# Yellowstone Grizzly Bear Investigations 2017

## Annual Report of the Interagency Grizzly Bear Study Team

USGS science for a changing world

The research described in this report complied with current laws of the United States of America, was conducted in accordance with animal care and use guidelines, and was approved by Institutional Animal Care and Use Committees of the respective member agencies. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S., State, or Tribal Governments.

Data contained in this report are preliminary and subject to change. Please obtain permission prior to citation. To give credit to authors, please cite the section within this report as a chapter in a book. Below is an example:

Nicholson, J. M., and C. Hendricks. 2018. Human-Grizzly Bear Conflicts in Idaho**.** Pages 75–77 *in* F. T. van Manen, M. A. Haroldson, and B. E. Karabensh, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2017. U.S. Geological Survey, Bozeman, Montana, USA.

Cover photo courtesy of Jake Davis (www.revealedinnature.com)

# YELLOWSTONE GRIZZLY BEAR

# INVESTIGATIONS

Annual Report of the Interagency Grizzly Bear Study Team

2017

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 Bryn E. Karabensh

U.S. Department of the Interior

U.S. Geological Survey

2018

# IGBST PARTNER WEBSITES

Interagency Grizzly Bear Study Team (U.S. Geological Survey):
http://www.usgs.gov/norock/igbst

Grizzly Bear Recovery Program (U.S. Fish and Wildlife Service):
https://www.fws.gov/mountain-prairie/es/grizzlyBear.php

Yellowstone and Grand Teton National Parks (National Park Service):
http://www.nps.gov/yell/planyourvisit/bearsafety.htm
http://www.nps.gov/grte/planyourvisit/bearsafety.htm

Wyoming Game and Fish Department:
https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Large-Carnivore/Grizzly-Bear-Management

Montana Fish, Wildlife and Parks:
http://fwp.mt.gov/fishAndWildlife/livingWithWildlife/grizzlyBears/default.html

Idaho Department of Fish and Game:
http://fishandgame.idaho.gov/public/wildlife/?getPage=248

# TABLE OF CONTENTS

# INTRODUCTION

*Frank T. van Manen and Mark A. Haroldson, Interagency Grizzly Bear Study Team, U.S. Geological Survey*

## 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 2017. This report also contains a summary of grizzly bear management actions to address conflict situations. Annual reports of the IGBST summarize annual data collection. Because additional information may be obtained after publication, data summaries are subject to change. Data, analyses, and summaries presented in this report supersede previously published data and analyses and interpretations may be subject to change contingent on future manuscript publication and the peer review process.

## The More Things Change, the More They Stay the Same

From a policy standpoint, 2017 was a noteworthy year for grizzly bear conservation. A Final Rule to delist the Yellowstone grizzly bear population was published on 30 June 2017 (U.S. Fish and Wildlife Service 2017) and took effect 30 days later, removing federal population protections provided under the Endangered Species Act. We recognize that the delisting of the population may raise concerns among some stakeholders regarding future monitoring and how scientific data are used to inform management. In reference to the subtitle of this section, the delisting marks a distinct shift in management authority from the federal government to the states of Wyoming, Montana, and Idaho, however, the role and responsibilities of IGBST will not change. We reaffirm our commitment to conducting independent science and communicating the findings to managers and the public at large. We emphasize that the IGBST will continue to monitor the population with effort and intensity similar to that of previous years, and as was specified in the 2016 Conservation Strategy, which was developed and signed by members of the Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee (now renamed to the Yellowstone Grizzly Bear Coordinating Committee).

Importantly, another thing that has not changed is the status and trend of the population itself. As you will learn in the subsequent chapters, the population status within the Demographic Monitoring Area (DMA) of the GYE remains stable to increasing. Additional indicators (e.g., new individuals encountered, range expansion, and long-term mortality rates) support that interpretation (see 2016 Annual Report, pages 1–3 for an overview).

## Population Monitoring

We followed monitoring protocols and recovery criteria established under the 2016 Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016). Given that we now operate under updated criteria, we provide the population criteria from the 2016 Conservation Strategy here for reference (slightly edited for clarity):

*Demographic Recovery Criterion 1*—Maintain a minimum population size of 500 animals and at least 48 females with cubs-of-the-year (hereafter, females with cubs) within the DMA (Fig. 1), as calculated by IGBST using methods established in published, peer-reviewed scientific literature and following the most recent protocol, as posted on the IGBST website. The estimate of total population size cannot drop below 500 or 48 females with cubs in three consecutive years. The 48 females with cubs metric is a model-averaged estimate of documented unique females with cubs as described in Appendix C of the Conservation Strategy.

*Demographic Recovery Criterion 2*—Sixteen of 18 bear management units within the Primary Conservation Area must be occupied by females with young, with no two adjacent bear management
units unoccupied, during a 6-year sum of observations. This criterion ensures that reproductive females occupy the majority of the Primary Conservation Area and are not concentrated in one portion of the ecosystem.

*Demographic Recovery Criterion 3*—Maintain the population within the DMA around the 2002–2014 model-averaged Chao 2 estimate of

674 (95% CI = 600–747; 90% CI = 612–735) by maintaining annual mortality limits for independent-age (≥2 years old) females, independent-age males, and dependent young (cubs and yearlings) as shown in Table 2 of the Conservation Strategy. The varying mortality rates were motivated by the objective of state managers to maintain population size near the model-averaged Chao2 population estimate of 674 bears that occurred during the time period the population had a relatively flat population trajectory. If mortality limits are exceeded for any sex or age class for three consecutive years and any annual population estimate falls below 612 (the lower bound of the 90% confidence interval), the IGBST will undertake a Biology and Monitoring Review to inform the appropriate management response. If any annual population estimate falls below 600 (the lower bound of the 95% confidence interval), this criterion will not be met and there will be no discretionary mortality, except as necessary for human safety.

In 2017, the model-averaged Chao2 estimate was 57 females with cubs within the DMA, from which we derived a total population estimate of 718 (see "***Estimating Number of Females with Cubs***". These estimates are similar to those from previous years and continue to support the notion that the population within the DMA may be oscillating around a long-term mean, which we predicted in previous annual reports and other publications (e.g., van Manen et al. 2016). Referencing the total population estimate of 718 against Table 2 of the 2016 Conservation Strategy, total mortality thresholds for independent females, independent males, and dependent young are 9%, 20% and 9%, respectively.

## Habitat Monitoring

In this annual report, we report on items identified in the 2016 Conservation Strategy. This report is also the 10 detailing monitoring programs implemented since the 2007 delisting rule and continues to document: 1) changes in secure habitat, open motorized access route density, and total motorized route density inside the Primary Conservation Area (equivalent to the former U.S. Fish and Wildlife Service Recovery Zone); 2) changes in number and capacity of developed sites inside the Primary Conservation Area; and 3) changes in number of commercial livestock allotments, changes in the number of permitted domestic sheep animal months inside the Primary Conservation Area, and livestock allotments with grizzly bear conflicts during the last 5 years (Appendix A).

Habitat monitoring includes documenting indices of abundance for 3 high-calorie foods throughout the GYE: 1) cutthroat trout (*Oncorhynchus clarkii*) spawning numbers, 2) bear use of army cutworm moth (*Euxoa auxiliaris*) sites, and 3) whitebark pine (*Pinus albicaulis*) cone production. We previously also reported on a fourth high-calorie food source, winter-kill carcasses of large ungulates. That resource was indexed based on spring carcass surveys in Yellowstone National Park. However, we are no longer conducting those surveys. The primary reason for this is the small number of ungulate carcasses observed in recent survey years, which does not produce sufficient data for trend analysis. In this annual report we present a final, summary report of the spring ungulate carcass surveys.

Results of these monitoring efforts have been reported by the IGBST for numerous years and are reported here for 2017. Additionally, monitoring of the health of whitebark pine in the ecosystem continued with the cooperation of the Greater Yellowstone Whitebark Pine Monitoring Working Group. We reference these monitoring efforts in Appendix B. The protocol has been modified to document mortality rate in whitebark pine from all causes, including mountain pine beetle (*Dendroctonus ponderosae*).

