Yellowstone Grizzly Bear Investigations 2007

IGBST photo

Annual Report of the Interagency Grizzly Bear Study Team

YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

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2007

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

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Introduction

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 2007 field season. The report also contains a summary of nuisance grizzly bear (*Ursus arctos horribilis*) management actions.

The grizzly bear was removed from protection under the Endangered Species Act on 30 April 2007 (USFWS 2007*a*). Under the Revised Demographic Recovery Criteria (U.S. Fish and Wildlife Service [USFWS] 2007*b*) and the demographic monitoring section of the Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007*c*), the Interagency Grizzly Bear Study Team (IGBST) is now task with reporting on an array of required monitoring programs. These include both population and habitat components. Annual population monitoring includes:

- Monitoring unduplicated females with cubs-of-the-year (COY) for the entire Greater Yellowstone Area (GYA). The IGBST developed improved methods to estimate the annual number of females with COY and we detail them in this year's report (see *Assessing trend and estimating population size from counts of unduplicated females*).
- Calculating a total population estimate for the entire GYA based on the model averaged Choa2 estimate of females with COY. Methods used to estimate the number of independent females and independent males (age ≥2 years old) are also provided (see *Assessing trend and estimating population size from counts of unduplicated females*).
- Monitoring the distribution of females with young of all ages and having a target of at least 16 of 18 Bear Management Units (BMUs) within the Primary Conservation Area (PCA) occupied at least 1 year in every 6, and no 2 adjacent BMUs can be unoccupied over any 6 year period (see *Occupancy of Bear Management Units by females with young*).
- Monitoring all sources of mortality for independent females and males (≥2 years old) within the entire GYA. Mortality limits are set at ≤9% for independent females, ≤15% for independent males from all causes. Mortality limits for dependent young are ≤9% for known and probably human-caused mortalities (see *Estimating sustainability of annual grizzly bear mortalities*).

Habitat monitoring includes documenting the abundance of the 4 major foods throughout the GYA including winter ungulate carcasses, cutthroat trout (*Oncorhynchus clarki*) spawning numbers, bear use of army cutworm moth (*Euxoa auxiliaris*) sites, and whitebark pine (*Pinus albicaulis*) cone production. These protocols have been monitored and reported by the IGBST for several years and are reported here. Additionally, we continued to monitor the health of whitebark pine in the ecosystem in cooperation with the Greater Yellowstone Whitebark Pine Monitoring Working Group. A summary of the 2007 monitoring is also presented (Appendix A). The protocol has been modified to document mortality rate in whitebark pine from all causes, including mountain pine beetle (*Dendroctonus ponderosae*).

Also the Conservation Strategy requires maintenance of secure habitat, livestock allotments, developed sites at 1998 levels in each BMU subunit. This year, the first report detailing this monitoring program is provided. This report documents 1) changes in secure habitat, open motorized access route density, total motorized route density inside the PCA, 2) changes in number and capacity of developed sites inside the PCA, 3) changes in number of commercial livestock allotments and changes in the number of permitted domestic sheep animal months inside the PCA, and livestock allotments with grizzly bear conflicts during the last 5 years (see Appendix D).

The IGBST continues to work on issues associated with counts of unduplicated females with COY. These counts are used to estimate population size, which is then used to establish mortality thresholds. The methods used to estimate total females with COY and population size have been revised (IGBST 2005, 2006) and are detailed in this report. 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 COY 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. Results of this work were published in the Journal of Wildlife Management in 2008 (Schwartz et al. 2008). Findings suggest that the rule set of Knight et al. (1995) returns conservative estimates, but with minor adjustments, counts of unduplicated females with COY can serve as a reasonable index of population size useful for establishing annual mortality limits. As a follow up to the findings of Schwartz et al. (2008), the IGBST held a workshop in October 2007 (Appendix F). The purpose of the workshop was to discuss the feasibility of developing new models to distinguish unique females with COY. The outcome of that workshop was a research proposal detailing methods to develop a hierarchical model that should improve the methods used to distinguish unique females with COY. Funding for this project should be available by autumn 2008, and we expect results to be available by autumn 2009.

Results of DNA hair snaring work conducted on Yellowstone Lake (Haroldson et al. 2005) from 1997–2000 showed a decline in fish use by grizzly bears when compared to earlier work conducted by Reinhardt (1990) in 1985–1987. As a consequence, the IGBST started a 3-year study to determine if spawning cutthroat trout continue to be an important food for bears, or if the trout population has declined to the level that bears no longer use this resource. If trout are no longer a useful food resource, we want to determine what geographical areas and foods the bears are using and if those foods are an adequate replacement to maintain a healthy population of grizzly bears. This project began in 2007. There are 2 graduate students and several field technicians working on the program. A summary of the 2007 field work can be found in Appendix B.

The State of Wyoming, following recommendations from the Yellowstone Ecosystem Subcommittee and the IGBST, launched the Bear Wise Community Effort in 2005. The focus is to minimize human/bear conflicts, minimize human-caused bear mortalities associated with conflicts, and safeguard the human community. Results of these efforts are detailed in Appendix E. Also, the State of Wyoming conducted a field study testing remote sensing cameras to count females with COY. Results of that study are reported in Appendix C.

Finally, this report contains a report that documents the possibility of cub adoption. It's an interesting story and we encourage you to read it.

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 Greater Yellowstone Ecosystem (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 Greater Yellowstone Ecosystem (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 USGS - C. Alarcon, J. Brown, J. Erlenbach, L. Felicetti, J. Fortin, K. Kapp, B. Karabensh, R. Mowry, M. Neuman, K. Quinton, G. Rasmussen, T. Rosen, C. Rumble, S. Schmitz, J. Smith, J. Teisberg, C. Whitman, G. Wilson; NPS - M. Boyce, T. Coleman, C. Daigle-Berg, S. Dewey, D. Ethier, L. Frattaroli, B. Gafney, B. Hamblin, K. Loveless, G. Monroe, E. Reinertson, J. Sayer, S. Sigler, D. Smith, D. Stahler, A. Tallian, K. Wells, P.J. White, S. Wolff, B. Wyman, T. Wyman; MTFWP - N. Anderson, V. Asher, J. Smolczynski, S. Stewart, MSU - S. Cherry; WYGF - G. Anderson, B. Barr, D. Brimeyer, G. Brown, L. Chartrand, J. Clapp, D. Clause, B. DeBolt, D. Ditolla, T. Fagan, G. Fralich, H. Haley, A. Johnson, L. Knox, B. Kroger, S. Lockwood, L. Lofgren, J. Longobardi, D. McWhirter, C. Queen, R. Roemmich, C. Sax, Z. Turnball; IDFG - C. Anderson, J. Koontz, S. Liss, G. Losinski, D. Meints, A. Sorensen; USFS - B. Aber, K. Barber, C. Bell, B. Davis, L. Dickerson, A. Donnel, M. Engler, M. Hinschberger, M. Maj, L. Otto, A. Pils, E. Riggs, R. Spiering; Pilots and observers - B. Ard, S. Ard, B. Brannon, N. Cadwell, T. Schell, D. Smith, D. Stinson, D. Stradley, R. Stradley; WS - G. McDougal, J. Rost. Without the collection efforts of many, the information contained within this report would not be available.

Photo courtesy Steve Ard

Results and Discussion

Bear Monitoring and Population Trend

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

During the 2007 field season, 65 individual grizzly bears were captured on 73 occasions (Table 1), including 20 females (12 adult), 44 males (28 adult). One yearling bear, the offspring of a radio-collared female, was capture on 2 occasions with its mother present and was released without handling; sex was not determined for this individual. Forty-three individuals were new bears not previously marked.

We conducted research trapping efforts for 667 trap days (1 trap day = 1 trap set for 1 day) in the GYE. During research trapping operations we had 54 captures of 47 individual grizzly bears for a trapping success rate of 1 grizzly capture every 12.4 trap days.

There were 19 management captures of 18 individual bears in the GYE during 2007 (Tables 1 and 2), including 5 females (4 adult) and 13 males (7 adult). None of the bears captured at management settings were subsequently caught at research trap sites. One subadult male was a non-target capture during a wolf management trapping operation. This bear was successfully anesthetized, tagged, and released on site by the wolf trappers. Ten individual bears (3 females, 7 males), were relocated due to conflict situations (Table 1). One subadult female that was relocated and then returned to the conflict site was subsequently removed (live to Washington State University) from the population by Yellowstone National Park personnel. Seven other individuals (2 females, 5 males) were captured and removed due to conflicts (see *Estimating sustainability of annual grizzly bear mortalities*).

We radio-monitored 86 individual grizzly bears during the 2007 field season (Table 2), including 35 adult females (Tables 2 and 3). Fifty-one grizzly bears entered their winter dens wearing active transmitters, including 23 adult females (Table 3). Two bears not tracked consistently in 2007 are considered missing. Fates of 3 bears whose collars went on mortality remain unresolved. Since 1975, 576 individual grizzly bears have been radiomarked in the GYE.

Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem during 2007.

Bear	Sex	Age	Date	General location[a]	Capture type	Release site	Agency[b]
545	Male	Adult	13 Apr	Pat O'Hara Creek, Pr-WY	Management	Bear Creek, State-WY	WYGF
398	Male	Adult	14 Apr	Bull Elk Creek, Pr-ID	Management	Removed	IDFG
546	Male	Adult	23 Apr	Pat O'Hara Creek, Pr-WY	Management	Long Creek, SNF	WYGF
323	Male	Adult	24 Apr	Fairy Creek, YNP	Research	On site	IGBST
			1 May	Fairy Creek, YNP	Research	On site	IGBST
547	Male	Subadult	1 May	Madison River, YNP	Research	On site	IGBST
548	Male	Adult	2 May	Madison River, YNP	Research	On site	IGBST
G114	Male	Subadult	7 May	Fairy Creek, YNP	Research	On site	IGBST
			9 May	White Creek, YNP	Research	On site	IGBST
549	Male	Adult	8 May	Greybull River, Pr-WY	Management	Fox Creek, SNF	WYGF
550	Male	Subadult	8 May	W Fork Painter Creek, SNF	Research	On site	WYGF
G115	Male	Subadult	8 May	White Creek, YNP	Research	On site	IGBST
551	Female	Adult	9 May	Sunlight Creek, SNF	Research	On site	WYGF
552	Male	Adult	13 May	W Fork Painter Creek, SNF	Research	On site	WYGF
553	Male	Adult	13 May	Pilot Creek, SNF	Research	On site	WYGF
G116	Male	Adult	14 May	Deadman Bench, SNF	Research	On site	WYGF
			18 May	W Fork Painter Crk, SNF	Research	On site	WYGF
554	Female	Subadult	15 May	Lodgepole Creek, SNF	Research	On site	WYGF

Table 1. Continued.

Bear	Sex	Age	Date	General location[a]	Capture type	Release site	Agency[b]
G117	Male	Adult	16 May	Beam Gulch, SNF	Research	On site	WYGF
G118	Male	Subadult	16 May	Reeder Creek, Pr-MT	Management	On site	WS/MTFWP
G119	Male	Adult	20 May	Sunlight Creek, SNF	Research	On site	WYGF
			23 May	Sunlight Creek, SNF	Research	On site	WYGF
G108	Male	Subadult	23 May	Clarks Fork River, Pr-WY	Management	Removed	WYGF
555	Female	Adult	3 Jun	Thumb Creek, YNP	Research	On site	IGBST
556	Male	Subadult	3 Jun	Arnica Creek, YNP	Research	On site	IGBST
			15 Aug	Warm River, CTNF	Research	On site	IGBST
363	Male	Adult	6 Jun	Monument Bay, YNP	Research	On site	IGBST
557	Male	Adult	15 Jun	Flat Mountain Arm, YNP	Research	On site	IGBST
G120	Male	Subadult	23 Jun	Trout Creek, SNF	Research	On site	WYGF
558	Female	Subadult	25 Jun	Trout Creek, SNF	Research	On site	WYGF
G121	Female	Subadult	25 Jun	Trout Creek, SNF	Research	On site	WYGF
539	Female	Subadult	28 Jun	Lake Gov. Area, YNP	Management	Quadrant Mountain, YNP	YNP
			19 Aug	Yellowstone River, YNP	Management	Removed	YNP
559	Female	Adult	3 Jul	Trail Creek, YNP	Research	On site	IGBST
G122	Male	Adult	14 Jul	N Fork Fish Creek, BTNF	Research	On site	WYGF
338	Male	Adult	18 Jul	Bridge Creek, YNP	Research	On site	IGBST
560	Female	Subadult	23 Jul	Cottonwood Creek, BTNF	Research	On site	WYGF
561	Female	Subadult	29 Jul	Fish Creek, BTNF	Research	On site	WYGF
507	Female	Subadult	1 Aug	Partridge Creek, CTNF	Research	On site	IGBST
529	Male	Subadult	2 Aug	Deadhorse Creek, GNF	Research	On site	IGBST
526	Male	Subadult	3 Aug	Squaw Creek, BTNF	Research	On site	WYGF
562	Male	Adult	7 Aug	Fish Creek, BTNF	Management	Sulphur Creek, SNF	WYGF
179	Female	Adult	9 Aug	Cottonwood Creek, BTNF	Research	On site	WYGF
289	Female	Adult	13 Aug	Deadhorse Creek, GNF	Research	On site	IGBST
G123	Male	Subadult	18 Aug	Lucky Dog Creek, CTNF	Management	Removed	IDFG/IGBST
502	Female	Adult	19 Aug	Lucky Dog Creek, CTNF	Management	Removed	IDFG/IGBST
G124	Male	Subadult	19 Aug	Lucky Dog Creek, CTNF	Management	Removed	IDFG/IGBST
563	Male	Adult	26 Aug	Reas Creek, CTNF	Research	On site	IGBST
373	Male	Adult	28 Aug	Bootjack Creek, CTNF	Research	On site	IGBST
564	Male	Adult	1 Sep	Wagon Creek, BTNF	Management	Mormon Crk, SNF	WYGF
565	Male	Adult	1 Sep	Greybull River, Pr-WY	Management	Squirrel Crk, CTNF	WYGF
188	Female	Adult	5 Sep	Sunlight Creek, SNF	Management	Removed	WYGF
G125	Male	Subadult	5 Sep	Sunlight Creek, SNF	Management	Removed	WYGF
566	Male	Subadult	7 Sep	Gibbon River, YNP	Research	On site	IGBST
295	Female	Adult	8 Sep	Gibbon River, YNP	Research	On site	IGBST
567	Male	Adult	9 Sep	Yellowstone River, YNP	Research	On site	IGBST
568	Male	Adult	9 Sep	Yellowstone River, YNP	Research	On site	IGBST
569	Female	Adult	9 Sep	N Fork Shoshone, Pr-WY	Management	Blackrock Creek, BTNF	WYGF
570	Male	Adult	11 Sep	Yellowstone River, YNP	Research	On site	IGBST
571	Male	Adult	11 Sep	Yellowstone River, YNP	Research	On site	IGBST
379	Male	Adult	25 Sep	Thorofare Creek, YNP	Research	On site	IGBST

Table 1. Continued.

Bear	Sex	Age	Date	General location[a]	Capture type	Release site	Agency[b]
572	Female	Adult	25 Sep	N Fork Shoshone, Pr-WY	Management	Grassy Creek, CTNF	WYGF
573	Male	Adult	26 Sep	Thorofare Creek, YNP	Research	On site	IGBST
574	Male	Subadult	10 Oct	Flat Mountain Creek, YNP	Research	On site	IGBST
575	Male	Adult	13 Oct	The Promontory, YNP	Research	On site	IGBST
492	Female	Subadult	13 Oct	Flat Mountain Creek, YNP	Research	On site	IGBST
576	Female	Adult	18 Oct	Stephens Creek, YNP	Research	On site	IGBST
			25 Oct	Stephens Creek, YNP	Research	On site	IGBST
577	Female	Adult	23 Oct	Stephens Creek, YNP	Research	On site	IGBST
Unm	Unk	Subadult	23 Oct	Stephens Creek, YNP	Research	On site	IGBST
			25 Oct	Stephens Creek, YNP	Research	On site	IGBST
578	Male	Adult	25 Oct	Stephens Creek, YNP	Research	On site	IGBST
579	Male	Subadult	24 Nov	Red Lodge, Pr-MT	Management	Boulder River, GNF	MTFWP

[a] BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.
[b] IDFG = Idaho Fish and Game; IGBST = Interagency Grizzly Bear Study Team, USGS; MTFWP = Montana Fish, Wildlife and Parks; WRR = Wind River Reservation; WS = Wildlife Services; WYGF = Wyoming Game and Fish; YNP = Yelowstone National Park.

IGBST photo

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
2006	92	54	36	25	23
2007	86	65	54	19	8

Table 3. Grizzly bears radio monitored in the Greater Yellowstone Ecosystem during 2007.

Bear	Sex	Age	Offspring[a]	Monitored		Current Status
				Out of den	Into den	
125	F	Adult	3 COY, lost 2[b]	Yes	No	Cast
179	F	Adult	2 young[c]	No	Yes	Active
205	F	Adult	3 yearlings, lost 1	Yes	Yes	Active
239	M	Adult		Yes	No	Cast
287	M	Adult		Yes	No	Cast
289	F	Adult	None	No	Yes	Active
295	F	Adult	None	No	Yes	Active
323	M	Adult		No	No	Cast
338	M	Adult		Yes	No	Cast/Cast
363	M	Adult		Yes	No	Cast
365	F	Adult	3 yearlings	Yes	Yes	Active
373	M	Adult		No	Yes	Active
379	M	Adult		No	Yes	Active
407	M	Adult		Yes	Yes	Active
415	M	Adult		Yes	No	Cast
428	F	Adult	1 yearling	Yes	Yes	Active
439	F	Adult	1 yearling	Yes	Yes	Active
448	F	Adult	None	Yes	No	Cast
459	M	Adult		Yes	Yes	Active
465	M	Adult		Yes	No	Cast
472	F	Adult	1 yearling	Yes	Yes	Active
476	F	Adut	1 yearling	Yes	No	Unresolved
478	F	Adult	2 COY, lost both	Yes	No	Cast
482	F	Adult	3 COY	Yes	Yes	Active
489	F	Adult	3 COY	Yes	Yes	Active
492	F	Subadult		No	Yes	Active
495	F	Adult	2 COY	Yes	No	Unexplained loss
497	F	Adult	Not seen	Yes	No	Missing
499	F	Adult	None	Yes	Yes	Active
500	F	Adult	None	Yes	Yes	Active
501	F	Adult	1 yearling	Yes	No	Cast
503	F	Adult	2 yearlings	Yes	Yes	Active
505	F	Adult	2 COY, lost 1	Yes	No	Died
507	F	Subadult		No	Yes	Active
509	F	Adult		Yes	No	Died
517	F	Adult	2 yearlings	Yes	No	Missing
525	F	Adult	2 COY	Yes	Yes	Active
526	M	Subadult		No	Yes	Active

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored Out of den	Monitored Into den	Current Status
529	M	Subadult		Yes	Yes	Active
530	F	Adult	Not seen	Yes	Yes	Active
531	F	Adult	None	Yes	Yes	Active
532	M	Adult		No	Yes	Active
533	F	Adult	3 2-year-olds	Yes	Yes	Active
534	M	Subadult		Yes	No	Cast
537	F	Subadult		Yes	Yes	Active
538	M	Adult		Yes	No	Cast
539	F	Subadult		Yes	No	Removed
541	F	Adult	None	Yes	Yes	Active
542	M	Adult		Yes	No	Cast
543	M	Adult		Yes	No	Cast
544	M	Subadult		Yes	No	Unresolved
545	M	Adult		No	No	Cast
546	M	Adult		No	No	Cast
547	M	Subadult		No	Yes	Active
548	M	Adult		No	No	Cast
549	M	Adult		No	No	Cast
550	M	Subadult		No	Yes	Active
551	F	Adult	None	No	Yes	Active
552	M	Adult		No	No	Cast
553	M	Adult		No	No	Cast
554	F	Subadult		No	Yes	Active
555	F	Adult	2 COY	No	No	Cast
556	M	Subadult		No	No	Active

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored Out of den	Monitored Into den	Current Status
557	M	Adult		No	No	Cast
558	F	Subadult		No	Yes	Active
559	F	Adult	1 yearling	No	Yes	Active
560	F	Subadult		No	Yes	Active
561	F	Subadult		No	Yes	Active
562	M	Adult		No	Yes	Active
563	M	Adult		No	Yes	Active
564	M	Adult		No	No	Died
565	M	Adult		No	Yes	Active
566	M	Subadult		No	Yes	Active
567	M	Adult		No	Yes	Active
568	M	Adult		No	No	Unresolved
569	F	Adult	None	No	Yes	Active
570	M	Adult		No	Yes	Active
571	M	Adult		No	No	Died
572	F	Adult	None	No	No	Cast
573	M	Adult		No	Yes	Active
574	M	Subadult		No	Yes	Active
575	M	Adult		No	Yes	Active
576	F	Adult	1 young[b]	No	Yes	Active
577	F	Adult	None at capture	No	Yes	Active
578	M	Subadult		No	Yes	Active
579	M	Subadult		No	Yes	Active

[a] COY = cub-of-the-year.
[b] See *Possible Cub Adoption* in the Greater Yellowstone Ecosystem.
[c] Age of young unknown.

Assessing Trend and Estimating Population Size from Counts of Unduplicated Females *(Mark A. Haroldson, Interagency Grizzly Bear Study Team)*

Methods

Grizzly bears in the GYE were removed from protection under the Endangered Species Act (ESA 1975) as of 30 April 2007 (USFWS 2007*a*). Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and the demographics monitoring section of the Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007*c*), IGBST is tasked with estimating the number of female with COY, determining trend in this segment of the population, and estimating size of specific population segments to assess sustainability of annual mortalities. Specific procedures used to accomplish these tasked are presented in IGBST (2005, 2006) and Harris et al. (2007). Briefly, the Knight et al. (1995) rule set is used to differentiate an estimate for the number of unique females with COY ($\hat{N}_{Obs}$) and tabulate sighting frequencies for each family. We then apply the Chao2 estimator (Chao 1989, Wilson and Collins 1992, Keating et al. 2002, Cherry et al. 2007)

$$\hat{N}_{Chao2} = m + \frac{f_1^2 - f_1}{2(f_2 + 1)},$$

where m is the number of unique females sighted randomly (i.e., without the aid of telemetry), f_1 is the number of families sighted once, and f_2 is the number families sighted twice. This estimator accounts for individual sighting heterogeneity and produces an estimate for the total number of females with COY present in the population annually.

Next, we estimate trend and rate of change (λ) for the number of unique females with COY in the population from the natural log (*Ln*) of the annual $\hat{N}_{Chao2}$ estimates using linear and quadratic regressions with model averaging (Burnham and Anderson 2002). The linear model for $Ln(\hat{N}_{Chao2})$ with year (y_i) is:

$$Ln(\hat{N}_{Chao2}) = \beta_0 + \beta_1 y_i + \varepsilon_i .$$

Thus the population size at time zero is estimated as $\hat{N}_0 = \exp(\hat{\beta}_0)$ and the rate of population change is estimated as $\hat{\lambda} = \exp(\hat{\beta}_1)$, giving $\hat{N}_i = \hat{N}_0 \hat{\lambda}^{y_i}$. The quadratic model:

$$Ln(\hat{N}_{Chao2}) = \beta_0 + \beta_1 y_i + \beta_2 y_i^2 + \varepsilon_i ,$$

is included to detect changes in tend. Model AIC (Akaike Information Criterion) will favor the quadratic model if the rate of change levels off or begins to decline (IGBST 2006, Harris et al. 2007). This process smoothes variation in annual estimates that result from sampling error or pulses in numbers of females producing cubs due to natural processes (i.e., process variation). Some changes in previous model-averaged estimates for unduplicated females with COY ($\hat{N}_{MAFC}$) are expected with each additional year of data. Retrospective adjustments to previous estimates are not done (IGBST 2006). Demographic Recovery Criterion 1 (USFWS 2007*b*) specifies a minimum requirement of 48 females with cubs for the current year ($\hat{N}_{MAFC}$). Model-averaged estimates below 48 for 2 consecutive years will trigger a biology and management review, as will a shift in AIC that favors the quadratic model (i.e., AICc weight > 0.50; USFWS 2007*a*).

Given the assumption of a reasonably stable sex and age structure, trend for the females with COY represents the rate of change for the entire population (IGBST 2006, Harris et al. 2007). It follows that estimates for specific population segments can be derive from the $\hat{N}_{MAFC}$ and the estimated stable age structure for the population. Estimates for specific population segments and associated confidence intervals follow IGBST (2005, 2006). Thus, the total number of females ≥2 years old in the population is estimated by

$$\hat{N}_{females\ 2+} = \frac{\hat{N}_{MAFC}}{(0.289 * 0.77699)},$$

where 0.289 is the proportion of females ≥4 years old accompanied by COY from transition probabilities (IGBST 2005), and 0.77699 is the ratio of 4+ females to 2+ females in the population (IGBST 2006). Using the model averaged results in these calculations has the effect of putting the numerator ($\hat{N}_{MAFC}$) on the same temporal scale as the denominator (i.e., mean transition probability and ratio) which smoothes estimates and alleviates extreme variation which are likely uncharacteristic of the true population (IGBST 2006, Harris et al. 2007). The number of independent aged males is given by

$$\hat{N}_{males\ 2+} = \hat{N}_{females\ 2+} * 0.63513,$$

where 0.63513 is the ratio of independent males:independent females (IGBST 2006). The number of dependent young is estimated by

$$\hat{N}_{dependent\ \ young} = \{\hat{N}_{MAFC,t} + [(\hat{N}_{MAFC,t-1})(0.638)]\}2.04$$

where 2.04 is the mean number of COY/litter (Schwartz et al. 2006*a*) and 0.638 is the mean survival rate for COY (Schwartz et al. 2006*b*). Estimates of uncertainty associated with parameters of interest were derived from the delta method (Seber 1982:7) as described in IGBST (2006).

Results

We documented 335 verified sightings of females with COY during 2007 (Fig. 1). This was a 95% increase from the number of sightings obtained in 2006 (n = 172). Most (68%) observations were attributable to ground observers (Table 4). Additionally, a large percentage (72%) of the observations occurred within the boundary of Yellowstone National Park. From the 335 sightings we were able to differentiate 50 unduplicated females using the rule set described by Knight et al. (1995). Total number of COY observed during initial sightings was 108 and mean litter size was 2.16 (Table 5). There were 10 single cub litters, 22 litters of twins, and 18 litters of triplets seen during initial observations (Table 5).

Forty-eight families and 275 observations were obtained without telemetry (Table 6). Using these data $\hat{N}_{Chao2}$ = 53 (Table 6). Annual $\hat{N}_{Chao2}$ estimates for the period 1983–2007 (Table 3) were used to estimate the rate of population change (Fig. 2). Parameter estimates and AICc weights for the linear and quadratic models (Table 7) suggest that only the linear model is needed to model changes in the unduplicated female population for the period. The estimate of $\hat{\lambda}$ = 1.0453 with 95% confidence interval 1.03109 to 1.05976. The estimated quadratic effect (-0.00086, SE = 0.00104) was not significant (P = 0.413), with 74% of the AICc weight associated with the linear model. Therefore, the linear model is the best approximating model for the data. The $\hat{N}_{MAFC}$ = 54 (95% CI 44–66). The model averaged point estimate exceeds the demographic objective of 48 specified in the demographic criteria for the GYE (USFWS 2007*a*, 2007*b*). Additionally, AICc weight continues to support the linear model (USFWS 2007*b*), indicating an increasing trend. Using $\hat{N}_{MAFC}$ = 54, the estimated population size for 2007 is 571 (Table 8).

Table 4. Method of observation for female grizzly bears with cubs-of-the-year sighted in the Greater Yellowstone Ecosystem during 2007.

Method of observation	Frequency	Percent	Cumulative percent
Fixed wing – other researcher	8	2.4	2.4
Fixed wing – observation	61	18.2	20.6
Fixed wing - telemetry	38	11.3	31.9
Ground sighting	225	67.2	99.1
Helicopter – other research	1	0.3	99.4
Trap	2	0.6	100.0
Total	335	100	

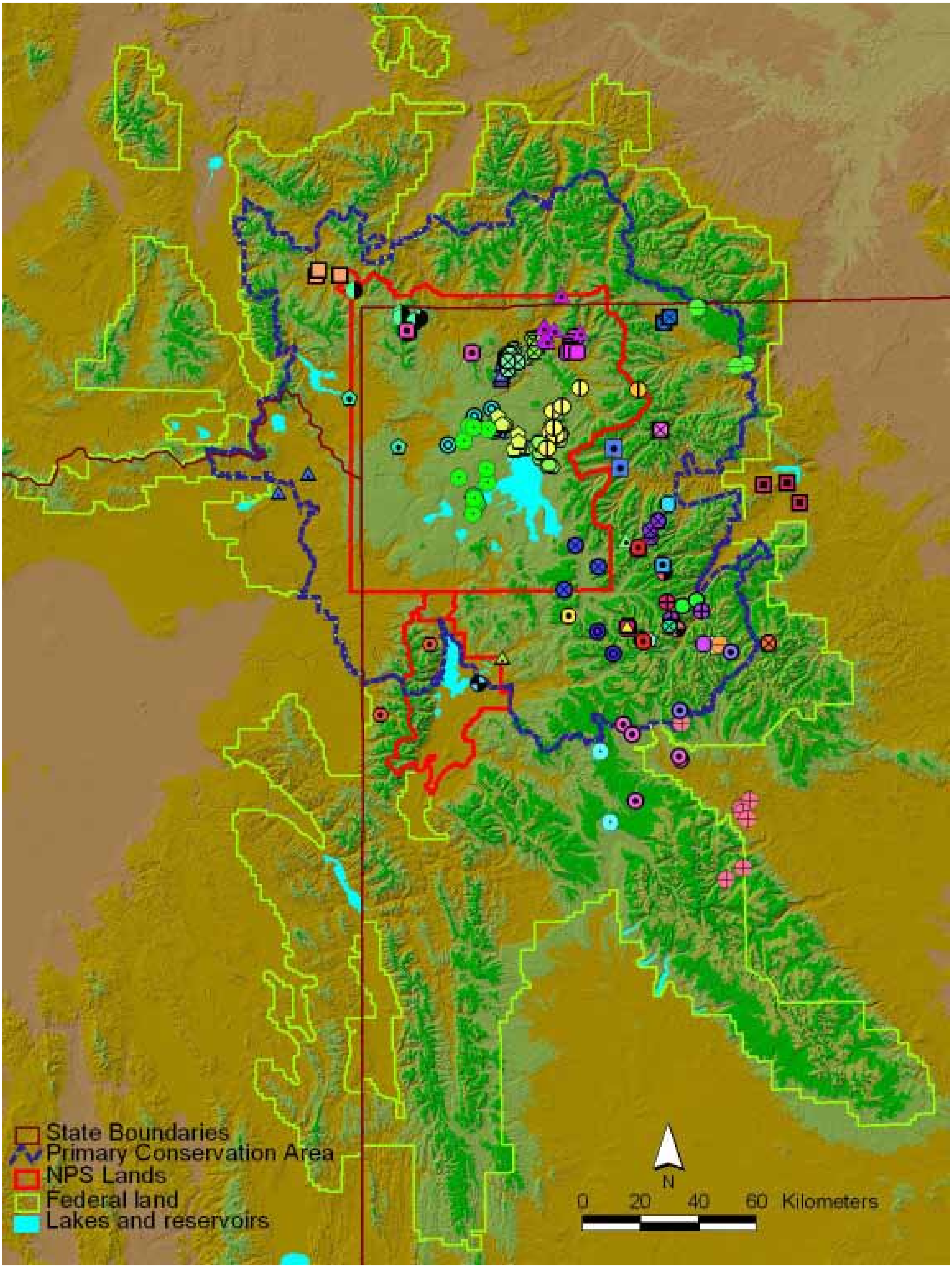

Figure 1. Distribution of 335 observations of 50 (indicated by unique symbols) unduplicated female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem

Table 5. Number of unduplicated females with cubs-of-the-year ($\hat{N}_{Obs}$), litter frequencies, total number of cubs, and average litter size at initial observation for the years 1973–2007 in the Greater Yellowstone Ecosystem.

Year	$\hat{N}_{Obs}$	Total sightings	Litter sizes: 1 cub	2 cubs	3 cubs	4 cubs	Total # cubs	Mean litter size
1973	14	14	4	8	2	0	26	1.86
1974	15	15	6	7	2	0	26	1.73
1975	4	9	2	2	0	0	6	1.50
1976	17	26	3	13	1	0	32	1.88
1977	13	19	3	8	2	0	25	1.92
1978	9	11	2	4	3	0	19	2.11
1979	13	14	2	6	5	0	29	2.23
1980	12	17	2	9	1	0	23	1.92
1981	13	22	4	7	2	0	24	1.85
1982	11	18	3	7	1	0	20	1.82
1983	13	15	6	5	2	0	22	1.69
1984	17	41	5	10	2	0	31	1.82
1985	9	17	3	5	1	0	16	1.78
1986	25	85	6	15	4	0	48	1.92
1987	13	21	1	8	4	0	29	2.23
1988	19	39	1	14	4	0	41	2.16
1989	16	33	7	5	4	0	29	1.81
1990	25	53	4	10	10	1	58	2.32
1991[a]	24	62	6	14	3	0	43	1.87
1992	25	39	2	12	10	1	60	2.40
1993	20	32	4	11	5	0	41	2.05
1994	20	34	1	11	8	0	47	2.35
1995	17	25	2	10	5	0	37	2.18
1996	33	56	6	15	12	0	72	2.18
1997	31	80	5	21	5	0	62	2.00
1998	35	86	9	17	9	0	70	2.00
1999	33	108	11	14	8	0	63	1.91
2000	37	100	9	21	7	0	72	1.95
2001	42	105	13	22	7	0	78	1.86
2002	52	153	14	26	12	0	102	1.96
2003	38	60	6	27	5	0	75	1.97
2004	49	223	14	23	12	0	96	1.96
2005	31	93	11	14	6	0	57	1.84
2006	47	172	12	21	14	0	96	2.04
2007	50	335	10	22	18	0	108	2.16

[a] One female with unknown number of cubs. Average litter size was calculated using 23 females.

Table 6. Annual estimates for the numbers of females with cubs-of-the-year in the Greater Yellowstone Ecosystem grizzly bear population, 1983–2007. The number of unique females observed ($\hat{N}_{Obs}$) includes those located using radio-telemetry; *m* gives the number of unique females observed using random sightings only; and $\hat{N}_{Chao2}$ gives the nonparametric biased corrected estimate, per Chao (1989). Also included are f_1, the number of families sighted once, f_2, the number of families sighted twice, and an annual estimate of relative sample size ($n / \hat{N}_{Chao2}$), where *n* is the total number of observations obtained without the aid of telemetry.

Year	$\hat{N}_{Obs}$	m	f_1	f_2	$\hat{N}_{Chao2}$	n	$n / \hat{N}_{Chao2}$
1983	13	10	8	2	19	12	0.6
1984	17	17	7	3	22	40	1.8
1985	9	8	5	0	18	17	0.9
1986	25	24	7	5	28	82	3
1987	13	12	7	3	17	20	1.2
1988	19	17	7	4	21	36	1.7
1989	16	14	7	5	18	28	1.6
1990	25	22	7	6	25	49	2
1991	24	24	11	3	38	62	1.6
1992	25	23	15	5	41	37	0.9
1993	20	18	8	8	21	30	1.4
1994	20	18	9	7	23	29	1.3
1995	17	17	13	2	43	25	0.6
1996	33	28	15	10	38	45	1.2
1997	31	29	13	7	39	65	1.7
1998	35	33	11	13	37	75	2
1999	33	30	9	5	36	96	2.7
2000	37	34	18	8	51	76	1.5
2001	42	39	16	12	48	84	1.7
2002	52	49	17	14	58	145	2.5
2003	38	35	19	14	46	54	1.2
2004	49	48	15	10	58	202	3.5
2005	31	29	6	8	31	86	2.8
2006	47	43	8	16	45	140	3.3
2007	50	48	12	12	53	275	5.1

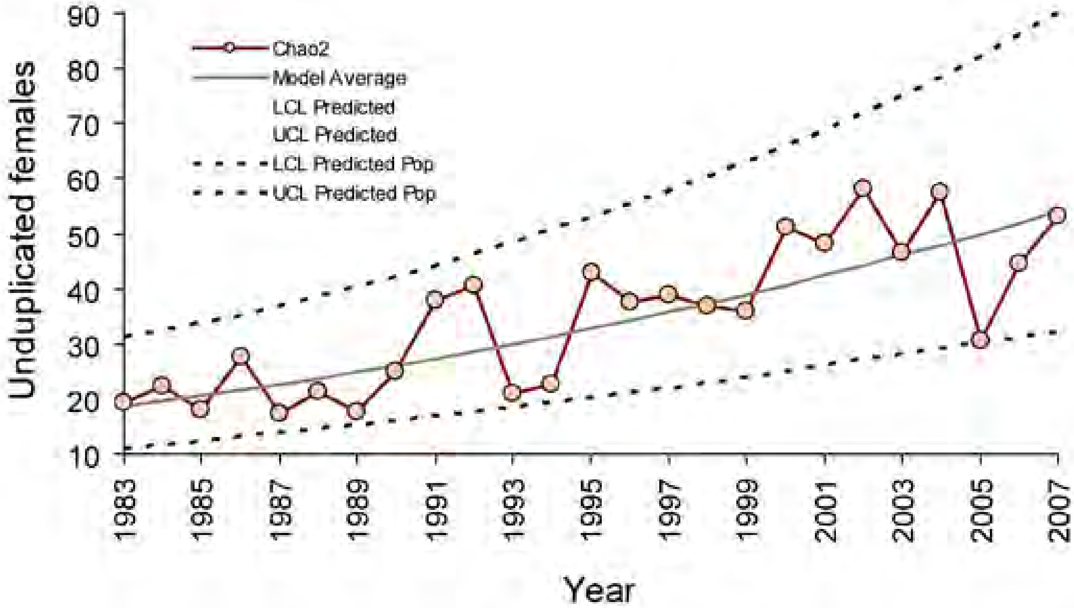

Fig. 2. Model-averaged estimates for the number of unduplicated female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem for the period 1983–2007, where the linear and quadratic models of $Ln(\hat{N}_{Chao2})$ were fitted. The inner set of light solid lines represents a 95% confidence interval on the predicted population size for unduplicated female, whereas the outer set of dashed lines represents a 95% confidence interval for the individual population estimates for unduplicated females.

