Yellowstone Grizzly Bear Investigations 2005

Photo by Jeremiah Smith, IGBST

Annual Report of the Interagency Grizzly Bear Study Team

Cover photo: IGBST field crew at Upper Blacktail Creek Patrol Cabin, Yellowstone National Park, 25 September 2005. Pictured from left to right in the front are: Joshua Brown, Meghan Riley, Bryn Karabensh, Angela Hornsby, and Jeremiah Smith; back row: Chad Dickinson, Shannon Podruzny, Andrew Sorensen, Jocelyn Akins, Matt Neuman, and Craig Whitman. Field crew members not pictured include Jonathan Ball and Janissa Balcomb.

YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

Annual Report of the Interagency Grizzly Bear Study Team

2005

U.S. Geological Survey
Wyoming Game and Fish Department
National Park Service
U.S. Fish and Wildlife Service
Montana Fish, Wildlife and Parks
U.S. Forest Service
Idaho Department of Fish and Game
Montana State University

Charles C. Schwartz, Mark A. Haroldson, and Karrie West, Editors

U.S. Department of the Interior
U.S. Geological Survey
May 2006

TABLE OF CONTENTS

INTRODUCTION (Charles C. Schwartz, Interagency Grizzly Bear Study Team, and David Moody, Wyoming Game and Fish Department)

This Report

The contents of this Annual Report summarize results of monitoring and research from the 2005 field season. The report also contains a summary of nuisance grizzly bear (*Ursus arctos horribilis*) management actions.

The Interagency Grizzly Bear Study Team (IGBST) continues to work on issues associated with counts of unduplicated females with cubs-of-the-year (COY). These counts are used to establish a minimum population size, which is then used to establish mortality thresholds for the Recovery Plan (U.S. Fish and Wildlife Service [USFWS] 1993). After considerable delays due to programming issues, a computer program that defines the rule set used by Knight et al. (1995) to differentiate unique family groups was development and tested in 2005 and 2006. Simulations using observations of collared females with cubs were randomly sampled to generate datasets of observations of random females with COY. These datasets were then run though the simulations program to test the accuracy of the rules. Data are currently being summarized. We hope to complete this project sometime in 2006.

The Grizzly Bear Recovery Plan (USFWS 1993) established mortality quotas at 4% of the minimum population estimate derived from female with COY data and no more than 30% of the 4% (1.2%) could be female bears. Simulation modeling (Harris 1984) established sustainable mortality at around 6% of the population. We used the latest information on reproduction and survival to estimate population trajectory in the same simulation model originally used by Harris. A Wildlife Monograph was accepted for publication in 2004. It was to be printed with the October issue of the Journal of Wildlife Management in 2005. Due to publication delays, it is now scheduled to be printed in spring of 2006. Additionally, the study team in cooperation with several quantitative experts reassessed how population size is indexed and how sustainable mortality rates are established. A draft report was presented to the Yellowstone Ecosystem Subcommittee in spring 2005. It was published as part of the U.S. Fish and Wildlife Service Delisting Rule (Federal Register Vol. 70, No. 221, Nov. 17, 2005, 69853-69884) and subjected to public comment. This workshop document can be found at: http://mountain-prairie.fws.gov/species/mammals/grizzly/yellowstone.htm. We plan to take all public comments and reassess our recommendations in 2006.

Our project addressing the potential application of stable isotopes and trace elements to quantify consumption rates of whitebark pine (*Pinus albicaulis*) and cutthroat trout (*Oncorhynchus clarki*) by grizzly bears was completed. Our manuscript on consumption rates of whitebark pine was published in the Canadian Journal of Zoology 81:763-770. Results of the mercury studies were also published in the Canadian Journal of Zoology 82:493-501. Copies can be found on the Interagency Grizzly Bear Study Team website http://www.nrmsc.usgs.gov/research/igbst-home.htm.

Results of DNA hair snaring work conducted on Yellowstone Lake were submitted and published in the Journal Ursus (Haroldson et al. 2005, Appendix A). Results of this study conducted from 1997–2000 showed a decline in fish use by grizzly bears when compared to earlier work conducted by Reinhart (1990) in 1985-1987. As a consequence, the IGBST submitted a proposal to the National Park Service and received 3 years funding to repeat that work. This project is scheduled to begin in 2007. During the summer of 2006, we intend to resurvey all the streams of Yellowstone Lake to determine the presence of spawning fish.

We completed the second field season in Grand Teton National Park evaluating habitat use both temporally and spatially between grizzly and black (*Ursus americanus*) bears. We continue to use Global Positioning System (GPS) technology that incorporates a spread spectrum communication system. Spread spectrum allows for transfer of stored GPS locations from the collar to a remote receiving station. Results of the 2005 field season are reported here.

The study team also produced a number of publications this past year focusing on (1) habituation and human safety (Appendix B), (2) assessing changing human values toward large carnivores in Europe and North America (Appendix C), and (3) reassessing grizzly bear distribution in the Greater Yellowstone Ecosystem (Appendix D). Additionally we continued our cooperative effort as part of the Greater Yellowstone Whitebark Pine Monitoring Working Group to track the health of whitebark pine in the GYE. A summary of the 2005 monitoring is also presented (Appendix E).

The annual reports of the IGBST summarize annual data collection. Because additional information can be obtained after publication, <u>data summaries are subject to change</u>. For that reason, data analyses and summaries presented in this report supersede all previously published data. The study area and sampling techniques are reported by Blanchard (1985), Mattson et al. (1991*a*), and Haroldson et al. (1998).

History and Purpose of the Study Team

It was recognized as early as 1973, that in order to understand the dynamics of grizzly bears throughout the GYE, there was a need for a centralized research group responsible for collecting, managing, analyzing, and distributing information. To meet this need, agencies formed the IGBST, a cooperative effort among the U.S. Geological Survey (USGS), National Park Service, U.S. Forest Service, USFWS, and the States of Idaho, Montana, and Wyoming. The responsibilities of the IGBST are to: (1) conduct both short- and long-term research projects addressing information needs for bear management; (2) monitor the bear population, including status and trend, numbers, reproduction, and mortality; (3) monitor grizzly bear habitats, foods, and impacts of humans; and (4) provide technical support to agencies and other groups responsible for the immediate and long-term management of grizzly bears in the GYE. Additional details can be obtained at our web site (http://www.nrmsc.usgs.gov/research/igbst-home.htm).

Quantitative data on grizzly bear abundance, distribution, survival, mortality, nuisance activity, and bear foods are critical to formulating management strategies and decisions. Moreover, this information is necessary to evaluate the recovery process. The IGBST coordinates data collection and analysis on an ecosystem scale, prevents overlap of effort, and pools limited economic and personnel resources.

Previous Research

Some of the earliest research on grizzlies within Yellowstone National Park was conducted by John and Frank Craighead. The book, "The Grizzly Bears of Yellowstone" provides a detailed summary of this early research (Craighead et al. 1995). With the closing of open-pit garbage dumps and cessation of the ungulate reduction program in Yellowstone National Park in 1967, bear demographics (Knight and Eberhardt 1985), food habits (Mattson et al. 1991*a*), and growth patterns (Blanchard 1987) for grizzly bears changed. Since 1975, the IGBST has produced annual reports and numerous scientific publications (for a complete list visit our web page http://www.nrmsc.usgs.gov/research/igbst-home.htm) summarizing monitoring and research efforts within the GYE. As a result, we know much about the historic distribution of grizzly bears within the GYE (Basile 1982, Blanchard et al. 1992), movement patterns (Blanchard and Knight 1991), food habits (Mattson et al. 1991*a*), habitat use (Knight et al. 1984), and population dynamics (Knight and Eberhardt 1985, Eberhardt et al. 1994, Eberhardt 1995). Nevertheless, monitoring and updating continues so that status can be reevaluated annually.

This report truly represents a “study team” approach. Many individuals contributed either directly or indirectly to its preparation. To that end, we have identified author(s). We also wish to thank the following individuals for their contributions to data collection, analysis, and other phases of the study: USGS - J. Akins, J. Balcomb, J. Ball, J. Brown, A. Hornsby, B. Karabensh, M. Neuman, M. Riley, J. Smith, A. Sorensen, C. Whitman; NPS - D. Blanton, H. Bosserman, A. Bramblett, L. Brunton, B. Clark, L. Coleman, T. Coleman, C. Daigle-Berg, S. Dewey, L. Frattaroli, B. Gafney, B. Hamblin, K. Loveless, M. McKinney, P. Perrotti, E. Reinertson, L. Roberts, D. Smith, J. Stroud, S. Wolff, J. Whipple, P.J. White, B. Wyman, T. Wyman; MTFWP - K. Alt, N. Anderson, S. Shepard, S. Stewart; WYGF - C. Anderson, D. Brimeyer, G. Brown, M. Bruscino, B. DeBolt, T. Fagan, T. Fuchs, H. Haley, K. Hendrix, D. Hyde, A. Johnson, S. Kilpatrick, B. Kroger, J. Longobardi, D. McWhirter, B. Nesvik, C. Queen, R. Roemmich, C. Sax, E. Shorma, D. Wroe; IDFG - S. Liss, G. Losinski, D. Meints, K. Miller, B. Penske; USFS; B. Aber, K. Barber, D. Ditolla, M. Engler, M. Hinschberger, J. Hollis, K. Johnson, L. Koch, L. Otto, A. Pils, K. Pindel; MSU - S. Cherry; Pilots - S. Ard, G. Lust, J. Martin, D. Stinson, R. Stradley, C. Tyrrel. Without the collection efforts of many, the information contained within this report would not be available.

RESULTS AND DISCUSSION

Grizzly Bear Capturing, Collaring, and Monitoring

Marked Animals *(Mark A. Haroldson and Chad Dickinson, Interagency Grizzly Bear Study Team; Dan Bjornlie, Wyoming Game and Fish Department)*

During the 2005 field season, 63 individual grizzly bears were captured on 74 occasions (Table 1), including 24 females (15 adult), 38 males (31 adult), and 1 yearling that was released without handling (sex unknown). Forty-two individuals, including the yearling, were new bears not previously marked.

We conducted research trapping efforts for 973 trap days (1 trap day = 1 trap set for 1 day) in 15 (of 28) Bear Management Units (BMUs) within the Grizzly Bear Recovery Zone (USFWS 1993) and adjacent 10-mile perimeter area. Research trapping efforts were also conducted outside the 10-mile perimeter in Montana and Wyoming. We had 47 captures of 40 individual grizzly bears during research trapping operations for a trapping success rate of 1 grizzly capture every 20.7 trap days.

There were 27 management captures of 26 individual bears in the GYE during 2005 (Tables 1 and 2), including 12 females (6 adult) and 14 males (10 adult). Three individuals initially captured during management actions and transported were subsequently caught at research trap sites. Twenty bears (11 females, 9 males), were relocated due to conflicts situations (Table 1). One adult female captured at a management trap site was not known to be involved in nuisance activity at the time of capture and was released on site. Four male grizzly bears captured at management trap sites were removed from the populations as a result of conflicts with humans. One orphaned male cub died during a management capture attempt. Cause of death was probably trauma that resulted from a fall out of a tree after it was anesthetized.

We radio-monitored 91 individual grizzly bears during the 2005 field season, including 31 adult females (Tables 2 and 3). Fifty-six grizzly bears entered their winter dens wearing active transmitters. An additional 3 bears not located since September are considered missing (Table 3). Since 1975, 515 individual grizzly bears have been radiomarked.

Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem during 2005.

Bear	Sex	Age	Date	General location[a]	Capture type	Release site	Trapper/Handler[b]
483	M	adult	5/5/05	Madison River, YNP	research	on site	IGBST
484	M	adult	5/7/05	Duck Cr, YNP	research	on site	IGBST
485	F	adult	5/23/05	Tepee Cr, GNF	research	on site	IGBST
486	F	adult	5/23/05	Francs Fork, SNF	research	on site	WYGF
487	M	adult	5/25/05	W Fork Timber Cr, SNF	research	on site	WYGF
488	M	adult	5/26/05	Lizard Cr, GTNP	research	on site	IGBST
398	M	adult	6/1/05	Lizard Cr, GTNP	research	on site	IGBST
			9/21/05	Lizard Cr, GTNP	research	on site	IGBST
361	M	adult	6/2/05	Dunior River, Pr-WY	management	removed	WYGF
419	M	subadult	6/15/05	Island Park, Pr-ID	management	Partridge Cr, CTNF	IDGF/IGBST
489	F	adult	6/15/05	S Fork Shoshone, Pr-WY	management	Road Camp Draw, BTNF	WYGF
			8/21/05	Blackrock Cr, BTNF	research	on site	WYGF
490	M	adult	6/23/05	Wapiti Cr, GNF	research	on site	IGBST
491	F	yearling	6/26/05	Stevenson Island, YNP	management	Charcoal Bay, YNP	YNP/IGBST
492	F	yearling	6/26/05	Stevenson Island, YNP	management	Charcoal Bay, YNP	YNP/IGBST
462	M	adult	6/30/05	Green River, Pr-WY	management	removed	WYGF
433	M	adult	7/1/05	Klondike Cr, BTNF	management	Sunlight Cr, SNF	WYGF
439	F	adult	7/3/05	Crow Cr, BTNF	management	Sunlight Cr, SNF	WYGF
			7/30/05	Francs Fork, SNF	research	on site	IGBST
474	F	adult	7/6/05	Lizard Cr, GTNP	research	on site	IGBST
			9/28/05	Lizard Cr, GTNP	research	on site	IGBST
493	M	adult	7/6/05	Wapiti Cr, GNF	research	on site	IGBST
494	M	adult	7/6/05	Pilgrim Cr, GTNF	research	on site	IGBST
			9/27/05	Pacific Cr, GTNF	research	on site	IGBST
495	F	adult	7/12/05	Crow Cr, BTNF	management	Fox Cr, SNF	WYGF
496	M	adult	7/14/05	Francs Fork, SNF	research	on site	IGBST
497	F	subadult	7/15/05	Crow Cr, BTNF	management	S Fork Fish Cr, BTNF	WYGF
373	M	adult	7/28/05	Warm River, CTNF	research	on site	IGBST
227	M	adult	7/30/05	Warm River, CTNF	research	on site	IGBST
498	M	adult	8/4/05	Strawberry Cr, BTNF	management	Park Cr, BTNF	WYGF
499	F	adult	8/5/05	Strawberry Cr, BTNF	management	on site	WYGF
408	M	adult	8/6/05	Rock Cr, BTNF	management	Mormon Cr, SNF	WYGF
500	F	adult	8/15/05	Dallas Fork, BTNF	research	on site	WYGF
			8/19/05	Dallas Fork, BTNF	research	on site	WYGF
501	F	adult	8/13/05	Plateau Cr, YNP	research	on site	IGBST
			8/18/05	Plateau Cr, YNP	research	on site	IGBST
502	F	subadult	8/19/05	Harriman State Park, ID	management	Snow Crest Cr, CTNF	IGBST/IDFG
			10/7/05	Strong Cr, Pr-ID	management	Keg Springs Cr, CTNF	IDFG
503	F	adult	8/19/05	Dallas Fork, BTNF	research	on site	WYGF

Table 1. Continued.

Bear	Sex	Age	Date	General location[a]	Capture type	Release site	Trapper/Handler[b]
315	F	adult	8/19/05	Game Cr, BTNF	research	on site	WYGF
G100	M	adult	8/19/05	S Fork Shoshone, Pr-WY	management	removed	WYGF
504	M	adult	8/20/05	Green River, BTNF	management	Fox Cr, SNF	WYGF
505	F	adult	8/21/05	S Fork Shoshone, Pr-WY	management	Wiggins Fork, SNF	WYGF
471	M	adult	8/22/05	Crow Cr, BTNF	management	removed	WYGF
506	M	adult	8/24/05	Dallas Fork, BTNF	research	on site	WYGF
507	F	subadult	8/25/05	Buffalo River, CTNF	research	on site	IGBST
508	M	yearling	8/27/05	Blackrock Cr, BTNF	research	on site	WYGF
509	F	adult	8/27/05	N Fork Spread Cr, BTNF	research	on site	WYGF
			8/30/05	N Fork Spread Cr, BTNF	research	on site	WYGF
unm	unk	yearling	8/31/05	N Fork Spread Cr, BTNF	research	on site	WYGF
510	F	yearling	9/1/05	Grouse Cr, BTNF	research	on site	WYGF
511	M	adult	9/1/05	Dallas Fork, BTNF	research	on site	WYGF
399	F	adult	9/9/05	Bailey Cr, GTNP	research	on site	IGBST
477	M	adult	9/10/05	Elk Cr, CTNF	management	Snow Cr, CTNF	WS/IDFG
			9/21/05	Bailey Cr, GTNP	research	on site	IGBST
401	M	adult	9/12/05	Bailey Cr, GTNP	research	on site	IGBST
460	M	subadult	9/13/05	Lizard Cr, GTNP	research	on site	IGBST
287	M	adult	9/13/05	Cascade Cr, YNP	research	on site	IGBST
512	M	adult	9/13/05	Gardner River, YNP	research	on site	IGBST
513	M	adult	9/17/05	Line Cr, SNF	management	Lost Lake, BTNF	WYGF
G101	F	cub	9/21/05	Carter Cr, Pr-WY	management	Fox Cr, SNF	WYGF
G102	M	cub	9/21/05	Carter Cr, Pr-WY	management	mortality	WYGF
281	M	adult	9/24/05	Cascade Cr, YNP	research	on site	IGBST
480	M	adult	9/25/05	Antelope Cr, YNP	research	on site	IGBST
448	F	subadult	9/25/05	Arnica Cr, YNP	research	on site	IGBST
			9/27/05	Arnica Cr, YNP	research	on site	IGBST
514	M	adult	9/28/05	Bailey Cr, GTNP	research	on site	IGBST
515	M	adult	9/28/05	Arnica Cr, YNP	research	on site	IGBST
516	M	adult	10/6/05	Antelope Cr, YNP	research	on site	IGBST
475	M	subadult	10/10/05	Antelope Cr, YNP	research	on site	IGBST
517	F	adult	10/11/05	S Fork Shoshone, Pr-WY	management	Glade Cr, CTNF	WYGF
G103	M	cub	10/11/05	S Fork Shoshone, Pr-WY	management	Glade Cr, CTNF	WYGF
G104	M	cub	10/11/05	S Fork Shoshone, Pr-WY	management	Glade Cr, CTNF	WYGF
518	F	subadult	10/15/05	Carter Cr, Pr-WY	management	Fox Cr, SNF	WYGF

[a] BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.

[b] IGBST = Interagency Grizzly Bear Study Team, USGS; MTFWP = Montana Fish, Wildlife and Parks; WS = Wildlife Services/Animal and Plant Health Inspection Service (APHIS); WYGF = Wyoming Game and Fish.

Table 2. Annual record of grizzly bears monitored, captured, and transported in the Greater Yellowstone Ecosystem since 1980.

Year	Number monitored	Individuals trapped	Total captures		
			Research	Management	Transports
1980	34	28	32	0	0
1981	43	36	30	35	31
1982	46	30	27	25	17
1983	26	14	0	18	13
1984	35	33	20	22	16
1985	21	4	0	5	2
1986	29	36	19	31	19
1987	30	21	15	10	8
1988	46	36	23	21	15
1989	40	15	14	3	3
1990	35	15	4	13	9
1991	42	27	28	3	4
1992	41	16	15	1	0
1993	43	21	13	8	6
1994	60	43	23	31	28
1995	71	39	26	28	22
1996	76	36	25	15	10
1997	70	24	20	8	6
1998	58	35	32	8	5
1999	65	42	31	16	13
2000	84	54	38	27	12
2001	82	63	41	32	15
2002	81	54	50	22	15
2003	80	44	40	14	11
2004	78	58	38	29	20
2005	91	63	47	27	20

Table 3. Grizzly bears radio monitored in the Greater Yellowstone Ecosystem during 2005.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current Status
155	M	Adult		Yes	No	Cast[b]
211	M	Adult		Yes	No	Cast
214	F	Adult	2 yearlings	Yes	Yes	Active
227	M	Adult		No	Yes	Active
273	M	Adult		Yes	No	Cast
287	M	Adult		No	Yes	Active
295	F	Adult	1 2-year-old	Yes	No	Cast
315	F	Adult	None	No	Yes	Active
321	F	Adult	None	Yes	Yes	Active
337	F	Adult	2 yearlings	Yes	No	Cast
349	F	Adult	2 COY	Yes	Yes	Active
365	F	Adult	Unknown	Yes	Yes	Active
373	M	Adult		No	Yes	Active
377	M	Adult		Yes	No	Cast
386	F	Adult	Unknown	Yes	No	Cast
398	M	Adult		No	No	Cast
399	F	Adult	None	Yes	Yes	Active
401	M	Adult		No	No	Cast
402	F	Adult	2 yearlings	Yes	Yes	Active
408	M	Adult		No	No	Dead
412	F	Adult	1 COY	Yes	Yes	Active
419	M	Subadult		No	Yes	Active
423	F	Adult	Unknown	Yes	Yes	Active
427	M	Adult		Yes	No	Cast
428	F	Adult	None	Yes	Yes	Active
433	M	Adult		No	Yes	Active
436	M	Adult		Yes	Yes	Active
437	M	Adult		Yes	Yes	Active
439	F	Adult	None	Yes	Yes	Active
441	M	Adult		Yes	No	Missing
448	F	Subadult		Yes	Yes	Active
452	M	Subadult		Yes	Yes	Active
453	M	Adult		Yes	No	Cast
457	M	Adult		Yes	No	Cast
460	M	Subadult		Yes	Yes	Active
461	F	Adult	2 COY	Yes	No	Cast
462	M	Adult		Yes	No	Cast
463	M	Adult		Yes	No	Cast

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current Status
464	M	Adult		Yes	No	Cast
465	M	Adult		Yes	Yes	Active
468	M	Subadult		Yes	No	Cast
469	M	Adult		No	No	Cast
470	M	Adult		Yes	No	Cast
471	M	Adult		Yes	No	Cast
472	F	Adult	None	Yes	No	Cast
473	M	Subadult		Yes	No	Cast
474	F	Adult	None	Yes	Yes	Active
475	M	Subadult		Yes	Yes	Active
476	F	Adult	None	Yes	Yes	Active
477	M	Adult		Yes	Yes	Active
478	F	Adult	Unknown	Yes	Yes	Active
479	M	Adult		Yes	No	Cast
480	M	Adult		Yes	Yes	Active
481	F	Subadult		Yes	Yes	Active
482	F	Adult	None	Yes	Yes	Active
483	M	Adult		No	No	Cast
484	M	Adult		No	No	Cast
485	F	Adult	1 yearling	No	Yes	Active
486	F	Adult	None	No	Yes	Active
487	M	Adult		No	No	Cast[b]
488	M	Adult		No	No	Cast
489	F	Adult	None	No	Yes	Active
490	M	Adult		No	No	Cast
491	F	Subadult		No	No	Cast
492	F	Subadult		No	No	Cast
493	M	Adult		No	No	Cast
494	M	Subadult		No	Yes	Active
495	F	Adult	None	No	Yes	Active
496	M	Adult		No	Yes	Active
497	F	Subadult		No	Yes	Active
498	M	Adult		No	Yes	Active
499	F	Adult	None	No	Yes	Active
500	F	Adult	None	No	Yes	Active
501	F	Adult	None	No	Yes	Active
502	F	Subadult		No	Yes	Active
503	F	Adult	None	No	Yes	Active

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current status
504	M	Adult		No	Yes	Active
505	F	Adult	None	No	Yes	Active
506	M	Adult		No	Yes	Active
507	F	Subadult		No	Yes	Active
508	M	Subadult		No	No	Missing
509	F	Adult	2 yearlings	No	Yes	Active
510	F	Subadult		No	No	Missing
511	M	Adult		No	Yes	Active
512	M	Adult		No	Yes	Active
513	M	Adult		No	Yes	Active
514	M	Adult		No	Yes	Active
515	M	Adult		No	Yes	Active
516	M	Adult		No	Yes	Active
517	F	Adult	2 COY	No	Yes	Active
518	F	Subadult		No	Yes	Active

[a] COY = cub-of-the-year.
[b] Transmitter was not retrieved in 2005, site will be visited as soon as possible in 2006 to determine status.

Unduplicated Females *(Mark A. Haroldson, Interagency Grizzly Bear Study Team)*

Thirty-one unduplicated females with COY were identified using the method described by Knight et al. (1995) in the Greater Yellowstone Ecosystem (GYE) during 2005 (Fig 1). Two of the 31 females were observed further than 10 miles from the Recovery Zone (in Wyoming). Under the rules established by the Grizzly Bear Recovery Plan (USFWS 1993:Appendix F), 29 females were used to calculate of the minimum population estimate and mortality threshold in the Yellowstone Grizzly Bear Recovery Zone for the year 2005.

