Yellowstone Grizzly Bear Investigations 2012

Report of the Interagency Grizzly Bear Study Team

IGBST photo

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Cover photo: Grizzly bear at trap site, 23 October 2012. IGBST photo.

YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

Annual Report of the Interagency Grizzly Bear Study Team

2012

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
Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department

Edited by Frank T. van Manen, Mark A. Haroldson, and Karrie West

U.S. Department of the Interior
U.S. Geological Survey
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Introduction

(Frank T. van Manen and Mark A. Haroldson, Interagency Grizzly Bear Study Team)

This Report

This Annual Report summarizes results of grizzly bear (*Ursus arctos*) monitoring and research conducted in the Greater Yellowstone Ecosystem (GYE) by the Interagency Grizzly Bear Study Team (IGBST) during 2012. The report also contains a summary of nuisance grizzly bear management actions, whitebark pine monitoring, and grizzly bear habitat monitoring.

This year we completed investigations that started in 2010 to (1) revise current protocols for estimating population size of the GYE grizzly bear population, (2) reevaluate current mortality limits as necessary based on updated demographic analyses, and (3) evaluate zoning the ecosystem for mortality limits given the expanding population. Three workshops were held by IGBST (Feb 2011, Jul 2011, and Feb 2012), with participation of all IGBST partners as well as quantitative ecologists from around the country with expertise in demographic analyses of bear populations. A final report was published in September 2012 detailing the primary findings of these workshops (http://nrmsc.usgs.gov/files/norock/IGBST/GYEGBMonMortWksRpt2012(2).pdf). In response to recommendations made in the report, the U.S. Fish and Wildlife Service (USFWS) prepared a Draft Revised Supplement to the Grizzly Bear Recovery Plan in the Greater Yellowstone Area (http://www.fws.gov/mountain-prairie/species/mammals/grizzly/yellowstoneindex.html). Improving population monitoring is a continuous process and the revised criteria will allow us to rapidly implement improved scientific methods as they become available in the peer-reviewed literature. Only by using the best available science can IGBST provide federal, state, and tribal managers and policy makers with reliable data to make informed decisions.

A case in point, one important product from the 3 workshops was the development of a mark-resight technique to estimate the number of females with cubs-of-the-year (COY) within our monitoring area. Current protocols are based on what we refer to as the Chao2 estimator. However, due to conservative criteria to identify unique females with COY, this estimate tends to be biased low, and this bias increases as the number of females with COY increases (Schwartz et al. 2008). The consequence of this negative bias is that we underestimate population size. The consensus among workshop participants was that a population estimation technique used for monitoring should be unbiased. Participants also agreed that any new technique should allow IGBST to backcast population estimates to discern population trends over the past 10–15 years and to allow comparison with current estimation protocols. The mark-resight technique met these criteria because it is based on 2 standardized, annual observation flights that have been conducted since 1997. More importantly, the estimate for the number of females with COY is approximately unbiased, thus addressing an important concern identified previously by IGBST. However, precision of the annual estimates is relatively low because only a relatively small number of radio-marked females with COY are available, and an even smaller number are counted during observation flights. Adding observations of radio-marked females with yearlings should improve precision. Existing data will allow IGBST to investigate this extension to the current method within the coming year. We provide more details in the section "Estimating Number of Females with Cubs-of-the-Year." A manuscript detailing these findings (coauthored by Megan Higgs, William Link, Gary White, Mark Haroldson, and Dan Bjornlie) has been accepted for publication in the *Journal of Agricultural, Biological, and Environmental Statistics* and should be available summer 2013.

The grizzly bear was removed from protection under the Endangered Species Act on 30 April 2007 (USFWS 2007*a*) but relisted by a District Court order in 2009. During November 2011 the U.S. Court of Appeals for the 9th Circuit upheld the lower court decision with regard to potential impacts of whitebark pine (*Pinus albicaulis*) decline on grizzly bears and vacated the delisting Rule (Greater Yellowstone Coalition v. State of Wyoming, No. 09-36100 [9th Cir. 2011). Consequently, in summer 2012 we started a comprehensive effort to improve our understanding of the relationships between grizzly bear population dynamics and of food resources in the GYE. Although the decline of whitebark pine was an important impetus for this work, the GYE is a dynamic landscape and changes in other food sources have occurred as well. Therefore, we are focusing our research on the influence of changing food resources in general on the GYE grizzly bear population. We are also assessing how changing food resources may affect the influence of anthropogenic factors, such as mortality, and to what degree density-dependent factors may play a role in the changing population demographics we are observing. In essence, we are investigating the ecological plasticity of grizzly bears in the GYE in light of extrinsic (changing food resources) and intrinsic (increasing population density) processes. This concerted effort involves about 10 new studies and an exhaustive synthesis of existing information. We were fortunate to have comprehensive databases in place to support these new analyses, an important benefit of a committed investment into the long-term grizzly bear research and monitoring program. Moreover, the interagency construct allowed IGBST to tap into considerable personnel and logistical resources of all partner agencies and establish effective collaborations with others (e.g., Greater Yellowstone Whitebark Pine Monitoring Working Group[GYWPMWG]). This work is ongoing and the study team will publish the synthesis report in October 2013.

We continue to follow monitoring protocols established under the Revised Demographic Recovery Criteria (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 IGBST will continue reporting on an array of required monitoring programs. These include both population and habitat components. Annual population monitoring includes:

- Monitoring unduplicated females with COY and estimating total population size for the entire GYE based on the model-averaged Chao2 estimate of females with COY (see "Assessing Trend and Estimating Population Size Using Counts of Unduplicated Females" on page 11). If the Draft Revised Supplement to the Grizzly Bear Recovery Plan is adopted, we may also start using estimates of females with COY (and, pending results of our investigations, possibly yearlings) based on the mark-resight estimator discussed previously.
- 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 Recovery Zone (i.e., 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 (≥2 years old) females and males within the entire GYE. During 2012, mortality limits were set at ≤9% for independent females and ≤15% for independent males from all causes. Mortality limits for dependent young were ≤9% for known and probable human-caused mortalities (see "Estimating Sustainability of Annual Grizzly Bear Mortalities").

Although monitoring requirements under the Conservation Strategy (USFWS 2007*c*) do not apply since the GYE grizzly bear population was relisted, the U.S. Forest Service (USFS) continues to report on items identified in the Conservation Strategy including changes in secure habitat, livestock allotments, and developed sites from the 1998 baseline levels in each BMU subunit. This year, the 5th report detailing this monitoring program is provided. This report documents (1) changes in secure habitat, open motorized access route density, and total motorized route density inside the Recovery Zone; (2) changes in number and capacity of developed sites inside the Recovery Zone; (3) changes in number of commercial livestock allotments, changes in the number of permitted domestic sheep animal months inside the Recovery Zone, and livestock allotments with grizzly bear conflicts during the last 5 years (see Appendix A).

Habitat monitoring includes documenting the abundance of the 4 major foods throughout the GYE including winter ungulate carcasses, cutthroat trout (*Oncorhynchus clarkii*) spawning numbers, bear use of army cutworm moth (*Euxoa auxiliaris*) sites, and whitebark pine 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 2012 monitoring is also presented (Appendix B). The protocol has been modified to document mortality rate in whitebark pine from all causes, including mountain pine beetle (*Dendroctonus ponderosae*).

The annual reports of the IGBST summarize annual data collection. Because additional information can be obtained after publication, data summaries are subject to change. For that reason, data analyses and summaries presented in this report supersede all previously published data. Descriptions of 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 IGBST

It was recognized as early as 1973 that a better understanding of the dynamics of grizzly bears in the GYE would best be accomplished by 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 (NPS), USFS, USFWS, and the state wildlife agencies of Idaho, Montana, and Wyoming. The Eastern Shoshone and Northern Arapaho Tribes formally joined the study team in 2009. Responsibilities of the IGBST are to: (1) conduct 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 (YNP) was conducted by John and Frank Craighead. Their 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 YNP in 1967, bear demographics (Knight and Eberhardt 1985), food habits (Mattson et al. 1991*a*), and growth patterns (Blanchard 1987) for grizzly bears changed. Since 1975, the IGBST has produced annual reports and numerous scientific publications (for a complete list visit our web page http://www.nrmsc.usgs.gov/research/igbst-home.htm) summarizing monitoring and research efforts within the GYE. As a result, we now 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, Schwartz et al. 2006c). Nevertheless, monitoring and updating continues so that status can be reevaluated annually.

This report truly represents a "study team" approach. Many individuals contributed either directly or indirectly to its preparation. To that end, we have identified author(s). We also wish to thank the following individuals for their contributions to data collection, analysis, and other phases of IGBST research; USGS: C. Hockenbary, C. Whitman; NPS: E. Albers, T. Bernacchi, D. Blanton, A. Bramblett, J. Carnes, L. Clarke, T. Coleman, S. Consolo Murphy, M. Cromp, C. Daigle-Berg, N. Derene, S. Dewey, S. Gunther, B. Helms, N. Herring, F. Madsen, P. Navaille, L. Quall, M. Renteria, J. Sacklin, D. Smith, B. Speeg, D. Stahler, A. Tallian, N. Welch, P.J. White, S. Wolff, B. Whitman; Montana Fish, Wildlife and Parks (MTFWP): N. Anderson, S. Brozovich, D. Fagone, R. Gosse, C. Kline, J. Paugh, J. Ramsey, M. Ross, S. Sheppard, J. Smolczynski, S. Stewart; Montana State University: S. Cherry, M. Higgs; Wyoming Game and Fish Department (WYGF): G. Anderson, D. Brimeyer, B. Brown, M. Bruscino, J. Clapp, R. Clapp, C. Clark, D. Clause, C. Daubin, J. Davis, D. Ditolla, L. Ellsbury, T. Fagan, T. Fergus, G. Fralick, M. Garcia, A. Johnson, T. Kreeger, B. Kroger, D. Lasseter, S. Lockwood, B. Long, J. Longobardi, J. Lund, D. McWhirter, K. Mills, J. Olsen, C. Queen, S. Werbelow, D. Wilckens, M. Withroder; Idaho Fish and Game (IDFG): T. Fletcher, T. Imthurn, J. Koontz, G. Losinski, L. Meates, H. Miyasaki, A. Sorenson, N. Walker, T. Wendt; USFS: J. Chutz, B. Davis, J. Harper, T. Matza, A. Pils, D. Probasco, D. Tyers; Pilots and Observers: B. Ard, S. Ard, H.

Leach, J. Martin, J. Ortman, K. Overfield, T. Schell, D. Stinson, R. Stradley; Wildlife Services: M. Foster, J. Rost; Shoshone and Arapaho Tribes: K. Smith, B. Snyder Jr., W. Thayer, B. Warren; USFWS: M. Mazur. Without the collection efforts, contributions, and dedication of all these people, the information contained within this report would not be available.

Finally, we acknowledge 2 people who have made significant contributions over the years. Study team member Mark Bruscino recently retired from his position as the Large Carnivore Section Supervisor after more than 30 years working for the WYGF. Mark witnessed many positive changes in the grizzly bear population and human attitudes towards grizzly bears during his career. His significant contributions and dedication to science-based management are much appreciated. Another long-term contributor to the study team, Shannon Podruzny, has moved to the eastern portion of the GYE and is now working for the Shoshone National Forest as a Natural Resource Specialist. Shannon worked for IGBST from 1994 to 2012; her tremendous field expertise and knowledge of grizzly bear habitats and foods will be sorely missed.

Beehive Basin, MT, 2012. Photo courtesy of Frank T. van Manen.

Bear Monitoring and Population Trend

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

During the 2012 field season, we captured 88 individual grizzly bears on 104 occasions (Table 1), including 31 females (21 adult) and 57 males (34 adult). Fifty-seven individuals were bears not previously marked. The percent of previously unmarked individual grizzly bears captured annually during 1998–2012 has remained relatively constant, averaging 62% although the number of individuals captured has increased (Fig. 1). This result supports the notion that grizzly bears continue to recruit into the GYE population at a relatively constant rate.

We conducted research trapping for 759 trap days (1 trap day = 1 trap set for 1 day) in the GYE. During research trapping operations we had 47 captures of 36 individual grizzly bears for a trapping success rate of 1 bear/16.1 trap days. Two bears that were initially non-target management captures were later captured at research trap sites.

There were 57 management captures of 54 individual bears in the GYE during 2012 (Tables 1 and 2), including 20 females (12 adults), and 34 males (15 adults). Thirty-five individual bears (14 females, 21 males) were relocated because of conflict situations (Table 1). There were 16 (6 females, 10 males) management removals. Two bears (1 female, 1 male) were transported and subsequently captured and removed when they were involved in additional conflicts. Five bears were released on site following management captures. An adult male and 3 subadult males were non-target captures at cattle depredations and were released on site after handling. A subadult female was a non-target capture in a wolf (*Canis lupus*) trapping operation and was released on site after handling.

We radio-monitored 112 individual grizzly bears during the 2012 field season, including 35 adult females (Tables 2 and 3). Fifty-eight grizzly bears entered their winter dens wearing active transmitters. Three additional bears not located during the fall are considered missing (Table 3). Since 1975, 731 individual grizzly bears have been radiomarked in the GYE.

Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem during 2012.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
697	male	adult	03/20/12	South Fork Shoshone, Pr-WY	management	Bear Creek, State-WY	WYGF
698	male	adult	04/08/12	Buffalo Fork River, Pr-WY	management	Mormon Creek, SNF	WYGF
			08/28/12	Pacific Creek, BTNF	management	removed	WYGF
699	male	adult	04/15/12	Wood River, Pr-WY	management	Mormon Creek, SNF	WYGF
682	male	adult	04/17/12	Wood River, Pr-WY	management	removed	WYGF
642	male	adult	04/18/12	Pat O'Hara Creek, Pr-WY	management	Long Creek, SNF	WYGF
690	female	subadult	04/22/12	Sweet Hollow Creek, Pr-ID	management	removed	IDFG
700	male	adult	05/03/12	Carmichael Creek, BLM-WY	research	on site	WYGF
701	male	subadult	05/04/12	Wind River, Pr-WY	management	Sunlight Creek, SNF	WYGF
Unm	female	subadult	05/07/12	Horse Creek, Pr-WY	management	removed	WYGF
702	female	subadult	05/08/12	Buffalo Fork River, Pr-WY	management	on site	WS/WYGF
			06/16/12	Dry Lake Creek, BTNF	research	on site	WYGF
			06/29/12	Kettle Creek, BTNF	research	on site	WYGF
703	female	adult	05/11/12	Little Grass Creek, BLM-WY	research	on site	WYGF
519	male	adult	05/12/12	Cottonwood Creek, SNF	research	on site	WYGF

Table 1. Continued.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
538	male	adult	05/13/12	Carmichael Creek, BLM-WY	research	on site	WYGF
704	male	subadult	05/17/12	Blaine Creek, Pr-WY	management	Bailey Creek, BTNF	WYGF
705	male	subadult	05/19/12	Carmichael Creek, SNF	research	on site	WYGF
706	female	adult	05/25/12	Henry's Fork, CTNF	research	on site	IDFG
			06/25/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
			07/12/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
707	female	adult	05/30/12	Gros Ventre River, BTNF	research	on site	WYGF
708	female	adult	06/06/12	Papoose Creek, Pr-MT	research	on site	IGBST
709	male	adult	06/07/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
			06/12/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
710	male	subadult	06/16/12	Hoodoo Creek, Pr-WY	management	Clark's Fork, SNF	WYGF
			06/25/12	Sunlight Creek, SNF	research	on site	WYGF
			07/21/12	Sunlight Creek, Pr-WY	management	Arizona Creek, BTNF	WYGF
G180	male	subadult	06/18/12	Blackrock Creek, BTNF	research	on site	WYGF
526	male	adult	06/21/12	Kettle Creek, BTNF	research	on site	WYGF
691	male	subadult	06/22/12	South Dry Creek, Pr-MT	management	removed	WS/MTFWP
227	male	adult	06/24/12	Warm River, CTNF	research	on site	IDFG/IGBST
			07/07/12	Warm River, CTNF	research	on site	IDFG/IGBST
			07/12/12	Warm River, CTNF	research	on site	IDFG/IGBST
			07/19/12	Warm River, CTNF	research	on site	IDFG/IGBST
			09/15/12	Gibbon River, YNP	research	on site	IGBST
			09/16/12	Gibbon River, YNP	research	on site	IGBST
			10/04/12	Gibbon River, YNP	research	on site	IGBST
711	male	adult	06/25/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
179	female	adult	06/25/12	Skull Creek, BTNF	research	on site	WYGF
712	male	adult	06/25/12	Sunlight Creek, SNF	research	on site	WYGF
674	male	adult	06/27/12	North Fork Spread Creek, BTNF	research	on site	WYGF
672	female	subadult	06/28/12	Sunlight Creek, SNF	research	on site	WYGF
713	male	subadult	06/28/12	Warm River, CTNF	research	on site	IDFG/IGBST
714	female	adult	06/28/12	Camp Creek, SNF	management	Sunlight Creek, SNF	WYGF
G181	female	subadult	06/28/12	Camp Creek, SNF	management	Sunlight Creek, SNF	WYGF
G182	female	subadult	06/28/12	Camp Creek, SNF	management	Sunlight Creek, SNF	WYGF
373	male	adult	07/05/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
			08/19/12	East Dry Creek, CTNF	research	on site	IGBST
715	male	adult	07/06/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
716	female	adult	07/08/12	Gypsum Creek, BTNF	management	Mormon Creek, SNF	WYGF
653	male	subadult	07/09/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
717	male	subadult	07/10/12	Sheridan Creek, SNF	management	Sunlight Creek, SNF	WYGF
648	male	adult	07/12/12	Kettle Creek, BTNF	research	on site	WYGF
718	female	adult	07/12/12	Blackrock Creek, BTNF	research	on site	WYGF
719	male	adult	07/17/12	Trail Creek, BTNF	management	Mormon Creek, SNF	WYGF
533	female	adult	07/19/12	Henry's Fork, CTNF	research	on site	IDFG/IGBST
720	female	adult	07/20/12	Tom Miner Creek, Pr-MT	research	on site	IGBST

Table 1. Continued.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
600	male	adult	07/21/12	Tom Miner Creek, Pr-MT	research	on site	IGBST
721	female	adult	07/22/12	Tom Miner Creek, Pr-MT	research	on site	IGBST
722	male	adult	07/21/12	Wagon Creek, BTNF	management	Fox Creek, SNF	WYGF
650	female	adult	07/28/12	Fish Creek, BTNF	management	removed	WYGF
499	female	adult	07/28/12	Kinky Creek, BTNF	management	Sunlight Creek, SNF	WYGF
304	male	adult	08/03/12	Wagon Creek, BTNF	management	removed	WYGF
723	male	adult	08/04/12	Tepee Creek, BTNF	management	Mormon Creek, SNF	WYGF
724	female	adult	08/14/12	Clark Fork River, Pr-WY	management	Blackrock Creek, BTNF	WYGF
725	female	adult	08/15/12	Clark Fork River, Pr-WY	management	Bailey Creek, BTNF	WYGF
G183	female	subadult	08/15/12	Clark Fork River, Pr-WY	management	Bailey Creek, BTNF	WYGF
726	male	adult	08/16/12	Bootjack Creek, CTNF	research	on site	IGBST
670	male	adult	08/17/12	Raspberry Creek, BTNF	management	removed	WYGF
727	male	adult	08/18/12	Bootjack Creek, CTNF	research	on site	IGBST
728	female	subadult	08/23/12	Bootjack Creek, CTNF	research	on site	IGBST
729	male	adult	08/23/12	Soda Creek, BTNF	research	on site	IGBST
730	male	adult	08/24/12	Sheridan Creek, CTNF	management	on site	WS/IDFG
Unm	male	subadult	08/24/12	Sheridan Creek, CTNF	management	on site	WS/IDFG
Unm	male	subadult	08/24/12	Sheridan Creek, CTNF	management	on site	WS/IDFG
G174	male	subadult	09/07/12	Eaglenest Creek, Pr-WY	management	removed	WYGF
731	male	subadult	09/09/12	Gypsum Creek, BTNF	management	on site	WYGF
732	female	adult	09/10/12	Buffalo Fork, BTNF	management	Fox Creek, SNF	WYGF
Unm	male	adult	09/12/12	Pacific Creek, BTNF	management	removed	WYGF
524	male	adult	09/13/12	Horse Creek, Pr-WY	management	removed	WYGF
315	female	adult	09/14/12	Buffalo Fork, BTNF	management	Sunlight Creek, SNF	WYGF
			10/20/12	Pacific Creek, BTNF	management	removed	WYGF
G184	male	subadult	09/14/12	Buffalo Fork, BTNF	management	Sunlight Creek, SNF	WYGF
G185	male	subadult	09/14/12	Buffalo Fork, BTNF	management	Sunlight Creek, SNF	WYGF
G186	male	subadult	09/14/12	Buffalo Fork, BTNF	management	Sunlight Creek, SNF	WYGF
G131	female	adult	09/16/12	Bear Creek, Pr-MT	management	removed	WS/MTFWP
735	female	subadult	09/17/12	Bear Creek, Pr-MT	management	Bear Creek, GNF	WS/MTFWP
733	male	subadult	09/17/12	North Piney Creek, Pr-WY	management	Mormon Creek, SNF	WYGF
Unm	male	adult	09/17/12	North Piney Creek, Pr-WY	management	removed	WYGF
Unm	male	subadult	09/18/12	Greybull River, Pr-WY	management	removed	WYGF
734	female	adult	09/21/12	South Fork Shoshone, Pr-WY	management	Mormon Creek, SNF	WYGF
G187	male	subadult	09/21/12	Rattlesnake Creek, Pr-WY	management	Boone Creek, CTNF	WYGF
G178	male	subadult	09/21/12	South Fork Shoshone, Pr-WY	management	Fox Creek, SNF	WYGF
G179	male	subadult	09/21/12	South Fork Shoshone, Pr-WY	management	Blackrock Creek, BTNF	WYGF
472	female	adult	09/22/12	South Fork Shoshone , Pr-WY	management	removed	WYGF
736	male	adult	10/01/12	Gibbon River, YNP	research	on site	IGBST
G188	male	subadult	10/01/12	North Fork Shoshone, SNF	management	Fox Creek, SNF	WYGF
737	male	subadult	10/10/12	North Fork Shoshone, SNF	management	Game Creek, BTNF	WYGF
556	male	adult	10/13/12	Flat Mountain Creek, YNP	research	on site	IGBST

Table 1. Continued.

Bear[a]	Sex	Age	Date	General location[b]	Capture type	Release site[b]	Agency[c]
574	male	adult	10/15/12	Flat Mountain Creek, YNP	research	on site	IGBST
738	male	adult	10/19/12	North Fork Shoshone, Pr-WY	management	Blackrock Creek, BTNF	WYGF
658	female	adult	10/26/12	Wind River, Pr-WY	management	Fishhawk Creek, BTNF	WYGF
739	female	subadult	10/28/12	Sheep Creek, Pr-WY	management	Bailey Creek, BTNF	WYGF

[a] Unm = unmarked.

[b] BLM = Bureau of Land Management; BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.

[c] IDFG = Idaho Fish and Game; IGBST = Interagency Grizzly Bear Study Team, USGS; MTFWP = Montana Fish, Wildlife and Park; WS = Wildlife Services, USDA; WYGF = Wyoming Game and Fish; YNP = Yellowstone National Park.

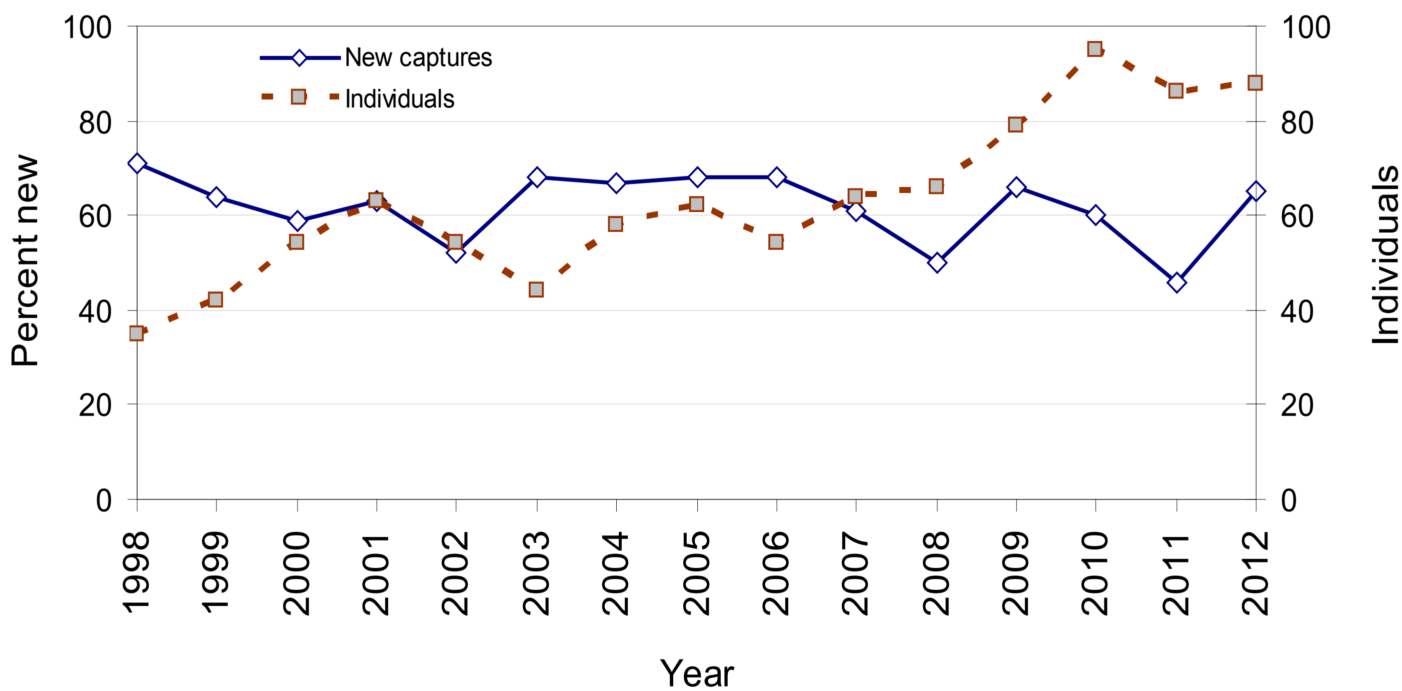


Fig. 1. Percent of previously unmarked and total number of grizzly bears captured annually during 1998–2012 in the Greater Yellowstone Ecosystem.

Table 2. Annual number of grizzly bears monitored, captured, and transported in the Greater Yellowstone Ecosystem, 1980–2012.

Year	Number monitored	Individuals trapped	Total captures: Research	Total captures: Management	Total captures: 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
2008	87	66	39	40	30
2009	97	79	63	34	25
2010	85	95	36	75	52
2011	92	86	61	46	24
2012	112	88	47	57	36

Table 3. Grizzly bears radiomonitored in the Greater Yellowstone Ecosystem during 2012.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current status
155	M	adult		yes	yes	active
179	F	adult	None	no	yes	active
204	M	adult		yes	yes	active
211	M	adult		yes	yes	active
227	M	adult		no	yes	active
281	M	adult		yes	yes	active
315	F	adult	3 COY, lost all	no	no	removed
321	F	adult	1 2-year-old (in den)	yes	no	dead
332	F	adult	2 COY	yes	no	cast
337	F	adult	Not seen	no	no	cast
373	M	adult		no	yes	active
394	M	adult		yes	no	cast
400	M	adult		yes	no	cast
416	F	adult	3 COY, lost all	yes	yes	active
423	F	adult	None	yes	yes	active
448	F	adult	3 COY	yes	no	cast
465	M	adult		yes	no	cast
481	F	adult	None	yes	yes	active
499	F	adult	None	no	yes	active
515	M	adult		no	no	dead
517	F	adult	2 2-year-olds, weaned	yes	no	cast
519	M	adult		no	no	cast
524	M	adult		yes	no	cast
526	M	adult		no	yes	active
533	F	adult	None	no	yes	active
541	F	adult	None	yes	yes	active
552	M	adult		yes	no	cast
556	M	adult		no	yes	active
566	M	adult		yes	no	cast
574	M	adult		no	yes	active
593	M	adult		yes	no	cast
600	M	adult		no	yes	active
611	M	adult		no	no	cast
623	M	adult		yes	no	cast
627	F	adult	3 COY, lost 1	yes	yes	active
642	M	adult		no	yes	missing

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current status
645	F	adult	3 COY	yes	no	cast
648	M	adult		no	yes	active
653	M	subadult		no	yes	active
658	F	adult	None	yes	yes	active
659	M	adult		yes	no	cast
661	F	adult	1 yearling	yes	no	cast
662	F	adult	2 COY, both dead	yes	no	dead
663	F	adult	2 COY, lost both	yes	yes	active
671	M	adult		yes	yes	active
672	F	subadult		yes	yes	active
673	M	adult		yes	no	cast
674	M	adult		no	yes	active
676	F	subadult		yes	no	cast
677	M	adult		yes	no	cast
678	F	adult	2 COY	yes	yes	active
679	M	adult		yes	no	cast
680	F	subadult		yes	no	cast
681	M	adult		yes	no	cast
682	M	subadult		yes	no	removed
683	M	adult		yes	no	cast
684	M	adult		yes	no	cast
685	M	adult		yes	no	cast
686	F	adult	None	yes	yes	active
687	M	adult		yes	no	cast
688	M	subadult		yes	no	cast
689	M	subadult		yes	no	dead
690	F	subadult		yes	no	removed
691	M	subadult		yes	no	cast
692	F	subadult		yes	yes	active
693	F	adult	2 COY, both dead	yes	no	dead
694	F	subadult		yes	no	cast
695	M	adult		yes	no	cast
696	M	adult		no	no	killed
697	M	adult		no	no	cast
698	M	adult		no	no	cast
699	M	adult		no	no	cast
700	M	adult		no	no	cast

Table 3. Continued.

Bear	Sex	Age	Offspring[a]	Monitored: Out of den	Monitored: Into den	Current status
701	M	adult		no	yes	active
702	F	subadult		no	yes	active
703	F	adult	3 yearlings	no	yes	active
704	M	subadult		no	no	cast
705	M	subadult		no	no	cast
706	F	adult	None	no	yes	active
707	F	adult	2 COY	no	yes	active
708	F	adult	None	no	yes	active
709	M	adult		no	yes	active
710	M	subadult		no	no	cast
711	M	adult		no	yes	active
712	M	adult		no	no	cast
713	M	subadult		no	yes	active
714	F	adult	2 yearlings	no	yes	active
715	M	adult		no	yes	missing
716	F	adult	None	no	yes	active
717	M	subadult		no	yes	active
718	F	adult	None	no	yes	active
719	M	adult		no	yes	missing
720	F	adult	1 COY	no	yes	active
721	F	adult	None	no	yes	active
722	M	adult		no	no	killed
723	M	adult		no	yes	active
724	F	adult	None	no	yes	active
725	F	adult	2 yearlings	no	yes	active
726	M	adult		no	no	killed
727	M	adult		no	yes	active
728	F	subadult		no	yes	active
729	M	adult		no	yes	active
730	M	adult		no	yes	active
731	M	subadult		no	yes	active
732	F	adult	None	no	yes	active
733	M	subadult		no	yes	active
734	F	adult	None	no	yes	active
735	F	COY		no	yes	active
736	M	adult		no	yes	active
737	M	subadult		no	no	cast
738	M	adult		no	yes	active
739	F	subadult		no	yes	active

Estimating Number of Females with Cubs-of-the-Year *(Mark A. Haroldson and Frank T. van Manen, Interagency Grizzly Bear Study Team; and Daniel Bjornlie, Wyoming Game and Fish Department)*

I. Assessing Trend and Estimating Population Size from Counts of Unduplicated Females

Background

Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) of the Grizzly Bear Recovery Plan (USFWS 1993), IGBST is tasked with estimating the number of female grizzly bears with COY in the GYE population annually, determining trend for this segment of the population, and estimating size of specific population segments to assess sustainability of annual mortalities. During 2011, results of our trend analysis indicated the trajectory for this annual estimate was changing (Haroldson 2012). This result triggered a demographic review (USFWS 2007*b*) which was held during February 2012. Results of this review using data collected during 2002–2011 indicated that some vital rates for the population had changed (IGBST 2012). A consequence of these changed vital rates was that the rate of increase for the grizzly bear population had also changed. Trend estimates using 2002–2011 vital rates suggest the population was stable to slightly increasing during the period (IGBST 2012). Since vital rates and trend had changed, it followed that age structure for the population had also changed. Thus it is appropriate to use updated vital rates and ratios for specific population segments to estimate size of those specific population segments and assess annual mortality limits.

These proposed changes were initially presented to the Yellowstone Ecosystem Subcommittee (YES) during the Spring 2012 meeting (18–19 Apr 2012, http://www.igbconline.org/images/pdf/YES-Spring-2012-Meeting-Minutes-FINAL.pdf). Also at that meeting, members approved a motion to count both: (1) females with COY for population estimation, and (2) known and probable mortalities for assessing annual mortalities limits, within a proposed Demographic Monitoring Area (Fig. 2; http://www.fws.gov/mountain-prairie/species/mammals/grizzly/Grizzly_Bear_Recovery_Plan_March2013.pdf). Formal adoption of these proposed changes in protocols is pending USFWS assessment of public comment. Here we present our 2012 findings for unduplicated females with COY, and the population estimate derived from that estimate, using the current protocols and the proposed changes, including updated vital rates and the new count line.

Methods

Specific procedures used to accomplish the above mentioned tasks under the current protocols are presented in IGBST (2005, 2006) and Harris et al. (2007). Under the proposed changes only females with COY observed within the Demographic

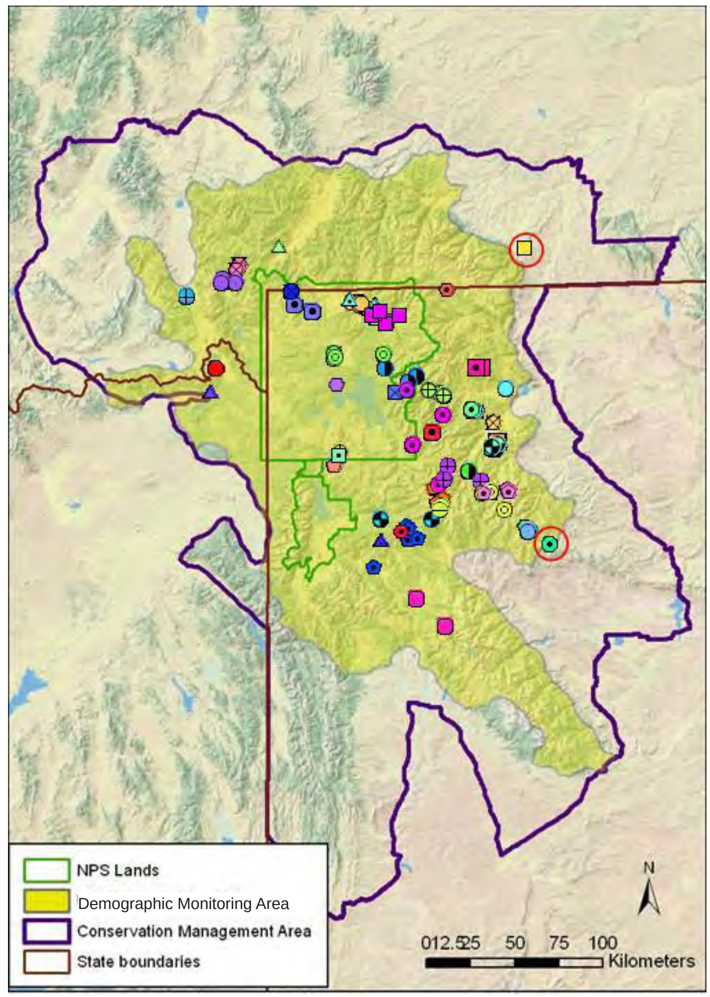


Fig. 2. Distribution of 124 sightings of 49 (indicated by unique symbols) unduplicated female grizzly bears with cubs-of-the-year (COY) observed in the Greater Yellowstone Ecosystem during 2012. Under current protocols, females with COY sighted within the boundaries of the Conservation Management Area are used for population estimation. Under proposed protocols, only sightings from females with COY occurring within the Demographic Monitoring Area will be used for population estimation. During 2012, 2 (indicated by red circles) sightings of females with COY occurred outside the proposed new count line, 1 of these was the only observation for that female. The other female was sighted 4 times, 3 of which occurred within the proposed count line.