Table 7. Parameter estimates and model selection results from fitting the linear and quadratic models for $Ln(\hat{N}_{Chao2})$ with years for the period 1983–2007.

Model	Parameter	Estimate	Standard Error	*t* value	Pr(>*t*)
Linear					
	β_0	2.90113	0.09854	29.4408	<0.0001
	β_1	0.04433	0.00663	6.6882	<0.0001
	SSE	1.31375			
	AICc	-66.50682			
	AICc weight	0.73882			
Quadratic					
	β_0	2.79998	0.15673	17.86490	<0.0001
	β_1	0.06681	0.02778	2.40520	0.02501
	β_2	-0.00086	0.00104	-0.83362	0.41346
	SSE	1.27353			
	AICc	-64.42714			
	AICc weight	0.26118			

Table 8. Estimates and 95% confidence intervals (CI) for population segments and total grizzly bear population size for 2007 in the Greater Yellowstone Ecosystem.

			95% CI	
	Estimate	Variance	Lower	Upper
Independent females	240	444.6	199	282
Independent males	153	321.1	118	188
Dependent young	178	98.9	158	197
Total	571	864.4	513	629

Possible Cub Adoption in the Greater Yellowstone Ecosystem *(Mark A. Haroldson, Interagency Grizzly Bear Study Team; and Kerry A. Gunther and Travis Wyman, Yellowstone National Park)*

We suspect that 2 females with COY observed frequently in the Dunraven Pass-Antelope Creek areas of Yellowstone National Park were involved in an exchange of COY during early August 2007. One of these females was radio-marked (#125) with an extensive research history. Bear #125 was first radio-collared as a 3-year-old in Antelope Creek on 6 August 1986. Subsequent to that she was captured and re-collared on 5 other occasions (1990, 1993, 1995, 2000, and 2006), each time in the Antelope Creek drainage. She has been radio-located during 18 of the 21 years since her initial capture. Bear #125's life range computed using Very High Frequency (VHF) telemetry locations (*n* = 272) and employing a fixed kernel estimator (95%) is centered on the Antelope Creek-Mount Washburn area (Fig. 3). We have knowledge of 4 previous litters produced by #125 (in 1990, 1994, 1997, and 2002). During 2007 she was observed with 3 COY during aerial telemetry and observation flights on 7 occasions between 3 June–3 August (Fig. 3, where observation and telemetry locations coincide). She was last seen with 3 COY during a telemetry flight on 3 August (Fig. 4). Agency personnel provided an additional 14 verified observations of a collared female with 3 COY (Fig. 3) in the Antelope Creek drainage that we considered re-sightings of female #125 using the rule set devised by Knight et al. (1995) to differentiate unique females with COY.

The second female (Fig. 5) was not marked but was observed by agency personnel with 2 cubs on 68 occasions between 29 May–7 August. She was easily distinguishable because she was highly habituated to people and frequently foraged native vegetation within 30 to 100 m of the Dunraven Pass road. She was the only habituated female grizzly bear with cubs that regularly foraged along this section of road. On 11 August a female with 4 cubs (Fig. 6) was first observed frequenting the same roadside habitats (Fig. 3, Yellow triangles), exhibiting the same behavior, and identical in physical characteristics as the second female. On 16 August, female #125 who had had 3 cubs was seen with only 1 cub (Fig. 7). Additionally, there were no further observations of a female with 2 cubs in the area, suggesting the second female adopted, or was fostering 2 of female #125's cubs. Subsequent to 11 August we obtained 8 additional observations of an unmarked female with 4 COY. Although possible, we think it unlikely that a previously unobserved, highly habituated female with 4 COY would appear in these roadside habitats this late in the season.

In an attempt to obtain samples for DNA analysis we set hair snares and a remote camera at a location between 2 areas frequented by the female with 4 COY on 19 August. We installed 1 strand of

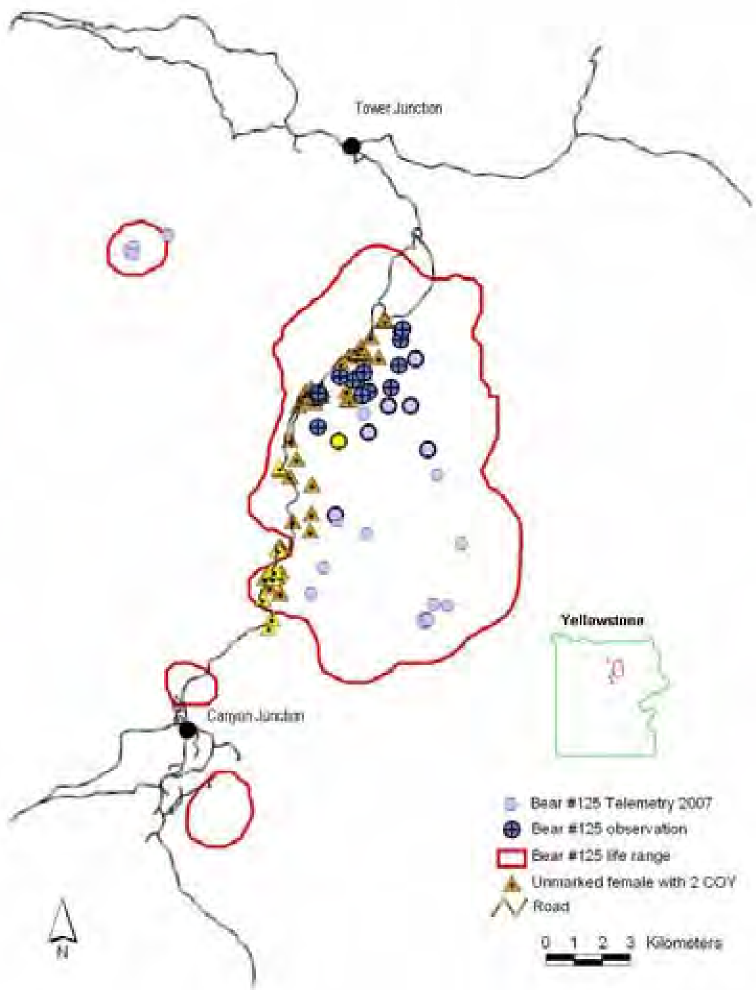

Fig. 3. Distribution of observations obtained on the female bears apparently involved in the exchange of cubs during August 2007. Yellow triangles and circles depict observations after numbers of young accompanying each female changed. Also shown (red polygon) is the 95% fixed kernel life range (272 locations over 18 years) for female #125.

barbed wire at adult bear height (approximately 60 cm) and 4 strands at cub height (approximately 25 cm). Inside each of the hair snares we applied one of a variety of call lures to pieces of downed timber debris. Hair samples were collected from the adult and cub height hair snares on 22 August. Remotely triggered photographs taken 20 August 2007 showed a female with 4 COY inside the wires (Fig. 8). Genetic analyses on the sampled hair and an archived sample from the most recent capture of bear #125 (taken 25 Sep 2006) is being conducted by Dr. David Peatkau (Wildlife Genetics International, Nelson, B.C., Canada) and may reveal if this was indeed a case of adoption and possibly the relatedness of the females.

Cub adoption in grizzly bears has been documented in Yellowstone National Park, but not since bears congregated at the open pit dumps during the late 1960s (Craighead et al. 1995). Natural cub adoptions had been observed primarily where bears congregate at abundant food sources such as salmon streams (Dean et al. 1992). Adoptions are generally thought to result from errors or mistakes made by females with young following the confusion and stress caused by confrontations with other bears (Erickson and Miller 1963). In this case, there were unconfirmed reports that an agonistic encounter between wolves and bear #125 led to her separation from 2 of her cubs. The adoptive mother probably happened by these cubs by chance and accepted them as her own. Because bears typically occur at low densities, mother-offspring recognition may not be as well developed as with more gregarious species (Lunn et al. 2000). We hope to obtain additional observation of these 2 families during 2008 that may determine if this was a case of long-term adoption or temporary fostering.

Fig. 4. Female grizzly bear #125 accompanied by 3 cubs-of-the-year on 3 August 2007, in Antelope Creek, Yellowstone National Park. Photograph by pilot Steve Ard.

Fig. 5. Unmarked female grizzly bear accompanied by 2 cubs-of-the-year on 11 June 2007, near Dunraven Pass, Yellowstone National Park. Photograph by Steve Koehler.

Fig. 6. Unmarked female grizzly bear accompanied by 4 cubs-of-the-year on 11 August 2007, near Dunraven Pass, Yellowstone National Park. Photograph by Steve Koehler.

Fig. 7. Female grizzly bear #125 accompanied by 1 cub-of-the-year on 16 August 2007, in Antelope Creek, Yellowstone National Park. Photograph by pilot Steve Ard.

Fig. 8. Remotely taken photograph of 4 cubs-of-the-year (a) and adult (b) at a hair snagging site on 20 August 2007

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

Dispersion of reproductive females throughout the ecosystem is assessed by verified observation of female grizzly bears with young (COY, yearlings, 2-year-olds, and/or young of unknown age) by BMU. The requirements specified in the Final Conservation Strategy (USFWS 2007c) and the Revised Demographic Recovery Criteria (USFWS 2007*b*) state that 16 of the 18 BMUs must be occupied by young on a running 6-year sum with no 2 adjacent BMUs unoccupied. Seventeen of 18 BMUs had verified observations of female grizzly bears with young during 2007 (Table 9). Females with young were not documented in the Hellroaring/Bear BMU. Eighteen of 18 BMUs contained verified observations of females with young in at least 4 years of the last 6-years (2002–2007) period.

Table 9. 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, 2002–2007.

Bear Management Unit	2002	2003	2004	2005	2006	2007	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		4
4) Boulder/Slough	X	X	X	X		X	5
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	5
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	16	17	18	16	17	

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

Grizzly bears in the GYE have, and are continuing, to expand their range. Nine new Bear Observation Areas (BOAs 29–37; Fig. 9) were added in 2007 to provide flight effort into areas bears have, or are expected, to expand into. Two rounds of observation flights were conducted during 2007. Forty-four BOAs were surveyed during Round 1 (24 May–2 Aug); only 30 BOAs were flown during Round 2 (21 Jun–14 Aug) primarily due to fire restrictions and poor weather. Observation time was 99 hours for Round 1 and 75 hours for Round 2; average duration of flights for both rounds combined was 2.4 hours (Table 10). Three hundred one bear sightings, excluding dependent young, were recorded during observation flights. This included 6 radio-marked bears (2 solitary bears, a female with 2 COY, 2 females with 3 COY, and a female with 2 yearlings seen in Area 10B during both rounds), 221 solitary unmarked bears, and 73 unmarked females with young (Table 10). Observation rate was 1.73 bears/hour for all bears. One hundred fifty-two young (108 COY, 36 yearlings, and 8 2-year-olds) were observed (Table 11). Observation rates were 0.37 for females with young/hour and 0.27 females with COY/hour (Table 11).

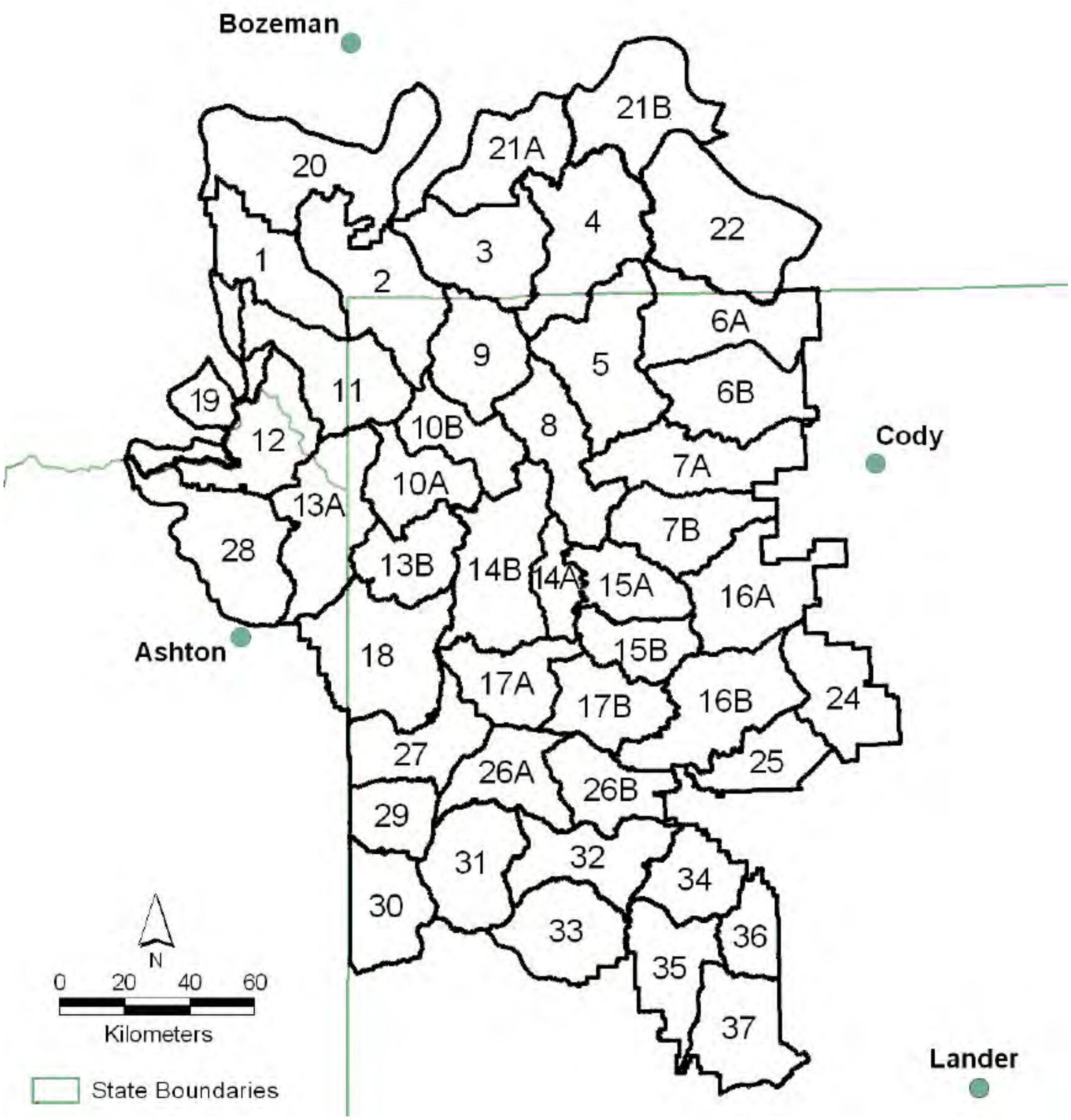

Fig. 9. Observation flight areas within the Greater Yellowstone Ecosystem, 2007. The numbers represent the 36 Bear Observation Areas. Those units too large to search during a single flight were further subdivided into 2 units. Consequently, there were 46 search areas.

Table 10. Annual summary statistics for observation flights conducted in the Greater Yellowstone Ecosystem, 1987–2007.

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	Total number of groups	Observation rate (bears/hour): All groups	Observation rate (bears/hour): With young	Observation rate (bears/hour): 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
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
2006[d]	Round 1	89.3	37	2.4	2	1	106	35	144	1.61		
	Round 2	77.0	33	2.3	3	1	76	24	104	1.35		
	Total	166.3	70	2.3	5	2	182	59	248	1.49	0.37	0.27
2007[d]	Round 1	99.0	44	2.3	2	1	125	53	181	1.83		
	Round 2	75.1	30	2.5	0	4	96	20	120	1.60		
	Total	174.1	74	2.4	2	5	221	73	301	1.73	0.45	0.29

[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 Jul–13 Sep); 2004 (12 Jun–26 Jul, 3 Jul–28 Aug); 2005 (4 Jun–26 Jul, 1 Jul–31 Aug); 2006 (5 Jun–9 Aug, 30 Jun–28 Aug); 2007 (24 May–2 Aug, 21 Jun–14 Aug).

Table 11. Size and age composition of family groups seen during observation flights in the Greater Yellowstone Ecosystem, 1998–2007.

	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
Date									
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
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
2006[a]									
Round 1	8	12	7	4	2	2	1	0	0
Round 2	5	11	2	2	1	0	2	2	0
Total	13	23	9	6	3	2	3	2	0
2007[a]									
Round 1	7	21	9	8	6	0	2	1	0
Round 2	2	6	6	3	2	3	0	2	0
Total	9	27	15	11	8	3	2	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 Jun–26 Jul, 1 Jul–31 Aug); 2006 (5 Jun–9 Aug, 30 Jun–28 Aug); 2007 (24 May–2 Aug, 21 Jun–14 Aug).

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

One hundred thirty-seven telemetry relocation flights were conducted during 2007, resulting in 484.4 hours of search time (ferry time to and from airports excluded) (Table 12). Flights were conducted at least once during all months, with 88% occurring May–November. During telemetry flights, 1,018 locations of bears equipped with radio transmitters were collected, 156 (15%) of which included a visual sighting. Fifty-two sightings of unmarked bears were also obtained during telemetry flights, including 40 solitary bears, 7 females with COY, 4 females with yearlings, and 1 female with 2-year-olds. Rate of observation for all unmarked bears during telemetry flights was 0.11 bears/hour. Rate of observing females with COY was 0.014/hour, which was considerably less than during observation flights (0.29/hour) in 2007.

Photo courtesy Steve Ard

Table 12. Summary statistics for radio-telemetry relocation flights in the Greater Yellowstone Ecosystem, 2007.

				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/hr)	Lone bears	With COY[a]	With yearlings	With young	All groups	Females with COY
January	9.40	3	3.13	24	0	0.00	0	0	0	0	---	---
February	3.70	1	3.70	16	0	0.00	0	0	0	0	---	---
March	7.37	2	3.69	31	1	0.14	0	0	0	0	---	---
April	29.50	8	3.69	73	11	0.37	5	0	0	1	0.20	0.000
May	81.73	21	3.89	144	35	0.43	6	1	0	0	0.86	0.012
June	69.02	18	3.83	124	39	0.57	8	2	0	0	0.12	0.029
July	60.57	20	3.03	119	14	0.23	1	2	0	0	0.05	0.033
August	50.36	18	2.80	112	17	0.34	12	2	2	0	0.32	0.040
September	52.13	19	2.74	125	19	0.36	5	0	0	0	0.10	0.000
October	47.96	9	5.33	103	16	0.33	3	0	1	0	0.08	0.000
November	63.61	15	4.24	115	4	0.06	0	0	0	0	---	---
December	9.08	3	3.03	32	0	0.00	0	0	0	0	---	---
Total	484.43	137	3.54	1,018	156	0.32	40	7	4	1	0.11	0.014

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

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

Grizzly bears in the GYE were removed from protection under the Endangered Species Act (ESA 1975) as of 30 April 2007 (USFWS 2007*a*). Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and the demographics monitoring section of the Final Conservation Strategy for Grizzly Bear in the Greater Yellowstone Area (USFWS 2007*c*), IGBST is tasked with evaluating the sustainability of annual mortalities. Specific procedures used to accomplish these tasked are presented in IGBST (2005, 2006). Briefly, estimates for specific population segments are derived from the modeled-averaged annual Chao2 estimate for females with COY (see *Assessing trend and estimating population size from counts of unduplicated females*).

Sustainable mortality for independent aged (≥2 years) females is considered 9% of the estimated size for this segment of the population (IGBST 2005, 2006; USFWS 2007*b*). Thus, female mortalities are within sustainable limits if,

$$\hat{D}_F \leq \hat{N}_F * 0.09 \ ,$$

where, $\hat{N}_F$ is the estimated population size for independent aged females and $\hat{D}_F$ is the estimated total mortality for independent aged females. All sources of mortality are used to evaluate sustainability for independent aged bears which includs an estimate of the unreported loss (Cherry et al. 2002, IGBST 2005). Thus,

$$\hat{D}_F = A_F + R_F + \hat{B}_F \ , \qquad (1)$$

where A_F is the number of sanctioned agency removals of independent females (including radio-marked individuals), R_F is the number of radio-marked bears lost (excluding sanctioned removals), and B_F is the median of the creditable interval for the estimated reported and unreported loss (Cherry et al. 2002). Exceeding independent female mortality limits for 2 consecutive years will trigger a biology and management review (USFWS 2007*a*).

Sustainability for independent aged males is 15% of the estimated male population (IGBST 2005, 2006; USFWS 2007*b*). Male mortality is considered sustainable if,

$$\hat{D}_M \leq \hat{N}_M * 0.15 \ ,$$

where $\hat{N}_M$ is the estimated population size for independent aged males and $\hat{D}_M$ is the estimated total mortality for independent males obtained by,

$$\hat{D}_M = A_M + R_M + \hat{B}_M \ , \qquad (2)$$

where A_M is the number of sanctioned agency removals of independent males (including radio-marked individuals), R_M is the number of radio-marked bears lost (excluding sanctioned removals), and B_M is the median of the creditable interval for the estimated reported and unreported loss (Cherry et al. 2002). Exceeding independent male mortality limits for 3 consecutive years will trigger a biology and management review (USFWS 2007*a*).

Sustainability for dependent young (i.e., COY and yearlings) is set at 9% of the estimate for this population segment. Only human-caused deaths are assessed against this threshold (USFWS 2007*a*). Exceeding the dependent young mortality limit for 3 consecutive years will trigger a biology and management review (USFWS 2007*a*).

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." When evidence is circumstantial, with no prospect for additional information, a "possible" mortality is designated. Possible mortalities are excluded from assessments of sustainability. We continue to tabulate possible mortalities because at the least they provide an additional source of location information for grizzly bears in the GYE.

2007 Mortality Results

We documented 31 known and probable and 2 possible mortalities in the GYE during 2007. Of the known and probable mortalities, 24 were attributable to human causes (Table 13). Twelve (50%) of the human-caused losses were hunting related; including 5 adult females, 3 of which were accompanied by 5 COY (Table 13). The remaining human-caused losses were management removals (*n* = 8), road kills (*n* = 3), and 1 death currently under investigation. We also documented 5 natural mortalities and 2 from undetermined causes (Table 13). Both possible mortalities were hunting related and no substantive evidence developed that mortalities had occurred.

Among independent aged female bears there were 3 management removals, 2 deaths of radio-marked individuals, and 6 other reported losses (Table 14). Most (67%) of the reported losses for independent females were hunting related. We documented 2 management removals, 1 radio-marked loss, and 4 reported losses for independent aged males (Table 14). Causes of reported losses for independent males included road kill (*n* =1), hunting related (*n* = 1), undetermined cause (*n* = 1), and 1 loss currently under investigation. All human-caused losses of dependent young were COY and totaled 10 (Table 14). Using the criteria specified under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and methodology presented by IGBST (2005, 2006), none of mortality thresholds (i.e., dependent young, independent females and males) were exceeded during 2007 (Table 14).

Table 13. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2007.

Bear[a]	Sex	Age[b]	Date	Location[c]	Certainty	Cause
398	M	Adult	4/14/07	Bull Elk Creek, Pr-ID	Known	Human-caused, management removal for human injuries at private residence, bear was feeding on moose carcass near house.
509	F	Adult	4/29/07	Joy Creek, BTNF	Known	Undetermined cause, last active location for bear #509 was 12/17/2006. Transmitter was on mortality when first located in spring 2007 (4/29). Bear was collared at time of loss.
G108	M	Subadult	5/23/07	Clarks Fork River, Pr-WY	Known	Human-caused, management removal for numerous conflicts and food rewards.
Unm	M	Adult	5/28/07	Dutch Joe Creek, BTNF	Known	Human-caused, hunting related, mistaken identity by black bear hunter.
Unm	Unk	COY	6/8/07	Bear Creek, Pr-WY	Probable	Natural, 1 COY lost by bear #505 between 6/5 and 6/11, date and location are approximate (average for interval).
Unm	M	COY	6/22/07	Clarks Fork River, SNF	Known	Human-caused, killed by a vehicle near MT state line on U.S. Highway 212.
Unm	Unk	COY	6/28/07	Cabin, Creek, SNF	Probable	Natural, 1st of 2 COY lost by bear #478 between 5/30 and 7/28, date and location are approximate (average for interval).
Unm	Unk	COY	6/28/07	Cabin, Creek, SNF	Probable	Natural, 2nd of 2 COY lost by bear #478 between 5/30 and 7/28, date and location are approximate (average for interval).
Unm	M	COY	7/14/07	Arizona Creek, GTNP	Known	Human-caused, killed by a vehicle near Arizona Island Picnic Area on Highway 89, GTNP .
G123	M	COY	8/17/07	Lucky Dog Creek, CTNF	Known	Human-caused, management removal (live to San Diego Zoo) for nuisance activity and food rewards by mother (#502).
502	F	Adult	8/18/07	Lucky Dog Creek, CTNF	Known	Human-caused, management removal (live to Washington State University) for numerous nuisance activity, food rewards and property damage, 2 COY (#G123 and #G124) also removed.

Table 13. Continued.

Bear[a]	Sex	Age[b]	Date	Location[c]	Certainty	Cause
G124	M	COY	8/19/07	Lucky Dog Creek, CTNF	Known	Human-caused, management removal (live to San Diego Zoo) for nuisance activity and food rewards by mother (#502).
539	F	Subadult	8/19/07	Fishing Bridge, YNP	Known	Human-caused, management removal (live to Washington State University) for numerous nuisance activity, food rewards, and property damage. Bear was collared when removed.
188	F	Adult	9/5/07	Sunlight Creek, SNF	Known	Human-caused, management removal for numerous nuisance activity and property damage.
G125	M	COY	9/5/07	Sunlight Creek, SNF	Known	Human-caused, management removal for numerous nuisance activity and property damage by mother (#188).
Unm	F	Adult	9/9/07	Little Trail Creek, GNF	Known	Human-caused, self-defense during chance encounter with hunter, female was accompanied by 2 COY. Carcass was found 10/4.
Unm	Unk	COY	9/9/07	Little Trail Creek, GNF	Probable	Human-caused, COY of female shot in self-defense during chance encounter with hunter.
Unm	Unk	COY	9/9/07	Little Trail Creek, GNF	Probable	Human-caused, COY of female shot in self-defense during chance encounter with hunter.
Unm	Unk	Subadult	9/20/07	Lamar River, YNP	Known	Natural, likely predation by bear or wolves, carcass was seen via optics, but was gone when site was visited 1 day later Hair samples obtained for sex determination.
571	M	Adult	9/24/07	Thorofare Creek, BTNF	Known	Human-caused, self-defense during conflict over hunter's elk carcass that was left overnight. Bear was collared at time of loss.
Unm	F	Adult	9/25/07	Lamar River, YNP	Known	Natural, likely predation by bear.
426	M	Adult	9/28/07	Thorofare Creek, BTNF	Known	Human-caused, under investigation.
Unm	F	Adult	10/2/07	Wiggins Fork, SNF	Known	Human-caused, hunting related, self-defense killing of female with 2 large young during chance encounter with elk hunter.
564	M	Adult	10/3/07	Blackrock Creek, BTNF	Known	Human-caused, killed by a vehicle on Togwotee Pass Highway 287, BTNF.
Unm	F	Adult	10/6/07	Beattie Gulch, GNF	Possible	Human-caused, self-defense during chance encounter with bow hunter, female was accompanied by 3 COY. One shot was fired at female with handgun. No evidence bear was shot during encounter. A female bear and 3 COY were sighted several times in area 24-29 Oct. Female did not appear injured.
Unm	F	Adult	10/6/07	Sunlight Creek, GNF	Known	Human-caused, self-defense during chance encounter with bow hunter, female was accompanied by 1arge young, not COY. Carcass found at conflict site.
Unm	F	Adult	10/5/07	Lodgepole Creek, SNF	Known	Human-caused, hunting related, self-defense killing of female with 2 COY.
Unm	Unk	COY	10/5/07	Lodgepole Creek, SNF	Probable	Human-caused, hunting related, COY of female killed by hunter.
Unm	Unk	COY	10/5/07	Lodgepole Creek, SNF	Probable	Human-caused, hunting related, COY of female killed by hunter.
Unm	Unk	Unk	10/8/07	Bobcat Creek, SNF	Possible	Human-caused, hunting related, independent bear shot at when hunters attempted to retrieve elk carcass left overnight.

Table 13. Continued.

Bear[a]	Sex	Age[b]	Date	Location[c]	Certainty	Cause
505	F	Adult	11/10/07	Bretesche Creek, Pr-WY	Known	Human-caused, hunting related, bear charged deer hunter and was killed. Female was collared and accompanied by 1 COY.
Unm	Unk	COY	11/10/07	Bretesche Creek, Pr-WY	Probable	Human-caused, hunting related, COY of female (#505) killed by hunter.

[a] Unm = unmarked bear, number indicates bear number.
[b] COY = cub-of-the-year. Unk = unknown age
[c] BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, WWR = Wind River Reservation, YNP = Yellowstone National Park, Pr = private.

Table 14. Annual size estimates ($\hat{N}$) for population segments and evaluation of sustainability for known and probable mortalities documented during 2007 in the Greater Yellowstone Ecosystem. Established mortality thresholds (USFWS 2007*b*) are 9%, 9%, and 15% for dependent young and independent (≥2) females and males, respectively. Only human-caused losses are counted against the mortality threshold for dependent young.

Population segment	$\hat{N}$	Human-caused loss	Sanctioned removals (A[a])	Radio-marked loss (R[b])	Reported loss	Estimated reported and unreported loss (B[c])	Estimated total mortality (D[d])	Annual mortality limit	Mortality threshold year result
Dependent young	178	10						16	Under
Independent females[e]	240	8	3	2	6	15	20	22	Under
Independent males[f]	153	6	2	1	4	10	13	23	Under

[a] Term A in equations 1 and 2 is the annual count of agency sanctioned management removals of independent aged bears including those involving radio-marked individual.
[b] Term R in equations 1and 2 is the annual count of loss for independent aged bears wearing active telemetry except those removed through management actions.
[c] Term B in equations 1 and 2 is the median of the credible interval for estimated reported and unreported loss calculated using methods described in Cherry et al. (2002) from the annual reported loss.
[d] Term D in equations 1 and 2 is estimated total mortality which is the sum of the sanctioned removals, the radioed-marked loss, and the estimated reported and unreported loss.
[e] Mortality counts and estimates for independent aged female bears are indicated by subscript F in equation 1.
[f] Mortality counts and estimates for independent aged male bears are indicated by subscript M in equation 2.

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 and Travis Wyman, Yellowstone National Park)*

It is well documented that grizzly bears use ungulates as carrion (Mealey 1980, Henry and Mattson 1988, Green 1994, Blanchard and Knight 1996, Mattson 1997) in Yellowstone National Park (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 2007, we surveyed routes in ungulate winter ranges to monitor the relative abundance of spring ungulate carcasses (Fig. 10).

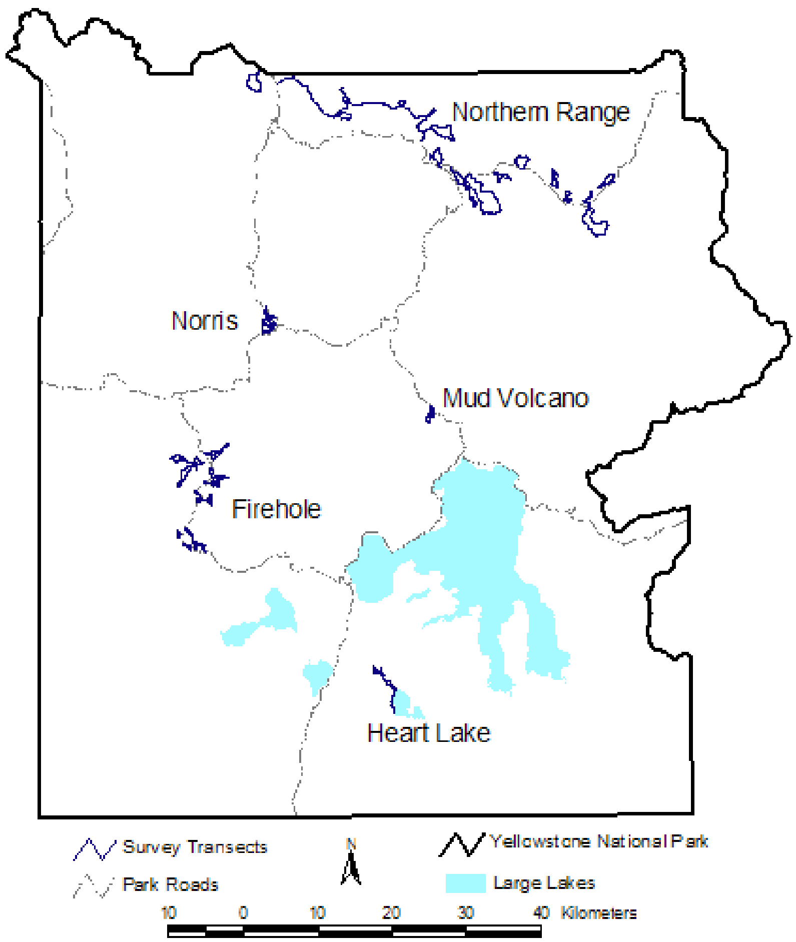

Fig. 10. Spring ungulate carcass survey transects in 5 areas of Yellowstone National Park.

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 2006–2007 is 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 151 km traveled. We used a Global Positioning System (GPS) to more accurately measure the actual distance traveled on most of the routes. We counted 30 carcasses, including 1 mule deer (*Odocoileus hemionus*), 28 elk, and 1 pronghorn (*Antilocapra americana*), which equated to 0.19 carcasses/km (Table 15). Sex and age of carcasses found are shown in Table 16. All carcasses were almost completely consumed by scavengers.

Evidence of use by grizzly bears was found at 3 elk carcasses. Evidence of use by wolves was found at 2 elk carcasses. Grizzly bear sign (e.g., tracks, scats, daybeds, or feeding activity) was observed along 6 of the routes and 3 grizzlies were seen during the surveys. Black bear (*Ursus americanus*) tracks were found along 2 survey routes.

Firehole River Area

We surveyed 8 routes in the Firehole drainage totaling 70.7 km. We found the remains of 6 bison and 2 elk, which equated to 0.11 carcasses/km traveled (Table 15). Definitive evidence of use by grizzly bears was found at 3 bison and 1 elk carcass. Grizzly bear sign was also found along 7 of the routes.

Norris Geyser Basin

We surveyed 4 routes in the Norris Geyser Basin totaling 21.1 km traveled. We observed no carcasses on these transects, but grizzly bear tracks were observed along all 4 routes.

Heart Lake

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 on all 3 routes. Two grizzly bears were seen in the survey area along 2 routes.

Mud Volcano

We surveyed a single route in the Mud Volcano area covering 8.4 km. No carcasses were observed this spring, but tracks and evidence of feeding by at least 2 grizzly bears were found along the route.

Table 15. Carcasses found and visitation of carcasses by bears, wolves, and unknown large scavengers along surveyed routes in Yellowstone National Park during spring 2007.

	Elk				Bison				
		# Visited by species				# Visited by species			
Survey area (# routes)	Number of carcasses	Bear	Wolf	Unknown	Number of carcasses	Bear	Wolf	Unknown	Total carcasses/km
Northern Range (13)	28	5	2	21	0	0	0	0	0.2[a]
Firehole (8)	2	1	0	1	6	3	0	3	0.1
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

[a] Included 1 pronghorn and 1 mule deer carcass used by unknown scavengers.

Table 16. Age classes and sex of elk and bison carcasses found, by area, along surveyed routes in Yellowstone National Park during spring 2007. The carcasses of 1 adult male mule deer and 1 adult female pronghorn were also found on the Northern Range.

