters and Lovejoy 1992). One early prediction that flows from early Intergovernmental Panel on Climate Change (IPCC) modeling (e.g., Intergovernmental Panel on Climate Change 1996a, b) that pertain to Yellowstone and the GYE include species on mountains needing to move to higher elevations or shift to higher latitudes (MacArthur 1972). Nobody doubts that faunal distributions must move (Lawler et al. 2009). Faunal displacements of hundreds of kilometers seem a certainty (Williams et al. 2007). Less obvious predicted impacts by IPCC and others included altered biotic community composition, changes in the directions and timing of animal migrations, alterations in ecosystem processes (e.g., productivity, nutrient cycling), movement of animal diseases to higher latitudes (Colwell 1996), altered aquatic processes (e.g., circulation, stratification), altered water composition (e.g., salinity, siltation, nutrients) and more exotic species invasions (Vitousek et al. 1996). Today, the impacts of climate change are being documented in the field (Lovejoy and Hannah 2005). Range shifts have been observed in plants, birds, butterflies and amphibians. Phenology shifts include plants flowering sooner, birds laying eggs sooner, and amphibians mating earlier (references in Lawler et al. 2009). Other climate change impacts include loss of habitat, species extirpation and extinction and decoupling of coevolved systems (The Heinz Center 2008). Additional reviews of worldwide impacts are available (Root et al. 2003, Parmesan and Yoho 2003). For a solid overview geared for the educated generalist, see Committee on Ecological Impacts of Climate Change (2008).

Based on vegetation models of Canada's National Park System, Scott et al. (2002) projected that a new biome would occur in one-half of the park units. Models predict a 20% loss of mammalian species in U.S. national parks upon a doubling of atmospheric CO_2 plus an additional influx of new species (Burns et al. 2003). A useful popular summary exists for current and projected climate impacts to western national parks (Saunders et al. 2006a, b) and for Yellowstone National Park in particular (Saunders et al. 2011). The litany of climate change induced threats to U.S. national parks will not be replicated here. The most well know examples with a solid scientific foundation include the loss of glaciers from Glacier National Park, Montana (Hall and Fagre 2003), small mammal species moving upward in elevation (i.e., one-half of 28 species moved at least 500 meters upward in elevation) in Yosemite National Park, California (Moritz et al. 2008) and the predicted loss of Joshua trees (*Yucca brevifolia*) from Joshua Tree National Park, California (Cole et al. 2011).

Recent Projections

Since 1996, IPCC predictions have increased in reliability. By 2100, air temperatures will increase by 1.1 to 6.4C (2.0 to 11.5F) and sea levels will rise 0.18-0.59 m (0.6-1.9 ft) (Intergovernmental Panel on Climate Change 2007, cited in US Fish and Wildlife Service 2011). However, present atmospheric CO_2 levels are rising faster than the worst case scenario offered by the IPCC in 2007 (Lovejoy 2010). Currently Yellowstone National Park has two spatial climate subdivisions, "summer-wet" and "summer-dry" (Whitlock and Barlein 1993) with an altitudinal gradient superimposed on top of that latitudinal gradient. There is no unanimity between climate models on the spatial pattern of temperature increases in the western U.S. (Duffy et al. 2006, cited in US Fish and Wildlife Service 2011; Romme and Turner 1992). Under one scenario, the western United States will experience milder, wetter winters and warmer, drier summers accompanied by snowpack volume reduction and earlier spring melting (Leung et al. 2004, cited in US Fish and Wildlife Service 2011).

Predictions for Yellowstone

Some examples from the scientific literature about ongoing environmental changes in the GYE, as well as some predictions, follow:

- Amphibians in Yellowstone National Park are on the decline and wetlands will continue to disappear (McMenamin et al. 2008) (Figure 56).
-

Figure 56. The Columbia spotted frog (*Rana luteiventris*) is on the decline In YellowstoneNational Park (http://lawprofessors.typpad.com/environmental_law/physical_science/page/3/)

- There will be continued invasion of trees into meadows (Jakubos and Romme 1993).

- Using temperature modeling, Romme and Turner (1991) predicted a general decrease in Yellowstone's vegetation. With increasing temperature, they predicted an expected upward movement of the "upper timberline" but the lower timberline, on the other hand, could move upward under drier conditions or downward under wetter conditions.

- Ongoing outbreaks of mountain pine beetle (*Dendroctonus ponderosae*) in whitebark pine trees (*Pinus alticaulis*) are occurring at higher elevations (Logan et al. 2010) and climate change could exacerbate the tree's decline (Schneider and Root 2002). Pathogen outbreaks like the blister rust (*Cronartium ribicola*) fungus should continue to increase (Logan et al. 2003) (Figure 57).

Figure 57. Whitebark pine (red color) dying from blister rust during 2007 near Avalanche Peak in Yellowstone National Park. The Peak is located on the eastern boundary of the park in the Absaroka Range (http://trib.com/news/state-and-regional/article-1f7f10b7-bf0c-51d3-a68e-0b5bld4d04af.html).

- Fire frequency should change (Westerling et al. 2011). The current fire regime has reportedly been in place for only 2000 years (Millspaugh et al. 2000). This will cause more sediment transport into rivers (Meyer et al. 1992).

- Earlier spring snowmelt could affect the distribution of species like wolverine (*Gulo gulo*) (McKelvey et al. 2011).

Parks at Risk

Which parks are most at risk remains a matter of inference. However, early IPCC documents allowed some generalizations (from Shafer 1999). Climate change effects will be seen at terrestrial parks for:

- Parks with mountains.
- Parks with interior wetlands.
- Parks with abrupt land use changes outside their boundaries (Peters and Darling 1985).
- Parks which harbor rare species with restricted habitats (Peters and Lovejoy 1992).
- Parks with species at their southern latitudinal limits (in the northern hemisphere).
- Parks without corridors between reserves (Graham 1988)
- Parks without continental scale corridors (Hunter et al. 1988).

Recommendations: Planning and Management

There are no simple solutions. Planning for climate change should have a time frame of 50-100 years (Root and Schneider 1993). It has long been questioned whether many species could migrate fast enough to keep up with climate change even if usable habitat was readily available (e.g., Ritchie and MacDonald 1986). Even bird distribution is lagging behind as temperature increases (Devictor et al. 2008). Early guidance for protected areas faced with climate change was attempted (e.g., Hansen et al. 1989, Parsons 1991, Halpin 1997). Based on a review of the literature, Shafer (1994) pulled together a few recommendations:

- establish corridors between reserves
- allow for continental-scale movement pathways, especially poleward
- create larger reserves
- create replicates of reserves
- increase habitat heterogeneity, especially in terms of altitude
- establish buffer zones/natural habitat adjacent to reserves
- establish stepping-stone reserves
- create reserves closer to poleward species limits

Some additional useful generalities have been reemphasized like “aligning reserves along latitudinal or elevational gradients” (Lawler 2009: 93). Others include maximizing resilience, maintaining ecosystem function, increasing landscape permeability and reducing non-climate stressors (The Heinz Center 2008). Mawdsley et al. (2009) describe 16 adaptation strategies that include the above and others like “managing the matrix” and translocation. Joyce et al. (2009:1026) argued “No single adaptation approach will work for all NFs [national forests] and NGs [national grasslands]” which requires a “toolbox” of approaches including translocation, increasing redundancy and buffers, increasing genetic diversity, managing for asynchrony, establishing neo-native plantations and restoration sites and connecting landscapes. Hodgden et al. (2009) argued that current support for the connectivity/corridor strategy should not result in our overlooking the more basic need to increase habitat quantity and quality. They also question how effective habitat connectivity will be in mitigating the effect of climate change. Doerr et al. (2011) disagree. Some scientists believe our present state of knowledge will not allow us to predict the outcome of climate change *and* habitat fragmentation on species and communities (Opdam and Wascher 2004). Travis (2003) thinks climate change will exacerbate the negative influence of habitat fragmentation.

What may be needed is what Van Dyke (2008:142) calls “Climate Change Integrated Conservation Strategies.” But such strategies, whatever they are, remain untested. “At present, many suggested natural area management responses are only vaguely defined and have yet to be fully tested” (Halpin 1997: 828). For example, almost all experiments on corridor effectiveness focused on corridors less than 150 m long (Beier and Gregory 2012). Lawler (2009:94) said “Managers already have many tools necessary to address climate change."   But they lack some critical ones. In the United States, they lack the political clout to implement land use planning outside their reserve boundaries (Chapter 5). More specifically, were they to implement land using planning outside reserve boundaries; they would aggravate the desires of many private land holders. Hannah et al. (2002) recommended five valid conservation responses for protected areas due to climate change.

Focusing on wide-ranging species like the grizzly bear was once thought to serve as an umbrella for some other species (Mills 2007). The umbrella concept actually has little empirical support (Roberge and Angelstam 2004). A grizzly bear umbrella will not subsume every other vertebrate species like reptiles (Noss et al. 1996). Although they could not identify specific criteria for an umbrella species, Branton and Richardson (2011) found that areas supporting a purported umbrella species had more species than comparative areas. Brock and Atkinson (2013) proposed an exhaustive method to identify a *suite* of species that will serve as an "ecosystem umbrella." Still, many have relied on the umbrella species idea for planning guidance (Craighead 2001). This study focuses on the grizzly bear because it is threatened, wide-ranging, has flagship status, and might serve as an umbrella for some other mammals.

In terms of climate change, there has been debate as to whether a species-based approach to corridor creation is feasible (Hulme 2005). "Because responses to climate change will be species specific, we will likely discover few generalities that will allow us to develop widely applicable strategies" (Lawler 2009: 92-93). Nick Haddad reportedly supports the umbrella species concept of corridor establishment to mitigate climate change (Martin 2012). In terms of addressing climate change, this author agrees with the following statement: "Connectivity conservation areas appear to be our best comparatively reasonable hope for protecting biodiversity long term" (Chester and Hilty 2010: 31).

Using the graphic example of Robert Peters (1992:22), "Few animals or plants would be able to cross Los Angeles on the way to new habitat." "For many protected areas, managing and reducing the effects of matrix degradation will become increasingly important for medium-to long-term conservation of biodiversity" (Gustavo et al. 2005:346-347). This comment was in reference to climate change. The following observation made nine years earlier was *not* focused on climate change: "The degree of security of biodiversity within the [United States protected] areas will depend almost entirely on the degree of management of the surrounding contextual landscape" (Harris et al. 1996: 178). Therefore, for both climate and non-climate rationale, managing the matrix is key.

Grizzly Bears

The GYE grizzly bear is a species returned to protection under the Endangered Species Act of 1973 (P.L. 93-205.16 U.S.C. 1531 et seq.; 87 Stat 884, as amended) for a climate change related reason. That is, a Federal Court restored the GYE grizzly bear's “threatened” status in 2009 because one key bear food, nuts of the whitebark pine tree, were in jeopardy in part from atmospheric warming (*Greater Yellowstone Coalition, Inc. vs. Christopher Servheen et al. United States District Court for the District of Montana, Missoula Division, CV 07-134-M-DWM (2009).* However, atmospheric warming was been judged by some scientists (Servheen and Cross 2010) to not affect United States and Canada grizzly bear habitat enough to place the population in jeopardy. Servheen and Cross do predict a decrease in snow pack level, differences in denning times, changes in the amount and distribution of food, and shifts in fire regimes. The frequency and intensity of fire could certainly increase with summer droughts (Nitschke and Innes 2008).

Aune and Kasworm (1989) indicate that grizzly bear home range could change in size each year with climate change. According to Heller and Zavaleta (2009), the climate mitigation option mentioned most often is habitat connectivity/corridors. Enhancing connectivity is a better strategy than assisted migration (Loss et al. 2010, Krosby et al. 2010). “In most areas, there are few options for large connected habitats, and those necessary for large predators will be, by default, those few large natural or semi-natural areas that remain connected” (Gustavo et al. 2005: 346). Participants at one workshop agreed that habitat connectivity should be the key management strategy to mitigate the impact of climate change on the ecosystems in and around Yellowstone National Park (Miller et al. 2008). As Hannah and Hansen (2005: 492, cited in Van Dyke 2008) said, “One of the best strategies is to maximize biodiversity-friendly land use in the matrix, including the option to revert human-oriented land uses to natural habitat." The ongoing Yellowstone to Yukon Initiative is what the GYE grizzly bears need in terms of threats from habitat fragmentation and climate change (Merrill 2005). A 2009 workshop about grizzly bears/wolverines and climate change in the Northern Rocky Mountains recommended that 1) grizzly bears be reintroduced to the Bitterroot Ecosystem, 2) habitat connectivity be increased, and 3) human tolerance for bears moving across the landscape be increased (Cross and Servheen 2009). This last task is easier said than done. The polar bear (*Ursus maritimus*) is now the symbol of climate change for the Arctic. As Wilkinson (2011) speculated, the grizzly bear may well become the new face of climate change in America (Wilkinson 2011).

What Does NPS Know and What is it Doing?

A review of the NPS Yellowstone Web site reveals an awareness of projected increases in snowmelt, changes in vegetation phenology, an increase in blister rust, changes in the frequency of fire and drought, amphibian decline, sagebrush steppe invasion by exotic species, changes in hydrologic regimes, and more. Many of these "projections" have already been documented in the field.

However, the early overarching NPS management strategy for dealing with climate change entails the continuance of the nationwide inventory and monitoring program (http://science.nature.nps.gov/im.pdf). This will certainly help document the landscape changes caused by atmospheric climate shifts. Important NPS initiatives include training park managers, holding technical workshops and conferences, educating visitors, facilitating research grants, publishing, offering internships, and Web site development. One of the first climate related plans was for energy conservation at park facilities to create "climate friendly" parks (http://www.nps.gov/sustaianability /parks/index.html). The *Climate Change Response Strategy 2010* says its general goals are "science, adaptation, mitigation and communication" (http://www.nature.nps.gov/climatechange/docs/NPS_CCRS.pdf.

Its specific stated goals are:

- Begin with Managers Needs
- Give Priority to Process as Well as Products
- Link information to Users
- Build Connections Across Disciplines
- Enhance Institutional Capacity
- Design for Learning

The above is well and good but little is said about actual *land use planning*.

At the Department of the Interior level, Secretary Salazar issued Secretarial Order 3289 on September 14, 2009. This *Climate Change Response Initiative* created a climate change response council, regional and national climate change centers, and "landscape conservation cooperatives" [http://www.doi.gov/whatwedo/climate/index.cfm]. This was also valuable.

By 2012, the NPS *Climate Change Action Plan* (NPS 2012) contained familiar sounding goals like enhancing literacy, engaging youth, developing planning frameworks, providing science to the parks, green parks implementation, fostering relationships, applying adaptation tools and strengthening communication. A highly significant statement in the document follows:

> "A well-managed network of parks and protected areas will require a comprehensive bold that sees beyond the current system of lands to identify and connect key features and processes through additional protection measures that include refugee, corridors and buffer zones."

In terms of its *Management Policies*, it only says collaboration is needed to create "cross-jurisdictional conservation plans to protect and restore connectivity..." (National Park Service 2006:16). What should the policy be for climate change? Is managing for some condition now a mute point? What about managing for processes instead of entities? "The focus is on system function rather than identity" (Bachelet 2013: 335). As Sinclair et al. (2006: 7) pointed out, having no management end point of course thwarts specifying specific management actions. Indeed, "climate change means that we can no longer manage for a historical reference point, but rather must manage for change" (Chester and Hilty 2012: 3). But can we manage for continual change? NPS may need to reexamine basic mandates (Tweed 2010). Indeed, the authors assigned to revisit the famous 1963 Leopold Report advised that the overriding NPS goal for the 21st century should be "steward NPS resources for continuous change that is not yet fully understood, in order to preserve ecological integrity" (Knowles et al. 2012: 11). The end point is blurry because there may be no known endpoint.

As Aldo Leopold (1942: 298) said "When we lay conservation in the lap of government, it will always do the things it can, even though they are not the things that most need doing." The lack of emphasis on regional land use planning that involves all potential partners (and not just voluntary planning absent incentives) is now almost absent in NPS and DOI documents examined. One NPS Website did mention land use planning as 13 among 18 key climate change initiatives (http://www.nature.nps.gov/climatechange/involved.cfm). However, few actual on-ground land use planning initiatives such as corridor creation, for habitat fragmentation *or* climate change, have been identified. Eckert (2012) mentions NPS involvement in corridor creation for the mountain lion (*Felis concolor*) in southern California. This activity was actually underway before climate change was in vogue in NPS. The agency has also been accused of not being forthright with the American public about the coming impacts of climate on parks (Cafaro 2012). NPS cannot "manage" away all the impending climate change impacts on U.S. national park biota (Cafaro 2012). This is why the current NPS *Management Policies* needs more than the following brief reference to climate change: “accelerated climate change may significantly alter park ecosystems” (NPS 2006: 53).

One truism warrants repetition: to deal with climate change, “It will be difficult, if not impossible, to maintain to maintain ecosystems and species at the landscape scale if private landowners to not engage in the effort” (Bachelet 2013:336). Like for corridors, climate change also demands another look at existing law. We may need different approaches to manage vast landscapes. Some legal scholars have already offered some ideas (Camacho 2010, Doremus 2010, Glickman 2009, Ruhl 2010, cited in Glickman and Cumming 2012).

REFERENCES

Aune, K., and W. Kasworm. 1989. Final Report East Front Grizzly Studies. Montana Department of Fish, Wildlife, and Parks.

Bachelet, D. 2013. Integrating conservation planning with projected trends in climate change. In F.L. Craighead and C.L. Convis, Jr. (eds), Conservation Planning: Shaping the Future, pp. 317-342. ESRI Press, Redlands, California.

Beier, P. and A.J. Gregory. 2012. Desperately seeking stable 50-year old landscapes with patches and long-wide corridors. *PloS Biology* 10(1): e1001253.doi:10: 371/journal.pbio. 1001253.

Brock, B.L. and E.C. Atkinson. 2013. Selecting species as targets for conservation planning. In: F. L. Craighead and C.L. Convis, Jr. (eds), Conservation Planning: Shaping the Future, pp. 123-147. ESRI Press, Redlands, California.

Burns, C.E., K.M. Johnston and O.J. Schmitz. 2003. Global climate change and mammalian species diversity in U.S. national parks. *Proceedings of the National Academy of Sciences, USA*: 100 (20): 11474-11477.

Cafaro, P. 2012. What should NPS tell visitors (and Congress) about climate change? *The George Wright Forum* 29(3): 287-298.

Chester, C.C. and J.A. Hilty. 2010. Connectivity science. In G.L. Worboys, W.L. Francis and M. Lockwood (eds), Connectivity Conservation Management: A Global Guide, pp. 22-31. Earthscan, London.

Cole, K.L., K. Ironside, J. Eischeld, G. Garfin, P. Duffy, and C. Tony. 2011. Past and ongoing shifts in Joshua tree distribution support future modeled climate change. *Ecological Applications* 21: 137-149.

Colwell, R.R. 1996. Global climate change and infectious disease: the cholera paradigm. *Science* 274: 2013-2055.

Comacho, A.E. 2010. Assisted migration: redefining nature and natural resource law under climate change. *Yale Journal on Regulation* 27:171-255.

Committee on Ecological Impacts of Climate Change. 2008. Ecological Impacts of Climate Change. National Research Council, National Academy of Science, National Academies Press, Washington, D.C.

Craighead, F. L. 2001. Craighead Environmental Research Institute. In C.L. Convis, Jr. (ed), Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism, pp. 42-51. ESRI Press, Redlands, California.

Cross, M.S. and C. Servheen. 2009. Climate Change Impacts on Wolverines and Grizzly Bears in the Northern U.S. Rockies: Strategies for Conservation. Final workshop Summary Report October 6-7, 2009. Wildlife Conservation Society and U.S. Fish and Wildlife Service, May 24, 2010.

Devictor, V., R. Julliard, D. Couvet and F. Jiguet. 2012. Birds are tracking climate warming, but not fast enough. *Proceedings of the Royal Society B* 275: 2743-2748.

Doerr, V.N., T. Barrett and E.D. Doerr. 2011. Connectivity, dispersal behaviour and conservation under climate change: a response to Hodgdon et al. *Journal of Applied Ecology* 48(1): 143-147.

Doremus, H. 2010. Adapting to climate change with law that bends without breaking. *San Diego Journal of Climate & Energy Law*: 46-85.

Duffy, P.B., R.W. Arritt, J. Coquard, W. Gutowski, J. Han, J. Iorio, J. Kim, L.R. Leung, J. Roads, and E. Zeledon. 2006. Simulations of present and future climates in the western United States with four nested regional climate models. *Journal of Climate* 19:873-895.

Eckert, G.E. 2012. Setting the stage-agency support for restoring corridors. *Restoration Ecology* 30(4): 271-273.

Glickman, R.L. 2009. Ecosystem resilience to disruptions linked to global climate change: an adaptive approach to federal land management. *Nebraska Law Review* 87: 833-892.

Glickman, R. and G.S. Cumming. 2012. Landscape level management of parks, refuges, and preserves for ecosystem resilience. In: C. Allen and A.S. Garmestani (eds), Resilience and the Law. Columbia University Press, New York.

Graham, R.W. 1988. The role of climatic change in the design of biological reserves: the paleoecological perspective for conservation biology. *Conservation Biology* 2: 391-394.

Gustavo, A., B. Da Fonseca, W. Sechrest and J. Oglethorpe. 2005. Managing the matrix. In T.E. Lovejoy and L. Hannah (eds), Climate Change and Biodiversity, pp. 346-358. Yale University Press, New Haven.

Hall, M.H.P. and D.R. Fagre. 2003. Modeled climate–induced glacier change in Glacier National Park, 1850-2100. *BioScience* 53: 131-140.

Halpin, P.N. 1997. Global climate change and natural-area protection: management responses and research directions. *Ecological Applications* 828-843.

Hannah, L. and L. Hansen. 2005. Designing landscapes and seascapes for change. In T.E. Lovejoy and L. Hannah (eds), Climate Change and Biodiversity, pp. 329-341. Yale University Press, New Haven.

Hannah, L., G.F. Midgley, T. Lovejoy, W.J. Bond, M. Bush, J.C. Lovett, D. Scott and F.I. Woodwards. 2002. Conservation of biodiversity in a changing climate. *Conservation Biology* 16(1): 264-268.

Hansen, J., D. Johnson, A. Lacis, S. Lebedeff, P. Lee, D. Rind, and G. Russell. 1981. Climate impact of increasing atmospheric carbon dioxide. *Science* 213 (4511): 957-966.

Hansen, J.S., G.P. Malanson, and M.P. Armstrong. 1989. Spatial constraints on the response of forest communities to climate change. In G.P. Malanson (ed), Natural Areas Facing Climate Change, pp. 1-23. SPB Academic BV, The Hague, The Netherlands.

Harris, L.D., T. Hoctor, D. Maehr and J. Sanderson. 1996. The role of networks and corridors in enhancing the value and protection of parks and equivalent areas. In R.G. Wright and L. Lemons (eds). National Parks and Protected Areas: Their Role in Environmental Protection, pp. 173-197. Blackwell Science, Cambridge, Massachusetts.

Heller, N.E. and E.S. Zavaleta. 2009. Biodiverity management in the face of climate change: a review of 22 years of recommendations. Biological Conservation 142: 14-32.

Hodgson, J.A., C.D. Thomas, B.A. Wintle and A. Moilanen. 2009. Climate change, connectivity and conservation decision making: back to basics. *Journal of Applied Ecology* 46(5): 964-969.

Hulme, P.E. 2005. Adapting to climate change: is there scope for ecological management in the face of a global threat? *Journal of Applied Ecology* 42: 784-794.

Hunter, M. Jr., G. Jacobson Jr. and T. Webb III. 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. *Conservation Biology* 2: 375-385.

Intergovernmental Panel of Climate Change. 1996a. J.T. Houghton, L.G. Meira Filho, B.A. Callander, N. Harris, and A. Maskell (eds), Climate Change 1995-The Science of Climate Change: Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, London.

Intergovernmental Panel of Climate Change. 1996b. R.T. Watson, M.C. Zinyowera and R.H. Moss (eds), Climate Change 1995-Impacts, Adaptation, and Mitigation of Climate Change: Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, London.

Intergovernmental Panel on Climate Change. 2007. Climate Change 2007: The Physical Science Basis. IPCC, Geneva, Switzerland.

Jakubos, B. and W.H. Romme. 1993. Invasion of subalpine meadows by lodgepole pine in Yellowstone National Park, Wyoming, USA. *Arctic and Alpine Research* 25 (4): 382-390.

Joyce, L.A., G.M. Blate, S.G. McNulty, C.I. Miller, S. Moser, R.P. Neilson, and D.L. Peterson. 2009. Managing for multiple resources under climate change: national forests. *Environmental Management* 44: 1022-1032.

Knowles, T. chairman. 2012. Revisiting Leopold: Resource Stewardship in the National Parks. A Report of the National Park System Advisory Board Science Committee. National Park Service, Department of the Interior, Washington, D.C.

Krosby, M., J. Tewksbury, N.M. Haddad and J. Hoekstra. 2010. Ecological connectivity for a changing climate. *Conservation Biology* 24 (6): 1686-1689.

Lawler, J. J., S.L. Shafer, D. White, P. Kareiva, E.P. Maurer, A.R. Blaustein, and P.J. Bartlein. 2009. Projected climate-induced faunal change in the Western Hemisphere. *Ecology* 90(3): 588-597.

Lawler, J. J. 2009. Climate change adaptation strategies for resource management and conservation planning. The Year in Ecology and Conservation Biology 2009: *Annals of the New York Academy of Sciences* 1162: 79-98.

Leopold, A. 1942. Land-use and democracy. In S.L. Flader and J.B. Callicott (eds), The River of the Mother of God and Other Essays, pp. 295-300. The University of Wisconsin Press. Madison.

Leung, L.R., Y. Qian, X. Bian, W.M. Washington, J. Han, and J.O. Roads. 2004. Mid-century ensemble regional climate change scenarios for the western United States. *Climate Change* 62:75-113.

Logan, J.A., W.M. Macfarlane and L. Willcox. 2010. Whitebark pine vulnerability to climate-driven mountain pine beetle disturbance in the Greater Yellowstone Ecosystem. *Ecological Applications* 20: 895-902.

Logan, J.A., J. Régnière and J.A. Powell. 2003. Assessing the impacts of global climate change warming on forest pest dynamics. *Frontiers in Ecology and the Environment* 1: 130-137.

Loss, S.R., L.A. Terwilliger and A.C. Peterson. 2010. Assisted colonization: integrating conservation strategies in the face of climate change. *Biological Conservation* 144(1): 92-100.

Lovejoy, T.E. and L. Hannah (eds.) 2005. Climate Change and Biodiversity. Yale University Press, New Haven.

Lovejoy, T.E. 2010. Climate change. In N.S. Sodhi and P.L. Erhrich (eds), Conservation Biology for All, pp. 153-162. Oxford University Press, UK Available at: http://www.conbio.org/publications/free-textbook Accessed September 2012.

MacArthur, R.H. 1972. Geographical Ecology. Harper and Row, New York.

Martin, L.J. 2012. Re-imagining conservation goals in light of global change. *Frontiers of Biogeography* 4(2) Available at: http://escholarship.org/uc/item/3tq3b36w

Mawdsley, J.R., R. O' Malley and D.S. Ojima. 2009. A review of climate-change adaptation strategies for wildlife management and biodiversity conservation. *Conservation Biology* 23 (5): 1080-1089.

McKelvey, K.S., J.P. Copeland, M.K. Schwartz, J.S. Littell, K.B. Aubry, J.R. Squires, S.A. Parks, M.M. Elsner, and G. S. Mauger. 2011. Climate change predicted to move wolverine distributions, connectivity, and dispersal corridors. *Ecological Applications* 21 (8): 2882-2897.

McMenamin, S.K., E.A. Hadley and C.K. Wright. 2008. Climatic change and wetland desiccation cause amphibian decline in Yellowstone National Park. *Proceedings of the National Academy of Sciences USA* 105 (44): 16988-16993.

Merrill, T. 2005. Grizzly Bear Conservation in the Yellowstone to Yukon Region. Yellowstone to Yukon Conservation Initiative, Technical Report #6 Available at: http://www.y2y.net Accessed June 2012.

Meyer, G.C., S.G. Wells, R.C. Balling, Jr., and A.J. Timothy Jull. 1992. Response of alluvial systems to fire and climate change in Yellowstone National Park. *Nature* 357: 147-150.

Miller, S., M. Cross and A. Scheag (eds) 2008. Anticipating Climate Change in Montana: A Report on the Workshop with Montana Department of Fish, Wildlife and Parks Focused on the Sagebrush-Steppe and Yellowstone River System. Available at: http://www.worldwide.org/what/wherewework/ngp/WWFBinaryitem12333.pdf Accessed June 2012.

Mills, L.S. 2007. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell, Malden, Massachusetts.

Millspaugh, S.H., C. Whitlock, and P.J. Bartlein. 2000. Variations in fire frequency and climate change over the past 17000 yr in central Yellowstone National Park. *Geology* 28 (3): 211-214.

Moritz, C., J.L. Patton, C.J. Conroy, J.L. Parra, G.C. White, and S.R. Beissinger. 2008. Impact of a century of climate change on small-mammal communities in Yosemite National Park, USA. *Science* 322 (5899): 261-264.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

Nitschke, C.R., and J.L. Innes. 2008. Climatic change and fire potential in south-central British Columbia, Canada. *Global Change Biology* 14:841-855.

Noss, R.F., H.B. Quigley, M.G. Hornocker, T. Merrill and P.C. Paquet. 1996. Conservation biology and carnivore conservation in the Rocky Mountains. *Conservation Biology* 10: 949-963.

Opdam, P. and D. Wascher. 2004. Climate change meets habitat fragmentation: linking landscape and biogeographical scale levels in research and conservation. *Biological Conservation* 117: 285-297.

Parmesan, C. and G. Yoho. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421: 37-42.

Parsons, D.J. 1991. Planning for climate change in national parks and other natural areas. *Northwest Environmental Journal* 7: 255-269.

Peters, R.L. and J.D.S. Darling. 1985. The greenhouse effect and nature reserves. BioScience 35: 707-717.

Peters, R.L. and T.E. Lovejoy (eds). 1992. Global Warming and Biological Diversity. Yale University Press, New Haven.

Peters, R.L. 1992. Conservation of biological diversity in the face of climate change. In R.L. Peters and T.E. Lovejoy (eds), Global Warming and Biological Diversity, pp. 15-30. Yale University Press, New Haven.

Ritchie, J.C. and G.M. MacDonald. 1986. The patterns of post-glacial spread of white spruce. *Journal of Biogeography* 13: 527-540.

Roberge, J.M. and P. Angelstam. 2004. Usefulness of the umbrella species concept as a conservation tool. *Conservation Biology* 18 (1): 76-85.

Romme, H. and M.G. Turner. 1991. Implications of global climate change for biogeographical patterns in the Greater Yellowstone Ecosystem. *Conservation Biology* 5(3): 373-386.

Romme, H. and M.G. Turner. 1992. Global climate change in Greater Yellowstone. *Park Science* 1(1): 2-5.

Root, T.L., J.T. Price, K.R. Hall, S.H. Schneider, C. Rozenburg and J. Pounds. 2003. Fingerprints of global warming in wild animals and plants. *Nature* 421: 57-60.

Root, T.L. and S.H. Schneider. 1993. Can large–scale climate models be linked with multiscale ecological studies? *Conservation Biology* 7: 256-270.

Ruhl, J.B. 2010. Climate change and the structural transformation of environmental law. *Environmental Law* 40: 363-435.

Saunders, S., T. Easley, J.A. Logan, and T. Spencer. 2006a. Western National Parks Endangered by Climate Disruption. Rocky Mountain Climate Organization and Natural Resources Defense Council, Denver and Washington, D.C.

Saunders, S., T. Easley, J.A Logan, and T. Spencer. 2006b. Losing ground: western national parks threatened by climate change. *George Wright Society Forum* 24(1): 41-81.

Saunders, S., D. Findlay, T. Easley and S. Christensen. 2011. Greater Yellowstone in Peril: The Threats of Climate Change. The Rocky Mountain Climate Organization and the Greater Yellowstone Coalition, Denver and Bozeman. Available at: http://www.rockymountainclimate.org/images/YellowstoneinPeril.pdf Accessed May 2012.

Scott, D., J. Malcolm and C. Lemieux. 2002. Climate change and biome representation in Canada's national park system: implications for system planning and park mandates. *Global Ecology and Biogeography* 11: 475-484.

Servheen, C., and M. Cross. 2010. Climate Change Impacts on Grizzly Bears and Wolverines in the Northern U.S. and Transboundary Rockies: Strategies for Conservation. Report on a Workshop held September 13-15, 2010, in Fernie, British Columbia, Canada.

Shafer, C.L. 1994. Beyond park boundaries. In E.A. Cook and H.N. van Lier (eds), Landscape Planning and Ecological Networks, pp. 201-223. Elsevier Science, Amsterdam.

Shafer, C.L. 1999. Reserve planning to protect biological diversity: some basic elements. *Landscape and Urban Planning* 44 (1999): 123-153.

Sinclair, A.R.E., J.F. Fryxell and G. Caughley. 2006. Wildlife Ecology, Conservation and Management. 2nd Ed. Blackwell, Malden, Massachusetts.

The Heinz Center. 2008. Strategies for Managing the Effects of Climate Change on Wildlife and Ecosystems. The Heinz Center, Washington, D.C.

Travis, J.M.J. 2003. Climate change and habitat destruction fragmentation: a deadly anthropogenic cocktail. *Proceedings of the Royal Society of London B* 270 (1514): 467-473.

Tweed, W.C. 2010. An idea in trouble: thoughts about the future of traditional national parks in the United States. *George Wright Forum* 27(1): 6-13.

US Fish and Wildlife Service. 2011. Grizzly Bear (*Ursus arctos horribilis*). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Grizzly Bear Recovery Office, Missoula, Montana Available at: http://www.fws/mountain-prairie/species/mammals/grizzly/Final%205YearReview_August%202011.pdf. Accessed May 2012.

Van Dyke, F. 2008. Conservation Biology: Foundations, Concepts, Applications, 2nd Ed. Springer, New York.

Vitousek, P.M., D'Antonio, C.M., L.L. Loope, and R. Westbrook. 1996. Biological invasions as global change. *American Scientist* 84: 468-478.

Westerling, A.L., M.G. Turner, E.A.H. Smithwick, W.H. Romme and M.G. Ryan. 2011. Continued warming could transform Greater Yellowstone fire regimes by mid-21st century. *Proceedings of the National Academy of Sciences USA* 108 (32): 13165-13170.

Whitlock, C.C. and P.J. Bartlein. 1993. Spatial variations in Holocene climatic change within the Yellowstone region. *Quaternary Research* 39: 231-238.

Wilkinson, T. 2011. Are Yellowstone's grizzly bears the new face of global warming? *Christian Science Monitor* December 24.

Williams, J.W., S.T. Jackson, and J.E. Kutzbach. 2007. Projecting distributions of novel and disappearing climates by 2100 AD. *Proceedings of the National Academy of Sciences, USA* 104: 5738-5742.

CHAPTER 12: MAPPING ANALYSIS

"*When properly done, a map can leave as vivid and unforgettable a concept as the most impassioned speech.*"

Convis 2001: xvi

Case Studies

This research could be called "land use science." It uses the case study approach because cause-effect relationships are too complex to deal with at the scale of Yellowstone National Park. Sometimes ecological research has to be content with correlations (Peters 1991). Conservation biology has been largely a science of case studies (Shrader-Frechette and McCoy 1993). This research also entails an historical approach (Salkind 2006). The historical approach to ecological insight is gaining acceptance (Jackson et al. 2001). Sometimes science can advance by looking at large amounts of data, looking for patterns at the landscape level, and then formulating hypotheses (Kelling et al. 2009). Put more simply, maps can make one think about spatial relationships.

Using case studies to illuminate ecological planning principles is a young endeavor. As Forman (1995: 445) explained, "in most cases only a single example exists for the application of a particular landscape-ecology principle." Both inductive and deductive approaches to science are valid (Gell-Mann 1994). NPS (1997:77) said, "Short of an epic science fiction treatment, it is impossible to imagine an experimental test approach broad, comprehensive, and massively funded enough to fully address all of the hypotheses either stated on implied in the natural regulation policy." Such an epic experiment is a fantasy. Early studies in landscape ecology did not achieve any experimental or statistical rigor (Hobbs 1997). Botkin (2008: 412) said, "There is a tendency [by ecological scientists] to dismiss good qualitative observations as totally useless." They are not useless.

Therefore, this research does not involve experimental science in the traditional hypothetico-deductive sense (sensu Popper 1965: manipulation, replicates, a control, and randomization). The case study approach is being adopted because replication controls, manipulation, and experimental tests are usually not possible for large-landscapes (Shrader-Frechette and McCoy 1993: 130-132). Case study information can come from "documents, archival records, interviews, direct observation and physical artifacts" (Shrader-Frechette and McCoy 1993: 129). The National Academy of Sciences advocated the case study approach for ecological studies rather than the general theory-driven hypothetico-deductive approach to science (Orians et al. 1986). As Shrader-Frechette and McCoy (1993:1230) explain, "In using a case study, however, one must confront the facts of a particular situation, and then look for a way to make sense of them." Terms that characterize case studies include descriptive, particularistic, heuristic, inductive, and holistic (Shrader-Frechette and McCoy 1993: 123). As Shrader-Freschette and McCoy (1993: 283) argue, "an hypothesis can be objective and have significant heuristic value, even if it is not ready to be subjected to rigorous testing."

A whole classification system has been proposed for the plethora of potential anthropogenic impacts to a landscape (Salafsky et al. 2008). Sixteen years before Glick et al. (1991) mapped many forms of consumptive use (e.g., roads, logging, mining, oil and gas, geothermal, grazing, water projects) in the GYE. This research cannot reinvestigate *all* of the land uses documented by Glick and colleagues. Furthermore, the 1987 data cannot be verified decades later. Therefore, it shall ignore logging, grazing, water projects, geothermal exploitation, and recreational facilities, all mostly on federal lands, and residential development on private lands. It shall, however, focus on roads and human population density, and to a lesser extent on mining. Roads are one activity identified by an NGO (National Parks and Conservation Association 2011) as interrupting park habitat connectivity.

Grizzly Bear

The grizzly bear is the focal species since it is both a flagship species and an umbrella species ((Lambeck 1997, Mills 2007). It can also serve a barometer for the effectiveness of protected area management (Peterson 2000). The bear is one component of the GYE's mammalian fauna that has a demonstrated sensitivity to human presence (Mattson 1990). For example, grizzly bears in Yellowstone National Park avoid roads and developments (Mattson et al. 1987). Such infrastructure, especially roads, is an essential part of resource extraction activity and become bear deterrents (McLellan and Shackleton 1988). GYE grizzly bear mortality is lowest in the park, rises on adjacent federal land within the "recovery zone," and rises very slightly again on public and private lands outside the recovery zone (Schwartz et al. 2006). Thus, certain land uses in the GYE can potentially influence grizzly bear abundance and distribution. Oil and gas pad construction and roads, for example, can contribute to habitat fragmentation, shrinkage, attrition, perforation and dissection (Forman 1995:407).

Hypothesis 1: There is no correlation between human population size and grizzly bear emigration from the GYE.

False. The overall pattern indicates grizzly bears have not traveled far from GYE national forests (Figure 58).

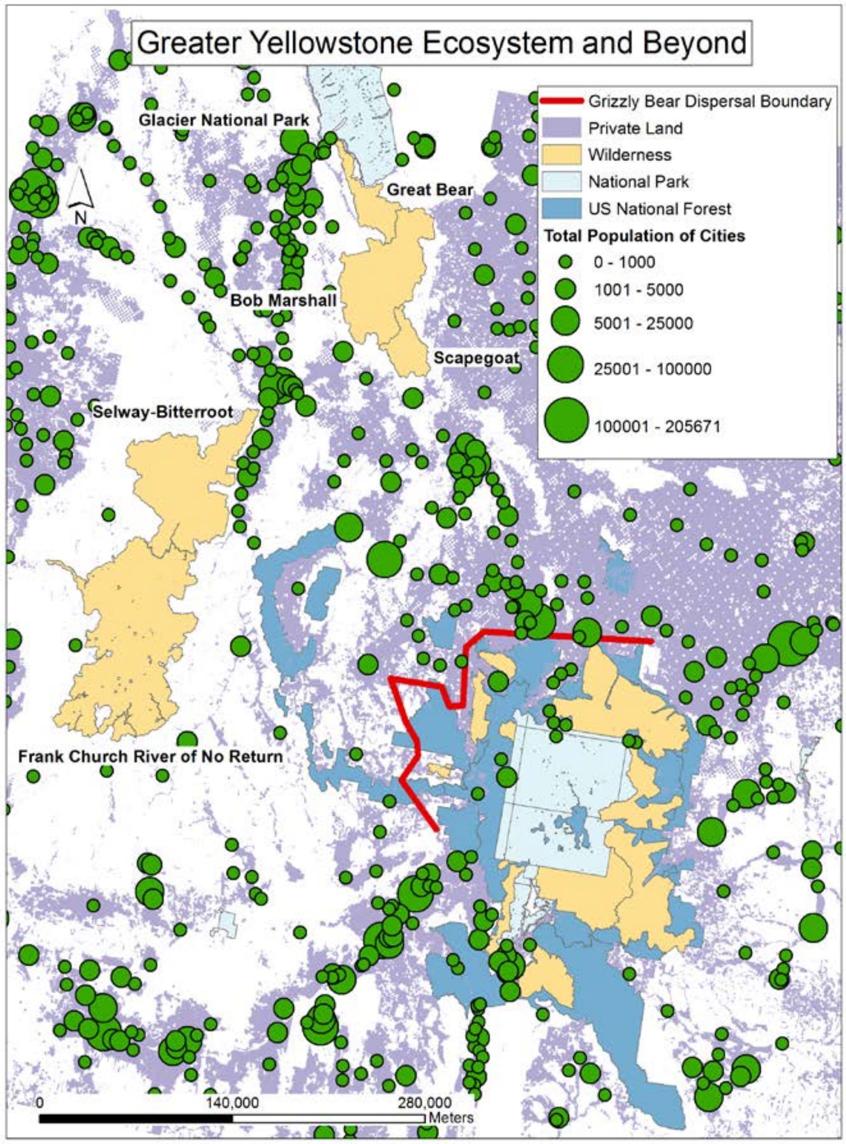


Figure 58. Grizzly bears have not dispersed far into private land or large centers of human population. Private land from state data bases: Idaho data from Idaho's Geospatial Clearinghouse [inside.uidaho.edu]; Wyoming data from Wyoming Geospatial Information Science Center [www.wwyo.edu/wygisc]; Montana data from BLM Montana Public Room [www.blm.gov/mt/st/en.html]. Human population size data from decimal Census form 2D10SF1. American Factfinder at factfinder2 [census.gov/faces/nav/jsf/pages/searchresults.zhtml]; census designated place from 2010 TIGERLine®Shapefiles.

Hypothesis 2: Highways do not thwart grizzly bear emigration from the GYE.

False. The GYE grizzly bear has crossed tertiary (=other) roads on national forests (Figures 59 and 60). However, primary roads (=interstate highways) look like they are avoided in one area (i.e., Interstate Highway 90 between Bozeman and Livingston). This mapping observation can be corroborated with other evidence.

First, Craighead et al. (2011:4) viewed Interstate Highway 90 west of Bozeman as a significant barrier for grizzly bears because “none have been documented crossing I-90 or recorded as roadkill.” However, grizzly bear movement across Interstate Highway 90 between Butte and Missoula is abundant though the bears are moving southeastward from the NCDE (Figure 61). Going about 200 miles northwest from Bozeman on Interstate Highway 90, Servheen and Shoemaker (2003) found no grizzly bears crossings the 35 mile stretch of highway between Alberton and St. Regis.

Second, there is no genetic evidence. Haroldson et al. (2010) found no evidence of NCDE bears moving into the GYE or vice versa. There is genetic evidence of grizzly bears crossing Interstate Highway 90 between Missoula and Butte moving southeastward from the NCDE. Genetic analysis has provided a new tool to access habitat connectivity (Braunisch et al. 2010, Lowe and Allendorf 2010). It can even be used to access isolation by highways (Simmons et al. 2010).

Note that one interstate highway needs to be traversed by grizzly bears going from GYE to the Selway-Bitterroot Ecosystem while two need to be traversed going from the GYE to the NCDE. Chruszuz et al. (2003) found the Trans Canada highway in Banff National Park, Alberta, a movement barrier for grizzly bears. The incidence of roads and numbers of people were found to be correlates of species imperilment on a statewide basis (Brown and Laband 2006).

