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1800 Continental Place, Suite 100
Mount Vernon, WA 98273

August 7, 2017

VIA U.S. Mail; Return Receipt Requested

Secretary Ryan Zinke
Department of the Interior
1849 C Street, N.W.
Washington DC 20240

RE: North Cascades Ecosystem Grizzly Bear Reintroduction Plan / Draft Environmental Impact Statement

Dear Secretary Zinke,

We are deeply concerned about the U.S. Fish and Wildlife Service's plan to reintroduce Grizzly Bears into our counties without full consideration of how the change will affect the safety and welfare of our residents, and without consideration of recent and compelling new science.

In 1993, the U.S. Fish and Wildlife Service issued a Grizzly Bear Recovery Plan that identified the North Cascades ecosystem in Washington State as a potential suitable habitat for bear reintroduction. The North Cascades are partially located in our Counties.

During the past few years, the U.S. Fish and Wildlife Service and National Park Service (Agencies) began preparing a draft Environmental Impact Statement (EIS) to reestablish grizzly bears near our communities. Neither agency considered our local plans, policies or programs when preparing the analysis. Because of this omission, the draft EIS does not fully outline the direct and indirect impacts to our communities, nor how transplanting bears into the North Cascades will affect our ability to protect the health, safety and welfare of our residents – a mission that is our primary responsibility as County Commissioners.

The agencies are nearing the completion of the study with plans to release the final EIS this fall.

We ask that you intercede and stop further work on this project until your Administration has an opportunity to closely review whether introducing grizzly bears into the North Cascades is warranted, for the following reasons:

1. The last confirmed sighting of a grizzly bear in the North Cascades was 21 years ago (1996); the anecdotal data referred to as proof there once was a viable grizzly bear population is unreliable. This area supports a robust hunting, fishing and backpacking population (8 million visitor days per year), as well as essential agricultural industries..

2. The Grizzly Bear Recovery Plan identifying the North Cascades as potential habitat for the bear was last revised in 1993. A supplemental plan for the North Cascades was added in 1997, but contained no new science. Although the plan was based on the best available science at that time, our understanding of bear behavior is far more advanced today. We now have several peer-reviewed studies that track bear movements in other recovery zones using modern GPS technology. These more recent studies provide superior insight into the habitats bears seek for forage and shelter, as well as their interactions with humans. A revised Recovery Plan should have been prepared prior to the development of the EIS for the North Cascades, incorporating the latest science.

3. The agencies failed to consider our local plans, policies and programs when preparing the environmental analysis. As a result, they have omitted significant direct and indirect impacts to our communities, and have not properly analyzed how transplanting bears into the North Cascades would harm our ability to protect the health, safety and welfare of the residents.

For these reasons and the others identified in the discussion below, we ask that you direct the U.S. Fish and Wildlife Service and the National Park Service to stop all work on the North Cascades Ecosystem Grizzly Bear Restoration Plan / Environmental Impact Statement. In place of this, we ask that the agencies prepare a revised recovery plan incorporating the new science, as well as local plans, policies and programs.

We are confident that given the current science, a new review by your Department will conclude that the North Cascades are not appropriate grizzly bear habitat and should be removed from future consideration as a recovery area.

Please do not hesitate to contact us if more information is necessary. We look forward to your response.

Sincerely,
CHELAN COUNTY, WASHINGTON

Keith W. Goehner

Doug England,
Chair

Kevin Overbay,
Commissioner

Keith Goehner,
Commissioner

OKANOGAN COUNTY, WASHINGTON

J DeTro
Jim DeTro,
Chair

Chris Branch
Chris Branch,
Commissioner

Approved via Teleconference
Andy Hover,
Commissioner

SKAGIT COUNTY, WASHINGTON

Ron Wesen
Ron Wesen,
Chair

Kenneth A. Dahlstedt
Kenneth A. Dahlstedt,
Commissioner

Lisa Janicki
Lisa Janicki,
Commissioner

Enclosures:

Deficiencies of the North Cascades Ecosystem Grizzly Bear Reintroduction Plan / Draft Environmental Impact Statement

April 24, 2017 Minutes Joint Coordination Meeting with Chelan and Skagit Counties and the U.S. Fish and Wildlife Service and National Park Service

cc:
Greg Sheehan, Acting Director, U.S. Fish and Wildlife Service
Casey Hammond, Special Assistant to the Secretary of the Dept. of the Interior
U.S. Fish and Wildlife Service State Supervisor Eric Rickerson
National Park Service Superintendent Karen Taylor-Goodrich
National Park Service Chief of Natural and Cultural Resources Jack Oelfke
National Park Service Chief of Interpretation and Education Denise Shultz
Snohomish County Councilman Nate Nehring
Town of Darrington Mayor Dan Rankin

Deficiencies of the North Cascades Ecosystem Grizzly Bear Reintroduction Plan / Draft Environmental Impact Statement

Contents:

I. New Science Not Considered in the Recovery Plan or Environmental Analysis;
II. Failure to Coordinate EIS with Counties and Consider Significant Local Impacts; and
III. Failure to Develop a Sufficient Draft Environmental Impact Statement.

Discussion:

April 24, 2017, we hosted the first coordination meeting with the U.S. Fish and Wildlife Service and the National Park Service on the potential reintroduction of grizzly bears into the North Cascades ecosystem. This occurred four days prior to the close of the public comment period for the Draft Environmental Impact Statement (DEIS). It is unfortunate that the agencies did not seek meaningful coordination prior to the preparation of their DEIS. Had they done so, they would have learned earlier how the potential reintroductions of grizzly bears into our communities conflicts with our plans, policies and programs. They would have also been informed early in the process that there were important peer-reviewed studies that should have been considered to properly analyze the impacts on our communities. These were presented to them during our meeting as well as other critical findings we have made regarding the sufficiency of the environmental analysis. We asked that they prepare a supplemental study taking these issues into account, or start the process over. They have yet to provide us with a response.

Below are some of the key issues we brought to their attention, which we are now bringing directly to you.

I. New Science Not Considered in the Recovery Plan or Environmental Analysis.

The U.S. Fish and Wildlife Service and National Park Service (Agencies) have determined that the North Cascades is suitable habitat for 200 grizzly bears and are currently studying three action alternatives for transplanting the bears into the area to reach this goal. The basis for their position is that the North Cascades was part of the bears' historic habitat. However, this position relies solely on anecdotal information, such as occasional sightings of bears, the last being in 1996, and the sale of bearskins in the area. While this information can be informative, it does not provide a basis for determining the historical numbers of bears and their distribution in the North Cascades. This is frankly, unknown.

To determine whether the North Cascades is suitable habitat today, and what an appropriate population and distribution should be, the Agencies have relied on outdated studies and modeling projections. The National Park Service website page provides links to the studies that provide the basis of the Recovery Plan and the DEIS. These are noted below. We have added next to each title the author and date of the study cited.

A. FWS Grizzly Bear Recovery Plan *(Revised in 1993)*
B. FWS Grizzly Bear Recovery Plan- North Cascades Ecosystem Chapter *(Supplemental 1997)*

C. Historical and Recent Grizzly Bear Sightings in the North Cascades *(Bjorklund 1980)*
D. Grizzly Bear Carrying Capacity in the North Cascades Ecosystem *(Lyons 2016)*
E. A Preliminary Study of Historic and Recent Reports of Grizzly Bears in the North Cascades Area of Washington *(Sullivan 1983)*
F. North Cascades Grizzly Bear Ecosystem Evaluation *(Almack 1993)*
G. Report of the Technical Review Team Evaluation of the Bitterroot and North Cascades to Sustain Viable Grizzly Bear Populations *(Servheen 1991)*
H. Landscape Permeability for Grizzly Bear Movements in Washington and Southwestern British Columbia *(Singleton 2004)*

(https://parkplanning.nps.gov/document.cfm?parkID=327&projectID=44144&documentID=64646)

Only one of these reports cites recent studies, the “Grizzly Bear Carrying Capacity in the North Cascades Ecosystem,” (Lyons). This report is a modeling study, meaning it makes a statistical prediction. However, some of the key recent studies we have noted below, were not used to inform the development of the model. Modeling studies are a poor substitute for real experiences.

Further, the Historical Sightings study, prepared by Bjorklund in 1980 found that during a 130-year span, only 233 reports of bears in the North Cascades were potentially reliable. That is at best two bear sightings a year, a number that does not support the theory that the North Cascades was home base to 200 bears.

What is more revealing, however, is the science the agencies have failed to consider. Grizzly bears have been reestablished or are recovering in four of the six recovery zones, and they are being closely monitored. The information we are learning from these bears, some transplanted and some native, is critical to determining whether the North Cascades should be considered suitable habitat. However, these studies have been left out of the analysis. Some of the most relevant are:

A. Waller, John Steven, 2005: *Movements and Habitat-Use of Grizzly Bears along U.S. Highway 2 in Northwestern Montana 1998-2001.*

   This was John Waller’s Ph.D. master thesis and was approved by Christopher Servheen, who was the head of the Interagency Grizzly Bear Committee and a U.S. Fish and Wildlife Biologist. The study used two methods to track grizzly bear movements. The first tracks radio telemetry collars (the method used in the early studies), and the second tracks satellite GPS collars (the method used in current studies). He recorded 912 radio telemetry positions and 20,944 GPS positions. He determined that the radio telemetry studies severely underestimated the home ranges of grizzly bears, with the home ranges determined by older, radio telemetry collars being only 30% of the home ranges determined by the more modern and accurate GPS technology. Therefore, if a radio telemetry study concluded that a bear’s home range was 30-square miles, the actual home range would be 100-square miles.

Had this study been reviewed by the agencies while preparing the DEIS, it surely would have suggested that they have overestimated the appropriate number of bear units for the North Cascades. The Waller study uses actual bear movements, not modeling predictions, and even though it was published in 2005, the Lyons 2016 modeling study failed to review and incorporate its findings. (Attachment 1)

B. Servheen, Chris, 2005 – Presentation on Grizzly Bear Movements in Swan Valley, Montana.

Dr. Chris Servheen provided a presentation of GPS monitoring data from the Swan Valley in Montana that tracked grizzly bears 24-hours a day in the early 2000s. The data shows actual bear movements and contradicts conventional thinking that grizzly bears live in the wilderness, mountain areas. What the tracking data showed is that grizzly bears live, forage and sleep in the valley bottom where there are robust agriculture activities and even, in this case, the small town of Condon, Montana. (Attachment 2)

The North Cascades DEIS should have included a projection of the potential bear movements for the proposed 200 bears within the 100-square mile range, based on the findings of this study. If this had been included in the DEIS, the public and decision makers would have been informed that the bears go where they can easily find food, and they feed on fruit, fish, chickens, bee hives, backyard gardens, and farmers' fields, all of which are readily available in our communities. In the North Continental Divide Recovery Area in Montana, bears are frequenting agriculture fields east of the Rocky Mountains, such as the wheat field pictured in Attachment 3.

C. Kasworm, Wayne, *2012: Autumn Cabinet-Yaak Ecosystem Report*

In this study, Kasworm tracked transplanted bears in the Cabinet-Yaak recovery area to learn their behavior once moved from their native home. Transplanted grizzly bear #725 traveled 115 miles back and forth from where it was trapped. (Attachment 4) Of the 14 grizzly bears transplanted, 5 grizzly bears left the area and travelled 82 miles back to their original home range, and 4 grizzly bears died within a year (2 shot in self-defense, 1 killed by a train, and 1 died naturally). (Attachment 5)

The grizzly bear named "Ethyl," moved 175 miles east and west, and 155 miles north and south over a three-year period after being trapped and transplanted into the Cabinet -Yaak Recovery Zone. (Attachment 6)

Considering that the agencies are studying whether they should transplant 5-7 or 200 bears within the first 25 years of the North Cascades recovery project, you would expect that they would have prepared an analysis in the DEIS that uses these recent studies to predict how far the bears might travel once introduced and what impact this may have on the surrounding communities. However, they have failed to consider this data and therefore failed to make the appropriate analysis. Attached is a map showing where the bears could potentially travel, based on this Kasworm study, once moved into the North Cascades. (Attachment 7)

> Additionally, it is important to note that Washington State code bars bringing grizzly bears into the state. Revised Code of Washington77.12.035 states:
>
> *"The commission shall protect grizzly bears and develop management programs on publicly owned lands that will encourage the natural regeneration of grizzly bears in areas with suitable habitat. Grizzly bears shall not be transplanted or introduced into the state. Only grizzly bears that are native to Washington state may be utilized by the department for management programs. The department is directed to fully participate in all discussions and negotiations with federal and state agencies relating to grizzly bear management and shall fully communicate, support, and implement the policies of this section."*
>
> This provision was enacted to protect the health, safety, and welfare of the residents, and is certainly more in line with current science today than the Federal Agencies Grizzly Bear Recovery Plan.

Any plan to reestablish grizzly bears in the North Cascades should consider the new and superior science regarding bear behavior in other recovery areas. Substantial amounts of public funding are being spent on monitoring these areas so that we can make better decisions. Our communities will be directly impacted by these decisions and we insist that the best available science be used to guide these decisions.

II. Failure to Coordinate EIS with Counties and Consider Significant Local Impacts.

When requesting the April 24th coordination meeting with the U.S. Fish and Wildlife Service and National Park Service, we noted the DEIS had failed to consider our plans, policies and programs when developing the analysis. In response, the agencies asked us to identify the conflicts with their proposed plan.

The responsibility to identify potential conflicts and restrictions with local plans should have been carried out by the agencies early in the process. One of the first tasks they should have undertaken was to consider the current and future plans of the Counties and how their proposal would impact these plans. They should have familiarized themselves with our Comprehensive Plans, and explained in the DEIS how they would resolve conflicts as well as carry forward an alternative that agreed with our local position.[1] The DEIS makes no mention of our plans.

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[1] See 40 C.F.R §1501.1(c) "Study, develop and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources as provided by section 102(2)(E) of the Act;"

See also 40 C.F.R. §1502.16, "It shall include discussions of: (c) Possible conflicts between the proposed action and the objectives of Federal, regional, State and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned;" and,

See 40 C.F.R. § 1506.2(d) "To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law."

To request of us, after the DEIS and the action alternatives had been developed, to identify the conflicts for them, was too late in the process to be meaningful. It is why we requested that they either prepare a Supplemental EIS, or start the process over, this time considering our plans and policies at the beginning of the study where we could help shape an alternative that would be good for the bears and our community.

It is important to recognize that our Comprehensive Plans serve a necessary purpose. We are charged with the responsibility to plan for the current and future prosperity of our communities, as directed by the Washington State Code for County Comprehensive Plans:

> *"The purpose and intent of this chapter is to provide the authority for, and the procedures to be followed in, guiding and regulating the physical development of a county or region through correlating both public and private projects and coordinating their execution with respect to all subject matters utilized in developing and servicing land, all to the end of assuring the highest standards of environment for living, and the operation of commerce, industry, agriculture and recreation, and assuring maximum economies and conserving the highest degree of public health, safety, morals and welfare."* (Washington State Code, RCW 36.70.010, County Comprehensive Plans)

The Fish and Wildlife Service and the National Park Service are charged with managing the bears and the habitat; however, we are required to protect the health, safety and welfare of the residents. These two planning positions must be harmonized, which is why Congress directed federal agencies to coordinate their planning processes with local governments.[2]

Five Counties will be impacted by the introduction of the grizzly bear. The plans and policies of all five of these Counties should have been considered and the conflicts with the federal proposal resolved before the DEIS was published. While the DEIS makes mention of some of these concerns, there is no real discussion or understanding presented in the analysis that accurately reflects how our economies function and what industries provide the revenue sources that allow us to pay for our schools, police, fire departments and infrastructure. As a result, critical information is missing from the analysis.

Following are some key facts and conflicts absent from the analysis:

A. The DEIS states that grizzly bears share the same habitat as black bears. Black bears frequently forage in the populated areas of the North Cascades. Based on these known facts, there should be an analysis in the DEIS projecting the number of encounters and fatalities expected between grizzly bears and humans. This analysis should provide the projected number for each of the three action alternatives throughout the 100-year project

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[2] 43 U.S.C. §4331(a) "it is the continuing policy of the Federal Government, *in cooperation with State and local governments*, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, *in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans*. (b) In order to carry out the policy set forth in this Act, *it is the continuing responsibility of the Federal Government to use all practicable means*, consistent with other essential considerations of national policy, *to improve and coordinate Federal plans*, functions, programs, and resources to the end that the Nation may —"

timespan. It should also incorporate the projected population increases. For instance, Snohomish County expects 200,000 new residents during the next 10 years. The number of grizzly-caused human fatalities, maulings, and bears killed by the Service found dangerous in other recovery zones, should also be reported and used in the analysis. The public should be apprised of these facts. Instead, the DEIS uses the example of Yellowstone National Park, where the bear – visitor experience is contained, and not at all comparable to how backcountry visitors use the North Cascades. Attached is a list of known fatalities for all the recovery zones, Canada and Alaska in recent history. This should be reported in the DEIS. (Attachment 8)

B. The North Cascades are a popular backcountry hiking and hunting recreational area in part because the area is easily accessible and uniquely suited to the recreational community. The Methow Valley hosts the largest contiguous trail system in North America. People can roam freely and safely in a way that is unlike any other outdoor recreational experience. The DEIS provides a map of the numerous campsites throughout the area that are frequently occupied, and estimates there are 8 million recreation visitor days per year. (Attachment 9) The introduction of a predator, such as the grizzly bear, will change this experience. While the DEIS states that those who do not feel safe will be replaced by those anxious to view a grizzly bear, we find no basis for this position cited in the analysis.

C. Agriculture is a strong economic engine for our Counties. We have robust livestock grazing, timber harvest, fruit orchards, cultivated crops, and flower bulb production, among other key industries. Based on the recent studies not analyzed in the DEIS, we can expect grizzly bears to spend most of their time in these areas, especially during the fall harvest periods when the bears are eating large quantities of food to prepare for hibernation. Even though there is reliable evidence confirming that the bears will spend most of their time foraging in these areas, there is no discussion or analysis of the impact this will have on these industries. Crops will be damaged, products lost and bear-human encounters increased. The lifestyles of the people who live and work in these rural agriculture areas will change. Again, the DEIS fails to consider and analyze these impacts.

Regardless of whether the grizzly bear's territory once included the North Cascades, the DEIS fails to consider that today, the area is not suitable habitat for the bear. The new normal for this area is that it is contiguous with large urban areas, is host to robust and necessary agriculture industries that attract the bears with food supplies, and is populated by hikers and hunters throughout the backcountry.

During the past seven years in the Montana and Wyoming recovery zones alone, there have been seven human fatalities caused by grizzly bears. The fact is that one human fatality is too many for our Counties to accept, and the agencies have not done a sufficient job reporting and analyzing these facts in the DEIS.

Currently, there is no alternative being carried forward that manages the bear in such a way that prevents them from entering our populated areas and keeps our residents safe. Additionally, all the action alternatives harm our recreation and agriculture industries, which are the backbone of our economy. Therefore, every action alternative being advanced conflicts with our Comprehensive plans.

III. Failure to Develop a Sufficient Draft Environmental Impact Statement.

Along with failing to consider recent grizzly bear studies, failing to coordinate with our Counties and prepare an alternative that resolves the conflicts with our Comprehensive plans, and failing to properly discuss and analyze the impacts to our local communities, there are other significant problems with the DEIS. Notably, the Purpose and Needs Statement is improperly narrowed and the range of alternatives is extremely limited.

A. The Purpose and Needs Statement for the North Cascades Grizzly Bear Recovery Plan EIS is Improperly Narrowed.

The Purpose and Needs Statement reads as follows:

> *"The purpose of this draft plan/EIS is to determine* ***<u>how</u>*** *to restore the grizzly bear to the NCE, a portion of its historical range. Grizzly bears in the NCE are at risk of local extinction. As a result, the proposed action is necessary to accomplish the following:*
>
> - *Avoid the permanent loss of grizzly bears in the NCE.*
> - *Contribute to the restoration of biodiversity of the ecosystem for the benefit and enjoyment of present and future generations of people.*
> - *Enhance the probability of long-term survival of grizzly bears in the NCE and thereby contribute to overall grizzly bear recovery.*
> - *Support the recovery of the grizzly bear to the point where it can be removed from the federal list of threatened and endangered wildlife species."*
>
> (Draft Grizzly Bear North Cascades Recovery Plan / Environmental Impact Statement, Executive Summary page ii) (Emphasis added)

This statement makes several assumptions based on the old science. Considering what we now know about the grizzly bear, the question that should be asked is not "how" to recover the grizzly bear in the North Cascades, but "whether" the grizzly bear should be recovered here.

The last sighting of a grizzly bear was in 1996 even though considerable resources have been expended on efforts to find a bear in the area. The 2009-2014 Five Year Work Plan / Accomplishments by the North Cascades Management Subcommittee of the Interagency Grizzly Bear Committee, reports that it conducted a three-year survey in approximately 23% of the backcountry ecosystem for grizzly bears, which included the North Cascades. The study took baited hair samples from 604 sites and detected 619 individual black bears, but detected no grizzly bears. Remote cameras were set at 40% of the sampling sites for 4,585 camera nights, again with no grizzly bears detected. The report states that the "Total cost of the 2010-2012 project (which was targeting grizzly bears) was $320,000." We have been looking for the bear in the North Cascades, but we have found none.

This recent evidence leads to the conclusion that the grizzly does not reside in the North Cascades, and the historical evidence that this was ever a permanent home base for grizzly bears is weak. Nevertheless, as stated above, the new normal for this area is that this is where people live, work and play. Humans are a prevalent part of this ecosystem today. For these reasons, the Purpose and Needs Statement should be reframed to analyze "whether" the bear should be returned to this area, instead of "how" quickly to transplant bears into this area.

B. The Range of Action Alternatives Advanced in the DEIS is not distinct.

The Council on Environmental Quality regulations implementing the NEPA process instructs the agencies to develop alternatives that are distinct, providing a clear choice between the different alternatives.

> *"This section is the heart of the environmental impact statement. Based on the information and analysis presented in the sections on the Affected Environment (Sec. 1502.15) and the Environmental Consequences (Sec. 1502.16), it should present the environmental impacts of the proposal and the alternatives in comparative form, thus sharply defining the issues and providing a clear basis for choice among options by the decision maker and the public."* (43 CFR 1502.14)

The North Cascades Grizzly Bear Draft EIS considers four alternatives:

- Alternative A – "No Action," would continue existing management actions.
- Alternative B – "Ecosystem Evaluation," would release up to 10 grizzly bears over the first two years and monitor the bears to inform future releases.
- Alternative C – "Incremental Restoration," would release up to 5-7 grizzly bears per year for 5-10 years to achieve an initial population of 25 bears.
- Alternative D – "Expedited Restoration," would release bears similar to the rate of Alternative C, but over a longer period of time until 200 bears are on the landscape.

All three of the action alternatives (B-D) have the goal of establishing 200 bears in the North Cascades system using similar protocols. The only "choice" for decision makers and the public to consider is how quickly the 200-bear unit goal will be met: 25 or 100 years. Table 2: Summary of Action Alternative Elements in the Draft EIS, illustrate the few differences between the three action alternatives. (Attachment 10)

This does not meet the spirit or plain language of the law. In fact, it makes the entire NEPA process meaningless. The agencies are writing an environmental analysis in such a way as to only allow one outcome: the reintroduction of the grizzly bears into the North Cascades. This on its face violates the law and is justification for rescinding this study.

Conclusion:

Critical science has been ignored by the U.S. Fish and Wildlife Service and the National Park Service in their efforts to reestablish grizzly bears in the North Cascades ecoystem. They have also ignored the fact that the new normal for this area is one where humans are ever present on the landscape, whether it be in the remote regions camping, hiking, raising livestock and harvesting timber, or in the productive valleys producing fruits, flower bulbs and other crops attractive to bears, or on the edges where we have robust urban areas and industries. Our plans and policies protect all these activities and the people, which the agencies have failed to consider. As a result, they have missed properly analyzing the harm that will come to our communities and residents if grizzly bears are transplanted into the North Cascades.

The productive uses of these lands will attract grizzly bears into the populated areas and significant human-grizzly bear conflicts will occur. Additionally, there is no discussion in the DEIS as to whether establishing a population of grizzly bears in this area is essential to the continued survival of the species.

We respectfully request that you rescind the current environmental study for the North Cascades Grizzly Bear Reintroduction Plan, and update the 1993 Recovery Plan incorporating the current science to determine whether the North Cascades is essential to the recovery of the bear. Our review of the current science has led us to conclude that the North Cascades is not an appropriate area to reestablish the grizzly bear. The DEIS's conclusion otherwise has been reached by improperly narrowing the alternatives and skipping over the most critical question of all: "whether" the grizzly bear should be transplanted into our communities.

Attachment 1

MOVEMENTS AND HABITAT-USE OF GRIZZLY BEARS ALONG U.S. HIGHWAY 2 IN NORTHWESTERN MONTANA 1998–2001

by

John Steven Waller

B.S. University of Montana, 1987

M.S. Montana State University, 1992

Presented in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

The University of Montana

May 2005

Approved by:

Christopher Servheen
Committee Chair

Dean, Graduate School

Date

Waller, John S. Ph.D., May 2005 Fish and Wildlife Biology

Movements and Habitat-Use of Grizzly Bears along U.S. Highway 2 in Northwestern Montana, 1998-2001.

Committee Chair: Dr. Christopher Servheen

Highways and railroads are suspected agents of population and habitat fragmentation worldwide. Animal movement and habitat selection studies are evolving rapidly thanks to collar-borne global positioning system (GPS) receivers and advances in statistics. I used these new technologies to investigate how U.S. Highway 2 (US-2) affects movements and habitat use of grizzly bears (*Ursus arctos*), examine fine-scale movement patterns, and compare habitat selection and home range estimation based on GPS telemetry and aerial very high frequency (VHF) telemetry. I discuss my findings relative to grizzly bear management.

I found that bears crossed highways, but that crossing frequency was negatively related to traffic volume; most crossings occurred at night when highway traffic was least and railroad traffic highest, and that grizzly bears avoided areas near highways. I projected that US-2 could become a barrier to bear movement in ~ 30 years.

Using GPS telemetry, I found that adult females moved most and adult males least. Habitat use was not related to residence time, path tortuosity, and directional persistence, and was not unequivocally related to human development. Habitat selection rankings stabilized at 8 telemetry locations/day. Habitat selection rankings and home ranges based on VHF telemetry were different than those based on GPS telemetry for some bears. Although VHF telemetry evenly sampled kernel home range isopleths constructed from GPS data, home ranges based on VHF data missed areas with concentrations of GPS telemetry points. Kernel home range size declined as GPS sampling intensity increased. All individuals showed selection among habitats and high concordance among sampling intensities within habitats. Selection strength declined as sampling intensity increased, but strongly selected habitats remained so across most GPS sampling intensities. I found no relationship between grizzly bear GPS telemetry points or movement paths and scored human impact categories within a model of predicted linkage areas. The shape of the distribution of habitat selection values among grizzly bear GPS telemetry points, as predicted by a previously constructed model, closely matched the distributional shape of values across our study area, although the mean value of GPS points was higher than the study area average.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Federal Highways Administration (FHWA) and the U.S. Fish and Wildlife Service. The success of this project, from concept to completion, is due to the efforts of many people. These include Paul Garrett of the FHWA, Dan Carney and Gayle Skunkcap of the Blackfeet Indian Nation, Layne Ross, Randy Wolff and Jim Molenda of the Burlington Northern-Santa Fe Railroad, Mark Traxler and Tom Bengston of the Montana Department of Transportation, Tim Manley and Erik Wenum of Montana Fish, Wildlife and Parks, Dave Hoerner of Red Eagle Aviation, Don Godtel of the Lewis and Clark National Forest, Kathy Barbeletos, Kathy Ake, Jeff Jones, and Jimmy de Herrera of the Flathead National Forest, Tom Radandt and Harry Carriles of the U.S. Fish and Wildlife Service, Leo Marnell, Jack Potter and Steve Frye of Glacier National Park, Jim Stewart of the Rising Wolf Ranch, and Brian Pilcher, Andrea Easter-Pilcher, Terence McClelland, and Tabitha Graves. I thank my committee members for their insight and patience: Fred Allendorf, Mark Boyce, Les Marcum, Dan Pletscher, and Jack Ward Thomas. I especially thank Chris Servheen, who made it all possible. I would never have been able to complete this project without the love and support of my wife, Amy Johnston Waller, who carried the load of raising 2 children and running a farm and household during my extended absences and during my long nights preparing these pages. I also appreciate the patience of my children, Scott and Linda, who remind me that we've got some catching up to do now.

Finally, I dedicate this work to mentor and friend, Bart Schleyer. Although our paths diverged years ago, he left a profound impression on me, and taught me much about grizzly bears. The newspapers reported that Bart died in the Yukon in the fall of 2004 of unknown causes, but I know that free spirits never die. Perhaps we will meet again.

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INTRODUCTION

BACKGROUND

The grizzly, or brown bear, the most widely distributed of eight recognized species of bear, ranges across Europe, Asia, and North America. Expanding human populations have severely reduced many grizzly bear populations, particularly in the southern portions of its range. In the coterminous United States (henceforth termed US), the grizzly bear was once common from the 95th meridian west to the Pacific coast, and from the 49th parallel south to the present-day border with Mexico (Rausch 1963).

Grizzly bear populations in the US experienced dramatic reductions due to the redistribution and expansion of human populations that occurred between 1850 and 1950. Grizzly bears were indiscriminately killed for sport, out of fear and ignorance, and because of perceived competition for resources. The grizzly bear was extirpated from 98% of its former range in the US by 1975 (Servheen 1999). Increasing public concern over the fate of the grizzly bear resulted in its listing as threatened under the Endangered Species Act of 1973.

The once large, probably continuous population of grizzly bears that inhabited the western US has been fragmented, as has its habitat. Grizzly bears in the US now occur in 5 populations: the Yellowstone Ecosystem of Idaho, Montana, and Wyoming; the Northern Continental Divide Ecosystem of Montana (NCDE); the Cabinet/Yaak Ecosystem of Montana; the Selkirks Ecosystem of northern Idaho; and the Northern Cascades Ecosystem of Washington (Servheen 1990). Habitat fragmentation is the separation of previously continuous blocks of habitat into one or more disconnected pieces (Forman 1995). Fragmentation is usually accompanied by habitat loss, due to reduction in size of the remaining habitats. Habitat fragmentation frequently results from conversion of land from habitats suitable for occupancy by a species to a state unsuitable for occupancy. A resident population within a habitat subject to fragmentation is consequently split into 2 or more smaller populations if individuals are unable to move between the habitat fragments. These new, smaller populations are more vulnerable to extinction. The consequences of reduced population size, isolation, and subsequent inbreeding and demographic vulnerability have been widely discussed in the scientific literature (Wright 1931, Soule 1980, Gilpin and Soule 1986, Lande 1988, Mills and Smouse 1994, Lande 1995).

Human transportation corridors and their associated developments can cause fragmentation of the habitats of many different species (Garland and Bradley 1984). The negative effects of habitat fragmentation can be partially offset by maintaining connectivity between the fragments (Noss 1987). A sub-population in one habitat fragment, depleted through adverse environmental conditions, catastrophe, or random demographic changes, can be bolstered by immigrants from neighboring sub-populations. Similarly, genetic impoverishment of sub-populations is forestalled through periodic infusion of gametes from neighboring sub-populations.

The Grizzly Bear Recovery Plan recommended establishment and maintenance of linkage zones between these 5 populations (USFWS 1993). Linkage between these populations is important to maintain genetic diversity within each population and to lessen the impacts of demographic and environmental stochasticity (Wilcox 1980).

Linkage zones are usually linear habitats that connect two or more larger blocks of suitable habitat across areas of less suitable habitat. Conservation of linkage zones benefits species if they foster connectivity between patches of suitable habitat. Currently, there is little empirical evidence for the conservation value of linkage zones, especially for those species most likely to benefit from the existence of such zones (Simberloff and Cox 1987, Simberloff et al. 1992). Beier and Noss (1998) described the difficulties of conducting replicated, randomized studies of movement through linkage zones at landscape scales, but suggested that valuable information can be obtained by using well designed observational studies. The first step is to understand actual animal movement patterns within and between patches and through linkage zones.

Recent advances in telemetry, such as GPS, and in statistical methods such as non-linear multivariate regression have opened new research opportunities. These include developing new approaches to solving old problems, like estimating home ranges and habitat use, as well as asking new questions about how animals and their environment interact.

RESEARCH OPPORTUNITIES

Transportation corridors currently bisect all 5 occupied grizzly bear ecosystems. The negative effects of transportation corridors and high-speed highways in particular, have been widely discussed in the scientific literature. Most of the literature concerns ungulate mortality (Bashore and Tzilkowski 1985, Gleason and Jenks 1993, Bruinderink and Hazebroek 1996, Romin and Bissonette 1996a, b); however, Florida panther mortality and habitat fragmentation has also been documented (Belden and Hagedorn 1993). The effects of highways on distribution and demographics have been investigated for woodchucks (Woodward 1990), sandhill cranes (Dwyer and Tanner 1992), ravens and red-tailed hawks (Knight and Kawashima 1993), and passerines (Reijnen and Foppen 1994). Indeed, the effects of highways on wildlife mortality have been noted for over 80 years (Stoner 1925). However, their effects on grizzly bears have only recently been investigated (Kaczensky et al. 2003, Chruszcz et al. 2003). Previous research on the effects of roads on grizzly bears has been largely confined to tertiary and/or unimproved road systems occurring within managed forests (Archibald et al. 1987, Mattson et al. 1987, McLellan and Shackleton 1988, Kasworm and Manley 1990, Mace et al. 1996) or within national parks (Mattson et al. 1987). All these studies, without exception, have shown that resident grizzly bears are displaced to varying degrees by roads. High-speed highways and developed transportation corridors also appear to have negative impacts (Kaczensky et al. 2003, Chruszcz et al. 2003).

Previous research into grizzly bear/road interactions required extremely large telemetry sample sizes distributed across broad geographic areas to reach conclusions with confidence. In past research efforts, conclusions concerning specific road segments, and movement patterns within the influence zones of specific road segments, have been limited by existing radio-telemetry technology. Close ground tracking of radio-instrumented grizzly bears is limited by the rugged topography in which they live. Close aerial tracking is limited by frequent periods of inclement weather, restriction to daylight hours, and the high monetary cost of flight time. Further, intensive aerial telemetry in mountainous terrain is inherently dangerous to the researchers involved. The recent development of Global Positioning System (GPS) technology and its incorporation into wildlife telemetry collar systems offers the opportunity to overcome these obstacles.

Frequent and accurate positions of instrumented grizzly bears can now be obtained day and night and in any weather. Accurate GPS locations, combined with a computer geographic information system (GIS), allows detailed analyses of the effects of specific road segments on grizzly bears.

Traditional analyses of grizzly bear habitat use have been based on aerial telemetry conducted once or twice per week; this is the favored method for most habitat studies of medium to large vertebrates in remote areas (White and Garrott 1990). Locations collected during aerial telemetry flights are often treated as random samples of habitat use. These are compared to habitat availability, using a variety of methods (Alldredge and Ratti 1986, White and Garrott 1990, Manly et al. 1993), to determine the preference or avoidance of particular habitats.

However, methods using aerial telemetry all rely on infrequent and non-random samples of habitat use. The samples are usually biased towards those times most conducive to aerial telemetry, e.g. early mornings on calm days. Although grizzly bears generally exhibit crepuscular activity patterns in areas far from frequent human disturbance, they will adjust their activity patterns to minimize conflict with humans where disturbance is more frequent (Aune and Kasworm 1989, Gunther 1991, McCann 1991, Wenum 1998). In these instances, diurnal aerial telemetry schedules provide little information on what may be important periods of habitat selection (Waller 1999). Furthermore, habitat use data accumulate slowly with twice weekly telemetry schedules. After long periods of continued aerial telemetry, sample sizes are often insufficient to examine habitat use patterns at spatial or temporal scales relevant to many questions of interest.

Until the development of GPS collar systems, our ability to describe grizzly bear habitat-use has been limited by our inability to track them closely. With improved satellite imagery and aerial photography, we can describe the grizzly bear environment in great detail, yet we have been forced to generalize this detail due to low VHF telemetry accuracy and sample size. Thus, our study of scale dependent processes was limited by our telemetry.

Now, GPS data can be considered a closely fitted movement vector through space and time (Aebischer et al. 1994). However, closely spaced telemetry locations result in a high degree of correlation and lack of statistical independence. The effects of autocorrelation on home range estimators and habitat-use analysis have been the subject of confusion within the literature. White and Garrott (1990) caution against using autocorrelated data based on the simulations of Swihart and Slade (1985). However, more recent investigations suggest that autocorrelation does not necessarily invalidate many commonly used home range estimators (Swihart and Slade 1997, Otis and White 1999). This confusion extends to analyses of habitat use and availability. Defining habitat availability has always been problematic (White and Garrott 1990). Home range polygons or a study area defined *a priori* have often been used as bounds to the availability of habitats. However, the results of the analysis (in terms of more or less selected habitats) will hinge heavily on how availability is defined. Burt (1943) defined home range as that area traversed by the individual in its normal activities of food gathering, mating and caring for young. Applications of Burt's method for estimating home range, as well as methods that followed (Jennrich and Turner 1969, Dixon and Chapman 1980, Samuel and Garton 1985, Worton 1987), used telemetry locations to estimate this area. With 1-hour GPS data, such estimation is no longer necessary. The GPS collar has explicitly described "that area traversed by the individual in its normal activities of food gathering, mating and caring for young" during the sampling period. What will be necessary is quantification of individual home range for periods greater than the GPS sampling period. As GPS technology becomes more common, questions concerning autocorrelation will need to be resolved, and new home range estimators and habitat-use analyses will need to be developed.

Current management direction for grizzly bears on public lands is specified in the Interagency Grizzly Bear Guidelines (IGBC 1986), an interagency policy document. The document designates 3 management situations. Management situation 1 (MS-1) refers to areas containing grizzly bear population centers and habitat components needed for the survival and recovery of the species. In these areas, grizzly bear habitat maintenance and grizzly-human conflict minimization receive the highest management priority. Grizzly-human conflicts are generally resolved in favor of grizzly bears. Management situation 2 (MS-2) refers to areas lacking distinct population centers, areas lacking important habitat resources, or areas of unknown status but where grizzly bears occasionally occur. Management direction for situation 2 specifies that the needs of grizzly bears be considered, but not necessarily take precedence over other land uses. Management situation 3 (MS-3) refers to areas where grizzly bears may be infrequently present. It includes areas where human developments make grizzly bear presence untenable. Management direction is that grizzly bear habitat needs are not considered. Grizzly bear presence and factors contributing to their presence will be actively discouraged. Any grizzly bear frequenting an area in MS-3 will be controlled by relocation or removal.

The boundaries of each of these 3 management situations were drawn by land managers having jurisdiction over portions of designated grizzly bear recovery areas. As such, boundary designations were often politically, not biologically motivated. Grizzly bears that become a nuisance under IGBC guidelines are invariably relocated to pre-approved release sites in MS-1 habitats. Further, grizzly bears frequenting MS-3 or private lands are often preemptively relocated to MS-1 habitats to protect them from illegal killing, habituation, or food conditioning. This policy effectively limits grizzly bears to predefined recovery areas. The adequacy of existing recovery areas for maintaining a viable grizzly bear population into the future has been a subject of considerable debate (Metzgar and Bader 1992, Mattson and Craighead 1994, Mattson et al. 1996, Craighead 1998). However, by collecting intensive movement data on bears that successfully live on private and/or MS-3 lands we may learn which factors contribute to the minimum security thresholds necessary to maintain sink populations. In this manner, linkage can be maintained between grizzly bear recovery areas and further the prospects for grizzly bear recovery by increasing the amount of occupied habitat.

RESEARCH APPROACH

Anecdotal observations (T. Manley, MFWP, pers. comm.) and preliminary data collected within the US-2 corridor between Essex and East Glacier during 1998 (J. Waller, unpublished data), suggested that resident grizzly bears did cross US-2, and perhaps at specific locations. Reasonably good access and limited levels of development made this a logical place to conduct this research.

I attempted to capture a representative sample of bears by placing traps equidistantly along the highway corridor. Captured adult grizzly bears were fitted with a GPS collar that collected 24 locations/day. With the cooperation of the Montana Department of Transportation and Burlington Northern Railroad, I installed traffic counters that measured hourly and daily traffic levels. I then used a variety of methods to examine the temporal and spatial relationships between bear locations and their relationship to the highway and traffic volume.

My project had 3 main objectives. The primary objective was to assess the effects of a 2-lane interstate highway (US-2) on resident grizzly bear movements and habitat use. Specifically, I wished to learn if resident grizzly bears used discrete crossing areas to traverse US-2, or if they crossed at random locations. If crossings did occur repeatedly at specific locations, did these locations differ from non-crossing areas in a measurable way? I also investigated if there were temporal patterns to crossings, and if they were related to patterns in highway or railroad traffic levels. A related question I addressed is whether or not resident grizzly bears actively avoided areas near the highway or corridor; e.g. were their movements biased away from the highway; what was the nature and extent of the bias; and did this bias result in displacement from preferred foraging sites? These questions address the immediate effects of the highway on grizzly bear movements and allow us to assess the extent to which highways fragment grizzly bear populations or displace them from important habitats. In Chapter 1, I attempt to answer these questions and provide insights as how the answers may help mitigate negative effects.

The second objective was to investigate how GPS technology increased our understanding of bear habitat-use patterns; if current methods of measuring home range and habitat selectivity could incorporate fine scale GPS telemetry data; and if this technology could improve our ability to recognize appropriate analytical scales.

Chapter 2 presents my attempt to apply new approaches to analyze the movement and habitat-use of grizzly bears based on fine-scale GPS telemetry. I organized the large volume of location data into logical categories of movement and non-movement, termed traveling and resting. Such treatment is essential to interpret the data due to its inherent autocorrelation. I specifically examined if there were relationships between movement metrics, such as residence time and tortuosity, and habitat and human development metrics, such as road density.

In Chapter 3, I used the GPS telemetry data to examine how sampling intensity changed the results of traditional habitat use-availability analyses, and how aerial VHF telemetry compared to GPS telemetry. Specifically, I examined if aerial VHF telemetry provided a robust estimate of habitat-use as determined from finer scale GPS telemetry. I used aerial VHF telemetry data, (collected concurrently with GPS data), to develop a use-availability analysis and compared it to one developed from GPS telemetry. Thus I was able to evaluate the efficiency and accuracy of traditional aerial VHF telemetry and make recommendations for its improvement. Further, I investigated the effect of autocorrelation on adaptive kernel home range estimators (Worton 1989). I also used the GPS data to assess the predictive capabilities of 2 currently applied grizzly bear habitat models; the linkage zone prediction (LZP) model, and the cumulative effects model (CEM).

The last objective was to examine how effectively current grizzly bear management paradigms fostered grizzly bear recovery in light of the information obtained during this research. We found that bears could successfully live in valley bottom habitats without conflict with humans, and suggest where management policy can be altered to facilitate this occupancy. Grizzly bear residence times, movement rates, reproductive success, and mortality within valley bottom habitats are interpreted as behavioral adjustments to human occupation. I assess the linkage zone concept and discuss how it works in my study area.

BENEFITS AND SIGNIFICANCE

This study has made significant contributions to the conservation of grizzly bears and the science of conservation biology on several fronts, in that it:

- provided the type of detailed movement data currently lacking in theoretical models of animal movement and dispersal patterns. This is the logical first step in applying diffusion models to empirical observations of real-world phenomenon (Boone and Hunter 1996, Noss et al. 1996).

- provided a referent for discerning the inferential strength of previous grizzly bear research on the impacts of human activity by comparing GPS data sets to concurrent aerial telemetry data sets.

- represented one of the first applications of a technologically advanced GPS telemetry system to a bear population inhabiting rugged, mountainous terrain.

- was one of the first investigation of the effects of a high-speed highway on the detailed temporal and spatial movements of a vertebrate. This is the data required to link landscape patterns to ecosystem and population processes (Kareiva and Wennergren 1995).

- tested a conceptual and analytical framework for analysis of GPS data, which will become increasingly available.

- provided important information to management biologists and highway engineers on the nature of grizzly bear highway crossing patterns and movements within developed corridors. This information will be used to inform planners of the potential value of underpasses, or evaluate the efficacy of alternative strategies to maintain ecosystem connectivity (Beier 1995, Foster and Humphrey 1995, Yanes et al. 1995, Guyot and Clobert 1997).

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CHAPTER 1: EFFECTS OF TRANSPORTATION INFRASTRUCTURE ON GRIZZLY BEARS IN NORTHWESTERN MONTANA

Abstract: Highways and railroads have come under increasing scrutiny as potential agents of population and habitat fragmentation for many mammalian species, including grizzly bears (*Ursus arctos*). Using global positioning system (GPS) technology and aerial very high frequency (VHF) telemetry, I evaluated the nature and extent of trans-highway movements of 42 grizzly bears along the U.S. Highway 2 corridor in northwest Montana 1998–2001, and related them to highway and railroad traffic volumes, and other corridor attributes. I employed highway and railroad traffic counters to continuously monitor traffic volumes. I found that 52% of the sampled population crossed highways at least once during the study, but that crossing frequency was negatively exponentially related to highway traffic volume. I found that grizzly bears strongly avoided areas within 500 m of the highway, and that highway crossing locations were clustered at a spatial scale of 1.5 km. Most highway crossings occurred at night when highway traffic volume was lowest, but when railroad traffic was highest. Highway crossing locations were flatter, closer to cover in open habitat types, and within grassland or deciduous forest vegetation types. Nighttime traffic volumes were low, averaging about 10 vehicles/hr, allowing bears to cross. However, I project that US-2 may become a significant barrier to bear movement in ~ 30 years if the observed trend of increasing traffic volume continues.

INTRODUCTION

The grizzly bear was once common throughout much of the coterminous United States (USA), from the 95th meridian west to the Pacific coast, and from Canada south to the present-day border with Mexico (Rausch 1963). However, expanding human populations severely reduced many grizzly bear populations, particularly in the southern portions of their range (Servheen 1999, Mattson and Merrill 2002). Grizzly bears in the USA now occur in 5 populations within the states of Idaho, Montana, Wyoming, and Washington (Servheen 1990). No natural grizzly bear movement between ecosystems has been documented (Kasworm et al. 1998).

The Grizzly Bear Recovery Plan recommends establishment and maintenance of linkage zones between these ecosystems (USFWS 1993) to maintain genetic diversity within each population and lessen the impacts of demographic and environmental stochasticity (Wilcox 1980).

Highways and/or railroads currently bisect all 5 grizzly bear ecosystems. Negative effects of transportation corridors have been documented for numerous wildlife species (Romin and Bissonette 1996, Woodward 1990, Dwyer and Tanner 1992, Knight and Kawashima 1993, Reijnen and Foppen 1994, Forman et al. 2002, Bhattacharya et al. 2003) and indeed, the negative effects of highways on wildlife have been noted for over 75 years (Stoner 1925). However, data for grizzly bears are limited.

Previous research on the effects of roads on grizzly bears has been largely confined to tertiary and/or unimproved road systems occurring within forests managed for timber harvest (Archibald et al. 1987, McLellan and Shackleton 1988, Kasworm and Manley 1990, Mace et al. 1996) or within national parks (Mattson et al. 1987). All have shown displacement due to roads. Previously published works from 2 areas specifically addressed the impacts of high-volume highways on brown bears. Chruszcz et al. (2003) found that traffic volume affected crossings on high-volume highways in Banff National Park, Alberta, Canada and Kaczensky et al. (2003) found a similar situation in Slovenia.

My objective was to describe the effects of a high-speed highway and its associated transportation corridor on the movement and habitat-use patterns of resident grizzly bears. Specifically, I wished to learn if grizzly bears avoided areas near the highway, if resident grizzly bears used specific crossing areas to traverse highways, and whether these locations differed from non-crossing areas. Further, I wished to learn if any existing temporal patterns of highway crossings were related to highway and railroad traffic levels.

STUDY AREA

My 2730 km^2 study area consisted of 4, 5th-order watersheds located along Montana Highway 49 (MT-49) and U.S. Highway 2 (US-2), approximately between Essex and East Glacier, Montana. US-2, the most northern east-west highway in the contiguous US, was a 2-lane highway separating Glacier National Park to the north from the Bob Marshall Wilderness complex to the south. The western portion of the highway lay within the valley bottom of the Middle Fork of the Flathead River and Bear Creek valley until it crossed the Continental Divide at Marias Pass (elevation 1610 m). East of Marias Pass, US-2 dropped into the prairie biome, paralleling the South Fork of the Two Medicine River and crossing the western boundary of the Blackfeet Indian Reservation (BIR).

MT-49 joined US-2 from the north at East Glacier. It was also a paved 2-lane highway, but carried primarily local and tourist traffic. It wound through the Rocky Mountain foothills near the eastern edge of Glacier National Park to its terminus with U.S. Highway 89 at Kiowa Junction, Montana. Only small portions of MT-49 lay within the study area.

A major railroad line paralleled US-2 for its entire length within the study area. This railroad line was a primary freight corridor between Chicago, Illinois, and Seattle, Washington, and was also the primary means of transporting grains from eastern Montana and North Dakota to markets on the west coast.

Small concentrations of homes, businesses, ranches, and small communities existed within the US-2 corridor, but the majority of the area was undeveloped federal land, (36% of the area lay within the boundaries of Glacier National Park). U.S. Forest Service lands were managed primarily for recreation, timber harvest, and grazing. Tribal lands were managed primarily for cattle grazing.

Topography associated with US-2 varied from flat valley bottoms to steep mountainsides. Dominant vegetation was primarily coniferous forest in the western portions of the study area, where a Pacific maritime climate predominated. Open grass/forb/deciduous tree communities were more common in the east where the climate was continental. The collision of these 2 climatic regimes often resulted in unsettled weather conditions. Riparian areas paralleled the highway for much of its length within the study area. Avalanche chutes are preferred grizzly bear foraging areas (Waller and Mace 1997, McLellan and Hovey 2001) and occurred in numerous locations, often close to the highway.