	Elk (*n* = 30)						Bison (*n* = 6)					
	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total
Age												
Adult	23	1	0	0	0	24	0	5	0	0	0	5
Yearling	1	0	0	0	0	1	0	0	0	0	0	0
Calf	2	0	0	0	0	2	0	0	0	0	0	0
Unknown	2	1	0	0	0	3	0	1	0	0	0	1
Sex												
Male	12	0	0	0	0	12	0	2	0	0	0	2
Female	10	1	0	0	0	11	0	2	0	0	0	2
Unknown	6	1	0	0	0	7	0	2	0	0	0	2

IGBST photo

Spawning Cutthroat Trout *(Kerry A. Gunther, Travis Wyman, Todd M. Koel, Patricia E. Bigelow, 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 of 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. Bears also occasionally prey on cutthroat trout in other areas of the park, including the highly hybridized fish (cutthroat x rainbow trout [*Oncorhynchus mykiss*] hybrids) of the inlet creek to Trout Lake located in the northeast section of the YNP.

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. 2006). Lake trout and whirling disease could depress the native cutthroat trout population and associated bear fishing activity (Haroldson et al. 2005). In addition to lake trout and whirling disease, drought may also be contributing to the decline of the Yellowstone Lake cutthroat trout population (Koel et al. 2005*b*). Due to the importance of cutthroat trout to grizzly bears and the potential threats from lake trout, whirling disease, and drought, monitoring of the cutthroat trout population is specified under the Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2007*c*). The cutthroat trout population is currently monitored annually using counts at a fish trap located on the east shore of Yellowstone Lake and through visual stream surveys conducted along North Shore and West Thumb tributaries of the lake (Koel et al. 2005*a*, USFWS 2007*c*). Visual stream surveys are also conducted along the inlet creek at Trout Lake in the northeast section of the park.

Yellowstone Lake

Fish Trap Surveys.--The number of spawning cutthroat trout migrating upstream are counted annually from a weir with a fish trap at the mouth of Clear Creek on the east side of Yellowstone Lake (Koel et al. 2005*a*). The fish trap is generally installed in May, the exact date depending on winter snow accumulation, weather conditions, and spring snow melt. 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 trap. An electronic fish counter is also periodically used. Due to the extremely low number of trout spawning in Bridge Creek in recent years, a second tributary that has been monitored for migrating cutthroat trout in the past, a weir and fish trap were not operated on that creek in 2007.

In 2007, 538 spawning cutthroat trout were counted ascending Clear Creek (Koel et al. in press). Although the 2007 count was slightly higher than the 489 trout counted in 2006 (Koel et al. 2007), it represents a 99% decrease from the peak upstream spawner count of 70,105 in 1978 (Fig. 11). The 538 spawners counted in 2007 was one of the lowest counts since monitoring began in 1945.

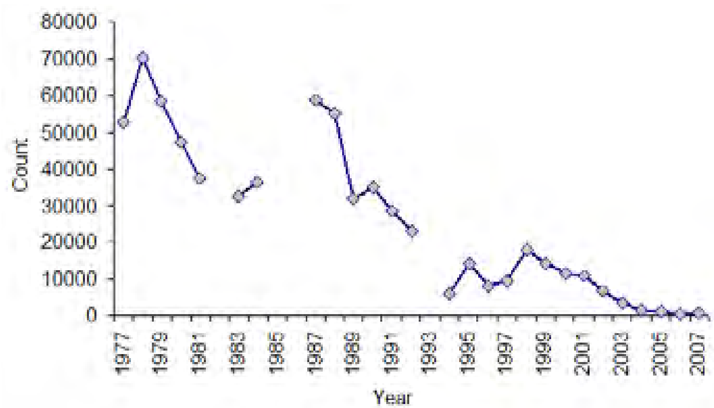

Fig. 11. Number of spawning cutthroat trout counted at the Clear Creek fish trap on the east shore of Yellowstone Lake, Yellowstone National Park, 1977–2007.

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 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 average number of spawning cutthroat trout counted per stream survey conducted during the spawning season is used to identify annual trends in the number of cutthroat trout spawning inYellowstone Lake tributaries.

Data collected in 2007 continued to show low numbers of spawning cutthroat trout on North Shore and West Thumb streams (Table 17). On North Shore streams, only 8 spawning cutthroat trout were counted including 7 in Bridge Creek and 1 in Hatchery Creek. No spawning cutthroat trout were observed in Lodge, Incinerator, or Wells Creeks. On West Thumb streams, only 3 spawning cutthroat trout were counted including 2 in Little Thumb Creek and 1 in Sandy 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 significantly since 1989 (Fig. 12). No evidence of grizzly bear or black bear fishing activity was observed along any of the 9 tributaries surveyed in 2007. However, grizzly bear tracks were observed along Lodge Creek and Hatchery Creek.

Table 17. 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, 2007.

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			Not surveyed			
Hatchery Creek	5/15	1	1	1	1	1
Incinerator Creek			No spawn			
Wells Creek			No spawn			
Bridge Creek	5/15	5/21	7	2	7	3.5
Weasel Creek			Not surveyed			
Sand Point Creek			Not surveyed			
West Thumb Streams						
1167 Creek			No spawn			
Sandy Creek	5/14	5/14	1	1	2	2
Sewer Creek			No spawn			
Little Thumb Creek	5/14	5/23	10	2	6	3
Total				6	16	2.7
Northern Range Stream						
Trout Lake Inlet	6/6	7/5	30	5	1,332	266

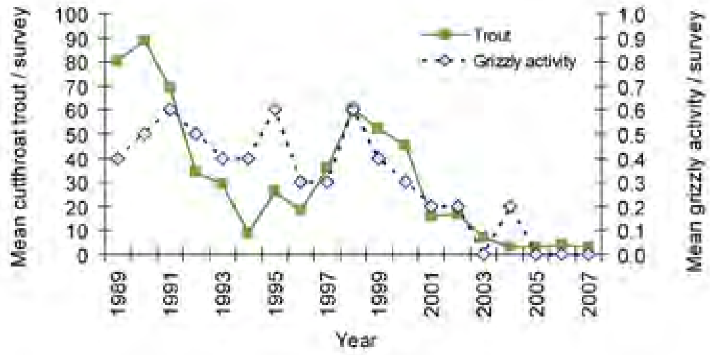

Fig. 12. Mean number of spawning cutthroat trout and mean activity by grizzly bears observed during weekly visual surveys of 8 North Shore and 4 West Thumb spawning streams tributary to Yellowstone Lake, Yellowstone National Park, 1989–2007.

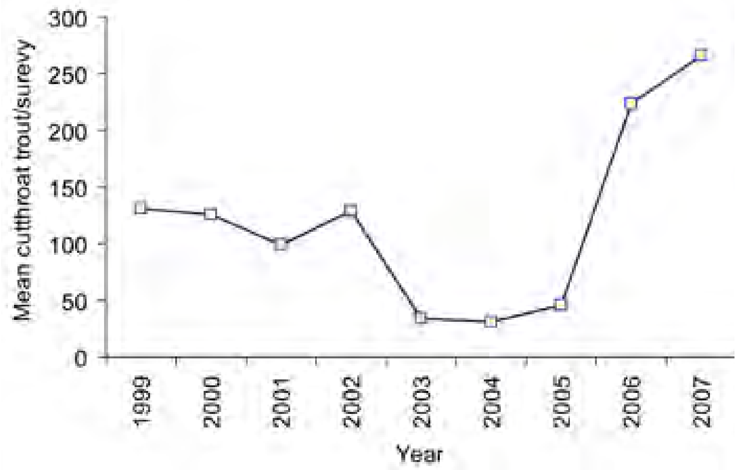

Fig. 13. Mean number of spawning cutthroat x rainbow trout hybrids observed during weekly visual spawning surveys of the Trout Lake inlet, Yellowstone National Park, 1999–2007.

<u>Trout Lake</u>

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 x rainbow trout hybrids. Once spawning trout are detected (i.e. onset of spawning), weekly surveys of adult cutthroat trout x rainbow trout hybrids 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 hybrids 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 spawning trout are observed through the last day spawning trout are observed. The mean number of spawning trout observed per visit is calculated by dividing the total number of adult trout hybrids counted by the number of surveys conducted during the spawning period.

In 2007, the first movement of spawning cutthroat trout x rainbow trout hybrids from Trout Lake into the inlet creek was observed on 6 June. The spawn lasted approximately 30 days with the last spawning trout hybrids being observed in the inlet creek on 5 July. During the once per week visual surveys, 1,332 spawning cutthroat trout x rainbow trout hybrids were counted, an average of 266 per visit (Table 17). The number of fish observed per survey in 2007 was the highest number counted since the surveys began in 1999 (Fig. 13).

No evidence of grizzly bear or black bear fishing activity was observed along the inlet creek during the surveys. A lone black wolf was observed near the mouth of the creek on one survey. The wolf seemed reluctant to leave the stream and may have been fishing, although we did not find conclusive evidence of this.

Cutthroat Trout Outlook.--Using gill nets, Park fisheries biologists caught and removed 73,316 lake trout from Yellowstone Lake in 2007 as part of management efforts to protect the native cutthroat trout population in YNP (Koel et al. in press). An additional 533 lake trout were removed from spawning grounds through electroshocking methods. The unintentional bycatch of cutthroat trout in smaller mesh size gill nets used to target juvenile lake trout increased in 2006 and again in 2007, indicating an increase in cutthroat trout recruitment in recent years. Fisheries biologists also had the highest cutthroat trout catch per net during fall sampling since 1998, another indication that the Yellowstone Lake cutthroat trout population may be increasing.

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. We used methods described in Bjornlie and Haroldson (2001, 2002) to identify and estimate the extent of sites.

In 2007, actively feeding grizzly bears were observed on 2 sites classified as possible in past years. Therefore, these sites were considered confirmed and analysis was done back to 1986. An observation of a grizzly bear actively feeding in 1 new area resulted in the classification of a new possible insect aggregation site. In addition, new locations between the buffers of 2 confirmed sites resulted in the boundaries of the 2 sites merging. These 2 sites were reclassified as 1 site for the 2007 analysis. Therefore, the reclassified site, a new possible site, and the merged site produced 31 confirmed sites and 20 possible sites for 2007.

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. 14). For example, the years 1993–1995 were probably poor moth years because the percentage of confirmed sites used by bears (Fig. 14) and the number of observations recorded at insect sites (Table 18) were low. Overall, the percent of insect aggregation site use by grizzly bears increased by 10% in 2007 (Fig. 14). However, the total number of observations or telemetry relocations at sites remained relatively constant from 2006 (Table 18). The number of insect aggregation sites used by bears increased from 19 in 2006 to 22 in 2007 (Table 18) and was slightly higher than the 5-year average of 21.2 sites/year from 2002–2006.

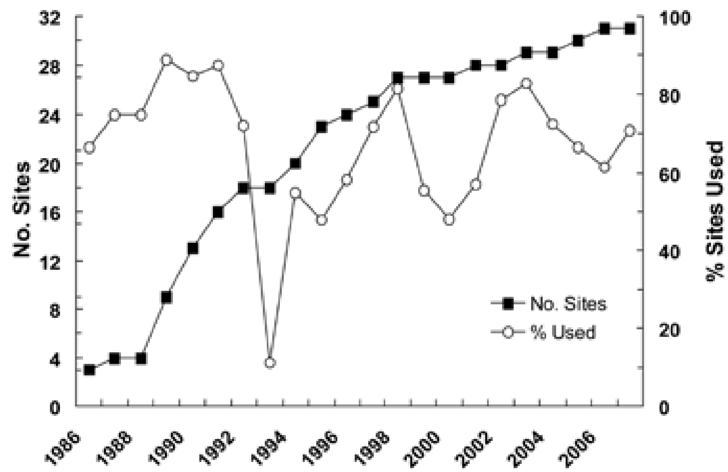

Fig. 14. Annual number of confirmed insect aggregation sites and percent of those sites at which either telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986–2007.

The IGBST maintains an annual list of unduplicated females observed with COY (see Table 5). Since 1986, 682 initial sightings of unduplicated females with COY have been recorded, of which 193 (28%) have occurred at (within 500 m, *n* = 170) or near (within 1,500 m, *n* = 23) insect aggregation sites (Table 19). In 2007, 17 of the 50 (34.0%) initial sightings unduplicated females with COY were observed at insect aggregation sites, an increase of 4 from 2006 (Table 19). This is higher than the 5-year average of 32.8% from 2002–2006.

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 19). If these sightings are excluded, an increasing trend in the annual number of unduplicated sightings of females with COY is still evident (Fig. 15), suggesting that some other factor besides observation effort at insect aggregation sites is responsible for the increase in sightings of females with COY.

Table 18. 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 1986–2007.

Year	Number of confirmed moth sites[a]	Number of sites used[b]	Number of aerial telemetry relocations	Number of ground or aerial observations
1986	3	2	5	5
1987	4	3	6	8
1988	4	3	15	27
1989	9	8	10	40
1990	13	11	9	75
1991	16	14	11	165
1992	18	13	5	102
1993	18	2	1	1
1994	20	11	1	27
1995	23	11	7	35
1996	24	14	21	65
1997	25	18	16	76
1998	27	22	10	171
1999	27	15	20	151
2000	27	13	38	87
2001	28	16	22	116
2002	28	22	33	236
2003	29	24	10	152
2004	29	21	2	129
2005	30	20	15	175
2006	31	19	17	170
2007	31	22	11	172
Total			285	2,185

[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.

Table 19. 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, 1986–2007.

Year	Unduplicated females with COY[a]	Number of moths sites with an initial sighting	Initial sightings: Within 500 m[b] *N*	Within 500 m[b] %	Within 1,500 m[c] *N*	Within 1,500 m[c] %
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
2006	47	11	13	27.7	15	31.9
2007	50	10	17	34.0	17	34.0
Total	682		170		193	
Mean	31.0	5.5	7.7	22.1	8.8	25.2

[a] Initial sightings of unduplicated females with COY; see Table 5.

[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 a insect aggregation site for this analysis, since some observations could be made of bears traveling to and from insect aggregation sites.

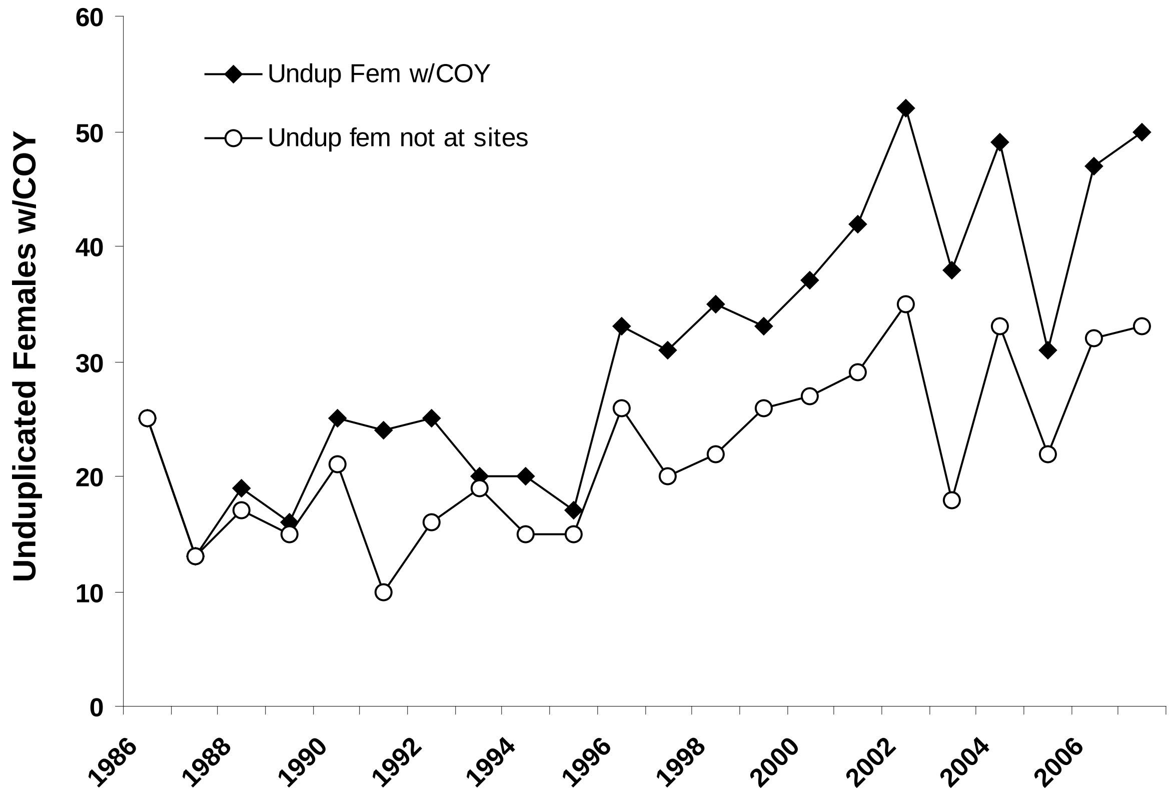

Fig. 15. The total number of unduplicated females with cubs-of-the-year (COY) observed annually in the Greater Yellowstone Ecosystem and the number of unduplicated females with COY <u>not</u> found within 1,500 m of known insect aggregation sites, 1986–2007.

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

Whitebark pine surveys showed good cone production during 2007. Twenty-five transects (Fig. 16) were read, including 6 new transects (CSA–CSF, Fig. 16). There was no difference in mean cones/tree between established and new transects (95% CI for mean difference = -16.4–4.3) so results presented are for all transects combined. Overall, mean cones/tree was 14.9 (Table 20). Best cone production occurred on transect CSE in the Gravelly Range, Beaverhead National Forest; poorest was on transect P near Sylvan Pass, Yellowstone National Park (Table 21). Cone production has been at, or above the overall average (15 cones/tree) during the last 3 years (Fig. 17).

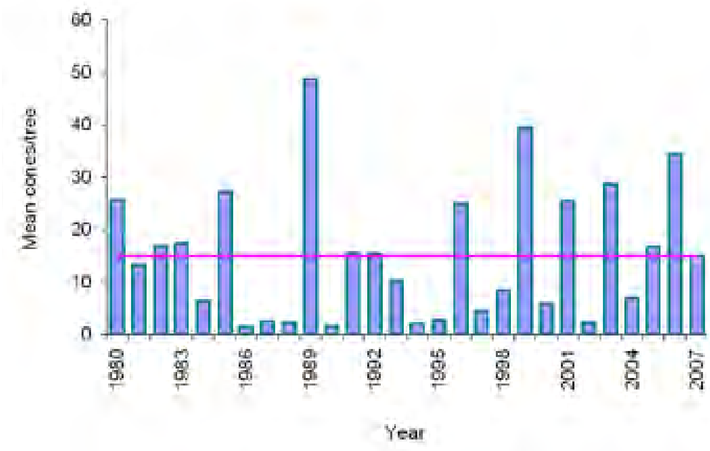

Fig. 17. Annual mean cones/tree on whitebark pine (*Pinus albicaulis*) cone production transects surveyed in the Greater Yellowstone Ecosystem during 1980–2007. The overall average of 15 cones/tree is shown by the line.

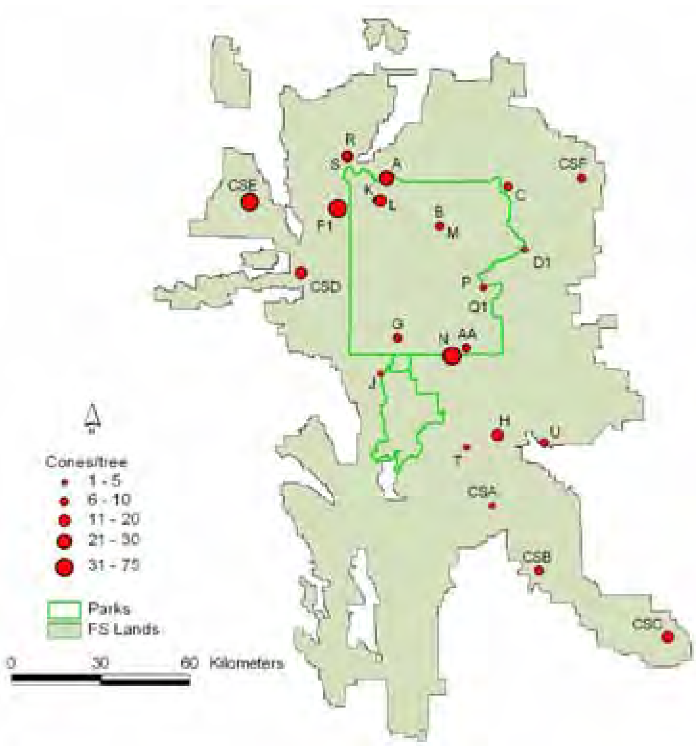

Fig. 16. Average cone production (mean cones/tree) for 19 whitebark pine (*Pinus albicaulis*) transects surveyed during 2007 in the Greater Yellowstone Ecosystem.

Near exclusive use of whitebark pine seeds by grizzly bears has been associated with falls in which mean cone production on transects exceeds 20 cones/tree (Blanchard 1990, Mattson et al. 1992). Typically, there is a reduction in numbers of management actions during fall months with abundant cone availability. During August-October of 2007, 8 management captures of bears 2 years of age or older (independent) resulted in 5 transports and 3 removals. This result was near the overall average of 9 management actions for August-October 1980–2006.

Mountain pine beetle activity continues at high levels on our original 19 transects. We observed an additional 12.2% (15/123) mortality among extent trees surveyed since 2002. Annual tree mortality through the last 5 years has ranged from 6.9% to 17.1%. Total tree mortality since 2002 is 43.2% (82/190) and 84.2% (16/19) of our original transects contain beetle killed trees. Four (67%) of the 6 new transects exhibited beetle activity.

Table 20. Summary statistics for whitebark pine (*Pinus albicaulis*) cone production transects surveyed during 2007 in the Greater Yellowstone Ecosystem.

Total			Trees				Transect			
Cones	Trees	Transects	Mean cones	SD	Min	Max	Mean cones	SD	Min	Max
3,451	237	25	14.9	29.3	0	258	141.6	179.3	13	724

Table 21. Whitebark pine (*Pinus albicaulis*) cone production transect results for 2007.

Transect	Cones	Trees	Mean	SD
A	169	7	24.1	48.1
B	85	10	8.5	3.5
C	78	9	8.7	3.6
D1	31	10	3.1	3.0
F1	678	10	67.8	56.9
G	62	10	6.2	7.4
H	156	10	15.6	12.3
J	28	10	2.8	2.4
K	100	10	10.0	7.5
L	204	10	20.4	17.0
M	76	10	7.6	4.8
N	338	10	33.8	52.9
P	13	10	1.3	2.3
Q1	16	10	1.6	2.3
R	119	10	11.9	11.6
S	72	10	7.2	9.8
T	28	6	4.7	5.4
U	33	5	6.6	4.0
AA	89	10	8.9	5.0
CSA	20	10	2.0	3.2
CSB	66	10	6.6	6.4
CSC	124	10	12.4	4.6
CSD	140	10	14.0	5.5
CSE	724	10	72.4	71.8
CSF	92	10	9.2	6.6

IGBST photo

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

In 2007, total visitation in Grand Teton National Park was 3,987,055 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 2,588,574. Backcountry user nights totaled 29,906. Long and short-term trends of recreational visitation and backcountry user nights are shown in Table 22 and Fig. 18.

Table 22. Average annual visitation and average annual backcountry use nights in Grand Teton National Park by decade from 1951 through 2007.

Decade	Average annual parkwide visitation[a]	Average annual backcountry use nights
1950s	1,104,357	Not available
1960s	2,326,584	Not available
1970s	3,357,718	25,267
1980s	2,659,852	23,420
1990s	2,662,940	20,663
2000s[b]	2,489,050	30,279

[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 2000–2007 only.

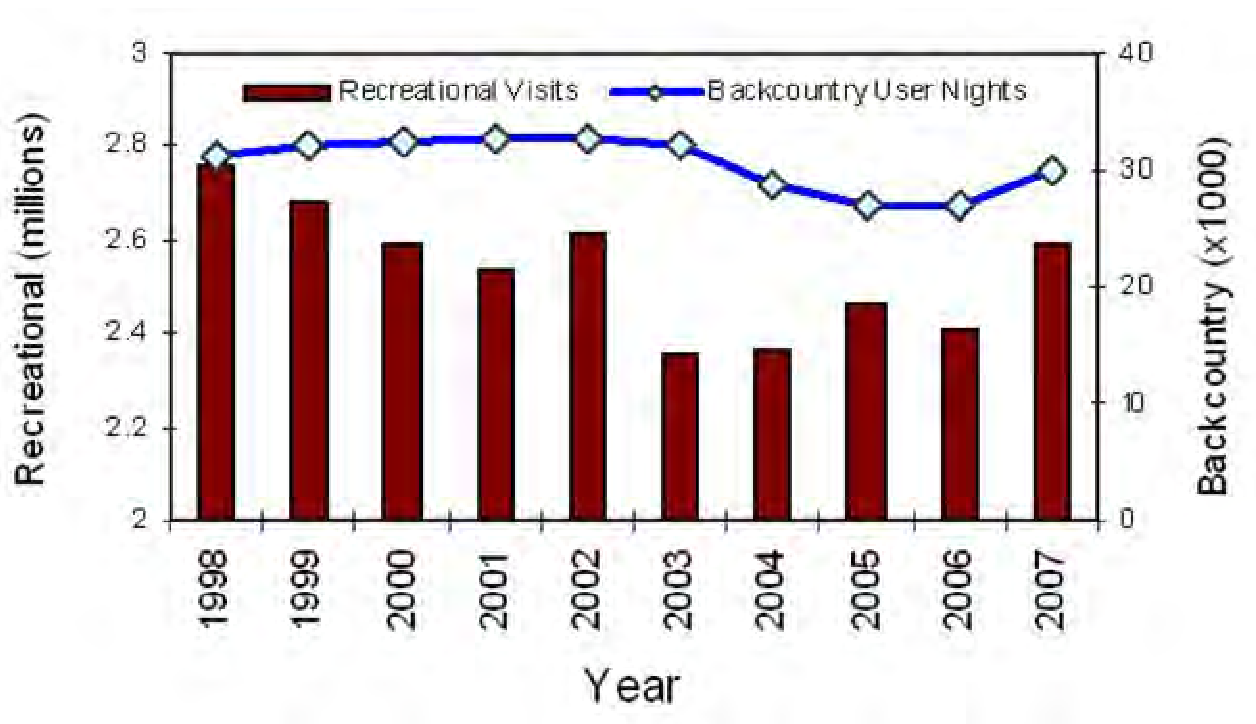

Fig. 18. Trends in recreational visitation and backcountry user nights in Grand Teton National Park during 1997–2007.

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

In 2007, total visitation to YNP including non-recreational use was 4,148,338 people. Recreational visits alone totaled 3,151,342. This was the most visitors to YNP in a year since it was established in 1872. These visitors spent 694,312 user nights camping in developed area roadside campgrounds and 37,933 user nights camping in backcountry campsites. The bulk of YNP's visitation occurs from May through September. Total recreational visits to the park during that time were 2,871,357, an average of 18,767 visitors/day.

Average annual recreational visitation has 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 23). Average annual recreational visitation has decreased slightly the first 8 years (2000–2007) of the current decade, to an average of 2,914,826 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 23). The number of backcountry user nights is limited by both the number and capacity of designated backcountry campsites in the park.

Table 23. Average annual visitation, auto campground user nights, and backcountry user nights in Yellowstone National Park by decade from 1895 through 2007.

Decade	Average annual parkwide total recreational visitation	Average annual auto campground user nights	Average annual backcountry user nights
1890s	7,378[a]	Not available	Not available
1900s	17,110	Not available	Not available
1910s	31,746	Not available	Not available
1920s	157,676	Not available	Not available
1930s	300,564	82,331[b]	Not available
1940s	552,227	139,659[c]	Not available
1950s	1,355,559	331,360	Not available
1960s	1,955,373	681,303[d]	Not available
1970s	2,240,698	686,594[e]	45,615[f]
1980s	2,344,485	656,093	39,280
1990s	3,012,653	647,083	43,605
2000s	2,914,826[g]	623,743[g]	40,575[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 2000–2007.

Trends in Elk Hunter Numbers within the Primary Conservation Area 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 PCA plus the 10-mile perimeter area. Because some hunt area boundaries do not conform exactly to the PCA and 10-mile perimeter area, regional biologists familiar with each hunt area were queried to estimate hunter numbers within the PCA 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 PCA 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 obtain data from all states from 1997 to 2007 (Table 24). 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.

Overall, hunter numbers have decreased since 1997, with the exception of 2002 when hunter numbers increased in Wyoming and Montana. Most of the decrease has occurred in Wyoming and Montana. Hunter numbers in Wyoming have decreased from the peak of 17,458 in 1997 to 8,716 in 2007. 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 as well as 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.

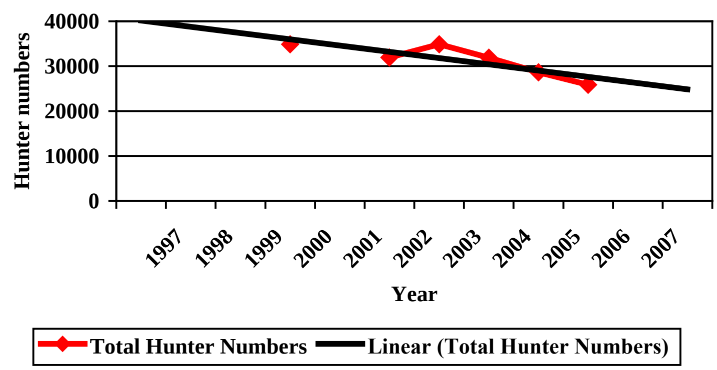

Fig. 19. Trend in elk hunter numbers within the Primary Conservation Area plus a 10-mile perimeter in Idaho, Montana, and Wyoming, 1997–2007.

Table 24. Estimated numbers of elk hunters within the Primary Conservation Area plus a 10-mile perimeter area in Idaho, Montana, and Wyoming, for the years 1997–2007.

	Year										
State	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Idaho[a]	2,869	2,785	2,883	[b]	2,914	3,262	3,285	3,454	3,619	3,016	2,592
Montana	[b]	[b]	16,254	17,329	15,407	17,908	16,489	14,320	12,365	[b]	[b]
Wyoming	17,458	15,439	15,727	12,812	13,591	13,709	11,771	10,828	9,888	9,346	8,716
Total			34,864		31,912	34,879	31,905	28,602	25,872		

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

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, 2006). 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 (2005–2007), using the fixed kernel estimator in the Animal Movements (Hooge and Eichenlaub 1997) extension for ArcView GIS (Environmental Systems Research Institute 1999).

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 late summer and fall 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 2007, the availability of high quality, concentrated bear foods was below average during the spring season, average during estrus and early hyperphagia, and good during late hyperphagia. During spring, the number of winter-killed ungulate carcasses were below average in both thermally influenced ungulate winter ranges and on the Northern Ungulate Winter Range (see *Spring ungulate availability and use by grizzly bears in Yellowstone National Park)*. During estrus, very few spawning cutthroat trout were observed in monitored tributary streams of Yellowstone Lake (see *Spawning cutthroat trout*). Predation on newborn elk calves was frequently observed during estrus. During early-hyperphagia many grizzly bears were observed at high elevation army cutworm moth aggregation sites (see *Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations*). During late hyperphagia, whitebark pine seeds were abundant throughout most of the ecosystem (see *Whitebark pine cone production*).

There were 201 grizzly bear-human conflicts reported in the GYE in 2007 (Table 25, Fig. 20). These incidents included bears obtaining anthropogenic foods (43%, n = 87), killing livestock (24%, n = 49), damaging property (18%, n = 37), obtaining apples from orchards (9%, n = 19), injuring people (4%, n = 8), and damaging beehives (>1%, n = 1). Most (62%, n = 125) conflicts occurred on private land in the states of Wyoming (36%, n = 73), Idaho (14%, n = 28) and Montana (12%, n = 24). Thirty-eight percent (n = 76) of the conflicts occurred on public land administered by the U.S. Forest Service (29%, n = 58), National Park Service (7%, n = 13), state of Wyoming (2%, n = 4), and Bureau of Land Management (<1%, n = 1). Fifty-five percent (n = 111) of the bear-human conflicts in 2007 occurred inside of the PCA. Almost half (45%, n = 90) of the bear-human conflicts occurred outside of the PCA.

When whitebark pine seed production is of average or above average abundance there are generally few grizzly bear-human conflicts during the fall season. This was not the case in 2007. In 2007, despite average whitebark pine cone production, the total number of bear-human conflicts were higher than average, suggesting that bears were nutritionally stressed. An increase in conflicts through time is also reflective of increased population size and range expansion. Incidents of bear-caused property damage, damage to apple orchards, and bear-inflicted human injuries were all higher than the long-term averages recorded from 1992–2006 (Table 26).

The conflict distribution map constructed using the fixed kernel 80% isopleths, identified 6 areas where most grizzly bear-human conflicts in the GYE occurred in the last 3 years (Fig. 21). These 6 areas contained 342 (71.8%) of the 476 conflicts that occurred from 2005–2007. The 6 areas where most conflicts occurred included: 1) the Gardiner Basin/Yellowstone River Area, 2) the Clarks Fork/Crandall Creek/Sunlight Creek drainages, 3) the North and South Forks of the Shoshone River, 4) the Wood River/Cottonwood Creek/Grass Creek drainages, 5) the Green River/Dunoir Creek drainages, and 6) the area encompassing West Yellowstone and Island Park. These 6 areas should receive high priority when allocating state, federal, and private resources available for reducing grizzly bear-human conflicts in the GYE.

Table 25. Number of incidents of grizzly bear-human conflicts reported within different land ownership areas in the Greater Yellowstone Ecosystem, 2007.

Land owner[a]	Property damages	Anthropogenic foods	Human injury	Gardens/ Orchards	Beehives	Livestock depredations	Total Conflicts
ID-private	1	25	1	1	0	0	28
ID-state	0	0	0	0	0	0	0
MT-private	3	13	1	6	0	1	24
MT-state	0	0	0	0	0	0	0
WY-private	18	39	0	8	1	7	73
WY-state	2	1	0	0	0	1	4
BLM	1	0	0	0	0	0	1
BDNF	0	0	0	0	0	0	0
BTNF	2	3	0	0	0	21	26
CNF	0	0	0	0	0	0	0
CTNF	0	1	1	0	0	3	5
GNF	0	1	3	0	0	0	4
SNF	3	4	0	0	0	16	23
GTNP/JDR	0	0	1	0	0	0	1
YNP	7	0	1	4	0	0	12
Total	37	87	8	19	1	49	201

[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.

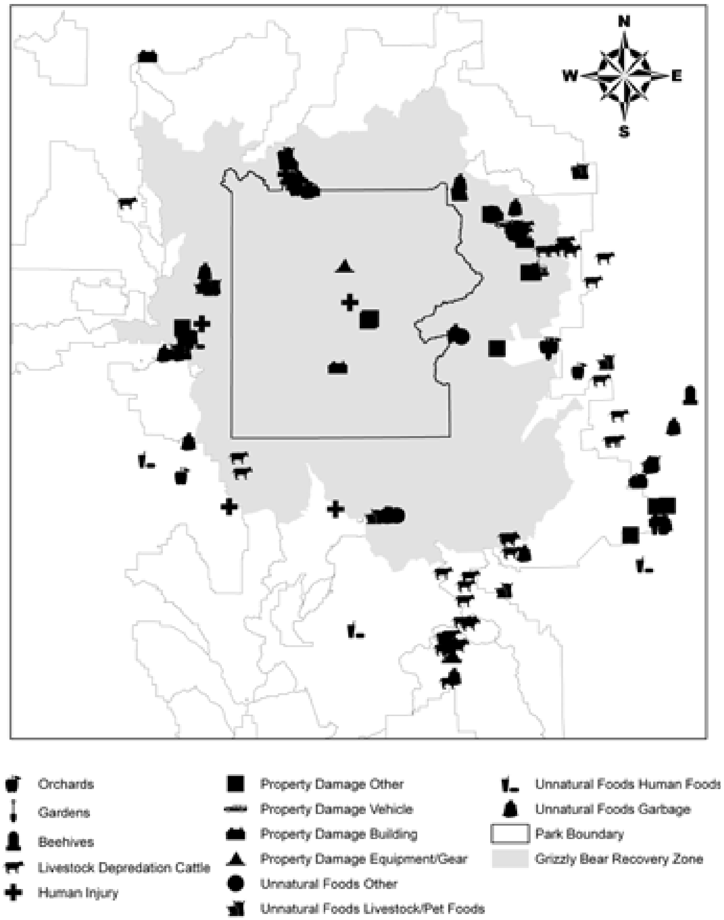

Fig. 20. Locations of different types of grizzly bear-human conflicts reported in the Greater Yellowstone Ecosystem in 2007. The shaded area represents the Greater Yellowstone Grizzly Bear Primary Conservation Area.