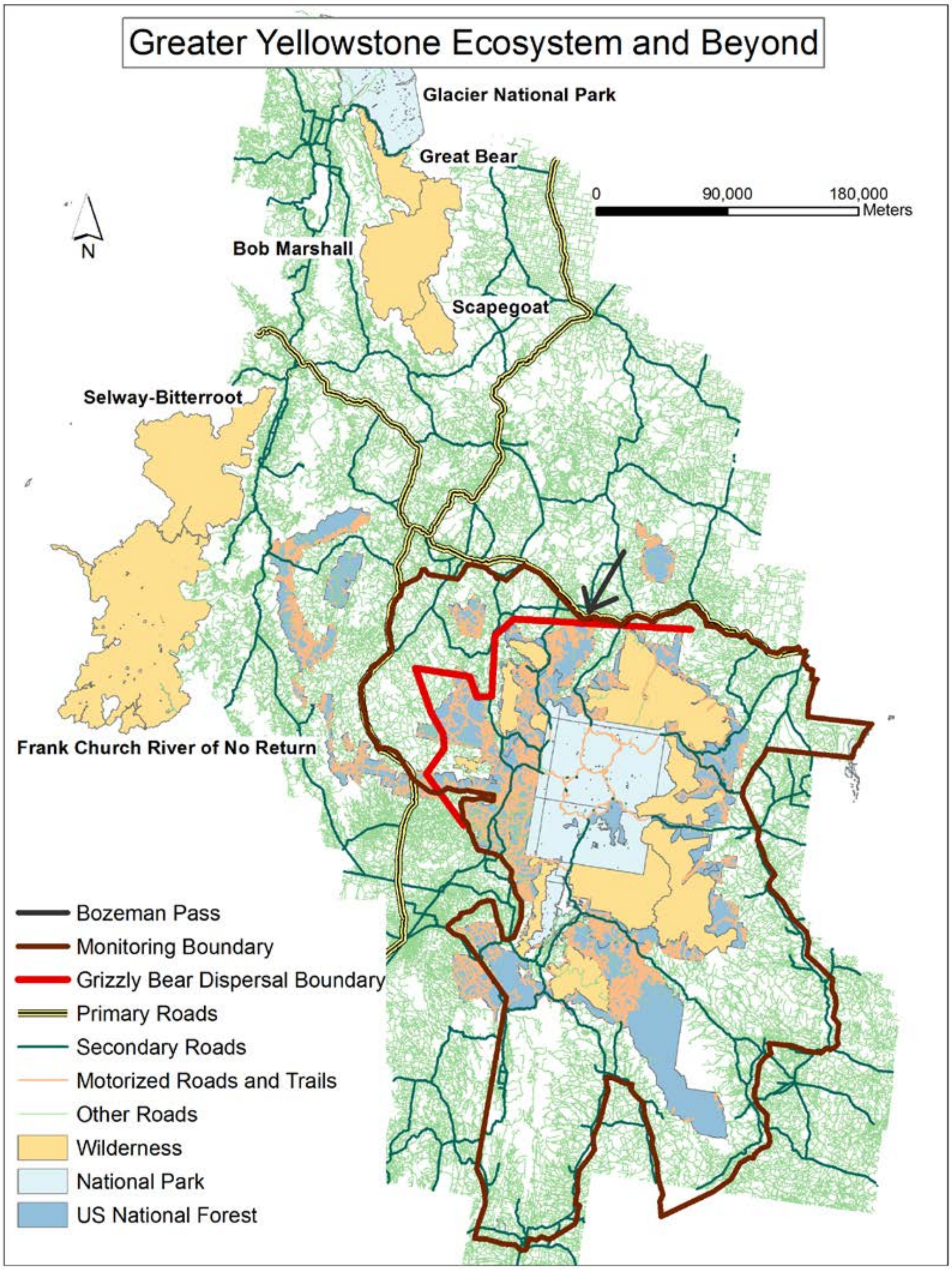


Figure 59. Roads in the GYE. Source for wilderness: University of Montana. Source for roads on national forests: USFS as of 2007. Source for roads outside national forests: TIGER 2011.

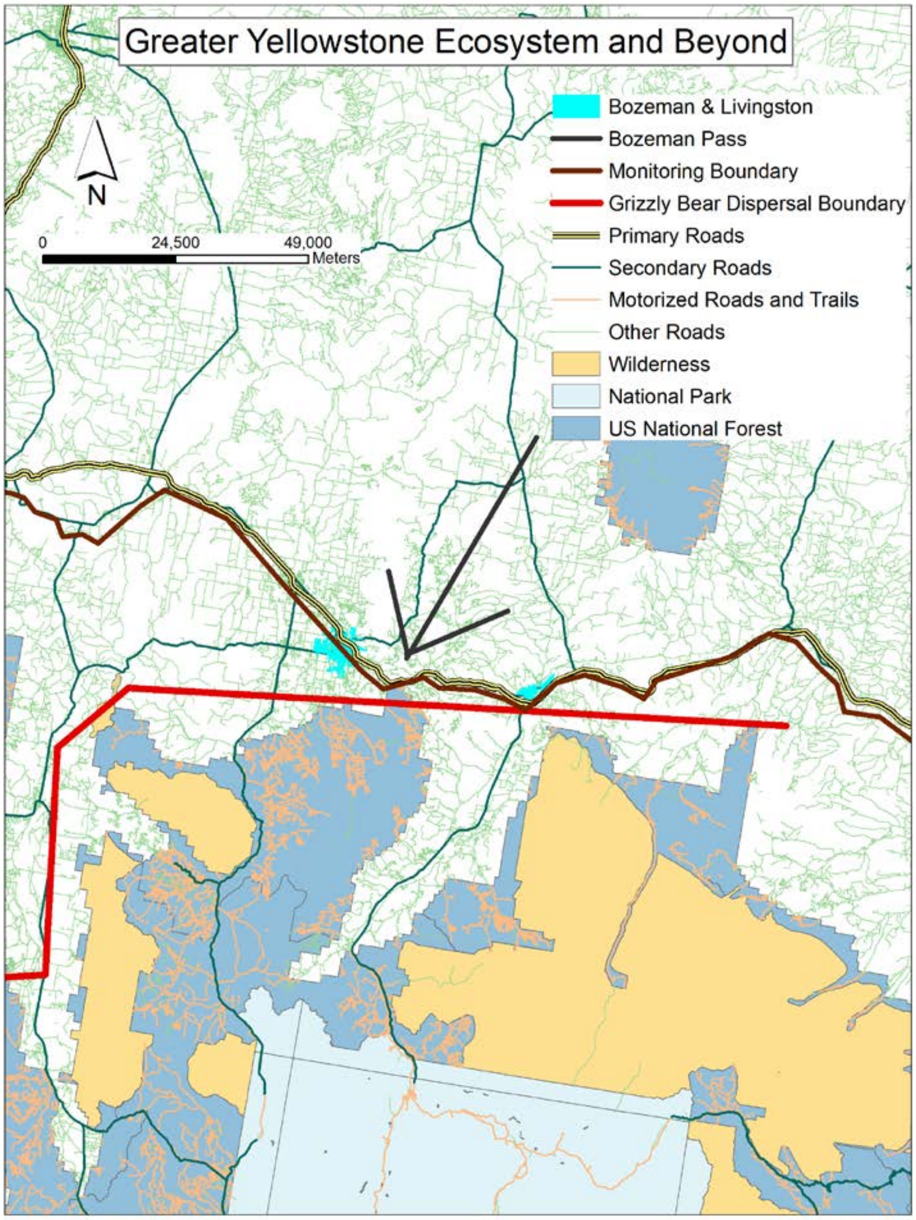


Figure 60. Note that the northern extent of the GYE grizzly bear monitoring boundary (dark brown) and Interstate Highway 90 (light green primary brown) are identical. Grizzly bear monitoring boundary from USGS [http://hrmsc.usgs.gov/products/IBBST (2011 Report). Accessed March 2013. Other data sources identical with Figure 59.

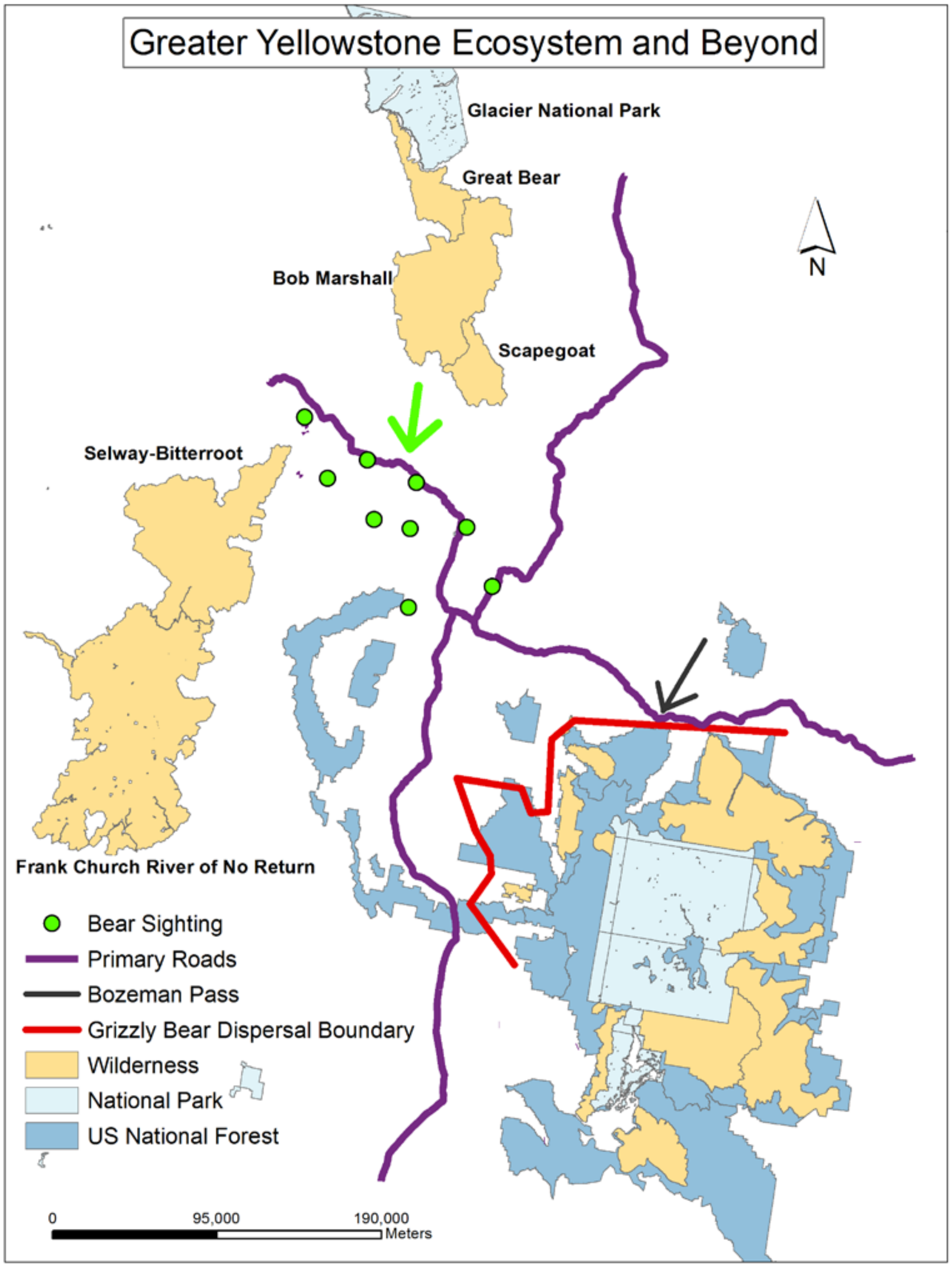


Figure 61. Grizzly bears are moving south from the NCDE. The green dots do not necessarily represent a single bear.

Traffic volume varies (Figure 62).

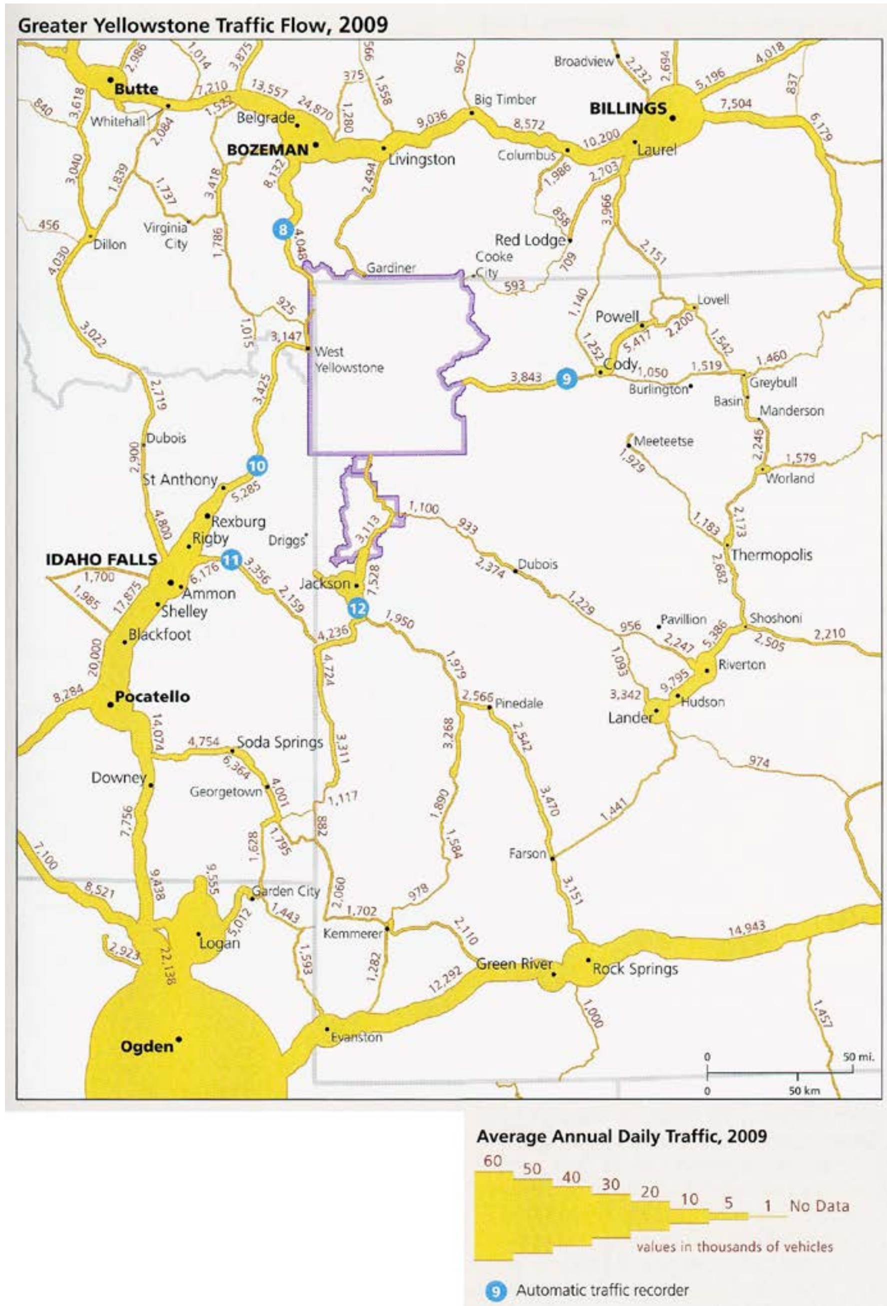


Figure 62. Traffic volume at Bozeman Pass on Interstate 90 is around 20,000 vehicles per day. However, on Interstate 15 west of Yellowstone National Park it is 5,000 vehicles per day or less (From Marcus et al. 2012).

Perhaps more importantly, note that the bears moving south from the NCDE are not all using habitat corridors identified by the Craighead Environmental Research Institute (Figure 63).

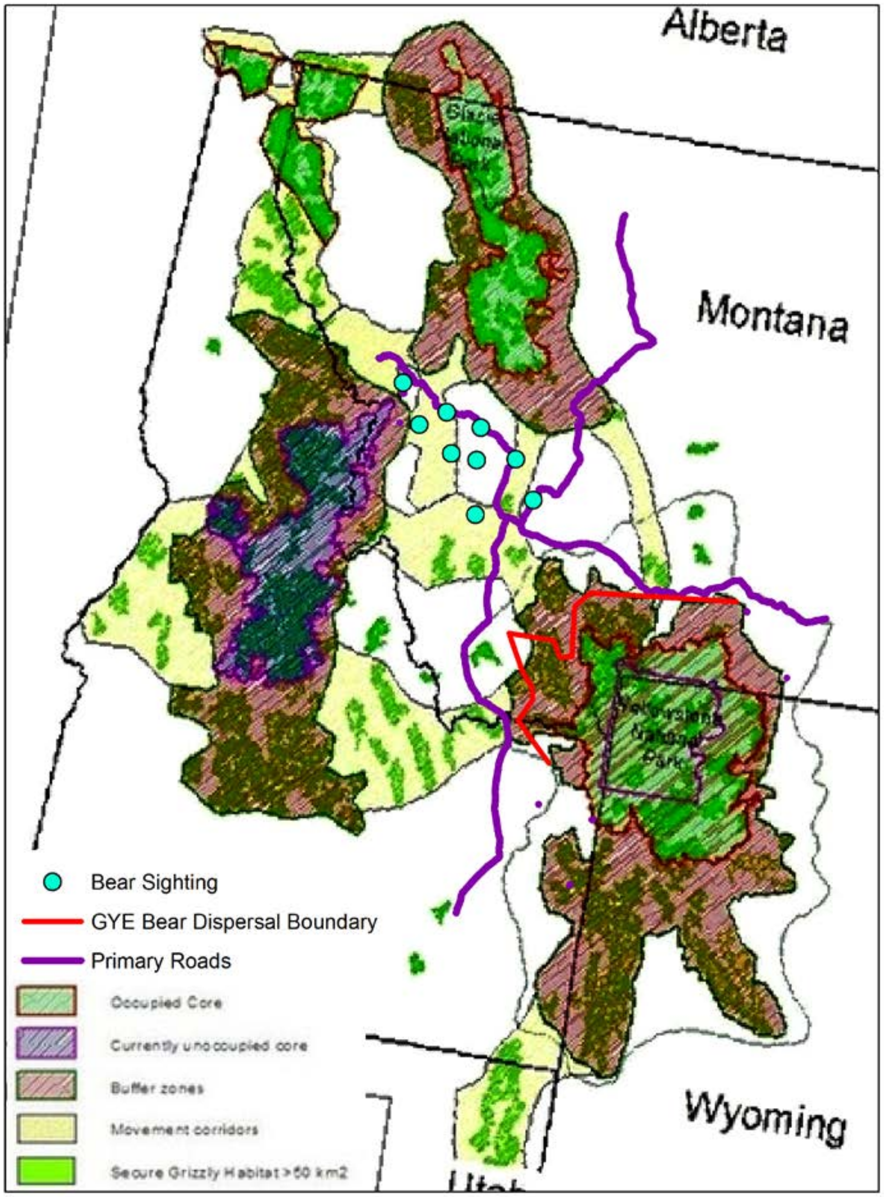


Figure 63. In this idealized reserve design, note that the grizzly bear sightings are not confined to the identified habitat corridors.

Hypothesis 3: Roadless areas are free of roads and mining claims/oil and gas leases.

False. There are many roads and mining/oil and gas opportunities in official GYE roadless areas (Figure 64). This should not come as a surprise to those few who have studied the Clinton Administration roadlesss areas rules, published in the *Federal Register* in January 2001. In addition, Idaho opted out of the roadless legislation.

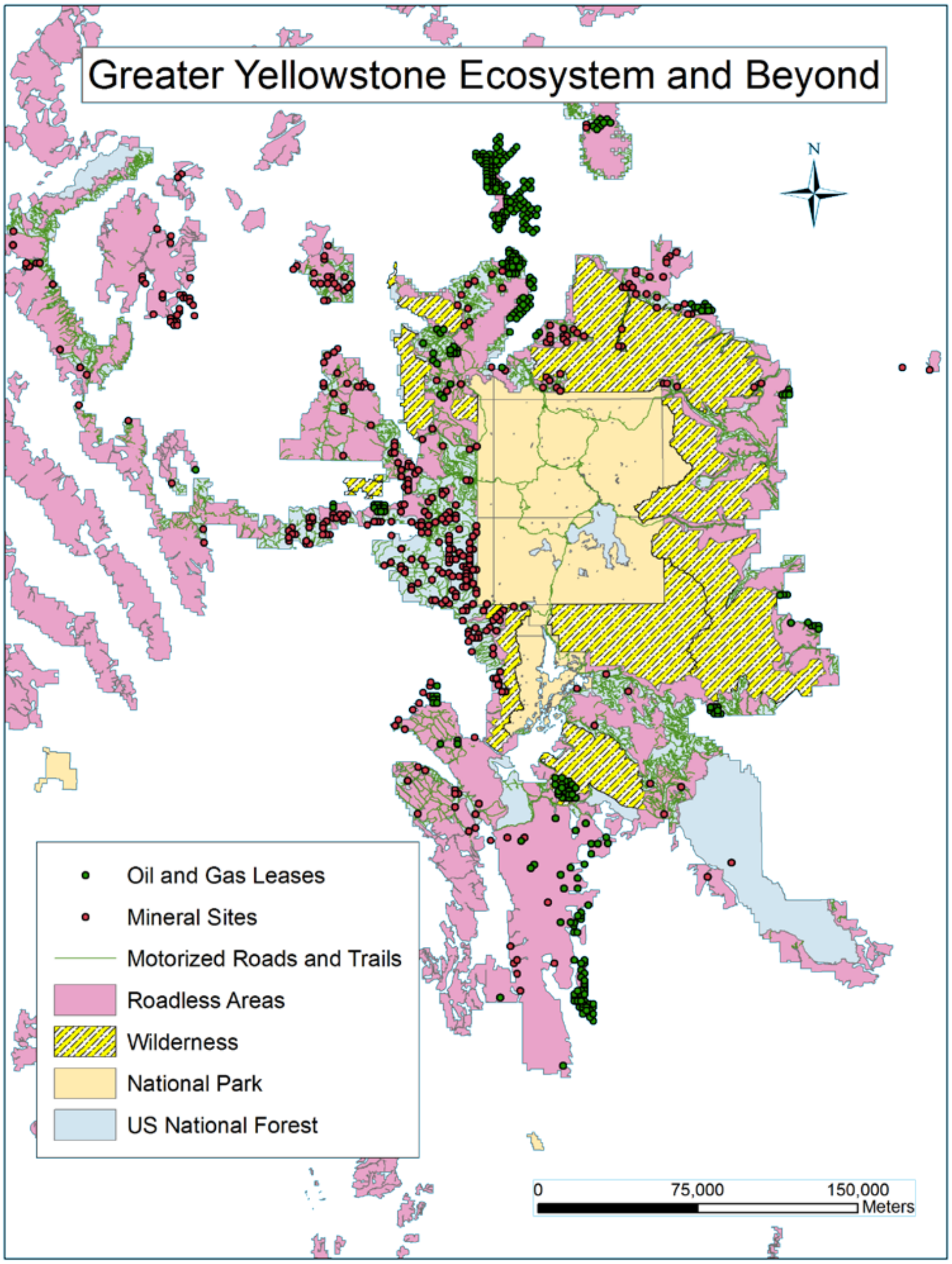


Figure 64. Roads and mineral sites/existing or suspended oil and gas leases in USFS roadless areas. Source for mining and oil/gas data: US Forest Service (2006). Source for wilderness: University of Montana. Source for roads on was USFS as of 2007.

Hypothesis 4: The GYE grizzly PCA is free of roads and mining claims/oil and gas leases.

False. The grizzly bear's Primary Conservation Area (PCA) has both roads and mining/oil and gas extraction opportunities (Figure 46). For mining claims in the PCA, there are 1,354 as of 2006 (US Forest Service 2006:209). For oil and gas leases in the PCA, there are 14 active wells on the Bridger-Teton National Forest (USFS 2006, cited in USFWS 2007). This may not be new insight for GYE grizzly bear managers and researchers but it may inform others. About 98% of the PCA is federal land (Schwartz and Gunther 2006).

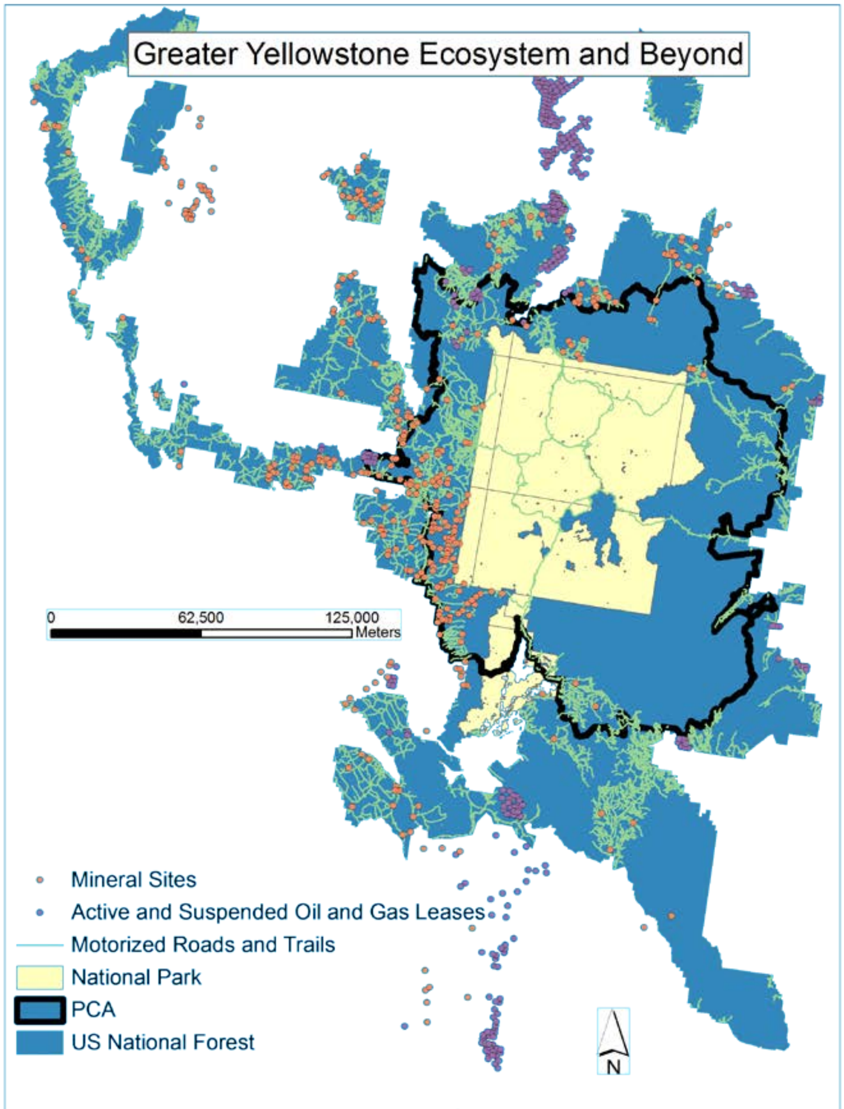


Figure 46. Road density and mineral sites/active/suspended oil and gas leases on national forests including inside the PCA. Source for mining/oil and gas data: US Forest Service (2006). Source for PCA: US Fish and Wildlife Service. Source for roads USFS as of 2007.

Wilderness Areas

The eight wildernesses in the GYE were created from 1964-1984 [http://www.wilderness.net].

Lee Metcalf (Monument Mountain Unit)	MT	1983	33,000	acres
Absaroka-Beartooth	MT	1978	943,626	“
Jedediah Smith	WY	1984	123,451	“
North Absaroka	WY	1964	350,488	“
Teton	WY	1964	585,238	“
Washakie	WY	1964	704,274	“
Wineger Hole	WY	1984	10,715	“
Popo Agie	WY	1984	101,870	“

In the enabling legislation that created the above wilderness areas, Congress did *not* mention any potential park buffer zone function. The Greater Yellowstone Coalition, an NGO, takes credit for helping create one million acres of wilderness in the Wyoming part of the GYE in 1984 to “provid[e] a critical buffer for the parks...” (Anonymous 2012). Can an evaluation of buffer zone effectiveness for Yellowstone National Park be performed when buffer zones per se were never created for that park? Yes, because the federal wilderness designations on national forests which abut segments of the park’s boundary function as *de facto* buffer zones. Buffer zones are not strips of land but are land use restrictions. A reading of the intent of the Wilderness Act of 1964 would lead one to think that wilderness areas were to be inviolate but, as described above, political compromises were made before and after that legislation became law (Shafer 2010). There are official "roadless areas" near the boundary of Yellowstone National Park in addition to official wilderness areas.

Hypothesis 5: Official USFS wilderness areas in the GYE have not provided a buffer against roads and mining.

False. Wilderness areas have prevented road construction (Figure 65).

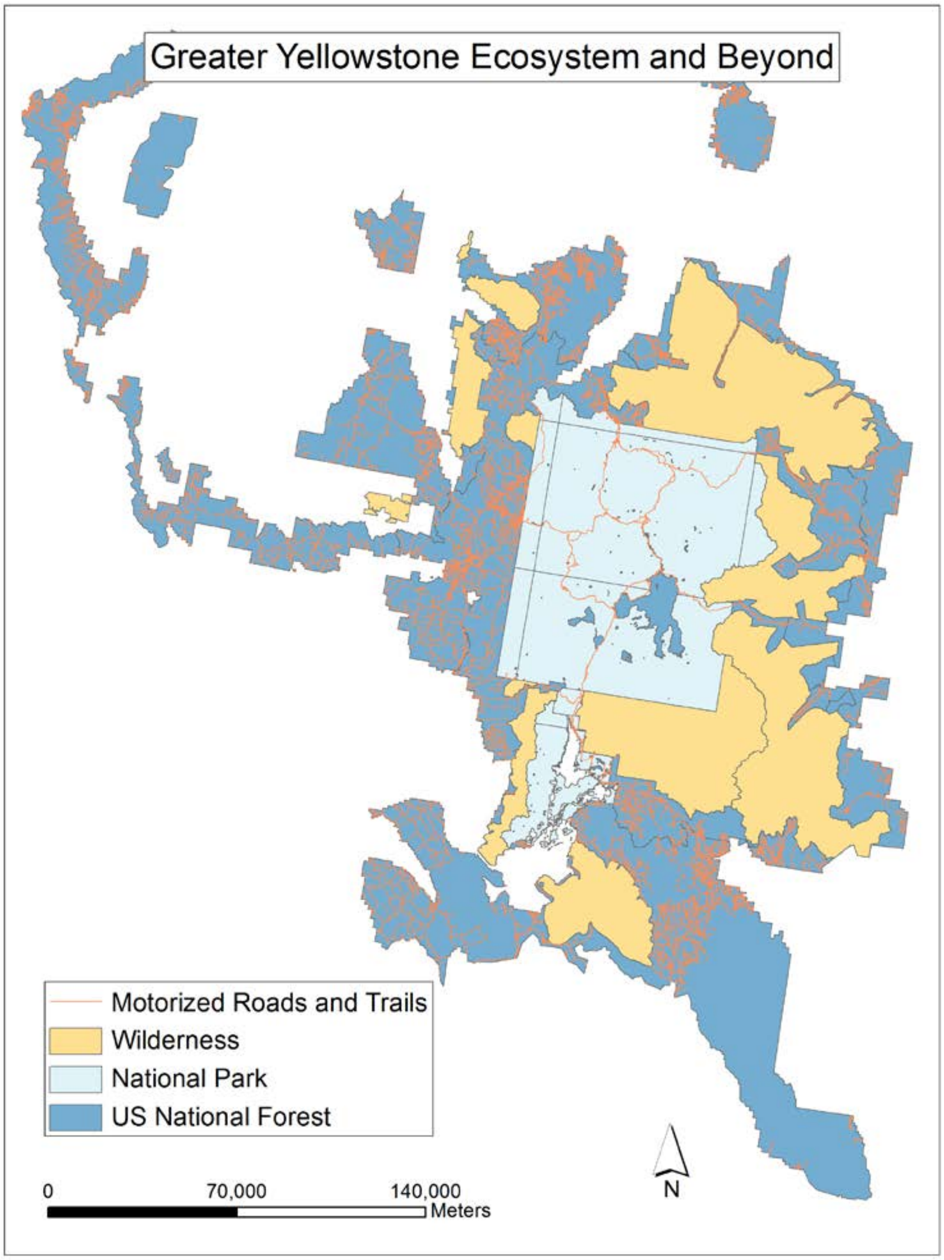


Figure 65. Tertiary roads on GYE national forests abut wilderness boundaries. Source for roads USFS as of 2007. Source for wilderness: University of Montana.

These GYE wilderness areas contain few mining and oil and gas exploitation opportunities (Figure 66). However, these few mining claims in wilderness are suspect as they do not correspond to other data sources (see Reese 1991:93). The New World Mine represents a mining threat inside one GYE wilderness that fostered international concern (Chapter 3).

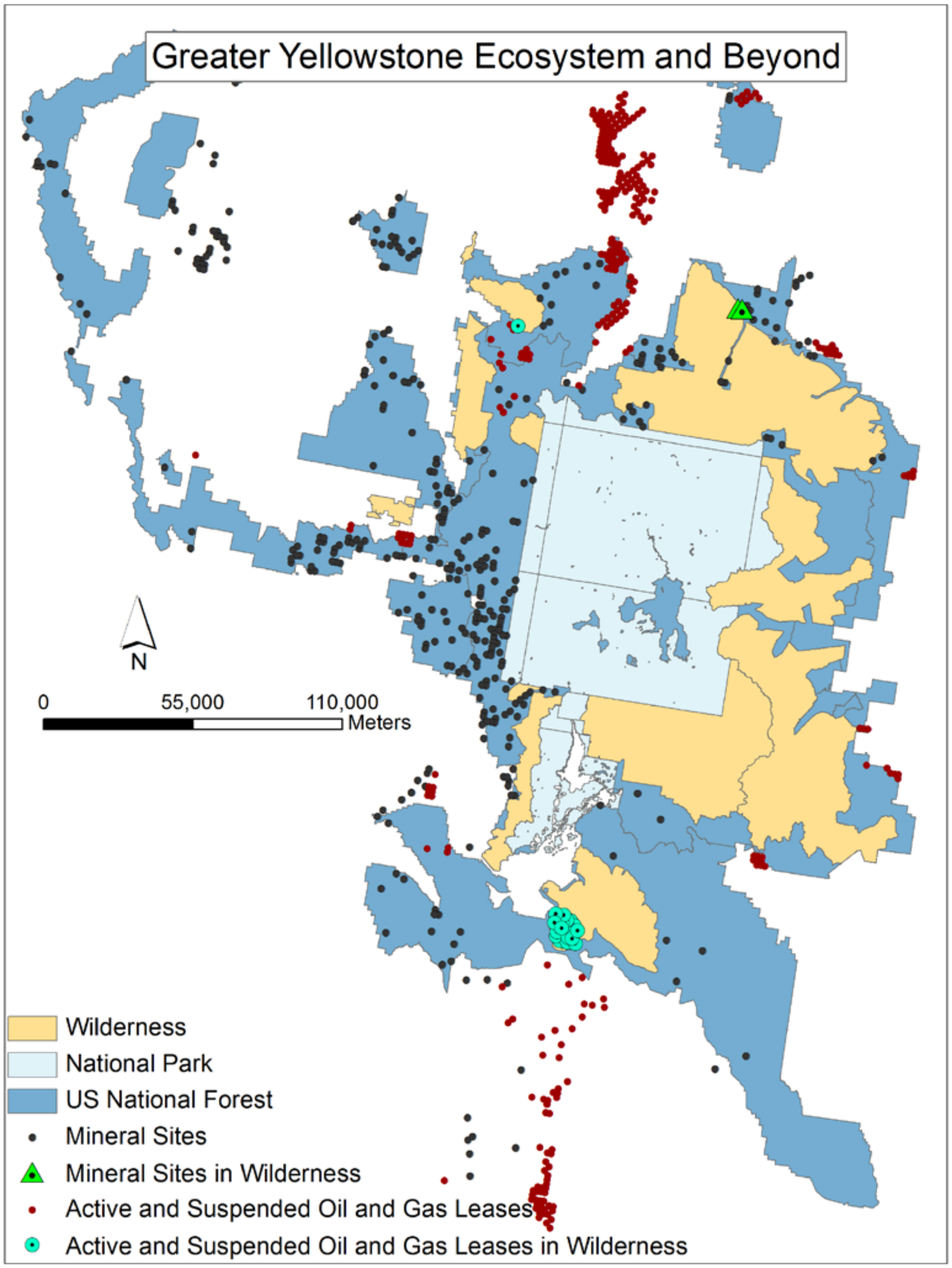


Figure 66. Mining claims and active and suspended oil and gas leases occur mostly outside of wilderness boundaries but note some exceptions. Source for wilderness: University of Montana. Source for mining/oil and gas data: US Forest Service (2006).

Therefore, tertiary roads and mineral claims and active or suspended oil and gas leases are very abundant at GYE wilderness boundaries. This is likely the result of Congressional preclusion of buffer zone creation next to wilderness on USFS lands (see Chapter 7).

Land ownership is perceived to influence bear dispersal (Figure 67). At a larger scale,

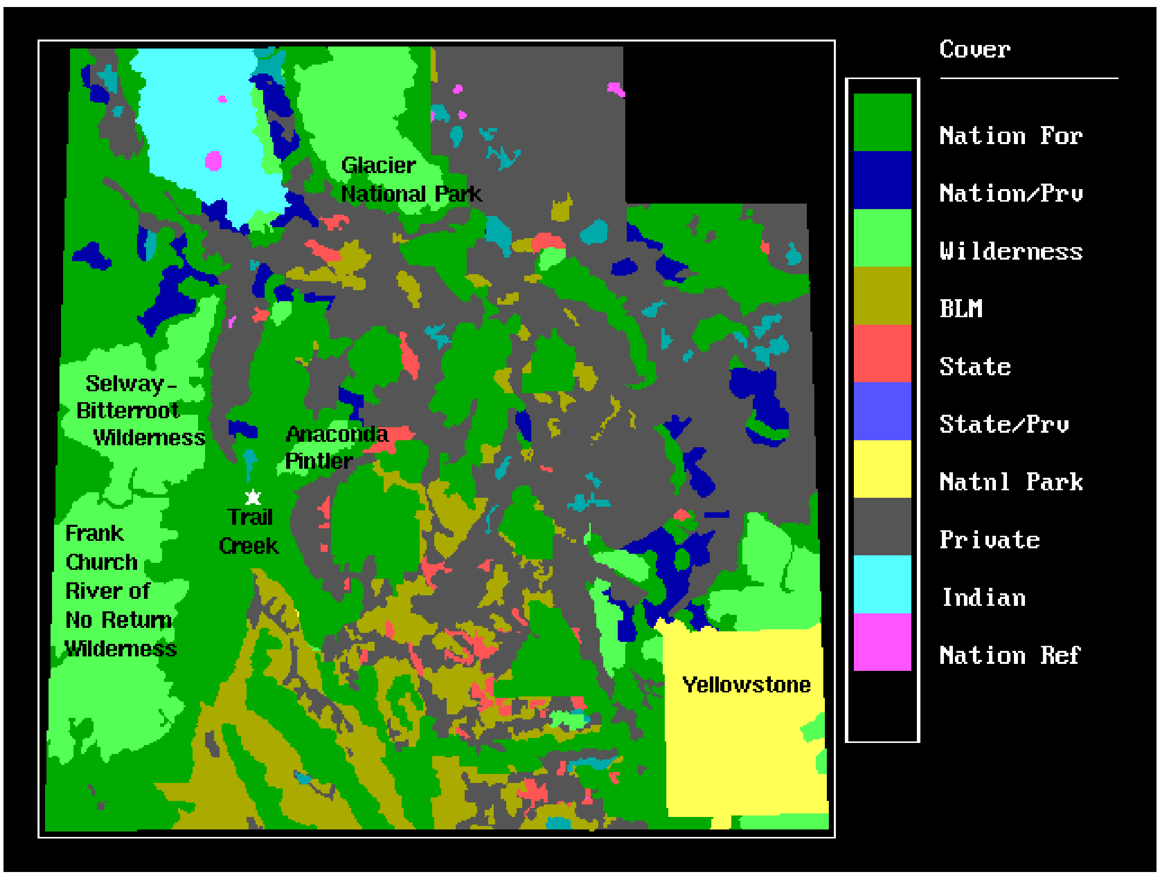


Figure 67. Land ownership containing potential habitat corridors linking the GYE with the NCDE and the Selway Bitterroot Ecosystems (From Boone and Hunter 1996).

mapping down to the level of sections is needed to see the real land ownership pattern (Figure 68).

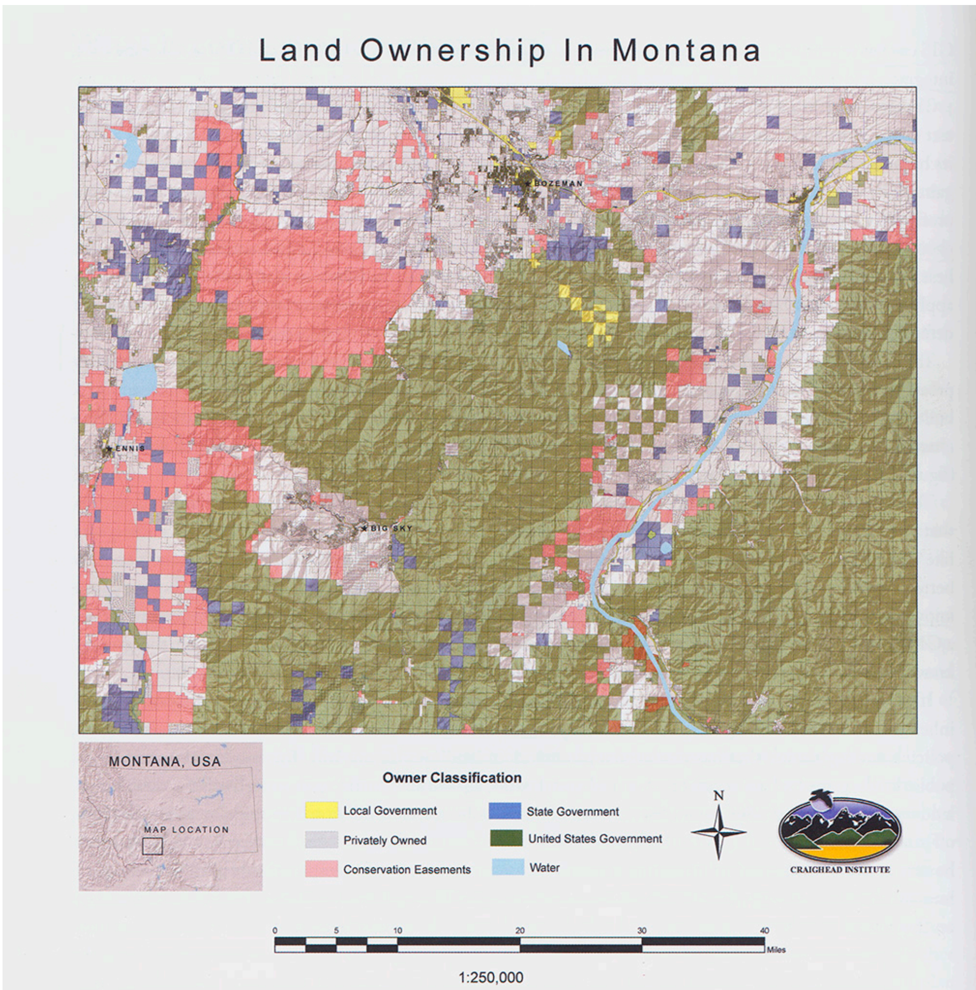


Figure 68. Land ownership mapped to section. The dark area in the upper middle is Bozeman, Montana (From Craighead and Convis 2013: 10).

However, infrastructure like roads may be the greater barrier at some locations (Figure 69).

Figure 69. Grizzly bear crossing an unknown highway Available at www.nytimes.com/2008/10/
14/science/14road.htm Accessed January 2013.

It has been shown that highways represent formidable barriers for grizzly bears in Alberta's Banff-Bow Valley (Chruszcz et al. 2003). The Northern and Central Rockies ironically are still one of the areas where road building is least dense in the United States (Figure 70).