Monitoring Area (Fig. 2) will be tallied for the Chao2 estimate. Updated vital rates and ratios for specific population segments used for population size estimates under the proposed changes are specified in IGBST (2012).

Briefly, the Knight et al. (1995) rule set is used to differentiate an estimate for the number of unique females with COY 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) to sighting frequencies for each unique family. 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 quadratic model is included to detect changes in trend. Akaike's Information Criterion (AIC_c) 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_c that favors the quadratic model (i.e., AIC_c weight > 0.50, USFWS 2007*b*). 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 derived 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) for the current protocols, and IGBST (2012) for the proposed changes in count line and vital rates.

<u>2012 Results</u>

We documented 124 verified sightings of females with COY during 2012 within the current count line (i.e., Conservation Management Area, Fig. 2). Only 2 sightings (1.6%) occurred outside the proposed count line (Fig. 2). One of these was a single observation of a family, the other was 1 of 4 sightings of a unique female with COY.

Most observations (62.9%) were obtained from aerial sources, with ground sources contributing the remaining (37.1%) observations (Table 4). We were able to differentiate 49 unduplicated females from the 124 sightings using the rule set described by Knight et al. (1995). Twenty-six percent of observations on 14 unique females with COY occurred within the boundary of YNP. This result exceeded the 5 unique females observed in Yellowstone during 2011, but was lower than the 20 observed during 2010. Total

Table 4. Method of observation for female grizzly bears with cubs-of-the-year sighted in the Greater Yellowstone Ecosystem during 2012.

Method of observation	Frequency	Percent	Cumulative percent
Fixed wing – other researcher	2	1.6	1.6
Fixed wing – observation	57	46.0	47.6
Fixed wing – telemetry	16	12.9	60.5
Helicopter – other researcher	3	2.4	62.9
Ground sighting	45	36.3	99.2
Trap	1	0.8	100.0
Total	124	100.0	

number of COY observed during initial sightings was 94 and mean litter size was 1.92 (Table 5). There were 14 single cub litters, 25 litters of twins, and 10 litters of triplets seen during initial observations of unique families (Table 5). Excluding 1 observation of a female with 1 COY that occurred outside the proposed count line, there were 48 unique females and 93 COY associated with females at initial sightings. Mean litters size was 1.94.

One-hundred ten observations of 44 families were obtained without telemetry (Table 6). Using the sighting frequencies associated with these families our 2012 $\hat{N}_{Chao2}$ = 59 (Table 6). The model-averaged point estimate ($\hat{N}_{MAFC}$) was 58 (95% CI 47–70) and exceeded the demographic objective of 48 specified in the demographic recovery criteria for the GYE (USFWS 2007*a*). Our 2012 estimated population size derived from $\hat{N}_{MAFC}$ was 610 (Table 7).

Excluding the single family observed on all occasions (i.e., once) outside the proposed count line, there were 109 observation of 43 families obtained without the aid of telemetry. Sighting frequencies for these families would produce a revised estimate for unique females with COY within the Demographic Monitoring Area of $\hat{N}_{NewLineChao2}$ = 56. Using this revised estimate in our linear and quadratic regression analyses produces a model-averaged estimate of $\hat{N}_{NewLineMAFC}$ = 57 (95% CI 45–72). This estimate does not retrospectively exclude unique families observed outside the revised count line during years prior to 2012. We include it here only to demonstrate what kind of changes we can expect in our $\hat{N}_{Chao2}$ estimates under the proposed changes to the area in which we count unique females with COY for purposes of population estimation. Changes will be small because nearly all females with COY are sighted within the proposed count line (IGBST 2012). Applying the updated 2002–2011 vital rates to $\hat{N}_{NewLineMAFC}$ produces larger changes to the estimated population size. This is due primarily to observed increases in survival rates for independent male bears, and the subsequent changes in the ratio between independent-aged females and males (i.e., 1:1) in the modeled population this produces. The resulting population estimate for the area within the proposed count line when applying the updated vital rates is 718 (Table 7).

We use the annual $\hat{N}_{Chao2}$ for the period 1983–2012 (Table 6) to estimate the rate of population change (Fig. 3) for females with COY segment of the population. For the second year since we began using an information-theoretical approach and competing linear and quadratic models, AIC_c weights (Table 8) exhibited more support for the quadratic (50.6%) than the linear (49.4%) model. However, the estimated quadratic effect (-0.00098, SE = 0.00061) was not significant (*P* = 0. 12049).

We do not report regression results using the single 2012 result applying the new count line with previous estimates for $\hat{N}_{Chao2}$ that do not include this change. However, if the proposed change is adopted we will retrospectively adjust our 1983–2011 Chao2 estimates, identifying and excluding families with COY that were only seen outside the proposed count line, and investigate trend using the revised estimates. There is also an outstanding question of what time period should be used to assess trend. Since a change in trajectory was detected in 2011 and subsequent investigation revealed a slowing of growth during 2002–2011 (IGBST 2012), anchoring the analysis to a start year of 1983 may not be appropriate.

Bear 416 with 3 cubs-of-the-year, 13 May 2012. Photo courtesy of Steve Ard.

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 1983–2012 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
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
2008	44	118	10	28	6	0	84	1.91
2009	42	117	10	19	11	2	89	2.12
2010	51	286	15	23	12	1	101	1.98
2011	39	134	13	17	9	0	74	1.90
2012	49	124	14	25	10	0	94	1.92

[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, 1983–2012. 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
2008	44	43	16	8	56	102	1.8
2009	42	39	11	11	44	100	2.3
2010	51	51	11	9	56	256	4.6
2011	39	39	14	10	47	123	2.6
2012	49	44	16	7	59	110	1.9

Table 7. Estimates and 95% confidence intervals (CI) for population segments, and total grizzly bear population size under alternative protocols for 2012 in the Greater Yellowstone Ecosystem.					
				95% CI	
Protocol	Segment	Estimate	Variance	Lower	Upper
Current	Independent females	257	508.0	213	301
	Independent males	163	366.9	126	201
	Dependent young	190	113.5	169	211
	Total	610	988.4	549	672
Proposed[a]	Independent females	250	672.0	199	301
	Independent males	250	796.5	195	305
	Dependent young	218	116.8	197	240
	Total	718	1,585.2	640	797

[a] USFWS Draft revised supplement to Grizzly Bear Recovery Plan: proposed revision to the demographic recovery criteria for the grizzly bear population in the Greater Yellowstone Area (Feb 2013).

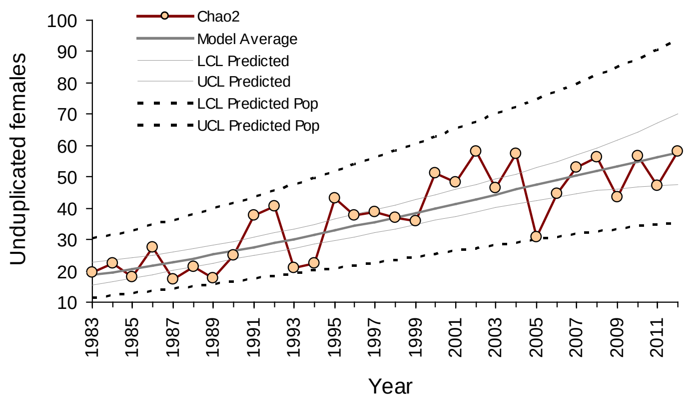


Fig. 3. Model-averaged estimates for the number of unduplicated female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem for the period 1983–2012, where the linear and quadratic models were fitted. The inner set of light solid lines represents a 95% confidence interval on the predicted population size for unduplicated females, whereas the outer set of dashed lines represents a 95% confidence interval for the individual population estimates for unduplicated females.

Table 8. Parameter estimates and model selection results from fitting linear and quadratic models for $Ln(\hat{N}_{Chao2})$ for the period 1983–2012.

Model	Parameter	Estimate	Standard error	*t* value	Pr(>*t*)
Linear					
	β_0	2.95263	0.08581	34.40745	<0.0001
	β_1	0.03899	0.00483	8.06672	<0.0001
	SSE	1.47038			
	AICc	-83.54728			
	AICc weight	0.49356			
Quadratic					
	β_0	2.79130	0.13076	21.34731	<0.0001
	β_1	0.06924	0.06924	3.56112	0.0014
	β_2	-0.00098	0.00061	-1.60334	0.12049
	SSE	1.34255			
	AICc	-83.59878			
	AICc weight	0.50644			

II. Mark-Resight Technique to Estimate Females with Cubs-of-the-Year

Schwartz et al. (2008) demonstrated biases inherent in the current method of estimating population size (Chao2; see previous section) using unduplicated counts of females with COY and the associated rule set of Knight et al. (1995). IGBST invited partner agencies and quantitative ecologists to participate in 3 workshops held in February 2011, July 2011, and February 2012 to consider alternative approaches. The product of these workshops was a recommendation to transition from the current protocol for estimating abundance to a mark-resight estimator using systematic flight observation data conducted since 1997. The mark-resight estimator yields an annual estimate of the number of females with COY based on (1) the presence of a radio-marked sample, and (2) 2 systematic observation flights/year, during which all bears observed are recorded and, following observation, checked for marks (i.e., radio collar) using telemetry. Pilots note whether family groups observed include COY, yearlings, or 2-year-old offspring. Mark-resight designs for population estimation are commonly used for wildlife monitoring because they can provide a cost-efficient and reliable monitoring tool. However, inference from such designs is very limited when data are sparse, either from a low number of marked animals, a low probability of detection, or both. In the GYE, annual mark-resight data collected for female grizzly bears with COY suffer from both limitations. As an important outcome of the 3 workshops, Higgs et al. (2013) developed a technique to overcome difficulties due to sparseness by assuming homogeneity in sighting probabilities over 16 years (1997–2012) of biannual aerial surveys. They modeled counts of marked and unmarked grizzly bears with COY as multinomial random variables, using the capture frequencies of marked females with COY for inference regarding the latent multinomial frequencies for unmarked females with COY (Fig. 4).

One important assumption of the mark-resight technique is that the geographic distribution of radio-collared female bears is generally representative of the geographic distribution and relative density of female bears in the population. Conclusions from workshop discussion were that this assumption is likely not violated within the GYE, with one exception. A subset of bears in the GYE annually spend 6 to 10 weeks in late summer (mid-Jul to late Sep) in alpine scree slopes feeding on army cutworm moths (Mattson et al.

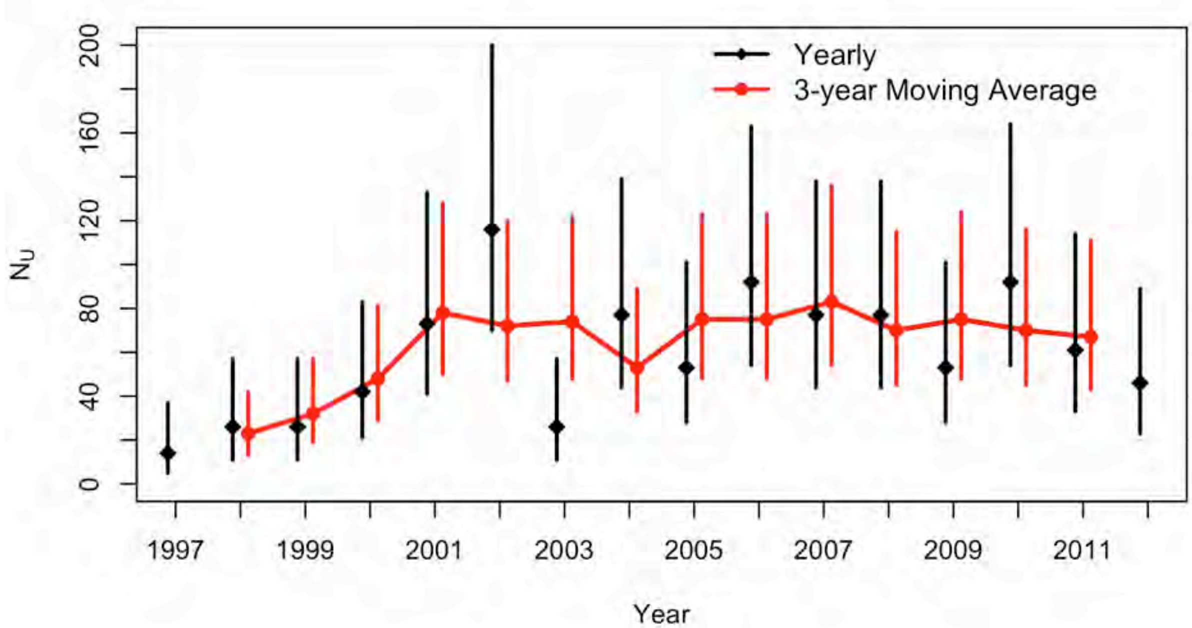


Fig. 4. Posterior intervals (95 %) and medians for N_u (number of unmarked females with cubs-of-the-year) assuming independent years with objective priors and 95% posterior intervals for 3-year moving averages connected by the line. Females with cubs-of-the-year (marked and unmarked) observed at army cutworm moth aggregation sites were excluded from these estimates. Modified from Higgs et al. (2013).

1991*b*, Bjornlie and Haroldson 2011). These bears are highly visible and constitute a substantial proportion of bears seen during observation flights. However, capturing and marking of bears is difficult because these remote, high-elevation areas are snow-covered early in the capture season and access is difficult. When access improves later in the season, most bears have already begun feeding on army cutworm moths and are difficult to capture. Thus, the proportion of radio-marked females with COY among those feeding on these high-visibility sites is lower than in the remainder of the ecosystem. Applying mark-resight estimates to the entire ecosystem without considering these moth sites would result in overestimation bias. However, moth sites are now well defined and the study team annually monitors these sites. Thus, the decision was made to exclude confirmed moth sites (defined as areas within 500 m from sites where multiple observations of bears feeding occurred >1 year) from the mark-resight analyses and conduct separate moth site-only aerial surveys to add the observed number of females with COY (marked and unmarked) to the mark-resight estimate for that year. We tested the accuracy of the aerial moth site surveys by simultaneously counting the number of grizzly bears from aerial and ground surveys at a subsample of moth sites. We conducted aerial and ground surveys simultaneously on 5 sites over 2 days in early August 2012. Wind curtailed survey flights on the second day so only 3 of the 5 sites could be surveyed, for a total of 8 flights. Over all survey flights, the total number of grizzly bear sightings was 58, whereas the number seen by ground observers totaled 59. The mean and median difference in numbers of bears observed between aerial and ground surveys were -0.125 and 0, respectively (range = -3–4). Therefore, we deemed aerial surveys adequate to obtain a reliable census of the number of grizzly bears feeding at moth sites.

Higgs et al. (2013) performed simulations based on a known population of 50 females with COY and resighting frequencies and proportions of bears sighted 0, 1, and 2 times from our flight observation data to determine accuracy and precision of the mark-resight technique. Accuracy was high, indicating that this technique addressed the bias concerns associated with estimates based on the Chao2 estimator. However, the simulations also indicated that precision was relatively low and the authors recommended that other sources of information are needed to increase precision and decrease variability among years. One such source may be observations of females with yearlings. Females with yearlings are readily identifiable from aerial observations; although in some instances yearling sightings may be confounded with 2-year-old offspring, the latter have typically separated from their mother once the observation flights commence. Addition of observations of females with yearlings would enhance the relatively small sample sizes of the current mark-resight dataset based only on females with COY. As part of ongoing efforts to improve population estimation, the IGBST will investigate how much precision improves with the addition of sightings of females with yearlings.

Occupancy of Bear Management Units by Females with Young *(Mark A. Haroldson, Interagency Grizzly Bear Study Team)*

Dispersion of reproductive females throughout the ecosystem is assessed by verified observations of female grizzly bears with young (COY, yearlings, 2-year-olds, and/or young of unknown age) by BMU. The requirements specified in the Demographic Recovery Criteria (USFWS 2007*b*) state that 16 of the 18 BMUs must be occupied by females with young on a running 6-year sum with no 2 adjacent BMUs unoccupied. Fifteen of 18 BMUs had verified observations of female grizzly bears with young during 2012 (Table 9). Eighteen of 18 BMUs contained verified observations of females with young in at least 4 years of the last 6-year (2007–2012) period.

Table 9. Bear Management Units (BMU) 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, 2007–2012.

Bear Management Unit	2007	2008	2009	2010	2011	2012	Number of years occupied 2007–2012
1) Hilgard	X	X	X	X	X	X	6
2) Gallatin	X	X	X	X	X	X	6
3) Hellroaring/Bear		X	X	X	X	X	5
4) Boulder/Slough	X	X	X	X	X	X	6
5) Lamar	X	X	X	X	X	X	6
6) Crandall/Sunlight	X	X	X	X	X	X	6
7) Shoshone	X	X	X	X	X	X	6
8) Pelican/Clear	X	X	X	X	X	X	6
9) Washburn	X	X	X	X		X	5
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	X	6
13) Plateau	X	X	X	X			4
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		5
Annual count of occupied BMUs	17	18	18	18	16	15	

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

Two rounds of observation flights were conducted during 2012. Forty-eight Bear Observation Areas (BOAs; Fig. 5) were surveyed during Round 1 (29 May–30 Jul) and 35 BOAs during Round 2 (9 Jul–23 Aug). Observation time was 95 hours for Round 1 and 74 hours for Round 2; average duration of flights for both rounds combined was 2.04 hours (Table 10). Three hundred sixty-nine bear sightings, excluding dependent young, were recorded during observation flights. This included 9 radio-marked bears, 295 solitary unmarked bears, and 65 unmarked females with young (Table 10). Observation rate was 2.18 bears/hour for all bears. One hundred twenty-eight young (69 COY, 42 yearlings, and 17 2-year-olds) were observed (Table 11). Observation rates were 0.40 females with young/hour and 0.23 females with COY/hour (Table 10).

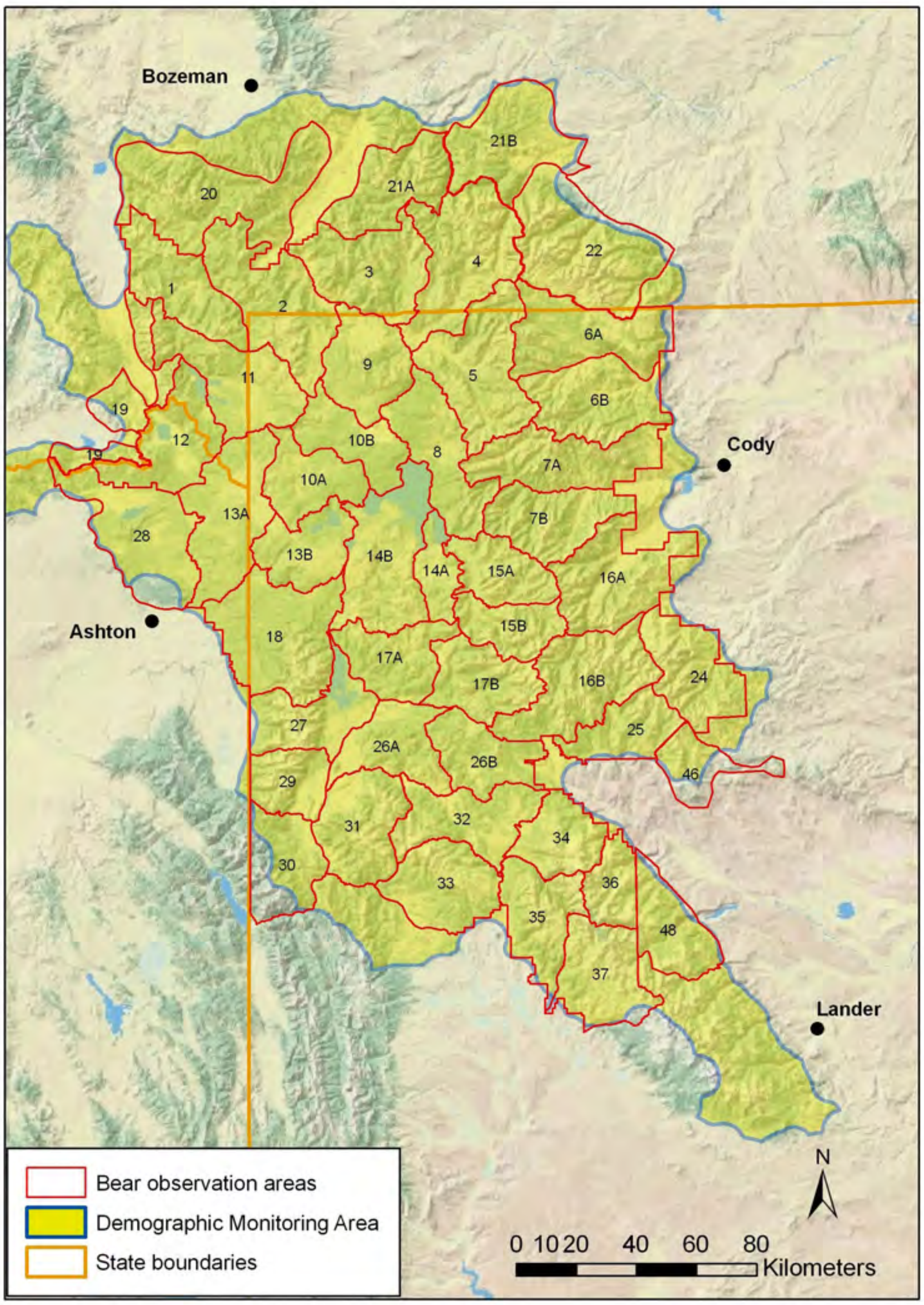


Fig. 5. Observation flight areas within the Greater Yellowstone Ecosystem, 2012. The numbers represent the 38 Bear Observation Areas. Those units too large to search during a single flight were further subdivided into 2 units (denoted by A and B). Consequently, there were 48 search areas.

Table 10. Annual summary statistics for observation flights conducted in the Greater Yellowstone Ecosystem, 1998–2012.

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]
1998[b]	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[b]	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[b]	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[b]	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[b]	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[b]	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[b]	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[b]	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[b]	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[b]	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
2008[b]	Round 1	97.6	46	2.1	2	1	87	36	126	1.29		
	Round 2	101.5	45	2.3	2	3	185	53	243	2.39		
	Total	199.1	91	2.2	4	4	272	89	369	1.85	0.47	0.23
2009[b]	Round 1	90.3	47	1.9	1	0	85	21	107	1.19		
	Round 2	93.6	47	2.0	2	0	157	34	193	2.06		
	Total	183.9	94	2.0	3	0	242	55	300	1.63	0.30	0.15
2010[b]	Round 1	101.1	48	2.1	0	2	93	22	117	1.16		
	Round 2	93.3	46	2.0	0	0	161	41	202	2.16		
	Total	194.4	94	2.1	0	2	254	63	319	1.64	0.33	0.20
2011[b]	Round 1	88.9	47	1.9	2	1	153	31	187	2.10		
	Round 2	71.0	35	2.0	4	0	109	23	136	1.92		
	Total	159.8	82	1.9	6	1	262	54	323	2.02	0.34	0.18
2012[b]	Round 1	95.4	48	2.0	4	2	178	35	219	2.97		
	Round 2	73.7	35	2.1	2	1	117	30	150	2.04		
	Total	169.1	83	2.0	6	3	295	65	369	2.18	0.40	0.23

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

[b] 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–31 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); 2008 (12 Jun–26 Jul, 1 Jul–23 Aug); 2009 (26 May–17 Jul, 8 Jul–27 Aug); 2010 (8 Jun–22 Jul, 10 Jul–24 Aug); 2011 (15 Jun–17 Aug, 21 Jul–29 Aug); 2012 (29 May–30 Jul, 9 Jul-23 Aug).

Table 11. Size and age composition of family groups seen during observation flights in the Greater Yellowstone Ecosystem, 1998–2012.

Year	Round	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
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
2008[a]	Round 1	3	10	0	9	5	2[b]	6	2	0
	Round 2	9	21	3	7	8	3	3	2	0
	Total	12	31	3	16	13	5	9	4	0
2009[a]	Round 1	0	6	4	2	3	1	3	1	0
	Round 2	6	11	1	3	7	1	4	1	1
	Total	6	17	5	5	10	2	7	1	1
2010[a]	Round 1	2	7	2	2	6	1	4	0	0
	Round 2	10	10	7	5	4	3	1	4	3
	Total	12	17	9	7	10	4	5	4	3
2011[a]	Round 1	4	8	3	3	6	1	2	2	3
	Round 2	2	8	4	2	2	1	1	3	0
	Total	6	16	7	5	8	2	3	5	3
2012[a]	Round 1	5	19	1	2	3	4	0	2	1
	Round 2	5	9	0	4	6	2	1	3	1
	Total	10	28	1	6	9	6	1	5	2

[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–31 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); 2008 (12 Jun–26 Jul, 1 Jul–23 Aug); 2009 (26 May–17 Jul, 8 Jul–27 Aug); 2010 (8 Jun–22 Jul, 10 Jul–24 Aug); 2011 (15 Jun–17 Aug, 21 Jul-29 Aug); 2012 (29 May–30 Jul, 9 Jul-23 Aug).

[b] Includes 1 female with 4 yearlings.

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

Ninety-seven telemetry relocation flights were conducted during 2012, resulting in 358.9 hours of search time (ferry time to and from airports excluded) (Table 12). Flights were conducted at least once during all months, with 74% occurring May–November. During telemetry flights, 1,128 locations of bears equipped with radio transmitters were collected, 87 (7.7%) of which included a visual sighting. Thirty-six sightings of unmarked bears were also obtained during telemetry flights, including 26 solitary bears, 4 females with COY, and 6 females with 2-year-olds or young of unknown age. Rate of observation for all unmarked bears during telemetry flights was 0.10 bears/hour. Rate of observing females with COY was 0.011/hour, which was considerably less than during observation flights (0.23/hour) in 2012.

In addition to the regular telemetry relocation flights, IGBST conducted flights to locate grizzly bears fitted with Global Positioning System (GPS) collars equipped with spread-spectrum technology (SST). These flights are not included as routine telemetry because of the additional time required to interrogate collars and download data. From these flights, we collected 29 locations from 7 bears that were part of our regular monitoring sample. We also collected 12 locations (1 visual) from 2 grizzly bears from the Taylor's Fork SST project (Podruzny 2012) and 9 locations (no visuals) from 3 grizzly bears that were part of our Bridger-Teton National Forest SST project (see "Use of Diminished Whitebark Pine Resources by Adult Female Grizzly Bears in Togwotee Pass, Spread Creek, and Mount Leidy in the Bridger-Teton National Forest, Wyoming, 2012"). We obtained 38 locations (1 visual) from 8 grizzly bears that were part of Idaho's Department of Transportation SST project.

Table 12. Summary statistics for radio-telemetry relocation flights in the Greater Yellowstone Ecosystem, 2012.

				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	19.82	6	3.30	70	1	0.05	0	0	0	0	---	---
February	5.75	1	5.75	36	0	0.00	0	0	0	0	---	---
March	19.63	6	3.27	87	0	0.00	0	0	0	0	---	---
April	22.90	7	3.27	65	6	0.26	7	0	0	0	0.31	0.000
May	44.57	10	4.46	136	22	0.49	7	0	0	1	0.18	0.000
June	35.23	11	3.20	110	12	0.34	3	1	0	3	0.20	0.028
July	36.22	10	3.62	107	16	0.44	0	0	0	1	0.03	0.000
August	43.86	13	3.37	134	15	0.34	3	1	0	0	0.09	0.023
September	35.07	8	4.38	113	6	0.17	1	1	0	1	0.09	0.029
October	39.20	10	3.92	101	8	0.20	3	1	0	0	0.10	0.025
November	40.15	10	4.02	105	1	0.02	2	0	0	0	0.05	0.000
December	16.50	5	3.30	64	0	0.00	0	0	0	0	---	---
Total	358.90	97	3.70	1,128	87	0.24	26	4	0	6	0.10	0.011

[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)*

Under the Revised Demographic Recovery Criteria (USFWS 2007*b*) of the Grizzly Bear Recovery Plan (USFWS 1993), IGBST is tasked with evaluating the sustainability of annual grizzly bear mortalities that occur within the boundary of the Conservation Management Area (Fig. 6). Specific procedures used to accomplish these tasks are presented in IGBST (2005, 2006). Briefly, estimates for specific population segments are derived from the model-averaged annual Chao2 estimate for females with COY (see section "Assessing Trend and Estimating Population Size from Counts of Unduplicated Females" on page 11). However, results of a demographic review conducted by the study team using data collected during 2002–2011 indicate that some vital rates have changed (IGBST 2012). A consequence of these changed vital rates is that the rate of increase of the grizzly bear population in the GYE has also changed. Population trend using 2002–2011 vital rates suggest the population was stable to slightly increasing for the period (IGBST 2012). Updated vital rates and ratios for population segments to assess mortality limits under the proposed changes are presented in IGBST (2012). In addition, during spring 2012 YES meeting (18–19 April 2012, http://www.igbconline.org/images/pdf/YES-Spring-2012-Meeting-Minutes-FINAL.pdf) members approved counting females with COY for population estimation and assessing annual mortalities limits within a proposed Demographic Monitoring Area (Fig. 6). Formal adoption of these changes is pending USFWS assessment of public comment. Here we report number of mortalities inside and outside the proposed new count line, and assess mortality limits under the current and proposed criteria.

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 they provide an additional source of location information for grizzly bears in the GYE.

2012 Mortality Results

We documented 55 known and probable mortalities in the GYE during 2012; 34 were attributable to human causes (Table 13). One of the documented mortalities occurred during 2011 (Table 13). Evidence indicated this bear likely died of natural causes and sex determination from collected samples is pending results of DNA analysis. When available, sex of this individual will be added to the appropriate 2011 mortality total.

Seven of the 54 known and probable losses in 2012 remain under investigation by USFWS and state law enforcement agencies. Therefore, specific information related to these mortalities is not provided. However, these events are included in the following summary. Thirteen (38.2 %) of the 34 human-caused losses were hunting related, including 2 mistaken identity kills by black bear (*Ursus americanus*) hunters and 11 losses from self-defense kills. These losses included 5 probable COY losses from adult females that were killed in self-defense. Sixteen (47.5 %) of the human-caused losses involved management removals due to livestock depredation (n = 7) and site conflicts (n = 9). The remaining human-caused losses were from road kills (5.9%, n = 2), malicious killings (5.9%, n = 2), and defense of property (3.0%, n = 1).

We documented 19 natural mortalities in 2012 and 1 grizzly bear death from an undetermined cause in 2011 (Table 13). Among the losses from natural causes, a 20-year-old radio-instrumented male died of maladies associated with old age in January. Three were radio-marked adult females that were killed by other bear(s) during May in YNP. Two of these bears were accompanied by 2 COY each when they were killed. One of these 4 COY was found dead with its mother; the other 3 are considered probable mortalities. The 2-year-old male offspring of the third female was also found dead in the general vicinity where its mother was killed. Although we consider this event a natural mortality, the specific cause of death for this subadult could not be determined due to scavenging of the carcass and the advanced state of decomposition. The remaining 10 known and

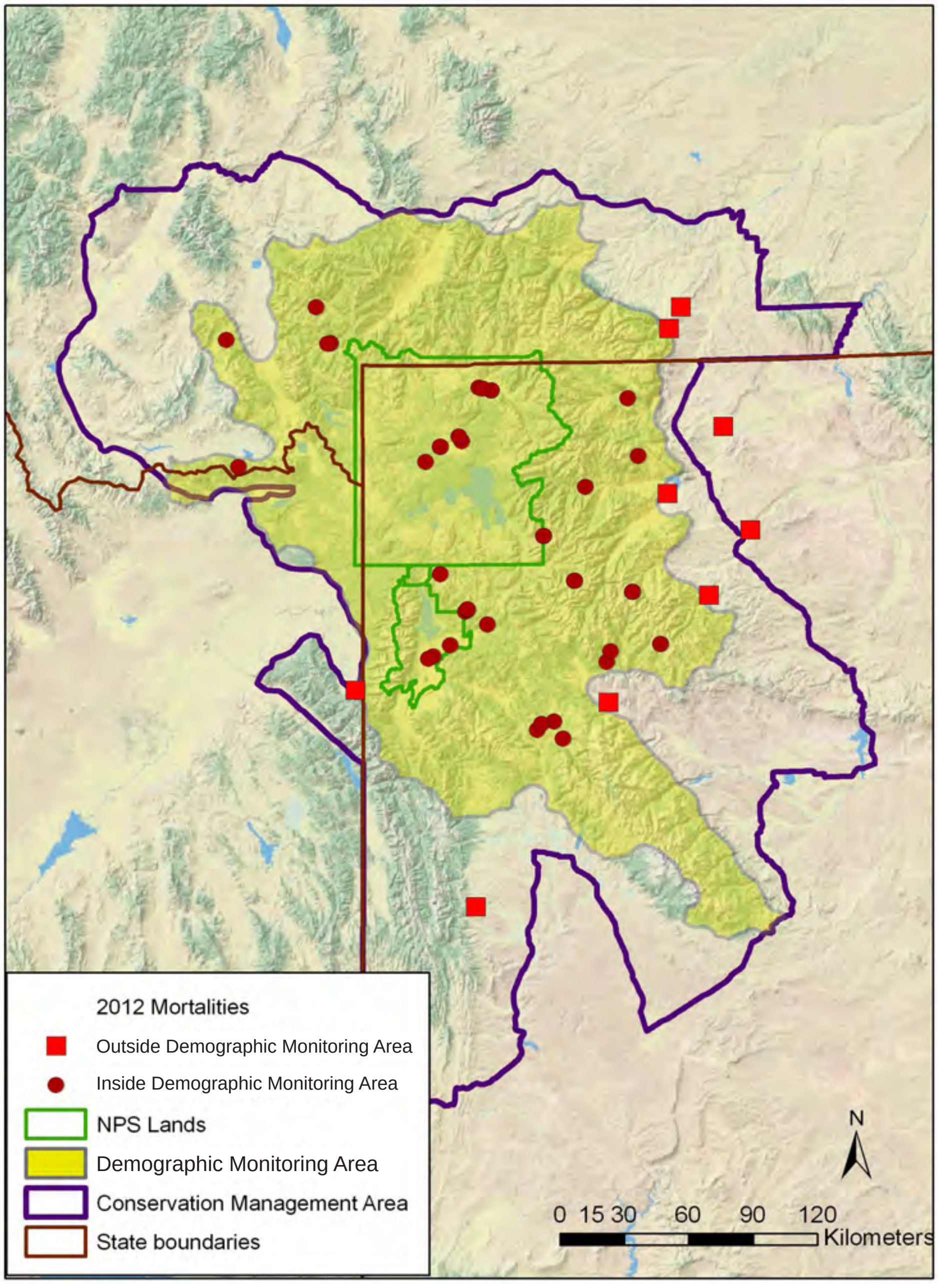


Fig. 6. Distribution of 54 known and probable grizzly bear mortalities occurring in the Greater Yellowstone Ecosystem during 2012. Under current protocols, mortalities occurring within the boundaries of the Conservation Management Area are counted against annual mortality limits. Under proposed protocols, known and probable mortalities occurring within a Demographic Monitoring Area will counted against annual mortality limits. During 2012, 9 mortalities were documented outside the proposed count line, 2 of these were outside the current count line.

Table 13. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2012.