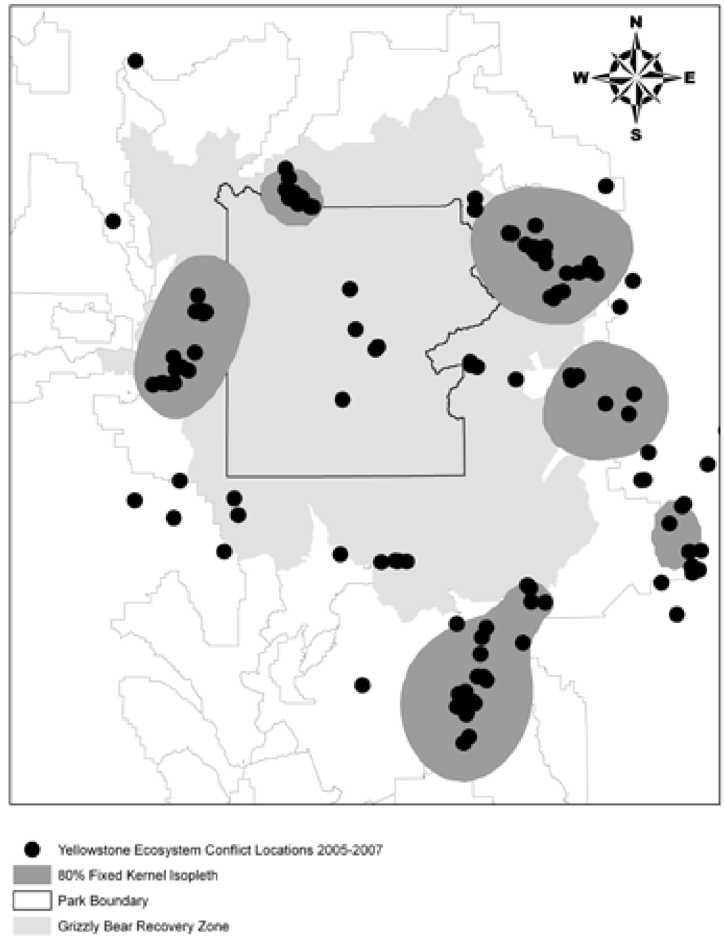

Fig. 21. Concentrations (dark shaded polygons) of grizzly bear-human conflicts that occurred from 2005–2007, identified using the 80% fixed kernel isopleth. The lightly shaded background area represents the Greater Yellowstone Grizzly Bear Primary Conservation Area.

Table 26. Comparison between the number of incidents of different types of grizzly bear-human conflicts in 2007 and the average annual number of conflicts recorded from 1992–2006 in the Greater Yellowstone Ecosystem.

Type of conflict	1992-2006 Average ± SD	2007
Human injury	4 ± 3	8
Property damage	19 ± 11	37
Anthropogenic foods	54 ± 40	87
Gardens/orchards	5 ± 3	19
Beehives	3 ± 4	1
Livestock depredations	51 ± 19	49
Total conflicts	135 ± 55	201

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2007 Annual Report

Greater Yellowstone Whitebark Pine Monitoring Working Group

Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

Whitebark pine occurs in the subalpine zone of western North America, including the Pacific Northwest and northern 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 (Tomback et al. 2001) and as a foundation species capable of changing forest structure and ecosystem dynamics (Ellison et al. 2005) in the subalpine zone. Whitebark pine contributes to a variety of ecological functions including the retention

Photo courtesy Anne Schrag

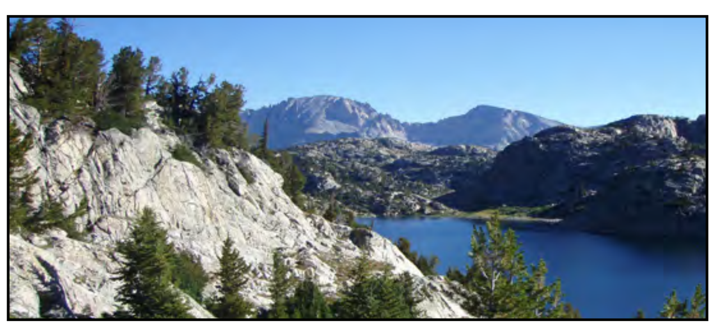
of snow in upper elevations helping to modulate runoff and streamflow (Farnes 1990). Its best known role in these ecosystems is as a high-energy food source for a variety of wildlife species, including red squirrels, Clark's nutcracker and the grizzly bear.

Background of the Program

Forest monitoring has shown a rapid and precipitous decline of whitebark pine 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 whitebark pine in the Greater Yellowstone Ecosystem (GYE) and that 98% of whitebark pine 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 whitebark pine 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 consists of representatives from the U.S. Forest Service (USFS), National Park Service (NPS), U.S. Geological Survey (USGS), and Montana State University (MSU).

Since 2004 the working group has collaborated to design and implement a long-term monitoring program. The purpose of the monitoring program is to detect how rates of blister rust infection and the survival and regeneration of whitebark are changing over time. A protocol for monitoring whitebark pine throughout the GYE was completed by the working group (GYWPMWG 2007a) and approved in 2007 by the NPS Intermountain Region Inventory and Monitoring Coordinator. Approved monitoring protocols are a key component of quality assurance helping to ensure the methods are repeatable and detected changes are truly occurring in nature and not simply a result of measurement differences. The complete protocol is available at: http://www.greateryellowstonescience.org/topics/biological/vegetation/whitebarkpine/projects/healthmonitoring/protocol.

This monitoring effort provides critical information on the



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status of whitebark pine on a comprehensive regional scale. The results of monitoring will help to establish the likelihood of this species' ability to persist as a functional part of the ecosystem and can be used to help justify and guide restoration efforts. This report is a summary of the monitoring data collected between 2004 and 2007 from this long-term monitoring project.

Objectives

Our objectives are to monitor the health of whitebark pine relative to levels of white pine blister rust and, to a lesser extent, mountain pine beetle. An additional monitoring objective to assess recruitment of whitebark pine into the cone producing population is in the early planning stages and not presented here.

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

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

Objective 3 *- To estimate survival of individual whitebark pine trees > 1.4 m tall explicitly taking into account the effect of blister rust infection rates and severity and mountain pine beetle activity, fire damage, and other agents.*

Study Area

Our study area is within the GYE and includes six National Forests and two National Parks (the John D. Rockefeller Memorial Parkway is included with Grand Teton National Park) (Figure 1). The target population is all whitebark pine trees in the GYE as defined by mapped stands or polygons in a GIS vegetative layer. The sample frame includes stands of whitebark pine approximately 2.5 ha or greater within the grizzly bear Primary Conservation Area (PCA) and was derived from the cumulative effects model for grizzly bears (Dixon 1997). Outside the PCA, the sample frame includes whitebark stands mapped by the US Forest Service. Areas that burned since the 1988 fires were excluded from the sample frame.

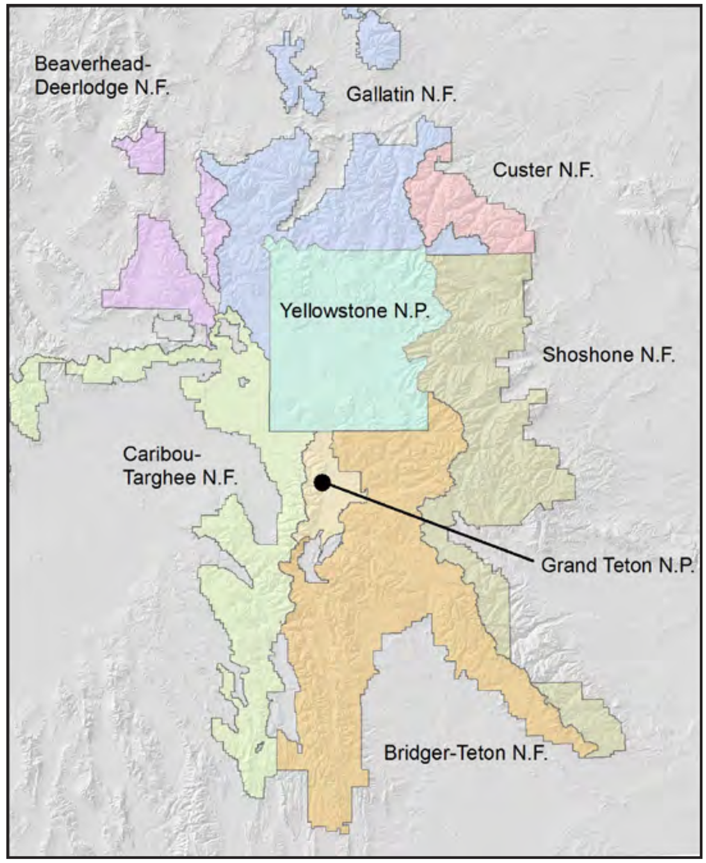

Figure 1. Study area showing national forest and national park units.

Methods

Details of our sampling design and field methodology can be found in the Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem (GYWPMWG 2007a) and in past project reports (GYWPMWG 2005, 2006 and 2007b). The 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. Monitoring took place between 2004 and 2007; during this period 176 permanent transects in 150 whitebark pine stands were established and 4774 individual trees >1.4 m tall were permanently marked in order to estimate changes in white pine blister rust infection and survival rates over an extended period. The sample of 176 transects is a probabilistic sample that provides statistical inference to the GYE.

White Pine Blister Rust

For each live tree, the presence or absence of indicators of white pine blister rust infection 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 white pine blister rust, at least three of five ancillary indicators needed to be present. Ancillary indicators of white pine blister rust included flagging, rodent chewing, oozing sap, roughened bark, and swelling (Hoff 1992).

Mountain Pine Beetle

The presence or absence of mountain pine beetle was noted in all whitebark pine based on the presence of small, popcorn-shaped resin masses called pitch tubes. We did not attempt to assign a cause of death for dead whitebark pine trees on transects when first established.

Within vs. Between Stand Variability

To access the potential for between stand variability, two permanent transects were established in 26 of the 150 whitebark pine stands. Both transects will be re-read the same year the stand is scheduled for resurvey.

Results

Table 1. Summary statistics for Greater Yellowstone Ecosystem 2004-2007.

Location	Within PCA	Outside PCA	Total for GYE
Number Stands	64	86	150
Number of Transects	66	110	176
Number of Unique Trees Sampled	1307	3467	4774
Proportion of Transects Infected	0.79	0.86	0.84
Estimated Proportion of Trees Infected.	0.14 ± (0.044 se)	0.217 ± (0.046 se)	0.20 ± (0.037 se)

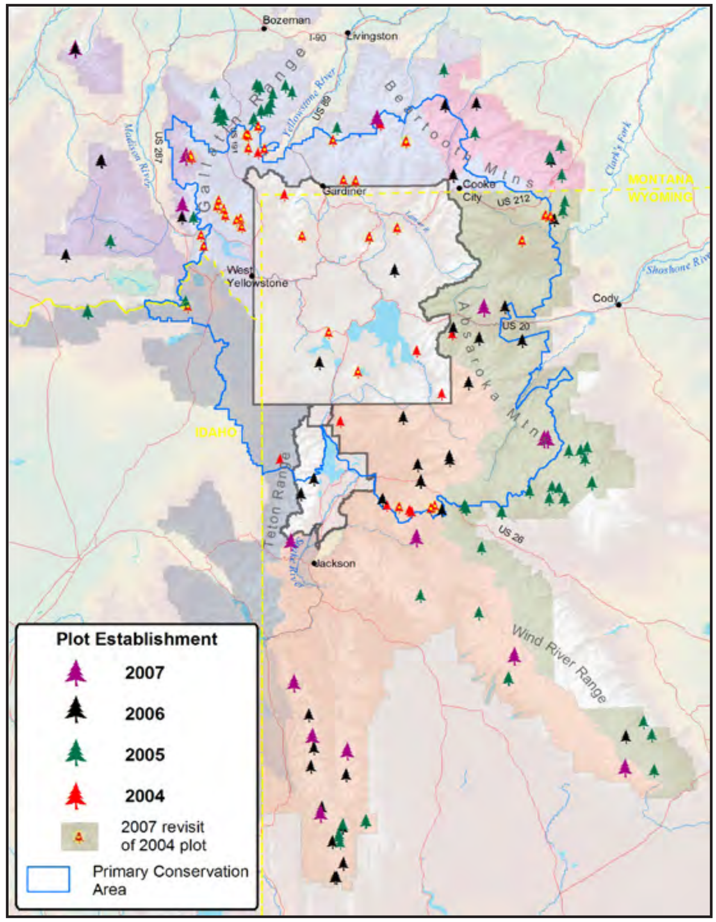

Figure 2. Distribution of samples (transects) established between 2004 and 2007. The grizzly bear PCA is shown in blue.

A total of 176 transects were surveyed within 150 stands of whitebark pine in the GYE between 2004 and 2007 (Figure 2). Of these, 66 transects in 64 stands were surveyed within the grizzly bear PCA and 110 transects within 86 stands were sampled outside the PCA. Summary statistics are presented in Table 1. Preliminary analysis of data from 33 transects established in 2004 and resurveyed in 2007 (see Figure 2) found that 29 of the 744 permanently marked trees (3.9%) had died over the three-year period.

Status of White Pine Blister Rust

Preliminary estimates suggest the proportion of live trees infected with white pine blister rust is 0.20 (± 0.037 se) in the GYE. The proportion of infected trees on a given transect ranged from 0 to 1.0. The number of live trees per transect (n = 176) ranged from 1 to 220 for a total of 4774 live trees examined. Although a formal spatial analysis has not yet been conducted, our preliminary data indicate that white pine blister rust infection is widespread and highly variable across the region (Figure 3).

Severity of White Pine Blister Rust on Infected Trees

The total number of cankers observed on infected live trees for the four years (2004-2007) combined was 3498, of which 3009 (86%) were located on branches and 489 (14%) were located on a main bole. The total number of cankers per infected tree ranged from 1 to 39. Bole cankers that are located on the lower portion of the bole (middle to bottom third) are generally considered lethal to trees whereas branch cankers are generally considered to be less lethal (Koteen 2002). Cankers that are found in the upper third of the bole are not necessarily lethal but can have a negative impact on cone production.

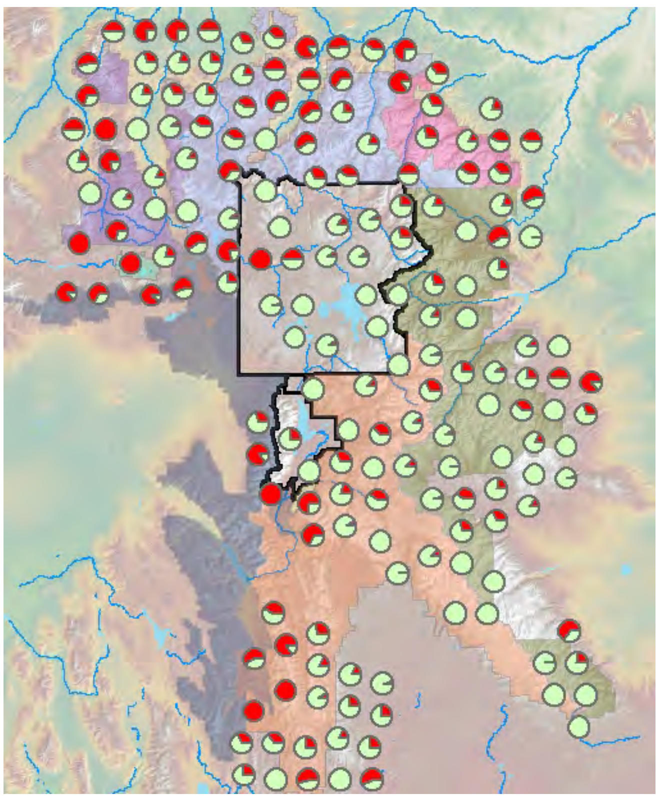

Figure 3. Chart showing the ratio (in red) of trees at each monitoring site in which white pine blister rust was recorded during ground-based surveys from 2004 through 2007. Due to map scale the pie charts are distributed for readability and may not be placed on the actual survey location.

Discussion

In this report, we consider the proportion of transects that show the presence of white pine blister rust as an indication of how widespread the disease is within the GYE. Our preliminary results indicate that 80% of all transects had some level of infection and white pine blister rust is widespread throughout the GYE. We consider the proportion of trees infected and the number and location (branch or bole) of cankers as indicators of the severity of white pine blister rust infections. We know that the proportion of trees infected with white pine blister rust in the GYE is 0.20 (± 0.037 se). This is the first GYE estimate of white pine blister rust based on a probabilistic sample design; comparison with results from efforts using different field methods or sampling design is not possible. Changes in white pine blister rust and rates of tree mortality will be derived from repeated sampling of permanent transects over time.

In addition to the white pine blister rust infection described above, a significant outbreak of mountain pine beetle is currently taking place in the GYE. Mountain pine beetle is a native North American insect persisting at low levels in lodgepole and whitebark pine throughout most of the last century. When favorable conditions exist, beetle populations can quickly increase to epidemic proportions and outbreaks occasionally result in high levels of mortality of mature trees. Research has shown that mountain pine beetle activity increases significantly in whitebark pine with heavy white pine blister rust infection. Furthermore, warming in the northern hemisphere has favored bark beetle reproductive success in whitebark pine ecosystems and interactions between the beetle and white pine blister rust are placing whitebark pine in a precarious state (Bockino 2008). Forest insects and disease can directly and indirectly affect many ecological processes in whitebark pine ecosystems. Episodes of tree mortality change the amount of coarse woody debris accumulation and net primary productivity in the subalpine ecosystems. The loss of cone producing trees has a direct affect on the amount of whitebark pine seeds available for wildlife.

Future Directions

Following the establishment of permanent transects, the working group decided how transects would be assigned to panels and determined the revisit design for implementation beginning in 2008. Infection by white pine blister rust is a slow process, such that detection of annual change would not be effective or practical. Consequently, we have based our design on a "rotating panel" with a 4-year rotation schedule. Panel membership is based on a random selection of stands that include the permanently monumented transects from both inside and outside the PCA. This approach ensures that each panel is representative of the population and not merely an artifact of the year the transect was first established.

In contrast to white pine blister rust infection, the effects of mountain pine beetle occur much more rapidly and a 1-2 year revisit schedule may be more appropriate during periods of rapid change such as the current mountain pine beetle outbreak. Although our approach of sampling every four years will be sufficient to establish mortality due to white pine blister rust, we believe an increase effort to document the amount of mortality due to mountain pine beetle is warranted during the current outbreak. Thus we have created a split panel design where alternating panels are revisited on a 2-year schedule to specifically record mortality of whitebark pine during the current outbreak. Also beginning in 2008 field crews will consistently strip a portion of the bark from recently dead trees to look for the characteristic J-shaped galleries under the bark. The presence of the J-shaped gallery is a positive and more reliable form of mountain pine beetle evidence than pitch tubes alone.

The next phase of planning for this project will focus on the recruitment of immature trees into the cone-producing population. The decline of whitebark pine can result either from increased mortality (e.g., as a result of white pine blister rust and/or mountain pine beetle), or it can result from a lack of recruitment into the reproductive population. A lack of recruitment can result from changes in a variety of life history stages from decreased cone production to recruitment of immature trees into the cone-producing population.

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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
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[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.

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Greater Yellowstone Whitebark Pine Monitoring Working Group. 2008. Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem: 2007 Annual Report. Pages 50-56 in C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2007. U.S. Geological Survey, Bozeman, Montana, USA.

Copies of this, and other products from this project can be found at the Greater Yellowstone Science Learning Center at: http://www.greateryellowstonescience.org/topics/biological/vegetation/whitebarkpine.

Assessing Habitat and Diet Selection for Grizzly and American Black Bears in Yellowstone National Park

Jennifer Fortin and Justin Teisberg
Washington State University

A broad study of grizzly (*Ursus arctos*) and black bears (*Ursus americanus*) using the area around Yellowstone Lake was initiated in the fall of 2006. The purpose of this 3-year study is to determine if spawning cutthroat trout (*Oncorhynchus clarki*) continue to be an important food for bears, or if the trout population has declined to the level that bears no longer use this resource. If trout are no longer a useful food resource, we want to determine what geographical areas and foods the bears are using and if those foods are an adequate replacement to maintain a healthy population of grizzly bears.

Capture and collaring

Bears were trapped in the vicinity of Yellowstone Lake during the fall of 2006 and early summer and fall of 2007. Ten grizzly bears (4 females and 6 males) and 1 male black bear were captured and fitted with Spread Spectrum Technology (SST) Global Positioning System (GPS) collars.

Telemetry results

Eight grizzly bears (3 female and 5 male) and 1 male black bear were radio tracked during the 2007 field season (7 May–17 Oct). Approximately 29,153 GPS locations were recorded by these collars. Male grizzly bear 556's collar was removed in August upon recapture outside of Yellowstone National Park (YNP). Four grizzly bear collars (2 female and 2 male) and 1 male black bear collar were "released" as programmed on 1 October 2007 and all were retrieved. One female and 2 male grizzly bears will continue to wear their collar through the 2008 field season. Female grizzly bear 555 had 2 cubs-of-the-year and female grizzly bear 559 had 1 yearling in 2007.

Site visits

Three crews of 2 persons each (2 graduate students and 1 biologist along with 3 volunteers), were employed for the 2007 field season. The field crews visited GPS locations to record bear activity, including habitat and dietary item use. We visited 1,172 GPS locations at which we collected 52 hair samples, 236 fecal samples, and forage samples. Of these sites, 493 were Level 1 only in their analysis, 679 continued to Level 2 analysis, and 116 to Level 3 analysis. All data was entered into an Access database. Level 2 site visits that included feeding consisted of: 19 elk (*Cervus elaphus*) and 3 mule deer (*Odocoileus hemionus*) carcasses, 67 fungi sites (*Rhizopogon* spp.), 49 whitebark pine (*Pinus albicaulis*) nut middens, 28 ants hills or log tears, 25 insects and/or earthworms sites, 5 cambium sites, 4 rodent caches, and 1 duck nest. Level 3 foraging or grazing sites included: 23 yampa (*Perideridia gairdnerii*), 17 licorice root (*Osmorhiza* spp.), 14 elk thistle (*Cirsium scariosum*), 10 fireweed (*Epilobium* spp.), 8 fern-leaved lovage (*Ligusticum filicinum*), 4 dandelion (*Taraxacum* spp.), 3 clover (*Trifolium* spp.), 2 onion grass (*Melica* spp.), 2 bluegrass (*Poa* spp.), and 1 each of horsetail (*Equisetum arvense*), cow parsnip (*Heracleum lanatum*), sticky geranium (*Geranium viscosissimum*), rye grass (*Elymus* spp.), and wheatgrass (*Agropyron* spp.). Grizzly bear 556 moved west out of YNP to the Ashton, Idaho, area where site visits revealed no feeding variation from within the park. It was an average whitebark pine cone year with counts in YNP averaging 14.9 cones/tree. All bears collared at the time of whitebark pine cone maturity used this resource.

Hair snares

Forty-eight hair snares were deployed on 35 streams on Yellowstone Lake. Hair snares were visited bi-weekly from mid-May through mid-August during which time 761 hair samples were collected. Stream surveys for spawning cutthroat trout were conducted in conjunction with hair snare visits. During stream surveys, 7 hair samples and 37 fecal samples were collected. Of the 35 streams surveyed, 12 were observed with spawning cutthroat and an additional 13 were observed to have fry and/or fingerlings. Maximum number of cutthroat trout spawners seen during one stream survey was 5. Fry and/or fingerling counts were often estimated to be several hundred. All data was entered into an Access database.

Testing Remote Sensing Cameras to Count Independent Female Grizzly Bears with Cubs-of-the-Year, 2006–2007

March 2008

Wyoming Game and Fish Department
Trophy Game Section – Management and Research Branch

INTRODUCTION

The Interagency Grizzly Bear Study Team (IGBST) currently uses ground and aerial observations of independent females with cubs-of-the-year (COY) to estimate population size and monitor trends of the Yellowstone grizzly bear population. The majority of the ground observations come from Yellowstone National Park. Observations of females with COY are high in Bear Management Units (BMU) containing large areas of open terrain or moth feed sites where bears are highly visible. However, there are several BMUs in Wyoming on the southern portion of the ecosystem that are heavily timbered and contain no moth sites. Observations of females in these units are extremely low, often resulting in no bears being observed.

As part of a 2-year systematic survey to obtain data on female grizzly bears with young, the Wyoming Game and Fish Department (WGFD) conducted separate surveys of 1 BMU using remote-sensing cameras. The study was designed to estimate the probability of detecting females with COY, while also creating a valid protocol for potential implementation in the future. If successful, this technique could be applied annually to obtain more accurate estimates of females with COY and total population size. Knowledge of current grizzly bear population estimation and monitoring techniques will remain essential to ensure that accurate estimates are obtained towards determining mortality thresholds to meet overall agency management objectives.

STUDY AREA

The Blackrock/Spread Creek Allotment (BSA) was chosen as the study area based on previous research trapping conducted by the WGFD, which indicated that a sufficient number of grizzly bears inhabit the area, and access was suitable to facilitate camera site data collection. The BSA occurs within Bridger-Teton National Forest (BTNF) and Grand Teton National Park (GTNP) in northwest Wyoming. The western half of this area is within the Buffalo/Spread Creek grizzly BMU (BMU #17). The eastern and southern portions of the allotment are within Observation Unit 26. Elevations range from 2,150–3,145 m. Dominant vegetation varies with elevation ranging from open sagebrush (*Artemesia tridentata*) meadows and lodgepole pine (*Pinus contorta*) stands with some interspersed aspen (*Populus tremuloides*) at lower elevations to stands of Englemann spruce (*Picea englemannii*), subalpine fir (*Pseudotsuga menziesii*), and whitebark pine (*Pinus albicaulis*), interspersed with big sage brush grass/forb meadows, and aspen at higher elevations. Riparian zones throughout the area are dominated by willow (*Salix* spp.). The portion of BSA within BTNF (87%) is managed by the U.S. Forest Service as a multiple use area, has relatively high road densities, and has been logged since the late 1950s. All data collection occurred on lands administered by the BTNF.

2006 STUDY YEAR

2006 METHODS

The initial 2006 pilot study was used to test varying camera set techniques and lures as well as the ability of various methods for detecting a target collared female within the BMU. Telemetry flights were conducted beginning in late April 2006 to locate radio-collared grizzly bears within the BMU. Female grizzly bear #503 was observed with 2 COY on 30 June 2006 in the study area. We estimated the home range (Minimum Convex Polygon) of #503 using Very High Frequency (VHF) locations collected from 2005–2006 to develop a grid for the study area and camera placement. Twenty-two individual sites (2.5 km intervals) were identified for camera placement covering 94 km^2 throughout the grid (Figure 1). Camera days were the sum of all 24-hour periods in which cameras were functioning and available for photographic detection.

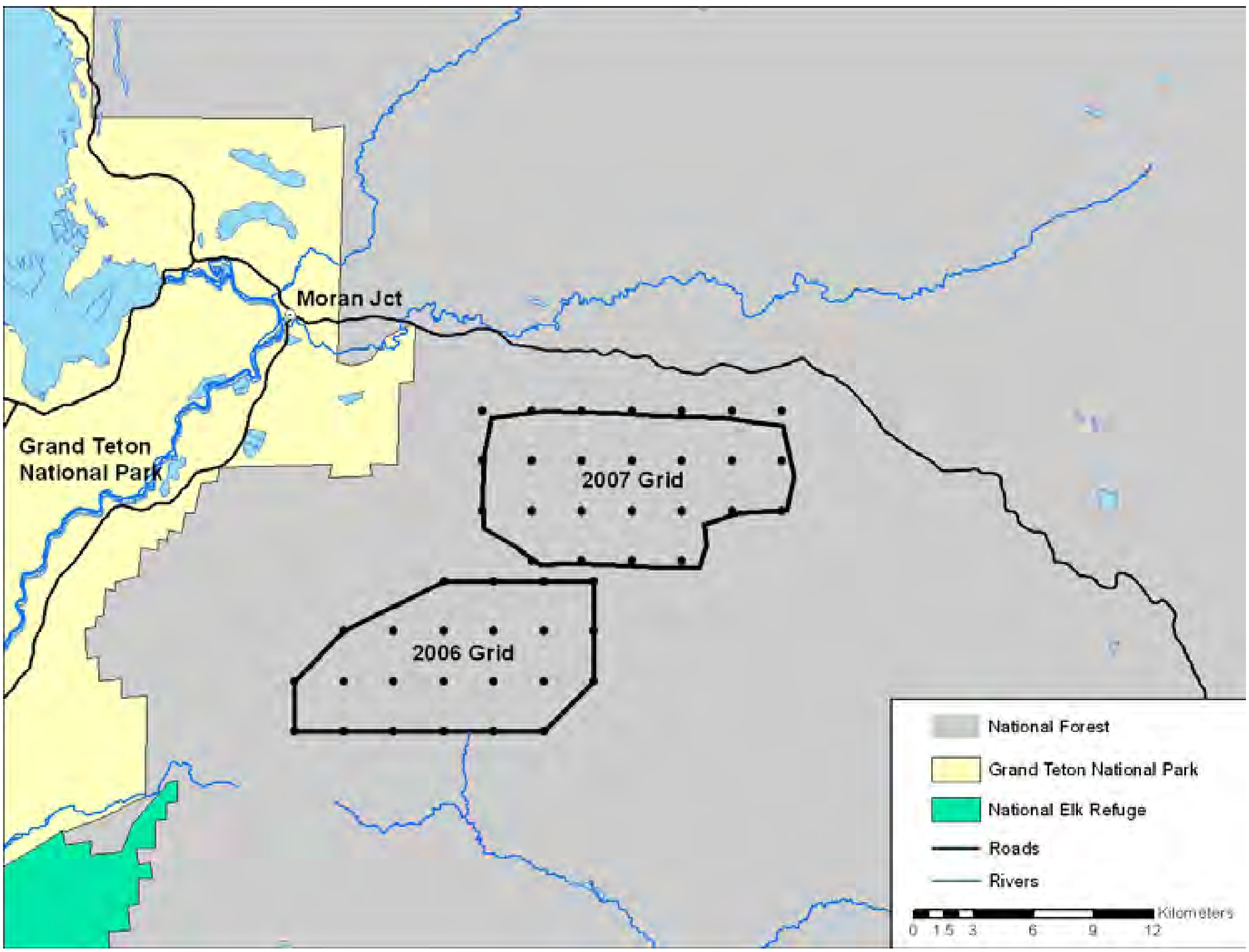

Figure 1. Study area grids for 2006 and 2007 camera studies.

Camera sites were placed as close to grid points as possible, depending on availability of suitable mounting trees, vegetation density, and proximity to human activity. Cameras were mounted on trees at a height of 1–1.5 m to provide optimal view and positioned facing a point below a 3–4 m high lure suspended from 2 trees (Mace et al. 1994). Lure was suspended in 1-gallon plastic jugs with holes cut in the upper portion to allow for scent dispersion (Anderson and Haroldson 1997). A small amount of lure was placed on the ground directly beneath the jug to increase bears' longevity of stay and probability of camera detection. The distance between the camera and the lure varied from 5–9 m. Cameras were placed out of apparent view as much as possible to reduce the likelihood of disturbance by bears or people. Sites were chosen that were clear of any obscuring vegetation, or vegetation was partially cleared to prevent inadvertent camera trigger. Camera sets were placed away from major roads or trails to minimize human and livestock disturbance. Game trails were utilized for camera placement when present. Cameras recorded the date and time of each photographic event along with ambient temperature. Field personnel recorded universe transverse mercator (UTM) location, elevation, and habitat type at each camera site.

Thirty-three Stealth Cam STC-IR1 cameras (Stealth Cam, LLC, Bedford, TX, USA) were used to determine the efficacy of detecting female bears with COY and deployed from 12 August to 14 September. Cameras were programmed to take 3 photographs when triggered, with a 1-minute delay before additional detections. All cameras were equipped with a 12-volt external battery. Two cameras set on complimentary 90-degree angles were placed at alternating sites to test the effectiveness of detecting bears with 1 versus 2 cameras at a particular site. Digital cameras were equipped with a passive infrared system sensitive to temperature differentials and motion. Cameras also were able to take nocturnal photos via infrared emitters without a deterring flash. Information from all cameras was downloaded to a computer, lures were refreshed, and camera/battery operability was inspected during each sampling session. Comments were noted as to the condition of the site and recommendations recorded for following visits.

We compared the effectiveness of 2 separate lures previously used for grizzly bears: a cattle blood lure with sodium citrate (an anticoagulant) effective in attracting grizzly bears in the Greater Yellowstone Ecosystem (GYE; Haroldson and Anderson 1997), and a lure composed of rendered fish and aged cattle blood similar to that used in the Northern Divide Grizzly Bear Project in Montana (http://www.nrmsc.usgs.gov/research/NCDElure.htm). Lure treatments alternated between sites to ensure that each lure was present at an equal number of corresponding sites (i.e., 50% of each lure was used across the study area, sequentially patterned to test effectiveness of particular lure type).

2006 RESULTS

During the 19 days the camera grid was operating, 53 bear events were recorded (44 black bears, 5 grizzlies, and 4 unknown). Although the Stealth Cam cameras did not perform as we anticipated, useful data was collected on the performance of various techniques. Sites with 2 cameras positioned at complimentary 90-degree angles were more effective at detecting all bears visiting sites. When bears or other disturbances repositioned one camera, the second camera generally successfully detected bears at the site. The blood lure was found to be the most effective attractant to the sites (Table 1). The blood/fish lure seemed to congeal over time diminishing scent dispersal. The collared female with COY was successfully detected by the camera grid set up within her home range. More detailed results of the 2006 field season can be found in the 2006 pilot study report (Barr et al. 2007).

Table 1. Bear detection events based on lure type at camera sites, 2006.

	Total bear detections	Grizzly dear detections	Black bear detections	Lure taken at site	Zero bear detections
Blood	32	3	27	2	3
Fish	21	2	17	0	2

2007 STUDY YEAR

2007 METHODS

Our objective during 2007 was to test the viability of the selected protocol and the overall detectability of grizzly bears. A similar 2.5 km sampling grid was superimposed upon a polygon defining the study area and used to identify sites for camera placement. Cameras were placed at 25 individual sites covering 100 km^2, and baited only with the more effective blood lure (Barr et al. 2007).

Due to unforeseen problems with Stealthcam models used during 2006, 50 Professional Model PM35 Reconyx cameras (Reconyx, LLP, Holmen, WI, USA) were used and placed in the sampling grid from 31 July to 13 September 2007. All cameras were programmed to take 10 black-and-white photographs at 1-second intervals when triggered, with a 30-second delay before another set of photos was initiated. All camera sites included 2 cameras set on complimentary 90-degree angles to increase the likelihood of photographing and identifying a family group, based on results from 2006 data. One camera was placed approximately 5 m closer to the lure at each site to obtain more optimal body and head photos while another camera was placed farther away (approximately 10 m) to help ensure that separate individuals were captured on each visitation.

All cameras sites were visited by WGFD personnel once weekly throughout the entire 42-day sampling session.

Event Sampling Methods

Photographs were cataloged by species, site number, and camera number, with only distinct photographic detection events being recorded. We assumed that different bears could visit a site within the 24-hour period. If a bear was detected/photographed at a site multiple times during a 24-hour sampling period it was assumed to be the same bear unless unique characteristics of the individual(s) in question could distinguish them between detection events. The sampling period began at 1200 hours daily assuming bears are typically inactive during mid portions of the day (Holm et al. 1999). Family groups were counted as independent photo detection events as offspring are not known to travel independently (Mace et al. 1994). We attempted to identify bears as individuals whenever possible based on size, color, unique markings, behavior, time, date, and location at a particular site.

Determining Probability of Detection, Occupancy, Camera Grid Density, and Sampling Period

We used the occupancy model of Mackenzie et al. (2002) to estimate detection probabilities and occupancy of grizzly bears within the sampling grid in Program MARK (White and Burnham 1999). Detection probability programs generally require marked individuals or an estimation of the population within the area to determine occupancy and the probability of detection. We separated the entire sampling session into 1-week periods ($n = 6$) to compare detection between sampling periods. Along with tracking marked individuals we used unique characteristics of bear detection events (i.e., eartags, physical attributes, appearance, number of bears during event) in order to quantify detection probabilities for individuals. We calculated overall detection probability for grizzly bears throughout the grid separated by 1-week intervals.

A frequency of occurrence value for known individuals was found by centering a standard-sized home range for each grizzly bear sex and age cohort (M. A. Haroldson, U.S. Geological Survey, IGBST, personal communication) on the camera sites where these individuals were detected to determine the amount of time spent on the grid. This proportion was used to determine the number of days that individual was available for detection by the camera grid. The proportion of the home range that fell within the grid was then calculated as a percentage and used to estimate the number of days that particular individual was available for detection by the grid. We estimated overall frequency of detection using the number of times an individual bear was detected.

Sampling at the higher camera grid density of 2.5 km allowed for an evaluation of an optimal density that affords a reasonable probability of detecting a female grizzly with COY or other uniquely identifiable bears. Evaluation of optimal grid density can be accomplished by deleting specific camera sites and subsequently testing the probability of detection with new grid densities (Noyce et al. 2001). Camera sites were deleted randomly and in alternating order to determine what proportion of bears would be detected using varying densities compared to the original density.