I chose this particular study area for several important attributes. First, grizzly bears occupied areas on both sides of US-2, and anecdotal observations and preliminary data showed that they crossed this portion of US-2. Second, the level of development within the corridor was significant, but not so great as to preclude observations of grizzly bear crossing patterns, and third, I could access areas in which to capture grizzly bears.

METHODS

Capture and Telemetry

To obtain a representative sample of grizzly bears residing within the highway corridor, I placed trap sites equidistantly as possible along both sides of US-2 within the study area. Grizzly bears were captured using Aldridge snares or culvert traps using standard techniques (Johnson and Pelton 1980, Jonkel 1993), or on the BIR, darted from tree stands placed over livestock carcasses (Jonkel 1993). All trapping occurred during the months of June and July 1998–2001. To assess the extent of highway crossing by resident grizzly bears before beginning full field efforts, all grizzly bears captured in 1998 were equipped with a Telonics model 500® VHF telemetry transmitter (Telonics Inc., Mesa, Arizona, USA).

In past research efforts, conclusions concerning specific road segments and their influence zones have been limited by existing radio-telemetry technology. Rugged topography often limited ground tracking and close aerial tracking was limited by frequent periods of inclement weather, restriction to daylight hours, and the high cost of flight time. Further, intensive aerial telemetry in mountainous terrain was inherently dangerous to the researchers involved. Recent incorporation of Global Positioning System (GPS) technology into radio collars offered the opportunity to overcome obstacles inherent to aerial VHF telemetry. Therefore, during 1999 and 2000, captured female grizzly bears weighing ≥ 91 kg were fitted with a Telonics Generation II® store-on-board GPS collar. I felt 91 kg was a minimum size bear for a collar weighing approximately 2 kg. I preferentially collared females because I believed they were more likely to remain near the highway corridor and provide information on highway crossings than were males. During 2001, the final year of fieldwork, I collared both male and female grizzly bears. Grizzly bears weighing < 91 kg were fitted with a VHF ear-tag transmitter (Advanced Telemetry Systems, Inc., Isanti, Minnesota, USA).

GPS collars obtained a position once every hr, 24 hrs per day, and location information was stored within the collar. The GPS collars could obtain either 2D or 3D positions. 2D positions are obtained using only 3 GPS satellites. 3D positions require at least 4 satellites and generally give a more accurate position. I chose the hourly location rate as a reasonable compromise between battery life and spatial specificity. I estimated battery life would be about 120 days, which was sufficient to provide GPS positions between time of trapping and denning. Because the collar needed to be retrieved and downloaded to obtain the accumulated information, all collars were equipped with a VHF beacon and a programmable breakaway device. The VHF beacon operated concurrently with the GPS unit, and through variable pulse rates, provided information about GPS system status and/or animal mortality. I located all transmitters twice-weekly from fixed-wing aircraft, as weather conditions allowed, to keep track of animals and provide timely cause-specific mortality information.

After GPS collars were retrieved and downloaded to a computer, I differentially corrected positions using Trimble Pathfinder Office® (Trimble Navigation Ltd., Sunnyvale, California, USA) and proprietary software developed by Telonics Inc.

Traffic Monitoring

I installed Peek Trafficomp II® pneumatic vehicle counters (Peek Traffic Corp., Palmetto, Florida, USA) on US-2 at each end of the study area (approximately 35 km apart). The counters operated June through mid-October during 1999–2001. I configured the counters to tally the number of vehicles passing over the counter sensors each hr of a 24-hr day in each lane (east and west-bound lanes). Having counters at each end of the study area provided system redundancy should 1 of the counters become inoperative and allowed calculation of local vs. through traffic. Because the counters actually counted axles, I developed a correction factor for multi-axle vehicles by tallying axles and classifying vehicle types during 11 30–60 min observation periods. These actual counts were then compared to those collected by the counter to derive a ratio estimate of the true number of vehicles. I then compared this estimate to the statewide correction factor used by the Montana Department of Transportation (MDOT).

I collected railroad traffic data by downloading automatic train counters through modem access provided by the Burlington-Northern Santa Fe railroad. The counters recorded date, time, direction, length, and speed of all trains crossing the counters. I used counters located just west and east of the study area boundaries. I measured differences in railroad traffic between months and between day and night.

Environmental Variables

Hourly weather data were collected during 1999–2001 from remote weather stations operated by MDOT located just west of the study area at Essex and 50 km southeast of the study area at Pendroy, Montana. The Essex weather data were most representative of weather conditions west of the Continental Divide while the Pendroy weather data were more representative of conditions east of the Continental Divide. Weather data included temperature, wind speed, wind direction, and presence, type, and rate of precipitation.

I grouped all GPS positions into dawn, day, evening, and night categories based upon day length. Dawn and evening were the periods between civil twilight and sunrise or sunset. Civil twilight was the period between sunrise or sunset and when the sun was 6 degrees below the horizon. Day was the period between sunrise and sunset, and night was the period between the end of evening twilight and the beginning of morning twilight. I calculated sunrise, sunset, and twilight periods for East Glacier, Montana using Sun.exe (www.sunrisesunset.com).

I obtained digital cover-type maps from the U.S. Forest Service and imported them into our computerized geographic information system (GIS). The Wildlife Spatial Analysis Lab at the University of Montana produced these maps by classifying Thematic Mapper satellite imagery (Redmond et al. 1998). The Flathead National Forest made further refinements based on potential vegetation types and recent wildfires. The minimum mapping unit for these maps was 2.5 ha. I simplified the map by combining similar vegetation types, thus reducing the number of cover types from 25 to 8. The 8 cover types were rock (barren/non-vegetated), grassland, shrubland, riparian, deciduous forest, mixed forest, conifer forest, and water.

I obtained grizzly bear habitat quality maps from the U.S. Forest Service, constructed during cumulative effects modeling efforts for the Northern Continental Divide Ecosystem (NCDE) (Mace et al. 1999). The habitat quality values were derived from resource selection function models created during an earlier study (Mace et al. 1999). These habitat quality values were most strongly influenced by elevation and greenness. Greenness was a measure of herbaceous phytomass and was strongly related to grizzly bear habitat selection (Mace et al. 1999, Stevens 2002).

I constructed digital maps of US-2 and the railroad within the study area by digitizing these features on U.S. Geological Survey (USGS) orthophoto quadrangles having 1 m resolution. I obtained hydrological and 10 m digital elevation data from the USGS. I represented terrain ruggedness along US-2 by calculating the standard deviation of elevation within a 1 km moving circle. The U.S. Forest Service, as part of its cumulative effects modeling efforts, classified campgrounds, housing, and other types of human developments into low, moderate, or high-impact categories based upon a Delphi consideration of their perceived impacts on grizzly bears. I obtained these digital maps of human impact points from the U.S. Forest Service, and then created maps displaying the distance from each of these development categories. I created a distance-to-cover map by digitizing the border of roadside vegetation from USGS orthophoto quadrangles.

I constructed a road density layer by running a moving circle procedure on digital road maps obtained from U.S. Forest Service and U.S. Census Bureau TIGER files. The moving circle (or focal-sum) process assigned the number of 30 m road cells within a 1 km circle to the center cell. The circle thus moved across the map assigning a value to every cell (Mace et al. 1996). I used ArcView GIS v.3.2 (ESRI Inc., Redlands, California, USA) for all GIS analyses.

Data Analysis

I tabulated observed highway crossing events and examined differences in crossing frequency between sex and age classes, season, and time of day. I regressed crossing frequency on traffic volume and evaluated fit using Kolmogorov-Smirnov and chi-square tests. I compared observed highway crossing frequencies to that expected for each grizzly bear having a GPS collar and that crossed US-2 or MT-49. I calculated expected crossing frequencies by generating 100 random walks within each individual bear's 100% minimum convex polygon (MCP) home range (Serrouya 2000). The random walks used the observed distances between relocations applied in random directions, thus preserving realistic rates of movement. The 100% MCP (Burt 1943) was arbitrarily selected as a reasonable means to limit the random walks to the areas in which the grizzly bears actually lived. I then calculated the mean number of times the random walks crossed US-2 along with the +/- 95% confidence intervals. Observed crossing frequencies outside +/- 95% confidence intervals were considered statistically significant. The home range polygons and random walks were generated using the Animal Movement extension for ArcView GIS (Hooge and Eichenlaub 1997).

I recognized that highway crossing patterns may be proportional to temporal patterns of activity. I compared mean movement distances and rates between highway crossings and non-crossings by individual and tested for significance ($P \leq 0.05$) using the Kruskal-Wallis test (Sokal and Rohlf 1995). I performed this test using mean 24 hr movement rates and mean movement rates calculated for only those hours in which crossings occurred.

To establish a putative distance over which grizzly bears modified their behavior patterns in response to road traffic, I created distance isopleths around US-2 and MT-49 from 0 to 1000 m in 100 m increments. I did not explicitly include the railroad because it generally ran closely parallel with US-2. The mean distance between the railroad and US-2 within the study area was 239 m and ranged from < 30 m to 1.7 km (+/-95% 151–328 m). I assumed that any disturbance associated with the railroad would be additive to that of US-2 and be reflected in isopleth selectivity. The use and availability of each isopleth by each of the 11 GPS-collared grizzly bears that came within 1 km of US-2 or MT-49 was quantified by creating selection ratios (Manly et al. 1993: 65). Selection ratios were combined over all animals for an estimate of the population selection ratio using equation 4.40 from Manly et al. (1993: 65). I estimated the variance of the population selection ratio as recommended by Manly et al. (1993: 38, 67).

I tested the selectivity of individual animals by calculating a chi-square statistic with I-1 degrees of freedom, where I was the number of categories. Overall selection was tested by summing these statistics over all *j* animals and testing with n(I-1) degrees of freedom (Manly et al. 1993; pg. 66). I then identified the putative disturbance zone using a Friedman non-parametric ANOVA on ranks (White and Garrott 1990) followed by post-hoc multiple comparisons (Conover 1980).

To assess the spatial clustering of highway crossing locations or the lack thereof, I modified the method derived by O'Driscoll (1998) and Clevenger et al. (2003). First, I assumed that the crossing location occurred at the intersection of the highway and a line connecting the subsequent locations on either side of the highway. Given that locations were 1 hr apart, I felt confident bears crossed the highway reasonably close to that point.

Using all the *n* intersections as crossing locations, I then calculated the distance between each crossing point *i* and its nearest neighbor *j*, along that portion of the highway where crossings occurred (i.e. the highway segment between the most distant crossing points). The accumulated distances were then binned into arbitrary 1-km distance classes, or scales, ranging from 500 m to 38 km. I then summed the number of nearest-neighbor distances in each bin to yield a form of Ripley's K-statistic (Ripley 1981). Because observations of highway crossings were pooled among individual bears, these statistics reflect the spatial distribution of crossing points of those individuals that crossed highways most often.

To assess significance of the K-statistics, I drew a random sample of points along the highway of size *n,* (simulated crossing locations), and computed K-statistics for each of 100 iterations. Results were displayed as plots of $L(t)$, the observed number of crossings minus the simulated mean, against distance. Values of $L(t) > 0$ indicated clustering and values < 0 indicated dispersion. Values of $L(t)$ outside the upper or lower 95th percentile were deemed significant (O'Driscoll 1998). I then used the scale distance with the first significant level of clustering as the basis for modeling potential crossing areas. This scale distance is referred to as the patch length or maximal cluster scale, and is independent of clustering intensity, represented by the height of the distribution.

Modeling

I used logistic regression to estimate the probability of bears crossing US-2 as a function of landscape factors that I believed might explain the observed clustering of crossing locations. These factors were: distance to water, distance to cover, cover type, change in elevation adjacent to the roadway, road density, distance to low, moderate, or high human impact points, and habitat quality. I tested each factor at both the base map scale (30 m raster map) and at the generalized "maximal cluster" scale identified above. I calculated factor values at the maximal cluster scale by computing the average (for continuous data) or modal (for categorical data) values within a moving circle with diameter equal to the maximal cluster scale. Each factor was tested for univariate significance with unbalanced, 1-way ANOVA (continuous data) or χ^2-tests computed from the marginal frequencies of 2 x *k* contingency tables (categorical data). I tested all factors for multicollinearity prior to logistic regression analysis (Menard 1995). I then included all these factors into a "full" log-linear model. I estimated model parameters using maximum likelihood techniques where the dichotomous response variables were "used" (1) or "available" (0) (Manly et al. 1993). During the moving circle procedure on cover type, the values for the rarest types (rock, riparian, and water) dropped out. I created 0/1 "indicator variables" for each of the 5 remaining cover types. For the categorical variable cover type, mixed forest was held out as the standard indicator variable against which others would vary. I iteratively removed non-significant model parameters based on χ^2-tests of Wald statistics (Hosmer and Lemeshow 1989). I used Akaike Information Criteria (AIC) to select the most parsimonious model describing grizzly bear crossing areas. I then derived 95% confidence intervals for each parameter estimate by creating a separate model for each *n* - 1 sample of individuals (jackknifing). In this manner I was able to assess the influence of individual animals on model stability and variability.

RESULTS

Capture and Telemetry

I captured 43 different grizzly bears in 51 capture events (13 adult males, 11 subadult males, 10 adult females, and 9 subadult females). I deployed 22 VHF radios on 19 individuals (3 individuals had VHF radios replaced) and 23 GPS collars on 23 individuals. Eight individuals fitted with GPS collars were also given VHF ear-tag transmitters to allow relocation after the GPS collar released (Table 1).

I collected 912 aerial telemetry locations in 242 hrs of flight time during 1998–2001, and 20,944 GPS positions during 1999–2001. Four of the 9 GPS collars deployed in 1999 and 2000 functioned properly. One collar failed due to a fault in the antenna power supply and 4 failed to initialize properly. I recovered 10 of 14 GPS collars deployed in 2001, and 2 of the 10 failed prematurely but still provided useable data. Four GPS collars were not recovered due to failure of the automatic release mechanism. Success rate over all hourly GPS position attempts was 72% for 2D and 3D locations combined and 39% for 3D only. Accuracy of differentially corrected locations was expressed as 95% circular-error probable (CEP), which is the distance from the true location encompassing 95% of the positions. CEP was 22.4 m for 3D locations and 67.7 m for 2D locations (Graves 2002).

Traffic Monitoring

Our traffic counters recorded over 6000 hrs of traffic from 1999–2001. During 8.5 hrs of counter testing, the counters accurately recorded the number of axle crossings (+/- 1%) for 1,063 vehicles, but overestimated the number of vehicles because every 2 axles counted as 1 vehicle. The actual number of vehicles was estimated to be 84% of the recorded vehicle counts. MDOT used a standard state-wide 82% correction for principal rural highways.

Traffic patterns on US-2 showed strong daily and seasonal patterns (Fig. 1). Traffic counts peaked during late afternoon then dropped to near 0 during pre-dawn hours. Average bi-directional hourly traffic at the west counter was 77 cars/hr (range 0–318) and mean daily traffic was 1,806 vehicles (range 220–3,338). Counts at the east counter were higher: 87 vehicles/hr (range 0–398) and 2,066 vehicles/day (range 17–4,289). Mean hourly counts by year in a given lane never differed by more than 9 vehicles at either location. Traffic counts peaked during the month of July then decreased monotonically through October. I estimated that approximately 30% of the east-bound and 24% of the west-bound traffic was local.

I collected 4,135 hrs of train counts at the west train counter during 1999–2001 and 1,141 hrs at the east counter during 1999–2000. Work and maintenance trains were generally shorter than 21 cars while freight trains averaged 75 cars. I found that train length (both types included) was consistently higher during early morning and late evening hours than during midday and that rail traffic did not vary substantially between years. Mean bi-directional rail traffic was 1.2 trains/hr and ranged from 0–3.75 trains/hr (Fig. 2). Overall, average rail traffic was slightly higher in October (1.53 trains/hr) than in July-September (1.19–1.34 trains/hr). I also found that rail traffic was higher ($\bar{x}$ = 1.5 trains/hr vs. 1.2 trains/hr) during hours of darkness, particularly the pre-dawn hrs, than during the daylight or evening hrs. Train speed averaged about 56 kph at the west counter, while west-bound speeds at the east counter were slower (40 kph) because of the increasing grade towards Marias pass. Average train speed was greater during pre-dawn hrs and peaked noticeably (~60 kph) at 0800 and 2000 hrs.

Grizzly Bear Movements

I tracked 25 grizzly bears with aerial telemetry and 13 of these crossed US-2 at least once (52%), for a total of 131 crossings (Table 1). I documented 39 crossings of US-2 by 6 of the 14 bears with GPS collars from which I obtained data. Of these 6 individuals, 3 also made an additional 11 crossings of adjacent MT-49. For those bears for which I had concurrent GPS and VHF crossing data, aerial VHF telemetry captured only 7 of 33 crossings (21%). Based on GPS data, subadult females and subadult males crossed highways the most (23 and 8 days between crossings, respectively), while adult females and adult males crossed the least (61 and 46 days between crossings, respectively). Adult females that crossed highways during monitoring did not do so when accompanied by cubs of the year ($n = 2$), but did so when accompanied by yearlings or 2-year olds ($n = 2$).

All bears with GPS crossing data crossed highways less than expected when compared to random moves of equal length (Table 2). Because US-2 closely paralleled the railroad tracks for most of its length within the study area, in most cases, bears that crossed US-2 also crossed the railroad tracks during the same move (Table 2). One exception, bear m289, frequented a large riparian area between the railroad tracks and highway.

Most (85%) crossings of US-2 were made at night and when highway traffic volumes were low (Fig. 3). Actual mean traffic volume during crossings was 30 vehicles/hr and ranged from 2–98 vehicles/hour (+/- 95% 20–40). Crossing frequency declined exponentially with increasing traffic volume (Fig. 4), and model fit was quite good (Kolmogorov-Smirnov d = 0.112, $P < 0.001$; $\chi^2 = 0.342$, df = 2, $P = 0.843$). All but 1 of the bears with GPS collars showed strong crepuscular activity patterns regardless of their distance from highways. The exception was an adult female (F14) with a diurnal activity pattern that occupied a tightly constricted home range within Glacier National Park. Morning highway crossings occurred before the morning period of peak bear activity, which was 0600–1100 hrs. However, evening highway crossings occurred during the peak of evening bear activity, 1900–2300 hrs (Fig. 5). None of the crossings recorded with GPS occurred during periods of precipitation. However, during 2001, precipitation was recorded on only 7 and 16 days at the Pendroy and Essex weather stations, respectively. There did not appear to be any seasonal patterns of crossing frequency.

Only 4 of the 39 recorded crossings of US-2 were recorded between fixes greater than 1 hr apart. For 4 of 6 GPS marked bears that crossed highways, mean sequential movement distances and movement rates were significantly greater when crossing highways than when not crossing highways. Differences were significant considering both mean 24-hr movements (676 m further and 700 m/hr faster) and movements only during those hours when highway crossings occurred (543 m further and 573 m/hr faster).

Eleven of the 14 GPS-marked bears ventured within 1 km of US-2 or MT-49. Based on their selection ratio statistics, most were highly selective of distance isopleths (Table 3). However, 1 individual (m289) was unique in having selectivity for isopleths closer to highways. This subadult male spent large amounts of time within a riparian area close to US-2. The variability introduced by this animal resulted in the Friedman

ANOVA failing to detect selectivity ($P = 0.370$). With m289 excluded, ANOVA results were significant ($P = 0.034$). I observed increasing selectivity for distance isopleths to an apparent asymptote within the 500–600 m category (Fig. 6). Based on post hoc multiple comparisons, inspection of the matrix of rank differences between isopleths, and groupings of similar categories based on significant differences, I chose distance isopleths 1–5 (0–500 m) as the disturbance area surrounding the highway and railroad.

Most (64%) of the observed crossings of US-2 were made by 2 subadult bears, f37 and m289. These crossings of US-2, when pooled with those of 4 other GPS-marked bears, were significantly clustered out to a scale distance of nearly 9 km, with an exception at the 3–4 km bin. Crossings were significantly dispersed at scales from 15 km to 26 km (Fig. 7). The strongest clustering was observed at the 1–2 and 5–6 km scales. Although the clustering intensity was somewhat higher at the 5–6 km scale, I selected the 1–2 km scale for modeling in order to maximize spatial specificity and because the first significant cluster represents the patch length (O'Driscoll 1998). As a result, I used a moving circle radius of 750 m (1/2 patch length) to calculate maximal cluster values in the habitat models.

Modeling

In univariate tests, all factors, except distance to cover, attained statistical significance ($P \leq 0.05$) at either the base scale or maximal cluster scale. Significance levels were at least as great at the maximal cluster scale. The only categorical factor, cover type, was also significant at both scales. All but the conifer forest cover type contributed significantly to the total chi-square. I found no significant multicollinearity among the factors ($r \leq 0.51$).

The full model was significant, but contained many non-significant terms and unstable standard errors ($-2LL = 279.40$, $\chi^2 = 53.15$, df = 12, $P \leq 0.001$, AIC = 305.40). The low, moderate, and high point distance terms dropped out of the full model, as did distance to water, road density and habitat quality. Our final, most parsimonious model ($-2LL = 287.92$, $\chi^2 = 44.58$, df = 6, $P \leq 0.001$, AIC = 301.92) consisted of only 3 parameters: elevation SD, distance-to-cover, and cover type (Table 4). Distance-to-cover assumed significance in multivariate models because of its interaction with cover type. Crossing areas in grassland or shrub cover types were significantly closer to cover than crossing areas in forested cover types. Based on the sign and strength of parameter estimates, crossing areas used by grizzly bears appeared to be flatter, closer to cover in open cover types, and more likely to be within grassland cover types (Table 4). Thirty-eight percent of the observed crossings of US-2 were made by m289, so as expected, this individual had the largest effect on model parameter estimates. Exclusion of this individual resulted in a much higher attraction for grassland, shrubland, and conifer habitats and strong avoidance of the deciduous forest cover type, relative to the mixed-forest cover type.

DISCUSSION

Grizzly bear crossings were relatively frequent and successful; nearly half of our sampled population successfully traversed US-2. However, I also presented evidence that US-2 impeded movement. All study animals crossed US-2 significantly less than expected under a random movement hypothesis, and crossed more often at night, even when outside their normal periods of activity. And when they did cross, they moved farther and faster than normal. Grizzly bears were apparently choosing to cross when they were less likely to encounter highway traffic. Hourly mean traffic during crossings was nearly half that of normal daytime traffic levels, suggesting a threshold of acceptable traffic level and/or that perceived vulnerability encouraged night crossings. Adult female grizzly bears appeared to be the most sensitive to traffic, especially when accompanied by cubs, whereas subadults and males appeared the least sensitive. This finding somewhat contradicts that of Chruszcz et al. (2003) who found that adult males were less likely to cross low-volume highways than females.

Chruszcz et al. (2003) found that traffic volume was the single greatest determinant of road crossings, and that grizzly bears crossed roads with high traffic volume less frequently. It is difficult to compare my study to that by Chruszcz et al. (2003) because of fundamental differences in methodology. However, they observed that only 11 individuals of 74 crossed the Trans-Canada highway during 12 years of research. Gibeau (2000) observed that traffic volumes on the Trans-Canada highway in Banff National Park can exceed 20,000 vehicles/day, but did not measure temporal changes in traffic volume. In Slovenia, Kaczensky et al. (2003) found similar effects of a 4-lane highway with an estimated traffic volume of 7,500 vehicles/day. In the US-2 corridor, peak traffic volumes are only a tenth that of the Trans-Canada highway and a fourth that observed in Slovenia.

My study, when considered with the work of Gibeau (2000), Chrusczc et al. (2003), and Kaczensky et al. (2003), suggests the existence of a threshold traffic volume beyond which highways become significant barriers to grizzly bear movement. I hypothesize that this threshold occurs near 100 vehicles/hr (Fig. 4). I believe that connectivity was maintained across US-2 because hourly traffic volumes decreased dramatically at night, sometimes reaching 0 vehicles/hr.

In my study area, grizzly bears had to contend with both a highway and a railroad. While grizzly bears appeared to make behavioral adjustments to temporal patterns of highway traffic volume, they were faced with a different situation along the railroad. During hours of low highway traffic, when grizzly bears were choosing to cross US-2, railroad traffic was high. Trains were more frequent, longer, and faster at night than during daylight hours. Furthermore, rail traffic was greater during fall when bears were in hyperphagia. This situation has arisen for a number of reasons. First, most track maintenance work is accomplished during daylight hours, thus freight traffic is often curtailed during the day to allow track work to proceed. Second, arrival times for freight trains depend partially on their departure time. Freight trains loaded on the Pacific coast (approximately 800 km to the west) during the day leave in the evening and arrive in our study area at night the next day, 24–36 hrs later. The result is that grizzly bears have to contend with high railroad traffic when highway traffic is lowest. I observed greater grizzly bear mortality caused by trains than that caused by cars on the highway. Between 1980 and 2002, 29 grizzly bears were killed on the 109-km section of railroad track between West Glacier and Browning, Montana, and 23 of these deaths occurred within the study area. During this same time period, 2 grizzly bears were killed by vehicles in the study area (Servheen, unpublished data). During this study, 2 radio-marked grizzly bears were struck and killed by trains and none were killed on the highway within the study area. Historically, grizzly bears have been attracted to the railroad by grain that leaked from cars along the tracks or accumulated at sites of repeated derailments. During the early 1990s many grizzly bears were killed because of this attractant. Since then, BNSF has been largely successful in cleaning-up and reducing the occurrence of grain spills, however, grizzly bears continue to be killed along this section of railroad. Our GPS data did not show any concentrated relocations on the railroad tracks that suggested the presence of an attractant. I suggest that the coincidence of high rail traffic volume, low highway traffic volume, and natural grizzly bear movement patterns may be partially responsible for the observed patterns of mortality.

GPS technology greatly improved our ability to assess the extent of highway crossings by grizzly bears. With traditional bi-weekly aerial telemetry, I missed 79% of the highway crossings. GPS technology also allowed me to examine fine scale avoidance of the highway corridor. Mattson et al. (1987) found avoidance of roads to 500 m for grizzly bears in Yellowstone National Park using aerial relocation data collected between 1974 and 1983. Kasworm and Manley (1990) found road avoidance occurring in a 274–915 m zone in the Cabinet/Yaak ecosystem. Since that time, other authors have used 500 m as an assumed zone of influence (Mace et al. 1996). I also showed avoidance of areas within 500 m of US-2, supporting the contention that 500 m is a representative zone of influence around high-use roads. Conversely, Chruszcz et al. (2003) showed a preference for areas within 1000 m of low-volume highways. However, my findings are based on more intensive telemetry (hourly vs. weekly) on a smaller number of individuals (11 vs. 24) over a shorter period of time (3 yrs vs. 12 yrs), and at a finer scale (100 m vs. 200 m). Furthermore, my analysis does not consider the distribution of habitats within the zones. Changes in topography can drastically alter the distribution of preferred habitats among the zones. Chruszcz et al. (2003) suggested that extreme topography within Banff National Park constricts bears to zones closer to roads than in other areas.

Spatial patterns of highway mortality suggest that many species utilize specific crossing areas and that the use of crossing areas can be expected to change seasonally as resource needs change (Bellis and Graves 1971). One of my goals was to identify crossing areas and describe their attributes. I was able to show that grizzly bear highway crossing locations were spatially clustered, and then model the attributes of these locations. However, I am not convinced that terrain, distance to cover and cover-type are the only factors affecting where grizzly bears cross highways. Other factors that I could not model include large-scale topographic position, bear density, and relative position of different age/sex classes. Chruszcz et al. (2003) found similar relationships, but also found that habitat quality influenced crossings of high-volume highways. My qualitative assessment is that the large scale attributes of US-2 provide for habitat connectivity. These attributes are low traffic levels, narrow road width, limited human developments, and expansive pristine habitats on either side of the highway.

The highway corridor studied here is the converse of that typically conceptualized in the literature – a narrow strip of habitat in a matrix of human development (Simberloff et al. 1992, Beir 1995, Forman 1995, Beir and Noss 1998). The US-2 corridor is a narrow strip of human development in a matrix of wild land. Such configurations have been termed "fracture zones" (Servheen et al. 1998). This fracture zone has the potential to act as a population sink because high quality spring habitats along the highway will tend to bring grizzly bears into close proximity to traffic and human activity. Also, population pressure may cause subdominant grizzly bear sex/age classes, seeking to avoid conspecifics, to place themselves within these fracture zones (Mattson et al. 1987, Allen and Sargeant 1993). I observed that situation here, where a subadult male spent a large amount of time in close proximity to US-2 and other developments. Judging from my capture success within the corridor, the area continues to provide resources for a resident bear population, and even if the area is a population sink, the result may be more grizzly bears and continued connectivity (Pulliam 1988). I believe that we can continue to maintain large scale habitat connectivity for grizzly bears as long as development remains limited (Boone and Hunter 1996).

MANAGEMENT IMPLICATIONS

Within my study area, mean hourly traffic levels have doubled since 1987 from 41.2 vehicles/hr to 77–91 vehicles/hr (Pedvillano and Wright 1987). Continued population growth in Montana's intermontane valleys will undoubtedly perpetuate this trend. Thus in the future, we may expect the US-2 corridor to become an agent of fragmentation requiring mitigative action. Such actions may range from radar-activated warning signs to bridges or tunnels specifically designed for wildlife passage. Currently, mean traffic volume during the time grizzly bears cross US-2 the most (2300–0700) is 10.9 vehicles/hr (range 0–67, SD = 9.5). If highways become impermeable at ≥ 100 vehicles/hr, then I expect US-2 to become impassable to grizzly bears in 30 yrs if the current traffic trends continue. Obviously, unforeseen developments could change this estimate. During this study, there was a proposal to widen US-2 into a 4-lane divided highway to encourage local economic development. While the economic benefits of such a project are debatable, the effects on grizzly bears appear predictable. Planning for wildlife passage now may offset some of the financial burden of providing wildlife crossing structures when they become a necessity. These results should help planners anticipate when mitigative action is required, and provide insights as to where such actions should occur.

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Table 1. Identification of grizzly bears captured and collared along US Highway 2 in northwest Montana, USA 1998–2001, dates of capture, and type of collar used. Radio days are the number of days between first and last relocations. Highway crossings are the number of times successive relocations were on opposite sides of US-2 and/or MT-49, documented with VHF and GPS telemetry. Days per crossing are radio days/crossings for VHF and GPS telemetry.

Sex-Age Code/ID[a]	Date of First Capture	Collar Type[b]	Radio Days VHF/GPS	Highway Crossings VHF/GPS	Days per crossing VHF/GPS
m2	6 Jun 1998	VHF/GPS	504/0	30/0	17/0
F5	10 Jun 1998	VHF	526	2	263
M6	11 Jun 1998	VHF/GPS	87/18	0/0	
M7	12 Jun 1998	VHF	67	0	
F8	14 Jun 1998	VHF	563	27	21
f9	14 Jun 1998	VHF	666	23	29
F11	14 Jun 1998	VHF	191	7	27
M12	14 Jun 1998	VHF/GPSe	54/26	2/2	27/13
M13	16 Jun 1998	VHF	42	0	
F921	11 Jun 1999	GPSe	239/140	0/0	
F14	12 Jun 1999	GPSe	321/115	0/0	
f922	18 Jun 1999	GPSe	479/140	0/0	
f20	1 Jul 1999	VHF	127	6	21
F24	15 Jun 2000	GPS	121/0	10/0	12/

F26	16 Jun 2000	GPS	59/0	0/0	
m286	22 Jun 2000	GPSe	0/0	0/0	
f293	13 Jul 2000	GPSe	176/100	0/0	
F218	28 Apr 2001	GPSe	180/0	7/0	26/
m34	4 Jun 2001	GPS	104/134	2/8	52/17
M365	6 Jun 2001	GPS	0/17	0/0	
M36	7 Jun 2001	GPS	110/138	0/0	
f37	7 Jun 2001	GPS	105/132	0/10	/13
M925	7 Jun 2001	GPS			
f367	8 Jun 2001	GPS	127/0	0/0	
M181	8 Jun 2001	GPS			
M274	1 Jun 2001	GPSe			
m926	11 Jun 2001	VHF			
M38	15 Jun 2001	GPS	104/124	1/5	104/25
m40	17 Jun 2001	VHF	127	10	13
F224	18 Jun 2001	GPS	0/15	0/7	/2
F42	20 Jun 2001	GPS	27/41	0/0	
m289	5 Jul 2001	GPS	94/86	4/18	23/5

[a] Sex-Age/ID codes: m = subadult male, M = adult male, f = subadult female, F = adult female.

[b] Some individuals wore both GPS and VHF collars at different times and GPS collars contained a VHF beacon. GPSe designates bears fitted with GPS collar and an eartag transmitter to allow relocation after the GPS collar fell away.

Table 2. Observed total number of highway crossings, crossings of US Highway 2 and the Burlington Northern - Santa Fe railroad (R.R.), and number of observed crossings of both US Highway 2 and the R.R. by GPS-marked grizzly bears compared to that expected in 100 random walks, northwest Montana, USA, 1999–2001.

Bear ID	Number of GPS locations	Observed number of highway crossings	Number crossings over US-2	Observed number of R.R. crossings	Number of US-2 crossings also crossing R.R.	Number of highway crossings in 100 random walks					
						$\bar{x}$	-95%	+0.95	Minimum	Maximum	SD
F224	236	7	3	5	3	8.5	7.4	9.5	0	26	5.3
m289	1176	18	15	11	6	33.9	31.2	36.5	8	64	13.4
f37	3161	10	10	9	8	53.5	48.5	58.5	6	155	25.4
m34	3216	8	4	6	4	26.6	22.1	31.1	0	87	22.8
M38	2972	5	5	6	5	34.1	29.8	38.5	1	77	21.8
M12	124	2	2	2	2	6.4	5.2	7.6	0	26	6.2

Table 3. Selection ratios, selectivity χ^2 values, and their significance for 11 grizzly bears along US Highway 2, northwest Montana, USA, 1999–2001. Selection ratios are the proportions of used/proportion of available road distance categories. Road Distance Categories are 100 m increments beginning with 0–100 m (category 0) through 900–1000 m (category 9).

	Road Distance Category											
Bear ID	0	1	2	3	4	5	6	7	8	9	χ^2	*P*
F14	0	3.898	0.375	0.910	0.688	0.492	0.913	1.202	1.647	1.089	25.420	0.002
F42	0.377	0.729	1.298	1.701	1.059	1.453	1.161	1.001	0.640	0.347	23.870	0.004
F224	1.040	1.240	1.268	1.592	0.836	1.846	0.338	0.769	0.759	0.335	10.370	0.321
F921	0.616	0.158	0.538	2.449	0.257	1.386	0.636	0.809	1.555	1.452	16.22	0.062
f922	0	0	0	0.092	0.227	2.088	2.106	2.012	1.464	0.724	168.630	0.001
f37	0.234	0.524	0.573	1.619	1.154	1.048	1.154	0.637	1.086	2.153	123.890	0.001
M6	0	0	0.965	0	0	2.720	1.999	0.657	1.544	0.304	9.570	0.386
M12	0.394	0	0	0	1.260	2.159	0.454	2.205	0.436	3.203	14.090	0.119
M38	0.203	0.150	0.419	0.414	0.283	1.465	3.202	0.732	1.693	1.566	51.480	0.001
m34	0.080	0.546	0.780	1.929	0.999	1.009	1.094	0.977	1.571	1.285	79.610	0.001
m289	3.912	1.003	0.656	0.407	0.202	0.043	0.225	0.990	0.900	1.143	114.41	0.001
Pooled	0.633	0.541	0.620	1.268	0.794	1.128	1.205	1.041	1.273	1.284	637.580	0.001
SE	0.441	0.096	0.100	0.256	0.152	0.035	0.031	0.031	0.016	0.074		
-95%	0.231	0.353	0.422	0.767	0.497	0.761	0.861	0.697	1.025	0.749		
+95%	1.527	0.729	0.818	1.769	1.091	1.495	1.549	1.385	1.521	1.819		

Table 4. Mean maximum likelihood estimates, their 95% confidence intervals, minimum and maximum values, and *t* statistics for a model describing locations where grizzly bears crossed U.S. Highway 2, northwest Montana, 2001.

	$\bar{x}$	- 95%	+ 95%	Maximum	Maximum	SE	*t*	*P*
Constant	-0.962	-2.643	0.720	-4.185	0.0534	0.654	-1.470	0.130
Elevation	-0.144	-0.207	-0.082	-0.195	-0.030	0.024	-5.991	0.001
Distance-to-cover	-0.021	-0.025	-0.016	-0.026	-0.016	0.002	-11.687	0.001
grassland	1.772	0.441	3.102	0.537	4.175	0.517	3.423	0.008
shrubland	0.181	-0.961	1.322	-0.888	2.289	0.444	0.407	0.348
deciduous forest	-2.698	-12.449	7.053	-21.663	1.203	3.793	-0.711	0.288
conifer forest	-0.277	-1.635	1.081	-2.198	1.879	0.528	-0.525	0.327

Figure 1. Corrected bi-directional mean vehicles by hour and month at the west traffic counter on US Highway 2, northwest Montana, USA 1999–2001.

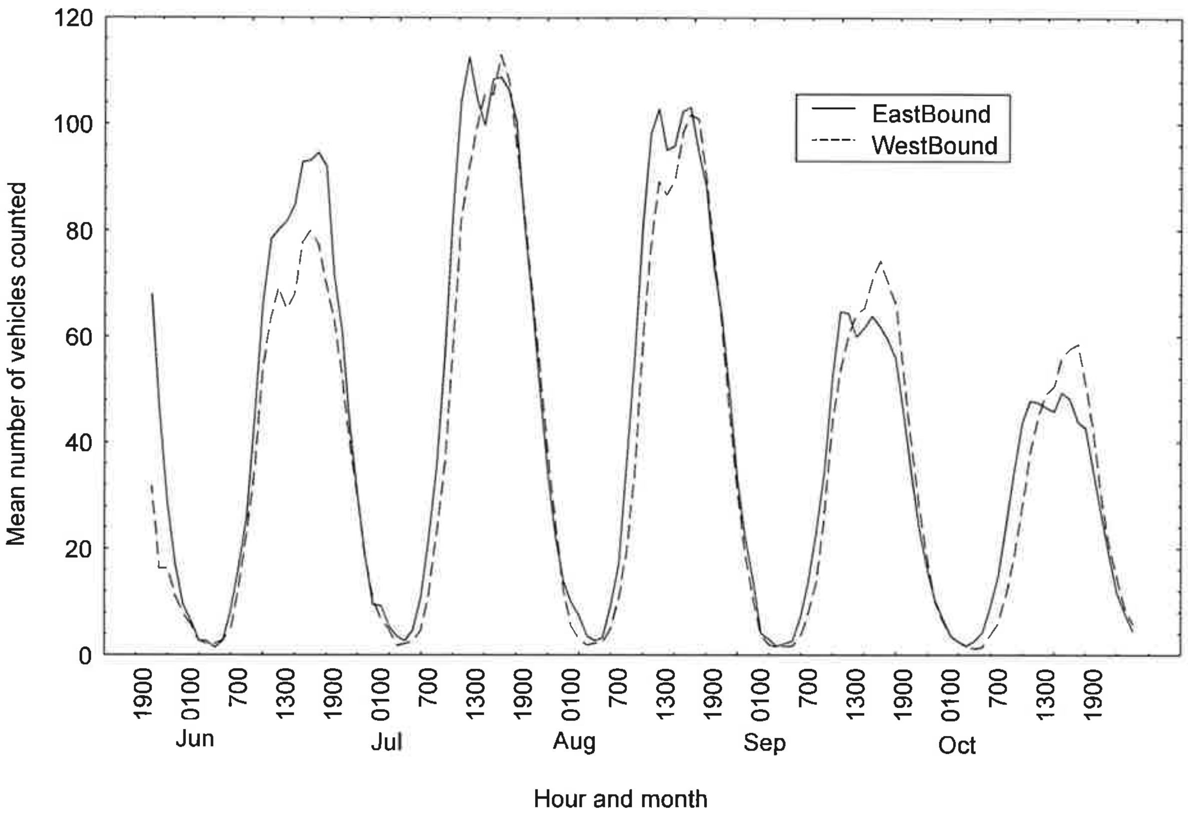


Figure 2. Range and mean number of trains by hour and month tallied at the west train counter in the US Highway 2 study area, northwest Montana, USA 1999–2001.

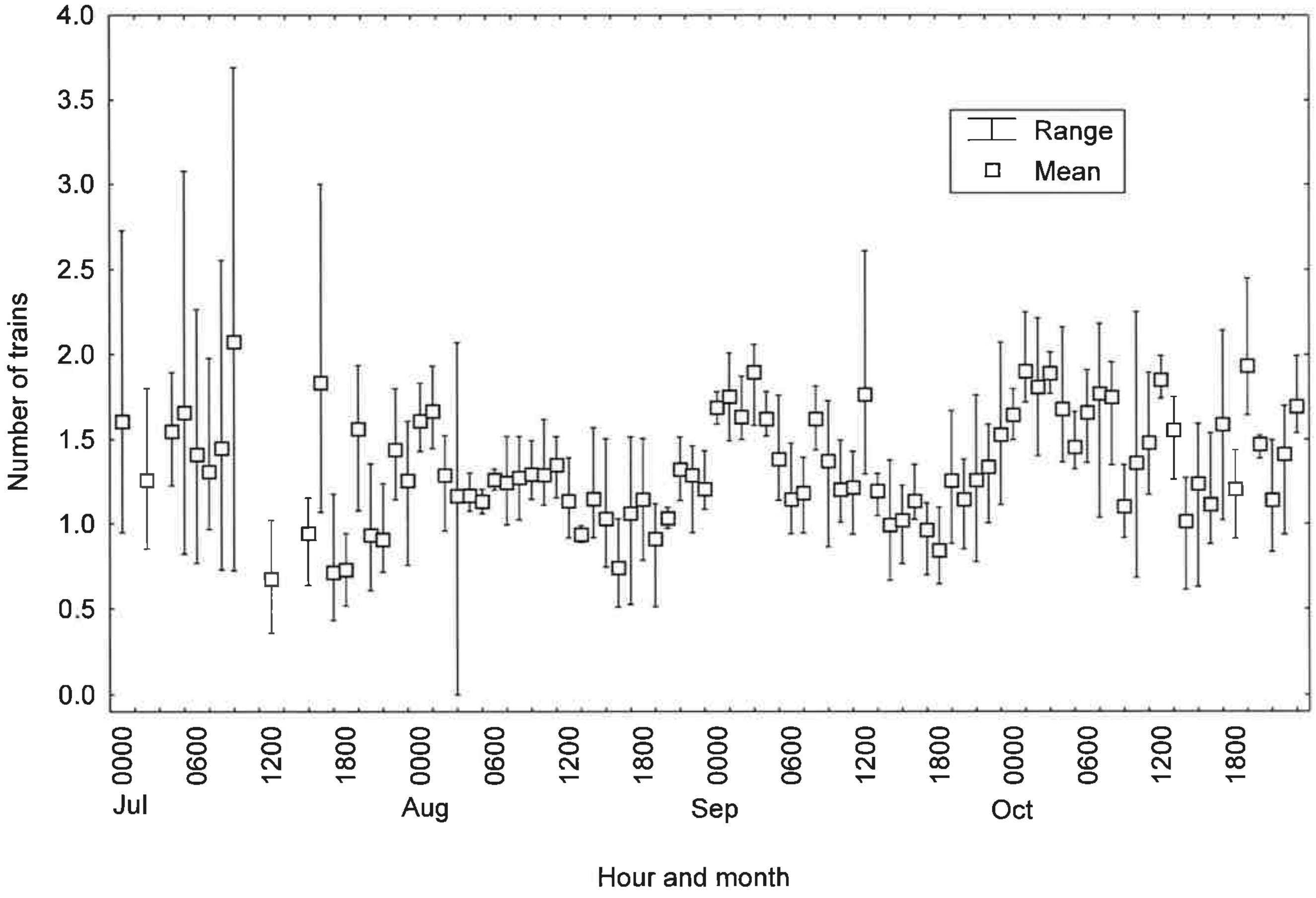


Figure 3. Frequency of US Highway 2 crossings by grizzly bears during 2001 plotted against mean traffic volume by hour, northwest Montana, USA.

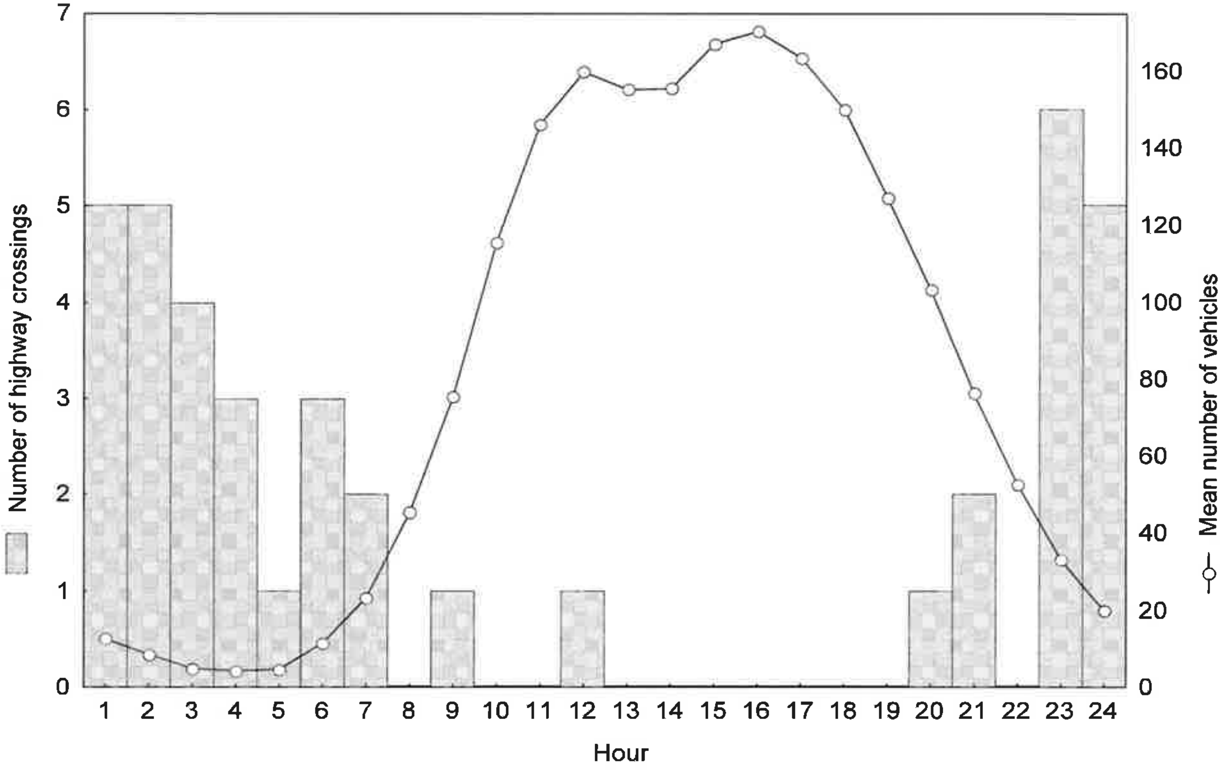


Figure 4. Observed grizzly bear crossings of US Highway 2 fitted to an exponential distribution with traffic volume categories, northwest Montana, USA 1999–2001.

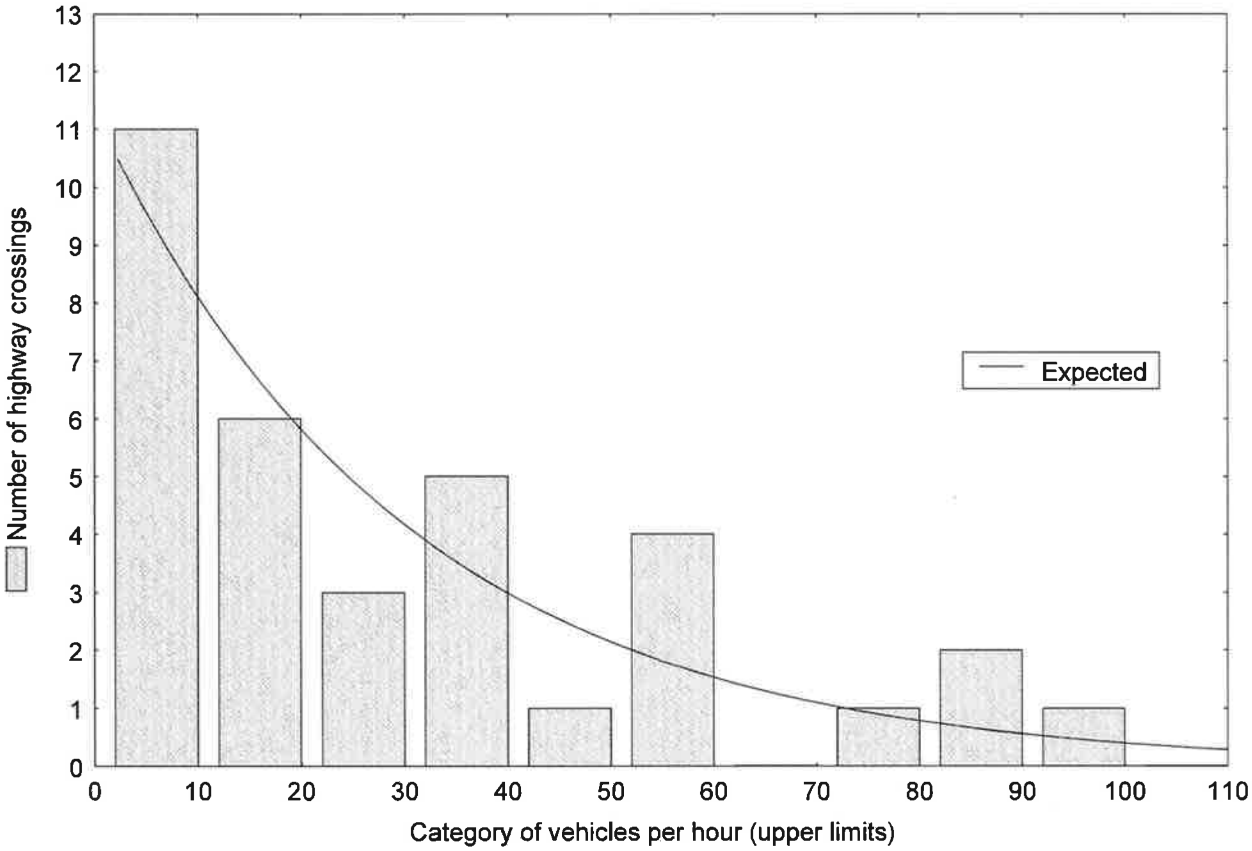


Figure 5. Frequency of observed grizzly bear crossings of US Highway 2 during 2001 plotted against mean grizzly bear movement distance by hour, northwest Montana, USA.