## History and Purpose of the IGBST

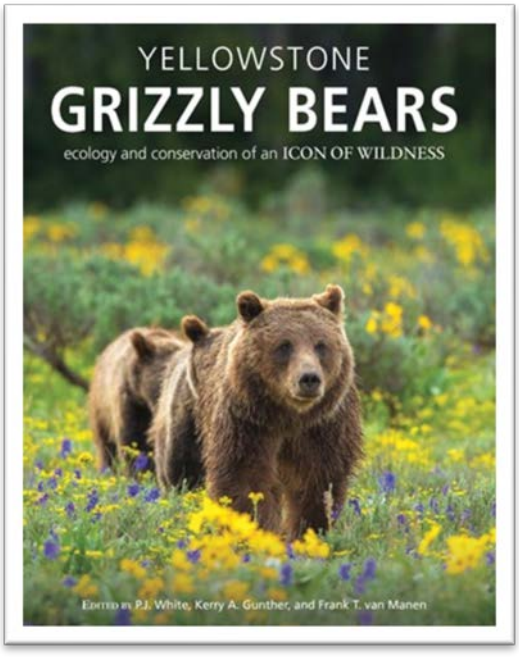
It was recognized as early as 1973 that a better understanding of the dynamics of grizzly bears in the GYE would best be accomplished by a centralized research group responsible for collecting, managing, analyzing, and distributing information. To meet this need, agencies formed the IGBST, a cooperative effort among the U.S. Geological Survey, National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, 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.usgs.gov/norock/igbst.

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 duplication of effort, and pools limited economic and personnel resources.

**Previous and Recent Research**

Since 1975, the IGBST has produced annual reports and numerous scientific publications summarizing the team's monitoring and research efforts within the GYE. Descriptions of the study area and sampling techniques are reported by Blanchard (1985), Mattson et al. (1991*a*), Haroldson et al. (1998), and Schwartz et al. (2006). A new book published by Yellowstone Forever




and the U.S. Geological Survey (White et al. 2017) provides a comprehensive overview of the ecology and management history of Yellowstone grizzly bears: *Yellowstone Grizzly Bears – Ecology and Conservation of an Icon of Wildness.* From the closures of open-pit garbage dumps to the recent delisting, the book provides a richly illustrated and accessible resource for anyone interested in the natural history of Yellowstone's iconic species and the most recent research findings from the IGBST. The book can be purchased from Yellowstone Forever and is also available free as a PDF file.

Development and enhancement of data collection and analysis techniques continues. As our summaries of recent longitudinal studies underscore, through long-term research and monitoring we continue to collect detailed data to support a variety of analyses, providing researchers and managers with a comprehensive assessment of population dynamics. We are currently in the process of re-evaluating criteria for the rule set to identify unique females with cubs. We are also collaborating with other researchers to develop integrated population models, or IPMs, which would take advantage of the full suite of data we collect on an annual basis. By integrating different data, our goal is to improve the reliability and precision of estimates of population size and trend.

Finally, a recent IGBST collaboration with the Northern Continental Divide Ecosystem (NCDE) Science Team (Peck et al. (2017) focused on identifying potential movement paths for male grizzly bears between the NCDE and GYE populations. Connectivity between these 2 populations is a management objective of both state and federal wildlife managers and would enhance the genetic health of the GYE population. The study used GPS-derived movement data from male grizzly bears and step-selection habitat models to predict likely paths. Our findings (Fig. 1) provide detailed, spatially explicit information for land managers and organizations working to identify, prioritize, and conserve areas that will maintain or enhance potential movement of male grizzly bears between these populations (e.g., through conservation easements and land purchases; mitigation of highway and other infrastructure barriers; proactive education and attractant management programs to prevent or reduce human–bear conflict).

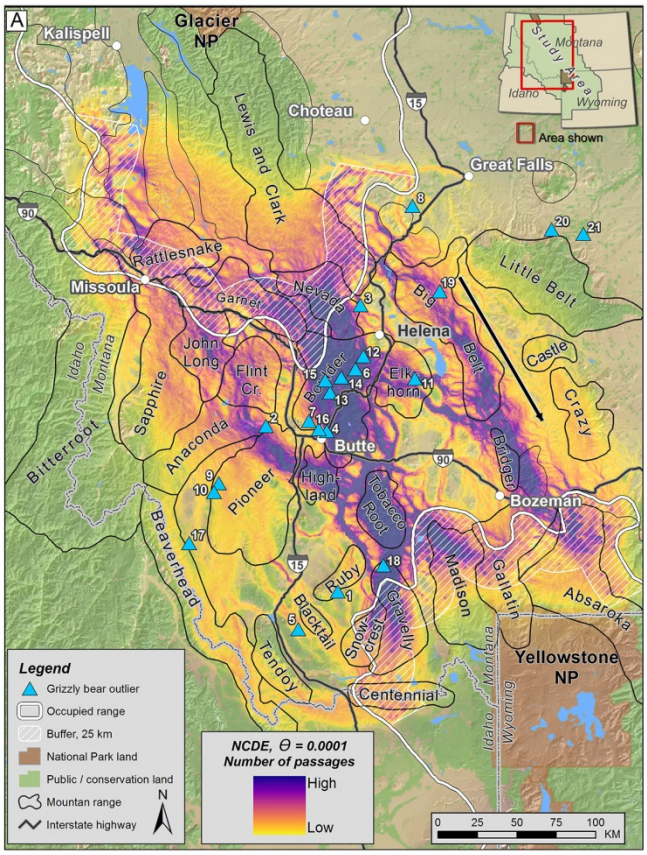



*Fig. 1. Predictions of randomized shortest paths (RSP) from the Northern Continental Divide Ecosystem (NCDE) to the Greater Yellowstone Ecosystem (GYE) based on data from GPS-collared, independent-age (≥2 years old) males monitored during 2000–2015. Shown are predicted paths with the highest level of exploration versus optimal movement (θ = 0.0001). Locations of 21 confirmed records of grizzly bear presence are shown as blue triangles. From Peck et al. (2017).*

## Acknowledgments

This report is a combined effort of the partner agencies and individual members of the IGBST and many individuals contributed directly or indirectly to its preparation. To that end, we have identified author(s). Additionally, we wish to thank the following individuals for their contributions to data collection, analysis, and other phases of IGBST research. **IDFG**: C. Anderson, P. Atwood, J. Beer, C. Bleke, J. Brower, L. Cepenzski, D. Cureton, J. Farr, K. Garrett, K. Guy, C. Hendricks, R. Howe, C. Johnson, L. Lane, G. Losinski, A. McKarley, J. Nicholson, T. Nicholson, M. Pieron, R. Poole, M. Proett, J. Rydalch, J. White: **MSU**: M. Higgs; **MTFWP**: S. Brozovich, K. Carson, C. Costello, J. Cunningham, D. Fagone, J. Feddes, K. Frey, M. Heaton, B. Lloyd, R. Pickens, R. Pohle, J. Ramsey, J. Smith, D. Scott, S. Stewart, M. Wemple, D. Waltee; **NPS** N. Adams, G. Angelo, B. Apel, K. Atkins, B. Bennett, J. Bennett, D. Bergum, N. Bowersock, E. Boyd, C. Butler, M.K. Clark, S. Consolo-Murphy, R. Coscarelli, S. Dewey, C. Donovan, J.Erwin, R. Evans, C. Flaherty, C. Greenbaum, S. Greenbaum, G. Grieco, K. Gunther, D. Gustine, C. Hayden, T. Hayden, A. Hanna, K. Harrigan, D. Harris, S. Hegg, B. Helms, D. Houck, J. Jakicic, B. Johns, E. Johnston, P. Kirchner, M. Landry, C. Liesen, J. Lodge, E. Maki, T.J. Mascia, R. Mascia, S. Mayberry, J. Mills, J. Mohr, J. Moul, L. Muir, P. Navaille, S. Nestler, E. Reinertson, M. Renteria, T. Ritter, A. Rodriguez, J. Roper, W. Scherer, D. Schneider, C. Schoner, P. Schoner, J. Schwabedissen, M. Scott, D. Stahler, P. Stalker, J. Stephenson, L. Stevenson, B. Swift, B. Tatu, T. Tatu, S. Stewart, L. Templin, C. Valdez, J. Warren, G. White, A. Willemain, C. Willemain, J. Willemain, K. Wilmot, G. Wilson, L. Wofford, R. Wofford, M. Wrigley, T. Wyman, A. Zuckerman; **Pilots and Observers**: S. Ard, N. Cadwell, J. Ortman, M. Packila, K. Robinson, J. Romero, T. Schell; **Shoshone and Arapaho Tribes**: J. Friday, A. Lawson, B. Snyder; **USFS**: J. Brandl, S. Derusseau, L. Dickerson, S. Halman, A. Pils, S. Pils, C. Pultz, D. Tyers, L. Raadt; **USFWS** S. Becker, Hilary Cooley, L. Connell, J. Fortin-Noreus, P. Hnilicka, M. Mazur, C. Servheen, S. Stoinski; **USGS**: D. Dickinson, M. Ebinger, M. Kurzen, V. Villalobos, C. Whitman; **WS**: K. Glazier, T.J. Dorvall, C. Hoover, J. Meitdke, G. McDougal, J. Rost, D. Tidwell; **WGFD:** G. Anderson, C. Atkinson, B. Baker, D. Bjornlie, M. Boyce, J. Clapp, D. Clause, A. Courtemanch, L. Ellsbury, Z. Gregory, H. Haley, A. Johnson, R. Kinderman, J. Kraft, B. Kroger, K. Lash, D. McWhirter, K. Mills, T. Mong, P. Quick, S. Ryder, J. Stephens, S. Stephens, D. Thompson, Z. Turnbull. Without the collection efforts, contributions, and dedication of all these people, the information contained within this report would not be available.