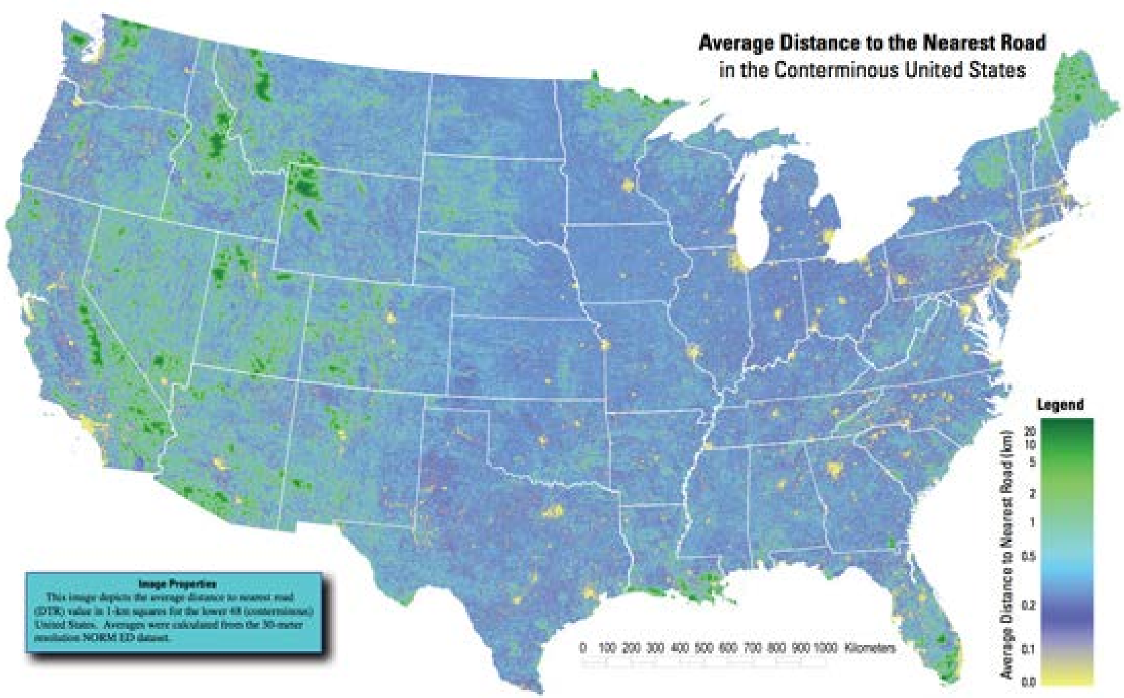


Figure 70. The dark green areas represent locations in the United States where average distance to the nearest road is furthest. Available at: www.fieldandstream.com/blogs/conservationist/2012/our-last-wild-and-why-they-need-stay-wild Accessed January 2013.

Some of these bears get killed crossing roads or highways (Figure 71). There is a growing literature about how to design roads and highways that are more wildlife friendly (e.g., Clevenger and Huijser 2011).

Figure 71. An 850-pound grizzly bear killed in 2007 by a pick-up truck on State Highway 200 near Lincoln, Montana. Available at: www.prosts.com/Article-Grizzly-Bear-Hit-Truck.htm Accessed January 2013.

REFERENCES

Anonymous. 2012. Greater Yellowstone Coalition Accomplishments. Available at: http://greateryellowstone.org/about/accomplishments.php Accessed May 8, 2010.

Boone, R.B. and M.L. Hunter. 1996. Using diffusion models to simulate the effects of land use on grizzly bear dispersal in the Rocky Mountains. *Landscape Ecology* 11(1): 51-64.

Botkin, D. 2008. The future of ecology and the ecology of the future. In L.L. Rockwood, R.E. Stewart, and T. Dietz (eds), Foundations of Environmental Sustainability: The Coevolution of Science and Policy, pp. 409-414. Oxford University Press, Oxford, UK.

Braunisch, V., G. Segelbacher and A.H. Hirzel. 2010. Modeling functional landscape connectivity from genetic population structure: a new spatially explicit approach. *Molecular Ecology* 19: 664-678.

Brown, R.M. and D.N. Laband. 2006. Species imperilment and spatial patterns of development in the United States. *Conservation Biology* 20(1): 239-244.

Chruszuz, B., A.P. Clevenger, K. Gunson and M.L. Gibeau. 2003. Relationship among grizzly bears, highways and habitat in the Banff-Bow Valley, Alberta, Canada. *Canadian Journal of Zoology* 81: 1378-1391.

Clevenger, T. and M. P. Huijser. 2011. Wildlife Friendly Structure Handbook: Design and Evaluation in North America. Available at: http://www.westerntransportationinstitute.org/documents/reports/426899-Final-Report-pdf Accessed February 2013.

Convis, C.L., Jr. 2001. Introduction. In C.L. Convis (ed). Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism, pp. xv-ixx. ESRI Press, Redlands, California.

Craighead, L.A., F.L. Craighead and L. Oechelli. 2011. Bozeman Pass post fencing wildlife monitoring. FH-10-006/8173 http://www.westerntransportationinstitute.org/documents/reports/426899-Final-Report-pdf Accessed February 2013

Craighead, F.L. and C.L. Convis, Jr. (2013). Introduction: shaping the future with conservation planning. In K.L. Craighead and C.L. Convis, Jr. (eds), pp. 1-2. ESRI Press, Redlands, California.

Davidson, D.K. 2003. Innovative partnerships that address highway impacts to wildlife habitat connectivity in the Northern Rockies. In: C.L. Irwin, P. Garrett, and K.P. McDermott (eds), Proceedings of the 2003 International Conference on Ecology and Transportation, pp. 195-203. Center of Transportation and the Environment, North Carolina State University, Raleigh, North Carolina.

Forman, R.T.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, New York.

Gell-Mann, M. 1994. The Quark and the Jaguar: Adventures in the Simple and the Complex. Henry Holt, New York.

Glick, D., M. Carr, and B. Harting. 1991. An Environmental Profile of the Greater Yellowstone Ecosystem. Greater Yellowstone Coalition, Bozeman, Montana.

Haroldson, M.A., C.C. Schwartz, K.C. Kendall, K.A.Gunther, D.S. Moody, K. Frey and D. Paetkau. 2010. Genetic analysis of individual origins supports isolation of grizzly bears in the Greater Yellowstone Ecosystem. *Ursus* 21 (1): 1-13.

Hobbs, R. 1997. Future landscapes and the future of landscape ecology. *Landscape and Urban Planning* 37: 1-9.

Jackson, J.B.C. et al. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293: 629-638.

Kelling, S., D. Fink, M. Riedewald, R. Caruana, G. Ballard and G. Hooker. 2009. Data-intensive science: a new paradigm for biodiversity studies. *BioScience* 59: 613-620.

Lambeck, R.J. 1997. Focal species: a multi-species umbrella for nature conservation. *Conservation Biology* 11: 849-856.

Lowe, W.H. and F.W. Allendorf. 2010. What can genetics tell us about population connectivity? *Molecular Ecology* 19: 38-51.

Mattson, D.J. 1990. Human impacts on bear habitat use. *International Conference on Bear Research and Management* 8: 33-56.

Mattson, D.J., R.R. Knight and B.M. Blanchard. 1987. The effects of developments and primary roads on grizzly bear habitat use in Yellowstone National Park, Wyoming. *International Conference on Bear Research and Management* 7: 259-273.

Mills, L.S. 2007. Bridging applied population and ecosystem ecology with focal species concepts (Chapter 13). In Conservation of Wildlife Populations: Demography, Genetics and Management, pp. 276-285. Blackwell, Malden, Massachusetts.

National Parks and Conservation Association. 2011. The State of America's National Parks. Center for Park Research, National Parks and Conservation Association, Fort Collins, Colorado.

National Park Service. 1997. Yellowstone's Northern Range: Complexity & Change in a Wildland Ecosystem. Yellowstone National Park, Mammoth Hot Springs, Wyoming.

Orians, G.H., J. Buckley, W. Clark, M. Gilpin, C. Jordan, J. Lehman, R. May, G. Robilliard, D. Simberloff, W. Erckmann, D. Policansky, and N. Grossblatt. 1986. Ecological Knowledge and Environmental Problem Solving. National Academy Press, Washington, D.C.

Peters, R.H. 1991. A Critique of Ecology. Cambridge University Press, New York.

Popper, K. 1965. The Logic of Scientific Discovery. Harper and Row, New York.

Reese, R. 1991. Greater Yellowstone: The National Park and Adjacent Lands. 2nd Ed. Montana Magazine, Helena, Montana.

Salafsky, N., D. Salzer, A.J. Stattersfield, C. Hilton-Taylor, R. Neugarten, S.H.M. Butchart, B. Collen, N. Cox, L.L. Master, S. O'Connor and D. Wilkie. 2008. A standard lexicon for biodiversity conservation: unified classifications of threats and actions. *Conservation Biology* 22(4): 897-911.

Salkind, N. 2006. Non-experimental research: qualitative methods (Chapter 10). In Exploring Research. 6th Ed., pp. 201-214. Pearson Education, Upper Saddle River, New Jersey.

Schwartz, C.C., M.A. Haroldson, K.A. Gunther and D. Moody. 2006. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. *Ursus* 17: 63-66.

Schwartz, C.C. and K. Gunther. 2006. Grizzly bear management in Yellowstone National Park: the heart of recovery in the Yellowstone ecosystem. In D.R. McCullough, K. Kaji and M. Yamanaka (eds), Wildlife in Shiretoko and Yellowstone National Parks: Lessons in Wildlife Conservation from Two World Heritage Sites, pp. 232-238. Shiretoko Nature

Foundation, Hokaido, Japan. Available at: http://www.nrmsc.usgs.gov/files/norock/products/Schwartz_Gunther.pdf Accessed May 2011.

Servheen, C. and R. Shoemaker. 2003. A sampling of wildlife use in relation to structure variables for bridges and culverts under I-90 between Alberton and St. Regis, Montana. In: C.L. Irwin, P. Garrett and K.P. McDermott (eds), Proceedings of the 2003 International Conference on Ecology and Transportation, pp. 331-341. North Carolina State University, Raleigh. Available at: http://escholarship.org/uc/item/4tt86932 Accessed February 2013.

Shafer, C.L. 2010. The unspoken option to help safeguard America's national parks: an examination of expanding U.S. national park boundaries by annexing adjacent federal lands. *Columbia Journal of Environmental Law* 35 (1): 57-125.

Shrader-Frechette, K.S. and E.D. McCoy. 1993. Method in Ecology: Strategies for Conservation. Cambridge University Press, Cambridge, UK

Simmons, J. M., P. Sunnucks, A. C. Taylor, and R. van der Ree. 2010. Beyond roadkill, radiotracking, recapture and *FST*—a review of some genetic methods to improve understanding of the influence of roads on wildlife. *Ecology and Society 15*(1): 9. [online] URL: http://www.ecologyandsociety.org/vol15/iss1/art9/

US Fish and Wildlife Service. 2007. Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears From the Federal List of Endangered and Threatened Wildlife; 90-Day Finding on a Petition To List as Endangered the Yellowstone Distinct Population Segment of Grizzly Bears. *Federal Register*, Vol. 72, No. 60, March 29, 2007, pp. 14866-14938.

US Forest Service. 2006. Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests. Final Environmental Impact Statement. US Forest Service, Department of Agriculture, Washington, D.C.

CHAPTER 13: SUMMARY

Research Importance

This research has touched on one of the "top 40" research priorities for US conservation and management policy: #28-What factors affect the ability of native species to move through and persist within human–dominated landscapes? (Fleischman et al. 2011: 295). It is also consistent with one 2009 GYE scientific research recommendation made by a panel of invited experts. Question 21 asked "How do changes in land use and land cover associated with consumption of natural resources (grazing, mining, logging, energy development) impact natural processes within and outside protected areas" (Olliff et al. 2010: 20). The NPS has already identified "land use" as one of the 12 "vital signs" that need to be monitored in park units, including those parks in the Greater Yellowstone Network. The guidance thus far on monitoring land use outside park boundaries is to focus on private homes and roads (Jean et al. 2005:60). This is good advice. However, the high concentration of roads and mining claims outside GYE wilderness areas, if developed, would reduce landscape permeability and become "fracture zones" (sensu Servheen and Sandstrom 1993). These roads and mining claims need to be watched even in official roadless areas. Questions have arisen that this research has not addressed:

whether allowing development right up to the boundaries of protected areas, like national forest wilderness boundaries in the GYE, sets the stage for more development at that very location (Moon and Farmer 2010)?

Mapping Results

Tertiary roads and human population centers keep GYE grizzly bears from moving northward towards to NCDE and northwestward towards Selway-Bitterroot Ecosystem. They have not ventured far from the GYE national forests. Based on data collected from 1998-2012, Interstate Highway 90 east of Bozeman is a dispersal barrier. But Interstate Highway 90 is not a complete dispersal barrier if one moves 90-130 miles northwestward. There is 2005 genetic confirmation for one or more grizzly bears crossing Interstate 90 near Butte, Montana, having originated from the NCDE (Kevin Frey, personal communication). There are many confirmed sightings of grizzly bears south of Interstate Highway 90 between Missoula and Butte (Jamie Jonkel, personal communication). There is also genetic confirmation for a grizzly bear killed by a hunter in 2007 near Lolo Pass, Montana and Idaho. This bear came down from the Selkirk subpopulation and also had to cross Interstate Highway 90 (Anonymous 2007; Jamie Jonkel, personal communication). In addition, there are media reports of two other grizzly bears killed in Idaho after presumably crossing Interstate Highway 90 (Maughn 2009). This author takes comfort in the following statement: “Good conservation planning does not depend on having complete data, only on making appropriate use of the best available data" (Davis 2013: 400).

The above data suggest it is most probable for NCDE grizzly bears to immigrate to the Selway-Bitterroot Ecosystem. It is less probable for them to move northward from the GYE across Interstate Highway 90 between Bozeman and Big Timber. None have apparently done so thus far but that does not mean they cannot or will not. As early as 1986, one scientist speculated that Interstate 90 might be a dispersal barrier but not an absolute one (Picton 1986). More underpasses in the right locations might help them get across Interstate 90 in this region. However, even more importantly, additional control of intervening land use would be important in allowing the bears to reach these interstate highways more easily. Forman (2003:479) said "No absolute barriers exist in nature, only filters." A related question is whether man-made barriers could be absolute? We await a crossing of Interstate Highway 90 east of Bozeman by a GYE grizzly bear.

There were some interesting by-product results of this mapping. First, it has confirmed that there are roads and mining claims/oil and gas leases in USFS roadless areas. Secondly, on the other hand, wilderness areas have thwarted road building and the exploitation of mining claims and oil and gas leases. Thirdly, wilderness areas in the GYE have served as buffer zones for Yellowstone National Park. However, the future of USFS roadless areas serving as buffer zones is unknown at this time. Now we move to the policy analysis aspect of this research.

Planning Insight

Under a simulated boom scenario, all privately owned natural landscape in the GYE will be developed in 40 years (Gude et al. 2007). Easements are the best way to protect private land. The Northern Rockies Ecosystem Protection Act, if enacted, could expand some existing protected areas, add still others, and create some vital habitat corridors. The USFS and BLM can make land exchanges with private land owners. With congressional support, NPS could expand the boundaries of Yellowstone National Park by annexing parts of adjacent national forests (Chapter 12). NPS needs clarification of its authority to regulate land use on both federal and private land outside park boundaries. County planning is unfortunately now conducted largely in isolation from what other GYE counties do and few have a county wide zoning plan (Hernandez 2004). Improving state planning is feasible if all three states could plan in unison. Effective regional planning is also a possibility. However, national land use planning legislation, another "Vision Document" exercise, or turning the GYE into a model biosphere reserve, all seem unlikely at this time due to predicted opposition by special interest groups (e.g., private land rights advocates and the natural resource extraction industries).   Magic solutions remain elusive. Climate change should exacerbate the problems already created by habitat fragmentation. However habitat connectivity is a key mitigation measure for habitat fragmentation and climate change. For climate change, the natural integrity or restoration of entire regional landscapes is needed. Thus we are advised to manage the entire intervening matrix (Hannah and Hansen 2005). The future of the GYE will hinge on its governance (Brunner et al. 2002).

The Future

According to Soulé and Terborgh (1999), the existing protected areas in North America will not provide adequate area and connectivity to allow long-term, large-scale ecological processes required to maintain biological diversity, which includes grizzly bears in the GYE. As Glick and Clark (1998: 253) stated, “Effective cross-boundary resource management in the GYE still is in its infancy.” Cross-boundary management is critical for the long term persistence of many species (Pierce et al. 2005) and is one our greatest 21st century biological diversity conservation challenges. Craighead et al. (1995: preface) correctly framed the issue in social rather than biological terms: “resource management agencies must focus on the broad problem of preserving and managing habitat in a resource exploitative society where politics and economic policies thwart sustainable resource management.”

The problem of increasing habitat insularity of national parks and wilderness areas in the GYE is a “wicked” environmental problem which is “characterized by a high degree of scientific uncertainty and a profound lack of agreement on values” (Balint et al. 2011: ix). This research does document the results of some past land use decisions.

Yellowstone National Park has been called the "last refuge" (Robbins 1993) at least in the lower 48 states (Figure 72). The optimism expressed in 1993 about the future of the

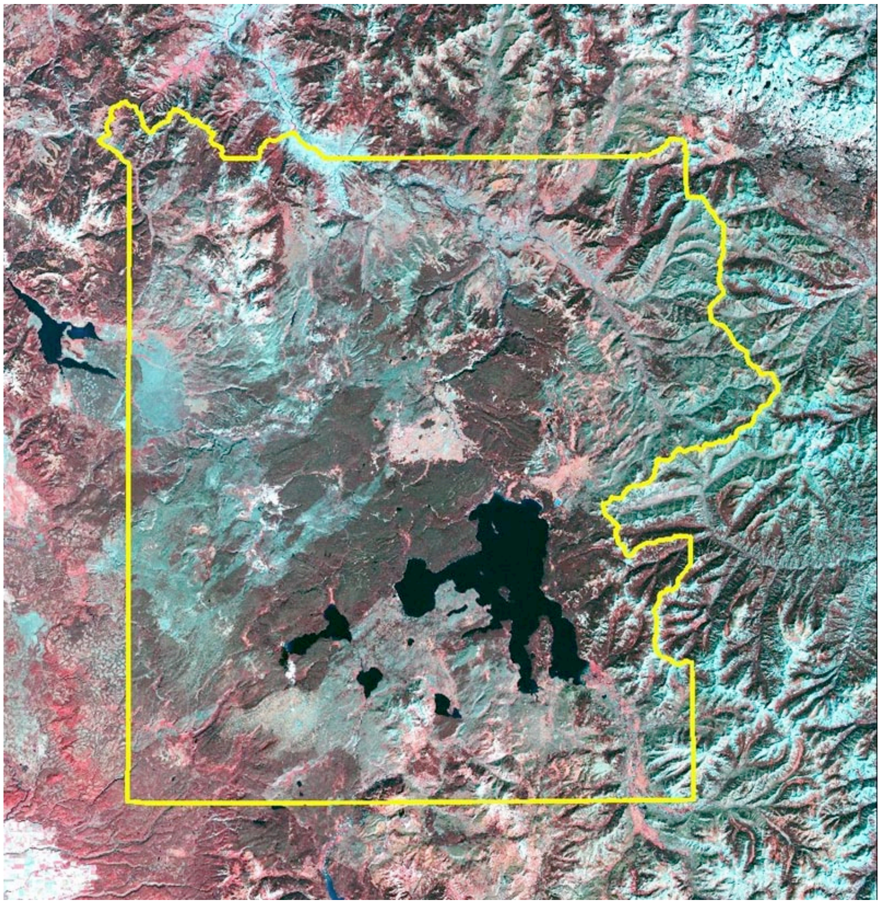


Figure 72. Landsat TM June 15, 1997 image of Yellowstone National Park and vicinity (http://earth.rice.edu/mtpe/bio/biosphere/topics/yellowstone/jpg)

GYE is no longer persuasive: "It will be relatively easy to do it right in the GYE and by doing so we will show how it can be done" (Boyce 1993: 17). Although great strides have been made in the last two decades, unless more steps are taken to control land use, it is likely that the GYE will become a permanent habitat island for one major subpopulation of grizzly bear in the lower 48 states.   But the GYE is not alone. The concern about emigration from the GYE by the grizzly bear can be extended to other large mammals in some other units of the U.S. National Park System (Figure 73).

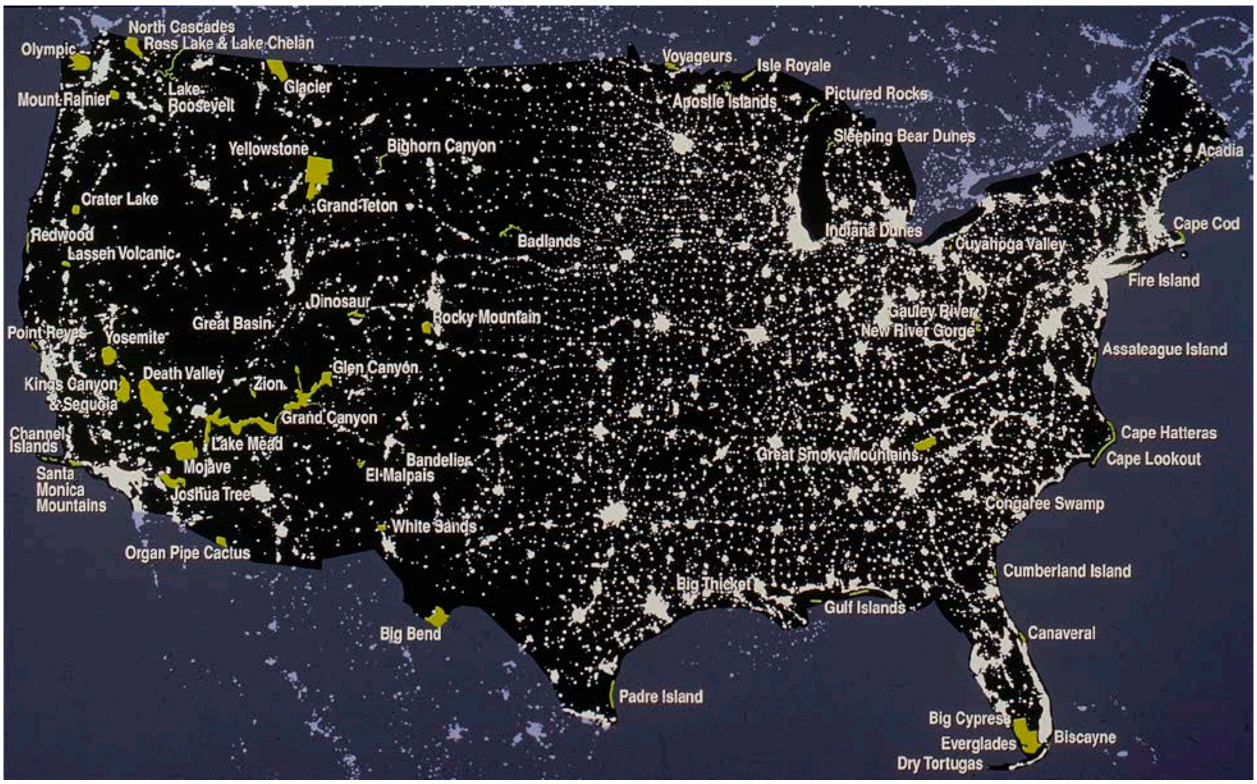


Figure 73. Large natural area units of the National Park System superimposed on a composite night satellite image of the United States. Images were derived from the US Air Force Meteorological Satellite Program
http://www.kui.name/NEWS/astroing/view_364.html

Epilogue

The habitat fragmentation dilemma studied here is really one of competition for space. The growing human population in and around the GYE has been on a collision course with the spatial needs of the grizzly bear in the lower 48 states. Residential development, abundant roads, some resource extraction activity, and ORV recreation is making it hazardous for the isolated GYE grizzly bear population to immigrate to the Northern Continental Divide Ecosystem in Montana and Canada or the Selway-Bitterroot Ecosystem in Idaho and Montana. The land use solution would seem relatively easy if we could wave a magic wand and create a permeable matrix for the grizzly bear between these three ecosystems. That wand would halt further development on private land, purchase non-conforming or “in-the-way” private development or property, preserve critical and supportive ranchland open space, restore some USFS tertiary roads, build underpasses beneath primary and some secondary roads along with fences, and stop more resource extraction activities that demand roads. Unless many of these ongoing GYE land use pressures are subdued, the genetic diversity of the grizzly bear in the GYE can only be maintained via periodic translocations from other populations. How successful such efforts would be is unknown.

To this mix of negative influences on the grizzly bear we must add “management removals” (i.e., killing nuisance bears), conflicts with hunters and ranchers, and land uses like ORVs and ski resorts in grizzly bear habitat. The GYE grizzly bear is unfortunately caught in the middle of various U.S. western social conflicts: Old West vs. New West life styles and attitudes, pressures from the extractive industries to make a profit from the public lands, pressures to recreate on some key USFS lands with ORVs, Federal vs. State vs. county vs. municipal land use prerogatives, and NPS vs. USFS mandates. Many people realize that the grizzly bear is a symbol of the American wilderness and Yellowstone National Park is a symbol of the beginnings of nature preservation in the United States (Figure 74). However, its future rests firmly in American values.

Figure 74. Grizzly bear in the GYE. Photo by the US National Park Service. Available at:www.examiner.com/article/yellowstone-grizzly-bears-dying-at-record-rate Accessed January 2013.

The Yellowstone model has been emulated by other countries and they often still look to the United States for conservation leadership. Is this enough reason to keep the grizzly bear in the lower 48 states? However, to do so, sacrifices in how we use land in the GYE have to be made. Some inherent fears also will need to be overcome. Some local people in the GYE share the viewpoint of Idaho's former Governor Dirk Kempthorne who in 2000 said, "I oppose bringing these massive, flesh eating carnivores into Idaho." The United States may still have an opportunity to set an example of ecosystem management for the rest of the world, however, with each new subdivision that opportunity is fading fast.

As this research has illustrated, the expertise needed to do regional planning has changed. In order to do modern "conservation planning" (sensu Craighead and Convis 2013), a team effort is required or one individual must be familiar with the fields of "geography, urban and regional planning, economics, behavioral sciences, law and other disciplines" (Davis 2013:398). As Forman (1995:524) eloquently stated, "When we plan, when we conserve, when we design, when we manage, and when we make wise decisions for landscapes, and especially for regions, we manifest sustainable thinking and act for human generations."

REFERENCES

Anonymous. 2007. Far-roaming grizzly bear thought to have crossed I-90 in Idaho. *The Seattle Times* Available at: http://seattletimes.com/html/outdoors/2003927825_webgrizzly05.htm Accessed March 2013.

Balint, P.J., R.E. Steward, A. Desai, and L.C. Walters. 2011. Wicked Environmental Problems: Managing Uncertainty and Conflict. Island Press, Washington, D.C.

Boyce, M.S. 1993. Book review: An environmental profile of the Greater Yellowstone Ecosystem. *Park Science* 1(3). 17.

Brunner, R.D., C.H. Colburn, C.M. Cromley, R.A. Klein and E.A. Olson. 2002. Finding Common Ground: Governance and Natural Resources in the American West. Yale University Press, New Haven.

Craighead, J.J., J.S. Sumner and J.A. Mitchell. 1995. The Grizzly Bears of Yellowstone: Their Ecology in the Yellowstone Ecosystem, 1959-1992. Island Press, Washington, D.C.

Davis, F.W. 2013. Summary: building a broader base for conservation planning. In: F.L. Craighead and C.L. Convis, Jr. (eds) Conservation Planning: Shaping the Future, pp. 397-404. ESRI Press, Redlands, California.

Fleischman, E. et al. 2011. Top 40 priorities for science to inform US conservation and management policy. *BioScience* 61 (4): 290-300.

Forman, R.T.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, New York.

Forman, R.T.T. et al. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C.

Glick, D.A. and T.W. Clark. 1998. Overcoming boundaries: the Greater Yellowstone Ecosystem. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 237-256. Island Press, Washington, D.C.

Gude, P.H., A.J. Andrews, and D. Jones. 2007. Biodiversity consequences of alternative future land use scenarios in Greater Yellowstone. *Ecological Applications* 17(4): 1004-1018.

Hannah, L. and L. Hansen. 2005. Designing landscapes and seascapes for change. In T.E. Lovejoy and L. Hannah (eds), Climate Change and Biodiversity, pp. 329-341. Yale University Press, New Haven.

Hernandez, P.C. 2004. Rural residential development in the Greater Yellowstone: rates, drivers, and alternative future scenarios. MS Thesis, Montana State University, Bozeman, Montana.

Jean, C., A.M. Schrag, R.E. Bennetts, R. Daley, E.A. Crowe, and S. O'Ney. 2005. Vital Signs Monitoring Plan for the Greater Yellowstone Network. National Park Service, Greater Yellowstone Network, Bozeman, Montana, 107 pp.

Maughan, R. 2009. Grizzly bear shot by Idaho elk farmer south of Interstate 90. *The Wildlife News* Available at: www.thewildlifenews.com.../grizzly-shot-by-elk-farmer-south-of-Interstate.

Moon, Z.K. and F.L. Farmer. 2010. Human–induced switches on public land boundaries: the emergence of ecological islands. *Society and Natural Resources* 23(7): 636-652.

Olliff, T., G. Plumb, J. Kershner, C. Whitlock, A. Hansen, M. Cross, and S. Bischke. 2010. A science agenda for the Greater Yellowstone Area: responding to landscape impacts from climate change, land use change, and invasive species. *Yellowstone Science* 18(2): 14-22.

Picton, H.D. 1986. A possible link between Yellowstone and Glacier grizzly bear populations. *International Conference on Bear Research and Management* 6: 7-10.

Pierce, S.M., R.M. Cowling, A.T. Knight. A.T. Lombard, M. Rouget, and T. Wolf. 2005. Systematic conservation planning products for land-use planning: interpretation for implementation. *Biological Conservation* 125: 441-458.

Robbins, J. 1993. Last Refuge: The Environmental Showdown in Yellowstone and the American West. William Morrow, New York.

Servheen, C. and P. Sandstrom. 1993. Ecosystem management and linkage zones for grizzly bears and other large carnivores in the Northern Rocky Mountains in Montana and Idaho. *Endangered Species Bulletin* 18: 1-23.

Soulé, M. E. and J. Terborgh. 1999. The policy and science of regional conservation. In M.E. Soulé and J. Terborgh (eds), Continental Conservation: Scientific Foundations of Regional Reserve Networks, pp. 1-17. Island Press, Washington, D.C.

APPENDIX 1: CHAPTER 2 PUBLISHED

Environmental Management (2012) 50:1098–1110
DOI 10.1007/s00267-012-9946-y

Chronology of Awareness About US National Park External Threats

Craig L. Shafer

Received: 27 January 2012 / Accepted: 20 August 2012 / Published online: 6 October 2012

Abstract The objective of this paper is to raise understanding of the history of protected area external threat awareness in the United States and at World Protected Area Congresses. The earliest concerns about external threats to US national parks began in the late nineteenth century: a potential railroad transgression of Yellowstone National Park in the 1880s. During the early and mid 1930s, George Wright and colleagues focused on outside boundary concerns like of hunting and trapping of furbearers, grazing, logging, disease and hybridization between species. In the 1960s, a worldwide recognition began about the role of outside habitat fragmentation/isolation on nature reserves and human generated stressors crossing their boundaries. The *State of the Park Report 1980* added a plethora of threats: oil/gas and geothermal exploration and development, hydropower and reclamation projects, urban encroachment, roads, resorts, and recreational facilities. The early 1980s ushered in political interference with NPS threats abatement efforts as well as Congressional legislative initiatives to support the abatement challenges of the agency. By 1987, the Government Accounting Office issued its first report on National Park Service (NPS) progress in dealing with external threats. Climate change impacts on parks, especially in terms of animals adjusting their temperature and moisture requirements by latitude and altitude, surfaced in the technical literature by the mid-1980s. By 1992, the world parks community stressed the need to integrate protected areas into the surrounding landscape and human community. The importance of the matrix has gradually gained appreciation in the scientific community. This chronology represents one example of national park and protected areas' institutional history contributing to the breath of modern conservation science.

Keywords Protected area · External threats · US national parks · History · Natural resource management

C. L. Shafer (✉)
Department of Environmental Science and Policy, George Mason University, Fairfax, VA 22030-4444, USA
e-mail: cshafer@gmu.edu

> "It became evident that in order to make our national parks effective wildlife refuges we must cope with the conditions which affect wildlife outside of the parks as well as within them" Wright and Thompson 1935, p. 50

Introduction

The progression of national park and protected area external threat awareness in the United States, and to a lesser degree in the world parks' community, will be examined. The primary perceived threats (external and internal) to national parks which were more frequently reported by less-developed countries included unlawful entry, fire, drought, harassment of animals, removal of animals and plants, and conflicting demands imposed on management. In contrast, the perceived threats often reported by more-developed countries included exotic plants, chemical pollution, legal removal of animals, noise pollution, and mining (Machlis and Tichnell 1985, p. 79).These same authors reported that 24 % of the reported threats globally were coming exclusively from outside of the protected area (Machlis and Tichnell 1985, p. 52). My objective is to raise awareness of the history of national park external threat awareness in the United States and at World Protected Area Congresses.

Threats Terminology

As Burgess and Woolmington (1981) note, the concept of threat is highly anthropogenic, a social metaphor used in a biological context. In terms of ecology, threats are "suspected stresses," and "thus threat [is] roughly equal to perceived (and sometimes imagined) stress" (Burgess and Woolmington 1981, p. 419, quoted in Machlis and Tichnell 1985, p. 10). Determination of threat demands a nonscientific judgment (Rapport and Regier, 1980, quoted in Machlis and Tichnell 1985, p. 11). However, it did not take long until the concept of "threat" was incorporated into mainstream ecological literature (e.g., Evans and others 2011; Wilcove and others 1998). Some authors differentiate threats (=sources) from their impacts. "Threats to wilderness [and protected areas in general] are generally defined as change agents that cause impacts on wilderness resource conditions and values–what causes the impacts–not the impacts themselves" (Dawson and Hendee 2008, p. 353).

Early Omens: 1880s–1920s

When was it realized that influences outside US national park boundaries could have a negative impact on that park's biota? It began during the 1880s when Congress defeated a proposal by railroad and mining interests to build a railroad track through the northern portion of Yellowstone National Park (Bartlett 1989, p. 309–314; Sellars 1997, p. 15). Yet another form of external threat included poachers and looters. The enactment of the National Park Protective Act of 1894 (28 Stat. 73), or Lacey Act, sponsored by Congressman John Lacey, but long pushed for by Senator George Graham Vest, stopped the killing of Yellowstone game and the despoilment of its thermal features (Bartlett 1989, p. 317). Like many events new to national parks, things began at Yellowstone (Pritchard 1999).

As early as 1916, Joseph Grinnell and Tracy Storer stressed that exotic species should be kept out of the parks. They also wanted to bar the entry of dogs, cats, cattle and sheep (Grinnell and Storer 1916). The next year, E.W. Nelson, Chief of the Biological Survey, complained that range and forage, which sustained Yellowstone National Park's Rocky Mountain elk (*Cervus elaphus*) population during the winter, was being depleted by domestic livestock ranched beyond the park's boundary (Nelson 1917).

By 1920, the NPS Director's Annual Report mentioned problems stemming from development outside park boundaries (Foresta 1984, cited in Buechner and others 1992). The American Association for the Advancement of Science passed a resolution that same year which "strongly opposes the introduction of nonnative animals and plants into parks…" (American Association for the Advancement of Science 1925, p. 353).

In 1921, Victor Shelford, chairman of the Committee on the Preservation of Natural Conditions, Ecological Society of America, spoke about external influences impinging on parks: "Even the national parks must be watched and defended against external aggression" (Shelford 1921, p. 431). Eight years later, Horace Albright, the NPS's second director, noted development on national park doorsteps as a "pushing of civilization to the very lines of the parks" (Albright 1929, p. 507).

George Wright and Colleagues: Scientific Park Policy Blooms

George Wright and colleagues, influential NPS biologists of the 1930s, frequently used the terminology "external influences." For example, "This matter of external influence incessantly acting upon the faunal resources of a national park cannot be overestimated" (Wright and Thompson 1935, p. 124). To these biologists, external influences included a wide array of stressors: hunting and trapping of furbearers and large carnivores, grazing, logging, exotic species, disease and sub-species hybridization after translocations. Mining, oil and gas extraction, and water and geothermal projects, which were to become prominent in later decades, were not mentioned.

Wright and colleagues noted a number of national parks were suffering from "external influences" (Wright and others 1933; Wright and Thompson 1935). For example, livestock grazing was a problem in Bryce Canyon National Park, Utah; Grand Canyon National Park, Arizona; Zion National Park, Utah; Glacier National Park, Montana; Yellowstone National Park, Wyoming, Montana and Idaho, Jackson Hole National Monument, Wyoming; Calsbad Caverns, New Mexico; Lassen Volcanic and Sequoia National Parks, California and Mesa Verde National Park, Colorado. Hunting and trapping occurred in Yosemite National Park, California, Lassen Volcanic, California and Mesa Verde, Colorado. Lumbering was a threat in Grand Canyon, Lassen Volcanic, Sequoia and Yosemite. Development was a concern at Lassen Volcanic. Hunting, trapping and poisoning were mentioned at Zion, Lassen Volcanic, Rocky Mountain National Park, Colorado and Mount McKinley National Park, Alaska.

George Wright and colleagues' outlook was obvious in a popular brochure published in 1938: "As civilization impinges upon all boundaries of a park, the wildlife may be forced to live under restricted and somewhat unnatural conditions" (American Planning and Civic Association circa 1938). During the 1930s, the Ecological Society of

America recommended buffer zones around national parks mostly to protect large mammals from poaching (Shelford 1933). The story of George Wright and colleagues as modern conservation biology trailblazers is outlined in Shafer (2001).

The 1940s–1950s: Science on Hold

There was almost a 30-year hiatus of expressed concern about research until the 1960s which corresponded to the period when NPS support for science ebbed to its lowest point (Sumner 1983). That does not mean that the need for research or biological expertise was not discussed (Sellars 1997, p. 149–203) but little of substance happened. By the early 1940s, the federal government was measuring a diminishing water flow into Everglades National Park, Florida (Ackerman and others 1963, Appendix 3). By the late 1940s, NPS began opposing the building of Echo Park Dam on the Green River by the Bureau of Reclamation which would have flooded much of Dinosaur National Monument, Colorado and Utah (Sellars 1997, p. 177–178). The Echo Park dam proposal was fought by the Sierra Club and the Wilderness Society. In doing so, it promoted the growth of the wilderness movement culminating in the Wilderness Act of 1964 (Sellars 1997, p. 187). By 1948, Director Newton Drury was concerned about proposed dams at Grand Canyon National Park, Arizona; Kings Canyon National Park, California; Glacier National Park, Montana and Mammoth Cave National Park, Kentucky (Sellars 1997, p. 178). The 1950s did not usher in a new wave of observed external threats but instead brought a new internal threat promoted by the agency itself. Mission 66 resulted in the construction of 2,800 miles (4,506 km) of new and reconstructed roads, 330 new parking areas, 114 visitor centers and hundreds of houses for park staff (Wright 1992, p. 23).

The 1960s: International Awareness and the Leopold and Robbins Reports

In 1961, the NPS prepared a booklet under the direction of NPS biologist Howard Stagner entitled *Get the Facts and Put Them to Work* (NPS 1961, p. 2, cited in Sellars 1997). It claimed that national parks were "rapidly becoming islands." The first international forum for national park and protected area scientists, managers, administrators and policy makers occurred in June-July, 1962 in Seattle, Washington. This forum–The First World Conference on National Parks–generated 28 park management recommendations (Adams 1964). Recommendation 7 was preceded by the following statement: "Few of the world's parks are large enough to be in fact self-regulatory ecological units; rather, most are ecological islands subject to the direct or indirect modification by activities and conditions in the surrounding areas" (p. 378). Finally, external park threats captured international attention. Protected areas are defined as "An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of the natural and associated cultural resources, and managed through legal or other effective means" (International Union for the Conservation of Nature and Natural Resources 1994).

The famous "Leopold Report" (Leopold and others 1963) was completed at the request of Secretary of the Interior Steward Udall. The Secretary wanted a blue ribbon committee of wildlife experts to evaluate the Service's wildlife policies, especially elk grazing in Yellowstone National Park. Besides including the First World Conference recommendations, the report provided examples of park issues stemming from influences outside their boundaries, for example, past livestock grazing near the eastern border of Yosemite and Kings Canyon National Parks, California, might have affected the abundance of bighorn sheep (*Ovis canadensis*). The Leopold Report was adopted by NPS in 1964 (NPS 1970b). Udall asked a scientific panel to evaluate the Service's research activities. Their report, called the Robbins Report (Ackerman and others 1963), also issued in 1963, warned of changes in land use or economic activity outside national park boundaries (p. xiv). The water supply problem at Everglades National Park, Florida, was highlighted. Other external problems included water flow into Carlsbad Caverns National Park, New Mexico, a dam upstream from Mammoth Cave National Park, Kentucky, the decline of glaciers at Glacier National Park, Montana, and exotic plants in Yellowstone National Park, Wyoming, Montana and Idaho. A supplement to an NPS research handbook (NPS 1966, I-2) declared that external threats and habitat isolation were preceding hand-in-hand: "The national parks are, in essence, ecological islands…these islands are impinged upon by forces resulting from the increasingly intensive use of bordering lands. Among them are fire, forest insect and disease infestation, exotic plant and animal infestation, stream pollution, predator control, overlapping ranges of domestic stock and wildlife, and the like." This point was dramatically illustrated at Death Valley National Monument, California. During 1968, water levels in the Monument began declining as a result of agricultural irrigation on adjacent private lands threatening the survival of the Devils Hole pupfish (*Cyprinodon diabolis*) (Risser and others 1992).

Public awareness of external threats was slowly being fostered by NGO reports. In a postscript to the second edition of *Man and Nature in the National Parks* (Darling and Eichhorn 1969, p. 85), William Edy wrote, "The point is that we are witnessing an increasing threat to our national parks that comes from outside the area of their authority and control, and which dramatically affects not only their immediate interests but their very existence." The perception that national parks were becoming "islands of primitive America" was even noted in official NPS 1968 management policy (NPS 1970a, p. 16). The "external influences" terminology surfaced in writings about protected areas internationally (Westoff 1970, p. 113).

By 1963, the Glen Canyon Dam was constructed on the Colorado River only 20 miles (32 km) upstream from Grand Canyon National Park, Arizona. That dam permanently altered the river's water flow and biotic communities (Johnson and Carothers 1987). The Dam was constructed after the proposed Echo Park Dam on the Green River (inside Dinosaur National Monument, Utah and Colorado) was defeated in 1956. As Sellars (1997, p. 179) explained, "[T]he Service signed on to help manage a reservoir [Lake Mead] that would drown some of the most spectacular sandstone canyons in North America. The sacrifice of the area to a new reservoir was part of the price of the compromise that had prevented construction of the Echo Park dam." That is, in the 1940s the Department of the Interior's Bureau of Reclamation proposed to build the dam as part of the Colorado River Storage Project. This action instigated a nationwide controversy beginning 1949, a time before American environmentalism had taken hold (Harvey 1994). For other water problems in the country, by the early 1960s there was an increasing recognition that Everglades National Park, Florida, was being deprived of upstream freshwater inflow (Kushlan 1987).

The 1970s: NGOs Spread the Word

A task force working under the auspices of the Conservation Foundation criticized the NPS in 1972: "generally we believe the Park Service has been much too tardy, timid and reluctant in identifying and challenging external threats to the parks and in aggressively guarding the parks against these threats" (Strong and other 1972, p. 84). They recommended that the NPS should designate a "park-influence zone" around each park. They even recommended that the US federal government begin national land use planning.

In 1973 the National Parks Centennial Commission issued a progress report recommending that the NPS "investigate and seek to implement mechanisms whereby cooperative efforts and legal constraints and controls may be utilized to assure that development outside of the parks and adjacent to the boundaries is of a character that does not adversely impact the integrity of the parks themselves" (NPS 1973, p. 143).