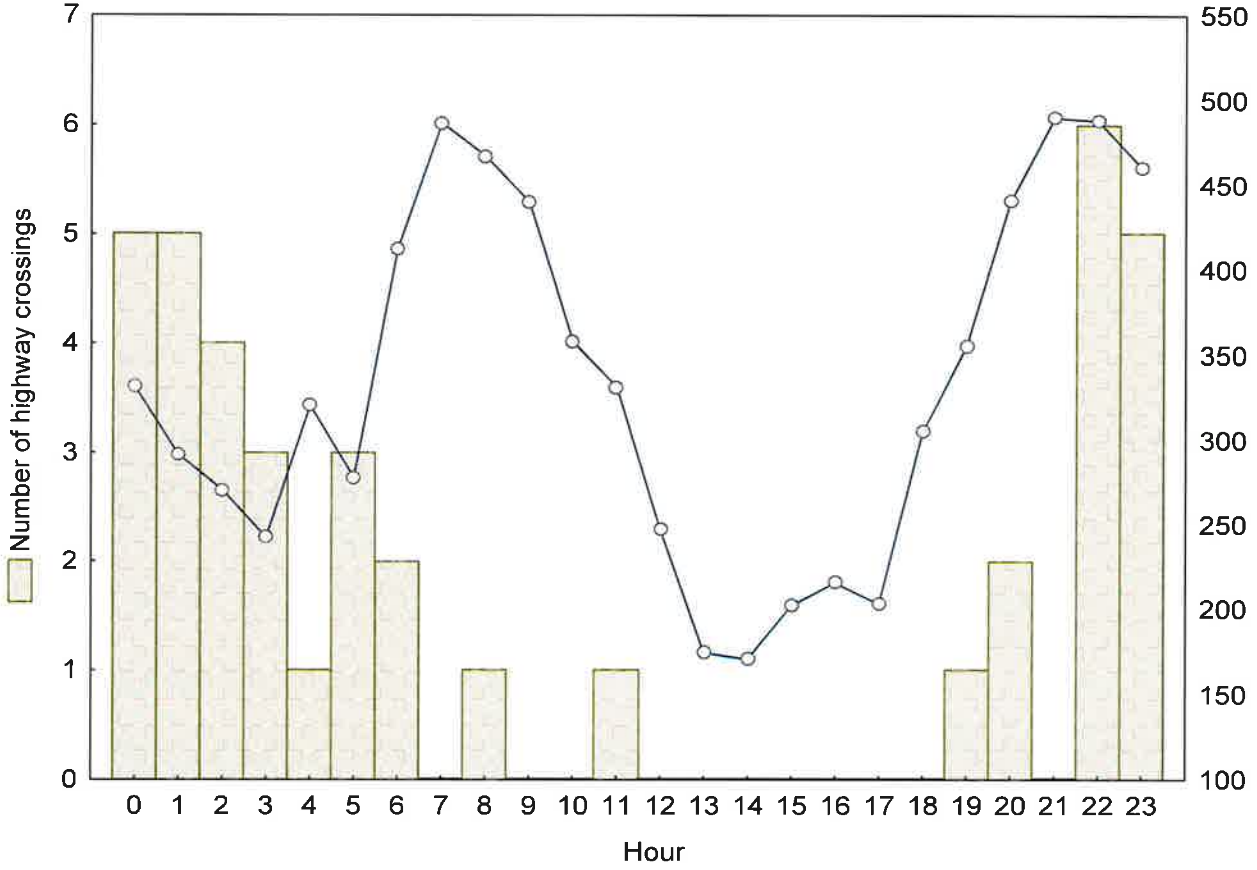


Figure 6. Selection ratios for 10 grizzly bears (m289 excluded) along US Highway 2, northwest Montana, USA 1999–2001. Mean and standard errors of selection ratios calculated for each 100 m distance isopleth away from the highway. Values > than 1.0 indicate selection and values <1.0 indicate avoidance.

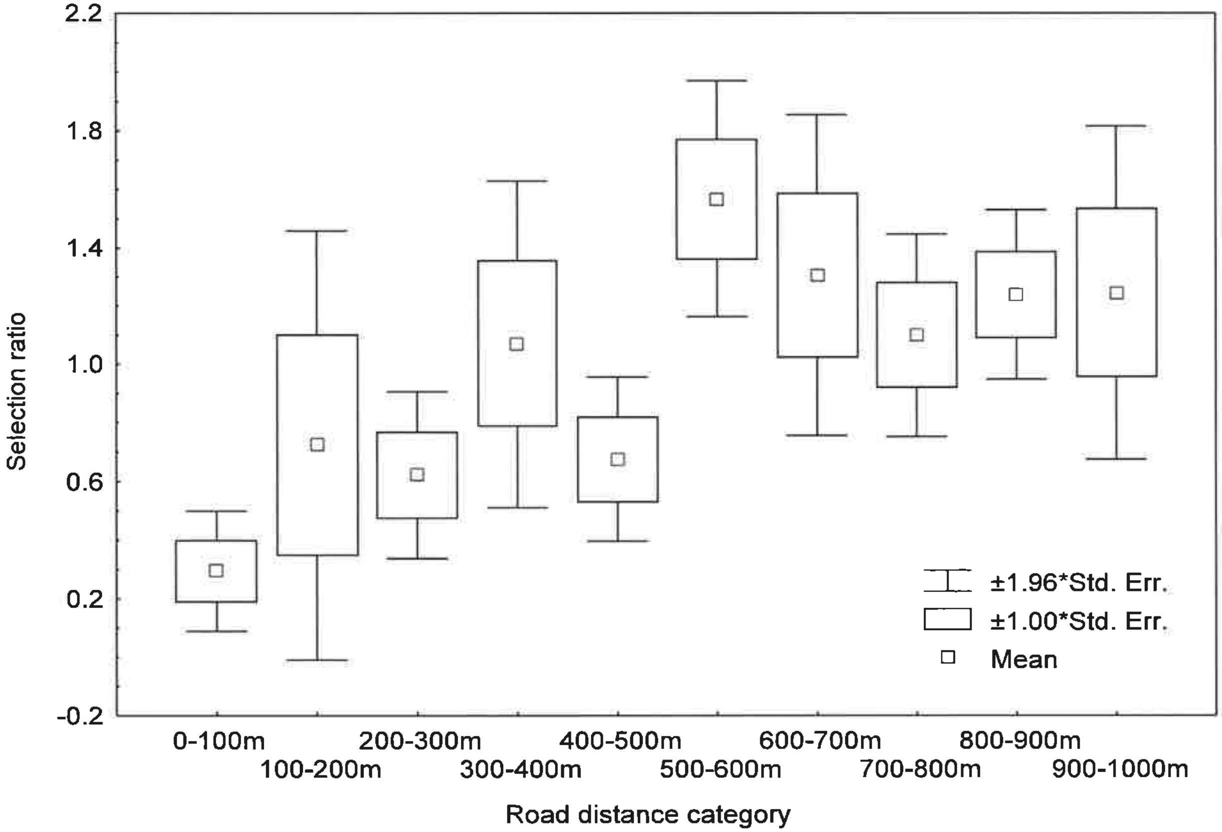
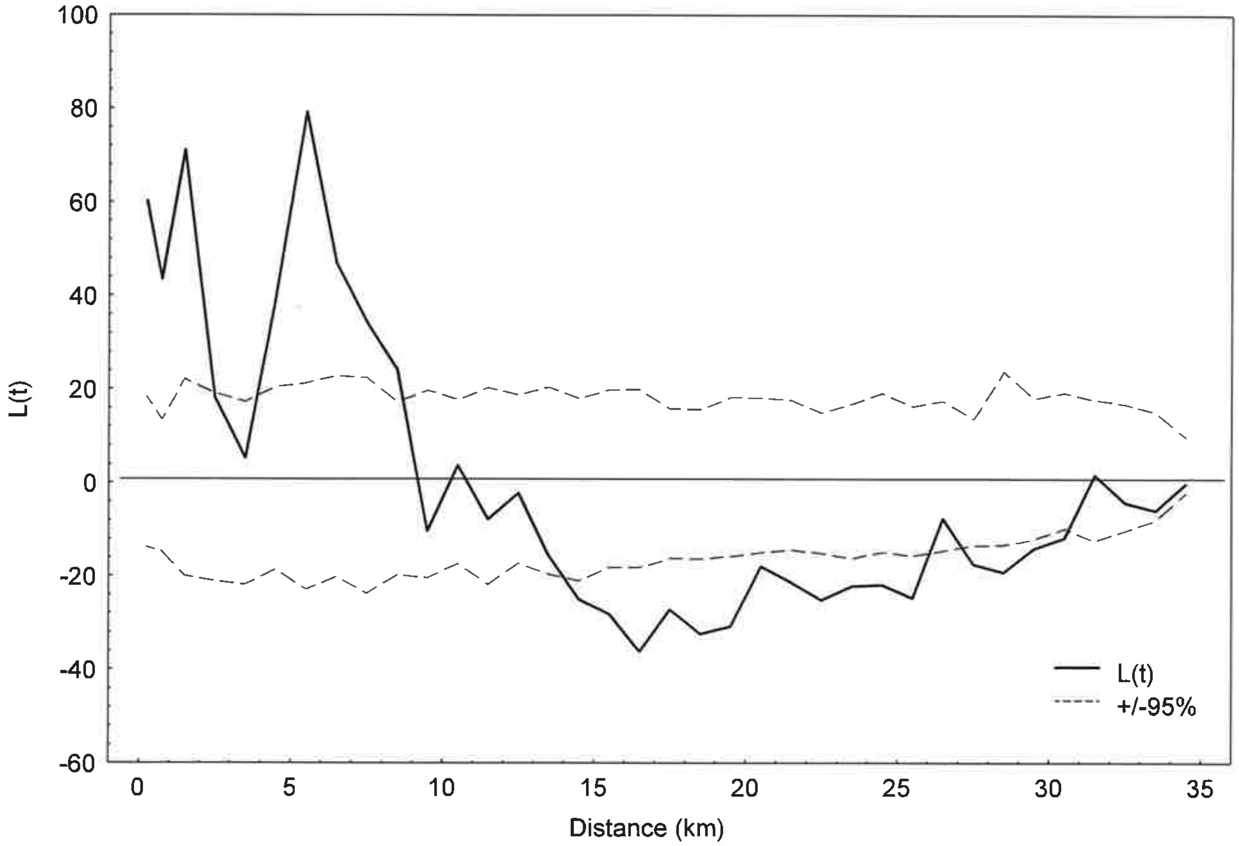


Figure 7. Plot of L(t) against distance, where L(t) is the difference between the observed number of highway crossings by grizzly bears during 2001 and the simulated mean, northwest Montana, USA. Values of L(t) >0 indicate clustering, values <0 indicate dispersion. Values above or below the 95th percentile were deemed significant.



CHAPTER 2: FINE SCALE ANALYSIS OF GPS-BASED GRIZZLY BEAR MOVEMENT DATA FROM NORTHWESTERN MONTANA

Abstract: Global positioning system (GPS) technology incorporated into wildlife radio telemetry collar systems has revolutionized the means and methods available to study wildlife movement and habitat use. Traditional techniques for analyzing radio telemetry data based on infrequent sampling schedules are often inadequate to deal with the large volumes of spatially autocorrelated data that can be obtained through GPS technology. Here, I attempt to apply new metrics for measuring habitat use and the effects of human development on grizzly bears, using a sample of 14 GPS marked grizzly bears (*Ursus arctos*) in northwest Montana. Each collared grizzly bear produced an average dataset of over 2,000 hourly relocation attempts (range 368-3367) gathered during 1 active season (approximately 120 days) during the period 1999-2001. I split these relocation data sets into resting or traveling data sets based on sequential hourly movements greater or less than the observed error rate. I used these data sets to describe GPS fix success and patterns of grizzly bear movement and compare them to findings from previous research. I then used the traveling and resting data sets to examine patterns of movement and non-movement, expressed as residence time, path tortuosity, and directional persistence, as functions of landscape variables. I used generalized linear modeling (GLZ) to relate residence time to various environmental and development variables, for example, elevation, distance to water, and road density. I also sought to detect patterns in path tortuosity and directional persistence with these same variables using analysis of variance (ANOVA) and correlation statistics. Fix success was reasonably high for bears both while resting (85%) and traveling (77%), but fix success declined with increasing residence time, and increased with movement rate. Fix success varied substantially by individual and time of day, but was highest for subadults. Female grizzly bears had the shortest residence times and the longest periods of activity. They moved furthest and fastest within movement vectors. Males rested longest and traveled least. When they moved, males traveled in less persistent directions than did females. Distances moved between resting points were relatively short averaging 1.1-5.8 km, and occurred during periods of activity ranging from 5-17 hr. Distances moved within vectors were also relatively short, averaging 2.6 km for males and 3.8 km for females. I found that none of the hypothesized dependent variables (residence time, path tortuosity, directional persistence) were particularly useful for predicting habitat use, and none were unequivocally related to various levels of human development. I suggest that widespread classification errors in habitat mapping was partially responsible, as was the theory that hourly movements (and non-movements) were directly related to the factors I measured.

INTRODUCTION

The development and availability of collar-borne GPS systems has dramatically increased our ability to gather fine scale movement data from wildlife and will undoubtedly revolutionize our understanding of wildlife-habitat relationships, particularly for those species for which movement data was difficult to obtain, such as those ranging widely across inaccessible terrain. Grizzly bears, wolves (*Canis lupus*), and lynx (*Lynx canadensis*) are examples of such species. Historically, telemetry information was collected through relatively infrequent aerial relocation, often limited by budget, weather, and time-of-day, and thus had inherent biases; aerial relocations were limited to daylight hours and good weather, and rugged terrain limited the accuracy of air and ground telemetry (Knight et al. 1976). Analyses of such data were coarse and usually relied on home range estimation to define habitat use and availability (Waller and Mace 1997). Kernel home range estimation methods display telemetry data nicely, but don't incorporate temporal patterns and may encompass many areas never actually used (Worton 1989).

Now, GPS collars have automated the relocation process. Relocations can be obtained after collar-retrieval with store-on-board collars or obtained real-time through radio or satellite links. Most importantly, relocation interval can be set without regard to weather, time-of-day, or accessibility. The result is an ability to gather extremely fine scale movement data – limited only by the power and storage capabilities of the collar. While this technology has expanded our research opportunities, it has also presented us with new challenges. While many of the biases associated with VHF telemetry have been understood and eliminated (White and Garrott 1990), new biases, including differential fix success caused by terrain, vegetation, and animal behavior, have arisen (Graves and Waller, in press). Spatial and temporal autocorrelation between fixes challenges traditional statistical techniques (Nielsen et al. 2002, Frair et al. 2004). Accuracy of relocations often exceeds that of most base maps and massive amounts of location data make analysis difficult. Traditional metrics of animal habitat use patterns, such as home range polygons, may become obsolete because more precise descriptions are now available. Animal movement and habitat-use are partially functions of the behavior of individuals and associated responses to external and internal stimuli which can never be measured through telemetry (Garshelis 2000). Furthermore, the concept of habitat availability may be radically altered. Traditional methods (e.g. Neu et al. 1974) have termed habitats 'preferred' or 'avoided' depending upon the amount of use they receive relative to that habitats availability within some larger area. This concept works in a statistical sense in that observed habitat use is tested against random (proportional) expectation. 'Preferred' or 'avoided' habitats are named based on deviations from expected values. Does this approach still work in a GPS/GIS environment? Use and availability no longer need to be estimated; they are essentially known quantities, at least in a spatial sense. We can still ask if these quantities differ from random expectation, but this exercise becomes largely heuristic and only informative if deviations from random expectation can generate new hypotheses. Also, deviations from random expectation still depend on how availability is defined. The trick, as always, is deciding on what's available. Garshelis (2000) provided a discussion of these issues and suggested that use and availability are not inextricably linked. There appears to be a need for a new unifying theory and method for the analysis of this new generation of telemetry data.

Here, I present an analysis of movement data collected on a sample of 14 grizzly bears equipped with GPS-positioning radio collars as part of a study to understand their response to transportation developments (Waller and Servheen, in press). While the primary objectives of that study were to document highway crossing behavior, frequency, displacement, and the effects of traffic volume, the resulting GPS data offer an opportunity to ask more in-depth questions regarding grizzly bear movement patterns, and to explore new techniques for analyzing fine-scale movement data. My objective is to describe the observed patterns of grizzly bear movement and relate them to physical landscape and climatic attributes.

STUDY AREA

My 2730 km^2 study area consisted of 4 fifth-order watersheds located between Essex and East Glacier, Montana. The study area was bisected by US Highway 2 (US-2) and the Burlington-Northern Santa Fe railroad, the most northern east-west highway and railroads in the contiguous US. This 2-lane highway and railroad separated Glacier National Park to the north from the Bob Marshall Wilderness complex to the south. The study area included the valleys of the Middle Fork of the Flathead River and Bear Creek to the Continental Divide and Marias Pass (elevation 1610 m). East of the Continental Divide, the study area dropped into the prairie biome, including the South Fork of the Two Medicine River and crossing the western boundary of the Blackfeet Indian Reservation (BIR).

Small concentrations of homes, businesses, and ranches, and small communities existed within the US-2 corridor, but the majority of the area was undeveloped federal land, (36% of the area lay within the boundaries of Glacier National Park). U.S. Forest Service lands were managed primarily for recreation, timber harvest, and grazing. Tribal lands were managed primarily for cattle grazing.

Study area topography varied from flat valley bottoms to steep mountainsides. Dominant vegetation was primarily coniferous forest in the western portions of the study area, where a Pacific maritime climate predominated. Open grass/forb/deciduous tree communities were more common in the east where the climate was continental. The collision of these 2 climatic regimes often resulted in unsettled weather conditions.

METHODS

Capture and telemetry

I fitted 14 grizzly bears (7 males, 7 females) captured at trap sites along both sides of US-2 within the study area, 1999-2001, with Telonics Generation II® store-on-board GPS collars (Telonics Inc., Mesa, Arizona, USA). These GPS collars obtained a position once every hr, 24 hr per day, and location information was stored within the collar. The GPS collars could obtain either 2-dimensional (2D) or 3-dimensional (3D) positions. 2D positions were obtained using only 3 GPS satellites. 3D positions required at least 4 satellites and generally gave a more accurate position. I chose the hourly location rate as a reasonable compromise between battery life and spatial specificity. I estimated that battery life would be about 120 days, which was sufficient to provide GPS positions between time of trapping and denning. I equipped all collars with a VHF beacon and a programmable breakaway device because the collar needed to be retrieved and downloaded to obtain the accumulated information. The VHF beacon operated concurrently with the GPS unit, and through variable pulse rates, provided information about GPS system status and/or animal mortality. I attempted to locate all transmitters twice-weekly from fixed-wing aircraft to verify that bears were still residing in the study area and to provide timely cause-specific mortality information.

After GPS collars were retrieved and downloaded to a computer, I differentially corrected positions using Trimble Pathfinder Office® (Trimble Navigation Ltd., Sunnyvale, California, USA) and proprietary software developed by Telonics Inc. I determined fix success rate as the number of successful location attempts/total location attempts. Additional details concerning capture and telemetry can be found in Waller and Servheen, in press, and Graves and Waller, in press.

Environmental Variables

I collected hourly weather data during 1999–2001 from remote weather stations operated by the Montana Department of Transportation located just west of the study area at Essex and 50 km southeast of the study area at Pendroy, Montana. The Essex and Pendroy weather data were most representative of weather conditions west and east of the Continental Divide, respectively. Weather data included temperature, humidity, wind speed, wind direction, and presence, type, and rate of precipitation.

I grouped all GPS positions into dawn, day, evening, and night categories based upon day length. Dawn and evening were the periods within 1 hr of sunrise or sunset, respectively. Day was the period beginning 1 hr after sunrise and ending 1 hr before sunset, and night was the period beginning 1 hr after sunset and ending 1 hr before sunrise.

I obtained digital cover-type maps from the U.S. Forest Service and imported them into our computerized geographic information system (GIS). The Wildlife Spatial Analysis Lab at the University of Montana produced these maps by classifying Thematic Mapper satellite imagery (Redmond et al. 1998). The Flathead National Forest made further refinements based on potential vegetation types and recent wildfires. The minimum mapping unit for these maps was 2.5 ha. I simplified the map by combining similar vegetation types, thus reducing the number of cover types from 25 to 8. The 8 cover types were rock (barren/non-vegetated), grassland, shrubland, riparian, deciduous forest, mixed forest, conifer forest, and water.

I obtained grizzly bear habitat quality maps from the U.S. Forest Service, constructed during cumulative effects modeling efforts for the Northern Continental Divide Ecosystem (NCDE; Waller 1999). The habitat quality values were derived from resource selection function models created by Mace et al. 1999. These habitat quality values were most strongly influenced by elevation and greenness. Greenness was a measure of herbaceous phytomass and was strongly related to grizzly bear habitat selection (Mace et al. 1999, Stevens 2002).

I constructed digital maps of US-2 and the railroad within the study area by digitizing these features on U.S. Geological Survey (USGS) orthophoto quadrangles having 1 m resolution. I obtained digital hydrological data from the USGS and created a distance to water map for the study area. I also obtained 10-m digital elevation data (DEM) from the

USGS. I created a terrain ruggedness map by calculating the standard deviation of elevation within a 1 km moving circle. Slope and aspect were also calculated from this DEM. The U.S. Forest Service, as part of its cumulative effects modeling efforts, classified campgrounds, housing, and other types of human developments into low, moderate, or high-impact categories based upon a Delphi consideration of their perceived impacts on grizzly bears. I obtained these digital maps of human impact points from the U.S. Forest Service, and then created maps displaying the distance from each of these development categories. I constructed a road density layer by running a moving circle procedure on digital road maps obtained from U.S. Forest Service and U.S. Census Bureau TIGER files. The moving circle (or focal-sum) process assigned the number of 30 m road cells within a 1 km circle to the center cell. The circle thus moved across the map assigning a value to every cell (Mace et al. 1996). I used ArcView GIS version 3.2 (ESRI Inc., Redlands, California, USA) for all GIS analyses.

Data Analysis

I imported location data downloaded from GPS collars into a statistics software program (Statistica version 5.5, StatSoft, Tulsa, Oklahoma, USA) with a separate file for each individual bear. Each line of the data file represented a relocation attempt with a date and time stamp, and if successful, geographic coordinates. These geographic coordinates represented the estimated location of the bear. The bear may have been moving or stationary at the time of relocation. Although relocation error was generally small (67 m for 2D, 22 m for 3D; Graves and Waller, in press), each position estimate had some unknown amount of error. Therefore, an animal at a fixed position for 2 or more relocation attempts will never appear as stationary and calculating movement rates using all the accumulated geographic coordinates would probably overestimate the actual movement rate. I also wanted to separate locations associated with travel from those associated with a stopping point because these activities (traveling or resting) may be associated with markedly different habitats. Because the amount of error in each position was unknown, I could only assign locations to resting or traveling categories based on the type of position (2D or 3D) and the average position error from test collars. The average position error became the spatial scale in which group membership was assigned. I wrote a simple computer program that parsed the databases and assigned group membership to relocations based upon their fix type (2D or 3D) and their distance from previous and subsequent locations. If the distance between subsequent relocations was less than the average error for that fix type (22 m for 3D, 67 m for 2D), it was considered resting. If the distance was greater than the average error for that fix type, it was considered traveling. Once resting locations were identified, the program recorded the beginning and ending times for the resting episode and assigned a unique identification number. The accumulated resting locations then became a new database that included only resting points. For each resting 'event', I calculated the start time, end time, elapsed time, time between resting events, mean geographic coordinate, euclidean distance between resting locations, average temperature and wind speed, and assigned values from the GIS layers described above. A potentially important environmental variable was the proximity of other grizzly bears, so I included the temporally matching location for each individual in every other individual bear data set for each resting point. Those relocations not identified as 'resting' points became, by default, 'traveling' points. I combined traveling points into vectors which were similarly ascribed duration and location attributes. However, vectors differed from resting points in that a vector was composed of several to many spatially disjunct points that could not be meaningfully described with an average coordinate. Therefore, I described vectors by the mean (or modal for categorical variables), minimum, and maximum values for environmental variables encountered at each point along the vector. I also calculated the following movement statistics for each vector: net displacement, vector distance, tortuosity, mean turning angle, directional persistence, and speed (following Turchin 1998). Net displacement was the Euclidean distance between the starting and ending points of the vector. Vector distance (or path distance) was the total distance moved within the vector. Tortuosity was a measure of the amount of turning within the vector and was simply net displacement/vector distance. Tortuosity values near 1 represented nearly straight vectors, values near zero described circuitous paths. Mean turing angle was the average change in direction from 1 point to the next within the vector, measured in degrees. Directional persistence was the cosine of the turing angle in radians. This was a measure of the consistency of turning within the vector. Values near 1 indicated consistent movement in 1 direction while values near -1 indicated frequent reversals of direction. Values near zero indicated no directional persistence (Turchin 1998).

This partitioning of the data set allowed me to specifically describe patterns of moment and non-movement, and relate them to habitat use. I specifically tested the hypothesis that time spent resting at a particular location (residence time) was related to the various landscape and proximity characteristics described above (Rempel et al. 1995). In other words, one would expect that bears would spend more time in places with beneficial characteristics. I used visual inspection of bivariate plots, correlation statistics, and ANOVA to examine the univariate relationships between residence time and landscape features. I then attempted to fit a generalized linear model (GLZ) with a gamma-log link function that used residence time as the response variable. I evaluated model fit to support or refute the hypothesis, and the sign and magnitude of parameter estimates indicated the association and strength of each parameter estimate (McCullagh and Nelder 1989). To account for the variation caused by unequal sample size and unique behavior, I employed a jack-knife routine to estimate model parameters wherein the analysis was repeated, dropping 1 bear from the sample each time. I then averaged the parameter estimates, calculated their standard errors, variance, and Wald statistics from the accumulated runs. To account for anticipated seasonal changes in behavior, I created a separate model for each season (spring, summer, and fall), based on previous studies of grizzly bear habitat use (Craighead et al. 1982, Mace and Jonkel 1983).

One might expect that direction reversals, speed of movement, or persistence would change when in preferred or avoided habitats (Kareiva and Shigesada 1983, Whittington et al. 2004). I used correlation analyses, ANOVA, multivariate regression, and visual inspection of distributions to determine if tortuousity or persistence changed in relation to an animal's proximity to human developments, or was related to the habitat attributes described above.

Spatial and temporal autocorrelation and its affect on the analysis of radio telemetry data has been a recent subject of discussion (Otis and White 1999, Lennon 1999, Nielsen et al. 2002). While autocorrelation of location estimates may not be an issue where the individual animal (not the location estimate) is the sample unit, within animal statistics may be problematic. To assess the effect of splitting location estimates into types (traveling or resting) on the autocorrelation structure, I used partial autocorrelation functions to compare pre- and post- splitting datasets out to a lag of 15 observations.

RESULTS

Resting

Because the 14 GPS collars were deployed at different times, and remained on the animals for varying lengths of time, the resulting location databases varied in size (Table 1). In correlation analyses, I found that 9 of 14 bears had significant correlations between fix success rate and time of day that resting events began (4 positive, 5 negative). Of those with negative correlations, 4 of 5 had higher fix success during resting events beginning in the morning and daytime than those beginning during evening or nighttime, and 1 had higher fix success for morning – evening starts than for those starting at night. Of those with positive correlations, 3 of 4 had higher fix success for resting events beginning at night than for those beginning during daytime, and 1 had no resting events starting in the evening, probably due to small sample size.

With ANOVA, I found that 6 of 14 bears had significant relationships between residence time and time of day. Using ANOVA and accompanying diagnostic statistics, I found that 3 of 14 individuals failed to show significant relationships between residence time and 17 factors, 10 of 14 individuals indicated significant relationships for 1-3 factors, and 1 individual showed significance for 6 factors. Only 1 factor, time of day, was significant for more than 2 individuals (Table 2).

Fix success at resting points was reasonably high, averaging 85% over all individuals, and ranging from 65–90% (Table 3). However, I also found that fix success decreased with increasing residence time ($r = -0.47$). Subadult females had significantly higher fix success and lower variance ($F = 12.58$, d.f. = 3, $P < 0.001$) than did other age/sex classes, which did not differ ($F = 2.07$, d.f. = 2, $P = 0.13$). Residence time was generally short, averaging 2.2 to 5.8 hr, but was occasionally prolonged to over 100 hr (Table 3). Time of day significantly influenced residence time for 6 of 14 bears. In all 6 cases, resting periods that began in the evening were longer than those beginning during the morning, significantly so in 4 of 6 cases. Of all age/sex classes, adult females had the shortest residence time ($\bar{x} = 2.7$ hr), followed by subadult females ($\bar{x} = 3.5$ hr), subadult males ($\bar{x} = 3.8$ hr) and adult males ($\bar{x} = 4.3$ hr). There was no statistical difference between adult and subadult male residence times ($F = 1.80$, d.f. = 1, $P = 0.18$).

Distance moved between resting points was relatively short, averaging 1.1–5.8 km, but occasionally ranging as high as 32 km (Table 3). There was no clear relationship between distance moved between beds and time of day. There was no apparent relationship between residence time and the proximity of other radio-collared bears. The active interval between resting points was generally long, averaging between 6–17 hours and ranging from 1–211 hr. Mean elevation of resting points did not vary more than 265 m among individuals (Table 3). All individuals tended to rest at least 200 m away from mapped water courses (Table 3). Mean total road density within the study area was 0.39 km/km^2. The majority of the study area (75%) was >1 km from a road. Average distance from resting points to a highway for all bears exceeded 1 km, although some bears rested quite close on occasion (Table 3). In univariate analyses, total road density was not related to residence time. Average distances from resting points to highways, or high-, moderate-, or low-impact developments tended to be large (Table 3), and in univariate analyses, were generally not related to residence time. The exception was bear 293, whose mean residence time was greater for resting points >3 km from a high-impact development. Average greenness of the study area was 6 and ranged from 1 to 11. Resting points for all but 2 bears exceeded the average value by at least 1.0, but was not related to residence time (Table 3). In univariate analyses, wind speed was not significantly related to residence time for any bear. Temperature was a significant factor for 2 individuals. Precipitation during the period of study was insufficient to detect any relationships. The use of cover types at resting points varied considerably between individuals, however the grassland and non-vegetated cover types were consistently used the least (Table 3).

I successfully fitted GLZ models to all 3 seasons (Tables 5–7), however model fit was poor with evident overdispersion (Table 8). I improved model fit slightly by eliminating 10 outliers with residence times ranging from 26 to 111 hr, of which 2 occurred during the spring, 6 during summer, and 2 during fall.

In the spring model (Table 5), residence time was negatively associated with distance from moderate disturbance points and grassland cover types and positively associated with deciduous cover types. There was a weak, but non-significant, negative association with elevation and a weak, non-significant positive association with highway distance.

During summer, more significant relationships were apparent within the model (Table 6). Residence time was significantly and negatively associated with aspect, elevation, road density, distance to high- and moderate-disturbance points, wind speed, and grassland cover types. Residence was significantly and positively associated with slope, distance to water, temperature, and parkland cover types.

During fall (Table 7), residence time was significantly and positively associated with aspect, slope, distance to high-impact disturbance points, and deciduous cover types. Fall residence time was significantly and negatively associated with temperature and parkland cover types. There were weak positive, but non-significant associations with wind speed and greenness, and a weak non-significant negative association with distance to highway.

Traveling

Average fix success within vectors was 77% over all and ranged from 61–84%. I also found that fix success increased with speed ($r = 0.37$). Subadult females had much higher fix success and smaller variance ($F = 28.18$, d.f. = 3, $P < 0.001$) than did other age/sex classes which did not differ (F = 0.20, d.f. = 2, P = 0.82). Average time spent traveling ranged from 5–16 hr (Table 4). Prolonged periods of movement were occasionally observed as well. Duration of moves by subadult males ($\bar{x}$ = 6.2 hr) did not differ from that of adult males ($\bar{x}$ = 5.6 hr, F = 1.14, d.f. = 1, P = 0.29). Duration of subadult female moves ($\bar{x}$ = 7.2 hr) was longer than that of subadult males (*F* = 4.54, d.f. = 1, *P* = 0.03). Average adult female movements were longest (11.7 hr), primarily due to females 14 and 921 ($\bar{x}$ = 12.1 and 15.9 hr, respectively) who had exceptionally long periods of movement (198 and 209 hr respectively). However, even without these outliers, their mean movement duration would have been over 10 hr, still significantly longer than that of any other age/sex class.

Distances moved within vectors was greatest (2 outliers excluded) for adult and subadult females ($\bar{x}$ = 3.6 km) followed by adult males ($\bar{x}$ = 2.8 km) and subadult males ($\bar{x}$ = 2.5 km). Distance moved was greatest during the summer season for all sex/age groups except adult males who moved furthest during spring. Net displacement within vectors (4 outliers excluded) was least for subadult males ($\bar{x}$ = 1.2 km), followed by adult females and adult males ($\bar{x}$ = 1.6 km), and subadult females ($\bar{x}$ = 1.9 km). Surprisingly, vector distance did not vary by time of day (*F* = 0.58, d.f. = 3, *P* = 0.62), but all sex/age groups showed strong crepuscular activity patterns (Figure 1). Speed within vectors averaged 425 m/hr and ranged up to 6,592 m/hr. Average speed only varied by a maximum of 123 m/hr between sexes and was not judged biologically significant. The maximum speeds were recorded for females.

Tortuosity was least for adult females ($\bar{x}$ = 0.62) and greatest for adult males ($\bar{x}$ = 0.73). Tortuosity did not differ significantly between subadult sexes ($\bar{x}$ = 0.67, *F* =

0.13, d.f. = 1, $P = 0.72$). I found no clear relationship between tortuosity and distance to human developments, road density, slope, aspect, elevation, distance to water, temperature, or time of day. However, I found that tortuosity decreased as maximum greenness increased, was higher in forest cover types than grassland cover types, and was lower in summer than spring or fall. Tortuosity also differed significantly between individuals ($F = 6.091$, d.f. = 13, $P < 0.001$).

I found no meaningful relationship between directional persistence and any measured factor. Average speed of movement differed significantly among individuals (F = 10.97, d.f. = 13, P <0.001), decreased at higher levels of greenness, increased in deciduous and grassland habitat types, and varied by month.

Autocorrelation

Individual bear data sets had strong temporal and spatial autocorrelation. Temporal partial autocorrelation was significant to at least lag 15 ($r \leq -0.197$) for all bears. Spatial partial autocorrelation was significant to at least lag 2 ($r \geq 0.047$) for all bears. In the bed data sets, all temporal partial autocorrelation was eliminated and nearly all spatial partial autocorrelation. Four individuals had partial autocorrelation in either the x or y ordinate to lag 2, and 1 individual had partial autocorrelation in both ordinates out to lag 2. There was no temporal or spatial partial autocorrelation in the vector data sets.

DISCUSSION

Fix success varied tremendously by time of day and individual, thus interpretation was difficult. Clearly, unmeasured factors affected fix success, some of which were likely correlated with time of day, such as changes in habitat use or behavior. Fix success was highest for subadults whether traveling or resting, suggesting that some characteristic of this sex/age group facilitated GPS relocation. Fix success was higher when resting for all bears, together and individually. This finding appears inconsistent with Graves and Waller (In press), however our findings were consistent when considered within resting or traveling categories. Graves and Waller (In press) found that fix success increased with movement rate, as did I. However, Graves and Waller (In press) did not discriminate between traveling and resting locations.

Average interbed activity and duration of vectors was 5–17 hr. However, some extremely long intervals of activity contained short periods of missed relocations, so that there was a good chance that bears were resting during portions of these periods. This level of activity is generally higher than that found during previous research, although most authors stress the high variability within activity patterns (IGBC 1987).

Females, adults and subadults, spent the least amount of time resting and the most time traveling. They traveled furthest, fastest and straightest. Previous research on activity patterns has been insufficient to adequately compare movement rates between different age and sex classes.

Grizzly bears have been reported as nocturnal (Holm 1998), crepuscular (Schleyer 1983), diurnal (Wenum 1998), or all of the above (Aune and Kasworm 1989). Wenum (1998) found that, on an annual basis, adult female grizzly bears were active 79% of the time while males were active only 61% . Our results for adult females may be higher but are not directly comparable due to methodological differences. In Wyoming, Holm

(1998), using radio collars with pulse rates altered by mercury tip-switches, found that female grizzly bears were crepuscular and males nocturnal. Garshelis and Pelton (1980) reviewed some limitations of indirect activity-monitoring techniques. Also, Wagner et al. (2001) found that mercury tip switches are not completely accurate and can give biased estimates of activity level. Hechtel (1985), through direct observation, found wide variation in activity patterns (15-74% active during 24 hr monitoring) of 5 female grizzly bears in northwestern Alaska. MacHutchon (2001), based on direct observation, found that 5 grizzly bears (4 female, 1 male) in the Yukon were active approximately 66% of the time, but that activity varied greatly by individual, reproductive status, and if a bear was feeding on meat or plant material. Activity monitoring using tip-switches indicates if an animal is moving its head, but does not necessarily indicate any movement of distance. Conversely, my analysis using GPS locations confirms movement, but I had no way to determine high levels of activity within a confined area when I classified the bear as resting. Direct observation is clearly the most accurate, but can only occur during limited windows of opportunity and not at night or during periods of inclement weather or in areas with heavy vegetation.

The bears I studied tended to rest away from watercourses and human developments, but did not adjust residence time or vectors. Avoidance of human developments is well established in the literature (Mattson et al. 1987, Mace et al. 1996, Gibeau 2000), but never before has an avoidance of water courses been noted. While not universal, many roads and trails in the study area with high levels of human use were in or adjacent to watercourses, possibly explaining bear avoidance of such areas. Residence time, as it was measured here, was apparently not a good predictor of response to human development. Neither was tortuosity or speed affected by distance to developments.

Greenness has been widely found to correlate highly with grizzly bear occurrence (Mace et al. 1996, Stevens 2002), and has been used to predict distributions of grizzly bear and other species (Carroll et al. 2001, Boyce and Waller 2003). In my study area, resting points had higher greenness values than average within the study area. Grizzly bear movement in areas with high greenness was slower and less tortuous, but there was no relationship between greenness and residence time. Again, this suggests that residence time, as measured here, was not a good indicator of grizzly bear habitat quality, or perhaps habitat quality is not a primary determinant of movement patterns. I did observe a negative relationship between temperature and residence time, but this probably reflected the coincidence of falling night-time temperatures and longer residence times for beds initiated in the evening.

Based on residence time, grassland and non-vegetated covertypes appeared to be the least favored. Vector speed was higher in grassland and deciduous types, and tortuosity was lower in grassland than forest cover types, suggesting they traveled more directly.

My GLZ models, though technically correct, are suspect due to known errors in the underlying habitat maps. Ground inspection of the habitat map layers verified profound inaccuracies both in classification and extent of cover types. Habitat mapping has, and continues to be, a difficult problem. In the northern Rocky Mountains, remote sensing technologies have not been up to the task and hand-mapping continues to be an arduous, time-consuming, and expensive methodology that also tends to be short-lived. Wildfires can quickly invalidate the best maps regardless of mapping technique. The time- and cost-attractiveness and ready availability of remotely sensed mapping data makes it a tempting choice for researchers examining habitat use by wildlife. However, such mapping technology, when combined with remotely down-loaded GPS position data, can place a researcher in a dangerous world of 'virtual biology', wherein statistically significant results may be biologically irrelevant or incorrect.

Splitting the relocation databases into movement and non-movement categories eliminated much of the autocorrelation inherent in such data sets. Further, it groups locations into intuitively natural groupings that may have strong ecological underpinnings. For example, Anderson and Lindzey (2003) used GPS radio collar relocation clusters to identify and describe mountain lion predation sites. Finally, separating relocation databases into traveling or resting categories by individual resolves 2 potential sources of fix-rate bias, previously established as being important in GPS relocation data sets (D'Eon 2003, Graves and Waller, in press).

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Table 1. Summary information for 14 GPS marked grizzly bears captured in northwest Montana, 1999-2001.

Bear Id	Sex/Age Class*	Date of 1st Position Attempt	Date of last position Attempt	Number of Position Attempts	Number of Successful Positions	Fix Success Rate (%)
14	F	6/12/1999	10/5/1999	2748	1551	56
921	F	6/11/1999	10/2/1999	2716	1570	58
293	f	7/13/2000	10/21/2000	2396	1879	78
922	f	6/2/2000	10/20/2000	3367	2736	81
224	F	6/18/2001	7/3/2001	368	236	64
37	f	6/7/2001	10/17/2001	3161	2563	81
42	F	6/20/2001	7/31/2001	979	749	76
289	m	7/5/2001	9/29/2001	2042	1177	58
34	m	6/4/2001	10/16/2001	3216	2314	72
36	M	6/7/2001	10/23/2001	3310	2006	61
365	M	6/6/2001	6/23/2001	422	264	62
38	M	6/15/2001	10/17/2001	2972	2135	72
6	M	6/8/2001	6/26/2001	437	124	28
12	M	5/15/2001	6/10/2001	623	406	65

* Sex/age class: M = adult male, F = adult female, m = subadult male, f = subadult female.

Table 2. Number and identification of GPS marked grizzly bears having significant univariate relationships between the listed factor and residence time, northwest Montana 1999-2001.

Factor	Number bears significant	ID numbers
Greenness	2	289,365
Aspect	1	365
Time of day	7	14,921,37,42,289,34,38
Bed distance	0	
Elevation	2	37,289
Slope	1	37
Distance to water	2	921,42
Average canopy cover	0	
Road density	0	
Distance to highway	0	
Distance to hi-impact point	2	293,37
Distance to moderate impact point	1	37
Distance to lo-impact point	0	
Temperature	2	922,37
Wind speed	0	
Cover type	1	293

Table 3. Means and +/- 95% confidence intervals for factors evaluated for their relationship to residence time by GPS-marked grizzly bear, captured in northwest Montana, 1999-2001. Sample sizes (*n*) are the number of discrete resting points identified within individual relocation databases. Maximum values are given for factors where maximums were deemed important.

	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
% Fix success rate	82	86	88	88	89	90	87	79	84	83	77	84	65	81
	78-86	82-90	85-90	85-90	82-96	88-92	83-91	75-83	81-86	80-86	67-86	81-86	41-88	75-86
Elapsed time (hr)	2.9	2.4	3.9	3.0	2.2	3.4	2.8	4.3	3.6	4.8	5.8	3.5	4.4	5.3
	2.5-3.3	2.1-2.8	3.4-4.4	2.7-3.4	1.2-2.7	3.1-3.7	2.4-3.2	3.2-5.5	3.2-4.0	3.9-5.8	3.6-7.9	3.1-3.8	2.5-6.3	3.9-6.7
maximum	10	13	19	16	5	16	8	69	29	111	19	17	8	21
Distance between beds (km)	1.3	1.9	1.8	2.1	2.9	1.7	1.6	1.4	1.2	1.5	5.5	1.4	4.6	3.6
	1.0 - 1.5	1.5-2.3	1.5-2.1	1.9-2.4	1.1-4.7	1.5-1.9	1.3-1.9	1.1-1.7	1.0-1.4	1.2-1.9	3.5-8.3	1.1-1.6	2.6-6.5	2.2-5.1
maximum	5.7	11.6	12.6	12.4	22.5	9.7	6.8	11.2	15.9	32.0	19.6	23.5	6.8	23.0

Table 3. Continued.

Factor	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
Aspect (degrees)	173	145	145	177	162	189	129	142	175	132	218	115	104	201
	161-186	126-165	131-158	163-190	118-207	175-203	117-141	128-157	164-186	104-161	139-298	103-128	65-143	164-237
Elevation (m)	1807	1546	1613	1738	1542	1664	1707	1553	1633	1740	1669	1657	1799	1587
	1778-1835	1521-1572	1581-1645	1722-1755	1522-1562	1649-1680	1676-1737	1536-1569	1613-1654	1692-1787	1587-1750	1639-1675	1688-1910	1548-1626
Slope (degrees)	25	22	20	22	11	17	20	15	15	24	11	9	17	13
	21-28	19-24	18-22	21-24	7-15	15-18	17-23	13-18	13-16	18-29	4-17	8-11	9-25	8-18

Table 3. Continued.

	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
Distance to water (m)	418	249	363	343	731	397	244	935	343	289	3868	6122	282	753
	365-470	220-279	320-406	315-371	435-1027	364-431	191-297	735-1136	313-374	185-392	2336-5400	5541-6703	87-477	378-1129
Road density (km/km^2)	0.02	0.68	0.32	0.85	1.22	0.96	0.22	0.83	0.24	0.29	0.45	0.13	*	0.24
	0.00-0.04	0.52-0.84	0.24-0.40	0.68-1.03	0.45-1.99	0.84-1.08	0.12-0.32	0.62-1.03	0.18-0.30	0.00-0.64	0.04-0.87	0.00-0.26		0.11-0.38

Table 3. Continued.

	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
Distance to highway (km)	1.83	5.16	14.63	4.74	2.35	2.16	1.67	2.21	2.91	10.82	29.02	18.58	2.21	5.00
	1.66-	4.58-	14.02	4.42-	1.20-	1.96-	1.40-	1.99-	2.67-	7.82-	23.57	17.15	1.36-	3.84-
	1.99	5.57	-	5.07	3.49	2.36	1.95	2.43	3.15	13.83	-	-	3.05	6.16
minimum	0.15	0.39	15.24	0.51	0.07	0.06	0.09	0.03	0.03	3.29	34.47	20.01	0.57	0.73
			4.80								4.86	0.21		
Distance to High point (km)	4.24	2.55	3.55	2.60	2.02	1.74	2.01	3.40	2.91	3.92	5.95	20.10	2.65	3.45
	4.09-	2.32-	3.23-	2.42-	1.04-	1.58-	1.77-	3.03-	2.67-	3.72-	4.54-	18.6-	1.82-	2.62-
	4.38	2.77	3.86	2.78	3.00	1.89	2.24	3.77	3.15	4.12	7.35	21.60	3.49	4.28
minimum	1.78	0.19	0.27	0.22	0.12	0.08	0.20	0.28	0.03	0.77	0.98	0.24	0.83	0.59

Table 3. Continued.

	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
Distance to moderate point (km)	3.16	13.14	11.48	4.32	10.62	6.60	9.77	10.00	7.61	35.26	18.56	11.24	7.53	9.12
	3.00-3.31	12.45-13.83	10.88-12.08	3.93-4.70	9.93-11.32	6.15-7.06	9.32-10.21	9.52-10.48	7.28-7.94	33.38-37.13	15.19-21.93	10.53-11.96	5.89-9.17	7.42-10.81
minimum	0.91	1.48	4.66	0.33	5.65	0.52	5.88	1.67	1.33	0.07	0.57	0.24	4.34	0.38
Distance to low point (km)	3.33	6.28	6.77	1.99	9.35	2.41	3.77	14.10	4.74	35.47	18.64	12.83	4.02	5.81
	3.19-3.47	5.81-6.74	6.42-7.13	1.86-2.12	6.48-12.23	2.24-2.57	3.38-4.17	13.16-15.04	4.47-5.02	33.64-37.29	14.44-22.83	11.93-13.73	2.81-5.24	4.98-6.65
	1.08	0.54	0.91	0.18	1.34	0.23	0.63	6.19	0.29	0.66	1.40	0.50	2.16	1.03

Table 3. Continued.

	Bear Id (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(154)	(137)	(205)	(266)	(28)	(275)	(89)	(154)	(311)	(273)	(26)	(300)	(9)	(44)
Greenness	9.4	7.9	8.5	5.3	7.6	7.0	8.9	7.9	7.6	5.1	8.0	7.3	7.2	7.4
	9.1-9.8	7.5-8.2	8.2-8.8	4.9-5.6	6.9-8.3	6.7-7.3	8.5-9.4	7.6-8.3	7.3-7.8	4.9-5.3	7.1-8.9	7.1-7.5	5.7-8.7	6.6-8.2

Table 4. Summary movement statistics for GPS-marked grizzly bears, captured in northwest Montana, 1999-2001. Sample sizes (*n*) are the number of discrete movement vectors identified within individual relocation databases. Maximum values are given for factors where maximum values were deemed important.