We separated the 42-day sampling period into 3-day intervals to compare frequency of detection events throughout the entire sampling effort. We used site-specific variables (i.e., habitat type, elevation, temperature) to evaluate site fidelity or habitat preferences of bears successfully detected at specific camera sites.

2007 RESULTS

The camera grid was operable for 42 days from 31 July to 13 September. During that time 106 bear events were recorded (Table 2). Of these, 83 were black bears and 23 were grizzlies (Table 2). Twenty-two of the 25 camera sites recorded bear events.

Table 2. Bear detection events at camera sites in Blackrock camera evaluation study, 2006–2007.

Study year	Total black bear detections	Total grizzly bear detections	Unknown bear detections	Total bear detections	Sites with no bear detections
2006	44	5	4	53	5
2007	83	23	0	106	3

Family groups of both bear species were detected by the camera grid in 2007. A total of 16 family group events were detected; 8 events of a black bear female with 1 COY, 3 events of a black bear female with 2 COY, 1 event of a black bear female with 1 yearling, and 4 events of a grizzly female with 2 2-year-olds. Many of the multiple detection events represent the same individual recorded multiple times. These 16 family group detection events accounted for 15% of all bear detection events recorded and 14% and 17% of the total black bear and grizzly bear detection events, respectively.

There were 7 events of marked bears (4 grizzly, 3 black bear) during the 2007 study. Of the 4 grizzly bear events, 2 were of a radio-collared bear and 2 were of an uncollared bear with ear tags. These were considered 2 uniquely identifiable bears due to appearance and location. No ear tag numbers were visible in the photographs. A female grizzly with 2 2-year-old cubs was also detected on 4 separate occasions. Based on her appearance and the age and number of cubs, she was also considered a uniquely identifiable bear.

Detection probabilities (*p*) by sampling period (1 week) varied from 0.00–0.55 for grizzly bears within the sampling grid (Table 3), with an occupancy (P_{si}) rate of 0.58. Throughout the entire sampling period, our overall probability of detecting grizzly bears was 0.21.

Table 3. Detection probability rates for grizzly bears within the sampling grid separated by weekly sampling periods, 31 Jul 2007–13 Sep 2007.

	Detection probability (*p*)			
Sampling period	All grizzly	Collared bear	Eartagged bear	Female with young
1	0.35	0.00	0.04	0.00
2	0.14	0.00	0.00	0.00
3	0.07	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	0.28	0.00	0.00	0.50
6	0.55	0.70	0.04	1.00

Using the 3 uniquely identifiable grizzlies (female with 2-year-olds and 2 marked grizzly bears), a frequency of occurrence was calculated for each individual using a circular home range estimated from previous data (M. A. Haroldson, U.S. Geological Survey, IGBST, personal communication), centered on the locations of cameras where the bears were detected. For the female grizzly with 2 2-year-olds, a circular 200 km^2 home range was centered on the locations of the camera sites where the group was detected. Based on the estimated time the family group spent within the camera grid, the detection frequency was 0.28 (Table 4). Using the same technique with larger 300 km^2 generic male home ranges, the 2 marked males had detection frequencies of 0.13 and 0.14 (Table 4).

Table 4. Estimated frequency of occurrence for unique individual grizzly bears in the camera sampling grid, Blackrock, WY, 2007.

Bear	Estimated home range (km^2)	Estimated home range within grid (%)	Estimated days available for detection	Days detected	Frequency of detection
Female with 2-yr-olds	200	34	14.3	4	0.28
Collared Male	300	35	15.0	2	0.13
Ear-tagged Male	300	35	14.5	2	0.14

Removing camera sites from the grid in regular and random patterns produced similar results for detection of uniquely identifiable bears. Alternately removing every other point so that 50% of the points remained allowed for successful detection (100%) of the 3 unique individuals. Randomly removing 50% of the points in the grid detected the unique individuals 80–100% of the time.

Breaking the 42-day sampling period into 14 3-day intervals illustrates the pattern of visitation at the camera sites by black and grizzly bears (Figure 2). Black bear visitation was highest during the first 12 days of the sampling period and then decreased before increasing slightly during the last 9 days of the sampling period. Grizzly bear visitation was low and relatively steady until the last 15 days of the sampling period when it increased approximately 5-fold (Figure 2).

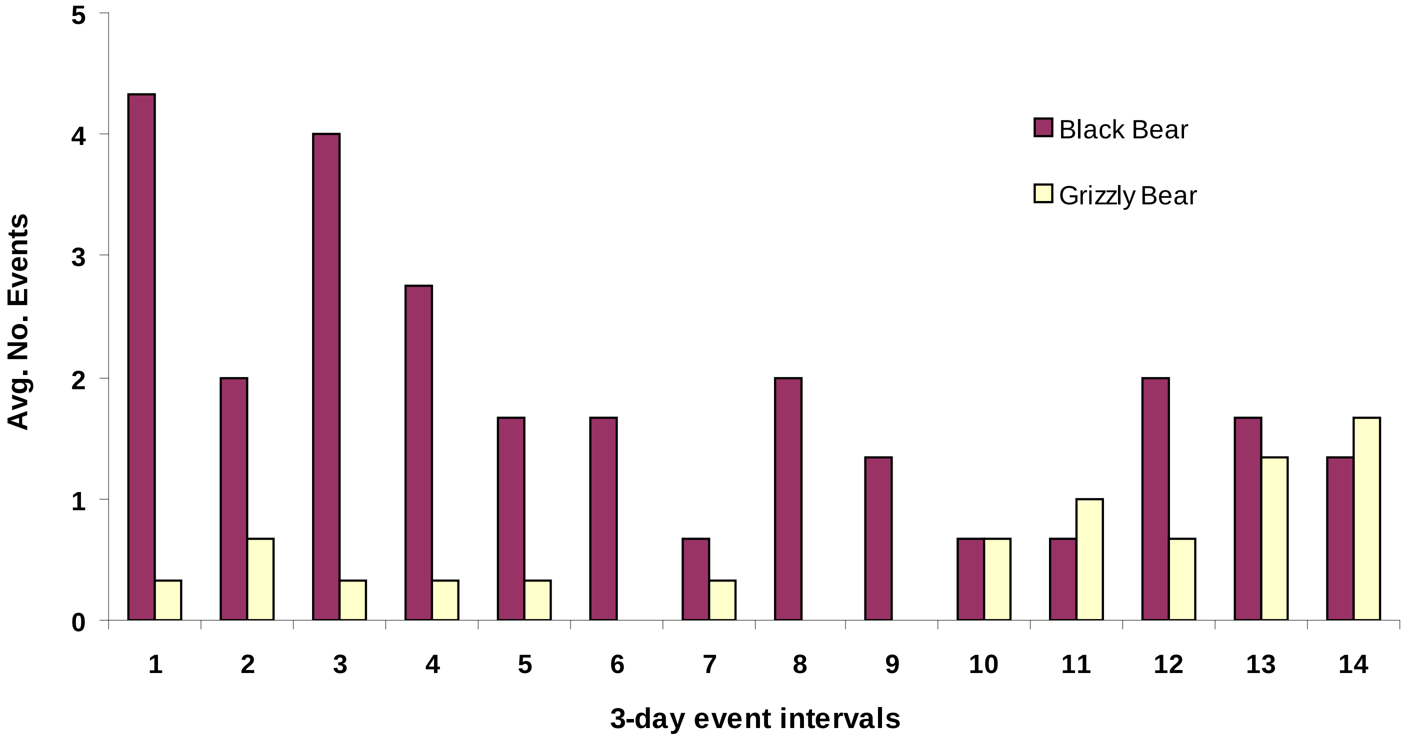

Figure 2. The number of events recorded at camera sites by 3-day interval for both black and grizzly bears. Documenting the habitat types and elevations of each of the camera sites provided some insight as to which habitats in the study area were more prone to bear detection events. Sites placed in areas of higher elevation and in close proximity to game trails received the most bear visits. Camera sites located at elevations >2,675 m (8,776 ft) accounted for the highest proportion of detection events (65%) for black bears, grizzly bears, and both species combined. Most grizzly bear detection events occurred at sites composed of whitebark pine and subalpine fir at elevations >2,800 m (9,186 ft).

DISCUSSION

Detection of grizzly bears, and bears in general, using remote cameras has been effective in previous studies (Mace et al. 1994, Noyce et al. 2001, Linkie et al. 2007). Although Mace et al. (1994) found that family groups were the least detectable cohort, the results from our camera study indicate that detection of grizzly bear females with COY is feasible using remote cameras. The collared target female with COY in 2006 was detected even though the cameras did not perform to the expected potential. In 2007, several family groups of both species, as well as some uniquely identifiable individuals, were detected on multiple occasions.

Studies suggest detection probabilities (p) > 0.30 are required to increase accuracy in occupancy and population estimates (White et al. 1982, Boulanger et al. 2002) for small populations (<100 individuals), and $p > 0.20$ for populations ranging from 100–200 animals. While our overall detection probability was low ($p = 0.21$) during the entire sampling period, we did see optimal detection probabilities for grizzly bears during the first and last 2 weeks of sampling (Table 2). Low detection probabilities are rather consistent with species, such as grizzly bears typically occurring at low densities (Boulanger et al. 2002, Mackenzie et al. 2002). Despite these relatively low values, we were successful in recording separate individuals, and based on our frequency of occurrence estimates, bears available within a grid will likely be detected using this protocol.

To most efficiently sample the area of concern, an optimal grid density covers the largest area possible while still providing high detection. By removing camera sites in both random and regular patterns, it was apparent that the grid spacing used in this study was quite low and could be increased to 5 km while still detecting nearly all bears that were detected at the 2.5 km grid spacing. Mace et al. (1994) reported a camera grid density of 5–8 cameras/100 km^2 in the Northern Continental Divide Ecosystem in Montana, or a grid spacing of approximately 3.2 km. A study on black bears in northern Minnesota (Noyce et al. 2001) used a grid density of 8.6–10.0 cameras/100km^2, or a grid spacing of approximately 4.4 km. Noyce et al. (2001) recommended that the distance between trap or camera sites not exceed the minimum width of a home range of a bear of any sex or age class. In the GYE, female grizzly bears with COY have an average home range of about 100 km^2 (M. A. Haroldson, U.S. Geological Survey, IGBST, personal communication). Thus, the diameter of that home range would be 11 km. In most recent DNA hair snare grid studies, the standard protocol for grid spacing ranges from 5 x 5 km to 9 x 9 km spacing (Boulanger et al. 2002, Boulanger et al. 2004). Boulanger et al. (2004) compared large (8 x 8 km) and small (5 x 5 km) scale study designs in Canada and found that the 5 x 5 km grid gives the best combination of precision and detection probability for populations <100 bears. Therefore, we recommend a grid spacing of 5 km for any future camera grid studies for grizzly bears in Wyoming.

Our data on the timing of bear visitation to the camera sites revealed 2 patterns. Total bear visitation was high during the first 2 weeks of the study in 2007, especially among black bears (Figure 2). This was likely due to the interest in investigating the new lure in the area. Because we used a non-rewarding lure that gave bears little incentive to revisit a site, bear visitation dropped off after 2 weeks. For that reason, we recommend placing the camera grid in an area for a minimum of 2 weeks, but no longer than 4 weeks. The data also showed seasonal variability in visitation by grizzly bears. Grizzly visitation increased in the latter 2 weeks of the study (Figure 2). A seasonal pattern was documented by Mace et al. (1994), where high seasonal food availability caused bears to move less, making them less susceptible to camera detection. To account for this variability, they used 3 seasonal sessions of 9–18 days each. It appears that some change, or use, of seasonal foods, most likely whitebark pine cones, in or near our study area around 1 September 2007 caused grizzly bear immigration and an increase in photographs. In the future it may be necessary to sample an area multiple times or use knowledge of local grizzly movement patterns and sample the area during the period when grizzly bears are most likely to be present and active.

Elevation seemed to play a role in bear visitation to specific sites, with higher elevation sites producing the majority of detection events for both bear species. This pattern is likely related to the seasonal availability of food and the elevations where those food resources are present, most notably whitebark pine seeds in the summer diet of grizzly bears. We noted higher detection of grizzly bears in habitats composed of whitebark pine and subalpine fir. Knowledge of the seasonal availability of bear foods and the elevations where they occur will aid in the placement of cameras in the future.

MANAGEMENT IMPLICATIONS

The overall objective of this study was to determine the feasibility of using remote cameras to document the presence of grizzly bears, specifically females with COY, in areas that are difficult to survey from the air due to canopy cover and other visual obstructions. While this study showed that using a camera grid was effective in documenting a known female with COY, the effort involved to likely gain, at most, 1–3 additional females with COY may not make a measurable difference in the overall population estimate for the ecosystem. The model averaging technique (Harris et al. 2007) currently used to estimate the overall grizzly bear population in the GYE smoothes large annual fluctuations and reduces overall variation in the estimate. For example, a hypothetical increase of 3 females with COY seen only once in the system would increase the Chao2 estimate (Cherry et al. 2007) from 53.08 to 59 in 2007 (11% increase). This would have translated into a model average estimate increase from 53.99 to 55.19 females with COY (2.2% increase) and a total population estimate increase from 571 to 582 bears (1.9% increase). Further, this is probably an unrealistic scenario. More likely, any increase in detection of females with COY by remote cameras would also include an increase in the frequency that these bears are seen multiple times. Multiple sightings of the same bear in an area reduces the impact of the Chao2 estimator (Chao 1989, Keating et al. 2002, Cherry et al. 2007) and adds very little to the estimate of females with COY. Thus, the population estimate would not likely increase by more than 1%–2%.

We feel a more efficient use of the camera grid technique may be in the thorough documentation of grizzly bear distribution and range expansion in the Wyoming portion of the GYE. Use of a systematic sampling grid allows for development of detection probabilities, occupancy rates, and at times populations estimates of a surveyed area without previous knowledge of existing animal densities. Systematic sampling is also beneficial when used with long-term monitoring studies (Morrison et al. 2001) such as the current grizzly bear research throughout the GYE. As grizzly bears continue to expand and repatriate outside national parks, accurate knowledge of their distribution will become essential. Each agency will be given management authority over the segment of the GYE population in proportion to the distribution of bears contained within the boundaries of each agency's jurisdiction. Accurate information on the distribution of grizzly bears will aid managers in correctly allocating state responsibilities. In addition, any females with COY detected by the remote camera grid while documenting distribution would still be applied to the population estimate.

The ability to use the camera grid technique may also be beneficial in instances where trapping has been a socially sensitive issue or in areas experiencing range expansion. Range expansion areas generally contain low grizzly bear densities, and are fairly remote and inaccessible. Trapping in these areas can be especially difficult and logistically inefficient. A camera grid may be a more effective way to document grizzly bear presence and relative density in such places as well as providing baseline data for future trapping possibilities. By reducing the camera density to 5 km x 5 km spacing, approximately 403 km^2 area can be effectively surveyed and still have a high likelihood of detecting grizzly bears in the area. The detection probabilities encountered during the 2007 sampling period appear sufficient to detect available bears including females with COY. Use of sampling grids to increase knowledge of grizzly bear distribution and abundance along with increasing data related to occupancy will assist towards collaborative grizzly bear management and will serve as a beneficial monitoring technique as population expansion continues to occur.

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Grizzly Bear Habitat Monitoring Report
Greater Yellowstone Area National Forests and National Parks
Yellowstone Grizzly Coordinating Committee
Habitat Modeling Team
June 2008

Background

The *Final Conservation Strategy* (hereinafter referred to as Strategy) *for the Grizzly Bear in the Greater Yellowstone Area* (ICST 2003) requires annual reporting of the evaluation of adherence to the habitat standards identified in that document. These monitoring requirements and habitat standards were formalized for the 2 National Parks in the Greater Yellowstone Area (GYA) by addition to the respective parks Superintendent's Compendium (GTNP 2007 and YNP 2007). Whereas, the *Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forest, Record of Decision (*hereinafter referred to as Amendment, USDA Forest Service 2006) incorporated the Strategy habitat standards and monitoring requirements. There are slight wording differences between some of the monitoring requirements and standards in the Strategy and Amendment, but wording differences do not significantly change the monitoring and reporting requirements or the application of the standards. These changes were made primarily for clarification and to fit the Amendment format. Additional monitoring requirements were added to the Amendment that only apply to the national forests. Monitoring requirements from the Strategy are listed in Attachment A and those from the Amendment in Attachment B. Additional guidance included in the Amendment, not found in the Strategy, is not listed in Attachment B unless the guidance is associated with a monitoring requirement.

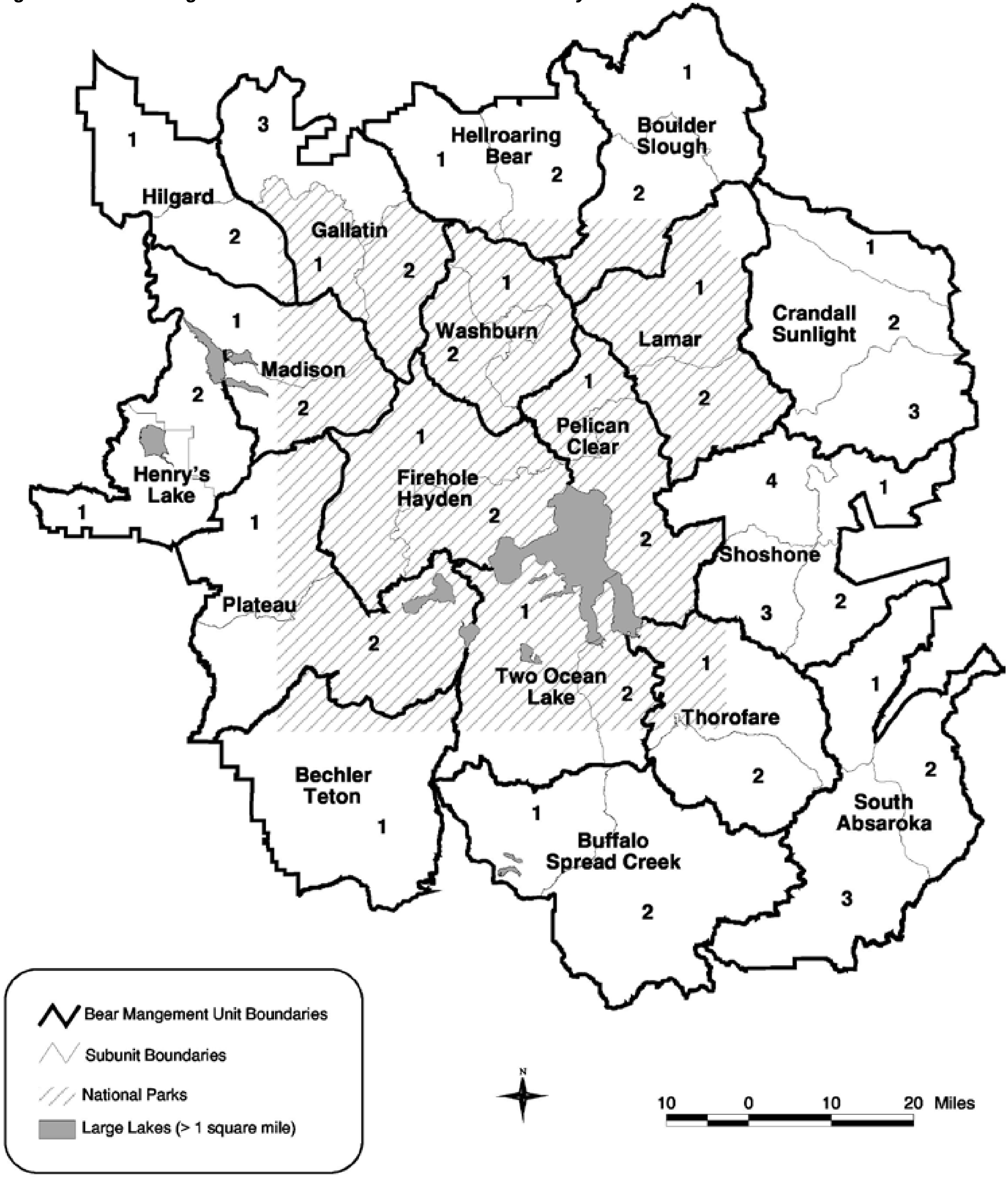
Introduction

This report is the combined response to the Strategy and Amendment requirements from the national parks and national forests in the GYA. This is the first monitoring report since the Strategy and the Amendment went into affect upon the delisting of the grizzly bear in April of 2007. This report documents 1) changes in secure habitat, open motorized access route density greater than 1 mile per square mile (OMARD) and total motorized access route density greater than 2 miles per square mile (TMARD) inside the Primary Conservation Area (PCA, Figure 1); 2) changes in number and capacity of developed sites inside the PCA; 3) changes in number of commercial livestock allotments and changes in the number of permitted domestic sheep animal months (AMs) inside the PCA; and 4) livestock allotments with grizzly bear conflicts during the last 5 years.

These monitoring items are required to be reported annually and the developed site and motorized access changes are required to be reported by Bear Management Unit subunit (Figure 1). All, except the livestock conflict information, are compared to the 1998 baseline. Tables included in each monitoring section show the 1998 baseline and the current situation. In some cases the 1998 baseline presented in the Strategy and the Amendment differs from that shown here. Differences are generally small and reflect a few errors where features were missed, features were counted that were not actually on the ground, or simply coded incorrectly. The 1998 baseline in this report represents the most accurate information to date. Forests and parks are consistently improving the quality of their information to more accurately reflect what was actually on the ground in 1998.

Other monitoring requirements for secure habitat outside the PCA (Amendment) and habitat effectiveness (Amendment and Strategy) do not require annual reporting and changes in these parameters will be summarized in future reports. Monitoring of whitebark pine (*Pinus albicaulis*) occurrence, productivity, and health inside and outside the PCA, as identified in the Amendment, is also part of this annual Interagency Grizzly Bear Study Team (IGBST) report (see Appendix A).

Figure 1. Bear Management Units and subunits inside the Primary Conservation Area.



Monitoring for Livestock Grazing

There were a total of 86 Commercial Cattle/Horse Grazing Allotments inside the PCA in 1998 (73 active and 13 vacant, Figure 2)[1]. Two vacant cattle allotments have been closed since 1998 and 2 active allotments were partially closed with small portions remaining vacant for use as a forage reserve. Several allotments that were active in 1998 are now vacant and 1 vacant allotment has been activated. This allotment was on the Caribou-Targhee National Forest where 3 allotments active in 1998 were vacant in 2007. Numbers of permitted cattle did not increase as a result of activating the vacant allotment. There has been a reduction of 8 active allotments with a subsequent increase in 6 vacant allotments since 1998 for an overall reduction of 2 allotments. Figure 2 summarizes the changes by administrative unit in numbers of active and vacant cattle/horse allotments from 1998 to 2007.

A total of 11 sheep allotments have been closed inside the PCA since 1998, 9 on the Caribou-Targhee National Forest and 2 on the Shoshone National Forest. Two additional sheep allotments active in 1998 on the Gallatin National Forest are now vacant. Sheep animal months have gone from a total of 23,090 permitted AMs in 1998 to only 1,970 permitted AMs in 2007 (Figure 2).

Grizzly bear-livestock conflicts were documented on 11 different commercial livestock allotments on the 6 national forests in the GYA during 2007 (Figure 3). Six of these allotments are entirely or partially within the PCA. During the last 5 years, conflicts have occurred on 28 different allotments that are currently active. Only 2 of these allotments are sheep allotments and both are located outside the PCA. Several allotments that have experienced conflicts during the last 5 years have been closed or are now vacant. The Amendment defines recurring conflicts as allotments that have experience conflicts with grizzly bears 3 out of the last 5 years. Only 3 allotments, 1 on the Shoshone and 2 on the Bridger-Teton have had recurring conflicts. The Custer and Gallatin National Forests have not had any livestock conflicts on currently active allotments in the last 5 years (Figure 3).

[1] The numbers of cattle and sheep allotments and sheep AMs in the 1998 baseline presented here differ slightly from numbers reported in the Strategy and the Amendment. Several allotments were inadvertently missed when previously tallying the 1998 baseline and some were incorrectly identified as vacant and vice versa. The data presented here are the best available at describing the number of livestock allotments and numbers of sheep AMs in the PCA in 1998 and 2007.

Figure 2 . Number of commercial livestock grazing allotments and sheep animal months (AMs) inside the Primary Conservation Area in 1998 and in 2007.

Administrative unit	Cattle/Horse allotments				Sheep allotments				Sheep AMs[1]	
	Active		Vacant[1]		Active		Vacant[1]			
	1998 Base	Current 2007	1998 Base	Current 2007	1998 Base	Current 2007	1998 Base	Current 2007	1998 Base	Current 2007
Beaverhead-Deerlodge NF[2]	3	3	2	0	0	0	0	0	0	0
Bridger-Teton NF[3]	8	6	0	2	0	0	0	0	0	0
Caribou-Targhee NF[4]	11	9	1	3	7	2	4	0	14,163	1,970
Custer NF	0	0	0	0	0	0	0	0	0	0
Gallatin NF[5]	26	23	10	13	2	0	3	5	3,540	0
Shoshone NF	24	24	0	0	2	0	0	0	5,387	0
Grand Teton NP[6]	1	0	0	1	0	0	0	0	0	0
Total in PCA	73	65	13	19	11	2	7	5	23,090	1,970

[1] Vacant allotments are those without an active permit but could be used periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns.

[2] The 2 vacant allotments shown in 1998, Indian Creek and Shedhorn, are now closed.

[3] Portions of 2 allotments within the PCA have been closed since 1998. These include the Blackrock-Spread Creek (75,759 acres closed 2003) and Fish Creek (77,135 acres closed 2007) allotments. The remaining portions of these 2 allotments are presently vacant and in a forage reserve status (Blackrock-Spread Creek – 12,941 acres and Fish Creek – 35,018 acres) that would allow periodic use by grazing permittees at the discretion of the Forest Supervisor, but an environmental assessment of any such action must be completed prior to permitting future grazing on the vacant range areas within these allotments. The 2 vacant allotments shown for 2007 are the remaining portions of the Blackrock-Spread Creek and Fish Creek Allotments.

[4] Three allotments active in 1998 are now vacant in 2007 (Twin Creek C&H, Meadow Creek C&H and Garner Canyon C&H). Meadow View C&H, vacant in 1998 is now active. Nine sheep allotments have been closed since 1998.

[5] Park, Beaver Creek, and Horse Butte cattle allotments were active in 1998 and vacant in 2007.

[6] Cattle traditionally using this allotment (Pacific Creek) were moved to the Elk Ranch allotment in the Park but outside the PCA in 2006. Permit holder took non-use in 2007. In 2008 and beyond cattle will be permitted outside PCA at the Elk Ranch allotment. Pacific Creek allotment expected to remain vacant for the foreseeable future.

Figure 3. Currently Active Commercial Livestock Allotments in the Greater Yellowstone national forests with documented conflicts with grizzly bears during the last 5 years. Allotments with conflicts during 3 of the last 5 years are considered to be experiencing recurring conflicts. (All allotments are cattle/horse allotments except Lime Creek and Rock Creek that are sheep allotments).

Allotment Name	Total Acres	Acres inside PCA	Conflicts 2003 (Y/N)	2004 (Y/N)	2005 (Y/N)	2006 (Y/N)	2007 (number)	Recurring conflicts Y or N (comments)
Beaverhead-Deerlodge National Forest								
West Fork Madison	53,093	0	N	N	Y	N	1	N
Bridger-Teton National Forest								
Bacon Creek	66,328	0	N	N	N	Y	0	N
Badger Creek	7,254	0	Y	N	Y	Y	0	**Y**
Beaver-Horse	25,358	0	N	N	N	N	3	N
Green River	125,663	0	Y	Y	Y	Y	18	**Y**
Jack Creek C&H	32,386	0	N	N	N	Y	0	N
Kinky Creek	22,833	0	N	N	Y	N	0	N
Lime Creek	4,973	0	Y	N	N	N	0	N
Rock Creek	5,147	0	N	N	Y	N	0	N
Caribou-Targhee National Forest								
Squirrel Meadows C&H	28,466	28,466	N	N	Y	N	2	N
Shoshone National Forest								
Bald Ridge	24,853	5,839	N	N	N	Y	0	N
Basin	73,115	72,067	N	N	N	N	2	N
Beartooth	30,316	24,169	N	N	Y	Y	0	N
Belknap	13,049	13,049	Y	N	N	Y	0	N
Bench (Clarks Fork)	28,751	4,736	N	N	N	N	3	N
Deep Lake	6,486	228	N	N	N	Y	0	N
Dunoir	52,872	39,304	Y	N	Y	N	0	N
Face of the Mountain	8,553	0	N	N	Y	N	0	N
Fish Lake	12,742	0	N	N	N	N	1	N
Hardpan Table Mountain	13,474	8,430	Y	N	Y	N	0	N
Little Rock	4,901	0	N	N	N	Y	0	N
Parque Creek	13,527	4,601	N	N	N	N	5	N
Piney	14,287	30	N	N	Y	N	0	N
Salt Creek	8,263	0	N	N	N	Y	0	N
Table Mtn.	13,895	13,895	Y	Y	N	N	2	**Y** (Livestock removed early in 2007)
Warm Spgs.	16,875	0	N	N	N	N	1	N
Wiggins Fork	37,653	88	N	N	Y	Y	0	N
Wind River	44,156	14,899	N	N	N	N	2	N

Monitoring for Developed Sites

Changes in Number of Developed Sites

There were 591 developed sites inside the PCA in 1998 and 586 in 2007 (Figure 4)[2]. Numbers of developed sites changed from 1998 to 2007 for 7 subunits. Total number of developed sites increased by 1 in two subunits, decreased by 1 in four subunits and decreased by 3 in another subunit.

A new site was added to Henry's Lake Subunit #2 on the Gallatin National Forest (Figures 4 and 5). This site was added to help mitigate the potential for bears obtaining food rewards along a high-use motorized trail. It was determined that the addition of this site was beneficial to the grizzly bear (Henry's Lake #2, Figure 6) and did not violate the developed site standard.

The only other increase in numbers of developed sites was in Hilgard #2 (Figures 4 and 5). A trailhead was moved from one side of the road to the other. In so doing the trailhead was moved from Hilgard #1 to Hilgard #2. It was determined that this was of no impact to the grizzly bear and did not violate the developed site standard (Figure 6).

The decrease of one site in Buffalo/Spread Creek #2 resulted from closing a picnic area and a Visitor information center in association with the Togwotee Highway reconstruction project. This was accomplished to mitigate for a commercial composting site permitted within an administrative site on the Bridger-Teton National Forest. The composting site has been approved but is not yet operational. Also see Buffalo/Spread Creek #2 in Figures 5 and 6.

Decreases in numbers of developed sites occurred in Hilgard #1 due to the abandonment of two cow camps on the Beaverhead-Deerlodge National Forest and the movement of the trailhead across the road to Hilgard #2 on the Gallatin National Forest. Madison #1 lost one developed site due to the closure of a snowmobile parking area on the Gallatin National Forest and an outfitter transfer corral closure on the Shoshone National Forest resulted in a decrease of one site in the South Absaroka #3. The Kitty Creek Trailhead in Shoshone #3 was closed in 1999 as part of the mitigation for the reconstruction of the North Fork of the Shoshone Highway (Figures 4, 5 and 6).

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[2] The total number of developed sites inside the PCA presented here (591) is slightly different that the 1998 baseline reported in the Strategy (590) and the Amendment (598). This is due to an improvement in data quality and an improved inventory of developed sites present in 1998. Several sites included in the 1998 baseline were found not to exist, several sites were inadvertently missed and not included in original tallies, several sites that should have been counted as a single site were identified as individual sites, several sites originally included in the 1998 baseline were actually not on the national forest but on private land, at least one site counted in the 1998 baseline is not really a developed site but just the end of the road, and at least one site was counted twice for separate subunits. The data presented here are the best available at describing the number of developed sites within each Bear Management subunit in the PCA in 1998.

Changes in capacity or type of use of Developed Sites

There were several instances of changes in capacity at existing developed sites on the Shoshone National Forest (Figure 6). In one instance, capacity banked from the change of a campground to a picnic area was used to mitigate for an increase in capacity at the Sleeping Giant Ski Area. An increase in capacity at a campground was mitigated by closing dispersed camping areas and another site was closed to allow for increase in capacity at a Lodge. An outfitter staging area was moved from one location to another in the same subunit. A change in type of use also occurred where a house at an administrative site was converted to a public rental facility. This and all other changes were mitigated according to the application rules for developed sites (Figure 6). Yellowstone National Park built a new visitor center on the same site as an old one in a highly developed area and increased the quality of grizzly bear information in the center.

Grand Teton National Park modified some facilities at an administrative site. Yellowstone National Park built a new courthouse and exchanged one use at an administrative site for a different use at the same location. The Bridger-Teton National Forest changed some activities associated with an administrative site. None of these changes required mitigation according to the application rules and the exemption for administrative sites. Figure 6 summarizes all changes in use, capacity, and numbers of sites inside the PCA since 1998 and the associated mitigation according to the applications rules for the developed site standard.

Figure 4. The 1998 baseline and the 2007 numbers of developed sites on public lands within each of the Bear Management Unit subunits in the Greater Yellowstone Area.