Unique	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Certainty	Cause
201201	682	M	adult	04/17/2012	Wood River, Pr-WY	Known	Human-caused, management removal for sheep depredation.
201202	690	F	subadult	04/22/2012	Sweet Hollow Creek, Pr-ID	Known	Human-caused, management removal for repeated property damage and food rewards.
201203		F	COY	05/07/2012	Horse Creek, Pr-WY	Known	Natural, management capture of orphaned COY at a private residence in Dubios, WY. Cub was in poor condition and died in captivity on 5/10.
201204	681	M	adult	05/25/2012	Gallatin River, Pr-MT	Known	Human-caused, bear was threatening dogs at private residence and was shot and killed.
201205	321	F	adult	05/31/2012	Yellowstone River, YNP	Known	Natural, killed by another bear.
201206	515	M	adult	01/19/2012	Spruce Creek, YNP	Known	Natural, died during winter from maladies associated with old age. Mortality date is approximate.
201207	662	F	adult	05/21/2012	Jasper Creek, YNP	Known	Natural, killed and consumed by another bear. Mortality date is approximate.
201208		Unk	COY	05/21/2012	Jasper Creek, YNP	Probable	Natural, 1st of 2 COY whose mother was killed and consumed by another bear. Mortality date and location are approximate.
201209		Unk	COY	05/21/2012	Jasper Creek, YNP	Probable	Natural, 2nd of 2 COY whose mother was killed and consumed by another bear. Mortality date and location are approximate.
201210	693	F	adult	05/21/2012	Alum Creek, YNP	Known	Natural, killed and consumed by another bear. Mortality date is approximate.
201211		Unk	COY	05/21/2012	Alum Creek, YNP	Probable	Natural, 1st of 2 COY whose mother was killed and consumed by another bear. Mortality date and location are approximate.
201212		Unk	COY	05/21/2012	Alum Creek, YNP	Probable	Natural, 2nd of 2 COY whose mother was killed and consumed by another bear. Mortality date and location are approximate.
201213		Unk	COY	06/11/2012	Lamar River, YNP	Known	Natural, likely killed by wolves.
201214		M	subadult	6/11/2012	Cherry Creek, BDNF	Known	Human-caused, mistaken identity kill by bow hunter.
201215		M	yearling	06/21/2012	Snake River, GTNP	Known	Human-caused, road kill.
201216	691	M	subadult	06/22/2012	South Dry Creek, Pr-MT	Known	Human-caused, management removal for repeated calf depredation.
201217	689	M	subadult	06/05/2012	Sour Creek, YNP	Known	Natural, specific cause unknown. Mortality date is approximate.
201218	696	M	adult	07/27/2012	Robbers Roost Creek, SNF	Known	Human-caused, shot and killed by hikers at close range during a surprise encounter.
201219	650	F	adult	07/28/2012	Fish Creek, BTNF	Known	Human-caused, management removal for repeated cattle depredation.
201220	304	M	adult	08/03/2012	Wagon Creek, BTNF	Known	Human-caused, management removal for repeated cattle depredation.

Table 13. Continued.							
Unique	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Certainty	Cause
201221	670	M	adult	08/17/2012	Raspberry Creek, BTNF	Known	Human-caused, management removal for repeated cattle depredation.
201222	455	M	adult	08/22/2012	Blackwater Creek, SNF	Known	Human-caused, road kill.
201223		M	adult	2012	WY	Known	Human-caused. UNDER INVESTIGATION.
201224	698	M	adult	08/28/2012	Pacific Creek, BTNF	Known	Human-caused, management removal for repeated property damage and obtaining food rewards.
201225	G174	M	subadult	09/07/2012	Eaglenest Creek, Pr-WY	Known	Human-caused, management removal for close association to humans and obtaining multiple food rewards.
201226		Unk	subadult	Fall 2011	Dago Creek, BTNF	Known	Natural, likely killed by another bear during fall of 2011. Sample submitted for DNA determination of sex.
201227		M	adult	09/12/2012	Pacific Creek, BTNF	Known	Human-caused, management removal for repeated property damage and obtaining food rewards.
201228	524	M	adult	09/13/2012	Horse Creek, Pr-WY	Known	Human-caused, management removal for repeated property damage and obtaining food rewards.
201229		M	adult	09/17/2012	North Piney Creek, Pr-WY	Known	Human-caused, management removal for repeated cattle depredations.
201230	G131	F	adult	09/16/2012	Bear Creek, Pr-MT	Known	Human-caused, management removal for repeated cattle depredations.
201231	735	F	COY				No zoo could be found to take this COY. She was instrumented and released back into the ecosystem and her fate is being monitored. She is not counted as a mortality at this time.
201232		M	subadult	09/18/2012	Greybull River, Pr-WY	Known	Human-caused, management removal for obtaining multiple food rewards and damaging apiaries.
201233		F	adult	09/17/2012	East Fork Wind River, SNF	Known	Human-caused, self-defense kill of female with 1 COY by hunter.
201234		Unk	COY	09/17/2012	East Fork Wind River, SNF	Probable	Human-caused, COY of female that was killed by hunter in self-defense.
201235	472	F	adult	09/22/2012	South Fork Shoshone River, Pr-WY	Known	Human-caused, management removal for repeated conflicts at residences and obtain food rewards.
201236		F	adult	09/24/2012	Thorofare Creek, BTNF	Known	Human-caused, self-defense kill of female with 2 COY by hunter.
201237		Unk	COY	09/24/2012	Thorofare Creek, BTNF	Probable	Human-caused, 1st of 2 COY whose mother was killed in self-defense by hunter.
201238		Unk	COY	09/24/2012	Thorofare Creek, BTNF	Probable	Human-caused, 2nd of 2 COY whose mother was killed in self-defense by hunter.
201239		M	adult	09/23/2012	Spread Creek, GTNP	Known	Undetermined cause, carcass found near highway.
201240		M	adult	2012	WY	Known	Human-caused. UNDER INVESTIGATION.

Table 13. Continued.

Unique	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Certainty	Cause
201241		F	adult	2012	WY	Known	Human-caused. UNDER INVESTIGATION.
201242		Unk	COY	2012	WY	Known	Human-caused. UNDER INVESTIGATION.
201243		Unk	COY	2012	WY	Probable	Human-caused. UNDER INVESTIGATION.
201244	722	M	adult	10/09/2012	Roaring Fork, BTNF	Known	Human-caused, self-defense kill by hunters.
201245	434	M	adult	10/12/2012	Cartridge Creek, SNF	Known	Human-caused, self-defense kill by hunters.
201246	315	F	adult	10/20/2012	Pacific Creek, BTNF	Known	Human-caused, management removal for repeated property damage and obtaining multiple food rewards.
201247	G184	M	COY	10/02/2012	Mountain Creek, SNF	Probable	Natural, 1st of 3 COY not accompanying mother when she was removed. Mortality date and location are approximate.
201248	G185	M	COY	10/02/2012	Mountain Creek, SNF	Probable	Natural, 2nd of 3 COY not accompanying mother when she was removed. Mortality date and location are approximate.
201249	G186	M	COY	10/02/2012	Mountain Creek, SNF	Probable	Natural, 3rd of 3 COY not accompanying mother when she was removed. Mortality date and location are approximate.
201250		M	adult	2012	MT	Probable	Human-caused. UNDER INVESTIGATION.
201251		M	adult	2012	WY	Known	Human-caused. UNDER INVESTIGATION.
201252		Unk	COY	06/02/2012	Lamar River, YNP	Probable	Natural, COY of radio-collared female lost between 5/14 and 6/21. Mortality date and location are approximate.
201253		Unk	COY	06/02/2012	Flints Crk, GNF	Probable	Natural, 1st of 3 COY of radio-collared female lost between 5/13 and 6/22. Mortality date and location are approximate.
201254		Unk	COY	06/02/2012	Flints Creek, GNF	Probable	Natural, 2nd of 3 COY of radio-collared female lost between 5/13 and 6/22. Mortality date and location are approximate.
201255		Unk	COY	06/25/2012	Meadow Creek, GNF	Probable	Natural, 3rd of 3 COY of radio-collared female lost between 6/22 and 6/28. Mortality date and location are approximate.
201256		Unk	COY	08/04/2012	North Fork Rodent Creek, BTNF	Probable	Natural, COY of radio-collared female lost between 5/29 and 10/1. Mortality date and location are approximate.

[a] Number indicates bear number for marked bears; no number indicates an unmarked bear.
[b] Unk = Unknown sex
[c] COY = cub-of-the-year, Unk = unknown age
[d] BTNF = Bridger-Teton National Forest, BLM = Bureau of Land Management, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.

probable natural mortalities were COY losses, 9 of which were lost from radio-monitored females. The sole mortality from an undetermined cause was an adult male found dead near the highway in Grand Teton National Park (GTNP). Specific cause of death for this individual could not be determined due to scavenging of the carcass.

We evaluated mortality limits under 2 alternative protocols: (1) current count line and population estimate, and (2) proposed Demographic Monitoring Area with population segments estimated from updated 2002–2011 vital rates (IGBST 2012). Under the current protocols, 2 (both independent-aged males) of the known and probable 2012 mortalities occurred outside of the Conservation Management Boundary (Fig. 6). Among mortalities within the current count line, we documented 11 known and probable losses of independent-aged female bears, including 5 management removals, 3 losses of radio-instrumented bears, and 3 other reported losses (Table 14). We documented 8 management removals, 5 losses of radio-collared bears, and 5 reported losses of independent-aged male grizzly bears (Table 14). Human-caused losses of dependent young totaled 6 (Table 14). Using the criteria specified under the Revised Demographic Recovery Criteria (USFWS 2007*b*) and methods presented by IGBST (2005, 2006), only estimated total mortality for independent males exceeded the mortality limit for 2012. Mortality limits for independent-aged females and dependent young from human causes were not exceeded during 2012 (Table 14).

Nine (4 females, 5 males) of the known and probable mortalities documented during 2012 occurred outside the proposed Demographic Monitoring Area (Fig. 6). Under the proposed protocols of counting mortalities against thresholds only when they occur within the Demographic Monitoring Area, there were 2 sanctioned removals, 3 losses of radio-instrumented bears, and 3 reported losses for independent-aged females during 2012 (Table 14). For independent males we documented 5 sanctioned removals, 5 losses of radio-instrumented bears, and 8 reported losses (Table 14). Human-caused losses of dependent young remained the same as reported previously (n = 6, Table 14). Using the proposed count line and updated estimates for population segments and sustainable levels of independent female mortality described in IGBST (2012), none of the mortality thresholds for independent females, or males, or dependent young were exceeded in 2012 (Table 14).

One documented mortality from 2009 remains under investigation as are 6 from 2011. None of the mortalities documented during 2010 remain under investigation. Specific information pertaining to closed mortality investigations will be updated in the 2009, 2011, and 2012 Mortality Lists (http://www.nrmsc.usgs.gov/science/igbst/mort) as they become available. We remind readers that some cases can remain open and under investigation for extended periods. The study team cooperates with federal and state law enforcement agencies and will not release information that could compromise ongoing investigations.

Table 14. Annual size estimates ($\hat{N}$) for population segments and evaluation of mortality limits for known and probable mortalities documented during 2012 under current protocols, and under proposed changes using updated vital rates and the Demographic Monitoring Area. Current mortality thresholds (USFWS 2007*b*) are 9%, 9%, and 15% for dependent young, independent (≥2 years) females, and independent males, respectively, within the Conservation Management Area. Proposed changes are 7.6%, 7.6%, and 15% of the updated population estimates (i.e., based on updated vital rates derived using 2002–2011 data) for dependent young, independent females, and independent males, respectively, within the Demographic Monitoring Area. Only human-caused losses are counted against the mortality threshold for dependent young.

Protocol	Population segment	$\hat{N}$	Human-caused loss	Sanctioned removals (a)	Radiomarked loss (b)	Reported loss	Estimated[a] reported and unreported loss (c)	Estimated total mortality (a + b + c)	Annual mortality limit	Mortality threshold status
Current	Dependent young	190	6						17	Under
	Females 2+	257	8	5	3	3	7	15	23	Under
	Males 2+	163	18	8	5	8	21	34	24	Exceeded
Proposed	Dependent young	218	6						17	Under
	Females 2+	250	5	2	3	3	7	12	19	Under
	Males 2+	250	15	5	5	8	21	31	37	Under

[a] Method of estimating unknown, unreported mortality from Cherry et al. (2002).

Grizzly bear cub-of-the-year likely killed by wolves, 11 June 2012. Photo courtesy of Frank and James Szerdy.

Key Foods Monitoring

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

Ungulate carrion is a frequently used food of grizzly bears in the GYE (Mealey 1975, Green 1994, Mattson 1997). The number of ungulate carcasses available to scavengers during the spring is significantly correlated to measures of snow-water equivalency (depth, density, and moisture) in the snowpack (Podruzny et al. 2012). Competition with recently reintroduced wolves 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 YNP. In 2012, we surveyed 28 routes in ungulate winter ranges to monitor the relative abundance of spring ungulate carcasses (Fig. 7).

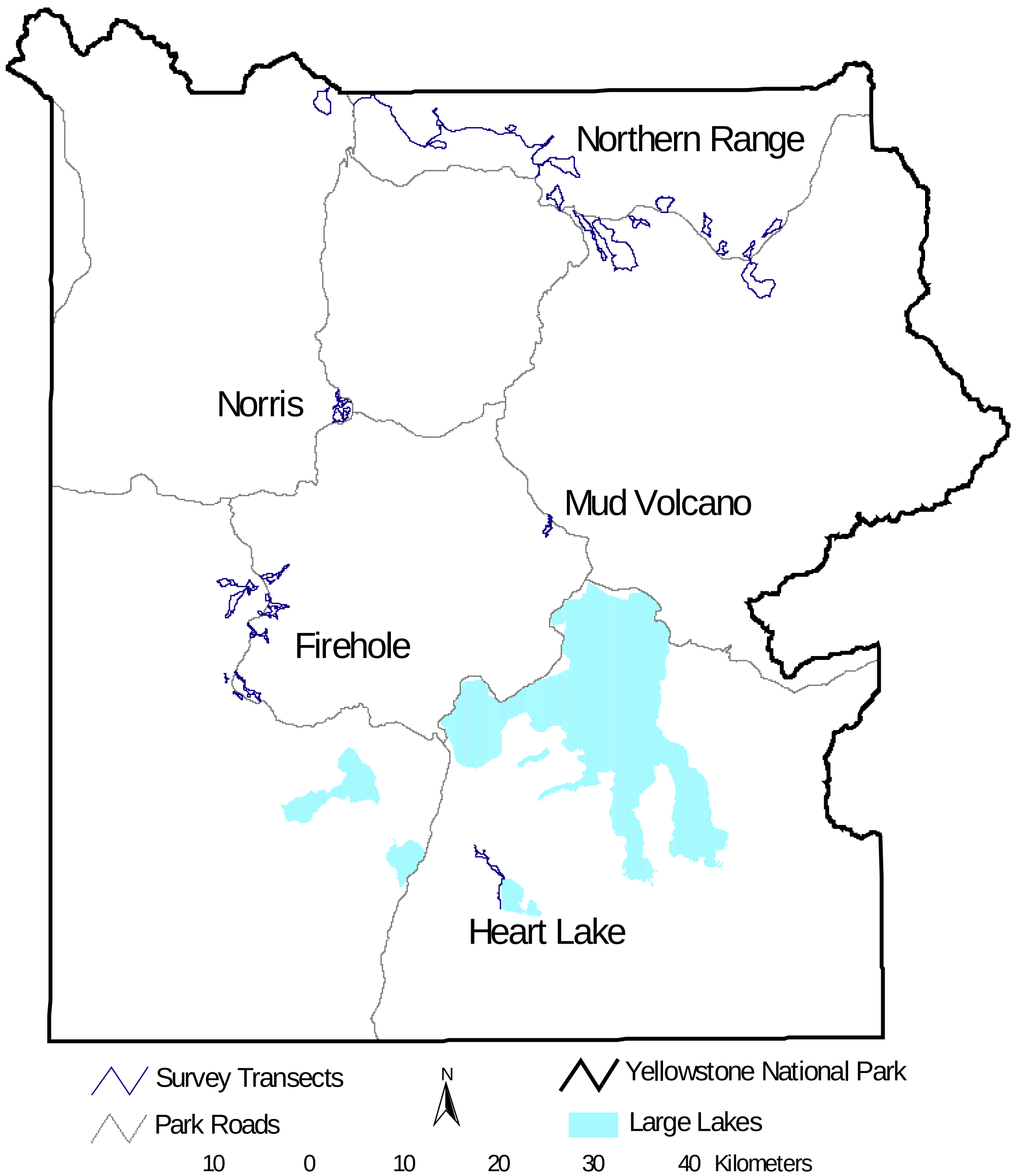


Fig. 7. Spring ungulate carcass survey transects in 5 ungulate winter ranges of Yellowstone National Park.

We surveyed each route once for carcasses between 10 April and 4 June. Since spring snow depths influence ungulate distribution and the area we can survey, we use a GPS to accurately measure the actual distance traveled on each route each year. 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 scavengers using the carcasses (i.e., species, percent of carcass consumed, scats present). We were unable to calculate the actual biomass consumed by bears, wolves, or other large scavengers with our survey methodology.

In 2012, we recorded 11 ungulate carcasses on 274.1 km of survey routes, for a total of 0.04 ungulate carcasses/km surveyed (Table 15). This rate was the lowest recorded for carcass availability since surveys began (Fig. 8).

Table 15. Ungulate carcasses found and visitation of carcasses by bears, wolves, and unknown large carnivores along surveyed routes in Yellowstone National Park during spring 2012.

	Elk				Bison				Bighorn sheep, pronghorn, and mule deer				
	Number of carcasses	# Visited by species			Number of carcasses	# Visited by species			Number of carcasses	# Visited by species			
Survey area (# routes)		Bear	Wolf	Unknown		Bear	Wolf	Unknown		Bear	Wolf	Unknown	Total carcasses/ km
Northern Range (11)	5	1	2	3	2	1	0	1	1[a]	0	0	1	0.05
Firehole (8)	0	0	0	0	3	2	2	1	0	0	0	0	0.04
Norris (4)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Heart Lake (3)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Mud Volcano (1)	0	0	0	0	0	0	0	0	0	0	0	0	0.00
Total all winter ranges	5	1	2	3	5	3	2	2	1	0	0	1[a]	0.04

[a] Adult bighorn sheep ram.

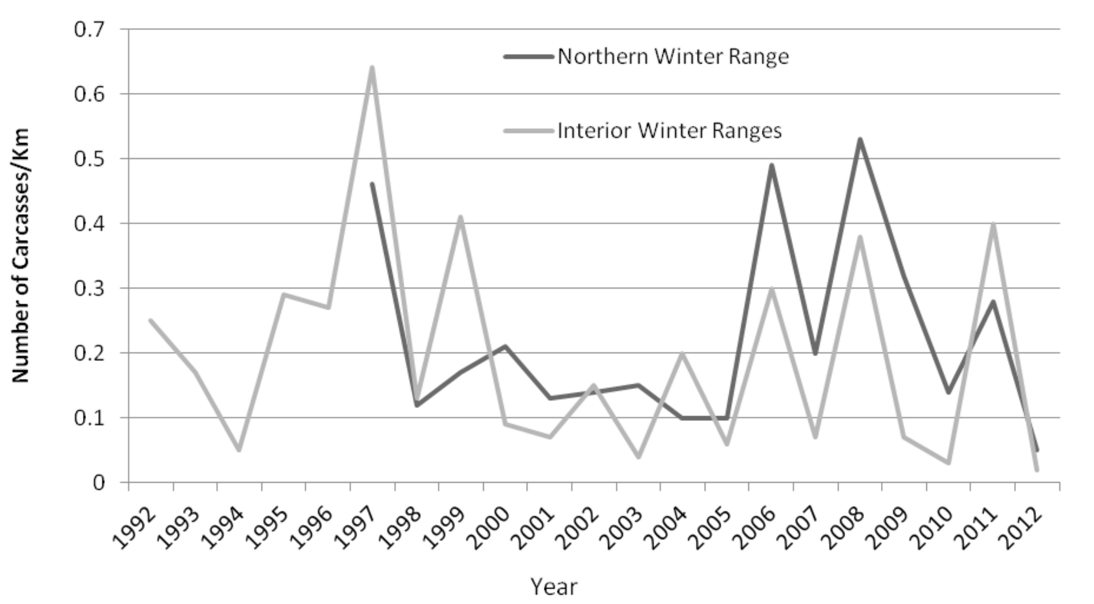


Fig. 8. Annual ungulate carcasses/km found on spring survey routes on the northern winter range and interior winter ranges of Yellowstone National Park, 1992–2012.

Northern Ungulate Winter Range

We surveyed 12 routes on Yellowstone's Northern Range totaling 151.4 km traveled. One route was not surveyed to avoid disturbing an active wolf den. We counted 8 carcasses, including 5 elk, 2 bison, and 1 bighorn sheep (*Ovis canadensis*), which equated to 0.05 ungulate carcasses/km of survey route (Table 15). Sex and age of carcasses found are shown in Table 16. All of the carcasses were 70–99% consumed by scavengers when we found them. One elk carcass had evidence of scavenging by a grizzly bear and 2 elk carcasses had evidence of consumption by wolves. One of the bison carcasses had been scavenged by a bear but the species of bear could not be determined. Grizzly bears or their sign (e.g., tracks, scats, daybeds, rub trees, or feeding activity) were observed along 9 of the 12 survey routes. We identified 7 bear feeding sites along the survey routes. Four primary feeding activities were identified at these locations: (1) digging pocket gopher (*Thomomys talpoides*) food caches, (2) digging up anthills for ants (Hymenoptera), (3) scavenging ungulate carcasses (elk and bison), and (4) geophagy digging sites (consuming geothermal soil).

Interior Winter Ranges

We surveyed a total of 122.4 km along 16 survey routes in 4 thermally-influenced interior ungulate winter ranges including the Firehole River area, Norris Geyser Basin, Heart Lake area (Witch Creek and Rustic Geyser Basin and associated thermal areas), and Mud Volcano area. We documented 3 carcasses for a total of 0.02 carcasses/km of survey route.

Firehole River Area

We surveyed 8 routes in the Firehole drainage in the central interior of the park covering 73.3 km. We found 3 bison carcasses (0.04 carcasses/km). Sex and age of carcasses found are shown in Table 16. All of the carcasses were 95–99% consumed by scavengers when we found them. Two of the bison carcasses had evidence of being scavenged by both grizzly bears and wolves. Grizzly bears or their sign (e.g., tracks, scats, daybeds, or feeding activity) were observed along 7 of the 8 survey routes. We identified 12 bear feeding sites along the survey routes. Four primary feeding activities were identified at these

Table 16. Age classes and sex of elk and bison carcasses found, by area, along surveyed routes in Yellowstone National Park during 2012.

	Elk (*n* = 5)						Bison (*n* = 5)					
	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total	Northern Range	Firehole	Norris	Heart Lake	Mud Volcano	Total
Age												
Adult	2	0	0	0	0	2	1	1	0	0	0	2
Yearling	2	0	0	0	0	2	0	2	0	0	0	2
Calf	0	0	0	0	0	0	0	0	0	0	0	0
Unknown	1	0	0	0	0	1	1	0	0	0	0	1
Sex												
Male	0	0	0	0	0	0	1	1	0	0	0	2
Female	1	0	0	0	0	1	0	0	0	0	0	0
Unknown	4	0	0	0	0	4	1	2	0	0	0	3

locations: (1) digging spring beauty (*Claytonia lanceolata*) bulbs, (2) scavenging bison carcasses, (3) ripping open logs for ants, and (4) geophagy digging sites.

Norris Geyser Basin

We surveyed 4 routes in the Norris Geyser Basin in the central interior of the park totaling 20.0 km traveled. We observed no carcasses on these survey routes. Grizzly bears or their sign (e.g., tracks, scats, daybeds, or feeding activity) were observed along 3 of the 4 survey routes. We identified 3 feeding sites where bears had dug earthworms (*Lumbricidae*) along the Norris Geyser Basin survey routes.

Heart Lake

We surveyed 3 routes in the Heart Lake thermal basin in the south central interior of the park covering 22.6 km. We observed no ungulate carcasses. Grizzly bear sign, including tracks and associated rub trees, daybeds, scats and feeding sites were observed on all 3 survey routes. One adult grizzly was visually observed digging earthworms. We identified 10 bear feeding sites along the survey routes. Three primary feeding activities were identified at these locations: (1) digging earthworms, (2) geophagy digging sites, and (3) grazing succulent clover (*Trifolium* spp.) and emerging graminoids.

Mud Volcano

We surveyed a single route in the Mud Volcano thermal area of the central interior of the park covering 6.5 km. We observed no ungulate carcasses. Grizzly bear sign, including tracks and associated daybeds, scats, and feeding sites were observed along the survey route. We identified 6 bear feeding sites along the survey route. Three primary feeding activities were observed at these locations: (1) geophagy digging sites, (2) digging spring beauty bulbs, and (3) digging pocket gopher food caches.

Discussion

The number of carcasses observed per km (0.05) of survey route on the northern ungulate winter range in 2012 was the lowest recorded since we began northern range carcass surveys in 1997. On thermally-influenced interior ungulate winter ranges, the number of carcasses observed per km (0.02) was also the lowest recorded since interior winter range surveys began in 1992. As an alternative to carcasses, grizzly bears consumed pocket gophers and their food caches consisting of roots, spring beauty bulbs, earthworms, ants, and emerging grasses, sedges (*Carex* spp.), and clover. In addition, bears consumed geothermal soil. Ingestion of geothermal soil may restore beneficial miroflora to the intestines after winter dormancy, remedy post-hibernation potassium deficiency, provide high levels of magnesium, or act as an anti-diarrheal during a period of high ungulate tissue consumption (Mattson et al. 1999).

Recording winter-killed carcass data. NPS photo.

Spawning Cutthroat Trout *(Kerry A. Gunther, Eric Reinertson, Todd M. Koel, and Patricia E. Bigelow, Yellowstone National Park)*

Spawning cutthroat trout were once commonly consumed by grizzly bears that had home ranges adjacent to Yellowstone Lake and its tributaries (Mealey 1975, Reinhart and Mattson 1990, Haroldson et al. 2005). In the 1970s and 1980s, grizzly bears were known to prey on cutthroat trout in at least 36 different tributary streams of the lake (Hoskins 1975, Reinhart and Mattson 1990). Haroldson et al. (2005) estimated that approximately 68 grizzly bears likely fished Yellowstone Lake tributary streams annually during the late 1990s. Bears also occasionally prey on cutthroat trout in other areas of the park, including the cutthroat trout (or cutthroat x rainbow trout [*Oncorhynchus mykiss*] hybrids) of the inlet creek to Trout Lake located in the northeast section of the park and in tributaries to the Gallatin River in the northwest section of the park.

Nonnative lake trout (*Salvelinus namaycush*), whirling disease caused by an exotic parasite (*Myxobolus cerebralis*), and drought have significantly reduced the native cutthroat trout population and associated bear fishing activity (Haroldson et al. 2005, Koel et al. 2005, 2006). In 1994, a small number of anglers reported catching lake trout in Yellowstone Lake (Koel et al. 2005). Lake trout are capable of rapid population increase (Curtis 1990) and have thrived in the Yellowstone Lake environment (Koel et al. 2005). Lake trout are not indigenous to Yellowstone Lake and their food habits are a significant threat to the native cutthroat trout population. Younger age classes of lake trout can compete with cutthroat trout for macroinvertebrates (Elrod 1983, Elrod and O'Gorman 1991). Adult lake trout are efficient predators that consume an estimated 41–59 cutthroat trout annually (Stapp and Hayward 2002, Ruzycki et al. 2003). In other areas where lake trout have been introduced, they have reduced or eliminated the native trout species (Martinez et al. 2009). Lake trout are not a suitable ecological substitute for cutthroat trout because they remain within the lake for all life stages and do not enter tributary streams to spawn, thus they cannot be preyed upon by grizzly bears. Whirling disease, discovered in Yellowstone Lake tributaries in 1998 (Koel et al. 2006), destroys head cartilage of young trout, resulting in loss of equilibrium, skeletal deformities, and inability to feed or avoid predators. Drought in the form of lower mountain snowfall has reduced stream flows, especially the amount of peak spring runoff. Without spring floods, wave and ice formed gravel bars at the mouths of smaller streams are not blown out, blocking spring access by spawning cutthroat trout and preventing fry from returning to the lake in the fall. The combined effect of all these factors has reduced the Yellowstone Lake cutthroat trout population by 90% (Koel et al. 2010*a*). Due to the past use of cutthroat trout as a food source by grizzly bears, and the cutthroat trout decline caused by lake trout, whirling disease, and drought, monitoring of the cutthroat trout population is a component of the bear foods and habitat monitoring program of the Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area (USFWS 2003). The cutthroat trout population is monitored through counts at a fish trap located on Clear Creek on the east-shore of Yellowstone Lake, and through visual stream surveys conducted along North Shore and West Thumb tributaries of the lake (USFWS 2003). Visual stream surveys are also conducted along the inlet to Trout Lake in the northeast section of the park.

New record large lake trout caught by the contract netters as part of the Lake Trout removal program. Photo courtesy of Hickey Brothers Fisheries, LLC.

Yellowstone Lake

Fish Trap Surveys--The number of spawning cutthroat trout migrating upstream are counted most years from a weir with a fish trap located at the mouth of Clear Creek on the east side of Yellowstone Lake (Fig. 9, Koel et al. 2005). 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 visually counting trout as they swim through wooden chutes attached to the trap. An electronic fish counter is also periodically used. In 2008, unusually high spring run-off damaged the Clear Creek weir and necessitated its removal. Due to removal of the weir, counts of the number of spawning cutthroat trout ascending Clear Creek have not been obtained since 2007. In the fall of 2012, the weir was removed, stream banks stabilized, and a suitable platform for an electronic sonar fish counter was installed. Installation and calibration of the sonar fish counter is scheduled for the summer 2013. It is anticipated that the sonar fish counter will be fully operational in the spring of 2014.

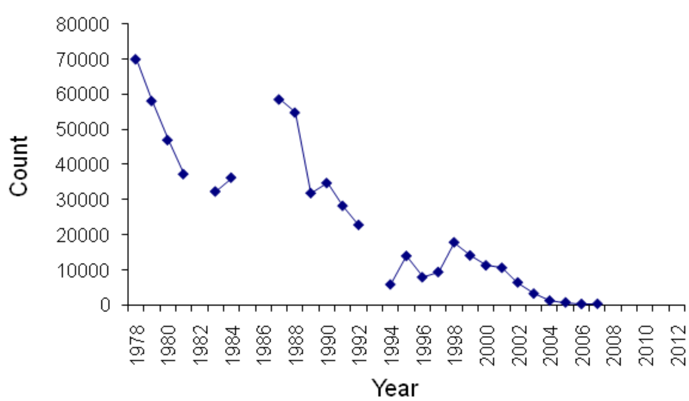


Fig. 9. Number of spawning cutthroat trout counted at the Clear Creek fish trap on the east shore of Yellowstone Lake, Yellowstone National Park, 1978–2012.

Visual Stream Surveys--Beginning 1 May most years, several streams including Lodge Creek, Hotel Creek, Hatchery Creek, Incinerator Creek, Wells Creek, Bridge Creek, Weasel Creek, and Sand Point Creek on the North Shore of Yellowstone Lake, and Sandy Creek, Sewer Creek, Little Thumb Creek, and unnamed creek #1167 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 from the stream mouth to the upstream extent that fish are observed 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 spawning season 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 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 in Yellowstone Lake tributaries.

Data collected in 2012 continued to show low numbers of spawning cutthroat trout in North Shore and West Thumb tributary streams (Table 17). In North Shore streams, only 20 spawning cutthroat trout were counted. Fifteen spawning trout were counted in Bridge Creek, 2 in Hatchery Creek, and 3 in Lodge Creek. No spawning cutthroat trout were observed in Incinerator Creek or Wells Creek. Hotel Creek, Weasel Creek, and Sand Point Creek were not surveyed in 2012. A partially consumed cutthroat trout was found along Bridge Creek on 17 June, no other evidence (fish parts, bear scats containing fish parts) of bear fishing activity was observed along any of the surveyed North Shore streams in 2012. On West Thumb streams, 154 spawning cutthroat trout were counted including 146 in Little Thumb Creek, 6 in Sandy Creek, and 2 in unnamed creek #1167. No spawning trout were observed in Sewer Creek. No evidence (fish parts, bear scats containing fish parts) of grizzly bear fishing activity was observed along any of the surveyed West Thumb streams in 2012. The number of spawning cutthroat trout counted in the North Shore and West Thumb streams has decreased significantly since 1989 (Fig. 10).

Trout Lake

Visual 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 (including cutthroat x rainbow trout hybrids). Once spawning trout are detected (i.e., onset of spawning), weekly surveys of adult trout in the inlet

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, 2012.

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	05/23/12	05/29/12	7	2	3	1.5
Hotel Creek			Not surveyed			
Hatchery Creek	05/23/12	05/23/12	1	1	2	2.0
Incinerator Creek			No spawn			
Wells Creek			No spawn			
Bridge Creek	05/09/12	05/23/12	15	3	15	5.0
Weasel Creek			Not surveyed			
Sand Point Creek			Not surveyed			
West Thumb Streams						
1167 Creek	05/14/12	05/14/12	1	1	2	2.0
Sandy Creek	05/14/12	05/21/12	8	2	6	3.0
Sewer Creek			No spawn	No spawn		
Little Thumb Creek	05/24/12	06/11/12	19	4	146	36.5
Total (Yellowstone Lake)				13	174	13.4
Northern Range Stream						
Trout Lake Inlet	06/12/12	07/17/12	36	6	434	72.3

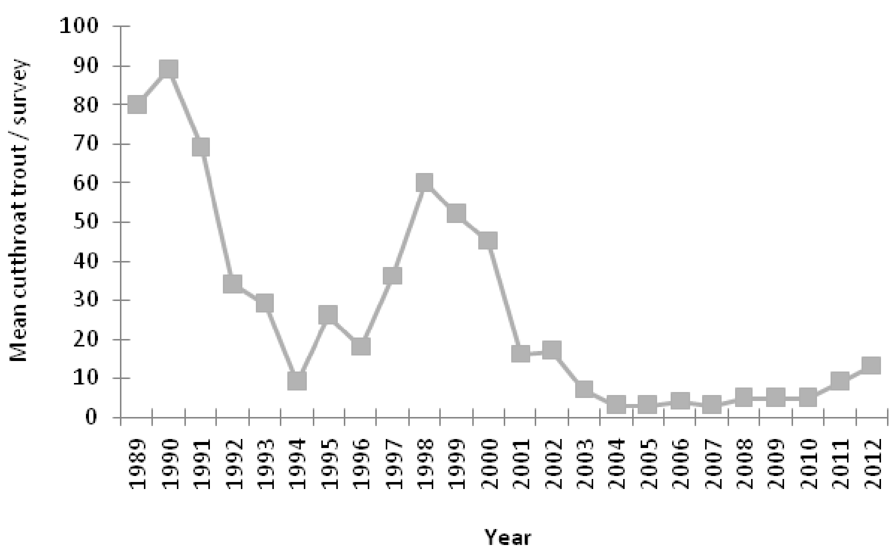


Fig. 10. Mean number of spawning cutthroat trout observed during weekly visual surveys of 8 North Shore and 4 West Thumb spawning streams tributary to Yellowstone Lake, Yellowstone National Park, 1989–2012.

creek are conducted. On each sample day, 2 people walk from the stream mouth to the upstream extent that fish are observed and record the number of adult trout observed. Sampling continues 1 day/week until 2 consecutive weeks when no trout are observed in the creek and all trout have returned to Trout Lake (i.e., end of spawn). The length of the spawning season 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 counted by the number of surveys conducted during the spawning season.

In 2012, the first movement of spawning trout from Trout Lake into the inlet creek was observed on 12 June. The spawn lasted approximately 36 days with the last spawning trout being observed in the inlet creek on 17 July. During the once per week visual surveys, 434 spawning cutthroat trout (and/or cutthroat trout x rainbow trout hybrids) were counted, an average of 72 per visit during the spawning season (Table 17). The number of fish observed per survey has ranged from a low of 31 in 2004 to a high of 306 in 2010 (Fig. 11). No grizzly bears or black bears, bear sign, or evidence of bear fishing activity was confirmed along the lake or inlet creek during the surveys in 2012.

Cutthroat Trout Outlook--As part of management efforts to protect the native cutthroat trout population, park fisheries biologists and private-sector (contracted) netters caught and removed 301,966 lake trout from Yellowstone Lake in 2012 (Koel et al. in press). Population modeling suggests that recent increased effort may have halted lake trout population growth and continued catch at these rates may begin reducing the population. A Native Fish Conservation Plan/Environmental Assessment was completed in 2011 (Koel et al. 2010*b*; NPS 2011). The plan outlines a program for significantly increasing lake trout suppression through increased use of private sector contract netters using both gill nets and large deep-water trap-nets. Population models suggest that the heightened removal over a period of at least 5 years will drive the lake trout population into decline (Syslo et al. 2011), reducing their predatory effects on the native cutthroat trout population and possibly restoring trout as a significant food item for grizzly bears with home ranges encompassing the Yellowstone Lake basin.