The Second World Conference on National Parks was held in Yellowstone and Grand Teton National Parks, Wyoming, during September 1972. The issue of external influences and progressive park isolation surfaced at this conference. One participant recommended "buffer areas in cases where incompatible development just across the boundary would compromise the integrity of the park" (Nicholson 1974, p. 36). A management recommendation was that "compatible land-use practices be implemented outside the boundaries of national parks" (Elliott 1974, p. 448). NPS Director George Hartzog boldly stated "it is highly important that parks should not be treated as isolated reserves, but as integral parts of the complex economic, social, and ecological relationships of the region in which they exist" (Hartzog 1974, p. 155).

A 1974 inventory of problems suffered by federal parks as a result of activities on adjacent lands was enlightening (Kusler 1974). Based on inquires made of 130 national parks, recreation areas, parkways and historic sites, the following threats were noted: incompatible development, trespass (including ORVs), litter, destruction of scenic beauty, air pollution, water pollution and extraction, noise and others. The author made reasoned recommendations to protect national parks from the effects of incompatible development on bordering private lands.

The year 1978 was an important point in NPS history for dealing with outside influences. Redwoods National Park, California, established in 1968, was expanded ten years later due to logging on private lands adjacent to the park's boundary (Hudson 1979). The land cost the government \$1.5 billion (Mackintosh 1991). This was the first time that private land was added to a US national park to avert adjacent incompatible natural resource extraction.

The National Parks and Conservation Association inventoried problems on adjacent lands by querying national park Superintendents. Residential and industrial developments as well as energy extraction were key concerns (NPCA 1979a, b). The report was not scientific but relied on the professional judgment of NPS land managers. However, the report caused Congress to ask NPS to do a State of the Parks Report that was completed in 1980. Almost concurrently, the Conservation Foundation conducted a broader survey of multiple federal land management agencies (e.g., US Forest Service, Bureau of Land Management, Fish and Wildlife Service) to ascertain their relationships with their US non-federal land neighbors. Adjacent land impacts to national parks included diminishing scenery, water diversion, and air pollution (Shands 1979).

State of the Parks Report 1980: Public and Congressional Awakening

At the request of Congress, NPS completed the first comprehensive survey of threats to the US National Park System (NPS 1980). More than 50 percent of the threats came from outside park boundaries. The report stated "Many previously pristine areas today have become surrounded by and exposed to an ever growing array of incompatible and threatening activities on adjacent lands…" (p. 34). The common external threats nationwide included industrial and commercial development, urban encroachment, air pollution and roads. More than 75 percent of the threats in this 1980 report were deemed insufficiently documented by scientific data. The report admitted that science-based documentation was not available for all threats and damages listed. It relied heavily on the professional judgment of land managers. This downside unfortunately was used to impugn the report by those who disliked its findings. However, many environmentalists and others recognized the importance of the reports' overall message. Reese (1984) correctly perceived the threats posing the greatest danger to the Greater Yellowstone Ecosystem (GYE) included oil/gas and geothermal exploration and development, mining, logging, hydropower and reclamation projects, resorts, subdivisions and recreational facilities. Most importantly, the report instigated American public awareness that US national parks were threatened by many influences outside their boundaries.

The report was unusually candid for a government document. Once Service leaders realized the negative public attention the report was garnering, they downplayed the seriousness of its findings (Sellars 1997). A 1986 Department of the Interior memorandum instructed NPS to drop the term park "threats" and adopt the more benign descriptor "adverse actions" (Zasowsky and Watkins 1994, p. 47). The report confirmed Sax's (1980, p. 106) observation: "You cannot build a wall around the parks and close your eyes to what goes on outside them." It also ended what Sax referred to as the agency's "enclave mentality" (Zaslowsky and Watkins 1994, p. 45). The public was now more involved in agency "affairs."

The following year the NPS produced a plan to help mitigate external threats (NPS 1981); however, with the exception of an endeavor to train NPS staff in doing specific resources management tasks, and in spite of NPS efforts to move forward, these initiatives fizzled out after the arrival of President Ronald Reagan's new Secretary of the Interior James Watt (Cahn 1982). During this time, NPS was instructed not to deal with or even talk about many resource issues occurring outside park boundaries. Abating external threats was perceived by some special interest groups as an infringement on private land rights and a preclusion of industry's resource extraction opportunities (Shafer 1999a). After a request by Congress to investigate, the Government Accounting Office (GAO) (1987) confirmed that most of the specific initiatives set forth by NPS in 1981 had not gone to fruition. This period of attempted threats' abatement by NPS was documented in detail (Supernaugh 1994). NPS (1988) presented an even more dismal picture than NPS (1980) on the degree that park resources were being impacted and their habitat isolated by adjacent human activities.

Beginning in 1982 and ending in 1992, various pieces of legislation were introduced in the US Congress to thwart external threats to national parks (Hiscock 1986; Keiter 1985). Congressional oversight hearings on park threats were held during February, March and June 1982 (Hiscock 1986, p. 43). None of this legislation became law due to political pressure exerted by special interest groups (Shafer 1999a).

Other 1980s Events: Activity Abounds

The Third World Congress on National Parks took place in Bali, Indonesia in 1982. By this time external threats were recognized as a serious worldwide problem. One recommendation of the Congress called for action to "reduce the external threats to protected areas" (McNeely and Miller 1984, p. 769). As a follow-up to this Congress, Machlis and Tichnell (1985) conducted a survey of 135 national parks in 49 countries. The results were summarized two years later: "Stage of economic development [sensu developed versus developing countries] emerged as a powerful variable related to type of threat, its location, and the 'core' of common threats faced by national parks" (Machlis and Tichnell 1987, p. 155).

By the mid-1980s, specific park threats in the 1980 *State of the Parks Report* were publicized by national conservation organizations like the Audubon Society (Elfring 1985, 1986a). This included pesticide application outside of Dinosaur National Monument, Colorado and Utah; mineral extraction, timber harvest, road construction and oil and gas leasing outside of Glacier National Park, Montana; a planned nuclear waste dump outside of Canyonlands National Park, Utah; additional attention to water diversion outside of Everglades National Park, Florida; and geothermal drilling, oil and gas leasing, and residential development outside of Yellowstone National Park, Wyoming, Idaho, and Montana. Park managers became concerned about private land development moving closer to the boundaries of Saguaro National Monument, Arizona (Shaw 1996). The Conservation Foundation (1985) concluded that the most frequently reported threat was development but they used the term broadly to include urban encroachment, utility infrastructure, mineral exploration, and logging. This NGO also called for "an inventory of cases in which park boundaries need to be expanded to protect the parks from external activities…" (p. 275–276).

When the Subcommittee on Public Lands of the House Interior Committee of Interior and Insular Affairs held hearings on the GYE in 1985, Freemuth (1991) inferred that the members were more concerned about external threats to national parks than the actual focus of the hearing: regional ecosystem management. Congress requested the Congressional Research Service to study the GYE resulting on a report a year later (Congressional Research Service 1986). By now external threats to the US National Park System were receiving attention in some professional journals (Elfring 1986b; Sun 1985). The Chairman of the Subcommittee on National Parks and Recreation, House Committee on Interior and Insular Affairs, asked the GAO to prepare a report. The resultant document was not just critical of progress in NPS threats abatement activity but also found fault in monitoring, documenting and mitigating threats (GAO 1987). Progress in modeling the threats issue was underway by park scientists. Schonewald-Cox and Bayless (1986) proposed their "boundary model" based on personal experience with US National Park System external threats.

Problems in specific units of the National Park System independent of these agency or NGO "threats reports" were themselves gaining public attention. The impacts of the Glen Canyon Dam on Colorado River riparian ecosystems in the Grand Canyon National Park, Arizona, became a concern (National Research Council 1987). From 1979 to 1981, air pollution was being measured in Southwestern units of the National Park System (Ostrov 1982). In the eastern US an air pollution detection device was installed at Great Smoky Mountains National Park, North Carolina and Tennessee, in the early 1980s and monitoring there has continued (Shaver and others 1994). NPS began experiments in 1987 to monitor haze in Grand National Park, Arizona (National Research Council 1990) though attempts to monitor for visibility started in 1978 (Shaver and Malm 1996).

A 1988 report by the National Parks and Conservation Association (NPCA) stated "The National Park Service should immediately begin an evaluation of lands around parks which have significant potential for adversely affecting park resources… If a park 'zone of concern' were established around a park, mapped and well publicized, potential users of these adjacent lands would know beforehand that the rules were somewhat different within the zone" (NPCA 1988, p. 23).

The NPCA and NPS appointed an independent commission to prepare a report that would update the Leopold Report (Leopold and others 1963). The resulting Gordon Report (1989) stressed that park Superintendents need to partner with diverse individuals and organizations in order to manage ecosystems that extend beyond park boundaries. The decade ended with an event noticed around the world. The beaches of Kenai Fjords National Park and Katmai National Park and Preserve, Alaska, were inundated with oil when the Exxon tanker *Valdez* went aground. This "external event" spilled 11 million gallons of crude oil into Prince Williams Sound which found its way to some national parks (Risser and others 1992).

The 1990s: Activity Continues

In 1990, the NPS Director concluded that the largest threats facing US national parks came from outside park boundaries (Ridenour 1990, cited in Buechner and others 1992). One NPS workshop produced recommendations on how to integrate parks into the larger regional landscape (Dottavio and others 1990, p. 69–74). Another report one year later by the NPCA declared that development outside park boundaries was among the five major threats facing the National Park System (NPCA 1991). J. Kenney (1991), writing in the Association's magazine, listed the most significant external threats to parks: oil and gas exploration and extraction, geothermal exploitation, hard-rock mining and logging on adjacent agency lands, urban encroachment and oil and gas development on state and private lands, and air pollution.

John Freemuth (1991), a Boise State University political scientist, examined in detail tar sands development near Canyonlands National Park, Utah, and adjacent to and inside Glen Canyon National Recreation Area, Utah and Arizona. Other NGOs (e.g., Natural Resource Defense Council) showcased certain external threats like air pollution, river management and development at Grand Canyon National Park, Arizona; urban smog/acid rain and private land development at Acadia National Park, Maine and Shenandoah National Park, Virginia; uranium mining outside of Arches National Park, Utah; logging, oil/gas leasing, mineral development, and grizzly bear/bison killing next to Yellowstone National Park, Idaho, Montana and Wyoming; water diversion and potential airport construction outside of Everglades National Park, Florida; channel dredging and wildlife poaching at Cumberland Island National Seashore, Georgia; antiquated upstream sewers, hazardous waste dumps and oil and gas operations at Cuyahoga Valley National Park, Ohio; and mineral exploration and development, hazardous waste spills, aircraft overflights, land development and grazing at Chaco Culture National Historical Park, New Mexico (Buccino and others 1997). National news media described the situation as "parks in peril" (Satchell 1997). The Natural

Resources Defense Council (1999) published a compendium of news media and magazine articles about threats to US national parks.

The working committees that produced *National Parks for the 21st Century: The Vail Agenda* (NPS 1991), an outgrowth of National Park Service's 75th Anniversary Symposium, recommended policy guidance in an array of NPS endeavors. The authors were very aware of the need to abate external park threats and plan in a regional context. One year later a respected science committee, commissioned to evaluate the NPS science program, published their conclusions. They were not oblivious to the need for research related to external threats (Risser and others 1992, p. 16): "Actions outside park boundaries are producing critical changes in ground and surface water, accelerated pest introduction, increasing stream sedimentation, and threatening wildlife populations." By now, magazines like *National Geographic* raised public awareness of external influences to national parks. One article in that magazine singled out housing construction, proposed highways and dams, and ongoing mining activity as of special concern (Mitchell 1994). GAO criticism extended into this decade (GAO 1994, 1995, 1997).

The Fourth Congress on National Parks and Protected Areas was held in Caracas, Venezuela, in February 1992. One of the recommendations of the Caracas Action Plan was to integrate protected areas into the surrounding region including the possible creation of buffer zones (McNeely 1993).

Awareness Extends to Other US Protected Areas: National Wildlife Refuges and Federal Wilderness Areas

As a result of the *State of Park Report 1980*, other US federal land management agencies began to survey their natural resource problems. US Fish and Wildlife Service (1983) reported that 58 % of the problems in national wildlife refuges were external in nature. The draft report copied some of the phraseology from NPS (1980) and said "In some cases, this degradation or loss of resource is irreversible. It represents a sacrifice by a public that, for the most part, is unaware that such a price is being paid." This statement was edited out of the final report by Reagan Administration political appointees. In addition, terms like "threats" and "conflicts" were downgraded to "problems" in the final version to appear less serious to the public (Zaslowsky and Watkins 1994, p. 180–181).

More than a decade later, Cole and Landres (1996) reviewed external threats to officially designated US wilderness areas. The threats included exotic species, domestic livestock, water flow disruption, and fire suppression. Other threats were only briefly mentioned: mining, gas and oil drilling, poaching, subsistence hunting and gathering, aerial overflights, and controlling disease and insects. A survey of wilderness managers in 1995 by Kelson and Lilieholm (1997) catalogued 60 different perceived impacts from external sources with the top five being fire, military overflights, exotic plants, air pollution and water pollution.

Climate Change: The Gravest External Threat

The most daunting impact of climate change on protected area biota reached the awareness of scientists in the mid-1980s (Peters and Darling 1985). There was a realization that some terrestrial reserve species cannot shift their latitudinal niche without running into an inhospitable human dominated landscape. "Few animals or plants would be able to cross Los Angeles on the way to new habitat" (Peters 1992, p. 22). There was also a question as to whether these species can move quickly enough to keep pace with predicted atmospheric temperature change

(e.g., Ritchie and MacDonald 1986). By the 1990s, such insight was gaining more attention (Peters and Lovejoy 1992). Scientific compilations of the entire climate change issue were released (Houghton and others 1996; Watson and others 1996) with updates to follow. There were some early efforts to provide protected area planners guidance in dealing with climate change (e.g., Shafer 1999b). The predictions for species extinctions based on climate change are chilling (Thomas and others 2003). By 2005, field documentation of climate change impacts was unequivocal (Lovejoy and Hannah 2005). The literature on global warming has burgeoned (e.g., Houghton 2005). Dealing with climate change will require more than just corridors between reserves (Kostyack and others 2011). This topic requires more in depth treatment than is feasible here.

The 2000s: Reports by Advisory Boards and Commissions

At the request of the Director of the NPS, the National Park System Advisory Board produced their report *Rethinking the National Parks for the 21st Century* (Franklin and others 2001). They recommended that the Service "encourage ecological stewardship outside the parks" and that parks should be "linked with other natural areas through wildlife migratory corridors and greenways" (p. 17). Years later, the National Parks and Conservation Association (NPCA) convened an independent commission and assigned them the task of creating a 21st century vision for the NPS. That vision report, the task of the National

Parks Second Century Commission, said "Today many of the most serious threats too our parks come from beyond their borders." For example, they noted that clearcutting on national and state forest land came right up to the boundary of Olympic National Park, Washington (Baker and others 2009, p. 26), an observation recognized much earlier (Shafer 1990, p. 8). They also noted that in the Greater Yellowtone Ecosystem during the last 20 years, "Human population has grown by 62 %, developed land by 350 %" (p. 41).

The State of America's National Parks, a report prepared by the National Parks and Conservation Foundation and published in 2011 (NPCA 2011), had a refreshing focus on the need for "landscape conservation." In other words, protecting US national parks required taking into account things going on in the surrounding region. The report listed activities that disrupted habitat connectivity: roads, logging, mining, residential development and grazing. In order the promote habitat connectivity, one inventive recommendation included Congress and the Administration offering land preservation incentives to private landowners who own land next to a park. Karkkainen (1997, p. 100) indicates that such incentives could include tax penalties/credits and tradable development rights. Another option is park expansion (Shafer 2010).

Matrix, Reserve Size and Outside Human Populations

The work of Jansen (1983, 1986) has been viewed by some conservation biologists as the beginning of an awareness of protected area "external threats." Jansen's examples included weedy species in abandoned or cultivated fields invading adjacent reserves. An awareness of external threats actually began more than half a century earlier for US national parks (Shafer 2001). History can provide important insights for modern ecology and conservation biology (or conservation science) (Meine 1999). Using modern landscape ecology jargon, it facilitated an appreciation of the importance of the "matrix." The matrix is "the most extensive and connected landscape element type present…a landscape element surrounding a patch" (Forman and Godron 1986, p. 596). For habitat islands, what exists in the matrix has recently been judged just as important as protected area size and habitat isolation for determining species number (Prugh and others 2008, cited in Triantis and Bhadwat 2011). The matrix can be an impediment for animals to traverse *and* a source of external threats to a reserve. Shafer (1990, p. 111–116) contrasted area/isolation affects with threats from external influences two decades earlier. This represents one example of national park and protected areas institutional history contributing to the breath of modern conservation biology.

An appreciation of the importance of park size and isolation is in large part the result of Newmark's (1986, 1987, 1995) research documenting that some mammalian extinctions in some North American national parks were correlated with park area. Newmark interpreted his work as implicating habitat size and isolation as the reason for the extinctions. However, related reasons for many of these extinctions have surfaced, namely outside human population density (Parks and Harcourt 2002). The same correlation between protected area species extirpations and outside human density was found for small West African parks (Harcourt and others 2001). It is hard to escape the conclusion that human activities outside protected areas play an important role in local species extirpations. One thing is very clear: animal species that wander out of protected areas around the world suffer mortalities and even local extirpations (Woodruffe and Ginsberg 1998). Thus the importance of the matrix to protected areas, which includes humans and their many activities, has gradually gained appreciation in the scientific community. In the international arena, the International Union for the Conservation of Nature (IUCN) was advocating that assessments of park management effectiveness include a consideration of development outside their boundaries (Hockings and others 2000). Writers discussing world parks observed "all manner of dynamic fluxes" moving across park boundaries (Myers 1984, p. 658, cited in Fall 2002).

What Does History Tell Us?

In the United States, a concern about outside development affecting protected areas can be traced back to 1920 (Foresta 1984), however, a general concern about mining, oil/gas extraction, and geothermal projects did not surface until 1979/1980 (NPCA 1979a, b; NPS 1980). Thus the *source* of these external threats expanded over time. The *State of the Park Report 1980* (NPS 1980) brought the issue of external threats to the attention of the US public and the Congress. This report represented an attempt to produce a credible list of park threats based on land managers' professional judgment albeit without across-the-board solid scientific documentation. Actions by Congress to help abate external threats to US national parks through new legislation began in 1982 but legislative efforts stopped in the early 1990s. During most of the 1980s, any NPS attempts to abate and publicize external national park threats were blocked by the Reagan administration. Science, planning, management and politics will always be unavoidably intertwined when addressing external threats to protected areas. As Harold Eidsvik (cited in Lowry 1998, p. 21) stressed in 1985, "Parks are a creation of the political process." Their management cannot avoid politics either (Shafer 2010).

Awareness in the United States after 1980 about outside park boundary concerns coincided with the same insight at the Third World Parks Congress in 1984 (Fall 2002). There was a general awakening in the mid-1970s, and especially by 1980, in the US conservation biology community about the importance of protected area size, habitat isolation and reserve system distribution (Frankel and Soulé 1981; Soulé and Wilcox 1980). A book about nature reserve design, written by an NPS staff ecologist, surfaced a decade later touting the importance of corridors and buffer zones (Shafer 1990). However, it was not until 2001 that a blue ribbon commission recommended that US national parks be connected by corridors (Franklin and others 2001). Some overall observations are warranted.

One must ask why such a time lag existed between publishing about a problem in 1990 and the resultant agency policy on the need for habitat corridors in 2006 (NPS 2006)? Until bolstered by recommendations

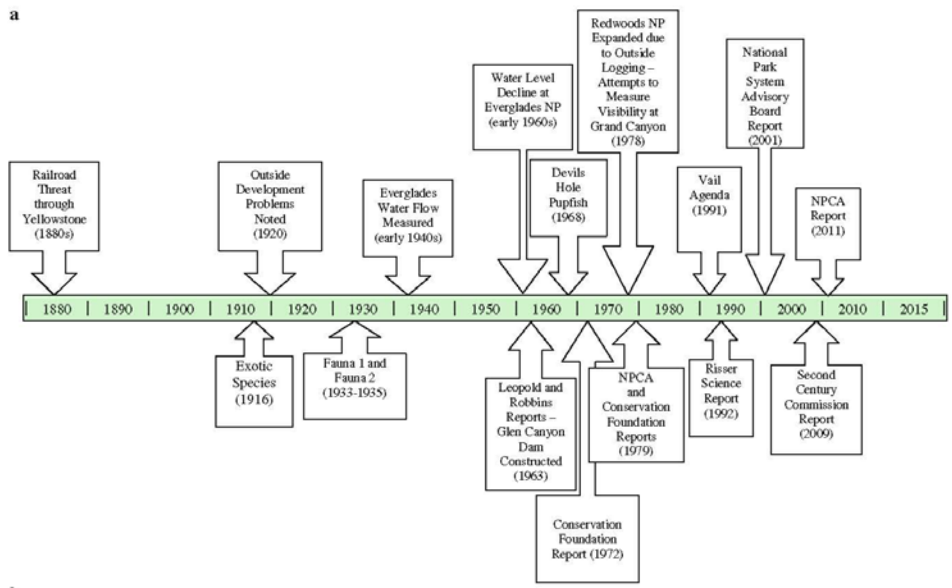


Fig. 1 **a** External threats timeline 1880–2015. **b** External threats timeline 1980–1990

championed by some respected high-level body, the NPS usually does not pursue bold policy initiatives. To be fair, however, during the early part of the decade after the turn of the century, NPS was embroiled in trying to keep its 2001 management policies from being altered by the George W. Bush Administration, a feat largely achieved by 2006 with the aid of an outraged public (Sellars 1997, p. 291–308). Stonewalling by that administration was common. For example, a 2004 scientific commission report on US national parks was withheld from public release for five years (Shafer 2010, p. 96). Figure 1a, b provides a US national park external threats awareness timeline. Based on experience since the late 1970s, the NPS usually does not undertake major threats abatement activities unless first pushed by NGOs or the Congress. NPS data on park threats and their impacts did not typically include impeccable scientific documentation for all threats. Such is the nature of threats reporting which relies heavily on land managers' professional judgment. The exact nature of such preferred documentation was not addressed in 1980 (NPS 1980). The reality is that documentation is often not possible or feasible. In lieu of better scientific support, it would be a mistake to view the professional judgment of park managers as unworthy of serious concern.

Lastly, there has been a steady stream of various commissioned and NGO reports dealing with park problems since the 1960s (see Risser and others 1992). However, it remains unclear as to the extent of the follow-up on these various recommendations. One significant agency initiative stands out: the 1999 Natural Resource Challenge (http://nature.nps.gov/challenge/reportstocongress.cfm).

After recognizing external threats to protected areas, the importance of park size and habitat isolation, and realizing that surrounding human populations can represent sink habitat (Pulliam 1988), one must wonder whether reserves can be designed, or governance systems put in place, to lessen these threats. This is a key issue facing all protected area managers. This broad topic is grist for future articles. The last phase of protected area design should entail "Integrating and coordinating with land use planning processes outside of protected areas" (Quinn and Alexander 2008, p. 74). As Pierce and others (2005) argued, this step is critical for the long term persistence of species in protected areas. Indeed, it may represent one of the greatest 21st century biological diversity conservation challenges facing the United States and the world.

Acknowledgments I thank Judy Shafer, George Taylor, Chris Parsons and two anonymous reviewers for comments on the draft manuscript. I thank the US National Park Service for affording me the work experience to write about this subject.

References

Ackerman EA, Bates M, Cain SA, Darling FF, Fogg JM Jr, Gil T, Gillson JM, Hall ER, Hubbs CL, Robbins WJ (1963) A report by the advisory committee to the National Park Service on research. National Academy of Sciences-National Research Council, Washington, DC, 156 pp

Adams AB (ed) (1964) Proceedings of the first world conference on national parks. National Park Service, Department of the Interior, Washington, DC, 471 pp

Albright HM (1929) Our national parks as wild life sanctuaries. Am For For Life 35:505–507, 536

American Association for the Advancement of Science (1925) A resolution bearing on the introduction of non-native plants and animals into the national parks of the United States. In: Grinnell GB, Sheldon C (eds) Hunting and conservation: the book of the Boone and Crockett Club. Yale University Press, New Haven

American Planning and Civic Association (circa 1938) Portfolio on the national park and monument system. Part II: conservation of nature. American Civic Association, Washington, DC

Baker HH Jr, Johnston JB, Bilmes L, Blanchard JJ, Chen M, Colwell R, Earle S, Fahey J, Faustinos B, Fazio V Jr, Finney C, Galvin DP, Hinojosa M, Jewel S, Knowles T, Lockhart SH, Long G, McPherson J, Nash GB, Senge PM, Shanley DA, West WR Jr, Wheatley M, Wilson EO (2009) Advancing the national park idea: national parks second century commission report. National Parks and Conservation Association, Washington, DC, 46 pp

Bartlett RA (1989). Yellowstone: a wilderness besieged. University of Arizona Press, Tucson, 437 pp

Buccino S, Clusen C, Norton E, Wald J (1997) Reclaiming our heritage: what we need to do to preserve America's national parks. Natural Resources Defense Council, New York, 100 pp

Buechner M, Schonewald-Cox C, Sauvajot R, Wilcox BA (1992) Cross-boundary issues for national parks: what works "on the ground?" Environ Manag 16(6):799–809

Burgess JS, Woolmington E (1981) Threat and stress in the Clarence River Estuary of northern South Wales. Hum Ecol 9(4):419–431

Cahn R (1982) Quelling the storm: what will it take. Christ Sci Monitor 18:1–6

Cole DN, Landres PB (1996) Threats to wilderness ecosystems: impacts and research needs. Ecol Appl 6(1):168–184

Congressional Research Service (1986) Oversight hearing before the Subcommittee on Public Lands and the Subcommittee on National Parks and Recreation of the Committee on Interior and Insular Affairs, House of Representatives, 99th Congress. First Session on Greater Yellowstone Ecosystem, Washington, DC, Oct 1985. Serial No. 99–18

Conservation Foundation (1985) National parks for a new generation: visions, realities, and prospects. The Conservation Foundation, Washington, DC, 407 pp

Darling FF, Eichhorn ND (1969) Man and nature in the national parks: reflections on policy. The Conservation Foundation, Washington, DC, 86 pp

Dawson CP, Hendee JC (2008) Wilderness management: stewardship and protection of resources and values (4th edn). Fulcrum Publishing, Golden, 525 pp

Dottavio FD, Brussard PF, McCrone JD (eds) (1990) Protecting biological diversity in the national parks: workshop recommendations. Transactions and proceedings series no. 9. National Park Service, Department of the Interior, Washington, DC, 79 pp

Elfring C (1985) Wildlife and the National Park Service. In: Eno AS, Di Silvestro RL (eds) Audubon wildlife report 1985. The National Audubon Society, New York, pp 280–304

Elfring C (1986a) Wildlife and the National Park Service. In: Eno AS, Di Silvestro RL, Chandler WJ (eds) Audubon wildlife report 1986. The National Audubon Society, New York, pp 463–494
Elfring C (1986b) US parks at a crossroads. BioScience 36:301–304
Elliott HE (ed) (1974) Second world conference on national parks. IUCN, Morges, 504 pp
Evans MC, Watson JE, Fuller RA, Venter O, Bennett SC, Marsack PR, Possingham HP (2011) The spatial distribution of threats to species in Australia. BioScience 61(4):281–289
Fall J (2002) Divide and rule: constructing human boundaries in "boundless nature". GeoJournal 58:243–251
Foresta R A (1984) America's national parks and their keepers. Johns Hopkins University Press, Baltimore, 328 pp
Forman RTT, Godron M (1986) Landscape ecology. Wiley, New York, 617 pp
Frankel OH, Soulé ME (1981) Conservation and evolution. Cambridge University Press, London, 327 pp
Franklin JH, Chandler RS, Brown ML, Earle SA, Gonzales JM, Jordan CR, Malcolm SM, Nabhan GP, Ridder MW, Selengut S, Westbrook P, Williams TB (2001) Rethinking the national parks for the 21st century. National Geographic Society, Washington, DC, 40 pp
Freemuth JC (1991) Islands under siege: national parks and the politics of external threats. University of Kansas, Lawrence, 186 pp
Gordon JC (chairman) (1989) National parks: from vignettes to global view. National Park Service, Washington, DC, 13 pp
Government Accounting Office (1987) Parks and recreation: limited progress made in documenting and mitigating threats to parks. GAO/RECD-87-36
Government Accounting Office (1994) National Park Service: activities outside park borders have caused damage to resources and will likely cause more. GAO/RCED-94-59
Government Accounting Office (1995) National parks: difficult choices need to be made about the future of the parks. GAO/RCED-95-238
Government Accounting Office (1997) National parks: National Park Service needs better information to preserve and protect resources. GAO/RCED-97-76
Grinnell J, Storer TL (1916) Animal life as an asset of national parks. Science 44:375–380
Harcourt AH, Parks SA, Woodruffe R (2001) Small reserves face a double jeopardy: small size and high surrounding human density. Biodivers Conserv 10:1011–1026
Hartzog GB Jr (1974) Management considerations for optimal development and protection of national park resources. In: Elliott H (ed) Second world conference on national parks. IUCN, Morges, pp 155–161
Harvey MWT (1994) A symbol of wilderness: Echo Park and the American wilderness. The University of New Mexico Press, Albuquerque
Hiscock JW (1986) Protecting national park system buffer zones: existing and proposed authority. J Energy Law Policy 7:35–94
Hockings M, Stolton S, Dudley N (2000) Evaluating effectiveness: a framework for assessing the management of protected areas. IUCN, Gland, 121 pp
Houghton J (2005) Global warming. Rep Prog Phys 68:1343–1403. doi:10.1088/0034-4885/68/6/R02
Houghton JT, Filho M, Callander BA, Harris N, Kattenburg A, Maskell K (eds) (1996) Climate change 1995-the science of climate change: contribution of working group I to the second assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, 588 pp
Hudson D (1979) Sierra Club vs. Department of the Interior: the fight to preserve the Redwood National Park. Ecol Law Q 7:781–859
International Union for the Conservation of Nature and Natural Resources (1994) Guidelines for protected area categories. IUCN Commission on National Parks and Protected Areas with assistance of the World Conservation Monitoring Center, Gland, 257 pp
Janzen DH (1983) No park is an island: increase in interference from outside as park size decreases. Oikos 41:402–410
Janzen DH (1986) The eternal external threat. In: Soulé M (ed) Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, MA, pp 286–303
Johnson RR, Carothers SW (1987) External threats: the dilemma of resource management on the Colorado River, Grand Canyon National Park, USA. Environ Manag 11(1):99–107
Karkkainen BC (1997) Biodiversity and land. Cornell Law Rev 83:1–104
Keiter RB (1985) On protecting the national parks from the external threats dilemma. Land Water Law Rev 20(2):355–420
Kelson AR, Lilieholm RJ (1997) The influence of adjacent land activities on wilderness resources: U.S. wilderness manager perceptions. Int J Wilderness 3(1):25–28
Kenney J (1991) Beyond park boundaries. National Parks 66(7/8): 20–25
Kostyack J, Lawler JL, Goble DD, Olden JD, Scott JM (2011) Beyond reserves and corridors: policy solutions to facilitate the movement of plants and animals in a changing climate. BioScience 61(9):713–719
Kushlan JA (1987) External threats and internal management: the hydrological regulation of the Everglades, Florida, USA. Environ Manag 11(1):109–119
Kusler JA (1974) Public/private parks and management of private lands for park protection. Institute for Environmental Studies Report No. 16, Institute for Environmental Studies, University of Wisconsin, Madison, 178 pp
Leopold AS, Cain SA, Cottam CM, Gabrielson IN, Kimball TM (1963) Wildlife management in the national parks: advisory board on wildlife management appointed by the Secretary of the Interior. Trans N Am Wildl Nat Resour 28:29–44
Lovejoy TE, Hannah, L (eds) (2005) Climate change and biodiversity. Yale University Press, New Haven, 418 pp
Lowry WR (1998) Preserving public lands for the future: the politics of intergenerational goods. Georgetown University Press, Washington, DC, 297 pp
Machlis GE, Tichnell DL (1985) The state of the world's parks: an international assessment for resource management, policy and research. Westview Press, Boulder, 131 pp
Machlis GE, Tichnell DL (1987) Economic development and threats to national parks: a preliminary analysis. Environ Conserv 14(2):151–156
Mackintosh B (1991) The national parks: shaping the system. National Park Service, Department of the Interior, Washington, DC, 128 pp
McNeely J (ed) (1993) Parks for life: report of the IVth World Congress on National Parks and Protected Areas. IUCN, Gland, 252 pp
McNeely JA, Miller KR (1984) Recommendations of the World National Parks Congress. In: McNeely JA, Miller KR (eds) National parks, conservation, and development: the role of protected areas in sustaining society. Smithsonian Institution Press, Washington, DC, pp 765–776
Meine C (1999) It's about time: conservation biology and history. Conserv Biol 13:1–3
Mitchell JG (1994) Our national parks. National Geogr 186:2–55
Myers N (1984) Eternal values for the parks movement and the Monday morning world. In: McNeely JA, Miller KR (eds) National parks, conservation, and development: the role of

protected areas in sustaining society. Smithsonian Institution Press, Washington, DC, pp 656–660
National Park Service (1961) Get the facts and put them to work. National Park Service. Department of the Interior, Washington, DC
National Park Service (1966) Natural science research handbook. National Park Service, Department of the Interior, Washington, DC
National Park Service (1970a) Administrative policies for the national parks and national monuments of scientific interest (natural area category). US Government Printing Office, Washington, DC, 138 pp
National Park Service (1970b) Memorandum from the Secretary of the Interior to the Director of the National Park Service, July 10, 1964. In: National Park Service (ed) Administrative policies for the national parks and national monuments of scientific interest (natural area category). US Government Printing Office, Washington, DC, pp 76–80
National Park Service (1973) Preserving a heritage: final report to the President and Congress of the National Parks Centennial Commission. National Park Service, Department of the Interior, Washington, DC, 196 pp
National Park Service (1980) State of the parks 1980: a report to the Congress. National Park Service, US Department of the Interior, Washington, DC, 57 pp
National Park Service (1981) State of the parks: a report to the Congress on a servicewide strategy for prevention and mitigation of natural and cultural resources management problems. National Park Service, Department of the Interior, Washington, DC
National Park Service (1988) Natural resource assessment and action program. National Park Service, Department of the Interior, Washington, DC
National Park Service (1991) National parks for the twenty-first century: the Vail Agenda. Report and Recommendations to the Director of the National Park Service from the Steering Committee of the 75th Anniversary Symposium, Chelsia Green, VT, 142 pp
National Park Service (2006) Management policies 2006. National Park Service, Department of the Interior, Washington, DC, 168 pp
National Parks and Conservation Association (1979a) NPCA adjacent lands survey: no park is an island. National Parks Conserv Assoc Mag 53(3):4–9
National Parks and Conservation Association (1979b) NPCA adjacent lands survey: part II. National Parks Conserv Assoc Mag 53(4):4–7
National Parks and Conservation Association (1988) Investing in park futures. The national park system plan: a blueprint for tomorrow. Executive summary. National Parks and Conservation Association, Washington, DC, 44 pp
National Parks and Conservation Association (1991) A race against time: five threats endangering America's national parks and solutions to avert them. National Parks and Conservation Association, Washington, DC, 50 pp
National Parks and Conservation Association (2011) The state of America's national parks. Center for Park Research. National Parks and Conservation Association, Fort Collins, CO, 64 pp
National Research Council (1987) River and dam management: a review of the Bureau of Reclamation's Glen Canyon Environmental Studies. National Academy Press, Washington, DC, 203 pp
National Research Council (1990) Haze in the Grand Canyon: an evaluation of the winter haze intensive tracer experiment. National Academy Press, Washington, DC, 97 pp
Natural Resources Defense Council (1999) Parks for tomorrow: news and commentary about the problems confronting America's national parks. Natural Resources Defense Council, New York, 24 pp
Nelson EW (1917) The Yellowstone and the game supply. In: National Park Service (ed) Proceedings of the National Parks Conference. Government Printing Office, Washington, DC, pp 200–204
Newmark WD (1986) Species-area relationship and its determinants for mammals in western North American national parks. Biol J Linn Soc 28(1–2):83–98
Newmark WD (1987) A land-bridge island perspective on mammalian extinctions in western North American parks. Nature 325:430–432
Newmark WD (1995) Extinction of mammal populations in Western North American national parks. Conserv Biol 9(3):512–526
Nicholson EM (1974) What is wrong with the national park movement. In: Elliott HE (ed) Second world conference on national parks. IUCN. Morges, Switzerland, pp 32–37
Ostrov J (1982) Visibility protection under the Clean Air Act: preserving scenic and parkland areas in the Southwest. Ecol Law Q 10:397–454
Parks SA, Harcourt AH (2002) Reserve size, local human density, and mammalian extinctions in US protected areas. Conserv Biol 16(3):800–808
Peters RL (1992) Conservation of biological diversity in the face of climate change. In: Peters RL, Lovejoy TE (eds) Global warming and biological diversity. Yale University Press, New Haven, pp 15–30
Peters RL, Darling JDS (1985) The greenhouse effect and nature reserves. BioScience 35:707–717
Peters RL, Lovejoy TE (eds) (1992) Global warming and biological diversity. Yale University Press, New Haven, 386 pp
Pierce SM, Cowling RM, Knight AT, Lombard AT, Rouget M, Wolf T (2005) Systematic conservation planning products for land-use planning: interpretation for implementation. Biol Conserv 125:441–458
Pritchard AA (1999) Preserving Yellowstone's natural conditions: science and the perception of nature. University of Nebraska Press, Lincoln
Prugh LR, Hodges KE, Sinclair ARE, Brashares JS (2008) Effect of habitat area and isolation on fragmented animal populations. Proc Natl Acad Sci USA 105:20770–20775
Pulliam HR (1988) Sources, sinks, and population regulation. Am Nat 132:652–661
Quinn MS, Alexander SM (2008) Information technology and the protection of biodiversity in protected areas. In: Hanna KS, Clark DA, Slocombe DS (eds) Transforming parks and protected areas. Routledge, New York, pp 62–83
Rapport DJ, Regier HA (1980) An ecological approach to environmental information. Ambio 9(1):22–27
Reese R (1984) Greater Yellowstone: the national park and adjacent wildlands. Montana Magazine, Helena 104 pp
Ridenour JM (1990) The director's report: working with our neighbors. Courier 35:1
Risser PG et al (1992) Science and the national parks. National Academy Press, Washington, DC, 156 pp
Ritchie JC, MacDonald GM (1986) The patterns of post-glacial spread of white spruce. J Biogeogr 13:527–540
Satchell M (1997) Parks in peril. US News World Rep 123(3):22–29
Sax JL (1980) Mountains without handrails: reflections on the national parks. University of Michigan Press, Ann Arbor 152 pp
Schonewald-Cox CM, Bayless JW (1986) The boundary model: a geographic analysis of design and conservation of nature reserves. Biol Conserv 38:305–322
Sellars RW (1997) Preserving nature in the national parks: a history. With a new preface and epilogue for 2009 edn. Yale University Press, New Haven 403 pp
Shafer CL (1990) Nature reserves: island theory and conservation practice. Smithsonian Institution Press, Washington, DC, 189 pp

Shafer CL (1999a) US national park buffer zones: historical, scientific, social, and legal aspects. J Environ Manage 23(1):49–73
Shafer CL (1999b) Reserve planning to protect biological diversity: some basic elements. Landsc Urban Plan 44:123–153
Shafer CL (2001) Conservation biology trailblazers: George Wright, Ben Thompson, and Joseph Dixon. Conserv Biol 15(2):332–344
Shafer CL (2010) The unspoken option to help safeguard America's national parks: an examination of expanding US national park boundaries by annexing adjacent federal land. Columbia J Environ Law 35(1):57–125
Shands WE (1979) Federal resource lands and their neighbors. The Conservation Foundation, Washington, DC, 98 pp
Shaver C, Malm C (1996) Air quality at the Grand Canyon. In: Halvorson WL, Davis GE (eds) Science and ecosystem management in the national parks. University of Arizona Press, Tucson, pp 229–250
Shaver CL, Tonnessen KA, Maniero TG (1994) Clearing the air at Great Smoky Mountains National Park. J Appl Ecol 4(4):690–701
Shaw WW (1996) Urban encroachment at Saguaro National Monument. In: Halvorson WL, Davis GE (eds) Science and ecosystem management in the national parks. University of Arizona Press, Tucson, pp 184–200
Shelford VE (1921) National parks. Science 77:281–282
Shelford VE (1933) The preservation of natural biotic communities. Ecology 14(2):240–245
Soulé ME, Wilcox B (eds) (1980) Conservation biology: an evolutionary-ecological perspective. Sinauer Associates, Sunderland, MA, 395 pp
Strong AL, Durning MB, Foster CHW, Rowntree R, Schulman SJ, Stoddard CH (1972) The national park system: ways and means, national parks for the future. The Conservation Foundation, Washington, DC, pp 75–114
Sumner L (1983) Biological research and management: a history. The George Wright Forum 3:3–27
Sun M (1985) Host of problems threaten national parks. Science 228:1413–1414
Supernaugh W R, Jr (1994) An assessment of progress between 1980 and 1992 in responding to threats to the National Park System. M.S. Thesis, Slippery Rock University, Pennsylvania
Thomas CD et al (2003) Extinction risk from climate change. Nature 427:145–148
Triantis KA, Bhagwat SA (2011) Applied island biogeography. In: Ladle RJ, Whittaker RJ (eds) Conservation biogeography. Wiley-Blackwell, Oxford, pp 190–223
US Fish and Wildlife Service (1983) Report on resource problems on national wildlife refuges, national fish hatcheries, research centers. US Fish and Wildlife Service, Department of the Interior, Washington, DC
Watson RT, Zinyowera MC, Moss RH (eds) (1996) Climate change 1995-Impacts, adaptation, and mitigation of climate change: contribution of working group II to the second assessment report of the intergovernmental panel on climate change. Cambridge University Press, London, 878 pp
Westoff V (1970) New criteria for nature reserves. New Sci 16:108–113
Wilcove DS, Rothstein D, Dubow J, Phillips A, Losos E (1998) Quantifying threats to imperiled species in the United States. BioScience 48:607–615
Woodruffe R, Ginsberg JR (1998) Edge effects and the extinction of populations inside protected areas. Science 280:2126–2128
Wright RG (1992) Wildlife research and management in the national parks. University of Illinois Press, Urbana
Wright GM, Thompson BH (1935) Fauna of the national parks of the United States: wildlife management in the national parks. Fauna Series No. 2. US Government Printing Office, Washington, DC, 145 pp
Wright GM, Dixon JS, Thompson BH (1933) Fauna and flora of the national parks of the United States: a preliminary survey of faunal relations in national parks. Fauna Series No. 1. Government Printing Office, Washington, DC, 157 pp
Zaslowsky D, Watkins TH (1994) These American lands: parks, wilderness, and the public lands. Island Press, Washington, DC, 398 pp

APPENDIX 2: LAW ARTICLE PUBLISHED

"Natural resources management also can be viewed as social conflict management."

Kennedy and Thomas 1995: 317

Introduction

Some scholars maintain that when technical people provide policy makers with advice, they are providing a service for society (e.g., Rasker and Hackman 1996). To be most valuable, the policy options often need to be presented using insight from more than one discipline. For example, law and ecology, though typically distinct fields of study in academia, are both indispensable when dealing with real environmental land use problems (Rohlf and Dobkin 2005). Why they remain separate seems odd given that "ecology remains the foundation of environmental law" (Bosselman and Tarlock 1993: 863). However, law and ecology are becoming more intertwined in academia (Brooks et al. 2002).

Noss et al. (1997: 79) maintained "it is the job of scientists to determine how best to attain that goal [biological conservation]." The debate about whether and how scientists should advocate is unlikely to result in a consensus viewpoint, therefore how one falls on this debate continuum and consequently carries out his/her own work boils down to a matter of personal judgment. The following article was written based on my conviction that technically trained individuals have a responsibility to point out protected area policy options for society to consider. As Lovejoy (1989:329) said, “We do not help either science or society by evading our responsibilities as experts.” It was also based on my thinking that resolving land use conflicts requires us to “work toward the goal of integrating the social, economic, and political aspects of resources management with its ecological aspects” (Ewel 2001: 718).

REFERENCES

Bosselman, F.P. and A.D. Tarlock. 1993. Influence of ecological science on American law: an introduction. *Chicago-Kent Law Review* 69: 847-873.

Brooks, R.O., R. Jones, and R.A. Virginia. 2002. Law and Ecology: The Rise of the Ecosystem Regime. Ashgate, Hants, England.