	Bear ID (*n*)													
	14	921	293	922	224	37	42	289	34	36	365	38	6	12
Factor	(157)	(136)	(204)	(266)	(29)	(276)	(90)	(155)	(312)	(272)	(27)	(301)	(10)	(45)
Mean % Fix Success	71.5	68.8	81.1	86.0	72.1	82.8	83.7	68.4	77.1	70.4	83.6	76.9	61.3	68.5
+/- 95% CI	67 -75	65-73	78-84	84-88	63-81	80-85	79-88	64-72	74-80	67-74	74-93	74-79	44-78	60-76
Mean duration (hrs)	10.9	15.9	6.6	8.4	8.7	6.7	5.7	7.5	5.6	4.9	7.8	5.0	12.5	7.4
+/- 95% CI	9-13	11-21	6-8	7-9	6-11	6-8	4-7	5-9	5-6	4-6	5-10	4-6	4-21	5-10
Maximum duration	67	209	37	45	21	69	54	89	41	34	30	49	36	33
Mean move length (km)	2.7	6.5	3.7	4.4	4.6	2.9	2.6	3.6	2.0	2.5	7.8	2.1	6.7	4.9
+/- 95% CI	2-3	4-9	3-4	4-5	3-7	2-3	2-3	3-5	1-2	2-3	5-10	2-3	4-9	3-7
Maximum	21	113	32	33	28	19	15	47	20	37	26	38	15	25
Mean displacement (km)	1.3	1.9	1.8	2.1	2.8	1.7	1.6	1.4	1.2	1.5	5.6	1.4	4.3	3.6
+/- 95% CI	1-1.5	1-2	1-2	1-2.3	1-4	1-2	1-2	1-2	1-1.3	1-2	3-8	1-2	2-6	2-5
Maximum	6	12	13	12	23	10	7	11	16	32	20	23	7	23
Mean Distance between relocations (m)	300	527	466	457	600	398	394	460	304	427	1008	360	1083	638

Table 5. Mean generalized linear model parameter estimates, their minimum and maximum values, confidence intervals, and significance for a spring season model of residence time, jacknifed from 14 GPS-marked grizzly bears, captured in northwest Montana, 1999-2001. Model loglikelihood was -937.753.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Intercept	1.888216	1.753458	2.022974	1.151352	2.196721	0.062830	17.544576	0.000028
Aspect	-0.000079	-0.000162	0.000004	-0.000399	0.000206	0.000039	0.013122	0.908800
Elevation	-0.000385	-0.000444	-0.000326	-0.000581	-0.000179	0.000028	2.726834	0.098675
Slope	-0.001913	-0.002354	-0.001472	-0.003415	-0.000619	0.000206	0.651665	0.419518
Distance to water	0.000188	0.000165	0.000210	0.000089	0 .000279	0.000011	1.482840	0.223331
Road Density	0.000411	0.000158	0.000664	-0.000573	0.001213	0.000118	0.062772	0.802167
Highway distance	0.000062	0.000058	0.000065	0.000042	0.000074	0.000002	2.820011	0.093096
Hi-point distance	-0.000070	-0.000077	-0.000064	-0.000087	-0.000042	0.000003	0.790071	0.374079

Table 5. Continued.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Mod-point distance	-0.000031	-0.000037	-0.000024	-0.000047	-0.000003	0.000003	4.721735	0.029784
Low-point distance	-0.000043	-0.000047	-0.000038	-0.000056	-0.000029	0.000002	2.343665	0.125793
Temperature	0.000018	-0.000000	0.000036	-0.000049	0.000071	0.000009	0.016736	0.897068
Wind speed	-0.000582	-0.000819	-0.000344	-0.001159	0.000207	0.000111	0.037235	0.846987
Greenness	0.019360	0.013832	0.024888	0.003553	0.049646	0.002577	0.157745	0.281934

Table 6. Mean generalized linear model parameter estimates, their minimum and maximum values, confidence intervals, and significance for a summer season model of residence time, jacknifed from 14 GPS-marked grizzly bears, captured in northwest Montana, 1999-2001. Model loglikelihood was -1174.06.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Intercept	1.642637	1.529878	.755396	.398985	2.239047	0.052573	65.081578	0.000000
Aspect	-0.000582	-0.000644	-0.000521	-0.000809	-0.000365	0.000029	27.655118	0.000000
Elevation	-0.000204	-0.000240	-0.000168	-0.000377	-0.000095	0.000017	9.835691	0.001712
Slope	0.002153	0.001815	0.002490	0.000349	0.003028	0.000157	12.458289	0.000416
Distance to water	0.000146	0.000118	0.000174	0.000051	0.000249	0.000013	8.426758	0.003697
Road Density	-0.002818	-0.002999	-0.002637	-0.003544	-0.001945	0.000084	74.365454	0.000000
Highway distance	0.000005	0.000003	0.000007	-0.000005	0.000010	0.000001	2.009291	0.156338
Hi-point distance	-0.000019	-0.000024	-0.000015	-0.000033	-0.000001	0.000002	5.658868	0.017367
Mod-point distance	-0.000013	-0.000016	-0.000010	-0.000024	-0.000004	0.000001	6.011195	0.014215

Table 6. Continued.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Low-point distance	0.000012	0.000004	0.000019	-0.000028	0.000030	0.000003	0.814962	0.366657
Temperature	0.000106	0.000087	0.000124	0.000036	0.000169	0.000009	9.822511	0.001724
Wind speed	-0.002699	-0.003049	-0.002349	-0.004328	-0.001902	0.000163	18.237882	0.000019
Greenness	0.002953	-0.001166	0.007072	-0.011812	0.022776	0.001921	0.157612	0.691364

Table 7. Mean generalized linear model parameter estimates, their minimum and maximum values, confidence intervals, and significance for a fall season model of residence time, jacknifed from 14 GPS-marked grizzly bears, captured in northwest Montana, 1999-2001. Model loglikelihood was -415.643.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Intercept	1.977924	1.458873	2.496975	-0.019162	4.232814	0.242006	4.453241	0.034835
Aspect	0.000967	0.000799	0.001136	0.000443	0.001831	0.000078	10.149113	0.001444
Elevation	-0.000454	-0.000724	-0.000184	-0.001642	0.000690	0.000126	0.868655	.351328
Slope	0.003202	0.002362	0.004042	-0.001479	0.005962	0.000391	4.460059	0.034696
Distance to water	-0.000127	-0.000188	-0.000067	-0.000224	0.000242	0.000028	1.353497	0.244668
Road Density	0.000408	-0.000009	0.000826	-0.000776	0.002465	0.000195	0.293400	0.588050
Highway distance	-0.000023	-0.000032	-0.000015	-0.000071	-0.000003	0.000004	2.586389	0.107786
Hi-point distance	0.000113	0.000090	0.000136	-0.000016	0.000165	0.000011	7.463715	0.006295

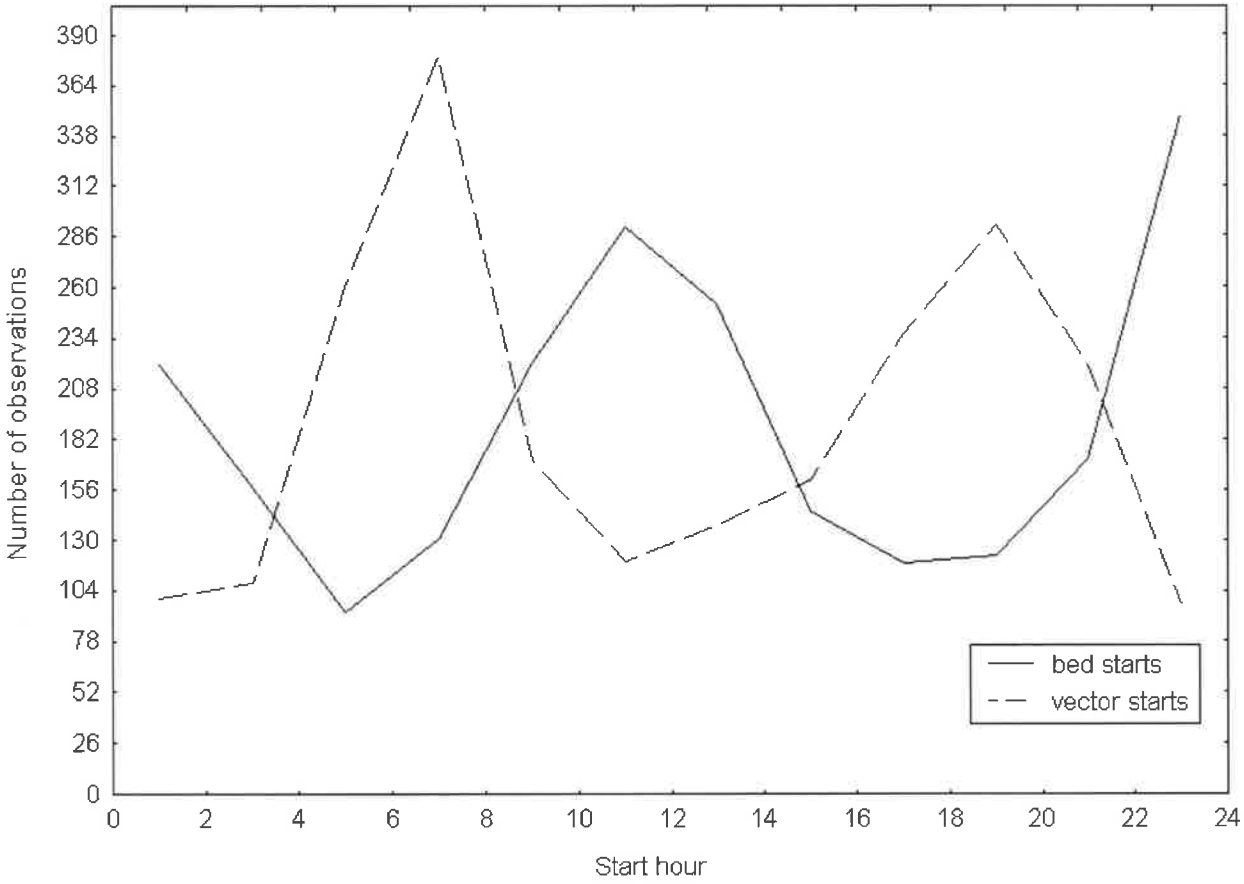
Table 7. Continued.

Parameter	Mean	Lwr 95%	Upper 95%	Minimum	Maximum	S.E.	Wald	P
Mod-point distance	-0.000017	-0.000026	-0.000008	-0.000038	0.000033	0.000004	1.098016	0.294702
Low-point distance	-0.000030	-0.000042	-0.000018	-0.000098	0.000003	0.000005	2.000108	0.157288
Temperature	-0.000219	-0.000230	-0.000208	-0.000263	-0.000188	0.000005	129.075828	0.000000
Wind speed	0.004342	0.002917	0.005768	-0.000888	0.010316	0.000665	2.846182	0.091591
Greenness	0.036580	0.025491	0.047669	-0.028249	0.069982	0.005170	3.337128	0.067733

Table 8. Diagnostic statistics for seasonal generalized linear models of residence time developed from 14 GPS marked grizzly bears captured in northwest Montana, 1999-2001. The ratio of the diagnostic statistic to the degrees of freedom is a measure of overdispersion.

Season	d.f	Deviance	Scaled Deviance	Pearson Chi2	Scaled Pearson Chi2
Spring	432	247.582	488.234	273.173	538.699
(statistic/d.f.)		(0.573107)	(1.130171)	(0.632345)	(1.246988)
Summer	521	340.27	590.36	351.72	610.22
(statistic/d.f.)		(0.653111)	(1.133130)	(0.675080)	(1.171245)
Fall	163	120.954	198.767	117.459	193.024
(statistic/d.f.)		(0.742049)	(1.219432)	(0.720608)	(1.184197)

Figure 1. Start times of resting points and traveling points (in Mountain daylight savings time) by hour for 14 GPS-marked grizzly bears captured in northwest Montana, 1999-2001.



CHAPTER 3: COMPARING GPS AND VHF TELEMETRY: IMPLICATIONS FOR HOME RANGE AND HABITAT SELECTION STUDIES

Abstract: Studies of animal movement and habitat selection are evolving rapidly thanks to collar-borne global positioning (GPS) receivers and new statistical methods. However, the implications of radically different telemetry sampling regimes on standard techniques and methods have not been completely explored. I used GPS telemetry and concurrent aerial very high frequency (VHF) telemetry data, collected from instrumented grizzly bears (*Ursus arctos*), to examine spatial and temporal differences between these systems and examined how home range size and habitat selection changed with increasing sample size. I used GPS data to evaluate a cumulative effects model (CEM) and a linkage zone prediction (LZP) model. On average, aerial VHF telemetry collected ~ 1% of the number of locations that GPS obtained, and generally sampled < 1% of the total number of hours available for sampling, compared to ~ 65% with GPS. Aerial VHF telemetry locations were biased towards morning when flying conditions were best, whereas GPS locations were more evenly distributed during the day. Both GPS and aerial VHF telemetry sampled similar proportions of moving and stationary locations, although VHF telemetry sampled temporally longer vectors proportionally more than shorter vectors, whereas GPS telemetry consisted of proportionally more short vectors. The temporal distribution of stationary locations was also more strongly right-skewed for GPS telemetry than VHF telemetry, which sampled proportionally more long stationary periods. The distributions of environmental variables sampled during GPS and concurrent VHF telemetry did not differ for most variables. Overall, changes in selection rankings were fewest between 4 and 24 locations/day and greatest between 1/week and 8/day. Habitat selection based on VHF telemetry was quite different than selection based on GPS telemetry for some bears. However, for most bears, VHF telemetry sampled all 4 utilization distribution (UD) isopleths within 95% kernel home ranges constructed from GPS data. Annual 95% kernel home range size declined with increasing GPS sampling intensity for most bears, and all individuals showed strong selection among habitat types and high concordance among sampling intensities within habitats. The strength of selection declined as sampling intensity increased, but the most strongly selected habitats remained so across nearly all GPS sampling intensities. On average, VHF MCP home ranges were only 30% of the area of GPS polygons, and frequently missed areas with significant concentrations of GPS telemetry points. I suggest that the capabilities of GPS collars may invalidate the need for complex home range estimators and that fine-scale GPS telemetry data may more accurately be described as a spatio-temporal census. I found no relationship between grizzly bear GPS telemetry points or movement paths and scored human impact categories within the LZP model. The shape of the distribution of CEM values among grizzly bear GPS telemetry points closely matched the distributional shape of values across our study area, although the mean value of GPS points was higher than the study area average.

INTRODUCTION

Studies of animal movement and habitat selection are now evolving rapidly due to the increasing availability of collar-borne GPS receivers, which have dramatically increased our ability to track animals through space and time. Concurrent advances in statistical methods such as generalized linear models and multivariate logistic regression are also transforming the analysis of wildlife telemetry data. However, the implications of radically different telemetry sampling regimes on standard techniques and methodologies, such as home range analyses and use-availability analyses, have not been completely explored. Many authors have recognized pitfalls associated with calculating use-availability metrics (McClean et al. 1998, Garshelis 2000, Morrison 2001). Numerous authors have addressed some of the implications of radically increased sample sizes on home range estimators (Arthur and Schwartz 1999, Girard et al. 2002) and habitat selection (Belant and Follmann 2002). However, fine scale GPS location data can be used to validate and index traditional methods of measuring habitat utilization by empirically describing the level and intensity of telemetry necessary to develop an unbiased estimate of the patterns revealed from GPS data sets.

Here, I used fine-scale GPS telemetry and concurrent aerial VHF telemetry data, collected during a study of the effects of transportation developments on bears (Waller and Servheen, In press) to examine the spatial and temporal differences between these methods, and then examined how home range size and habitat selection changed with increasing sample size. Other authors have relied on random-draw subsets and simulations to assess the effects of sample size on home range estimates and habitat selection (Seaman et al. 1999). I used actual VHF telemetry to take a closer look at concurrent GPS data and assess how habitat selection can change with changes in methodology. My GPS sampling rate and concurrent VHF relocation rate exceeded that of any previous grizzly bear research effort.

Mace et al. (1999) included a portion of my study area south of US Highway 2 in their habitat model extrapolation area. Their model used resource selection functions (RSF; Manly et al. 1993), developed using grizzly bear telemetry data from the northern Swan Mountains, to estimate relative probability of use at 30 m resolution for spring, summer, and fall seasons. Model outputs were expressed as habitat effectiveness (HE) and habitat value (HV). The latter was the relative probability of use in the absence of human developments (Mace et al. 1999). A slightly modified form of this model was used as a cumulative effects model (CEM) for the Northern Continental Divide Ecosystem (NCDE), which included my entire study area (Waller 1999).

Servheen and Sandstrom (1993) and Mietz (1994) developed a Linkage Zone Prediction (LZP) model that used landscape and human development features to predict where grizzly bears might successfully cross developed areas between suitable habitats. No telemetry data was used to build the model; rather, expert opinion was used to score the landscape as to its relative permeability to bears. Servheen et al. (2001) expanded this effort to evaluate potential linkage between grizzly bear recovery areas.

These 2 models are important to current grizzly bear management and future conservation efforts. The CEM model is currently being used to assess the impact of U.S. Forest Service land management activities in the NCDE. The LZP models are a component of the Grizzly Bear Recovery Plan (USFWS 1993), and will be used to direct conservation efforts to areas where the most benefit can be derived. I used my GPS data to evaluate how well the CEM and LZP models matched observed grizzly bear habitat-use and movement patterns.

STUDY AREA

My 2730 km^2 study area consisted of 4, 5th-order watersheds straddling the Continental Divide, approximately between Essex and East Glacier, Montana. Most of the study area lay within the Bob Marshall wilderness complex or in Glacier National Park, which were separated by US Highway 2 (US-2). The study area included the valley bottoms of the Middle Fork of the Flathead River and Bear Creek valley, the Continental Divide and Marias Pass (elevation 1610 m). East of Marias Pass, the study area encompassed portions of the prairie biome, paralleling the South Fork of the Two Medicine River and including western portions of the Blackfeet Indian Reservation (BIR).

A major railroad line paralleled US-2 for its entire length within the study area. This railroad line was a primary freight corridor between Chicago, Illinois, and Seattle, Washington, and was also the primary means of transporting grains from eastern Montana and North Dakota to markets on the west coast.

Small concentrations of homes, businesses, ranches, and small communities existed within the US-2 corridor, but the majority of the area was undeveloped federal land, (36% of the area lay within the boundaries of Glacier National Park). U.S. Forest

Service lands were managed primarily for recreation, timber harvest, and grazing. Tribal lands were managed primarily for cattle grazing.

Topography varied from flat valley bottoms to steep mountainsides. Dominant vegetation was primarily coniferous forest in the western portions of the study area, where a Pacific maritime climate predominated. Open grass/forb/aspen communities were more common in the east where the climate was continental. The collision of these 2 climatic regimes often resulted in unsettled weather conditions. Riparian areas and avalanche chutes are preferred grizzly bear foraging areas (Waller and Mace 1997, McLellan and Hovey 2001) and occurred in numerous locations within the study area.

METHODS

Capture and Telemetry

I captured grizzly bears using Aldridge snares or culvert traps using standard techniques (Johnson and Pelton 1980, Jonkel 1993), or on the BIR, darted from tree stands placed over livestock carcasses (Jonkel 1993). All trapping occurred during the months of June and July 1998–2001. During 1999 and 2000, captured female grizzly bears weighing $\geq$ 91 kg were fitted with a Telonics Generation II® store-on-board GPS collar (Telonics Inc., Mesa, Arizona, USA). During 2001, the final year of fieldwork, I collared both male and female grizzly bears.

GPS collars obtained a position once every hr, 24 hr per day, and location information was stored within the collar. I chose the hourly location rate as a reasonable compromise between battery life and spatial specificity. I estimated battery life would be about 120 days, which was sufficient to provide GPS positions between time of trapping and denning. Because the collar needed to be retrieved and downloaded to obtain the accumulated information, all collars were equipped with a VHF beacon and a programmable breakaway device. The VHF beacon operated concurrently with the GPS unit, and through variable pulse rates, provided information about GPS system status and/or animal mortality. After GPS collars were retrieved and downloaded to a computer, positions were differentially corrected using Trimble Pathfinder Office® (Trimble Navigation Ltd., Sunnyvale, California, USA) and proprietary software developed by Telonics Inc.

I located all transmitters twice-weekly from a Cessna 185 fixed-wing aircraft (Cessna Aircraft Co., Wichita, Kansas, USA), as weather conditions allowed, to keep track of animals and provide timely cause-specific mortality information. A pilot and observer homed in on the VHF beacon using 2-element H-antennas affixed to each wing strut. A location was considered adequate when the bear was spotted, or when the signal could be pinpointed to a relatively small area from approximately 150 m above ground level. The pilot then recorded the position on a GPS unit and the observer took a self-developing photograph of the vicinity and circled the position on the photo. Upon return from the flight, all location coordinates were double-checked against digital orthophoto quadrangles and entered into a computer database. Aerial telemetry error was approximately 150 m, based on informal error testing using radio collars placed in the field by assistants.

Environmental variables

I obtained digital cover-type maps from the U.S. Forest Service and imported them into our computerized geographic information system (GIS). The Wildlife Spatial Analysis Lab at the University of Montana produced these maps by classifying Thematic Mapper satellite imagery (Redmond et al. 1998). The Flathead National Forest made further refinements based on potential vegetation types and recent wildfires. The minimum mapping unit for these maps was 2.5 ha. I simplified the map by combining similar vegetation types, thus reducing the number of cover types from 25 to 7. The 7 cover types were rock (barren/non-vegetated), grassland, parkland (open stands of conifers with grass understory), deciduous (mixtures of deciduous trees and shrubs), mesic conifer forest (mixtures of shade-tolerant conifers on moist sites), dry conifer forest (mixtures of shade intolerant conifers on dry sites), and water (ponds, lakes, and streams).

I obtained grizzly bear habitat quality maps from the U.S. Forest Service, constructed during cumulative effects modeling efforts for the NCDE (Mace et al. 1999). The habitat quality values were from resource selection function models derived from grizzly bear telemetry locations during an earlier study (Mace et al. 1999). These habitat quality values were most strongly influenced by elevation and greenness. Greenness was a measure of herbaceous phytomass and was strongly related to grizzly bear habitat selection (Mace et al. 1999, Stevens 2002).

I constructed digital maps of US-2 and the railroad within the study area by digitizing these features on U.S. Geological Survey (USGS) orthophoto quadrangles having 1 m resolution. I obtained hydrological and 10 m digital elevation data from the USGS. The U.S. Forest Service, as part of its cumulative effects modeling efforts, classified campgrounds, housing, and other types of human developments into low, moderate, or high-impact categories based upon a Delphi consideration of their perceived impacts on grizzly bears. I obtained these digital maps of human impact points from the U.S. Forest Service, and then created maps displaying the distance from each of these development categories. I constructed a road density layer by running a moving circle procedure on digital road maps obtained from U.S. Forest Service and U.S. Census Bureau TIGER files. The moving circle (or focal-sum) process assigned the number of 30-m road cells within a 1 km circle to the center cell. The circle thus moved across the map assigning a value to every cell (Mace et al. 1996). I used ArcView GIS v.3.2 (ESRI Inc., Redlands, California, USA) for all GIS analyses.

Data analysis

For each individual bear with concurrent VHF and GPS telemetry locations, I matched each VHF telemetry position with its nearest temporally-matching GPS position. Positions were matched to the nearest hour. I then tabulated the total number of hours available for monitoring (length of time the bear wore the GPS collar), the number of GPS positions obtained, and the number of VHF positions obtained. All GPS positions had previously been attributed as either moving or stationary (Waller 2005, this volume), so each VHF position could be identified as occurring during a moving or stationary event. I then compared the sampling distributions of moving and stationary events within the VHF and GPS telemetry data sets. I also calculated the temporal and spatial distance between each VHF relocation and its nearest GPS position, and noted where GPS positions fell within the VHF error polygon. I attributed each VHF and GPS position with values from the GIS layers described in the previous section, compared the proportional distribution of habitat types within GPS and VHF samples, and then tested for pooled differences in habitat values using T-tests for dependent samples (Statsoft 1999).

I calculated the areal extent of each bears annual 100% minimum convex polygon (MCP) home range (Burt 1943, Hayne 1949) using GPS and VHF data in turn, and then examined the size differences. Next, using GPS telemetry points, I calculated each bears annual 95%, 75%, 50%, and 25% fixed-kernel home range isopleths with the Animal Movement extension for ArcView GIS (Hooge and Eichenlaub 1997). I allowed the program to automatically select the appropriate smoothing parameters for each individual and did not perform least squares cross validation (Worton 1989) due to the large size of the GPS data sets. I then overlaid the VHF telemetry points on these estimated UDs to see how well VHF telemetry sampled these distributions.

To examine how habitat use and availability changed with varying sampling intensity and methods, I chose 7 arbitrary sampling regimes. I subdivided our GPS telemetry database, which was collected at a 24 times/day sampling intensity, into 5 additional sampling intensities: 1/week, 3 /week, 1/day, 4 /day, 8 /day, and 12 /day. For the 1/ week subset, I uniformly chose the 1st location of the day on the 1st day of the week. These locations were usually in the early morning hours. For the 3 /week subset, I selected the 1st location of a random day within that week. These locations were also generally during early morning hours. For the 1/day subset, I uniformly chose the 1st location of the day. Again, these were generally during early morning hours. For the 4/day and 8 /day subsets, I drew locations at regular 6 and 3 hr intervals respectively, starting at 0000 hr. For the 12 /day subset, I selected every other location, again starting at 0000 hr. The 7th and last level of sampling intensity consisted of the entire VHF telemetry data set for each bear. Locations were generally twice/week, but were occasionally missed due to weather, schedule conflicts, or aircraft malfunction. Although it would be possible to sub-sample the GPS locations to simulate an aerial telemetry sample, it would be difficult to retain the biases inherent to aerial telemetry (e.g. weather patterns, temporal variations, observer experience, etc.).

I used each subset of each bear's telemetry points to construct a unique 95% fixed-kernel home range polygon and noted how home range size changed with sampling intensity. I used each of these home range polygons to define the availability of cover types, (described in the previous section), to each individual bear at that particular sampling intensity. The actual intersection of points and cover types served to define the use of that cover type for each individual at that sampling intensity. I calculated the difference between the percent used and percent available and tested for significance with a Friedman non-parametric ANOVA on ranks (White and Garrott 1990, Conover 1980). Changes within habitats and between intensities were quantified using Spearman rank-order correlation and Kendall's coefficient of concordance (Sokal and Rohlf 1995). I illustrated the changes in habitat selection for each individual by graphing the percent differences in use and availability against sampling intensity by individual.

Model testing

I used GIS to overlay annual 95% kernel home ranges and GPS points from 14 grizzly bears on a map derived from the LZP model, which displayed the landscape in 4 human-impact categories (minimal, low, moderate, and high). I then calculated the percent of each of the 4 impact categories available within each individual home range. I compared these to the percent of GPS points within each category for each individual. I tested for selection for or against the impact levels with a Friedman test as described above. Next, I examined the distribution of highway crossing points for 6 individual bears in relation to their classification by the LZP model. Highway crossings were assumed to occur at the intersection of the highway and a straight line connecting subsequent hourly locations on either side of the highway (Waller 2005, this volume). Finally, I counted the number of highway crossings that occurred inside and outside areas identified by Servheen et al. (2001) as linkage zones.

For each of 14 individual bears, I overlaid spring (from capture to 15 July), summer (16 July – 15 September), and fall (16 September to collar drop) GPS points on their respective seasonal CEM maps in our GIS. I then compared the observed mean RSF values and distributions to that observed within the study area. I assessed model performance by how closely our observed points fit model predictions. Finally, I used spring-season CEM model outputs to assess habitat quality within LZP impact categories.

RESULTS

Capture and Telemetry

I captured 43 different grizzly bears in 51 capture events (13 adult males, 11 subadult males, 10 adult females, and 9 subadult females). I deployed 22 VHF radios on 19 individuals (3 individuals had VHF radios replaced) and 23 GPS collars on 23 individuals. From this sample I identified 13 individuals with concurrent VHF/GPS telemetry, of which 10 were suitable for analysis (Table 1).

I collected 912 aerial telemetry locations in 242 hrs of flight time during 1998–2001, and 20,944 GPS positions during 1999–2001. Four of the 9 GPS collars deployed in 1999 and 2000 functioned properly. One collar failed due to a fault in the antenna power supply and 4 failed to initialize properly. I recovered 10 of 14 GPS collars deployed in 2001, and 2 of the 10 failed prematurely. Four GPS collars were not recovered due to failure of the automatic release mechanism. Success rate over all hourly GPS position attempts was 72% for all locations. Accuracy of differentially corrected locations, expressed as 95% circular-error probable (CEP; the distance from the true location encompassing 95% of the positions), was 22.4 m for 3D locations and 67.7 m for 2D locations (Graves 2002).

On average, VHF telemetry collected about 1% of the number of locations that GPS obtained ($\bar{x}$ = 1.18%; Table 1). Our aerial VHF telemetry generally sampled less than 1% of the total number of hours available for sampling ($\bar{x}$ = 0.78%), compared to over 65% with GPS ($\bar{x}$ = 65.43%; Table 1). Only 10 individuals provided GPS data and concurrent VHF telemetry data of sufficient sample size to compare differences (Table

1). Temporal distribution of VHF and GPS telemetry differed. Aerial VHF telemetry locations were highly biased towards morning when flying conditions were best (Figure 1). My GPS locations were more evenly distributed, although relocation rate did vary during the day (Figure 2), most likely due to behaviorally mediated changes in habitat use (Graves and Waller, In press). Both GPS and VHF telemetry sampled similar proportions of moving locations (GPS 70.3%, VHF 80.7%) and stationary locations (GPS 29.7%, VHF 19.3%). However, VHF telemetry sampled temporally longer vectors proportionally more than shorter vectors (Figure 3), whereas GPS telemetry consisted of proportionally more short vectors (Figure 4). The temporal distribution of stationary locations was also strongly right-skewed for GPS telemetry (Figure 5) compared to VHF telemetry which sampled proportionally more long stationary periods (Figure 6).

The average elapsed time between each of 163 VHF locations and its contemporary GPS location was 3.59 hr (range = 5 sec to 13 days). The spatial distance between these locations averaged 863.1 m (range = 10.1 – 19,142.5 m). There was no strong correlation between spatial and temporal distance ($r = 0.05$). The distributions of environmental variables sampled during GPS and concurrent VHF telemetry did not differ for most variables (Table 2), and cover types were similarly represented (Table 3).

I estimated that our aerial VHF telemetry error was approximately 150 m, and this is consistent with previous estimates (Waller and Mace 1997). Of 163 concurrent VHF and GPS telemetry points, 31 were within 150 m of one another (19%). Average elapsed time between them was 27 min.

Home range analyses

Home ranges (100% MCP) constructed using VHF and GPS samples were very different (Table 4). On average, VHF home range polygons were only 30.3% of the area of GPS polygons, and for 6 of 10 bears with VHF MCP areas < 32.5% of GPS MCP area, VHF polygons missed areas with significant concentrations of GPS telemetry points (Table 4). However, for most bears, VHF telemetry sampled all 4 UD isopleths within 95% fixed-kernel home ranges constructed from GPS data (25%, 50%, 75%, and 95% isopleths; Table 5). Annual 95% kernel home range size declined with increasing GPS sampling intensity for most bears (Figure 7).

Habitat selection

All individuals showed strong selection among habitat types and relatively high concordance among sampling intensities within habitats (Table 6). The strength of selection generally declined as sampling intensity increased (Figures 8–9). The most strongly selected habitats remained so across nearly all GPS sampling intensities for all bears; 8 bears remained unchanged and 2 showed minimal changes at lower sampling intensities (Figures 8–9). The same was true for the least selected habitat type; 6 bears remained unchanged across all GPS sampling intensities while 4 showed minor changes at lower sampling intensities (Figures 8–9). However, for 4 bears, selection as determined from GPS was dramatically different from that of VHF, with habitats generally changing from least to most selected and vice versa. Overall, changes in selection rankings were fewest between 4 and 24 locations per day and greatest between 1 per week and 8 per day (Figures 8–9).

Model testing

Within the LZP model map, the high, moderate, and low impact categories comprised a small proportion of the total landscape Observed use of impact categories was proportional to their occurrence and I detected no selection ($\chi^2 = 5.03$, df = 3, $P = 0.17$). I identified 39 crossings by 6 individual bears (Waller 2005, this volume); 11 occurred within the minimal, 10 within the low, 12 within the moderate, and 6 within the high impact categories. Ten of the 39 crossings (25.6%) occurred within areas identified by Servheen et al. (2001) as linkage zones. Mean HV values in the minimal impact category were higher than those in the low, moderate and high impact categories (Table 8).

The distribution of observed HE values was similar to that in the seasonal CEM maps, being highly right skewed for most bears (Figures 10–11). Mean observed HE values were slightly higher than available within the study area (Table 7). Mean HV values were slightly higher than average study area HE values (Table 7–8).

DISCUSSION

I found that our GPS collars were quite effective at obtaining many locations per day, far exceeding the capabilities of conventional aerial VHF telemetry. However, our GPS collars had a 39% failure rate, and cost per collar was high (~$3500 US/collar). Given the disparity in temporal sampling intensity between GPS and aerial VHF telemetry, I was surprised at the apparent efficiency of VHF telemetry at sampling different movement categories (moving or stationary), environmental classes (e.g. cover type, distance from developments), and UD isopleths. The similarity in environmental classes between concurrent GPS and VHF telemetry data sets is somewhat surprising given that the average time and distance between them averaged 5 hr and 800 m, and that only 19% were within 30 min/150 m.

Our finding that the size of MCP home range polygons increase, and that the size of kernel home range polygons decrease, with sample size was expected and is consistent with previous research (Hansteen et al. 1997, Arthur and Schwartz 1999, Belant and Follmann 2002). Previous authors have attempted to quantify the accuracy of various home range estimators, most recently by assessing the change in home range size or size coefficient of variation with increasing sampling intensity (Arthur and Schwartz 1999, Belant and Follmann 2002), and arbitrarily assigning a cut point at which further additions have minimal influence on home range size. However, Seaman et al. (1999) point out that other factors can strongly influence home range and UD estimates, including the underlying distribution of relocations and the particular method used to estimate the kernel UD. I suggest that the capabilities of GPS collars, in many cases, may invalidate the need for complex UD estimators. Instead, simpler bivariate histogram methods may be used. This would eliminate problems associated with meeting the independence assumptions of kernel UD estimation. Anderson (1982) summarily dismissed bivariate histograms as useful estimators of UDs due to perceived subjectivity in the selection of cell size, origin, and orientation of the axes. Given the typical spatial and temporal resolution of telemetry data available at the time that was a reasonable assertion; telemetry points could logically be considered independent samples from a UD, thus lending themselves to more efficient estimation techniques. Now, however, fine scale GPS telemetry data may more accurately be described as a spatio-temporal census, at least at the scales in which most wildlife research is conducted. Such fine scale GPS telemetry can have high degrees of temporal and spatial autocorrelation. While Otis and White (1999) argue that such autocorrelation is inconsequential if proper study design is applied (e.g. treating animals rather than locations as sample units), such autocorrelation does violate the independence assumption underlying all UD estimators. This only begs the question why we wish to estimate a distribution that is essentially known. Bivariate histograms are an appropriate tool for examining home ranges under such conditions. Choice of ordinates, orientation, and cell-size may indeed be arbitrary, but can be grounded in common concepts. Intuitive axis orientations might be east-west and north-south. Choice of cell size can be intuitively based on common measures of distance such as cm, m, or km. Ostro et al. (1999) presented a non-statistical alternative that used digitized polygons of movement paths. I suggest that use of these alternative approaches would facilitate investigation of questions related to spatial and temporal scale.

A common use of home range estimators is to define habitat 'availability' within a use/availability analysis. One can argue that a 95-100% MCP or kernel home range provides a rational delineation of an area likely available to an animal during some period of time. Our finding that home range area changed noticeably with sample size would suggest that determinations of habitat selection based on availability defined by home ranges would be extremely suspect. On the contrary, I found that habitat selection was reasonably constant within habitat types across sampling intensities. In most cases, the most highly selected types (+/-) retained their ranks, showing that strong selection is robust to sampling intensity. Interestingly, the strength of selection declined as intensity increased. This is an expected result of using a UD estimator to define availability for fine scale telemetry data: as the UD shrinks, availability approaches use, and thus is an argument against using UD estimators to define availability.

Despite the surprisingly good performance of VHF telemetry and the apparent robustness for strongly selected types, it was less so for weaker types. Indeed, I observed some dramatic reversals in habitat selection, particularly for males, between GPS and VHF telemetry. Despite what appeared to be a strong showing by VHF telemetry, I believe that habitat selection results at lower sampling intensities are questionable; 8 locations/day would seem to be the minimum sample size based on these results for grizzly bears. I suspect that these results would vary based on species and locale because the underlying relationship between home range area, sampling intensity, and movement rate would differ. For example, I found that if VHF MCP home range areas were less than 32.5% of GPS MCP home range area, significant areas of concentrated use were missed. Given an equal telemetry effort, species having smaller home ranges would have had more samples/unit area, and thus would have missed fewer areas of concentrated use.

My VHF telemetry sample sizes in this analysis were very low because they only represented 1 year of data, and fall below the minimum of 50 locations generally recommended for estimating stable kernel home ranges (Seaman et al. 1999). I suspect that if multiple years had been available, habitat selection results would have been more consistent with those based on GPS telemetry.

My results did not demonstate that the LZP model predicted where grizzly bears might choose to traverse human-impact areas (termed fracture zones) and I detected no selection for or against the 4 human-impact zones. However, these results are uncertain because, even though there was very little use of high-impact zones, there was very little high impact area available in the study area. Furthermore, habitat quality was not high in the higher-impact areas predicted in the model. The model was designed to predict areas where bears are at less risk of conflicts with human activities while traversing fracture zones, but I could not test this premise.

The distribution of CEM values within the study area closely matched the observed distribution of CEM values across GPS telemetry points. Given that CEM values are intended to represent relative probability of use, I expected to see higher use in the higher probability classes. However, observed use was much closer to that available within the study area, suggesting little or no selection for higher probability classes.

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Table 1. Summary of VHF and GPS telemetry effort for radio-collared grizzly bears with concurrent VHF and GPS telemetry in northwest Montana, 1999-2001.

Bear ID**	n - VHF	n - GPS	Year	VHFn/GPSn %	Total Hr Available	% Total Hr VHF/GPS
M12	4	406	2001	0.98	622	0.64/65.27
F14*	25	1551	1999	1.61	2732	0.91/56.77
m34*	19	2314	2001	0.82	3215	0.59/71.97
M36*	15	2006	2001	0.75	3296	0.45/60.86
f37*	21	2563	2001	0.82	3159	0.66/81.13
M38*	14	2135	2001	0.65	2963	0.47/72.05
F42*	6	749	2001	0.80	970	0.62/77.22
F224	10	236	2001	4.24	367	2.72/64.30
m289*	16	1177	2001	1.36	2041	0.78/57.62
f293*	16	1879	2000	0.85	2395	0.67/78.45
M365	3	264	2001	1.14	421	0.71/62.71
F921*	23	1570	1999	1.46	2715	0.85/57.83
F922*	30	2736	2000	1.10	3366	0.89/81.28
Total	202	19,586				

* Sufficient sample size for further analysis.

** M = adult male, m = subadult male, F = adult female, f = subadult female

Table 2. Variable means and results of T-tests for differences between environmental variables sampled at VHF and concurrent GPS locations of 10 grizzly bears in northwest Montana, 1999-2001.

Variable	$\bar{x}$ - VHF (+/- 95% C.I.)	$\bar{x}$ - GPS (+/- 95% C.I.)	*t*	df	*P*
Greenness	7.1 (6.7 – 7.5)	7.6 (7.2 – 8.0)	2.38	137	0.018
Road density	42.0 (33.9 – 50.2)	39.5 (30.7 – 48.4)	-1.06	42	0.294
Distance to water (m)	1132 (670 – 1595)	1114 (656 – 1572)	-0.13	148	0.896
Distance to highway (m)	5672 (4400 – 6944)	5836 (4566 – 7105)	1.75	148	0.081
Distance to high-impact point (m)	8206 (5925 – 10487)	8135 (5915 – 10356)	0.850	162	0.397
Distance to moderate impact point (m)	11663 (9882 – 13444)	11443 (9705 – 13181)	-1.31	162	0.191
Distance to low impact point (m)	9019 (7130 – 10908)	8946 (7100 – 10791)	0.398	162	0.691

Table 3. Number (and percent) of concurrent VHF and GPS positions within 6 cover types sampled from 10 grizzly bears in northwest Montana, 1999-2001.

Cover type	GPS (%)	VHF (%)
Parkland	37 (27)	38 (27)
Dry conifer	14 (10)	21 (15)
Mesic conifer	45 (32)	46 (33)
Deciduous	35 (25)	24 (17)
Grassland	5 (4)	6 (4)
Rock/non-vegetated	2 (1)	3 (2)

Table 4. Areas (km^2) and sample sizes for VHF and GPS annual 100% minimum convex polygon home ranges, and their size ratios, for 10 grizzly bears in northwest Montana, 1999-2001.

Bear ID	VHF 100% MCP	n - VHF	GPS 100% MCP	n - GPS	VHF % of GPS MCP
14*	13.7	22	49.0	1551	28
34*	82.1	19	642.7	2314	12.8
36*	404.0	15	1521.5	2006	26.5
37	69.6	19	212.9	2563	32.7
38*	374.5	14	1162.0	2135	32.2
42*	18.0	6	67.4	749	26.8
289*	76.4	14	377.3	1176	20.3
293	101.9	14	212.2	1879	48.0
921	92.3	17	230.8	1570	40.0
922	87.5	23	244.4	2736	35.8

*VHF polygons missed significant areas of concentrated use, based on GPS telemetry.

Table 5. Fixed kernel home range isopleth areas (km^2) and smoothing factors (*h*), and the number of VHF locations within each isopleth in parentheses, developed from GPS telemetry for 10 grizzly bears in northwest Montana, 1999-2001.

	Utilization isopleth					
Bear ID	95%	75%	50%	25%	*h*	VHF n
14	18.2 (7)	5.8 (3)	2.2 (6)	0.5 (5)	332.34	22
921	159.2 (6)	56.3 (7)	7.3 (1)	1.5 (3)	915.04	17
293	106.5 (3)	36.4 (7)	5.9 (3)	2.3 (1)	843.40	14
922	92.4 (7)	21.8 (7)	7.8 (2)	2.9 (5)	757.33	23
37	97.8 (3)	36.4 (8)	11.2 (3)	3.2 (3)	740.92	19
42	52.7 (1)	23.2 (4)	5.8 (0)	1.1 (1)	617.93	6
289	131.0 (1)	41.1 (4)	14.1 (5)	5.3 (3)	1045.30	14
34	153.8 (2)	57.2 (8)	15.8 (4)	4.5 (4)	1157.30	19
38	340.5 (3)	73.9 (0)	39.1 (1)	16.7 (8)	3014.46	14
36	765.8 (4)	257.6 (5)	100.8 (2)	24.5 (4)	3167.81	15

Table 6. Habitat selection results from Friedman ANOVA on ranks, Kendall concordance coefficients (τ), and Spearman rank correlation coefficients (*r*). All χ^2 (n = 8, df = 6) were significant to $P < 0.0001$.

Bear	τ	Mean rank *r*	χ^2
14	0.93	0.92	44.84
921	0.91	0.90	43.77
293	0.64	0.59	30.64
922	0.79	0.75	37.71
37	0.70	0.65	33.43
42	0.80	0.78	38.68
289	0.71	0.67	34.07
34	0.85	0.83	40.87
36	0.55	0.49	26.73
38	0.71	0.67	33.96

Table 7. Mean HE values for seasonal CEM maps and seasonal GPS data sets.

Model	Study area						GPS Observed overall mean	GPS Observed Quantile	GPS Skewness (Kurtosis)
	Mean	+/- 95% C.I.	Variance	Range	Quantile	Skewness (Kurtosis)			
West, spring	25.18	25.16 – 25.20	166.76	0 – 94	3	0.54 (0.20)	29.21	3	0.23 (-0.80)
East, spring	7.47	7.46 – 7.48	32.28	0 – 76	3	1.78 (5.23)	11.41	4	1.33 (2.00)
West, summer	20.98	20.96 – 21.01	338.74	0 – 100	3	1.44 (1.82)	31.67	4	0.59 (-0.98)
East, summer	3.57	3.56 – 3.58	20.56	0 – 94	3	4.14 (25.02)	5.00	4	2.24 (5.54)
West, autumn	27.09	27.06 – 27.12	384.74	0 – 100	3	0.99 (0.61)	19.19	2	1.90 (3.94)
East, autumn	4.15	27.06 – 27.12	20.79	0 – 76	2	3.72 (20.62)	5.02	3	3.08 (11.37)

Table 8. Average spring CEM habitat values (HV), 95% confidence intervals, range, and standard deviation within LZP model impact categories along US Highway 2, northwestern Montana.

Season/Model	Impact category	Mean	+/- 95% CI	Range	SD
Spring, East HV	Minimal	14.08	13.27 – 14.89	1 – 63	8.36
	Low	10.58	9.68 – 11.47	1 – 55	7.93
	Moderate	12.36	11.32 – 13.41	2 – 55	7.92
	High	13.87	11.83 – 15.91	3 – 40	8.04
Spring, West HV	Minimal	33.05	31.75 – 34.35	14 – 73	12.37
	Low	26.05	24.99 – 27.10	7 – 61	11.18
	Moderate	27.65	26.16 – 29.14	11 – 59	11.23
	High	26.75	23.79 – 29.72	11 – 59	11.18

Figure 1. Number of VHF aerial telemetry locations by hour for 10 grizzly bears in northwestern Montana, 1999-2001.

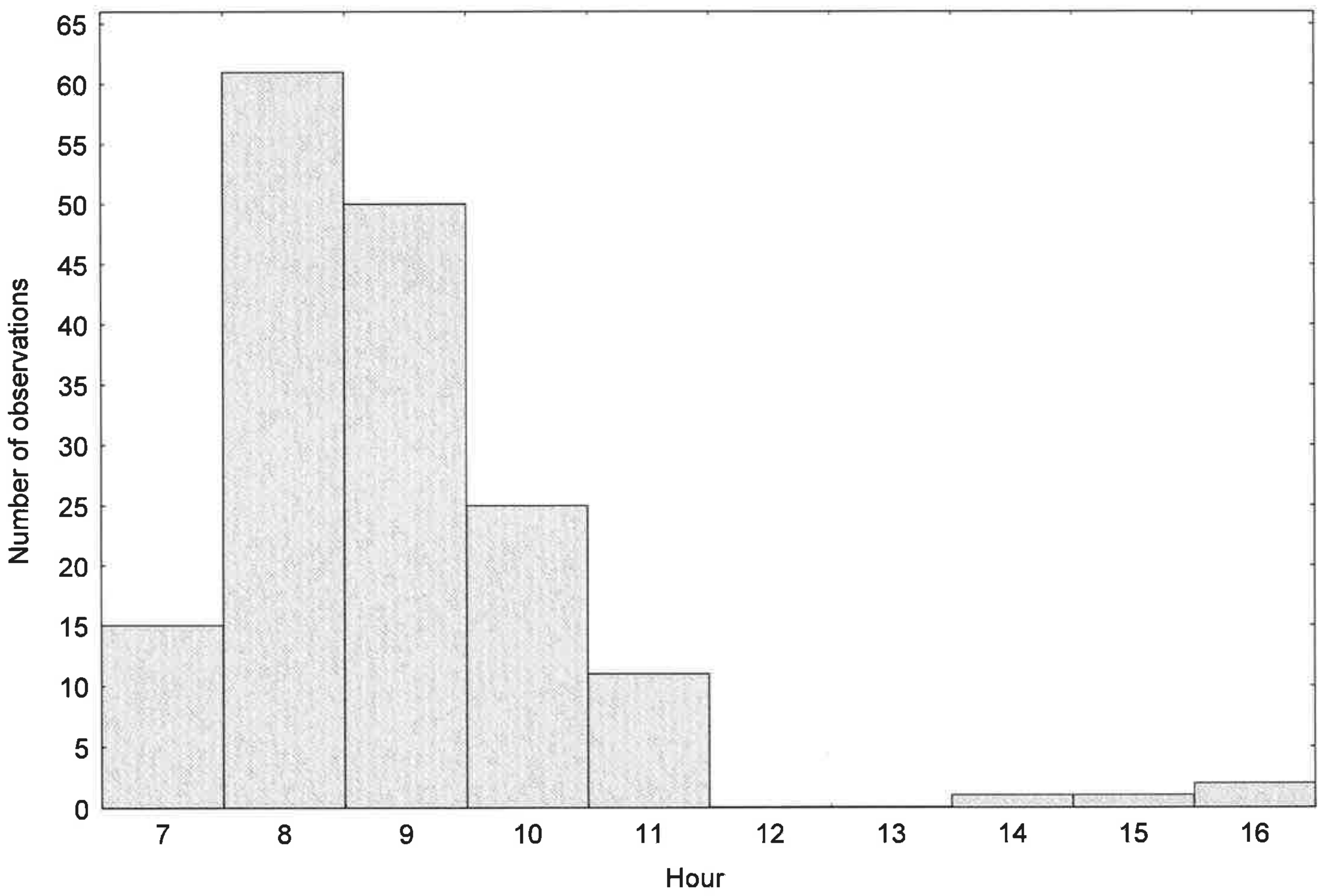


Figure 2. Number of GPS telemetry locations by hour for 10 grizzly bears in northwestern Montana, 1999-2001.