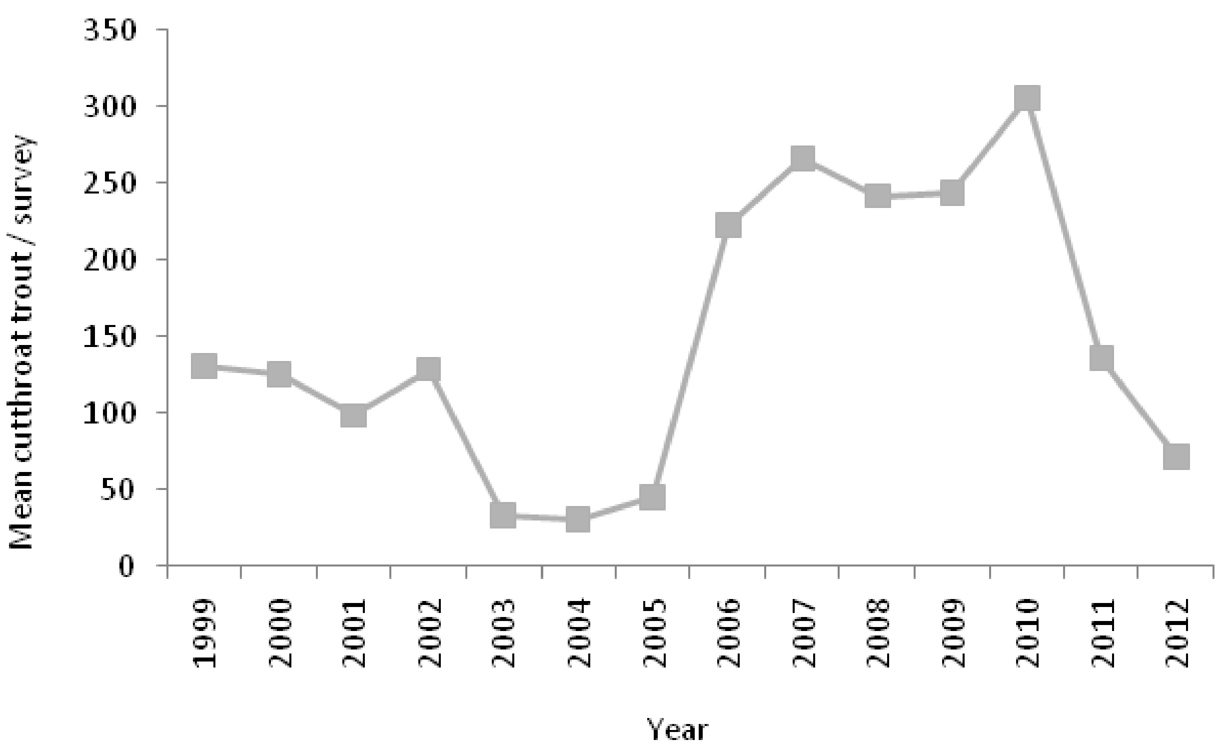


Fig. 11. Mean number of spawning cutthroat (including cutthroat x rainbow trout hybrids) observed during weekly visual spawning surveys of the Trout Lake inlet creek, Yellowstone National Park, 1999–2012.

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

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

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

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

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

In 2012, there was 1 observation of a grizzly bear actively feeding on a previously unknown insect aggregation site. This site was classified as a possible site and will be monitored for future use. Adding the new possible site to the 2011 sites produced 37 confirmed sites and 17 possible sites for 2012.

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. 12). For example, 1993–1995 were probably poor moth years because the percentage of confirmed sites used by bears (Fig. 12) and the

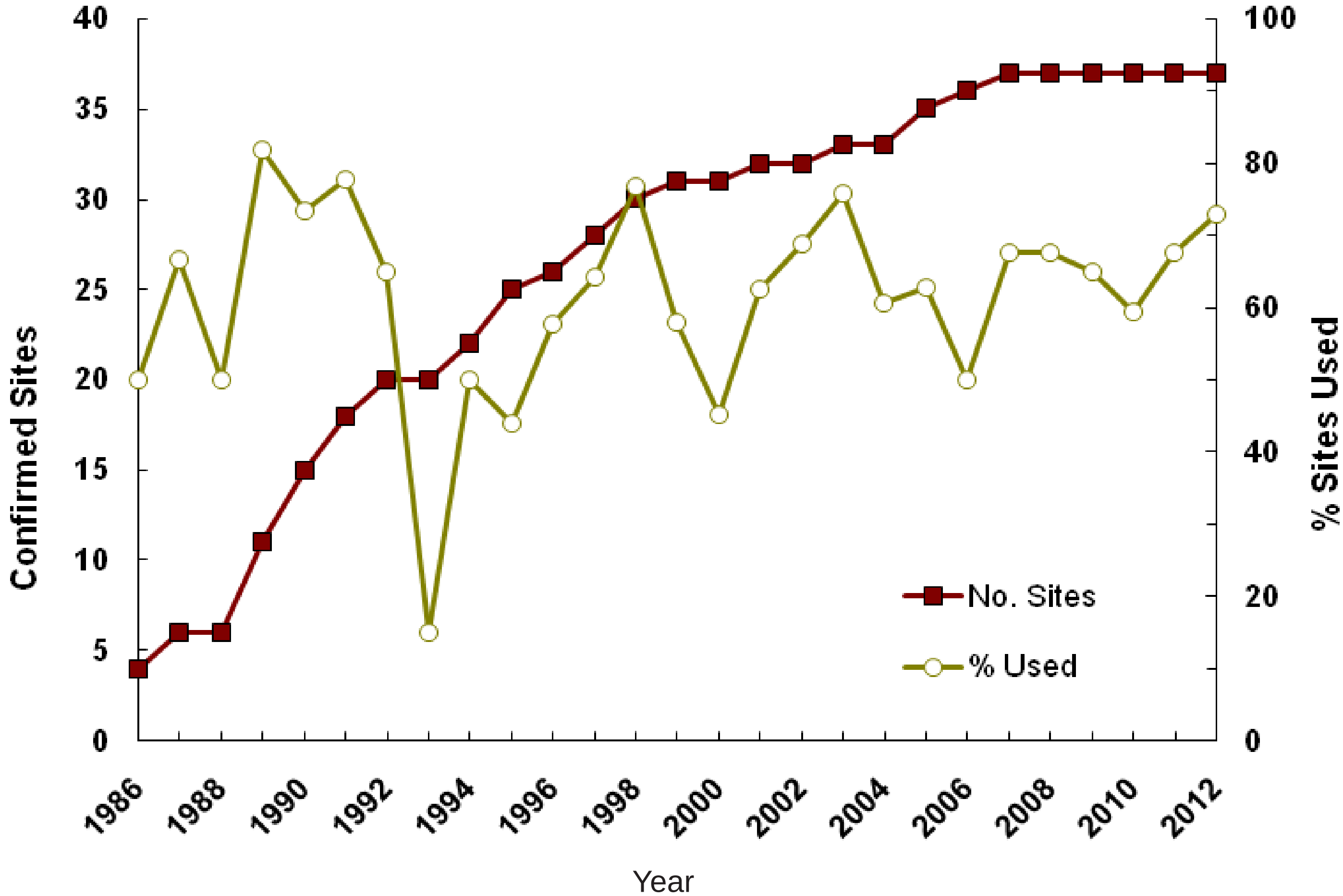


Fig. 12. Annual number of confirmed insect aggregation sites and percent of those sites at which either telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986–2012.

number of observations recorded at insect sites (Table 18) were low. In 2012, the percentage of insect aggregation sites used by grizzly bears increased by 5% from the previous year (Fig. 12). However, 2012 was a record year for the number of grizzly bear observations or telemetry relocations at sites; more than double the 2007–2012 mean of 198.2 (Table 18). The number of insect aggregation sites used by bears in 2012 increased by 2 sites to 27 (Table 18) and was greater than the 5-year mean of 24.2 sites/year from 2007–2011.

The IGBST maintains an annual list of unduplicated females observed with COY (see Table 5). Since 1986, 907 initial sightings of unduplicated females with COY have been recorded, of which 242 (26.7%) have occurred at (within 500 m, n = 226) or near (within 1,500 m, n = 16) insect aggregation sites (Table 19). In 2012, 13 of the 49 (26.5%) initial sightings of unduplicated females with COY were observed at insect aggregation sites, higher than the 17.9% from 2011 (Table 19) and the 5-year mean of 21.8% from 2007–2011.

Survey flights at insect aggregation sites contribute to the count of unduplicated females with COY; however, it is typically low, with a mean of 11.9 initial sightings/year since 2003 (Table 19). If these sightings are excluded, a similar trend in the annual number of unduplicated sightings of females with COY is still evident (Fig. 13), suggesting that other factors besides observation effort at insect aggregation sites are responsible for the increase in sightings of females with cubs.

Table 18. Number of confirmed insect aggregation sites in the Greater Yellowstone Ecosystem annually, number used by bears, and the number of aerial telemetry relocations and ground or aerial observations of bears recorded at sites during 1986–2012.

Year	Number of confirmed moth sites[a]	Number of sites used[b]	Number of aerial telemetry relocations	Number of ground or aerial observations
1986	4	2	5	5
1987	6	4	7	8
1988	6	3	12	29
1989	11	9	11	42
1990	15	11	8	76
1991	18	14	12	166
1992	20	13	6	100
1993	20	3	1	2
1994	22	11	1	28
1995	25	11	7	37
1996	26	15	21	66
1997	28	18	18	79
1998	30	23	11	176
1999	31	18	25	156
2000	31	14	42	89
2001	32	20	25	122
2002	32	22	36	240
2003	33	25	10	161
2004	33	20	2	131
2005	35	22	15	183
2006	36	18	18	179
2007	37	25	15	174
2008	37	25	23	221
2009	37	24	9	177
2010	37	22	4	162
2011	37	25	9	197
2012	37	27	22	385
Total			375	3,391

[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 $\geq$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, 1986–2012.

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	8	12	50.0	14	58.3
1992	25	5	7	28.0	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	7	7	21.2	7	21.2
1997	31	8	11	35.5	11	35.5
1998	35	10	13	37.1	13	37.1
1999	33	3	6	18.2	7	21.2
2000	37	6	8	21.6	10	27.0
2001	42	6	12	28.6	13	31.0
2002	52	11	17	32.7	17	32.7
2003	38	11	19	50.0	20	52.6
2004	49	11	16	32.7	16	32.7
2005	31	5	7	22.6	9	29.0
2006	47	11	14	29.8	15	31.9
2007	50	10	17	34.0	17	34.0
2008	44	7	11	25.0	14	31.8
2009	42	4	6	14.3	6	14.3
2010	51	7	9	17.6	9	17.6
2011	39	7	7	17.9	7	17.9
2012	49	7	13	26.5	13	26.5
Total	907		226		242	
Mean	33.6	5.7	8.4	22.6	9.0	24.6

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

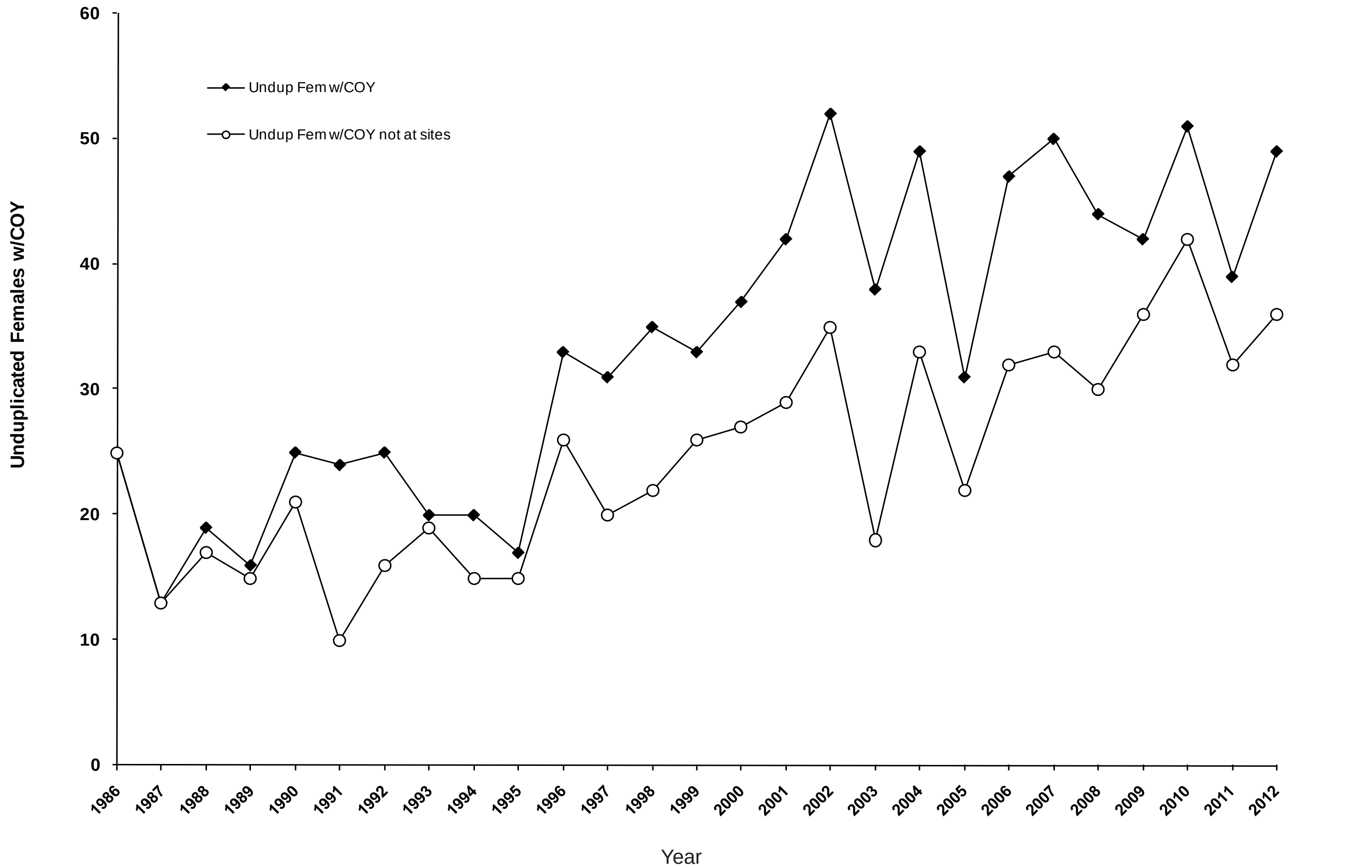


Fig. 13. The total number of unduplicated females with cubs-of-the-year (COY) observed annually in the Greater Yellowstone Ecosystem and the number of unduplicated females with COY not found within 1,500 m of known insect aggregation sites, 1986–2012.

Grizzly bear on moth site, 2 Aug 2012. IGBST photo.

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

Whitebark pine surveys on established transects indicated good cone production during 2012 (Fig. 14). Twenty-one transects were read. Overall, mean number of cones/tree was 33.0 (Table 20). Whereas cone production on most transects was good (Table 21), once again we observed better cone production (57.7 vs. 21.3 mean cones/tree, *Student's* $t = -4.830$, $P < 0.001$) on transects surveyed since 2007 (CSA–CAG, Fig. 14 and Table 21) that tend to be located on the periphery of the GYE and outside the Recovery Zone. Differences in mean cones/tree between the 7 transects established in 2007 and older transects were also evident in 2009, 2010, and 2011; while no differences were observed in 2007 and 2008. Cone production among extant trees has been above average during the last 2 consecutive years (Fig. 15).

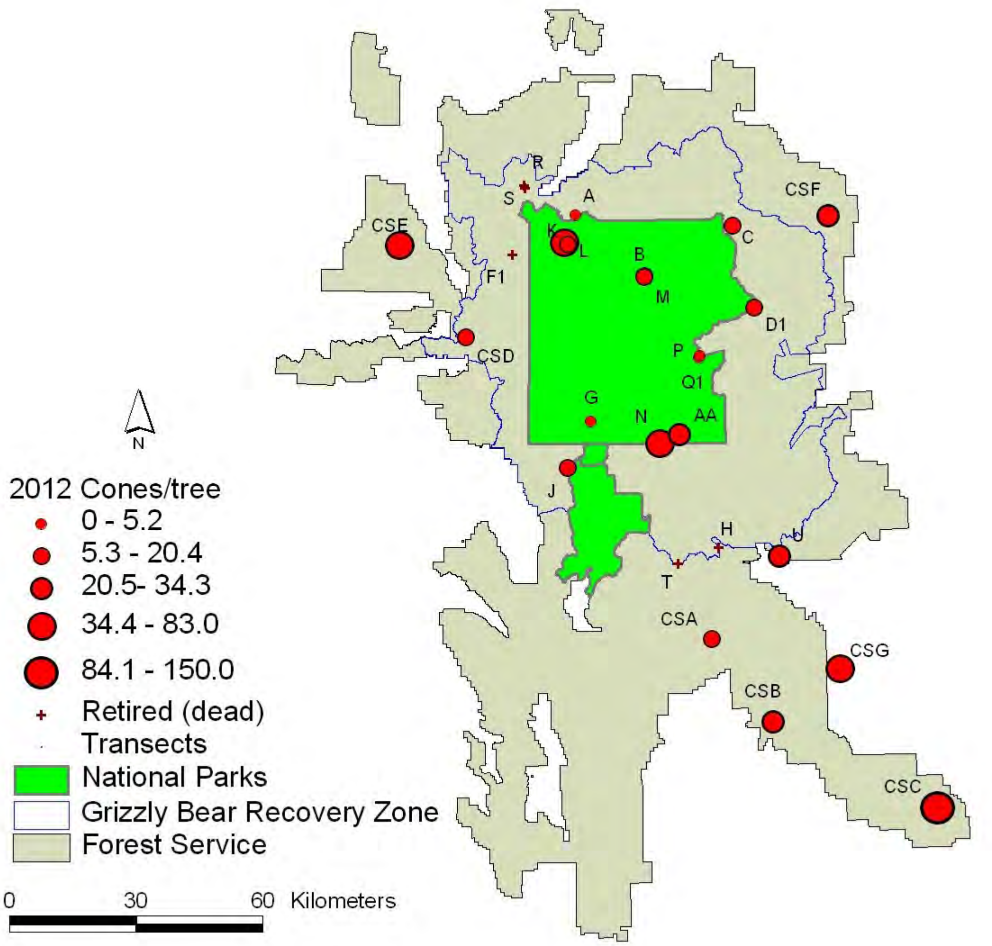


Fig. 14. Locations and mean number of cones/tree for 26 whitebark pine cone production transects surveyed in the Greater Yellowstone Ecosystem during 2012.

Table 20. Summary statistics for whitebark pine cone production transects surveyed during 2012 in the Greater Yellowstone Ecosystem.

Total			Trees				Transect			
Cones	Trees	Transects	Mean cones	SD	Min	Max	Mean cones	SD	Min	Max
5,879	178	21	33.0	48.8	0	335	279.9	349.9	25	1,497

Table 21. Whitebark pine cone production transect results for 2012.

Transect	# Cones	# Trees	Mean	SD
A	31	6	5.2	9.8
B	166	10	16.6	13.4
C	105	8	13.1	9.0
D1	60	5	12.0	7.7
F1	Retired in 2008			
G	52	10	5.2	8.7
H	Retired in 2008			
J	115	10	11.5	10.6
K	489	9	54.3	30.5
L	174	10	17.4	12.2
M	129	10	12.9	8.7
N	768	10	76.8	48.7
P	37	10	3.7	4.2
Q1	41	10	4.1	5.9
R	Retired in 2009			
S	Retired in 2010			
T	Retired in 2008			
U	25	1	25.0	
AA	343	10	34.3	19.8
CSA	92	9	10.2	12.2
CSB	305	10	30.5	39.8
CSC	1,497	10	149.7	100.5
CSD	184	9	20.4	17.0
CSE	238	3	79.3	77.6
CSF	198	8	24.8	19.2
CSG	830	10	83.0	37.8

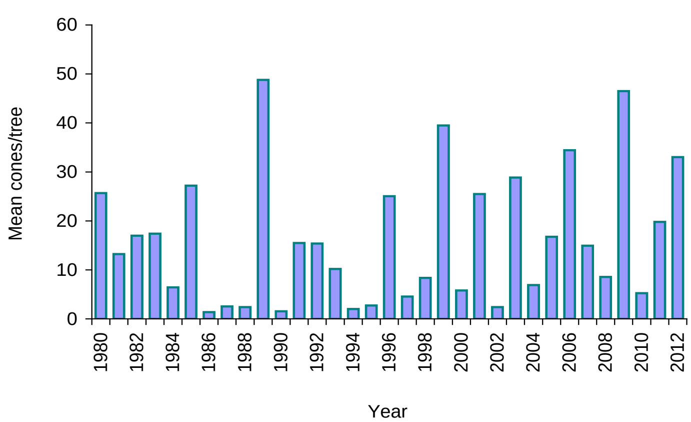


Fig. 15. Annual mean number of cones/tree on whitebark pine cone production transects surveyed in the Greater Yellowstone Ecosystem during 1980–2012.

We continue to observe mountain pine beetle-caused tree mortality in stands that contain our cone production transects. In 2012, we observed only 1 additional beetle-caused mortality among individual trees surveyed since 2002. Total mortality on these transect trees surveyed since 2002 is now at 73.2% (139 of 190 trees) with 94.7% (18/19) of transects exhibiting beetle-killed trees. Although tree mortality from mountain pine beetle is still occurring, it appears the rate of loss has slowed (Fig. 16). In addition, 6 (85.7%) of the 7 transects established during 2007 now also exhibit beetle-caused mortality among transect trees.

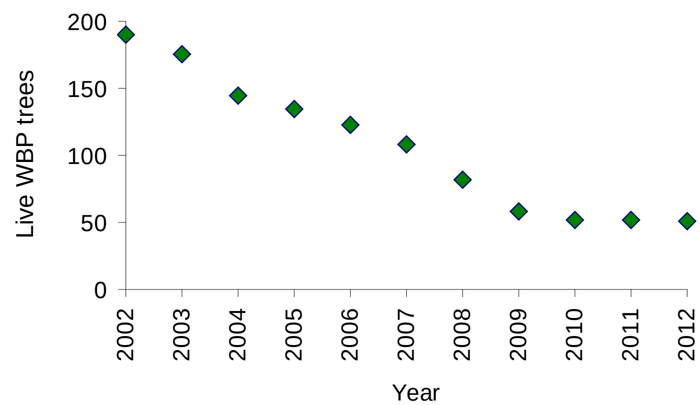


Fig. 16. Number of live whitebark pine (WBP) trees on cone production transects among 190 individual tress monitored since 2002.

Historically, near exclusive use of whitebark pine seeds by grizzly bears has been associated with falls in which mean cone production on transects exceeded 20 cones/tree (Blanchard 1990, Mattson et al. 1992). Typically, numbers of grizzly bear-human conflicts and management actions tend to increase during years with poor cone availability. Extensive areas of beetle-killed whitebark pine likely exacerbate this effect by reducing cone availability even when mean cones/tree is high on extant trees. Preliminary results of efforts to document the health of whitebark pine forests across the GYE are presented in Appendix B of this report. In 2011, we initiated a pilot project to examine use of mountain pine beetle-impacted whitebark pine habitats by adult female grizzly bears. Preliminary results from 2012 indicate that the 3 grizzly bears monitored made limited use of whitebark pine cones in an area heavily impacted by mountain pine beetle (see “Use of Diminished Whitebark Pine Resources by Adult Female Grizzly Bears in Togwotee Pass, Spread Creek, and Mount Leidy in the Bridger-Teton National Forest, Wyoming, 2012”).

Use of Diminished Whitebark Pine Resources by Adult Female Grizzly Bears in Togwotee Pass, Spread Creek, and Mount Leidy in the Bridger-Teton National Forest, Wyoming, 2012 *(Kyle Orozco and Nick Miles, Interagency Grizzly Bear Study Team)*

The importance of whitebark pine as a food source for Yellowstone grizzly bears is well documented (Kendall 1983, Mattson et al. 1991*a*, Mattson et al. 1992, Felicetti et al. 2003, Schwartz et al. 2006*c*). The Yellowstone population was delisted from the federal Threatened Species List in 2007, but that decision was overturned by a district court judge in 2009 partially on the grounds that the USFWS had not adequately addressed potential future impacts to bears by changes in whitebark pine availability resulting from rapid, widespread whitebark pine mortality that began in the early 2000s.

Several recent evaluations document the decline of whitebark pine in the GYE. Interpretation of 2007 satellite imagery by the U.S. Department of Agriculture (USDA) Remote Sensing Applications Center indicated over 40% of whitebark pine stands in the GYE contained some level of canopy mortality (Goetz et al. 2009). Aerial surveys by the USDA Forest Health Protection program found beetle activity in more than 50% of whitebark pine stands in the GYE in 2008. Aerial photo evaluation at a sub-watershed level documented the spatial extent and severity of whitebark pine damage from mountain pine beetle outbreaks across the entire GYE (Macfarlane et al. 2010). Data from that project indicates that over 50% of whitebark pine stands in the GYE have suffered high to complete mortality of overstory trees and 95% of forest stands containing whitebark pine have measurable mountain pine beetle activity (Macfarlane et al. 2010). White pine blister rust (*Cronartium ribicola*), a fungus introduced from Eurasia, is widespread and continuing to increase in incidence and severity; GYE-wide infection rates range from 20 to 81% (Bockino 2008, Bockino and McCloskey 2010, GYWPMWG 2010, Jean et al. 2011). In the northern Rocky Mountains, mortality is as high as 90% (Gibson et al. 2008) and the Interior Columbia Basin whitebark pine populations have declined by at least 45% (Kendall and Keane 2001).

Previous studies provide some perspective on the degree to which grizzly bears in the GYE use whitebark pine seeds. During 1977–1987, scats from bears in the population centered on YNP consisted of 39% whitebark pine seeds on average for the month of September (typically the peak of whitebark pine feeding activity, Mattson et al. 1991*a*). The 1977–1987 period represented the typical range of cone production. Female grizzly bears captured in GTNP in 2004–2006 had <10% digestibility-corrected volume of whitebark pine in their scats (IGBST, unpublished data). Volume of whitebark pine in scats from male grizzly bears was >40%. Mountain pine beetle impacts in that area were light to moderate.

In the fall of 2012, we conducted a study to examine how grizzly bears are currently using whitebark pine in an area of the GYE that had been heavily impacted by mountain pine beetles (Fig. 17). We deployed 3 downloadable GPS collars on adult female grizzly bears. We documented habitat use by on-site examinations of those bear locations, and food habits through analysis of fecal samples collected at visited sites during autumn.

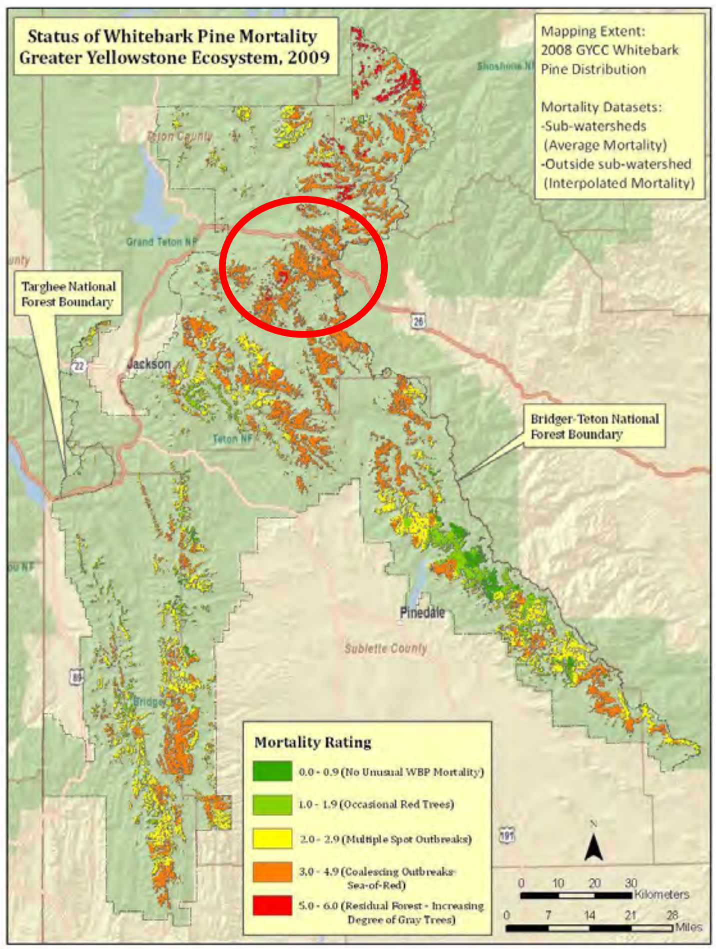


Fig. 17. Map showing status of whitebark pine mortality in the southeastern portion of the Greater Yellowstone Ecosystem. Togwotee Pass, Mount Leidy, and Spread Creek areas circled (From Macfarlane et al. 2010).

Methods

Once a week, we remotely downloaded location data from transmitters via fixed-wing aircraft. We conducted site visits of GPS telemetry locations to determine habitat selection and foraging patterns. Each week, we randomly selected a day from the week's download of each bear. For each bear-day, we visited most GPS locations collected for that 24-hour period. Our goal was to discern the foraging patterns of each sampled bear over a 24-hour time period.

At each visited location, we performed a detailed search for evidence of bear feeding activity and feces within approximately 20 m of the GPS location. Depending upon the evidence of bear use found, we collected 2 different levels of data to describe bear activity and relevant information about the vegetation on site. For all plots, we collected basic site description information (level 1) and recorded types of feeding activities found. If evidence of feeding was found, we collected more detailed information on species used (level 2). Scats found at each site were collected and frozen.

Laboratory analysis of scat contents followed the procedures of Mealey (1980). Fecal samples were first air-dried then rehydrated and rinsed through coarse (0.125 in^2) and fine (0.0328 in^2) soil sieves. Any loss of small seeds was noted during the rinsing process. Rinsed samples were placed in a white enamel pan with water to disperse items. Individual items were identified to the finest possible taxonomic level, and estimated percent composition of each item recorded. Diet items were grouped into categories following Mattson et al. (1991*a*). Because consumed items vary in digestibility and may be over- or underrepresented in scat volumes, we used the correction factors recommended by Hewitt and Robbins (1996) to estimate percent digestible dry matter for each group of items in the scats.

Results

In spring of 2012, WYGF deployed 3 SST collars on 2 adult and 1 subadult female grizzly bears around Togwotee Pass, Mount Leidy, and Spread Creek, in the Bridger-Teton National Forest. A field crew visited 283 locations of the collars between 4 September and 7 October. The sample represented a combined number of 15 bear-days. One hundred ten (38.9%) sites were located within approximately 20 m of a daybed, with 20 daybeds recorded. One hundred forty-two (50%) sites were within approximately 20 m of a scat, with 41 scats collected. Of the locations visited, 127 (44.9%) sites had evidence of feeding activity (Table 22). Four major feeding activities were identified at these locations:

1. Carcasses – large ungulate carcasses (elk, deer, bison) from predation or scavenging.
2. Roots – primarily licorice root (*Osmorhiza berteroi*) dug directly by bears.
3. Whitebark pine – squirrel middens excavated to obtain cones.
4. Insects – excavations of deadfall logs or anthills for insects.

Table 22. Feeding activities at 283 Global Positioning System locations of 2 female grizzly bears, Bridger-Teton National Forest, September–October 2012.

	As a % of	
Feeding activity	all 283 sites visited	127 sites with feeding activity
Ungulates (*n* = 111)	39.2%	87.4%
Roots (*n* = 9)	3.2%	7.8%
Whitebark pine (*n* = 4)	1.4%	3.2%
Insects (*n* = 3)	1.1%	2.4%

Whitebark pine seed feeding was documented at 4 sites, or 3.1% of all feeding activity observed. All of these observations were from the month of September, with the earliest sign of whitebark pine feeding on 4 September. Combined, our 3 collared bears had a total of 111 locations on carcasses, representing 87.4% of all feeding activity. Root feeding was documented at 9 sites, or 7.1% of all feeding activity, and insect feeding was found at 3 sites or 2.4% of feeding activity (Table 22).

Whitebark pine constituted 8.1% of the dry digestible matter in collected scats, but were present in 9.8% of scats. Forbs were the most common item found (63.4%) in scats, however they only a made up 5.6% of dry digestible material. Ungulates occurred in 46.3% of scats and made up 54.2% of dry digestible material. Roots made up the second highest percent of digestible material (9.8%). Other items found in scats include grasses, berries, and insects (Table 23).

Table 23. Food items in 41 scats of 3 female grizzly bears, Bridger-Teton National Forest, September–October 2012. Percent volume of dry digestible material was calculated using procedures and correction factors of Hewitt and Robbins (1996).

Food item	% volume[a]	% occurrence
Roots	9.8%	34.2%
Grasses and sedges	3.8%	61.0%
Forbs	5.6%	63.4%
Berries	0.8%	9.8%
Insects	2.9%	24.4%
Ungulates	54.2%	46.3%
Whitebark pine seeds	8.1%	9.8%

[a] Percent volumes of dry digestible material do not add up to 100% because the amount of dirt and debris found in scats was excluded from calculations.

Discussion

Whitebark pine cone production in 2012 was very good, with an average of 33 cones/live tree on established transects throughout the GYE (Haroldson and Podruzny 2012). The mapping effort in 2009 (Macfarlane et al. 2010) shows that the Bridger-Teton National Forest has experienced high whitebark pine mortality on nearly 100,000 hectares, and categorizes the severity of mortality around Mount Leidy and Togwotee Pass as extreme.

The heavy overstory mortality was evident in our feeding data, with only 4 sites (3.1%) showing evidence of whitebark pine seed feeding. In our forested study plots, between 5 and 10 trees were measured for diameter at breast height (DBH) and recorded for status: either live or dead. On Togwotee Pass, 28 whitebark pine trees were measured. Of these 28 trees, 5 (18%) were alive and 23 (82%) were dead. On Mount Leidy, a total of 75 whitebark pine trees were observed. We observed 11 (15%) live and 64 (85%) dead whitebark pine. Spread Creek had the fewest number of whitebark pine due to that areas low elevation; 7 whitebark pine were observed with only 1 live tree, or a mortality of 86%. Total mortality for all measured whitebark pine in the area for this study was 84.5% (93/110). This is higher than the mortality of 73.2% seen in established plots throughout the GYE since 2002 (Haroldson and Podruzny 2012). The higher rate of mortality in our study area could explain the low use of whitebark pine seeds we observed in our bears. Furthermore, the average DBH for live whitebark pine was 21.8 cm whereas the average DBH for dead whitebark pine was 34.6 cm, confirming data from other studies that beetles targeted and killed larger, more mature trees that produce the most cones.

Over 87% of feeding activity was recorded at carcass sites (Table 22). The 3 bears visited a total of 12 confirmed carcasses during the 15 bear days we visited. The carcasses included 6 hunter-killed elk, 3 mule deer, 1 bison, and 2 domestic horses. The majority of the study area is open for archery hunting in early September and rifle hunting at the end of September/early October, which explains why our bears targeted gut piles and wounding loss during this time. We found that ungulates constituted 54.2% of dry digestible material, whereas whitebark pine only made up 8.1% of dry digestible material (Table 23). Given the low levels of whitebark pine feeding and high frequency of carcass feeding, it seems that hunter-killed elk and deer provided an alternative food source for bears during fall in these areas with high whitebark pine mortality.

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

In 2012, total visitation in GTNP was 3,918,416 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 2,705,255. Backcountry user nights totaled 30,214. Long- and short-term trends of recreational visitation and backcountry user nights are shown in Table 24 and Fig. 18.

Table 24. Average annual visitation and average annual backcountry use nights in Grand Teton National Park by decade from 1951 through 2009, and the most recent 10-year average.

Decade	Average annual parkwide visitation[a]	Average annual backcountry use nights
1950s	1,104,357	Data not available
1960s	2,326,584	Data not available
1970s	3,357,718	25,267
1980s	2,659,852	23,420
1990s	2,662,940	20,663
2000s	2,497,847	30,049
2003–2012	2,520,269	29,176

[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.