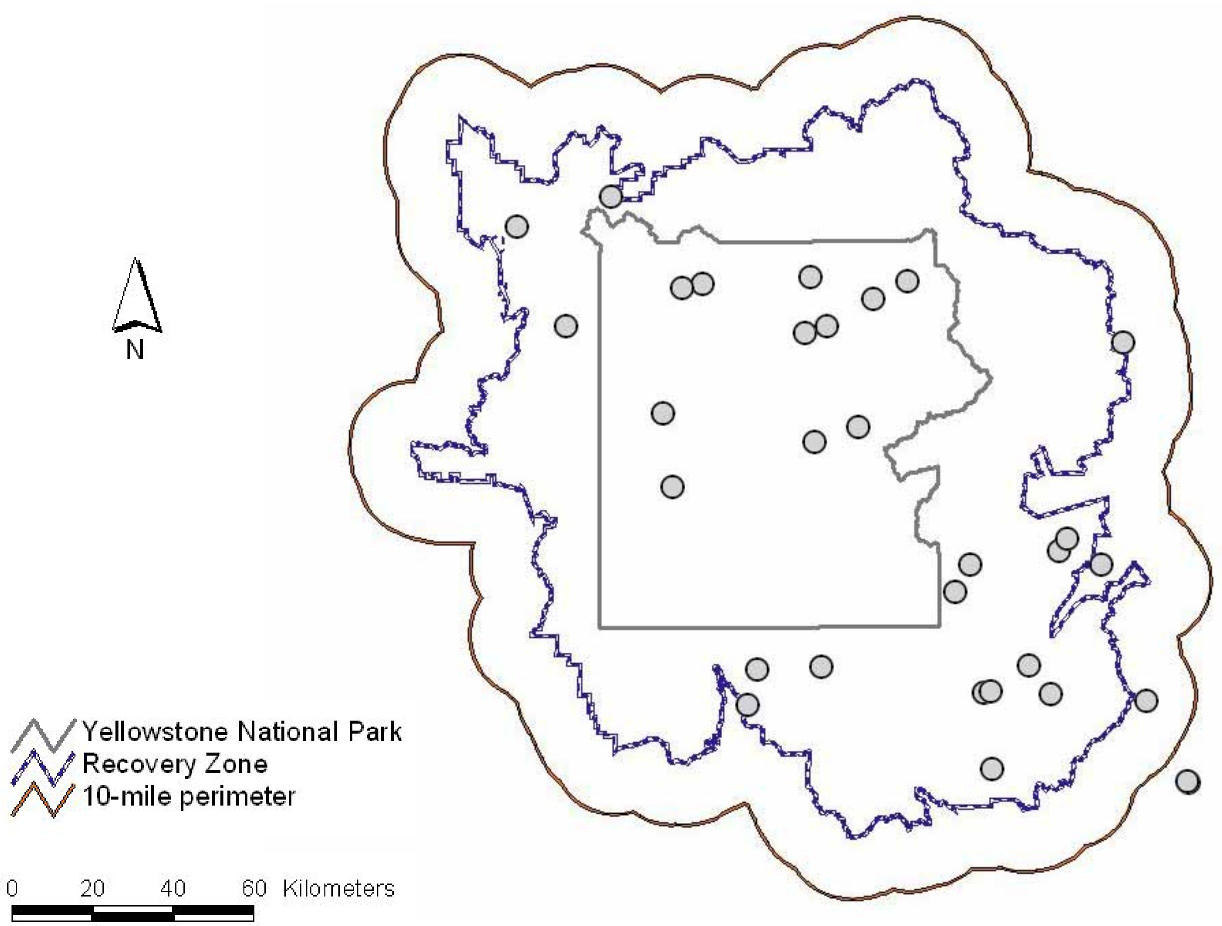

Fig. 1. Distribution of initial sightings for 31 unduplicated females with cubs-of-the-year identified in the Greater Yellowstone Ecosystem during 2005. The single point outside the 10-mile peremiter represents 2 sightings.

Total number of COY observed during initial sighting of the 31 unique females was 57 (Table 4). Mean litter size was 1.84 (Table 4). There were 11 single cub litters, 14 litters of twins, and 6 litters of triplets. The current 6-year average (2000-2005) for counts of unduplicated females with COY within the Recovery Zone and the 10-mile perimeter is 40 (Table 4). The 6-year average for total number of COY and average litter size observed at initial sighting were 76 and 1.9, respectively (Table 4).

Table 4. Number of unduplicated females with cubs-of-the-year (COY), number of COY, and average litter size at initial observation for the years 1973-2005 in the Greater Yellowstone Ecosystem. Six-year running averages were calculated using only unduplicated females with COY observed in the Recovery Zone and 10-mile perimeter.

	Greater Yellowstone Ecosystem			Recovery Zone and 10-mile perimeter 6-year running averages		
Year	Females	COY	Mean litter size	Females	COY	Litter size
1973	14	26	1.9			
1974	15	26	1.7			
1975	4	6	1.5			
1976	17	32	1.9			
1977	13	25	1.9			
1978	9	19	2.1	12	22	1.8
1979	13	29	2.2	12	23	1.9
1980	12	23	1.9	11	22	1.9
1981	13	24	1.8	13	25	2.0
1982	11	20	1.8	12	23	2.0
1983	13	22	1.7	12	23	1.9
1984	17	31	1.8	13	25	1.9
1985	9	16	1.8	13	23	1.8
1986	25	48	1.9	15	27	1.8
1987	13	29	2.2	15	28	1.9
1988	19	41	2.2	16	31	1.9
1989[a]	16	29	1.8	16	32	1.9
1990	25	58	2.3	18	36	2.0
1991[b]	24	43	1.9	20	41	2.0
1992	25	60	2.4	20	43	2.1
1993[a]	20	41	2.1	21	45	2.1
1994	20	47	2.4	21	46	2.1
1995	17	37	2.2	22	47	2.2
1996	33	72	2.2	23	50	2.2
1997	31	62	2.0	24	53	2.2
1998	35	70	2.0	26	55	2.1
1999[a]	33	63	1.9	28	58	2.1
2000[c]	37	72	2.0	31	62	2.0
2001	42	78	1.9	35	69	2.0
2002[c]	52	102	2.0	38	73	1.9
2003[d]	38	75	2.0	38	74	1.9
2004[d]	49	96	2.0	40	77	1.9
2005[c]	31	57	1.8	40	76	1.9

[a] One female with COY was observed outside the 10-mile perimeter.
[b] One female with unknown number of COY. Average litter size was calculated using 23 females.
[c] Two females with COY were observed outside the 10-mile perimeter.
[d] Three females with COY were observed outside the 10-mile perimeter.

We documented 93 verified sightings of females with COY during 2005 (Fig. 2). This was a 58% decrease from the number of sightings obtained in 2004 (*n* = 223). A likely explanation for the decline in sightings and number of unique females differentiated is that many reproductive-aged females in the population were accompanied by cubs or yearlings during 2004 and were unavailable for breeding. This is supported by the finding that bears/hour observed during observation flights was high during 2005 but females with cubs observed/hour declined (Fig. 3). Another probable contributing factor was snow cover that persisted on many of the moth aggregation sites until late July. Persistent snow cover likely affected moth use of some aggregation sites (see Moth section this report) and subsequently our ability to observe females with COY.

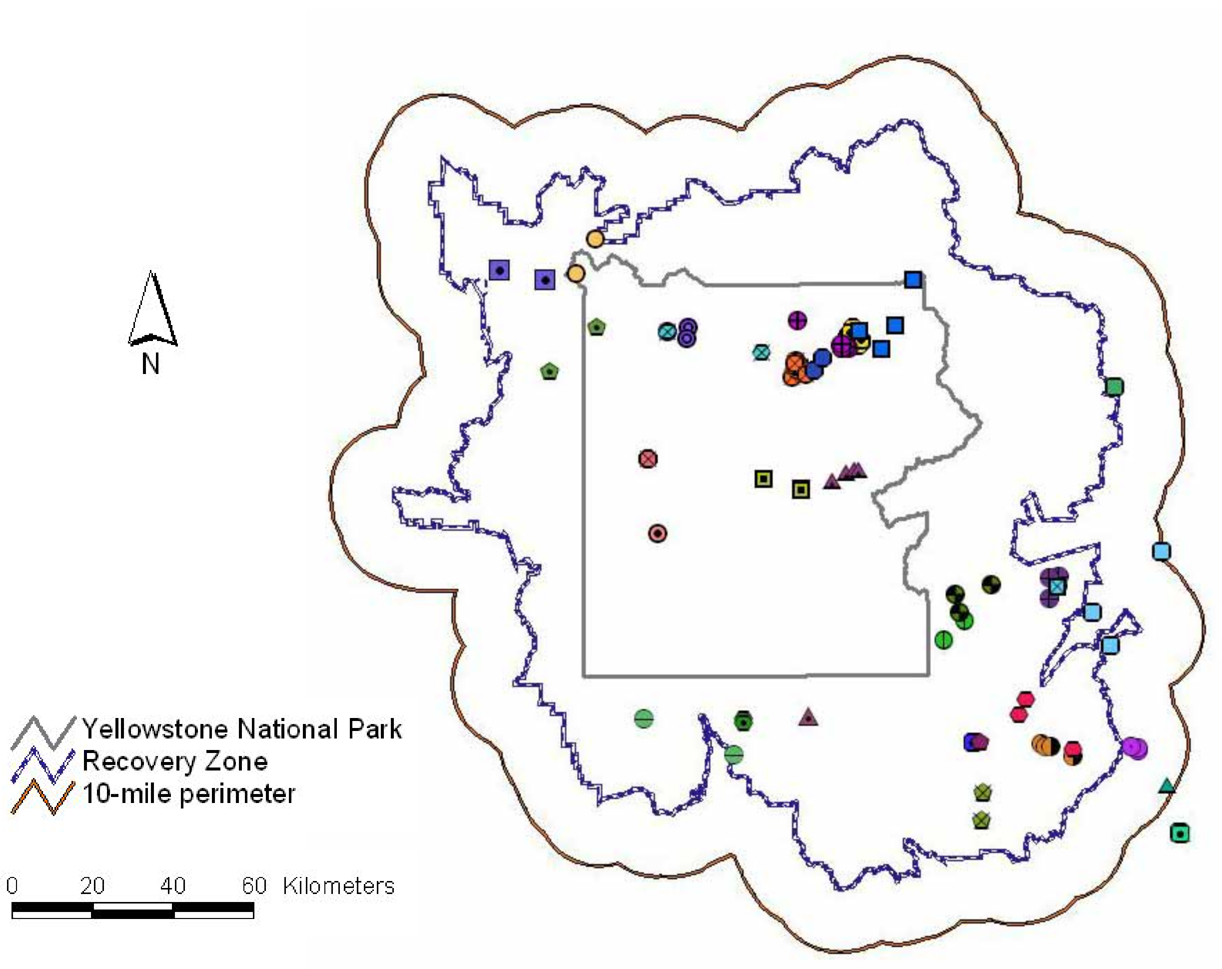

Fig. 2. Distribution of 93 observations of 31 unduplicated females (indicated by unique symbols) with cubs-of-the-year during 2005.

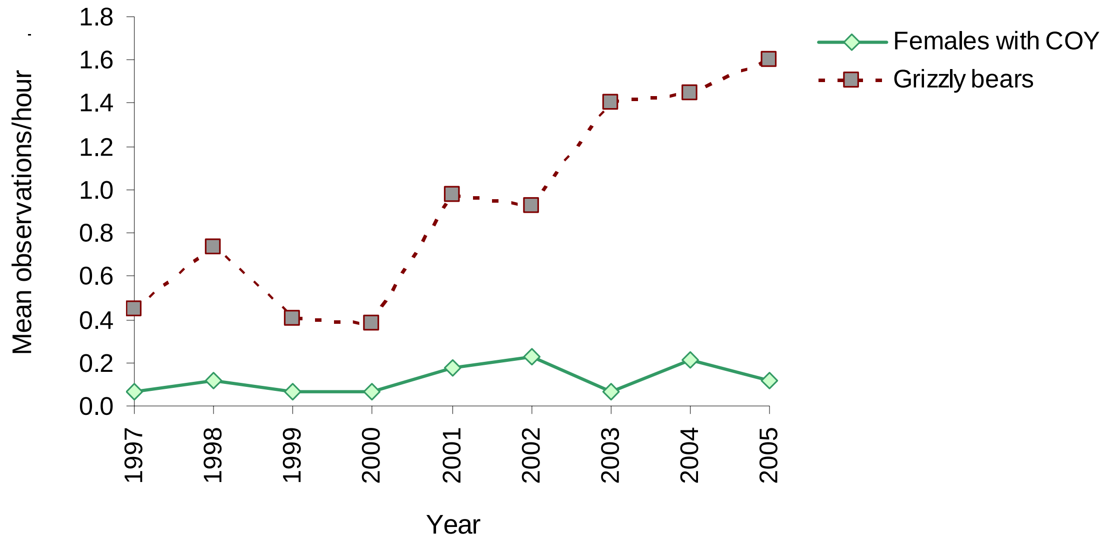

Fig. 3. Mean observations/hour for total number of unmarked grizzly bears, and females with cubs of the year (COY), in non-moth Bear Management Units within the Recovery Zone, 1997-2005.

Most observations (56%) obtained during 2005 were attributable to ground observers (Table 5), and most (55%) occurred within the boundary of Yellowstone National Park (YNP). The correlation between the number of sightings obtained and the number of unduplicated females with COY identified annually (Fig. 4) remains strong (Pearsons $r = 0.87$).

Table 5. Method of observation for sightings of unduplicated females with cubs-of-the-year during 2005.

Method of observation	Frequency	Percent	Cumulative Percent
Fixed wing – other researcher	2	2.2	2.2
Fixed wing – observation	30	32.3	34.4
Fixed wing - radio flight	5	5.4	39.8
Ground sighting	52	55.9	95.7
Helicopter – other research	4	4.3	100.0
Trap	0	0.0	100.0
Total	93	100.0	

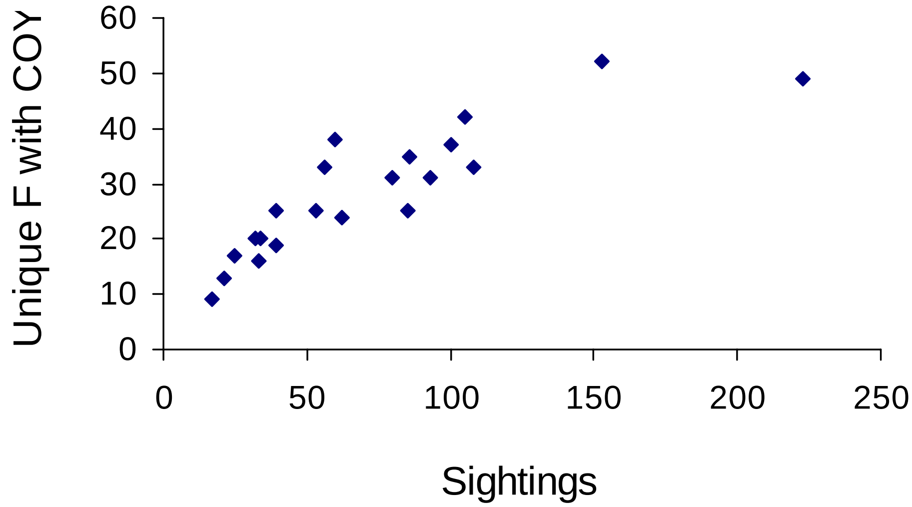

Fig. 4. Relationship between number of sightings and number of unduplicated females (F) with cubs-of-the-year (COY) identified annually during 1985-2005.

Current methodology to determine number of unduplicated females with COY provides a minimum count ($\hat{N}_{Obs}$, Knight et al. 1995). Keating et al. (2002) investigated 7 methods to estimate the total number of females with COY annually using sighting frequencies of randomly observed bears and recommended the 2nd order sample coverage ($\hat{N}_{SC2}$) estimator of Lee and Chao (1994). Recently, Cherry et al. (in review), identified 2 problems with the recommendations of Keating et al. (2002). First, Keating et al. (2002) assumed coefficients of variation (CV) < 1 and recent data (Haroldson 2005:Table 6) indicated CV sometimes exceeds 1. Secondly, additional work has shown that CV is not adequate by itself to quantify capture heterogeneity and the $\hat{N}_{SC2}$ is not robust to this problem. Cherry et al. (in review) suggest using estimates derived by Chao (1989) (Table 6). Simulations (Cherry et al. in review) suggest that this estimator ($\hat{N}_{Chao2}$) is relatively unbiased when effort ($n / \hat{N}_{Chao2}$) is ≥1.5. Additionally, when it is biased, $\hat{N}_{Chao2}$ tends to be biased low, thus producing conservative estimates for the number of females with cubs in the population. Overestimation of numbers of females with cubs could have negative consequences for population trend when mortality thresholds are based on the estimate.

Table 6. Estimates of annual numbers ($\hat{N}_{Obs}$) of females with cubs-of-the-year (F_{Cub}) in the Greater Yellowstone Ecosystem grizzly bear population, 1986–2005. $\hat{N}_{Obs}$ gives the number of unique F_{Cub} actually observed, including those located using radiotelemetry; m gives the number of unique F_{Cub} observed using random sightings only; and $\hat{N}_{Chao2}$ gives the nonparametric biased corrected estimate, per Chao (1989). Lower, 1-tailed confidence bounds are for $\hat{N}_{Chao2}$ and were calculated using Efron and Tibshirani's (1993) percentile bootstrap method. Also included are annual estimates of relative sample size (n / $\hat{N}_{Chao2}$, where n is the total number of observations of F_{Cub}).

				Lower 1-tailed confidence bounds				
Year	$\hat{N}_{Obs}$	m	$\hat{N}_{Chao2}$	70%	80%	90%	95%	$n / \hat{N}_{Chao2}$
1986	25	24	27.5	26.1	25.0	23.9	22.8	3.0
1987	13	12	17.3	15.2	14.0	12.2	11.2	1.2
1988	19	17	21.2	19.5	18.4	17.0	16.0	1.7
1989	16	14	17.5	16.1	15.0	13.8	12.8	1.6
1990	25	22	25.0	23.8	22.9	21.9	21.0	2.0
1991	24	24	37.8	33.3	31.0	27.6	25.3	1.6
1992	25	23	40.5	35.1	32.3	29.0	26.5	0.9
1993	20	18	21.1	19.9	19.0	17.9	16.9	1.4
1994	20	18	22.5	20.8	19.7	18.3	17.2	1.3
1995	17	17	43.0	35.3	30.0	25.3	22.0	0.6
1996	33	28	37.5	34.6	33.0	30.7	29.0	1.2
1997	31	29	38.8	35.8	34.0	31.6	29.8	1.7
1998	35	33	36.9	35.6	34.6	33.4	32.4	2.0
1999	33	30	36.0	33.8	32.6	30.8	29.5	2.7
2000	37	34	51.0	46.3	43.7	40.4	37.8	1.5
2001	42	39	48.2	45.6	43.8	42.1	40.1	1.7
2002	52	49	58.1	55.5	53.9	51.8	50.1	2.5
2003	38	35	46.4	43.5	41.5	39.1	37.3	1.2
2004	49	48	57.5	54.6	53.1	50.7	48.8	3.5
2005	31	29	30.7	30.0	29.3	28.4	27.7	2.8

Occupancy of Bear Management Units (BMU) by Females with Young *(Shannon Podruzny, Interagency Grizzly Bear Study Team)*

Dispersion of reproductive females throughout the ecosystem is represented by verified reports of female grizzly bears with young (COY, yearlings, 2-year-olds, and/or young of unknown age) by BMU. The population recovery requirements (USFWS 1993) include occupancy of 16 of the 18 BMUs by females with young on a running 6-year sum with no 2 adjacent BMUs unoccupied. Eighteen of 18 BMUs had verified observations of female grizzly bears with young during 2005 (Table 7). Eighteen of 18 BMUs contained verified observations of females with young in at least 5 years of the last 6-year period.

Table 7. Bear Management Units in the Greater Yellowstone Ecosystem occupied by females with young (cubs-of-the-year, yearlings, 2-year-olds, or young of unknown age), as determined by verified reports, 2000-2005.

Bear Management Unit	2000	2001	2002	2003	2004	2005	Years occupied
1) Hilgard	X	X	X	X	X	X	6
2) Gallatin	X	X	X	X	X	X	6
3) Hellroaring/Bear	X	X	X	X		X	5
4) Boulder/Slough	X	X	X	X	X	X	6
5) Lamar	X	X	X	X	X	X	6
6) Crandall/Sunlight	X	X	X	X	X	X	6
7) Shoshone	X	X	X	X	X	X	6
8) Pelican/Clear	X	X	X	X	X	X	6
9) Washburn	X	X	X	X	X	X	6
10) Firehole/Hayden	X	X	X	X	X	X	6
11) Madison	X	X	X		X	X	5
12) Henry's Lake	X	X	X		X	X	5
13) Plateau	X	X	X	X	X	X	6
14) Two Ocean/Lake	X	X	X	X	X	X	6
15) Thorofare	X	X	X	X	X	X	6
16) South Absaroka	X	X	X	X	X	X	6
17) Buffalo/Spread Creek	X	X	X	X	X	X	6
18) Bechler/Teton	X	X	X	X	X	X	6
Totals	18	18	18	16	17	18	

Observation Flights *(Karrie West, Interagency Grizzly Bear Study Team)*

Two rounds of observation flights were conducted during 2005. The 37 Bear Observation Areas (BOA; Fig. 5) were surveyed once during each round (Round 1: 4 June-26 July; Round 2: 1 July-31 August). Observation time was just over 86 hours for each round; average duration of flights for both rounds combined was 2.3 hours (Table 8). One hundred ninety-one bear sightings, excluding dependent young, were recorded during observation flights. This included 1 solitary radio-marked bear, 142 solitary unmarked bears, and 48 unmarked females with young (Table 9). Observation rates were 1.11 bears/hour for all bears or 0.28 females with young/hour. Eighty-five young (39 COY, 35 yearlings, and 11 2-year-olds) were observed (Table 10). Observation rate was 0.13 females with COY/hour.

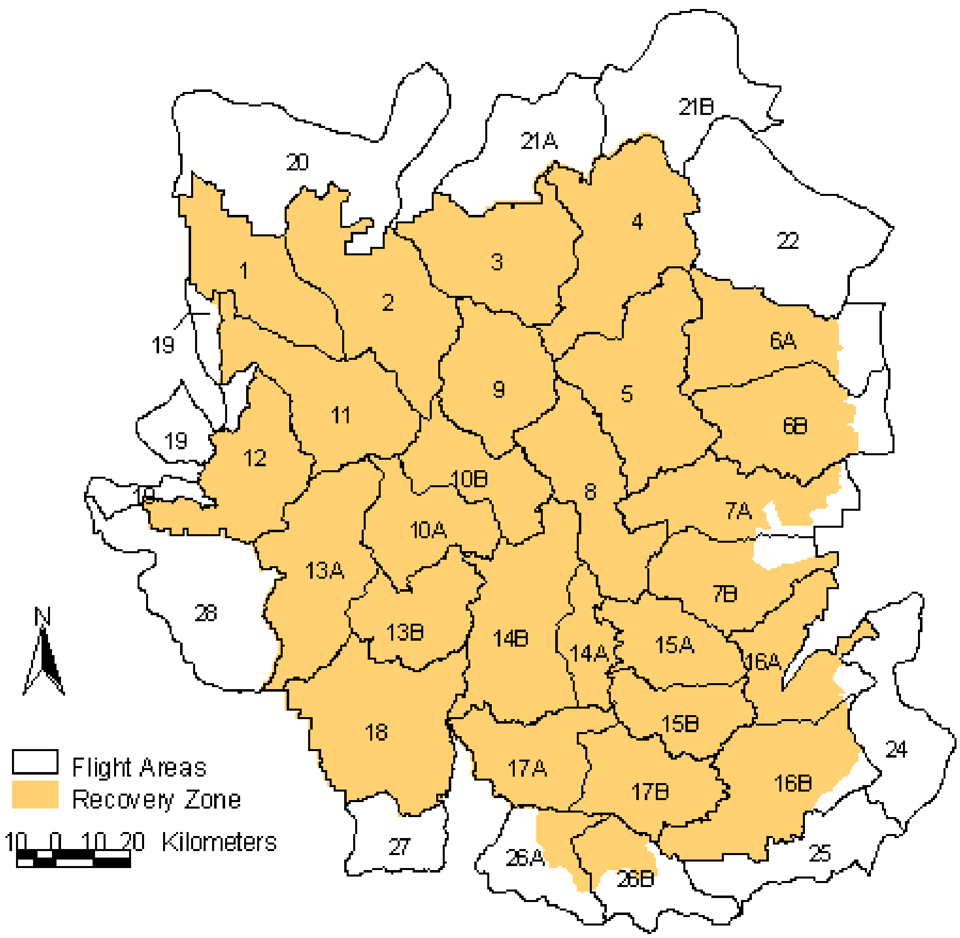

Fig. 5. Observation flight areas within the Greater Yellowstone Ecosystem, 2005. The numbers represent the 27 bear observation areas (BOA). Those units too large to search during a single flight were further subdivided into 2 units. Consequently, there were 37 search areas. BOA 23 was recombined with BOAs 6A and 6B.

Table 8. Annual summary statistics for observation flights conducted in the Greater Yellowstone Ecosystem, 1987-2005.

					Bears seen					Observation rate (bears/hour)		
					Marked		Unmarked		Total			
Date	Observation period	Total hours	Number of flights	Average hours/flight	Lone	With young	Lone	With young	number of groups	All groups	With young	With COY[a]
1987	Total	50.6	21	2.4					26[b]	0.51	0.16	0.12
1988	Total	34.8	17	2.0					30[b]	0.86	0.43	0.23
1989	Total	91.9	39	2.4					60[b]	0.65	0.16	0.09
1990	Total	88.1	41	2.1					48[b]	0.54	0.19	0.15
1991	Total	101.3	46	2.2					134[b]	1.32	0.52	0.34
1992	Total	61.1	30	2.0					113[b]	1.85	0.54	0.29
1993[c]	Total	56.4	28	2.0					32[b]	0.57	0.10	0.05
1994	Total	80.1	37	2.2					67[b]	0.84	0.30	0.19
1995	Total	70.3	33	2.1					62[b]	0.88	0.14	0.09
1996	Total	88.6	40	2.2					71[b]	0.80	0.27	0.23
1997[d]	Round 1	55.5	26	2.1	1	1	38	19	59	1.08		
	Round 2	59.3	24	2.5	1	1	30	17	49	0.83		
	Total	114.8	50	2.3	2	2	68	36	108	0.94	0.33	0.16
1998[d]	Round 1	73.6	37	2.0	1	2	54	26	83	1.13		
	Round 2	75.4	37	2.0	2	0	68	18	88	1.17		
	Total	149.0	74	2.0	3	2	122	44	171	1.15	0.31	0.19
1999[d]	Round 1	79.7	37	2.2	0	0	13	8	21	0.26		
	Round 2	74.1	37	2.0	0	1	21	8	30	0.39		
	Total	153.8	74	2.1	0	1	34	16	51	0.33	0.11	0.05
2000[d]	Round 1	48.7	23	2.1	0	0	8	2	10	0.21		
	Round 2	83.6	36	2.3	3	0	51	20	74	0.89		
	Total	132.3	59	2.2	3	0	59	22	84	0.63	0.17	0.12
2001[d]	Round 1	72.3	32	2.3	0	0	37	12	49	0.68		
	Round 2	72.4	32	2.3	2	4	85	29	120	1.66		
	Total	144.7	64	2.3	2	4	122	41	169	1.17	0.31	0.25
2002[d]	Round 1	84.0	36	2.3	3	0	88	34	125	1.49		
	Round 2	79.3	35	2.3	6	0	117	46	169	2.13		
	Total	163.3	71	2.3	9	0	205	80	294	1.80	0.49	0.40

Table 8. Continued.