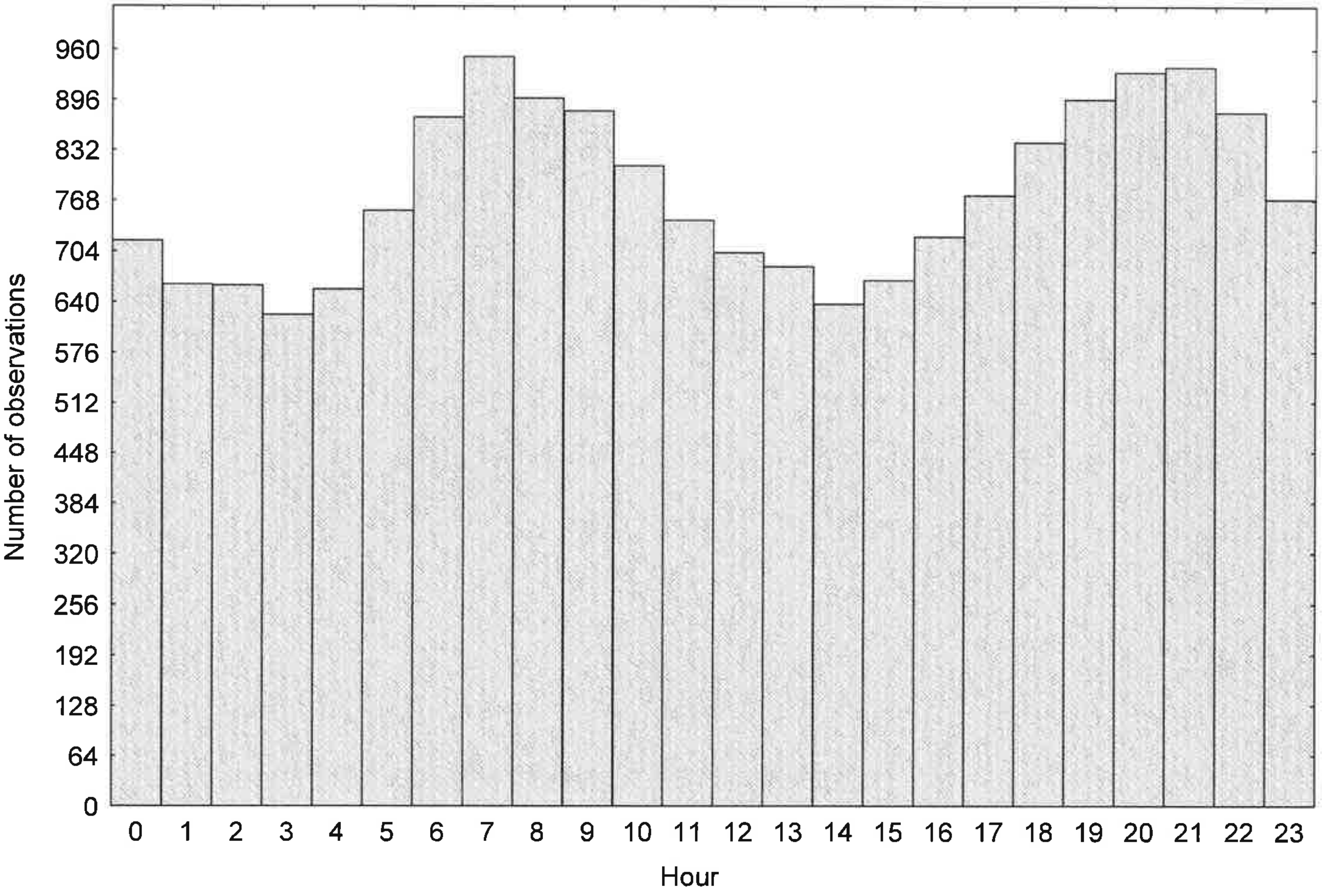


Figure 3. Histogram of the temporal distribution of movement vectors, (as determined from GPS telemetry), sampled during aerial VHF telemetry of 10 grizzly bears in northwest Montana, 1999-2001.

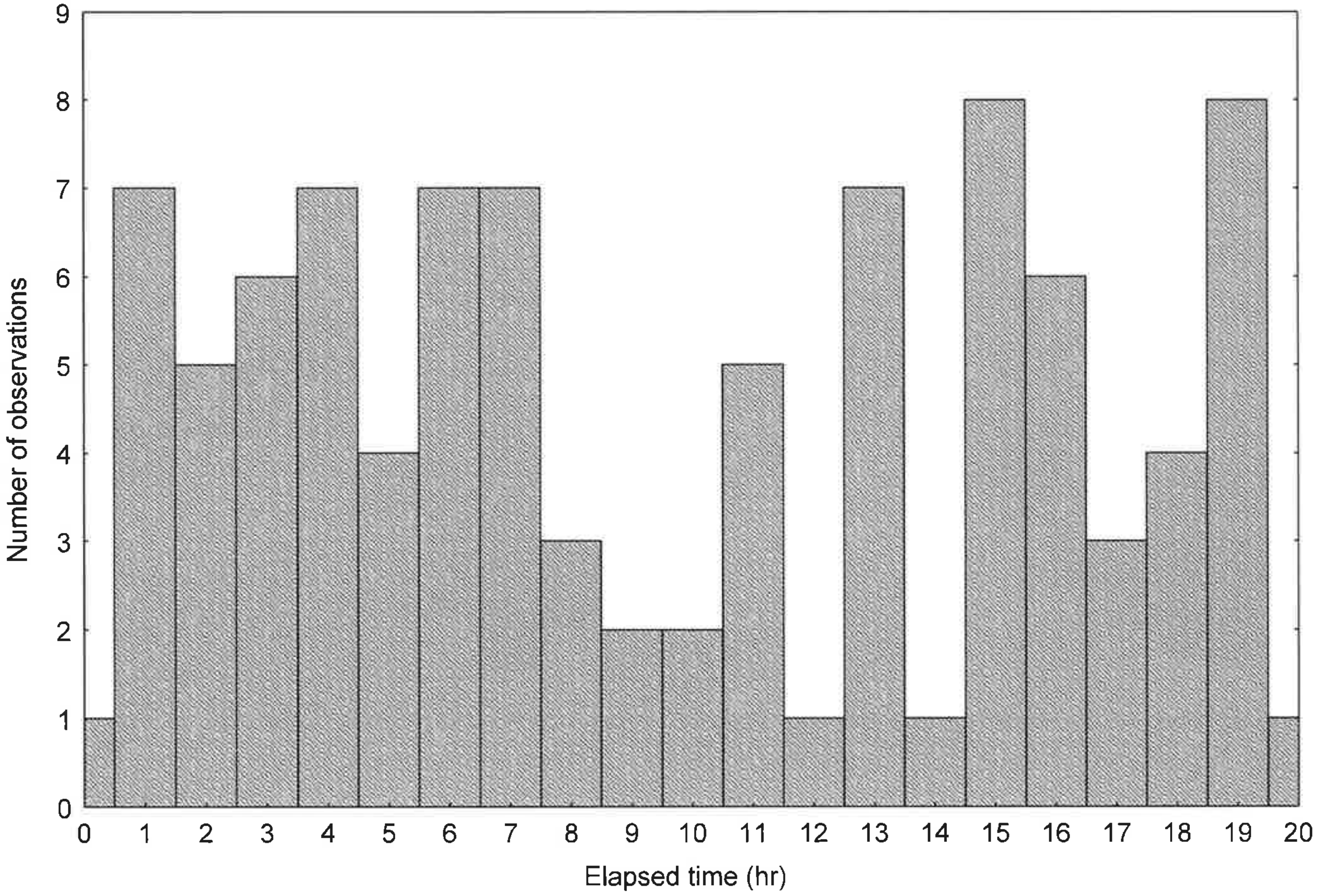


Figure 4. Histogram of the temporal distribution of movement vectors sampled during GPS telemetry of 10 grizzly bears in northwest Montana, 1999-2001.

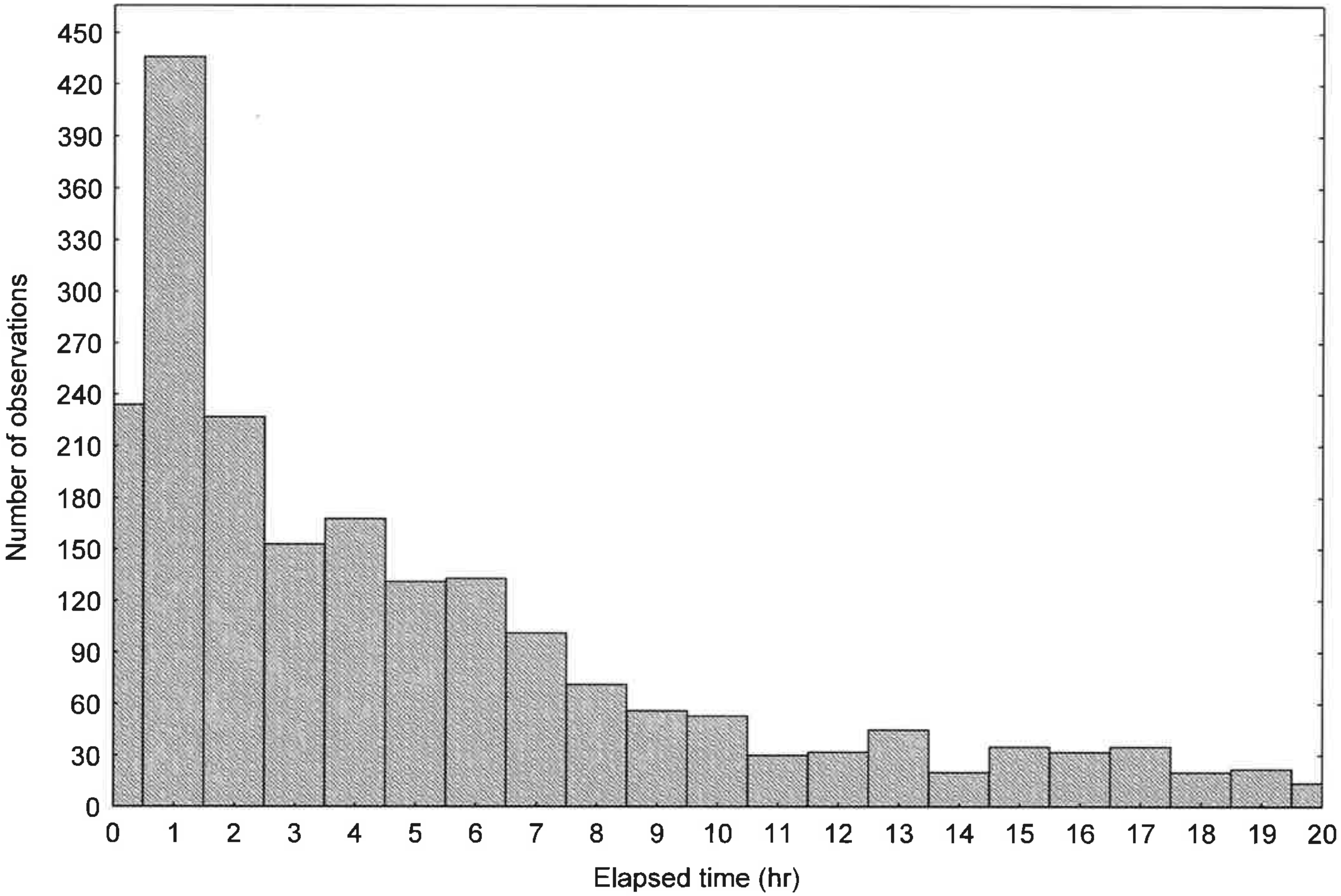


Figure 5. Histogram of the temporal distribution of stationary locations sampled during GPS telemetry of 10 grizzly bears in northwest Montana, 1999-2001.

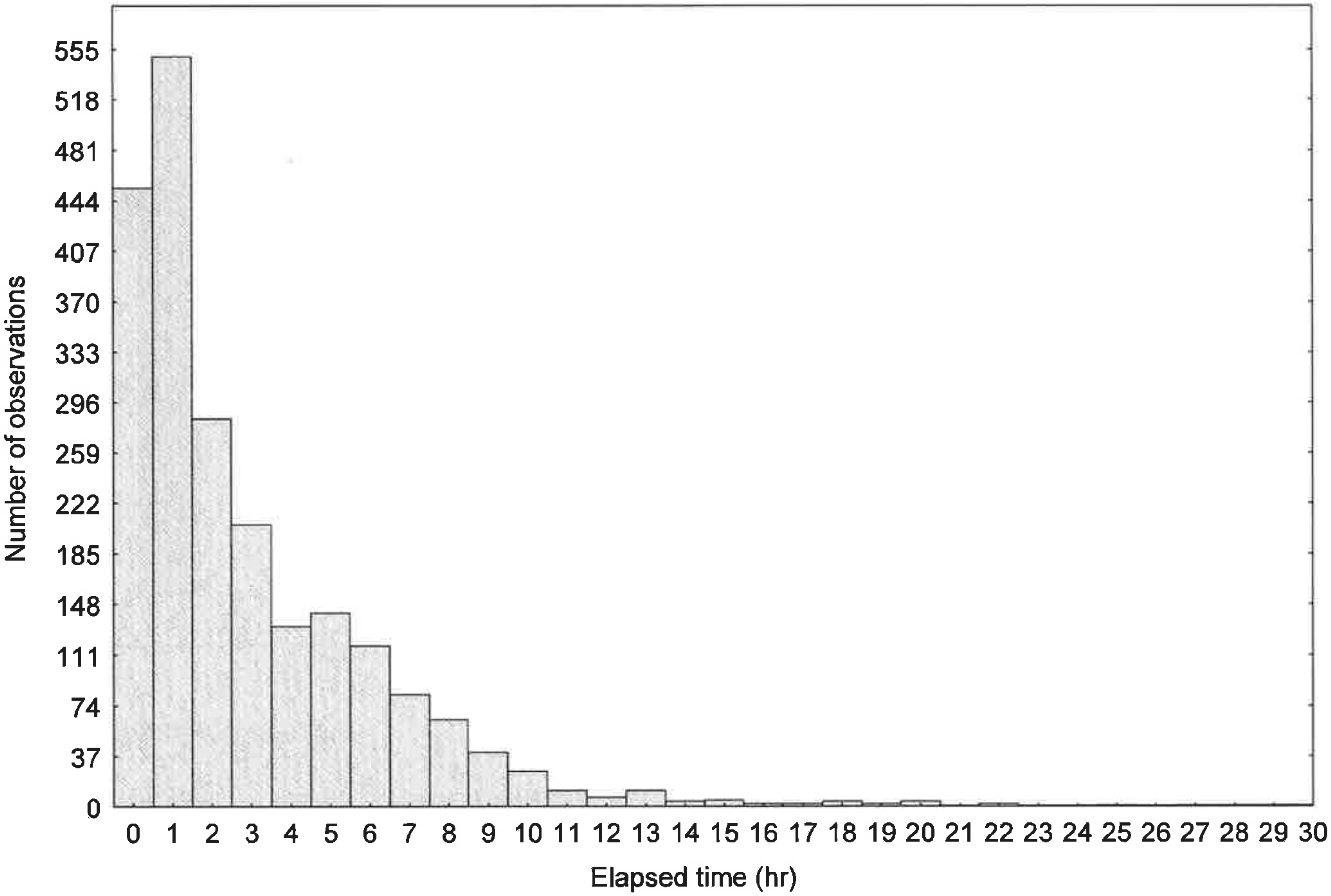


Figure 6. Histogram of the temporal distribution of stationary locations sampled during VHF telemetry of 10 bears in northwest Montana, 1999-2001.

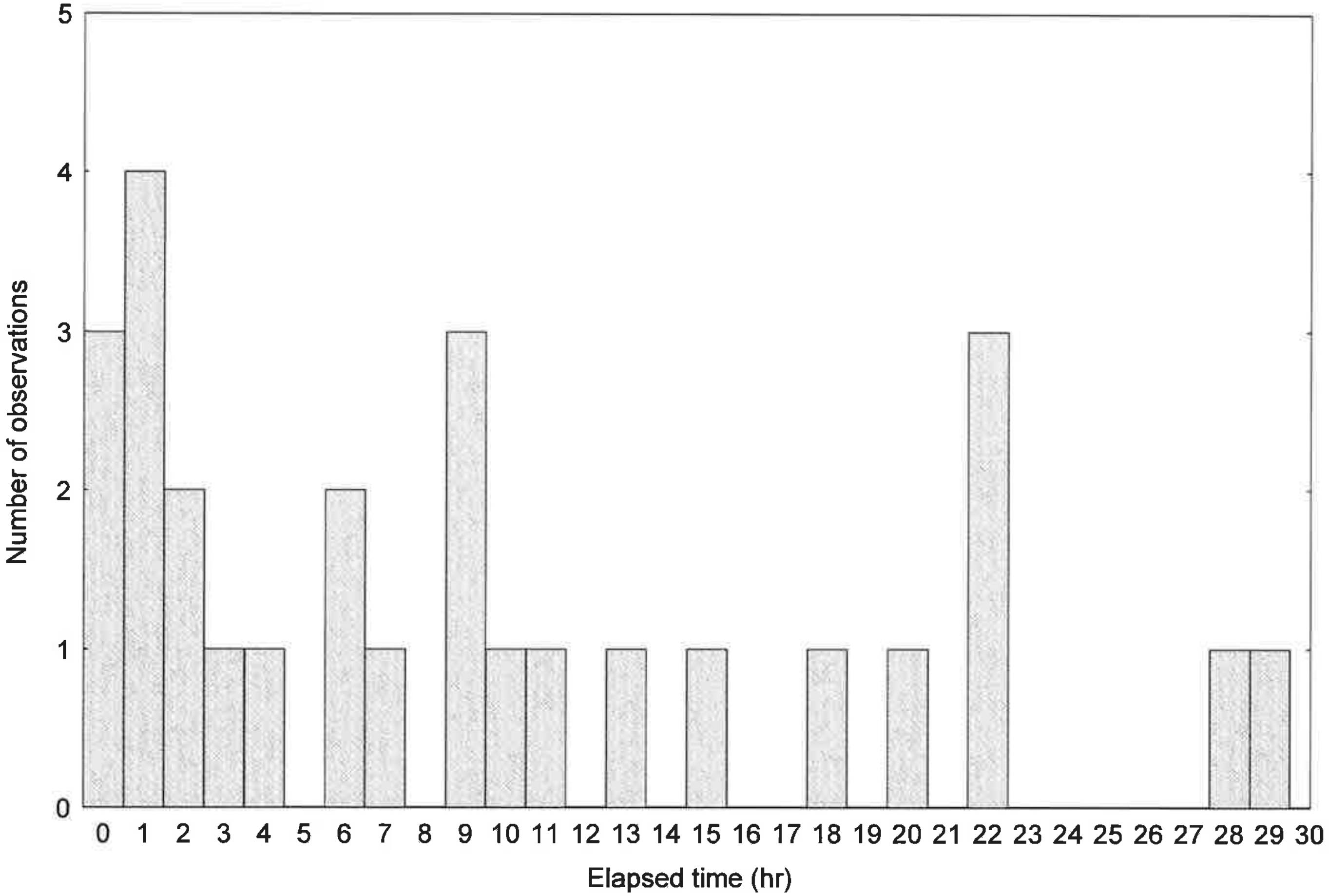


Figure 7. Change in home range size (plotted on logarithmic scale) with 7 sampling intensities for 10 bears with GPS collars in northwest Montana, 1999-2001.

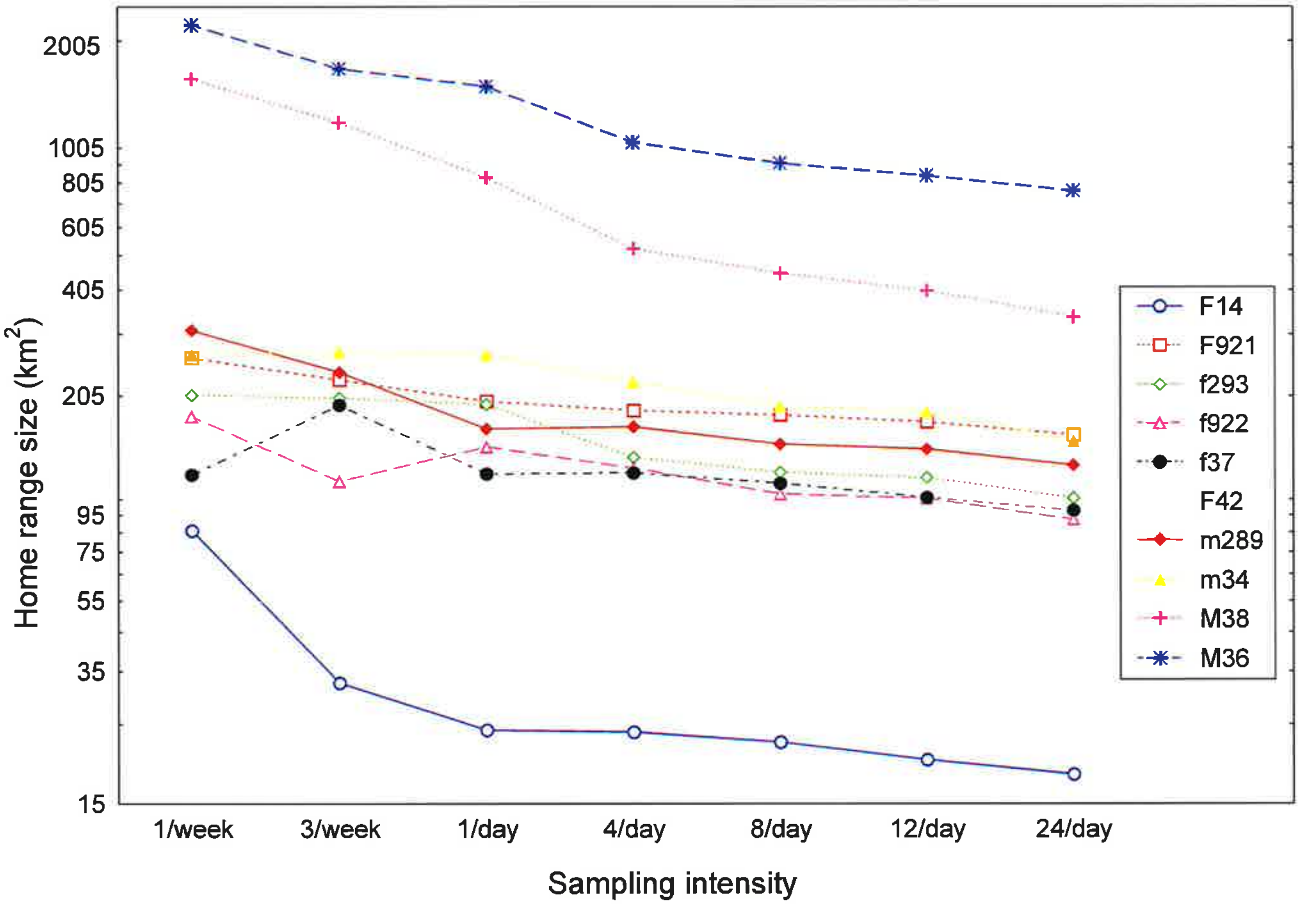


Figure 8. Selection indices by sampling intensity for 6 adult (F) and subadult (f) female grizzly bears in northwestern Montana, 1999-2001. Numbers along the interior of the x- ordinate indicate the number of habitats changing ranks from the previous sampling intensity. Selection indices are differences between % used and % available.

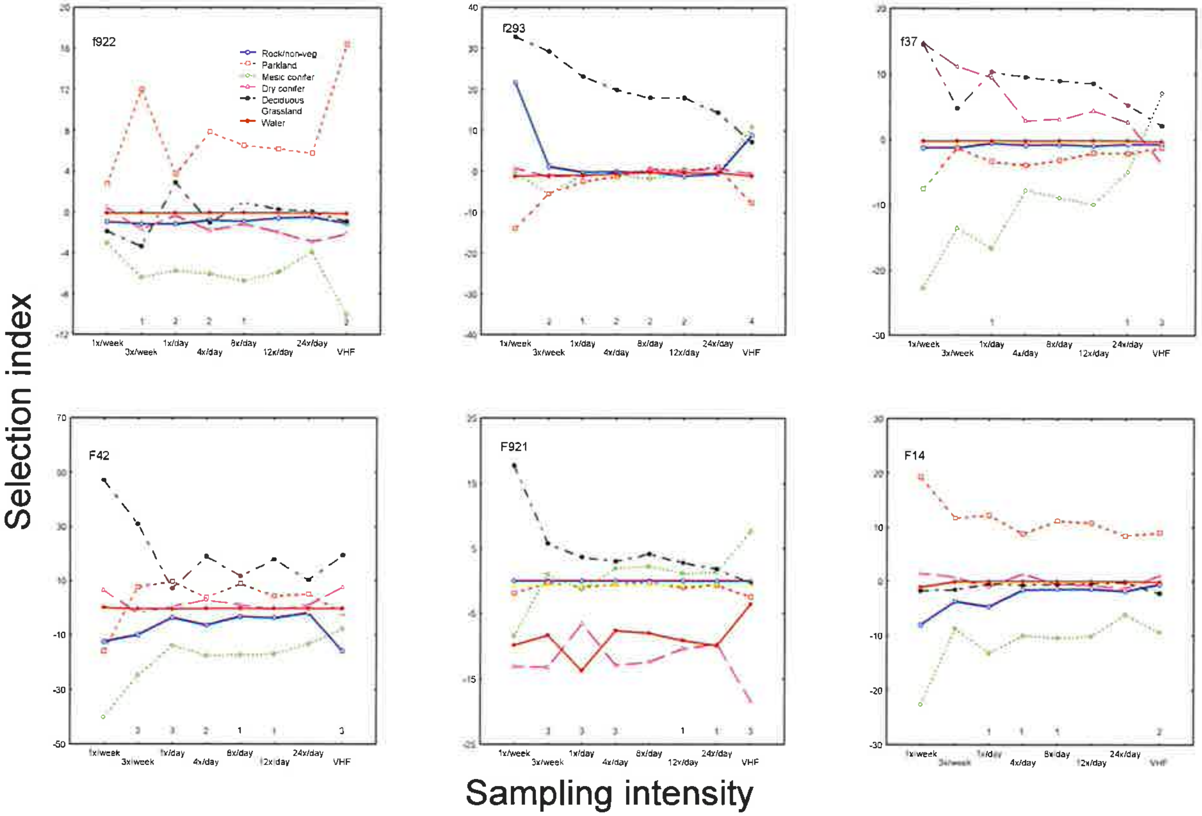


Figure 9. Selection index by sampling intensity for 4 adult (M) and subadult (m) male grizzly bears in northwestern Montana, 1999-2001. Numbers along the interior of the x- ordinate indicate the number of habitats changing ranks from the previous sampling intensity. Selection indices are differences between % used and % available.

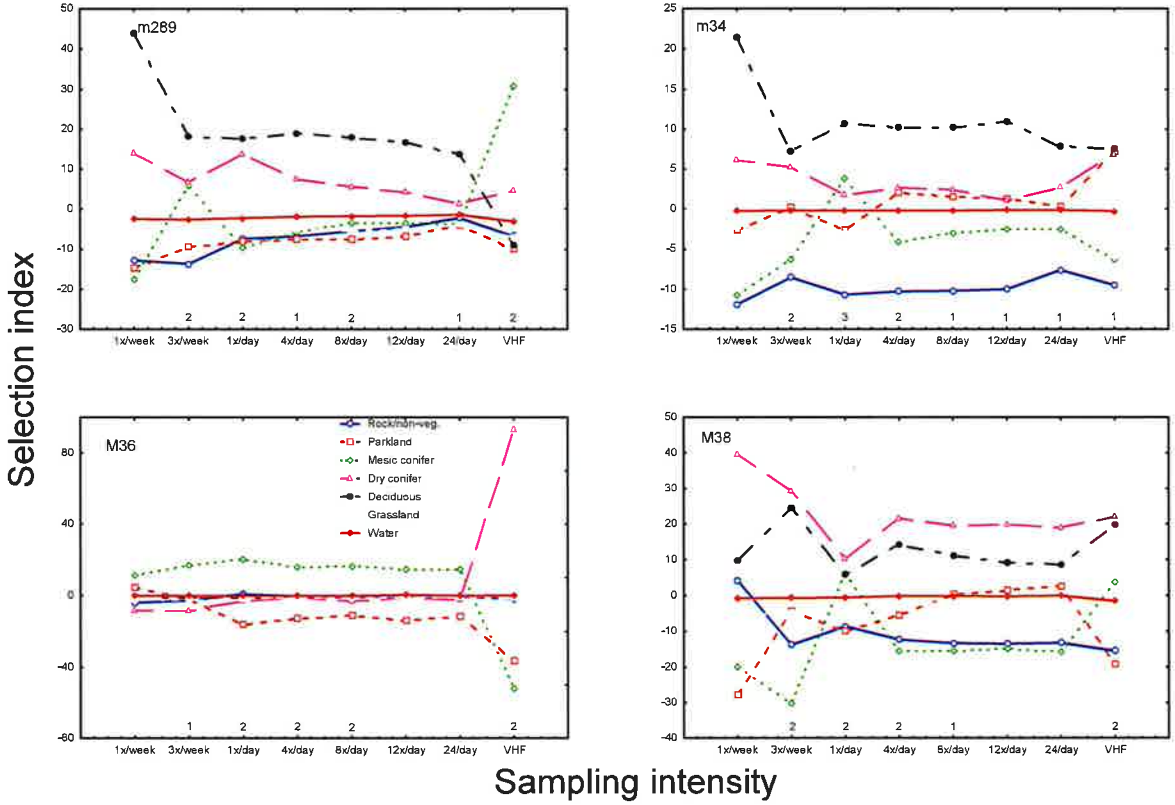


Figure 10. Histogram of seasonal study area and GPS telemetry point HE values based on the west-side CEM model.

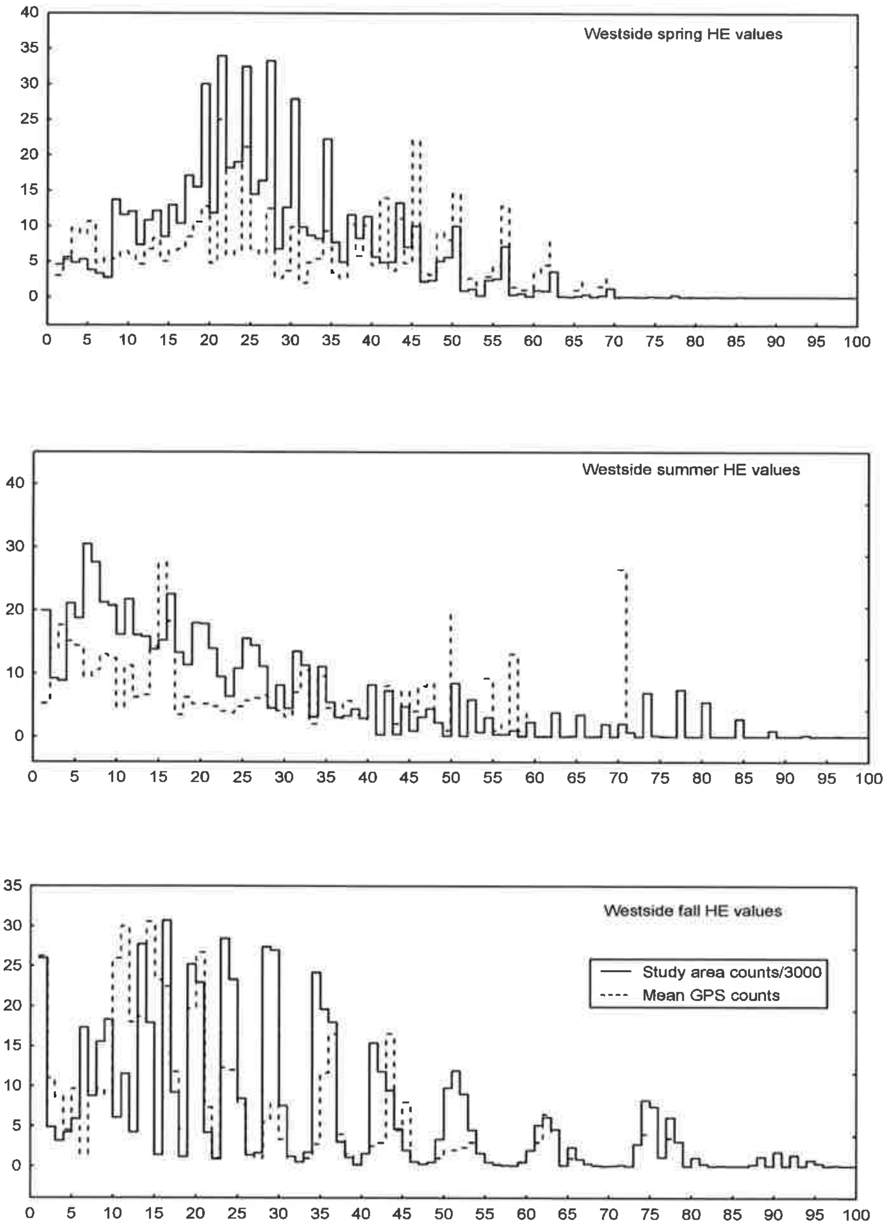
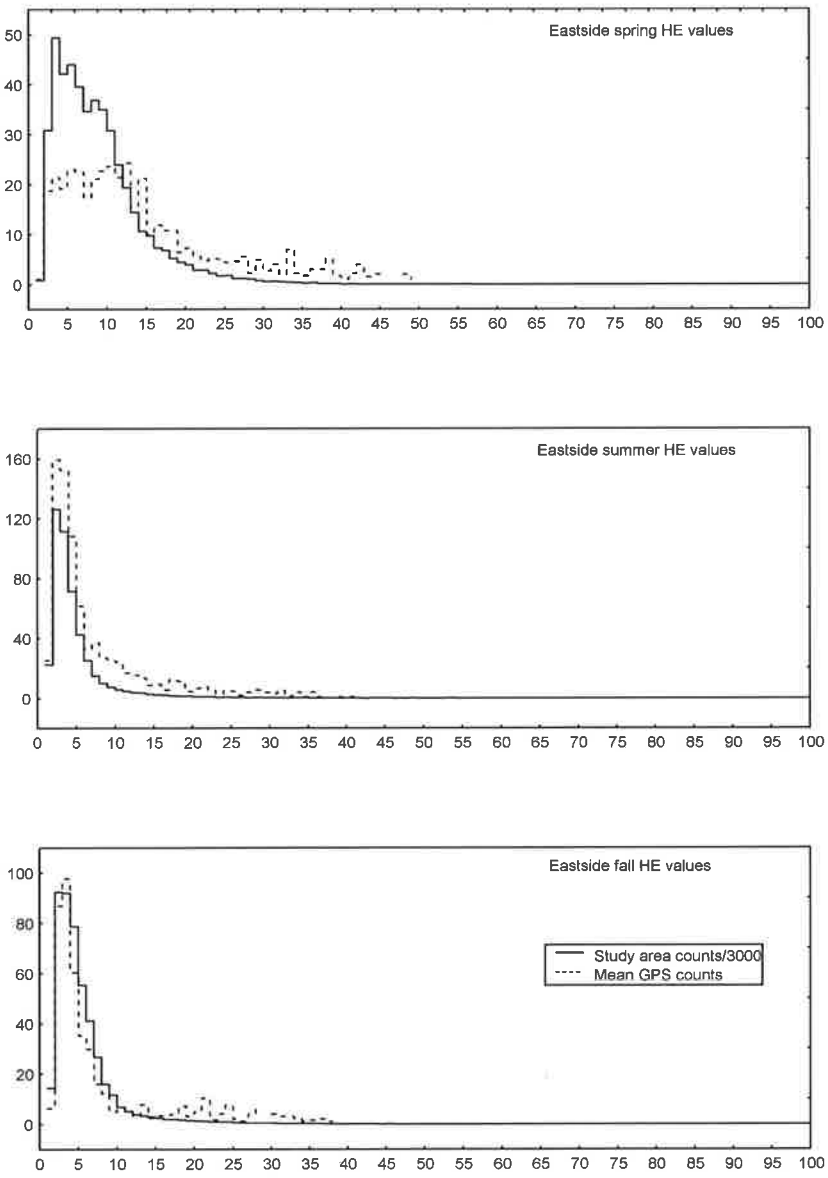


Figure 11. Histogram of seasonal study area and GPS telemetry point HE values based on the east-side CEM model.



CHAPTER 4: RESEARCH SUMMARY AND MANAGEMENT IMPLICATIONS

Abstract: Human development occurring in valley bottoms between mountain ranges throughout the western US has resulted in isolation and fragmentation of remaining grizzly bear (*Ursus arctos*) populations. The US Highway 2 (US-2) corridor is one of the few developed mountain valleys that grizzly bears can still move through. Management programs that actively remove bears from intermountain valleys may serve to further isolate grizzly bear populations and prevent dispersal to unoccupied habitats. Maintenance of linkage zones is one way to provide continued connectivity within fractured bear populations. During 1998-2001, I conducted a study of grizzly bear habitat and movement patterns along US-2 and related the findings of that research to the concept of linkage, observed grizzly bear's habitat-use and movement patterns in that context, and related findings to grizzly bear management.

I found that the US-2 corridor had a high-density of resident grizzly bears; that many of these bears crossed highways, and that some made behavioral adjustments to human developments that facilitated use of this valley. I found that the levels of conflict with humans varied by management jurisdiction. I also suggest that these resident bears suffer a high level of mortality, but that such a condition might be expected and is not necessarily detrimental to the larger population provided that population connectivity is maintained. I also suggest that as public awareness and agency action resolves existing management challenges the level of mortality might be expected to decline. However, increasing human occupation of such areas will pose an ongoing challenge to managers who seek to limit bear mortality due to conflicts with humans.

INTRODUCTION

Human development occurring in valley bottoms between mountain ranges results in isolation and fragmentation of remaining grizzly bear (*Ursus arctos*) populations when they can no longer move across the valley. This has occurred in mountain valleys throughout the western US (Mattson and Merrill 2002). The US Highway 2 (US-2) corridor is one of the few developed mountain valleys in the conterminous United States that grizzly bears can still move through. This is presumably due to several factors; the narrow width of the valley, low levels of human development, and low traffic volume on US-2 (Waller 2005; Chapter 1, this volume).

The Interagency Grizzly Bear Committee (IGBC) has grouped grizzly bear habitats into 3 management situations (MS): MS-1, where human-bear conflicts are resolved in favor of grizzly bears, MS-2 where human-bear conflicts can be resolved in favor of either bears or human uses, and MS-3 where human-bear conflicts are resolved in favor of people (IGBC 1986). In habitats designated MS-3, occupation by grizzly bears is often actively discouraged by resource management agencies (MFWP 2002). MS-3 typically occurs where private lands and human developments dominate the landscape. The US-2 corridor contains a mixture of these management zones. Local land management authorities mapped management zones within their jurisdictions.

Mace and Waller (1998) showed that movement of grizzly bears from a high density core population into adjacent attractive MS-3 habitats can result in a source-sink situation where annual reproduction is offset by management removals or illegal mortality. Management programs that actively remove bears from intermountain valleys may serve to further isolate grizzly bear populations and prevent dispersal to unoccupied habitats (Mattson et al. 1992). However, we know that in some settings, bears can successfully coexist with humans in concentrated numbers. In some areas, such as Alaska's McNeil River State Game Sanctuary and Katmai National Park, bears and humans generally coexist in close proximity. The low level of conflicts in these areas, where people often view brown bears from only a few feet away, is due to strictly enforced protocols of human and bear behavior (Walker and Aumiller 1993). While expecting a similar situation in rural intermountain valleys may be unrealistic, it does illustrate that mutual tolerance is possible when human activities are closely supervised and controlled. Grizzly bear mortality within developed areas in mountain valleys can be expected to continue, but as long as source-sink dynamics operate in a density-dependent fashion, little harm to source populations would result (Doak 1995). As long as mortality does not eliminate all animals in these valleys there should be continued dispersal and gene flow between occupied habitats. The challenge will be gauging the impact of mortality on the source population and determining the socially acceptable level of bear occupancy within the valley (Mladenoff et al. 1997).

One way to maintain population connectivity through developed areas is through the maintenance of linkage zones (Servheen et al. 2001). Linkage zones may exist in various configurations, but I envision 2 general types: the first type is a relatively narrow passage that allows animals to safely move between habitat patches (type I linkage). The second type, (type II linkage), is a larger block of habitat that allows animals to safely *reside* between larger habitat patches. The sizes of these linkage zones will vary depending upon the species under consideration, but for grizzly bears, it is unlikely that the latter will ever be large enough to provide year-long occupancy secure from all human-related mortality risks given current levels of human development in the Rocky Mountains.

During 1998-2001, I conducted a study of grizzly bear habitat and movement patterns along US-2 in northwestern Montana. Various levels of human development were scattered along the highway such that there was a mixture of developed and undeveloped land, thus providing an opportunity to examine the concept of linkage, observe grizzly bear habitat use and movement patterns, and relate these findings to grizzly bear management.

My objective was to identify conditions or behaviors that allowed grizzly bears to successfully cross or inhabit developed areas in the US-2 corridor. These behaviors included those of both people and bears. This information can be used to better undertand the coexistence of bears and people in such areas. Such knowledge could facilitate linkage between existing bear populations by tailoring current management programs to specific bear or human behaviors.

STUDY AREA

The study area was located along US-2 between Essex, Montana and the western boundary of the Blackfeet Indian Reservation near East Glacier, Montana. The only high-speed highway bisecting the US portion of the Northern Continental Divide Ecosystem (NCDE), US-2 was a 2-lane highway separating Glacier National Park to the north from the Bob Marshall Wilderness complex to the south. The western portion of the highway lay in the valley bottom of the Middle Fork of the Flathead River to its confluence with Bear Creek. Here the highway continued to follow the Bear Cr. valley bottom in a north-easterly direction until it rose to cross the Continental Divide at Marias Pass (elevation 1610 m). East of Marias Pass, the highway dropped into the prairie biome, paralleling the South Fork of the Two Medicine River to the western boundary of the Blackfeet Indian Reservation. A major railroad line paralleled the highway for its entire length. This railroad line was a primary freight corridor between Chicago, Illinois and Seattle, Washington. It was also the primary means of transporting grain from eastern Montana and North Dakota to markets on the west coast. Trains have been, and continue to be, a significant source of grizzly bear mortality. Grizzly bears have been attracted to the tracks by grain spilled during train derailments and during normal operations. Small concentrations of seasonal home sites, businesses, ranches, and small communities existed within the highway corridor, but the majority of the area was undeveloped.

Associated roadway topography varied from flat, valley bottom to steep mountainside. Dominant vegetation was primarily coniferous forest in the western portions of the study area, with open grass/forb/aspen communities in the eastern portions. Riparian areas associated with the Middle Fork Flathead River and Bear Creek paralleled the highway for much of its length within the study area. Avalanche chutes, preferred grizzly bear foraging areas (Waller and Mace 1997), occurred in numerous locations, often close to the highway.

Most of eastern Montana lay within a climatic transition zone between Pacific Maritime dominated climates west of the Continental Divide and Continental dominated climates east of the Divide. This transition was most abrupt along the eastern front of the Rocky Mountains, a portion of which lay within the study area. The collision of these 2 climatic regimes resulted in unsettled weather conditions. Snowfalls were heavy and persistent west of the Continental Divide but less so east of the Divide. Temperatures could vary from -40° c during winter to over 38° c during summer east of the Divide, but were moderated by Pacific Maritime weather patterns west of the Divide (Alwin 1993).

METHODS

I conducted a 4-year study of the effects of a transportation corridor on resident grizzly bears (Waller 2005; this volume). Using GPS-instrumented grizzly bears, I examined their fine-scale movement patterns in relation to US-2 and the BNSF railroad. I examined the spatial and temporal characteristics of their highway crossing behaviors and linked them to traffic volume and habitat (Waller 2005; Chapter 1, this volume). Next, I attempted to describe how human development and habitat affected particular aspects of grizzly bear movement, such as residence time, tortuosity, and directional persistence (Waller 2005; Chapter 2, this volume). Finally, I used the GPS telemetry and a concurrent VHF telemetry data set to examine how previous research efforts may have been biased through technological limitations, and tested 2 models relevant to grizzly bear management; the linkage zone prediction (LZP) model and the cumulative effects model (CEM; Waller 2005; Chapter 3, this volume).

Here, I interpret the results of these efforts relative to how grizzly bears successfully lived in valley bottom habitats without conflict with humans, and how that may suggest where management policy can be altered to facilitate occupancy. I examined grizzly bear residence times, movement rates, reproductive success, and mortality within valley bottom habitats as being more consistent with either type I or type II linkage. The extant linkage type will provide a framework in which to tailor management activities.

Further, I noted if GPS-marked bears exhibited food-conditioned or habituated behavior, and if they were, tried to learn where bears were most vulnerable to corruption and indicate where corrective action could be most effective. I plotted movement vectors against the spatial distribution of human developments within the US Highway 2 corridor and discussed timing, frequency, and nature of bear transgressions.

RESULTS

During 1998-2001, I captured 43 individual grizzly bears within the US-2 corridor. All but 2 of the 14 GPS-marked bears used for analyses had home ranges that substantially overlapped the developed portions of the US-2 corridor. Subadults and adult females continued to spend large portions of their time in the corridor after capture, and appeared to move across the landscape independent of land ownership. In general, the grizzly bears followed during this study avoided homes and transportation developments by ~500 m (Chapter 1, Chapter 2). When bears did approach or use roads, it was usually under cover of darkness. I observed no concentrated use of areas near or on the railroad tracks by any of the 14 GPS marked bears that would indicate the presence of an attractant such as spilled grain. However, 2 bears used riparian areas close to the highway on numerous occasions. Highway crossing frequency was negative-exponentially related to traffic volume, and no crossings occurred when traffic volumes exceeded 100 vehicles/hr. Grizzly bears had a relatively low-risk of being hit by a car when they crossed US-2 at night (<5%), but incurred a higher risk when crossing US-2 during the day or the railroad tracks at anytime (>5%).

Only 2 GPS-marked grizzly bears closely approached houses (F224, F921). These 2 bears died during the study; F224 by management removal and F921 by self-defense. Of the 28 grizzly bears monitored by aerial VHF radio telemetry, 3 spent time along the railroad tracks (F8, f9, F11) and 3 came in close proximity to houses (m2, F8, f9). Of these 4 bears, only F11died during the study; she was hit and killed by a train while crossing a trestle). One bear that had previously been GPS-marked (and not located on the tracks) was killed by a train after the conclusion of the study (F42). During 1998-2001, 3 of the 14 GPS marked bears died (21%); 1 of natural causes (m34) and 2 human-related (F224, F921).

During aerial telemetry flights, I occasionally observed marked grizzly bears in close proximity to livestock. Only 1 of these bears (m2) was implicated in livestock depredations on the Blackfeet Reservation; he was never apprehended.

Only 1 of the 4 adult males with GPS collars spent much time in the US-2 corridor after capture, the others traveling long distances; 3 of the 4 left the study area. Human developments had no strong effects on several common measures of grizzly bear movement patterns: residence time, tortuosity, and directional persistence.

For all bears, assessment of habitat selection using small samples of aerial VHF telemetry locations was robust for strongly selected habitat types, but unstable for less strongly selected habitat types. For grizzly bears, a relocation rate of at least 8 locations/day gave the most stable habitat selection results.

My study area spanned the continental divide and included 4 jurisdictions with bear management responsibilities. These were Montana Fish, Wildlife, and Parks (MFWP) Regions 1 and 4, Glacier National Park, and the Blackfeet Tribe. In 1997, MFWP region 1 personnel responded to numerous human-bear conflicts in the US-2 corridor west of the divide. Deterrent actions included education and outreach to landowners about proper storage of livestock feeds and aversive conditioning actions that attempted to teach bears to avoid human developments. During the period of this study, there were no reported bear-human conflicts west of the divide. East of the divide, few bear-human conflicts occurred on non-tribal lands. There are very few year-long residences within the corridor and on non-tribal lands. Glacier Park removed a family group implicated in a human fatality from the Two Medicine area in 1998, but this area was not within the highway corridor or the study area. No other conflicts occurred in the corridor and within Glacier Park. Glacier National Park has strict policies regarding food and garbage handling. Numerous bear-human conflicts occurred on tribal lands. Most of the conflicts involved livestock depredation, or food and garbage conditioned bears in the vicinity of East Glacier.

DISCUSSION

Although this study was not designed to answer questions pertaining to demography, the number of bears captured during this study suggests that the US-2 corridor contained a high density of grizzly bears relative to other portions of the NCDE and to other ecosystems (Mowat et al. 2005).

Some alteration of grizzly bear behavior to fit human occupation was apparent, especially in regards to avoidance of highways. Avoidance of forest roads by grizzly bears has been documented elsewhere (e.g. Mace et al. 1996) using VHF daytime telemetry. This pattern of occupation of a fracture zone is indicative of my suggested Type II linkage.

Observed mortality during the study was high (21%) and, if representative, was above that generally considered sustainable for grizzly bears (Bunnell and Tait 1980). The US-2 corridor may be acting as a population sink that is replenished from source populations in Glacier National Park and the Bob Marshall Wilderness. Habitat values, based on the CEM, are not so high as to suggest that the US-2 corridor is functioning as an ecological trap (Battin 2004). More intensive research would be required to test these assertions.

One of the largest sources of bear mortality in the corridor has been train kills. During the late 1980's and early 1990's, numerous derailments resulted in huge spills of corn and wheat. These spills were not adequately remediated and the resulting odor of fermenting grain attracted bears, some from long distances. Many bears were struck and killed as they gathered along the railroad tracks, although the exact number is unknown. The ensuing outcry prompted the formation of the Great Northern Environmental Stewardship Area (GNESA). Formed as a non-profit group with representatives of numerous private and public entities, the organization worked with BNSF to develop protocols for rapid response to grain spills and appropriate remediation, and to find means to minimize bear attractants in the corridor. Since that time, grain spills have been cleaned up relatively quickly and efforts made to keep the railroad tracks as free of grain as possible. Large grain spills can take up to 6 weeks to remove thus can continue to serve as an attractant, although trained staff work to keep bears from obtaining grain at the spill site. Other measures include fencing livestock off the tracks and rapid removal of train killed livestock and wildlife. These measures appear to have been partially successful. I observed no concentrated use of areas on the tracks during the period of study. Nevertheless, we know that bears continue to obtain and consume grain along the tracks. The stomach of F11, examined after she was killed along the tracks, contained corn.