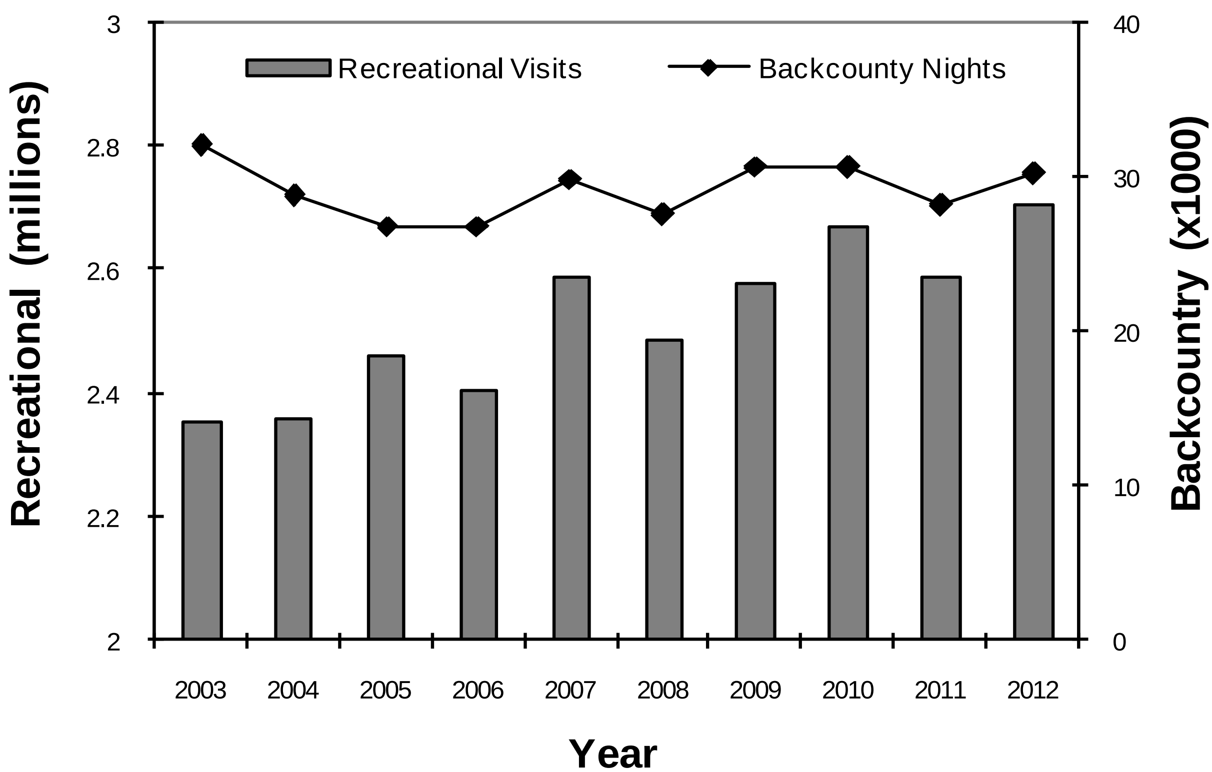


Fig. 18. Trends in recreational visitation and backcountry user nights in Grand Teton National Park during 2003–2012 (data available at https://irma.nps.gov/Stats).

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

Total visitation to YNP was 4,459,573 people in 2012 (https://irma.nps.gov/Stats) including recreational and nonrecreational (e.g., traveling through the Park on U.S. Highway 191 but not recreating) use. Recreational visits in 2012 totaled 3,447,729 the sixth straight year that recreational visitation has topped the 3 million mark. Most of YNP's visitation occurs during the 6-month period from May through October. In 2012, there were 3,313,376 recreational visitors (96%) during those peak months, an average of 18,007 recreational visitors/day. In 2012, visitors spent 697,613 user nights camping in developed area roadside campgrounds, and 40,397 user nights camping in backcountry campsites in Yellowstone Park.

Average annual recreational visitation had increased each decade from an average of 7,378 visitors/year during the late 1890s to 3,012,653 visitors/year in the 1990s (Table 25, Fig. 19). Average annual recreational visitation decreased slightly during 2000–2009, to an average of 2,968,037 visitors/year. The decade 2000–2009 was the first in the history of the park that visitation did not increase from the previous decade. However, the decade beginning in 2010 is on pace to set a new park record for visitation. The last 3 years (2010–2012) have been the highest 3 years of recreational visitation ever recorded. Although total park recreational visitation has increased steadily over time, the average number of user nights in roadside campgrounds in the park has remained relatively stable since the 1960s (Table 25, Fig. 20). The number of campground user nights is limited by the number and capacity of roadside campgrounds in the park. The average annual number of backcountry user nights have also been relatively stable ranging from 39,280 to 45,615 user nights/year (Table 25, Fig. 21). The number of backcountry user nights is limited by both the number and capacity of designated backcountry campsites in the park.

Table 25. Average annual visitation, auto campground user nights, and backcountry user nights in Yellowstone National Park by decade from 1895 through 2012.

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	2,968,037	624,450	40,362
2010s	3,494,080[g]	678,719[g]	40,855[g]
1990s	3,012,653	647,083	43,605
2000s	2,967,718	624,450	40,362
2010s	3,517,253[g]	669,273[g]	41,084[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 1972–1979.
[g] Data for 2010–2012.

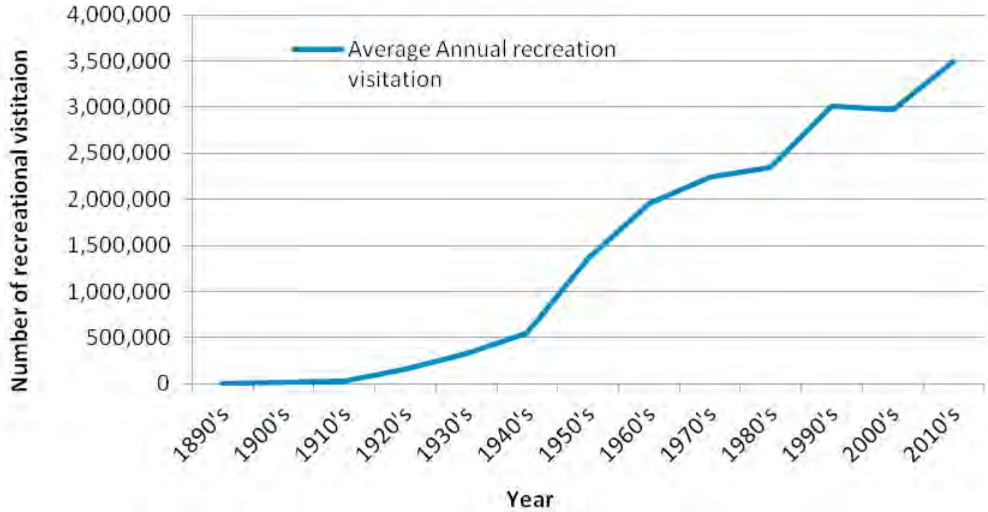


Fig. 19. Trends in recreational visitation in Yellowstone National Park, 1895–2012.

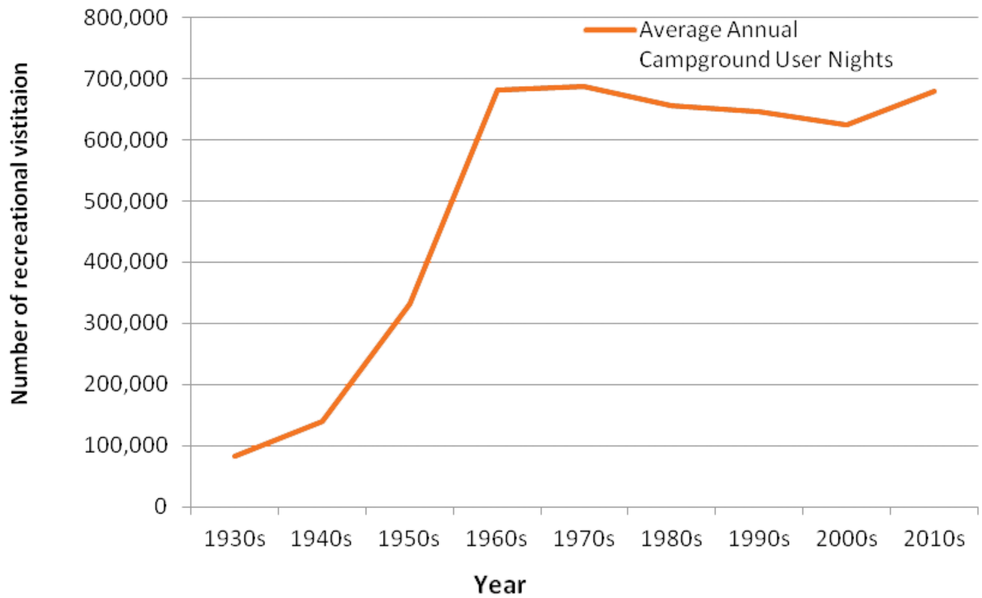


Fig. 20. Trends in roadside campground user nights in Yellowstone National Park, 1930–2012.

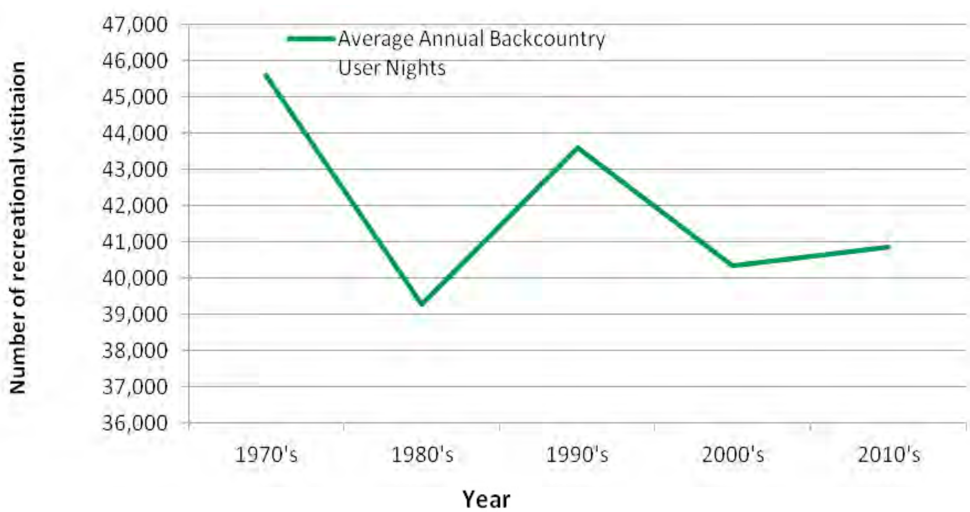


Fig 21. Trends in overnight backcountry recreational user nights in Yellowstone National Park, 1972–2012.

Trends in Elk Hunter Numbers within the Grizzly Bear Recovery Zone Plus the 10-Mile Perimeter Area *(Daniel Bjornlie, Wyoming Game and Fish Department; Kevin Frey, Montana Fish, Wildlife and Parks; and Daryl Meints, Idaho Department of Fish and Game)*

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

We generated data from all states for 2002–2012 (Table 26). There has been a consistent downward trend in hunter numbers in Idaho, Montana, and Wyoming since 2002, when hunter numbers peaked at 34,879 (Fig. 22). Hunter numbers in Idaho appear to have stabilized around 1,800–1,900 since they peaked at 3,619 in 2005. Hunter numbers in Wyoming peaked at 13,709 in 2002 and since that time have decreased to approximately 6,500–7,500 in recent years. Montana has experienced the largest decrease in hunter numbers since 2002. Hunter numbers in Montana declined from 17,908 in 2002 to fewer than 11,000 in 2012. Both Montana and Wyoming began to decrease the harvest of female elk in many hunt areas in or near the Recovery Zone in the mid 2000s as some elk herds approached their population objectives. However, in 2012 Wyoming increased the number of licenses for female elk in some hunt areas near Meeteetse and Dubois, resulting in an overall increase in hunters for that state (Table 26). Idaho reduced harvest objectives for females in 2008, which accounts for the decrease in hunter numbers in 2008 through 2012.

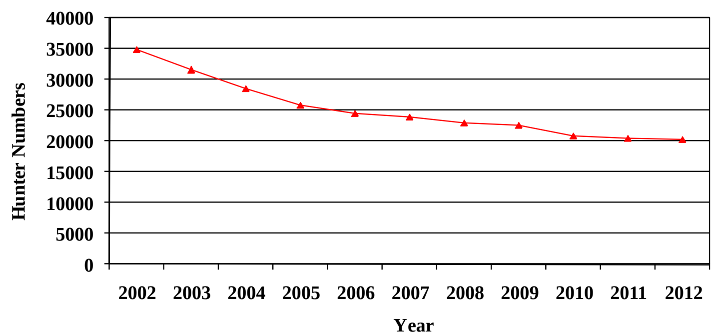


Fig. 22. Trend in elk hunter numbers within the Recovery Zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, 2002–2012.

Table 26. Estimated numbers of elk hunters within the Recovery Zone plus a 10-mile perimeter in Idaho, Montana, and Wyoming, for the years 2002–2012.

	Year										
State	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Idaho	3,262	3,285	3,454	3,619	3,016	2,592	1,763	1,819	1,904	1,860	1,803
Montana	17,908	16,489	14,320	12,365	12,211	12,635	12,470	12,382	12,334	12,269	10,936
Wyoming	13,709	11,771	10,828	9,888	9,346	8,716	8,792	8,440	6,712	6,413	7,566
Total	34,879	31,545	28,602	25,872	24,573	23,943	23,025	22,641	20,950	20,542	20,305

Grizzly Bear-Human Conflicts in the Greater Yellowstone Ecosystem

Grizzly Bear-Human Conflicts in Grand Teton National Park (*Kate Wilmot and Steve Cain, Grand Teton National Park)*

No management actions were taken on grizzly bears in GTNP in 2012. However, 2 human-bear conflicts and 1 human-caused bear mortality were recorded.

On 27 May 2012, a yearling grizzly bear was allegedly fed by occupants in a car and received a food reward in the Colter Bay developed area. On 22 November 2012, an unmarked adult male grizzly bear was shot and killed in self-defense during the park's elk reduction program. The bear charged a group of 3 hunters at close range and 2 discharged their weapons when the bear was approximately 10 ft away, killing the bear instantly. A cached cow elk carcass was discovered approximately 50 ft away (IGBST Mortality Number 201251). A human-caused bear mortality occurred on 21 June 2012, when a yearling male grizzly bear was hit and killed by a vehicle on Highway 89/191, approximately 1 mile north of Schwabacher Landing (IGBST Mortality Number 201215).

An additional mortality was documented on 1 October 2012, when a visitor found a dead adult male grizzly bear along Highway 89/191, approximately 1/5 mile south of the Moosehead Ranch entrance in GTNP. The cause of mortality is unknown; however, the location (125 ft from the highway) suggests the possibility of trauma from a vehicle strike (IGBST Mortality Number 201239).

In 2007 the park established the "Wildlife Brigade," a corps of paid and volunteer staff to manage congested roadside wildlife jams, promote ethical wildlife viewing, patrol developed areas to secure bear attractants, and disseminate bear information and education material throughout the park. The 2012 Wildlife Brigade was comprised of 1 permanent supervisory park ranger, 2 seasonal park rangers, 12 volunteers, and 1 Greater Yellowstone Coalition intern. Volunteers and interns contributed over 4,460 hours toward this important bear conservation and public education program.

We responded to at least 287 bear jams (170 grizzly, 105 black, 12 species not recorded) in 2012. Bear jams occur when habituated, nonfood conditioned bears frequent roadsides and the outskirts of other developments and draw crowds of onlookers. The Wildlife Brigade managed most of these jams, in addition to enforcing food storage at campgrounds, picnic areas, and other developments. Grizzly bear jams peaked in May and tapered significantly in August. Black bear jams occurred at nearly constant rates throughout July, August, and September.

New in 2012 were daily bear spray presentations hosted by park staff, primarily interpretive rangers. These programs highlighted proper safety behavior in bear country and concluded with a physical demonstration using inert bear spray. The program was well received with approximately 2,905 visitors attending.

GTNP continued its partnership with the Grand Teton National Park Foundation in 2012 to cost-share expenses for the purchase and installation of bear-resistant food storage lockers. One-hundred four boxes were purchased in 2012. A total of 378 new bear boxes have been purchased since 2008. Three of the 6 front-country campgrounds in GTNP now have 1 box at each site (Jenny Lake, Lizard Creek, and Signal Mountain campgrounds).

Finally, building on results from previous research done in GTNP by the Wyoming Survey and Analysis Center and Master's student Ariel Blotkamp, GTNP contracted marketing professor Dr. Graham Austin from Montana State University to evaluate our bear safety message from a marketing and advertising perspective. Dr. Austin (Austin et al. 2013) focused their research on the following questions: (1) Is there too much variation in the bear safety message posted by federal and state agencies? (2) Does variation result in diluting or confusing the message rendering the message less effective? (3) Would a clear and concise message with standardized signs be more effective in disseminating bear safety messages? They concentrated field work in GTNP and YNP and briefly examined bear safety messaging found in surrounding National Forests. They concluded that "The messages throughout the ecosystem should *not* be identical - branding is most effective when it is context-specific and salient for the intended audience. Thus, various stakeholders in the GYE (federal and state agencies) can maintain autonomy regarding bear safety messaging in their jurisdictions, while promoting an effective (i.e., cohesive and persuasive) message for outdoor enthusiasts, regardless of whether they are hunters in their local forests, or international tourists visiting the National Parks." They (Austin et al. 2013) also provided several suggestions as to how agencies can improve their marketing strategies.

***Grizzly Bear-Human Conflicts in Yellowstone National Park** (Kerry A. Gunther, Travis Wyman, and Eric Reinertson, Yellowstone National Park)*

Yellowstone National Park is located in the approximate center of the designated Yellowstone Grizzly Bear Recovery Zone (USFWS 1993). Conservation of grizzly bears in YNP and the GYE requires providing secure habitat (Schwartz et al. 2003) and keeping human-caused bear mortality at sustainable levels (IGBST 2005). Most human-caused grizzly bear mortalities are directly related to grizzly bear-human conflicts (Gunther et al. 2004*a*). Grizzly bear-human conflicts may also erode public support for grizzly bear conservation. The foundation of YNP's strategy for preventing human-caused bear mortalities is to reduce conflicts by preventing bears from obtaining anthropogenic foods. This is accomplished through education programs for park visitors, use of bear-proof food and garbage storage facilities, and strict enforcement of bear-related food and garbage storage regulations. Major components of YNP's Bear Management Program include:

- Educating park visitors about the causes of bear-human conflicts and how park visitors can modify their behavior to prevent conflicts from occurring. Educational efforts are made both before and after park visitors arrive in the park.
- All garbage cans and dumpsters are of a bear-resistant design.
- Food storage devices (food hanging poles or bear-proof boxes) are provided in all designated backcountry campsites. Backcountry users not staying in backcountry campsites are required to store their food and garbage in a bear-proof manner through the use of bear-proof backpacking canisters or rigging their own food hanging system.
- Regulations that require all anthropogenic foods, garbage, and other attractants to be stored in a bear-proof manner are strictly enforced.
- Regulations prohibiting park visitors from feeding bears are strictly enforced.
- Developed areas and roadside auto campgrounds are frequently patrolled to ensure compliance with food and garbage storage regulations. All anthropogenic bear attractants left unattended in auto campgrounds are confiscated.
- To effectively allocate resources for implementing management actions designed to prevent grizzly bear-human conflicts, park managers need baseline information for the types, causes, locations, and recent trends of conflict incidents. To address this need, all grizzly bear-human conflicts reported in YNP are recorded annually. Conflicts are grouped into 6 broad categories using standard definitions (Gunther et al. 2012).

Generally, the frequency of grizzly bear-human conflicts is inversely associated with the abundance of natural bear foods (Gunther et al. 2004*a*). When native bear foods are abundant, there tend to be few grizzly bear-human conflicts involving property damage and anthropogenic foods. When native bear foods are scarce, incidents of grizzly bears damaging property and obtaining anthropogenic foods increase, especially during late summer and fall when bears are hyperphagic (Gunther et al. 2004*a*).

In 2012, the availability of high-quality, concentrated bear foods in YNP was poor during the spring and estrus seasons, average during early hyperphagia, and good during late hyperphagia. During spring, winter-killed ungulate carcasses were scarce on the Northern Ungulate Winter Range and in thermally-influenced ungulate winter ranges in the interior of the park (see "Spring Ungulate Availability and Use by Grizzly Bears in Yellowstone National Park"). During spring, sign of grizzly bears grazing succulent emerging grasses, sedges, and clover, digging up pocket gopher caches, earthworms, and spring beauty bulbs, and foraging for mound and log dwelling ant species were encountered while conducting fieldwork. Evidence of grizzly bear consumption of geothermal soils (geophagy, Mattson et al. 1999) was also observed during spring. During estrus, there were very few spawning cutthroat trout observed in monitored tributary streams of Yellowstone Lake (see "Spawning Cutthroat Trout"). However, predation on newborn elk calves was common during the estrus season. During early-hyperphagia, many grizzly bears were observed at high-elevation army cutworm moth aggregation sites east of the park boundary (see "Grizzly Bear Use of Insect Aggregation Sites Documented from Aerial Telemetry and Observations"). During late hyperphagia, whitebark pine seed production was good throughout YNP and the GYE (see "Whitebark

Pine Cone Production") and most bear scats encountered contained primarily whitebark pine seed remains.

There were 3 grizzly bear-human conflicts reported in YNP in 2012 (Table 27, Fig. 23). This was among the lowest grizzly-human conflict years reported in YNP in recent times (Fig. 24). In all 3 of the conflict incidents, grizzly bears damaged property but did not obtain anthropogenic foods. There were no incidents where bears attacked people in YNP in 2012. All of the grizzly bear-human conflicts that occurred inside YNP were on public land inside of the Grizzly Bear Recovery Zone boundary (USFWS 1993). The 3 conflicts were widely dispersed and no geographic concentrations of conflicts were evident (Fig. 23). The number of different types of grizzly bear-human conflicts in 2012 were similar to the long-term averages recorded from 1990–2011 (Table 28).

Due to the low number of conflicts, no grizzly bears were captured and relocated or removed in YNP in 2012. However, considerable management effort was dedicated toward preventing conflicts from occurring. As part of the park's strategy for preventing bears from obtaining human foods, 92 bear-proof food storage boxes were purchased and installed in roadside campgrounds. Four of the parks 11 campgrounds, including the Pebble Creek, Slough Creek, Tower Falls, and Indian Creek Campgrounds, now have a food storage box at 100% of their campsites. In an effort to prevent the need to capture and relocate or remove bears, grizzly bears were hazed out of human use areas 21 times. Grizzly bears were hazed out of developments 13 times, off of primary roads 7 times, and off of high-use trails 1 time.

Although there were few conflicts in YNP, management of nonfood conditioned, human-habituated bears required considerable management effort. Habituation is the waning of a bear's response to humans (McCullough 1982, Jope 1985, Herrero et al. 2005, Hopkins et al. 2010). Habituation is adaptive and reduces energy costs by reducing irrelevant behavior (McCullough 1982, Smith et al.

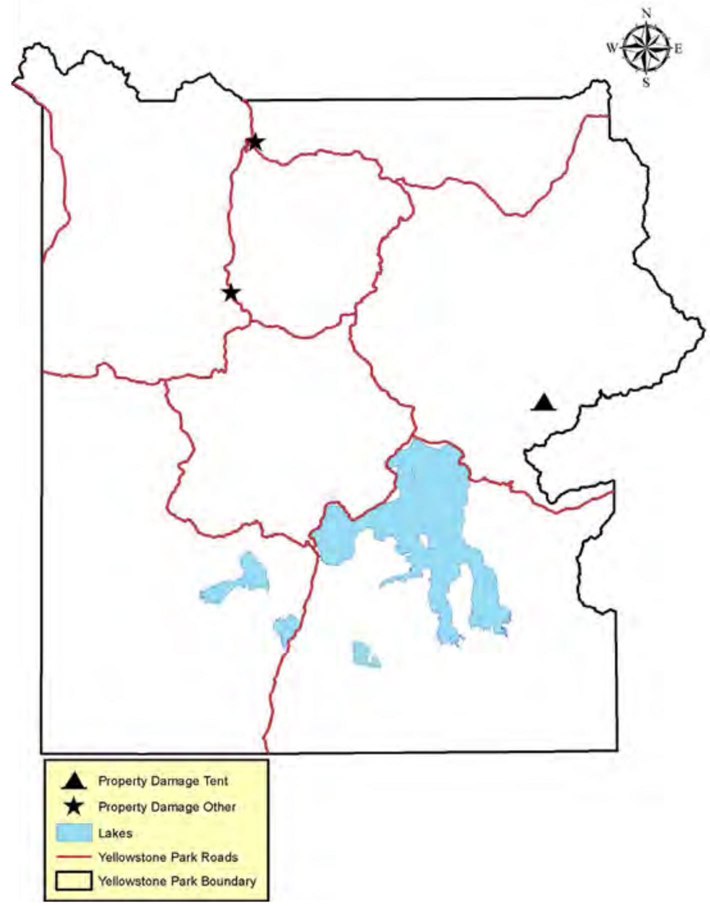


Fig. 23. Locations of grizzly bear-human conflicts in Yellowstone National Park in 2012.

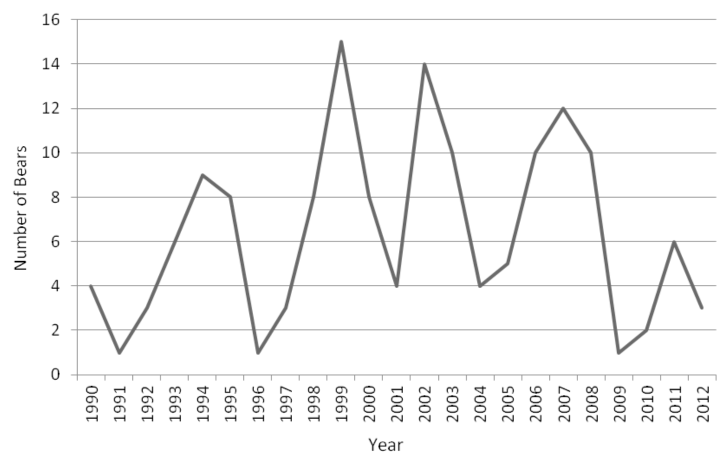


Fig. 24. Number of incidents of grizzly bear-human conflict in Yellowstone National Park, 1990–2012.

Table 27. Number of grizzly bear-human conflicts reported in Yellowstone National Park, 2012.

Land owner	Property damage/ no food reward	Property damage/ with food reward	Human injury	Gardens/ orchards	Beehives	Livestock depredations	Total conflicts
Yellowstone National Park	3	0	0	0	0	0	3

Table 28. Comparison between the average annual number of grizzly bear-human conflicts recorded from 1990–2011 and the number reported in 2012, in Yellowstone National Park.

Type of conflict	1990–2011 Average ± SD	2012
Human injury	1.0 ± 1.1	0
Property damage	2.7 ± 2.8	3
Anthropogenic foods	2.0 ± 1.9	0
Gardens/orchards	0.7 ± 1.3	0
Beehives	0 ± 0	0
Livestock depredations	0 ± 0	0
Total conflicts	6.4 ± 4.2	3

2005), such as fleeing from park visitors that are not a threat. Habituation allows bears to access and utilize habitat in areas with high levels of human activity, thereby increasing habitat effectiveness (Gunther and Biel 1999, Herrero et al. 2005). Habituation is most likely to occur in national parks where human-caused mortality is low, and exposure to humans is frequent and predictable and does not result in negative consequences. Bears will readily habituate to people, human activities, roads, vehicles, and buildings. In 2012, 279 roadside traffic-jams caused by visitors viewing habituated grizzly bears along roadsides were reported in YNP. Park staff responded to 241 (86%) of the grizzly jams and spent over 751 personnel hours managing habituated bears, the traffic associated with bear-jams, and the visitors that stopped to view and photograph habituated bears. On average, park staff spent 3.1 hours managing each grizzly bear jam.

Foraging activity by habituated grizzly bears in road-side meadows increases during the fall of years when whitebark pine cone production is poor (Haroldson and Gunther 2013). This suggests that food resources found in roadside meadows may be alternative for bears during periods of whitebark pine cone shortages (Haroldson and Gunther 2013). White pine blister rust, mountain pine beetle, and changing climate have the potential to reduce the abundance of whitebark pine in the Yellowstone region (Schwandt 2006). If whitebark pine is reduced in YNP, the annual number of fall bear-jams may increase (Haroldson and Gunther 2013). Park managers should take this into consideration when planning future bear management strategies. The safety of park visitors that view habituated bears along roadsides, as well as the safety of those bears, is a legitimate concern for YNP managers (Herrero et al. 2005). To be successful, alternatives for managing habituated bears that feed in roadside meadows need to consider the energetic needs and nutritional state of these bears (Robbins et al. 2004) and their contribution to GYE population viability (Gunther et al. 2004*b*, Herrero et al. 2005), along with human safety and the value of bear viewing to the public.

Grizzly Bear-Human Conflicts in Idaho *(Bryan Aber, Idaho Department of Fish and Game)*

Idaho Department of Fish and Game investigated 22 grizzly bear-human conflicts during 2012. Conflicts are incidents where grizzly bears injure people, damage property, obtain anthropogenic foods, kill or injure livestock, damage beehives, or obtain vegetables or fruit from gardens and orchards (Gunther et al. 2000). These conflicts vary from a single bear involved in a single incident to bears involved in multiple incidents before the conflict can be resolved. In Idaho, variation occurs annually in the number and location of conflicts, influenced by natural food abundance, livestock use patterns, availability of unsecured anthropogenic foods, and an expanding population (both geographic and numbers) of both grizzly bears and humans.

One archery elk hunter was injured in Idaho in 2012 (Table 29). This incident was the result of 2 hunters surprising a day-bedded grizzly bear while trying to blood-trail a wounded elk. The elk carcass was not in the vicinity of the incident. Two other hunting incidents occurred during archery season but did not result in injuries. Grizzly bears frequenting developed areas (e.g., subdivisions, landfill) were the most common conflict type in 2012. The electric fence at the Island Park landfill failed and allowed a female with 2 young and a single female grizzly to access the landfill for 7 nights. Livestock-related conflicts were the second most prevalent with 7 cattle losses on one Forest Service allotment in July and 2 on another allotment in August. One swine and 2 chickens were lost to a bear in April on private land in Teton Valley. Bears in developed areas are often trying to obtain anthropogenic foods. Public education and a cost share program for bear-resistant garbage storage containers have reduced the number of bears obtaining human foods.

There has been a general increasing trend in number of conflicts in the Idaho portion of the GYE since 2002 (Fig. 25). This trend would be expected with the overall increase in bear numbers and distribution that has occurred in Idaho in recent years.

During 2012, there were 2 known and probable grizzly bear mortalities in Idaho. The known mortality was a management removal of a young bear that caused multiple conflicts on private land. The probable mortality was a carcass found in mid-summer on the Caribou-Targhee National Forest. Due to the condition of the remains (bones, old hair) it was impossible to definitively determine cause of death or even species. DNA samples were taken from the carcass and analysis is ongoing.

Climatic conditions in the Idaho portion of the GYE varied substantially in 2012. We started the season with a wet and cold spring and late frost that affected many berry-producing shrubs when they were in bloom. In July we moved into hot drought conditions until fall. This caused a failure in most of the berry crops in mid- to high-elevation areas and an early curing of other vegetative foods. We documented increased grizzly bear use of carcass remains from archery hunter wounding loss and offal.

Table 29. Number of grizzly bear-human conflicts by conflict type in Idaho, Greater Yellowstone Ecosystem, 2012.

Conflict type	Number	Land ownership
Human injury	1	Caribou-Targhee National Forest
Aggression towards humans	2	Caribou-Targhee National Forest
Livestock – cattle	9	Caribou-Targhee National Forest
Livestock – poultry	2[a]	Private
Livestock – swine	1[a]	Private
Anthropogenic foods	10[a]	Private (9), Bureau of Land Management (1)
Beehives	2[a]	Private

[a] Totals more than 22 because of multiple conflict types by same bear in same night.

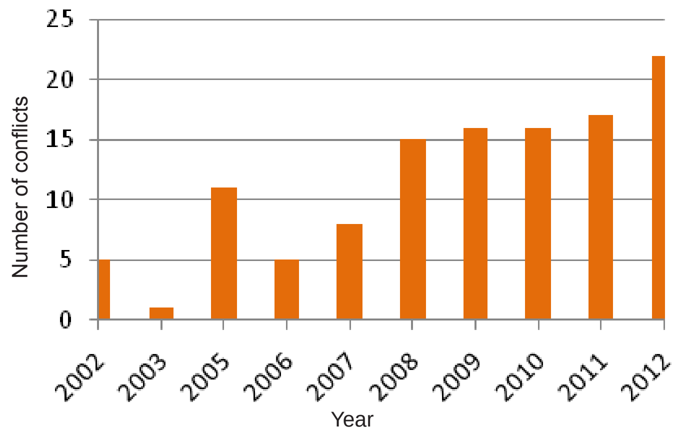


Fig. 25. Number of grizzly bear-human conflicts in Idaho, Greater Yellowstone Ecosystem, 2002–2012.

Grizzly Bear-Human Conflicts in Montana *(Kevin Frey and Jeremiah Smith, Montana Fish, Wildlife and Parks)*

During 2012, MTFWP investigated 46 grizzly bear-human conflicts in Montana's portion of the GYE. Incidences that result in grizzly bears causing public safety concerns, property damage, livestock depredations, human injuries, obtaining anthropogenic (unnatural) foods, or grizzly bear mortalities are considered conflicts requiring agency investigations, which may involve management actions. These conflicts usually vary from 1 bear being involved in a single incident to bears involved in multiple incidences over a period of time before conflicts can be resolved. The yearly average (11 years) number of conflicts is 61. The 2012 reported and investigated grizzly bear-human conflict types and the number of each are listed in Table 30. Land ownerships of individual conflict sites are listed in Table 31. The 2012 geographic locations of the reported and investigated conflicts are shown in Fig. 26. In Montana, there is annual variation in the number and location of conflicts. Additionally, with an expanding grizzly bear population in geographic distribution and individual numbers, conflicts are occurring in a larger geographic area of public and private land. Annually, efforts continue to reduce various types of conflicts, increase public safety, and reduce mortalities in areas of historic high conflicts and also at individual sites.

Table 30. Number of grizzly bear-human conflicts in Montana, Greater Yellowstone Ecosystem, 2012.

Conflict type	Number of conflicts
Human injury	2
Encounter situations	4
Livestock depredations - cattle	11 (12 head)
Livestock depredations - poultry	1
Property damage	3
Anthropogenic foods	2
Anthropogenic foods w/ property damage	2
Human caused mortalities	4
Near developed sites- safety concerns	16
Relocations	1
Total	46

Table 31. Number of private and public land grizzly bear conflicts in Montana, Greater Yellowstone Ecosystem, 2012.

Land ownership	Number of conflicts
Private	29
State	0
Bureau of Land Management	0
Gallatin National Forest	13
Beaverhead-Deerlodge National Forest	4
Custer National Forest	0
Total	46

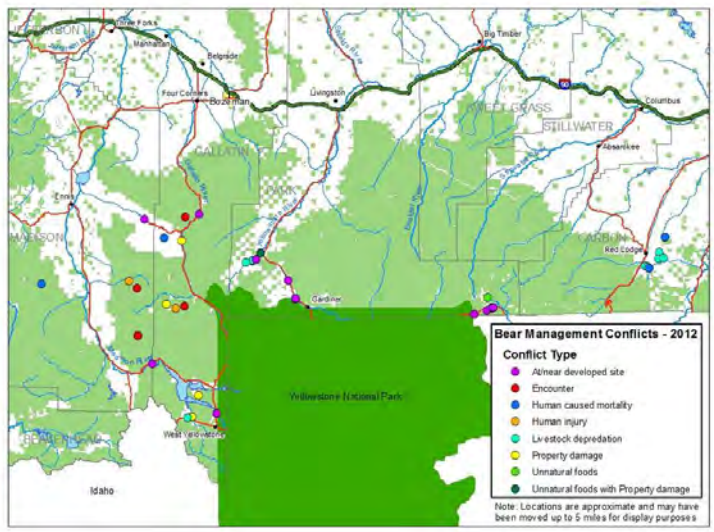


Fig. 26. Location of grizzly bear-human conflicts in Montana, Greater Yellowstone Ecosystem, 2012.