Ewel, K.C. 2001. Natural resource management: the need for interdisciplinary collaboration. *Ecosystems* 4: 716-722.

Kennedy, J.J. and J.W. Thomas. 1995. Managing natural resources as social value. In R.L. Knight and S.F. Bates (eds). A New Century for Natural Resources Management, pp. 311-321. Island Press, Washington, D.C.

Lovejoy, T.L. 1989. The obligations of a biologist. *Conservation Biology* 3(4): 329-330.

Noss, R.F., M.A. O'Connell and D.D. Murphy. 1997. The Science of Conservation Planning: Habitat Conservation Under the Endangered Species Act. Island Press, Washington, D.C.

Rasker, R. and A. Hackman. 1996. Economic development and the conservation of large carnivores. *Conservation Biology* 10: 991-1002.

Rohlf, D.J. and D.S. Dobkin. 2005. Legal ecology: ecosystem function and the law. *Conservation Biology* 19: 1344-1348.

The Unspoken Option to Help Safeguard America's National Parks:

An Examination of Expanding U.S. National Park Boundaries by Annexing Adjacent Federal Lands

Craig L. Shafer*

* The author is a Ph.D student in the Department of Environmental Science and Policy, George Mason University, Fairfax, Virginia.

INTRODUCTION

The boundaries of national parks in the United States are inadequate to provide sufficient protected wildlife habitat. There is perhaps no better example of the dilemma that arises around the boundaries of United States national parks than the situation of the grizzly bear (*Ursus arctos horribilus*) of the Greater Yellowstone Ecosystem ("GYE"). As former National Park Service ("NPS") Director George Hertzog recognized, over half of the roughly 5.7 million acres of grizzly bear-occupied habitat in the GYE lies within U.S. Forest Service ("USFS") lands, the primary mission of which is not preservation, but "consumptive resource utilization."[1] The territory within these national forests provides limited protection

1. GEORGE B. HARTZOG, JR., BATTLING FOR THE NATIONAL PARKS 256 (1988).

for the GYE grizzly bear population. Of the 477 grizzly bear mortalities that occurred in the GYE from 1959–1987, where the cause of death was unknown, almost twenty percent could be attributed to marauder bears, mistaken identity, poaching, and vandalism. The majority of these deaths occurred in national forests.[2] From 1975 through 1994, the grizzly bear mortality rate was identified as 2.3 times higher outside Yellowstone National Park than inside the park.[3]

This Article addresses the wildlife habitat boundary dilemma by discussing in detail one option to safeguard the biota within America's national parks: the selective annexation of USFS and Bureau of Land Management ("BLM") property adjacent to national parks. This option is consistent with the American tradition of annexing other federal agency lands to create larger national parks. In this case, however, the added lands would be adjacent USFS and BLM tracts that have present or future uses that are not compatible with preserving park biota. This Article addresses the scientific, socioeconomic, legal, and political aspects of annexation, using the illustrative example of the GYE grizzly bear. Part I of the Article provides an overview of the current status of the GYE grizzly bear and the threats facing the bear population. Part II of the Article describes the current state of land management policies of the NPS, the BLM, and the USFS. Part III proposes a manner in which annexation may work, and discusses the regional socioeconomic impacts of this option. Part IV addresses alternatives to annexation: two "landless" tools (existing authorities or persuasion) and three "landed" tools (BLM national monuments/conservation areas, wilderness areas, and roadless areas). Part IV also addresses twelve anticipated arguments against annexation. Part V highlights the inevitable political pressures on land managers and compares these often-utilitarian values with broader American values that the annexation option would help safeguard.

2. JOHN CRAIGHEAD ET AL., GRIZZLY BEAR MORTALITIES IN THE YELLOWSTONE ECOSYSTEM, REPORT OF THE MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS; CRAIGHEAD WILDLIFE-WILDLANDS INSTITUTE; INTERAGENECY GRIZZLY BEAR STUDY TEAM; AND NATIONAL FISH AND WILDLIFE FOUNDATION, 1959–1987 8–11 (1988).

3. David J. Mattson et al., *Designing and Managing Protected Areas for Grizzly Bears: How Much is Enough?*, *in* NATIONAL PARKS AND PROTECTED AREAS: THEIR ROLE IN ENVIRONMENTAL PROTECTION 133, 141 (R. Gerald Wright ed., 1996).

I. THE GRIZZLY BEAR POPULATION OF THE GREATER YELLOWSTONE ECOSYSTEM

The GYE, approximately eighteen million acres in size,[4] is the largest relatively intact temperate ecosystem in the world.[5] It contains two national parks, all or parts of six national forests, and lands administered by the BLM and the U.S. Fish and Wildlife Service.[6] In addition, the GYE contains some Native American reservation lands, state lands, and private lands.[7]

There are at least 1200 to 1400 grizzly bears surviving in the United States today, according to the U.S. Fish and Wildlife Service, in five separate subpopulations.[8] The largest subpopulation is in the GYE.[9] Over the last three decades, the GYE grizzly bear population has been in recovery. In the mid-1970s, the population estimate was a mere 136 bears; by 2009, however, the estimate stood at 596 individuals.[10] The GYE population's range has expanded by about fifty percent since 1970.[11] Some of the expansion, however, is occurring in areas that provide limited protection for the GYE population—as of 2000, 30.9 percent of occupied habitat is outside the Primary Conservation Area ("PCA").[12] The PCA, which is 23,850 km^2, is comprised of 58% USFS land, 39.4% national park

4. Hannah Gosnell, Julia H. Haggerty & William R. Travis, *Ranchland Ownership Change in the Greater Yellowstone Ecosystem, 1990–2001: Implications for Conservation*, 19 SOC'Y & NAT. RESOURCES 743, 745 (2006).

5. Robert D. Barbee & John D. Varley, *The Paradox of Repeating Error: Yellowstone National Park from 1872 to Biosphere Reserve and Beyond*, 4(3) GEORGE WRIGHT F. 1, 1 (1985).

6. Charles R. Preston, *Saving the Charmed Goose: Reconciling Human Demands with Inherent Limitations in the Greater Yellowstone Ecosystem*, 13 YELLOWSTONE SCI. 5, 6 (2005).

7. *Id.*

8. U.S. Fish & Wildlife Serv., Mountain-Prairie Region Endangered Species Program, Grizzly Bear Recovery, http://www.fws.gov/mountain-prairie/species/mammals/grizzly (last visited Jan. 29, 2010).

9. John J. Craighead, *Yellowstone in Transition*, *in* THE GREATER YELLOWSTONE ECOSYSTEM: REDEFINING AMERICA'S WILDERNESS HERITAGE 27, 33 (Robert B. Keiter & Mark S. Boyce eds., 1991).

10. NAT'L PARK SERV., YELLOWSTONE RESOURCES & ISSUES 2009 160–61 [hereinafter NAT'L PARK SERV., YELLOWSTONE], *available at* http://www.nps.gov/yell/planyourvisit/upload/ri09ch8.pdf.

11. Mike Bader, *Wilderness-Based Ecosystem Protection in the Northern Rocky Mountains of the United States*, *in* WILDERNESS WITHIN THE CONTEXT OF LARGER SYSTEMS 99, 104 (Stephen F. McCool et al. eds., 2000).

12. *See* Charles C. Schwartz et al., *Study Area and Methods for Collecting and Analyzing Demographic Data on Grizzly Bears in the Greater Yellowstone Ecosystem*, 161 WILDLIFE MONOGRAPHS 9, 9 (2006).

land, and 2.1% other lands.[13]

A. The Threats

Ecological theory identifies two types of "habitat-specific demographic rate" areas: "source habitats," which have higher birth rates than mortality rates, and "sink habitats," which yield the opposite.[14] Threats to grizzly bear populations include roads,[15] grazing,[16] and development, which bring more roads and additional people.[17] The majority of grizzly bear mortality sites, or population sinks, were outside the park near development and grazing locations.[18]

In addition to the hazards arising from land uses in the GYE grizzly bear habitat, the high human-induced mortality of the GYE grizzly bear is a serious concern. A 1996 study cited a five percent human-caused mortality level as a sustainable rate for the bear population; thus, human-caused grizzly bear deaths from all sources, including automobile collisions, management removals, the defense of property, and both illegal and accidental hunting kills, should not exceed this level.[19] From 1998 to 2008, a total of 262 bears died; sixty percent of the deaths were human related.[20] During this period, a minimum of twenty-two percent of the deaths was directly hunter related; however, the number of such kills is likely higher.[21]

Conservation efforts have been further limited by the size of the

13. Sterling D. Miller, *Distinct Population Segments and Grizzly Bear Delisting in Yellowstone: A Response to Rosen*, 18(1) URSUS 117, 120 (2007).

14. H. Ronald Pulliam, *Sources, Sinks, and Population Regulation*, 132 AM. NATURALIST 652, 652 (1988).

15. Bruce N. McLellan & David M. Shackelton, *Grizzly Bears and Resource-Extraction Industries: Effects of Roads on Behavior, Habitat Use and Demography*, 25 J. APPLIED ECOLOGY 451, 451 (1988); Bruce N. McLellan & David M. Shackelton, *Immediate Reactions of Grizzly Bears to Human Activities*, 17 WILDLIFE SOC'Y BULL. 269, 273 (1989).

16. Richard R. Knight, Bruce M. Blanchard & L. Lee Eberhardt, *Mortality Patterns and Population Sinks for Yellowstone Grizzly Bears, 1973–1985*, 16 WILDLIFE SOC'Y BULL. 121, 122–23 (1988).

17. Schwartz, *supra* note 12, at 60.

18. Knight, Blanchard & Eberhardt, *supra* note 16, at 122–23.

19. John L. Weaver, Paul C. Paquet & Leonard F. Ruggiero, *Resilience and Conservation of Large Carnivores in the Rocky Mountains*, 10 CONSERVATION BIOLOGY 964, 972 (1996).

20. CHRIS SERVHEEN ET AL., INTERAGENCY GRIZZLY BEAR STUDY TEAM, YELLOWSTONE GRIZZLY BEAR MORTALITY AND CONFLICT REDUCTION REPORT 4 (2009), *available at* http://www.nrmsc.usgs.gov/files/norock/products/Yellowstone_Mortality_Report_Final_v2.pdf.

21. *See generally id.*

GYE grizzly population and habitat, the lack of genetic diversity, and the changes in the grizzly's endangerment status. There is significant disagreement regarding the number of bears necessary to sustain the GYE population. The GYE agencies' stated long-range goal is to sustain a GYE grizzly bear population at above 500 individuals.[22] However, according to a group of 269 concerned scientists who sent a letter to the U.S. Fish and Wildlife Service in 2006, this stated aspiration is not sufficient—2000 to 3000 individuals are needed for the bear population to withstand regional-scale random events and to provide for genetic diversity.[23] Additionally, the GYE grizzly bear population has been isolated for a century, further impeding the long-term sustainability of the GYE bear population.[24] Finally, changes in legal protection have further imperiled grizzly bear conservation efforts. On March 29, 2007, the U.S. Fish & Wildlife Service removed the "Yellowstone District Population Segment" of the U.S. grizzly bear population from the federal threatened and endangered species list.[25] Delisting precludes any protection the Endangered Species Act might provide the GYE grizzly bear should it or its habitat be in jeopardy from consumptive resource harvest or other reasons relating to national forest management. This distinct population segment, however, was ordered back on the Endangered Species List as threatened by the Federal District Court for the District of Montana on September 21, 2009.[26] The population is still being proposed for delisting.[27]

22. NAT'L PARK SERV., YELLOWSTONE, *supra* note 10, at 161.

23. Group Letter to Dr. Christopher Servheen, Grizzly Bear Recovery Coordinator, U.S. Fish and Wildlife Serv. (Mar. 20, 2006), *available at* http://www.grizzlybear.org/education/index.php?cmd=issl.

24. Craig R. Miller & Lisette P. Waits, *The History of Effective Population Size and Genetic Diversity in the Yellowstone Grizzly (Ursus arctos): Implications for Conservation*, 100 PROC. NAT'L ACAD. SCI. 4334, 4334 (2003).

25. Endangered and Threatened Wildlife and Plants; Final Rule Designating the Greater Yellowstone Area Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears from the Federal List of Endangered and Threatened Wildlife, 72 Fed. Reg. 14866, 14866 (Mar. 29, 2007).

26. Greater Yellowstone Coal. v. Servheen, 2009 U.S. Dist. LEXIS 111139, *54 (2009) (finding that "[t]he Final Rule . . . does not demonstrate that the Conservation Strategy and states plans are adequate regulatory mechanisms to maintain a recovered grizzly bear population" and thus, "[w]ithout the protections of the ESA, the Yellowstone grizzly bear . . . will be placed in jeopardy.").

27. U.S. Fish & Wildlife Serv., Species Profile, Grizzly Bear (*Ursus arctos horribilis*), http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A001 (last visited Feb. 4, 2010).

Given these conservation challenges, connectivity with other grizzly bear inhabited ecosystems is essential to maximize the health of the population.[28] Compounding the above concerns, the current geographic boundaries of the habitat of the GYE grizzly bear are limited and insufficiently protected.[29]

Natural reconnection is the best solution for the current isolation of the GYE grizzly bear population.[30] The roughly 400 km of landscape that once existed between Yellowstone and Glacier National Parks, for example, is now fragmented by highways, towns, ranches, and private home development.[31] Few potential passageways through this maze exist for the grizzly bear. Securing contiguous, potentially usable natural corridors requires land purchase, highway underpasses or overpasses, and the cooperation of land management agencies and private landowners. The nearest candidate for potential reconnection, Idaho's Selway-Bitterroot Wilderness Area, presently has no grizzly bears. The U.S. Fish and Wildlife Service created a plan in 2000 to reintroduce the grizzly bear to the Selway-Bitterroot Wilderness Area; however, Idaho Governor Dirk Kempthorne's opposition to reintroduction into his state persuaded Department of the Interior Secretary Gale Norton to shelve the proposed plan.[32]

B. The Broader Context

The problem of inadequate habitat size is not unique to Yellowstone. U.S. national parks are simply too small to protect some species, especially large carnivores, over the long term.[33] Fourteen western North American national parks have experienced

28. Troy Merrill & David Mattson, *The Extent and Location of Habitat Biophysically Suitable for Grizzly Bears in the Yellowstone Region*, 14 URSUS 171, 172 (2003).

29. *Id.*

30. *See* Steve Primm & Seth M. Wilson, *Re-Connecting Grizzly Bear Populations: Prospects for Participatory Projects*, 15 URSUS 104 (2004) (examining possible connection options). *See also* TROY MERRILL, YELLOWSTONE TO YUKON CONSERVATION INITIATIVE, GRIZZLY BEAR CONSERVATION IN THE YELLOWSTONE TO YUKON REGION (2005), http://www.y2y.net/data/1/rec_docs/507_Merrill_Grizzly_Conservation_in_Y2Y.pdf.

31. *See generally* Primm & Wilson, *supra* note 30.

32. Fact Sheet, Sierra Club, Guard the Grizzly Campaign, Selway Bitterroot Reintroduction: Bears on Ice (May 5, 2002), http://www.sierraclub.org/grizzly/pdfs/Selway_Bitterroot.PDF.

33. *See* CRAIG L. SHAFER, NATURE RESERVES: ISLAND THEORY AND CONSERVATION PRACTICE 59–74 (1990); *see also* REED F. NOSS & ALLEN Y. COOPERRIDER, SAVING NATURE'S LEGACY: PROTECTING AND RESTORING BIODIVERSITY 161–65 (1994).

local extinctions of lagomorphs, carnivores, and artiodactyls.[34] For example, the white-tailed jackrabbit (*Lepus townsendii*) is gone from Bryce Canyon National Park, mink (*Mustela vison*) from Yosemite and Crater Lake National Parks, and caribou (*Rangifer tarandus*) from Glacier National Park.[35] The smaller the park, the more rapid the extinction rate has been.[36] For example the last time Mount Rainier National Park in Washington—a relatively small park of only 235,625 acres—provided habitat for four carnivorous species (the gray wolf (*Canis lupus*), the fisher (*Martes pennanti*), the striped skunk (*Spilogale putorius*), and the lynx (*Lynx canadensis*)), was during the mid-1930s.[37] Other small parks have seen similar extinctions, including Zion, Bryce, Crater Lake, and Rocky Mountain National Parks.[38] According to Newmark, park size correlates with extinction rate, but connectivity influences whether small populations can be supplemented by individuals moving in from other blocks of habitat.[39]

Seasonal movement of large mammals is a biological phenomenon that demands a lot of space. Globally, where reserve size has decreased, threats experienced by migratory species have increased.[40] Some mammals in U.S. national parks leave their park sanctuary for part of the year, thus losing the protection of the National Park system. For example, much of the Northern Yellowstone elk herd leaves the park in search of better grazing opportunities as winter approaches.[41] Local reserve extinctions worldwide also correlate with how far a species wanders outside reserve boundaries.[42] Moreover, some park biota depend on physical cross-boundary processes, including essential natural

34. William D. Newmark, *Extinction of Mammal Populations in Western North American National Parks*, 9 CONSERVATION BIOLOGY 512, 518–20 (1995).

35. *Id.*

36. *Id.*

37. Mount Rainier National Park Frequently Asked Questions, National Park Service Homepage, http://www.nps.gov/mora/faqs.htm (last visited Feb. 4, 2010); Newmark, *supra* note 34, at 517.

38. Newmark, *supra* note 34, at 517.

39. *See id.*

40. *See* R. Gerald Wright & Gary E. Machlis, *Natural Park Size and Threats to Their Wildlife: Any Relationship?*, *in* 2 CONFERENCE ON SCIENCE IN THE NATIONAL PARKS 173 (F. Singer ed., July 13–18, 1986).

41. Craig L. Shafer, *The Northern Yellowstone Elk Debate: Policy, Hypothesis, and Implications*, 20 NAT. AREAS J. 342, 343 (2000).

42. Rosie Woodruff & Joshua R. Ginsberg, *Edge Effects and the Extinction of Populations Inside Protected Areas*, 280 SCI. 2126, 2128 (1998).

disturbance regimes whose scale can exceed existing park area,[43] and specific processes, like the movement of sand at Great Sand Dunes National Park and Preserve, Colorado, and on a larger scale, water sheet flow southward from Lake Okeechobee towards Everglades National Park, Florida.[44] Cross-boundary species movement and cross-boundary physical processes can significantly increase problems when conditions outside the national parks differ markedly from those within. Such differences can include higher human density. A study that looked at some western United States national parks found that not only a greater proportion of the original mammalian species have gone extinct, but also at a higher rate in those parks surrounded by high human density.[45] For example, Mount Rainier and Rocky Mountain National Parks, both with a high outside human density, had more extinctions and higher extinction rates than at the more remote Lassen and Zion National Parks.[46] Habitat fragmentation has decreased the ability of some animals to traverse the landscape between national parks and other large reserves.[47] In addition to fragmentation from land development, extractive land use practices outside park boundaries (e.g., logging, mining, and ranching) further fragment habitat.

C. A Potential Solution

In the U.S. and Canada, only 0.53 percent of protected areas are more than 100,000 hectares.[48] This is dramatically too small of an area to protect grizzly bears—the only wilderness areas that have

43. William L. Baker, *Landscape Ecology and Nature Reserve Design in the Boundary Waters Canoe Area, Minnesota*, 70 ECOLOGY 23, 23–24 (1989); William L. Baker, *The Landscape Ecology of Large Disturbances in the Design and Management of Nature Reserves*, 7 LANDSCAPE ECOLOGY 181, 182–83 (1992).

44. Andrew Valdez, *Hydrologic, Geologic, and Biologic Research at Great Sand Dunes National Monument and Vicinity, Colorado*, *in* U.S. GEOLOGICAL SURVEY, PROCEEDINGS OF NATIONAL PARK SERVICE RESEARCH SYMPOSIUM NO. 1 182, 182 (Christopher J. Schenk ed., 1999); James A. Kushlan, *Design and Management of Continental Wildlife Reserves: Lessons from the Everglades*, 15 BIOLOGICAL CONSERVATION 281, 284–85 (1979).

45. S.A. Parks & A.H. Harcourt, *Reserve Size, Local Human Density, and Mammalian Extinctions in U.S. Protected Areas*, 16 CONSERVATION BIOLOGY 800, 805 (2002) (their study parameters were not identical to Newmark's work: only thirteen western U.S. national parks were studied, only mammalian orders Carnivora and Artiodactyla were considered, and different definitions of extinction were adopted).

46. *Id.*

47. SHAFER, *supra* note 33.

48. Dominick A. DellaSala et al., *An Updated Protected Areas Database for the United States and Canada*, 21 NAT. AREAS J. 124, 124 (2001).

succeeded in maintaining grizzly bear populations (more than 200 bears) are those that, in 1920, were 2,000,000 hectares or larger.[49] At the height of the grizzly bear's range expansion in 1850, there were approximately 50,000 bears in the United States. Today they occupy less than two percent of their original range.[50]

A partial solution to these threats to the grizzly bear is the congressional annexation of adjacent USFS lands. Annexation of both wilderness and non-wilderness lands could begin resolving some of the existing threats facing the GYE grizzly bear. The expansion of Yellowstone National Park is not a new idea. As John Craighead explained, in 1882 General Philip Sheridan wanted to double the size of the park for ecological reasons; however, "[t]he areas he proposed eventually became, instead, part of the national forest system; his proposal of a single management entity became lost in the bureaucratic struggle for turf."[51] If ongoing land use is detrimental to park biota, portions of this lost turf could be added to Yellowstone National Park, as well as many unprotected sites in the GYE that are biologically irreplaceable and vulnerable to degradation.[52]

II. THE CURRENT STATE OF FEDERAL LAND MANAGEMENT

A. Differing Land Management Policies

1. The National Park Service

In 1911, Horace McFarland, president of the American Civic Association, remarked that national parks were "the nation's playground" and national forests were "the nation's woodlot."[53] The dichotomy between the land management policies of the NPS and the USFS is a frequently discussed phenomenon. The public has long perceived that the NPS has the "dual mandate" of

49. *See* David J. Mattson & Troy Merrill, *Extirpations of Grizzly Bears in the Western Contiguous United States*, 16 CONSERVATION BIOLOGY 1123, 1130 (2002).

50. Lance Craighead, Address at the BioForum Presentation on Conservation Biology, Designing Nature Reserves: Past, Present, and Future (Feb. 6, 1999), *available at* http://www.accessexcellence.org/BF/bf06/craighead/bf06a11.php.

51. Craighead, *supra* note 9, at 27, 33.

52. *See generally* Reed Noss et al., *A Multicriteria Assessment of the Irreplaceability and Vulnerability of Sites in the Greater Yellowstone Ecosystem*, 16 CONSERVATION BIOLOGY 895 (2002).

53. RICHARD W. SELLARS, PRESERVING NATURE IN THE NATIONAL PARKS: A HISTORY 37 (1997).

resource protection and visitor enjoyment, which the Service acknowledged.[54] Unless authorized by Congress or allowed because of preexisting rights, the NPS does not allow resource extraction. As Joseph Sax observed, "[p]arks promote intensive experience rather than intensive use."[55] A recent commentator, however, argued that the NPS's purported "dual mandate" is actually one of resource protection taking precedence over visitor enjoyment,[56] and the NPS later incorporated this argument into its management policies.[57] Both legislation and court decisions also support the primacy of preservation.[58]

2. United States Forest Service

In contrast to the NPS's preservation-based mandate, USFS land management is more resource-extraction focused. The USFS allows more conventional forms of recreation than the NPS, such as ski resorts, which can have serious environmental impacts.[59] History suggests that the vision for the earliest "forest reserves" resembled that for national parks.[60] The original manager of these forest reserves, the Department of the Interior ("DOI"), believed that the public should not enter the reserves, cut trees, or search for valuable minerals.[61] This DOI viewpoint was short lived, as the

54. NAT'L PARK SERV., MANAGEMENT POLICIES 1, 3 (1988) [hereinafter NAT'L PARK SERV., 1988 MANAGEMENT POLICIES].

55. JOSEPH L. SAX, MOUNTAINS WITHOUT HANDRAILS: REFLECTIONS ON THE NATIONAL PARKS 111 (1980).

56. Robin W. Winks, *The National Park Service Act of 1916: A Contradictory Mandate?*, 74 DENV. U. L. REV. 575, 623 (1997).

57. *See* NAT'L PARK SERV., DEP'T OF THE INTERIOR, MANAGEMENT POLICIES (2006) [hereinafter NAT'L PARK SERV., 2006 MANAGEMENT POLICIES], *available at* http://www.nps.gov/policy/MP2006.pdf.

58. DAVID A. WATTS, NAT'L PARK SERV., DEP'T OF THE INTERIOR, CANYONLANDS NATIONAL PARK AND THE ORGANIC ACT: BALANCING RESOURCE PROTECTION AND VISITOR USE 10–15 (2008), *available at* http://www.nps.gov/history/history/online_books/cany/resource_protection.pdf (providing a legal history of the National Park Service's handling of issues related to off-road recreational vehicles in the Canyonlands National Park).

59. *See* Shiro Tsuyuzaki, *Environmental Deterioration Resulting from Ski-Resort Construction in Japan*, 21 ENVTL. CONSERVATION 121, 123–25 (1994) (explaining environmental and landscape deterioration caused by the construction and operation of ski-resorts in Japanese forests).

60. James Morton Turner, *Charting American Environmentalism's Early (Intellectual) Geography, 1890–1920*, 10(2) WILD EARTH 18, 21 (2000).

61. *Id.*

1897 Organic Administration Act[62] authorized resource extraction.[63] Specifically, the Act proclaimed that forest reserves were for the purpose of providing timber and favorable water flows, a privilege that obscured the Act's co-mandate, to "improve and protect the forest."[64] The purpose of forest reserves announced in the 1897 Act was further developed in the 20th century through the concepts of multiple use and sustained yield. The concepts first appeared in the 1960 Multiple-Use Sustained Yield Act, and were perpetuated in the 1974 Forest and Rangeland Renewable Resources Planning Act and the 1976 National Forest Management Act ("NFMA").[65] Unfortunately, multiple use creates multiple ecological stresses.[66]

The exact meaning of NFMA has been subject to some debate. The language of NFMA could be interpreted to mandate biological diversity conservation or ecosystem management for USFS.[67] However, the courts have dismissed that interpretation,[68] and instead it has been asserted that NFMA does not specifically direct the USFS to elevate wildlife preservation, roadless recreation, and ecosystem management above the traditional multiple use mission that Congress established.[69]

Thus, the mandates of the NPS and the purpose of the NFMA conflict. Ideally, the language of the 1897 Act and the NPS mandates would be interpreted to provide protection for the park lands. If the language in the 1897 Act ("improve and protect the

62. Organic Administration Act of 1897, 16 U.S.C. §§ 473–78, 479–82, 551 (2006).

63. Federico Cheever, *The United States Forest Service and National Park Service: Paradoxical Mandates, Powerful Founders, and the Rise and Fall of Agency Discretion*, 74 DENV. U. L. REV. 625, 629 (1997).

64. *Id.*

65. Multiple-Use Sustained-Yield Act of 1960, 16 U.S.C. §§ 528–31 (2006); Forest and Rangeland Renewable Resources Planning Act of 1974, 16 U.S.C. §§ 1601–10 (2006); National Forest Management Act of 1976, 16 U.S.C. §§ 1600–14 (2006).

66. This may explain why USFS water rights conflicts for in-stream flows (if adjusted for total area differences) are five times those of the National Park System. *See, e.g.*, Catherine M. Pringle, *Threats to U.S. Public Lands from Cumulative Hydrologic Alterations Outside their Boundaries*, 10 ECOLOGICAL APPLICATIONS 971, 971 (2000). There are those who argue that a policy of sustained yield has guided both USFS (commodity production) and NPS (visitor services). *See, e.g.*, HANNA J. CORTNER & MARGARET A. MOOTE, THE POLITICS OF ECOSYSTEM MANAGEMENT 17 (1999). The key point, however, is that NPS lacks a traditional multiple-use mandate.

67. Heidi J. McIntosh, *Natural Forest Management: A New Approach Based on Biodiversity*, 16 J. ENERGY NAT. RESOURCES & ENVTL. L. 257, 262–63 (1996).

68. *Id.* at 292–301.

69. Karen J. Budd, *Ecosystem Management: Will National Forests be "Managed" into National Parks?*, *in* THE GREATER YELLOWSTONE ECOSYSTEM: REDEFINING AMERICA'S WILDERNESS HERITAGE, *supra* note 9, at 65, 73.

forest") were officially interpreted to mean "ecosystem health" and "biological diversity," professional foresters would subordinate all other land use to serve those goals.[70] Further, only the courts can decide whether NPS mandates, if interpreted in this manner, would trump the NFMA, and thereby require the USFS to manage its lands lying adjacent to national parks in a manner ensuring that no degradation of park lands occurs. There is some case law suggesting NPS protection mandates may supersede the NFMA.[71] However, in order to do so, these mandates would have to be interpreted to mandate a resource protection focus for adjacent federal lands.

3. Bureau of Land Management

The BLM administers almost twice as much land as the USFS and three times that of the NPS.[72] It also performs a broader range of activities than either the USFS or the NPS. Besides promoting recreation and preservation, the BLM allows grazing, logging, mining, oil and gas extraction, water development projects, and more.[73] Younger than the USFS, the BLM was established in 1946 by merging the General Land Office and the Grazing Service.[74] Commodity management was endorsed by both the Taylor Grazing Act of 1934 and the Classification and Multiple Use Act of 1964.[75]

70. KELSEY ALEXANDER ET AL., FOREST OF DISCORD: OPTIONS FOR GOVERNING OUR NATIONAL FORESTS AND FEDERAL PUBLIC LANDS 53 (Donald W. Floyd ed., 2d ed., 2009).

71. *See* Friends of the Earth v. Armstrong, 485 F.2d 1 (10th Cir. 1974) (suggesting that federal agencies have the discretion to manage for the more protective mandate where two public lands under different jurisdiction are interrelated and the interrelation could be "disturbed" if they are not managed protectively); Sierra Club v. Dep't of the Interior, 376 F. Supp. 90, 95–96 (N.D. Cal. 1974) (finding not only such discretion but a "paramount legal duty" on the part of the Secretary of the Interior to utilize his powers for the protection of National Parks, arising from both the National Park System Act and the "public trust doctrine"); *see generally* Charles F. Wilkinson, *The Public Trust Doctrine in Public Land Law*, 14 U.C. DAVIS L. REV. 269 (1980); *but cf.* Sierra Club v. U.S. Forest Serv., 259 F.3d 1281 (10th Cir. 2001) (holding that more specific mandates must be effectuated even where they "prevent maximization of other mandates," at least within the same jurisdiction). *See generally* Mark R. Thompson, *Keeping the Door Open: Protecting Biological Corridors with Existing Federal Statutes*, 34 ENVTL. L. 703 (2004) (examining NFMA, FLPMA, NEPA, and the ESA for their usefulness in protecting biological corridors on federal lands).

72. Bruce Babbitt, *A Bureau of Land Management for the 21st Century*, PEOPLE, LAND & WATER, July 2000, at 17–18.

73. About the BLM, http://www.blm.gov/wo/st/en/info/About_BLM.html (last visited Jan. 29, 2010).

74. *Id.*

75. *See generally* Joseph V.H. Ross, *Managing the Public Rangelands: 50 Years Since the Taylor Grazing Act*, 6 RANGELANDS 147 (1984).

The Federal Land Planning and Management Act ("FLPMA") of 1976 endorsed "multiple use" on BLM lands.[76] But the Act also specified that this must occur "without impairment of the productivity of the land"[77] while safeguarding "areas of critical environmental concern."[78] This has been interpreted to mean that the BLM should not negatively impact park resources, but this remains untested in court.[79]

Each year the BLM authorizes nearly 20,000 western ranchers to use public land for cattle grazing, sells 170 million board feet of saw timber and other forest products, and issues thousands of leases for oil, gas, and geothermal exploration and development.[80] Some of this resource consumption occurs next to national parks. In this way, NPS efforts at biotic preservation will often be hampered by the BLM mandate.

The BLM has had success in protecting federal lands. For instance, the BLM has placed fifteen percent of its land holdings within its National Landscape Conservation System,[81] an admirable achievement. In 1997, the BLM was involved in 1200 restoration projects.[82] In addition, it has initiated many actions that have favored the interests of the NPS. For example, the BLM proposed establishing "areas of critical environmental concern," three of which were next to Canyonlands National Park, Utah, where mineral development would be prohibited in three areas, and off-road vehicle ("ORV") use would be prohibited in all four areas;[83] the agency later denied applications for oil and gas leases at

76. 43 U.S.C. § 1732(a) (2006).

77. 16 U.S.C. § 531 (2006).

78. 43 U.S.C. § 1712(c)(3) (2006).

79. John M. Hiscock, *Protecting National Park System Buffer Zones: Existing, Proposed and Suggested Authority*, 7 J. ENERGY L. & POL'Y 35, 74 (1986).

80. Larry Hamilton & Michelle Dawson, *Sustaining the Gift*, PEOPLE LAND & WATER 4–5, June 1996.

81. Carol Hardy Vincent et al., *Federal Land Management Agencies: Background on Land and Resources Management*, *in* FEDERAL LAND MANAGEMENT: CURRENT ISSUES AND BACKGROUND 37, 75 (Samuel T. Prescott ed., 2003). The National Landscape Conservation System was created to give the included lands "greater recognition, management attention, and resources," while being managed under their relevant authorities (e.g., wilderness areas under FLPMA and the Wilderness Act). *Id.*

82. Bruce P. Van Haveren et al., *Restoring the Ecological Integrity of Public Lands*, 52(4) J. SOIL & WATER CONSERVATION 226, 228 (1997).

83. William E. Shands, *Planning for Forest Service and Bureau of Land Management Lands*, *in* MANAGING NATIONAL PARK SYSTEM RESOURCES: A HANDBOOK ON LEGAL DUTIES, OPPORTUNITIES AND TOOLS 107, 119–20 (Michael A. Mantell ed., 1990).

Canyonlands and at other park units.[84]

In other instances, however, the BLM has taken actions near national parks that directly impaired park preservation efforts. For example, during the Clinton Administration, the BLM agreed to a land swap to facilitate the creation of Eagle Mountain Landfill, a megadump that will receive approximately 20,000 tons of trash daily and is next to Joshua Tree National Park, California.[85] By 2000, amid objections voiced by some government managers and scientists, BLM approved oil and gas leasing near Arches and Canyonlands National Parks, Utah.[86] In 2003, the George W. Bush Administration asked BLM to expand an open-pit gold mine on the southeastern border of Death Valley National Park, by 32.4 hectares, which would include 40.2 km of new road.[87]

Other authorities have sometimes curtailed BLM activity. For example, in order to protect the Rocky Mountain Front Range from mineral leasing and mining near Glacier National Park, Congress withdrew USFS and BLM lands from leasing or mining.[88] In June of 2008, the Natural Resources Committee of the House of Representatives invoked a provision in FLPMA to require the DOI to withdraw from mineral entry for three years one million acres on BLM land adjacent to Grand Canyon National Park in the Kaibab National Forest.[89] In 2009, the House of Representatives introduced the Grand Canyon Watersheds Protection Act to withdraw those same acres from mineral entry in order to stop a proposed uranium mining project.[90]

B. Ineffective Boundaries

As Miller and Gershman observed, "[b]oundaries become

84. William J. Lockhart, *External Threats to Our National Parks: An Argument for Substantive Protection*, 6 STAN. ENVTL. L.J. 3, 59–60 (1997).

85. Seth Shteir, *Don't Trash Joshua Tree National Park*, HIGH COUNTRY NEWS, July 16, 2008, *available at* http://www.hcn.org/articles/17783.

86. Bob Burtman, *Open Season on Open Space*, MOTHER JONES, July–Aug. 2002, at 44.

87. Julie Cart, *Battle Lines Drawn over Proposal for Mine Near Death Valley Park*, L.A. TIMES, Apr. 9, 2003.

88. Joseph L. Sax & Robert B. Keiter, *Glacier National Park and Its Neighbors: A Twenty-Year Assessment of Regional Resource Management*, 24(1) GEORGE WRIGHT F. 23, 31 (2007).

89. Press Release, Ctr. For Biological Diversity, Committee on Natural Resources Votes to Enact Emergency Uranium Protections for Grand Canyon (June 25, 2008), *available at* http://www.biologicaldiversity.org/news/press_releases/2008/uranium-exploration-06-25-2008.html.

90. Grand Canyon Watersheds Protection Act of 2009, H.R. 644, 111th Cong. (1st Sess. 2009).

ineffective when they interfere with the ability of landowners or managers on either side to meet their land management goals."[91] The lands adjacent to boundaries of some national parks have been subject to degradation. The results of the interface of one segment of Yellowstone National Park's west boundary with the Gallatin and Targhee National Forests—where clear-cutting stopped in that area[92]—can even be seen from space.[93] There is a history of timber harvest on federal and state lands next to the boundary of Olympic National Park, Washington,[94] and it continues today. The abrupt habitat transition caused by this activity may discourage the emigration or immigration of some park species.

The *State of the Parks Report, 1980,* published by the NPS, precipitated national public awareness that the degradation of National Park System resources was a result of a wide range of human activities originating beyond park boundaries (e.g., urban development, mining, water diversion, pollution, and the introduction of exotic species). The report also indicated that many of these "external threats" emanated from lands adjacent to national parks.[95] Subsequent Government Accountability Office reports noted the validity of these concerns and stated that not enough progress was being made to mitigate these threats.[96] Since most park areas are not ecologically self-sufficient for species over the long term, human activity that damages species outside a park boundary can diminish their chances of survival despite park protections.

Many BLM and USFS land-use practices, including geothermal

91. Clinton K. Miller & Mark D. Gershman, *Outdoor Recreation and Boundaries: Opportunities and Challenges, in* STEWARDSHIP ACROSS BOUNDARIES 141, 145 (Richard L. Knight & Peter B. Landres, eds., 1998).

92. Craig L. Shafer, *Beyond Park Boundaries, in* LANDSCAPE PLANNING AND ECOLOGICAL NETWORKS 201, 210 (Edward A. Cook & Hubert N. van Lier eds., 1994); NOSS & COOPERRIDER, *supra* note 33, at 137.

93. Dennis H. Knight, *Congressional Incentives for Landscape Research,* 72(4) BULL. ECOLOGICAL SOC'Y AM. 195, 197 (1991).

94. SHAFER, *supra* note 33, at 8.

95. NAT'L PARK SERV., STATE OF THE PARKS—1980: A REPORT TO THE CONGRESS 3–5, 21–23 (1980).

96. GOV'T ACCOUNTABILITY OFFICE, GAO/RECD-87-36, PARKS AND RECREATION: LIMITED PROGRESS MADE IN DOCUMENTING AND MITIGATING THREATS TO PARKS (1987); GOV'T ACCOUNTABILITY OFFICE, GAO/RECD-94-59, NATIONAL PARK SERVICE: ACTIVITIES OUTSIDE PARK BORDERS HAVE CAUSED DAMAGE TO RESOURCES AND WILL LIKELY CAUSE MORE (1994); GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-97-76, NATIONAL PARKS: PARK SERVICE NEEDS BETTER INFORMATION TO PRESERVE AND PROTECT RESOURCES (1997).

exploration, oil and gas extraction, hydroelectric power development, road construction, water flow disruption, and livestock grazing have threatened adjacent park biota. The proposed actions of other agencies (e.g., the DOI's Bureau of Reclamation, the U.S. Army Corps of Engineers, and the Department of Transportation's Federal Highway Administration) can have similar effects. But because of their large land holdings, the USFS and the BLM more commonly cause negative impacts on parklands.

Since other federal land management agencies may not always stop their development plans after the NPS voices objections, the NPS stated, "we must be prepared to identify viable alternatives."[97] Accordingly, this Article suggests that when incompatible uses threaten conservation values within national parks or near their boundaries, one possible option that should be considered is the annexation of some USFS and BLM property into adjacent national parks.

C. Consumptive and Recreational Use Differs

A detailed comparison of NPS, USFS, and BLM policies for allowed land uses, including for wilderness, is illustrative.

Livestock grazing. One-third of all federal wilderness areas, excluding Alaska, have livestock grazing,[98] which has negative biological consequences.[99] Grazing in federal wilderness is unlikely to cease,[100] though many grazing allotments in the GYE have been retired.[101] In the National Park System, on the other hand, livestock grazing is not allowed unless it is authorized by federal law, allowed under a reserved right, is required to perpetuate an historic scene, is part of an exhibit, is used to achieve certain resource conditions,

97. NAT'L PARK SERV., STATE OF THE PARKS—1980, *supra* note 95, at 35.

98. John C. Hendee & Chad P. Dawson, *Wilderness Use and User Trends*, *in* WILDERNESS MANAGEMENT: STEWARDSHIP AND PROTECTION FOR RESOURCES AND VALUES 383 (John C. Hendee & Chad P. Dawson eds., 3d ed., 2002) [hereinafter Hendee & Dawson, *Wilderness Use and User Trends*].

99. Thomas L. Fleischner, *Ecological Costs of Livestock Grazing in Western North America*, 8 CONSERVATION BIOLOGY 629, 630–31 (1994).

100. Mitchel P. McClaran, *Livestock in Wilderness: A Review and Forecast*, 20 ENVTL. L. 857, 886–88 (1990).

101. National Wildlife Foundation, National Wildlife Federation Grazing Allotment Retirements in the Greater Yellowstone Ecosystem (2002–2009), *available at* http://www.nwf-wcr.org/PDFs/NWFAllotmentMap-11.09.09.pdf.

or does not cause unacceptable impacts.[102] Violation of a special use permit will cause revocation.[103]

Hunting. Hunting occurs in all GYE national forests and BLM lands, including wilderness areas. Grizzly bear management areas were established in Yellowstone National Park to exclude humans, permanently or seasonally.[104] Most GYE grizzly bear mortalities occur outside Yellowstone National Park.[105] In the National Park System, hunting or trapping is prohibited unless authorized by park enabling legislation (e.g., Grand Teton National Park).[106] Some subsistence hunting is allowed in Alaskan park units.[107]

Mining. Mining can occur on any federal land if preexisting rights exist. In the GYE, for example, including in wilderness areas, there are more than 12,000 active and abandoned hardrock mining claims, and two-thirds of these national forests are available for mining and mineral leasing.[108] Mining opportunities on USFS wilderness are limited, with only nine percent of wilderness managers reporting active claims in 1987.[109] Unless authorized by law, prospecting, mining, and mineral leasing in the National Park System are prohibited.[110] However, old claims are abundant in national parks and wilderness areas.[111] If the NPS determines that mineral development will cause unacceptable damage to a park ecosystem, the agency will seek to extinguish such mining claims and non-federal mineral interests.[112] In parks, where Congress authorized the leasing of federal minerals, the NPS will preclude such leasing within wilderness only if authorized to do so.[113]

102. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 116.

103. 36 C.F.R. § 2.60 (2006); NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 116.

104. David J. Mattson & Mathew M. Reid, *Conservation of the Yellowstone Grizzly Bear*, 5 CONSERVATION BIOLOGY 364, 367 (1991).

105. *See generally* Michael Bader, *Distribution of Grizzly Bears in the U.S. Northern Rockies*, 74 NORTHWEST SCI. 325 (2000).

106. 36 C.F.R § 2.2 (2009).

107. Alaska National Interest Lands Conservation Act, 16 USC §§ 3111–26 (2006).

108. DENNIS GLICK ET AL., GREATER YELLOWSTONE COALITION, AN ENVIRONMENTAL PROFILE OF THE GREATER YELLOWSTONE ECOSYSTEM 110 (1991).

109. *See* Vance G. Martin & Alan Watson, *International Wilderness*, *in* WILDERNESS MANAGEMENT, *supra* note 98, at 381 (2002).

110. 36 C.F.R. § 5.14 (2009).

111. DUANE A. THOMPSON, CONG. RESEARCH SERV., MINING IN NATIONAL PARKS AND WILDERNESS AREAS: POLICY, RULES (1996), *available at* http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-353:1.

112. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 118.

113. *See id.*

Oil and gas extraction. As with mining, oil and gas leasing can occur on any federal lands if preexisting rights exist. Oil and gas leasing in GYE wilderness was halted in 1984, as specified by the Wilderness Act. Only one percent of wilderness managers reported active oil or gas wells in 1987.[114] In the Upper Green River Valley of the GYE, more than 8500 well sites have been drilled and another 10,000–15,000 were planned.[115] The George W. Bush Administration repeatedly sought to sell more oil and gas leases in proposed wilderness. In the National Park System, if a park resource can be impaired by oil and gas exploration, NPS will try to extinguish such rights.[116] Oil and gas exploration does occur in a few National Park System units, but only because Congress authorized the practice.