I found no reason to suspect that previous investigations of general grizzly bear habitat-use, based on multi-annual compilations of aerial VHF telemetry (eg. Mace and Waller 1997, McLellan and Hovey 2001), were inaccurate in their findings, especially for strongly selected habitat types. Therefore, the CEM, which was based on aerial VHF telemetry was probably accurate, but was difficult to assess. Areas predicted as having relatively high probability of use were small.

During this study, grizzly bears appeared to move independently of all but the highest impact zones described within the LZP model. However, the purpose of the LZP model was to predict where bears might cross valleys while incurring the least risk (Servheen et al. 2001). A definitive assessment of the LZP model was impossible because observed mortalities were insufficient to draw conclusions regarding relative mortality risk as predicted by the model.

MANAGEMENT IMPLICATIONS

Long-term conservation of grizzly bears in the US-2 corridor will depend on 2 factors: maintenance of habitat conditions that facilitate occupancy (e.g. low human density, low traffic volume), and reduction of human caused mortality. Bears died during this study from being hit by trains, removed by management authorities, or shot in self-defense. It is unclear if train kills will decline further without increased management actions. Keeping bears off the railroad tracks is difficult and providing opportunities for safe crossings would require significant modifications to the railroad infrastructure and/or its operation. However, awareness of the problem has increased and there is interest in finding creative solutions to the problem. This research has shown that the likelihood of significant mortality due to automobiles on US-2 is low and may remain so for the next several decades.

If more people become familiar with bear pepper spray and gain confidence in its effectiveness, there may be a decrease in the number of self-defense kills. However continuing increases in human occupancy and turnover in these residents provides a management and education challenge for bear managers in this corridor. Local management jurisdictions need to take the lead in educational efforts. Management removals due to site conflicts at residences continue to be the largest source of grizzly bear mortality in the NCDE. Most management removals occur because bears learn to associate human developments with food rewards. Food and garbage storage on private and tribal lands has long been problematic. Cultural and economic conditions often confound education, outreach and management actions that would help to keep food and garbage away from bears. This research has shown that bears will avoid human developments unless strong attractants exist that draw them to such sites. Local management jurisdictions need to continue to educate people about the simplicity and effectiveness of securing food and garbage out of reach of bears.

Currently, US-2 by itself appears to have little demographic impact on grizzly bears in my study area. However, improved access due to US-2 has increased the indirect effects of human site development on grizzly bears as evidenced by the displacement and avoidance documented here. As traffic volume and land development continue to increase, the combination of the highway and human site developments in a linear fashion will have long-term impacts on the NCDE grizzly bear population. When combined with the significant mortality risk associated with the adjacent railroad, the cumulative impacts of the highway and site developments pose a serious threat to the integrity of the NCDE grizzly bear population. Solutions to this issue should combine mitigation directed at site development on both private and public lands, such as conservation easements and acquisitions of key habitat areas, enhanced sanitation requirements at each site development, limitations on road density and resource extraction, and considerations of density limits on future development. Solutions related to the highway must include crossing structures at key sites and a realization that decisions that widen the highway or increase traffic volume must be associated with significant investments in crossing structures for wildlife. Finally, the present railroad location and train volume produce a constant risk of mortality for resident and transient bears. An ecosystem approach to maintaining connectivity and reducing mortality in the

US-2 corridor must involve simultaneous management actions on the highway, the adjacent public and private lands, and the railroad if this area is to continue to provide habitat for resident bears and movement and dispersal opportunities for bears in the NCDE.

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Provided by Retired Wildlife Biologist Fielder

Attachment 2

GRIZZLY BEAR MOVEMENTS IN SWAN VALLEY OF MONTANA (FLATHEAD LAKE UPPER LEFT)

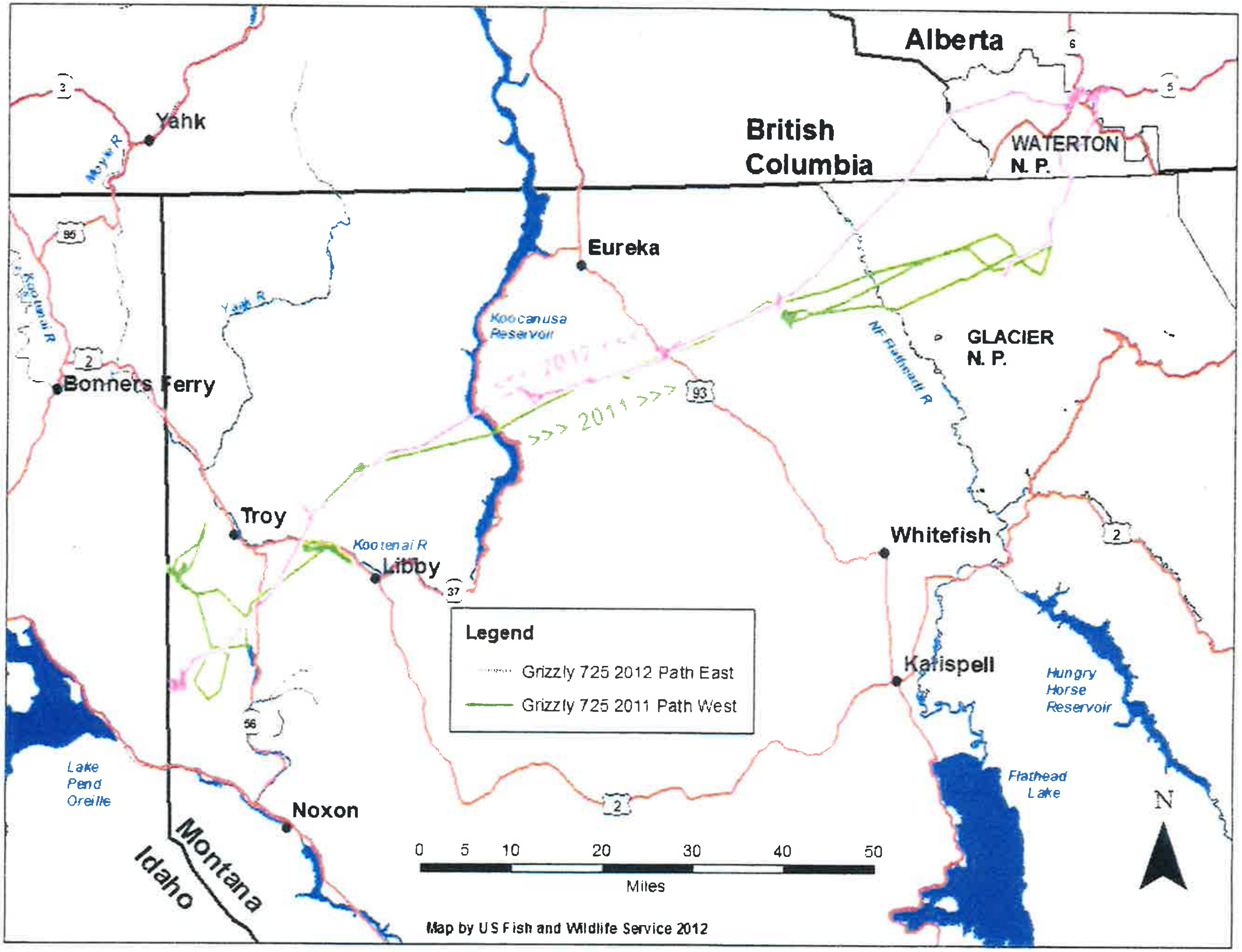
Attachment 3

http://www.greatfallstribune.com/story/news/local/2016/09/16/grizzlies-observed-open-country-west-dutton/90515128/

http://www.greatfallstribune.com/story/news/local/2016/07/16/brink-grizzlies-roar-back/87168406/

http://www.tsln.com/news/bears-pose-threat-to-more-than-livestock/

GRIZZLY BEAR #725 MOVEMENTS IN NW MONTANA AFTER TRAPPING + RELOCATION. (115 MILES)



Provided by Retired Wildlife Biologist Fielder

Attachment 4

Attachment 5

mother was killed leaving 3 orphaned yearlings. One of the yearlings is known to be dead. The last bear was a male captured after a livestock conflict. Nine of the 35 are known to be dead.

In summary, fourteen bears have been added to the Cabinet Mountains population since 1990 (11 females and 3 males) through the augmentation effort. Three female bears and one male have left the target area and 4 bears are known to be dead. One of the bears that is known to be dead survived for 16 years in the Cabinet Mountains and produced at least 9 young. Those offspring are known to have produced at least 8 young. Few captures or hair snags of native bears in the Cabinet Mountains since the beginning of the augmentation program in 1990 suggest that the population was probably smaller than originally estimated (much fewer than 15 bears). The information also indicates that the Cabinet Mountains grizzly population would probably have disappeared without augmentation.

Table 1. Sex, age, capture date, capture location, release location, and fate of augmentation grizzly bears moved to the Cabinet Mountains, 1990-2012.

Bear #	Sex	Age	Capture date	Capture Location	Cabinet Mtns Release Location	Fate
218	F	5	7/21/1990	NF Flathead River, BC	EF Bull River	Denned in Cabinet Mtns 1990, Lost collar August 1991, observed July 1992 1YEAR
258	F	6	7/21/1992	NF Flathead River, BC	EF Bull River	Denned in Cabinet Mtns 1992 Produce 1 cub 1992, Natural mortality July 1993 1YEAR
286	F	2	7/14/1993	NF Flathead River, BC	EF Bull River	Denned in Cabinet Mtns 1993-95, Lost collar April 1995, self-defense mortality November 2009
311	F	3	7/12/1994	NF Flathead River, BC	EF Bull River	Lost collar July 1994, recaptured October 1995 south of Eureka, MT, released in EF Bull River, Signal lost November 1995 1 MONTH
A1	F	7-8	9/30/2005	NF Flathead River, MT	Spar Lake	Denned West Cabinet Mountains 2005 and 2006, Lost collar September 2007 2 YEARS
782	F	2	8/17/2006	SF Flathead River, MT	Spar Lake	Denned West Cabinet Mountains 2006-07, Lost collar August 2008 2 YEARS
635	F	4	7/23/2008	Stillwater River, MT	EF Bull River	Killed by train near Heron, MT October, 2008
790	F	3	8/7/2008	Swan River, MT	EF Bull River	Illegally killed near Noxon, MT October, 2008
715	F	10	9/17/2009	NF Flathead River, MT	Spar Lake	Denned in West Cabinet Mountains 2009-10, returned to NF Flathead R, May 2010
713	M	5	7/18/2010	NF Flathead River, MT	Spar Lake	Denned in Cabinet Mountains 2010, Lost collar September 2011, returned to Stillwater R 2012
714	F	4	7/24/2010	NF Flathead River, MT	Silverbutte Creek	Returned to NF Flathead July 2010, produced 2 cubs 2012
725	F	2	7/25/2011	MF Flathead River, MT	Spar Lake	Returned to Glacier National Park, September 2011, came back to Cabinet Mtns August 2012
723	M	2	8/18/2011	Stillwater River, MT	Spar Lake	Denned in Cabinet Mountains 2011, lost radio collar June 2012 10 MONTHS
918	M	2	7/6/2012	Stillwater River, MT	EF Bull River	Denned in the Cabinet Mountains 2012

LOST COLLAR

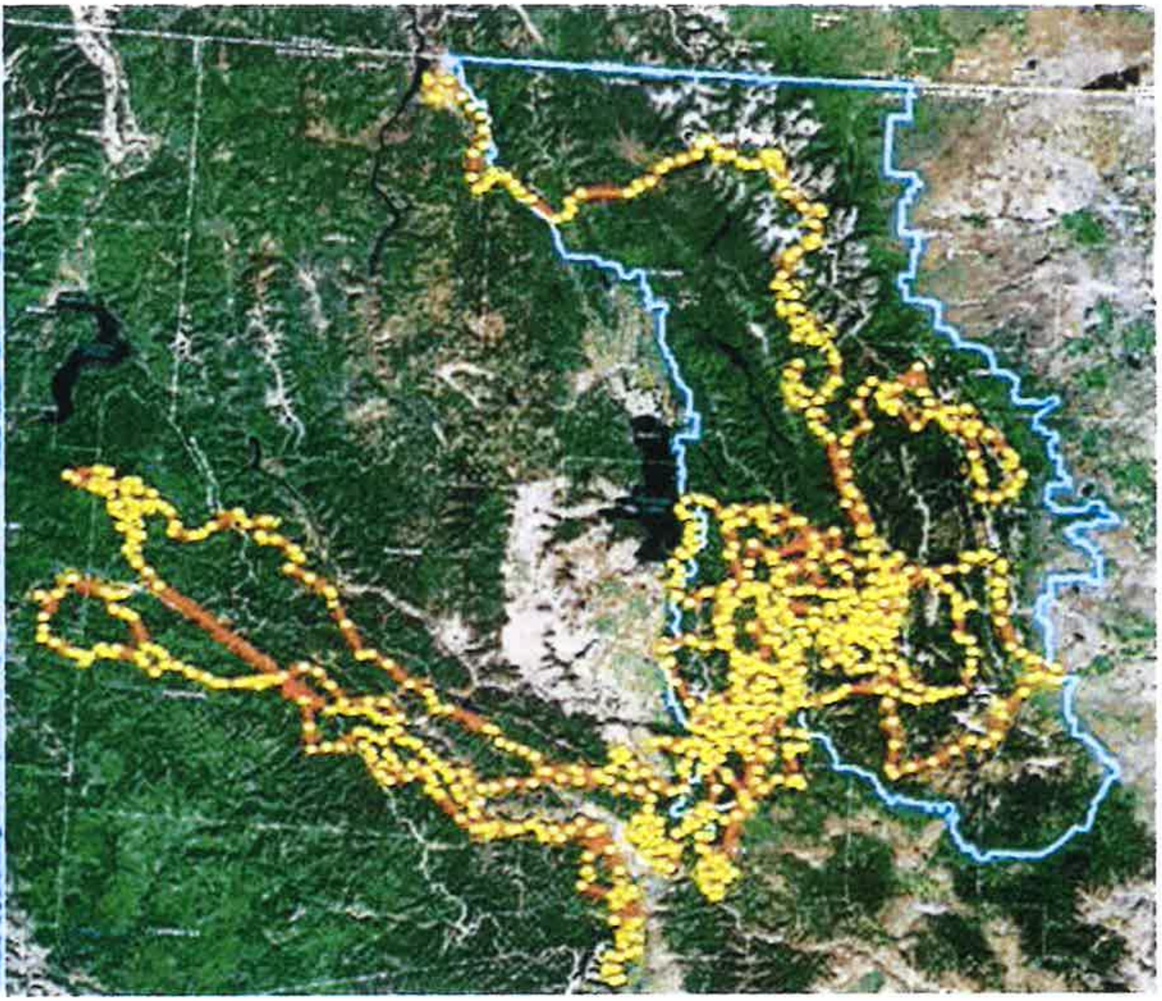
82 MILES

LOST COLLAR

Wayne Kasworm 2012
ICE REPORT

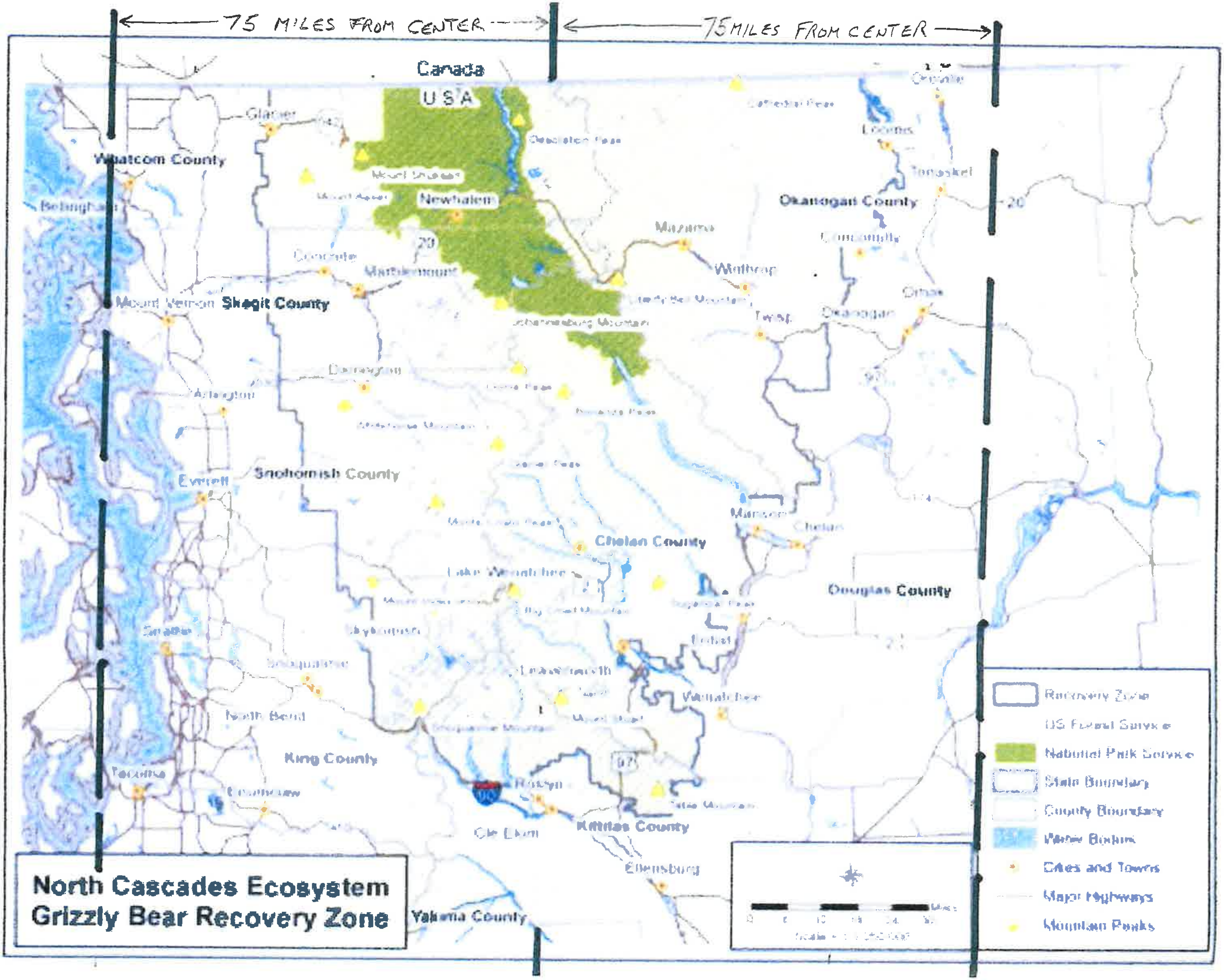
14 Bears
5 returned 82 miles to point of capture
4 Died - 2 in self defense

Grizzly Bear Ethyl's movements during 2012 - 2015 after trapping and transplant.
175 miles east + west and 155 miles north + south



Provided by Retired Wildlife Biologist Fielder

Attachment 6



← 75 MILES FROM CENTER → ← 75 MILES FROM CENTER →

North Cascades Ecosystem
Grizzly Bear Recovery Zone

Provided by Retired Wildlife Biologist Fielder

Attachment 7

Provided by Retired Wildlife Biologist Fielder **Attachment 8**

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
Brad Treat, 38, male	June 29, 2016	Wild	Halfmoon Lakes area south of Glacier National Park, Montana	Treat and another man were on mountain bikes on U.S. Forest Service land near Halfmoon Lakes. The two bikers surprised the bear and Treat was knocked off his bike by the bear. The second rider escaped uninjured and summoned help.[16] As of June 30, 2016, the bear is still being sought.
Lance Crosby, 63, male	August 7, 2015	Wild	Yellowstone National Park, Wyoming	Crosby, an employee at a medical clinic in the park, was reported missing when he did not report for work. A park ranger found his body in a popular off-trail area less than a mile from Elephant Back Loop Trail, an area he was known to frequent. His body was partially consumed and covered. Puncture wounds on his arms indicated he had tried to defend himself. Based on the presence of a sow grizzly and a cub in the area, the sow was deemed responsible for the attack. The sow was captured and euthanized after it was found to be the bear that killed Crosby.[17][18] There were public appeals to not kill the sow, but the park superintendent decided there was a risk the sow might kill again; based on July 6, 2011 and August 24, 2011 killings in the park, where another sow was present at both those killings.[19]
Ken Novotny, 53, male	September 17, 2014	Wild	near Norman Wells, Northwest Territories	While on a hunting trip near Norman Wells, Novotny was charged and struck by a bear. Friends reported Novotny had just killed a moose and was prepping his prize when the bear "came out of nowhere." He died on the scene. Authorities later found and killed the bear responsible for his death.[20]
Rick Cross, 54, male	September 7, 2014	Wild	Kananaskis Country, Alberta	Cross, a hunter, was killed by a mother bear when he accidentally got between her and her cubs. Park rangers stated that it appeared that Cross managed to fire his rifle before being overwhelmed. He was discovered with a knife clenched in each hand. His body was found near his backpack, but the corpse was only identified by his boots. RCMP said it appeared he wandered into the area where the mother and cub were feeding on a dead deer.[21]

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
Adam Thomas Stewart, 31, male	September 4, 2014	Wild	Bridger-Teton National Forest, Wyoming	Stewart was conducting research alone in the Bridger-Teton National Forest in northwest Wyoming. After he failed to return, a search found his body.[22] The coroner suspects it was a grizzly bear, but the species hasn't officially been determined.
Richard White, 49, male	August 24, 2012	Wild	Denali National Park, Alaska	White was backpacking alone along the Toklat River. After hikers found an abandoned backpack and torn clothing, rangers investigated and found a male grizzly bear sitting on White's remains. The bear was shot and killed by an Alaska State Trooper. A necropsy of the bear and photographs recovered from White's camera confirmed the attack.[23] The photographs in White's camera showed that he was taking photos of the bear in a span of eight minutes from 50 yards (46 m) to 100 yards (91 m).[24] It was the first fatal bear attack recorded in Denali National Park.[23]
Tomas Puerta, 54, male	October 2012	Wild	Chichagof Island, Alaska	After passers-by spotted an unattended skiff, they investigated and encountered a grizzly bear sow and two cubs. Alaska State troopers and Sitka Mountain rescue personnel then found evidence of a campsite and fire on the beach. There was evidence of a struggle, and upon following a trail of disturbed vegetation, they found Puerta's body, cached and partially eaten.[25]
John Wallace, 59, male	August 24, 2011	Wild	Yellowstone National Park, Wyoming	Wallace's remains were found by hikers on the Mary Mountain Trail, northeast of Old Faithful.[26] Wallace was hiking alone.[27] An autopsy showed that Wallace died from a bear attack.[27] According to a report released by Yellowstone rangers, park officials had attempted to give Wallace a lecture about bear safety, but he was not interested, calling himself a "grizzly bear expert".[28] DNA evidence later determined that the same sow that killed Brian Matayoshi July 6, 2011 was in the vicinity of Wallace's corpse, though it was not proved that this bear killed Wallace. The bear was killed by park officials.[29] Evidence showed that Wallace was attacked after sitting down on a log to

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				eat a snack and the attack was predatory, rather than defensive.[29][30]
Brian Matayoshi, 57, male	July 6, 2011	Wild	Yellowstone National Park, Wyoming	Matayoshi and his wife were hiking the Wapiti Lake Trail, and came upon a mother grizzly bear in an open meadow. The couple began to walk away, and the bear charged. After attempting to run away, Matayoshi was fatally bitten and clawed. Matayoshi's wife hid behind a tree, was lifted from the ground by the bear, and dropped. She played dead, and the bear left the area. She was not injured.[31][32] An initial investigation by the National Park Service found the bear's actions were defensive against a perceived threat to her cubs. Since the attack was not predatory and the bear had no known violent history towards humans, no immediate action was taken towards the bear, the bear was later euthanized after it was found to be at the site of another fatal attack August 24, 2011.[29][31][32] A later investigation determined that the couple running from the bear was a mistake, and the fatal attack was a "one in 3 million occurrence".[33]
Kevin Kammer, 48, male	July 28, 2010	Wild	Gallatin National Forest, Montana	Kammer was in his tent at Soda Butte Campground when a mother bear attacked and dragged him 25 feet (7.6 m) away. Two other campers in separate campsites were also attacked: a teenager was bitten in the leg, and a woman was bitten in the arm and leg. The bear was caught in a trap set at the campground using pieces of a culvert and Kammer's tent.[34] Later, the bear was euthanized, and her cubs were sent to ZooMontana.[35] The mother bear's unusual predatory behavior was noted by authorities.[35]
Erwin Frank Evert, 70, male	June 17, 2010	Wild	Shoshone National Forest, Wyoming	Evert, a field botanist, was mauled by a grizzly bear while hiking in the Kitty Creek Drainage area of the Shoshone National Forest, just east of Yellowstone National Park. The bear was trapped and tranquilized earlier in the day by a grizzly bear research team. Two days after the attack, the bear was shot and killed from a helicopter by wildlife officials.[36] Initially it was reported that Evert ignored posted warnings to avoid the area due to the potential danger involved with the bear research.[36] However,

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				the sheriff's deputy who recovered the body and members of Evert's family stated that the warning signs were no longer present.[37] A report released the following month confirmed that the warning signs were removed, though it also asserted that Evert knew there was a bear research study being conducted in the area.[38] Evert's wife filed a wrongful death lawsuit against the federal government, which was dismissed by district court judge Nancy D. Freudenthal.[39][40]
Robert Wagner, 48, male	October 1, 2008	Wild	near Sundre, Alberta	Wagner was reported missing after not returning from a hunting trip. His body was found less than 1-kilometre (0.62 mi) from his parked truck. An autopsy revealed that he had been killed by a grizzly bear, which was shot by wildlife officers.[67][68]
Don Peters, 51, male	November 25, 2007	Wild	near Sundre, Alberta	Peters' body was found 200 metres (660 ft) from his parked truck. He was on a hunting trip. An autopsy confirmed that he died due to a grizzly bear attack. The bear that attacked Peters was captured and killed the following April.[71][72]
Jean-Francois Pagé, 28, male	April 28, 2006	Wild	near Ross River, Yukon	Pagé was mauled while staking mineral claims. He unknowingly walked right past a bear den containing a sow and two cubs.[73]
Arthur Louie, 60, male	September 20, 2005	Wild	near The Bowron River, British Columbia	A female and two cubs attacked Louie on a remote forestry road. He was walking back to his gold mining camp after his car broke down.[74][75]
Rich Huffman, 61, male Kathy Huffman, 58, female	June 23, 2005	Wild	Arctic National Wildlife Refuge, Alaska	The Huffmans were attacked while in their tent at a campsite along the Hulahula River 12 miles (19 km) upriver from Kaktovik.[76] Two days later the campsite was discovered by three rafters while the bear was still nearby. The bear chased the rafters down the river for over half a mile until it finally gave up. Later, a North Slope Borough Police officer investigating the scene shot and killed the bear at the campsite.[77]
Isabelle Dube, 35, female	June 5, 2005	Wild	Canmore, Alberta	Dube was killed while jogging with two friends on the Bench Trail. After an initial attack, Dube climbed a tree while her friends sought help. The bear brought Dube down from the tree and mauled her.[78][79]

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				Fish and wildlife officers shot and killed the bear.[79] At the time of the attack, the trail was closed, and the public was told to avoid it.[80] A few days beforehand, the bear had been relocated from Canmore to Banff National Park.[78]
Timothy Treadwell, 46, male Amie Huguenard, 37, female	October 5, 2003	Wild	Katmai National Park, Alaska	Treadwell and Huguenard's corpses were found by their pilot at Kaflia Bay. Treadwell was famous for his books and documentaries on living with wild bears in Alaska. State Troopers investigating the incident recovered an audiotape of the attack. The two were killed on the last night before their scheduled pickup after spending several months in the Alaskan bush.[81] The attack is chronicled in the 2005 American documentary film Grizzly Man by German director Werner Herzog.
Timothy Hilston, 50, male	October 30, 2001	Wild	Blackfoot-Clearwater Wildlife Management Area, Montana	Hilston was attacked as he field dressed an elk in Western Montana.[82] A female bear and her cubs suspected in the attack were killed by U.S. Fish and Wildlife officials.[83] Hilston's widow sued federal and state agencies for negligence, and the lawsuits were dismissed by District Court judge Donald W. Molloy.[84]
George Tullos, 41, male	July 14, 2000	Wild	Hyder, Alaska	Tullos' partially consumed body was found at a campground near the Canada–US border in Southeast Alaska. The bear was shot and killed.[85]

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complex. Golden West Visitor Center, which is the visitor contact point for the Lake Chelan National Recreation Area, is the other main visitor center.

According to NPS, backcountry visitation in the park complex in the summer of 2015 was higher than average due to low snowpack. Visitors must obtain backcountry use permits for overnight camping and adhere to additional rules and regulations when visiting backcountry areas. Popular activities include hiking, mountaineering, rock climbing, whitewater rafting, and wilderness camping. Among visitors to the backcountry, 77% were Washington State residents; 19% were residents of other states; 3% were residents of British Columbia, Canada, and 1% were residents from other areas (2015). The average group size for backcountry visitors was three people (NPS 2015e).

Visitor Use of National Forest Lands in the North Cascades Ecosystem

The national forests within the NCE attract many visitors per year. In 2010, Mt. Baker-Snoqualmie National Forest and Okanogan-Wenatchee National Forest attracted 3,363,000 national forest visits. Of these areas, Mt. Baker-Snoqualmie National Forest attracted 1,995,000 national forest visits, and Okanogan-Wenatchee National Forest attracted 1,368,000 national forest visits (USFS 2016a).

According to a FY 2010 USFS Visitor Use Report for the Okanogan National Forest, almost one-quarter of visits come from people living within 25 miles of the forest. However, more than one-third of visits are from people who live more than 200 miles away (USFS 2011b). The USFS also produced a Visitor Use Report for the Wenatchee National Forest, analyzing data from FY 2010. According to that report, approximately 45% of visits come from people who reside within 50 miles of the forest, while 40% of visitors live between 75 and 200 miles away (USFS 2011c).

Most visits to Okanogan National Forest last less than 5 hours. However, the average is more than 20 hours, indicating that some visitors stay significantly longer. A majority (63%) of visits come from people who frequent the forest no more than five times annually (USFS 2011b).

According to 2010 data provided by Mt. Baker-Snoqualmie National Forest, the average group size for forest-wide visitors was 3.47 adults and 2.63 children under the age of 17. The average number of adults in groups visiting backcountry areas was 2.75, while the average group size for adults visiting front country areas was 2.85 (Plumage pers. comm. 2016a)

Recreation on Federal Lands within the North Cascades Ecosystem

Recreational use of federal lands in the NCE is estimated to be 8 million recreation visitor days per year. Most of this use is associated with dispersed recreation rather than developed campgrounds or wilderness areas (figure 6). Almost 1 million recreation visitor days occur annually in wilderness areas; however, visitation is not equally distributed, and some areas receive much higher recreational use than others. The majority of the trails in the NCE occur in wilderness and roadless areas. Recreation also occurs on lands managed by the State of Washington, although state lands make up a relatively small portion of the NCE. As noted by Almack et al. in 1993, recreational use data for these areas are not readily available.

Both the NPS and USFS encourage and sustain a diverse and balanced spectrum of quality recreation opportunities within the NCE. Recreational activities enjoyed by visitors to both national park and national forest lands include hiking, backpacking, biking, birding, boating, fishing, hunting (on forest lands and within the NPS national recreation areas only), swimming, horseback riding, and mountain and rock climbing. Several of these activities are described in further detail below.

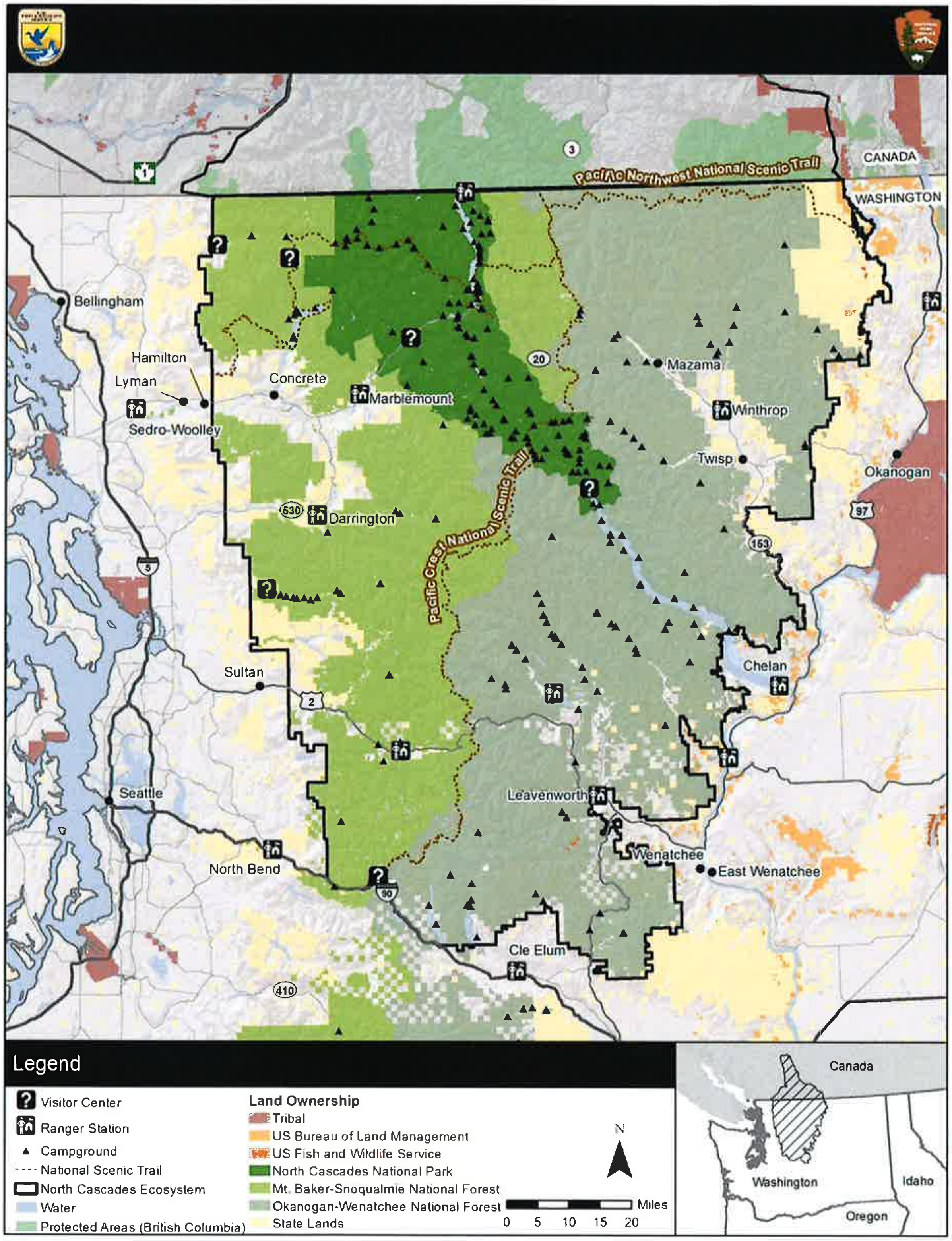


FIGURE 6. RECREATIONAL OPPORTUNITIES IN THE NORTH CASCADES ECOSYSTEM

TABLE 2. SUMMARY OF ACTION ALTERNATIVE ELEMENTS

Element	Alternative B: Ecosystem Evaluation Restoration	Alternative C: Incremental Restoration	Alternative D: Expedited Restoration
Number of Grizzly Bears to be Released			
Source of grizzly bears that share similar ecology	Multisource.	Multisource.	Multisource.
Primary Phase – Number of bears to be released per year Note: Grizzly bears would be replaced based on any source of mortality and emigration for all alternatives during the primary phase.	Up to 10 grizzly bears released in first 2 years; monitor for habitat use and human conflict over years 1–4 and make decision in year 4 for additional release of grizzly bears in year 5.	5 to 7 grizzly bears per year over 5–10 years to achieve an initial population of 25 grizzly bears.	Maximum number of grizzly bears available for capture (anticipated to be 5–7 per year) would be released each year to achieve a minimum population estimate of ~200 grizzly bears on the landscape over shortest possible time frame (the 200 population estimate would include reproduction).
Sex and age class of released grizzly bears	Target grizzly bears roughly 2–5 years old depending on independence and breeding status. Target 40% male; 60% female.	Same as alternative B.	Less restrictive for age and sex ratio given the need for a larger number of grizzly bears. Target grizzly bears up to 10 years old.
Adaptive Management Phase Activities – Number of grizzly bears to be released per year after the primary release	Default to alternative C or repeat primary phase as specified in alternative B depending on results of monitoring information, such as habitat use and human conflict.	Number based on adaptive management criteria. Additional bears would be released based on a number of factors including the following: • human-caused sources of mortality • genetic limitations • population trends • adjustment of sex ratio.	No adaptive management phase.
Time to achieve restoration goal (200 bears in the NCE)	Approximately 60–100 years. Slightly longer (approximately 2 to 5 years) than alternative C because of the 2 year pause for monitoring.	Approximately 60–100 years.	Approximately 25 years.

Attachment 10

Element	Alternative B: Ecosystem Evaluation Restoration	Alternative C: Incremental Restoration	Alternative D: Expedited Restoration
ESA Designation			
Section 10(j) designation option	The option to designate the NCE grizzly bear population as an experimental population under section 10(j) of the ESA would be common to all of the action alternatives. If the option was not implemented, the population would be managed as a threatened species under all of the action alternatives.		
Spatial Extent of Grizzly Bear Release Sites	Release sites would be based on capture timing and availability of food.		
Primary release sites on federal lands	Single initial release site based on habitat criteria.	Multiple release sites based on habitat criteria.	Same as alternative C.
Adaptive management phase release sites	Derived from spatial monitoring. Note: No additional releases beyond replacement during 2-year evaluation period in years 3 and 4.	Derived from spatial monitoring.	No adaptive management phase.
Habitat Security			
NCE grizzly habitat conservation (core habitat)	Maintain at least 70% of core habitat under management direction provided in the Ross Lake GMP (NPS 2012c). Maintain no net loss of core habitat for USFS under the 1997 interagency MOU until forest plans are revised.		
Management Tools	Note: Minimum requirements analysis pursuant to the *Wilderness Act* was conducted for actions that could occur in wilderness areas. See appendix F.		
Tools for capture of grizzly bears	Baited foot snares or culvert traps would be used to capture grizzly bears with possible helicopter support in wilderness or roadless areas. Also potential to evaluate and use helicopter-based capture darting.		
Release approach	Grizzly bears would be released from culvert traps transported by truck and/or from culvert traps ferried in by helicopter. Release sites would be remote. All release activities would be conducted by the FWS, NPS, and USFS, in consultation with WDFW.		
Helicopters and other remote access tools	Helicopters used for release and possibly retrieval of collars. Fixed-wing aircraft and satellites used for periodic monitoring. All release activities would be conducted by the FWS, NPS, and USFS in consultation with WDFW.		
Timing of Management Actions			
Initial and adaptive management releases	Early summer-early fall depending on release site (may have more latitude based on food availability). Release timing is food source dependent and may be limited by capture timing.		
Maintenance activities (monitoring activities, etc.)	Monitoring activities would take place from early spring to late fall and would be done in cooperation among the USFS, FWS, NPS, and WDFW.		

Element	Alternative B: Ecosystem Evaluation Restoration	Alternative C: Incremental Restoration	Alternative D: Expedited Restoration
Other Considerations			
RCW 77.12.035	As a result of the RCW, participation in active grizzly bear restoration by the WDFW would be subject to state authorization.		
Management actions across jurisdictions	Joint management under IGBC subcommittee. Monitoring would be accomplished through cooperation among FWS, NPS, USFS, and WDFW.		
Conflict grizzly bear management	Responses, including removal/relocation of human-conflict grizzly bears as necessary, would be based on updated 2002 IGBC Guidelines applicable to the NCE (appendix E) and could result in potential temporary, local closures (up to several days) for public safety. Additional modifications could be made in consultation with the IGBC NCE Subcommittee.		
Public access management	No long-term closures expected. Occasional short-term (a few hours to a few days) closures for releases and public safety may occur, but would be site-specific.		
Research and monitoring	Habitat use and spatial distribution monitoring and analysis to inform subsequent releases. Recapture work to maintain collared sample. Hair collection for genetic monitoring. Use of camera traps for monitoring. Includes activities to retrieve collars and bear mortalities.		
Public outreach and education/information	Increased efforts related to outcome of program with regular (initially weekly) updates on grizzly bear restoration efforts; includes education and outreach that are also common to the no-action alternative.		
Ungulate hunting management	Increased public outreach and education efforts for hunters to avoid grizzly bear encounters, increase use of bear spray, clean camping, etc.		
Black bear hunting management	Mandatory species identification training would be considered, additional grizzly bear information would be provided to all bear hunters, especially in areas within the recovery zone and areas immediately adjacent to the recovery zone that grizzly bears are likely to use (public outreach and education).		

Commissioners' Record Of the Proceedings – Skagit County, Washington

Date: **April 24, 2017**

The Skagit County Board of Commissioners met in regular session on Monday, April 24, 2017, with Chair Ron Wesen, Commissioner Kenneth A. Dahlstedt, and Commissioner Lisa Janicki present.

I. CALL TO ORDER:

Chair Wesen called the proceedings to order at 9:00 a.m.

II. PLEDGE OF ALLEGIANCE:

Chair Wesen led the gallery in the salute to the flag.

III. AGENDA

a) 9:00 a.m. - 9:45 a.m. Consent Agenda, Vouchers, Warrants and Miscellaneous Items

b) 3:00 p.m. - 5:30 p.m. Joint Coordination Meeting with Chelan County, National Park Service, and U.S. Fish and Wildlife Service RE: Draft Environmental Impact Statement on Grizzly Bear Reintroduction in North Cascades

1. Call to Order

Skagit County Chair Wesen convened the proceedings at 3:00 p.m. and announced that Skagit County Commissioner Dahlstedt would be arriving a little late.

2. Skagit County Open Meeting

3. Introductions

In attendance were Skagit County Commissioner Ron Wesen, Skagit County Commissioner Ken Dahlstedt, Skagit County Commissioner Lisa Janicki, Chelan County Commissioner Doug England, Chelan County Commissioner Kevin Overbay, Chelan County Commissioner Keith Goehner, Okanogan County Commissioner Andy Hover, Snohomish County Councilman Nate Nehring, Town of Darrington Mayor Dan Rankin, retired wildlife biologist Paul Fielder, Executive Director of American Stewards of Liberty Margaret Byfield, Ron Scutt of Stehekin, U.S. Fish and Wildlife Service State Supervisor Eric Rickerson, National Park Service Superintendent Karen Taylor-Goodrich, National Park Service Chief of Natural and Cultural Resources Jack Oelfke, National Park Service Chief of Interpretation and Education Denise Shultz. Attending by telephone was U.S. Fish and Wildlife Service Biologist Gregg Kurz.

4. Opening Remarks (Commissioner Janicki)

Skagit County Commissioner Janicki said they were meeting to address concerns about the *Draft Environmental Impact Statement of Grizzly Bear Reintroduction in the North Cascades* (Draft EIS) and conflicts with the Comprehensive Plans of Skagit County, Chelan County, Okanogan County, Snohomish County, and the Town of Darrington to protect the health, safety, welfare and economy of residents. Skagit County Commissioner Janicki said that Executive Director of American Stewards of Liberty Margaret Byfield, and retired wildlife biologist Paul Fielder had been engaged to assist them in addressing their concerns.

5. Opening Remarks (U.S. Fish & Wildlife and National Park Service)

National Park Service Superintendent Karen Taylor-Goodrich thanked the counties for the opportunity to meet and looked forward to discussing the items on the agenda.

U.S. Fish and Wildlife Service State Supervisor Eric Rickerson also appreciated the opportunity to meet and discuss the Draft EIS and the counties' concerns that may not have been taken into account. He looked forward to better understanding the counties' perspective and appreciated the cooperative effort. He said that the process had been lengthy and that an alternative had not yet been selected. He said that any new information provided that would help them make the best informed decision for all involved would be considered.

6. Overview of Coordination with Local Governments and Requirements under the National Environmental Policy Act and Endangered Species Act

Executive Director of American Stewards of Liberty Margaret Byfield provided a PowerPoint presentation outlining mandatory requirements under the National Environmental Policy Act (NEPA) and the Endangered Species Act to consider and coordinate plans with local government for consistency. She said coordination worked best if it was done early in the initial planning stages in order to avoid, or address conflicts.

Coordination on the Draft EIS was important due to the numerous conflicts that arise when one agency is working towards the introduction of a species that endangers the health, safety, and welfare of residents.

Executive Director Byfield provided an overview of the law and regulations that required the National Park Service and U.S. Fish and Wildlife Service to coordinate with local governments as well as the requirements and purpose of preparing an Environmental Impact Statement. These Federal Statues included the:

1. Federal Land Policy and Management Act of 1976 (FLPMA) 43 U.S.C.A. § 1712(c)(9)
2. National Environmental Policy Act of 1969 (NEPA) 42 U.S.C.A. § 4321 and 4331(a) & (b) and 4332
3. National Forest Management Act of 1976 (NMFA) 16 U.S.C.A. § 1604(a)
4. Endangered Species Act of 1973 (ESA) 16 U.S.C.A. § 1533(b)(1)(A)

The Federal Land Policy and Management Act of 1976 (FLPMA) 43 U.S.C.A. § 1712(c)(9) requires that the National Park Service and U.S. Fish and Wildlife Service keep apprised of local plans, give consideration to local plans, resolve inconsistencies between plans, involve local governments in the planning process, and make Federal plans consistent with local plans.

Executive Director Byfield pointed out that local governments were responsible for implementing and maintaining large, comprehensive, countywide plans to address planning elements required by the state Growth Management Act, and to provide goals, policies, and strategies for managing growth, and ensuring that a community's health, safety, and general welfare were protected by striving for and creating a better, healthier, more efficient, and aesthetically pleasing environment in which to live.

The Draft EIS was just one piece that needed to fit in with the larger Comprehensive Plans of the local governments.

The National Environmental Policy Act of 1969 (NEPA) 42 U.S.C.A. § 4321 and 4331(a) & (b) and 4332 declared a national policy to encourage productive and enjoyable harmony between man and his environment; to promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans; assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

Executive Director Byfield pointed out that planning was often laser-focused on wildlife and needed to be broader to fit man in his environment together.

Per 42 USC 4332, NEPA also provides a solution for unresolved conflicts: (E) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources.

Executive Director Byfield said unresolved conflicts between federal and local plans were to be studied by the federal agency in order to provide an alternative within the EIS which represented the position of the local government. Another important aspect of planning was the use of good information with scientific integrity. A problem with the current Draft EIS is that it contains no alternative for the local government's position and that, essentially, the local position and plans were left out of the Draft EIS. She said that three of the four alternatives provided were all in support of a single position (to introduce grizzly bears to the environment). She said alternatives were required to provide a broad range of options to choose from.

Executive Director Byfield discussed additional policies and regulations that outlined the importance of equally balancing the human environment and the wildlife environment. Had NEPA been applied earlier in the process, conflicts between local plans and the Draft EIS could have been taken into consideration and addressed. She also stated that a Draft EIS was meant to explore multiple options and data instead of only providing information to support one option.

Executive Director Byfield ended her presentation saying that Washington State Code RCW 36.70.010 provided for County Comprehensive Plans and that the purpose and intent was to provide the authority and procedures in "guiding and regulating the physical development of a county or region through correlating both public and private projects and coordinating their execution with respect to all subject matters utilized in developing and servicing land, all to the end of assuring the highest standards of environment for living, and the operation of commerce, industry, agriculture and recreation, and assuring maximum economies and conserving the highest degree of public health, safety, morals and welfare."

She said that the local government had responsibilities to meet which were in conflict with the Draft EIS.

Executive Director Byfield's PowerPoint presentation can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

7. Discussion of County Comprehensive Plans, Key Policies and Conflicts

Chelan County Commissioner Kevin Overbay said that five areas had been identified within their County's Comprehensive Plan which were incompatible and in conflict with the proactive approach of the Draft EIS. These were:

1. Ranching and Agriculture
2. Tourism and Recreation
3. Rural Communities
4. Impacts on Existing Habitat Restoration
5. Lack of Coordinated Planning

Chelan County Commissioner Overbay discussed the landscape and geography of Chelan County which ranked 3rd in area size among Washington State Counties and said that the majority of land was publicly owned and managed by an assortment of federal, state, and local agencies. Chelan County was concerned about their ranching and agricultural economies: the majority of Chelan County was open range and allowed ranchers to freely roam their animals regardless of land ownership. The introduction of grizzly bears could limit the area available for open range and lead to economic challenges and hardships.

In regards to tourism and recreation, he quoted Land Use Policy 17.2, Development Goal #2, Economic Development Policy 6.8, and Land Use Policy 14.5. These were put into place to sustain, develop, support, implement, and encourage the growth of Chelan County's tourism and recreation industries which were key elements of local economic development efforts. He said that many of Chelan County's tourist destinations, including Leavenworth, Upper Entiat Valley, Stehekin, Lake Chelan, Lake Wenatchee, and a portion of the Pacific Crest Trail, are all located around natural resource areas so that residents and visitors are able to access the natural surroundings. The introduction of grizzly bears would pose real or perceived safety concerns, both of which would result in reduced tourism activities and negatively affect economic growth. Chelan County Commissioner Overbay pointed out that many of the areas accessed by visitors, and where residents lived, were located in areas where emergency services were limited or not available at all. This would increase the likelihood of a fatal outcome with a negative encounter with a grizzly bear.

Chelan County Commissioner Overbay said that his County was home to many rural communities surrounded by significant federal and state lands and that Chelan County had numerous goals and policies addressing these communities and protecting them. Land Use Policy 14.5 was adopted to protect residential neighborhoods from potential detrimental impacts of incompatible land uses.