Two people were injured by grizzly bears in Montana during 2012, 1 while archery elk hunting and 1 while mountain biking. Both of these were a result of surprise encounters with a female bear with COY. There was 1 front-country self-defense or defense of life or property (DLP) killing of a grizzly bear in 2012. Bears frequenting or being near developed sites (e.g., homes, campgrounds) was the most common conflict in 2012. Bears that are near developed sites are generally investigating the possibility of obtaining foods. Education has helped reduce the actual number of bears obtaining human-related foods and reduces the need for capture, relocation, or removal.

From 2002 through 2012, there have been 672 reported and investigated grizzly bear-human conflicts in Montana. During the time period of 1992–2001, there were 448 grizzly bear-human conflicts investigated. Overall, the trend is slightly increasing, which would be expected with an increase in grizzly bear population numbers, increase in grizzly bear distribution, and an increase in human activity. Historically, livestock depredations by grizzly bears have been relatively low in southwest Montana. However, as bears expand distribution farther away from recognized suitable habitat, livestock depredations are increasing in these areas. This has mostly happened in the northeast area of the ecosystem near Red Lodge. During 1992–2001, there were 3 livestock depredations. This conflict type increased to 51 livestock depredations during 2002–2012. Annual number of conflicts for 2002–2012 ranged from a low of 22 in 2005 to a high of 110 in 2008 (Fig. 27).

Even as the Yellowstone grizzly bear population has been expanding throughout the entire ecosystem, Montana's mortality trend has remained fairly constant since 1992, averaging 4 bear mortalities/year. Comparing time periods of 1992–2001 to 2002–2012, bear mortalities associated with anthropogenic foods have actually decreased from 42% to 27% of the total yearly mortalities. However, during this same time period, grizzly bear close (surprise) encounters resulting in human injuries and DLP bear mortalities has increased from 22% to 36% of the average yearly bear mortalities. The numbers and variations of grizzly bear management mortalities compared to all other mortalities from 2002 through 2012 are shown in Fig. 28. The expected trend will be for grizzly bears to continue occupying more areas within and beyond the USFWS recognized Demographic Monitoring Area, potentially resulting in increase of conflicts and bear mortalities.

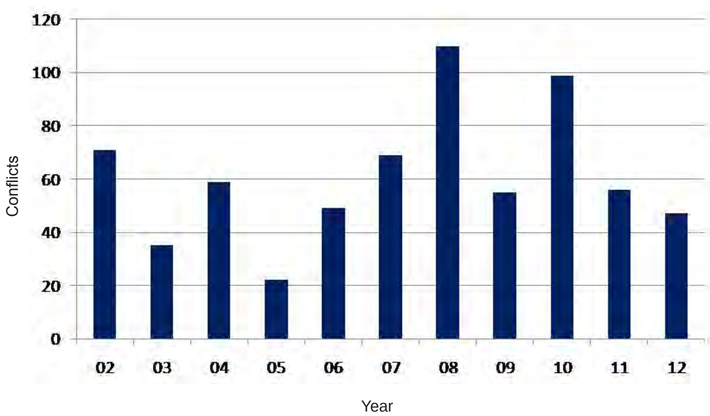


Fig. 27. Number of grizzly bear-human conflicts in Montana, Greater Yellowstone Ecosystem, 2002–2012.

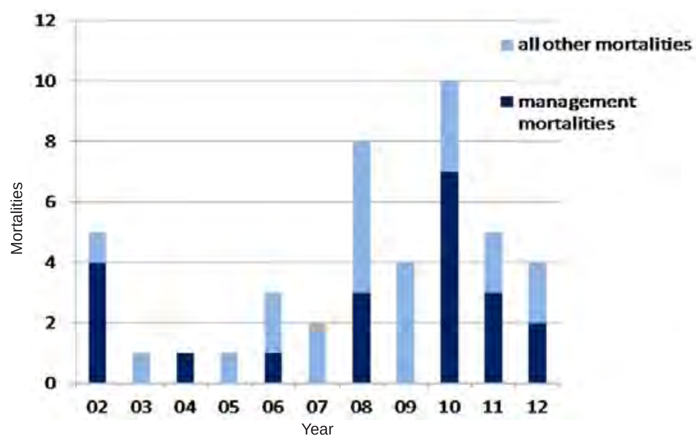


Fig. 28. Mortality trend of grizzly bears in the Montana portion of the Greater Yellowstone Ecosystem, 2002–2012.

During 2012, there were 4 known or probable grizzly bear mortalities in the Montana portion of the GYE. Three of the mortalities occurred on private land and 1 occurred on public land within the Beaverhead-Deerlodge National Forest.

Management removals accounted for 2 mortalities in 2012. Both of these grizzly bear mortalities involved livestock (cattle) depredations on private land by bears with previous management histories. One adult male bear was killed in a DLP situation at a private residence and 1 subadult male bear was killed illegally on public land due to mistaken identification by a black bear hunter.

In 2012, the summer climatic conditions were dry with relatively hot temperatures. Interestingly, these conditions allowed for good berry production from low elevations to alpine zones. Normally, high-elevation berry production is very limited to nonexistent due to a short growing season and freezing temperatures killing the berries before maturity. Grizzly bear conflicts (n = 46) and sightings in 2012 were lower in number than the long-term conflict average (n = 62). Field investigations found more grizzly bears using heavy shaded timber and wet areas. This behavior likely allows bears to avoid the hot dry conditions, find adequate vegetative foods, thereby resulting in fewer human interactions and conflicts. Summer vegetative foods were adequate in these shaded and moist areas and high-quality fall foods (e.g., berries, whitebark pine seeds, roots, carcasses) were in good quantity. No single factor can be attributed to low or high conflicts in a given year and it is always the accumulation of multiple factors. Natural foods, climate conditions, bear numbers, previous bear removals, management efforts and public actions all factor into the annual variation in bear-human conflicts.

An extensive effort has been made to reduce all types of conflicts and a measure of success is being observed in a reduction of sanitation and anthropogenic food related conflicts and bear mortalities numbers. However, the most difficult conflicts to prevent are surprise encounters that can lead to human injuries, which are currently trending into the second leading cause of grizzly bear mortalities. MTFWP continues to distribute bear conflict information to hunters through license holders, postcards, letters, personal contacts, hunter education classes, newspaper, websites, and televised news. In general, most of the public is aware of grizzly bear presence and potential encounter situations, but due to the unpredictable random occurrence and location of surprise encounters, it is most difficult to alleviate these types of conflicts.

Fence damaged by grizzly bear, 2010. MTFWP photo.

Grizzly Bear-Human Conflicts in Wyoming *(Brian DeBolt, Zach Turnbull, Michael Boyce, Kyle Bales, and Zach Gregory, Wyoming Game and Fish Department)*

Conflicts occur between people and grizzly bears when there is damage to property, pets, livestock, or apiaries, bears receive nonnatural food rewards, cause human injury or death, or humans cause injury or death to grizzly bears. The number and location of human-grizzly bear conflicts is influenced by unsecured unnatural attractants (e.g., human foods and garbage), natural food distribution and abundance, grizzly bear numbers and distribution, and human and livestock use patterns on the landscape.

In 2012, several grizzly bears were trapped in conflict situations far from what has been known as occupied habitat in Wyoming, and up to 122 km (76 miles) from the Grizzly Bear Recovery Zone (RZ). Two adult male bears were captured at the same location in one morning in the Piney Creek drainage west of Big Piney, marking the first capture of a grizzly bear in the Wyoming Range in recent history. A subadult male was caught near Ralston after gaining access to human foods and causing property damage, and 1 subadult male was trapped east of Meeteetse after getting into trash and apiaries. These incidents, and the general increasing trend in conflicts in Wyoming, are indicative of the grizzly bear population expanding in numbers and distribution. Areas where conflicts were concentrated in 2012 included the areas adjacent to GTNP in Teton County, and the Upper Green River Basin in Sublette County. Three people were injured by grizzly bears in Wyoming in 2012, 2 while hunting and 1 while sleeping on the ground.

The WYGF Large Carnivore Section and regional personnel investigated and recorded 213 human-grizzly bear conflicts in 2012 (Table 32). This pattern is consistent with the increasing trend in conflicts in recent years (Fig. 29). This year was marked by significant drought conditions and very little summer moisture. As a result, overall annual vegetal food availability throughout the State was probably less than optimal. However, whitebark pine production was above average (http://www.nrmsc.usgs.gov/files/norock/products/IGBST/2012WBPReport.pdf) and army cutworm moth aggregation site use by bears was very high in 2012.

During 2012, WYGF captured 45 grizzly bears on 48 occasions (3 bears were captured twice) in an attempt to prevent or resolve conflicts. Of the 48 capture events, 40 (83%) involved grizzly bears that were relocated from areas where they were causing conflicts with livestock or property, or moved preemptively to avoid conflicts. Thirteen capture events involved grizzly bears that were removed from the population by agency personnel due to a history of previous conflicts, a known history of close association with humans, or they were deemed unsuitable for release into the wild (i.e., orphaned COY, poor physical condition, or a human safety concern). All relocated grizzly bears were released on USFS (n = 34) or

Table 32. Type and number of grizzly bear-human conflicts in Wyoming, 2012.

Conflict Type	Number	Percent
Aggression toward humans	5	2.3
Human-caused grizzly death	7	3.3
Human-caused grizzly injury	1	0.5
Beehive	5	2.3
Cattle	127	59.6
Garbage	24	11.3
Horse	0	0.0
Human death	0	0.0
Human injury	3	1.4
Other (pet/livestock/bird feeder)	7	3.3
Pet/guard animal	0	0.0
Poultry	0	0.0
Properly stored game meat	2	0.9
Property damage	29	13.6
Sheep	3	1.4
Swine	0	0.0
Total	213	100.0

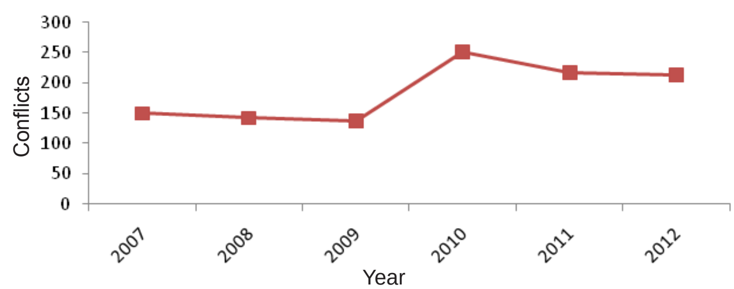


Fig. 29. Number of grizzly bear-human conflicts in Wyoming, 2007–2012.

WYGF (n = 1) lands in, or adjacent to, the RZ. The WYGF's annual report of grizzly bear relocations can be found at: http://wgfd.wyo.gov/web2011/wildlife-1000674.aspx.

Conflicts outside of the RZ comprised the majority (87%) of conflicts in Wyoming (Fig. 30). Conflicts occurred at nearly similar rates on private lands (49%) versus lands administered by the State or Federal government (51%) (Fig. 31).

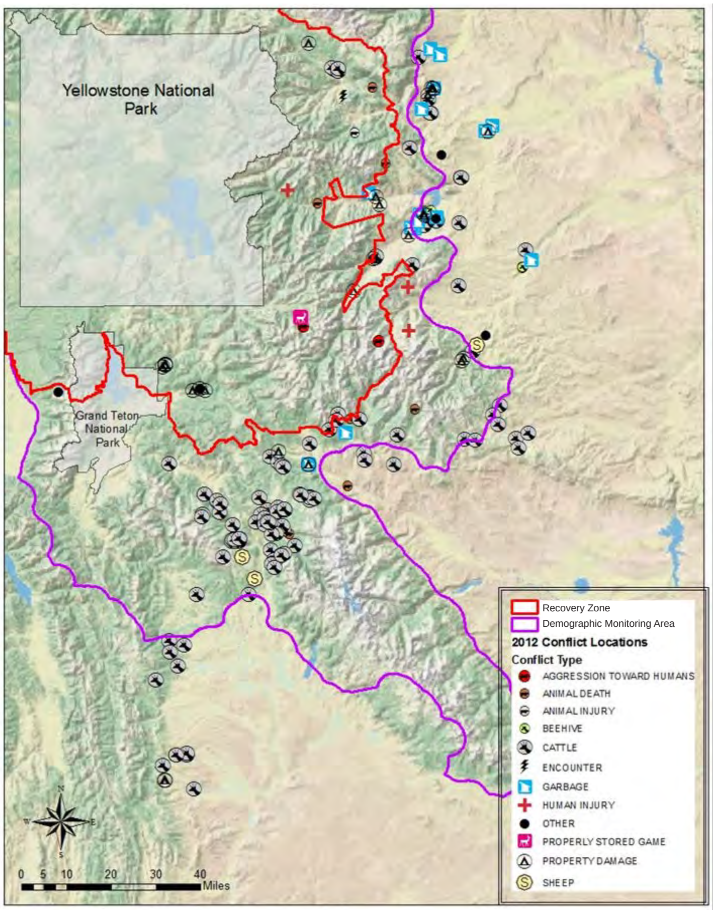


Fig. 30. Type and number of grizzly bear-human conflicts in relation to the Recovery Zone boundary and proposed Demographic Monitoring Area, Wyoming, 2012.

Within Wyoming, outside of the National Parks, there were 28 known or probable human-caused mortalities in 2012. Twenty-one of the mortalities occurred on public lands administered by the USFS. Management removals accounted for 12 mortalities in 2012. Of the 12 grizzly bears removed in management actions, 5 were removed due to livestock depredations, 6 due to property damage and human food rewards, and 1 that was extremely habituated to humans. Five of these management removals occurred outside of the Demographic Monitoring Area. In addition to the 12 management removals, 1 grizzly bear was struck and killed by a vehicle, 2 were killed in hunter encounters, 2 were COY presumed to have died after their mother was killed in a self-defense hunter encounter, 2 were found dead of apparent natural causes, 1 was found dead of natural causes and appeared to have died in 2011, and 8 mortalities are under investigation by law enforcement.

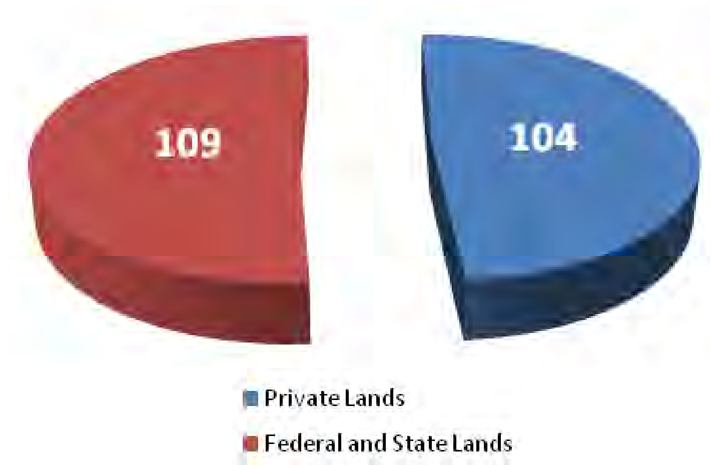
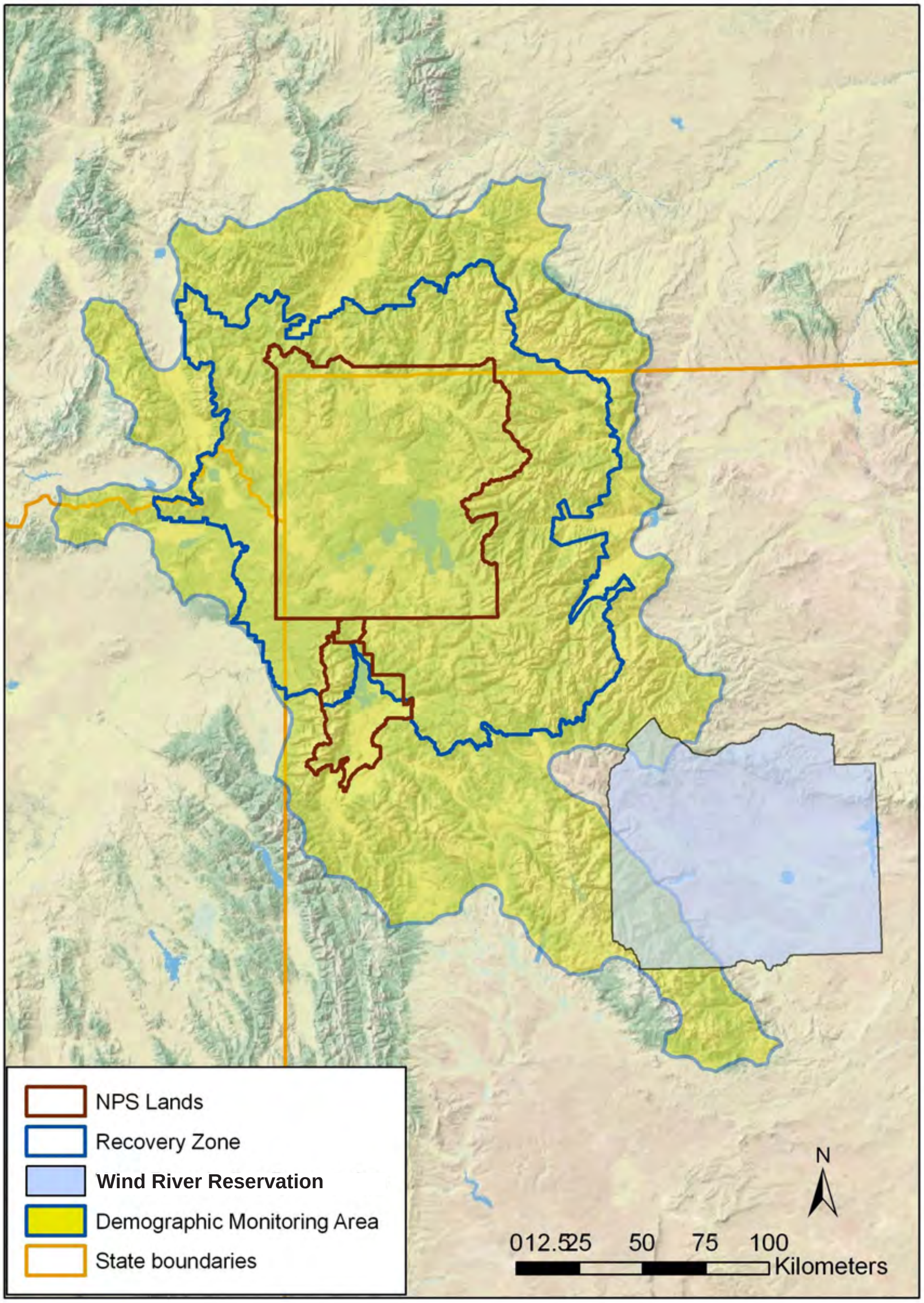


Fig. 31. Number of grizzly bear-human conflicts on private and public lands in Wyoming, 2012.

Most grizzly bear-human conflicts in Wyoming were a result of domestic livestock depredations and food rewards from humans in the form of garbage or pet and livestock feed. Conflicts (Fig. 29), and the resulting capture, relocation, and removal of grizzly bears in Wyoming are increasing. This trend is a result of grizzly bears increasing in numbers and distribution into areas used by humans, including livestock production, both on public and private lands. As this population and distribution growth continues, bears will search out food sources such as livestock and livestock feed, garbage, and pet food resulting in increased property damage and threats to human safety and associated human-caused mortality of bears. Conflict prevention measures such as attractant storage, deterrence, and education are the highest priority for the WYGF. In general, there is less social and biological suitability for bear occupancy in areas further from the RZ due to development, land use patterns, and various forms of recreation. Although prevention is the preferred option to reduce conflicts, each situation is managed on a case-by-case basis with education, securing of attractants, relocation or removal of individual bears, or a combination of methods, as specific situations warrant.

Grizzly Bear-Human Conflicts on the Wind River Reservation *(Pat Hnilicka, U.S. Fish and Wildlife Service)*

There were no grizzly bear-human conflicts reported on the Wind River Reservation in 2012.



Location of the Wind River Reservation in the Greater Yellowstone Ecosystem.

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2012 Grizzly Bear Annual Habitat Monitoring Report

Greater Yellowstone Area Grizzly Bear Habitat Modeling Team
April 2013

BACKGROUND

This appendix fulfills the annual grizzly bear habitat monitoring obligations for a recovered population as put forth in the *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area* (U.S. Fish and Wildlife Service [USFWS] 2007). The Conservation Strategy requires annual reporting to evaluate adherence to the grizzly bear habitat standards identified in that document. Habitat standards and monitoring requirements were formalized in 2007 when federal protections under the Endangered Species Act (ESA) were removed for the grizzly bear population occupying the Greater Yellowstone Ecosystem (GYE, Fig. 1). However, the legal status of the Yellowstone grizzly bear population remains a contentious issue and the original delisting was challenged and overturned in a Montana District Court in 2009. In compliance with this order, the grizzly bear population in the GYE is once again listed as a threatened species under the ESA. The USFWS appealed that ruling in 2011and a mixed final decision rendered by the U.S. Court of Appeals ultimately upheld the district court ruling. The decision by the appellate court fundamentally agreed with the USFWS' argument that regulatory mechanisms under the Conservation Strategy are adequate to maintain a recovered grizzly population. However, the court opined that the USFWS failed to present a convincing argument that the decline in whitebark pine throughout the ecosystem does not threaten the long-term survival of the Yellowstone grizzly bear population. In direct response to that ruling, the Interagency Grizzly Bear Study Team (IGBST) is currently conducting a comprehensive synthesis and assessment to examine the ecological plasticity of Yellowstone grizzly bears in response to changing resource conditions, including decline of whitebark pine. This synthesis report is scheduled for completion October 2013 and will contribute to the scientific information needed by the USFWS to decide whether or not to move forward with a new proposed delisting rule.

The Conservation Strategy is an interagency (federal and state) decision document for managing a recovered population once the Yellowstone grizzly bear is removed from federal protection under the ESA. The habitat standards and monitoring requirements in the Conservation Strategy were made legally binding for the 6 national forests and 2 national parks in the GYE when the Conservation Strategy was incorporated into the *Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forest, Record of Decision* (U.S. Department of Agriculture [USDA] Forest Service 2006) and the Superintendent's Compendiums (Grand Teton National Park 2006, Yellowstone National Park 2007). Recent reinstatement of threatened status to the Yellowstone grizzly bear renders the Conservation Strategy and Forest Plan Amendment legally void. However, management agencies throughout the GYE remain committed to the long-term well-being of the grizzly bear population. Regardless of the legal status of the Yellowstone grizzly bear, management agencies will continue in good faith to comply with the intent and monitoring requirements of habitat standards identified in the Conservation Strategy document and the Forest Plan Amendment.

INTRODUCTION

Habitat standards were established in the Conservation Strategy to reduce negative impacts of human presence on occupied grizzly bear habitat throughout the core area of the GYE. Three distinct habitat standards enumerated in the Conservation Strategy pertain to motorized access, human development, and commercial livestock grazing. All 3 are known to contribute to mortality and displacement of grizzly bears in occupied areas across the landscape. Habitat standards apply only within the Grizzly Bear Recovery Zone (GBRZ)[1],

1 The Grizzly Bear Recovery Zone (GBRZ) is a term used when the Yellowstone grizzly bear is under federal protection. The Conservation Strategy (USFWS 2007), a document that will go into effect if and when the GYE grizzly population becomes delisted, refers to the recovery area as the Primary Conservation Area. The GBRZ term will be used in this 2012 report to reflect the current legal status of the Yellowstone grizzly bear as a threatened population.

which is located at the core of the GYE, and specifically require that these 3 attributes be maintained at or improved upon levels that existed in 1998. The 1998 baseline is predicated on evidence that habitat conditions at that time, and for the preceding decade, contributed to the observed 4% to 7% population growth of the Yellowstone grizzly bear population. This report is the collective response from the national parks, national forests, and other partner agencies in the GYE to the Conservation Strategy requirement that adherence to the 1998 habitat baseline be monitored and reported annually.

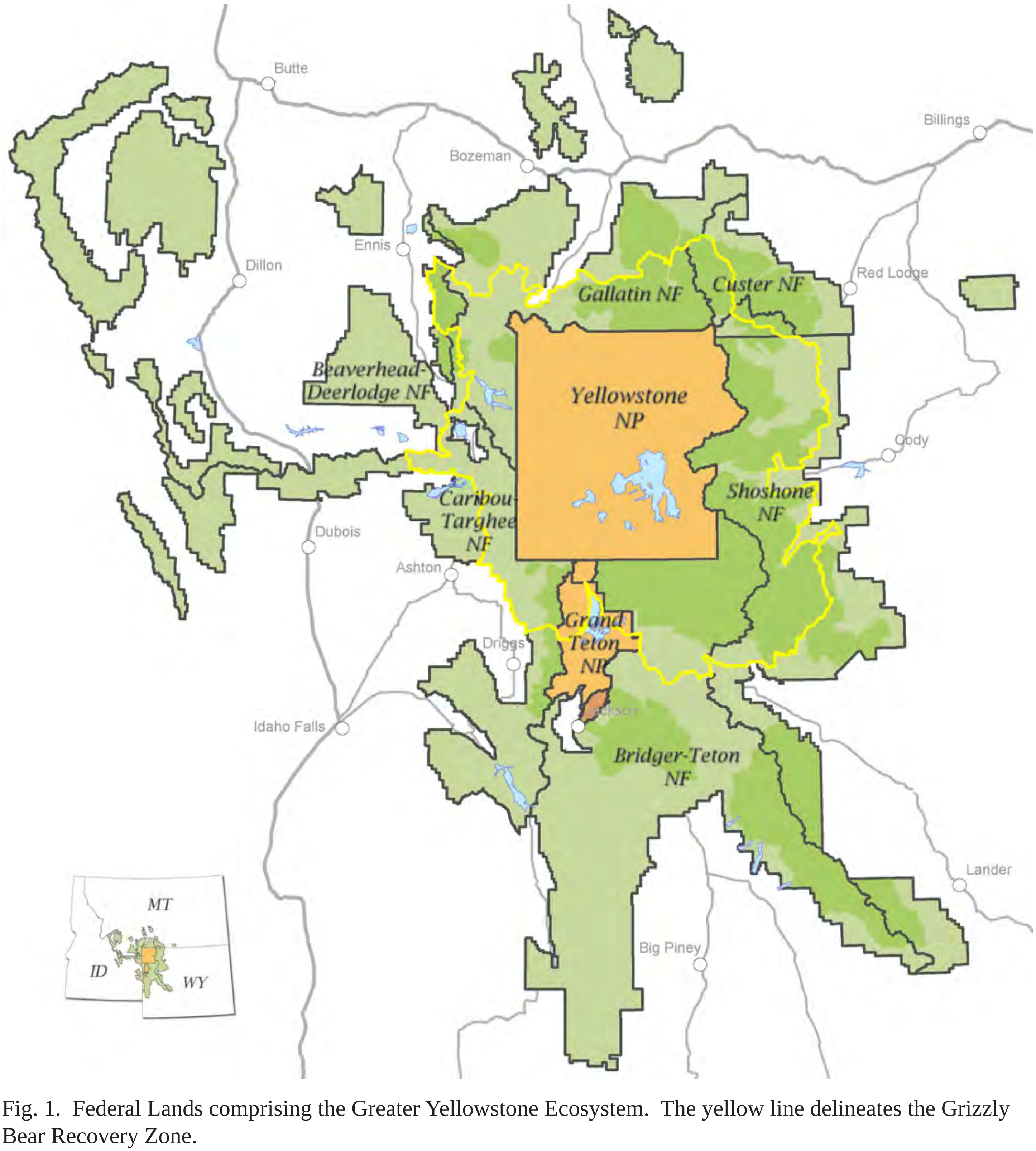

Fig. 1. Federal Lands comprising the Greater Yellowstone Ecosystem. The yellow line delineates the Grizzly Bear Recovery Zone.

HABITAT MONITORING REQUIREMENTS

Annual Monitoring Requirements

This report provides a summary of all changes incurred inside the GBRZ during the past year for the following parameters: (1) secure habitat, (2) open motorized access route densities (OMARD) for seasons 1 and 2, (3) total motorized access route densities (TMARD), (4) number and capacity of developed sites, (5) temporary changes in secure habitat due to federal projects on federal land, and (6) number of livestock grazing allotments and permitted domestic sheep animal months (AMs). In addition, all grizzly bear conflicts and recurring conflicts associated with livestock allotments throughout the ecosystem (both inside and outside the GBRZ) are summarized. The status of the first 4 of these monitoring parameters are evaluated and reported annually for each of the 40 subunits within the 18 Bear Management Units (BMU) comprising the GBRZ (Fig. 2). All parameters, except grizzly bear conflict data and temporary changes to secure habitat, are to be compared against levels existing in 1998. The 1998 baseline measurements found in this report represent the most accurate information available to date. Forest and park personnel continue to improve the quality of their information to more accurately reflect what was on the ground in 1998.

Fig. 2. Bear Management Units and subunits comprizing the Grizzly Bear Recovery Zone.

Biennial Monitoring Requirements (outside the GBRZ)

In addition to annual monitoring requirements imposed by the Conservation Strategy, the Forest Plan Amendment requires the monitoring of changes in percent secure habitat on national forest land outside the GBRZ every 2 years (this coincides with even years). The Forest Plan Amendment is a legal document that formally appends the habitat standards of the Conservation Strategy and other relevant provisions to the forest plans of the 6 national forests inside the GYE. The states of Idaho, Montana, and Wyoming developed state grizzly bear management plans that were also incorporated as integral parts of the Conservation Strategy. The 3 state plans recommend and encourage federal land management agencies to maintain habitat in areas identified as biologically suitable and socially acceptable for grizzly bear occupancy. Monitoring of secure grizzly bear habitat outside the GBRZ is reported for each of 43 Bear Analysis Units (BAU, Fig. 3). The BAUs are areas determined by the states to be biologically suitable and socially acceptable for grizzly bear occupancy. These analysis units were established in the Forest Plan Amendment to be comparable in size to BMU subunits inside the GBRZ, and are tied to areas where the states are currently managing for grizzly bears. There are no habitat standards outside the GBRZ, but monitoring secure habitat in BAU areas is part of the overall evaluation of grizzly bear habitat conditions throughout the GYE.

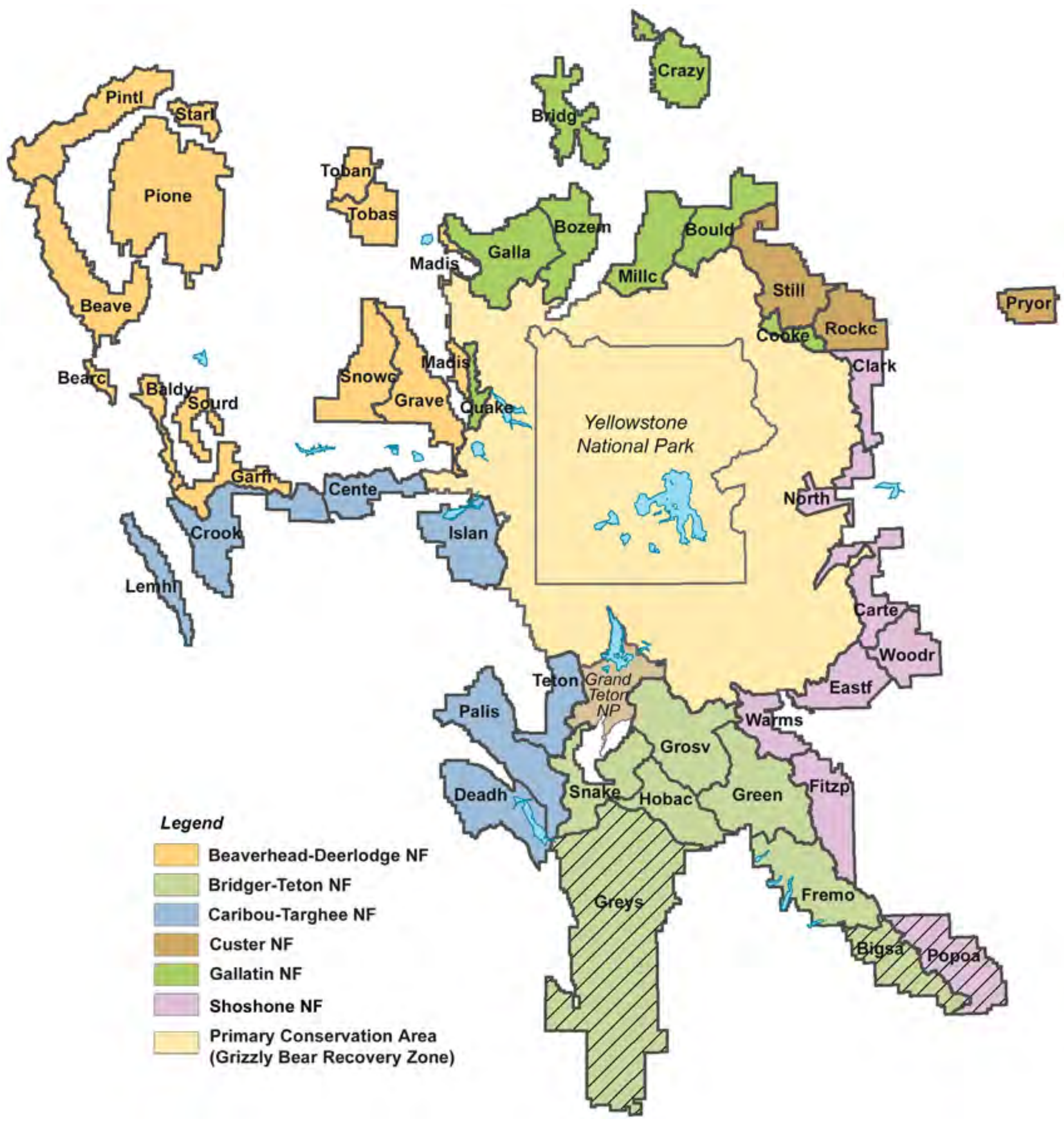

Fig. 3. Bear Analysis Units (BAUs) outside the Grizzly Bear Recovery Zone. BAUs marked with hatched lines are considered areas socially unacceptable for grizzly bear occupancy and are not currently evaluated.

MONITORING FOR LIVESTOCK GRAZING

Number of Allotments and Sheep Animal Months inside the GBRZ

The livestock allotment standard established in the Conservation Strategy requires that there be *no increase in commercial livestock grazing allotments or any increase in permitted sheep AMs* inside the GBRZ from that which existed in 1998. Animal months are calculated by multiplying the permitted number of sheep times the months of permitted grazing on a given allotment. Existing grazing allotments are to be phased out as opportunity arises with willing permittees. The change in number of active and vacant livestock allotments cited in this report account for all commercial grazing allotments occurring on national forest land within the GBRZ. Upon closure of the lone cattle allotment inside Grand Teton National Park, today there are no grazing allotments on National Park land inside the GYE. Horse grazing areas associated with outfitters in backcountry situations or livestock grazing on private inholdings are not included in this report. Operational status of allotments is categorized as *active*, *vacant*, or *closed*. An active allotment is one with a current grazing permit. However, an active allotment can be granted a "no-use" permit when a permittee chooses not to graze livestock that year. Vacant allotments are those without an active permit, but may be grazed periodically by other permittees at the discretion of the land management agency to resolve resource issues or other concerns. Where chronic conflicts occur on cattle allotments inside the GBRZ and an opportunity exists with a willing permittee, cattle can be moved to a vacant allotment where there is less likelihood of conflict. A closed allotment is one that has been permanently deactivated such that commercial grazing will not be permitted to occur anytime in the future.

Changes in Allotments since 1998

Cattle allotments: Commercial cattle grazing on public lands inside the GBRZ has decreased since 1998 (Table 1). In 1998 there were 71 active and 12 vacant cattle allotments inside the GBRZ. Today there are 57 active and 18 vacant commercial cattle allotments operating inside the GBRZ. Since 1998, 4 active allotments have been permanently closed to commercial grazing and 11 have been vacated and are no longer being actively grazed. Of the 12 vacant cattle allotments present in 1998, 1 was reactivated in 2007 (Meadow View cattle allotment on the Caribou-Targhee National Forest), 4 have since been permanently closed, and 7 have remained vacant up until the present.