Bear Management Subunit	Area (mi^2)[1]	Admin Units	Total Number of Developed sites in subunit 1998 Base	Summer Home Complexes		Developed Campgrounds[2]		Trail Heads		Major Developed Sites and Lodges[3]		Administrative Or Maintenance Sites		Other Developed Sites		Plans of Operation for Minerals Activities[4]		Change in Number of Sites From 1998 Base (+ or -)
				1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	
Bechler/Teton #1	534	TNF	59	0	0	1	1	5	5	2	2	4	4	16	16	0	0	0
		YNP		0	0	0	0	2	2	0	0	2	2	2	2	0	0	
		GTNP		0	0	8	8	3	3	1	1	3	3	10	10	0	0	
Boulder/Slough #1	282	CNF	20	0	0	0	0	1	1	0	0	0	0	0	0	6	6	0
		GNF		0	0	1	1	6	6	0	0	1	1	3	3	2	2	
Boulder/Slough #2	232	GNF	9	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
		YNP		0	0	1	1	3	3	0	0	2	2	1	1	0	0	
Buffalo/Spread Creek #1	222 (220)	BTNF	18	0	0	1	1	1	1	0	0	0	0	2	2	0	0	0
		GTNP		0	0	0	0	7	7	2	2	2	2	3	3	0	0	
Buffalo/Spread Creek #2	508	BTNF	22	1	1	4	4	3	3	3	3	5	5	5	4[5]	1	1	-1
Crandall/Sunlight #1	130	SNF	22	0	0	2	2	5	5	1	1	1	1	5	5	0	0	0
		GNF		0	0	1	1	2	2	0	0	0	0	5	5	0	0	
Crandall/Sunlight #2	316	SNF	19	0	0	5	5	4	4	1	1	2	2	5	5	1	1	0
		GNF		0	0	1	1	0	0	0	0	0	0	0	0	0	0	
Crandall/Sunlight #3	222	SNF	11	0	0	2	2	3	3	0	0	1	1	2	2	0	0	0
		WG&F		0	0	2	2	0	0	0	0	1	1	0	0	0	0	
Firehole/Hayden #1	339	YNP	26	0	0	1	1	5	5	1	1	6	6	13	13	0	0	0
Firehole/Hayden #2	172	YNP	15	0	0	1	1	3	3	1	1	2	2	8	8	0	0	0
Gallatin #1	128	YNP	4	0	0	0	0	3	3	0	0	1	1	0	0	0	0	0
Gallatin #2	155	YNP	21	0	0	2	2	5	5	1	1[6]	12	12[7]	1	1	0	0	0
Gallatin #3	218	GNF	17	0	0	2	2	9	9	0	0	0	0	6	6	0	0	0
		YNP		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hellroaring/Bear #1	185	GNF	36	0	0	5	5	12	12	1	1	2	2	6	6	8[8]	8[8]	0
		YNP		0	0	0	0	1	1	0	0	0	0	1	1	0	0	
Hellroaring/Bear #2	229	GNF	4	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0
		YNP		0	0	0	0	0	0	0	0	2	2	0	0	0	0	
Henrys Lake #1	201 (191)	TNF	20	2	2	3	3	1	1	0	0	3	3	10	10	1	1	0

Bear Management Subunit	Area (mi²)[1]	Admin Units	Total Number of Developed sites in subunit 1998 Base	Summer Home Complexes 1998 Base	Summer Home Complexes 2007	Developed Campgrounds[2] 1998 Base	Developed Campgrounds[2] 2007	Trail Heads 1998 Base	Trail Heads 2007	Major Developed Sites and Lodges[3] 1998 Base	Major Developed Sites and Lodges[3] 2007	Administrative Or Maintenance Sites 1998 Base	Administrative Or Maintenance Sites 2007	Other Developed Sites 1998 Base	Other Developed Sites 2007	Plans of Operation for Minerals Activities[4] 1998 Base	Plans of Operation for Minerals Activities[4] 2007	Change in Number of Sites From 1998 Base (+ or -)
Henrys Lake #2	153	TNF	18	0	0	0	0	1	1	0	0	1	1	1	1	1	1	+1
	(140)	GNF		5	5	3	3	4	4	0	0	0	0	2	3[9]	0	0	
Hilgard #1	202	BDNF	14	0	0	0	0	0	0	0	0	3	1[9]	0	0	0	0	-3
		GNF		0	0	0	0	6	5[11]	1	1	2	2	2	2	0	0	
Hilgard #2	141	GNF	9	0	0	0	0	4	5[11]	0	0	1	1	1	1	0	0	+1
		YNP		0	0	0	0	3	3	0	0	0	0	0	0	0	0	
Lamar #1	300	YNP	37	0	0	1	1	5	5	0	0	3	3	2	2	0	0	0
		GNF		0	0	2	2	5	5	0	0	6	6	4	4	6	6	
		SNF		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		CNF		0	0	0	0	1	1	0	0	0	0	0	0	2	2	
Lamar #2	181	YNP	4	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0
Madison #1	228	GNF	20	0	0	1	1	10	10	0	0	1	1	8	7[12]	0	0	-1
		YNP		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Madison #2	157	GNF	25	8	8	2	2	1	1	1	1	4	4	5	5	0	0	0
	(149)	YNP		0	0	0	0	1	1	0	0	2	2	1	1	0	0	
Pelican/Clear #1	108	YNP	2	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
Pelican/Clear #2	252	YNP	13	0	0	1	1	4	4	1	1	4	4	3	3	0	0	
Plateau #1	286	TNF	3	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0
		GNF		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
		YNP		0	0	0	0	0	0	0	0	1	1	0	0	0	0	
Plateau #2	431	TNF	7	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0
	(420)	YNP		0	0	0	0	0	0	0	0	4	4	0	0	0	0	
Shoshone #1	122	SNF	9	1	1	2	2	0	0	0	0	0	0	6	6	0	0	0
Shoshone #2	132	SNF	2	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
Shoshone #3	141	SNF	4	2	2	0	0	1	0[13]	1	1	0	0	0	0	0	0	-1
Shoshone #4	189	SNF	23	3	3	3	2[14]	3	3	6	6	0	0	8	9[14]	0	0	0
South Absaroka #1	163	SNF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Absaroka #2	191	SNF	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
South Absaroka #3	348	SNF	15	1	1	3	3	4	4	1	1	1	1	5	4[15]	0	0	-1
Thorofare #1	273	BTNF	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		YNP		0	0	0	0	0	0	0	0	4	4	0	0	0	0	

Bear Management Subunit	Area (mi^2)[1]	Admin Units	Total Number of Developed sites in subunit 1998 Base	Summer Home Complexes		Developed Campgrounds[2]		Trail Heads		Major Developed Sites and Lodges[3]		Administrative Or Maintenance Sites		Other Developed Sites		Plans of Operation for Minerals Activities[4]		Change in Number of Sites From 1998 Base (+ or -)
				1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	1998 Base	2007	
Thorofare #2	180	BTNF	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
		YNP		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Two Ocean/Lake #1	485	YNP	14	0	0	2	2	3	3	1	1	3	3	2	2	0	0	0
	(372)	BTNF		0	0	1	1	0	0	0	0	0	0	0	0	0	0	
		GTNP		0	0	0	0	1	1	0	0	0	0	1	1	0	0	
Two Ocean/Lake #2	143	YNP	4	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
	(125)	BTNF		0	0	0	0	0	0	0	0	1	1	1	1	0	0	
Washburn #1	178	YNP	25	0	0	2	2	8	8	2	2	7	7	6	6	0	0	0
Washburn #2	144	YNP	12	0	0	1	1	6	6	0	0	1	1	4	4	0	0	0
Primary Conservation Area	**9,210 (9,036)**	**ALL**	**591**	**24**	**24**	**67**	**66**	**160**	**159**	**29**	**29**	**115**	**113**	**168**	**167**	**28**	**28**	-5

[1] Area in parenthesis is the area of the subunit without large lakes > 1 square mile.
[2] Four trailheads on the Bridger-Teton combined with associated campground as a single developed site.
[3] Mining claims with Plans of Operation are considered developed sites for this baseline. Not all sites currently have active projects.
[4] Grant, Lake, Fishing Bridge, Old Faithful, Canyon, and Mammoth in Yellowstone National Park are coded as Major Developed Areas. However, these sites are a combination of recreation facilities and administrative facilities. There are too many sites to track individually. Changes in use or capacity will be evaluated based on whether the use is recreational or administrative. Individual buildings or other facilities within these areas are not tracked individually.
[5] UW Forestry Walk VIS and Four Mile Picnic Area closed to mitigate for a New site - Terra Firma Landscaping and Organics composting site.
[6] New courthouse constructed in Mammoth Major Developed Area. Individual sites not tracked in several major developments in Yellowstone National Park. See footnote #4. The courthouse is considered an administrative site and mitigation not necessary. See Figure 6.
[7] Closed Gardiner gravel/crusher site present in 1998 and added the Heritage Research Center in Gardiner.
[8] Includes one materials mineral site with an outside contractor.
[9] New Rees Pass day use site added in 2006.
[10] Indian Creek and Shedhorn cow camps no longer in use.[11] Taylor Falls/Lightning Trailhead moved across the road from Hilgard #1 to Hilgard #2 in 2005.
[12] Tepee Creek snowmobile parking area eliminated.
[13] Kitty Creek Trailhead was closed in 1999.
[14] Sleeping Giant Campground was converted to a picnic area in 2003.
[15] Outfitter transfer corrals closed in 2002 and use transferred to existing facilities at Brooks Lake Lodge.

Figure 5. Type and name of developed sites that constitute the 1998 baseline and the 2007 numbers of developed sites within each of the Bear Management Unit subunits in the Greater Yellowstone Area. (Developed sites that are new since 1998, removed since 1998, or where type of site has changed are shaded and italicized).

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Bechler/Teton #1	**CTNF**	**Developed Campgrounds:** Cave Falls. **Trailheads:** Coyote Meadows, Hominy Peak, S. Boone Creek, Fish Lake, Cascade Creek. **Major Developed Sites:** Loll Scout Camp, Idaho Youth Services Camp. **Administrative or Maintenance Sites:** Squirrel Meadows Guard Station/Cabin, Porcupine Guard Station, Badger Creek Seismograph Site, and Squirrel Meadows GS/WY Game & Fish Cabin. **Other Developed Sites:** Grassy Lake Dam, Tillery Lake Dam, Indian Lake Dam, Bergman Res. Dam, Loon Lake Disperse sites, Horseshoe Lake Disperse sites, Porcupine Creek Disperse sites, Gravel Pit/Target Range, Boone Creek Disperse Sites, Tillery Lake O&G Camp, Calf Creek O&G Camp, Bergman O&G Camp, Granite Creek Cow Camp. Poacher's TH, Indian Meadows TH, McRenolds Res. TH/Wildlife Viewing Area/Dam.
	YNP	**Trailheads**: 9K1 and Cave Falls. **Administrative or Maintenance Sites:** South Entrance and Bechler Ranger Stations. **Other Developed Sites:** Union Falls and Snake River picnic areas.
	GTNP	**Developed Campgrounds:** Grassy Lake Road campsites (8 individual car camping sites). **Trailheads**: Glade Creek, Lower Berry Creek, Flagg Canyon. **Major Developed Sites:** Flagg Ranch (lodge, cabins and campground including remote cistern and sewage treatment plant sites). **Administrative or Maintenance Sites:** Flagg Ranch Ranger Station, employee housing, maintenance yard. **Other Developed Sites:** 3 Backcountry cabins (Upper Berry, Lower Berry, and Moose Basin), 5 Backcountry campsites {Berry Designated Horse Camp, Jackson Lake designated campsites (1 group, 3 individual)}, 2 boat launches (Flagg Ranch, Yellowstone South Entrance.)
Boulder/Slough #1	**CNF**	**Trailheads:** Goose Lake/Grasshopper Glacier (administered by Gallatin National Forest). **Plans of Operation:** East Iron Mtn Beartooth Plateau 1, East Iron Mtn Beartooth Plateau 2, Iron Mountain Idaho Construction Metal, Crescent Creek Pan Palladium, Crescent Creek Chromium Corp America, and Crescent Creek Beartooth Platinum. (Note: Goose Lake TH in Gallatin coverage)
	GNF	**Developed Campgrounds:** Hicks Park. **Trailheads**: Upsidedown Creek, Boulder Pass/West Boulder, Sheep Creek, Copper Creek, Bridge Creek, Box Canyon. **Administrative or Maintenance Sites:** Box Canyon. **Other Developed Sites**: 2 recreation residences (Rasnick and Mandeville), Independence Mine Site (no plan of operations). **Plans of Operation:** 2 (Carolyn and Cray)
Boulder/Slough #2	**GNF**	**Administrative or Maintenance Sites:** Slough Creek and Buffalo Fork Cabins.
	YNP	**Developed Campgrounds:** Slough Creek. **Trailheads:** Specimen ridge, Slough Creek, and the Lamar Ford. **Administrative or Maintenance Sites:** Elk Tongue and Lower Slough patrol cabins. **Other Developed Sites:** Yellowstone River picnic area.

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Buffalo/Spread Creek #1	**BTNF**	**Developed Campgrounds:** Pacific Creek CG/TH**. Trailheads:** Colter Dump. **Other Developed Sites:** Teton Horseback Adventures, Shoal Creek Outfitters Base Camp
	GTNP	**Trailheads:** Grand View Point, Two Ocean Lake, Christian Pond, Arizona Creek #1, Pilgrim Creek, Arizona Lake, Arizona Creek #2. **Major Developed Sites:** Moran Entrance Station housing, Jackson Lake housing. **Administrative or Maintenance Sites:** Moran Entrance Ranger Station**,** Jackson Lake Ranger Station. **Other Developed Sites:** Moran Post Office, Moran School, Colter Bay storage/staging area.
Buffalo/Spread Creek #2	**BTNF**	**Summer Home Complex:** Turpin Meadows. **Developed Campgrounds:** Box Creek CG/TH, Hatchet, Turpin Meadows, and Angles CG/TH. **Trailheads:** Turpin Meadows, Lava Creek, Clear Creek. **Major Developed Sites:** Heart Six Ranch, Turpin Meadows Ranch, and Togwotee Lodge. **Administrative or Maintenance Sites:** Buffalo Ranger District Office, Buffalo Ranger District Compound (Includes a gravel pit), Enos Lake Patrol Cabin, Nowlin Meadows Patrol Cabin; Hatchet administrative site. **Other Developed Sites:** *UW Forestry Walk VIS and Four Mile Picnic Area (closed to mitigate for composting site)*, Lost Lake Info Station, Togwotee Overlook, Historic ranger station; *Blackrock Administrative Area Composting Site (Terra Firma Landscaping and Organics). New since 1998 but not currently operational*. **Plans of Operation:** 1 gravel pit
Crandall/Sunlight #1	**SNF**	**Developed Campgrounds:** Beartooth and Island Lake. **Trailheads:** Beartooth Lake, Island Lake, Clay Butte, Muddy Creek, Morrison Jeep. **Major Developed Sites:** The Top of the World Store complex. **Administrative or Maintenance Sites:** YNP highway maintenance site, which includes 2 summer residences. **Other Developed Sites:** Island Lake Boat Ramp, Beartooth Lake Boat Ramp, Clay Butte Lookout, Pilot/Index Overlook, and Beartooth Lake Picnic Area.
	GNF	**Developed Campgrounds:** Ovis Lake Road Camp. **Trailheads:** Clarks Fork Horse Trailhead, Clarks Fork Foot Trailhead. **Other Developed Sites:** Arbor Day Watchable Wildlife site, Kersey Lake rental cabin and boat dock, Round Lake rental cabin/warming hut, Clarks Fork fishing platform and interpretive exhibit, 1 recreation residence (summer home).
Crandall/Sunlight #2	**SNF**	**Developed Campgrounds:** Fox Creek, Lake Creek, Hunter Peak, Crazy Creek and Lily Lake Campsites. **Trailheads:** Pilot Creek, Clarks Fork, North Crandall and Crazy Creek. **Major Developed Sites:** K-Z Lodge. **Administrative or Maintenance Sites:** Crandall admin site (2 residences, office, shop and bunkhouse), Crandall Game and Fish Cabin. **Other Developed Sites:** Crandall waste transfer site, Clarks Fork Overlook, Lily Lake Boat ramp, Swamp Lake Boat Ramp, and Reef Creek Picnic Area. **Plan of Operations**: Commercial sale gravel pit at Ghost Creek for Beartooth Hwy Construction.
	GNF	**Campgrounds:** Chief Joseph
Crandall/Sunlight #3	**SNF**	**Developed Campgrounds:** Dead Indian, Little Sunlight. **Trailheads:** Little Sunlight trailhead and corrals, Dead Indian and Hoodoo Basin/Lamar. **Administrative or Maintenance Sites:** Sunlight Ranger Station. **Other Developed Sites:** Sunlight Picnic Area, Sunlight Bridge Overlook.
	WG&F	**Developed Campgrounds:** Sunlight Unit Campground #1, Sunlight Unit Campground #2. **Administrative or Maintenance Sites:** Sunlight Unit Complex.

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Firehole/Hayden #1	**YNP**	**Developed Campgrounds:** Madison Junction. **Trailheads:** for Nez Perce Cr, 7-Mile Bridge, Fountain freight road, Lone Star, and OK5. **Major Developed Sites:** Old Faithful. **Administrative or Maintenance Sites:** Norris employee/govt area, Norris hot mix plant, Madison employee/govt site, the Mesa Pit site; and the Mary Lake and Nez Perce patrol cabins. **Other Developed Sites:** the Norris, Gibbon Meadows, Tuft Cliffs, Gibbon Falls, Madison, Buffalo Ford, Cascade, Firehole Canyon, Nez Perce, Feather Lake, Goose Lake, and Excelsior picnic areas and the Norris Geyser Basin Museum.
Firehole/Hayden #2	**YNP**	**Developed Campgrounds:** Bridge Bay. **Trailheads:** Divide, Beach Lake, and DeLacy Creek. **Major Developed Sites:** Lake. **Administrative or Maintenance Sites:** Lake gov't area and the Bridge Bay Marina. **Other Developed Sites:** Gull Point and Sand Point picnic areas with 6 additional lakeshore picnic areas.
Gallatin #1	**YNP**	**Trailheads:** WK2, WK3, and WK6. **Administrative or Maintenance Sites:** Daly Creek patrol cabin.
Gallatin #2	**YNP**	**Developed Campgrounds:** Mammoth and Indian Creek**. Trailheads:** Rescue Creek, Lava Creek, Golden Gate, Bunsen Peak, and Fawn Pass. **Major Developed Sites:** Mammoth. **Administrative or Maintenance Sites:** Stephens Creek area, *closed Gardiner gravel crusher/asphalt site present in 1998 and added the Heritage Research Center in Gardiner;* Xanterra headquarters site in Gardiner, the Lower Mammoth employee housing area, the YCC employee housing area, the Indian Creek pit site, the Deaf Jim patrol cabin (burned in 2001), the North Entrance Ranger Station, the Fawn Pass and Winter Creek patrol cabins, the Bunsen Peak radio repeater site, and the Mt Holmes fire lookout. **Other Developed Sites:** Sheepeater picnic area.
Gallatin #3	**GNF**	**Developed Campgrounds:** Tom Miner, Red Cliff. **Trailheads:** Buffalo Horn, Sphinx Creek, Elkhorn, Wilson Draw, Tom Miner, Tom Miner Horse Facilities, Sunlight, Twin Cabin, Tepee Creek (Bozeman Ranger district). **Other Developed Sites:** Corwin Spring fishing and boat access, Yankee Jim fishing access and boat ramp, Elkhorn River Ford (horse access), Windy Pass rental cabin, Yankee Jim picnic area, Porcupine Creek recreation residence.
	YNP	**No Developed Sites**
Hellroaring/Bear #1	**GNF**	**Developed Campgrounds:** Eagle Creek campground, Eagle Creek horse facility, Bear Creek, Timber Camp, Canyon. **Trailheads:** Cedar Creek, LaDuke, Little Trail Creek, Pine Creek, Knox Lake, Palmer Mt.(3 trailheads), North Fork of Bear Creek, Joe Brown, Bear Creek, Sixmile. **Major Developed Sites:** OTO Ranch. **Administrative or Maintenance Sites:** Blanding Station house and barn (horse facility), Hayes/ McPherson Property. **Other Developed Sites:** LaDuke picnic area, LaDuke bighorn sheep watchable wildlife site, 1 recreation cabin, Lonesome Pond camping area, McConnell fishing and boat access, Watchable Wildlife-Big Game Winter Range, Watchable Wildlife Site-fish. **Plans of Operation:** total 8; Counts (1), Mineral Hill Mine (3), and (2), Independence (1), Livingston (1).
	YNP	**Trailheads:** Crevice. **Other Developed Sites:** Crevice Cabin
Hellroaring/Bear #2	**GNF**	**Trailheads:** West Fork Mill Creek. **Administrative or Maintenance Sites:** Hellroaring Cabin and tack shed.
	YNP	**Administrative or Maintenance Sites:** Buffalo Plateau and Hellroaring patrol cabins.

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Henrys Lake #1	**CTNF**	**Summer Home Complexes:** Big Springs SHA North, Big Springs SHA South. **Developed Campgrounds**: Big Springs, Flat Rock, and Upper Coffee Pot. **Trailheads:** Howard Creek. **Administrative or Maintenance Sites:** Sawtelle Peak Electronics Site, Keg Springs Seismograph Site, Big Springs Fire Tower. **Other Developed Sites:** Big Springs Interpretive Trail, Big Springs Bridge Fish Viewing, Johnny Sack Cabin, Big Springs Boat Ramp, Big Springs Snow Park/Warming Hut, Macks Inn Water Treatment Plant, Macks Inn Substation, County/State Sheds Complex, FAA Maintenance Sheds, Cold Springs Substation. **Plans of Operation:** Willow Creek Mining Claim
Henrys Lake #2	**CTNF**	**Trailheads:** Targhee Creek. **Administrative or Maintenance Sites:** Defosses Cabin. **Other Developed Sites:** Howard Springs Family Picnic/Wayside Area. **Plans of Operation:** Turquoise Mountain Mine
	GNF	**Summer Home Complexes:** Clark Springs (8 lots), Rumbaugh Ridge (5), Romsett (9), Lonsomehurst A, Lonsomehurst B. **Developed Campgrounds:** Lonesomehurst, Cherry Creek, Spring Creek. **Trailheads:** Basin, Watkins Creek, Continental Divide, West Denny Creek. **Other Developed Sites:** Basin rental cabin, Lonsomehurst boat ramp, *Reas Pass day use site added in 2006*.
Hilgard #1	**BDNF**	**Administrative or Maintenance Sites:** McAtee Cabin, *Indian Creek Cow Camp and Shedhorn Cow Camps present in 1998 no longer in use as of 2007.*
	GNF	**Trailheads:** Doe Creek, Cinnamon, Meadow Creek Cutoff, Cache Creek, Buck Creek winter, *Taylor Falls/Lightning Creek (moved to Hilgard #2 in 2005)*. **Major Developed Sites:** Covered Wagon Ranch. (**Administrative or Maintenance Sites:** Cinnamon Cabin, Cinnamon Mountain Lookout. **Other Developed Sites:** Yellow Mule Rental Cabin, Buck Creek Recreation Residence.
Hilgard #2	**GNF**	**Trailheads:** Eldridge, Wapiti, Lower Wapiti, Sage/Elkhorn. *Taylor Falls/Lightning Creek (moved here from Hilgard #1 in 2005*). **Administrative or Maintenance Sites:** Eldridge Cabin. **Other Developed Sites:** Wapiti rental cabin.
	YNP	**Trailheads:** WK1, WK5, and WK4.
Lamar #1	**YNP**	**Developed Campgrounds:** Pebble Creek. **Trailheads:** 3K1, 3K3, 3K4, Trout Lake, and Lamar. **Administrative or Maintenance Sites:** The Northeast Entrance Ranger Station and supporting govt operation, the Lamar Buffalo Ranch Ranger Station/Institute, and the Cache Creek patrol cabin. **Other Developed Sites:** Warm Creek and Buffalo Ranch Picnic areas.
	GNF	**Developed Campgrounds:** Soda Butte, Colter. **Trailheads**: Republic Creek; Lady of Lake (lower), Lady of Lake 1, Woody Pass, Daisy Pass. **Administrative or Maintenance Sites:** Cooke City guard station and warehouse, 2nd Forest Service warehouse, Highway borrow pit, mine tailings repository, old mine buildings at Woody Pass trailhead, mine reclamation pond. **Other Developed Sites**: Cooke City dump (SUP), Beartooth Highway Interpretive site (near Silver Gate), Cooke City burn pile, parking lot for Lady of the Lake Trailhead. **Plans of Operation**: 6, all New World Mine.
	CNF	**Trailheads:** Abundance Lake/upper Stillwater (Custer admin by Gallatin). **Plans of Operation:** Cray Placer and New World Mine. *(note: this TH is in the Gallatin coverage)*
	SNF	**No Developed Sites.**

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Lamar #2	**YNP**	**Administrative or Maintenance Sites:** Calfee Creek, Upper Miller Creek, Cold Creek, and Lamar Mountain patrol cabins.
Madison #1	**GNF**	**Campgrounds:** Cabin Creek. **Trailheads**: Potamogeton, West Fork Beaver Creek, Whit's Lake, Johnson Lake, Tepee Creek (Hebgen RD), Red Canyon, Kirkwood, Cub Creek, Fir Ridge, Hebgen Mountain. **Administrative or Maintenance Sites:** Building Destruction Site. **Other Developed Sites:** gravel pit, *Tepee Creek snowmobile parking area removed in 2007,* Watchable Wildlife Site at Beaver Creek, Beaver Creek rental cabin, Cabin Creek rental cabin, Hebgen Dam fishing access and admin site; 2 day use areas (Yellowstone Holiday picnic area and North Shore picnic area).
	YNP	**No Developed Sites.**
Madison #2	**GNF**	**Summer Home Complexes:** California (2 lots), Lakeshore A (6), Lakeshore B (8), Lakeshore C (3), Lakeshore E (19), Baker's Hole (3), Railroad (3), Horse Butte (2). **Developed Campgrounds:** Rainbow Point, Baker's Hole (includes watchable wildlife site). **Trailheads:** Rendezvous Ski Trail (includes 2 cabins and a biathlon range). **Major Developed Sites:** Madison Arm Resort. **Administrative or Maintenance Sites:** West Yellowstone Ranger Station, WY Interagency Fire Center (Includes crew quarters IAFCC, fire control center and mixing site), Bison capture facility (SUP), Game Warden Residence. **Other Developed Sites:** Solid Waste Transfer Station (SUP), Madison picnic area/boat ramp, Rainbow Point picnic area/boat ramp, Horse Butte Lookout/Picnic Site, South Plateau shooting range.
	YNP	**Trailhead:** Cable Car. **Administrative or Maintenance Sites:** West Entrance Ranger Station/housing complex, and the Cougar Cr patrol cabin. **Other Developed Sites:** Madison River Picnic area.
Pelican/Clear #1	**YNP**	**Trailheads:** Lower Falls and Sour Creek.
Pelican/Clear #2	**YNP**	**Developed Campgrounds:** Fishing Bridge RV Park. **Trailheads:** Pelican Valley, 9-mile, Clear Creek, and Avalanche Peak. **Major Developed Sites:** Fishing Bridge store/gas station/employee housing/museum. **Administrative or Maintenance Sites:** East Gate Ranger Station/housing complex, the Fern Lake, Pelican Cone, and Pelican Springs patrol cabins. **Other Developed Sites:** Steamboat Point, Lake Butte, and Sylvan Lake picnic areas.
Plateau #1	**CTNF**	**Summer Home Complexes:** Moose Creek SHA. **Other Developed Sites:** Lucky Dog Lodge/TNC/SUP
	GNF	**No Developed Sites.**
	YNP	**Administrative or Maintenance Sites:** South Riverside patrol cabin.
Plateau #2	**CTNF**	**Developed Campgrounds:** None. **Trailheads:** Moose Creek/Trail Canyon. **Administrative or Maintenance Sites:** Warm River Springs GS/Cabin. **Other Developed Sites:** Snow Creek Pond Disperse sites
	YNP	**Administrative or Maintenance Sites:** Cove, Outlet, Buffalo Lake, and 3 Rivers patrol cabins.
Shoshone #1	**SNF**	**Summer Home Complexes:** Moss Creek (7). **Developed Campgrounds:** Newton Creek and Rex Hale. **Other Developed Sites:** One summer home across from Newton Creek Campground (isolated lot E), the Fire Memorial, Robbers Roost Cabin (Cow Camp), Newton Springs Picnic Area, Blackwater Pond Picnic/Fishing Area, Palisades Interpretive Site.

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Shoshone #2	**SNF**	**Trailheads:** Blackwater. **Major Developed Sites:** Blackwater Lodge.
Shoshone #3	**SNF**	**Summer Home Complexes:** Eagle Creek (8) and Kitty Creek (14). **Trailheads:** *Kitty Creek (Closed in 1999).* **Major Developed Sites:** Buffalo Bill Boy Scout Camp.
Shoshone #4	**SNF**	**Summer Home Complexes:** Grinnell Creek (2), Pahaska (2), Mormon Creek (13). **Developed Campgrounds:** Eagle Creek and Three Mile; *Sleeping Giant was a campground in 1998 and was converted to a picnic area in 2003.* **Trailheads:** Fishhawk North, Eagle Creek, and Pahaska. **Major Developed Sites:** Elephant Head Lodge, Absaroka Mountain Lodge, Shoshone Lodge, Cross Sabers Lodge, Goff Creek Lodge, and Pahaska Tepee. **Other Developed Sites:** Sleeping Giant ski area, Wyoming Game and Fish cabin, Wayfarers Chapel, 1 summer home near Game and Fish cabin (50 Mile, isolated lot C), 2 summer homes across from Eagle Creek summer home complex (isolated lots A and B, West Gateway Interpretive Site, and Cody Peak Interpretive Site, *and Sleeping Giant picnic area (converted from a campground to a picnic area in 2003*.
South Absaroka #1	**SNF**	**No Developed Sites.**
South Absaroka #2	**SNF**	**Administrative or Maintenance Sites:** Venus Creek Cabin and the Needle Creek Administrative site (2 cabins.
South Absaroka #3	**SNF**	**Summer Home Complexes:** Pinnacles (20). **Developed Campgrounds:** Brooks Lake, Pinnacles (23) and the dispersed campground near Brooks Lake Campground (23 sites). **Trailheads:** Long Creek/Dunoir, Brooks Lake, Pinnacles Trailhead, and Bonneville. **Major Developed Sites:** Brooks Lake Lodge. **Administrative or Maintenance Sites:** Wolf Creek. **Other Developed Sites:** Brooks Lake boat ramp, transfer corral/Bud Betts, Transfer Corral/Paul Gilroy, *Transfer Corral/Bridger Teton Outfitter on Brooks Lake Creek removed in 2002*, Winter Cabin/warming hut.
Thorofare #1	**BTNF**	**No Developed Sites.**
	YNP	**Administrative or Maintenance Sites:** Cabin Creek, Howell Creek, Trail Creek, and Thorofare patrol cabins.
Thorofare #2	**BTNF**	**Administrative or Maintenance Sites:** Hawk's Rest patrol cabin (USFS) and WY G&F patrol cabin.
	YNP	**No Developed Sites.**
Two Ocean/Lake #1	**YNP**	**Developed Campgrounds:** Lewis Lake and Grant Village. **Trailheads:** Shoshone Lake, Heart Lake, and Riddle Lake. **Major Developed Sites:** Grant Village. **Administrative or Maintenance Sites:** Heart Lake and Harebell patrol cabins, and Mt Sheridan fire lookout. **Other Developed Sites:** West Thumb warming hut, and the Frank Island picnic area.
	BTNF	**Developed Campgrounds:** Sheffield Creek Campground/Trailhead.
	GTNP	**Trailheads:** Sheffield Creek. **Other Developed Sites:** Snake River Picnic Area.

Bear Management Subunit	Admin Unit[1]	Name and type of each site tallied in Figure 4
Two Ocean/Lake #2	**YNP**	**Administrative or Maintenance Sites:** Peale Island and Fox Creek patrol cabins.
	BTNF	**Administrative or Maintenance Sites:** Fox Park Patrol Cabin. **Other Developed Sites:** Huckleberry Lookout Historic Site on edge of Two Ocean Lake #2 and Buffalo/Spread Creek #1.
Washburn #1	**YNP**	**Developed Campgrounds:** Tower and Canyon Village. **Trailheads:** Lower Blacktail, Upper Blacktail, Blacktail Plateau Rd/ski trail, Hellroaring, Wraith Falls, Mount Washburn, Dunraven Pass, and the Howard Eaton trail. **Major Developed Sites:** Canyon Village and the Roosevelt Lodge complex. **Administrative or Maintenance Sites:** Frog Rock and Grebe Lake pits, Tower Ranger Station (Includes maintenance building and employee housing), and the Upper Blacktail, Lower Blacktail, and Observation Pk patrol cabins; and the Mount Washburn fire lookout. **Other Developed Sites:** the Lava Creek, Antelope Creek, Dunraven Pass, Dunraven, and Howard Eaton picnic areas; and the Yancey's Hole cookout site.
Washburn #2	**YNP**	**Developed Campgrounds:** Norris. **Trailheads:** Bighorn Pass, Winter Creek, Solfatara Creek, Grizzly, Grebe, and Ice Lakes. **Administrative or Maintenance Sites:** Ice Lake gravel pit. **Other Developed Sites:** Apollinaris Springs, Beaver Lake, Norris Junction, and Virginia Meadows picnic areas.

[1]**Admin Unit - BDNF** = Beaverhead-Deerlodge National Forest, **BTNF** = Bridger-Teton National Forest, **CTNF** = Caribou-Targhee National Forest, **CNF** = Custer National Forest, GNF = Gallatin National Forest, **GTNP** = Grand Teton National Park, **WG&F** = Wyoming Game and Fish Department, **YNP** = Yellowstone National Park.

Figure 6. Developed site changes from 1998 baseline and associated mitigation.

Subunit	Developed Site	Change from 1998 Baseline	Mitigation as per the application rules	Comments
Beaverhead-Deerlodge National Forest				
Hilgard #1	Indian Creek Cow Camp	No longer in use	None required	Site and Capacity banked
Hilgard #1	Shedhorn Cow Camp	No longer in use	None required	Site and Capacity banked
Bridger-Teton National Forest				
Buffalo/Spread Creek #2	Blackrock Administrative Site	New Plan of Operations (POO) and Contract for Blackrock Administrative Mineral Materials Site, March 6, 2006. Includes trailers for office space and occasional overnight stays.	This site replaces the gravel pit Plan of Operations for the Minerals Material site present in the Blackrock Administrative Site. This site will only be used for highway reconstruction and is part of the Administrative Site. Mitigation under the application rules not required. On-going site reclamation includes development of additional wetlands on excavated areas (7.49 acres of which have already been completed). Other disturbed areas will be seeded using native species after gravel removal. Food Storage required (Order #04-00-104). Site is fenced.	This mineral materials site is within the Blackrock Administrative site and supports reconstruction of the Dubois US Highway 287/26 project. The POO and Contract authorized WDOT to mine; process and stockpile gravel, and occupy an 80 acre site from May 1, 2006 through December 31, 2015.
Buffalo/Spread Creek #2	Composting Site	New Special Use Permit (SUP), and Site and Operating Plans for Terra Firma Landscaping and Organics composting site within the permitted area for the minerals materials site noted above and added to the 2007 values	SUP Terms and Conditions for grizzly bear protection and requirements of SUP Grizzly Bear Management and Protection Plan attachment. Disturbed sites will be seeded with native plant species during reclamation phase. Two developed sites (Four Mile Meadow picnic area and UW Forestry Walk VIS) will be removed with the highway reconstruction project between 2008 and 2011 as mitigation for the composting operation.	SUP authorizes Terra Firma to develop 4.88 acres into a composting site within the Blackrock Administrative site from September 2005 through December 31, 2016. This site is not yet active.

Subunit	Developed Site	Change from 1998 Baseline	Mitigation as per the application rules	Comments
Buffalo/Spread Creek #2	Four Mile Meadow Picnic Area and UW Forestry Walk VIS	These 2 sites categorized as 'other developed sites' in 1998 closed as integral part of the Togwotee Highway reconstruction.	Closed to mitigate for the new composting site listed above	Results in a decrease of one developed site from the 1998 baseline in this subunit. This decrease will not be banked.
Gallatin National Forest				
Henry's Lake #2	Reas Pass day use site	This is a new site constructed in 2006.	This site lies on a major motorized trail which receives heavy use. The rationale is that if this site was not developed with an outhouse and pull out that there would be more difficulty dealing with dispersed trash and garbage in this area. No opportunities in subunit to mitigate. Beneficial to the grizzly bear. See comments.	This is a very small day use site with 1 outhouse and no overnight use. Bear resistant garbage containers installed. Closure of Tepee Creek snowmobile parking area in Madison #1 partial mitigation.
Hilgard #1	Taylor Fall/ Lightning Creek Trailhead	Moved across the road in 2005 and into Hilgard #2.	No mitigation – see comments	There would be no change in the impact to bears of moving this trailhead across the road.
Hilgard #2	Taylor Fall/ Lightning Creek Trailhead	Moved from Hilgard #1 across the road in 2005.	No mitigation – see comments	There would be no change in the impact to bears of moving this trailhead across the road.
Madison #1	Tepee Creek snowmobile parking area	Removed in 2007	No mitigation necessary, beneficial to the grizzly bear.	Capacity not banked used to offset new Rees Pass day use site in Henry's #2
Grand Teton National Park				
Buffalo/Spread Creek #1	Moran Entrance Station Administrative site	Widened road at station from 3 to 4 lanes, 3 new kiosks replaced 2 old kiosks, added 28 space parking lot.	None required.	Necessary for administration of the park. Affected road is PCA boundary.

Subunit	Developed Site	Change from 1998 Baseline	Mitigation as per the application rules	Comments
Shoshone National Forest				
Crandall/Sunlight #2	Fox Creek Campground	Addition of 7 campsites in this developed campground in June of 2006 (increased from 27 sites to 34 sites).	Eight dispersed sites in this subunit were closed to mitigate for the expansion of the campground which was opened to the public at the same time the disperesed sites were closed. Five sites were closed by putting up a permanent barrier where the access road left the Chief Joseph Highway. Three other sites were closed using large rocks to prevent access to the sites.	This campground was reconstructed to serve as a work camp for the workers on the reconstruction of the Beartooth Highway. Highway construction did not begin as anticipated. This campground may still be closed to the public in the future and used as a work camp.
Crandall/Sunlight #2	Sunlight Ranger Station	House at this administrative site converted to a public use cabin.	Season of use and intensity of use same with public use cabin as when used as employee housing. In addition a road accessing 3 dispersed camping sites was closed with a permanent barrier.	As a rental cabin food storage is required. No pets or livestock are allowed. The house will not be rented during the hunting season. On site caretaker to monitor compliance with food storage regulations.
Shoshone #3	Kitty Creek Trailhead	Closed in 1999	None required.	Capacity not banked as closure was part of the mitigation for the reconstruction of the North Fork Highway.
Shoshone #4	Pahaska Tepee Lodge and Sleeping Giant Ski Area	Use of corrals and barn as staging area for an outfitter eliminated at Pahaska Tepee in 2006.	Moved outfitter staging operation to the Sleeping Giant ski area parking lot in the same subunit in 2006. No new permanent structures. Same season and type of use.	Capacity at barn and corrals will not be refilled.
Shoshone #4	Sleeping Giant Campground	The 10 overnight sites were converted to picnic area sites in 2003.	No mitigation necessary. Beneficial to the grizzly bear.	The 10 overnight sites were banked for possible future use within the subunit. Each site is considered to have an average use of 4 people from May 16-November 15. Two sites used to mitigate expansion at Sleeping Giant ski area in 2007. See below. Eight sites remain banked.

Subunit	Developed Site	Change from 1998 Baseline	Mitigation as per the application rules	Comments
Shoshone #4	Sleeping Giant Ski Area	Construction of a residence for a full time caretaker, addition of a storage shed and an extension of the ski run.	Capacity bank from the change of Sleeping Giant campground to a picnic area allowed for the residence. Food storage required. The storage shed will be used to house snow grooming equipment, supplies and various chemicals/petroleum products for the maintenance of the ski area. that in the past had been left outside and unattended.	Two of the overnight sites banked from the closure of Sleeping Giant overnight sites were used to offset the increased use associated with the residence. Eight overnight sites remain banked.
South Absaroka #3	Brooks Lake Lodge and Brooks Lake Creek Outfitter Transfer Corrals	Lodge added 2 cabins (8 pillows) and a spa in 2002.	Eliminated outfitter hunting transfer corral operation and 0.15 miles of road to Brooks Lake Creek, included trailer house used by wrangler, haystack, corrals, vehicle parking and water gap to creek, area rehabilitated and road closed. Area closed before additions at Brooks Lake Lodge.	Outfitter moved transfer corral operation to existing facilities at Brooks Lake Lodge.
Yellowstone National Park				
Gallatin #2	New Heritage Research Center in Gardiner, MT	No change in number of sites.	No mitigation necessary. Replacement of one administrative site for another.	Old gravel crushing site/asphalt plant closed and Heritage Center built on same site in the town of Gardiner. No change in overnight capacity. No effect on grizzly bear.
Gallatin #2	New Mammoth Justice Center	Increase in number of buildings in the Mammoth Major Developed Area.	No Mitigation necessary. Administrative site necessary to meet new security guidelines for a courthouse.	Located in the Mammoth major developed area between the Post Office and a concessions dormitory and the engineering building. No change in overnight visitor use. No effect on grizzly bear.
Washburn #2	Canyon Visitor Center	Replaced old visitor center.	No mitigation necessary.	Removed old single story building and built new two-story building on the same site in a highly developed area. No increase in overnight use. Increased quality of grizzly bear education facilities. No effect on grizzly bear.