Regarding impacts on existing habitat restoration, Rural Element Policy 2.6 sought to protect and encourage the enhancement and restoration of habitat for fish and wildlife. He said that, since 2005, Chelan County and its federal and state partners had engaged in over 188 restoration projects to enhance listed fish populations on the Endangered Species Act and address water quality issues. These efforts would be in vain if endangered grizzly bears ate endangered fish.

Chelan County Commissioner Overbay said that the U.S. Department of Agriculture, Natural Resources Conservation Service, noted that the reason for grizzly bear decline was human encroachment from activities such as recreational development, improper livestock grazing, poaching, excessive road access, and poorly designed timber harvest. This, paired with Chelan County's goals to support and increase recreational development, grazing, road development and access, timber activities, and mining, was in conflict with introducing a predator that declined under those conditions.

Chelan County was committed to integrated planning with the National Park Service and U.S. Fish and Wildlife Service. Land Use Goal 25 encouraged coordination of federal, state, local and private planning, and he asked that the National Park Service and U.S. Fish and Wildlife Service take into consideration the conflicts with their Comprehensive Plan and impacts to their residents who entrusted the Commissioners to protect them from adverse environmental, physical and economic impacts.

The talking points provided by Chelan County Commissioner Overbay can be found here: ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Skagit County Commissioner Dahlstedt shared concerns that were similar to Chelan County and discussed their responsibility to provide public safety. Risks such as volcanoes, lahars, earthquakes, and floods could not be controlled. He did not support the introduction of a risky predator species, the grizzly bear.

Like Chelan, Skagit County was also involved in mandated fish habitat restoration projects and he found it unwise to introduce predators to an area with this food source. He said the Skagit River hosted all 5 species of salmon, including the endangered Chinook, and Skagit County had spent millions of dollars on fish habitat restoration projects. Another concern Skagit County Commissioner Dahlstedt had was that approximately 80% of Skagit County was timber lands. The ability to adequately harvest and maintain healthy forests was difficult and he believed difficulties would increase if grizzly bears were introduced.

Skagit County Commissioner Dahlstedt was also concerned about the management of introduced grizzly bears. He was concerned they would enjoy the same mismanagement as the elk herd that had been introduced to the area a number of years ago. Complaints about safety (elk vs. vehicles on the roadway) and the destruction of crops have yet to be addressed.

Tourism was one Skagit County's economic drivers and he shared the same concerns as Chelan County Commissioner Overbay.

Finally, he asked about the science supporting the introduction of grizzly bears to the North Cascades. He said Skagit County is constantly challenged on using the best and most up-to-date science available when planning and he was concerned about whether the National Park Service and U.S. Fish and Wildlife Service had used the best, available science.

Skagit County Commissioner Janicki inquired if National Park Service or U.S. Fish and Wildlife Service had any questions.

National Park Service Chief of Natural and Cultural Resources Jack Oelfke requested that comments be provided in written form.

8. Discussion of the Science Determining the Suitability of the North Cascades for the Establishment of a Grizzly Bear Population

Retired wildlife biologist Paul Fielder informed those present that he had worked, lived, hunted, trapped, and fished in Chelan County for 30 years and that he now lived in Montana at the southern end of the Cabinet-Yaak Grizzly Bear Recovery Zone and that he had been involved in the biology and politics associated with the Cabinet-Yaak Recovery Zone for over 5 years. He came to discuss concerns about the science used in determining the suitability of the North Cascades for a grizzly bear population, and, to share firsthand experiences of living in a grizzly bear recovery zone.

Mr. Fielder shared concerns about the outdated science, reports, and materials used by the National Park Service and U.S. Fish and Wildlife Service to prepare the Draft EIS. Better science could have been used and he provided an overview of comprehensive information and updated science about grizzly bears that would need to be considered by the National Park Service and U.S. Fish and Wildlife Service.

Some of the problems he discovered with the Draft EIS and additional questions he had included:

1. What was the science used to determine a 200 grizzly bear population was suitable in the North Cascades Ecosystem?

He was concerned about a quote he found in the Draft EIS used to support the conclusion that the North Cascades Ecosystem was suitable for a population of 200 grizzly bears had come from a 9-page paper written by Chris Servheen 26-years ago that had been presented to the Interagency Grizzly Bear Committee but had not been published. Mr. Fielder asked to see the information used to determine this.

2. What other grizzly bear recovery zones were used as a comparison to determine that the North Cascades Ecosystem was suitable for grizzly bears and was science and experiences from current grizzly bear recovery zones considered?

Mr. Fielder said when the 1993 *Grizzly Bear Recovery Plan* was written 24-years ago, it identified 6 recovery zones: Yellowstone, North Continental Divide, Cabinet-Yaak, Selkirk, Bitterroot, and the North Cascades. Grizzly bears were now in 4 of those zones. He said there were no bears in the Bitterroot and no documented bears in the North Cascades for 21 years. He said the Cabinet-Yaak recovery zone was 2.2 million acres and was divided up into 22 grizzly bear management units.

3. How many bear management units would need to be established in the North Cascades and what will that be based on?

He was concerned that the number would be based on the number of square miles within the recovery zone but pointed out that not all land within the area was suitable habitat, which is what the science should be based on.

4. What was the historical abundance and distribution of grizzly bears in the North Cascades Ecosystem?

Mr. Fielder stated that he could not find any information in the Draft EIS regarding the historical abundance of grizzly bears in the North Cascades. Were there 200 grizzly bears? What were their numbers and distribution? He supposed that some of that information could come from wildlife control services and livestock loss reports. Mr. Fielder said that there were verified grizzly bear tracks in the North Cascades in 1989 and in 1990. Also, there had been a report of a sow and her cub near Lake Chelan in 1991. He asked why this information had not been included in the 1993 *Grizzly Bear Recovery Plan*.

Mr. Fielder said in 2014, Montana State senators, commissioners and mayors requested that the Selkirk and Cabinet-Yaak Interagency Grizzly Bear Committee sub-committee update the 1993 *Grizzly Bear Recovery Plan* to include the best available science and provide proper planning needed for grizzly bears, people, and resource management. He said that a 24-year old plan should not be dictating the health, safety, and welfare of people in vast areas of the country. This was also requested by the Montana legislature.

In Idaho, the Fish and Game Commission requested the delisting of grizzly bears because the population had increased to the point where grizzly bears were dispersing into other areas where there was conflict with people. Delisting was not granted because the science was still based on an out-of-date plan.

In Montana, the Legislature passed a Joint Resolution between the House and Senate asking congress to delist the grizzly bear because the Endangered species Act (ESA) was not moving forward to delist. They delisted the wolf in this manner also because the ESA had also not acted to do so.

Mr. Fielder said that a good study that, for some reason, is not ever used was a 2005 study by John Steven Waller. The study, *Movements and Habitat-Use of Grizzly Bears along U.S. Highway 2 in Northwestern Montana 1998-2001*, was John Waller's Ph.D. Master Thesis and was approved by Christopher Servheen who was the head of the Interagency Grizzly Bear Committee and who was a U.S. Fish and Wildlife Biologist. The study used two methods to track grizzly bear movements: 1) by radio telemetry collars, and 2) by satellite GPS collars.

The study showed that radio telemetry collars only provided a fraction of information about a grizzly bears range. This was due to the manner in which data from radio telemetry collars could be collected (about once a week, early in the morning, by airplane). This method only provided a snapshot of the grizzly bears range.

The information captured by the satellite GPS collars provided an in-depth look at the movements and habitat use of a grizzly bear. Data was captured hourly.

By the end of the three-year study, 940 data points had been collected using the radio telemetry collars and 21,000 data points had been collected using the GPS collars. The study showed that the current method and science being used, which the 1993 *Grizzly Bear Recovery Plan* was based on, greatly underestimated the roaming range of a grizzly bear. It showed only 30% of what the modern information showed. So, for example, if the old estimation showed the range was 30 square miles, the new data showed the range was more like 100 square miles. Mr. Fielder asked the National Park Service and U.S. Fish and Wildlife Service to apply the study to the Draft EIS.

Also in 2005, Dr. Chris Servheen provided a presentation of GPS monitoring data from New Swan Valley in Idaho. The data showed grizzly bears movements and showed that their home range was not located in the wilderness areas, but in the valley bottom where there was a road and the Town of Condon.

GPS map showing grizzly bear range in New Swan Valley can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Another study proving that grizzly bears ranged further than the information provided in the 1993 *Grizzly Bear Recovery Plan* was completed by Dr. Kendall in 2015. Dr. Kendall was with the U.S. Geological Survey and she performed a hair snag study which showed that bears from the North Continental Divide Recovery Zone were mixing with grizzly bears from the Cabinet-Yaak Recovery Zone.

A 1997 report *Grizzly Bear and Road Density Relationships in the Selkirk and Cabinet-Yaak Recovery Zones* prepared by Wayne Wakkinen of Idaho Department of Fish and Game and Wayne Kasworm of U.S. Fish and Wildlife Service was used to determine road density standards and then implemented by the Forest Service to start closing roads and cutting out public access to areas. The problem with the study was that it was not based on good statistics and it was only peer reviewed by the people who worked on it. The statistics and calculations contained in the document were incorrect and Mr. Fielder had this verified by a professor at the University of Washington. Furthermore, the report was based on a small sample size: a mother and daughter grizzly bear. The science was inadequate and when challenged in court for its statistical validity, the court ordered a review of to consider the findings of other studies measuring habitat parameters in other ecosystems, but the New Swan Valley data from Dr. Servheen was not considered. The New Swan Valley was only 90 miles away. The report prepared in the case by Lydia Allen, and others, who worked for Forest Service in Idaho was printed by the Forest Service when they enacted their *Forest Plan Amendments for Motorized Access Management Plan within the Selkirk and Cabinet-Yaak Grizzly Bear Recovery Zones* and is being used to close roads in Montana and Idaho.

Mr. Fielder discussed the Endangered Species Act (ESA) and whether the definitions: endangered species or threatened species applied to the grizzly bear. When congress amended the ESA in 1978 to include Distinct Population Segments (DPS), they granted authority to U.S. Fish and Wildlife Serves and National Marine Fishery Service agencies. Congress required that the designation be used sparingly. The problem came later in 1996 when the agencies made a policy clarifying DPS zones and that a population could be considered genetically isolated if they were delineated by an international government boundary. He said that the U.S./Canadian Border could be used to designate a DPS (and that this was an agency policy, not an act of congress), and that the proposed North Cascades population had, instead, been designated as a recovery zone.

The *Interagency Grizzly Bear committee Five-Year Plan for 2010-2014* discussed social and political aspects of managing grizzly bears and that public support is critical for recovery and funding, that working closely with local residents and communities (as they live with bears) is important in building confidence, and that the needs of the community and grizzly bears must be balanced. The report also stated that given level of human development in bear habitat, there were limits to where grizzly bear populations could be recovered and Mr. Fielder found that applied to the North Cascades Ecosystem.

Mr. Fielder also pointed out that grizzly bear ranges differ between a transplanted grizzly bear and naturally found grizzly bear. He showed a map of a transplanted bear and over 3-years the range established was that the bear was traveling 175 miles by 155 miles.

Map showing transplanted grizzly bear range can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Another map shown was from Wayne Kasworm's *2012 Autumn Cabinet-Yaak Ecosystem Report* which showed a transplanted bear was traveling 115 miles back and forth from where it was transplanted from. In the same report was a table that showed of the 14 grizzly bears transplanted to the Cabinet-Yaak Recovery Zone, 5 grizzly bears left area and travelled 82 miles back to near where they were released from, and 4 grizzly bears died within a year (2 shot in self-defense, 1 killed by a train, and 1 died naturally).

Map showing transplanted grizzly bear's 115 mile movements can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Mr. Fielder took the 82 miles of travel by the 5 transplanted grizzly bears who left their new site and applied it to the North Cascades area to show where the potential range could be (and with only 75 miles applied). He also showed a photograph of grizzly bears in a wheat field in eastern Montana to point out that grizzly bears move to where the best food source can be found. This is often within wheat and corn fields. He said the North Cascades was incompatible for grizzly bears based on what has occurred in Montana.

Map showing the 75 mile overlay in the North Cascades can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

He asked that the Draft EIS include research from Montana and Wyoming on the number bears killed by the U.S. Department of Agriculture, Wildlife Service Division, to control conflicts between grizzly bears and people, and, that it address the food sources that are attractants to grizzly bears: fruit orchards, fish, chickens, bee hives, backyard gardens, and farmers' fields.

In the Draft EIS, Mr. Fielder disagreed with the statement "recreation will benefit because of grizzly bears". He said he prefers to avoid grizzly bears in the wilderness and provided examples of negative encounters friends had experienced and legal hurtles of defending themselves from a grizzly bear. He wondered if Yellowstone was the model used for this statement. He said the 50 – 70 grizzly bears in the Cabinet-Yaak area were not an attraction to recreationalists, and one of the reasons was because the roads were closed down.

He asked that human population be analyzed in the study: Wyoming has a population of 6 people per square mile. Montana has 7 people per square mile. Washington has 107 people per square mile. Washington has more potential for conflicts between people and grizzly bears.

Regarding road closures, the U.S. Fish and Wildlife Service provides input to the Interagency Grizzly Bear Committee which is made up of representatives from federal and state agencies and they listen to reports and make recommendations. Mr. Fielder said a reoccurring recommendation to the U.S. Forest Service is that they have to manage access because people in certain areas is bad for grizzly bears, and, grizzly bear habitat is not measured by the available food source, but by how many miles of road can be removed. A grizzly bear management unit in Montana is where there are no roads within 1/3 of a mile.

Removing roads reduces public access, limits recreational opportunities, and increase risks to public health, safety and welfare. Game wardens, sheriff, search and rescue, fire departments, and border patrols need roads for access and to provide services. Removing roads negatively affects economies that depend on access: the timber industry, mining, and recreation.

Mr. Fielder said that grizzly bear attacks are legitimate. In Wyoming and Montana, 7 people have been killed in the last 7 years. He showed a comprehensive list of people killed in Canada and the United States. It did not include many more who were mauled. He asked that the Draft EIS better address the health, safety, and welfare of people.

The table documenting grizzly bear caused human fatalities can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Skagit County Commissioner Janicki asked if the National Park Service or U.S. Fish and Wildlife Service had any questions or information to provide to some of the answers asked by Wildlife Biologist Fielder and that perhaps, due to the volume of information inquired about, they would prefer to send a response at a later date.

U.S. Fish and Wildlife Service State Supervisor Eric Rickerson said some information could be provided to the group now and some more detailed information at a later date. He did point out that the habitat suitability of the North Cascades was researched and came from a report *Grizzly Bear Carrying Capacity in the North Cascades Ecosystem* where there was extensive analysis that modeled suitable habitat for grizzly bears and included 16 studies on range sizes, 14 studies on survival rates, and 18 studies on population density. He said that it was the report that was used to determine the targeted population of 200 grizzly bears in the North Cascades Ecosystem. He said the report showed that 83-400 female bears could be supported, and, that wherever you find black bears, you are liable to find grizzly bears due to their generalist behaviors.

Okanogan County Commissioner Hover asked how many square miles the report was based on.

National Park Service Chief of Natural and Cultural Resources Jack Oelfke said 9,600 square miles.

U.S. Fish and Wildlife Service State Supervisor Eric Rickerson answered Mr. Fielder's question about the number of bear management units: there were 42 planned bear management units in the North Cascades.

After listening to Mr. Fielder, Skagit County Commissioner Janicki asked if the systematic dismantling of roads and access had really been to create grizzly bear habitat instead of the reason provided (that there was not enough revenue to maintain the road system).

Skagit County Commissioner Janicki recessed the proceedings for a short break at 4:45 p.m.

9. Discussion of Local Impacts and Conflicts that have not been Sufficiently Addressed in the Draft Environmental Impact Statement

Skagit County Commissioner Wesen reconvened the proceedings at 4:54 p.m.

Skagit County Commissioner Janicki requested a copy of the *Grizzly Bear Carrying Capacity in the North Cascades Ecosystem* report that U.S. Fish and Wildlife Service State Supervisor Eric Rickerson referred to and National Park Service Chief of Natural and Cultural Resources Jack Oelfke informed her that it could be located online and was linked to the Draft EIS.

Snohomish County Commissioner Nehring said that Snohomish County was expecting their population to grow by an additional 200,000 people over the next 10 years and planning was in place for recreation and tourism to occur in the surrounding communities. He said that he had not yet encountered anyone being excited to encounter a grizzly bear while participating in a recreational activity. He asked what evidence there was within the Draft EIS to suggest that encountering a grizzly bear would be positive.

Town of Darrington Mayor Rankin discussed the town's Comprehensive Plan which addressed recreation, natural resource extraction, forest health, and water quality. He was concerned that the reintroduction of the grizzly bear would negatively impact all of those initiatives. If U.S. Fish and Wildlife Service State Supervisor Eric Rickerson indicated that grizzly bears would be found where there are black bears, then grizzly bears would end up in all of the communities on both the west and east slopes of the Cascades. Black bears are already encountered within the city limits of many communities including Darrington, Issaquah, and many other suburban neighborhoods. He asked what repercussions could be expected for running into grizzly bears in neighborhoods and in the backcountry?

Regarding the health and welfare of communities, he said that in the last 24-years the Town of Darrington and the Town of Concrete have experienced the highest poverty rates between the two counties. This was due to timber activity, natural resource activity, forest health issues, water quality, and the stability of jobs (and this was taking into account a fairly robust tourism industry). He said that public impressions, perceived or real, regarding safety while participating in recreational activities within their communities has adverse impacts. He said the percent of children who received free or reduced lunches in their schools was at 50 – 57%. He said the last perceived threat to safety, a landslide that occurred in 2014, jumped that number up to 65-70% of children who were receiving free or reduced lunches. He said that the introduction of the grizzly bear would have the same impact.

Ron Scutt, a retired school teacher from Stehekin, Washington, was present to read a letter from Clifford Courtney with Stehekin Outfitters regarding the economy and jobs of those who take visitors into the high country and whether or not the amount of visitors would increase or decrease with the introduction of grizzly bears. The business started in 1947 with familial roots dating back to 1889 and he questioned whether grizzly bears ever had a sustained population in the area. Mr. Courtney determined that the stigma and fear of a grizzly bear encounter would equate to people avoiding the outdoor experience entirely and he had additional concerns regarding increased regulations and additional closures. Mr. Scutt said that Stehekin Outfitters had not been engaged in any conversations in relation to the Draft EIS.

The letter from Clifford Courtney which Mr. Scutt read from can be found here:
ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

Okanagan County Commissioner Hover shared that the Methow Valley had the largest contiguous trial system in North America and he noted that portions of the trail system would be coming into contact with the North Cascades ecosystem. He said that the Town of Mazama and the Town of Winthrop were approximately 20 – 30 miles away from the grizzly bear drop off site. He said that he understood that a male grizzly bear had a 500 square mile range and a female grizzly bear had a 100 square mile range.

Regarding cattle grazing, he did not find any impacts on cattle grazing identified in the Draft EIS. Okanagan County has a long history of cattle grazing with some of the first permits issued in the 1930's. Cattle grazing was part of their customs, culture, and economic vitality. He asked which agency was lead for the management, mitigation and resolving conflicts with grizzly bears?

Randy Good of Hamilton and vice president of the Skagit County Cattleman's Association was a beef farmer and said that predation by grizzly bears would cause huge losses. He said the loss of one beef cattle amounted to $3,500 and one calf to $900. He said the Draft EIS failed address how ranchers and dairy farms would be compensated for losses. He was also concerned about the transmission of TB by grizzly bears and the mismanagement of the grizzly bears. He briefly discussed the mismanagement of the introduced herd of elk in Skagit County.

Skagit County Commissioner Janicki said that the Draft EIS focused on forest service land for grizzly bear habitat since not a lot of activity was occurring on forest service land, which, they had purposely pre-planned.

She was concerned about the forestry industry and what amount of state trust lands would need to be put in place for the plan. She said additional restrictions were not needed on state managed trust lands. She was concerned about grizzly bears migrating onto private lands and what additional restrictions would follow the grizzly bear. After speaking to the Uplands Manager from Sierra Pacific, a large, local lumber mill in Skagit County who had land in the Finney Creek area, she understood that they were not interested in setting aside any additional lands for grizzly bears since they already mitigate for many other species.

10. Discussion of the Impact Analysis, Alternatives and Sufficiency of the Grizzly Plan Draft Environmental Impact Statement

Executive Director Byfield discussed concerns that no analysis of local impacts was contained in the Draft EIS. She said that there were a lot of conclusionary statements and no analysis of other Grizzly Bear Recovery Zones and how similar events would relate to the North Cascades. Just what would impacts be to the economy and jobs? Executive Director Byfield said that the $3,500 loss from a cow has a multiplier effect.

A study by King County showed the multiplier effect from livestock grazing was 45% (compared to 3 – 4 % of recreation) because people who live here buy things here. Also, local people are the infrastructure of their counties. They are the ranchers who are also in search and rescue, on-call volunteer firefighters, on school boards, etc. The loss of one cow equals to so much more and the Draft EIS did not recognize or analyze that information. NEPA requires it be analyzed.

Chelan County Commissioner England thanked Ron Scutt for attending. He understood that the National Park Service and U.S. Fish and Wildlife Service was focused on finding another location for grizzly bears, but the Commissioners were focused on the health, safety and welfare of residents. The comment that the range for a grizzly bear would be similar to that of the black bear had concerned him. He lives in Manson, a tourist town with apple orchards, cherry orchards, and black bear problems. Fish and Wildlife was no longer providing fire crackers to scare off nuisance bears due to safety concerns. Instead they offered cases of dryer sheets to tie on the tree limbs to scare off the black bears.

At past meetings held in Cashmere and Wenatchee with the National Park Service and U.S. Fish and Wildlife Service the Commissioners and residents were informed that any worries about grizzly bears could be handled using a 10(j) determination, and in the Draft EIS it is common to all action alternatives, but, there were no requirements that the designation would actually be pursued.

On further review of the Draft EIS, he also could not find any discussion regarding what would trigger the 10(j) determination. What level of "problem grizzly bear" would trigger action? Chelan County Commissioner England read from the Draft EIS which said that if the population of grizzly bears was designated as a 10(j) experimental population, then additional management measures may become available to further reduce any impacts on communities or economic sectors.

A document used by federal agencies to guide NEPA preparations called *Forty Most Asked Questions Concerning EEQ's NEPA Regulations* said that all relevant, reasonable mitigation measures that could improve the project are to be identified, even if outside the jurisdiction of the lead or cooperating agencies, so that extra measures can be implemented. He also read that the EIS was supposed to be the most comprehensive environmental document and was an ideal vehicle for laying out the full range of environmental impacts and the full spectrum of appropriate mitigation. He could not find specific mitigation measures in the Draft EIS nor whether or not the grizzly bear population would be designated as an essential or non-essential population.

Chelan County Commissioner England read from page 31 of the Draft EIS that said if U.S. Fish and Wildlife decides to pursue the designation of a 10(j) experimental population, then they would conduct a rulemaking process, which would be initiated during the EIS process. He asked why they were delaying the 10(j) process and said that precedence showed that it should be prepared at the same time along with the Draft EIS. He said if rules were available for landowners to protect themselves, why were they not already drafted for comment? There were many areas of mitigation measures that Chelan County would want to see and contribute input towards.

Regarding grizzly bears that leave the designated recovery zone, he understands they will retain the same protections within the area that they occupy. Would this not expand the recovery zone? He found written in the Draft EIS that "On-going human actions in grizzly bear habitat may contribute to bear-human conflicts....Management of livestock grazing, timber harvest, mining, road construction, recreation, oil and gas exploration and development should be compatible with grizzly bear habitat requirements. An effort is needed to reduce road densities throughout the Recovery Zone." Chelan County Commissioner England said that most of the area designated today is state and private land, and the grizzly bears would be ranging onto private lands.

Chelan County Commissioner England also pointed out that the Draft EIS did not adequately explore the possibility and impacts regarding fish predation. Millions of dollars have been spent by local agencies to reintroduce salmon to rivers and streams. To bring an apex predator to the same area, and say that they will not eat fish, shows inexperience. He said grizzly bear traps use cattle blood and fish meal as the attractant, and if grizzly bears are generalists, they will be eating fish.

The comments provided by Chelan County Commissioner England can be found here: ftp://ftp.skagitcounty.net/countycommissioners/documents/agendapackets/04242017/

11. Follow up Issues and Next Meeting Date

Executive Director Byfield said that one of the concerns was about the way the Draft EIS was constructed. It was a very narrow review of alternatives. NEPA requires a comparative look at alternatives in order to provide the public different options for moving forward which are sharply defined. The three action alternatives are not sharply defined. The goal of each is the same: to bring 200 grizzly bears to the North Cascades Ecosystem and the only difference is how quickly it is done.

She said this was one of the fundamental problems with the Draft EIS and she is aware of case law to that effect.

The EIS prepared for the Bitterroot Recovery Zone was comparable to the North Cascades Draft EIS in that they each called for a population of 200 grizzly bears. The alternatives contained in the Bitterroot plan were better defined and included: the use of the 10(j) Rule, the action to recover 200 grizzly bears, and no action at all. She said this broader look sharply comparing alternatives was missing from the North Cascades Draft EIS.

Also missing from the Draft EIS was an alternative to resolve conflicts with the counties' positions. The Draft EIS needed to be revised to include sharply defined alternatives which also included one that addressed the counties' positions. Executive Director Byfield said that this work could be accomplished by going back and providing a Supplemental EIS (which is done frequently) or re-doing the Draft EIS.

Executive Director Byfield was also concerned about the National Park Service and U.S. Fish and Wildlife Service's public relations materials. She noted that the stated intentions of the study were not what was worked on, and that the Needs and Purpose Statement was missing. She said a Needs and Purpose Statement was "the four corners of a document" and that every single alternative studied needed to agree with the Needs and Purpose Statement.

Additional concerns were that press releases said that the purpose of the Draft EIS was to determine whether or not to recover grizzly bears in the North Cascades Ecosystem. She did not find public analysis performed on whether or not grizzly bears should be reintroduced in the North Cascades. She found that the alternatives were disingenuous and too similar.

Executive Director Byfield recommended that the counties request that the National Park Service and U.S. Fish and Wildlife Service consider whether a supplemental EIS would accomplish addressing their concerns and create a Draft EIS that was sufficient enough to move forward, or if the National Park Service and U.S. Fish and Wildlife Service should start the process over from the beginning.

She suggested that the National Park Service and U.S. Fish and Wildlife Service answer the questions asked during the meeting and let the counties know if they would be providing a Supplemental EIS or starting over. She said that these needed to be answered before releasing the final EIS and that the problems with the studies and the science be addressed.

Discussion followed regarding answering questions and setting additional meetings, and, the steps that would be taken after the public comment period closed on April 28, 2017.

National Park Service Superintendent Karen Taylor-Goodrich said that they would continue to work the counties after April 28, 2017, since it was government to government.

Discussion followed regarding the comments received by the National Park Service and U.S. Fish and Wildlife Service and that the length of time estimated to review and respond to comments (123,000 had been received to date) and finalize the EIS would be pushed out from Winter of 2018.

Discussion followed regarding the dissemination of the comments and if they could be grouped by geographical area. There were concerns that an international comment might be given more consideration than a local comment.

National Park Service Superintendent Karen Taylor-Goodrich said that comments were weighted by substance and they were looking to see what might have been missed or what might need to be reconsidered within the Draft EIS.

Town of Darrington Mayor Rankin asked if, in the spirit of coordination, the questions asked today would be answered before the 123,000 other comments/questions, and, how long might it take the National Park Service and U.S. Fish and Wildlife Service to provide answers?

Skagit County Commissioner Janicki suggested that another meeting be set after the National Park Service and U.S. Fish and Wildlife Service provided answers to their questions and concerns.

U.S. Fish and Wildlife Service State Supervisor Eric Rickerson requested a copy of the transcript of the meeting so that they could work on providing answers, and, he said that while some of the information could be provided quickly, some of it might take longer to put provide to the counties. He agreed that additional meetings and conversations would be beneficial.

Executive Director Byfield reminded the National Park Service and U.S. Fish and Wildlife Service that not only would answers need to be provided, but additional information needed to be provided on how they were going to be working on the conflicts with the counties' positions and objections, how that would be stated in the environmental consequences section, and how they would put together an alternative to resolve those conflicts.

The Draft EIS needs to include how the local governments position is going to be stated in the study and how it will be addressed.

Chelan County Commissioner England noted that the phrase "if funds are available" was scattered throughout the document. He asked who would be paying and said that the Draft EIS should include that information.

Skagit County Commissioner Janicki requested that another meeting be scheduled approximately 30 days after the minutes were finalized.

U.S. Fish and Wildlife Service State Supervisor Eric Rickerson thanked the counties for the meeting and said that they would start collecting some of the information requested today (which was a lot of the background information).

12. Adjournment/Counties Close Respective Meetings

Skagit County Commissioner Wesen thanked everyone for their attendance and recessed the proceedings at 5:51 p.m.

IV. CONSENT AGENDA ITEMS FOR FURTHER DISCUSSION:

Behavioral Health Program Coordinator Sarah Hinman provided additional information on Consent Agenda Item no. 14.

Equipment Division Manager Mike Elde provided additional information on Consent Agenda Item no. 20.

Chair Wesen briefly discussed Consent Agenda Item no. 9.

V. CONSENT AGENDA FOR MONDAY, APRIL 24, 2017 (items 1 through 20):

A motion was made by Commissioner Dahlstedt to approve Consent Agenda Items 1 through 20, including all items requiring ratification, vouchers and warrants for Monday, April 24, 2017. Commissioner Janicki seconded the motion. The vote passed unanimously.

a) COMMISSIONERS:

1. Record of the Proceedings for Monday, April 17, 2017. **(Approved)**

2. Record of the Proceedings for Tuesday, April 18, 2017. **(Approved)**

b) BUDGET AND FINANCE:

3. Amendment No. 2 to Interlocal Cooperative Agreement No. C20160410 with the Town of Concrete which awards $350,000 of Economic Development/Public Facilities Project grant funds to support the First Street Waterline Extension Project as authorized by Resolution No. R20160202. This Amendment extends the expiration date of the Agreement from June 30, 2017, to December 31, 2017, to allow for completion of the project. All other terms and conditions of the original Agreement and subsequent Amendment shall remain in effect. **(Amendment No. A20170033)**

c) DISTRICT COURT:

4. Resolution to increase the amount of the Skagit County District Court change fund from $450 to $600 in order to make change of larger bills. **(Resolution No. R20170092)**

d) FACILITIES MANAGEMENT:

5. Vendor Services Agreement with Wetlands Creation, Inc. to remove 100 linear feet of railroad tie retaining wall behind the Technology Center and replace it with an interlocking stone block wall. Compensation shall not exceed $8,900 plus applicable sales tax. The Agreement shall commence on the date of execution and shall continue for three months. **(Contract No. C20170201)**

6. Vendor Services Agreement with Kamps Painting Company, Inc. to remove and replace decaying curbs at the Technology Center and at the gated staff parking lot on the southwest corner of Kincaid and 3rd Street in Mount Vernon. Compensation shall not exceed $9,920. The Agreement shall Commence on

the date of execution and continue for three months. **(Contract No. C20170202)**

e) GEOGRAPHIC INFORMATION SERVICES:

7. Interlocal Cooperative Agreement with the City of Burlington to establish a cost sharing partnership for Pictomety aerial photography and support software. Compensation shall not exceed $10,000. The Agreement shall commence on the date of execution and continue until June 30, 2019. **(Contract No. C20170203)**

f) INFORMATION SERVICES:

8. Agreement with Adaptive Insights, Inc. to provide budget preparation software. Compensation shall not exceed $93,901 plus applicable taxes and fees. The Agreement shall commence on June 20, 2017 and continue until June 19, 2019. **(Contract No. C20170204)**

g) PROSECUTING ATTORNEY:

9. Ordinance amending Skagit County Code Chapter 2.40, Claims Against the County, to avoid conflicts between state and local procedures. **(Ordinance No. O20170004)**

h) PUBLIC HEALTH:

10. Resolution to call for a public hearing to consider testimony regarding the HOME Investment Partnerships Program: Consolidated Plan Action Plan for 2017-2018. The public hearing is scheduled to take place on Monday, May 15, 2017, at 11:00 a.m. or as soon thereafter as possible. **(Resolution No. R20170093)**

11. Personal Services Agreement with Language Exchange to provide translation services as needed. Compensation shall not exceed $25,000 and is based on an hourly rate schedule. The Agreement is being ratified to commence on January 1, 2017, and shall continue until December 31, 2018. **(Contract No. C20170205)**

12. Personal Services Agreement with Compass Health for the provision of services in accordance with the Department of Commerce 10B Home Security requirements for individuals exiting inpatient behavioral health settings who are homeless, or homeless individuals with behavioral health disorders. Compensation shall not exceed a total of $6,000 for reimbursement of rent and shelter related expenses. This Agreement is being ratified to commence on April 1, 2017, and shall continue until June 30, 2017. **(Contract No. C20170206)**

13. Funding Agreement with Home Trust of Skagit to distribute Economic Development Facility Funds pursuant to RCW 82.14.370 which will be used to reimburse recipients for eligible impact and utility fees for four (4) affordable homes being built. Compensation shall not exceed $66,668. This Agreement is ratified to commence on April 3, 2017, and shall continue for one year. **(Contract No. C20170207)**

14. Amendment No. 1 to Professional Service Consultant Agreement No. C20150561 with Paul Schissler Associates, Inc. to provide technical assistance services for the Community Development Block Grant-funded Assistance for On-Farm Infrastructure project. This Agreement updates the Payment Schedule to allow work to be performed by a subcontractor of Paul Schissler Associates, Inc. The term remains the same, ending December 31, 2017, and compensation remains the same and shall not exceed $60,000. All other terms and conditions of the original Agreement shall remain in effect. **(Amendment No. A20170034)**

15. Amendment No. 2 to County Program Agreement No. C20150623 with the Washington State Department of Social and Health Services (DSHS) Behavioral Health and Service Integration-Division of Behavioral Health and Recovery DSHS Agreement No. 1663-53477 to provide vouchers to Access to Recovery eligible clients for chemical dependency treatment and/or recovery services. This Amendment

extends the term an additional year, ending April 30, 2018. Compensation is increased by $100,000 pursuant to the Special Terms and Conditions (Section 7, 7, and Exhibit B). Compensation shall not exceed $300,000 which is funded by a Federal Access to Recovery grant. All other terms and conditions of the original Agreement and subsequent Amendment shall remain in effect. **(Amendment No. A20170035)**

16. Amendment No. 3 to County Program Agreement No. C20150623 with the Washington State Department of Social and Health Services (DSHS) Behavioral Health and Service Integration-Division of Behavioral Health and Recovery DSHS Agreement No. 1663-53477 to provide vouchers to Access to Recovery eligible clients for chemical dependency treatment and/or recovery services. This Amendment corrects the amount of compensation and reduces it by $40,000. Compensation shall not exceed $260,000 which is funded by a Federal Access to Recovery grant. All other terms and conditions of the original Agreement and subsequent Amendments shall remain in effect. **(Amendment No. A20170036)**

17. Amendment No. 1 to Personal Services Agreement No. C20160448 with Denna Vandersloot dba Vandersloot Training and Consulting to provide consultancy and leadership activities around the County's transition to full healthcare integration. This Amendment increases compensation by $20,000, for a new total amount not to exceed $89,000, and extends the term by six (6) months, ending December 31, 2017, in order to fully facilitate the Scope of Work. All other terms and conditions of the original agreement shall remain in effect. **(Amendment No. A20170037)**

i) PUBLIC WORKS:

18. Amendment No. 1 to Vendor Services Agreement No. C20160469 with Cummins Inc. to provide for main engine overhaul, repair, and technical support for the Guemes Island Ferry as authorized by sole source Resolution No. R20160153. This Amendment increases compensation by $5,066.44 for additional, unanticipated repairs. Total compensation shall not exceed $121,920.44. All other terms and conditions of the original Agreement shall remain in effect. **(Amendment No. A20170038)**

19. Vendor Services Agreement with Pacific Northwest Scale Company, Inc. to provide scale calibration, maintenance and repair at the Transfer and Recycling Station located at 14158 Ovenell Road in Mount Vernon, and at the Transfer Station located at 50796 Sauk Landfill Road in Concrete. Compensation shall not exceed $24,000 based on a rate schedule. The Agreement shall commence on June 1, 2017 and shall continue for two years. **(Contract No. C20170208)**

20. Vendor Services Agreement with At Work to provide landscaping and maintenance for divisions in Public Works to include the Guemes Island Ferry Terminal, Operations, and Solid Waste. Compensation shall not exceed $18,534 plus applicable sales tax. The Agreement shall commence on the date of execution and continue for one year. **(Contract No. C20170209)**

VI. MISCELLANEOUS:

a) FACILITIES MANAGEMENT:

1. Resolution Bid Award for Furniture, Fixtures, and Equipment (FF &E) for Use in Skagit County Community Justice Center. **(Resolution No. R20170094)**

Facilities Manager Dan Fitting provided information on the miscellaneous agenda item.

A motion was made by Commissioner Janicki to approve the Resolution as presented by Mr. Fitting. Commissioner Dahlstedt seconded the motion. The vote passed unanimously.

VIII. <u>ADJOURNMENT:</u>

Chair Wesen adjourned the proceedings at 5:51 p.m.

BOARD OF COMMISSIONERS
SKAGIT COUNTY, WASHINGTON

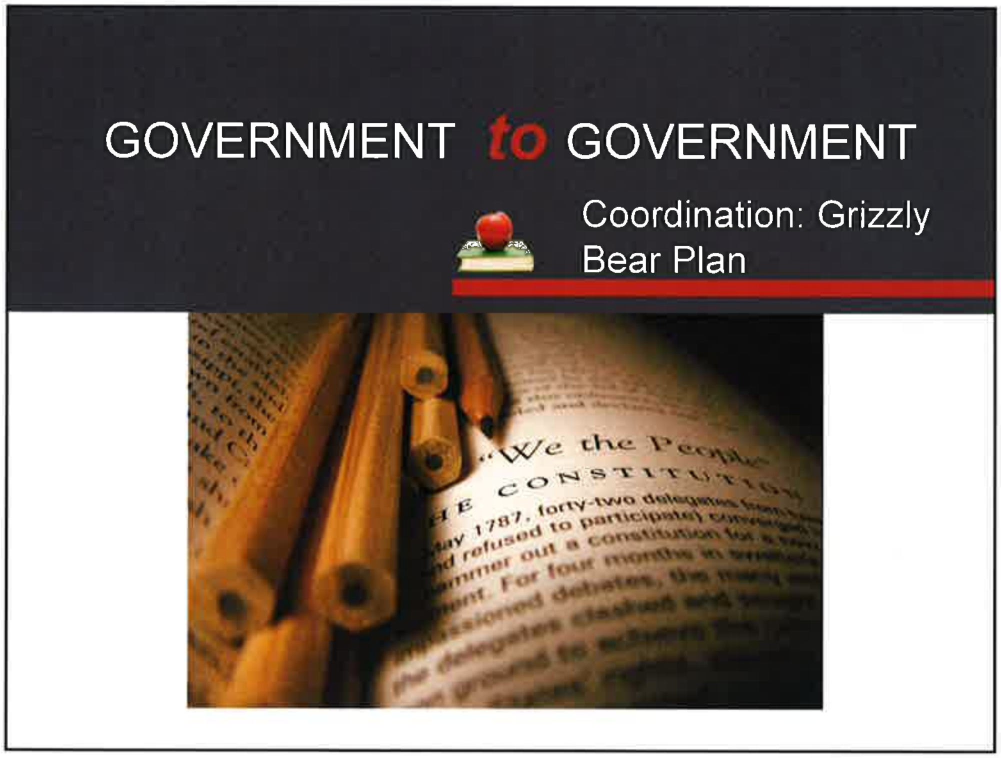
Ron Wesen
Ron Wesen, Chair

ABSENT
Kenneth A. Dahlstedt, Commissioner

Lisa Janicki
Lisa Janicki, Commissioner

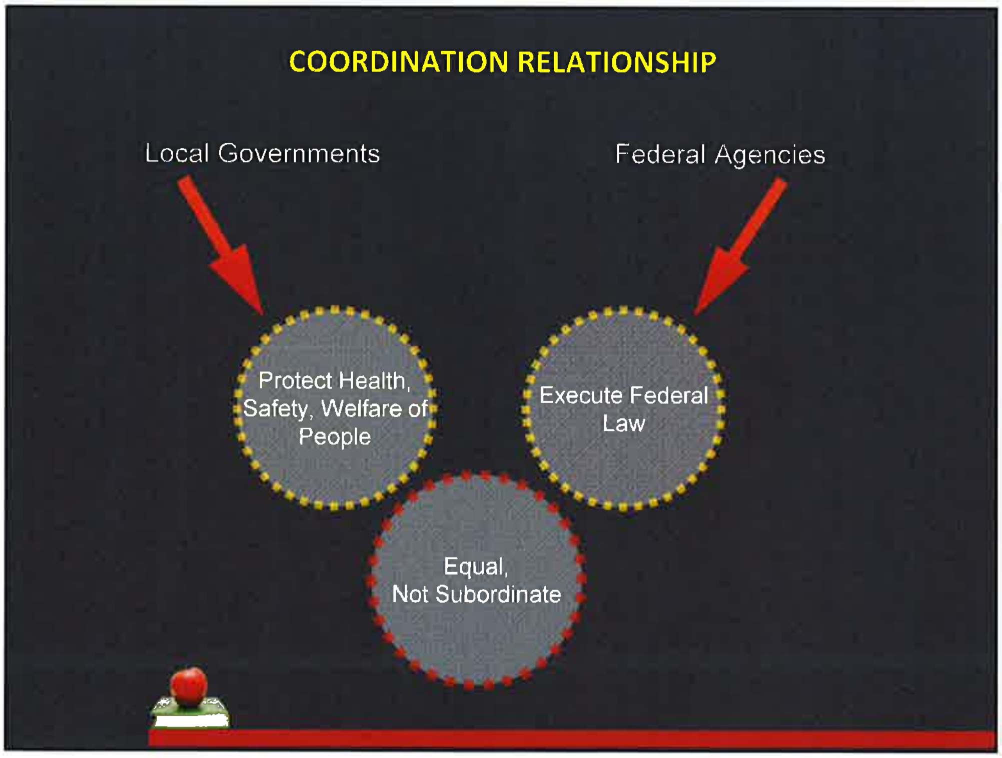
ATTEST:

Amber Erps
Amber Erps, Clerk of the Board



GOVERNMENT *to* GOVERNMENT

Coordination: Grizzly Bear Plan



COORDINATION RELATIONSHIP

Local Governments

Federal Agencies

Protect Health, Safety, Welfare of People

Execute Federal Law

Equal, Not Subordinate

Coordination is…

1. **A Process**

   - Not a status.

2. **Government-to-Government**

   - Recognizes Local Governments are Representatives of the Public and "not" the Public.

3. **Transparent**

   - Meetings are Open to the Public.

4. **Mandatory**

   - Congress said "shall coordinate." It's not optional if the Local Government insists that it be implemented.

5. **Continuous**

   - For all planning, and management activities.

6. **To Resolve Conflicts between Local and Federal Plans**

   - Federal Agencies charged with being consistent with local plans.

Legal *Authority*

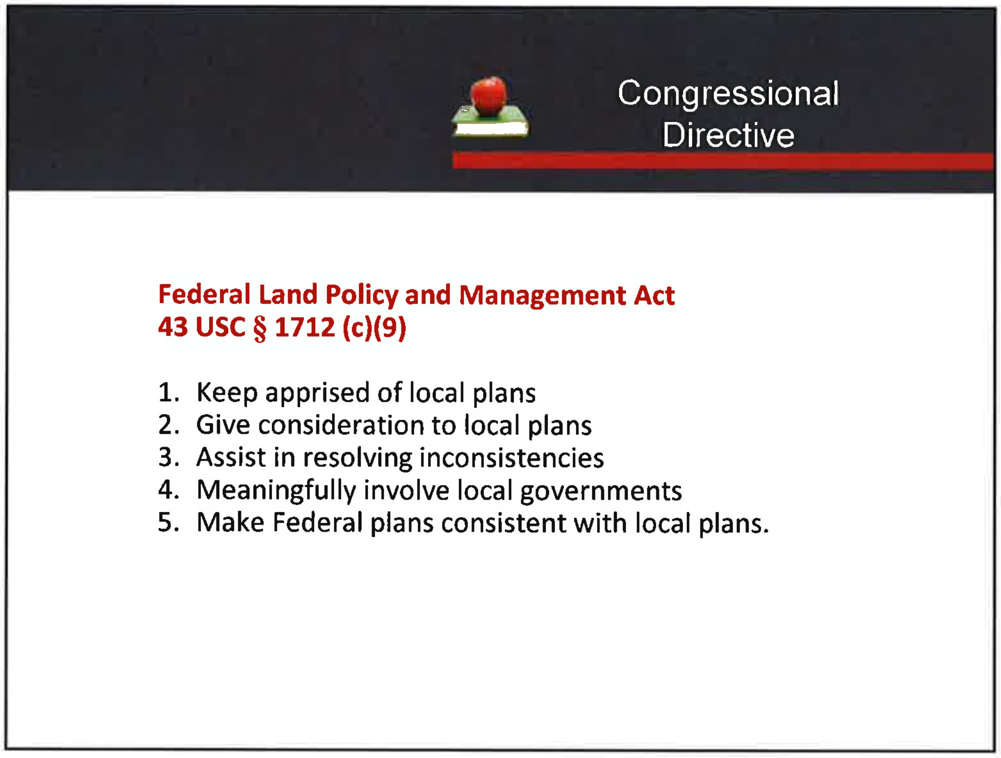
Key Federal Statutes

Federal Land Policy and Management Act of 1976
(FLPMA) (43 U.S.C.A. § 1712(c)(9)

National Forest Management Act of 1976
(NMFA) (16 U.S.C.A. § 1604(a)

National Environmental Policy Act of 1969
(NEPA) 42 U.S.C.A. § 4331

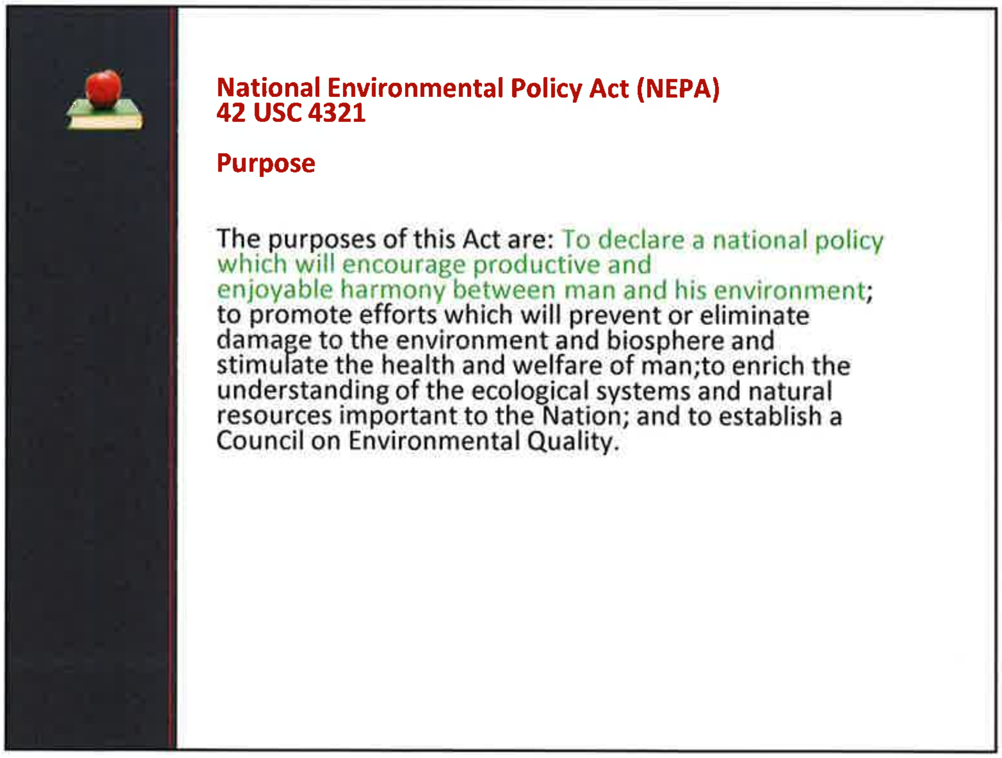
Endangered Species Act of 1973
(ESA) 16 U.S.C.A. § 1533(b)(1)(A)



Congressional Directive

Federal Land Policy and Management Act
43 USC § 1712 (c)(9)

1. Keep apprised of local plans
2. Give consideration to local plans
3. Assist in resolving inconsistencies
4. Meaningfully involve local governments
5. Make Federal plans consistent with local plans.



National Environmental Policy Act (NEPA)
42 USC 4321

Purpose

The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man;to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality.

National Environmental Policy Act (NEPA)
42 USC 4331(a) & (b)

"The Congress, … declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

(b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may … "

National Environmental Policy Act (NEPA)
42 USC 4331(a) & (b)

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding
generations;

2. assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings;

3. attain the widest range of beneficial uses of the environment without degradation, risk to
health or safety, or other undesirable and unintended consequences;

4. preserve important historic, cultural, and natural aspects of our national heritage, and maintain,wherever possible, an environment which supports diversity, and variety of individual choice;

5. achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

National Environmental Policy Act (NEPA)
42 USC 4332

Unresolved Conflicts

(E) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

CEQ Regulations
Sec 1500.1

Purpose

(a) The National Environmental Policy Act (NEPA) is our basic national charter for protection of the environment. It establishes policy, sets goals (section 101), and provides means (section 102) for carrying out the policy. Section 102(2) contains "action-forcing" provisions to make sure that federal agencies act according to the letter and spirit of the Act. The regulations that follow implement section 102(2). Their purpose is to tell federal agencies what they must do to comply with the procedures and achieve the goals of the Act. The President, the federal agencies, and the courts share responsibility for enforcing the Act so as to achieve the substantive requirements of section 101.