Sheep allotments: Domestic sheep allotments inside the GBRZ have mostly been phased out since 1998. In 1998 there were 11 active and 7 vacant sheep allotments inside the GBRZ. Today there are 1 active and 2 vacant commercial sheep allotments remaining inside the GBRZ (Table 1). Of the 11 sheep allotments active in 1998, 9 have been permanently closed to all commercial grazing, 1 has been vacated, and 1 remains active. The Meyers Creek allotment on the Caribou-Targhee National Forest is the only active sheep allotment currently remaining inside the GBRZ. Of the 7 sheep allotments that were vacant in 1998, 6 have been permanently closed and 1 remains vacant today and has not been grazed since 1998. Sheep AMs have diminished from a total of 23,090 permitted in 1998 to 870 in 2012.

Changes in Allotments during 2012

There were no changes in the number of sheep or cattle allotments inside the GBRZ in 2012. The Meyers Creek allotment, federally administered by the USDA and the only active sheep allotment remaining inside the GBRZ, took a no-grazing permit in 2012. The permit for this allotment was changed from a grazing (month-long) to a trailing permit (3-day) to allow the U.S. Sheep Experimental Station to move sheep to alternative grazing land outside of occupied grizzly bear habitat.

Table 1. Number of commercial livestock grazing allotments and sheep animal months (AMs) inside the Grizzly Bear Recovery Zone (GRBZ) in 1998 and 2012.										
	Cattle/Horse Allotments				Sheep Allotments				Sheep AMs	
	Active		Vacant		Active		Vacant			
Administrative Unit	1998 Base	Current 2012	1998 Base	Current 2012	1998 Base	Current 2012	1998 Base	Current 2012	1998 Base	Current 2012
Beaverhead-Deerlodge NF	3	3	2	0	0	0	0	0	0	0
Bridger-Teton NF	9	6	0	2	0	0	0	0	0	0
Caribou-Targhee NF[a]	11	9	1	3	7	1	4	0	14,163	870
Custer NF	0	0	0	0	0	0	0	0	0	0
Gallatin NF	23	15	9	13	2	0	3	2	3,540	0
Shoshone NF	24	24	0	0	2	0	0	0	5,387	0
Grand Teton NP	1	0	0	0	0	0	0	0	0	0
Total in GBRZ	71	57	12	18	11	1	7	2	23,090	870

[a] The Meyers Creek allotment, the only domestic sheep allotment remaining active inside the GBRZ, took a "no graze" trailing permit in 2012.

Livestock Conflicts Inside and Outside the GBRZ

Conflicts between grizzly bears and livestock have historically led to the trapping and relocation or removal of the bears. Grizzly bear conflicts associated with livestock depredation are reported on an annual basis for all sheep and cattle grazing allotments and forage reserves on National Forest land within the GYE. This section summarizes the reported annual incidences of grizzly bear-livestock conflict occurring on commercial grazing allotments maintained on National Forest lands throughout the ecosystem, and does not include livestock conflicts on private or State land.

Livestock Conflicts in 2012

In 2012, 88 grizzly bear-livestock (cattle and sheep) conflicts were reported on 23 distinct grazing allotments on National Forest land within the GYE (Table 2, column 8). Fifteen (17%) of the reported livestock conflicts occurred inside the GBRZ, whereas 41 (47%) occurred on the Upper Green River cattle allotment located outside the GBRZ on the northern portion of the Bridger-Teton National Forest. Ninety-eight percent of livestock conflicts reported in 2012 involved grizzly bear depredation on cattle and only 2 incidents involved sheep. The reported incidents collectively account for the death of 50 calves, 17 yearlings, 8 cows, 1 ewe, and 2 sheep by grizzly bears. An additional 2 cows, 7 calves, and 4 yearlings were injured by grizzlies. Two of the injured calves and 1 yearling were euthanized. Management action in response to these conflicts led to the removal of 1 adult female and 2 adult male grizzly bears. All 3 grizzly bear mortalities were due to persistent conflicts associated with the Upper Green River cattle allotment.

Recurring Livestock Conflicts 2012

Thirteen commercial grazing allotments, 6 on the Bridger-Teton National Forest and 7 on the Shoshone National Forest, had recurring conflicts (Table 2). Livestock-related conflicts are considered recurring if 3 or more years of recorded conflict have occurred on a given allotment during the most recent 5-year period (USDA Forest Service 2006:A9). Four of the allotments with recurring conflicts fall partially or completely within the GBRZ and 9 are completely outside the GBRZ. The 3 grizzly bear mortalities referred to in the previous paragraph represent management responses to recurring conflicts on the Upper Green River cattle allotment on the Bridger-Teton National Forest.

Table 2. Commercial livestock allotments with documented grizzly bear conflicts during the past 5 years. Allotments with conflicts occurring in 3 of the last 5 years are considered to be recurring conflicts.

Allotment Name	Total Acres	Percent inside GBRZ	Conflicts 2008 (Y/N)	2009 (Y/N)	2010 (Y/N)	2011 (Y/N)	2012 (number of conflicts)	Recurring conflicts (Y or N)
Beaverhead-Deerlodge National Forest								
Bufiox	13,077	0%	N	N	N	Y	0	N
Bridger-Teton National Forest								
Bacon Creek	64,556	0%	N	N	N	N	1	N
Badger Creek	7,254	0%	N	Y	Y	N	0	N
Beaver-Horse	25,358	0%	N	N	N	N	2	N
Crow's Nest	3,640	0%	N	N	N	Y	0	N
Elk Ridge	6,365	0%	Y	Y	Y	Y	1	Y
Fish Creek	111,835	35%	N	N	N	Y	0	N
Green River Drift	1,002	0%	N	N	N	Y	0	N
Jack Creek	13,714	0%	N	N	N	N	1	N
Kinky Creek	22,834	0%	N	N	N	N	1	N
Kohl Ranch	178	0%	N	N	N	N	1	N
Lime Creek	4,973	0%	Y	Y	Y	N	0	Y
Noble Pasture	762	0%	N	N	Y	Y	0	N
Prospect Peak	8,917	0%	N	N	N	N	1	N
Roaring Fork	8,416	0%	N	N	N	N	1	N
Rock Creek	5,148	0%	N	Y	Y	N	1	Y
Sherman C&H	8,287	0%	N	N	Y	Y	1	Y
Tosi Creek	14,090	0%	N	Y	Y	N	1	Y
Turpin Meadow	1,493	100%	N	N	N	Y	0	N
Upper Green River	131,944	0%	Y	Y	Y	Y	41	Y
Upper Gros Ventre	67,497	0%	N	N	N	N	5	N
Caribou-Targhee National Forest								
Antelope Park	14,492	0%	N	N	Y	N	0	N
Bootjack	8,468	100%	N	N	Y	N	0	N
Palisades	16,812	0%	N	Y	N	N	0	N
Squirrel Meadows	28,797	100%	Y	Y	Y	N	7	N
Shoshone National Forest								
Bald Ridge	24,853	23%	N	N	Y	N	0	N
Basin	73,115	99%	Y	N	N	N	0	N
Bear Creek	33,672	0%	Y	N	N	N	1	N
Belknap	13,049	100%	N	Y	Y	N	0	N
Bench (Clarks Fork)	28,751	16%	Y	Y	Y	Y	0	Y
Crandall	30,089	100%	Y	N	Y	N	0	N
Dick Creek	9,569	0%	N	N	Y	N	0	N

Table 2. Continued.								
			Conflicts					
Allotment name	Total acres	Percent inside GBRZ	2008 (Y/N)	2009 (Y/N)	2010 (Y/N)	2011 (Y/N)	2012 (number of conflicts)	Recurring conflicts (Y or N)
Face of the Mtn.	8,553	0%	Y	N	Y	N	0	N
Fish Lake	12,742	0%	Y	N	N	N	0	N
Ghost Creek	11,579	100%	N	N	N	N	6	N
Hardpan Table Mountain	13,474	63%	Y	N	N	N	0	N
Horse Creek	29,980	62%	Y	N	N	Y	1	Y
Little Rock	4,901	0%	N	N	Y	N	0	N
Parque Creek	13,528	34%	N	Y	Y	N	2	Y
Piney	14,287	0%	N	Y	Y	Y	0	Y
Rock Creek	16,833	36%	N	N	N	N	1	N
Salt Creek	8,263	0%	Y	N	N	N	0	N
Union Pass	39,497	0%	Y	Y	Y	Y	6	Y
Warm Springs	16,875	0%	N	N	N	Y	4	N
Wiggins Fork	37,653	0%	Y	Y	Y	Y	1	Y
Wind River	44,158	34%	Y	Y	Y	Y	1	Y

MONITORING FOR DEVELOPED SITES

The Conservation Strategy habitat standards require that the number of and capacity for human use of developed sites inside the GBRZ be maintained at or below the level existing in 1998. Exceptions to this requirement include any increase, expansion, or change of use of developed sites from the 1998 baseline that have been properly analyzed, with potential detrimental impacts sufficiently mitigated for and documented through biological evaluation or assessment by the action agency. A developed site includes, but is not limited to, sites on public land that are 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 natural resource development sites such as oil and gas exploratory wells, production wells, mining activities, and work camps. Projects that change the number or capacity of developed sites on federal land inside the GBRZ must follow the Application Rules identified in the Forest Plan Amendment, Record of Decision (USDA Forest Service 2006:A-3-4). Such projects require that mitigation of detrimental impacts be conducted within the affected BMU subunit and be equivalent to the type and extent of impact. Administrative site expansions are exempt from mitigation if such developments are deemed necessary for enhancement of public lands and when other viable alternatives are not plausible. Developments on private land are not counted against this standard.

Changes in Developed Sites since 1998

The number of developed sites inside the GBRZ has decreased from 592 sites in 1998 to 584 in 2012. This net reduction in developed sites affected 7 subunits throughout the GBRZ (Table 3). Only 1 subunit (Hilgard #1) has shown an increase in developed sites since 1998. This increase occurred when a trailhead located in subunit 1 of the Hilgard BMU was moved from one side of a road to the other, placing it in subunit #2. Although

Table 3. The 1998 baseline and 2012 numbers of developed sites on public lands within each of the Bear Management Subunits in the Greater Yellowstone Ecosystem.

Bear Management Subunit	Admin units[a]	Total number of developed sites in subunit 1998 Base	Summer home complexes		Developed campgrounds		Trailheads		Major developed sites and lodges[b]		Administrative or maintenance sites		Other developed sites		Plans of operation for minerals activities[c]		Change in number of sites from 1998 Base (+ or -)
			1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	
Bechler-Teton #1	CTNF	60	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	4	4	10	10	0	0	
Boulder-Slough #1	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	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	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	BTNF	22	1	1	4	4	3	3	3	3	5	5	5	4	1	1	-1
Crandall - Sunlight #1	SNF	23	0	0	2	2	5	5	1	1	1	1	5	5	0	0	0
	GNF		0	0	2	2	2	2	0	0	0	0	5	5	0	0	
Crandall - Sunlight #2	SNF	18	0	0	5	5	4	4	1	1	2	2	5	5	1	1	0
	GNF		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Crandall - Sunlight #3	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	YNP	26	0	0	1	1	5	5	1	1	6	6	13	13	0	0	0
Firehole-Hayden #2	YNP	15	0	0	1	1	3	3	1	1	2	2	8	8	0	0	0
Gallatin #1	YNP	4	0	0	0	0	3	3	0	0	1	1	0	0	0	0	0
Gallatin #2	YNP	21	0	0	2	2	5	5	1	1	12	12	1	1	0	0	0
Gallatin #3	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	GNF	35	0	0	5	5	11	11	0	0	3	3	6	6	8	8	0
	YNP		0	0	0	0	1	1	0	0	0	0	1	1	0	0	
Hellroaring-Bear #2	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	

Table 3. Continued.

Bear Management Subunit	Admin units[a]	Total number of developed sites in subunit 1998 Base	Summer home complexes		Developed campgrounds		Trailheads		Major developed sites and lodges[b]		Administrative or maintenance sites		Other developed sites		Plans of operation for minerals activities[c]		Change in number of sites from 1998 Base (+ or -)
			1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	
Henrys Lake #1	CTNF	20	2	2	3	3	1	1	0	0	3	3	10	10	1	0	-1
Henrys Lake #2	CTNF	18	0	0	0	0	1	1	0	0	1	0	1	1	1	1	0
	GNF		5	5	3	3	4	4	0	0	0	0	2	3	0	0	
Hilgard # 1	BDNF	14	0	0	0	0	0	0	0	0	3	1	0	0	0	0	-3
	GNF		0	0	0	0	6	5	1	1	2	2	2	2	0	0	
Hilgard # 2	GNF	9	0	0	0	0	4	5	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	YNP	37	0	0	1	1	5	5	0	0	3	3	2	1	0	0	-1
	GNF		0	0	2	2	6	6	0	0	6	6	3	3	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	YNP	4	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0
Madison #1	GNF	21	0	0	1	1	11	11	0	0	1	1	8	7	0	0	-1
	YNP		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Madison #2	GNF	25	8	8	2	2	1	1	1	1	4	4	5	5	0	0	0
	YNP		0	0	0	0	1	1	0	0	2	2	1	1	0	0	
Pelican-Clear #1	YNP	2	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0
Pelican-Clear #2	YNP	13	0	0	1	1	4	4	1	1	4	4	3	3	0	0	0
Plateau #1	CTNF	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	CTNF	7	0	0	0	0	1	1	0	0	1	1	1	1	0	0	0
	YNP		0	0	0	0	0	0	0	0	4	4	0	0	0	0	
Shoshone #1	SNF	9	1	1	2	2	0	0	0	0	0	0	6	6	0	0	0
Shoshone #2	SNF	2	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0
Shoshone #3	SNF	4	2	2	0	0	1	0	1	1	0	0	0	0	0	0	-1
Shoshone #4	SNF	23	3	3	3	2	3	3	6	6	0	0	8	9	0	0	0

Table 3. Continued.

Bear Management Subunit	Admin units[a]	Total number of developed sites in subunit 1998 Base	Summer home complexes		Developed campgrounds		Trailheads		Major developed sites and lodges[b]		Administrative or maintenance sites		Other developed sites		Plans of operation for minerals activities[c]		Change in number of sites from 1998 Base (+ or -)
			1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	1998 Base	2012	
South Absaroka #1	SNF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
South Absaroka #2	SNF	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
South Absaroka #3	SNF	15	1	1	3	3	4	4	1	1	1	1	5	4	0	0	-1
Thorofare #1	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	
Thorofare #2	BTNF	2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
	NP		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Two Ocean Lake #1	YNP	14	0	0	2	2	3	3	1	1	3	3	2	2	0	0	0
	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	BTNF	4	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0
	GTNP		0	0	0	0	0	0	0	0	1	1	1	1	0	0	
Washburn #1	YNP	25	0	0	2	2	8	8	2	2	7	7	6	6	0	0	0
Washburn #2	YNP	12	0	0	1	1	6	6	0	0	1	1	4	4	0	0	0
Total GBRZ	ALL	592	24	24	67	66	161	160	28	28	117	114	167	165	28	27	-8

[a] Abbreviations for administrative units: BDNF = Beaverhead-Deerlodge National Forest, BTNF = Bridger-Teton National Forest, CNF = Custer National Forest, CTNF = Caribou-Targhee National Forest, GNF = Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, WG&F = Wyoming Game and Fish, YNP = Yellowstone National Park.

[b] Grant, Lake, Fishing Bridge, Old Faithful, Canyon and Mammoth in YNP are classified as Major Developed Areas. However, these sites are a combination of recreation facilities and administrative facilities. 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.

[c] Mining claims with Plans of Operations are considered developed sites for this baseline. Not all Plan sites currently have active projects.

this transfer technically accounted for an increase in developed sites on Hilgard #2, it was determined to have no measurable impact to the grizzly bear and did not violate the intent of the developed site standard. For a complete list of developed sites comprising the 1998 baseline, please see Supplementary Tables S1 and S2.

Changes in Developed Sites for 2012

There were no reported changes in number or capacity of developed sites inside the GBRZ in 2012.

MONITORING SECURE HABITAT AND MOTORIZED ACCESS

Maintaining or improving grizzly bear secure habitat at or above 1998 levels in each BMU subunit inside the GBRZ is required under the Conservation Strategy and Forest Plan Amendment. Calculation of secure habitat is based entirely on proximity to motorized routes (roads and trails), and serves as a metric of human impacts to grizzly bear habitat. Secure habitat is defined as any contiguous area ≥10 acres and more than 500 m from an open or gated motorized route. Lakes >1 square mile in size are excluded from calculations for secure habitat. Monitoring protocol in the Conservation Strategy requires that secure habitat and seasonal OMARD and TMARD be reported annually for each BMU subunit in the GBRZ.

Gains in secure habitat are achieved primarily through decommissioning of open motorized access routes. In context to the measurement of grizzly bear secure habitat, a route is considered decommissioned when it has been effectively treated on the ground so that motorized access by the public and administrative personnel is restricted. Road decommissioning can range from complete obliteration of the road prism on one end of the spectrum to physical barriers permanently and effectively blocking all access points to motorized traffic. Any route that is open to public or administrative motorized use during any portion of the non-denning season (1 Mar–30 Nov) detracts from secure habitat. This includes routes that are gated to the public yearlong but which may be accessed by administrative personnel.

The Conservation Strategy and Forest Plan Amendment do not impose any mandatory standards pertaining to motorized route density, however, changes in this parameter are monitored and reported annually. Monitoring protocol requires that the following parameters be reported for each BMU subunit on an annual basis: 1) seasonal OMARD >1 mile/square mile, and 2) TMARD >2 miles/square mile. Seasonal OMARD is measured for 2 seasons: Season 1 (1 Mar–15 Jul) and Season 2 (16 Jul–30 Nov). Gated routes that block public access for an entire season do not count toward seasonal route density (i.e., season of closure) but do contribute toward TMARD. All motorized routes open to the public and or administrative personnel during any portion of the non-denning season contribute to TMARD. Decommissioned roads do not contribute to OMARD or TMARD and do not detract from grizzly bear secure habitat.

Permanent Changes in Secure Habitat since 1998

Since 1998, there has been no net decline in the amount of secure habitat measured in any of the 40 BMU subunits within the GBRZ (Table 4). Secure habitat inside the GBRZ has increased by 125 square miles (324 km^2) since 1998, an increase comparable to the area of Yellowstone Lake. In the past 14 years, 19 subunits have shown an increase in secure habitat ranging from 0.1% to 16.7%. The greatest improvements in secure habitat have occurred on subunits inside or straddling the Gallatin National Forest and are due to systematic decommissioning of nonsystem roads in compliance with the 2006 Gallatin National Forest Travel Plan. Most notably, 6 subunits (Gallatin #3, Hellroaring/Bear #1, Henrys Lake #2, Hilgard #1 and #2, and Madison #1) demonstrate substantial increases ranging from 3.6% to 16.7%. Three Gallatin National Forest subunits, Henrys Lake #2, Gallatin #3, and Madison #2, were identified in the Conservation Strategy and Forest Plan Amendment as having need for improvement in secure habitat above 1998 levels. Timing for this improvement

Table 4. 1998 Baseline and 2012 percentages per subunit of open motorized access route density (OMARD), total motorized access route density (TMARD), and secure habitat for 40 Bear Management Unit subunits in the Grizzly Bear Recovery Zone.

	OMARD % > 1 mile / sqmile												Area (square miles) (excluding lakes)		
	Season 1 (1 Mar-15 Jul)			Season 2 (16 Jul-30 Nov)			TMARD % > 2 miles/sqmile			% Secure Habitat					
BMU subunit name	1998	2012	% chg	1998	2012	% chg	1998	2012	% chg	1998	2012	% chg	Subunit	1998 secure habitat	2012 secure habitat
Bechler/Teton	17.0	16.9	-0.1	17.0	16.9	-0.1	5.8	5.8	0.0	78.1	78.1	0.0	534.3	417.0	417.0
Boulder/Slough #1	3.2	2.8	-0.5	3.2	2.8	-0.5	0.3	0.2	-0.1	96.6	97.1	0.5	281.9	272.2	273.7
Boulder/Slough #2	2.1	2.1	0.0	2.1	2.1	0.0	0.0	0.0	0.0	97.7	97.7	0.0	232.4	227.1	227.1
Buffalo/Spread Creek #1	11.4	11.4	0.0	11.5	11.5	0.0	5.3	5.3	0.0	88.3	88.3	0.0	219.9	194.1	194.1
Buffalo/Spread Creek #2	14.5	15.3	0.8	15.6	14.8	-0.8	12.7	12.5	-0.2	74.3	74.3	0.0	507.6	377.2	377.3
Crandall/Sunlight #1	13.3	12.5	-0.9	19.3	18.5	-0.8	7.2	6.3	-0.9	81.1	81.9	0.8	129.8	105.2	106.2
Crandall/Sunlight #2	15.6	15.1	-0.5	16.6	16.3	-0.3	11.7	11.4	-0.3	82.3	82.4	0.1	316.2	260.3	260.5
Crandall/Sunlight #3	14.4	14.3	-0.1	19.2	19.1	-0.1	10.6	10.6	0.0	80.4	80.7	0.3	221.8	178.3	178.9
Firehole/Hayden #1	10.4	10.5	0.1	10.4	10.5	0.1	1.7	1.7	0.0	88.3	88.3	0.0	339.2	299.7	299.6
Firehole/Hayden #2	8.9	8.9	0.0	9.0	9.0	0.0	1.5	1.5	0.0	88.4	88.4	0.0	172.2	152.3	152.3
Gallatin #1	3.6	2.7	-0.9	3.6	2.7	-0.9	0.5	0.1	-0.4	96.3	96.9	0.6	127.7	122.9	123.7
Gallatin #2	9.5	9.1	-0.4	9.5	9.1	-0.4	4.5	4.5	0.0	90.2	90.2	0.0	155.2	139.9	139.9
Gallatin #3	46.0	18.6	-27.4	46.0	27.4	-18.5	22.9	12.5	-10.5	55.3	72.0	16.7	217.6	120.2	157.3
Hellroaring/Bear #1	22.4	18.4	-4.0	23.1	18.4	-4.7	15.8	11.6	-4.2	77.0	80.6	3.6	184.7	142.2	148.8
Hellroaring/Bear #2	0.1	0.0	-0.1	0.1	0.0	-0.1	0.0	0.0	0.0	99.5	99.6	0.1	228.9	227.8	228.0
Henry's Lake #1	49.0	49.2	0.2	49.0	49.2	0.2	31.2	31.1	-0.1	45.4	46.1	0.7	191.2	86.8	88.2
Henry's Lake #2	49.9	41.3	-8.6	49.9	41.3	-8.6	35.2	30.5	-4.7	45.7	51.7	6.0	140.2	64.1	72.5
Hilgard #1	29.0	9.4	-19.6	29.0	14.6	-14.4	15.3	4.6	-10.7	69.8	81.7	11.9	201.2	140.3	164.4
Hilgard #2	21.0	8.8	-12.2	21.0	16.1	-4.9	13.6	4.6	-9.0	71.4	80.2	8.8	140.5	100.4	112.7
Lamar #1	9.9	9.7	-0.1	9.9	9.7	-0.1	3.8	3.9	0.1	89.4	89.9	0.5	299.9	268.1	269.5
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	180.8	180.8	180.8

Table 4. Continued.

BMU subunit name	OMARD % >1 mile/sqmile						TMARD % >2 miles/sqmile			% Secure Habitat			Area (square miles) (excluding lakes)		
	Season 1 (1 Mar-15 Jul)			Season 2 (16 Jul-30 Nov)											
	1998	2012	% chg	1998	2012	% chg	1998	2012	% chg	1998	2012	% chg	Subunit	1998 secure habitat	2012 secure habitat
Madison #1	29.2	13.2	-16.0	29.5	20.3	-9.1	12.5	7.5	-5.0	71.5	80.7	9.2	227.9	162.9	183.9
Madison #2	33.7	32.0	-1.8	33.7	32.0	-1.7	24.0	21.6	-2.4	66.5	67.5	1.0	149.4	99.4	100.9
Pelican/Clear #1	2.0	2.0	0.0	2.0	2.0	0.0	0.5	0.5	0.0	97.8	97.8	0.0	108.4	106.0	106.0
Pelican/Clear #2	5.4	5.4	0.0	5.4	5.4	0.0	0.4	0.4	0.0	94.1	94.1	0.0	251.6	236.7	236.7
Plateau #1	22.0	16.9	-5.2	22.2	19.0	-3.3	12.9	10.3	-2.7	68.8	70.6	1.8	286.3	197.0	202.1
Plateau #2	8.5	8.5	0.0	8.5	8.5	0.0	3.5	3.2	-0.2	88.7	88.8	0.1	419.9	372.3	372.7
Shoshone #1	1.5	1.5	0.0	1.5	1.5	0.0	1.1	1.1	0.0	98.5	98.5	0.1	122.2	120.3	120.4
Shoshone #2	1.3	1.3	0.0	1.3	1.3	0.0	0.7	0.7	0.0	98.8	98.8	0.0	132.4	130.9	130.9
Shoshone #3	3.9	2.9	-0.9	3.8	2.9	-0.9	2.1	1.6	-0.5	97.0	97.7	0.8	140.7	136.5	137.6
Shoshone #4	4.5	4.5	0.0	5.3	5.3	0.0	2.9	2.9	0.0	94.9	94.9	0.0	188.8	179.1	179.1
South Absaroka #1	0.6	0.6	0.0	0.6	0.6	0.0	0.1	0.1	0.0	99.2	99.2	0.0	163.2	161.9	161.9
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	190.3	190.3
South Absaroka #3	2.4	2.4	0.0	2.4	2.4	0.0	2.7	2.7	0.0	96.8	96.8	0.0	348.3	337.1	337.2
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	273.4	273.4
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	180.1	180.1	180.1
Two Ocean/Lake #1	3.5	3.5	0.0	3.5	3.5	0.0	0.3	0.3	0.0	96.3	96.3	0.0	371.9	358.3	358.3
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	124.9	124.9
Washburn #1	16.1	16.1	0.0	16.1	16.1	0.0	4.2	4.2	0.0	83.0	83.0	0.0	178.3	147.9	147.9
Washburn #2	7.4	7.4	0.0	7.4	7.4	0.0	1.1	1.1	0.0	92.0	92.0	0.0	144.1	132.6	132.6
PCA Mean / Total Area	**12.3**	**9.9**	**-2.5**	**12.7**	**11.0**	**-1.8**	**6.7**	**5.4**	**-1.3**	**85.6**	**87.0**	**1.4**	**9025.4**	**7724.5**	**7849.2**

was subject to the development of the Gallatin National Forest Travel Plan. Two of these 3 subunits, Gallatin #3 and Hilgard #1, show a significant increase in secure habitat of 16.7% and 11.9%, respectively. The improvements exhibited in these 2 subunits are partly attributable to decommissioning of relic logging roads on lands acquired through a land exchange between the Gallatin National Forest and Big Sky Lumber Company via the 1998 Congressional Gallatin Range Consolidation Act. This land exchange resulted in the trade of Forest Service timber (mostly from outside the GBRZ) for heavily-roaded timber lands inside the GBRZ. With implementation of the Gallatin National Forest Travel Plan, many of these historic logging routes have been permanently decommissioned, while a few were repaired and converted to motorized system routes.

Table 4 summarizes the permanent change in secure habitat, seasonal OMARD, and TMARD for each subunit within the GBRZ.

Permanent Changes in OMARD, TMARD, and Secure Habitat for 2012

No new permanent motorized roads or trails were constructed inside the GBRZ during 2012. Ten subunits within the GBRZ exhibit increases in secure habitat, each accompanied with decreases in motorized route density (Table 5). Except for Crandall-Sunlight #2, all increases in secure habitat during 2012 were due to actions conducted on the Gallatin National Forest pursuant with the penultimate phase of Travel Plan implementation. Most of the increases in secure habitat on the Gallatin National Forest resulted from road decommissioning that occurred over the past several years but were reported in 2012 as part of updates to motorized status in the Grizzly Bear Access Database. Extensive closures conducted during this time in the Hellroaring-Bear #1, Henrys Lake #1, Hilgard #1 and #2, and Madison #1 subunits led to measurable increases in secure habitat ranging from 2.9% to 8.9%.

An increase of 3.1% in the Gallatin #3 subunit is partially attributable to actions mandated by a special court order signed in May 2012 prohibiting motorized use on 6 miles of existing motorcycle trail in the Hyalite-Porcupine-Buffalo Horn (HPBH) Wilderness Study Area (WSA). Due to litigation on the Forest Travel Plan, motorized access in the HPBH WSA is currently under interim direction that reduces motorized access below the level that would have occurred with full implementation of the Gallatin Travel Plan decision.

Projects with Temporary Changes to Secure Habitat in 2012

Projects that temporarily affect secure habitat are allowed under the Conservation Strategy and Forest Plan Amendment, but must adhere to application rules for temporary changes to secure habitat. A project under the secure habitat standard is one that results in a temporary reduction in secure habitat due to construction of new, or changes to existing, motorized access routes. Projects may involve the building of new roads, constructing existing roads, and or opening permanently restricted roads. Application rules allow only 1 temporary project to be active at any given time in a particular subunit. Also, the total acreage of secure habitat affected by the project within a given BMU must not exceed 1% of the total acreage of the largest subunit within that BMU.

Three projects involving temporary reductions in secure habitat were operational inside the GBRZ during 2012 (Table 6). All 3 of these projects occurred on the Shoshone National Forest. Two of these projects came to completion by the end of 2012, and 1 will continue operations into 2013. Below is a brief summary of the 3 projects conducted inside the GBRZ during 2012.

Reef Creek Timber Sale – Shoshone National Forest

The Reef Creek timber sale in the north zone of the Shoshone National Forest was initiated in 2010 as part of the larger *Upper Clarks Fork Vegetation Management Project*. Harvest activities were mostly completed by the end 2011 and all roads were closed except 1 segment of a temporary road that was kept open to allow

Table 5. Change between 2011 and 2012 in open motorized access route density (OMARD), total motorized access route density (TMARD), and secure habitat for 40 Bear Management Unit (BMU) subunits in the Grizzly Bear Recovery Zone.

BMU subunit Name	OMARD % > 1 mile/sqmile						TMARD % >2 miles/sqmile			% Secure Habitat			Area (square miles) (excluding lakes)		
	Season 1 (1 Mar-15 Jul)			Season 2 (16 Jul-30 Nov)											
	2011	2012	% chg	2011	2012	% chg	2011	2012	% chg	2011	2012	% chg	Subunit	2011 secure habitat	2012 secure habitat
Bechler/Teton	16.9	16.9	0.0	16.9	16.9	0.0	5.8	5.8	0.0	78.1	78.1	0.0	534.3	417.0	417.0
Boulder/Slough #1	3.2	2.8	-0.5	3.2	2.8	-0.5	0.3	0.2	-0.1	96.6	97.1	0.5	281.9	272.2	273.7
Boulder/Slough #2	2.1	2.1	0.0	2.1	2.1	0.0	0.0	0.0	0.0	97.7	97.7	-0.0	232.4	227.1	227.1
Buffalo/Spread Creek #1	11.4	11.4	0.0	11.5	11.5	0.0	5.3	5.3	0.0	88.3	88.3	0.0	219.9	194.1	194.1
Buffalo/Spread Creek #2	15.3	15.3	0.0	14.8	14.8	0.0	12.5	12.5	0.0	74.3	74.3	0.0	507.6	377.3	377.3
Crandall/Sunlight #1	12.9	12.5	-0.4	18.9	18.5	-0.4	6.7	6.3	-0.4	81.4	81.9	0.5	129.8	105.6	106.2
Crandall/Sunlight #2	15.2	15.1	-0.1	16.4	16.3	-0.1	11.6	11.4	-0.2	82.3	82.4	0.1	316.2	260.3	260.5
Crandall/Sunlight #3	14.3	14.3	0.0	19.1	19.1	0.0	10.6	10.6	0.0	80.7	80.7	0.0	221.8	178.9	178.9
Firehole/Hayden #1	10.5	10.5	0.0	10.5	10.5	0.0	1.7	1.7	0.0	88.3	88.3	0.0	339.2	299.6	299.6
Firehole/Hayden #2	8.9	8.9	0.0	9.0	9.0	0.0	1.5	1.5	0.0	88.4	88.4	0.0	172.2	152.3	152.3
Gallatin #1	3.0	2.7	-0.3	3.0	2.7	-0.3	0.5	0.1	-0.4	96.9	96.9	-0.0	127.7	123.7	123.7
Gallatin #2	9.5	9.1	-0.4	9.5	9.1	-0.4	4.5	4.5	-0.0	90.2	90.2	-0.0	155.2	139.9	139.9
Gallatin #3	30.8	18.6	-12.3	30.8	27.4	-3.4	12.9	12.5	-0.4	68.9	72.0	3.1	217.6	150.0	157.3
Hellroaring/Bear #1	21.3	18.4	-2.9	22.0	18.4	-3.6	14.6	11.6	-2.9	77.6	80.6	2.9	184.7	143.4	148.8
Hellroaring/Bear #2	0.1	0.0	-0.1	0.1	0.0	-0.1	0.0	0.0	-0.0	99.5	99.6	0.1	228.9	227.8	228.0
Henry's Lake #1	49.0	49.2	0.2	49.0	49.2	0.2	31.2	31.1	-0.1	46.1	46.1	0.0	191.2	88.1	88.2
Henry's Lake #2	48.8	41.3	-7.5	48.8	41.3	-7.5	31.3	30.5	-0.8	47.5	51.7	4.2	140.2	66.6	72.5
Hilgard #1	23.5	9.4	-14.1	23.5	14.6	-8.9	8.5	4.6	-3.9	74.1	81.7	7.6	201.2	149.2	164.4
Hilgard #2	20.5	8.8	-11.7	20.5	16.1	-4.4	11.8	4.6	-7.2	73.1	80.2	7.1	140.5	102.8	112.7
Lamar #1	9.8	9.7	-0.1	9.8	9.7	-0.1	3.7	3.9	0.2	89.4	89.9	0.5	299.9	268.1	269.5
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	180.8	180.8	180.8
Madison #1	28.9	13.2	-15.7	29.2	20.3	-8.8	11.5	7.5	-4.0	71.8	80.7	8.9	227.9	163.7	183.9
Madison #2	32.9	32.0	-0.9	32.9	32.0	-0.9	21.4	21.6	0.2	67.3	67.5	0.2	149.4	100.6	100.9
Pelican/Clear #1	2.0	2.0	0.0	2.0	2.0	0.0	0.5	0.5	0.0	97.8	97.8	0.0	108.4	106.0	106.0
Pelican/Clear #2	5.4	5.4	0.0	5.4	5.4	0.0	0.4	0.4	0.0	94.1	94.1	0.0	251.6	236.7	236.7
Plateau #1	20.6	16.9	-3.7	20.8	19.0	-1.8	10.3	10.3	-0.0	70.9	70.6	-0.3	286.3	203.0	202.1
Plateau #2	8.5	8.5	0.0	8.5	8.5	0.0	3.2	3.2	0.0	88.8	88.8	0.0	419.9	372.7	372.7

Table 5. Continued.