Date	Observation period	Total hours	Number of flights	Average hours/flight	Bears seen: Marked: Lone	Bears seen: Marked: With young	Bears seen: Unmarked: Lone	Bears seen: Unmarked: With young	Bears seen: Total number of groups	Observation rate (bears/hour): All groups	Observation rate (bears/hour): With young	Observation rate (bears/hour): With COY[a]
2003[d]	Round 1	78.2	36	2.2	2	0	75	32	109	1.39		
	Round 2	75.8	36	2.1	1	1	72	19	93	1.23		
	Total	154.0	72	2.1	3	1	147	51	202	1.31	0.34	0.17
2004[d]	Round 1	84.1	37	2.3	0	0	43	12	55	0.65		
	Round 2	76.6	37	2.1	1	2	94	38	135	1.76		
	Total	160.8	74	2.2	1	2	137	50	190	1.18	0.32	0.23
2005[d]	Round 1	86.3	37	2.3	1	0	70	20	91	1.05		
	Round 2	86.2	37	2.3	0	0	72	28	100	1.16		
	Total	172.5	74	2.3	1	0	142	48	191	1.11	0.28	0.13

[a] COY = cub-of-the-year.

[b] Only includes unmarked bears. Checking for radio-marks on observed bears was added to the protocol starting in 1997.

[c] Three flights were excluded from the 1993 data because they were not flown as part of the 16 observation flight areas.

[d] Dates of flights (Round 1, Round 2): 1997 (24 Jul–17 Aug, 25 Aug-13 Sep); 1998 (15 Jul-6 Aug, 3-27 Aug); 1999 (7-28 Jun, 8 Jul–4 Aug); 2000 (5-26 Jun, 17 Jul–4 Aug); 2001 (19 Jun–11 Jul, 16 Jul–5 Aug); 2002 (12 Jun–22 Jul, 13 Jul–28 Aug); 2003 (12 Jun-28 Jul, 11 July-13 Sep); 2004 (12 Jun-26 Jul, 3 Jul-28 Aug); 2005 (4 June-26 July, 1 July-31 Aug).

Table 9. Size and age composition of family groups seen during observation flights in the Greater Yellowstone Ecosystem, 1998-2004.

	Females with cubs-of-the-year (number of cubs)			Females with yearlings (number of yearlings)			Females with 2-year-olds or young of unknown age (number of young)		
Date	1	2	3	1	2	3	1	2	3
1998[a]									
Round 1	4	10	4	0	4	2	1	2	1
Round 2	0	7	3	2	4	1	0	1	0
Total	4	17	7	2	8	3	1	3	1
1999[a]									
Round 1	2	1	1	0	1	2	1	0	0
Round 2	2	2	0	0	3	1	0	1	0
Total	4	3	1	0	4	3	1	1	0
2000[a]									
Round 1	1	0	0	0	0	0	0	1	0
Round 2	3	11	1	1	2	0	0	2	0
Total	4	11	1	1	2	0	0	3	0
2001[a]									
Round 1	1	8	1	1	0	0	0	0	1
Round 2	14	10	2	4	2	1	0	0	0
Total	15	18	3	5	2	1	0	0	1
2002[a]									
Round 1	8	15	5	3	2	0	0	0	1
Round 2	9	19	9	2	4	2	0	1	0
Total	17	34	14	5	6	2	0	1	1
2003[a]									
Round 1	2	12	2	2	6	2	3	3	0
Round 2	2	5	3	2	5	0	2	0	1
Total	4	17	5	4	11	2	5	3	1
2004[a]									
Round 1	4	1	3	1	1	0	2	0	0
Round 2	6	16	7	4	7	0	0	0	0
Total	10	17	10	5	8	0	2	0	0

Table 9. Continued.

	Females with cubs-of-the-year (number of cubs)			Females with yearlings (number of yearlings)			Females with 2-year-olds or young of unknown age (number of young)		
	1	2	3	1	2	3	1	2	3
2005[a]									
Round 1	5	5	3	2	3	1	0	1	0
Round 2	4	4	1	3	6	3	5	2	0
Total	9	9	4	5	9	4	5	3	0

[a] Dates of flights (Round 1, Round 2): 1998 (15 Jul-6 Aug, 3-27 Aug); 1999 (7-28 Jun, 8 Jul–4 Aug); 2000 (5-26 Jun, 17 Jul–4 Aug); 2001 (19 Jun–11 Jul, 16 Jul–5 Aug); 2002 (12 Jun–22 Jul, 13 Jul–28 Aug); 2003 (12 Jun-28 Jul, 11 Jul-13 Sep); 2004 (12 Jun-26 Jul, 3 Jul-28 Aug); 2005 (4 June-26 July, 1 July-31 Aug).

Telemetry Relocation Flights *(Karrie West, Interagency Grizzly Bear Study Team)*

We flew 103 telemetry relocation flights with 411.5 hours of search time (ferry time to and from airports excluded) in 2005 (Table 10). Flights were conducted at least once during all months, with over 80% occurring May-November. During telemetry flights, 942 locations of bears equipped with radio transmitters were collected, 95 (10%) of which included a visual sighting. Forty-nine sightings of unmarked bears were also recorded, including 40 solitary bears and 3 females with COY. Rate of observation for all unmarked bears during telemetry flights was 0.12 bears/hour. Rate of observing females with COY was 0.007/hour, which was considerably less than during observation flights (0.13/hour) in 2005.

Table 10. Summary statistics for radio-telemetry relocation flights in the Greater Yellowstone Ecosystem, 2005.

				Radioed bears			Unmarked bears observed					
								Females			Observation rate (groups/hour)	
Month	Hours	Number of flights	Mean hours per flight	Number of locations	Number seen	Observation rate (groups/hour)	Lone bears	With COY[a]	With yearlings	With young	All groups	Females with COY
January	10.97	4	2.74	30	0	0.00	0	0	0	0	-----	-----
February	3.37	1	3.37	22	0	0.00	0	0	0	0	-----	-----
March	3.63	1	3.63	22	0	0.00	0	0	0	0	-----	-----
April	30.89	7	4.41	77	14	0.45	1	0	0	0	0.03	0.00
May	52.19	13	4.01	95	20	0.38	5	0	0	0	0.10	0.00
June	30.95	10	3.10	76	12	0.39	3	0	1	0	0.13	0.00
July	44.07	10	4.41	86	10	0.23	6	1	1	0	0.18	0.00
August	72.81	17	4.28	131	15	0.21	13	1	2	0	0.22	0.01
September	66.41	16	4.15	157	10	0.15	11	1	1	1	0.21	0.02
October	49.60	12	4.13	138	12	0.24	1	0	0	0	0.02	0.00
November	36.29	9	4.03	80	2	0.06	0	0	0	0	-----	-----
December	10.33	3	3.44	28	0	0.00	0	0	0	0	-----	-----
Total	411.51	103	4.00	942	95	0.23	40	3	5	1	0.12	0.007

[a] COY = cub-of-the-year.

Grizzly Bear Mortalities *(Mark A. Haroldson, Interagency Grizzly Bear Study Team; and Kevin Frey, Montana Fish, Wildlife and Parks)*

We continue to use the definitions provided in Craighead et al. (1988) to classify grizzly bear mortalities in the GYE relative to the degree of certainty regarding each event. Those cases in which a carcass is physically inspected or when a management removal occurs are classified as “known” mortalities. Those instances where evidence strongly suggests a mortality has occurred but no carcass is recovered are classified as “probable” mortalities. When evidence is circumstantial, with no prospect for additional information, a “possible” mortality is designated.

We documented 14 known grizzly bear mortalities during 2005 (Table 11). Three of these bear deaths occurred prior to 2005; 1 likely during 1999, 1 during 2001, and 1 during the fall of 2004 (Bear #467, Table 11). Cause of death for these 3 bears could not be determined. The approximate location for the 2001 mortality was >10 miles outside the Recovery Zone. Bear #467, a radiomarked female, was first noted on a slow (i.e. stationary) pulse rate during a telemetry flight on 29 November 2004. The mortality was discovered when the site was investigated on 24 June 2005.

The remaining 11 mortalities (2 females and 9 males) documented during 2005 were all known human-caused bear deaths (Table 11). Four of the losses were the result of management removals of males bear involved in either livestock depredation ($n = 2$), or anthropogenic foods ($n = 2$). Three were self-defense kills that occurred as a result of chance encounters between hunters and bears. Two of these mortalities involved females accompanied by yearlings. The 4 remaining human-caused mortalities resulted from road kills ($n = 2$), mistaken identity ($n = 1$), and an accidental mortality during a management capture attempt ($n = 1$). Four of the human-caused mortalities, all males, occurred >10 miles outside the Recovery Zone in Wyoming (Tables 11 and 12).

In addition, we documented 2 possible mortalities during 2005 (Table 11). Both of these instances were hunting related. One involved a conflict at a hunter-killed deer that was left unattended over night. Human injuries were incurred and shots were fired at the bear, but no evidence of wounding of the bear was found. The second possible mortality involved a female with a yearling that was shot at when she charged a bow hunter. This females was wounded, but evidence at the site indicted the wound was minor. She was observed moving away from the encounter with her yearling.

The Grizzly Bear Recovery Plan (USFWS 1993:41-44) provides criteria for determining if human-caused grizzly bear mortalities have exceeded annual thresholds established in the plan. Appendix F of the Grizzly Bear Recovery Plan (USFWS 1993) intended that known mortalities occurring within the Yellowstone Grizzly Bear Recovery Zone **and** a 10-mile perimeter area be counted against mortality quotas. The USFWS clarified this with an amendment to the Recovery Plan. In addition, beginning in 2000, probable mortalities were included in the calculation of mortality thresholds, and COY orphaned as a result of human causes will be designated as probable mortalities (see Appendix A in Schwartz and Haroldson 2001). Prior to these changes, COY orphaned after 1 July were designated possible mortalities (Craighead et al. 1988). Sex of probable mortalities is randomly assigned as described in Appendix A in Schwartz and Haroldson (2001). Under these criteria, 7 known human-caused grizzly bear mortalities, including 2 adult females and 2 total females, were applied to the calculation of mortality threshold (USFWS 1993) for 2005. Using these results, total human-caused mortality was under, but female mortalities exceeded the annual mortality thresholds during 2005 (Table 13). This is the second consecutive year that the female mortality threshold had been exceeded.

In March of 2005, IGBST began a series of workshops with the intent of reviewing mortality thresholds specified in the USFWS Recovery Plan (1993). This effort was a continuation of the demographics work begun in 2000. The draft document (Reassessing Methods to Estimate Population Size and Sustainable Mortality Limits for the Yellowstone Grizzly Bear 70 FR 70632) summaries results and recommendations of the working group and was included as an amendment to the Recovery Plan as part of the USFWS proposed rule change regarding the status of grizzly bears in the GYE (Federal Register 71 FR 4097). Public comment on the rule was taken until March 2006.

Table 11. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2005.

Bear[a]	Sex	Age[b]	Date	Location[c]	Certainty	Cause
225	M	adult	5/15/05	Fir Ridge, GNF	Known	Human-caused, road kill, bear #225.
Unm	Unk	adult	Fall 1999	S Fork Shoshone, SNF	Known	Undetermined cause, skull found May 2000. Date of mortality and location are approximate.
361	M	adult	6/2/05	Dunior River, Pr-WY	Known	Human-caused, management removal of bear #361 for repeated conflicts.
Unm	M	yearling	6/11/05	Buffalo Fork River, GTNP	Known	Human-caused, road kill.
467	F	subadult	11/1/04	Squaw Basin, BTNF	Known	Undetermined cause, bear #467 found dead 6/24/05, location did not change after 11/1/04, collar went on mortality between 11/18-11/29/2004.
462	M	adult	6/30/05	Green River, PR-WY	Known	Human-caused, management removal of bear #462 for repeated livestock depredation. Outside 10-mile perimeter.
G100	M	adult	8/19/05	S Fork Shoshone, Pr-WY	Known	Human-caused, management removal of #G100 for property damage and anthropogenic foods.
471	M	adult	8/22/05	Fish Cr, BTNF	Known	Human-caused, management removal of #471 for repeated livestock depredation. Outside 10-mile perimeter.
Unm	Unk	Unk	9/11/05	Aspen Cr, BTNF	Possible	Human-caused, hunting related, conflict at hunter-killed deer that was left unattended over night. Human Injury. Shots were fired at bear, unknown if bear was hit, no evidence of wounding found.
G102	M	COY	9/21/05	Carter Cr, PR-WY	Known	Human-caused, accidental mortality of #G102 during management capture. Outside 10-mile perimeter.
Unm	F	adult	9/22/05	Elizabeth Cr, SNF	Known	Human-caused, hunting related. Female with 2 yearlings charged hunters. Guide was injured. Hunter shot bear with crossbow, guide killed down bear with gun..
Unm	Unk	Unk	May 2001	E Fork Wind, SNF	Known	Undetermined cause. Under investigation.
Unm	F	adult	9/28/05	Rose Cr, GNF	Possible	Human-caused, hunting related, self defense. Bow hunter shot at charging female with pistol. Small amount of blood found. Female was accompanied by 1 yearling.
Unm	M	subadult	9/29/05	Lady of the Lake Cr, GNF	Known	Human-caused, mistaken identity. Under investigation.

Table 11. Continued.

Bear[a]	Sex	Age[b]	Date	Location[c]	Certainty	Cause
Unm	F	adult	10/1/05	Venus Cr, BTNF	Known	Human-caused, hunting related, self defense. Female with 2 yearlings charged hunters who were sitting down eating lunch.
408	M	adult	10/14/05	Fish Cr, BTNF	Known	Human-caused, hunting related, self defense. Chance encounter during pursuit of game. Deer hunter jumped bear #408 from daybed at close range. Outside 10-mile perimeter.

[a] Unm = unmarked bear; mkd = marked bear, number indicates bear number .
[b] COY = cub-of-the-year. Unk = unknown age
[c] BLM = Bureau of Land Management, BTNF = Bridger-Teton National Forest, GNF = Gallatin National Forest, SNF = Shoshone National Forest, YNP = Yellowstone National Park, GTNP = Grand Teton National Park, Pr = private.
[d] Occurred >10 miles outside the Recovery Zone.

Table 12. Number of known and probable grizzly bear deaths in the Greater Yellowstone Ecosystem by cause and location relative to the USFWS Grizzly Bear Recovery Zone and 10-mile perimeter, 1983-2005. This table has been corrected from previous reports to reflect the best estimate of year of death for bears whose deaths occurred prior to the year they were found. Location of mortalities relative to the Recovery Zone and 10-mile perimeter were also corrected using digital coverage and ArcView 3.3 (Environmental Systems Research Institute 1992).

	All bears				Adult females			
	Human-caused		Other[a]		Human-caused		Other	
Year	In[b]	Out[b]	In	Out	In	Out	In	Out
1983	6	0	1	0	2	0	0	0
1984	8	0	2	0	2	0	0	0
1985	5	1	7	0	2	0	0	0
1986	5	4	2	0	1	1	0	0
1987	3	0	0	0	2	0	0	0
1988	5	0	6	0	0	0	0	0
1989	2	0	1	0	0	0	0	0
1990	9	0	0	0	4	0	0	0
1991	0	0	0	0	0	0	0	0
1992	4	0	4	0	0	0	0	0
1993	3	0	2	0	2	0	1	0
1994	10	1	0	0	3	0	0	0
1995	17	0	0	0	3	0	0	0
1996	10	0	4	1	3	0	0	0
1997	8	2	10	0	3	0	0	0
1998	1	2	3	0	1	0	0	0
1999	7	1	8	0	1	0	0	0
2000[c]	16	6	14	0	3	1	0	0
2001	17	3	8	1	6	0	2	0
2002	15	2	8	0	4	0	2	0
2003	10	2	5	0	3	0	0	0
2004	17	2	7	0	6	0	0	0
2005	7	4	0	0	2	0	0	0

[a] Includes deaths from natural and unknown causes.

[b] In refers to inside the Recovery Zone or within a 10-mile perimeter of the Recovery Zone. Out refers to >10 miles outside the Recovery Zone.

[c] Starting in 2000, includes human-caused orphaned cubs-of-the-year (Appendix A in Schwartz and Haroldson 2001).

Table 13. Annual count of unduplicated females with cubs-of-the-year (COY), and known and probable[a] human-caused grizzly bear mortalities within the Recovery Zone and the 10-mile perimeter, 1994-2005. Calculations of mortality thresholds (USFWS 1993) do not include mortalities or unduplicated females with COY documented outside the 10-mile perimeter.

								U.S. Fish and Wildlife Service Grizzly Bear Recovery Plan mortality thresholds				
		Human-caused mortality			Human-caused mortality 6-year running averages				Total human-caused mortality		Total female mortality	
Year	Unduplicated females with COY	Total	Female	Adult female	Total	Female	Adult female	Minimum population estimate	4% of minimum population	Year result	30% of total mortality	Year result
1994	20	10	3	3	4.7	2.0	1.5	215	8.6	Under	2.6	Under
1995	17	17	7	3	7.2	3.2	2.0	175	7.0	Exceeded	2.1	Exceeded
1996	33	10	4	3	7.3	2.8	1.8	223	8.9	Under	2.7	Exceeded
1997	31	7	3	2	8.5	3.3	2.2	266	10.7	Under	3.2	Exceeded
1998	35	1	1	1	8.0	3.3	2.3	339	13.6	Under	4.1	Under
1999	32	5	1	1	8.3	3.2	2.2	343	13.7	Under	4.1	Under
2000[a]	35	16	5	3	9.3	3.5	2.2	354	14.2	Under	4.2	Under
2001	42	17	8	6	9.3	3.7	2.7	361	14.5	Under	4.3	Under
2002	50	15	7	4	10.2	4.2	2.8	416	16.6	Under	5.0	Under
2003	35	10	6	3	10.7	4.7	3.0	416	16.6	Under	5.0	Under
2004	46	17	9	6	13.3	6.0	3.8	431	17.2	Under	5.2	Exceeded
2005	29	7	2	2	13.7	6.2	4.0	361	14.5	Under	4.3	Exceeded

[a] Beginning in 2000, probable human-caused mortalities are used in calculation of annual mortality thresholds.

Key Foods Monitoring

Spring Ungulate Availability and Use by Grizzly Bears in Yellowstone National Park *(Shannon Podruzny, Interagency Grizzly Bear Study Team; and Kerry Gunther, Yellowstone National Park)*

It is well documented that grizzly bear use ungulates as carrion (Mealey 1980, Henry and Mattson 1988, Green 1994, Blanchard and Knight 1996, Mattson 1997) in YNP. Competition with recently reintroduced wolves (*Canis lupus*) for carrion and changes in bison (*Bison bison*) and elk (*Cervus elaphus*) management policies in the GYE have the potential to affect carcass availability and use by grizzly bears. For these and other reasons, we continue to survey historic carcass transects in Yellowstone National Park. In 2005, we surveyed routes in ungulate winter ranges to monitor the relative abundance of spring ungulate carcasses (Fig. 6).

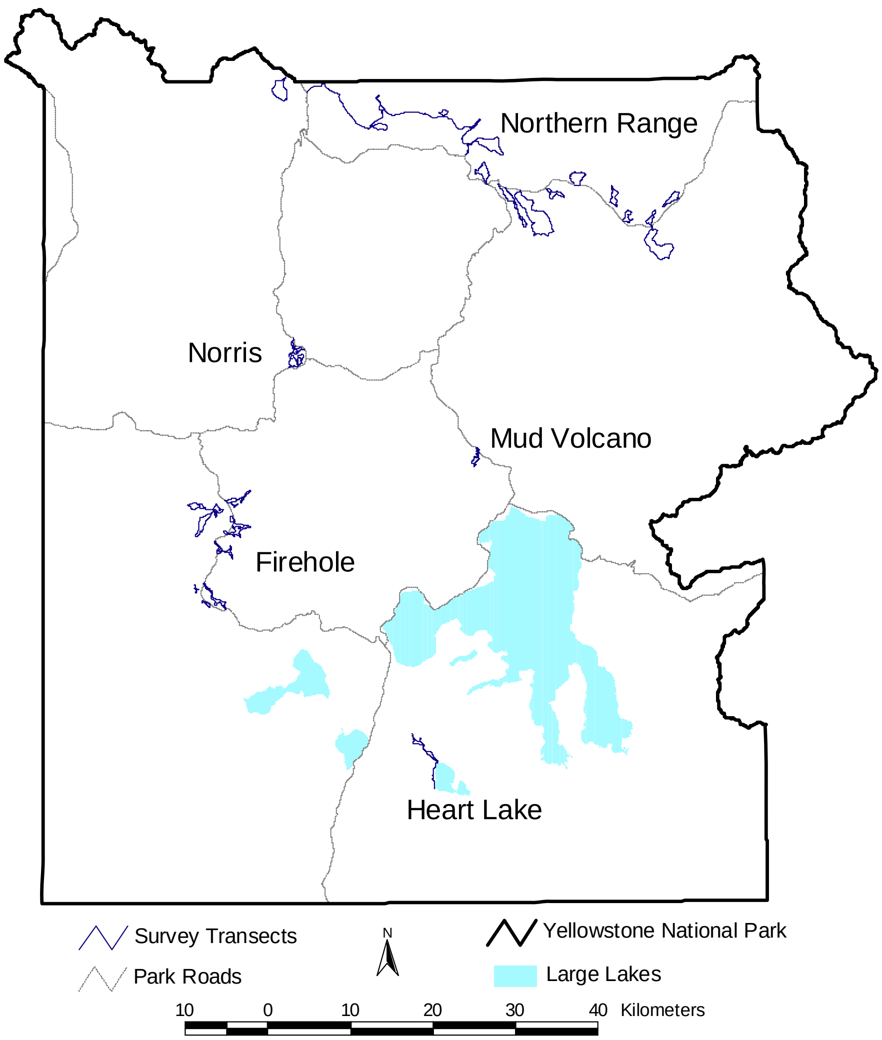

Fig. 6. Spring ungulate carcass survey transects in 5 areas of Yellowstone National Park.

We surveyed each route once for carcasses between April and early May. At each carcass, we collected a site description (i.e., location, aspect, slope, elevation, distance to road, distance to forest edge), carcass data (i.e., species, age, sex, cause of death), and information about animals using the carcasses (i.e., species, percent of carcass consumed, scats present). We were unable to calculate the biomass consumed by bears, wolves, or other unknown large scavengers with our survey methodology.

We are interested in relating the changes in ungulate carcass numbers to potential independent measures of winter die-off. Such measures include weather, winter severity, and forage availability. All are considered limiting factors to ungulate survival during winter (Cole 1971, Houston 1982). Long-term changes in weather and winter severity monitoring may be useful in predicting potential carcass availability. The Winter Severity Index (WSI) developed for elk (Farnes 1991), tracks winter severity, monthly, within a winter and is useful to compare among years. WSI uses a weight of 40% of minimum daily winter temperature below 0° F, 40% of current winter's snow pack (in snow water equivalent), and 20% of June and July precipitation as surrogate for forage production (Farnes 1991). We reported relationships between WSI and carcass numbers in previous years, however WSI for the winter of 2004-2005 was not available for our study area due to lack of funding.

<u>Northern Range</u>

We surveyed 13 routes on Yellowstone's Northern Range totaling 137.5 km traveled. We used hand-held GPS units to more accurately measure the actual distance traveled on most of the routes. We counted 13 carcasses, including 4 bison and 9 elk, which equated to 0.095 carcasses/km (Table 14). Sex and age of carcasses found are shown in Table 15. All carcasses were almost completely consumed by scavengers, except 1 untouched male elk. One adult male elk was confirmed by YNP biologists to have been killed by wolves early in the spring. Grizzly bear sign (e.g., tracks, scats, daybeds, or feeding activity) was observed along 6 of the routes. One black bear and 1 grizzly were also observed during the surveys.

Table 14. Carcasses found and visitation of carcasses by bears, wolves, and unknown large scavengers along surveyed routes in Yellowstone National Park during spring 2005.

	Elk				Bison				
	Number of carcasses	# Visited by species			Number of carcasses	# Visited by species			
Survey area (# routes)		Bear	Wolf	Unknown		Bear	Wolf	Unknown	Total Carcasses/km
Northern Range (13)	9	0	0	8	4	0	0	4	0.095
Firehole (8)	0	0	0	0	7	2	1	4	0.086
Norris (4)	0	0	0	0	0	0	0	0	0
Heart Lake (3)	0	0	0	0	0	0	0	0	0
Mud Volcano (1)	0	0	0	0	0	0	0	0	0

Table 15. Age classes and sex of elk and bison carcasses found, by area, along surveyed routes in Yellowstone National Park during spring 2005.