# BEAR MONITORING AND POPULATION TREND

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

During the 2017 field season, we captured 87 individual grizzly bears on 99 occasions (Table 1), including 26 females (11 adult), 54 males (34 adult) and 7 bears (6 yearlings, 1 subadult) of unknown sex that were released without handling. Fifty-eight (67%) individuals were bears not previously marked. The percent of previously unmarked individual grizzly bears captured annually during 1998–2017 has remained relatively constant, averaging 62%, with no evidence ($F$ = 0.263, 1 df, $P$ = 0.614) of a change in trend (Fig. 2). This result suggests that bears are recruiting into the population at a relatively constant rate. In this closed population, we would expect the number of new individuals encountered annually to decline if bears were not recruiting into the population.

We conducted research capture efforts for a total 779 trap days (1 trap day = 1 trap set for 1 day). Research trapping operations resulted in 62 captures of 53 individual grizzly bears for a trapping success rate of 1 grizzly bear capture every 12.6 trap days.

There were 37 management captures of 35 individual bears during 2017 (Tables 1 and 2), including 8 females (2 adults), and 27 males (13 adults). Fifteen individual bears (3 females, 12 males), were relocated because of conflict situations (Table 1). One subadult male (#904, Table 1) was transported after capture at a cattle depredation site; he subsequently returned to the vicinity of his initial conflict site, was captured at a second cattle depredation and subsequently removed. Another adult male (#736, Table 1) captured in the vicinity of cattle depredations was instrumented and released on site. Additional cattle depredations confirmed his involvement and he was removed from the population. In total there were 16 management captures that resulted in removals (2 females, 14 males) during 2017 (Table 1). One 27-year-old male (#228, Table 1) was captured twice at research trap sites in May and was later removed after breaking into multiple buildings and obtaining food rewards in October.

We radiomonitored 111 individual grizzly bears during the 2017 field season, including 48 (34 adults) females (Tables 2 and 3). Fifty-eight grizzly bears entered their winter dens wearing active transmitters. Since 1975, 907 individual grizzly bears have been radiomarked in the GYE.

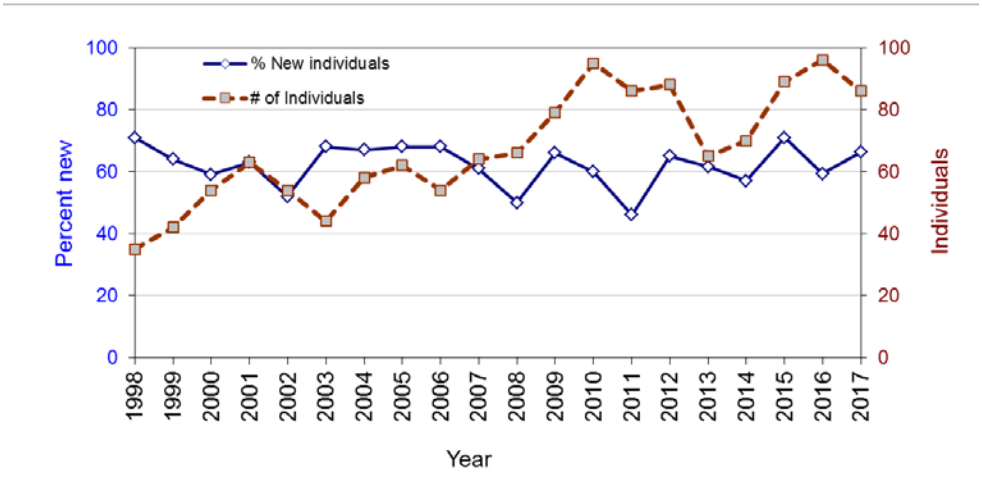



*Fig. 2. Percent of previously unmarked (new individuals) and total number of grizzly bears captured annually in the Greater Yellowstone Ecosystem, 1998–2017.*

| Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem during 2017. | | | | | | | |
|---|---|---|---|---|---|---|---|
| Bear | Sex | Age | Date | General location[a] | Capture type | Release site[a] | Handler[b] |
| Unm1 | Male | Subadult | 03/24/17 | Greybull River, PR-WY | Management | Removed (201701) | WGFD |
| 877 | Male | Subadult | 04/12/17 | Dell Crk, PR-WY | Management | Removed (201702) | WGFD |
| G223 | Female | Yearling | 04/22/17 | Jakeys Fork, PR-WY | Management | On site | WGFD |
| G224 | Male | Yearling | 04/23/17 | Jakeys Fork, PR-WY | Management | On site | WGFD |
| 884 | Male | Adult | 04/29/17 | Pat O'Hara Crk, PR-WY | Management | Transport | WGFD |
| G225 | Male | Subadult | 05/09/17 | South Fork Shoshone, PR-WY | Management | Transport | WGFD |
| G226 | Male | Subadult | 05/10/17 | South Fork Shoshone, PR-WY | Management | Transport | WGFD |
| 885 | Male | Adult | 05/10/17 | South Fork Shoshone, PR-WY | Management | Transport | WGFD |
| 630 | Male | Adult | 05/19/17 | Antelope Crk, YNP | Research | On site | IGBST |
| 886 | Female | Subadult | 05/22/17 | Carter Crk, PR-WY | Management | Transport | WGFD |
| 887 | Male | Adult | 05/22/17 | Elk Crk, YNP | Research | On site | IGBST/YNP |
| 228 | Male | Adult | 05/24/17 | Stephens Crk, YNP | Research | On site | IGBST |
| 228 | Male | Adult | 05/25/17 | Stephens Crk, YNP | Research | On site | IGBST |
| 228 | Male | Adult | 10/14/17 | Grayling Crk, PR-MT | Management | Removed (201735) | MTFWP |
| 888 | Male | Adult | 05/25/17 | Gibbon River, YNP | Research | On site | IGBST |
| 888 | Male | Adult | 06/05/17 | Gibbon River, YNP | Research | On site | IGBST |
| 889 | Male | Subadult | 06/01/17 | Horse Crk, SNF | Research | On site | WGFD |
| 890 | Male | Subadult | 06/02/17 | Buck Crk, PR-WY | Management | Transport | WGFD |
| 769 | Male | Adult | 06/05/17 | Stephens Crk, YNP | Research | On site | IGBST |
| 891 | Male | Adult | 06/05/17 | Charlie Crk, SNF | Research | On site | WGFD |
| 892 | Male | Adult | 06/08/17 | East Fork Long Crk | Research | On site | WGFD |
| G227 | Male | Subadult | 06/11/17 | Brent Crk, PR-WY | Research | On site | WGFD |
| G228 | Male | Adult | 06/12/17 | Frontier Crk, SNF | Research | On site | WGFD |
| 893 | Female | Adult | 06/16/17 | Charlie Crk, SNF | Research | On site | WGFD |
| 894 | Male | Adult | 06/16/17 | Horse Crk, SNF | Research | On site | WGFD |
| 695 | Male | Adult | 06/16/17 | Gibbon River, YNP | Research | On site | IGBST |
| 227 | Male | Adult | 06/16/17 | Gibbon River, YNP | Research | On site | IGBST |
| 227 | Male | Adult | 07/09/17 | Henrys Fork, CTNF | Research | On site | IDFG |
| 227 | Male | Adult | 07/12/17 | Warm River, CTNF | Research | On site | IDFG |
| 227 | Male | Adult | 07/13/17 | Warm River, CTNF | Research | On site | IDFG |
| 227 | Male | Adult | 07/14/17 | Warm River, CTNF | Research | On site | IDFG |
| 895 | Female | Adult | 06/18/17 | Tappen Crk, SNF | Research | On site | WGFD |
| G229 | Male | Subadult | 06/19/17 | East Fork Long Crk, SNF | Research | On site | WGFD |
| 896 | Female | Subadult | 06/20/17 | Tappen Crk, SNF | Research | On site | WGFD |
| G230 | Male | Adult | 06/23/17 | Horse Crk, SNF | Research | On site | WGFD |
| 816 | Male | Adult | 06/30/17 | Trout Crk, SNF | Research | On site | WGFD |
| 897 | Male | Adult | 06/30/17 | Standard Crk, BDNF | Research | On site | IGBST |
| 898 | Female | Adult | 06/30/17 | Trout Crk, SNF | Research | On site | WGFD |