Monitoring for Secure Habitat, Open (OMARD > 1 mile/mile^2) and Total (TMARD > 2 mile/mile^2) Motorized Access Route Density

Maintaining or improving secure habitat at or above 1998 levels in each of the Bear Management Unit subunits inside the PCA is required by the Strategy and the Amendment. Both permanent and temporary changes in secure habitat are allowed under the application rules.

A project may permanently change secure habitat if secure habitat of equivalent habitat quality (as measured by the Cumulative Effects Model or equivalent technology) is replaced in the same Bear Management Unit subunit. To meet the intent of this requirement; the replacement secure habitat must be of equal or greater size and the Secure Area Habitat Value Score (SHVS) in the replacement secure habitat must be the same or greater as the lost secure habitat. Calculation of SHVS will be accomplished by multiplying the habitat value of each habitat component in the secure habitat area times area of the habitat component and then summing all these calculated values for the secure habitat area. SHVSs for lost secure habitat are then compared to SHVS for the replacement secure habitat. SHVSs are not banked. This analysis of SHVSs is used to document that permanent changes in secure habitat do not result in an erosion of the habitat value of the secure habitat in the subunit.

There are no standards for maintenance of seasonal open motorized access route density > 1 mile/mile^2 (OMARD) or total motorized access route density > 2 mile/mile^2 (TMARD), but changes in these parameters must be monitored and reported annually (Attachments A and B). OMARD > 1 mi/mi^2 and TMARD > 2 mi/mi2 will be referred to as OMARD and TMARD throughout this and following sections for simplicity. OMARD is monitored for two seasons. Season 1 is March 1 through July 15 and Season 2 is July 16 through November 30. Motorized access from December 1 through the end of February is not considered.

Motorized access route density is calculated using Arc Info software and a moving windows process with 30-meter cells and a one-mile square window. All motorized access routes are included in the TMARD calculation. This includes gated, permanently restricted and open motorized routes. Only open motorized access routes are included in the OMARD calculations. Secure habitat is defined as any area >= 10 acres that is greater than 500 meters from an open or gated motorized access route. Recurring helicopter flight lines are considered open motorized access routes. See Figure A-1 in Attachment A and Figure B-1 in Attachment B for more information.

Baseline values for 1998 for secure habitat, seasonal OMARD and TMARD are reported to the nearest tenth of a percent here in Figure 7 and in the Strategy and the Amendment. The actual percent change from 1998 to 2007 for each subunit is tracked in the motorized access analysis process and in the project record to 4 decimal places. Any positive changes in these parameters not evident by rounding to the nearest tenth of a percent are discussed to the nearest hundredth of a percent in the following sections for individual subunits. Increases in secure habitat or decreases in OMARD or TMARD less than one hundredth of a percent are not presented. Any decreases in secure habitat or increases in OMARD or TMARD are discussed such that rounding is not misrepresenting any changes.

The following sections summarize the permanent changes in these motorized access parameters since 1998 and on going or approved projects that temporarily affect secure habitat.

Summary of Permanent Changes in Secure Habitat

Secure habitat increased in 15 subunits from that identified in the 1998 baseline. Secure habitat percentage did not decrease in any of the 40 subunits. Increases ranged from as little as 0.02% (Buffalo/Spread Creek #2 and Crandall/Sunlight #2) up to 13.4% for Gallatin #3 (Figure 7). The average secure habitat for the PCA increased from 86.0% to 86.6%. Secure habitat was unchanged in the remaining subunits. Increases in secure habitat were always accompanied by decreases in OMARD for one season or both seasons or TMARD and most often by decreases in all three motorized access route density parameters.

The increase in secure habitat in most of the subunits was a result of decommissioning or permanently restricting motorized routes that were open or gated in 1998. In some cases motorized routes were officially changed to non-motorized routes. Increases in secure habitat in nine subunits were due solely to the Gallatin National Forest primarily in association with their Travel Management Planning Effort. Increases occurred in four subunits on the Shoshone National Forest, one subunit on the Bridger-Teton National Forest, and in one subunit secure habitat increased due to actions by both the Caribou-Targhee and Gallatin National Forests.

The increase in secure habitat for Buffalo/Spread Creek #2, Crandall/Sunlight #2, and Madison #1 and #2 also included new route construction, realignment or the opening of permanently restricted roads as well as decommissioning or permanently restricting motorized access routes resulting in a net gain of secure habitat. An analysis was performed comparing the acres and Secure Area Habitat Value Scores (SHVSs) of secure habitat lost and secure habitat gained in these subunits and is discussed below in the sections summarizing changes in secure habitat for specific subunits. In all instances the net SHVSs increased.

Increases in secure habitat may be banked to offset the impacts of future projects of that administrative unit within that subunit. However, increases in secure habitat in those subunits identified as 'Subunits with Potential for Improvement' in the Strategy (Gallatin #3, Henry's Lake #2, and Madison #2) will not be banked for future projects.

Summary of Permanent Changes in OMARD and TMARD

OMARD decreased for 15 subunits for Season 1 and 16 subunits for Season 2. TMARD decreased for 16 subunits (Figure 7). Decreases for OMARD ranged from 0.04% in Shoshone #1 for both seasons to 13.9% in Gallatin #3 for both seasons. Decreases in TMARD ranged from 0.04% for Shoshone #2 to 6.8% for Gallatin #3. Decreases in OMARD and TMARD did not always result in an increase in secure habitat by definition. The mean OMARD for Season 1 decreased from 10.4% in 1998 to 9.8% in 2007. Similarly OMARD for Season 2 decreased from 10.7% to 10.1% and TMARD decreased from 5.3% to 4.7%. The follow sections summarize changes in OMARD and TMARD by subunit.

OMARD increased by 1.2% in Buffalo/Spread Creek #2 in Season 1. This is the only subunit showing any increase in OMARD or TMARD. See discussion below for Buffalo/Spread Creek #2.

Permanent Changes in Secure Habitat, OMARD, and TMARD by Subunit

Bechler/Teton #1

This small decrease (0.2%) in OMARD > 1 mi/sq mi for Season 1 and Season 2 was the result of land exchanges wherein the Caribou-Targhee acquired private land at Squirrel Meadows, which enabled the Forest to change an open access road to a gated access road.

Buffalo/Spread Creek #2

OMARD increased by about 1.2% in subunit #2 of the Buffalo/Spread Creek BMU during Season 1 since 1998. This is primarily due to administrative decisions by the Bridger-Teton National Forest since 1998 regarding seasonal closures of gated roads. Roads that were gated in Season 1 and Season 2 in 1998 were administered as open roads during Season 1 after 1998. Similarly some roads that were permanently restricted during both seasons in 1998 are currently administered as open roads for Season 1 and gated roads for Season 2.

OMARD for Season 2 decreased by about 0.4% due to roads that were open during Season 2 in 1998 being administered as gated roads since 1998.

There was a slight increase in secure habitat and some permanent changes in secure habitat in this subunit. The permanently restricted roads that were opened for Season 1 and gated for Season 2 discussed above resulted in a decrease in secure habitat of about 695 acres. However, several roads that were open in 1998 were decommissioned resulting in an increase of 751 acres of secure habitat. The overall result was a net increase of 56 acres of secure habitat which is an increase of about .02% over the 1998 baseline. The Cumulative Effects Model was used to evaluate the habitat value of the permanent change in secure habitat. The secure area habitat value score for secure habitat lost was 382,020.4 and 529,911.8 for the new secure habitat. This resulted in an SHVS increase of 147,891.4. These figures were based on the average yearly habitat values for each habitat component in the secure habitat areas. The newly created secure habitat will remain for at least 10 years.

As a result of the changes in motorized access routes in this subunit, the TMARD in this subunit decreased by 0.3% from the 1998 baseline.

Crandall/Sunlight #1
OMARD for Season 1 and Season 2 and TMARD decreased by about .02% due to decommissioning of about 1 mile of road in association with the New World Mine Reclamation effort near Cooke City on the Gallatin National Forest. Decommissioning these roads did not increase secure habitat due to the proximity of these roads to other existing open roads.

Crandall/Sunlight #2
OMARD decreased by about 0.5% during Season 1 and by about 0.4% for Season 2. TMARD decreased by about 0.1%. These changes are due to the decommissioning of roughly 1.4 miles of road that were open in 1998 and the addition of about 0.5 miles of a new gated road in the subunit in association with a timber sale project on the Shoshone National Forest.

There was a slight increase in secure habitat and some permanent changes in secure habitat. The new year-round gated road resulted in a decrease in secure habitat of about 12.4 acres. However, the decommissioning of the roads that were open in 1998 resulted in an increase of 43.4 acres of secure habitat. The overall result was a net increase of 31 acres of secure habitat which is an increase of about .02% over the 1998 baseline. (Rounding issues show the increase to be 0.1% in Figure 7). The Cumulative Effects Model was used to evaluate the habitat value of the permanent change in secure habitat. The secure area habitat value score for secure habitat lost was 3,844.8 and 6,509.6 for the new secure habitat. This resulted in an SHVS increase of 2,664.8. These figures were based on the average yearly habitat values for each habitat component in the secure habitat areas. The newly created secure habitat will remain for at least 10 years.

Crandall/Sunlight #3
OMARD decreased by approximately 0.2% for both Seasons 1 and 2 and secure habitat increased by about 0.3% or roughly 382 acres due to the permanent restriction of the Little Sunlight Road, a 1.1-mile long road which was open in 1998. This was completed in association with closing some dispersed sites as mitigation for change in use at the Sunlight Ranger Station. TMARD did not change.

Gallatin #1
OMARD for Seasons 1 and 2 decreased by about 0.4% and secure habitat increased by 0.6%. Several motorized access routes along the border between Gallatin #1 and Gallatin #3 that were open in 1998 were designated as non-motorized routes as a result of the Travel Management Planning effort on the Gallatin National Forest. See Gallatin #3 below. TMARD did not change.

Gallatin #3
This subunit is located at the south end of the Gallatin Mountain Range, and a significant portion of the subunit is the Hyalite-Porcupine-Buffalo Horn Wilderness Study Area. This subunit had the most significant increase

in secure habitat (13.4%) and reduction in OMARD for Season 1 and Season 2 (13.9%) and TMARD (6.8%) of all subunits in the PCA. This is one of the subunits that were designated as 'Subunits with Potential for Improvement' in the Strategy. This improvement was accomplished through the Travel Management Planning effort on the Gallatin National Forest where many previously motorized routes were designated as non-motorized routes when the Travel Plan was signed.

Hellroaring/Bear #1
OMARD for Seasons 1 and 2 and TMARD decreased by about 1.1% and secure habitat increased by about 0.7%. This was a result of the decommissioning of numerous small sections of motorized routes that were open in 1998 on the Gallatin National Forest.

Henry's Lake #2
Henry's Lake #2, one of the subunits identified as 'Subunits with Potential for Improvement' in the Strategy had numerous roads decommissioned on the Gallatin National Forest since 1998. However, because of their proximity to other motorized routes, OMARD for Season 1 and Season 2 only decreased by about 0.6% and secure habitat only increased by 0.3%. TMARD however did decrease by 1.6%. Henry's Lake #2 will likely show a further increase in secure habitat and decrease in OMARD and TMARD as the Travel Plan on the Gallatin National Forest is fully implemented.

Hilgard #1
This subunit on the west side of the Gallatin National Forest, specifically the Taylor Fork area, has been the focus of major road decommissioning efforts since 1998. This was also the location of some changes in land ownership both in the Taylor Fork (increase in National Forest System lands) and south of Big Sky (adjustment of National Forest System and private lands). In addition, several routes that were motorized use in 1998 were changed to non-motorized use by the Gallatin Travel Plan decision. OMARD for both Seasons 1 and 2 and TMARD decreased by over 6% and secure habitat increased by about 4.4%. There will be some additional changes which result in increased secure habitat and decreased OMARD and TMARD as the Gallatin Travel Plan is fully implemented.

Hilgard #2
This subunit showed an increase of about 1.7% in secure habitat and a 0.4% decrease in OMARD for each season and a 1.3% decrease in TMARD. These improvements are due to road decommissioning efforts on the Gallatin National Forest since 1998. There will be additional improvements in this subunit with full implementation of the Travel Plan.

Lamar #1
Several roads were decommissioned and two roads were constructed on the Gallatin National Forest in this subunit but these changes had no affect on secure habitat due to the proximity to other motorized access routes. OMARD decreased by about 70 acres for each season but did not result in a change to these values in Figure 7 due to rounding. TMARD decreased by 0.1%.

Madison #1
Small decreases in OMARD for Seasons 1 and 2 and an increase secure habitat (0.2%) were due to the decommissioning of several motorized other routes. TMARD decreased by about 1%.

The rerouting of several motorized routes resulted in a decrease of about 36 acres of secure habitat. The decommissioning of the many other motorized routes resulted in an increase of about 298 acres of secure habitat for a net gain of 262 acres of secure habitat. The Cumulative Effects Model was used to evaluate the habitat value of the permanent change in secure habitat.

The secure area habitat value score for secure habitat lost was 13,839.3 and 100,384.6 for the new secure habitat. This resulted in an SHVS increase of 86,545.3. These figures were based on the average yearly habitat values for each habitat component in the secure habitat areas. The newly created secure habitat will remain for at least 10 years.

Madison #2

This subunit was identified as one of the 'Subunits with Potential for Improvement' in the Strategy. OMARD decreased for each season by about 1%, TMARD by over 2% and secure habitat increased by 0.8% due to the decommissioning of numerous motorized routes near West Yellowstone on the Gallatin National Forest since 1998. This subunit will show some additional improvement as the Gallatin Travel Plan is fully implemented.

In addition to the many roads that were decommissioned a couple of new roads were constructed. The newly constructed roads resulted in a loss of about 27 acres of secure habitat. The road decommissioning resulted in about 757 acres of new secure habitat for a net increase of about 730 acres of secure habitat. The Cumulative Effects Model was used to evaluate the habitat value of the permanent change in secure habitat. The secure area habitat value score for secure habitat lost was 2,715.6 and 169,657.8 for the new secure habitat. This resulted in an SHVS increase of 166,942.2. These figures were based on the average yearly habitat values for each habitat component in the secure habitat areas. The newly created secure habitat will remain for at least 10 years.

Plateau #1

Secure habitat increased by about 2.0%, OMARD decreased by 1.5% for each season and TMARD decreased by 2.6%. Improvements occurred both on the Caribou-Targhee and Gallatin National Forests. Changes on the Caribou-Targhee included a situation where two roads open in 1998 on two Idaho State land sections are no longer accessible to the public because of road decommissioning and road restrictions on the surrounding National Forest System land. One road was gated yearlong and the other was decommissioned. In another instance two roads on National Forest System land on the Caribou-Targhee that were restricted by gates yearlong in 1998 were decommissioned before 2007. Numerous roads were decommissioned on the Gallatin National Forest since 1998 in this subunit.

Plateau #2

There was a small decrease in TMARD of 0.2% and a small increase in secure habitat of 0.1%. These changes occurred because of the following: a) Roads open in 1998 on one Idaho State land section are no longer accessible to the public because of road decommissioning on the surrounding National Forest System land; b) One short road segment (less than ½ mile) on National Forest System land that was open in 1998 was decommissioned.

Shoshone #1

OMARD decreased by about 0.04% for both Season 1 and Season 2, TMARD decreased by about 0.1% and secure habitat increased by around 0.06%, or roughly 44 acres. These improvements occurred on the Shoshone National Forest due to the decommissioning about 0.4 miles of road open in 1998 within the subunit. Road decommissioning was related to the North Fork Shoshone road reconstruction project done by the Federal Highways Administration.

Shoshone #2

No road changes were made in subunit 2. TMARD decreased by about 0.04% due to the decommissioned road in the adjacent subunit 1. Secure habitat did not change from 1998.

Shoshone #4

OMARD decreased by about 0.9% for both Season 1 and Season 2, TMARD decreased by about 0.2%, and secure habitat increased by 0.7%. These improvements were due to decommissioning about 3.0 miles of roads open in 1998 on the Shoshone National Forest. Road changes were associated with the North Fork Shoshone road reconstruction project. This increase in secure habitat will not be banked as these roads were closed as mitigation for the road reconstruction project.

Temporary Changes in Secure Habitat

Projects that temporarily affect secure habitat must follow the application rules for temporary changes to secure habitat (Attachments A and B). A project under the secure habitat standard is one that involves building new roads, reconstructing roads or opening a permanently restricted road. In other words, secure habitat is reduced due to the new motorized access. The application rules require that only one project that affects secure habitat can be active at one time in a subunit and the total acreage of secure habitat affected by those projects within a given Bear Management Unit (BMU) will not exceed 1% of the acreage in the largest subunit within that BMU.

There are currently 6 approved projects in 4 subunits inside the PCA (Figure 8). Five of these projects are on the Shoshone National Forest and the other is on the Bridger-Teton National Forest. Two projects have been approved for Crandall/Sunlight #2 and 2 projects have been approved for Shoshone #4. In both subunits the project listed first in Figure 8 will be completed and roads decommissioned or permanently restricted before the second project is initiated. All of the projects affect less than 1% of the acreage of the largest subunit within the respective BMU (Figure 8). All of these projects involve vegetation management.

Figure 7. The 1998 baseline and 2007 values for secure habitat, open motorized access route density (OMARD) >1 mile per square mile, and total motorized access route density (TMARD) >2 miles per square mile for 40 Bear Management Unit (BMU) Subunits in the Greater Yellowstone Area. Includes Forest Service, Bureau of Land Management, state, county, and private motorized access routes (OMARD AND TMARD values for the 1998 baseline changed slightly from that reported in the Strategy and the Record of Decision (ROD) for the Amendment due to technical analysis issues, see footnote.[1]

Subunit Name	OMARD % >1 mi/mi² Season 1 (3/1-7/15)			OMARD % >1 mi/mi² Season 2 (7/16-11/30)			TMARD % > 2 mi/mi²			% Secure Habitat			Size [2] Sq Miles	Size [2] 1000's of Acres
	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg		
Bechler/Teton	12.7	12.5	-0.2	12.7	12.5	-0.2	4.0	4.0	0.0	78.1	78.1	0.0	534.3	341.9
Boulder/Slough 1	2.2	2.2	0.0	2.2	2.2	0.0	0.1	0.1	0.0	96.6	96.6	0.0	281.9	180.4
Boulder/Slough 2	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0	0.0	97.7	97.7	0.0	232.4	148.7
Buffalo/Spread Creek 1	10.2	10.2	0.0	10.3	10.3	0.0	4.1	4.1	0.0	88.3	88.3	0.0	219.9 (222.4)	140.7 (142.4)
Buffalo/Spread Creek 2	13.3	14.5	+1.2	14.5	14.1	-0.4	10.4	10.1	-0.3	74.3	74.3	+ < 0.1	507.6	324.9
Crandall/Sunlight 1	12.1	11.9	-0.2	16.3	16.2	-0.1	4.0	3.9	-0.1	81.1	81.1	0.0	129.8	83.1
Crandall/Sunlight 2	13.6	13.1	-0.5	14.6	14.2	-0.4	8.8	8.7	-0.1	82.3	82.4	+0.1	316.2	202.3
Crandall/Sunlight 3	12.8	12.6	-0.2	16.6	16.4	-0.2	8.1	8.1	0.0	80.4	80.7	+0.3	221.8	142.0
Firehole/Hayden 1	6.4	6.4	0.0	6.4	6.4	0.0	1.2	1.2	0.0	88.4	88.4	0.0	339.2	217.1
Firehole/Hayden 2	6.2	6.2	0.0	6.2	6.2	0.0	0.8	0.8	0.0	88.4	88.4	0.0	172.2	110.2
Gallatin 1	1.6	1.2	-0.4	1.6	1.2	-0.4	0.2	0.2	0.0	96.3	96.9	+0.6	127.7	81.7
Gallatin 2	7.8	7.8	0.0	7.8	7.8	0.0	3.9	3.9	0.0	90.2	90.2	0.0	155.2	99.3
Gallatin 3	41.2	27.3	-13.9	41.2	27.3	-13.9	16.9	10.1	-6.8	55.3	68.7	+13.4	217.6	139.3
Hellroaring/Bear 1	20.7	19.6	-1.1	21.4	20.2	-1.1	13.5	12.3	-1.1	77.0	77.7	+0.7	184.7	118.2
Hellroaring/Bear 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.5	99.5	0.0	228.9	146.5
Henry's Lake 1	45.3	45.3	0.0	45.3	45.3	0.0	26.0	26.0	0.0	45.4	45.4	0.0	191.2 (200.8)	122.4 (128.5)

Subunit Name	OMARD % >1 mi/mi²						TMARD % > 2 mi/mi²			% Secure Habitat			Size [2]	
	Season 1 (3/1-7/15)			Season 2 (7/16-11/30)									Sq Miles	1000's of Acres
	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg		
Henry's Lake 2	46.1	45.5	-0.6	46.1	45.5	-0.6	28.2	26.6	-1.6	45.7	46.0	+0.3	140.2 (152.4)	89.7 (97.6)
Hilgard 1	25.0	18.9	-6.1	25.0	18.9	-6.1	12.5	6.4	-6.1	69.8	74.2	+4.4	201.2	128.8
Hilgard 2	16.2	15.8	-0.4	16.2	15.8	-0.4	10.4	9.1	-1.3	71.5	73.2	+1.7	140.5	89.9
Lamar 1	6.9	6.9	0.0	6.9	6.9	0.0	3.2	3.1	-0.1	89.4	89.4	0.0	299.9	191.9
Lamar 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	180.7	115.7
Madison 1	24.3	24.1	-0.2	24.6	24.4	-0.2	10.3	9.3	-1.0	71.5	71.7	+0.2	227.9	145.8
Madison 2	31.8	30.7	-1.1	31.8	30.7	-1.1	22.3	19.9	-2.4	66.5	67.3	+0.8	149.4 (156.8)	95.6 (100.4)
Pelican/Clear 1	1.3	1.3	0.0	1.3	1.3	0.00	0.4	0.4	0.0	97.8	97.8	0.0	108.4	69.4
Pelican/Clear 2	3.0	3.0	0.0	3.0	3.0	0.00	0.2	0.2	0.0	94.1	94.1	0.0	251.6	161.0
Plateau 1	18.9	17.4	-1.5	19.1	17.6	-1.5	9.6	7.0	-2.6	68.9	70.9	+2.0	286.3	183.2
Plateau 2	6.3	6.3	0.0	6.3	6.3	0.0	2.4	2.2	-0.2	88.7	88.8	+0.1	419.8 (430.8)	268.7 (275.7)
Shoshone 1	1.4	1.4	-< 0.1	1.4	1.4	-< 0.1	0.9	0.8	-0.1	98.5	98.5	+< 0.1	122.2	78.2
Shoshone 2	1.1	1.1	0.0	1.1	1.1	0.0	0.4	0.4	-< 0.1	98.8	98.8	0.0	132.4	84.7
Shoshone 3	3.4	2.5	-0.9	3.4	2.4	-0.9	1.2	1.0	-0.2	97.0	97.7	+0.7	140.7	90.1
Shoshone 4	3.9	3.9	0.0	4.6	4.6	0.0	2.0	2.0	0.0	94.9	94.9	0.0	188.8	120.8
South Absaroka 1	0.4	0.4	0.0	0.4	0.4	0.0	0.0	0.0	0.0	99.2	99.2	0.0	163.2	104.4
South Absaroka 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	99.9	99.9	0.0	190.6	122.0
South Absaroka 3	2.1	2.1	0.0	2.1	2.1	0.0	2.3	2.3	0.0	96.8	96.8	0.0	348.3	222.9

Subunit Name	OMARD % >1 mi/mi²						TMARD % > 2 mi/mi²			% Secure Habitat			Size [2]	
	Season 1 (3/1-7/15)			Season 2 (7/16-11/30)									Sq Miles	1000's of Acres
	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg	1998	2007	% chg		
Thorofare 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	273.4	175.0
Thorofare 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	180.0	115.2
Two Ocean/Lake 1	1.8	1.8	0.0	1.8	1.8	0.0	0.1	0.1	0.0	96.3	96.3	0.0	371.9 (494.5)	238.0 (316.5)
Two Ocean/Lake 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	124.9 (143.6)	79.9 (91.9)
Washburn 1	12.3	12.3	0.0	12.3	12.3	0.0	2.9	2.9	0.0	83.0	83.0	0.0	178.3	114.1
Washburn 2	4.0	4.0	0.0	4.0	4.0	0.0	0.6	0.6	0.0	92.0	92.0	0.0	144.1	92.2
Mean for PCA/Total Acres	**10.4**	**9.8**	NA	**10.7**	**10.1**	NA	**5.3**	**4.7**	NA	**86.0**	**86.6**	NA	9,025.1 (9,209.3)	5,776.1 (5,894.0)

[1] The original analysis for OMARD, TMARD, and secure habitat in the Strategy (Appendix F, Table 2) and the Amendment ROD (Figure A-4) used the 1998 baseline motorized access coverage in NAD27. This analysis was conducted in NAD83 (the new Forest Service standard) using the same baseline coverage. The original analysis was also conducted using a PCA sized snapgrid to perform the moving windows analysis. It was discovered when finalizing the access analysis process for yearly monitoring that a slightly different answer was obtained for OMARD and TMARD in certain cases when only performing the analysis at the BMU level. The mean OMARD and TMARD values did not change; demonstrating it was a snapgrid positioning issue when calculating individual subunit values. The process has been standardized to use an individual BMU sized snapgrid and all analysis will be preformed only at the BMU level for future monitoring as reflected by the baseline data above. Secure habitat values did not change as they were not affected by the snapgrid issue or the projection change. The mean secure habitat for the PCA in Figure A-4 (85.6%) was calculated from the PCA sized secure habitat coverage by dividing total acres of secure habitat in the PCA without lakes by total area in the PCA without lakes. The mean secure habitat shown here was calculated by averaging the percent secure habitat values from individual subunit secure habitat coverages, producing a slightly different mean due to rounding issues. The mean secure habitat shown here is the correct mean and this process will be used in all future analysis.

Acre totals for the individual subunits in the Figure A-4 in the Amendment ROD were calculated from the original square miles reported in the Strategy (Appendix F, Table 2) that were rounded to the nearest square mile. The acre and square mile totals here are calculated directly from the subunit coverage and are more precise. In some cases rounding the square miles shown in this figure to the nearest whole square mile will not match the square miles shown in the Strategy (Appendix F, Table 2). These small differences are due to corrections in the subunit boundaries associated with Yellowstone and Hebgen lakes after the Strategy analysis and before the analysis for the Amendment.

[2] Lakes >1 mile in size were removed from subunit totals, OMARD, TMARD, and secure habitat calculations. Numbers in parentheses include the area of these large lakes.

Figure 8. Approved or ongoing projects that temporarily affect secure habitat inside the Primary Conservation Area, April 2008.

Bear Management Unit Subunit	Square Miles Secure Habitat 1998	Square Miles Secure Habitat 2007	1% of the Area of the Largest Subunit in Square Miles[1]	Project Name and Administrative Unit[2]	Square Miles of Secure Habitat with the Project	Square Miles of Secure Habitat Affected by the Project	Total Percent Temporary Change in Secure Habitat in the BMU Based on the Area of the Largest Subunit
Buffalo/Spread Creek #1	194.12	194.12	**5.08**		194.12	**0.00**	**0.27%**
Buffalo/Spread Creek #2	377.27	377.36		**North Fork Fish Creek** Bridger-Teton NF	375.98	**1.38**	
Crandall/Sunlight #1	105.28	105.28	**3.16**		105.28	**0.00**	**0.02%**
Crandall/Sunlight #2	260.33	260.38		**Deadman** Shoshone NF	260.31	**0.07**	
Crandall/Sunlight #3	178.40	179.00			179.00	**0.00**	
Crandall/Sunlight #1	105.28	105.28	**3.16**		105.28	**0.00**	**0.05%**
Crandall/Sunlight #2	260.33	260.38		**Upper Clarks Fork** Shoshone NF	260.23	**0.15**	
Crandall/Sunlight #3	178.40	179.00			179.00	**0.00**	
Shoshone #1	120.35	120.42	**1.89**		120.42	**0.00**	**0.08%**
Shoshone #2	130.87	130.87			130.87	**0.00**	
Shoshone #3	136.46	137.56			137.56	**0.00**	
Shoshone #4	179.15	179.15		**Sleeping Giant** Shoshone NF	179.00	**0.16**	
Shoshone #1	120.35	120.42	**1.89**		120.42	**0.00**	**0.07%**
Shoshone #2	130.87	130.87			130.87	**0.00**	
Shoshone #3	136.46	137.56			137.52	**0.04**	
Shoshone #4	179.15	179.15		**Canfield** Shoshone NF	179.06	**0.09**	

Bear Management Unit Subunit	Square Miles Secure Habitat 1998	Square Miles Secure Habitat 2007	1% of the Area of the Largest Subunit in Square Miles[1]	Project Name and Administrative Unit[2]	Square Miles of Secure Habitat with the Project	Square Miles of Secure Habitat Affected by the Project	Total Percent Temporary Change in Secure Habitat in the BMU Based on the Area of the Largest Subunit
South Absaroka #1	161.89	161.89	**3.48**		161.89	**0.00**	**0.03%**
South Absaroka #2	190.31	190.31			190.31	**0.00**	
South Absaroka #3	337.14	337.14		**Upper Wind River** Shoshone NF	337.05	**0.10**	

[1] This is the maximum allowable temporary change in secure habitat for all projects within the Bear Management Unit. Only one project can be active in a BMU subunit at any time.

[2] Projects are listed in the BMU subunit where the activity occurs. Projects in a given BMU subunit may affect secure habitat in adjacent subunits or subunits in adjacent BMUs. Where two projects are shown for a given BMU subunit, the first project listed will be completed before starting the subsequent project. None of the listed projects affect secure habitat in adjacent BMU subunits.

Literature Cited

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Yellowstone National Park. 2007. Superintendents Compendium. 36 CFR 1.7 (b) 1.2 (d).

Attachment A

Conservation Strategy Habitat Standards and Monitoring Requirements

Habitat Standards

References to appendices and baseline tables in the Strategy have been deleted. Tables presented in the body of this document represent the 1998 baseline and current situation.

Secure Habitat Standard

The percent of secure habitat within each bear management subunit must be maintained at or above levels that existed in 1998. Temporary and permanent changes are allowed under specific conditions identified below. Figure A-1 provides a summary of the secure area management rules. The rule set in Figure A-1 will be used in management and evaluation of projects and habitat management actions as appropriate under this Conservation Strategy.

Application Rules for Changes in Secure Habitat

Permanent changes to secure habitat. A project may permanently change secure habitat provided that replacement secure habitat of equivalent habitat quality (as measured by the Cumulative Effects Model (CEM) or equivalent technology) is provided in the same grizzly subunit. The replacement habitat must either be in place before project initiation or be provided concurrently with project development as an integral part of the project plan.

Temporary changes to secure habitat. Temporary reductions in secure habitat can occur to allow projects, if all of the following conditions are met:

• Only one project is active per grizzly subunit at any one time.

• Total acreage of active projects within a given BMU will not exceed 1% of the acreage in the largest subunit within that BMU. The acreage of a project that counts against the 1% limit is the acreage associated with the 500-meter buffer around any motorized access route that extends into secure habitat.

• Secure habitat is restored within one year after completion of the project.

Figure A-1. The rule set for secure habitat management in the Yellowstone Primary Conservation Area.

Criteria	Definition
Software, Database, and Calculation Parameters	ARC INFO using the moving window GIS technique (Mace et al. 1996), 30-meter pixel size, square mile window size and density measured as miles/square mile. Motorized access features from the CEM GIS database
Motorized Access Routes in Database	All routes having motorized use or the potential for motorized use (restricted roads) including motorized trails, highways, and forest roads. Private roads and state and county highways counted.
Season Definitions	Season 1 – 1 March to 15 July. Season 2 – 16 July to 30 November. There are no access standards in the winter season (1 December to 28 February).
Habitat Considerations	Habitat quality not part of the standards but 1) Replacement secure habitat requires equal or greater habitat value 2) Road closures should consider seasonal habitat needs.
Project	An activity requiring construction of new roads, reconstructing or opening a restricted road or recurring helicopter flights at low elevations.
Secure Habitat	More than 500 meters from an open or gated motorized access route or reoccurring helicopter flight line. Must be greater than or equal to 10 acres in size. Replacement secure habitat created to mitigate for loss of existing secure habitat must be of equal or greater habitat value and remain in place for a minimum of 10 years. Large lakes not included in calculations.
Activities Allowed in Secure Habitat	Activities that do not require road construction, reconstruction, opening a restricted road, or reoccurring helicopter flights. Over the snow use allowed until further research identifies a concern.
Inclusions in Secure Habitat	Roads restricted with permanent barriers (not gates), decommissioned or obliterated roads, and/or non-motorized trails.
Temporary Reduction in Secure Habitat	One project per subunit is permitted that may temporarily reduce secure habitat. Total acreage of active projects in the BMU will not exceed 1% of the acreage in the largest subunit within the BMU. The acreage that counts against the 1% is the 500-meter buffer around open motorized access routes extending into secure habitat. Secure habitat is restored within one year after completion of the project.
Permanent Changes to Secure Habitat	A project may permanently change secure habitat provided that replacement secure habitat of equivalent habitat quality (as measured by CEM or equivalent technology) is provided in the same grizzly subunit. The replacement habitat either must be in place before project initiation or be provided as an integral part of the project plan.
Subunits with Planned Temporary Secure Habitat Reduction	Secure habitat for subunits Gallatin #3 and Hilgard #1 will temporarily decline below 1998 values due to the Gallatin Range Consolidation Act. Upon completion of the land exchange and associated timber sales, secure habitat in these subunits will be improved from the 1998 baseline.
Subunits with Potential for Improvement	Access values for Henrys Lake #2, Gallatin #3, and Madison # 2 have the potential for improvement. The quantity and timing of the improvement will be determined by the Gallatin National Forest Travel Management Plan.
Proactive Improvement in Secure Habitat	A proactive increase in secure habitat may be used at a future date to mitigate for impacts of proposed projects of that administrative unit within that subunit.
Exceptions for Caribou-Targhee NF	When fully adopted and implemented the Standards and Guidelines in the 1997 revised Targhee Forest Plan met the intent of maintaining secure habitat levels.

Developed Site Standard

The number and capacity of developed sites within the PCA will be maintained at or below the 1998 level with the following exceptions: any proposed increase, expansion, or change of use of developed sites from the 1998 baseline in the PCA will be analyzed, and potential detrimental and positive impacts documented through biological evaluation or assessment by the action agency.

A developed site includes but is not limited to sites on public land developed or improved for human use or resource development such as campgrounds, trailheads, lodges, administrative sites, service stations, summer homes, restaurants, visitor centers, and permitted resource development sites such as oil and gas exploratory wells, production wells, plans of operation for mining activities, work camps, etc.

Application Rules

Mitigation of detrimental impacts will occur within the affected subunit and will be equivalent to the type and extent of impact. Mitigation measures will be in place before the initiation of the project or included as an integral part of the completion of the project.

• Consolidation and/or elimination of dispersed camping will be considered adequate mitigation for increases in human capacity at developed campgrounds if the new site capacity is equivalent to the dispersed camping eliminated.

• New sites will require mitigation within that subunit to offset any increases in human capacity, habitat loss, and increased access to surrounding habitats.

• Administrative site expansions are exempt from human capacity mitigation expansion if such developments are necessary for enhancement of management of public lands and other viable alternatives are not available. Temporary construction work camps for highway construction or other major maintenance projects are exempt from human capacity mitigation if other viable alternatives are not available. Food storage facilities and management must be in place to ensure food storage compliance, i.e., regulations established and enforced, camp monitors, etc. All other factors resulting in potential detrimental impacts to grizzly bears will be mitigated as identified for other developed sites.

• Land managers may improve the condition of developed sites for bears or reduce the number of sites. The improvements may then be used at a future date to mitigate equivalent impacts of proposed site development increase, expansion, or change of use for that administrative unit within that subunit.