	Elk (n = 9)						Bison (n = 11)					
	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total
<u>Age</u>												
Adult	7	0	0	0	0	7	3	5	0	0	0	8
Yearling	0	0	0	0	0	0	1	1	0	0	0	2
Calf	0	0	0	0	0	0	0	1	0	0	0	1
Unknown	2	0	0	0	0	2	0	0	0	0	0	0
<u>Sex</u>												
Male	3	0	0	0	0	3	1	2	0	0	0	3
Female	4	0	0	0	0	4	1	4	0	0	0	5
Unknown	2	0	0	0	0	2	2	1	0	0	0	3

<u>Firehole River Area</u>

We surveyed 8 routes in the Firehole drainage totaling 81.4 km. We found the remains of 7 bison, which equated to 0.086 carcasses/km traveled (Table 14). Evidence of use by wolves was found at 1 yearling bison carcass. Definitive evidence of use by grizzly bears was found at 2 bison carcasses, 1 adult female may have been killed by a bear. Grizzly bear sign was also found along 5 of the routes.

<u>Norris Geyser Basin</u>

We surveyed 4 routes in the Norris Geyser Basin totaling 19.4 km traveled. We observed no carcasses but grizzly bear tracks were found along all 4 routes.

<u>Heart Lake</u>

We surveyed 3 routes in the Heart Lake thermal basin covering 16.0 km. We observed no carcasses. Grizzly bear sign, including tracks, scats, and other feeding activities, was observed along all routes. Two grizzly bears were seen in the survey area.

<u>Mud Volcano</u>

We surveyed a single route in the Mud Volcano area covering 3.9 km. No carcasses were observed this spring, but tracks of at least 2 grizzly bears were found along the route.

Spawning Cutthroat Trout *(Kerry A. Gunther, Travis Wyman, Todd M. Koel, Patrick Perrotti, and Eric Reinertson, Yellowstone National Park)*

Spawning cutthroat trout are a high-quality, calorically dense food source for grizzly bears in YNP (Mealey 1975, Pritchard and Robbins 1990), and influence the distribution of bears over a large geographic area (Mattson and Reinhart 1995). Grizzly bears are known to prey on cutthroat trout in at least 36 different tributary streams to Yellowstone Lake (Hoskins 1975, Reinhart and Mattson 1990). Haroldson et al. (2005) estimated that approximately 68 grizzly bears likely fished Yellowstone Lake tributary streams annually. Male grizzly bears appear to dominate those spawning streams and consume greater quantities of trout than female bears (Felicetti et al. 2004). Bears also occasionally prey on cutthroat trout in other areas of the park, including the inlet to Trout Lake located in the northeast section of the park.

The cutthroat trout population in Yellowstone Lake is now threatened by the introduction of nonnative lake trout (*Salvelinus namaycush*) and the exotic parasite (*Myxobolus cerebralis*) that causes whirling disease (Koel et al. 2005*a*, Koel et al. in press *a*). Lake trout and whirling disease could depress the native cutthroat trout population and associated bear fishing activity (Haroldson et al. 2005). Unlike cutthroat trout, lake trout do not move up tributary streams to spawn, but spawn in the lake making them unavailable to terrestrial predators such as bears.

There is evidence that the number of spawning cutthroat trout in Yellowstone Lake is declining. Reinhart et al. (1995) reported a decline in the number of spawning cutthroat trout in North Shore and West Thumb spawning streams during the period 1989-1995, as compared to the period 1985-1987. The downward trend has generally continued in all monitored streams during the period 1996-2005. Non-native lake trout were discovered in Yellowstone Lake in 1994 (Kaeding et al. 1996) and have probably been present in the lake since 1988 (Munro et al. 2005). Lake trout are highly predatory on cutthroat trout and have significantly reduced native trout populations in other lakes where they have been introduced (Gerstung 1988, Donald and Alger 1993). Younger age classes of lake trout compete with cutthroat trout for macroinvertebrates consumed by both species (Elrod and O'Gorman 1991). Older lake trout are highly predatory on cutthroat trout and may consume at least 41 cutthroat trout/year (Ruzycki et al. 2003). Without control, non-native lake trout could reduce the native cutthroat trout population in Yellowstone Lake by as much as 90% (McIntyre 1996).

Whirling disease was discovered in Yellowstone Lake in 1998 (Koel et al. In press *a*). Whirling disease primarily affects young cutthroat trout by destroying head cartilage, resulting in loss of equilibrium, skeletal deformities, and inability to feed normally and avoid predators (Yellowstone Center for Resources 2002). Whirling disease has devastated wild trout populations in other waters of the Intermountain West (Nickum 1999). In addition to lake trout and whirling disease, wildfire and drought may also be contributing to the decline of the Yellowstone Lake cutthroat trout population. Due to the importance of cutthroat trout to grizzly bears and the potential threats from lake trout and whirling disease, monitoring of the cutthroat trout population is specified under the Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2003). The cutthroat trout population is currently monitored annually using counts at fish traps and during stream surveys (Koel 2001, USFWS 2003).

Yellowstone Lake

Fish Trap Surveys.--The number of spawning cutthroat trout migrating upstream are counted annually from weirs with fish traps at the mouths of Clear Creek and Bridge Creek on the east and north sides of Yellowstone Lake, respectively (Koel 2001). The fish traps are generally installed in May, the exact date depending on winter snow accumulation, weather conditions, and spring snow melt (Koel 2001). Fish are counted by dip netting trout that enter the upstream trap box and/or visually counting trout as they swim through wooden chutes attached to the traps (Koel 2001). An electronic fish counter is also periodically used (Koel 2001).

In 2005, 917 spawning cutthroat trout were counted ascending Clear Creek (Koel et al. in press *b*), this represents a 36% decrease from the total of 1,438 trout counted in 2004, a 73% decrease from the 3,432 trout counted in 2003 (Koel et al. 2005*b*), and a 99% decrease since the peak upstream spawner count of 70,105 in 1978. The 917 spawners counted in 2005 was the lowest count since monitoring began in 1945 (Koel et al. in press *b*). Lake trout are thought to have been illegally introduced into Yellowstone Lake in the mid-1980s (Munro et al. 2001). The number of cutthroat trout counted at Clear Creek has generally declined (Fig. 7) since the mid-1980s (Koel et al. 2005*a*). The number of spawning cutthroat trout ascending Bridge Creek has also declined in recent years (Fig. 8) (Koel et al. 2005*b*). In 1999, 2,363 cutthroat trout ascended the stream to spawn. By 2004, the number of spawning cutthroat trout ascending Bridge Creek had decreased by >99% (Koel et al. 2005*b*). In 2005, no cutthroat trout were counted at the Bridge Creek fish trap (Koel et al. in press *b*).

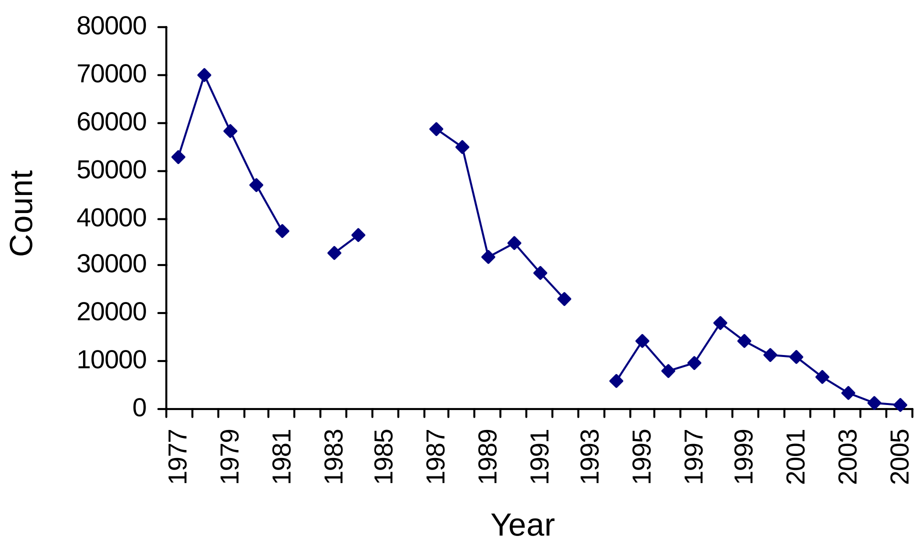

Fig. 7. Number of spawning cutthroat trout counted at the Clear Creek fish trap on the east shore of Yellowstone Lake, Yellowstone National Park, 1977-2005.

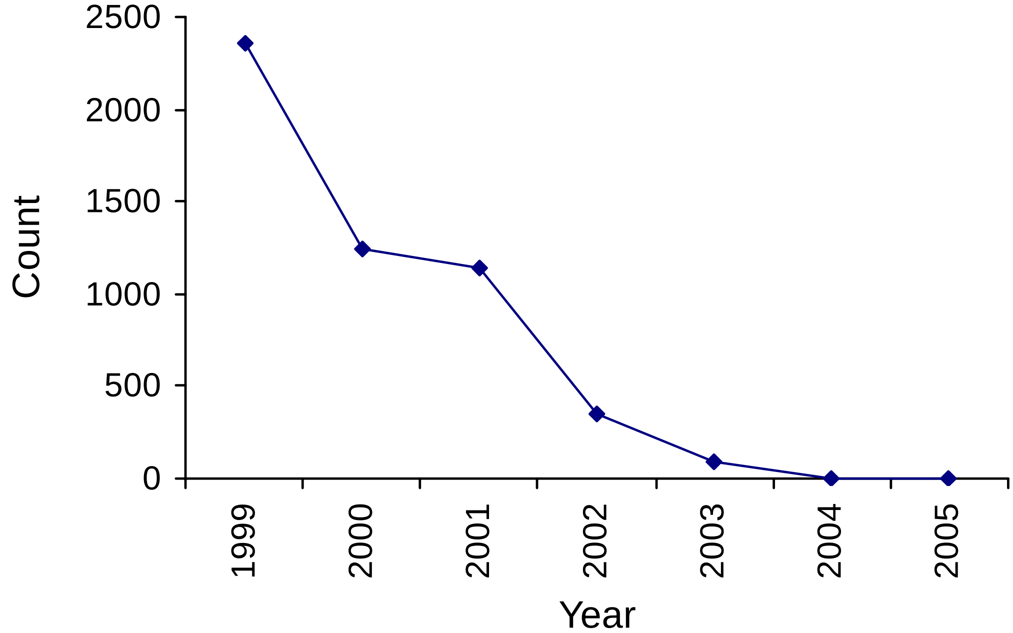

Fig. 8. Number of spawning cutthroat trout counted at the Bridge Creek fish trap on the north shore of Yellowstone Lake, Yellowstone National Park, 1999-2005.

Spawning Stream Surveys.--Beginning 1 May each year, several streams including Lodge, Hotel, Hatchery, Incinerator, Wells, Bridge, Weasel, and Sand Point Creeks on the North Shore of Yellowstone Lake, and Sandy, Sewer, Little Thumb, and 1167 Creeks in the West Thumb area are checked daily to detect the presence of adult cutthroat trout (Andrascik 1992, Olliff 1992). Once adult trout are found (i.e., onset of spawning), weekly surveys of cutthroat trout in these streams are conducted. Sample methods follow Reinhart (1990), as modified by Andrascik (1992) and Olliff (1992). In each stream on each sample day, 2 people walk upstream from the stream mouth and record the number of adult trout observed. Sampling continues 1 day/week until most adult trout return to the lake (i.e., end of spawning). The average number of spawning cutthroat trout counted per stream survey is used to identify annual trends in the number of cutthroat trout spawning in Yellowstone Lake tributaries.

Data collected in 2005 continued to show low numbers of spawning cutthroat on North Shore and West Thumb streams (Table 16). On North Shore streams, only 3 spawning cutthroat trout were counted, 2 in Bridge Creek and 1 in Wells Creek. No spawning cutthroat trout were observed in Lodge, Hotel, Hatchery, Incinerator, Weasel, or Sand Point Creeks. On West Thumb streams, 10 spawning cutthroat trout were counted in Sandy Creek and 12 in Little Thumb Creek. No spawning cutthroat trout were counted in Sewer Creek or 1167 Creek. The number of spawners counted in the North Shore and West Thumb streams have decreased noticeably since 1989 (Fig. 9).

Table 16. Start of spawn, end of spawn, duration of spawn, and average number of spawning cutthroat trout counted per survey in North Shore and West Thumb spawning tributaries to Yellowstone Lake, Yellowstone National Park.

Stream	Start of spawn	End of spawn	Duration of spawn (days)	Number of surveys during spawning period	Number of fish counted	Average fish/survey
North Shore Streams						
Lodge Creek			No spawn			
Hotel Creek			No spawn			
Hatchery Creek			No spawn			
Incinerator Creek			No spawn			
Wells Creek	5/23	5/23	1	1	1	1
Bridge Creek	5/31	5/31	1	1	2	2
Weasel Creek			No spawn			
Sand Point Creek			No spawn			
West Thumb Streams						
1167 Creek			No spawn			
Sandy Creek	5/24	6/6	14	3	10	3
Sewer Creek			No spawn			
Little Thumb Creek	5/31	6/13	14	4	12	3
Total				9	25	3
Northern Range Stream						
Trout Lake Inlet	6/22	7/13	22	4	185	46

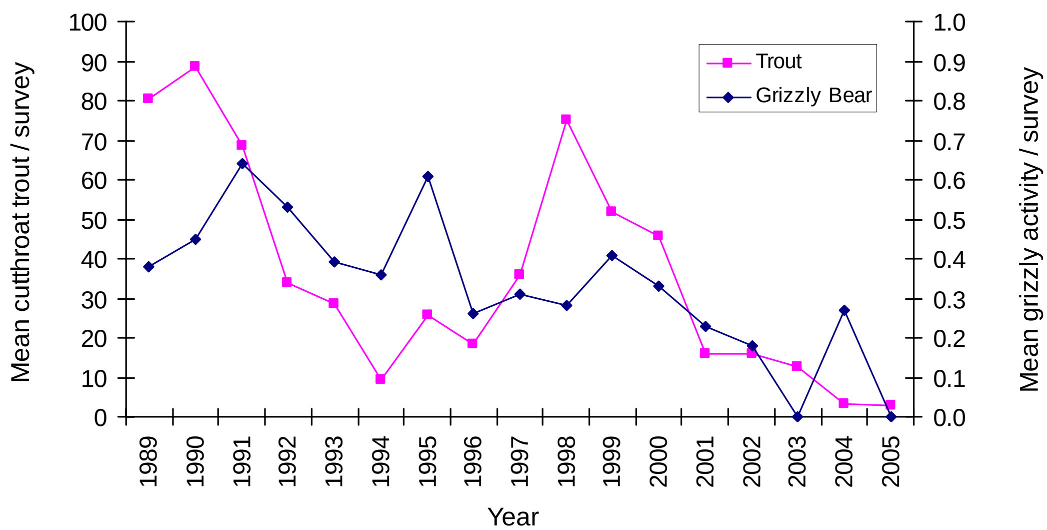

Fig. 9. Mean number of spawning cutthroat trout and mean activity by grizzly bears observed during weekly visual surveys of 8 North Shore and 4 West Thumb spawning streams tributary to Yellowstone Lake, Yellowstone National Park, 1989-2005.

Trout Lake

Spawning Stream Surveys.--Beginning in mid-May of each year, the Trout Lake inlet creek is checked once per week for the presence of spawning cutthroat trout. Once spawning trout are detected (i.e. onset of spawning), weekly surveys of adult cutthroat trout in the inlet creek are conducted. On each sample day, 2 people walk upstream from the stream mouth and record the number of adult trout observed. Sampling continues 1 day/week until 2 consecutive weeks when no trout are observed in the creek and all trout have returned to Trout Lake (i.e. end of spawn). The length of the spawn is calculated by counting the number of days from the first day spawners are observed through the last day spawners are observed. The mean number of spawners observed per visit is calculated by dividing the total number of adult cutthroat trout observed by the number of surveys conducted during the spawning period.

In 2005, the first movement of spawning cutthroat trout from Trout Lake into the inlet creek was observed on 22 June. The spawn lasted approximately 22 days with the last spawner being observed in the inlet creek on 13 July. During the once per week surveys, 185 spawning cutthroat trout were counted, an average of 46 per visit (Table 16). No evidence of grizzly bear activity or fishing was observed along the inlet creek during the surveys. The number of fish observed per survey in 2005, is well below the high of 131 fish/survey observed in 1999 (Fig. 10).

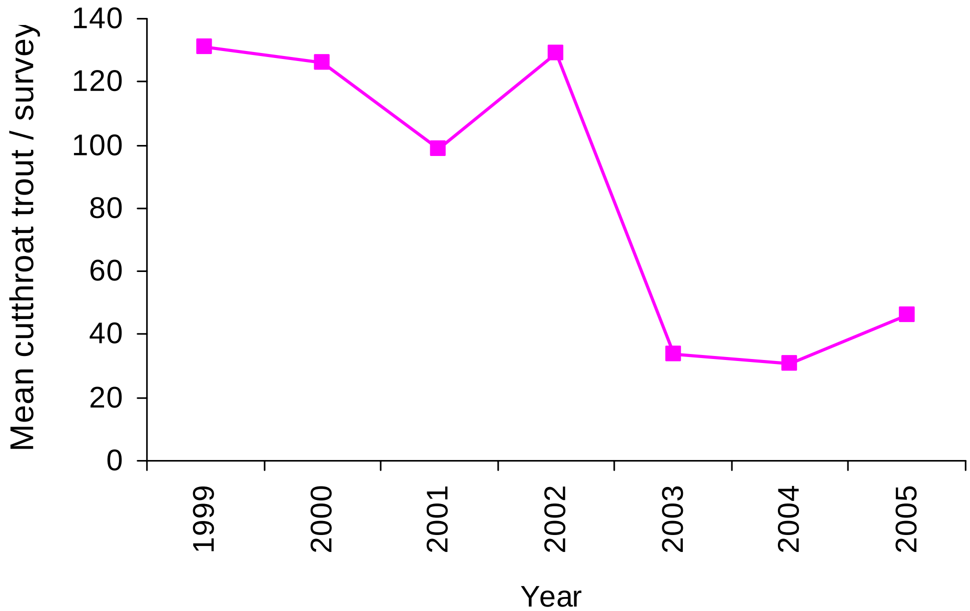

Fig. 10. Mean number of spawning cutthroat trout observed during weekly visual spawning surveys of the Trout Lake inlet, Yellowstone National Park, 1999-2005.

Grizzly Bear Use of Insect Aggregation Sites Documented from Aerial Telemetry and Observations *(Dan Bjornlie, Wyoming Game and Fish Department; and Mark Haroldson, Interagency Grizzly Bear Study Team)*

Army cutworm moths (*Euxoa auxiliaris*) were first recognized as an important food source for grizzly bears in the GYE during the mid 1980s (Mattson et al. 1991*b*, French et al. 1994). Early observations indicated that moths, and subsequently bears, showed specific site fidelity. These sites are generally high alpine areas dominated by talus and scree adjacent to areas with abundant alpine flowers. Such areas are referred to as "insect aggregation sites." Since their discovery, numerous bears have been counted on or near these aggregation sites due to excellent sightability from a lack of trees and simultaneous use by multiple bears.

Complete tabulation of grizzly presence at insect sites is extremely difficult. Only a few sites have been investigated by ground reconnaissance and the boundaries of sites are not clearly known. In addition, it is likely that the size and location of insect aggregation sites fluctuate from year to year with moth abundance and variation in environmental factors such as snow cover.

Since 1986, when insect aggregation sites were initially included in aerial observation surveys, our knowledge of these sites has increased annually. Our techniques for monitoring grizzly bear use of these sites have changed in response to this increase in knowledge. Prior to 1997, we delineated insect aggregation sites with convex polygons drawn around locations of bears seen feeding on moths and buffered these polygons by 500 m. The problem with this technique was that small sites were overlooked due to the inability to create polygons around sites with fewer than 3 locations. From 1997-1999, the method for defining insect aggregation sites was to inscribe a 1-km circle around the center of clusters of observations in which bears were seen feeding on insects in talus/scree habitats (Ternent and Haroldson 2000). This method allowed trend in bear use of sites to be annually monitored by recording the number of bears documented in each circle (i.e., site).

A new technique was developed in 2000 (D. Bjornlie, Wyoming Game and Fish Department, personal communication). Using this technique, sites were delineated by buffering only the locations of bears observed actively feeding at insect aggregation sites by 500 m to account for error in aerial telemetry locations. The borders of the overlapping buffers at individual insect sites were dissolved to produce a single polygon for each site. These sites are identified as "confirmed" sites. Because these polygons are only created around feeding locations, the resulting site conforms to the topography of the mountain or ridge top where bears feed and does not include large areas of non-talus habitat that are not suitable for cutworm moths. Locations from the grizzly bear location database from 1 July through 30 September of each year were then overlaid on these polygons and enumerated. The technique to delineate confirmed sites developed in 2000 substantially decreased the number of sites described compared to past years in which locations from both feeding and non-feeding bears were used. Therefore, annual analysis for this report is completed for all years using this technique. Areas suspected as insect aggregation sites but dropped from the confirmed sites list using this technique, as well as sites with only 1 observation of an actively feeding bear or multiple observations in a single year, are termed "possible" sites and will be monitored in subsequent years for additional observations of actively feeding bears. These sites may then be added to the confirmed sites list. When possible sites are changed to confirmed sites, analysis is done on all data back to 1986 to determine the historic use of that site. Therefore, the number of bears using insect aggregation sites in past years may change as new sites are added, and data from this annual report may not match that of past reports. In addition, as new actively feeding bear observations are added to existing sites, the polygons defining these sites increase in size and, thus, more overlaid locations fall within the site. This retrospective analysis brings us closer each year to the "true" number of bears using insect aggregation sites in past years.

In 2005, actively feeding grizzly bears were observed on 1 site classified as possible in past years. Therefore, this site was reclassified to confirmed and analysis was done back to 1986. In addition, an observation of a grizzly bear actively feeding in 1 new area resulted in the classification of a new possible insect aggregation site. Two previously known sites were also combined into 1 site because locations demonstrated that they were 1 large site without topographical isolation between them. Therefore, a combination of reclassified sites, a new possible site, and grouping some sites into 1 produced 29 confirmed sites and 21 possible sites for 2005.

The percentage of confirmed sites with documented use by bears varies from year to year, suggesting that some years have higher moth activity than others (Fig. 11). For example, the years 1993-1995 were probably poor moth years because the percentage of confirmed sites used by bears (Fig. 11) and the number of observations recorded at insect sites (Table 17) were low. Overall, the percent of insect aggregation site use by grizzly bears decreased slightly in 2005 (Fig. 11). However, the total number of observations or telemetry relocations at sites increased by 58% from 2004 (Table 17). This was due to most bears observed on a small number of sites in 2005. It is believed that late-melting snowpack on some sites prevented moths from using those areas, while other sites melted earlier and moths were able to find open talus. The number of insect aggregation sites used by bears in 2005 decreased to 20 from 21 in 2004 (Table 17) and was near the 5-year average of 19.8 sites/year from 2000-2004.

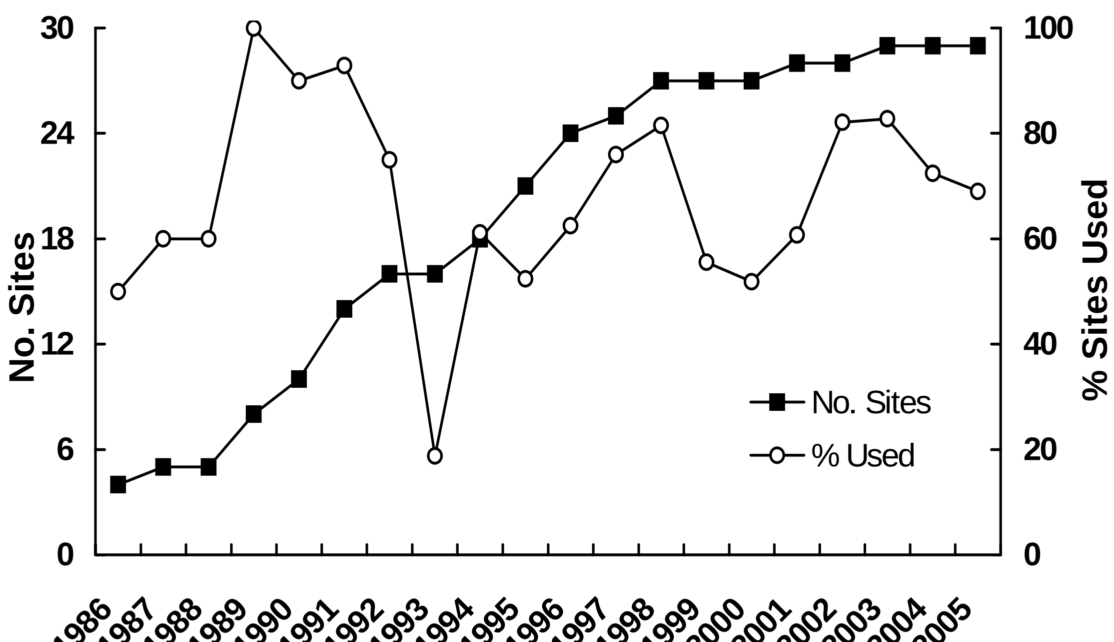

Fig. 11. Annual number of confirmed insect aggregation sites and percent of those sites at which either telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986-2005.

Table 17. The number of confirmed insect aggregation sites in the Greater Yellowstone Ecosystem annually, the number actually used by bears, and the total number of aerial telemetry relocations and ground or aerial observations of bears recorded at each site during 1986-2005.