**Table 1. Continued.**

| Bear | Sex | Age | Date | General location[a] | Capture type | Release site[a] | Handler[b] |
|---|---|---|---|---|---|---|---|
| 786 | Female | Adult | 07/01/17 | Papoose Crk, PR-MT | Research | On site | IGBST |
| Unm2 | Unk | Yearling | 07/02/17 | Enos Crk, SNF | Research | On site | WGFD |
| Unm12 | Unk | Yearling | 07/02/17 | Enos Crk, SNF | Research | On site | WGFD |
| 899 | Female | Subadult | 07/08/17 | Warm River, CTNF | Research | On site | IDFG |
| 899 | Female | Subadult | 08/04/17 | Warm River, CTNF | Research | On site | IDFG |
| 824 | Male | Adult | 07/09/17 | West Goosewing Crk, BTNF | Management | Removed (201710) | WGFD |
| 900 | Female | Subadult | 07/10/17 | Beauty Crk, BTNF | Research | On site | WGFD |
| 736 | Male | Adult | 07/11/17 | West Fork Madison, BDNF | Management | On site | WS |
| 736 | Male | Adult | 08/21/17 | West Fork Madison, BDNF | Management | Removed (201720) | WS |
| 653 | Male | Adult | 07/12/17 | Henrys Fork, CTNF | Research | On site | IDFG |
| 653 | Male | Adult | 08/12/17 | Bootjack Crk, CTNF | Research | On site | IDFG |
| G231 | Female | Subadult | 07/12/17 | Beauty Crk, BTNF | Research | On site | WGFD |
| 902 | Male | Adult | 07/14/17 | Papoose Crk, PR-MT | Research | On site | IGBST |
| 485 | Female | Adult | 07/15/17 | Gneiss Crk, YNP | Research | On site | IGBST |
| 903 | Female | Adult | 07/17/17 | Jesse Crk, CTNF | Research | On site | IDFG |
| 904 | Male | Adult | 07/19/17 | Green River, BTNF | Management | Transport | WGFD |
| 904 | Male | Adult | 09/12/17 | Mosquito Lake, BTNF | Management | Removed (201726) | WGFD |
| 905 | Female | Adult | 07/20/17 | Beauty Crk, BTNF | Research | On site | WGFD |
| 825 | Male | Adult | 07/21/17 | Green River, BTNF | Management | Removed (201712) | WGFD |
| 880 | Male | Subadult | 07/21/17 | Green River, BTNF | Management | Transport | WGFD |
| 763 | Male | Adult | 07/27/17 | Enget Crk, CTNF | Research | On site | IDFG |
| 906 | Female | Adult | 07/29/17 | East Fork Cream Crk, CGNF | Research | On site | IGBST |
| 907 | Female | Subadult | 07/31/17 | Meadow Crk, CGNF | Research | On site | IGBST |
| 908 | Male | Subadult | 07/31/17 | East Fork Cream Crk, CGNF | Research | On site | IGBST |
| 909 | Female | Subadult | 08/02/17 | East Fork Cream Crk, CGNF | Research | On site | IGBST |
| G130 | Male | Adult | 08/02/17 | North Fork Owl Crk, PR-WY | Management | Removed (201713) | WGFD |
| 910 | Male | Subadult | 08/04/17 | Eldridge Crk, CGNF | Research | On site | IGBST |
| 866 | Male | Subadult | 08/05/17 | Gypsum Crk, BTNF | Management | Removed (201716) | WGFD |
| Unm3 | Unk | Yearling | 08/07/17 | Henrys Fork, CTNF | Research | On site | IDFG |
| 911 | Female | Subadult | 08/10/17 | Buck Crk, CGNF | Research | On site | IGBST |
| 912 | Female | Subadult | 08/10/17 | Eldridge Crk, CGNF | Research | On site | IGBST |
| 711 | Male | Adult | 08/10/17 | Warm River, CTNF | Research | On site | IDFG |
| Unm4 | Male | Yearling | 08/10/17 | Camp Crk, SNF | Management | Removed (201718) | WGFD |
| Unm5 | Male | Yearling | 08/09/17 | Camp Crk, SNF | Management | Removed (201719) | WGFD |
| 810 | Male | Adult | 08/11/17 | Greybull River, PR-WY | Management | Transport | WGFD |
| G232 | Male | Subadult | 08/12/17 | Eldridge Crk, CGNF | Research | On site | IGBST |
| Unm6 | Unk | Yearling | 08/12/17 | Meadow Crk, CGNF | Research | On site | IGBST |
| Unm7 | Unk | Yearling | 08/12/17 | Meadow Crk, CGNF | Research | On site | IGBST |
| 720 | Female | Adult | 08/18/17 | Wigwam Crk, CGNF | Management | On site | WS |
| 913 | Female | Subadult | 08/23/17 | Wyoming Crk, CTNF | Research | On site | IDFG |

**Table 1. Continued.**

| Bear | Sex | Age | Date | General location[a] | Capture type | Release site[a] | Handler[b] |
|---|---|---|---|---|---|---|---|
| 914 | Female | Adult | 08/25/17 | Bootjack Crk, CTNF | Research | On site | IDFG |
| Unm8 | Unk | Yearling | 08/13/17 | Warm River, CTNF | Research | On site | IDFG |
| Unm9 | Unk | Yearling | 08/16/17 | Henrys Fork, CTNF | Research | On site | IDFG |
| G205 | Male | Subadult | 09/08/17 | Heart Lake, YNP | Management | Removed (201722) | IGBST/YNP |
| G213 | Female | Subadult | 09/09/17 | Greybull River, PR-WY | Management | Removed (201723) | WGFD |
| 915 | Female | Adult | 09/14/17 | Wagon Crk, BTNF | Management | Transport | WGFD |
| Unm10 | Male | Subadult | 09/24/17 | Green River, BTNF | Management | Removed (201727) | WGFD |
| 394 | Male | Adult | 09/26/17 | Jasper Crk, YNP | Research | On site | IGBST |
| 916 | Male | Adult | 09/27/17 | South Fork Shoshone, PR-WY | Management | Transport | WGFD |
| G233 | Female | Yearling | 09/30/17 | North Fork Shoshone, SNF | Management | On site | WGFD |
| 917 | Male | Adult | 09/30/17 | Bull Crk, PR-WY | Management | Transport | WGFD |
| 516 | Male | Adult | 10/02/17 | Oxbow Crk, YNP | Research | On site | YNP |
| 516 | Male | Adult | 10/12/17 | Jasper Crk, YNP | Research | On site | IGBST |
| 918 | Male | Subadult | 10/03/17 | North Fork Shoshone, PR-WY | Management | Transport | WGFD |
| 704 | Male | Adult | 10/07/17 | Jasper Crk, YNP | Research | On site | IGBST |
| 919 | Female | Subadult | 10/17/17 | Pat O'Hara Crk, PR-WY | Management | Transport | WGFD |
| 789 | Male | Adult | 10/20/17 | Snake River, GTNP | Research | On site | GTNP |
| 772 | Male | Adult | 10/25/17 | North Fork Shoshone, SNF | Management | On site | WGFD |
| Unm11 | Female | Subadult | 10/25/17 | Aspen Crk, SNF | Management | Removed (201743) | WGFD |
| 542 | Male | Adult | 11/02/17 | Carter Crk, PR-WY | Management | Removed (201751) | WGFD |
| 920 | Male | Subadult | 10/03/17 | North Fork Shoshone, PR-WY | Management | Transport | WGFD |

[a] BLM = Bureau of Land Management; BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, CGNF = Custer-Gallatin National Forest, SNF = Shoshone National Forest, YNP = Yellowstone National Park, WRIR = Wind River Reservation, PR = private; removals show mortality number (see Table 16) in parentheses or under the bear number column for unmarked bears.