Water projects and dams. Water development is often encouraged by the USFS and the BLM, and as specified by the Wilderness Act, can occur in wilderness with Presidential approval. The Act also allows for water storage on USFS lands, and small reservoirs that existed prior to 1964 designation may continue to be used. In 1987, around 100 dams existed in national forest wilderness.[117] In the GYE, there were eighteen existing major water projects, with seventeen more proposed, including in USFS wilderness areas.[118] Water projects, such as dams, impoundments, and other water barriers contributed to the decline of thirty percent of United States threatened and endangered species.[119] In the National Park System, dams and reservoirs will not be constructed.[120] In fact, park advocates have fought proposed water development projects in parks since 1913.[121]

Logging. Logging is common on non-wilderness USFS and BLM lands, though only one USFS wilderness area has ever allowed logging (the Boundary Waters Canoe Area in Minnesota).[122] In the

114. *See* Hendee & Dawson, *Wilderness Use and User Trends*, *supra* note 98, at 381.

115. Joel Berger, *The Last Mile: How to Sustain Long Distance Migration in Mammals*, 18 CONSERVATION BIOLOGY 320, 324 (2004).

116. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 118–19.

117. Hendee & Dawson, *Wilderness Use and User Trends*, *supra* note 98, at 382.

118. GLICK ET AL., *supra* note 108, at 111.

119. David S. Wilcove et al., *Quantifying Threats to Imperiled Species in the United States*, 48 BIOSCIENCE 607, 612 (1998).

120. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 140.

121. In 1913, the Hetch Hetchy dam controversy in Yosemite National Park resulted in Congress passing legislation to flood the valley in 1913. The Raker Act of 1913, 38 Stat. 242 (1913).

122. Hendee & Dawson, *Wilderness Use and User Trends*, *supra* note 98, at 381.

National Park System, removing plants for sale or commercial use is banned.[123]

Road building. In accordance with the Wilderness Act, temporary or permanent road building is banned in wilderness areas (except for Alaska). The National Forest road system grew from 160,934 km in 1944 to 552,005 km in 1985.[124] On GYE national forest land, roads extend for 12,070 km.[125] In the National Park System, non-wilderness roads are allowed only after a long list of considerations is met.[126] Roads can have serious biological impacts[127] and were implicated in fifteen percent of federal threatened and endangered species listings.[128]

Rights-of-way. In accordance with the Wilderness Act, development, structures, utilities, or new rights-of-way are banned in NPS wilderness areas (except for Alaska). NPS management policy states, "Existing rights-of-way in park wilderness should be terminated or phased out where practicable."[129] For National Park System non-wilderness, unless authorized by Congress, rights-of-way for dams, conduits, reservoirs, power houses, transmission lines, storage or carriage of water, or the development and transmission of power are banned.[130]

ORVs. All federal agencies must regulate ORVs according to Executive Orders 11644[131] and 11989.[132] ORVs are banned in federal wilderness areas (with some exceptions). More than 300,000 miles of USFS roads and about 133,000 miles of trails are open to ORVs,[133] and an estimated additional 14,000 miles of unauthorized trails exist.[134] A 2005 USFS ORV rule resulted in each of the 175 national forests and grasslands specifying which roads

123. 36 C.F.R. § 2.1 (2004).

124. MICHAEL P. DOMBECK ET AL., FROM CONQUEST TO CONSERVATION: OUR PUBLIC LANDS LEGACY 103 (2003).

125. GLICK ET AL., *supra* note 108, at 113.

126. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 132–33.

127. *See generally* Stephen C. Trombulak & Christopher A. Frissell, *Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities*, 14 CONSERVATION BIOLOGY 19 (2000).

128. Wilcove et al., *supra* note 119, at 612.

129. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 88.

130. 36 C.F.R. § 14.10 (2004).

131. Exec. Order No. 11644, 3 C.F.R. 666 (1971–1975).

132. Exec. Order No. 11989, 3 C.F.R. 120 (1977).

133. Travel Management; Designated Routes and Areas for Motor Vehicle Use, 70 Fed. Reg. 68,264 (Nov. 9, 2005) (to be codified at 36 C.F.R. §§ 212, 251, 261, 295).

134. Dale Bosworth & Hutch Brown, *The Timber Wars: Community-Based Stewardship*, 105 J. FORESTRY 271, 272 (2007).

and trails were open to ORV use.[135] The impacts of all forms of recreational use on species and their habitats are only beginning to be understood, but ORVs have been accused of doing more such damage than any other recreational activity.[136] In the NPS, the Agency's Organic Act demands the most restrictive stance on ORVs (i.e., park-specific regulations govern the activity in preserves, lakeshores, seashores, or recreation areas).[137] If authorized in legislation, snowmobiles must stay on designated routes, and their use must be consistent with park values.[138]

Yet politics can divert the NPS from acting on research by scientists. Based on a decade of scientific study of the effects of snowmobiles in Yellowstone National Park, the Clinton Administration proposed to ban snowmobiles in the park.[139] In November 2007, the NPS issued a final rule allowing up to 540 snowmobiles per day in Yellowstone National Park. The U.S. District Court for the District of Columbia vacated this final rule on September 15, 2008.[140] After an Environmental Assessment and a Finding of No Significant Impact, a Final Rule was entered into the *Federal Register* on November 20, 2009, allowing 318 snowmobiles per day in the park.[141]

D. Historical Precedent

With Congressional support, the NPS could assume management of some adjacent USFS and BLM lands in order to better fulfill the NPS preservation mandate. Such a practice would expand the historical American practice of taking USFS and BLM lands to create new or enhanced units of the National Park System.[142] For

135. Travel Management; Designated Routes and Areas for Motor Vehicle Use, 70 Fed. Reg. 68,264 (Nov. 9, 2005).

136. Elizabeth Losos et al., *Taxpayer-Subsidized Resource Extraction Harms Species*, 45 BIOSCIENCE 446, 448 (1995).

137. GOV'T ACCOUNTABILITY OFFICE, ENHANCED PLANNING COULD ASSIST AGENCIES IN MANAGING INCREASED USE OF OFF-HIGHWAY VEHICLES 7–8 (2009); *see generally* National Park Service Organic Act, 16 U.S.C. §§ 1–4 (2006).

138. 36 C.F.R. § 2.18(c) (2009).

139. Daniel L. Dustin & Ingrid E. Schneider, *The Science of Politics/The Politics of Science: Examining the Snowmobile Controversy in Yellowstone National Park*, 34 ENVTL. MGMT. 761, 762 (2005).

140. Greater Yellowstone Coal. v. Kempthorne, 577 F. Supp. 2d 183 (D.D.C. 2008).

141. Special Regulations; Areas of the National Park System, 74 Fed. Reg. 60,159 (Nov. 20, 2009) (to be codified at 36 C.F.R. pt. 7).

142. *See generally* NAT'L PARK SERV., THE NATIONAL PARKS: SHAPING THE SYSTEM (2005); GERALD W. WILLIAMS, NATIONAL MONUMENTS AND THE FOREST SERVICE (Nov. 18, 2003),

example, to upgrade Joshua Tree and Death Valley National Monuments into national parks in 1994, Congress expanded them into adjacent BLM property.[143] The California Desert Protection Act of 1994 added 485,633 hectares to Death Valley making it the largest unit of the National Park System in the lower forty-eight states.[144] The subsumed BLM land was withdrawn from appropriation or entry under public land, mining, and mineral and geothermal leasing laws. Further, ORV use became easier to control under NPS administration. The added land also increased the size of the designated park wilderness. In addition, the 1994 Act added 94,699 hectares to Joshua Tree National Park.[145] In this case, the enlarged boundary formed an improved ecological boundary since it followed mountain ranges instead of survey lines. The other benefits mentioned for Death Valley—withdrawal, ORV use control, and larger wilderness designation—also applied to Joshua Tree. Such action also has additional Congressional precedent: in the 1970s, rather than cope with an incompatible adjacent land use, the proposed Mineral King ski resort land in the Sequoia National Forest was instead added to Sequoia National Park, California.[146] This Congressional practice could be extended today to protect adjacent lands from incompatible usage.

E. The Socio-Economics of Annexation

The general public and its political representatives may fear that NPS expansion entails the loss of economically productive extractive uses of annexed public land. It is important, however, to consider the actual costs of resource extraction. Neither the BLM grazing program nor timber sales from BLM lands and national forests are profitable. In FY 1990, BLM spent $49.8 million to carry out its grazing program, but collected only $19.3 million from permittees.[147] In 1992, ninety-five of the 120 national forests lost $174.9 million operating their timber sales programs.[148] During 1992 the federal government received no payment for at least $1.2

available at http://www.fs.fed.us/fstoday/080822/03.1Looking_Back/national_monuments.pdf.

143. 16 U.S.C. § 410aaa-23 (2006); 16 U.S.C. § 410aaa-2 (2006).

144. 16 U.S.C. §§ 410aaa–410aaa-83 (2006).

145. 16 U.S.C. § 410aaa-23 (2006).

146. 16 U.S.C. § 45f (2006).

147. Losos et al., *supra* note 136, at 446.

148. *Id.*

billion worth of hardrock minerals extracted from federal lands.[149] The U.S. Government Accountability Office estimated that reforms of subsidies for mining, timber harvest, and grazing on federal lands would have saved $4 billion between 1993 and 1997.[150] Consider the position of the Society of American Foresters: "planning and managing for the harmonious conservation of all public values on the national forests and public lands are not currently cost effective and may never be practical."[151]

The American taxpayer funds this loss-producing situation twice by also expending significant sums for threatened or endangered species recovery efforts. In FY 1991, $21 to $28 million of federal and state expenditures for listed species recovery efforts were for repairing damage from livestock grazing, logging, hard-rock mining, water development, and/or recreation on federal land.[152] Americans also suffer the unquantifiable loss of rare and endangered species whose stocks are thinned by extractive activity. Of sixty threatened or endangered species that occur only on federal lands, forty-two to sixty-two percent are endangered by hard-rock mining, livestock grazing, logging, and recreation.[153] Livestock grazing alone affects twenty to twenty-seven percent, logging affects seven to twenty percent, and recreation affects twenty-three to twenty-eight percent.[154] All forms of mining activities affected fourteen to twenty-one percent.[155] The continuation of mining, grazing, logging, and biologically harmful forms of recreation on public lands will likely precipitate the listing of additional species and ensure continued escalation in the cost of recovery efforts. Among the federal land agencies, USFS and BLM land have the most occurrences of federally listed threatened and endangered species.[156]

149. *Id.* at 450.

150. STEPHEN M. JOHNSON, ENVIRONMENTAL LAW INSTITUTE, ECONOMICS, EQUITY, AND THE ENVIRONMENT 93 (2004).

151. *See* ALEXANDER ET AL., *supra* note 70, at 56–57.

152. *See* Losos et al., *supra* note 136, at 453.

153. *Id.*

154. *Id.*

155. *Id.* at 448.

156. Bruce A. Stein, Tom Breden & Richard Warner, *Significance of Federal Lands for Endangered Species*, *in* OUR LIVING RESOURCES: A REPORT TO THE NATION ON THE DISTRIBUTION, ABUNDANCE, AND HEALTH OF U.S. PLANTS, ANIMALS, AND ECOSYSTEMS 398, 400 (Edward T. LaRoe et al. eds., 1995).

1. Local Economies and Resource Extraction

As of 1991, in the Rocky Mountain West states (i.e., Montana, Wyoming, Colorado, Idaho, Utah, Nevada, New Mexico, and Arizona), the combined activity of mining, farming, ranching, and the lumber and wood products industries yielded less than six percent of the region's employment and less than five percent of personal income.[157] By USFS estimate, from 1969 through 1987 recreation on USFS land in the GYE contributed eighty-three percent of "forest-related jobs," while logging contributed only eleven percent.[158] From 1969 through 1992, less than one percent of new GYE jobs were in mining, logging, ranching, or farming.[159] Less than five percent of the GYE workforce depends, directly or indirectly, on logging, mining, energy development, or grazing on national forest land.[160] Still, many local people fear that prioritizing land protection over extractive uses will lead to local job losses.[161] However, continued extractive use on public lands does not measure up to a profitable bottom line for the USFS, the BLM, or for the American taxpayer. In 1997, Secretary of the Interior Bruce Babbitt noted the weak correlation between logging and the economic prosperity of nearby small, western towns.[162]

2. Tourism and Economic Prosperity

Since their early beginnings, U.S. National Parks have been key tourist attractions.[163] Indeed, as early as 1962, Secretary of the Interior Stewart Udall observed that recreation on park land would provide more local income than would consumptive exploitation.[164]

157. Raymond Rasker, *A New Look at Old Vistas: The Economic Role of Environmental Quality in Western Public Lands*, 65 U. COLO. L. REV. 369, 377 (1994) (discussing role of Western public lands in the economic stability of communities who are dependent on natural resources).

158. Thomas M. Power, *Ecosystem Preservation and the Economy of the Greater Yellowstone Area*, 5 CONSERVATION BIOLOGY 395, 401 (1991).

159. Raymond Rasker & Arlin Hackman, *Economic Development and the Conservation of Large Carnivores*, 10 CONSERVATION BIOLOGY 991, 996 (1996).

160. *See* Rasker, *supra* note 157, at 381.

161. Richard P. Reading, Tim W. Clark & Stephen R. Kellert, *Attitudes and Knowledge of People Living in the Greater Yellowstone Ecosystem*, 7 SOC'Y & NAT. RESOURCES 349, 362 (1994).

162. *See* Bruce Babbitt, *New Forestry in an Old Struggle*, 4 PEOPLE, LAND, & WATER 1, 8–9 (1997).

163. *See generally* MARGUERITE S. SHAFFER, SEE AMERICA FIRST: TOURISM AND NATIONAL IDENTITY 1880–1940 (2001) (discussing national tourism and the parallel growth of the nation state and tourism).

164. Stewart L. Udall, *Nature Islands for the World*, *in* FIRST WORLD CONFERENCE ON

But the public's understanding of such economic insights lags behind that of experts. Since only five percent of the economic wealth of Western states is derived from natural resource extraction,[165] those states should look to recreation and tourism as a primary source of revenue. For example, the 2.8 million visitors to Colorado's national parks during FY 2005 generated $199.2 million for the local economy and supported 4794 local jobs.[166] Foreign visitors significantly contributed to this economic windfall. Using 2000 rates as a barometer, the number of international tourists coming to the U.S. will increase by 98.1% through 2020.[167] While observers have put forward some hypotheses,[168] social scientists do not know for certain why park visitation rates rise and fall; however, as the integrity of park resources declines, it seems possible that visitation to these parks might also decline.

According to an economic model endorsed by the NPS, NPS visitors spent $10.4 billion during FY 2005 in the local regions around national parks, supporting 235,000 local jobs.[169] Some local officials representing business interests understand their economic dependence on national parks and support park resource protection. More than seventeen years ago, local officials opposed oil and gas leasing and logging next to Yellowstone National Park and advocated wilderness expansion.[170] More recently, the Chamber of Commerce in Dubois, Wyoming opposed a USFS decision to allow oil and gas leasing on the Shoshone National Forest because it might halt the establishment of new businesses attracted to the area's scenic beauty and environmental

NATIONAL PARKS 1, 5 (Alexander B. Adams ed., 1962).

165. Thomas M. Power, *Wilderness Economics Must Look Through the Windshield, Not the Rearview Mirror*, 2 INT'L J. WILDERNESS 5, 5 (1996).

166. DANIEL J. STYNES, DEPARTMENT OF COMMUNITY, AGRICULTURE, RECREATION, AND RESOURCE STUDIES, NATIONAL PARK SPENDING AND PAYROLL IMPACTS FISCAL YEAR 2005 15–31 (2006).

167. GARY E. MACHLIS ET AL., A LOOK AHEAD: KEY SOCIAL AND ENVIRONMENTAL FORECASTS RELEVANT TO THE NATIONAL PARK SERVICE 39 (2000), *available at* http://www.nature.nps.gov/socialscience/pdf/A_Look_Ahead.pdf.

168. *See, e.g.*, Oliver R.W. Pergams & Patricia A. Zaradic, *Is Love of Nature in the U.S. Becoming Love of Electronic Media? 16-Year Downtrend in National Park Visits Explained by Watching Movies, Playing Videos, Internet Use, and Oil Prices*, 80 J. ENVTL. MGMT. 387 (2006).

169. STYNES, *supra* note 166, at 5.

170. Robert B. Keiter, *An Introduction to the Ecosystem Management Debate*, *in* THE GREATER YELLOWSTONE ECOSYSTEM: REDEFINING AMERICA'S WILDERNESS HERITAGE, *supra* note 9, at 3, 8–9.

amenities.[171] The Jackson Hole Chamber of Commerce supported a USFS December 2000 plan to exempt 149,735 hectares in the Bridger-Teton National Forest from oil and gas drilling, and the Teton County commissioners supported keeping the oil and gas industries out of sensitive areas of national forests.[172] In Idaho, the County Commissioners for Blaine County unanimously supported wilderness designation for the Boulder-White Clouds area, and by January 2004, 130 local businesses rallied behind the proposed wilderness designation.[173]

One stark indicator of the economic importance of national parks was the economic devastation when the parks were shut down. After the failure of President Clinton and Congress to reach agreement on funding measures, the federal government shut down twice between November 14, 1995 and January 6, 1996.[174] When many national parks had to shut down for lack of staff, the hardship to small businesses near parks was so severe that the Governor of Arizona led his National Guard troops to reopen Grand Canyon National Park and made an agreement with the federal government to reopen the park during the holidays.[175] The DOI estimated that local communities near park units lost $14 million in tourism sales each day that the parks were closed.[176]

As noted above, however, national parks are by no means the only United States federal land tourist destinations. As for the National Park System, visitation to BLM and USFS lands has increased dramatically.[177] USFS recreational visitor days rose from under twenty million in 1946 to over 200 million fifty years later.[178] Looking at the U.S. National Wildlife Refuge System, visitors

171. JIM HOWE ET AL., BALANCING NATURE AND COMMERCE IN GATEWAY COMMUNITIES 13 (1997).

172. Laura Paskas, *Grass Roots Prevail in the ANWR and Wyoming*, HIGH COUNTRY NEWS, Apr. 14, 2003, *available at* http://www.hcn.org/issues/248/13874.

173. RAY RASKER ET AL., PROSPERITY IN THE 21ST CENTURY WEST 3 (2004).

174. Adam Charles Mednick, *Estimated Economic Impacts of the 1995–1996 U.S. National Park Shutdowns*, 14(2) GEORGE WRIGHT F. 39, 39 (1997).

175. NAT'L PARKS AND CONSERVATION ASS'N, THE ECONOMIC IMPORTANCE OF NATIONAL PARKS: EFFECTS OF THE 1995–1996 GOVERNMENT SHUTDOWNS ON SELECTED PARK DEPENDENT BUSINESSES AND COMMUNITIES 27 (1996).

176. *Id.* at 7.

177. James R. Rasband, *The Rise of the Urban Archipelagoes in the American West: A New Preservation Policy*, 31 ENVTL. L. 1, 25–26 (2001).

178. DOMBECK ET AL., *supra* note 124, at 175; U.S. FOREST SERV., NATIONAL FOREST RECREATION USE, 1924–1996 (1997), *available at* http://www.fs.fed.us/recreation/programs/facts/use/rec_use_1924-96.pdf.

generated $169.2 million in employment income in 1995.[179] The forty-two million acres of roadless areas in the lower forty-eight states generated almost $600 million in recreational economic benefits per year, more than $280 million in passive use values and nearly 24,000 jobs.[180] Since different methods are used to arrive at visitation counts in national parks, national forests, and on BLM lands, visitation rate comparisons between the agencies are currently impossible. Still, one thing seems certain: attractive natural areas yield economic benefits for local communities.[181]

III. The Annexation Option

A. How Annexation May Work

The annexation option invokes two conservation biology protected area management models: the multiple-use module[182] and the diversity maintenance area.[183] The multiple-use module ("MUM") consists of a core area dedicated to strict preservation, but is surrounded by concentric land use zones that allow for less restrictive forms of land use. The diversity maintenance area ("DMA") was proposed for landscapes managed for multiple uses, like United States national forests. DMAs would be specific, mapped zones within a forest where biological diversity preservation is the priority (e.g., existing Research Natural Areas) and could include areas that have suffered multiple use extraction, but were subsequently set aside for restoration. The two key ideas these models provide that are relevant to annexation are concentric zoning around protected areas (MUM) and set-asides for restoration within a broader multiple use management regime (DMA).

Under the annexation option, for example, Yellowstone National Park would be the nucleus of a larger reserve under NPS

179. A. Laughlin & J. Caudill, U.S. Fish & Wildlife Serv., Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation v (1997).

180. John B. Loomis & Robert Richardson, Economic Values of Protecting Roadless Areas in the United States iii (2000).

181. Rasker, *supra* note 157, at 396.

182. Reed F. Noss & Larry D. Harris, *Nodes, Networks, and MUMs: Preserving Diversity at All Scales*, 10 Envtl. Mgmt. 299, 299 (1986).

183. William S. Alverson, Walter Kuhlmann & Donald W. Waller, Wild Forests: Conservation Biology and Public Policy 160–78 (1994).

administration. This expanded reserve would consist of selected, subsumed national forest property, both wilderness and non-wilderness. Some of this USFS land may have already been logged, roaded, mined, grazed, and developed for oil and gas extraction or water projects.[184] But such land could be restored to a more natural condition over time under the oversight of the NPS. The National Park Second Century Commission advocated "new kinds of parks," including "ecological restoration areas."[185] Restoration can entail reestablishing natural landscape contours and hydrological regimes, removing infrastructure and roads, and revegetating landscapes.

If adjacent mining was a threat to a park, the process for annexation could resemble Congress's expansion of Arches National Park in 1998. The Arches National Park Expansion Act of 1998 added 1270 hectares of arches, narrow canyons, and redrock formations administered by the BLM.[186] It also amended Section 5 of P.L. 92-155 by inserting "[the added] land is appropriated and withdrawn from entry, location, selection, leasing and other disposition and the public land laws (including mineral leasing laws)."[187] Specifications for grazing leases were also added.[188] Therefore, Congress could use park boundary expansion as an opportunity to phase out certain resource extraction activities on to-be-annexed BLM and USFS lands. Mere annexation will not invalidate preexisting rights, but such rights could be extinguished by Congress during the annexation process to make such land compatible with NPS mandates. Valid existing private rights (e.g., mining, grazing) on USFS and BLM lands could be determined on a case-by-case basis.

Five decades ago, a world-class mathematical ecologist was the first to advocate corridors between reserves.[189] The NPS Advisory Board has since adopted this, stating: "[national parks] need to be linked with other natural areas through wildlife and migratory

184. See Losos et al., *supra* note 136, at 450.

185. NAT'L PARK SECOND CENTURY COMMISSION, ADVANCING THE NATIONAL PARK IDEA 23 (2009).

186. Arches National Park Expansion Act of 1998, S. 2106, 105th Cong. (1998); S. Rep. No 105-330 (1998).

187. 16 U.S.C. § 272d (1998).

188. Arches National Park Expansion Act, *supra* note 186.

189. P.W. Preston, *The Canonical Distribution of Commonness and Rarity: Part II*, 43 ECOLOGY 410, 427 (1962).

corridors or greenways."[190] As already discussed, USFS and BLM land annexation will enhance two critical ecological aspects of protected areas within a protected area system: size and connectivity. Land annexation creates wider reserves and enhances corridor functionality between reserves. In the GYE, for example, boundary expansion alone cannot achieve the needed habitat connection with other grizzly bear habitats, such as Idaho's Salmon-Selway ecosystem (515 km distant) or the Northern Continental Divide Ecosystem (579 km distant).[191] But at least over a very short distance, boundary expansion would represent a very small, incremental step in supporting the goals of a proposed Yellowstone-to-Yukon ("Y2Y") corridor.[192]

National park annexation can help stop external threats on land that is accreted. There is little doubt that reducing logging, livestock grazing, mining, oil and gas development, water projects, and the use of ORVs on federal land next to national park boundaries would benefit some national park biota. In the GYE, the USFS administers four times the amount of land as does the NPS, and such USFS property is dotted with inholdings, which are often encumbered with various pre-existing rights (e.g., oil and gas exploration, hard-rock mining).[193] However, were the NPS to manage that adjacent land, and if it were given the freedom to pursue legal solutions, the agency, based on guidance in its management policies,[194] would try to prevent, limit, or phase out such practices.

B. Thinking Boldly

The Advisory Board considered the NPS "perhaps too cautious, too resistant to change, too reluctant to engage the challenges that must be addressed in the 21st century."[195] Thus, one truism warrants repeating: "Ideas must precede action . . . ."[196]

190. JOHN HOPE FRANKLIN ET AL., NAT'L PARK SERV., RETHINKING THE NATIONAL PARKS FOR THE 21ST CENTURY 17 (2001), *available at* http://www.nps.gov/policy/report.htm.

191. These figures are based on the author's calculations.

192. *See generally* DOUGLAS H. CHADWICK & RAYMOND GEHMAN, YELLOWSTONE TO YUKON: NATIONAL GEOGRAPHIC DESTINATIONS SERIES (2000).

193. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-96-40, LAND OWNERSHIP: INFORMATION ON THE ACREAGE, MANAGEMENT, AND USE OF FEDERAL AND OTHER LANDS (1996).

194. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 88.

195. *See* FRANKLIN ET AL., *supra* note 190, at 8.

196. STEWART L. UDALL, THE QUIET CRISIS 52 (1963).

Unfortunately, a common governmental organizational practice is information "filtering." That is, particular ideas are not discussed based on their perceived political sensitivity.[197] A recent academic conference on the future of the USFS did not even mention annexing adjacent USFS land to boost national park viability.[198] In addition, this Article does not address the challenge of seeking land use conformity on private lands in the GYE that are not federal land inholdings, yet that too is an important consideration.[199] In order to assure continuous compatible land use in the GYE for the grizzly bear, for example, the owners of the private lands outside federal inholdings need to be encouraged to practice land use that is compatible with bear survival.

Still, ideas not unlike the annexation option have been proposed before. For example, in 1986 a legislative discussion draft produced by House of Representatives staff proposed to consolidate federal lands in the GYE under one agency.[200] As recently as February 2009, the GAO released a study about the effects of transferring the national forests managed by the USFS, part of the Department of Agriculture, to the DOI.[201] Further, the Public Land Law Review Commission, a Congressionally-created commission that reviewed federal agencies' management of public lands,[202] recommended that where public land represents the best or sole habitat for a threatened species (e.g., the GYE grizzly bear), competing uses should be dropped or restricted.[203] Such ideas have not gained much traction as, for example, logging and oil and gas

197. PARKS CANADA AGENCY, MINISTER OF PUBLIC WORKS AND GOVERNMENT SERVICES, 2 "UNIMPAIRED FOR FUTURE GENERATIONS?" CONSERVING ECOLOGICAL INTEGRITY WITH CANADA'S NATIONAL PARKS, SETTING A NEW DIRECTION FOR CANADA'S NATIONAL PARKS 2–15 (2000).

198. *See* Robert A. Sedjo, *Does the Forest Service Have a Future? A Thought Provoking View*, *in* A VISION FOR THE U.S. FOREST SERVICE: GOALS FOR ITS NEXT CENTURY 176 (Robert A. Sedjo ed., 2000).

199. *See, e.g.*, L. Breckenridge, *Reweaving the Landscape: The Institutional Challenges of Ecosystem Management for Lands in Private Ownership*, 19 VT. L. REV. 363 (1995).

200. Tim W. Clark & Dusty Zaunbrecher, *The Yellowstone Ecosystem: The Ecosystem Concept in Natural Resource Policy and Management*, 5 RENEWABLE RESOURCES J. 8, 14 (1987).

201. GOV'T ACCOUNTABILITY OFFICE, GAO/09-223, FEDERAL LAND MANAGEMENT: OBSERVATIONS ON A POSSIBLE MOVE OF THE FOREST SERVICE INTO THE DEPARTMENT OF THE INTERIOR (2009).

202. Charles M. Stephenson, *Implications of PLLRC Tax Recommendations for Federal Hydro Projects and Power Facilities*, 49 LAND ECON. 67, 67 (1973).

203. PUB. LAND LAW REVIEW COMM'N, ONE THIRD OF THE NATION'S LAND: A REPORT TO THE PRESIDENT AND THE CONGRESS BY THE PUBLIC LAND LAW REVIEW COMMISSION 160 (1970).

extraction continue in U.S. National Forests.[204]

Many opportunities for annexation exist. For example, among the new BLM and USFS "landscape reserves," opportunities for annexation include: Grand Canyon-Parashant National Monument into Grand Canyon National Park, Arizona; Giant Sequoia National Monument into Sequoia National Park, California; Gunnison Gorge National Conservation Area into Black Canyon of the Gunnison National Monument, Colorado; and Great Sand Dunes National Preserve into Great Sand Dunes National Park, Colorado.

Existing wilderness areas present another opportunity for annexation. National Park System units exceeding 25,000 hectares that abut USFS wilderness include: North Cascades and Mount Rainier National Parks; Crater Lake National Park, Oregon; Yosemite and Sequoia National Parks, California; Badlands National Park, South Dakota; Glacier National Park, Montana; Grand Teton National Park, Wyoming; and Yellowstone National Park, Wyoming, Idaho, Montana.[205] National Park System units over 70,000 hectares that abut BLM wilderness areas include Death Valley National Park, Nevada and California, and Joshua Tree National Park and Mojave National Preserve, California.[206]

C. Potential Economic Impact

Annexing adjacent USFS and BLM lands would not only create larger national parks but also, ultimately, national parks with fewer or no resource-extraction and land-use conflicts at their boundary interfaces. Any increase in tourism to these parks could be

managed. As under the status quo, the NPS could also manage adjacent incompatible land use through persuasion or through possible legal authority.[207]

In our GYE example, many park visitors would relish the opportunity to see wild, non-habituated bears. Correlations are already strong between economic prosperity and wild lands.[208] It is conceivable, even probable, that increasing the viability of parks for

204. *See supra* notes 114–16 and accompanying text; *see also supra* notes 122–23 and accompanying text.

205. NAT'L PARK SERV., WILDERNESS REPORT 2004–2005, at app. 1–3 (2005), *available at* http://wilderness.nps.gov/document/2004-2005_wilderness_report.pdf.

206. *Id.*

207. *See infra* Part IV.A.1.a.

208. *See* Rasker & Hackman, *supra* note 159, at 1000.

bears might ensure, or even enhance, the economic benefits these visitors provide to nearby towns. Similarly, during 2005, 94,000 visitors came to Yellowstone National Park to see wolves.[209] Along with this boost in tourism revenue, there will be some costs associated with expanding wildlife habitat. For example, although boundary expansion might eventually decrease livestock depredations by the grizzly bear on subsumed GYE federal land, as the bear population increases, bear livestock killings could be expected to occur beyond the new park boundary as well. From 1997 to 2005, Defenders of Wildlife compensated ranchers in the northern Continental Divide ecosystem $122,650 for cattle and sheep depredation by bears.[210] This sum is less than what some Yellowstone concessionaires gross in a single day.[211] Before the gray wolf was reintroduced to Yellowstone National Park in 1995 and 1996, a study by Dr. John Duffield, Professor of Economics at the University of Montana, estimated that adding the gray wolf to the GYE would contribute $19 million annually to the local economy, compared with a potential loss of $200,000 from wolf predation on livestock and game animals.[212] After the gray wolf was reintroduced to Yellowstone, Duffield estimated that the park's 90,000 wolf watchers during 2005 generated direct expenditures of $35.5 million.[213] Similarly, one researcher estimated an overall increase in regional economic benefits if British Columbia's Waterton Lakes National Park were to expand into the adjacent Flathead Valley, in spite of initial revenue loss from logging, rock quarrying, hunter outfitting, and mechanized recreation.[214] All the above suggests

209. John W. Duffield et al., *Wolf Recovery in Yellowstone: Park Visitor Attitudes, Expenditures, and Economic Impacts*, 16 YELLOWSTONE SCI. 20, 22 (2008), *available at* http://www.nps.gov/yell/planyourvisit/upload/ys16(1)partII.pdf.

210. MINETTE JOHNSON, DEFENDERS OF WILDLIFE, PLACES FOR GRIZZLY BEARS: A BLUEPRINT FOR RESTORATION AND RECOVERY IN THE LOWER 48 STATES 10 (2006), *available at* http://www.defenders.org/resources/publications/programs_and_policy/wildlife_conservation/imperiled_species/grizzly/a_place_for_grizzlies.pdf.

211. Based on a 365 days per year calculation, some Yellowstone National Park concessionaires gross $186,000 per day. Personal Communication from Jo A. Pendry, Nat'l Park Serv. (July 2008).

212. Duffield et al., *supra* note 209, at 22.

213. John W. Duffield, Chris J. Neher & David A. Patterson, *Wolf Recovery in Yellowstone: Park Visitor Attitudes, Expenditures, and Economic Impacts*, 25(1) GEORGE WRIGHT F. 13, 17 (2008).

214. JIM JOHNSON, WATERTON-GLACIER INTERNATIONAL PEACE PARK: THE ECONOMIC IMPLICATIONS OF EXPANDING INTO THE FLATHEAD REGION OF BC 7 (2005), *available at* http://www.kendall.org/publications/reports/waterton_park_report%202005%20.pdf.

that if Yellowstone National Park's boundary is expanded to benefit its large carnivores, any economic loss suffered by livestock from bear and wolf depredation would likely be miniscule compared to the economic benefits from increased tourism.

Economist Michael Garrity has offered a bold proposal that dovetails intriguingly with the annexation option.[215] In lieu of logging, he proposes that grizzly bear habitat be restored. This would save $245 million over ten years and create 2300 high-paying, labor-intensive Western jobs (e.g., road removal).[216] In support of Garrity's proposal is a road removal success story that already exists for Redwoods National Park, California.[217]

D. Natural Amenities and Human Population Growth

Scenery, wildlife, and opportunities for outdoor recreation are among the reasons offered to explain the high human population growth rate in the Intermountain West.[218] Further, in a southeastern Utah survey, when local people were asked to photograph what they believed was central to their quality of life, sixty percent included pictures of scenic vistas.[219] Reflecting these priorities, national parks and national forests increase the human quality of life in a much larger region, and enhance the whole region's economic vitality.[220] Of course wilderness areas, not just national parks, are another way to protect the long-term economic future of local communities and the nearby region.[221]

Additionally, private property directly adjacent to national parks or wilderness areas is growing in real estate value. For example, residential lands increase in value the closer they are to wilderness in Vermont's Green Mountain National Forest.[222] As one analyst

215. MICHAEL GARRITY, ECONOMIC ANALYSIS OF THE NORTHERN ROCKIES ECOSYSTEM ACT (2003), *available at* *http://www.wildrockiesalliance.org/about/programs/publications/reports/nrepa_econ_analysis.pdf.*

216. *Id.* at 3.

217. *See generally* David Havlick, *Removing Roads: The Redwood Experience*, 3 CONSERVATION IN PRAC. 28, 28–33 (2002).

218. Andrew J. Hansen et al., *Ecological Causes and Consequences of Demographic Change in the New West*, 52 BIOSCIENCE 151, 156 (2002).

219. Jonathan G. Taylor et al., *Thinking Outside the Lines: Parks and the Quality of Life in Area Communities*, 20 PARK SCI. 14, 15 (2000).

220. *See* Rasker & Hackman, *supra* note 159; Thomas M. Power, *The Economic Role of America's National Parks: Moving Beyond a Tourist Perspective*, 15(1) GEORGE WRIGHT F. 33, 33–35 (1998).

221. *See* Power, *supra* note 220, at 39–40.

222. *See* Spencer R. Phillips, Windfalls for Wilderness: Land Protection and Land Value

observed, "[h]ealthy forests do a lot more for the quality of life than stumps."[223] National parks and wilderness also attract business interests; the same thing that attracts individuals to wilderness counties also draws new companies.[224] Therefore, seen through a long-range lens, extractive activities such as clear-cutting that affect a region's scenic vistas actually damage its future economic prosperity. Consequently, the most economically effective role of public land agencies is to safeguard the land's ecological integrity.[225]

The above indicates that any planning must consider the social and economic dynamics in regions surrounding national parks.[226] "Social impact analysis"[227] could clarify the benefits and disadvantages of expanding national park boundaries, a task required by NEPA when warranted.[228] Thus, ecological, social, economic, and other considerations can and should be integrated into land planning.[229]

We still have much to learn. In the early stages of gray wolf recovery planning, Yellowstone National Park launched an effective public education effort. Some of the factors deemed crucial in getting public support included: doing social survey research, keeping the public informed at all times, not imposing restrictions on resource extraction, publicizing potential compensation for wolf depredation, doing an EIS getting interagency and NGO support, getting local media coverage, and doing a public education

in the Green Mountains (Feb. 4, 2004) (unpublished doctoral dissertation, Virginia Polytechnic Institute), *available at* http://scholar.lib.vt.edu/theses/available/etd-02042004-141616/unrestricted/Phillips-Spencer_VPISU-AAEC_PHD-Dissertation_2004-02-10.pdf.

223. Ernie Niemi et al., *Bird of Doom . . . or was it?*, 22 AMICUS J. 19, 24 (2000).

224. *See generally* Jerry D. Johnson & Raymond Rasker, *The Role of Economic and Quality of Life Values in Rural Business Location*, 11(4) J. RURAL STUD. 405 (1995).

225. *See* Rasker, *supra* note 157.

226. *See* Patrick C. Jobes, *Population and Social Characteristics in the Greater Yellowstone Ecosystem*, 6(2) SOC'Y & NAT. RESOURCES 149 (1993); Raymond Rasker, *Rural Development: Conservation and Public Policy in the Greater Yellowstone Ecosystem*, 6(2) SOC'Y & NAT. RESOURCES 109 (1993); Raymond Rasker & Andrew Hansen, *Natural Amenities and Population Growth in the Greater Yellowstone Region*, 7(2) HUM. ECOLOGY REV. 30 (2000).

227. *See generally* RABEL J. BURDGE, A CONCEPTUAL APPROACH TO SOCIAL IMPACT ASSESSMENT: COLLECTION OF WRITINGS BY RABEL J. BURDGE AND COLLEAGUES (Social Ecology Press rev. ed., 1998); Rabel J. Burdge, *Social Impact Assessment: Understanding How Outside Development Alters the Park Experience*, 20 PARK SCI. 27, 29 (2000) [hereinafter Burdge, *Social Impact Assessment*].

228. *See* Burdge, *Social Impact Assessment*, *supra* note 227, at 27.

229. *See, e.g.*, APPLYING ECOLOGICAL PRINCIPLES TO LAND MANAGEMENT (Virginia H. Dale & Richard A. Haeuber eds., 2001).

campaign.[230] Lessons could be taken from this effort; however, expanding Yellowstone National Park's boundaries may require a level of public relations skills that no one organization could muster.

IV. ALTERNATIVES TO ANNEXATION

A. Potential Approaches

The word "annexation" conjures up images of a last resort, when less coercive efforts have been tried and failed. It may be viewed as a hostile expansion of the NPS dominion at the expense of the roles of other important federal land management agencies and their assigned land use practices. If similar results could be produced by more palatable means, should these not be attempted first? Perhaps, but these alternatives have downsides. In addition, while there may be the possibility of mixing some of these approaches, a review of possible alternatives reveals that annexation is, at a minimum, the most expedient method.

1. Landless Tools for Preservation

a. Using or Augmenting Existing Authorities

Some legal scholars have argued that the NPS already has the legal authority it needs to deter external threats, including on private lands.[231] NPS may have more authority than it utilizes to abate deleterious land use next to park boundaries.[232] According to Lockhart, the DOI has not determined whether this untapped NPS clout exists,[233] yet almost half of park superintendents once believed they need more authority than they have in order to respond to adjacent harmful uses.[234]

230. *See* SUSAN K. JACOBSON, COMMUNICATION SKILLS FOR CONSERVATION PROFESSIONALS 293–317 (Island Press 1999).

231. Harry R. Bader, *Not So Helpless: Application of the U.S. Constitution Property Clause to Protect Federal Parklands from External Threats*, 39 NAT. RESOURCES J. 193, 193 (1999).

232. *See* Lockhart, *supra* note 84, at 45–59. *See also* Bader, *supra* note 231, at 193–209; Craig L. Shafer, *U.S. National Park Buffer Zones: Historical, Scientific, Social and Legal Aspects*, 23 ENVTL. MGMT. 49, 59 (1999) [hereinafter Shafer, *Buffer Zones*].

233. Lockhart, *supra* note 84, at 45–51.

234. Nat'l Parks & Conservation Ass'n, *NPCA Adjacent Lands Survey: Part II*, NAT'L PARKS & CONSERVATION MAG., Apr. 1979, at 4.

Two laws are available to assist the NPS in combating harmful adjacent land use. First, the National Environmental Policy Act of 1969 ("NEPA") requires that environmental review be conducted for proposed projects that might impact nearby parks.[235] Second, the Endangered Species Act of 1973 ("ESA") requires federal agencies to ensure that their activities do not negatively impact threatened or endangered species or their habitats.[236] However, some national forests and BLM lands outside national parks lack critical ESA habitat designations, and therefore cannot provide proper protection for endangered species. For example the GYE lacks a critical habitat designation for the grizzly bear.[237] Further, as NEPA only requires an environmental review, but has no enforcement powers, it cannot ensure that a park will be protected against harmful adjacent federal actions.[238]

To compensate for the lack of protection provided under NEPA and the ESA, the President could sign an Executive Order prohibiting any agency from harming park resources.[239] An additional source of protection is the Secretary of the Interior's authority to prevent certain federal agencies, including the BLM, from authorizing incompatible uses next to parks.[240] Congress considered legislation giving the NPS more clout in the 1980s and early 1990s, but it never became law.[241] One of the foremost reasons that legislation has not been successful is that powerful special interest groups, like farmers and ranchers, have vehemently opposed legislative action.[242]

235. *See* Hiscock, *supra* note 79, at 52–53. *See also* Robert B. Keiter, *Natural Ecosystem Management in Park and Wilderness Areas: Looking at the Law*, *in* ECOSYSTEM MANAGEMENT FOR PARKS AND WILDERNESS 15, 21–23 (J.K. Agee & D.R. Johnson eds., 1998).

236. Keiter, *supra* note 235, at 21–23.

237. Endangered and Threatened Wildlife and Plants; Designating the Greater Yellowstone Ecosystem Population of Grizzly Bears as a Distinct Population Segment; Removing the Yellowstone Distinct Population Segment of Grizzly Bears from the Federal List of Endangered and Threatened Wildlife, Proposed Rule, 70 Fed. Reg., 69853, 69861 (Nov. 17, 2005).

238. *See* Hiscock, *supra* note 79, at 52–54.

239. *See* SHARON BUCCINO ET AL., RECLAIMING OUR HERITAGE: WHAT WE NEED TO DO TO PRESERVE AMERICA'S NATIONAL PARKS 23 (Natural Resources Defense Council ed., 1997).

240. William J Lockhart, *External Park Threats and Internal Limits: The Need for an Independent National Park Service*, *in* OUR COMMON LANDS: DEFENDING THE NATIONAL PARKS 3, 51 (David J. Simon ed., 1988).

241. CONSERVATION FOUNDATION, NATIONAL PARKS FOR A NEW GENERATION: VISIONS, REALITIES, PROSPECTS 145 (Robert J. McCoy ed., 1985); Shafer, *Buffer Zones*, *supra* note 232, at 59.