Year	Number of confirmed moth sites[a]	Number of sites used[b]	Number of aerial telemetry relocations	Number of ground or aerial observations
1986	4	2	5	5
1987	5	3	5	9
1988	5	3	11	31
1989	8	8	8	42
1990	10	9	9	72
1991	14	13	10	163
1992	16	12	5	93
1993	16	2	1	1
1994	18	11	1	25
1995	21	11	7	23
1996	24	15	21	53
1997	25	19	15	77
1998	27	22	9	170
1999	27	15	20	150
2000	27	14	30	87
2001	28	17	20	117
2002	28	23	24	241
2003	29	24	8	153
2004	29	21	0	118
2005	29	20	15	171
Total			224	1,801

[a]The year of discovery was considered the first year a telemetry location or aerial observation was documented at a site. Sites were considered confirmed after additional locations or observations in a subsequent year and every year thereafter regardless of whether or not additional locations were documented.

[b]A site was considered used if ≥1 location or observation was documented within the site that year.

The IGBST maintains an annual list of unduplicated females observed with COY (see Table 4). Since 1986, 585 initial sightings of unduplicated females with COY have been recorded, of which 161 (28%) have occurred at (within 500 m, n = 140) or near (within 1,500 m, n = 21) insect aggregation sites (Table 18). In 2005, there were 9 unduplicated females with COY observed at insect aggregation sites, a decrease of 6 from 2004 (Table 18). Of the total observations of unduplicated females with COY, 29.0% (9 of 31) were recorded at insect aggregation sites in 2005, below the 5-year average of 36.3% from 2000-2004.

Survey flights at insect aggregation sites contribute to the count of unduplicated females with COY; however, it is typically low, ranging from 0 to 20 initial sightings/year since 1986 (Table 18). If these sightings are excluded, an increasing trend in the annual number of unduplicated sightings of females with COY is still evident (Fig. 12), suggesting that some other factor besides observation effort at insect aggregation sites is responsible for the increase in sightings of females with cubs.

Table 18. Number of initial sightings of unduplicated females with cubs-of-the-year (COY) that occurred on or near insect aggregation sites, number of sites where such sightings were documented, and the mean number of sightings per site in the Greater Yellowstone Ecosystem, 1986-2005.

Year	Unduplicated females with COY[a]	Number of moth sites with an initial sighting[b]	Initial sightings: Within 500 m[b]		Initial sightings: Within 1,500 m[c]	
			N	%	*N*	%
1986	25	0	0	0.0	0	0.0
1987	13	0	0	0.0	0	0.0
1988	19	1	2	10.5	2	10.5
1989	16	1	1	6.3	1	6.3
1990	25	3	3	12.0	4	16.0
1991	24	7	11	45.8	14	58.3
1992	25	4	6	24.0	9	36.0
1993	20	1	1	5.0	1	5.0
1994	20	3	5	25.0	5	25.0
1995	17	2	2	11.8	2	11.8
1996	33	4	4	12.1	7	21.2
1997	31	8	11	35.5	11	35.5
1998	35	11	13	37.1	13	37.1
1999	33	3	6	18.2	7	21.2
2000	37	6	7	18.9	10	27.0
2001	42	6	11	26.2	13	31.0
2002	52	10	14	26.9	17	32.7
2003	38	11	19	50.0	20	52.6
2004	49	10	15	30.6	16	32.7
2005	31	8	9	29.0	9	29.0
Total	585		140		161	
Mean	29.3	5.0	7.0	21.4	8.1	24.4

[a] Initial sightings of unduplicated females with COY; see Table 4.
[b] Insect aggregation site is defined as a 500-m buffer drawn around a cluster of observations of bears actively feeding.
[c] This distance is 3 times what is defined as an insect aggregation site for this analysis, since some observations could be made of bears traveling to and from insect aggregation sites.

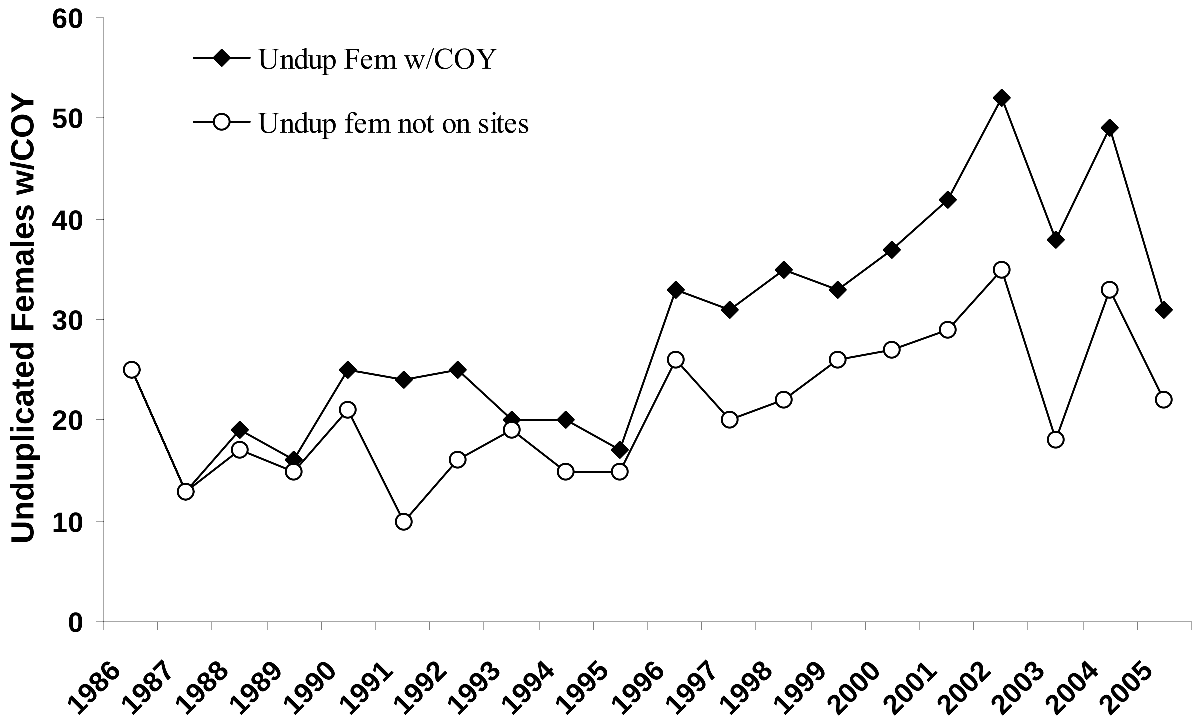

Fig. 12. The total number of unduplicated females with COY observed annually in the Greater Yellowstone Ecosystem and the number of unduplicated females with COY *not* found within 1,500 m of known insect aggregation sites, 1986-2005.

Whitebark Pine Cone Production *(Mark A. Haroldson and Shannon Podruzny, Interagency Grizzly Bear Study Team)*

The whitebark pine surveys on established transects showed generally good cone production during 2005. Mean cones/tree was 16.8 (Table 19). Nineteen transects were read. Poor cone production occurred on transects in the center of the distribution (Fig. 13). The alternating pattern of poor then good cone production we have seen during the continuing drought (since 1998) was evident again during 2005 (Fig. 14).

Table 19. Summary statistics for the 2005 whitebark pine cone production transects in the Greater Yellowstone Ecosystem.

Total			Trees				Transect			
Cones	Trees	Transects	Mean cones	SD	Min	Max	Mean cones	SD	Min	Max
3,186	190	19	16.8	25.9	0	235	159.2	129.4	14	487

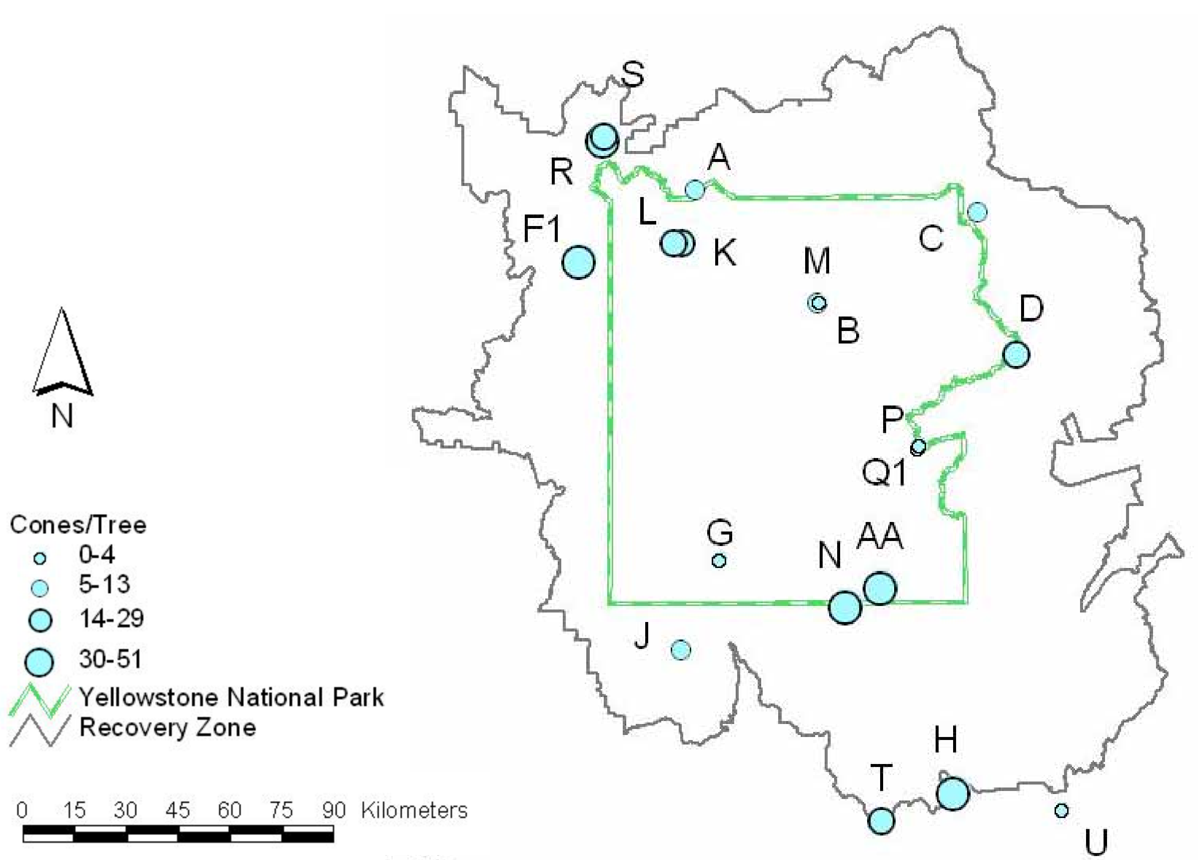

Fig. 13. Average cone production (mean cones/tree) for 19 whitebark pine (*Pinus albicaulis*) transects surveyed during 2005 in the Greater Yellowstone Ecosystem. Transect AA replaced transect O in which all trees were dead from pine beetle (*Dendroctonus ponderosae*). Transect F1 and Q1 are composed of all new trees within previously sampled stands (old transects F and Q).

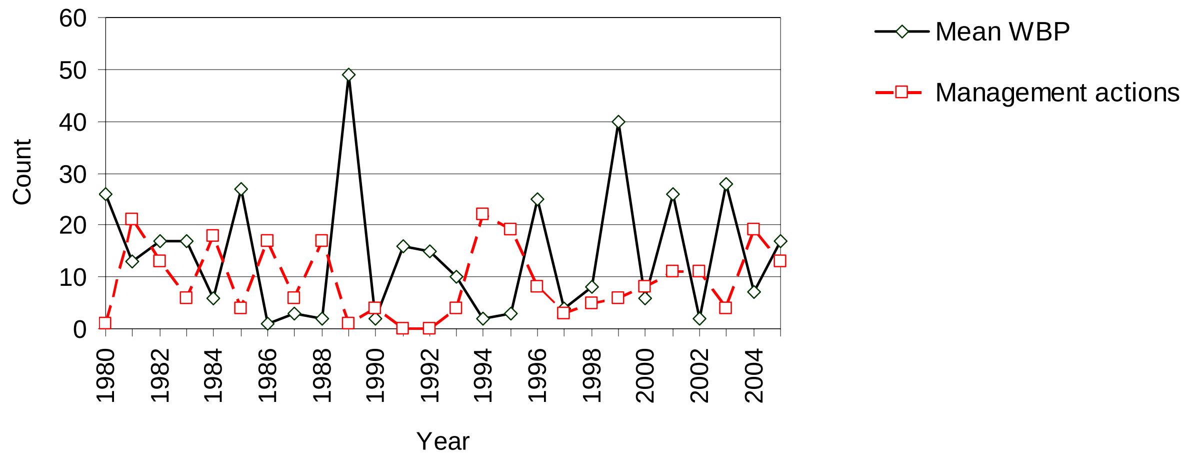

Fig. 14. Mean whitebark pine (WBP) cone production and the number of management actions of grizzly bears older than yearlings during August through October in the Greater Yellowstone Ecosystem, 1980-2005.

Mountain pine beetle (*Dendroctonus ponderosae*) activity continued throughout the GYE at historically high levels (Gibson 2006 [http://www.fs.fed.us/r1-r4/spf/fhp/publications/bystate/R1Pub06-03_MPB_Yellowstone_gibson.pdf]). An estimated 720,000 whitebark pine trees killed during 2004 and were recorded as faders in 2005 (Gibson 2006 citing Meyer 2006). This was the highest level of mountain pine beetle-caused whitebark pine mortality in any one year for which data were available (Gibson 2006). On our transects, we observed an additional 7.5% (11/146) mortality among trees that had survived since 2002. Overall 29% (55/190) of transect trees alive in 2002 were dead by 2005. The majority of this mortality was attributable to pine beetle activity. Four (F, O, P, and Q) of the 19 transects were most affected, with F, O, and Q losing all trees by 2005. Dead trees within transects were replaced, as were transects that had 100% tree mortality. Transect O, was replaced with trees in a different stand. The designation for this new transect is AA (Fig. 13). Transects F and Q were replaced with trees within the same stands and are now designated F1 and Q1, respectively.

Near exclusive use of whitebark pine seeds occur during years in which mean cone production on transects exceeds 20 cones/tree (Blanchard 1990, Mattson et al. 1992). Typically, there is reduction in numbers of management actions during years of abundant cone availability (Fig. 14). During August-October of 2005, 19 management captures of bears 2 years of age or older (independent) resulted in 15 transports and 4 removals.

Habitat Monitoring

Grand Teton National Park Recreational Use *(Steve Cain, Grand Teton National Park)*

In 2005, total visitation in Grand Teton National Park was 3,907,354 people, including recreational, commercial (e.g. Jackson Hole Airport), and incidental (e.g. traveling through the Park on U.S. Highway 191 but not recreating) use. Recreational visits alone totaled 2,463,442. Backcountry user nights totaled 26,836. Long and short-term trends of recreational visitation and backcountry user nights are shown in Table 20 and Fig. 15.

Table 20. Average annual visitation and average annual backcountry use nights in Grand Teton National Park by decade from 1951 through 2005.

Decade	Average annual parkwide visitation[a]	Average annual backcountry use nights
1950s	1,104,357	Data not available
1960s	2,326,584	Data not available
1970s	3,357,718	25,267
1980s	2,659,852	23,420
1990s	2,662,940	20,663
2000s[b]	2,486,225	30,912

[a] In 1983 a change in the method of calculation for parkwide visitation resulted in decreased numbers. Another change in 1992 increased numbers. Thus, parkwide visitation data for the 1980s and 1990s are not strictly comparable.

[b] Data for 2000-2005 only.

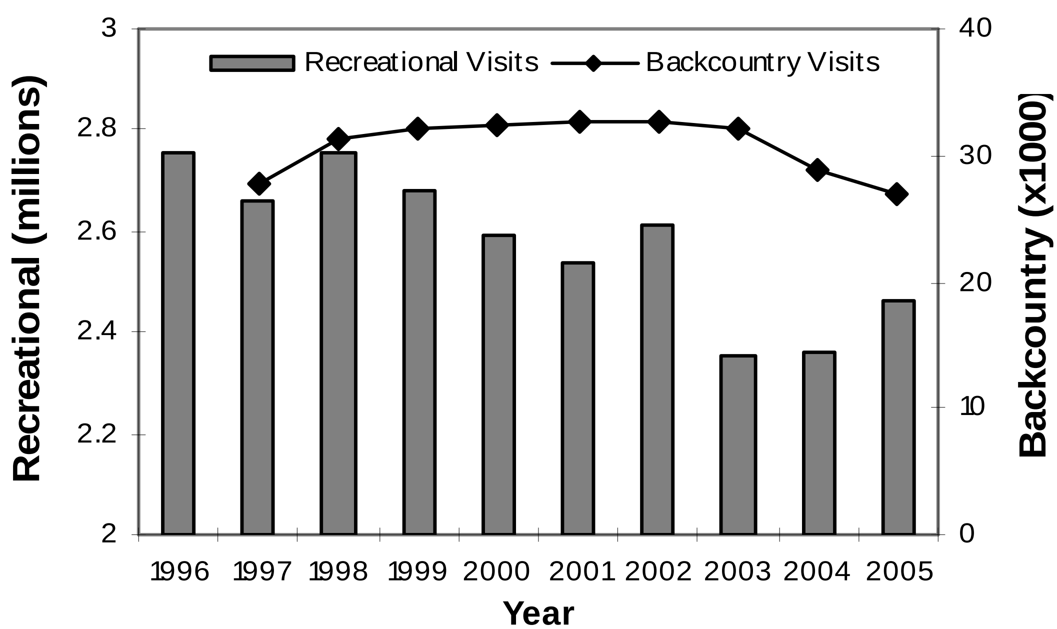

Fig. 15. Trends in recreational visitation and backcountry user nights in Grand Teton National Park during 1996-2005.

Yellowstone National Park Recreational Use *(Kerry Gunther, Yellowstone National Park)*

In 2005, total visitation to Yellowstone National Park, including non-recreational use, was 3,775,626 people. Recreational visits alone totaled 2,835,649. These visitors spent 619,042 user nights camping in developed area roadside campgrounds and 39,344 user nights camping in backcountry campsites. Average annual recreational visitation increased each decade from an average of 7,378 visitors/year during the late 1890s to an average of 3,012,653 visitors/year in the 1990s (Table 21). Average annual recreational visitation has decreased slightly the first 6 years (2000-2005) of the current decade, to an average of 2,882,999 visitors/year. Average annual backcountry user nights have been less variable between decades than total park visitation, ranging from 39,280 to 45,615 user nights/year (Table 21). The number of backcountry user nights is limited by both the number and capacity of designated backcountry campsites in the park.

Table 21. Average annual visitation, auto campground user nights, and backcountry user nights in Yellowstone National Park by decade from 1895 through 2005.

Decade	Average annual parkwide total recreational visitation	Average annual auto campground user nights	Average annual backcountry user nights
1890s	7,378[a]	Data not available	Data not available
1900s	17,110	Data not available	Data not available
1910s	31,746	Data not available	Data not available
1920s	157,676	Data not available	Data not available
1930s	300564	82,331[b]	Data not available
1940s	552,227	139,659[c]	Data not available
1950s	1,355,559	331,360	Data not available
1960s	1,955,373	681,303[d]	Data not available
1970s	2,240,698	686,594[e]	45,615[f]
1980s	2,344,485	656,093	39,280
1990s	3,012,653	690,044	43,605
2000s	2,882,999[g]	618,760[g]	41,580[g]

[a]Data from 1895-1899. From 1872-1894, visitation was estimated to be not less than 1,000 nor more than 5,000 each year.
[b] Data from 1930-1934
[c] Average does not include data from 1940 and 1942.
[d] Data from 1960-1964.
[e]Data from 1975-1979.
[f] Backcountry use data available for the years 1972-1979.
[g]Data for the years 2000-2005.

Trends in Elk Hunter Numbers within the Grizzly Bear Recovery Zone plus the 10-mile Perimeter Area *(David S. Moody, Wyoming Game and Fish Department; Lauri Hanauska-Brown, Idaho Department of Fish and Game; and Kevin Frey, Montana Department of Fish, Wildlife and Parks)*

State wildlife agencies in Idaho, Montana, and Wyoming annually estimate the number of people hunting most major game species. We used state estimates for the number of elk hunters by hunt area as an index of hunter numbers for the Grizzly Bear Recovery Zone plus the 10-mile perimeter area. Because some hunt area boundaries did not conform exactly to the Recovery Zone and 10-mile perimeter area, field personnel familiar with each area were queried to estimate hunter numbers within the Recovery Zone plus the 10-mile perimeter area. Elk hunters were used because they represent the largest cohort of hunters for individual species. While there are sheep, moose, and deer hunters using the Recovery Zone and 10-mile perimeter area, their numbers are fairly small and many hunt in conjunction with elk, especially in Wyoming, where seasons overlap. Elk hunter numbers represent a reasonably accurate index of total hunter numbers within areas occupied by grizzly bears in the GYE.

We generated a data set from all states from 1995 to 2005 (Table 22). Complete data does not exist for all years. Idaho and Montana do not calculate these numbers annually or, in some cases the estimates are not available in time for completing this report. If data does become available it will be added in the future.

Table 22. Estimated numbers of elk hunters within the Grizzly Bear Recovery Zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, for the years 1995-2005.

	Year										
State	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Idaho[a]	2,366	3,102	2,869	2,785	2,883	[b]	2,914	3,262	3,285	3,454	3,619
Montana	18,783	18,044	[b]	[b]	16,254	17,329	15,407	17,908	16,489	[b]	[b]
Wyoming	17,464	16,283	17,458	15,439	15,727	12,812	13,591	13,709	11,771	10,828	9,888
Total	38,613	37,429			34,864		31,912	34,879	31,905		

[a] Idaho has recalculated hunter numbers. As such, they differ from previous reports.
[b] Hunter number estimates not currently available.

Overall, hunter numbers have decreased since 1995, most notably in Wyoming where hunter numbers have decreased over 7,500 in the last 10 years. Hunter numbers have also decreased in Montana but at reduced levels compared to Wyoming. Elk seasons were liberalized in the early 1990s to reduce elk herds toward their population objective. The majority of the increased harvest was focused on females. In the late 1990s, as elk populations reached objective, the number of elk hunters decreased to reduce total harvest, primarily on females. It is felt that hunter numbers in Idaho have not fluctuated significantly over the last 10 years. The increase in hunters starting in 2002 is the result of a new method of calculating hunter numbers.

Habitat use by Grizzly and Black Bears in Grand Teton National Park: Second Year Report
(*Charles C. Schwartz, Interagency Grizzly Bear Study Team; Steven Cain, Grand Teton National Park; and Shannon Podruzny, Interagency Grizzly Bear Study Team*)

In May of 2004, IGBST and Grand Teton National Park (GTNP) initiated a study of grizzly bear-black bear interactions in GTNP. The objectives of the study are to determine habitat use and food habits of grizzly and black bears, evaluate the habitat partitioning of the 2 species, evaluate inter-specific competition between black and grizzly bears for food resources in GTNP, and to examine movements and activity patterns of both species in relation to human activities and the availability of major food resources. Field data will be collected for 3 years (2004-2006). This report reviews the progress of location and habitat use data collection efforts for the 2005 field season.

Our general approach to field data collection was to combine the use of advanced GPS technology with traditional field survey methods. We instrumented bears of both species with the latest generation of GPS collars equipped with Spread Spectrum Technology (SST; Podruzny and Schwartz 2004). SST allows for interrogation of the collars to collect stored GPS fixes on demand, which in turn allows for timely investigation of bear-used sites by field crews. This approach allows us to collect large quantities of spatial data relative to bears' movements, as well as detailed information about the habitat use and feeding activities present at a representative sample of GPS locations.

Study Area

The study is located in the southern part of the GYE, focused within GTNP. This includes the portion of GTNP north of Leigh Canyon and Spread Creek, and adjacent areas of the John D. Rockefeller, Jr. Memorial Parkway and Bridger-Teton and Targhee-Caribou National Forests. Movements of bears captured in GTNP for this study will determine the final extent of the study area. The terrain and vegetation of the study area are quite variable. The lower elevations included the riparian bottom land of the Snake River and sagebrush (*Artemesia* sp.) covered moraines of the valley floor. Surrounding mountains included subalpine forests and meadows, forest burns of various ages, shrub fields, rocky canyons, and exposed ridgelines. The highest elevations were typified by steep slopes, glaciated peaks, and alpine tundra.

Methods

Capture operations were conducted throughout the field season in GTNP to outfit adult bears of both species with SST collars. Each collar was equipped with a VHF beacon, a store-on-board GPS receiver, a SST transmitter, and a programmable collar release mechanism. The GPS receivers attempted to fix locations at regular intervals. The inter-fix interval was preset for each collar, and was calculated to maximize battery life according to transmitter weight and the amount of time a bear was expected to wear the collar. Intervals ranged from 35 minutes between fixes for adult male collars to 190 minutes for female black bear collars. Male collars were programmed to drop off at the end of the first season of deployment; female collars were programmed to release at the end of the second season.

All fix attempts were permanently stored in the collar's receiver, and the SST transmitters were available for downloading copies of the data during 2 mornings each week. We attempted to download location data from each collar via a fixed-wing aircraft once per week. When conditions did not allow flying, we occasionally downloaded data using a high-gain antenna on the ground if bears were close enough to accessible areas. The downloaded data were imported into a database, and the locations translated into Universal Trans-Mercator (UTM) Zone 12N NAD83 coordinates.

From these data, we selected locations on which to perform field reconnaissance. We randomly selected the order of bears to sample, and then randomly selected a date from the previous week to sample. Field crews attempted to visit all successful fixes recorded for each bear in a 24 hour period. Location data were uploaded into personal GPS units for navigation to the sites. We attempted to follow 2–7 days behind the bears to maximize detectability of sign without disturbing the animals. We left the survey area if VHF signals indicated that the bear was present.