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

**Table 2. Annual number of grizzly bears monitored, captured, and transported in the Greater Yellowstone Ecosystem, 1980–2017.**

| Year | Number monitored | Individuals trapped | Total captures | | Transports |
|---|---|---|---|---|---|
| | | | Research | Management | |
| 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 | 56 | 35 |
| 2013 | 88 | 65 | 58 | 30 | 20 |
| 2014 | 94 | 70 | 51 | 30 | 20 |
| 2015 | 101 | 89 | 34 | 72 | 41 |
| 2016 | 106 | 96 | 59 | 49 | 18 |
| 2017 | 99 | 87 | 62 | 37 | 15 |

| Table 3. Grizzly bears radiomonitored in the Greater Yellowstone Ecosystem during 2017. | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Monitored | | Current |
| Bear | Sex | Age | Offspring[a] | Out of den | Into den | status |
| 227 | M | Adult | | Yes | No | Cast |
| 228 | M | Adult | | No | No | Removed |
| 394 | M | Adult | | No | | Den/cast? |
| 399 | F | Adult | 2 cubs | Yes | Yes | Active |
| 427 | M | Adult | | Yes | No | Cast |
| 439 | F | Adult | 3 cubs | Yes | No | Cast |
| 468 | M | Adult | | Yes | | Active |
| 485 | F | Adult | 3 cubs, 3 lost | No | No | Killed |
| 506 | M | Adult | | Yes | Yes | Active |
| 516 | M | Adult | | No | Yes | Active |
| 630 | M | Adult | | No | | Cast |
| 653 | M | Adult | | Yes | Yes | Active |
| 676 | F | Adult | 1 yearling, lost? | Yes | Yes | Active |
| 678 | F | Adult | 2 cubs, 1 lost? | Yes | Yes | Active |
| 679 | M | Adult | | Yes | Yes | Active |
| 695 | M | Adult | | No | Yes | Active |
| 711 | M | Adult | | No | No | Killed |
| 728 | F | Adult | 3 2-year olds, weaned | Yes | No | Cast |
| 736 | M | Adult | | No | No | Removed |
| 743 | F | Adult | 2 2-year olds, weaned | Yes | Yes | Active |
| 747 | F | Adult | 2 cubs | Yes | No | Cast |
| 749 | F | Adult | None | Yes | Yes | Active |
| 762 | F | Adult | None | Yes | Yes | Active |
| 763 | M | Adult | | No | Yes | Active |
| 772 | M | Adult | | No | Yes | Active |
| 773 | F | Adult | None | Yes | Yes | Active |
| 782 | M | Adult | | Yes | No | Cast |
| 786 | F | Adult | 1 cub, lost | Yes | Yes | Active |
| 788 | M | Adult | | Yes | No | Probable battery failure |
| 789 | M | Adult | | No | Yes | Active |
| 799 | F | Adult | 2 yearlings | No | No | Dead |
| 800 | F | Adult | None | Yes | No | Cast |
| 803 | M | Adult | Not seen | No | No | Dead |
| 808 | M | Subadult | | Yes | No | Cast |
| 810 | M | Adult | | No | Yes | Active |
| 815 | F | Adult | 1 yearling | Yes | Yes | Active |
| 816 | M | Adult | | No | No | Cast |
| 819 | M | Adult | | Yes | No | Cast |
| 824 | M | Adult | | Yes | No | Removed |
| 825 | M | Adult | | Yes | No | Removed |
| 828 | M | Adult | | Yes | No | Cast |
| 831 | F | Adult | 1 2-year old, weaned | Yes | No | Cast |
| 833 | F | Adult | 2 cubs, 1 lost | Yes | Yes | Active |

**Table 3. Continued.**

| Bear | Sex | Age | Offspring[a] | Monitored | | Current status |
|---|---|---|---|---|---|---|
| | | | | Out of den | Into den | |
| 840 | M | Adult | | Yes | No | Cast |
| 842 | M | Adult | | Yes | No | Cast |
| 848 | F | Adult | 1 2-year old, weaned | Yes | Yes | Active |
| 851 | F | Adult | 2 cubs | Yes | Yes | Active |
| 852 | M | Adult | | Yes | No | Cast |
| 853 | M | Adult | | Yes | Yes | Active |
| 855 | M | Adult | | Yes | No | Cast |
| 856 | M | Adult | | Yes | No | Cast |
| 857 | F | Adult | 3 cubs, lost 1 | Yes | Yes | Active |
| 858 | M | Adult | | Yes | No | Cast |
| 859 | M | Subadult | | Yes | No | Cast |
| 861 | F | Adult | 2 cubs, lost 2 | Yes | No | Dead |
| 863 | F | Subadult | None | Yes | Yes | Active |
| 864 | F | Adult | None | Yes | No | Cast |
| 865 | M | Subadult | | Yes | No | Cast |
| 866 | M | Subadult | | Yes | No | Removed |
| 867 | F | Subadult | None | Yes | Yes | Active |
| 868 | F | Adult | None | Yes | Yes | Active |
| 869 | F | Adult | 2 3-year olds, weaned | Yes | Yes | Active |
| 870 | M | Subadult | | Yes | No | Cast |
| 871 | F | Adult | 2 yearlings | Yes | No | Killed |
| 872 | M | Adult | | Yes | No | Cast |
| 873 | M | Adult | | Yes | No | Cast |
| 875 | F | Adult | 3 cubs, 1 lost | Yes | Yes | Active |
| 876 | F | Subadult | None | Yes | Yes | Active |
| 877 | M | Subadult | | Yes | No | Removed |
| 878 | M | Adult | | Yes | Yes | Active |
| 879 | M | Subadult | | Yes | Yes | Active |
| 880 | M | Subadult | | Yes | Yes | Active |
| 881 | M | Adult | | Yes | No | Cast |
| 882 | M | Adult | | Yes | No | Cast |
| 883 | F | Subadult | None | Yes | Yes | Active |
| 884 | M | Adult | | No | No | Cast |
| 885 | M | Adult | | No | No | Cast |
| 886 | F | Subadult | None | No | Yes | Active |
| 887 | M | Adult | | No | No | Cast |
| 888 | M | Adult | | No | Yes | Active |
| 889 | M | Yearling | | No | No | Cast |
| 890 | M | Subadult | | No | Yes | Active |
| 891 | M | Adult | | No | No | Cast |
| 892 | M | Adult | | No | No | Cast |
| 893 | F | Adult | None | No | Yes | Active |
| 894 | M | Adult | | No | No | Cast |
| 895 | F | Adult | None | No | Yes | Active |
| 896 | F | Subadult | None | No | Yes | Active |
| 897 | M | Adult | | No | No | Cast |

**Table 3. Continued.**

| Bear | Sex | Age | Offspring[a] | Monitored | | Current status |
|---|---|---|---|---|---|---|
| | | | | Out of den | Into den | |
| 898 | F | Adult | 2 yearlings | No | Yes | Active |
| 899 | F | Subadult | None | No | Yes | Active |
| 900 | F | Yearling | (Mom - #905) | No | Yes | Active |
| 902 | M | Adult | | No | Yes | Active |
| 903 | F | Adult | 3 cubs, 3 lost | No | No | Killed |
| 904 | M | Subadult | | No | No | Removed |
| 905 | F | Adult | 3 yearlings (1 - #900) | No | Yes | Active |
| 906 | F | Adult | 2 yearlings | No | Yes | Active |
| 907 | F | Subadult | None | No | Yes | Active |
| 908 | M | Subadult | | No | Yes | Active |
| 909 | F | Subadult | None | No | Yes | Active |
| 910 | M | Subadult | | No | No | Cast |
| 911 | F | Subadult | None | No | Yes | Active |
| 912 | F | Subadult | None | No | Yes | Active |
| 913 | F | Subadult | None | No | Yes | Active |
| 914 | F | Adult | 2 cubs | No | Yes | Active |
| 915 | F | Adult | Not seen | No | Yes | Active |
| 916 | M | Adult | | No | Yes | Active |
| 917 | M | Adult | | No | Yes | Active |
| 918 | M | Subadult | | No | Yes | Active |
| 919 | F | Subadult | None | No | Yes | Active |
| 920 | M | Subadult | | No | | Missing |

***Estimating Number of Females with Cubs*** *(Mark A. Haroldson and Frank T. van Manen, Interagency Grizzly Bear Study Team, U.S. Geological Survey; and Daniel D. Bjornlie, Wyoming Game and Fish Department)*

## I. Assessing Trend and Estimating Population Size from Observations of Unique Females with Cubs

### Background

Under the 2016 Conservation Strategy for the grizzly bears in the GYE (Yellowstone Ecosystem Subcommittee 2016), IGBST is tasked with annually estimating the number of female grizzly bears with cubs in the GYE population, determining trend for this segment of the population, and estimating size of specific population segments to assess annual mortalities relative to population size. Here, we present our 2017 findings for counts of unique females with cubs, and the population estimate derived from numbers of females with cubs observed within the Demographic Monitoring Area (DMA) based on the most recent vital rates from the period 2002–2011 (IGBST 2012).