242. Shafer, *Buffer Zones*, *supra* note 232, at 59.

In the event that an NPS decision-maker detects an activity that could lead to park impairment, NPS policy encourages park superintendents to "take appropriate action, to the extent possible within the Service's authorities and available resources, to eliminate the impairment."[243] While this is a seemingly broad policy, whether park superintendents will be instructed that they have more authority than currently perceived and will be allowed to act on it is yet to be determined. As the Conservation Foundation feared, "the service cannot take care of the [external] threats unless the [S]ecretary of the [I]nterior, Congress, and ultimately the public are fully committed to doing so."[244] Unless a finding is made that the NPS has abundant, untapped authority and park superintendents are encouraged to use it, annexation is the logical alternative.

b. Preservation Through Persuasion

The NPS's preferred approach to stop the degradation of park biotic resources from human activity on adjacent federal, state, or private property has been coined "cooperative conservation."[245] This policy is a continuation of the Reagan Administration's concept of "cooperative regional planning."[246] Such an approach relies primarily on persuasion and developing relationships to muster support.[247] It also entails encouraging local governments to exercise their own planning and zoning authorities, as well as prompting other federal and state agencies to enforce existing park-beneficial environmental legislation. This philosophy highlights volunteerism, not coercion, and most certainly not litigation. Stories of successfully minimizing development next to a national park exist,[248] but attempted partnering may still have outcomes that are not optimal for a park. For example, logging on USFS land was occurring right up to the boundary of Mount Rainier National Park, Washington.[249] As a result, windthrow was toppling large Douglas-fir (*Pseudotsuga taxifolia*) trees inside that

243. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 12.
244. *See* CONSERVATION FOUNDATION, *supra* note 241, at 155.
245. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 13.
246. NAT'L PARK SERV., 1988 MANAGEMENT POLICIES, *supra* note 54, at 2–9; NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 25.
247. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 13.
248. *See* HOWE ET AL., *supra* note 171, at 89.
249. *See* CONSERVATION FOUNDATION, *supra* note 241, at 144.

park. As specified by NEPA, the USFS allowed the NPS to review and comment on its timber sales, determine any potential negative effects, and make recommendations on how to reduce windthrow.[250] The NPS comments were considered, and the USFS periodically contacted the NPS to see if there were any problems with their ongoing timber sales, but USFS logging still continued right next to the park boundary.[251] This agreement represented a setback for the park.

As Scheffer et al. pointed out, "[c]ompromises have the advantage of seeming fair, but they leave neither party satisfied and so do not generally represent long-term solutions;"[252] this has also been described as the NPS's "middle-of-the-road approach."[253] Reported compromises incrementally erode park resources. Furthermore, sometimes NPS objections have no effect. For example, in 1982, after the NPS provided its opposition to the USFS regarding its leasing of oil and gas rights next to Theodore Roosevelt National Park, North Dakota, the NPS was ignored.[254] Similarly, in 2006, NPS objections provided to the BLM about their issuance of oil and gas leasing next to Dinosaur National Monument, Utah, Colorado, were also ignored; NGO litigation, however, temporarily stopped the plan.[255] Later, without conferring with the NPS, the BLM announced it would auction off 50,000 acres of oil and gas exploration leases, some within 1.3 miles of Delicate Arch in Arches National Park, Utah.[256] The sale was scheduled for December 19, 2008, the last days of the George W.

250. *See id.*

251. *Id.*

252. Marten Scheffer, William Brock & Frances Westley, *Socioeconomic Mechanisms Preventing Optimum Use of Ecosystem Services: An Interdisciplinary Theoretical Analysis*, 3 ECOSYSTEMS 451, 463 (2000).

253. John Lemons & Kirk Junker, *The Role of Science and Law in the Protection of National Park Resources*, *in* NATIONAL PARKS AND PROTECTED AREAS: THEIR ROLE IN ENVIRONMENTAL PROTECTION, *supra* note 3, at 384, 409.

254. *See* DAVID HARMON, AT THE OPEN MARGIN: THE NPS'S ADMINISTRATION OF THEODORE ROOSEVELT NATIONAL PARK, ch. 5 (1986), *available at* http://www.nps.gov/history/history/online_books/thro/adhit.htm.

255. Mary Bernard, *Dust Up Over Drilling Leases Near Dinosaur*, VERNAL EXPRESS, Nov. 19, 2008, *available at* http://www.vernal.com/printer_friendly/694730.

256. *Drilling Platforms Near National Parks?*, ASSOCIATED PRESS, Nov. 16, 2008, *available at* http://www.msnbc.msn.com/id/27753981. It should be noted that active and potential coal and hard rock mining, coal bed methane, and oil and gas development take place next to fifty-three NPS units. *See* Nat'l Park Serv., Mining Operations Management, http://www.nature.nps.gov/geology/mining (last visited Jan. 31, 2010) [hereinafter Nat'l Park Serv., Mining].

Bush Administration. On February 4, 2009, President Barack Obama's Secretary of the Interior, Ken Salazar, announced that the BLM would withdraw leases on seventy-seven tracts of land near Arches and Canyonlands National Parks and Utah's Nine Mile Canyon.[257] On June 11, 2009, the DOI released a report indicating that the procedure used to sell these seventy-seven Utah oil and gas leases was flawed.[258]

Further, it is not clear whether some sister agencies have the authority to comply with NPS protests. For example, according to one observer, USFS mining regulations do not appear to allow the agency to deny a plan of operations.[259] Thus, in order to preclude negative impacts to Yellowstone National Park from a gold mining project (i.e., the New World Mine, 1.7 km outside the park's north boundary), President Clinton brokered a land exchange in 1996.[260] Both FLPMA and NFMA provide language that can be interpreted to require that national parks be protected from activities on adjacent BLM and USFS lands, respectively, but this is yet to be decided.[261]

Agency goals also may be so disparate that reaching an acceptable compromise is not possible. When that happens, conservation organizations may initiate action on behalf of the park resource. For example, after the USFS authorized a ski development, Ski Yellowstone, on the Gallatin National Forest near Yellowstone National Park boundaries, NGOs filed competing applications that resulted in its cancellation.[262] Because persuasion by the NPS is infrequently effective, compromises can lead to a diminishment of park integrity. Courts might intervene if NPS actions and competing uses are incompatible: the 10th Circuit has held that NPS actions are required if any activity does not leave

257. Rick Snow, *Team Studying Withdrawn BLM Leases in Utah Issues Recommendations*, OIL & GAS J., Oct. 8, 2009, *available at* http://www.ogj.com/index/article-display/190/288842/articles/oil-gas-journal/general-interest-2/government/2009/10/team-studying-withdrawn.html.

258. Press Release, Bureau of Land Mgmt., Dep't of the Interior, Interior Review Shines Light on Controversial Utah Oil and Gas Leases (June 11, 2009), http://www.blm.gov/wo/st/en/info/newsroom/2009/june/NR_0611_2009.html.

259. Joel A. Ferre, *Forest Service Regulations Governing Mining: Ecosystem Preservation Versus Economically Feasible Mining in the National Forests*, 15 J. ENERGY NAT. RESOURCES & ENVTL. L. 351, 361–64 (1995).

260. *See* Lockhart, *supra* note 84, at 7.

261. *See* Hiscock, *supra* note 79, at 59–61.

262. SAX, *supra* note 55, at 70–72. Ski resorts of this type often include shops, restaurants, bars, and nightclubs.

park resources "unimpaired for the enjoyment of future generations."[263] The uses described above would likely fail under such review: as the NPS Advisory Board science committee explicitly stated, "national parks with decreased biological diversity and diminished natural systems can in no way be considered unimpaired."[264]

Why does persuasion, or even NEPA compliance by sister government agencies, often not produce results more favorable to the NPS? Former NPS Director George Hartzog explained: it is "not because of bad faith, but because the resource missions of the forest service and the park service are, for the most part, incompatible and adversarial . . . . Moreover, there was no final authority to adjudicate between the differing management options and missions."[265] The Government Accountability Office later confirmed that perception.[266] Because of differences in mission, antagonism between the two agencies, at least at the highest levels, has lasted for more than ninety years.[267] If the USFS or the BLM gave resource preservation priority over visitor enjoyment, key legislation would provide little direction on how to deal with competing demands.[268] Differing mandates therefore make annexation an expedient option.

c. Multiple Use and Ecosystem Management

Some USFS scientists and managers believe they can effectively manage resource consumption, like logging, services, and recreation, to allow for faster ecosystem recovery.[269] However, many federal lands have already been extremely degraded by USFS and BLM management.[270] One comprehensive analysis of habitat

263. *See* Southern Utah Wilderness Alliance v. Dabney, 222 F.3d 819, 827 (10th Cir. 2000) (quotations omitted).

264. NAT'L PARKS SCI. COMM., REPORT D-1589A, NATIONAL PARK SCIENCE IN THE 21ST CENTURY 1 (2d ed., 2009) (written 2004, released 2009).

265. *See* HARTZOG, *supra* note 1, at 258.

266. GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-94-111, ECOSYSTEM MANAGEMENT: ADDITIONAL ACTIONS NEEDED TO ADEQUATELY TEST A PROMISING APPROACH 54 (1994).

267. Hal Rothman, *A Regular Ding-Dong Fight: The Dynamics of Park Service-Forest Service Controversy During the 1920s and 1930s*, *in* AMERICAN FORESTS: NATURE, CULTURE, AND POLITICS 109–24 (Char Miller ed., 1997).

268. *See* GOV'T ACCOUNTABILITY OFFICE, GAO/RCED-99-166, FOREST SERVICE PRIORITIES: EVOLVING MISSION FAVORS RESOURCE PROTECTION OVER PRODUCTION 1–2 (1999).

269. MERRILL R. KAUFMANN ET AL., U.S. FOREST SERV., AN ECOLOGICAL BASIS FOR ECOSYSTEM MANAGEMENT RM-246 (1994).

270. *See* Losos et al., *supra* note 136.

destruction found livestock grazing, logging, and resource extraction in United States lands to be at least partly responsible for the harm to twenty-two percent, twelve percent, and eleven percent, respectively, of the endangered plant and animal species inhabiting those lands.[271] For resource harvest, tradeoffs are inevitable.[272] As one observer notes, "[s]omehow we have to develop management plans for public lands that will allow both consumptive and non-consumptive uses but will do so in such a way that no net loss of native species will occur."[273] The USFS may be unable to fulfill such a daunting task, especially if optimal results are expected; this issue cannot be answered here. Nonetheless, the USFS could attempt to pursue its multiple-use mandate from an ecosystem management perspective.[274]

Federal agencies have endorsed ecosystem management,[275] an approach elevated to panacea status in some circles.[276] Both the USFS and the BLM praised its virtues,[277] though each agency looked at the idea differently.[278] The USFS has, to some extent, adapted to the concept of ecosystem management,[279] perhaps in part as an attempt to resolve internal conflict.[280] The agencies have also

271. Wilcove et al., *supra* note 119, at 610. For the purposes of this study, "endangered" species were taken to include those listed as endangered or threatened under the Endangered Species Act, as well as those proposed for listing in the Act. *Id.*

272. *See generally* Donald Ludwig, Ray Hilborn & Carl Walters, *Uncertainty, Resource Exploitation, and Conservation: Lessons from History*, 260 SCI. 17 (1993).

273. Robert C. Szaro, *Biodiversity in Managed Landscapes: Principles, Practice, and Policy*, *in* BIODIVERSITY IN MANAGED LANDSCAPES: THEORY AND PRACTICE 727, 739 (Robert Szaro & David W. Johnston eds., 1996).

274. *See* R. McGreggor Cawley & John Freemuth, *A Critique of the Multiple Use Framework in Public Lands Decisionmaking*, *in* WESTERN PUBLIC LANDS AND ENVIRONMENTAL POLITICS 32 (Charles Davis ed., 1997).

275. WAYNE A. MORRISSEY ET AL., CONG. RESEARCH SERV., CRS REPORT No. 94-339, ECOSYSTEM MANAGEMENT: FEDERAL AGENCY ACTIVITIES (1994), *available at* http://ncseonline.org/nle/crsreports/biodiversity/biodv-4.cfm.

276. Robert B. Keiter, *Beyond the Boundary Line: Construction of a Law of Ecosystem Management*, 65 U. COLO. L. REV. 293, 294 (1994).

277. Jack Ward Thomas, *Forest Service Perspective on Ecosystem Management*, 6 ECOLOGICAL APPLICATIONS 703, 703 (1996); Michael P. Dombeck, *Thinking Like a Mountain: BLM's Approach to Ecosystem Management*, 6 ECOLOGICAL APPLICATIONS 699, 699 (1996).

278. *See* Thomas R. Stanley, Jr., *Ecosystem Management and the Arrogance of Humanism*, 9 CONSERVATION BIOLOGY 255, 256 (1995).

279. *See generally* James J. Kennedy & Thomas M. Quigley, *Evolution of USDA Forest Service Organizational Culture and Adaptation Issues in Embracing an Ecosystem Management Paradigm*, 40 LANDSCAPE & URB. PLAN. 113 (1998).

280. George Hoberg, *The Emerging Triumph of Ecosystem Management: The Transformation of Federal Forest Policy*, *in* WESTERN PUBLIC LANDS AND ENVIRONMENTAL POLITICS, *supra* note 274, at 55, 78–79.

offered examples of their activities that embody or employ ecosystem management, including: entering into memorandums of understanding and cooperative agreements with other government entities for regional management of lands, utilizing Geographic Information Systems to improve resource management decisions, providing educational programs to loggers, and demonstrating environmentally aware harvesting techniques.[281] There is no denying that collaboration on some western resource issues has been successful,[282] though measures of success for any collaborative conservation effort vary.[283] It is also difficult to determine whether success is clearly attributable to these measures. One study of Glacier National Park over a twenty-year time span attributed much success over this period in dealing with other agency external threats to a philosophy of "regionalism" which created a de facto buffer zone on adjoining national forests.[284] Thus ecosystem management was perhaps less important here than the buffer zone. Overall, the NPS has practiced some aspects of ecosystem management for decades,[285] but when compared with the management visions of park managers of yesteryear, a total ecosystem management approach has distinct advantages.[286] Many diverse aspects of land management and planning[287] and recent success stories have been described as ecosystem management.[288]

Despite these successes, federal agencies face challenges in translating ecosystem management philosophy into practice.[289] Insufficient coordination is one major problem. Although coordination between federal agencies in the GYE has been a century-long goal,[290] this aim gained more public attention in the

281. *See* MORRISSEY ET AL., *supra* note 275.

282. *See* STEVEN L. YAFFE ET AL., ECOSYSTEM MANAGEMENT IN THE UNITED STATES: AN ASSESSMENT OF CURRENT EXPERIENCE 27–28 (1996).

283. Alexander Conley & Margaret A. Moote, *Evaluating Collaborative Natural Resource Management*, 16 SOC'Y & NAT. RESOURCES 371, 375–77 (2003).

284. *See* Sax & Keiter, *supra* note 88, at 36.

285. *See* Brian Czech, *Ecosystem Management Is No Paradigm Shift: Let's Try Conservation*, 93(12) J. FORESTRY 17, 20 (1995).

286. Susan P. Bratton, *National Park Management and Values*, 7 ENVTL. ETHICS 117, 129 (1985).

287. *See generally* 2 ECOLOGICAL STEWARDSHIP: A COMMON REFERENCE FOR ECOSYSTEM MANAGEMENT, 3–19 (Nels C. Johnson et al. eds., 1999).

288. *Id.* at 330–31.

289. Bruce Goldstein, *Can Ecosystem Management Turn an Administrative Patchwork Into a Greater Yellowstone Ecosystem?*, 8(4) NORTHWEST ENVTL. J. 285, 285–86 (1992).

290. Joel Berger, *Greater Yellowstone's Native Ungulates: Myths and Realities*, 5

1980s.[291] All land managers today should recognize that success demands coordination with other organizations and individuals.[292] Both NFMA and FLPMA require coordination[293]—there is some, but not enough.[294] For example, the USFS collaborates with many other parties,[295] and the BLM participates in regional biological conservation endeavors.[296] Even though some agency critics readily acknowledge successes among GYE cooperative endeavors,[297] others believe such joint responsibilities are counter-productive.[298] One source lists fifty different maps depicting common NPS and USFS GYE resources and land uses that require joint management.[299] A legal review was not optimistic: "History . . . demonstrates that the prospects for preventing and abating threats through intergovernmental coordination alone are bleak."[300] The legal framework to achieve what ecosystem management demands does not exist.[301] As one commentator observed, "cross-boundary stewardship is a social ideal, not a legal standard."[302] Additional barriers to federal agency ecosystem management include inadequate ecological and socioeconomic data, separate planning requirements, needed collaboration with non-federal partners, and various incentives, interests, and limitations that are beyond the

CONSERVATION BIOLOGY 353, 356–57 (1991).

291. *See generally* GREATER YELLOWSTONE COORDINATING COMMITTEE, NATL PARK SERV., THE GREATER YELLOWSTONE AREA: AN AGGREGATION OF NATIONAL PARK AND NATIONAL FOREST MANAGEMENT PLANS (1987).

292. *See* STEWARDSHIP ACROSS BOUNDARIES, *supra* note 91.

293. Keiter, *supra* note 276, at 309–12.

294. *See, e.g.*, Edward R. Grumbine, *Cooperation or Conflict? Interagency Relationships and the Future of Biodiversity for U.S. Parks and Forests*, 15 ENVTL MGMT. 27 (1991).

295. JULIA M. WONDOLLECK & STEVEN L. YAFFE, BUILDING BRIDGES ACROSS AGENCY BOUNDARIES: IN SEARCH OF EXCELLENCE IN THE U.S. FOREST SERVICE, RESEARCH REPORT TO THE USDA (1994) (describing thirty-five such collaborations).

296. Patrick A. Shea, *Finding the Stegnerian Compromise Between Conservation and Development*, 19 J. ENERGY NAT. RESOURCES & ENVTL. L. 1, 6–7 (1999).

297. Dennis A. Glick & Tim W. Clark, *Overcoming Boundaries: The Greater Yellowstone Ecosystem*, *in* STEWARDSHIP ACROSS BOUNDARIES, *supra* note 91, at 237, 247–51.

298. *See* Ronald D. Brunner & Tim Clark, *A Practice-Based Approach to Ecosystem Management*, 11 CONSERVATION BIOLOGY 48, 49, 55–56 (1997).

299. Stephen P. Mealy, *U.S. Forest Service Wilderness Management: Challenge and Opportunity*, *in* ECOSYSTEM MANAGEMENT FOR PARKS AND WILDERNESS, *supra* note 235, at 214.

300. George C. Coggins, *Protecting the Wildlife Resources of National Parks from External Threats*, 22 LAND & WATER L. REV. 1, 18–19 (1987).

301. George C. Coggins, *Legal Problems and Powers Inherent in Ecosystem Management*, 5 NAT. RESOURCES & ENVTL. ISSUES 36, 40 (1995).

302. Errol E. Meidinger, *Laws and Institutions in Cross-Boundary Stewardship*, *in* STEWARDSHIP ACROSS BOUNDARIES, *supra* note 91, at 87, 106.

ability of agencies to influence.[303] Given these challenges, direct park expansion may achieve more optimal results for park biota residing near the current park boundary.

2. Landed Tools for Preservation: Special Designation Abutments

A buffer zone is "a collar of land managed to filter out inappropriate influences from surrounding activities."[304] National park buffer zones can be created using federal special designation abutments. Some legal scholars have called for Congressional establishment of "national resource areas" or "national preserves" next to park boundaries.[305] Keiter's national resource areas would remain under USFS or BLM jurisdiction, but with stiffer land-use prescriptions, while Coggins' national preserves would be an extension of NPS lands.[306] Buffer zones for federal protected areas have always had their opponents in the United States. For example, most state wilderness acts passed since 1983 and formal USFS and BLM policy forbid wilderness buffer zones.[307] A federal zoning scheme is another way to provide buffer zones,[308] but passage of enabling legislation has faced challenges.[309] Nonetheless, U.S. national park buffer zones could serve multiple positive functions.[310]

a. BLM National Monuments and Conservation Areas

Recent national monuments and national conservation areas on

303. GOV'T ACCOUNTABILITY OFFICE, *supra* note 266, at 51–60.

304. WALTER V. REID & KENTON R. MILLER, KEEPING OPTIONS ALIVE: THE SCIENTIFIC BASIS FOR CONSERVING BIODIVERSITY 80 (1989).

305. Robert B. Keiter, *On Protecting the National Parks from the External Threats Dilemma*, 20 LAND & WATER L. REV. 355, 408–13 (1985); Coggins, *supra* note 300, at 25.

306. Coggins, *supra* note 300, at 25.

307. Aaron R. Kelson & Robert J. Lilieholm, *Transboundary Issues in Wilderness Management*, 23 ENVTL. MGMT. 297, 298 (1999); John C. Hendee & Chad P. Dawson, *Wilderness Designation Process, Legislation, and Management Implications, Part II*, *in* WILDERNESS MANAGEMENT, *supra* note 98, at 164–65 [hereinafter Hendee & Dawson, *Wilderness Designation*].

308. Keiter, *supra* note 305, at 415; John S. Davis, *The National Trail System and the Use of Protective Federal Zoning*, 10 HARV. ENVTL. L. REV. 189, 217–22 (1986); *see generally* Joseph Sax, *Helpless Giants: The National Parks and the Regulation of Private Lands*, 75 MICH. L. REV. 239 (1976).

309. Richard Haeuber, *Setting the Environmental Agenda: The Case of Ecosystem Management*, 36 NAT. RESOURCES J. 1, 14–26 (1996).

310. *See generally* Shafer, *Buffer Zones*, *supra* note 232.

BLM lands have some similarities to the above buffer zone prescriptions. DOI Secretary Bruce Babbitt explained that the presidential creation in 1996 of Grand Staircase-Escalante National Monument in Utah was to protect adjoining NPS parks, monuments, and recreation areas from coal mining,[311] namely Bryce Canyon and Capital Reef National Parks in Utah and Glen Canyon National Recreation Area in Arizona and Utah. Similarly, when President Clinton established the 410,000 hectare Grand Canyon-Parashant National Monument in Arizona in 1999, it was intended to preserve more of Grand Canyon National Park's drainage basin.[312] BLM National Monuments, like their legislative counterparts, BLM National Conservation Areas, prioritize natural values, discourage construction of roads and visitor centers, withdraw the lands from mineral entry, and regulate ORVs.[313]

However, BLM monuments and national conservation areas usually do not have land use restrictions comparable to NPS national monuments.[314] Generally, NPS policies for national monuments forbid mineral development, hunting (unless authorized by law), and timber harvest.[315] In contrast, BLM National Conservation Areas allow hunting and judicious livestock grazing.[316] USFS national monuments have a similar lack of comparable land use restrictions. For instance, even though President Clinton's April 15, 2000 proclamation creating Giant Sequoia National Monument on California's Sequoia National Forest forbids commercial logging, in 2005 the George W. Bush Administration reversed USFS forest policy in order to allow it.[317]

311. Bruce Babbitt, *Protecting America's Unique National Landscapes*, PEOPLE LAND & WATER, Jan. 2001, at 12–13.

312. Bruce Babbitt, *Crowding the West Spurs Need for Integrated Landscape Management*, PEOPLE LAND & WATER, Feb./Mar. 2000, at 24–25.

313. Babbitt, *supra* note 72, at 17–18.

314. Sanjay Ranchod, *The Clinton National Monuments: Protecting Ecosystems with the Antiquities Act*, 25 HARV. ENVTL. L. REV. 535, 538 (2001).

315. CAROL HARDY VINCENT, CRS REPORT FOR CONGRESS: NATIONAL MONUMENT ISSUES 3 (Feb. 6, 2006).

316. *See, e.g.*, Bureau of Land Management, Grazing and Rangeland Management, http://www.blm.gov/az/st/en/prog/grazing.html (last visited Feb. 9, 2010); Bureau of Land Management, San Predro Riparian National Conservation Area, http://www.blm.gov/az/st/en/prog/blm_special_areas/ncarea/sprnca.html (last visited Feb. 9, 2010).

317. Jonathan Mendoza, *The Giant Sequoia National Monument Plan Final Environmental Impact Statement*, http:ice.ucdavis.edu/education/esp179/?q=node/175 (last visited Feb. 9, 2010). This decision to allow logging was declared illegal by the United States District Court for Northern California. Sierra Club v. Bosworth, 465 F. Supp. 2d 931, 941 (N.D.Cal. 2006).

Examples of Bush Administration proposed management plans for National Monuments include the decision to allow almost 2897 kilometers of ORV routes in the Grand Canyon-Parashant and Vermillion Cliffs National Monuments in Arizona; however, in 2009 NGOs filed suit in order to block this proposed land use.[318]

In addition, BLM lands are severely under-resourced. The entire National Landscape Conservation System (which includes other designations like wilderness areas and wild and scenic rivers) received only $2 per acre in 2007 with one BLM ranger assigned for every 200,000 acres of land.[319] The lack of money and staff has led to a failure to complete even routine maintenance.[320] Thus, the System is suffering from development, vandalism and ORV traffic.[321] However, the System did receive formal status via the Omnibus Public Land Management Act of 2009, which included a provision to permanently protect the twenty-seven million acres in the System.[322]

b. Wilderness

Wilderness preservation is in some respects "the highest refinement of [the national parks] idea"; thus, Congressionally created wilderness is viewed as the most stringent form of American federal land protection.[323] For example, uses typically allowed in National Parks that are precluded by the Wilderness Act of 1964 include commercial enterprises, roads, motor vehicles, mechanical transport, motorized equipment, motorboats, landing of aircraft, and structures or installations (though most may be permitted under some circumstances).[324] Unfortunately, the original concept of wilderness in national forests (and later BLM lands) was diluted by legislators during passage of the 1964 Act. For example, in

318. *Coalition Sues to Save Arizona National Monuments*, ARIZONA DAILY SUN, Feb. 5, 2009, *available at* http://www.biologicaldiversity.org/news/center/articles/2009/arizona-daily-sun-01-27-2009.html.

319. SONORAN INSTITUTE, WESTERN LANDSCAPES IN THE CROSSFIRE: URBAN GROWTH AND THE NATIONAL LANDSCAPE CONSERVATION SYSTEM 52 (2009), *available at* http://www.sonoraninstitute.org/library/recoreading/doc_download/684-western-landscapes-in-the-crossfire.html.

320. *Id.*

321. *Id.* at 54.

322. *Id.* at 4.

323. Wallace Stegner, *A Capsule History of Conservation*, *in* WHERE THE BLUEBIRD SINGS TO LEMONADE SPRINGS: LIVING AND WRITING IN THE WEST 117, 128 (Wallace Stegner ed., 1992).

324. Frank Buono, *The Wilderness Act of 1964: Its Relationship to the NPS Organic Act*, 11(1) GEORGE WRIGHT F. 48, 49 (1994).

national forests, the Act allowed: mineral surveys; mining claims until the end of 1983; continued mineral leasing until January 1, 1984; water project development with Presidential approval; continuation of existing grazing rights; retention of state authority over wildlife management; guarantee of adequate access to non-federal lands surrounded by wilderness; and customary ingress and egress to mining claims and other occupancies surrounded by wilderness.[325] In addition, subsequent state wilderness legislation provided more concessions for development interests.[326]

Because of these concessions and because of NPS regulations and policies, the protection afforded USFS and BLM wilderness is inferior to the protection provided for NPS non-wilderness. Consider Yellowstone National Park, which has no designated wilderness.[327] In Yellowstone, or national parks in general, mineral surveys, mining, mineral leasing, oil and gas extraction, and commercial grazing are not allowed unless preexisting rights exist or are authorized by Congress; hunting is banned unless authorized by Congress; water projects are not acceptable, nor are destructive ingress or egress to private inholdings or mining claims.[328] If mining, mineral leasing, or oil and gas extraction become harmful to the resource, the NPS will attempt to phase it out.[329]

c. Roadless Areas

The Clinton Administration defined roadless areas, sections of National Forests under the jurisdiction of the USFS, in a November 2000 proposed rule finalized on January 12, 2001.[330] Because this designation bypassed the 1964 Wilderness Act, these areas have been characterized as "administrative wilderness."[331] The Roadless Rule offers fewer land use restrictions than a wilderness designation.[332] The rule proposed banning road building on

325. *Id.* at 51–52; John C. Hendee & Chad P. Dawson, *The Wilderness Act: Legal Basis for Wilderness Management*, *in* WILDERNESS MANAGEMENT, *supra* note 98, at 105–17.

326. Hendee & Dawson, *Wilderness Designation*, *supra* note 307, at 160–65.

327. *See generally* NAT'L PARK SERV., WILDERNESS REPORT 2004–2005, *supra* note 205.

328. *See supra* footnotes 98–141 and accompanying text.

329. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 88.

330. Special Areas; Roadless Conservation, 66 Fed. Reg. 3244 (Jan. 12, 2001).

331. *See* Brandon Dalling, Note, *Administrative Wilderness: Protecting Our National Forest Lands in Contravention of Congressional Intent and Public Policy*, 42 NAT. RESOURCES J. 385, 386–89 (2002).

332. Sandra Zellmer, *A Preservation Paradox: Prestidigitation and an Enduring Resource of*

2,390,000 hectares of national forest land in thirty-nine states and halting road construction and timber harvesting.[333] Regardless, grazing and oil, and gas development could still occur, no existing roads would be shut down, and existing logging rights would continue.[334] The proposed rule also allowed access to private and state land in national forests; logging and roads to deal with wildlife, disease, and insects; access by off-road vehicles and snowmobiles; and all forms of USFS multiple use except timber sales—providing such sale does not deal with a wildlife issue.[335] Nevertheless, proposed roadless areas would increase biotic protected area representation in the U.S. enormously,[336] and most of them would contribute to the conservation of threatened, endangered, or imperiled species.[337] Since the majority of roadless areas are adjacent to designated wilderness,[338] large carnivores that require a large amount of space will surely benefit.[339] In fact, six U.S. Fish and Wildlife Service grizzly bear recovery zones include 15,300 km^2 of roadless areas.[340] Those proposed USFS roadless areas lacking wilderness designation which lie next to National Park System units include: Grand Canyon National Park, Arizona; Glacier National Park, Montana; Crater Lakes National Park, Oregon; Lava Beds National Monument and Redwoods National Park, California; Capital Reef National Park, Utah; Rocky Mountains and Great Sand Dunes National Park, Colorado; Guadalupe Mountains National Park, Texas; North Cascades National Park/Ross Lake National Resource Area/Lake Chelan National Resource Area, Washington; Grand Teton National Park, Wyoming; and Yellowstone National Park, Wyoming/Montana/Idaho. These roadless areas would enjoy additional protection if some were subsumed into adjacent national

Wildness, 34 ENVTL. L. 1015, 1080 (2004).

333. *Id.* at 1075.

334. PAMELA BALDWIN, CONG. RESEARCH SERV., RS20384, THE PRESIDENT'S FOREST/ROADLESS AREA INITIATIVE (1999), *available at* http://digital.library.unt.edu/govdocs/crs/permalink/meta-crs-1014.

335. *Id.*

336. *See* Robert L. DeVelice & Jon R. Martin, *Assessing the Extent to Which Roadless Areas Complement the Conservation of Biological Diversity*, 11 ECOLOGICAL APPLICATIONS 1008 (2001).

337. Colby Loucks et al., *USDA Forest Service Roadless Areas: Potential Biodiversity Conservation Reserves*, 7 CONSERVATION ECOLOGY 5, 12 (2003), *available at* http://www.ecologyandsociety.org/vol7/iss2/art5/print.pdf.

338. *See* DeVelice & Martin, *supra* note 336.

339. *See* Loucks et al., *supra* note 337, at 10.

340. *Id.* at 9.

parks. A federal judge reinstated the Clinton era Roadless Rule on September 20, 2006 (except for the Tongass National Forest)[341] but its final outcome is uncertain at this time.

B. Addressing Anti-Annexation Arguments

This Part anticipates and addresses arguments against annexation.

1. The NPS Allows Some Resource Extraction

The USFS and the BLM are not the only U.S. land management agencies that allow resource harvest. The NPS's history, not unlike that of the USFS or the BLM, includes a plethora of legislative decisions to allow resource harvest. As of today, oil and gas development occurs in thirteen units outside parks.[342] At least twenty-two NPS units contain significant geothermal resources.[343] Hunting is allowed in some NPS managed parks, monuments, recreation areas, seashores, reserves, and preserves.[344]

Unless previous rights existed, all such uses were authorized by Congress. Such Congressional compromises can, however, create difficulties in managing the lands. For example, when Congress created Big Cypress National Preserve in 1974, it allowed oil and gas leasing.[345] Due to land management conflicts, however, the DOI is now buying out oil and gas leases in the Preserve.[346] Regardless of whether extraction takes place inside or outside park boundaries, the NPS's pursuit of its mission—retaining park values unimpaired—becomes more difficult. Therefore, based on Congressional decisions, NPS lands have had to accommodate

341. Press Release, Earthjustice, Court Reinstates Roadless Rule (Sep. 20, 2006), *available at* http://www.earthjustice.org/news/press/006/court-reinstates-roadless rule.html.

342. Nat'l Park Serv., Mining, *supra* note 256.

343. *Id.*

344. *See* Find Recreation Areas, http://www.recreation.gov/recFacilitySearch.do (last visited Feb. 21, 2010) (select National Park Service in "Agencies" drop-down menu and Hunting in "Activities" drop-down menu).

345. An Act to Establish Big Cypress National Preserve, Pub. L. 93-440 (1974).

346. *See* Erica Rex, *The Big Cypress Preserve and the Controversy Over Oil*, FOREST MAG., SUMMER 2002, *available at* http://www.fseee.org/index.html?page=http%3A//www.fseee.org/forestmag/backissues2002.shtml; Press Release, Dep't of Interior, Interior Reaches Agreement to Acquire Mineral Rights in Everglades, Settles Litigation on Offshore Oil and Gas Leases in Destin Dome (May 29, 2002), *available at* http://www.gomr.mms.gov/homepg/whatsnew/newsreal/2002/020529hq.html.

some resource extraction like mining.[347] This fact should not preclude annexation, however, as the NPS still has the most stringent preservation mandate of any federal land management agency.

2. Land Grabbing, Endless Boundary Expansion, and External Threats

The NPS has long been considered an expansionist agency.[348] Though some boundary changes were minor, by 1988 over 500 had been authorized for nearly 200 parks,[349] and more are always being considered.[350] But these actions were not unilateral agency decisions; they were endorsed and approved by Congress. NPS policy acknowledges that accretion of USFS or BLM land can occur.[351] The USFS and the BLM do continually lose parts of their domain to the National Park System, but the USFS and the BLM still manage around ninety percent of all federal land. Therefore, Congress has been the ultimate decision-maker for any past NPS land grabbing.

It is unlikely that the outward movement of a park's boundary would become an endless process. A 1930s natural history survey suggested that expanding park boundaries to follow natural boundaries may improve park protection effectiveness.[352] A natural boundary limits how far some species can easily wander. For example, "[a]s a natural barrier, a mountain crest is better than a valley or stream . . . ."[353] Natural boundaries do not always exist where NPS and USFS/BLM boundary conflicts occur, and unnatural boundaries potentially facilitate some external threats (e.g., logging, mining, oil and gas exploration). For example, logging that has occurred directly outside some parks (e.g., Olympic, Crater Lake, Yellowstone) may result from the unnatural boundaries at that location. Selecting more natural boundaries is

347. *See* THOMPSON, *supra* note 111.

348. *See* HARLAN D. UNRAU & G. FRANK WILLIS, EXPANSION OF THE NATIONAL PARK SERVICE IN THE 1930S: ADMINISTRATIVE HISTORY (1983).

349. NAT'L PARKS & CONSERVATION ASS'N, 5 THE NATIONAL PARK SYSTEM PLAN, PARK BOUNDARIES: WHERE WE DRAW THE LINE 7 (1988).

350. *See, e.g.*, Robert B. Keiter, *Completing Canyonlands*, 74 NAT'L PARKS 26 (2000).

351. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 14.

352. GEORGE M. WRIGHT ET AL., FAUNA OF THE NATIONAL PARKS OF THE UNITED STATES: A PRELIMINARY SURVEY OF FAUNAL RELATIONS IN NATIONAL PARKS, FAUNA SERIES ONE 38 (1933).

353. *Id.* at 38.

not intended to be a "vicious process of territorial acquisition."[354] Rather, natural boundaries might provide understandable limits for park expansion while better protecting park resources.

3. Annexed Land Must be Nationally Significant

Since at least 1918, a national park must possess national importance (i.e., national significance) in order to receive a favorable recommendation from the NPS.[355] However, the common perception of the NPS's national significance criteria can be broadened. For example, NPS internal guidance has expanded the criteria. After the passage of the Arizona Desert Wilderness Act of 1990,[356] the NPS developed boundary expansion criteria.[357] One of these criteria is that if the expansion is designed to protect a park resource, the boundary expansion land itself does not have to meet national significance criteria.[358] There is precedent for this interpretation. In order to protect Redwoods National Park, California, from further logging-induced siltation, Congress added adjacent, timbered property to the park in 1978.[359] Adding adjacent, heavily logged USFS land to Yellowstone National Park would represent a dilution of the park's overall integrity, but such accretion would serve a broader purpose: the park could become the inner-core of a larger NPS-managed Yellowstone protected area.[360] Reserves should circumscribe very large areas, not excluding modified habitat, with the objectives of restoring such degraded habitat to a more natural condition and ultimately

354. *Id.* at 108.

355. Letter from Secretary Franklin K. Lane to Director Stephen T. Mather (May 13, 1918), *in* COMPILATION OF THE ADMINISTRATIVE POLICIES FOR THE NATIONAL PARKS AND NATIONAL MONUMENTS OF SCIENTIFIC SIGNIFICANCE, at app. A-1 (1968); NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 8–9.

356. Arizona Desert Wilderness Act of 1990, Pub. L. No. 101-628, 104 Stat. 4469 (1990).

357. *See* Warren L. Brown, *Park Boundaries: Where to Draw the Line*, *in* PARTNERS IN STEWARDSHIP: PROCEEDINGS OF THE 7TH CONFERENCE ON RESEARCH AND RESOURCE MANAGEMENT IN PARKS AND ON PUBLIC LANDS 314, 315–17 (William E. Brown & Stephen D. Veirs, Jr. eds., 1993).

358. NAT'L PARK SERV., TOOLS FOR PARK PLANNING, APP. C: NATIONAL PARK SERVICE CRITERIA FOR BOUNDARY ADJUSTMENTS, SUPPLEMENT TO PLANNING PROCESS GUIDELINE (NPS-2) 5 (1991).

359. *See* James K. Agee, *Issues and Impacts of Redwoods National Park Expansion*, 4 ENVTL. MGMT. 407, 409–19 (1980); Robert Belous, *Restoration Among the Redwoods*, 2 RESTORATION & MGMT. NOTES 57 (1984).

360. *See supra* note 182 and accompanying text.

creating a more functional ecosystem.[361]

4. Boundary Expansion is Not a Panacea

Boundary expansion cannot preclude all external park threats. It would not eliminate federal inter-organizational conflict or the need to coordinate closely with state and private landowners. But annexation could offer an opportunity to preclude or phase out some biologically deleterious land uses like mining, oil and gas development, and geothermal exploration by, for example, expanding Yellowstone National Park's boundary. By contrast, USFS and BLM policy does not encourage phasing out these uses.[362] By examining present boundary interfaces where current USFS and BLM management is confounding park management, some problems that appear intractable might be resolved. Past interagency cooperation has already resulted in better park boundaries. For example, the NPS and the USFS traded land to create a more ecologically sound boundary for Rocky Mountain National Park, Colorado.[363] Where trades are not feasible, annexation is the logical alternative. Though certainly not a panacea for all park problems, annexation would provide greater sources of protection for park biota.

5. Annexation Will Cause Private Inholders Hardship

There are 2.19 million hectares of privately held land in the National Park System,[364] or about ten percent of what exists in the National Forest System.[365] However, the USFS plans on acquiring only ten percent of such inholdings, and the extent of inholdings on BLM lands is unknown.[366] Some cases of blatant inholder land abuse exist,[367] but any concern that NPS acquisition of transferred private property might result in the imposition of immediate heavy-

361. *See* Dominick A. DellaSala et al., *Forest Health: Moving Beyond the Rhetoric to Restore Healthy Landscapes in the Inland Northwest*, 23 WILDLIFE SOC'Y BULL. 346 (1995).

362. *See* John Freemuth & R. McGreggor Cawley, *Science, Expertise and the Public: The Politics of Ecosystem Management in the Greater Yellowstone Ecosystem*, 40 LANDSCAPE & URB. PLAN. 211 (1998).

363. *See* JOHN B. LOOMIS, INTEGRATED PUBLIC LANDS MANAGEMENT 526 (2d ed. 2002) (1993).

364. Personal communication with Bill Shaddox, National Park Service (July 2006).

365. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, *supra* note 193.

366. *See id.*

367. Randy Tanner, *Inholdings in Wilderness: Legal Foundations, Problems, and Solutions*, 8 INT'L J. WILDERNESS 9, 10–11 (2002).

handed land use specifications to combat abuse is based more on fear than on agency history.[368] After USFS or BLM lands were accreted into national parks, the NPS would ask private landholders to adhere to its conforming use standard; if these landowners wanted to sell, they would have the negotiating advantage.[369] For nonconforming inholdings, the NPS might first pursue conservation easements. If that was unsuccessful, phase-out or sunset offers might be considered. Finally, the government may resort to purchase; more than ninety percent of the private land acquired by the federal government comes from willing sellers.[370] For wilderness areas, federal agencies cannot condemn land without the approval of Congress. Furthermore, the NPS does not always wish to acquire all park inholdings. The 1990 Farm Bill, through its Forest Legacy Program, encourages the USFS to acquire private property easements using covenants, voluntary deed restrictions, and fee acquisition from willing sellers.[371] Therefore, the extent that annexation would cause private landowners hardship is unknown. However, in many cases, it may provide these landowners with economic benefits.[372]

6. The NPS is Pro-Development

The fear that the NPS is pro-development may have some justification. Park development is driven by growing visitation, concessionaires, and some park legislation.[373] If large tracts of undeveloped federal land were added to existing parks, adding more roads and visitor centers to those tracts might compromise their value as faunal habitat extensions. Whether such development would actually happen cannot be known beforehand. However, the NPS is restraining some of its past pro-development tendencies. For example, the NPS has been gradually phasing out road expansion and development in the Yosemite Valley since

368. *See* John F. Lambert, Jr., *Private Landholdings in the National Parks: Examples from Yosemite National Park and Indiana Dunes National Lakeshore*, 6 HARV. ENVTL. L. REV. 35 (1982).

369. Joseph L. Sax, *Buying Scenery: Land Acquisition for the National Park Service*, 1980 DUKE L.J. 709, 726 (1980).

370. WILLIAM H. ROGERS, JR. ET AL., BOARD ON ENVIRONMENTAL STUDIES AND TOXICOLOGY, SETTING PRIORITIES FOR LAND CONSERVATION 91 (1993).

371. 16 U.S.C. § 2103(c) (2006).

372. Sax, *supra* note 369, at 730–31.

373. *See, e.g.*, Jim Walters, *An Evaluation of the National Park Service's Wilderness Program on the 40th Anniversary of the Wilderness Act*, 21(3) GEORGE WRIGHT F. 9, 9 (2004).

1980, even in the face of strong opposition.[374] Therefore, only time will tell whether development within potentially annexed USFS and BLM habitat extensions will occur. The NPS mandate, however, provides more authority than does that of the BLM or the USFS to preserve land unimpaired.

7. The NPS has a Weak Wilderness Record

Wilderness designation was originally sought for national parks to thwart further NPS development.[375] Now, however, based on its own policies the NPS is a wilderness advocate.[376] In spite of this, the agency was slow to implement the wilderness concept,[377] encountered administrative difficulties,[378] and received much criticism in the process.[379] Compared to the NPS, both the USFS and the BLM have a better record at creating wilderness, yet as of 2006, eighty-four percent of the land in the National Park System has been designated as wilderness by Congress (forty-seven units: 17,619,046 total hectares), deemed by the NPS to be eligible for study (seventeen units: 7,801,295 total hectares), proposed by the NPS for designation (seven units: 1,003,598 total hectares), or recommended as wilderness by the DOI to the Congress (nineteen units: 54,472 total hectares).[380] NPS policy, moreover, specifies that the latter three categories be managed as if they were designated wilderness until final Congressional decisions are made.[381] Therefore, the NPS has been hampered by some constraints that were and are beyond the agency's control.

When compared to the BLM, the USFS, and the Fish and Wildlife Service, the NPS has the most wilderness acreage, one-third of which is in Alaska.[382] When coupled with NPS mandates

374. *See* LOOMIS, *supra* note 363.

375. *See* Walters, *supra* note 373, at 9.

376. *See, e.g.*, NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 78.

377. *See* Wes Henry, *Status and Prospects for Wilderness in the US National Park Service*, 2 INT'L J. WILDERNESS 19, 19 (1996).

378. *See* Walters, *supra* note 373; Wes Henry & Steve Ulvi, *Securing an Enduring Wilderness in the National Park System: The Role of the National Wilderness Steering Committee*, 20(3) GEORGE WRIGHT F. 91 (2003).

379. *See* Richard West Sellars, *The Path Not Taken: National Park Service Wilderness Management*, 17(4) GEORGE WRIGHT F. 4 (2000).