At each UTM site, we performed a detailed reconnaissance within a 15-m radius. We recorded site visit data in 3 levels of detail depending upon what we found at the site. For all sites, we recorded descriptive and quantitative data on the physical and vegetal characteristics, including habitat type and forest cover information. We recorded presence or absence of bear sign and made general notes about the site. If bear sign was found, we completed a more detailed "Level 2" plot. This included specific measurements of daybeds, rub trees, and feeding activity as well as percentages of ground cover (foliage, shrubs, deadfall, etc) as determined by 4 10-m point-line intercept transects. If the bear had been consuming plant foods, we went on to complete a "Level 3" plot. This consisted of measuring vegetation and specific bear foods within 10 0.1-m^2 Daubenmire plot frames laid out along the cover transect tapes.

We collected samples of scat at visited sites for food habits analysis. A small portion of each scat was collected for species determination via mitochondrial DNA (mtDNA) analysis. When multiple scats occurred at daybed sites, only 1 mtDNA sample was collected for that group of scats. In areas near used sites, we collected samples of bear foods for stable isotope and nutritional analysis (Robbins et al. 2004).

Preliminary Results

One capture crew recorded 177 trap nights at 11 locations in GTNP between mid-May and the end of September. Twenty-two black bear captures of 18 individuals and 12 grizzly bear captures of 9 individuals were recorded. SST collars were installed or replaced on captured individuals who met the appropriate species/sex/age criteria for an available collar. We attempted to include as many individuals in the study as possible, but we replaced collars on previously studied females to maintain an adequate sample.

In 2005, we tracked 7 grizzly bears and 7 black bears (Table 23). All 3 adult female grizzly bears were previous tracked in 2004. Two were re-instrumented in 2005, and we tracked throughout the season 1 female with new cubs who was collared late in 2004. Four male grizzlies, including 2 young adult and 2 mature, were included in this year's sample. Three adult male black bears were instrumented in 2005, we could not do site visits for 1 of those bears due to a programming glitch which prevented downloading data remotely from that collar. One young adult female black bear was added to the sample of 3 females re-instrumented in 2005. One female black bear was struck by a vehicle and killed in June 2005. Black bear 22049, an adult female who was monitored through the end of the 2004 season, was apparently killed by male grizzly bear 398 before she would have emerged from the den this spring. This was confirmed by finding a bitten-off grizzly bear claw at 22049's death site which matched a missing claw on the right front paw of the subsequently captured 398.

Table 23. Black and grizzly bears tracked with GPS-equipped Spread Spectrum Technology (SST) collars in 2004 and 2005, Grand Teton National Park, Wyoming.

Bear	Species	Sex	Dates tracked
<u>2004</u>			
399	Grizzly	Female	07/16/04 – 12/31/04
461	Grizzly	Female	09/24/04 – 12/31/04
474	Grizzly	Female	09/26/04 – 12/31/04
22030	Black	Female	05/26/04 – 12/31/04
22042	Black	Female	06/07/04 – 12/31/04
22044	Black	Female	06/20/04 – 10/01/04
22048	Black	Female	07/29/04 – 08/16/04
22049	Black	Female	07/29/04 – 12/31/04
22036	Black	Male	05/25/04 – 12/31/04
22037	Black	Male	05/26/04 – 10/01/04
22039	Black	Male	06/05/04 – 08/29/04
<u>2005</u>			
399	Grizzly	Female	01/01/05 – 05/01/05 and 09/09/05 – 12/31/05
461	Grizzly	Female	01/01/05 – 10/01/05
474	Grizzly	Female	01/01/05 – 12/31/05
398	Grizzly	Male	06/01/05 – 09/21/05
401	Grizzly	Male	09/12/05 – 10/15/05
460	Grizzly	Male	09/14/05 – 12/31/05
488	Grizzly	Male	05/26/05 – 10/01/05
22030	Black	Female	01/01/05 – 12/31/05
22042	Black	Female	01/01/05 – 06/27/05
22044	Black	Female	06/03/05 – 12/31/05
22060	Black	Female	07/15/05 – 12/31/05
22053	Black	Male	05/24/05 – 09/14/05
22054	Black	Male	06/06/05 – 10/01/05
22058	Black	Male	07/02/05 – 10/01/05 (no habitat site visits)

In 2005, the GPS units on the collars attempted to collect 37,044 fixes while on bears. From these attempts, 27,021 locations were acquired (Table 24). Collars deployed on male black bears had the highest rates of successful fixes (84.5%) and grizzlies of both sexes had the highest proportions of 3D fixes (65.1%; where elevation was not calculated from previous fixes). Female grizzly bears had the lowest overall fix success rate (65.0%), while female black bears had the lowest proportion of 3D fixes (44.8%). We experienced some problems with fatiguing and separation of the GPS antenna wire from the receiver of some units, and this contributed to the reduction in successful fix rates from those observed in 2004 (Schwartz et al. 2005). We believe this problem has been rectified in the more recently deployed collars.

Table 24. GPS fixes attempted and success rates from SST collars deployed on 7 black and 7 grizzly bears in Grand Teton National Park, 2005. Attempted fixes reported only for active, not denned bears.

	Attempted fixes	Successful fixes		3D fixes	
	N	*n*	%	*n*	%
Female black	4,368	3,375	77.27	1,512	44.80
Male black	10,760	9,090	84.48	4,932	54.26
Female grizzly	11,205	7,282	64.99	4,739	65.08
Male grizzly	10,711	7,274	67.91	4,735	65.09
All collars	37,044	27,021	72.49	15,918	58.91

Between 19 May 2005 and 25 October 2005, field crews visited 1,201 bear locations, encompassing 4.4% of successful fixes and 108 bear/date combinations. Bear sign was found at 803 (67%) of these locations. Sign included feeding activity, daybeds, scats, and tracks. Evidence of feeding activity was found at 493 locations (Table 25). Grizzly bears most commonly fed on carcasses (including elk calf predations), on insects, or grazed on vegetation. Black bears most often fed on insects, browsed berries, or grazed (Table 26). Grizzly bears 488, 461, and 401 plus black bear 22054 moved west out of GTNP across the Teton Range into Idaho where berry production was better than in the northern part of the park. Whitebark pine cone production was average in 2005 (Haroldson and Podruzny, in this report). Males of both species made some use of whitebark pine seeds in 2005. Grizzly bears took advantage of gut piles and carcasses provided by the early elk hunting season adjacent to GTNP.

We collected 208 scats, including 117 at black bear locations and 91 at grizzly bear locations. Analysis of scat contents is in progress. Results of mtDNA analysis of 169 scats collected in 2004 showed that we correctly categorized 92 of the 94 scats identified to bear species. Eighteen samples of bear foods were collected and are being analyzed for nutritional analysis along with those collected in 2004. We also collected 84 samples of shed hair at bear locations.

<u>Future Directions</u>

We will conduct 1 more field season following the protocols established in 2004 and 2005. All SST collars are programmed to release on 1 October 2006, and will be retrieved at the end of the 2006 field season. Results of scat content analysis will help guide food sampling efforts in the subsequent field season. Data will continue to be maintained in GIS and Microsoft Office databases. Final analyses and reports will be completed in 2007.

Table 25. Feeding activities observed at 1,201 GPS locations of 6 black and 7 grizzly bears visited in and near Grand Teton National Park, 2005. Feeding sign was found at 213 and 280 grizzly and black bear locations, respectively. More than 1 type of feeding activity may be found at any location.

	Black bears		Grizzly bears		Total	
Feeding activity	*n*	%	*n*	%	*n*	%
Carcasses	7	2.50	117	54.93	124	25.15
Roots	0	0.00	7	3.29	7	1.42
Whitebark pine	31	11.07	5	2.35	36	7.30
Rodent caches	1	0.36	14	6.57	15	3.04
Grazing	96	34.29	42	19.72	138	27.99
Insects	158	56.43	51	23.94	209	42.39
Berries	62	22.14	24	11.27	86	17.44
Cambium	11	3.93	0	0.00	11	2.23
Other	0	0.00	2	0.94	2	0.41

Table 26. Most common species feed upon by black and grizzly bears at 493 GPS locations, Grand Teton National Park, 2005.

Type of feeding activity	Common name of species used	Genus
Carcasses		
	Elk	*Cervus*
	Mule deer	*Odocoileus*
	Domestic cow[a]	*Bos*
Roots		
	Yampa	*Perideridia*
	Oniongrass	*Melica*
	Angelica	*Angelica*
Caches		
	Various roots	
Whitebark pine		
	Whitebark pine	*Pinus*
Grazing		
	Grasses and sedges	various
	Fern-leaved lovage	*Ligusticum*
	Sticky geranium	*Geranium*
	Bracted lousewort	*Pedicularis*
	Dandelion	*Taraxacum*
	Cow parsnip	*Heracleum*
	Fireweed	*Epilobium*
	Horsetail	*Equisetum*
Insects		
	Ants	
	Other insects	
Berries		
	Huckleberry	*Vaccinium*
	Serviceberry	*Amalanchier*
	Buffaloberry	*Sherpherdia*
	Grouse whortleberry	*Vaccinium*
	Rose	*Rosa*
	Chokecherry	*Prunus*
	Oregon grape	*Berberis*
	Hawthorn	*Crataegus*
	Thimbleberry	*Rubus*
	Mountain ash	*Sorbus*
	Currant	*Ribes*
Cambium		
	Lodgepole pine	*Pinus*
	Subalpine fir	*Abies*

[a]Steer died of unknown causes.

Grizzly Bear-Human Conflicts in the Greater Yellowstone Ecosystem *(Kerry A. Gunther, Yellowstone National Park; Mark T. Bruscino, Wyoming Game and Fish Department; Steve L. Cain, Grand Teton National Park; Kevin Frey, Montana Fish, Wildlife and Parks; Lauri Hanauska-Brown, Idaho Department of Fish and Game; Mark A. Haroldson and Charles C. Schwartz, Interagency Grizzly Bear Study Team)*

Conservation of grizzly bears in the GYE requires providing sufficient habitat (Schwartz et al. 2003) and keeping human-caused bear mortality at sustainable levels (IGBST 2005). Most human-caused grizzly bear mortalities are directly related to grizzly bear-human conflicts (Gunther et al. 2004). Grizzly bear-human conflicts may also erode public support for grizzly bear conservation. To effectively allocate resources for implementing management actions designed to prevent grizzly bear-human conflicts from occurring, land and wildlife managers need baseline information as to the types, causes, locations, and trends of conflict incidents. To address this need, we record all grizzly bear-human conflicts reported in the GYE annually. We group conflicts into 6 broad categories using standard definitions described by Gunther et al. (2000, 2001). To identify trends in areas with concentrations of conflicts, we calculated the 80% isopleth for the distribution of conflicts from the most recent 3-year period (2003-2005), using the fixed kernel estimator in the Animal Movements (Hooge and Eichenlaub 1997) extension for ArcView GIS (Environmental Systems Research Institute 1992).

The frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther et al. 2004). When native bear foods are of average or above average abundance there tend to be few grizzly bear-human conflicts involving property damage and anthropogenic foods. When the abundance of native bear foods is below average, incidents of grizzly bears damaging property and obtaining human foods and garbage increase, especially during the season when bears are hyperphagic (Gunther et al. 2004). Livestock depredations tend to occur independent of the availability of natural bear foods (Gunther et al. 2004). In 2005, the availability of high quality, concentrated bear foods was poor during the spring season, but good during estrus, early hyperphagia, and late hyperphagia. During spring, few winter-killed ungulate carcasses were available in either thermally influenced ungulate winter ranges or the Northern Ungulate Winter Range (see *Spring Ungulate Availability)*. During estrus, very few spawning cutthroat trout were observed in monitored tributary streams of Yellowstone Lake (see *Spawning Cutthroat Trout*). However, wet conditions during spring and summer resulted in abundant vegetal foods being available to bears throughout estrus and early hyperphagia. Early hyperphagia was characterized by continued wet, rainy conditions that kept vegetal bear foods succulent late into the season. Micro-sites in portions of the GYE produced good crops of chokecherry (*Prunus virginiana*) and grouse whortleberry (*Vaccinium scoparium*). Fewer grizzly bears were observed at high elevation army cutworm moth aggregation sites than in most years (see *Grizzly Bear Use of Insect Aggregation Sites*). Snow still covered the talus slopes in the moth aggregation areas late into the summer. During late hyperphagia, whitebark pine seeds were abundant throughout the ecosystem (see *Whitebark Pine Cone Production*). The abundance of whitebark pine seeds kept bears at high elevations away from human activities during fall, and likely contributed to the low numbers of bear-human conflicts in the GYE.

There were 127 grizzly bear-human conflicts reported in the GYE in 2005 (Table 27, Fig. 16). These incidents included bears killing livestock (50%, n = 64), obtaining anthropogenic foods (28%, n = 35), damaging property (14%, n = 18), obtaining apples from orchards (4%, n = 5), injuring people (3%, n = 4), and damaging beehives (1%, n = 1). Most (68%, n = 86) of the conflicts occurred on public land administered by the U.S. Forest Service (61%, $n = 78$), National Park Service (4%, $n = 5$), Bureau of Land Management (2%, $n = 2$), and the state of Idaho (>1%, $n = 1$). Thirty-two percent ($n = 41$) of the conflicts occurred on private land in the states of Wyoming (23%, $n = 29$), Idaho (6%, $n = 7$), and Montana (4%, $n = 5$). Most of the conflicts (72%, $n = 92$) occurred outside of the designated Yellowstone Ecosystem Grizzly Bear Recovery Zone. Only 28% ($n = 35$) of the conflicts occurred inside of the recovery zone.

Table 27. Number of incidents of grizzly bear-human conflicts reported within different land ownership areas in the Greater Yellowstone Ecosystem, 2005.

Land owner[a]	Property damages	Anthropogenic foods	Human injury	Gardens/ Orchards	Beehives	Livestock depredations	Total Conflicts
BLM	0	2	0	0	0	0	2
BDNF	0	0	0	0	0	0	0
BTNF	1	2	1	0	0	38	42
CNF	0	0	0	0	0	0	0
CTNF	0	0	0	0	0	3	3
GNF	1	7	0	0	0	0	8
GTNP/JDR	0	0	0	0	0	0	0
ID-private	0	3	0	4	0	0	7
ID-state	0	1	0	0	0	0	1
MT-private	3	2	0	0	0	0	5
MT-state	0	0	0	0	0	0	0
SNF	7	1	1	0	0	16	25
WY-private	5	15	0	1	1	7	29
WY-state	0	0	0	0	0	0	0
YNP	1	2	2	0	0	0	5
Total	18	35	4	5	1	64	127

[a] BLM = Bureau of Land Management, BDNF = Beaverhead-Deerlodge National Forest, BTNF = Bridger-Teton National Forest, CNF = Custer National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP/JDR = Grand Teton National Park/John D. Rockefeller, Jr. Memorial Parkway, ID = Idaho, MT = Montana, SNF = Shoshone National Forest, WY = Wyoming, YNP = Yellowstone National Park.

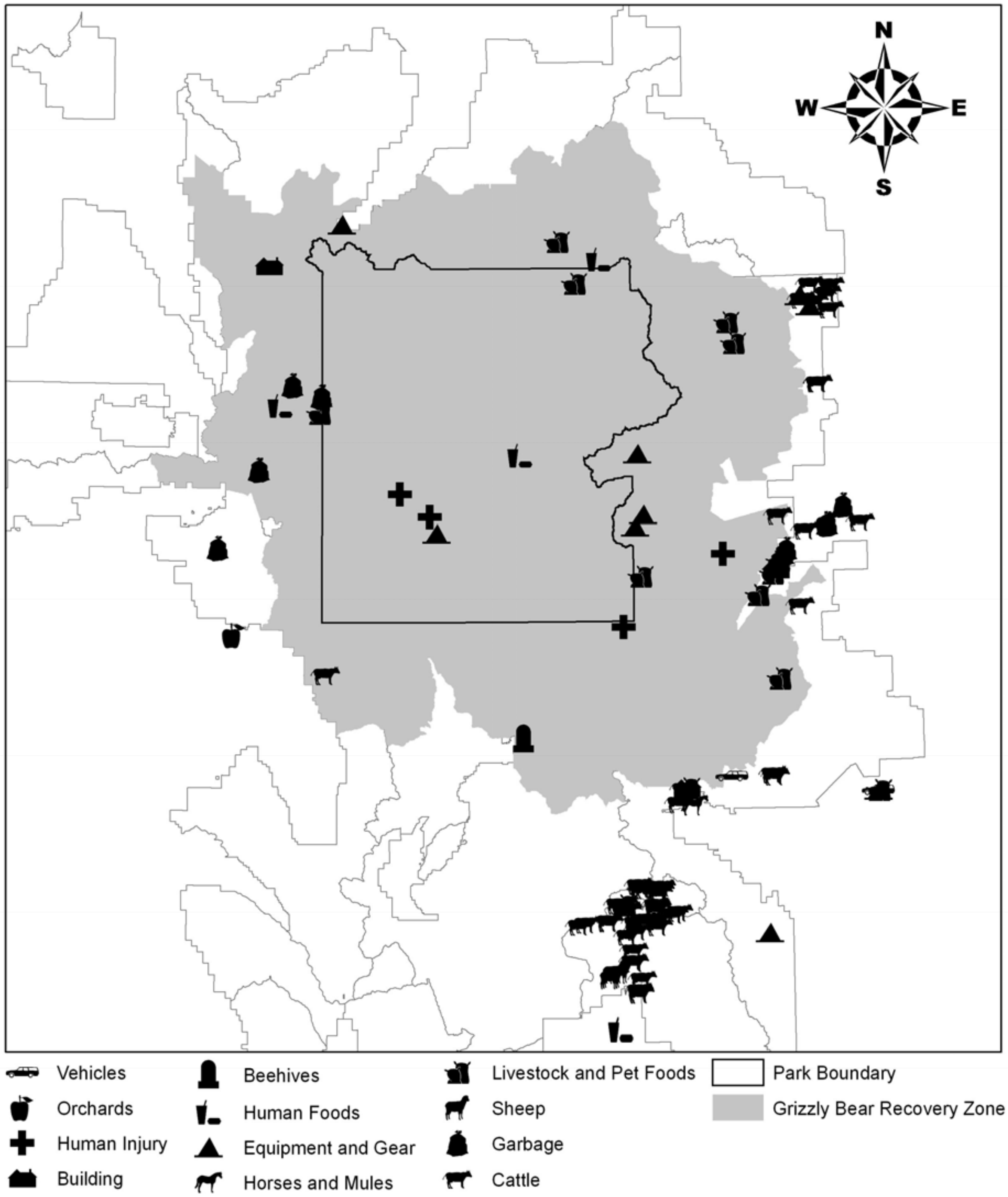

Fig. 16. Locations of different types of grizzly bear-human conflicts reported in the Greater Yellowstone Ecosystem in 2005. The shaded area represents the Yellowstone Grizzly Bear Recovery Zone.

The below average abundance of winter-killed ungulate carcasses, spawning cutthroat trout, and army cutworm moths in 2005, was likely mitigated by the good crop of whitebark pine seeds and the wet conditions which produced good vegetal bear foods. In 2005, the number of livestock depredations, property damages, incidents of bears obtaining anthropogenic foods, bear-inflicted human injuries, and damage to gardens, orchards, and beehives were all similar to the long-term averages recorded in the GYE from 1992-2004 (Table 28).

Table 28. Comparison between the number of incidents of different types of grizzly bear-human conflicts in 2005, and the average annual number of conflicts recorded from 1992-2004 in the Greater Yellowstone Ecosystem.

Type of conflict	1992-2004 Average ± SD	2005
Human injury	4 ± 3	4
Property damage	18 ± 12	18
Anthropogenic foods	54 ± 42	35
Gardens/orchards	5 ± 3	5
Beehives	3 ± 4	1
Livestock depredations	51 ± 20	64
Total conflicts	135 ± 59	127

The conflict distribution map constructed using the fixed kernel 80% conflict distribution isopleths, identified 3 hot spots where most grizzly bear-human conflicts in the GYE occurred over the last 3 years (Fig. 17). These 3 areas contained 274 of the 408 (67%) conflicts that occurred from 2003-2005. The 3 areas where most conflicts occurred included: 1) the Green River area where grizzly bears killed cattle and sheep, 2) the North and South Forks of the Shoshone River where bears ate garbage, human foods, and livestock and pet foods, damaged property, and killed cattle, and, 3) the Crandall Creek/Sunlight Basin area where bears killed cattle, ate grain, and damaged property. These 3 areas should be a high priority for allocating state, federal, and private resources available for reducing grizzly bear-human conflicts in the GYE.

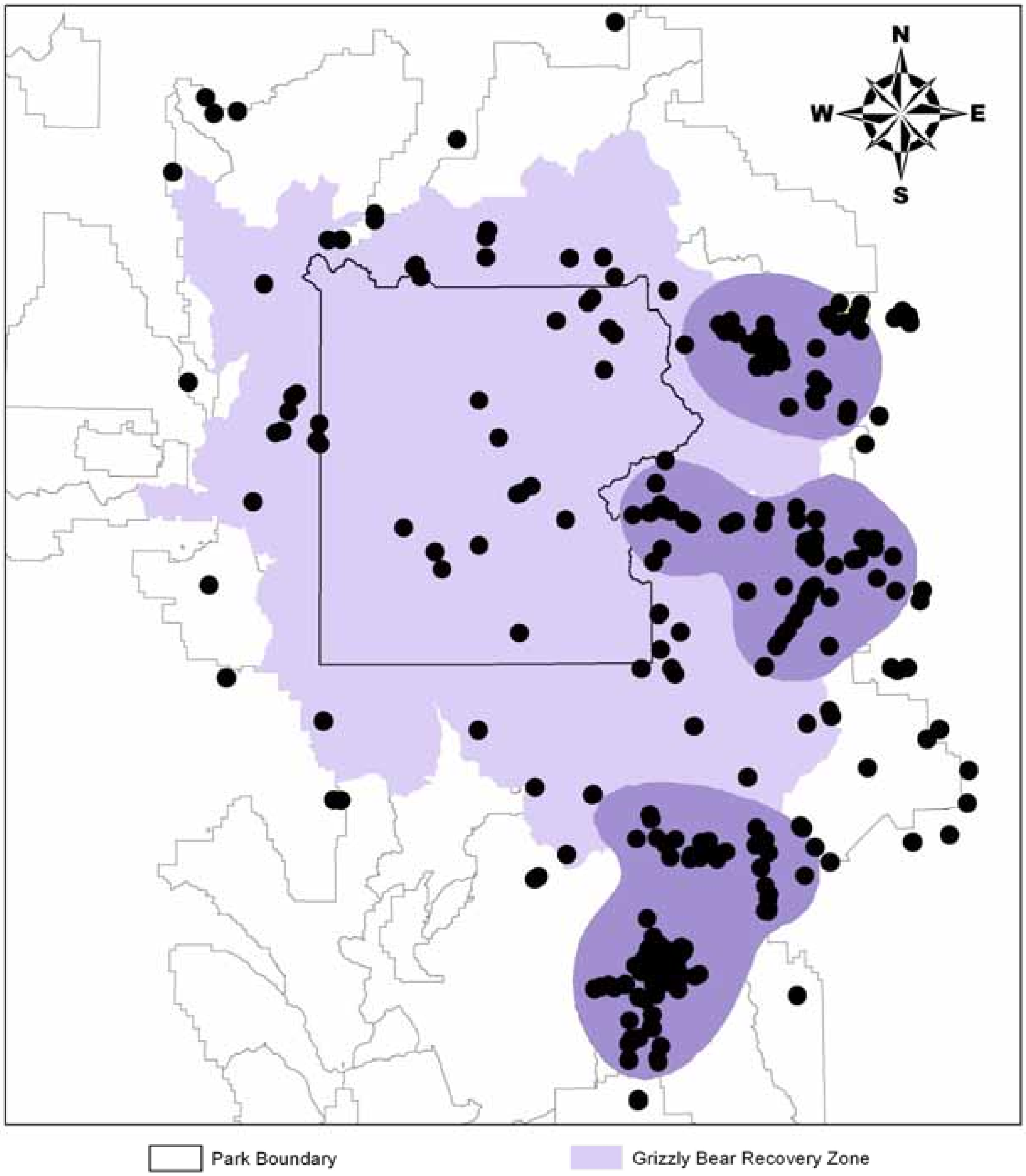

Fig. 17. Concentrations of grizzly bear-human conflicts that occurred from 2003-2005, identified using the 80% fixed kernel isopleth. The shaded area represents the Yellowstone Grizzly Bear Recovery Zone.

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Appendix A

Changing Numbers of Spawning Cutthroat Trout in Tributary Streams of Yellowstone Lake and Estimates of Grizzly Bears Visiting Streams from DNA

Mark A. Haroldson, Kerry A Gunther, Daniel P. Reinhart, Shannon R. Podruzny, Chris Cegelski, Lisette Waits, Travis Wyman, and Jeremiah Smith

Abstract: Spawning Yellowstone cutthroat trout (*Oncorhynchus clarki*) provide a source of highly digestible energy for grizzly bears (*Ursus arctos*) that visit tributary streams to Yellowstone Lake during the spring and early summer. During 1985-87, research documented grizzly bears fishing on 61% of the 124 tributary streams to the lake. Using track measurements, it was estimated that a minimum of 44 grizzly bears fished those streams annually. During 1994, non-native lake trout (*Salvelinus namaycush*) were discovered in Yellowstone Lake. Lake trout are efficient predators and have the potential to reduce the native cutthroat population and negatively impact terrestrial predators that use cutthroat trout as a food resource. In 1997, we began sampling a subset of streams (*n* = 25) from areas of Yellowstone Lake surveyed during the previous study to determine if changes in spawner numbers or bear use had occurred. Comparisons of peak numbers and duration suggested a considerable decline between study periods in streams in the West Thumb area of the lake. The apparent decline may be due to predation by lake trout. Indices of bear use also declined on West Thumb area streams. We used DNA from hair collected near spawning streams to estimate the minimum number of bears visiting the vicinity of spawning streams. Seventy-four individual bears were identified from 429 hair samples. The annual number of individuals detected ranged from 15 in 1997 to 33 in 2000. Seventy percent of genotypes identified were represented by more than 1 sample, but only 31% of bears were documented more than 1 year of the study. Sixty-two (84%) bear were only documented in 1 segment of the lake, whereas 12 (16%) were found in 2-3 lake segments. Twenty-seven bears were identified from hair collected at multiple streams. One bear was identified on 6 streams in 2 segments of the lake and during 3 years of the study. We used encounter histories derived from DNA and the Jolly-Seber procedure in Program MARK to produce annual estimates of grizzly bears visiting streams. Approximately 68 grizzly bears visited the vicinity of cutthroat trout spawning streams annually. Thus, approximately 14-21% of grizzly bears in the Greater Yellowstone Ecosystem may have used this threatened food resource annually. Yellowstone National Park is attempting to control lake trout populations in Yellowstone Lake; our results underscore the importance of that effort to grizzly bears.