### Methods

Specific procedures used to accomplish the above-mentioned tasks under the previous protocols are presented in IGBST (2005, 2006) and Harris et al. (2007). Under these protocols only females with cubs observed within the DMA (Fig. 3) are counted for the Chao2 estimate. The most recent vital rates and ratios for numerical estimation of specific population segments are provided in IGBST (2012).
Briefly, the Knight et al. (1995) rule set is used to estimate the number of unique females with cubs 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 number of females with cubs present in the population. Next, we estimate trend and rate of change ($\lambda$) for the number of unique females with cubs 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. Model $AIC_c$ (Akaike Information Criterion) weight 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 unique females with cubs ($\hat{N}_{MAFC}$) are expected with each additional year of data. Retrospective adjustments to previous estimates are not done (IGBST 2006).
Demographic Recovery Criterion 1 specifies a minimum of 48 females with cubs for the current year ($\hat{N}_{MAFC}$) (Yellowstone Ecosystem Subcommittee 2016). Given the assumption of a reasonably stable sex and age structure, trend for the females with cubs 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 $\hat{N}_{MAFC}$ and the estimated stable age distribution for the population. Estimates for specific population segments and associated confidence intervals follow IGBST (2005, 2006) for the previous protocol and IGBST (2012) for the updated protocol, which incorporates observed changes in vital rates during 2002–2011 and is based on the DMA. In modeling the rate of change (trend) of females with cubs as described in the Supplement to the Reassessing Methods Document (IGBST 2006), if the $AIC_c$ weight favors the quadratic term and corresponding $\Delta AIC_c \geq 2.0$ compared with the linear model for 3 consecutive years, a full review of the population's demographics will be undertaken to better understand its status (Yellowstone Ecosystem Subcommittee 2016).

### 2017 Sightings of Females with Cubs and number Unique

We documented 180 verified sightings of females with cubs during 2017 in the GYE. Nearly twice as many observations of females with cubs were obtained from aerial sources (63.9%) than from ground observers (36.1%, Table 4). We were

able to differentiate 58 unique females with cubs from the 180 sightings using the rule set described by Knight et al. (1995). Four sightings (2.2%) from 3 unique females occurred outside the DMA (Fig. 3). One of the 58 unique females was only observed ($n$ = 1 sightings) outside the DMA. Thirty-three (18.3%) observations from an estimated 14 unique females with cubs occurred within the boundary of Yellowstone National Park (YNP).

The total number of cubs observed during initial sightings of the 58 unique females with cubs was 115 and mean litter size was 1.98 (Table 5). There were 15 single cub litters, 30 litters of twins, and 12 litters of triplets, and 1 litter of quadruplets (Table 5). Including only initial observations that occurred inside the DMA, there were 57 unique females with a total of 113 cubs and a mean litter size of 1.98.

2017 DMA Chao2 and Population Estimate

Excluding the 4 sightings (1 female) observed outside the DMA, there were 125 observations of 53 families obtained without the aid of telemetry. Using sighting frequencies for these families produced an estimate for unique females with cubs within the DMA of $\hat{N}_{DMAChao2}$ = 64. Using this estimate in our linear and quadratic regression analyses produced a model-averaged estimate for 2017 of $\hat{N}_{DMAChao2}$ = 57 (95% CI = 45–71). This estimate does not retrospectively exclude unique families observed outside the DMA for years prior to 2012. However, if those sighting of unique families observed outside the DMA were excluded, changes in our estimates of trend and population size would be small because nearly all females with cubs are sighted within the DMA. This was especially true during years prior to 2012 (IGBST 2012). Applying the updated 2002–2011 vital rates to $\hat{N}_{DMAChao2}$ produces a total population estimate for the DMA of 718 (Table 7).

We used the annual $\hat{N}_{Chao2}$ for the DMA during the period 1983–2017 (Table 6) to evaluate trend for the female with cubs segment of the population (Fig. 4). With the 2017 addition, $AIC_c$ weights (Table 8) continue to support for the quadratic (86.8%) over the linear (13.2%) model. The estimated quadratic effect ($\beta$ = -0.00098) was statistically significant ($P$ = 0.017, Table 8). We note that findings from Schwartz et al. (2008) indicated the number of unique females with cubs estimated using the Knight et al. 1995 method is biased low and becomes more biased with increasing population size. We again observed strong support for a leveling off of population growth for the more restricted geographic area of the DMA; this was not unexpected and is consistent with other results. Indeed, linear regression of $\hat{N}_{Chao2}$ values with year for the period 2002–2017 shows no support for either a positive or negative trend ($F$ = 1.590, 1 df, $P$ = 0.228).

**Table 4. Method of observation for female grizzly bears with cubs sighted in the Greater Yellowstone Ecosystem, 2017.**

| Method of observation | Frequency | % | Cumulative % |
|---|---|---|---|
| Fixed wing aircraft – other researcher | 5 | 2.8 | 2.8 |
| Fixed wing aircraft – observation flight | 50 | 27.8 | 30.6 |
| Fixed wing aircraft – telemetry flight | 56 | 31.1 | 61.7 |
| Fixed wing aircraft – ferry time | 2 | 1.1 | 62.8 |
| Helicopter – other researcher | 2 | 1.1 | 63.9 |
| Ground sighting | 64 | 35.6 | 99.5 |
| Trap | 1 | 0.5 | 100 |
| Total | 180 | 100 | |

**Table 5. Number of unique females with cubs ( $\hat{N}_{Obs}$), litter frequencies, total number of cubs, and average litter size at initial observation, Greater Yellowstone Ecosystem, 1983–2017.**

| Year | $\hat{N}_{Obs}$ | Total no. of sightings | Litter size | | | | Total no. of cubs | Mean litter size |
|---|---|---|---|---|---|---|---|---|
| | | | 1 cub | 2 cubs | 3 cubs | 4 cubs | | |
| 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 |
| 2013 | 58 | 183 | 8 | 35 | 14 | 3 | 126 | 2.17 |
| 2014 | 50 | 119 | 16 | 22 | 12 | 0 | 96 | 1.92 |
| 2015 | 46 | 156 | 15 | 17[b] | 14[b] | 0 | 91[b] | 1.98[b] |
| 2016 | 50 | 144 | 15 | 22 | 13 | 0 | 98 | 1.96 |
| 2017 | 58 | 180 | 15 | 30 | 12 | 1 | 115 | 1.98 |

[a] One female with unknown number of cubs; average litter size was calculated based on 23 females.
[b] Corrected values for 2015; online version of 2015 Annual Report has also been corrected.

**Table 6. Annual Chao2 estimates for the numbers of female grizzly bears with cubs in the Greater Yellowstone Ecosystem, 1983–2017. Estimates in parenthesis for 2012–2017 are specific to the Demographic Monitoring Area (DMA). The number of unique females observed ( $\hat{N}_{Obs}$ ) includes those located using radio telemetry; *m* is the number of unique females observed using random sightings only; and $\hat{N}_{Chao2}$ gives the nonparametric bias-corrected estimate, per Chao (1989). Also included are the number of females with cubs sighted once ($f_1$) or twice ($f_2$), and the annual estimate of relative sample size ( $n/\hat{N}_{Chao2}$ ), where *n* is the total number of observations obtained without the aid of telemetry. Female with cubs sighted ≥3 time can be derived ($f_3+ = m - (f_1 + f_2)$).**

| 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 | 3.0 |
| 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 | 2.0 |
| 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 | 2.0 |
| 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 (48) | 44 (43) | 16 (15) | 7 (7) | 59 (56) | 110 (108) | 1.9 (1.9) |
| 2013 | 58 (57) | 53 (52) | 13 (14) | 11 (11) | 60 (60) | 160 (152) | 2.6 (2.5) |
| 2014 | 50 (47) | 46 (44) | 23 (21) | 13 (13) | 64 (59) | 92 (90) | 1.4 (1.5) |
| 2015 | 46 (44) | 43 (41) | 14 (13) [a] | 10 (11) [a] | 51 (47) [a] | 135 (131) | 2.6 (2.8) |
| 2016 | 50 (45) | 50 (45) | 15 (12) | 15 (13) | 56 (50) | 129 (121) | 2.3 (2.4) |
| 2017 | 58 (57) | 54 (53) | 19 (19) | 16 (15) | 64 (64) | 127 (125) | 2.0 (1.9) |

[a] Corrected sighting frequencies and Chao2 estimate in 2015; online version of 2015 Annual Report has also been corrected.