• To the fullest extent of its regulatory authority, the Forest Service will minimize effects on grizzly habitat from activities based in statutory rights, such as the 1872 General Mining Law. In those expected few cases where the mitigated effects will result in an exceedance of the 1998 baseline that cannot be compensated for within that subunit, compensation, in the PCA, to levels at or below the 1998 baseline will be accomplished in adjacent subunits when possible, or the closest subunit if this is not possible, or in areas outside the PCA adjacent to the subunit impacted. Mitigation for Mining Law site impacts will follow standard developed site mitigation to offset any increases in human capacity, habitat loss, and increased access to surrounding habitats. Access impacts relating to Mining Law activities will be mitigated per the applications rules for changes in secure habitat.

• Developments on private land are not counted against this standard.

Livestock Allotment Standard

Inside the PCA, no new active commercial livestock grazing allotments will be created and there will be no increases in permitted sheep Animal Months (AMs) from the identified 1998 baseline. Existing sheep allotments will be monitored, evaluated, and phased out as the opportunity arises with willing permittees.

Application Rules

Allotments include both vacant and active commercial grazing allotments. Vacant allotments are those without an active permit, but may be used periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns. Reissuance of permits for vacant cattle allotments may result in an increase in the number of permitted cattle, but the number of allotments would remain the same as the 1998 baseline. Combining or dividing existing allotments would be allowed as long as acreage in allotments does not increase. Any such use of vacant cattle allotments resulting in an increase in permitted cattle numbers will be allowed only after an analysis by the action agency to evaluate impacts on grizzly bears. Where chronic conflicts occur on cattle allotments inside the PCA, and an opportunity exists with a willing permittee, one alternative for resolving the conflict may be to phase out cattle grazing or to move the cattle to a currently vacant allotment where there is less likelihood of conflict.

Habitat Monitoring

Habitat monitoring will focus on evaluation of adherence to the habitat standards identified in this Strategy. Monitoring of other important habitat parameters will provide additional information to evaluate fully the status of the habitat for supporting a recovered grizzly bear population and the effectiveness of habitat standards. Habitat standards and other habitat parameters will be monitored as follows.

Secure Habitat and Motorized Access Route Density - Monitoring Protocol

Secure habitat, open motorized access route density (OMARD) greater than one mile/square mile, and total motorized access route density (TMARD) greater than two miles/square mile will be monitored utilizing Yellowstone Grizzly Bear Cumulative Effects Model (CEM), Geographic Information System (GIS) databases, and reported annually within each subunit in the IGBST Annual Report. Protocols are established for an annual update of motorized access routes and other CEM GIS databases for the PCA. To provide evaluation of motorized access proposals relative to the 1998 baseline, automated GIS programs are available on each administrative unit.

Developed Sites - Monitoring Protocol

Monitoring numbers of developed sites can indirectly assess displacement from habitat, habituation to human activities, and increased grizzly mortality risk. Changes in the number and capacity of developed sites on public lands will be compiled annually and compared to the 1998 baseline. Developed sites are currently inventoried in existing GIS databases and are an input item to the CEM.

Livestock Grazing - Monitoring Protocol

To ensure no increase from the 1998 baseline, numbers of commercial livestock grazing allotments and numbers of sheep AMs within the PCA will be monitored and reported to the IGBST annually by the permitting agencies.

Habitat Effectiveness and Habitat Value - Monitoring Protocol

The agencies will measure changes in seasonal Habitat Effectiveness in each BMU and subunit by regular application of the CEM or the best available system, and compare outputs to the 1998 baseline. CEM databases will be reviewed annually and updated as needed. These databases include location, duration, and intensity of use for motorized access routes, non-motorized access routes, developed sites, and front country and backcountry dispersed uses. Emphasis and funding will continue to refine and verify CEM assumptions and to update databases.

Representative trails or access points, where risk of grizzly bear mortality is highest, will be monitored when funding is available. CEM databases will be updated to reflect any noted changes in intensity or duration of human use.

Attachment B

Habitat Standards and Monitoring Requirements in the Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area Forests

Habitat Standards and Guidelines

Only habitat standards from the Amendment that are tied to monitoring requirements are listed here. References to appendices and baseline tables in the Amendment have been deleted here. Tables presented in the body of this document represent the 1998 baseline and current situation.

Grizzly bear habitat conservation standard for secure habitat

Inside the Primary Conservation Area, maintain the percent of secure habitat in Bear Management Unit subunits at or above 1998 levels. Projects that change secure habitat must follow the Application Rules.

Application Rules for changes in secure habitat

Permanent changes to secure habitat. A project may permanently change secure habitat if secure habitat of equivalent habitat quality (as measured by the Cumulative Effects Model or equivalent technology) is replaced in the same Bear Management Unit subunit. The replacement habitat must be maintained for a minimum of 10 years and be either in place before project implementation or concurrent with project development. Increases in secure habitat may be banked to offset the impacts of future projects of that administrative unit within that subunit.

Temporary changes to secure habitat. Projects can occur with temporary reductions in secure habitat if all the following conditions are met:

- Only one active project per Bear Management Unit subunit can occur at any one time.
- The total acreage of active projects within a given Bear Management Unit does not exceed 1 percent of the acreage in the largest subunit within that Bear Management Unit. The acreage of a project that counts against the 1 percent limit is the acreage associated with the 500-meter buffer around any gated or open motorized access route or recurring low level helicopter flight line, where the buffer extends into secure habitat.
- To qualify as a temporary project, implementation will last no longer than three years.
- Secure habitat must be restored within one year after completion of the project.
- Project activities should be concentrated in time and space to the extent feasible.

Acceptable activities in secure habitat. Activities that do not require road construction, reconstruction, opening a permanently restricted road, or recurring helicopter flight lines at low elevation do not detract from secure habitat. Examples of such activities include thinning, tree planting, prescribed fire, trail maintenance, and administrative studies/monitoring. Activities should be concentrated in time and space to the extent feasible to minimize disturbance. Effects of such projects will be analyzed in the National Environmental Policy Act process.

- Helicopter use for short-term activities such as prescribed fire ignition/management, periodic administrative flights, fire suppression, search and rescue, and other similar activities do not constitute a project and do not detract from secure habitat.

- Motorized access routes with permanent barriers, decommissioned or obliterated roads, non-motorized trails, winter snow machine trails, and other motorized winter activities do not count against secure habitat.
- Project activities occurring between December 1 and February 28 do not count against secure habitat.
- Minimize effects on grizzly habitat from activities based in statutory rights, such as access to private lands under the Alaska National Interest Lands Conservation Act and the 1872 General Mining Law. Where the mitigated effects exceed the 1998 baseline within the affected subunit, compensate secure habitat to levels at or above the 1998 baseline, in this order: 1) in adjacent subunits, or 2) nearest subunits, or 3) in areas outside the Primary Conservation Area adjacent to the subunit impacted.
- Honor existing oil and gas and other mineral leases. Proposed Applications for Permit to Drill and operating plans within those leases should meet the Application Rules for changes in secure habitat. New leases, Applications for Permit to Drill, and operating plans must meet the secure habitat and developed site standards.

Grizzly bear habitat conservation standard for developed sites

Inside the Primary Conservation Area, maintain the number and capacity of developed sites at or below 1998 levels, with the following exceptions: any proposed increase, expansion, or change of use of developed sites from the 1998 baseline in the Primary Conservation Area will be analyzed and potential detrimental and positive impacts on grizzly bears will be documented through biological evaluation or assessment. Projects that change the number or capacity of developed sites must follow the Application Rules.

Application Rules for developed sites

Mitigation of detrimental impacts must occur within the affected subunit and be equivalent to the type and extent of impact. Mitigation measures must be in place before implementation of the project or included as an integral part of the completion of the project.

- New sites must be mitigated within that subunit to offset any increases in human capacity, habitat loss, and increased access to surrounding habitats. Consolidation and/or elimination of dispersed campsites is adequate mitigation for increases in human capacity at developed campgrounds if the new site capacity is equivalent to the dispersed camping eliminated.
- Administrative site expansions are exempt from human capacity mitigation expansion if such developments are necessary for enhancement of management of public lands and other viable alternatives are not available. Temporary construction work camps for highway construction or other major maintenance projects are exempt from human capacity mitigation if other viable alternatives are not available. Food storage facilities and management, including camp monitors, must be in place to ensure food storage compliance. All other factors resulting in potential detrimental impacts to grizzly bears must be mitigated as identified for other developed sites.
- To benefit the grizzly bear, capacity, season of use, and access to surrounding habitats of existing developed sites may be adjusted. The improvements may then be banked to mitigate equivalent impacts of future developed sites within that subunit.
- Minimize effects on grizzly habitat from activities based in statutory rights, such as the 1872 General Mining Law. Where the mitigated effects exceed the 1998 baseline within that subunit, provide mitigation to levels at or below the 1998 baseline in this order: 1) adjacent subunits, or 2) the nearest subunit, or 3) in areas outside the Primary Conservation Area adjacent to the subunit impacted. Mitigation for Mining Law site impacts must follow standard developed site mitigation to offset any increases in human capacity, habitat loss, and increased access to surrounding habitats.

- Honor existing oil and gas and other mineral leases. Proposed Applications for Permit to Drill and operating plans within those leases should meet the developed site standard. New leases, Applications for Permit to Drill, and operating plans must meet the developed site standard.
- Developments on private land are not counted against this standard.

Grizzly bear habitat conservation standard for livestock grazing

Inside the Primary Conservation Area, do not create new active commercial livestock grazing allotments, do not increase permitted sheep animal months from the 1998 baseline, and phase out existing sheep allotments as opportunities arise with willing permittees.

Application Rule for livestock grazing standard

Allotments include both vacant and active commercial grazing allotments. Reissuance of permits for vacant cattle allotments may result in an increase in the number of permitted cattle, but the number of allotments must remain at or below the 1998 baseline. Allow combining or dividing existing allotments as long as acreage in allotments does not increase. Any such use of vacant cattle allotments resulting in an increase in permitted cattle numbers could be allowed only after an analysis to evaluate impacts on grizzly bears.

Grizzly bear habitat conservation guideline for livestock grazing

Inside the Primary Conservation Area, cattle allotments or portions of cattle allotments with recurring conflicts that cannot be resolved through modification of grazing practices may be retired as opportunities arise with willing permittees. Outside the Primary Conservation Area in areas identified in state management plans as biologically suitable and socially acceptable for grizzly bear occupancy, livestock allotments or portions of allotments with recurring conflicts that cannot be resolved through modification of grazing practices may be retired as opportunities arise with willing permittees.

Application Rule for livestock grazing guideline

Permittees with allotments with recurring conflicts will be given the opportunity to place livestock in a vacant allotment outside the Primary Conservation Area where there is less likelihood for conflicts with grizzly bears as these allotments become available.

Grizzly bear habitat conservation guideline for food sources

Inside and outside the Primary Conservation Area in areas identified in state management plans as biologically suitable and socially acceptable for grizzly bear occupancy, maintain the productivity, to the extent feasible, of the four key grizzly bear food sources as identified in the Conservation Strategy. Emphasize maintaining and restoring whitebark pine stands inside and outside the Primary Conservation Area.

Habitat Monitoring

Grizzly bear habitat conservation monitoring for secure habitat and motorized access

Inside the Primary Conservation Area, monitor, compare to the 1998 baseline, and annually submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: secure habitat, open motorized access route density (OMARD) greater than one mile per square mile, and total motorized access route density (TMARD) greater than two miles per square mile in each subunit on the national forest.

Outside the Primary Conservation Area in areas identified in state management plans as biologically suitable and socially acceptable for grizzly bear occupancy, monitor, and submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: changes in secure habitat by national forest every two years.

Grizzly bear habitat conservation monitoring for developed sites

Inside the Primary Conservation Area, monitor, and annually submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: changes in the number and capacity of developed sites on the national forest, and compare with the 1998 baseline.

Grizzly bear habitat conservation monitoring for livestock grazing

Inside the Primary Conservation Area, monitor, compare to the 1998 baseline, and annually submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: the number of commercial livestock grazing allotments on the national forest and the number of permitted domestic sheep animal months. Inside and outside the Primary Conservation Area, monitor and evaluate allotments for recurring conflicts with grizzly bears.

Grizzly bear habitat conservation monitoring for habitat effectiveness

Inside the Primary Conservation Area, monitor, and every five years submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: changes in seasonal habitat effectiveness in each Bear Management Unit and subunit on the national forest through the application of the Cumulative Effects Model or the best available system and compare outputs to the 1998 baseline. Annually review Cumulative Effects Model databases and update as needed. When funding is available, monitor representative non-motorized trails or access points where risk of grizzly bear mortality is highest.

Grizzly bear habitat conservation monitoring for whitebark pine

Monitor whitebark pine occurrence, productivity, and health inside and outside the Primary Conservation Area in cooperation with other agencies. Annually submit for inclusion in the Interagency Grizzly Bear Study Team Annual Report: results of whitebark pine cone production from transects or other appropriate methods, and results of other whitebark pine monitoring.

Figure B-1. Criteria and definitions used in the Amendment ROD.

Criteria	Definition
Motorized access routes	Motorized access routes are all routes having motorized use or the potential for motorized use (restricted roads) including motorized trails, highways, and forest roads. Private roads and state and county highways are counted.
Restricted road	A restricted road is a road on which motorized vehicle use is restricted seasonally or yearlong. The road requires effective physical obstruction, generally gated.
Permanently restricted road	A permanently restricted road is a road restricted with a permanent barrier and not a gate. A permanently restricted road is acceptable within secure habitat.
Decommissioned or obliterated or reclaimed road	A decommissioned or obliterated or reclaimed road refers to a route which is managed with the long-term intent for no motorized use, and has been treated in such a manner to no longer function as a road. An effective means to accomplish this is through one or a combination of several means including recontouring to original slope, placement of logging or forest debris, planting of shrubs or trees, etc.
Secure habitat	Secure habitat is more than 500 meters from an open or gated motorized access route or recurring helicopter flight line. Secure habitat must be greater than or equal to 10 acres in size[1]. Large lakes (greater than one square mile) are not included in the calculations.
Project	A project is an activity requiring construction of new roads, reconstructing or opening a permanently restricted road, or recurring helicopter flights at low elevations. Opening a gated road for public or administrative use is not considered a project as the area behind locked, gated roads is not considered secure habitat.
Temporary project	To qualify as a temporary project under the Application Rules, project implementation will last no longer than three years.
Opening a permanently restricted road	Removing permanent barriers such that the road is accessible to motorized vehicles.
Permanent barrier	A permanent barrier refers to such features as earthen berms or ripped road surfaces to create a permanent closure.
Removing motorized routes	To result in an increase in secure habitat, motorized routes must either be decommissioned or restricted with permanent barriers, not gates. Non-motorized use is permissible.
Seasonal periods	Season 1 – March 1 through July 15 Season 2 – July 16 through November 30 Project activities occurring between December 1 and February 28 do not count against secure habitat.
Developed site	A developed site includes but is not limited to sites on public land developed or improved for human use or resource development such as campgrounds, trailheads, improved parking areas, lodges (permitted resorts), administrative sites, service stations, summer homes (permitted recreation residences), restaurants, visitor centers, and permitted resource development sites such as oil and gas exploratory wells, production wells, plans of operation for mining activities, work camps, etc.
Vacant allotments	Vacant allotments are livestock grazing allotments without an active permit, but could be restocked or used periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns.
Recurring conflicts	Recurring grizzly bear/human or grizzly bear/livestock conflicts are defined as three or more years of recorded conflicts during the most recent five-year period.

[3] Secure habitat in this amendment does not include areas open to cross country off-highway vehicle (OHV) travel.

2007 Wapiti and Jackson Hole Bear Wise Community Projects Update

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Introduction

In 2004, a committee comprised of members of the Interagency Grizzly Bear Study Team (IGBST) conducted an analysis of the causes and spatial distribution of human caused grizzly bear mortalities and conflicts in the Greater Yellowstone Area (GYA) from 1994-2003. The analysis identified that of the known human caused bear mortalities, the majority occurred because of agency management actions in response to conflicts (34%), self defense killings primarily by ungulate hunters (20%), and vandal killings (11%). The report recommended 33 specific actions to reduce human-grizzly bear conflicts and mortalities with focus on three actions that the committee felt could be positively influenced by agency actions. Those actions were to employ strategies to: 1.) Reduce conflicts at developed sites; 2.) Reduce self defense killings; and 3.) Reduce vandal killings (Servheen et al. 2004).

The committee recommended that a demonstration area be established to focus proactive, innovative, and enhanced management strategies where developed site conflicts and agency management actions resulting in relocation or removal of bears have been high. Spatial examination of conflicts identified the Wapiti area in northwest Wyoming as having some of the highest concentration of black bear and grizzly bear conflicts in the GYA. The North Fork of the Shoshone drainage west of Cody was therefore chosen as the first area composed primarily of private land to have a multi agency/public approach to reducing developed site conflicts. In July of 2005 funding was secured to hire a full time project coordinator and begin implementation of the project.

In addition, during 2005 the Wyoming Game and Fish Department (WGFD) initiated a smaller scale project in Teton County to address an increasing number of black bear and grizzly bear conflicts (WGFD, unpublished data). Progress of both projects through 2006 are reported in the 2006 annual report of the Interagency Grizzly Bear Study Team. This update contains information on accomplishments and challenges during 2007.

With the success of grizzly bear recovery in the Greater Yellowstone Area (GYA) has come the re-colonization of former habitats by bears that are also occupied by humans. This has resulted in a general increasing trend of site conflicts between humans and bears on private lands. In turn, there became a need for state agencies to adopt preventive conflict mitigation efforts to keep pace with grizzly bear expansion and reoccupancy of habitat outside the Primary Conservation Area (PCA).

In 2005, the Wyoming Game & Fish Department (WGFD) drafted, proposed and adopted the *Wyoming Bear Wise Community Plan* (Chartrand and Bruscino 2005). This plan was designed to minimize human/bear conflicts, minimize management-related bear mortalities associated with preventable conflicts, and to safeguard the human community. The overall context of this plan was to foster community ownership of a conflict situation that is fundamentally a community-related issue that requires a community-based solution. What’s more, this plan strives to raise awareness and to proactively influence local infrastructures with the specific intent of preventing conflicts from recurring.

Thus far, significant progress has been made in the Wapiti and North Fork of the Shoshone River as well as in Jackson Hole. Though a wide array of challenges remain and vary significantly from community to community, significant progress is expected to continue as Bear Wise efforts gain momentum. This report is intended to provide background and justification for this initiative as well as a review of this effort's primary goals and strategies followed by a summary of notable accomplishments to date and an overview of expected future results and challenges.

Wapiti Project Update

In 2005, the Wyoming Bear Wise Community Project was initiated and human-bear conflict prevention efforts were focused within the community of Wapiti, WY. To oversee and coordinate the Bear Wise Community effort, a project coordinator was hired when the program was initiated. For the first year of the project, the coordinator's efforts focused primarily on researching options for addressing sanitation issues within the Wapiti community, securing grant funding to implement the program, working with local government to raise awareness of the scope of preventable conflicts, and launching an educational campaign to reduce knowledge gaps regarding human-bear conflicts. Specific accomplishments include numerous presentations and educational workshops; bear aware informational kiosks; signage; public service announcements aired on television and radio; Bear Aware advertising in a local calendar fundraiser; newspaper articles; the creation of a "Living with Bears" portable display; a Bear Aware Day public event; and distribution of educational materials such as the *Living with Bears* book, *Staying Safe* and *Living in Bear Country* DVD's and videos, magnets, bookmarks, brochures, and coloring placemats.

In March 2006, the North Fork Bear Wise group was formed to aid local bear management authorities in a community-based approach in minimizing human-bear conflicts through effective attractant management, education, and outreach. The group consists of 5 area residents, the coordinator, and the area bear biologist. The group meets monthly at the Wapiti School and has assisted in securing funds for the program and been responsible for the decisions leading to the implementation of educational projects and bear-resistant sanitation.

The most notable Bear Wise Community accomplishments in 2007 involve efforts by the North Fork Bear Wise Group to address waste management issues and the proper storage of attractants. A bear-resistant garbage cart program began in February of 2007 as a collaborative effort between the North Fork Bear Wise group and the WGFD. *Bear Saver* 95-gallon bear-resistant rollout carts have been made available to residents for a cost share price of $49.99. Most of the cost per cart ($174.00) is covered through secured grant funding. Partial funds received for carts are put directly back into a fund to purchase additional carts. 55-gallon bear-resistant grain barrels have also been made available to residents who live in bear habitat. These are available for no charge and are for the storage of livestock feed, pet food, birdseed, or garbage.

In 2007 the coordinator continued work with the Park County Planning and Zoning Commission and the Park County Commissioners regarding human-bear conflict prevention and land use regulations. Although conflict prevention recommendations were not incorporated in the new Development Standards and Regulations for Park County, the coordinator is able to review new development on a case-by-case basis and make recommendations regarding ways to minimize human-bear conflicts and promote human safety for new development through proper attractant management..

Other program accomplishments for 2007 include assisting the Draper Museum of Natural History with the update of the grizzly bear exhibit, in which conflict prevention was a key theme, continued presentations and conflict prevention workshops, and a spring Bear Aware mailing to North Fork residents. These accomplishments can largely be attributed to the partnership between the WGFD and the North Fork Bear Wise group and to the individual commitment and consistent efforts of each group member.
Future initiatives include the design and posting of a Bear Aware highway billboard, the posting of seven

smaller bear aware highway signs, the implementation of a carcass management program for producers and rural landowners, and continuing efforts to address the proper storage of attractants within the Wapiti Community. The Bear Wise Community program also hopes to expand efforts into neighboring communities that are experiencing a high number of human-bear conflicts such as the South Fork of the Shoshone River, Crandall, Sunlight Basin, and Meeteetse.

Jackson Hole Project Update

In Jackson Hole, 2007 efforts focused primarily on improving bear resistant sanitation infrastructure, education, and raising public awareness of the causes of human bear conflicts and steps that can be taken to prevent conflicts.

Numerous public service announcements (PSA's) were aired on local radio and television channels. These PSA's focused on proper storage of attractants, proper bear resistant bird feeding techniques, and hunting safely in bear country. Department information and education staff and the Bear Wise Community Coordinator made numerous educational presentations to homeowners associations, groups, schools, and local government agencies with the educational message focusing on conflict prevention. Work was done with several homeowners associations to revise and ratify their Covenants, Codes, and Restrictions to require bear resistant garbage storage. Work continued with the Teton County Planning and Development Office to develop and adopt a Land Development Regulation (LDR) that would require residents in parts of Teton County to store garbage in a bear resistant building or container and hang bird feeders in a way that they are inaccessible to bear. Several presentations on the proposed LDR were made to the Teton County Board of Commissioners during 2007. The LDR is currently being revised to meet changes suggested by the Commission.

During 2007, we met the goal of providing 100% of commercial residential customers in Teton Village with bear resistant garbage carts. This goal was met largely by the efforts of the Jackson Hole Wildlife Foundation's leadership in acquiring and distributing the carts. The Foundation also provided numerous carts at a reduced cost to residents outside of Teton Village.

Challenges

The Bear Wise Community effort faces some unique challenges regarding lack of interest and community participation in proper attractant management. Despite the fact that the community of Wapiti experiences a higher number of human-bear conflicts than any other community in the GYA and that there is local support for the program, many Wapiti residents remain complacent or unaware of the level of conflicts in the area. Rural communities in the Cody region lack organized groups, such as Homeowner's Associations, and also have a large number of summer-only residents. This situation coupled with the fact that many local residents assume that the program's educational efforts are geared toward newcomers or visitors, have made education initiatives especially difficult. In addition, the last three years were very inactive in terms of bear conflicts in the community of Wapiti so there has been a general lack of awareness about conflicts and receptiveness to the program. Another challenge is that the Wapiti area has no ordinance or law addressing feeding of bears or negligence in leaving attractive items out for bears. The Bear Wise Community program relies on 100% voluntary compliance and educational efforts to discourage residents from feeding or attracting bears.

Reducing human-bear conflicts in Jackson Hole will require a new waste management infrastructure and citizen participation in keeping attractants unavailable to bears. Product deployment, county regulation, and continued public education will be essential to successfully reducing the number of conflicts. Goals for 2008 include working with county officials to adopt and implement waste management regulations and implement bear proof waste management systems in parts of the county, and continue an aggressive public education campaign.

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Reassessing methods to distinguish unique female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem[1]

Photo by Steve Ard

Report detailing discussion of issues covered during a workshop at Bozeman, MT, 1-2 October 2007

[1] This document is the product of teamwork. All participants contributed to its production. Please cite as follows:

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Background

The current method to distinguish among unique females with cubs-of-the-year (FCOY) in the Greater Yellowstone Ecosystem (GYE) employs a rule set developed by Knight et al. (1995). Counts of unique FCOY are used as an index of population size. The method was conceived early in the history of the Interagency Grizzly Bear Study Team (IGBST) because of a prohibition against marking bears in Yellowstone National Park following the controversial closure of the open pit garbage dumps and subsequent high bear mortality (NSA 1974). Knight and Eberhardt (1984) observed that FCOY were readily observable and that the presence of young provided cues for distinguishing family groups. Summing the count of unique females over 3 successive years provided a minimum estimate of adult females in the population. Efforts were made to develop other methods, but Knight and Eberhardt (1984) considered this technique the best available index of grizzly abundance in the GYE. A running 3-year mean of FCOY was used as a basis for a minimum population estimate from which mortality limits were established (USFWS 1993). As annual minimum counts of FCOY likely always underestimated the true number of FCOY in the population, mortality limits were conservative.

Researchers have recently investigated a number of methods to estimate total annual numbers of FCOY that employ the sighting frequencies associated with unique families (Boyce et al. 2001, Keating et al. 2002, Cherry et al. 2007). Cherry et al. (2007) determined that the Chao2 (Wilson and Collins 1992, Keating et al. 2002) was less biased than alternatives, given the sampling intensity and recapture patterns observed in the GYE. Trend and rate of change (λ) for the FCOY segment of the population can then be estimated from the annual Chao2 estimates using linear and quadratic regressions with model averaging (IGBST 2006, Harris et al. 2007). Given the assumption of a reasonably stable sex and age structure, trend for this segment of the population represents the rate of change for the entire population (Harris et al. 2007).

Criteria used to distinguish unique FCOY were developed over a period of years and included a 30-km rule based on observed patterns of movement by radio-marked FCOY (Knight et al. 1995). Recently, the rule set was evaluated by Schwartz et al. (2008) and was shown to be inherently conservative. This is because a pair of sightings is only classified as sightings of 2 distinct bears if the evidence for classifying them separately is very strong. Thus the probability of incorrectly calling a pair of sightings as from 2 distinct bears, when they really are sightings of the same bear is likely near 0. In contrast, the probability of incorrectly calling a pair of sightings as from 1 bear when they are really from 2 is almost certainly considerably greater than 0. It is this asymmetry in the classification errors that leads to bias in estimating the female bear population size. This bias likely ensured that mortality thresholds derived from minimum counts (USFWS 1993) were conservative.

Grizzly bears in the GYE were removed from protection under the Endangered Species Act (ESA 1973) as of 30 April 2007 (USFWS 2007*a*). Under the demographics monitoring section of the Final Conservation Strategy for Grizzly Bear in the Greater

Yellowstone Area (USFWS 2007*b*), IGBST is tasked with assessing sustainability of annual mortalities. Model averaged (Burnham and Anderson 2002) estimates of FCOY are currently used to establish annual mortality threshold for segments of the population (IGBST 2006, Harris et al. 2007). However, the negative bias in the existing rules can inevitably lead to mortalities that exceed the established threshold (Schwartz et al. 2008). This can occur, not because mortalities are occurring at unsustainable numbers, but because true population size is underestimated due to the conservative nature of the rule set used to differentiate families.

Objective

The purpose of the workshop was to discuss the feasibility of developing new models that improve our ability to distinguish unique FCOY.

Conceptual Model

After reviewing the existing rule set and lengthy discussions about how we might address the negative bias associated with the existing rule set, the group concluded a new model was necessary. We proposed to develop a new method for classifying bear sightings using probabilistic methods. The approach is based on modeling observations of bears, their movements, and the numbers of cubs. In this approach, the true sighting history for bears will be treated as an unobserved (latent) random variable that must be predicted. The current method in effect selects one of the possible true sighting histories and then treats it as if it were known. In the approach we propose here, the prediction of the latent sighting histories is an intermediate step in the estimation of bear abundance N. Importantly, the uncertainty in predicting which potential sighting history is the "true one" is carried over into the quantified uncertainty in N. Thus, our proposed method can (1) correct for bias in estimation resulting from an arbitrary classification of bears, and (2) correct for underestimation of uncertainty in N resulting from un-modeled uncertainty in the determination of the true sighting history.

Existing Data

Existing movement data from radio-marked FCOY were reviewed and considered adequate to meet the needs of the modeling exercise. Telemetry locations for FCOY obtained during 1983-2006 will be used. Ninety-one individual females accompanied by from one to four cub litters were radio-tracked. A total of 1,855 locations were obtained during 125 bear years. More detailed movement data obtained from FCOY that wore store-on-board GPS collars are also available. This dataset contains 11,860 locations from 13 FCOY.

Proposal outline

We propose to develop a hierarchical model for (1) information on locations and times of sightings of radio-collared bears and (2) locations and times of sightings of bears from observational flights and ground surveys of the study area, including both collared and uncollared bears. This model will then be fit using a Bayesian modeling approach to obtain inferences regarding *N*.

Key steps in the development and fitting of this joint model are:

1) Development of the algebraic structure of the joint model.

2) Writing computer code for fitting the model to data.

An initial step toward developing the model in step 1 was carried out during the workshop. An outline of the model developed is provided in Appendix A. Further work that is required involves the development of a model for changes in the numbers of cubs during the survey period and a spatial model describing the distribution of FCOY in the GYE. The second step of this project will involve developing a Markov chain Monte Carlo updater for Bayesian fitting of the model developed in stage 1.

Approximate costs for each stage will be:

1) Development of the algebraic structure of the joint model $15,000.

2) Writing computer code for fitting the model to data $15,000.

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Appendix A, From Barker

Data and Model

There are two sources of female cub-of-the-year (FCOY) data: (1) information on locations and times of sightings of radio-collared bears and (2) locations and times from sightings of bears from observational flights and ground surveys of the study area, including both collared and uncollared bears. Knight et al. (1995) refer to the second data set as sightings of unduplicated bears.

The identities are missing for most bears in the second data set. They are known only for those radio-collared bears seen in this survey that were positively identified.

Notation

The problem is to write a model for the location data x, y, $x^{(r)}$, and $y^{(r)}$ and the numbers of cubs c and $c^{(r)}$, conditional on unknown quantities of interest: the number of bears in the population N, the missing D's and any other parameters θ.

For analysis, we condition on the identities of the bears in the radio-telemetry study. This step allows us to model the information in the $\{x_i^{(r)}, y_i^{(r)}\}$ pairs in terms of spatial model that will depend on parameters θ and the times of sighting $t_i^{(r)}$.

All information on abundance comes from survey (2) data. Bear sighting information in survey (2) can be summarized in the matrix X, where $X_{ij} = 1$ if bear i ($i = 1, \ldots, N$) was seen in sample j ($j = 1, \ldots, S$) and zero otherwise. Note that

1. X is a deterministic function of the set of the true identities of all bears available to be seen during the S sighting occasions. Note that this includes identities of bears that were not seen. Also, X is the true sighting matrix which is not observed. It is not the same as the observed sighting matrix X^{obs}which will be corrupted through mis-identifications of bears.

2. Because only one bear can be seen at a time only a single '1' can appear in any column of X. Rows can have multiple instances of '1' as the same bear can appear in several samples.

Term	Definition
general parameters	
N	the number of female bears in the study area
R	the number of female bears with radio-collars
S	the number of female bears seen during the unduplicated bear survey
n	the true (but unknown) number of distinct bears seen in the unduplicated bear surveys
Radio-telemetry survey	
$D_i^{(r)}$	the identity of the bear in radio-telemetry observation i ($i = 1, \ldots, R$)
$c_i^{(r)}$	the number of cubs seen with the bear in radio-telemetry observation i ($c_i^{(r)} > 0$)
$x_i^{(r)}$	the easting of the bear in radio-telemetry observation i
$y_i^{(r)}$	the northing of the bear in radio-telemetry observation i
$t_i^{(r)}$	the time of radio-telemetry observation i
Unduplicated bear survey – survey (2)	
D_j	the identity of the bear in sample j of survey (2) ($j = 1, \ldots, S$)
c_j	the number of cubs seen with the bear in observation j of survey (2) ($c_j > 0$)
x_j	the easting of the bear in observation j of survey (2)
y_j	the northing of the bear in observation j of survey (2)
t_j	the time of observation j of survey (2)

3. X is partially latent because bear identities are unknown. Also, the information from the $N - n$ individuals who never appeared in any sample is completely missing. Thus, X can be decomposed as

$$X = \begin{pmatrix} X' \\ \mathbf{0} \end{pmatrix}$$

where X' is of dimension $S \times n$.

Note that

Conditioning on the bear identities in the radio-telemetry survey the complete data likelihood (CDL) for this problem can thus be written as:

$$CDL \propto [c, x, y, c^{(r)}, x^{(r)}, y^{(r)}, X|\theta, N, D^{(r)}, t, t^{(r)}]$$

and assuming that the numbers of cubs are unrelated to locations we can factor the CDL as

$$\begin{aligned}[c, x, y, c^{(r)}, x^{(r)}, y^{(r)}, X|\theta, N, D^{(r)}, t, t^{(r)}] &= [c|X, \theta, t][x, y|X, \theta, t][X|N, \theta] \\ &\times [c^{(r)}|D^{(r)}, \theta, t^{(r)}][x^{(r)}, y^{(r)}|D^{(r)}, \theta, t^{(r)}] \quad (1)\end{aligned}$$

In equation (1) the terms $[x, y|X, \theta, t]$ and $[x^{(r)}, y^{(r)}|D^{(r)}, \theta, t^{(r)}]$ represent the joint density of the locations conditional on the bear identities. The terms $[c|X, t]$ and $[c^{(r)}|D^{(r)}, t^{(r)}]$ represent the distributions of the number of cubs given the identities of the females and the times of sighting.

Modeling the numbers of cubs

The terms $[c|X, t]$ and equivalently $[c^{(r)}|D^{(r)}, t^{(r)}]$ can be decomposed into sets corresponding to distinct females. For any particular female we model the number of cubs she has at her first sighting according to a suitable distribution. We then model the number of cubs seen on subsequent sightings conditional on the number seen at the first sighting. This second term will involve cub mortality parameters.

Modeling the Locations

For bear i seen k_i times we require the joint density:

$$[\{x_{ij}, y_{ij}\}_{j=1}^{k_i}|X, \theta, t] \quad (2)$$

for the bears in survey (2). This is identical, by assumption, to the equivalent density for the radio-telemetry data.

For this part of the likelihood we require a suitable space-time process model. One approach is to factor (2) as

$$[\{x_{il}, y_{il}\}_{l=1}^{k_i}|X, \theta, t] = [\{x'_{il}, y'_{il}\}_{l=1}^{k_i}|X, \theta, t][\bar{x}_i, \bar{y}_i|X, \theta]$$

where $\bar{x}_i = \sum_{l=1}^{k_i} x_{il}$ and $\bar{y}_i = \sum_{l=1}^{k_i} y_{il}$ measure the center of the k_i locations and $x'_{il} = x_{il} - \bar{x}_i$ and $y'_{il} = y_{il} - \bar{y}_i$ represent the location data scaled to be centered on the point (0,0).

As a simple initial model we can model the x' and y' vectors independently but with equal variances. This is equivalent to describing the population-level distributional data by a bivariate normal distribution with mean zero, common variances and correlation of zero. In adopting this model we expect no directional bias at the population level, once the cluster of points for a bear have been scaled, and no asymmetry in the orientation of the clusters of points for each bear.

For the term $[\bar{x}_i, \bar{y}_i|X, \theta, t]$ we require a suitable model for a spatial point process that describes the distribution of the center of clusters of points for each bear.

The model $[X|N]$

Generally, the model $[X|N]$ is given by

$$\frac{N!}{n!(N-n)!} \prod_{i=1}^{N} \prod_{j=1}^{S} \pi_{ij}^{X_{ij}}. \tag{3}$$

where π_{ij} is the probability that the sighting at time t_j is of individual i. The model (3) is over-parameterized with each of the N individuals sampled having their own sampling probability in each sample.

Under the assumption that each bear has the same probability of being seen in each sample the likelihood reduces to

$$\frac{N!}{n!(N-n)!} \frac{S}{w_1! \cdots w_n!} \left(\frac{1}{N}\right)^S$$

where w_i is the number of times bear i was seen ($i = 1, \ldots, n$) in survey (2).

Another simplifying assumption is that each bear has a distinct sampling probability drawn from some distribution f indexed by parameters γ with $f(\cdot)$ common to all the bears. That is,

$$\frac{N!}{n!(N-n)!} \prod_{i=1}^{n} \prod_{j=1}^{S} \pi_i^{X_{ij}}$$

where $[\pi_i|\gamma] = f(\gamma)$.

MCMC Updater

For inference we propose constructing a Markov chain Monte Carlo (MCMC) algorithm in order to sample from the joint posterior density of all unknowns including N, unknown identities and parameters θ. Our intention is to use a Gibbs sampling algorithm in which the posterior sample is obtained by sampling from full conditional distributions of the unknowns derived from the CDL (1).