Key Words: cutthroat trout, DNA, grizzly bear, lake trout, *Oncorhynchus clarki, Salvelinus namycush*, spawning, *Ursus arctos*, Yellowstone

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http://www.nrmsc.usgs.gov/products/ursus-16-02-Haroldson_et-al.pdf

Appendix B

Brown Bear Habituation to People—Safety, Risks, and Benefits

Stephen Herrero, Tom Smith, Terry D. DeBruyn, Kerry Gunther, and Colleen A. Matt

Abstract: Recently, brown bear (*Ursus arctos*) viewing has increased in coastal Alaska and British Columbia, as well as in interior areas such as Yellowstone National Park. Viewing is most often being done under conditions that off acceptable safety to both people and bears. We analyze and comment on the underlying processes that lead brown bears to tolerate people at close range. Although habituation is an important process influencing the distance at which bears tolerate people, other variables also modify levels of bear-to-human tolerance. Because bears may react internally with energetic costs before showing an overt reaction to humans, we propose a new term, the Over Reaction Distance, to emphasize that what we observe is the external reaction of a bear. In this paper we conceptually analyze bear viewing in terms of benefits and risks to people and bears. We conclude that managers and policy makers must develop site-specific plans that identify the extent to which bear-to-human habituation and tolerance will be permitted. The proposed management needs scientific underpinning. It is our belief that bear viewing, where appropriate, may promote conservation of bear populations, habitats, and ecosystems as it instills respect and concern in those who participate.

Key Words: bear-human interactions, bear management, bear viewing, brown bears, habituation, individual distance, overt reaction distance, personal space, *Ursus arctos.*

Herrero, S., T. Smith, T.D. DeBruyn, K. Gunther, and C.A. Matt. 2005. Brown bear habituation to people—safety, risks, and benefits. Wildlife Society Bulletin 33(1):362-373.

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Appendix C

Large Carnivores, Moose, and Humans: A Changing Paradigm of Predator Management in the 21st Century

Charles C. Schwartz, Jon E. Swenson, and Sterling D. Miller

Abstract: We compare and contrast the evolution of human attitudes toward large carnivores between Europe and North America. In general, persecution of large carnivores began much earlier in Europe than North America. Likewise, conservation programs directed at restoration and recovery appeared in European history well before they did in North America. Together, the pattern suggests there has been an evolution in how humans perceive large predators. Our early ancestors were physically vulnerable to large carnivores and developed corresponding attitudes of respect, avoidance, and acceptance. As civilization evolved and man developed weapons, the balance shifted. Early civilizations, in particular those with pastoral ways, attempted to eliminate large carnivores as threats to life and property. Brown bears (*Ursus arctos*) and wolves (*Canis lupus*) were consequently extirpated from much of their range in Europe and in North America south of Canada. Efforts to protect brown bears began in the late 1880s in some European countries and population reintroductions and augmentations are ongoing. They are less controversial than in North America. On the other hand, there are no wolf introductions, as has occurred in North America, and Europeans have a more negative attitude towards wolves. Control of predators to enhance ungulate harvest varies. In Western Europe, landowners own the hunting rights to ungulates. In the formerly communistic Eastern European countries and North America, hunting rights are held in common, although this is changing in some Eastern European countries. Wolf control to increase harvests of moose (*Alces alces*) occurs in parts of North America and Russia; bear control for similar reasons only occurs in parts of North America. Surprisingly, bears and wolves are not controlled to increase ungulates where private landowners have the hunting rights in Europe, although wolves were originally exterminated from these areas. Both the inability of scientific research to adequately predict the effect of predator control on ungulate populations and a shift in public attitudes toward large carnivores have resulted in an accelerating number of challenges to predator management in places where it is still espoused. Utilitarian attitudes towards wildlife are declining in Western cultures and people now increasingly recognize the intrinsic value of wildlife, including large predators. In the future, agencies responsible for managing resident wildife will face increased pressure to balance the needs of the hunting public with the desires of non-hunting publics. We suggest that in the next century we will witness a continued shift in how wildlife agencies manage both moose and large carnivores. More attention will be paid to maintaining and restoring intact ecosystems and less toward sustainable yield of meat.

Key Words: *Alces alces*, brown bear, *Canis lupus*, gray wolf, grizzly bear, moose management, predator control, *Ursus arctos*

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http://www.nrmsc.usgs.gov/products/Alces39_41.pdf

Appendix D

Distribution of Grizzly Bears in the Greater Yellowstone Ecosystem in 2004

Charles C. Schwartz, Mark A. Haroldson, Kerry A. Gunther, and Dave Moody

Abstract: The US Fish and Wildlife Service (USFWS) proposed delisting the Yellowstone grizzly bear (*Ursus arctos horribilis*) in November 2005. Part of that process required knowledge of the most current distribution of the species. Here, we update an earlier estimate of occupied range (1990–2000) with data through 2004. We used kernel estimators to develop distribution maps of occupied habitats based on initial sightings of unduplicated females (n = 481) with cubs of the year, locations of radiomarked bears (n = 170), and spatially unique locations of conflicts, confrontations, and mortalities (n = 1,075). Although each data set was constrained by potential sampling bias, together they provided insight into areas in the Greater Yellowstone Ecosystem (GYE) currently occupied by grizzly bears. The current distribution of 37,258 km^2 (1990–2004) extends beyond the distribution map generated with data from 1990-2000 (34,416 km^2). Range expansion is particularly evident in parts of the Caribou–Targhee National Forest in Idaho and north of Spanish Peaks on the Gallatin National Forest in Montana.

Key Words: distribution, grizzly bear, kernel density, range analysis, *Ursus arctos,* Yellowstone ecosystem

Schwartz CC, Haroldson MA, Kerry A. Gunther KA, Moody D. 2006. Distribution of grizzly bears in the Greater Yellowstone Ecosystem in 2004. Ursus 17(1):63-66.
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Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2005 Annual Report

Whitebark pine (WbP) occurs in the subalpine zone of western North America, including the Pacific Northwest and Rocky Mountains, where it is adapted to a harsh environment of poor soils, steep slopes, high winds and extreme cold temperatures. While its inaccessibility and sometimes crooked growth form lead to low commercial value, it is a highly valuable species ecologically and is often referred to as a "keystone" species in the subalpine ecosystem (Tomback et al. 2001). Its best known role in these ecosystems is as a high-energy food source for a variety of wildlife species, including red squirrels, Clark's nutcracker and the threatened grizzly bear.

NPS Photo by Bryan Harry

Whitebark is a high-energy food source for grizzly bears and other wildlife.

NPS Photo by R.G. Johnsson

Background of the Program

Forest monitoring has shown a rapid and precipitous decline of WbP in varying degrees throughout its range due to non-native white pine blister rust (Kendall and Keane 2001) and native mountain pine beetle (Gibson 2006). Given the ecological importance of WbP in the Greater Yellowstone Ecosystem (GYE) and that 98% of WbP occurs on public lands, the conservation of this species depends heavily on the collaboration of all public land management units in the GYE. Established in 1998, the Greater Yellowstone Whitebark Pine Committee, comprised of resource managers from eight federal land management units, has been working together to ensure the viability and function of WbP throughout the region. As a result of this effort, an additional working group was formed for the purpose of integrating the common interests, goals and resources into one unified monitoring program for the Greater Yellowstone area. The Greater Yellowstone Whitebark Pine Monitoring Working Group (GYWPMWG) consists of representatives from the U.S. Forest Service (USFS), National Park Service (NPS), U.S. Geological Survey (USGS), and Montana State University (MSU). This report is a summary of the data collected from the second field season of this long-term monitoring project.

A Unified Effort

Although other efforts within the GYE have contributed greatly to our initial understanding of the status of whitebark pine, differences in study designs and field methods make it difficult to make reliable comparisons across the region and among other monitoring efforts. In order to effectively detect how rates of blister rust infection, survival and regeneration of whitebark are changing over time in the GYE, a repeatable, long-term sampling design provides the most advantageous approach.

The Greater Yellowstone Whitebark Pine Monitoring Working Group has been developing a protocol for monitoring whitebark pine in a consistent manner throughout the entire ecosystem. This program will facilitate a more effective effort to understand the status and trends of whitebark on a comprehensive, regional scale. The GYWPMWG method was designed with the intent of detecting long-term health shifts in the GYE whitebark population, which in turn, will provide critical information on the likelihood of this species' ability to persist as functional part of the ecosystem.

Photo courtesy B.R. McClelland

Whitebark has experienced considerable decline in the Northwest.

Objectives

Our objectives are intended to monitor the health of whitebark pine relative to levels of white pine blister rust and to a lesser extent mountain pine beetle. The approach we are taking is a combination of assessing the status and trends of whitebark pine with respect to these potentially injurious agents as well as to assess the demographic rates that would enable us to determine the probability of whitebark pines persisting in the Greater Yellowstone Ecosystem.

Objective 1 - To estimate the proportion of live whitebark pine trees (>1.4 m high) infected with white pine blister rust, and to estimate the rate at which infection of trees is changing over time.

Objective 2 - Within infected transects, to determine the relative severity of infection of white pine blister rust in whitebark pine trees > 1.4 m high.

Objective 3 - To estimate survival of individual whitebark pine trees > 1.4 m high, explicitly taking into account the effect of infection with, and severity of, white pine blister rust, infestation by mountain pine beetle and fire.

Additional objectives aimed at assessing recruitment and the effect of forest succession are being planned.

Study Area

Our study area is in the Greater Yellowstone Ecosystem and includes 6 National Forests and 2 National Parks (the John D. Rockefeller Memorial Parkway is included with Grand Teton National Park) (Figure 1). The habitat types from which our sample was selected correspond to aggregation of "High Elevation Whitebark Pine Dominated Sites" described by Mattson et al. (2004). However, it should be noted that this name is a bit confusing because "high elevation" in the context of this report, refers to the entire ecosystem, not just to whitebark. Thus, it does not imply that the whitebark sites are limited to higher elevation sites within the whitebark pine cover types. Rather, it includes whitebark pine cover types ranging from relatively pure whitebark pine stands that occur at higher elevations, to mixed-species stands that occur at lower elevations within the range of whitebark.

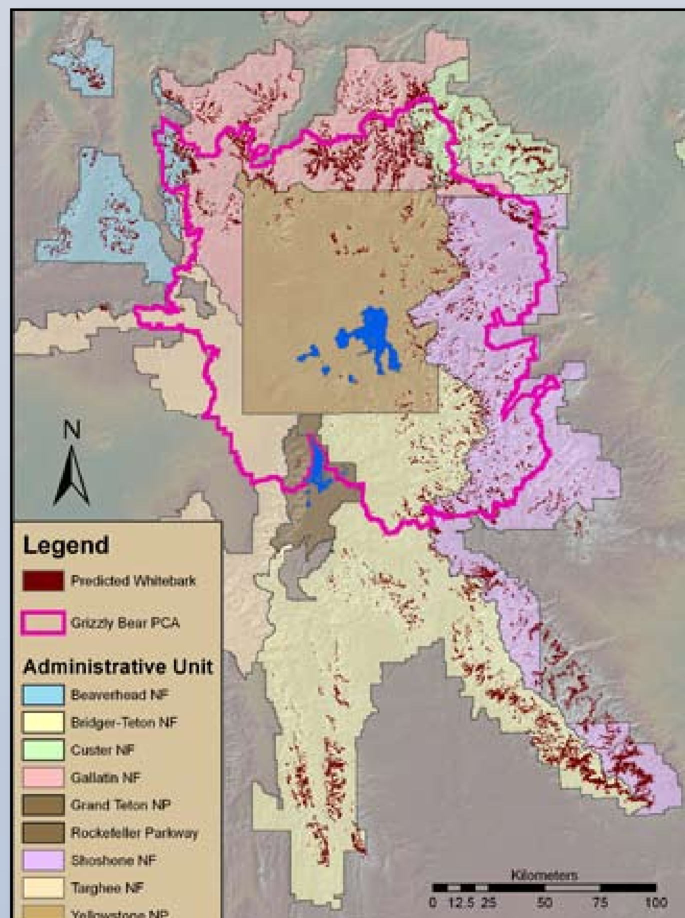


Figure 1. Study area showing administrative units and predicted occurrence of whitebark pine.

Methods

Details of our sampling design and field methodology can be found in GYWPMWG (2005, 2006). However, our basic approach is a 2-stage cluster design with stands (polygons) of whitebark pine being the primary units and 10x50 m transects being the secondary units. During 2004 all WbP stands sampled were within the Grizzly Bear Primary Conservation Area (PCA) due to the limitations in the mapped distribution of WbP across the study area. Our sample during 2005 extended outside of the PCA to the boundaries of what is considered the GYE (Figure 2). Future samples over the next few years will encompass the entire region. Separation of the areas within and outside the PCA enabled us to account for map limitations during 2004 and to analyze survey results separately. Transects and individual trees within each transect were permanently marked in order to estimate changes in infection and survival rates over an extended period. Transects will be revisited approximately every 5 years to determine changes in blister rust or survival since the previous visit.

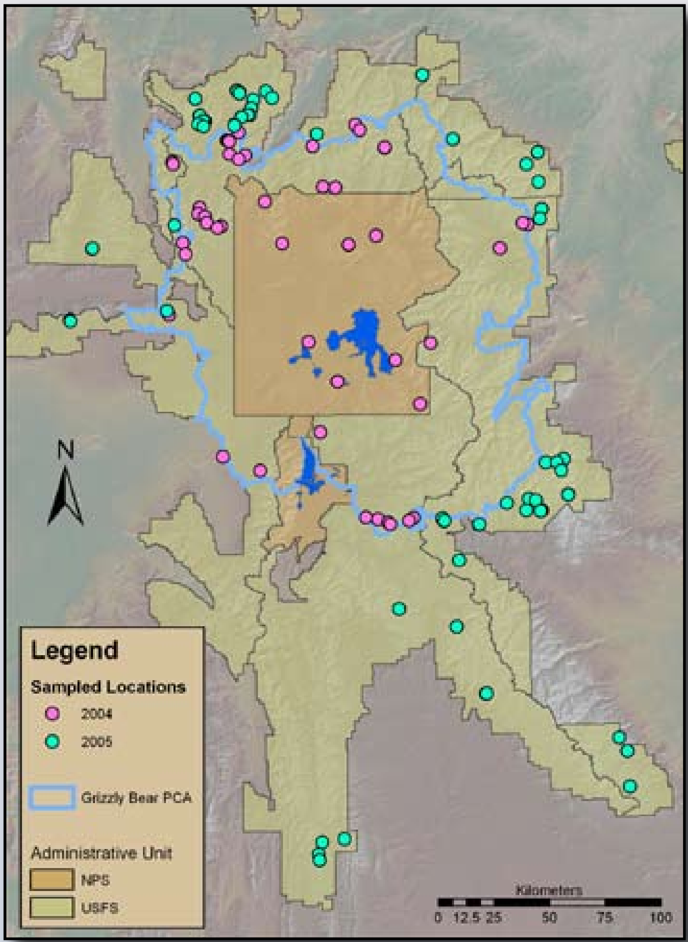
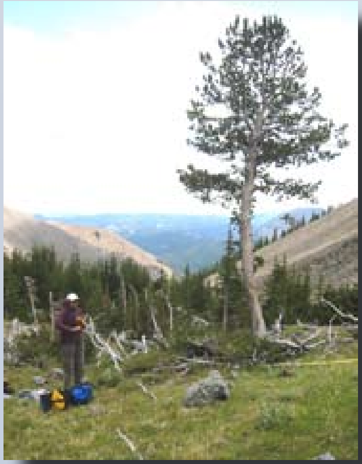


Figure 2. Sites sampled during 2004 from within the grizzly bear PCA and 2005 outside the PCA.

White Pine Blister Rust



For each live tree, the presence or absence of indicators of blister rust were recorded. For the purpose of analyses presented here, a tree was considered infected if either aecia or cankers were present. For a canker to be conclusively identified as resulting from blister rust, at least three of five ancillary indicators needed to be present. Ancillary indicators of blister rust included flagging, rodent chewing, oozing sap, roughened bark, and swelling.

Mountain Pine Beetle

The presence or absence of mountain pine beetle was noted in all WbP; however, we did not attempt to assign a cause of death for dead WbP trees. Mountain pine beetle presence was identified in the following ways: 1) small, popcorn-shaped resin masses called pitch tubes; 2) dust in bark crevices; 3) and presence of live mountain pine beetle and characteristic J-shaped galleries under the bark.

Based on Hoff (1992)

Evaluating Observer Differences

Previous monitoring efforts for WbP have largely ignored observer variability in identifying white pine blister rust infection. To assess this effect, we conducted independent surveys by different observers on 6 transects in 2004 and 18 transects in 2005. The first observer marked the individual trees which were subsequently visited by each of the other observers.

Preliminary Results

White Pine Blister Rust

A total of 51 transects were surveyed within 45 stands of WbP in 2004. In 2005, a total of 76 transects were surveyed within 55 stands. Of the 51 transects surveyed within the PCA in 2004 and the 76 transects outside the PCA in 2005, we observed some level of blister rust on 36 (71%) and 65 (86%), respectively (Figure 3). The proportion of infected trees on a given transect ranged from 0 to 1.0. The number of live trees per transect for each year ranged from 1 to 219 for a total of 1,012 live trees examined during 2004 and 2,732 during 2005. Taking into account both within and between-stand variation, our preliminary estimates of the proportion of live trees infected with blister rust was 0.17 ± (0.062 se) within the PCA, 0.27 ± (0.036 se) outside the PCA, and 0.25 ± (0.031 se) for the overall GYE.

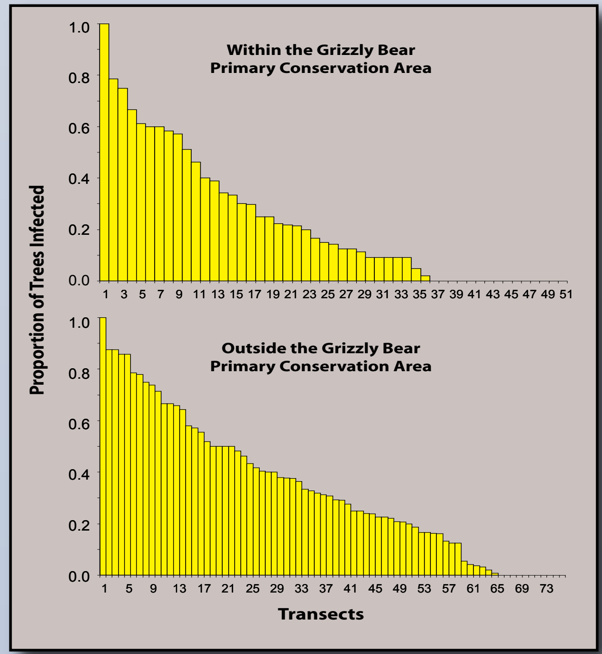


Figure 3. The 127 individual transects sampled in 2004 (n=51) and 2005 (n=76) showing the proportion of infected trees on each transect. The transects are shown in rank order from those with the highest percentage of infected trees per transect to those that were least infected.

Although a formal spatial analysis has not yet been conducted, our preliminary data indicate that infection rates are highly variable across the region (Figure 4).

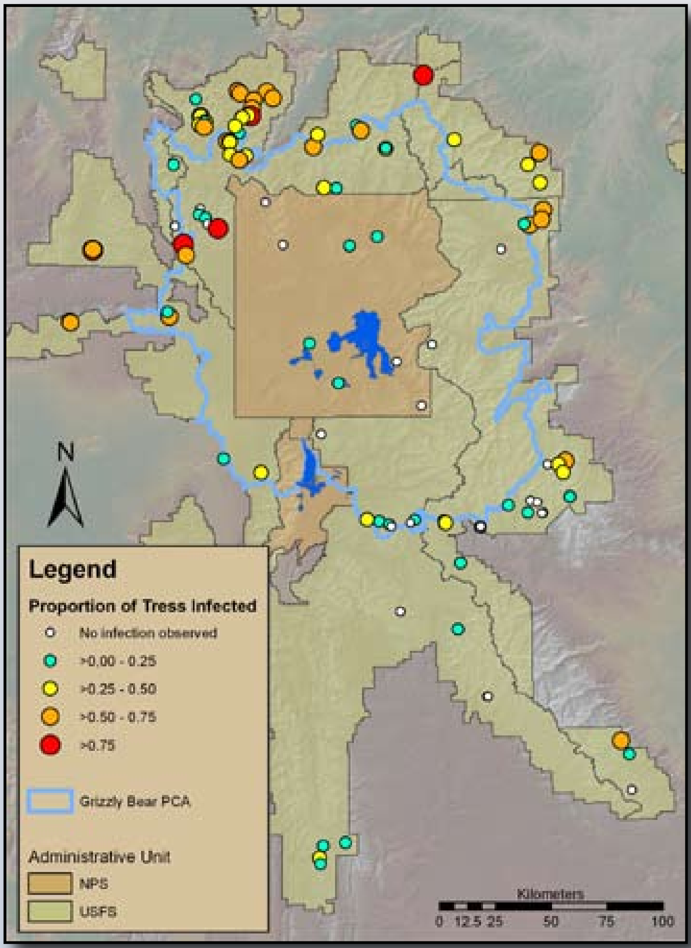


Figure 4. The proportion of trees infected on transects sampled during 2004 and 2005.

Severity of White Pine Blister Rust on Infected Trees

The total number of cankers observed on infected live trees in 2004 and 2005 combined was 2,425, of which 1,942 (80%) were located on branches and 483 (20%) were located on a main bole (Figure 5). The total number of cankers per infected tree ranged from 1 to 35. Bole cankers that are located on the lower portion of the bole (middle to bottom third) are generally considered lethal to trees. Cankers that are found in the upper third of the bole are not necessarily lethal but can have a negative impact on cone production. Such cankers were less numerous than branch cankers and ranged from 0 to 7 per infected tree; whereas branch cankers ranged from 0 – 32 per infected tree.

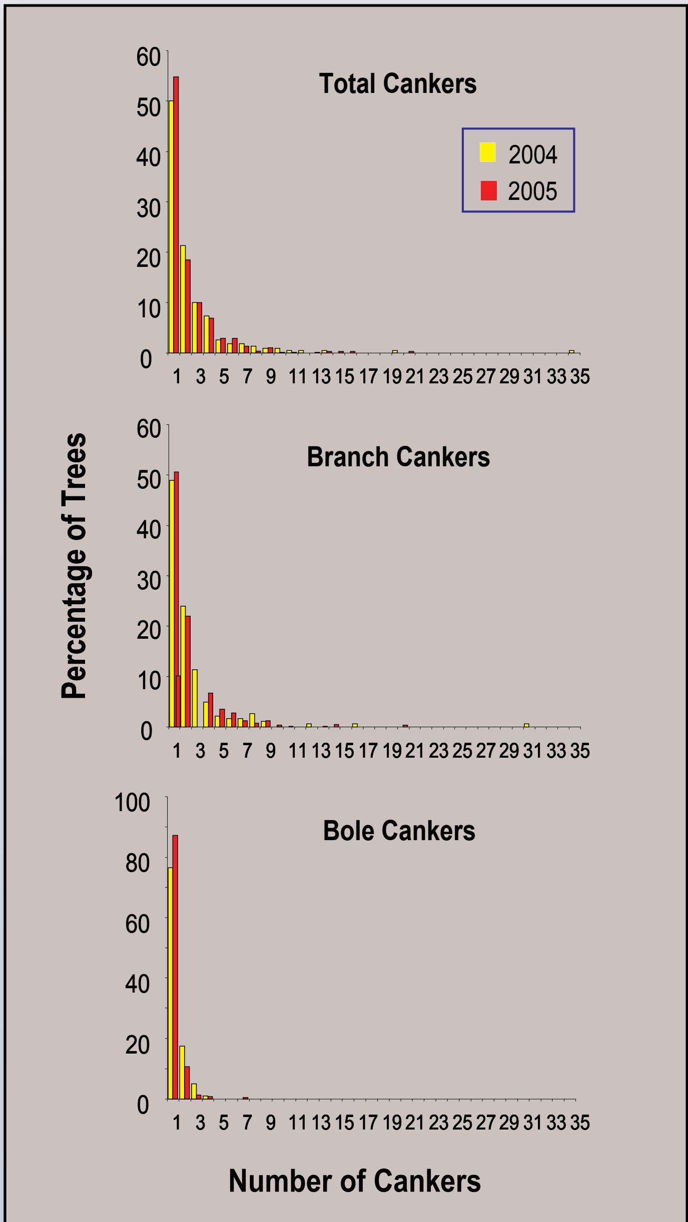


Figure 5. The percentage of whitebark pine trees from the sample in each year infected with one, two, three, etc number of cankers per tree for (1) the total number of cankers, (2) branch cankers, and (3) bole cankers.