**Table 7. Estimates and 95% confidence intervals (CI) for population segments and total grizzly bear population size derived using the Chao2 estimate for females with cubs within the Demographic Monitoring Area, 2017.**

| | | 95% CI | |
|---|---|---|---|
| Segment | Estimate | Lower | Upper |
| Independent females (≥2 years old) | 250 | 199 | 301 |
| Independent males (≥2 years old) | 250 | 195 | 305 |
| Dependent young (cubs and yearlings) | 217 | 196 | 238 |
| Total | 718 | 640 | 796 |

**Table 8. Parameter estimates and model selection results from fitting linear and quadratic models for $Ln(\hat{N}_{Chao2})$ (number of female grizzly bears with cubs) with year for the time period 1983–2017. During 2012–2017, Chao2 estimates were restricted to the Demographic Monitoring Area.**

| Model | Parameter | Estimate | Standard error | *t* value | *P* |
|---|---|---|---|---|---|
| Linear | | | | | |
| | $\beta_0$ | 3.00866 | 0.07795 | 38.60 | <0.0001 |
| | $\beta_1$ | 0.03404 | 0.00378 | 9.01 | <0.0001 |
| | SSE | 1.68029 | | | |
| | $AIC_c$ | -99.50 | | | |
| | $AIC_c$ weight | 0.132 | | | |
| | | | | | |
| Quadratic | | | | | |
| | $\beta_0$ | 2.79168 | 0.11254 | 24.81 | <0.0001 |
| | $\beta_1$ | 0.06922 | 0.01441 | 4.80 | <0.0001 |
| | $\beta_2$ | -0.00098 | 0.00039 | -2.52 | 0.017 |
| | SSE | 1.40267 | | | |
| | $AIC_c$ | -103.261 | | | |
| | $AIC_c$ weight | 0.868 | | | |

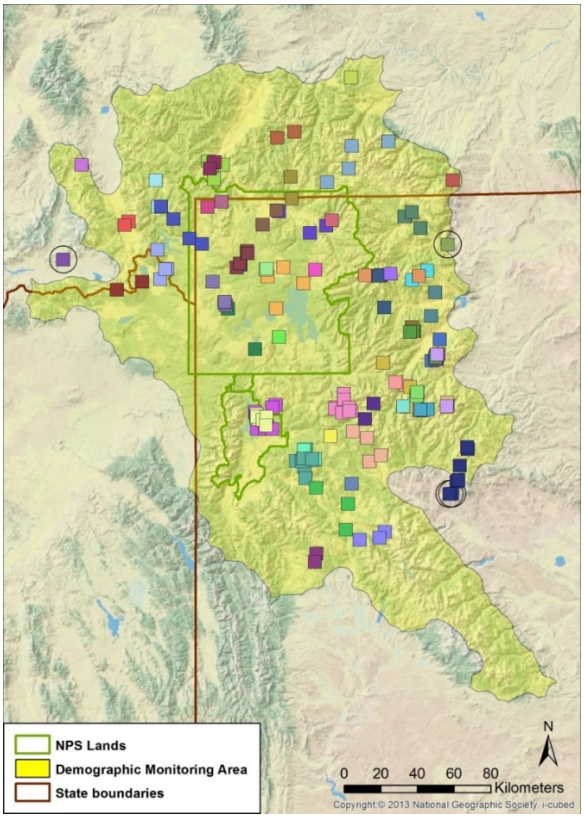



*Fig. 3. Distribution of 180 sightings of 58 (indicated by unique colors) unduplicated female grizzly bears with cubs observed in the Greater Yellowstone Ecosystem, 2017. Only sightings from females with cubs occurring within the Demographic Monitoring Area (DMA) are used for population estimation. During 2017, 4 sightings (black circles around symbols) from 3 unique females with cubs occurred outside the DMA. One of these females (1 observation) was only observed outside the DMA.*

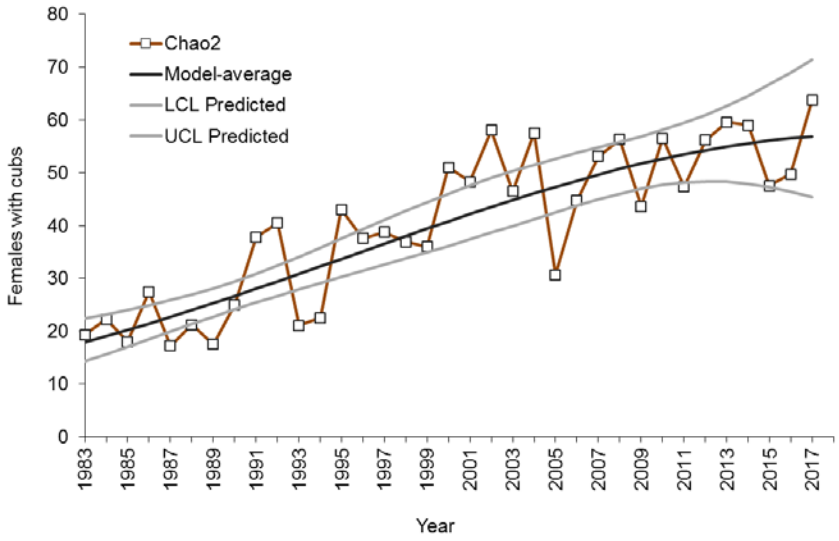



*Fig. 4. Model-averaged estimates for the number of unique female grizzly bears with cubs, 1983–2017, where the linear and quadratic models of* $Ln(\hat{N}_{Chao2})$ *were fitted. Estimates for 2012–2017 were restricted to the Demographic Monitoring Area (DMA). The inner set of light solid lines represents a 95% confidence interval on the predicted population size.*

## II. Mark-Resight Technique to Estimate Females with Cubs

Schwartz et al. (2008) demonstrated biases inherent in the method of estimating population size based on the Chao2 estimator (see previous section) using counts of unique females with cubs and the associated rule set of Knight et al. (1995). The 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. An important product of these workshops was a recommendation to use systematic flight observation data conducted since 1997. The mark-resight estimator yields an annual estimate of the number of females with cubs 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 cubs, 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 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 cubs suffer from both limitations. As an important outcome of the 3 workshops, Higgs et al. (2013) developed a technique to overcome difficulties due to data 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 cubs as multinomial random variables, using the capture frequencies of marked females with cubs for inference regarding the latent multinomial frequencies for unmarked females with cubs (Fig. 5).

One important assumption of the mark-resight technique is that the geographic distribution of radio-marked female bears is generally representative of the geographic distribution and relative density of female bears in the population. Conclusions from workshop discussions were that this assumption is likely not violated within the GYE, with one exception. A subset of bears in the southeastern portion of 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. 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 limited due to high spring runoff. 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 cubs 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 aerial census surveys of confirmed moth sites to add the observed number of females with cubs (marked and unmarked) to the mark-resight estimate for that year.

Higgs et al. (2013) performed simulations based on a known population of 50 females with cubs and resighting frequencies and proportions of bears sighted 0, 1, and 2 times from the observation flight 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 low. In our 2015 annual report, Peck (2016, Appendix C) reported on poor ability of the mark-resight technique to detect declines of 1% and 2% per year, but was moderately effective at detecting a 5% per year decline in annual estimates of females with cubs. Although the IGBST concluded that this was insufficient for effective monitoring of population trend, we continue applying the method because it does provide relatively unbiased

estimates and would likely detect large changes in numbers of females with cubs.

2017 Mark-Resight Results

Six female grizzly bears with cub(s) wore functioning radio-transmitters during June-August 2017 when aerial observation flights were conducted and were available for sighting. Two of these 6 families were observed once each during observation flights >500 m from a moth site. The 4 other radio-marked females with cubs were not sighted during observation fights. All 6 females were included in the Mark-Resight analysis. We observed 18 unmarked females with cubs >500 m from moth sites (Table 9). Using the method of Higgs et al. (2013) with updated 1997–2017 data, and excluding observations at army cutworm moth aggregation sites, our 2017 mark-resight estimate for unique females with cubs was 75 (95% inter-quartile range = 41–126) with a low probability of ≤48 females with cubs ($P < 0.070$; Table 10). The mark-resight 3-year-moving average for 2016 (i.e., using 2015–2017 results) was 82 unique females with cubs (95% inter-quartile range = 54–124), with a $P = 0.010$ probability of ≤48 females with cubs (Table 11, Fig. 5). We did not conduct moth site-only flights to count females with cubs on army cutworm moth aggregation sites during 2017.