(b) NEPA procedures must insure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The information must be of high quality. Accurate scientific analysis, expert agency comments, and public scrutiny are essential to implementing NEPA. Most important, NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail.

(c) Ultimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork--even excellent paperwork--but to foster excellent action. The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take actions that protect, restore, and enhance the environment. These regulations provide the direction to achieve this purpose.

CEQ Regulations
Sec. 1502

Policy

(e) Use the NEPA process to identify and assess the reasonable alternatives to proposed actions that will avoid or minimize adverse effects of these actions upon the quality of the human environment.

(f) Use all practicable means, consistent with the requirements of the Act and other essential considerations of national policy, to restore and enhance the quality of the human environment and avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

CEQ Regulations
Sec. 1508

Human Environment

"Human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment. (See the definition of "effects" (Sec. 1508.8).) This means that economic or social effects are not intended by themselves to require preparation of an environmental impact statement. When an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment.

CEQ Regulations
Sec. 1501.2

Apply NEPA Early in the Process

Agencies shall integrate the NEPA process with other planning at the earliest possible time to insure that planning and decisions reflect environmental values, to avoid delays later in the process, and to head off potential conflicts.

CEQ Regulations
Sec. 1506.2

Discuss and Reconcile Inconsistencies

(d) To better integrate environmental impact statements into State or local planning processes, statements shall discuss any inconsistency of a proposed action with any approved State or local plan and laws (whether or not federally sanctioned). Where an inconsistency exists, the statement should describe the extent to which the agency would reconcile its proposed action with the plan or law.

CEQ Regulations
Sec. 1502.16

Environmental Consequences

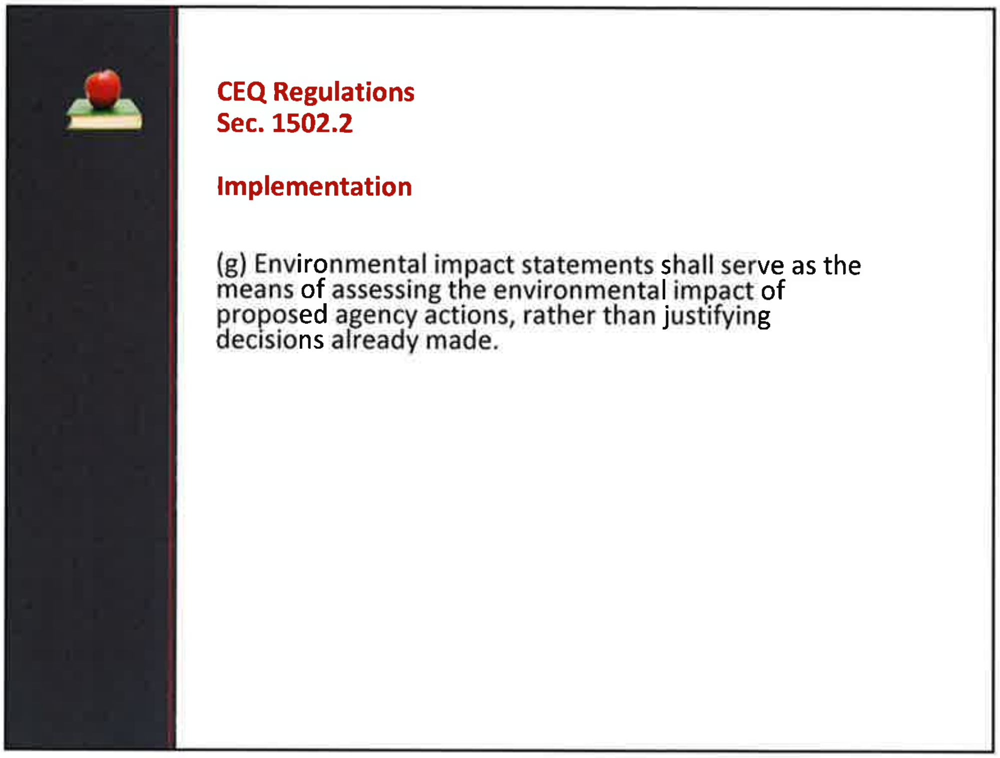
(c) Possible conflicts between the proposed action and the objectives of Federal, regional,State, and local (and in the case of a reservation, Indian tribe) land use plans, policies and controls for the area concerned. (See Sec. 1506.2(d).)

CEQ Regulations
Sec 1508.27

Definition of Significantly

"Significantly" as used in NEPA requires considerations of both context and intensity:

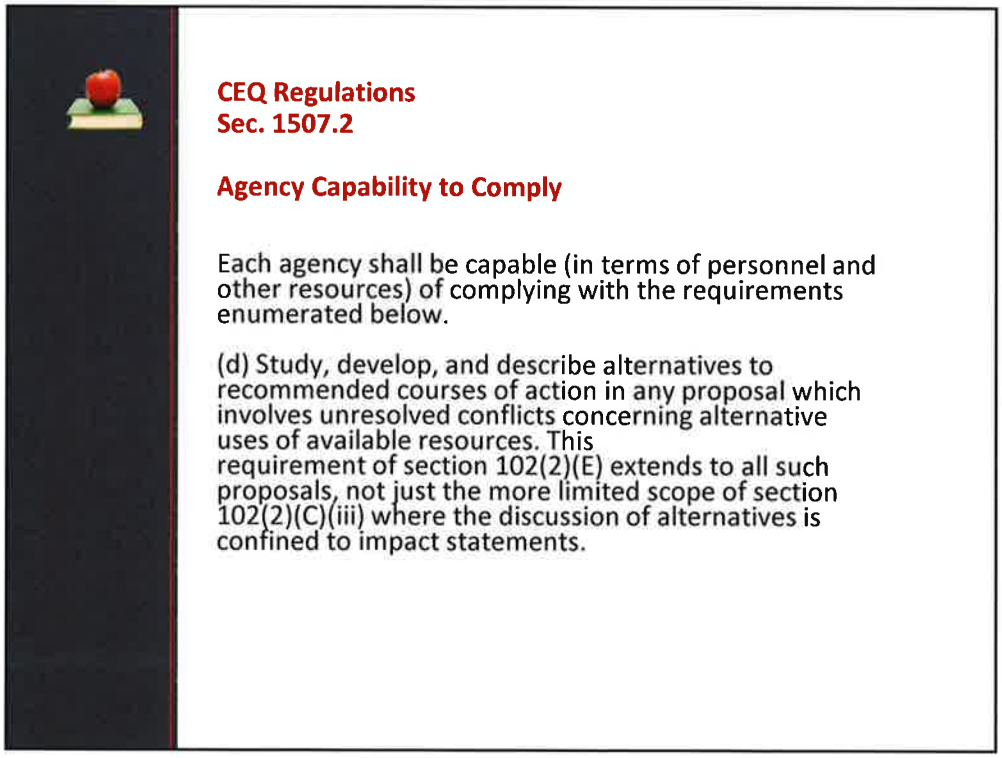
(a) Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.



CEQ Regulations
Sec. 1502.2

Implementation

(g) Environmental impact statements shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made.

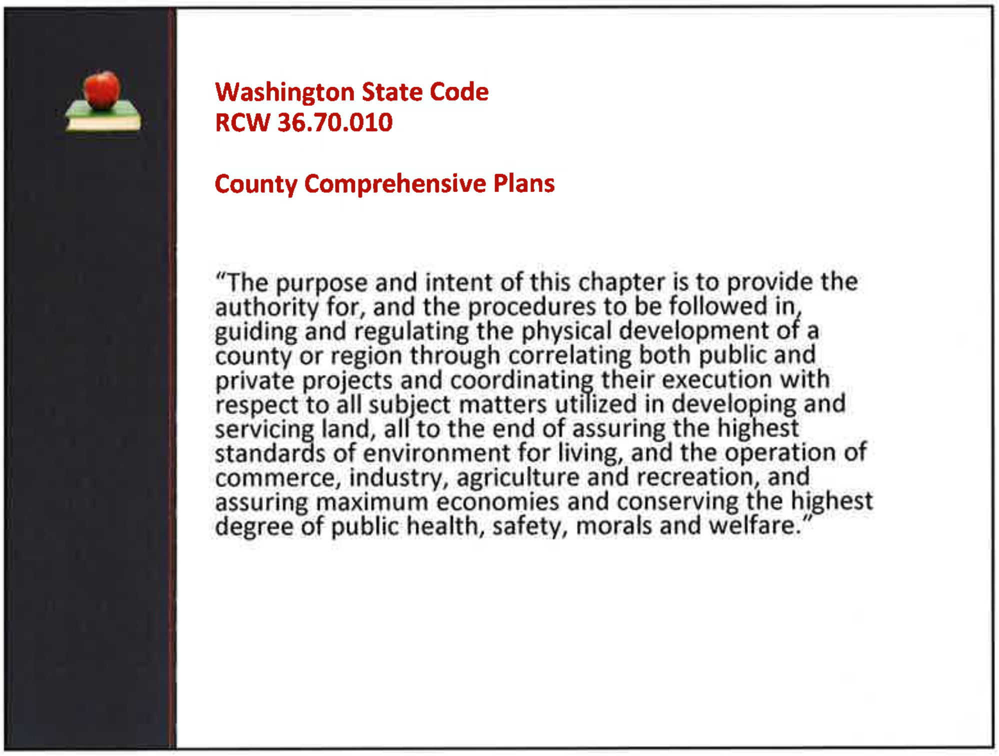


CEQ Regulations
Sec. 1507.2

Agency Capability to Comply

Each agency shall be capable (in terms of personnel and other resources) of complying with the requirements enumerated below.

(d) Study, develop, and describe alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources. This requirement of section 102(2)(E) extends to all such proposals, not just the more limited scope of section 102(2)(C)(iii) where the discussion of alternatives is confined to impact statements.



Washington State Code
RCW 36.70.010

County Comprehensive Plans

"The purpose and intent of this chapter is to provide the authority for, and the procedures to be followed in, guiding and regulating the physical development of a county or region through correlating both public and private projects and coordinating their execution with respect to all subject matters utilized in developing and servicing land, all to the end of assuring the highest standards of environment for living, and the operation of commerce, industry, agriculture and recreation, and assuring maximum economies and conserving the highest degree of public health, safety, morals and welfare."

Provided by Chelan County Commissioner Overbay

Grizzly Implementation North Cascades

Chelan County Talking Points

Introduction:

~~The~~ Chelan County ~~Comprehensive Plan~~ PORTIONS OF has identified five element areas within its Comprehensive Plan that are incompatible or conflict with the pro-active approach of Grizzly Bear re-introduction into the North Cascades. Those element areas include:

- Ranching and Agriculture
- Tourism and Recreation
- Rural Communities
- Impacts on Existing Habitat Restoration
- Lack of Coordinated Planning

I will provide you a brief synopsis of the policies/rationale/and goals in each element area that we feel are in conflict.

The first element I will address is **Ranching and Agriculture**.

Chelan County encompasses a land area of over 2,920 square miles in north central Washington State. This ranks it 3rd in area size among the state's counties. The County's northwestern border is shared with Skagit County. The crest of the Cascade Mountains defines its western borders with Snohomish and King Counties. Its northeast border is shared with Okanogan County. The eastern border is the Columbia River which is shared with Douglas County. Kittitas County is to the south. The vast majority of the County (approximately 87percent) is publicly owned. Much (80 percent) of this public land is part of the Okanogan-Wenatchee National Forest. The County's additional public lands are managed by an assortment of federal, state, and local agencies.

Chelan County is an open range County for "cattle, horses, mules and donkeys." Open range allows for ranchers and hobbyist to freely roam their animals regardless of land ownership. The majority of the County is open range[1] used by ranchers and hobbyists. - ~~WITH ONE HERD DESIGNATED AREA IN ENTIAT~~ VALLEY.

The benefits of open range are extensive. Ranchers have come to depend on these open range lands to provide grazing options not otherwise available. The introduction of the Grizzly Bear could greatly limit the area available for open range. The anticipated impacts will result in economic challenges to the local ranching industry and a change in the culture of ranches/ranchettes supported in the seven community vision statements contained within the Comprehensive Plan[2].

The next element I will speak to is **Tourism and Recreation**.

---

[1] Resolutions 98D, 178E, 330E, 378E, 388E, 99-90 and 2003-50

[2] Chelan County Comprehensive Plan Land Use Element pages 8, 9 and 10

Chelan County Land Use Policy (17.2) states: ***Develop implementation regulations that ensure that recreation or tourist uses and commercial facilities to serve them in rural areas are compatible with surrounding land uses.***

The rationale behind the policy was to ensure that potential adverse impacts to surrounding land uses are properly addressed.

Additionally, Chelan County's Economic Development Goal #2 is to ***Encourage the retention and growth of recreational and tourist based industries consistent with the comprehensive plan. With the rational that recreation and tourism play a significant role in the county's economy. Opportunities exist to strengthen and build upon the many tourist and recreational amenities and the locational advantages the county has to offer.***

Chelan County's Economic Development Policy 6.8 reads; ***Seek to retain and support existing businesses and industries where consistent with the comprehensive plan.***

This policy was put into place with the rationale that the retention and health of existing businesses and industries should be a key element of local economic development efforts.

Chelan County is home to many tourist destinations, including Leavenworth, Upper Entiat, Valley, Stehekin, Lake Chelan, Lake Wenatchee, and a portion of the Pacific Crest Trail, to name a few. The County has developed around the natural resources of the area and the ability for residents and visitors to get out and enjoy the natural surroundings. The introduction of additional Grizzly Bears could pose ~~a~~ real or perceived safety concerns. These concerns would result in a reduction in tourism and recreational activities greatly impacting the county's economic growth. Additionally, when negative interactions occur between the public and the Grizzly Bear, not only would there be an adverse economic impact, driven by safety concerns, but many times these interactions occur in rural lands where emergency services are very limited or not available at all thus increasing the likelihood of a fatal outcome.

As I earlier mentioned, Chelan County is comprised of several rural communities surrounded by significant Federal and State lands. These communities, such as Stehekin, rely heavily upon recreational tourism, as a vital part of their long-term survival. Any reduction in tourism would threaten their livelihood.

Chelan County has numerous goals and policies addressing rural communities within the Chelan County Comprehensive Plan. Additionally, the plan divides the County into study areas which are summarized with rural and natural characteristics and, in some areas, specific goals and policies.

Land Use Policy 14.5 encompasses the general intent of Chelan County by ***recognizing and protecting residential neighborhoods from potential detrimental impacts of incompatible land uses.*** *Incompatible land uses located in close proximity to residential neighborhoods may create adverse impacts which could lead to a reduction of the high quality of life for the County residents.*

Chelan County has long been an active participant in efforts to restore lost fish habitat and address water quality issues. Rural Element Policy 2.6 states; ***Protect and encourage the enhancement and restoration of habitat for fish and wildlife.*** With the rationale that Adequate protection is necessary for the quality of life for residents and ~~for~~ visitors, and for the health of the environment. Since 2005, Chelan County and its Federal and State partners have engaged in over 188 restoration projects in the three county watersheds with the purpose of enhancing ESA (Endangered Species Act) listed fish populations. (Note: efforts in vain of protecting one species at the potential cost of another)

Chelan County is committed to integrated planning to ensure the long-term success of any planning effort. The US Department of Ag NRCS (Natural Resources Conservation Service) notes[3] the reason for Grizzly bear decline is human encroachment from such activities as "recreational development, improper livestock grazing, poaching, excessive road access, and poorly designed timber harvest..."

Given the County's goals to support and increase recreational development, grazing, road development (access), timber activities, and mining, it would be a conflict to un-naturally introduce a predator which declines under these conditions unless clear coordinated planning could result in addressing these conflicting goals.

The County has various goals and policies addressing coordinated planning within the Chelan County Comprehensive Plan. Land Use Goal 25 ***Encourages coordination of federal, state, local and private recreation planning. With the idea that coordination and cooperation of public agencies and private individuals will lead to increased opportunities and eliminate duplication of effort.***

It is my hope that you will take into consideration the items presented to you today, and truly consider, not only the areas that are averse to our comprehensive plan but take into consideration the impacts to our citizens who have entrusted us, their local elected representatives, with the responsibility of protecting them from adverse environmental, physical, and economic impacts.

Thank You.

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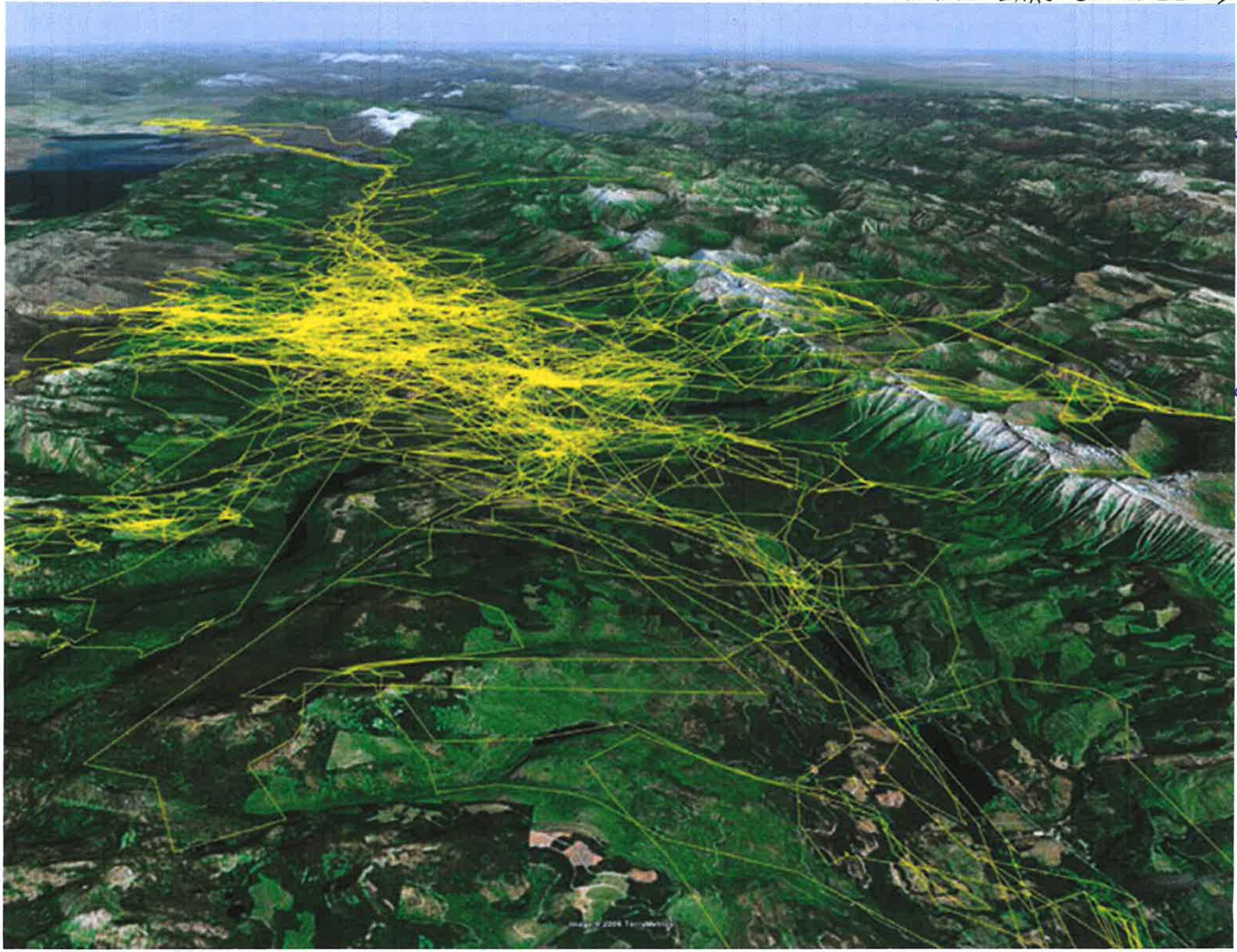
[3] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/mt/home/?cid=nrcs144p2_057920)

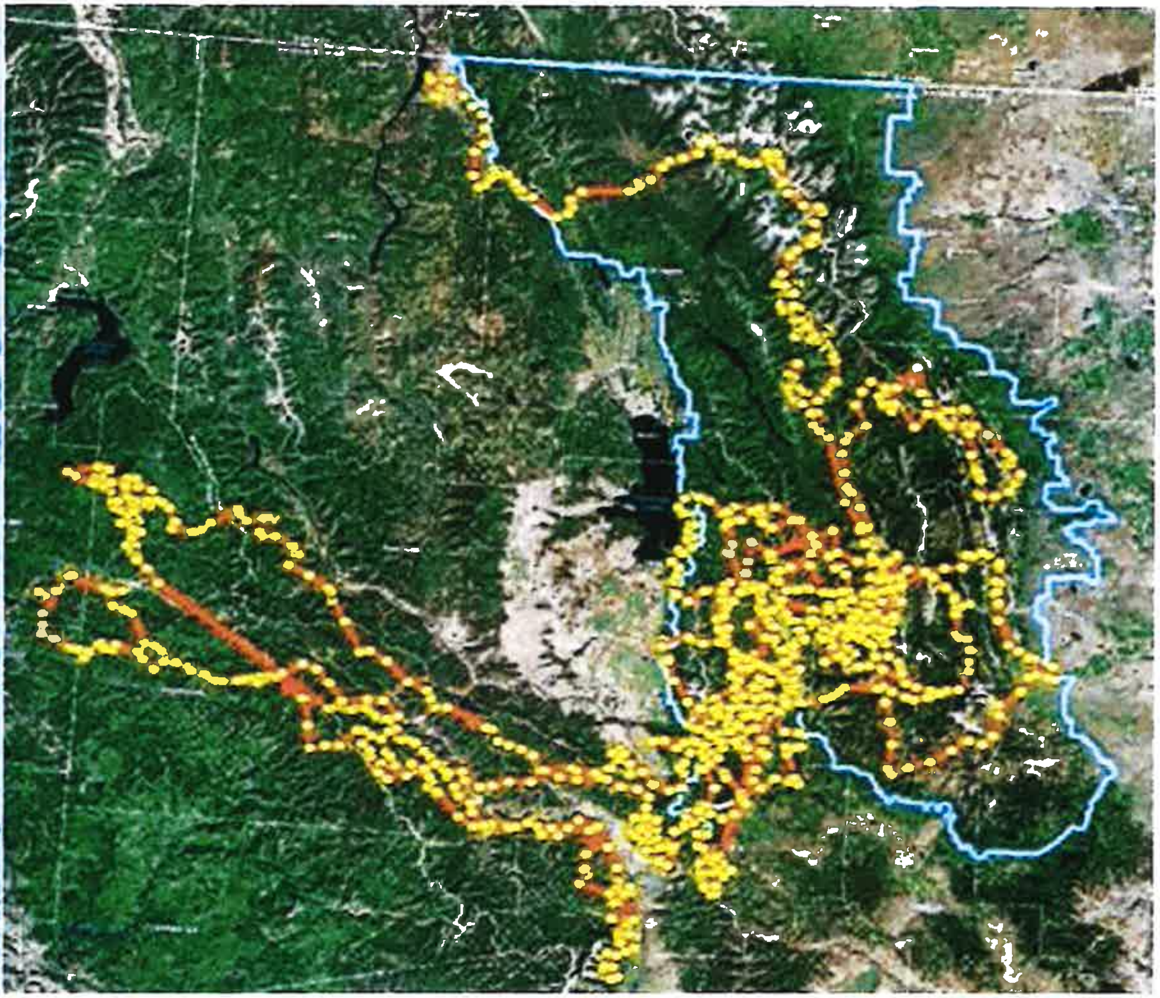
GRIZZLY BEAR MOVEMENTS IN SWAN VALLEY OF MONTANA (FLATHEAD LAKE UPPER LEFT)



Provided by Retired Wildlife Biologist Fielder

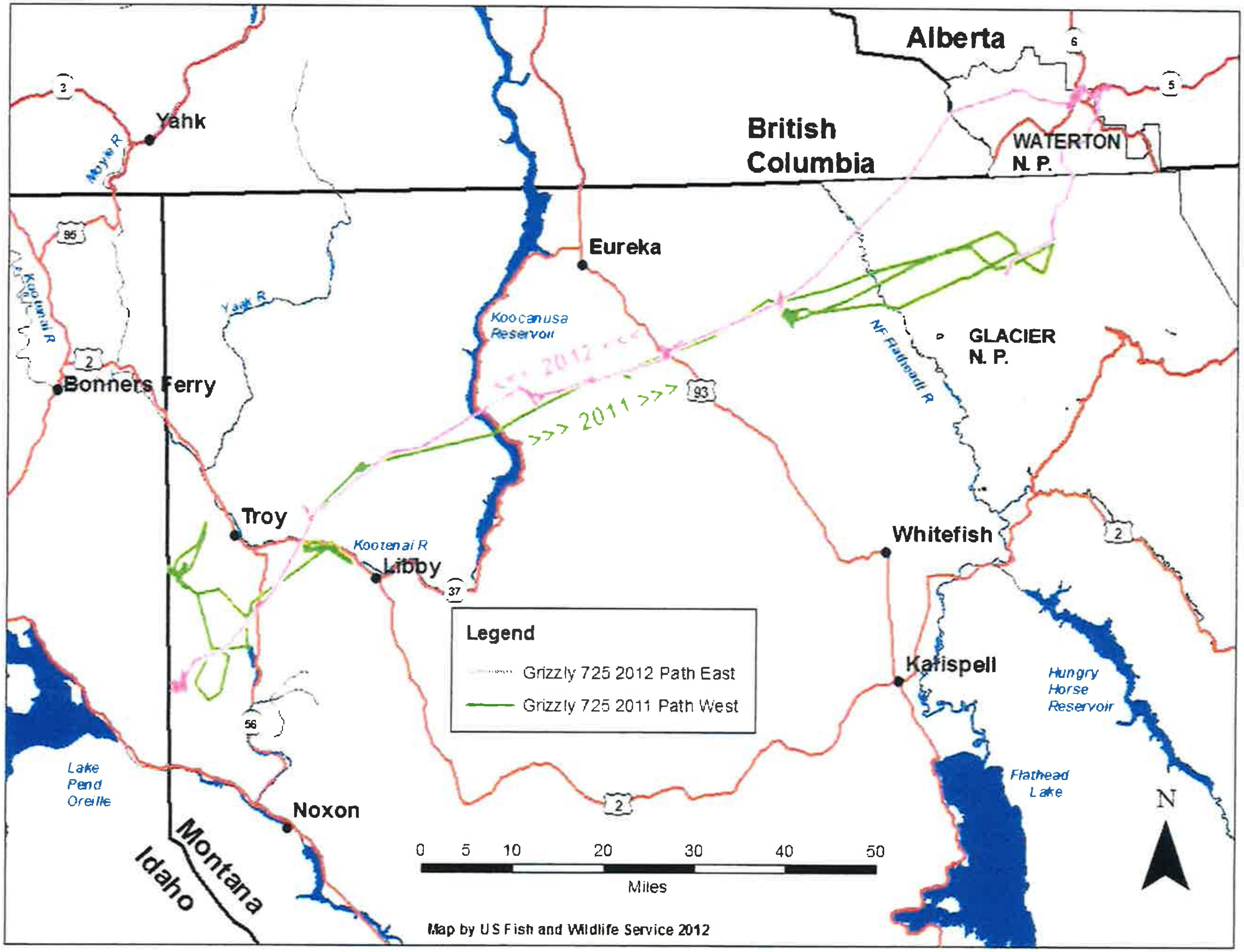
Grizzly Bear Ethyl's movements during 2012 - 2015 after trapping and transplant.

175 miles east + west and 155 miles north + south



Provided by Retired Wildlife Biologist Fielder

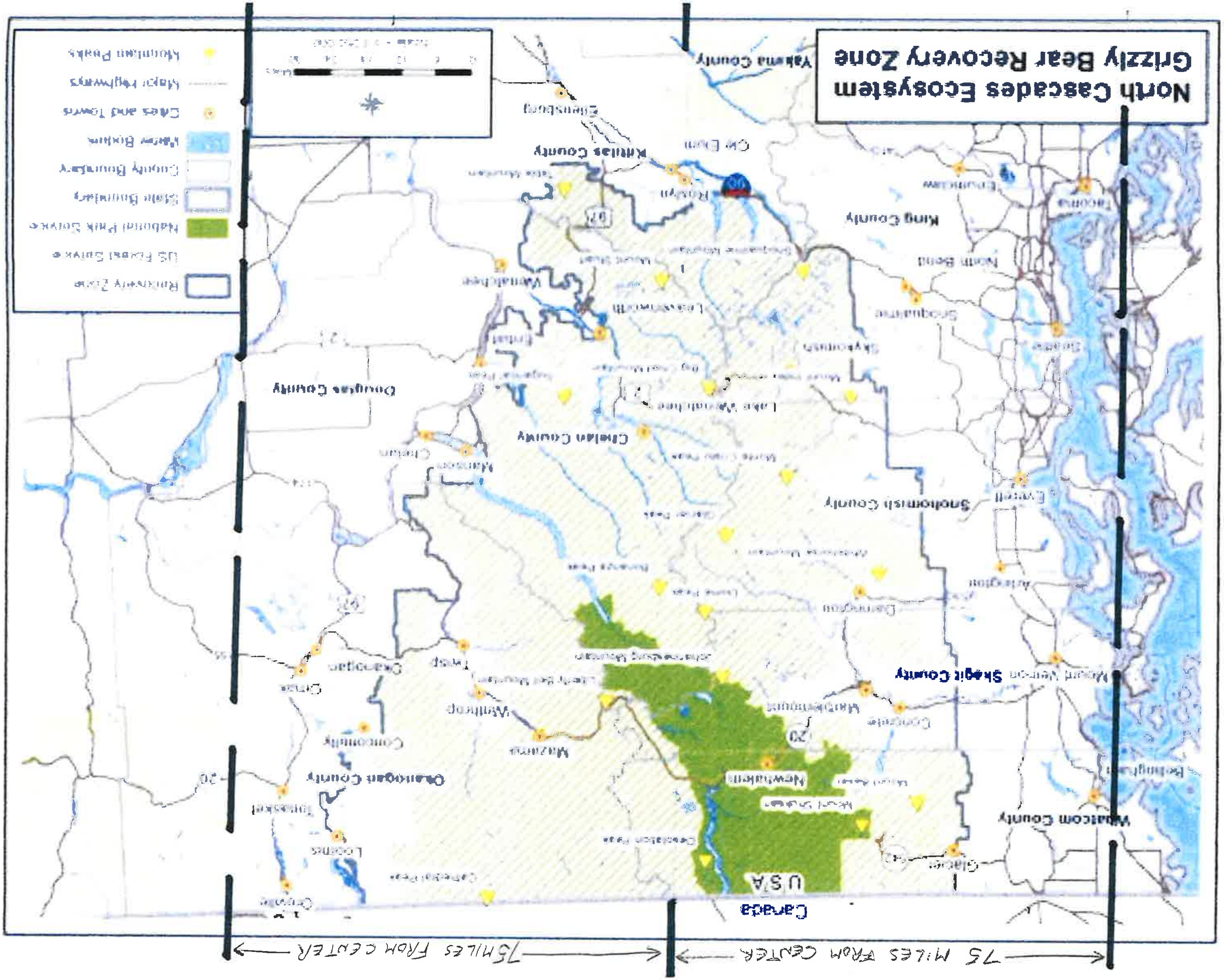
GRIZZLY BEAR #725 MOVEMENTS IN NW MONTANA AFTER TRAPPING + RELOCATION.
(115 MILES)



Map by US Fish and Wildlife Service 2012

Provided by Retired Wildlife Biologist Fielder

Provided by Retired Wildlife Biologist Fielder



Provided by Retired Wildlife Biologist Fielder

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
Brad Treat, 38, male	June 29, 2016	Wild	Halfmoon Lakes area south of Glacier National Park, Montana	Treat and another man were on mountain bikes on U.S. Forest Service land near Halfmoon Lakes. The two bikers surprised the bear and Treat was knocked off his bike by the bear. The second rider escaped uninjured and summoned help.[16] As of June 30, 2016, the bear is still being sought.
Lance Crosby, 63, male	August 7, 2015	Wild	Yellowstone National Park, Wyoming	Crosby, an employee at a medical clinic in the park, was reported missing when he did not report for work. A park ranger found his body in a popular off-trail area less than a mile from Elephant Back Loop Trail, an area he was known to frequent. His body was partially consumed and covered. Puncture wounds on his arms indicated he had tried to defend himself. Based on the presence of a sow grizzly and a cub in the area, the sow was deemed responsible for the attack. The sow was captured and euthanized after it was found to be the bear that killed Crosby.[17][18] There were public appeals to not kill the sow, but the park superintendent decided there was a risk the sow might kill again; based on July 6, 2011 and August 24, 2011 killings in the park, where another sow was present at both those killings.[19]
Ken Novotny, 53, male	September 17, 2014	Wild	near Norman Wells, Northwest Territories	While on a hunting trip near Norman Wells, Novotny was charged and struck by a bear. Friends reported Novotny had just killed a moose and was prepping his prize when the bear "came out of nowhere." He died on the scene. Authorities later found and killed the bear responsible for his death.[20]
Rick Cross, 54, male	September 7, 2014	Wild	Kananaskis Country, Alberta	Cross, a hunter, was killed by a mother bear when he accidentally got between her and her cubs. Park rangers stated that it appeared that Cross managed to fire his rifle before being overwhelmed. He was discovered with a knife clenched in each hand. His body was found near his backpack, but the corpse was only identified by his boots. RCMP said it appeared he wandered into the area where the mother and cub were feeding on a dead deer.[21]

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
Adam Thomas Stewart, 31, male	September 4, 2014	Wild	Bridger-Teton National Forest, Wyoming	Stewart was conducting research alone in the Bridger-Teton National Forest in northwest Wyoming. After he failed to return, a search found his body.[22] The coroner suspects it was a grizzly bear, but the species hasn't officially been determined.
Richard White, 49, male	August 24, 2012	Wild	Denali National Park, Alaska	White was backpacking alone along the Toklat River. After hikers found an abandoned backpack and torn clothing, rangers investigated and found a male grizzly bear sitting on White's remains. The bear was shot and killed by an Alaska State Trooper. A necropsy of the bear and photographs recovered from White's camera confirmed the attack.[23] The photographs in White's camera showed that he was taking photos of the bear in a span of eight minutes from 50 yards (46 m) to 100 yards (91 m).[24] It was the first fatal bear attack recorded in Denali National Park.[23]
Tomas Puerta, 54, male	October 2012	Wild	Chichagof Island, Alaska	After passers-by spotted an unattended skiff, they investigated and encountered a grizzly bear sow and two cubs. Alaska State troopers and Sitka Mountain rescue personnel then found evidence of a campsite and fire on the beach. There was evidence of a struggle, and upon following a trail of disturbed vegetation, they found Puerta's body, cached and partially eaten.[25]
John Wallace, 59, male	August 24, 2011	Wild	Yellowstone National Park, Wyoming	Wallace's remains were found by hikers on the Mary Mountain Trail, northeast of Old Faithful.[26] Wallace was hiking alone.[27] An autopsy showed that Wallace died from a bear attack.[27] According to a report released by Yellowstone rangers, park officials had attempted to give Wallace a lecture about bear safety, but he was not interested, calling himself a "grizzly bear expert".[28] DNA evidence later determined that the same sow that killed Brian Matayoshi July 6, 2011 was in the vicinity of Wallace's corpse, though it was not proved that this bear killed Wallace. The bear was killed by park officials.[29] Evidence showed that Wallace was attacked after sitting down on a log to

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				eat a snack and the attack was predatory, rather than defensive.[29][30]
Brian Matayoshi, 57, male	July 6, 2011	Wild	Yellowstone National Park, Wyoming	Matayoshi and his wife were hiking the Wapiti Lake Trail, and came upon a mother grizzly bear in an open meadow. The couple began to walk away, and the bear charged. After attempting to run away, Matayoshi was fatally bitten and clawed. Matayoshi's wife hid behind a tree, was lifted from the ground by the bear, and dropped. She played dead, and the bear left the area. She was not injured.[31][32] An initial investigation by the National Park Service found the bear's actions were defensive against a perceived threat to her cubs. Since the attack was not predatory and the bear had no known violent history towards humans, no immediate action was taken towards the bear, the bear was later euthanized after it was found to be at the site of another fatal attack August 24, 2011.[29][31][32] A later investigation determined that the couple running from the bear was a mistake, and the fatal attack was a "one in 3 million occurrence".[33]
Kevin Kammer, 48, male	July 28, 2010	Wild	Gallatin National Forest, Montana	Kammer was in his tent at Soda Butte Campground when a mother bear attacked and dragged him 25 feet (7.6 m) away. Two other campers in separate campsites were also attacked: a teenager was bitten in the leg, and a woman was bitten in the arm and leg. The bear was caught in a trap set at the campground using pieces of a culvert and Kammer's tent.[34] Later, the bear was euthanized, and her cubs were sent to ZooMontana.[35] The mother bear's unusual predatory behavior was noted by authorities.[35]
Erwin Frank Evert, 70, male	June 17, 2010	Wild	Shoshone National Forest, Wyoming	Evert, a field botanist, was mauled by a grizzly bear while hiking in the Kitty Creek Drainage area of the Shoshone National Forest, just east of Yellowstone National Park. The bear was trapped and tranquilized earlier in the day by a grizzly bear research team. Two days after the attack, the bear was shot and killed from a helicopter by wildlife officials.[36] Initially it was reported that Evert ignored posted warnings to avoid the area due to the potential danger involved with the bear research.[36] However,

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				the sheriff's deputy who recovered the body and members of Evert's family stated that the warning signs were no longer present.[37] A report released the following month confirmed that the warning signs were removed, though it also asserted that Evert knew there was a bear research study being conducted in the area.[38] Evert's wife filed a wrongful death lawsuit against the federal government, which was dismissed by district court judge Nancy D. Freudenthal.[39][40]
Robert Wagner, 48, male	October 1, 2008	Wild	near Sundre, Alberta	Wagner was reported missing after not returning from a hunting trip. His body was found less than 1-kilometre (0.62 mi) from his parked truck. An autopsy revealed that he had been killed by a grizzly bear, which was shot by wildlife officers.[67][68]
Don Peters, 51, male	November 25, 2007	Wild	near Sundre, Alberta	Peters' body was found 200 metres (660 ft) from his parked truck. He was on a hunting trip. An autopsy confirmed that he died due to a grizzly bear attack. The bear that attacked Peters was captured and killed the following April.[71][72]
Jean-Francois Pagé, 28, male	April 28, 2006	Wild	near Ross River, Yukon	Pagé was mauled while staking mineral claims. He unknowingly walked right past a bear den containing a sow and two cubs.[73]
Arthur Louie, 60, male	September 20, 2005	Wild	near The Bowron River, British Columbia	A female and two cubs attacked Louie on a remote forestry road. He was walking back to his gold mining camp after his car broke down.[74][75]
Rich Huffman, 61, male Kathy Huffman, 58, female	June 23, 2005	Wild	Arctic National Wildlife Refuge, Alaska	The Huffmans were attacked while in their tent at a campsite along the Hulahula River 12 miles (19 km) upriver from Kaktovik.[76] Two days later the campsite was discovered by three rafters while the bear was still nearby. The bear chased the rafters down the river for over half a mile until it finally gave up. Later, a North Slope Borough Police officer investigating the scene shot and killed the bear at the campsite.[77]
Isabelle Dube, 35, female	June 5, 2005	Wild	Canmore, Alberta	Dube was killed while jogging with two friends on the Bench Trail. After an initial attack, Dube climbed a tree while her friends sought help. The bear brought Dube down from the tree and mauled her.[78][79]

Name, age, gender	Date	Type	Location	Grizzly Bear Caused Human Fatalities in last two decades - Attack Description
				Fish and wildlife officers shot and killed the bear.[79] At the time of the attack, the trail was closed, and the public was told to avoid it.[80] A few days beforehand, the bear had been relocated from Canmore to Banff National Park.[78]
Timothy Treadwell, 46, male Amie Huguenard, 37, female	October 5, 2003	Wild	Katmai National Park, Alaska	Treadwell and Huguenard's corpses were found by their pilot at Kaflia Bay. Treadwell was famous for his books and documentaries on living with wild bears in Alaska. State Troopers investigating the incident recovered an audiotape of the attack. The two were killed on the last night before their scheduled pickup after spending several months in the Alaskan bush.[81] The attack is chronicled in the 2005 American documentary film Grizzly Man by German director Werner Herzog.
Timothy Hilston, 50, male	October 30, 2001	Wild	Blackfoot-Clearwater Wildlife Management Area, Montana	Hilston was attacked as he field dressed an elk in Western Montana.[82] A female bear and her cubs suspected in the attack were killed by U.S. Fish and Wildlife officials.[83] Hilston's widow sued federal and state agencies for negligence, and the lawsuits were dismissed by District Court judge Donald W. Molloy.[84]
George Tullos, 41, male	July 14, 2000	Wild	Hyder, Alaska	Tullos' partially consumed body was found at a campground near the Canada–US border in Southeast Alaska. The bear was shot and killed.[85]

1. ^ Jump up to:a b c *Fraser, Caroline. "You Are in Bear Country". Outside Magazine Online. Retrieved 25 June 2010.*
2. **Jump up^** *Celizic, Mike. "New TV show is unfair to bears, some experts growl". MSNBC.com. Retrieved 6 January 2011.*
3. ^ Jump up to:a b *"Bear Kills Woman and Her Son in Alaska". New York Times. 4 July 1995. Retrieved 8 July 2010.*
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Read by Ron Scott

4/24/17
To: Karen Taylor-Goodrich, Superintendent, North Cascades National Park Service Complex
To: Eric Rickerson, State Supervisor, Washington Fish and Wildlife Office, U.S. Fish and Wildlife Service

The following letter is written in response to the Draft Grizzly Bear Restoration Plan EIS North Cascades Ecosystem and in support of Alternative A, the no action alternative. Thank you for allowing us to be part of this process

As outfitters and guides in the North Cascades ecosystem we have shared this amazing part of the world with visitors since 1947. Our first hand knowledge of this area dates back five generations to 1889 when J. Robert Moore Homesteaded near the head of Lake Chelan.

There have only been a handful of credible reports of grizzly bear sightings or evidence since non-Native Americans have inhabited Stehekin and The Lake Chelan drainage. There has also been a plethora of reports and sightings of grizzly bears that have, upon closer analysis, been determined to be black bears. I could lay a foundation to question whether there was ever actually a sustained population in these two drainages. I say this to make one point: This does not feel like re-introduction to us, it feels like introduction.

The chilling effect to backcountry users caused by merely introducing grizzly bears into this drainage is evident...any actual confrontation will be devastating. Whether or not all of the perceptions are accurate, camping in grizzly country comes with a stigma involving much trepidation and fear and many will avoid the experience entirely.

If we are to assume that we have habitat capable of sustaining a grizzly population, we are looking at two possible scenarios whereby visitors may eventually need to adapt and interact with a population of grizzlies. The first involves an amazing event where nature either evolves or possibly heals from prior pressures put on by humans. This sighting involves a natural uncollared bear in the wild and would most likely be a bear somewhat out of their element that has perhaps some uncertainty and shyness toward humans. There's a good chance that this encounter will be non-confrontational and truly a once-in-a-lifetime experience worthy of sharing with the grandkids.

Compare that to an encounter with a planted bear. That encounter will likely be prefaced by a harsh lecture by a recently graduated ranger who will counsel you on how you must act to accommodate this species and how you must camp, if in fact you are allowed to camp at all. In all likelihood it will be a bear that has been transferred that became too bold already in some other area. There is a much higher probability of this encounter being closer or even confrontational. This siting will not be natural as it will likely be a collared bear. This bear may be in poor shape or perhaps even desperate for food since it is not here on its own volition. Perhaps this encounter and wilderness experience is even further degraded by helicopter over flights, monitoring cameras, federal personnel in the backcountry, and other equipment and other forms of monitoring. We maintain this is not what a visitor should be subjected to and it is not how a Wilderness should be managed.

The two encounters are totally different. The first encounter, even if confrontational in nature, is as if your resort was in the line of fire of a naturally caused wildfire and you suffered damage. The second is as if you were the owner of a resort (such as Domke Lake) and your entire livelihood was destroyed by a raging fire that was set intentionally as a backfire to protect holdings below you at Lucerne Bar. Either could happen, but if it is your own government that put you in the line of fire it leaves you bitter. Introducing Grizzlies in to these drainages will put us in harms way and the socioeconomic impacts of this action, coupled with all of the other onerous regulations and lack of trail maintenance, will likely be the demise of the outfitted public.

Can this area adapt to a grizzly bear population? Absolutely. It would happen slowly, would be a natural progression of local bears expanding their range and would be a bear there by choice because of favorable conditions. I am dubious about adapting to a process designed and carried out by any of the alternatives other than the one allowing for natural processes.

This leads me to a fear of mine that far exceeds any fear of a bear. Even though it is soft-pedaled now, and even though it is being stated that any problems will not be handled by closures or excluding human activity, we know that is not what actually happens. What will happen will be increased regulation, partial or complete closures, justification to set more rigid controls on outfitters' group size, total area occupancy and camping practices. We are already plagued by a mishmash of federal areas, jurisdictions and overlays. We have already experienced denial of use and have been burdened by excessive regulation adopted in preparation for this event because agencies have been managing areas as grizzly habitat while the issue was studied.

Can we adapt to the natural habitation of grizzly bears? I believe we can. Can we continue to survive with yet another layer of bureaucracy that brings with it an aura of well-advertised fear for the visitor and further restrictions...I doubt it. I hereby implore you to do the very best thing to protect the North Cascades Ecosystem, the visitor experience, and most likely the harmonious well-being of grizzly bears and other species that will be disrupted by actions proposed: Do nothing!

Thank you for considering the impacts of your choice,
Cliff Courtney - Stehekin WA 98852

Enclosed please find a hard copy of my generalized notes made during our Mount Vernon meeting.

Thank you
Doug England
Chelan County Commissioner

Thank you from meeting with us to address some of our concerns. We realize that you are focused upon finding another home for Grizzly Bears. They are magnificent creatures. Again please recognize that our focus is on the health, safety and welfare of our citizens. I spent time with twelve of my grandchildren last night. They are magnificent also.

I am very concerned by your offhand comment today that wherever Black Bears roam, to expect grizzly. I live in Manson in the middle of apple and cherry orchards. We currently are having Black Bear problems. There are at least five resident bear in the middle of the project. Blacks are a nuisance, grizzly a danger.

Repeatedly in both our Cashmere meeting and our meeting with you in Wenatchee, we were assured not to worry about our concerns – that everything could be taken care of using a l0(j) determination.

-It is common to all action alternatives.

-But there are no requirements that the designation will be pursued or if so that it will be approved.

-There is also no discussion on what level of "problem" will trigger action. Is it concern with

- Property?
- People?
- Access?
- Enviromental?

This is from the DEIS:

> "In the event that the option to designate the population of Grizzly Bears as a section 10(j) experimental population is implemented, additional management measures may become available to further reduce any impacts on communities or economic sectors."

There's a document used by federal agencies to guide NEPA preparations. It's called Forty Most Asked Questions Concerning EEQ's NEPA regulations, and it states the following:

> "All relevant, reasonable mitigation measures that could improve the project are to be identified, even if they are outside the jurisdiction of the lead agency of the cooperating agencies, and thus could not be committed as part of the RODs of these agencies, Sections 1502.16(j), 1505.2(c). This will serve to (46 FR 18032) alert agencies or officials who can implement these extra measures, and will encourage them to do to."

"Because the EIS is the most comprehensive environmental document, it is an ideal vehicle in which to lay out not only the full range of environmental impacts, but also the full spectrum of appropriate mitigation."

Therefore, the DEIS is promising reduced effects without describing the specific mitigation measures that will cause the reduction.

Is this not clearly a mitigation measure that should be - under NEPA rules-be spelled out this DEIS?

Are you proposing that this population be designated as an essential or a non-essential population?

So are you arguing that they are there or not there?

- If there, where?
- If not there, aren't you admitting that the population doesn't exist?

Here's an excerpt from Page 31 of the DEIS:

> "If the FWS decides to pursue the designation of a 10(j) experimental population under any of the action alternatives, the FWS would conduct a rulemaking process, which would be initiated during this environmental review process and would be subject to its own comment period. In order for a 10(j) designation to occur, the rulemaking process must determine that the translocation of Grizzly Bears would further the conservation of the species."

Why are you delaying the 10(j) process when precedence shows that it should be prepared at the same time as the DEIS?

If the rules are available for landowners to protect themselves, why aren't the rules already drafted for comment?

How can we comment if we don't know what those rules are?

In the November 2016 Pacific Region Fact Sheet from U.S. Fish and Wildlife, it states "Only the specific take prohibitions listed in the individual 10(j) rule apply." Isn't this a "Take" if bears are eliminated as problems?

In the Grizzly Bear Recovery Plan, which is not found within the DEIS but buried in an appendix, it states:

"On-going human actions in Grizzly Bear habitat may contribute to bear-human conflicts... Management of livestock grazing, timber harvest, mining, road construction, recreation, oil and gas exploration and development should be compatible with Grizzly Bear habitat requirements. An effort is needed to reduce road densities throughout the Recover Zone." Most of the area within the expanded range noted today is state and private land. Unless otherwise specified (by a rule that has not yet been published), I understand that any individuals that wander outside the boundary will assume the ESA Status of their species in the area they occupy.

- Does that not expand the area into a majority that is private land?

What rules within the 10(j), designation assures that our local land use regulations (that have to be state approved after extensive local input) will be followed, even if a 10(j) designation is approved?

We have spent or supervised millions of dollars on the recovery of other species, mainly Salmon. If there is a conflict, who gets to live? Is this "Take" allowed in that recovery plan? Sprinkled throughout also is a phrase "if funding is provided". Does that mean all of those provisions go away? From whom, under this plan, does all of this funding originate?

Again, thank you for being here today.