Mountain Pine Beetle

Of the 45 stands visited in 2004, 10 (22%) had evidence of mountain pine beetle attacks in live or recently dead (i.e., with intact needles) trees. Of the 1,062 live or recently dead trees we sampled in these stands, 30 (3%) had evidence of mountain pine beetle attacks. In 2005, 12 out of 55 (22%) stands had evidence of mountain pine beetle attacks and of the 2,827 live or recently dead trees, 26 (1%) had evidence of mountain pine beetle attacks.

Observer Differences

Some of the factors that may influence observer variability are observer positioning, observation effort, stand density and physical structure, observer experience, lighting, and equipment (e.g., binoculars). Twenty four transects in 2004 and 2005 were surveyed by multiple observers. Each observer recorded blister rust infections independently for each tree on the same transect. The results of this effort are still being analyzed and will be reported in detail in a separate manuscript intended for publication.

Discussion

As previously stated, this study concentrates on the health and status of whitebark pine in the Greater Yellowstone area. Although WbP is important to an array of wildlife including the grizzly bear, it is important to reiterate that the focus of this project is on WbP as opposed to any of the species with which it may be associated.

It is also important to be very clear about what we are reporting. When examining reports of blister rust infection, it often is not clear whether the rates of infection being reported are the proportion of plots (e.g., transects) that have some indication of infection, or the proportion of trees that have some level of infection. In this report, we consider the proportion of transects that show the presence of blister rust as an indication of how widespread blister rust is within the GYE. Our preliminary results indicate that the occurrence of white pine blister rust is widespread throughout the GYE (i.e, 80% of all transects had some level of infection).

We consider the proportion of trees infected and the number and location (branch or bole) of cankers as indicators of the severity of blister rust infections. By these measures, the severity of infections was less alarming than the spatial extent, with an estimated 25% of the trees in the GYE estimated as having some level of infection.

In most cases, the number of cankers per tree was low with approximately 73% of the infected trees having ≤ 2 cankers observed, 80% of which were branch cankers. Branch cankers are generally considered to be less lethal (Koteen 2002).

It should be noted that the results presented here are preliminary and some caution in interpretation is warranted. First, we have not yet completed a full sample of the ecosystem. Our sampling design is such that a full sample is achieved over several years, after which the samples are

The location of blister rust on the tree can greatly influence its effect.

USFS Photo: Dorena Genetic Resource Center

revisited. Thus, our estimates to date comprise only a subset of what will be a complete sample of the ecosystem.

An additional caution to take into consideration is that the results presented here are estimates from a specific protocol of sampling design and field methods. Few, if any other efforts within the GYE have selected sites using a probabilistic sampling design specifically intended for deriving inference to the GYE population as a whole. Thus, comparison with results from efforts using different field methods or sampling designs is likely to produce questionable conclusions. It is largely for this reason, that we have attempted a consistent approach for the entire GYE.

The detection of blister rust cankers can be difficult under some circumstances, and can vary among observers.

It should also be noted that our estimates from 2004 and 2005 do not represent an annual change in blister rust infection. Rather, these samples were taken from different parts of the ecosystem (within and outside of the PCA) and are more likely to reflect spatial variation rather than an annual change. Our estimates of change in infection within the GYE will be derived from repeated sampling of our selected sites over time.

Finally, our overall estimate of blister rust infections is likely conservative. Our criteria of having aecia or at least three of the other indicators (rodent chewing, flagging, oozing sap, roughened bark or swelling) present to confirm infection, may result in the rejection of questionable cankers. We are continuing to evaluate the efficacy of these criteria for future sampling. Our data also suggests that observer variability may be quite important. This result has broad implications for all monitoring efforts of whitebark pine where observer differences are not considered. For monitoring efforts to be reliable, differences in infection rates observed over time should not be confounded with observer differences.

Acknowledgments

We thank our field technicians Justin Hof, Karla Sartor, and Amy Jesswein. We also thank Maria Newcomb, Veronika Klukas, Dale Dawson, Rachel Feigley, Andy Pils, Bill Oliver, Rob Daley, Jim Robertson, Steve Schadt, Jodie Canfield, Dennis Barron, Allen Kyles, David Meyers, Marcus Engler, Jeff Dibenedetto, Ellen Jungck, Bev Dixon, and Anne Schrag for their advice and/or field and logistic support. Funding for the field work portion of this project was provided by USFS FHM. Additional funding and support for preliminary analysis of data, mapping, additional field gear, and vehicle support was provided by NPS (Greater Yellowstone Network and Yellowstone National Park), USGS (Interagency Grizzly Bear Study Team) and the Greater Yellowstone Coordinating Committee (GYCC).

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Our sampling is intended to encompass a wide range of whitebark pine stand types, from higher elevation stands of pure whitebark pine to relatively lower elevation mixed-species stands.

Photo credits clockwise from upper left: NPS, R.G. Johnsson; Lisa Landenburger; Karla Sartor; Dan Reinhart

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Cooperating Organizations:

Greater Yellowstone Coordinating Committee (GYCC)

USDA Forest Service

Forest Health Protection
Beaverhead-Deerlodge National Forest
Bridger-Teton National Forest
Caribou-Targhee National Forest
Custer National Forest
Gallatin National Forest
Shoshone National Forest

USDI National Park Service

Greater Yellowstone Inventory and Monitoring Network
Grand Teton National Park
John D. Rockefeller, Jr. Memorial Parkway
Yellowstone National Park

USDI Geological Survey

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USDI National Park Service
Yellowstone National Park

[a] This project represented a collaboration in the truest sense of the word, such that distinguishing order of participants with respect to relative contribution was virtually impossible. Consequently, order of participants is alphabetical.

Photo courtesy Anne Schrag

The Realm of Whitebark

Recommended citation for GYWPMWG (2006):

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2006. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2005 Annual Report. Pages 73-80 in C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2005. U.S. Geological Survey, Bozeman, Montana, USA.

Appendix F

The Ecological Relationship between a Rocky Mountain Threatened Species and a Great Plains Agricultural Pest

Hillary Robison, Ph.D. candidate, University of Nevada, Reno

Project Summary

Army cutworm moth (ACM) adults migrate from low elevations in the Great Plains and Intermountain West (hereafter low elevations) to the Rocky Mountains and aggregate in high-elevation talus slopes. These ACM aggregations provide an important food resource for grizzly bears. Much is known about the agricultural aspect of the life history of ACMs. However, relatively little is known about their alpine and migratory ecology and their population genetics.

This study was designed to understand how ACM ecology and population genetics might impact grizzly bear conservation in the GYE. Fieldwork was conducted in high-elevation areas from late June through September and in low-elevation areas from August through October in 1999, 2000, and 2001.

This study addresses the following: the scale at which ACMs migrate to high-elevation areas; whether ACMs harbor pesticides which could biomagnify in bears; and identification of sites where ACMs may aggregate and bears may feed on them. The results of this study will provide groundwork for further investigations of the affects of moth variability and abundance on grizzly bear fecundity and mortality, as well as provide insights to biologists that may help them make management decisions.

Background and Significance

Army cutworm moth migration and grizzly bear conservation.--Grizzly bears were first found feeding on ACMs aggregated in talus slopes in the Mission Mountains in 1952 (Chapman et al. 1955). Since this discovery, grizzly bears have been observed feeding on ACMs at several high-elevation sites in Montana and Wyoming (Craighead et al. 1982, Servheen 1983, Mattson et al. 1991*b*, French et al. 1994, White 1996).

ACMs are an important summer and fall food source for grizzly bears. Grizzly bears excavate the moths from the talus and consume millions of them from July through September (Pruess 1967, Chapman et al. 1955, Mattson et al. 1991*b*, French et al. 1994, White 1996). When compared to other food sources in the GYE, ACMs are the richest food available to grizzly bears (Mealey 1975, Pritchard and Robbins 1990, French et al. 1994, Craighead et al. 1995, White 1996). In 30 days, a grizzly bear feeding extensively on ACMs can consume 47% of its annual energy needs (White 1996).

When ACMs and whitebark pine nuts (WBPNs) are abundant in the summer and fall, grizzly bears move to high elevations to forage on these rich foods, and in doing so, the bears geographically separate themselves from areas of human activity. Due to this geographic separation, fewer grizzly bear management situations and grizzly bear mortalities are recorded during years when WBPNs and ACMs are abundant or present than during years when they are scarce or absent (Gunther et al. 1993, 1994, 1995, 1996, 1997). WBPN abundance positively correlates with increased grizzly bear fecundity (Mattson et al. 1992). Cyclic crashes in the

WBPN crop and damage to whitebark pine from white pine blister rust (*Cronartium ribicola*) increase the importance of understanding the factors influencing ACM presence and abundance at grizzly bear foraging sites.

In 1991 and 1992, researchers estimated that an average of 44% of GYE grizzly bears foraged at ACM aggregation sites in the Absaroka Mountains and that female grizzly bears comprised 40% of these bears (O'Brien and Lindzey 1994). Female grizzly bear survivorship and reproduction is important to grizzly bear population persistence (Bunnell and Tait 1981, Eberhardt 1990, Craighead and Vyse 1996). Female reproduction depends on adequate pre-hibernation weight gain and fat deposition (Rogers 1987) and is influenced by the quantity and quality of available food (Stringham 1990, McLellan 1994). The goal of the Endangered Species Act is to recover species and ensure their persistence through time. ACMs and WBPNs are likely important to grizzly bear recovery in the GYE because presence and abundance of these foods influence grizzly bear survival, reproduction, and, in turn, persistence.

Biology of the army cutworm moth.--The ACM is native to North America and ranges from California to Kansas and from Alberta, Canada, to New Mexico. When agriculture began to dominate ACM habitat at the turn of the 20th century, the ACM became an agricultural pest. Adult moths oviposit in loose soil in the fall (Strickland 1916, Burton et al. 1980), and the larvae develop underground. In spring, the larvae surface and feed on emergent plants (e.g., native plants as well as sugar beets, small grains, and alfalfa). The larvae pupate underground, and the adult moths emerge in June and migrate to high-elevation talus slopes in the Rocky Mountains (Pruess 1967). Once ACMs reach the mountains, they remain there from July through September and forage on alpine flower nectar at night and hide in talus during the day (Pruess 1967, French et al. 1994, O'Brien and Lindzey 1994, White 1996). From late August through the beginning of October, the moths migrate back to low elevations and oviposit into soil (Pruess 1967, Burton et al. 1980).

Project Objectives

The main objectives of this study are to determine the scale of ACM origins and, hence, the scale at which factors may influence ACM migration to high-elevation areas where they are fed on by bears; to determine whether ACMs harbor pesticides that could biomagnify in bears; and to identify sites where moths may aggregate and bears may feed on them.

Determining the scale of ACM origins and if ACMs exhibit site fidelity is important because pressures on ACMs in natal areas, whether natural (e.g., weather patterns) or humancaused (e.g., pesticides or habitat loss), may affect moth recruitment and the numbers of adults reaching high-elevation sites used by bears. Genetic techniques can be used to determine the origins of species and to differentiate populations (Bolten et al. 1997, Palsboll et al. 1997, Rankin-Baransky et al. 1997, Eldridge et al. 2001). Because ACMs are small, wide-ranging insects that are not amenable to physical tagging, genetic techniques are well-suited to determining the scale of their origins.

Because grizzly bears eat millions of ACMs and the moths are agricultural pests that are controlled with pesticides, concern exists about whether ACMs contain pesticides that could be toxic to bears (French et al. 1994). Hence, we aimed to analyze ACMs for pesticides and estimate risk to bears.

The Conservation Strategy for the Yellowstone grizzly bear (USFWS 2003) allows the population to expand into biologically suitable and socially acceptable areas beyond the Primary

Conservation Area. The conservation strategy requires use of georeferenced habitat data to aid in monitoring the 4 major Yellowstone grizzly bear foods (ACMs, cutthroat trout, whitebark pine seeds, and winter-killed ungulates) and to identify habitats into which bears may expand. To this end, we aimed to develop models of high-elevation ACM habitat in the GYE with the purpose of creating a tool with which bear biologists and managers can identify potential ACM habitats into which grizzly bears may expand.

Field Sampling

***High elevation*.--**From mid-July through September 1999-2001 crews used black-light traps at moth aggregation sites to collect ACMs for genetic and pesticide analyses. ACMs were collected from 6, 9, and 5 sites in 1999, 2000, and 2001, respectively. In total, ACMs were collected from 11 different high-elevation sites, including 9 sites in Wyoming, 1 site in Washington, and 1 site in New Mexico.

Low elevation.--In the late summer and early fall, field crews trapped ACMs with pheromone traps in agricultural lands in Wyoming and Idaho. These efforts were coordinated with the ACM trapping programs of university agricultural extension services in Nebraska, Montana, and South Dakota who sent ACM samples.

Fifteen sites were sampled in 1999 and were re-sampled along with 24 new sites in 2000. All 39 sites were re-sampled in 2001 along with 2 new sites. The sampling effort was expanded in 2000 and 2001 in order to sample a 360-degree radius around the high-elevation study areas.

Methods

The ACM samples collected in 1999 were analyzed by the U.S. Geological Survey's Columbia Environmental Research Center (CERC), in Colombia, Missouri. Samples were analyzed using gas chromatography with electron capture (GCE). A detailed protocol is contained in Lebo et al. (2000). ACMs were not collected for pesticide residue analysis during the 2000 field season. In winter 2000, a question arose as to whether the method used in 1999 was sensitive enough to detect traces of certain pesticides in the ACMs. In 2001, a sample of ACMs was submitted to the Agricultural Experiment Station (AES) Analytical Laboratory at Montana State University-Bozeman, for pesticide screening with GC with tandem mass spectrometry (GC-MS/MS) according to the methods described in Sheridan and Meola (1999).

The genetic data are being analyzed in the Laboratory for Ecological and Evolutionary Genetics and the Nevada Genomics Center at the University of Nevada, Reno. Each of the several thousand moths that have been collected must be individually keyed to species, and the DNA of moths identified as ACMs is extracted. A microsatellite DNA library was developed for the ACM. Eight microsatellite loci (hereafter loci) have been isolated from this library, and polymerase chain reactions (PCRs) are being optimized to amplify these loci. Analyses of the variability at these loci are performed using an Applied Biosystems (ABI) 3730 microsatellite fragment analysis machine and GeneMapper software.

Models are being developed of high-elevation ACM habitat in the GYE using attribute data extracted from GIS layers at bear locations (n = 490) that were collected during aerial surveys from 1986-2002.

Results to date

The CERC lab found only non-significant traces of pesticides in the samples analyzed with GCE. The sample analyzed with GC-MS/MS by the Montana State University AES lab came back negative for traces of pesticides (see Appendix G).

Analyses indicate loci are variable within and among populations (see Appendix H). Because the genetic data will be influenced by when and where ACMs mate, I am analyzing ACM reproduction.

I am developing presence/random models of ACM habitat. To date, these models indicate elevation, aspect, rate of change in slope, and a few Thematic Mapper bands are important. These models will be displayed as maps showing probabilities of moth habitat in the GYE. Models were generated using a subset of bear locations and are being tested with locations not used in model development (see Appendix I).

As an additional project, I am examining pollen from ACMs to identify which high elevation plants they feed on (see Appendix J). Determining plants used by ACMs is important because changes in climate and plant composition may influence the availability of ACM nectar sources.

Project Products

The results of this research will be written as manuscripts and submitted to peer-reviewed journals. A Ph.D. dissertation will be submitted to the University of Nevada, Reno and research results will be presented in a public defense.

Funding sources

Rob and Bessie Welder Wildlife Foundation; Yellowstone Park Foundation; International Bear Association – Bevins Fund; The Wyoming Chapter of the Wildlife Society Memorial Bear Fund; Sigma Xi; American Museum of Natural History; U.S. Forest Service Region 1; Yellowstone National Park Bear Management Office; Greater Yellowstone Coordinating Committee; Wyoming Game and Fish Department; and the U.S. Geological Survey, Northern Rocky Mountain Science Center, Interagency Grizzly Bear Study Team. Donations from the Turner Foundation, Camp Fire Conservation Fund, Bernice Barbour Foundation, Earth Friends, and National Park Foundation were contributed through the Yellowstone Park Foundation.

Cooperators

U.S. Geological Survey, Northern Rocky Mountain Science Center, Interagency Grizzly Bear Study Team; Yellowstone National Park Bear Management Office; U.S. Forest Service Region 1; Montana State University-Bozeman Agricultural Extension agents; and the Wyoming Game and Fish Department.

Appendix G

Assessment of pesticide residues in army cutworm moths (*Euxoa auxiliaris*) from the Greater Yellowstone Ecosystem and their potential consequences to foraging grizzly bears (*Ursus arctos horribilis*)

H.L. Robison, C.C. Schwartz, J.D. Petty, and P.F. Brussard

Abstract: During the summer, grizzly bears (*Ursus arctos horribilis*) in the Greater Yellowstone Ecosystem can each excavate and consume millions of army cutworm moths (*Euxoa auxiliaris*) (ACMs) that aggregate in talus. ACMs are agricultural pests and concern exists about whether they contain pesticides that could be toxic to bears. Consequently, in 1999 we collected and analyzed ACMs from six moth aggregation sites. ACMs were screened for 32 pesticides with gas chromatography with electron capture (GCE). Because gas chromatography with tandem mass spectrometry (GC-MS/MS) can be more sensitive than GCE, we revisited one site in 2001 and analyzed a second sample of ACMs with GC-MS/MS. This sample was screened for six pesticides previously screened with GCE and one pesticide not included in the GCE analysis, but approved to control ACMs. Results suggest ACMs contained trace or undetectable levels of pesticides in 1999 and 2001, respectively. Based on chemical levels in ACMs and the number of ACMs bears can consume, we calculated the potential of chemicals to reach physiological toxicity. These results allay concerns that bears are at risk from pesticides. If chemical control of ACMs changes in the future, screening new ACM samples taken from bear foraging sites may be warranted.

Robison, H.L., C.C. Schwartz, J.D. Petty, and P.F. Brussard. In press. Assessment of pesticide residues in army cutworm moths (*Euxoa auxiliaris*) from the Greater Yellowstone Ecosystem and their potential consequences to foraging grizzly bears (*Ursus arctos horribilis*). Chemosphere.

Appendix H

Army Cutworm Moth Population Genetics Study

Hillary Robison

There are many similar-looking moth species in the high elevation areas I sample; however, only army cutworm moths (*Euxoa auxiliaris*) (ACM) aggregate in the talus and are fed on by grizzly bears. Hence, I have to identify each moth to species before I can determine if is an ACM. The population genetic structure of ACMs will be influenced by whether ACMs reach reproductive maturity in the alpine and by whether they mate there. After I determine the moths I've collected are ACMs and determine the reproductive status of females, I extract their DNA. Proper species identification requires two dissection procedures per individual and the use of a taxonomic key. Since I had thousands of samples, it was very time consuming. All the ACM samples for this project have been keyed and extracted. Preliminary analyses of reproductive data suggest that ACMs become reproductively mature and begin mating in high elevations.

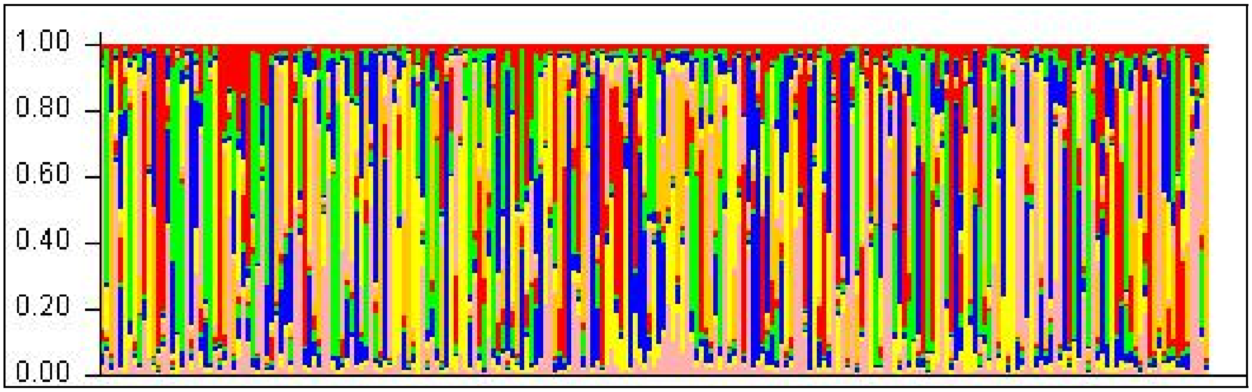
I am analyzing the genetic data in the Laboratory for Ecological and Evolutionary Genetics (LEEG) and the Nevada Genomics Center at the University of Nevada, Reno. I have optimized polymerase chain reactions (PCRs) for eight microsatellite loci, and I am running these loci in two four-loci PCRs. To date, I have performed PCRs, fragment analyses and tests of genetic variation for eight low elevation populations at eight loci using the software programs FSTAT (Goudet 1995) and STRUCTURE (Pritchard et al. 2000).

Results of these analyses indicate that ACMs from these eight locations represent a panmictic (i.e. randomly mating) population. F_{ST} values (measures of population subdivision) are not significant at a table-wide Bonferroni-corrected level for simultaneous tests (Appendix H Table 1). Outputs from STRUCTURE also indicate that these populations are panmictic (Appendix H Fig. 1). If panmixia (i.e. random mating) holds across both high and low elevations, then ACMs would be effectively one population across a large geographic area. Panmixia is the most favorable situation for grizzly bears because one large population of interbreeding ACMs is more likely to persist in perpetuity (e.g. survive habitat conversion/loss, pesticide use, weather patterns at local levels) than small subdivided populations with site fidelity. Hence, ACM panmixia is more likely to ensure persistence of ACM migration to bear foraging areas.

Appendix H Table 1. F_{ST}[a] values for eight low elevation ACM populations.

	pop2	pop3	pop4	pop5	pop6	pop7	pop8
pop1	0.72857	0.18036	0.95	0.16071	0.29286	0.5	0.775
pop2		0.16786	0.78393	0.03214	0.50714	0.48393	0.26607
pop3			0.45357	0.22857	0.1125	0.78929	0.27857
pop4				0.65357	0.94107	0.97143	0.95179
pop5					0.3	0.60179	0.25536
pop6						0.16964	0.41429
pop7							0.39286

[a] Fst values are not significant at the table-wide Bonferroni-corrected alpha level (p<0.001786).



Appendix H Fig.1. Structure bar plot for eight low elevation ACM populations indicating panmixia.

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Appendix I

Army cutworm moth habitat and grizzly bear conservation in the Greater Yellowstone Ecosystem

H. Robison, C. Schwartz, R. Aspinall, and P. Brussard

Army cutworm moths (*Euxoa auxiliaris*) (ACMs) are an important food for grizzly bears (*Ursus arctos horribilis*) in the Rocky Mountains (Mattson et al. 1991, French et al. 1994). ACMs oviposit in soil in low elevations in the Great Plains and intermountain west. Larvae emerge in spring, eat various plants, and burrow underground to pupate (Burton et al. 1980). The moths emerge in late June and migrate from low elevations to alpine areas in the Rocky Mountains (Pruess 1967). Here ACMs consume flower nectar nightly and aggregate in talus daily. Bears excavate ACMs from talus and consume millions of them from July-September (Mattson et al. 1991, French et al. 1994, White et al. 1999). In 30 days of feeding on ACMs a grizzly bear can obtain close to half of its yearly calories (White 1996).

The U.S. Fish and Wildlife Service's (USFWS) conservation strategy for the Yellowstone grizzly bear allows the population to expand into biologically suitable and socially acceptable areas beyond the Primary Conservation Area (USFWS 2003). The conservation strategy requires use of georeferenced habitat data to aid in monitoring the four major Yellowstone grizzly bear foods (ACMs, cutthroat trout, WBP seeds, and winter-killed ungulates) and to identify habitats into which bears may expand (USFWS 2003).

To this end, we are developing models of high elevation ACM habitat in the Greater Yellowstone Ecosystem (GYE) with the purpose of creating a tool with which bear scientists and managers can identify potential ACM habitats into which grizzly bears may expand. We predict ACM habitat will be related to elevation, heat load index, topographic roughness index, rate of change along contours, slope, rate of change in slope. We also investigated whether reflectance values at individual Landsat TM bands 1,2,3,4,5,7 could be used as surrogates for ACM habitat characteristics. We are developing models using attribute data extracted from bear locations (N = 490) collected during aerial surveys from 1986-2002 and random points (N = 5000) generated in a GIS. Using Huberty's (1994) rule we determined a 25% training to testing ratio and divided the data into four cross-validation groups. To identify important habitat characteristics or their surrogates for ACMs and display maps ranking probability of moth use in the GYE, we are training the data on three of the four data sets and validating it with the fourth data set using logistic regression models (a.k.a. logistic discriminant functions) in S-plus. We are then running and visualizing these models in the program generalized regression analysis for spatial prediction (GRASP) (Lehmann et al. 2002). Subsequent to generating these models, our next step will be to update the probability ranks generated from GRASP using geology layers.

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Appendix J

Army Cutworm Moth Nectar Plants

Hillary Robison

Project objective

In this project, I am investigating which flowers ACM are visiting in the alpine. Observing cryptically-colored ACMs feed on nectar plants is difficult and is complicated by precipitous terrain and the fact ACMs forage at night. Hence, I am trying to determine on which nectar plants ACMs feed based on pollen retrieved from their heads and mouthparts.

Methods

In 2001, we established four to five 2 x 10 m plots at different elevations at four high elevation sites – one in the Absaroka range and one in the Teton range. One site in the Absaroka range was revisited four times to investigate temporal differences in flower use. Plots were visited during the day, and all inflorescences were counted and flowers were keyed to species. Sites were revisited a night to attempt to observe ACMs feed and to collect ACMs as they visited flowers.

Results to date

This project is in progress. To date, I have identified pollen on ACMs collected at all the plots from all sites. Results so far indicate that ACMs carry pollen from local alpine flower species as well as from plants from lower elevations, which they may be visiting enroute to high elevations.