380. NAT'L PARK SERV., WILDERNESS REPORT 2004–2005, *supra* note 205, at app. 1–3.

381. NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 80.

382. Wilderness in Alaska is governed by the Alaska National Interest Lands Conservation Act ("ANILCA"), PL 96-487, 94 Stat. 2371, which allows land uses that do not conform to the requirements of the Wilderness Act of 1964, 16 U.S.C. §§ 1131–36, P.L. 88-5770, 78 Stat. 890.

and policies, National Park System wilderness could provide very stringent protection to some USFS and BLM land additions. Thus, especially in some western national parks that could serve as the nucleus of a larger protected area under the NPS administration, the NPS's future position could improve upon and surpass its early posture and performance on wilderness.

8. The NPS Cannot Properly Care for its Existing Lands

The NPS already faces significant land recovery challenges without the additional burden of annexing adjacent federal land. For example, more than two million hectares support exotic species, and at least 200,000 hectares require restoration, including the stabilization of 4000 abandoned mines.[383] However, transferring land between government agencies, as one landmark study recommended, should result in simplification of government administration and some cost savings.[384] The Federal Office of Management and Budget considers three criteria when ranking proposed government land acquisitions: providing better protection for valuable natural resources, making the management of a unit of land more efficient, and saving federal money.[385] Annexing key USFS or BLM land into adjacent national parks should achieve all these goals. Transferring these lands would not only return current taxpayer USFS and BLM subsidies, but may also boost local and regional economies.[386] Furthermore, the NPS would receive more to manage that same land: during FY 2000, the NPS received $18 per acre, the USFS received $7 per acre, and the BLM received a mere $3 per acre.[387] Therefore, under NPS administration, the former BLM land might receive more funding per acre than it received under its former agency. Further tipping the scales, some western ranchers presume that USFS and BLM land will be managed to allow them to benefit from grazing public lands,[388] but the resource extraction industries are no longer the

383. FRANKLIN ET AL., *supra* note 190, at 29.
384. PUB. LAND LAW REVIEW COMM'N, *supra* note 203, at 282–83.
385. *See* ROGERS ET AL., *supra* note 370.
386. *See supra* Part III.C.
387. John G. Mitchell, *The Big Open: Going Public with Public Land*, NAT'L GEOGRAPHIC, Aug. 2001, at 2, 10 (2001).
388. Richard H. Cowart & Sally K. Fairfax, *Public Lands Federalism: Judicial Theory and Administrative Reality*, 15 ECOLOGY L.Q. 375, 385–86 (1988).

primary, nor the best, providers of local economic support.[389] Furthermore, some "Lords of Yesterday," such as the General Mining Act of 1872, are now seen as needing reform by both environmentalists and some in industry.[390] Therefore, the added responsibilities of annexation may include more funding for land administration.

9. Biological Harvest on Adjacent Federal Lands Can be Sustainable

Many scientists question whether sustainable use of wild living resources is possible, but all scientists should concede that society's recent performance at sustainable harvest has been very poor.[391] Resource sustainability is a fine goal, but past attempts at sustainable natural resource management have rarely succeeded.[392] Case studies demonstrate that the outcome of resource harvest, such as that which occurs on USFS and BLM lands, depends on the particular circumstances.[393] The Multiple Use Sustained Yield Act of 1960 was intended to apply to the National Forest System as a whole, not at the "stand" level, where most USFS decision-making takes place.[394] Compounding the problem is the fact that foresters actually know little about ecosystem sustainability.[395] In fact, our present knowledge of the science behind forestry is not yet adequate to develop informed management practices.[396] If resource stability measures cannot be relied upon to protect these ecosystems, there is little meaning in the claim that federal lands next to national parks will be managed to sustain the ecosystem.

389. *See supra* Part II.E.

390. *See* CHARLES F. WILKINSON, CROSSING THE NEXT MERIDIAN: LAND, WATER AND THE FUTURE OF THE WEST (Island Press 1992).

391. Marc Mangel et al., *Principles for the Conservation of Wild Living Resources*, 6 ECOLOGICAL APPLICATIONS 338, 338–39 (1996).

392. *See* Ludwig, Hilborn & Walters, *supra* note 272, at 36; *see generally* Richard Hilborn, John Walters & Donald Ludwig, *Sustainable Exploitation of Renewable Resources*, 26 ANN. REV. ECOLOGY & SYSTEMATICS 45 (1995).

393. CURTIS FREESE, WILD SPECIES AS COMMODITIES: MANAGING MARKETS AND ECOSYSTEMS FOR SUSTAINIBILITY 2 (1998).

394. *See* ALEXANDER, *supra* note 70, at 21.

395. *See* Jerry F. Franklin, *Ecosystem Management: An Overview*, *in* ECOSYSTEM MANAGEMENT: APPLICATIONS FOR SUSTAINABLE FOREST AND WILDLIFE RESOURCES 21 (M.S. Boyce & A. Hanley eds., 1997).

396. *See* NAT'L RESEARCH COUNCIL, FORESTRY RESEARCH: A MANDATE FOR CHANGE (1990).

10. Agency Good Intentions Will Prevail

Politics can kill the best of agency intentions. Prepared jointly by the NPS and the USFS for release in August 1990, the draft "Yellowstone Vision Document" was an innovative plan of interagency cooperation in the GYE that would, the document claimed, "pioneer ecosystem management" while allowing for recreation and resource extraction.[397] The plan's many goals included, *inter alia*, allowing natural processes to prevail; curbing logging, oil and gas exploration and extraction on national forests; acknowledging the economic dependency of local towns on park tourism; and encouraging interagency coordination.[398] Even after extensive public hearings before and after its release, special interest groups killed the plan.[399] The Wyoming legislature asked Congress to have the DOI withdraw the document because they feared it would create a de facto Yellowstone National Park management philosophy on adjacent forests that would prevent multiple-use extraction.[400] The DOI replaced the Vision Document with an eleven-page policy statement. This politicization of the Greater Yellowstone Coordinating Committee, driven by resource extraction interests, derailed the effort,[401] in what could be described as a clash between Old West ("rural, working class, natural resource-based economy, resource use") and New West ("urban, professionals, service-based economy, environmentalism") beliefs.[402] In this case, an attempt by both the NPS and the USFS to implement ecosystem management for the GYE failed due to organized opposition, likely because "the managers involved simply did not understand the dynamics of public discourse."[403]

Scientific and professional modes of decision-making are supposed to interface with democratic decision-making processes,[404]

397. Freemuth & Cawley, *supra* note 362, at 213.

398. *See supra* Part IV.A.1.b.

399. *See* Pamela Litchman & Tim W. Clark, *Rethinking the "Vision" Exercise in the Greater Yellowstone Ecosystem*, 7 SOC'Y NAT. RESOURCES 459, 463 (1994); Tim W. Clark & Ann Harvey, *The Greater Yellowstone Ecosystem Policy Arena*, 3 SOC'Y NAT. RESOURCES 281 (1990).

400. *See* Freemuth & Cawley, *supra* note 362, at 211–19; Tim W. Clark et al., *Policy and Programs for Ecosystem Management in the Greater Yellowstone Ecosystem: An Analysis*, 5 CONSERVATION BIOLOGY 412, 418 (1991).

401. Freemuth & Cawley, *supra* note 362, at 215.

402. *See* Mark K. McBeth et al., *The Science of Storytelling: Measuring Policy Beliefs in Greater Yellowstone*, 18 SOC'Y NAT. RESOURCES 413, 414 (2005).

403. *See* Freemuth & Cawley, *supra* note 362, at 217.

404. *Id.* at 211–19.

but the results are often disappointing for those who seek to guide decision-making with technical expertise and data. An agency should have a park staff that is familiar with the scientific aspects of ecosystem management,[405] but this is often not the determining factor for success or failure. Politics, including democratic discourse, are part of ecosystem management,[406] but the Vision Document exercise was more like combat polarization than give-and-take accommodation. In this case, the good intentions of the NPS and the USFS did not prevail over political opposition to ecosystem management.

11. Congress Will Rise Above Special Interest Group Loyalties

When BLM and USFS field managers try to phase out livestock grazing, mining, logging, or ORV use, they often encounter well-orchestrated opposition. For instance, soon after the USFS suspended new road construction in February 1999, four members of Congress threatened to slash the agency's budget because they believed that the USFS was not logging enough timber.[407] Additionally, after the USFS sought to discontinue logging in the Targhee National Forest, located in Idaho and Montana, political intervention perpetuated that practice against the wishes of agency scientists and researchers.[408]

The NPS faces similar dilemmas. The NPS tentatively abandoned its plan to enhance grizzly bear habitat by removing the Fishing Bridge campground after local business leaders, fearful that revenue derived from park visitors might drop after the campground disappeared, complained to members of Congress.[409] Park superintendents perceive that the single, largest obstacle to cross-boundary management is economic pressure to exploit adjacent lands.[410] This economic pressure has been present throughout the history of the National Park System. For instance, 1883 Senate debates over extending the boundary of Yellowstone

405. *See* Norman L. Christensen et al., *The Scientific Basis for Ecosystem Management*, 6 ECOLOGICAL APPLICATIONS 665 (1996).

406. *See* CORTNER & MOOTE, *supra* note 66.

407. *See* DOMBECK ET AL., *supra* note 124, at 106.

408. Louisa Willcox, *The Yellowstone Experience*, 45 BIOSCIENCE S79, S82 (1995).

409. Richard Schneebeck, *State Participation in Federal Policy Making for the Yellowstone Ecosystem: A Meaningful Solution or Business as Usual?*, 21 LAND & WATER L. REV. 397, 415 (1986).

410. Marybeth Buenchner et al., *Cross-boundary Issues for National Parks: What Works "On the Ground"*, 16 ENVTL. MGMT. 799, 807 (1992).

National Park "brought protests from adjoining ranchmen, miners and others."[411]

Compared to the NPS, the USFS and the BLM are more vulnerable to political pressure instigated by industries that harvest trees, oil, minerals, water, and grass on public land. The George W. Bush Administration sought to weaken NPS policies and have the agency function more like the USFS and the BLM.[412] The USFS plans are blocked by the actions of special interest groups more often than NPS plans.[413] Since land use restrictions imposed in national parks are generally widely understood, subsuming key adjacent USFS and BLM property within national parks may encourage legislators to prevent biotic degradation to those reclassified tracts of land because the lawmakers realize that, under NPS legislation and jurisdiction, biotic damage is forbidden. Unfortunately, as David Orr explained, the problems of ecology are "unavoidably political."[414] There will always be members of Congress who will support industry at the expense of the parks.

12. The USFS and the BLM Could Change Their Policies for Managing Land Next to Parks

Could the USFS and the BLM change regulations and policies for how they manage land adjacent to national parks? Yes, but such rule changes have not been instituted at the national level. At the field level, many USFS and BLM managers rigidly abide by their mandates. For example, faced with an NPS request that the BLM's San Juan resource management plan provide protective management for key land beside Canyonlands National Park, the Utah state office responded, "[w]e do not manage public lands as a 'buffer zone' to the park . . . . Congress provided that [BLM] lands are to be managed for multiple use and sustained yield, whether in proximity to an NPS unit or not."[415] Some believe that given the extractive industries' declining contribution to local economies, the cost for resource extraction subsidies, and the potential cost of

411. JOHN ISE, OUR NATIONAL PARK POLICY: A CRITICAL HISTORY 41 (1961).

412. *See* John G. Mitchell, *Threatened Sanctuaries: The State of U.S. Parks*, 210 NAT'L GEOGRAPHIC 88, 92 (2006).

413. Cawley & Freemuth, *supra* note 274, at 32–44.

414. David Orr, *Orr's Laws*, 18 CONSERVATION BIOLOGY 1457, 1458 (2004).

415. William J. Lockhart, *"Faithful Execution" of the Laws Governing Greater Yellowstone: Whose Law? Whose Priorities?*, *in* THE GREATER YELLOWSTONE ECOSYSTEM: REDEFINING AMERICA'S WILDERNESS HERITAGE, *supra* note 9, at 49, 55.

subsequent habitat restoration by taxpayers, suggestions to phase out some land use practices in forthcoming USFS forest plan revisions are eminently sensible.[416] But a rulemaking during the administration of George W. Bush, relying upon the Supreme Court's decision in *Norton v. Southern Utah Wilderness* (2004),[417] treated such plans as nonbinding.[418] After the George W. Bush Administration made three attempts to weaken the rules that governed USFS forest management, Judge Claudia Wilken of the Northern District of California ordered on June 30, 2009, that the 1982 or 2000 versions of the regulations be reinstated.[419] Although judicial intervention is a possible avenue, a different policy on how the BLM or the USFS manage their lands next to national parks may require the enactment of new legislation.[420] As mentioned, there is no unequivocal legal requirement that the BLM or the USFS manage their lands so as not to harm park resources.[421]

Conservation-oriented organizations and interest groups remain unsatisfied with the USFS and the BLM's performance. The agencies' shortcomings may reflect their mandates, which make multiple use seem like an impossible mission.[422] In addition, the breadth of the USFS mission contributes to a loss of focus within that agency.[423] This reflects the lack of a recent shared vision by Congress and the American people as to the purpose of the national forests. The NPS's mission, by contrast, is easier to grasp.

Based on national support and mission, and even national culture, the NPS may be better positioned, at least theoretically, to manage federal land adjacent to national parks for the very "new values" endorsed by the USFS and the BLM.[424] This best possible position could be achieved if the USFS and the BLM change their policies regarding land management of areas adjacent to NPS land;

416. Dennis A. Glick & Ben Alexander, *Development by Default, Not Design: Yellowstone National Park and the Greater Yellowstone Ecosystem*, *in* NATIONAL PARKS AND RURAL DEVELOPMENT: PRACTICE AND POLICY IN THE UNITED STATES 182 (Gary E. Machlis & Don R. Field eds., 2000).

417. 542 U.S. 55 (2004).

418. *See* 36 C.F.R. § 219 (2005); Michael C. Blumm & Sherry L. Bosse, Norton v. SUWA *and the Unraveling of Federal Public Land Planning*, 18 DUKE ENVTL. L. & POL'Y F. 105 (2007).

419. Citizens for Better Forestry v. USDA, 632 F.Supp. 2d 968, 982 (2009).

420. Keiter, *supra* note 276.

421. See *supra*, Part II.A for a discussion of differing land management policies.

422. Sedjo, *supra* note 198, at 183.

423. *See* ALEXANDER, *supra* note 70, at 17.

424. *See* 2 ECOLOGICAL STEWARDSHIP: A COMMON REFERENCE FOR ECOSYSTEM MANAGEMENT, *supra* note 287.

however, legislation would likely be needed for such a new viewpoint to carry weight.

V. PARK VALUES IN A DEMOCRACY

A. Public Values or Industry Freedom

The American public reportedly values resource availability for future generations above democracy, economic growth, or property rights.[425] As E.O. Wilson wrote, "[t]he drive toward perpetual expression—or personal freedom—is basic to the human spirit. But to sustain it, we need the most delicate, knowing stewardship of the living world that can be devised."[426] The knowing stewardship necessary to sustain perpetual expression cannot be maintained through unregulated development and economic growth. Americans may not like to be under the control of others, but beyond a certain point, "independence becomes irresponsibility and liberty becomes license."[427] The U.S. economy has been likened to "shoveling fuel for a runaway train."[428]

U.S. public land generates private wealth.[429] Some industries rely on resource harvest next to national parks: mining, oil and gas extraction, logging, grazing, geothermal power, and water resource development.[430] Reliance on industry to voluntarily phase into a steady-state economy is a naive ideal.[431] Gifford Pinchot, the father of American forestry, wrote, "[t]he earth, I repeat, belongs of right to all its people, and not to a minority, insignificant in numbers but tremendous in wealth and power. The public good must come first."[432] The public good involves many other values that may be jeopardized by the pursuit of private wealth generation. The

425. Brian Czech & P.R. Krausman, *Public Opinion on Endangered Species Conservation Policy*, 12 SOC'Y & NAT. RESOURCES 469, 472 (1999).

426. Edward O. Wilson, *The Current Status of Biological Diversity*, *in* BIODIVERSITY 3, 16 (E.O. Wilson & F.M. Peters eds., 1988).

427. DURWARD L. ALLEN, OUR WILDLIFE LEGACY 338 (1974).

428. *See generally* BRIAN CZECH, SHOVELING FUEL FOR A RUNAWAY TRAIN: ERRANT ECONOMISTS, SHAMEFUL SPENDERS AND A PLAN TO STOP THEM (2000).

429. RICHARD W. BEHAN, PLUNDERED PROMISE: CAPITALISM, POLITICS, AND THE FATE OF THE FEDERAL LANDS 168–69 (2001).

430. *See supra* Part II.C.

431. John R. Gentile, *Environmental Cooperation: Panacea or Myth*, 2 J. SOC'Y & NAT. RESOURCES 85, 85 (1989).

432. GIFFORD PINCHOT, BREAKING NEW GROUND 509 (Island Press 1998) (1947).

"tragedy of the commons" occurs when no economic incentive exists to make the resource extractor practice conservation.[433] If he were to stop extracting, he would forfeit an immediate economic benefit and allow a competitor to harvest what remains. Resource extractors may think of public resources as their own resources.[434] This ideology finds some expression in the wise-use movement,[435] exemplified during the waning days of the George W. Bush Administration, which released federal agencies from consulting with other agency experts as to whether development projects would impact a threatened or endangered species (required by Section 7 of the Endangered Species Act).[436]

In theory, the American public decides how U.S. public land is used, but in practice many powerful industries greatly influence such decisions.[437] Although social, economic, and political factors demand that 21st century land management leave 20th century practice behind, there are powerful people both inside and outside of the natural resource professions and in public agencies that will resist any such plan.[438] Selling off U.S. public lands to private corporations is an idea that never dies.[439]

During the Reagan Administration, certain members of Congress sought transfer of BLM land to the states,[440] and such efforts continue—during 2005, members of the House of Representatives attempted to use the Mining Law of 1872 to allow the selling of federal lands.[441] After that congressional initiative was defeated, the President's 2006 budget proposed to sell off 300,000 acres of USFS

433. Garrett Hardin, *Political Requirements for Preserving Our Common Heritage*, *in* WILDLIFE AND AMERICA: CONTRIBUTIONS TO AN UNDERSTANDING OF AMERICAN WILDLIFE AND ITS CONSERVATION 310–17 (Howard Brokaw ed., 1978); Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243 (1968).

434. Siegfried V. Ciriacy-Wantrop & Richard C. Bishop, *"Common Property" as a Concept in Natural Resources Policy*, 15 NAT. RESOURCES J. 713, 714–15 (1975).

435. Jon Roush, *Freedom and Responsibility: What We Can Learn from the Wise Use Movement*, *in* LET THE PEOPLE JUDGE 3–4 (John Echeverria & Raymond B. Eby eds., 1995).

436. Endangered Species Act of 1973, 16 U.S.C. § 1531 et seq. (2006).

437. DAVID C. KORTEN, WHEN CORPORATIONS RULE THE WORLD 25–36 (1999).

438. *See* Mitchell, *supra* note 412, at 92–96; James L. Kennedy, Michael P. Dombeck & Niels E. Koch, *Values, Beliefs, and Management in the Western World at the Close of the Twentieth Century*, 49 UNASYLVA 16 (1998).

439. Joseph L. Sax, *Why We Will Not (Should Not) Sell the Public Lands: Changing Conceptions of Private Property*, 1983(2) UTAH L. REV. 313, 313 (1983).

440. C. BRYANT SHORT, RONALD REAGAN AND THE PUBLIC LANDS: AMERICA'S CONSERVATION DEBATE, 1979–1984 81–99 (1989).

441. Ray Ring, *Bipartisan Uprising Sinks Public-lands Sell Off*, HIGH COUNTRY NEWS, Dec. 26, 2005, *available at* http://www.hcn.org/issues/313/16008.

and BLM lands for $1 billion.[442] The future of vital federal land external to national park boundaries should not be taken for granted, but the future of property within national parks is more secure than most non-wilderness USFS and BLM lands. Adjacent USFS lands should not be taken for granted for yet another reason: By 2030, there will be a projected large increase in housing density on 21.7 million acres of private land located within ten miles of a national forest or national grassland.[443] This means there will be more pressure to utilize multiple use USFS land now lying adjacent to national parks, and such use may not be harmonious with park biota.

The American special interest groups most likely to oppose an annexation option (e.g., in the GYE) include consumptive resource industries (cattle, timber, hard-rock mining, oil and gas, geothermal, and water resource development), the recreational vehicle industry, the wise-use movement, private land rights groups, and some hunters and outfitters. In the past, these special interest groups have opposed related park protection measures. The National Park System Protection and Resources Management Act of 1983[444] would have required park resource impact assessments for federal actions within or adjacent to national parks. Because of opposition by the resource extraction industries, it never passed the Senate.[445] H.R. 3383, calling for a comprehensive review of park boundaries, never survived a 1989 vote in the House of Representatives.[446] Therefore, it is likely that any annexation option will encounter opposition from predictable special interest groups.

The NPS is not immune to political interference. In fact, since 2001, the ability of land management agencies to fend off blatant political pressures has decreased.[447] However, once NGOs and the American public became aware of anti-environmental George W. Bush Administration initiatives, industry was increasingly challenged. The Barack Obama Administration continues to overturn rules promulgated by the George W. Bush Administration.

442. Brett Wilkison, *Public Lands For Sale*, HIGH COUNTRY NEWS, Mar. 3, 2006, *available at* http://www.hcn.org/issues/317/16142.

443. SUSAN M. STEIN ET AL., U.S. FOREST SERVICE, PNW-GTR-728, NATIONAL FORESTS ON THE EDGE: DEVELOPMENT PRESSURES ON AMERICA'S NATIONAL FORESTS AND GRASSLANDS 7 (2007).

444. H.R. 2379, 98th Cong. 1st Sess. (1983).

445. Hiscock, *supra* note 79, at 71–74.

446. Brown, *supra* note 357, at 314–15.

447. Mitchell, *supra* note 412, at 92–96.

In past decades, Congressional representatives have attempted to dictate park management, manipulate the NPS budget process, criticize officials,[448] impede their ability to work,[449] or follow their mandates, regulations or policies. Two former NPS Regional Directors have described the result of political intervention in agency decision-making during the 1980s.[450] They both tried to manage national parks to preserve resources but were forced out of the agency when their actions were contrary to the wishes of DOI political appointees.[451] The NPS relies on one simple fact to thwart such political interventions: "Americans love the national parks," a sentiment shared by one of the world's most well known biological field scientists, E.O. Wilson.[452] As John Hope Franklin, chairman of the National Park System Advisory Board, remarked, "the public looks upon national parks almost as a metaphor for America itself."[453]

B. Scientists and Economists Object

On May 15, 2002, E.O. Wilson and 220 other scientists wrote a letter to President George W. Bush calling for an end to logging on federally-owned forests.[454] They explained that the funds generated from these timber sales were minor compared to the environmental damage left behind.[455] Wilson himself brought the issue to the attention of the American public in the newspaper media.[456] Their argument is compelling, but the annexation option would not require banning all future logging on USFS and BLM lands.

Later, on December 3, 2003, more than 100 U.S. economists wrote to President George W. Bush and eleven Western governors

448. WILLIAM R. LOWRY, THE CAPACITY FOR WONDER: PRESERVING NATIONAL PARKS 55–60 (1994); *see generally* Robert Cahn & Patricia Cahn, *Disputed Territory*, 61 NAT'L PARKS 28 (1987).

449. James L. Huffman, *The Inevitability of Private Rights in Public Lands*, 65 U. COLO. L. REV. 241, 245–54 (1994).

450. Lorraine Mintzmyer, *Disservice to the Parks*, 66 NAT'L PARKS 24, 24–25 (1992); Howard Chapman, *Politicization of the National Park Service*, 8 FOREST WATCH 13, 14–17 (1988).

451. *See, e.g.*, Edward O. Wilson, *Selling Out Our Forests*, WASH. POST, Aug. 28, 2003, at A27.

452. Edward O. Wilson, *From Deep History to the Century of the Environment: The National Park Service as Environmental Leader*, 21(1) GEORGE WRIGHT F. 5, 5 (2004).

453. FRANKLIN ET AL., *supra* note 190, at 8.

454. Jim Robbins, *Scientists Seek Logging Ban on U.S.-Owned Land*, N.Y. TIMES, Apr. 16, 2002, at A22.

455. *Id.*

456. *See* Wilson, *supra* note 452.

warning that any policy that promoted business growth without being mindful of natural resources and wildlife would harm the economy and the environment. Specifically, they warned that activities that degrade the environment would "diminish the economic well-being of many residents, divert natural resources from their highest and best use, reduce the environmental amenities that are essential ingredients of the West's quality of life, and pass to future generations the costs of cleaning up this generation's environmental messes."[457]

Later still, in October 2004, 125 prominent scientists, including Jane Goodall and E.O. Wilson, signed a letter to the USFS objecting to their efforts to compromise the Clinton Administration's Roadless Rule.[458] In the GYE, only 600,000 acres of USFS land were deemed "roadless" by these authors.[459] In September 2006, the Federal District Court of Northern California ordered the Bush Administration to reinstate the Clinton Administration's Roadless Rule.[460] By August 5, 2009, a federal circuit court judge affirmed the Bill Clinton Administration's 2001 Roadless Rule protections.[461]

C. Which Values Will Prevail

The full range of values provided by national parks, or any protected area whose aim is conserving biological diversity, is slowly gaining more appreciation.[462] While protected areas on USFS and BLM lands provide many of these same values, units of the National Park System are more frequently recognized for offering certain benefits—linking Americans to their past by contributing to a

457. A Letter from Economists to President Bush and the Governors of Eleven Western States Regarding the Economic Importance of the West's Natural Environment 1–2 (Ed Whitelaw ed. 2003), *available at* http://www.plantsocieties.org/PDFs/100EconLettBush12.03.pdf.

458. Letter from Dominick A. DellaSala, Director, World Wildlife Fund et al. to USFS Content Analysis Team (Oct. 19, 2004), *available at* http://www.ourforests.org/fact/Roadless_Scientist_Support.pdf.

459. LOUISA WILCOX & DAVID ELLENBERGER, THE SIERRA CLUB, THE BEAR ESSENTIALS FOR RECOVERY: AN ALTERNATIVE STRATEGY FOR LONG-TERM RESTORATION OF THE GREAT BEAR, GRIZZLY BEAR ECOSYSTEMS PROJECT 18 (2000), *available at* http://www.sierraclub.org/grizzly/reports.asp.

460. Citizens for Better Forestry v. USDA, 632 F.Supp. 2d 968, 982 (N.D. Cal. 2009).

461. California ex rel. Lockyer v. U.S. Dep't of Agric., 459 F. Supp. 2d 874, 919 (N.D. Cal. 2006).

462. *See* THE FULL VALUE OF PARKS: FROM ECONOMICS TO THE INTANGIBLE (David Harman & Allen D. Putney eds., 2003).

"sense of place"; providing a sense of national dignity, identity, and inspiration; supplying spiritual values and religious meaning; and exporting such values to other countries. One scientist and conservationist even asserted that national parks represent the "nuclei of cells in the body of a nation."[463] As former NPS Director George Hartzog explained, "[p]erhaps second only to liberty itself, the national park idea is the finest contribution of the United States to world culture. These parklands are more than physical resources. They are the delicate strands of nature and culture that bond generation to generation."[464]

National parks, in particular, may increasingly serve as psychological and physical life rafts for society. For example, the U.S. Army used some national parks during 1941 for the recuperation of its World War II-weary troops.[465] The stresses of life in the 21st century may result in an urban-weary U.S. society. Visitors are welcome to enjoy some, but not all, forms of outdoor recreation in national parks. For example, hang-gliding demands park-specific regulations.[466] National parks may indeed be "vantage points" from which to achieve a "balance and equilibrium through a wisdom and perspective which will enable us to evaluate the progress we have made" may be achieved.[467] Thus, national parks are a major component in creating what many Americans seek—domestic tranquility.[468] If ecosystems are not only more complex than we know, but more complex than we can know,[469] our dependence on national park ecosystems may also be deeper than we can even now perceive. However, as this Article reveals, national parks are under siege from a multitude of outside uses. Parks must be protected from resource degradation, species loss, and other injuries if they are to remain for future generations of Americans to enjoy.

463. Frank Fraser Darling, *The Park Idea and Ecological Reality*, NAT'L PARKS MAG. 21, 24 (1969).

464. HARTZOG, *supra* note 1, at xvi.

465. *See* FREEMAN TILDEN, THE NATIONAL PARKS 38 (Alfred A. Knopf 2d. rev. ed. 1970) (1951).

466. *See* NAT'L PARK SERV., 2006 MANAGEMENT POLICIES, *supra* note 57, at 2.

467. Sigurd F. Olson, *A Philosophical Concept*, *in* FIRST WORLD CONFERENCE ON NATIONAL PARKS, *supra* note 164, at 45, 50.

468. *See* Theodore W. Sudia, *Domestic Tranquility and the National Park System: A Context for Human Ecology*, 2(1) GEORGE WRIGHT F. 22 (1982).

469. FRANK E. EGLER, THE NATURE OF VEGETATION: ITS MANAGEMENT AND MISMANAGEMENT, AN INTRODUCTION TO VEGETATION SCIENCE 2 (1977).

D. New Century Option: Annexation

The annexation option is an idea whose consideration may well have arrived. While scientists may wish to avoid making broad-scale public land disposition recommendations, some may be amenable to performing a public service by outlining options for consideration. Informed federal land use decisions demand this scientific and technical information. Democratic principles suggest that people with technical backgrounds have an obligation to recognize options that have the potential for offering some greater societal good.[470] Examining the social and economic aspects of a biological issue is not necessarily advocacy.[471] While the general public is the proper arbitrator for all major federal land decisions that invoke public values, the public first needs assimilated, multidisciplinary information from disparate sources in order to consider all options. Although many proposals to better manage the GYE have been offered, no simple formula has yet surfaced.[472]

The annexation option is not new. Aldo Leopold remarked that the only way to save threatened national park carnivores was for the "wilder parts of the National Forests . . . to function as parks . . . ."[473] But today, the wilder parts of many adjacent national forests (e.g., some official USFS wilderness areas) cannot function as parks. While the Wilderness Act of 1964 has provided many protective benefits, many extractive land uses, including mining, oil and gas exploration and extraction, grazing, hunting, water storage projects (with Presidential approval), tolerance of former rights-of-way, providing new road access to private inholdings and mining claims, and state control of wildlife, do occur or are allowed to persist in many USFS or BLM wildernesses areas (e.g., the GYE) that border national parks.[474] Unless the law indicated otherwise or political pressure interfered, the NPS would exclude or seek to phase out mining, oil and gas extraction, deleterious grazing, water projects, and destructive road access in national park non-wilderness. The option being outlined here is not complicated—move the park

470. *See* Ronald D. Brunner & William Ascher, *Science and Social Responsibility*, 25 POL'Y SCI. 295 (1992) (outlining ways to improve the accountability of science to society).

471. *See* Gregory J. Anderson, *The Nearly Invisible Voice of Organismal Biology in Public Policy*, 52 BIOSCIENCE 85, 87 (2002).

472. SUSAN G. CLARK, ENSURING GREATER YELLOWSTONE'S FUTURE: CHOICES FOR LEADERS AND CITIZENS 63–64 (2008).

473. ALDO S. LEOPOLD, A SAND COUNTY ALMANAC 276–77 (Oxford University Press 1949).

474. *See* Tanner, *supra* note 367, at 10–11; Buono, *supra* note 324, at 49.

boundary outward to subsume the incompatible land uses on USFS and BLM lands, eventually extinguishing prior existing rights if they threaten the park resource.[475]

In 1916, J. Horace McFarland, president of the American Civic Association, said, "[t]hese great parks are, in the highest degree . . . a sheer expression of democracy. . . ."[476] According to Gifford Pinchot, "National Forests exist to-day because the people want them. To make them accomplish the most good, the people themselves must make clear how they want them run."[477] In the 21st century, federal land managers must recognize that beyond just the business of traditional resources management, they are also in the business of social value management.[478] Eighty-five years ago, C.C. Adams observed that "national forests were created about the Yellowstone National Park, in order to protect it . . . ."[479] Parts of adjacent national forests may today better protect national parks by being subsumed into those parks. If the American people think that it is in their best interest, then more USFS and BLM land adjacent to national parks could be transformed into spatial extensions of "the best idea America ever had."[480]

475. *See* David M. Ostergren, *The National Park Service and Implementation of the 1964 Wilderness Act: Thirty-Seven Years of Competing Interests on the Colorado Plateau*, *in* THE COLORADO PLATEAU: CULTURAL, BIOLOGICAL AND PHYSICAL RESEARCH 47, 57 (Charles van Riper III & Kenneth L. Cole eds., 2004) (noting that "one may make the argument that undesignated NPS land is *more* protected than USFS and BLM Wilderness designations.").

476. RONALD F. LEE, FAMILY TREE OF THE NATIONAL PARK SYSTEM 17 (1972).

477. GIFFORD PINCHOT, THE USE OF THE NATIONAL FORESTS 26 (Intaglio Press 1907).

478. Mark W. Brunson & James J. Kennedy, *Redefining "Multiple Use": Agency Responses to Changing Social Values*, *in* A NEW CENTURY FOR NATURAL RESOURCES MANAGEMENT 143, 143 (R.B. Keiter & M.S. Boyce eds., 1995).

479. Charles C. Adams, *Ecological Conditions in National Parks and in National Forests*, 20 SCI. MONTHLY 561, 567 (1925).

480. Mitchell, *supra* note 412, at 88.

APPENDIX 3: KEY TERMINOLOGY

All of the terminology associated with this research has not been used consistently. I shall therefore define some key terms though all of them have not been used herein.

Administrative Boundary: Typically an imaginary one-dimensional line which delineates space thereby allowing for different land use rules on either side of that line (i.e., laws, ownerships, administrations, and cultures) (based on Schonewald 2000).

Ecological Boundary: "An area of sharp gradients in ecological flows that slows or redirects flows or organisms, matter, or energy between patches" (Puth and Wilson 2001: 22, after Wiens et al. 1985).

Buffer: to lessen or absorb the shock of impact; intercepting or moderating adverse pressures or influences; separating potentially antagonistic entities (American Heritage College Dictionary, 4th Edition, 2007).

Buffer zone: an intangible space of proposed land use compliance designed to counteract potential negative human influences on the core of a protected area. A buffer zone does not occupy physical space (e.g., a collar of land) but constitutes a set of social rules (Christine Schonewald personal communication).

Boundary effect: Landscape change resulting from the establishment and protection of a protected area boundary. A boundary effect causes a "generated edge" which usually begins as social awareness followed by a physical edge (e.g., habitat modification outside or inside a boundary) (based on Schonewald-Cox and Bayless 1986, Schonewald 2000).

Lateral flux: A vector that moves across a boundary (Wiens et al. 1985) in a lateral direction. In the context of protected areas, it often means a force generated by human activity which travels across an administrative boundary (after Reiners and Driese 2001). For example, pollution could represent a lateral flux.

Ecological flux: "Flows of matter or energy within the ground, along the surface, and in the air" (Landres et al. 1998: 45). Such phenomena have also been described as "ecological flows," often human generated (Hansen et al. 2011). An ecological flux does not have to be lateral (e.g., between a lake's water and its sediments).

Vector: "a transport mechanism" (Forman and Godron 1986: 315), for example, wind, water, volant and non-volant animals, and humans. They have also been described as "movers" (Puth and Wilson 2001:22).

Matrix: "the most extensive and connected landscape element type present...a landscape element surrounding a patch" (Forman and Godron 1986: 596).

Line: A one-dimensional figure formed by a point moving along a fixed direction (modified from American Heritage College Dictionary, 4th Edition, 2007).

Boundary space: The sum of all components, boundaries, changes, effects, and multidimensional dynamics in time that revolve around, affect, or are affected by an administrative boundary (based on Schonewald 2000).

Edge: "the outer portion of a patch where the environment differs significantly from the interior of the patch" (Dramstad et al. 1996:27).

Edge effect: Ecological changes that occur at the edges of ecosystems which include species composition and gradients of moisture, sunlight, temperature and wind speed. These factors can have negative ecological consequences (Noss and Cooperrider 1994: 391). Some authors use the term edge effect to include anthropogenic influences like poaching (Revilla et al. 2001) and disease which might also be described as a ***matrix effect*** (e.g., Noon and McKelvey 1996:129).

Ecotone: a relatively narrow overlap zone between communities (Forman and Godron 1986: 592).

Boundary permeability: The blocking or deflecting of vectors (Wiens et al. 1985, Landres et al. 1998) or the process of generated edges serving as filters (Schonewald-Cox 1988). Sometimes referred to as boundary *porosity* (e.g., Forman and Godron 1986).

Filter: **"**Avenues of dispersal and colonization which are not equally favorable for all species" (MacDonald 2003: 248).

Patch: "a nonlinear surface area differing in appearance from its surroundings" (Forman and Godron 1986: 597).

Connectivity: "a measure of how connected or spatially continuous a corridor or matrix is" (Forman and Godron 1986: 591).

Corridor: "a narrow strip of land that differs from the matrix on either side (Forman and Godron 1986: 591).

Network: interconnecting corridors (Dramstad et al. 1996:41).

Landscape*:* "a heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout" (Forman and Godron 1986: 594) and "a kilometers-wide mosaic over which local land uses recurs" (Dramstad et al. 1996:12-13).

Dispersal: "The movement of organisms away from their point of origin" (Lomolino et al. 2010: 770).

Migration (seasonal): "Annual movements of organisms from one region to another for purposes of avoiding harsh conditions, feeding, and mating" (MacDonald 2003:235).

Immigration: "The arrival of new individuals to an isolated site" (Lomolino et al. 2010: 774).

Emigration: "Dispersal of organisms away from a region of interest" (Lomolino et al. 2010: 770).

Drivers: "the societal causes of environmental problems" (Fortuin et al. 2011:811).

Region: "an area, usually containing a number of landscapes, that is determined by a complex of climate, physiographic, biological, economic, social, and cultural characteristics" (Forman and Godron 1986: 598).

Null hypothesis: "A statistical hypothesis stating what would be expected by chance alone, which can be tested in order to determine whether an observation could be the result of chance or is instead a result of some directing force” (Lomolino et al. 2010: 777).

Threats: **“**Change agents that cause impacts on wilderness resource conditions and values--what causes the impacts--not the impacts themselves” (Dawson and Hendee 2008: 353).

Case study: “One of several ways of doing research, an intensive study of a single group, incident, activity or community” (Clarke 2011: 323).

Management: “Any activity directed toward achieving or maintaining a given condition on plant and/or animal populations and/or habitats in accordance with the conservation plan for the area” (Bourliére 1962: 364).

Environmental Policy**:** The overall direction sought by society (e.g., to preserve natural landscapes). Based on this definition, a policy *instrument* could be the Yellowstone Act of 1872 or the creation of the National Park Service via the Organic Act of 1916. By some definitions, there can be levels of policy. For example, an NPS land management *goal* once included the preservation of landscapes as they existed at the time of presettlement. In NPS jargon, management policy can include such an overarching goal as well as specific *management guidelines* to achieve that goal (e.g. controlled burning is encouraged when feasible). Therefore, the NPS idea of policy is very broad: “it may prescribe the process through which decisions are made, how an action is to be accomplished, or the results to be achieved" (NPS 2006: 4). The terms policy and goal are used inconsistently in the literature (see Wagner et al. 1995).

Planning: "To form a scheme ...for the accomplishment...of a ...course of action" (American Heritage College Dictionary, 4th Edition, 2007). Some authors view land planning as a part of land management.

Development: construction.

Model: "a simplified verbal, graphic, or mathematical description used to help visualize a complex object" (Forman and Godron 1986: 596).

De facto wilderness: "Public lands that are wilderness in the general sense of the term, roadless and undeveloped, but which as wilderness have not been designated by Congress. Lands potentially available for wilderness classification" (Dawson and Hendee 2008: 508).

REFERENCES

Bourliére, F. 1962. Management of national parks. In A.B. Adams (ed), First World Conference on National Parks, 364-365. National Park Service, Department of the Interior, Washington, D.C.

Clarke, K.C. 2011. Getting Started with Geographic Information Systems. 5th Ed. Prentice Hall, Upper Saddle River, New Jersey.

Dawson, C.P. and J.C. Hendee. 2008. Wilderness Management: Stewardship and Protection of Resources and Values. 4th Ed. Fulcrum Publishing, Golden, Colorado.

Dramstad, W.E., J.D. Olson and R.T.T. Forman. 1996. Landscape Ecology Principles in Landscape Architecture and Land-Use Planning. Island Press, Washington, D.C.

Forman, R.T.T. and M. Godron. 1986. Landscape Ecology. John Wiley and Sons, New York.

Fortuin, K.P.J., C.S.A. (Kris) van Koppen, and R. Leemans. 2011. The value of conceptual models in coping with complexity and interdisciplinarity in environmental sciences education. BioScience 61(10): 802-814.

Hansen, A.J., C.R. Davis, N. Piekielek, J. Gross, D.M. Theobald, S. Goetz, F. Melton, and R. De Fries. 2011. Delineating the ecosystems containing protected areas for monitoring and assessment. *BioScience* 61 (5): 363-373.

Landres, P.B., R.L. Knight, S.T.A. Pickett, and M.L. Cadenasso. 1998. Ecological effects of administrative boundaries. In R.L. Knight and P.B. Landres (eds), Stewardship Across Boundaries, pp. 39-64. Island Press, Washington, D.C.

Lomolino, M.V., B.R. Riddle, R.J. Whittaker and J.H. Brown. 2010. Biogeography. 4th Ed. Sinauer Associates, Sunderland, Massachusetts.

MacDonald, G.M. 2003. Biogeography: Space, Time, and Life. John Wiley and Sons, New York.

National Park Service. 2006. Management Policies 2006. National Park Service, Department of the Interior, Washington, D.C.

Noon, B.R. and K.S. McKelvey. 1996. A common framework for conservation planning: linking individual and metapopulation models. In D.R. McCullough (ed), Metapopulation and Wildlife Conservation, pp. 111-138. Island Press, Washington, D.C.

Noss, R.F. and A.T. Cooperrider. 1994. Saving Nature's Legacy: Protecting and Restoring Biodiversity. Island Press, Washington, D.C.

Puth, L.M. and K.A. Wilson. 2001. Boundaries and corridors as a continuum of ecological flow control: lessons from river and streams. *Conservation Biology* 15 (1): 21-30.

Reiners, W.A., and K.L. Driese. 2001. The propagation of ecological influences through heterogeneous environmental space. *BioScience* 51 (11): 939-950.

Revilla, E., F. Palomares, and M. Delibes. 2001. Edge-core effects and effectiveness of traditional reserves in conservation: Eurasian badgers in Doñana National Park. *Conservation Biology* 15: 148-158.

Schonewald, C. 2000. Introduction to boundary space. *Complexity* 6 (2): 41-57.

Schonewald-Cox, C. and J. Bayless. 1986. The boundary model: a geographical analysis of design and conservation of nature reserves. *Biological Conservation* 38: 305-322.

Schonewald-Cox, C. 1988. Boundaries in the protection of nature reserves. *BioScience* 38: 480-486.

Wagner, F.H., R. Foresta, R.B. Gill, D.R. McCullough, M.R. Pelton, W.F. Porter, and H. Salwasser. 1995. Wildlife Policies in the U.S. National Parks. Island Press, Washington, D.C.

Wiens, J.A., C.S. Crawford, and J.R. Gosz. 1985. Boundary dynamics: a conceptual framework for studying landscape ecosystems. *Oikos* 45: 421-427.

CURRICULUM VITAE

Craig L. Shafer grew up in California and Maryland. He studied at the university level at Montgomery College, the University of Maryland, the American University and George Washington University before taking course work at George Mason University in late 2007.

Craig served as an ecologist with the US National Park Service for decades. During that time he helped administer a nationwide natural area preservation program, carried out data compilation for the National Park System Plan, enrolled park staff in training to manage parks from a biological diversity perspective, served as the Washington Office point person during part of the 1990s for the U.S. Man and the Biosphere Program and the Clinton Administration's climate change activities, worked on agency ecosystem management initiatives, and gave some presentations in other countries (i.e., Canada, Venezuela, South Africa, Canary Islands). He was awarded by the Secretary of Interior in 1987. Before coming to NPS, he worked as a technician for the Bureau of Land Management, the US Fish and Wildlife Service and the Maryland Natural Resources Institute.

He authored one book, three books chapters, eleven peer reviewed science journals articles and one law journal article, all about protected area planning and management. He is a fisherman, hunter, photographer, scuba diver, hiker, skier and traveler. He has visited protected areas on six continents.