BMU subunit Name	OMARD % > 1 mile/sqmile						TMARD % >2 miles/sqmile			% secure habitat			Area (square miles) (excluding lakes)		
	Season 1 (1 Mar-15 Jul)			Season 2 (16 Jul-30 Nov)											
	2011	2012	% chg	2011	2012	% chg	2011	2012	% chg	2011	2012	% chg	Subunit	2011 secure habitat	2012 secure habitat
Shoshone #1	1.5	1.5	0.0	1.5	1.5	0.0	1.1	1.1	0.0	98.5	98.5	0.0	122.2	120.4	120.4
Shoshone #2	1.3	1.3	0.0	1.3	1.3	0.0	0.7	0.7	0.0	98.8	98.8	0.0	132.4	130.9	130.9
Shoshone #3	2.9	2.9	0.0	2.9	2.9	0.0	1.6	1.6	0.0	97.7	97.7	0.0	140.7	137.6	137.6
Shoshone #4	4.5	4.5	0.0	5.3	5.3	0.0	2.9	2.9	0.0	94.9	94.9	0.0	188.8	179.1	179.1
South Absaroka #1	0.6	0.6	0.0	0.6	0.6	0.0	0.1	0.1	0.0	99.2	99.2	0.0	163.2	161.9	161.9
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	190.3	190.3
South Absaroka #3	2.4	2.4	0.0	2.4	2.4	0.0	2.7	2.7	0.0	96.8	96.8	0.0	348.3	337.2	337.2
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	273.4	273.4
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	180.1	180.1	180.1
Two Ocean/Lake #1	3.5	3.5	0.0	3.5	3.5	0.0	0.3	0.3	0.0	96.3	96.3	0.0	371.9	358.3	358.3
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	124.9	124.9
Washburn #1	16.1	16.1	0.0	16.1	16.1	0.0	4.2	4.2	0.0	83.0	83.0	0.0	178.3	147.9	147.9
Washburn #2	7.4	7.4	0.0	7.4	7.4	0.0	1.1	1.1	0.0	92.0	92.0	0.0	144.1	132.6	132.6
Total GBRZ	11.6	9.9	-1.8	12.0	11.0	-1.0	5.9	5.4	-0.5	86.2	87.0	0.7	9025.4	7781.9	7849.2

Table 6. Temporary projects inside the Grizzly Bear Recovery Zone during 2012.							
Bear Management Subunit[a]	Area of BMS excluding lakes (sqmiles)	Maximum change allowed (sqmiles)[b]	Project name and administrative unit	Secure habitat 2011 (sqmiles)	Secure habitat with project (sqmiles)	Secure habitat affected by project (sqmiles)	Project status
Crandall/Sunlight #1	129.8			105.6	105.6	0.00	COMPLETED (All temporary roads closed in 2012)
Crandall/Sunlight #2	**316.2**	**3.2**	**Reef Creek** (Shoshone NF)	**260.3**	**260.3**	**0.003**	
Crandall/Sunlight #3	221.8			178.9	178.9	0.000	
Crandall/Sunlight #1	129.8			105.6	105.6	0.00	COMPLETED (All temporary roads closed in 2012)
Crandall/Sunlight #2	**316.2**	**3.2**	**Hunter Peak** (Shoshone NF)	**260.3**	**260.3**	**0.00**	
Crandall/Sunlight #3	221.8			178.9	178.9	0.00	
South Absaroka #1	163.2			161.9	161.9	0.00	
South Absaroka #2	190.6	**3.5**	**Upper Wind River Vista Timber Sale** (Shoshone NF)	190.3	190.3	0.00	ACTIVE
South Absaroka #3	**348.3**			**337.2**	337.0	**0.17**	

[a] The subunit(s) affected by the temporary project is denoted in bold font.
[b] The maximum allowable temporary change in secure habitat for a project cannot exceed 1% of the area of the largest subunit within the bear management unit.

public access for retrieval of firewood from slash piles and to provide access to an additional harvest unit in 2012. Sale activities were completed and the remaining project road closed to all motorized use by the end of 2012. Timber harvest operations for the duration of the project were confined to the Reef Creek area in the Crandall/Sunlight #2 subunit and entailed construction of approximately 1 km (0.7 mi) of new temporary road in proximity to Reef Creek and east of the Crandall Ranger Station. Less than 0.1 square mile of secure habitat was temporarily affected by this project.

Hunter Peak Timber Sale – Shoshone National Forest Service

The Hunter Peak timber sale, like the Reef Creek sale, was approved for harvest operations in the Crandall/Sunlight #2 subunit as part of the *Upper Clarks Fork Vegetation Management Project*. Prior to 2012, motorized activities associated with this sale were limited to preexisting motorized routes and did not impact secure habitat. During 2012, upon closure of the Reef Creek timber sale, approximately 2.3 km (1.4 mi) of new temporary roads were constructed and open for harvest activities. All project roads were closed and sale activities completed by the year's end.

Upper Wind River Vista Timber Sale – Shoshone National Forest

The *Upper Wind River Vegetation Treatment Project*, initially approved in 2007, consisted of 1 timber sale (Vista), with 5 timber cutting units for the South Absaroka #3 subunit. In 2011 the Vista timber sale was broken up into 3 separate sales: Vista, Brooks Lake Creek, and Pinnacles Heights timber sales. The treatments were proposed to expedite hazardous fuel reduction in an at-risk timbered area south of Brooks Lake on the Wind River Ranger District of the Shoshone National Forest. Access to timber units inside the GBRZ require the reactivation of approximately 2.7 km (1.7 mi) of decommissioned Forest Service routes in a small area concentrated immediately south of Brooks Lake and north of U.S. Highway 212. An additional 1.1 km (0.7 mi) of new road was constructed in 2010 just outside of the subunit's southwest boundary and hence, outside of the GBRZ. Upon termination of the project, this road will be closed to the public and open only to Forest Service personnel for administrative purposes. It is calculated that the 3 timber sales associated with this project will collectively result in a temporary reduction of <0.2 square miles of secure habitat. All temporary changes to motorized access routes inside the GBRZ will be decommissioned upon closure of the project.

MONITORING SECURE HABITAT OUTSIDE THE GBRZ

Monitoring change in secure habitat every 2 years on national forest land outside the GBRZ is required by the 2006 Forest Plan Amendment for grizzly bear conservation in the GYE. Current protocol for quantifying and tracking change in secure habitat compares current levels against an established baseline. Prior to this year's report, a 2003 transportation layer referenced in the 2004 Draft Forest Plan Amendment constituted a "baseline" for comparing and monitoring changes in secure habitat outside the GBRZ. However, 2003 data for motorized access routes was incomplete outside the GBRZ as some forests had not yet completed a digital inventory of motorized trails and/or lacked a comprehensive inventory of motorized status for all system and/or unauthorized nonsystem routes. The 2003 baseline layer has been replaced with a more recent 2008 layer.

In 2008, all 6 forests in the ecosystem except for the Bridger-Teton National Forest updated their 2003 transportation layers to more accurately reflect true motorized use on the landscape. The 2008 updates incorporated motorized trails that had not been accounted for in the 2003 baseline. Many of the changes in secure habitat outside the GBRZ reported between 2003 and 2008 were due to updates in the accuracy of the data and were not tied to on-the-ground changes. Because the 2008 transportation layer is more current and up-to-date than the 2003 information, changes in secure habitat will henceforth be measured against the more accurate 2008 transportation layer. This process of constructing a reliable baseline for monitoring change outside the GBRZ is an iterative process. Baseline data will continue to improve for some years as forests within the ecosystem complete updates as resources allow, and pursuant to travel management analysis required by the 2005 Travel Management Rule (TMR, USDA 2005).

The 2005 TMR prescribes a new management direction for the national forest transportation system by requiring that each forest clearly identify an unambiguous system of roads, trails, and areas to which all motor vehicle use is restricted, and make this information available to the public by publishing Motor Vehicle Use Maps (MVUMs). This process, in a very broad sense, consists of 3 major components: 1) completing a digital inventory of all system and unauthorized roads and trails, 2) assigning current motorized status to all inventoried routes, and 3) deciding and implementing the desired future status of each road and trail inventoried. The 6 national forests within the GYE are in various stages of developing forest-wide Travel Plans to comply with direction mandated in the TMR. To date, the Gallatin National Forest is the only forest unit within the ecosystem that has fully developed and implemented a forest-wide Travel Plan decision identifying a complete system of designated routes for motorized travel pursuant to the TMR. Additionally, a final decision notice was issued in 2011 by the Forest Supervisor of the Beaverhead-Deerlodge National Forest, officially enacting travel management direction for the Madison Ranger District. An interim system of motorized roads and trails has been established to facilitate future decisions for travel management plans for the rest of the Beaverhead-Deerlodge National Forest. Until final travel management decisions are made for districts other than the Madison, motorized travel is limited to routes designated as motorized in the interim roads and trails inventory.

The following sections provide context for changes in secure habitat outside the GBRZ resulting from travel management revisions and or refined inventory data on the Beaverhead-Deerlodge and Gallatin National Forests and summarized in Table 7.

Table 7. Percent secure habitat in Bear Analysis Units (BAUs) outside the Grizzly Bear Recovery Zone for each of the 6 national forests in the Greater Yellowstone Ecosystem. 2012 values are compared against 2008 levels.				
	Percent secure habitat			
Bear Analysis Unit (BAU)	2008 (baseline)	2012 (current)	% change between 2008 and 2012	BAU area[a] (square miles)
Beaverhead-Deerlodge National Forest				
Baldy Mountain	46.2	55.0	8.9	96.9
Bear Creek	60.7	62.6	1.9	36.4
Beaver Creek	48.5	57.3	8.8	478.9
Garfield	64.8	71.6	6.8	182.0
Gravelies	60.6	58.5	-2.1	384.4
Madison	99.2	99.4	0.2	89.2
Pintler Mountains	59.2	57.6	-1.6	410.3
Pioneer Mountains	52.9	55.1	2.2	912.2
Snowcrest	70.9	74.8	3.8	357.2
Sourdough	40.1	46.9	6.8	111.2
Starlight	40.0	34.8	-5.2	79.0
Tobacco North	52.7	53.4	0.7	106.7
Tobacco South	46.9	47.5	0.6	186.3
Mean secure and total area	57.1	59.6	2.5	3430.7
Bridger-Teton National Forest				
Fremont	88.0	88.2	0.2	440.0
Green River	65.7	65.7	0.0	527.9
Gros Ventre	63.7	63.7	0.1	507.7
Hoback	58.9	58.9	-0.0	292.9
Snake	64.0	64.2	0.3	348.9
Mean secure and total area	68.1	68.2	0.1	2117.3
Caribou-Targhee National Forest				
Centennial	50.9	50.9	0.0	199.1
Crooked	59.4	59.3	-0.1	403.0
Deadhorse	50.8	50.8	0.0	364.8
Island Park	36.7	36.7	0.0	333.9
Lemhi	70.0	70.0	0.0	143.1
Palisades	59.8	59.8	0.0	472.5
Teton	64.8	64.8	0.0	209.5
Mean secure and total area	56.1	56.0	-0.0	2126.0
Custer National Forest				
Pryor	38.8	38.8	0.0	121.8
Rock Creek	83.8	83.8	0.0	237.2
Stillwater	85.3	85.7	0.4	404.7
Mean secure and total area	69.3	69.4	0.1	763.7

Table 7. Continued.

Bear Analysis Unit (BAU)	Percent Secure Habitat 2008 (baseline)	2012 (current)	% change between 2008 and 2012	BAU area[a] (square miles)
Gallatin National Forest				
Boulder	64.8	69.9	5.1	277.9
Bozeman	45.6	59.8	14.1	270.5
Bridger	28.3	38.4	10.1	236.3
Cooke	99.6	99.6	0.0	68.7
Crazy	57.2	67.6	10.4	254.8
Gallatin	52.3	59.8	7.5	415.0
Mill Creek	82.3	83.8	1.6	312.2
Quake	85.0	92.1	7.2	66.2
Mean secure and total area	64.4	71.4	7.0	1901.6
Shoshone National Forest				
Carter	77.6	77.9	0.3	261.1
Clarks Fork	70.1	70.1	0.0	160.5
East Fork	73.2	73.2	0.0	251.0
Fitzpatrick	98.4	98.4	0.0	317.8
North Fork	78.0	78.0	0.0	143.2
Warm Springs	30.6	30.5	-0.1	183.0
Wood River	84.7	85.3	0.6	228.5
Mean secure and total area	73.2	73.3	0.1	1545.2

[a] Lakes greater than 1 square mile were excluded from secure habitat calculations and from total area of Bear Analysis Units (BAUs)

Beaverhead-Deerlodge National Forest

In 2012, a revised digital layer of motorized routes was submitted by the Beaverhead-Deerlodge National Forest as revisions to the Grizzly Bear Motorized Access Database. These revisions reflect the 2011 Travel Plan Decision for the Madison District system of designated motorized roads and trails, as well as the Forest Plan Interim Roads and Trails Inventory for the remaining portion of the Forest within the GYE. These changes submitted by the Beaverhead-Deerlodge are part of the overall effort to comply with the 2005 TMR and the 2009 Forest Plan. A final Travel Plan Decision has been finalized only for the Madison Ranger District. Decisions for the Dillon, Wisdom, and Wise River Ranger Districts will be completed in subsequent years as funding permits.

Current estimates for change in secure habitat (compared to 2008 levels) are reported for each BAU outside the GBRZ (Table 7). However, in the case of the Beaverhead-Deerlodge National Forest, it is important to note that route features in the 2008 "baseline" had been attributed at the coarse Forest Plan scale, and more recently have been attributed with more site-specific motorized status, which has resulted in changes to secure area. Concurrent with the establishment of the interim roads and trails inventory was the publication of the Record of Decision (ROD) Number 2 for the Beaverhead-Deerlodge Forest Plan. This decision closed any route that was not captured in the interim inventory. The combination of the effects of route closures stemming from ROD 2, the Madison Ranger District Travel Plan Decision Notice, and more site-specific attribution of routes in the interim inventory since 2008 has resulted in the changes to secure area reflected in Table 7.

Key changes in motorized access on the Madison District resulted from the 2011 Decision Notice for motorized travel and include the following: 1) closing 41.7 miles of system roads and trails and 3.4 miles of unauthorized routes, 2) adding 5.5 miles of unauthorized routes to the system, and 3) adding 6.6 miles of unauthorized access to dispersed camping sites to system motorized trails. No new motorized roads or trails were constructed on the Madison District under the Travel Plan Decision. Table 7 reports changes in secure habitat as a result of travel revisions for the 4 BAUs comprising the Madison District (Gravellies, Madison, Snowcrest, and Tobacco South). Although the Gravellies BAU exhibits a reduction of 2.1% in secure habitat, increases are reported for the other 3 Madison District BAUs. An overall increase of 0.7% in secure habitat was calculated for the entire Madison District as a result of Travel Plan implementation.

Gallatin National Forest

In 2012, the Gallatin National Forest submitted a complete forest-wide digital layer of motorized routes for incorporation into the current Grizzly Bear Motorized Access Database. This new layer captures the current implementation stage of the 2006 Gallatin Forest Travel Plan, and represents a greatly enhanced, more accurate and complete inventory of current motorized routes (roads and trails) on the landscape. The Gallatin Travel Plan Record of Decision specifies the types of uses to be allowed and managed for on each system road and trail. Actions stemming from implementation of the Travel Plan can be summarized as follows: 1) decommissioning of significant numbers of relic logging routes acquired via land exchanges with Big Sky Lumber Company, 2) decommissioning of some system and most unauthorized motorized routes determined as excess to long-term administrative and recreational needs, 3) construction of some new motorized trails and connector routes where needed to accommodate designated use and discourage unauthorized cross-country travel, and 4) reconstruction of some existing routes to accommodate designated use and or minimize erosion and resource damage. Decommissioned roads were also rehabilitated and stabilized to minimize sedimentation production, restore historic hydrologic function, and encourage re-vegetation. Travel Plan implementation on the Gallatin National Forest resulted in a net increase in secure habitat for all BAUs outside the GBRZ, most notably in the Bozeman, Bridger, and Crazy Mountain BAUs (Table 7).

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Greater Yellowstone Whitebark Pine Monitoring Working Group

2012 ANNUAL REPORT SUMMARY

Monitoring Whitebark Pine in the Greater Yellowstone Ecoregion

Introduction

Whitebark pine (*Pinus albicaulis*) occurs at high-elevations and in subalpine communities in the Pacific Northwest and Northern Rocky Mountains. It is a key component in the upper ranges of these ecosystems where it provides a multitude of ecological functions, including regulating runoff by slowing the progress of snowmelt and providing high energy food sources to birds and mammals.

As a stone pine species, it produces indehiscent cones and relies primarily on birds for seed dispersal. High in calories and rich in fat, these seeds provide seasonal forage for a variety of wildlife. In addition to its ecological importance in high elevation ecosystems, whitebark pine is a revered icon for backcountry explorers and mountain recreationists.

In mixed and dominant stands, whitebark pine occurs in over two million acres within the six national forests and two national parks that comprise the Greater Yellowstone Ecosystem (GYE). Currently, whitebark pine is impacted by multiple ecological disturbances. White pine blister rust (*Cronartium ribicola*), mountain pine beetle (*Dendroctonus ponderosae*), wildfires, and climate change all pose significant threats to the persistence of healthy whitebark pine populations on the landscape. Substantial declines in whitebark pine populations have been documented throughout its range.

Interagency Whitebark Pine Monitoring Program

Under the auspices of the Greater Yellowstone Coordinating Committee (GYCC), the National Park Service Inventory and Monitoring Program and several other agencies began a collaborative, long-term monitoring program to track and document the health and status of whitebark pine across the GYE. This alliance resulted in the formation of the Greater Yellowstone Whitebark Pine Monitoring Working Group (GYWPMWG), which consists of representatives from the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), U.S. Geological Survey (USGS), and Montana State University (MSU).

A protocol for monitoring the health and status of whitebark pine populations in the GYE was developed between 2004 and 2007. After rigorous peer review, the Interagency Whitebark Pine Monitoring Protocol for the Greater Yellowstone Ecosystem received final approval in 2007 and was recently updated in 2011 (GYWPMWG 2011). The complete protocol is available at: https://irma.nps.gov/App/Reference/Profile/660369 (accessed June 13, 2013). This report summary provides an overview of the 2012 annual report which can viewed at https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=471383&file=GRYN_GYE_Whitebark_Pine_2012_Annual_Report.pdf. The full annual report provides more data summary results than what is provided here.

Monitoring Objectives

Generally, the objectives of the whitebark pine monitoring program are to detect and monitor changes in the health and status of whitebark pine populations across the GYE due to infection by white pine blister rust, attack by mountain pine beetle, and damage by other environmental and anthropogenic agents. Specifically, the Interagency Whitebark Pine Monitoring Protocol (GYWPMWG 2011) addresses the following four objectives:

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 effects of white pine blister rust infection rates and severity, mountain pine beetle activity, and fire.

Objective 4 - To assess and monitor recruitment of whitebark pine understory individuals (≤1.4 m tall) into the cone producing population.

Study Area

The 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. The sample frame includes stands of whitebark pine approximately 2.5 ha or greater within and outside of the grizzly bear Recovery Zone (RZ). A total of 10,770 mapped whitebark polygons or stands were identified in the mapping process with 2,362 located within the RZ and 8,408 located outside of the RZ. Stands within the RZ were derived from the cumulative effects model for grizzly bears while outside the RZ, the sample frame includes whitebark stands mapped by each of the six separate USFS units and compiled by the NPS for the cumulative effects model effort (Dixon 1997). Areas that burned between 1971 and 2002 were excluded from the sample frame.

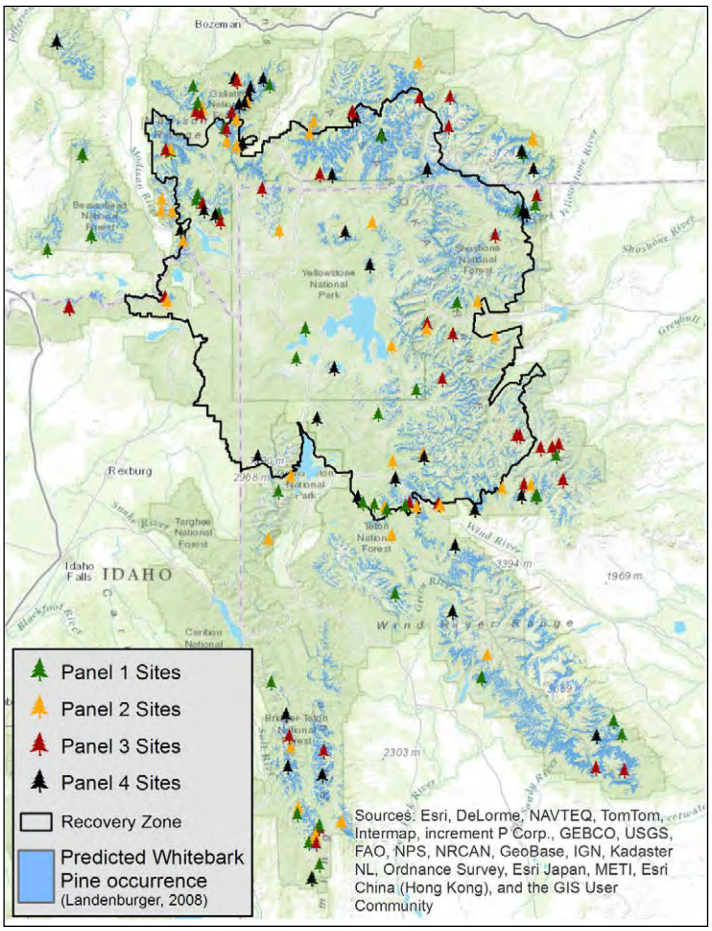

Figure 1. Location of whitebark pine survey transects, Greater Yellowstone Ecosystem.

Methods

Details of the sampling design and field methodology can be found in the Interagency Whitebark Pine Monitoring Protocol for the GYE. The basic approach is a two-stage cluster design with stands of whitebark pine being the primary units and 10x50 m transects being the secondary units. Initial establishment of permanent transects took place

NPS/ERIN SHANAHAN

Whitebark pine monitoring crew on Table Mountain in the Centennial Range of Idaho.

between 2004 and 2007; during this period, 176 permanent transects in 150 whitebark pine stands were established and all 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. During revisits, new trees that grow to 1.4 m tall are tagged and monitored into the future. The sample of 176 transects is a probabilistic sample that provides statistical inference to the GYE.

In 2008, individual transects were randomly assigned to one of four panels; each panel consists of approximately 44 transects. This is the number of transects that can be realistically visited in a given field season by a two-person field crew. Sampling every four years is sufficient to detect change in blister rust infection; however, sites in each panel were surveyed every other year from 2008 through 2012 to incorporate the dynamic nature of the current mountain pine beetle epidemic. These extra surveys focused solely on mountain pine beetle indicators. Both surveys record tree status as live, dead, or recently dead.

Time-Step Assignment

In order to evaluate step-trends in white pine blister rust infection, infection transition, and overall mortality, every four-year revisit period has been classified as a time-step (T#) interval. Time-step 0 (T0) consists of the 176 transects established in the period from 2004 to 2007 and is considered the baseline. Time-step 1 (T1) is comprised of Panels 1 through 4 that were revisited between 2008 and 2011. Time-step 2 (T2) was initiated in 2012 and will be completed in 2015 once all four panels are revisited a second time (Figure 2).

Full Survey: White Pine Blister Rust and Mountain Pine Beetle Surveys (BR&MPB)

During a full survey visit, the presence or absence of white pine blister rust infection is recorded for all live trees in each panel. A tree is considered infected if either aecia or cankers were present. For a canker to be conclusively identified as resulting

Survey Schedule		Time0	Time1				Time2				Continued Monitoring 2016 Forward
Sample Panel	Sites per panel	2004 thru 2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	43	initial surveys for all 176 transects	BR & MPB		MPB only		BR & MPB				
2	45			BR & MPB		MPB only		BR & MPB			
3	44		MPB only		BR & MPB		MPB only		BR & MPB		
4	44			MPB only		BR & MPB		MPB only		BR & MPB	

Figure 2. Panel sampling revisit schedule that includes full surveys for blister rust (BR) and mountain pine beetle (MPB) and mountain pine beetle/mortality only surveys (MPB only). This table denotes the designated time series for each Time-Step assignment (Time0 [T0]: 2004-2007, Time1 [T1]: 2008-2011, Time2 [T2]: 2012-2015).

from white pine blister rust, at least three of five ancillary indicators needed to be present (GYWPMWG 2011). Ancillary indicators of white pine blister rust included flagging, rodent chewing, oozing sap, roughened bark, and swelling (Hoff 1992). For each live tree, pitch tubes and frass are recorded as evidence that the tree had been infested with mountain pine beetle.

Mountain Pine Beetle Only (MPB only)

For mountain pine beetle only/mortality surveys, data are collected solely on mountain pine beetle indicators. Each live tree is examined for pitch tubes and frass, while all dead trees are investigated for J-shaped galleries under the bark.

Recruitment and Understory Individuals

During a full survey visit, all whitebark pine trees ≤1.4 m tall on a given transect are counted and observed for white pine blister rust infection. Once a tree has reached a height greater than 1.4 m, it is permanently tagged and assessed in a manner consistent with all other live, marked trees in the sample frame.

In 2012, Objective 4 of the Interagency Whitebark Pine Monitoring Protocol was initiated to assess and monitor recruitment of whitebark pine understory individuals (≤1.4 m tall) at an enhanced level. This objective was designed and integrated into the established transect surveys as an effort to detect trends in the understory population of whitebark pine. We provide a general description of the methods for measuring recruitment in this report. These methods will be further expanded to include analysis methodology and peer review for inclusion in the protocol.

Results

In 2012, 85 transects were resurveyed between June and September from Panels 1 and 3 by a two-person crew led by the GRYN and another two-person crew led by the USGS Interagency Grizzly Bear Study Team (IGBST). This marks the second revisit to Panel 1 in our time-step series (first panel resurveyed in T2) for full survey data collection (BR and mortality), and the third revisit to Panel 3 for MPB only/mortality.

Status of White Pine Blister Rust

Approximately 885 live tagged trees (including new trees added in 2012) in 43 transects from Panel 1 were examined for BR infection. Results from a paired Student t-test comparing the proportion of trees infected with BR on a transect level for Panel 1 between 2008 and 2012 revealed no significant evidence of a change in the percent of live trees ≥1.4 m tall infected with BR .

Of the 807 trees that were surveyed both in 2008 (T1) and 2012 (T2), approximately 66% (531) had no evidence of blister rust infection, 19% (155) were infected in both years, 7% (59) transitioned from no evidence of infection to infected, and 8% (62) went from infected to uninfected. A transition from infected to uninfected could be the result of factors such as observer error, an earlier-documented infection that upon resurvey no longer meets the established standards of three indicators in the same location rule set, or infected branches that broke and fell off.

Status of Mountain Pine Beetle

Trees in high-elevation forests across the GYE are experiencing elevated mortality as a result of the current mountain pine beetle epidemic. Mountain pine beetle primarily attack whitebark pine trees that are ≥10 cm DBH. Trees that are ≤10 cm DBH are typically not large enough to successfully support mountain pine beetle brood (Amman et al. 1977); consistent with this observation, tree mortality observed in transects was much greater in trees >10 cm DBH. Of the 156 dead trees recorded in 2012, 108 trees (69%) occurred in the >10-30 cm DBH size class, with approximately 56% of those having evidence only of mountain pine beetle infestation.

Similar to white pine blister rust infection, the mountain pine beetle infestation is widespread and varies in severity throughout the GYE. Of the 176 established transects, 123 have recorded evidence of mountain pine beetle infestation while 53 have no observed evidence of mountain pine beetle infestation by the end of 2012 (Figure 3).

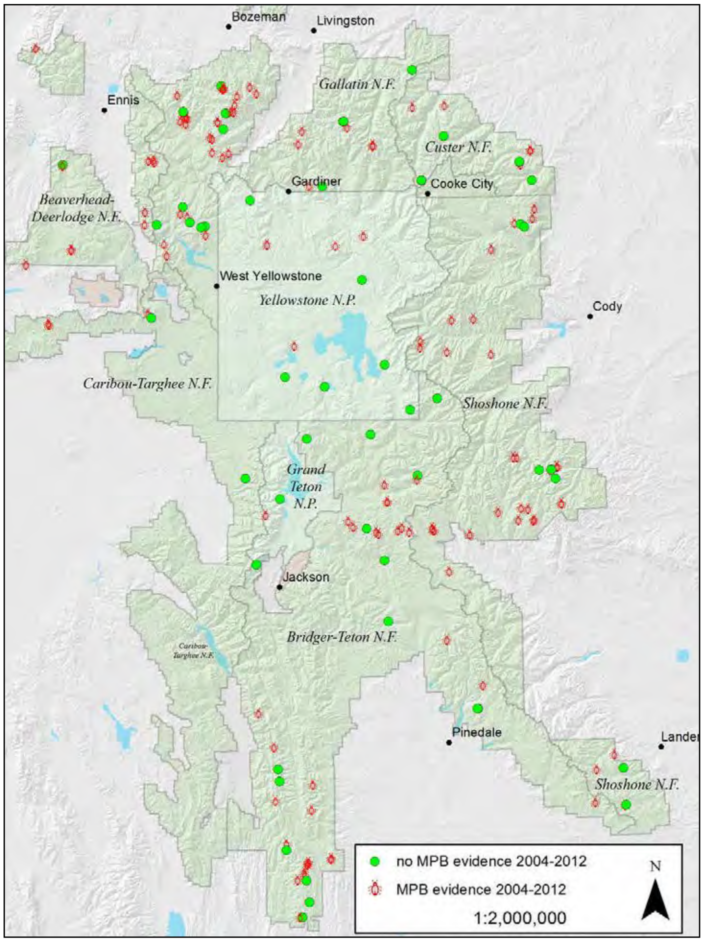

Figure 3. Location of transects throughout the Greater Yellowstone Ecosystem with and without evidence of mountain pine beetle infestation.

Mortality and Recruitment Status

In 2012, we observed a total of 1,801 live tagged trees and 156 newly dead tagged trees from Panels 1 and 3. Trees died with evidence of fire; BR; a combination of fire, MPB, and/or BR; or with other factors, such as wind damage, animal damage, or unknown. Figure 4 presents health indicators that were recorded for each dead tagged tree by DBH size class (<2.5 cm, >2.5-10 cm, >10-30 cm, and >30 cm).

While transects are experiencing varying degrees of mortality, they are also experiencing varying degrees of recruitment. In 2012, we tagged a total of 85 new trees (42 on Panel 1 and 43 on Panel 3) that grew to >1.4 m tall since the last survey visit.

The majority of trees that have been added to the sample frame fall within the ≤2.5 cm DBH size class; this cohort has experienced a net increase of roughly 25%. Based on monitoring observations, trees ≤2.5 cm DBH can reproduce; it will be informative to track how this metric changes as more data are collected in future years, particularly as the mountain pine beetle outbreak wanes.

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Following a successful attack, the canopy of an infested whitebark pine rapidly starts to fade from green to red (upper photo). Mountain pine beetle enter host trees through the bark; and as a defense mechanism, the infested tree will attempt to pitch out the beetle resulting in a pitch tube (lower left). Beetles feed in galleries under the bark of the host tree (below right).

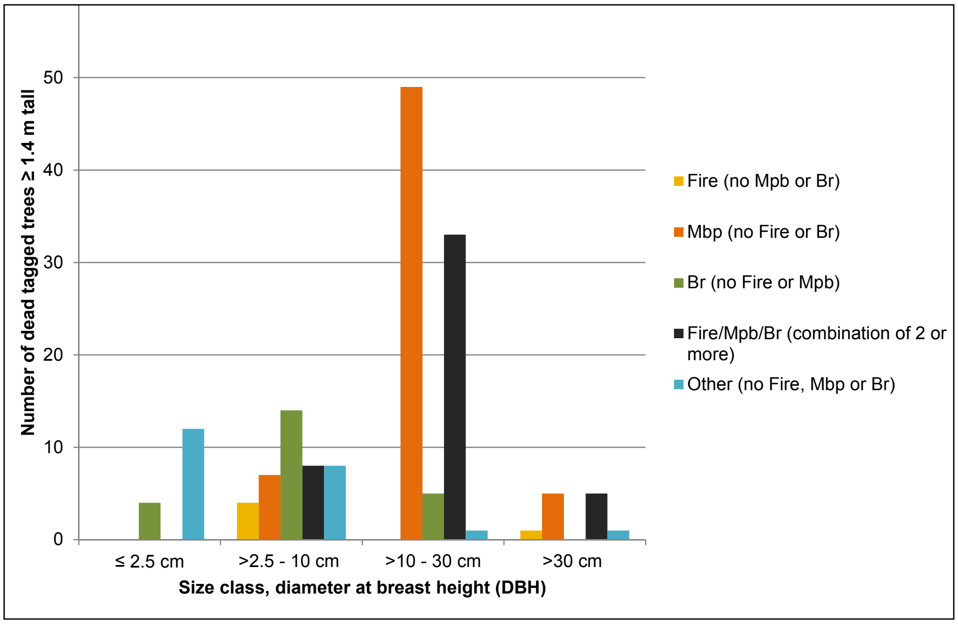

Figure 4. Mortality of tagged trees from 2012 surveys with associated health status indicators. Indicators (fire, mountain pine beetle, white pine blister rust, a combination of the three, or other) were recorded for each dead tagged tree by DBH size class (≤2.5 cm, >2.5-10 cm, >10-30 cm, and >30 cm).

Discussion

Status and trend assessments are more meaningful after many years of monitoring as comparable data accumulate over time. Comparisons of whitebark pine monitoring data from year to year is misleading due to different transects being monitored each year. The reader is cautioned not to draw conclusion about the health and status of whitebark pine in the GYE based solely on this summary report.

Based on 2012 data, white pine blister rust infection remains widespread and variable across the ecosystem. Our proportional estimate of a 20% to 30% infection rate for the GYE reflects the geographical differences that exist throughout the sample frame (Figure 5). Preliminary analysis showed that blister rust infection in Panel 1 transects remained relatively stable with no indication of significant increases or decreases between the 2008 and 2012 surveys. Our data suggest that the rate of mortality of tagged trees has decreased in the transects compared to mortality levels from previous years. These findings lend support to a waning MPB outbreak as articulated by other federal agencies and private entities (Hayes 2013, Olliff et al. 2013).

Following the panel revisit schedule, both Panels 2 and 4 are scheduled for resurvey in 2013. In a deviation from the monitoring schedule, crews will conduct full survey visits on both panels during the 2013 season in order to help determine if the established four-year revisit interval sufficiently captures blister rust infection spread and transition. A step-trend analysis of data collected between 2004 and 2011 will be completed (Irvine et al. in prep, Shanahan et al. in prep). In addition, we will establish whitebark pine monitoring transects on BLM lands in Wyoming following the Interagency Whitebark Pine Monitoring Protocol. And finally, we will continue to collaborate with other research endeavors that are taking place in the ecosystem as well as participate on the Greater Yellowstone Coordinating Committee Whitebark Pine Subcommittee.

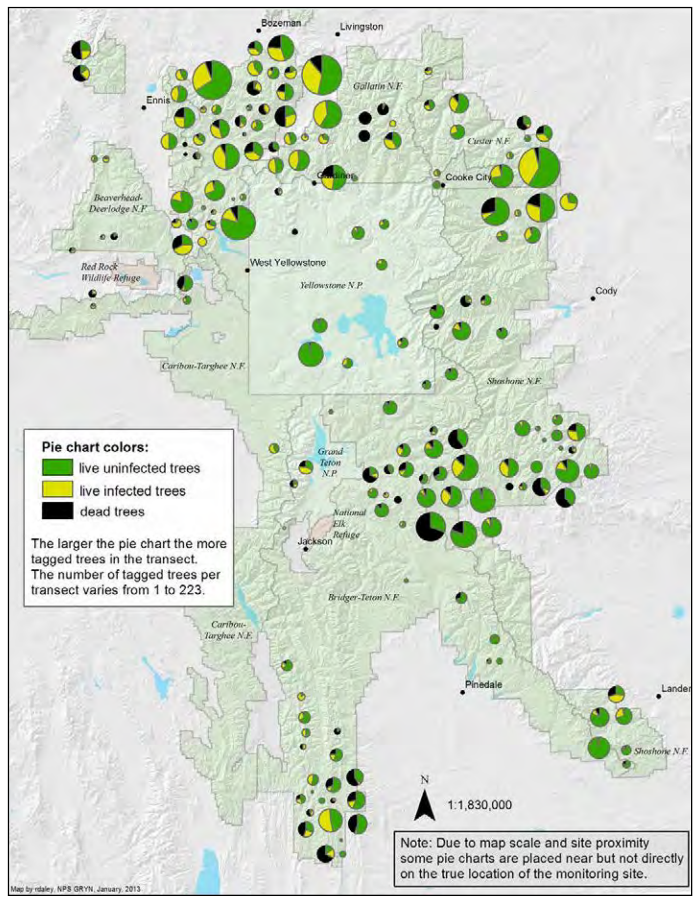

Figure 5. Preliminary map of the ratio of whitebark pine trees within each transect as alive, dead, or with the presence of blister rust infection from surveys 2009-2012. The infection status ranges from a tree with a single canker on a branch to a tree that may have a bole canker.

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Greater Yellowstone Whitebark Pine Monitoring

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