**Table 9. Data used in mark-resight analysis on female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1997–2017, including number of radio-marked female grizzly bears available for sighting during observation flights (*m*), the number seen zero time ($Y_0$), seen once ($Y_1$), the number seen twice ($Y_2$), and the number of unmarked females bears with cubs (*S*). Estimates exclude females with cubs observed <500 m of army cutworm moth aggregation sites.**

| Year | *m* | $Y_0$ | $Y_1$ | $Y_2$ | *S* |
|---|---|---|---|---|---|
| 1997 | 6 | 4 | 2 | 0 | 4 |
| 1998 | 4 | 2 | 2 | 0 | 7 |
| 1999 | 6 | 5 | 1 | 0 | 7 |
| 2000 | 7 | 7 | 0 | 0 | 11 |
| 2001 | 8 | 4 | 4 | 0 | 17[a] |
| 2002 | 5 | 5 | 0 | 0 | 29[a] |
| 2003 | 4 | 3 | 1 | 0 | 7 |
| 2004 | 4 | 2 | 2 | 0 | 20 |
| 2005 | 3 | 3 | 0 | 0 | 14 |
| 2006 | 7 | 7 | 0 | 0 | 23[a] |
| 2007 | 5 | 3 | 2 | 0 | 23[b] |
| 2008 | 5 | 3 | 1 | 1 | 19[a] |
| 2009 | 6 | 6 | 0 | 0 | 14 |
| 2010 | 3 | 3 | 0 | 0 | 23[a] |
| 2011 | 3 | 2 | 1 | 0 | 16 |
| 2012 | 5 | 3 | 2 | 0 | 12 |
| 2013 | 10 | 10 | 0 | 0 | 28 |
| 2014 | 5 | 4 | 1 | 0 | 12 |
| 2015 | 1 | 0 | 1 | 0 | 22 |
| 2016 | 2 | 1 | 1 | 0 | 19 |
| 2017 | 6 | 4 | 2 | 0 | 18 |

[a] Numbers decreased from 2013 data due to boundary changes of moth sites.

[b] Numbers increased from 20 to 23 due to boundary changes of moth sites.

**Table 10. Results from mark-resight analysis of female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1997–2017. Data from all years were used to inform sightability, and previous years' posterior distributions were updated based on data from radio-marked females with cubs in 2017. Estimates exclude females with cubs observed <500 m of army cutworm moth aggregation sites.**

| | | | | | Quartile | | |
|---|---|---|---|---|---|---|---|
| Year | Sighted | Marked | Mean | Median | 0.025 | 0.975 | $P \leq 48$ |
| 1997 | 4 | 6 | 17 | 15 | 5 | 37 | 0.99 |
| 1998 | 7 | 4 | 29 | 27 | 12 | 57 | 0.93 |
| 1999 | 7 | 6 | 29 | 27 | 12 | 57 | 0.93 |
| 2000 | 11 | 7 | 46 | 44 | 22 | 83 | 0.60 |
| 2001 | 17 | 8 | 71 | 68 | 38 | 119 | 0.11 |
| 2002 | 29 | 5 | 121 | 117 | 72 | 192 | 0.00 |
| 2003 | 7 | 4 | 29 | 27 | 12 | 57 | 0.93 |
| 2004 | 20 | 4 | 83 | 80 | 47 | 138 | 0.03 |
| 2005 | 14 | 3 | 58 | 56 | 30 | 101 | 0.30 |
| 2006 | 23 | 7 | 96 | 92 | 55 | 156 | 0.01 |
| 2007 | 23 | 5 | 96 | 93 | 55 | 156 | 0.01 |
| 2008 | 19 | 5 | 79 | 76 | 44 | 132 | 0.04 |
| 2009 | 14 | 6 | 58 | 56 | 30 | 101 | 0.30 |
| 2010 | 23 | 3 | 96 | 93 | 55 | 155 | 0.01 |
| 2011 | 16 | 3 | 67 | 64 | 36 | 113 | 0.16 |
| 2012 | 12 | 5 | 50 | 48 | 25 | 88 | 0.49 |
| 2013 | 28 | 10 | 117 | 113 | 69 | 186 | 0.00 |
| 2014 | 12 | 5 | 50 | 48 | 25 | 88 | 0.50 |
| 2015 | 22 | 1 | 92 | 88 | 52 | 150 | 0.01 |
| 2016 | 19 | 2 | 79 | 76 | 44 | 132 | 0.04 |
| 2017 | 18 | 6 | 75 | 72 | 41 | 126 | 0.07 |

*Observation of a female grizzly bear and a single cub in the Greater Yellowstone Ecosystem. (photo courtesy of Jake Davis/revealedinnature.com)*

**Table 11. Three-year moving average for mark-resight estimates of female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1998–2016. Estimates exclude females with cubs observed <500 m of army cutworm moth aggregation sites.**

| | | | | Quartile | | |
|---|---|---|---|---|---|---|
| Year | Mean | Median | Mode | 0.025 | 0.975 | $P \leq 48$ |
| 1998 | 25 | 24 | 23 | 14 | 42 | 0.99 |
| 1999 | 35 | 34 | 31 | 20 | 56 | 0.92 |
| 2000 | 49 | 47 | 44 | 30 | 76 | 0.54 |
| 2001 | 79 | 77 | 75 | 51 | 120 | 0.01 |
| 2002 | 74 | 72 | 67 | 47 | 112 | 0.03 |
| 2003 | 78 | 76 | 70 | 50 | 118 | 0.02 |
| 2004 | 57 | 55 | 53 | 36 | 88 | 0.27 |
| 2005 | 79 | 77 | 71 | 51 | 120 | 0.01 |
| 2006 | 83 | 81 | 76 | 54 | 126 | 0.01 |
| 2007 | 90 | 88 | 81 | 59 | 136 | 0.00 |
| 2008 | 78 | 76 | 72 | 50 | 118 | 0.02 |
| 2009 | 78 | 76 | 72 | 50 | 117 | 0.02 |
| 2010 | 74 | 72 | 70 | 47 | 111 | 0.03 |
| 2011 | 71 | 69 | 68 | 45 | 108 | 0.05 |
| 2012 | 78 | 76 | 72 | 50 | 118 | 0.02 |
| 2013 | 72 | 70 | 65 | 46 | 110 | 0.04 |
| 2014 | 86 | 84 | 81 | 56 | 130 | 0.00 |
| 2015 | 74 | 72 | 68 | 47 | 112 | 0.03 |
| 2016 | 82 | 80 | 79 | 53 | 124 | 0.01 |

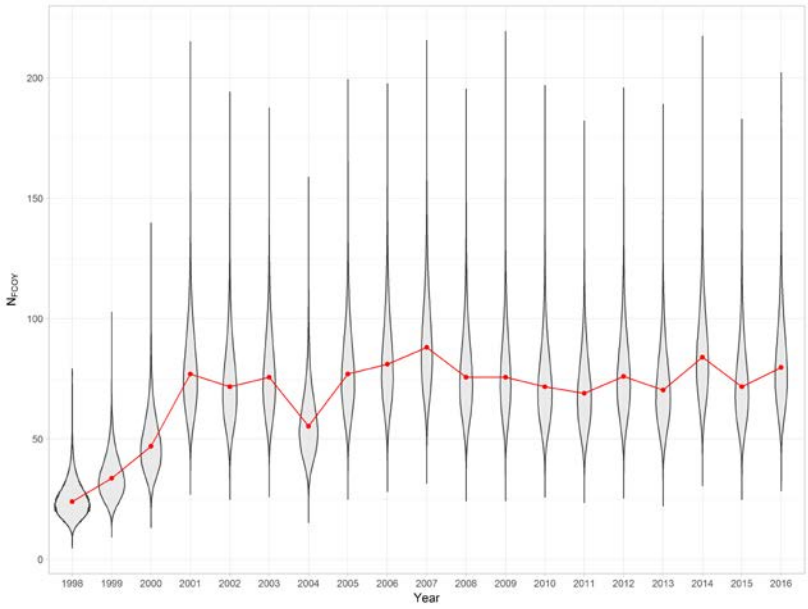



*Fig. 5. Annual mark-resight estimates (3-year moving average [red dots], 95 % inter quartile [gray area]) of the number of female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1998–2016. Estimates exclude females with cubs observed <500 m of army cutworm moth aggregation sites.*

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

Dispersion of reproductive females throughout the ecosystem is assessed by verified observations of female grizzly bears with young (cubs, yearlings, 2-year-olds, or young of unknown age) by BMU. The second demographic recovery criterion specified in 2016 Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016) states 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. Seventeen of 18 BMUs had verified observations of female grizzly bears with young during 2017 (Table 12). Eighteen of 18 BMUs contained verified observations of females with young in at least 3 years of the last 6-year (2012–2017) period.

**Table 12. Bear Management Units in the Greater Yellowstone Ecosystem occupied by females with young (cubs, yearlings, 2-year-olds, or young of unknown age), as determined by verified reports, 2012–2017.**

| Bear Management Unit | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Years occupied |
|---|---|---|---|---|---|---|---|
| 1) Hilgard | X | X | X | X | X | X | 6 |
| 2) Gallatin | X | X | X | X | X | X | 6 |
| 3) Hellroaring/Bear | X | X | X | X | X | X | 6 |
| 4) Boulder/Slough | X | X | X | X | X | X | 6 |
| 5) Lamar | X | X | X | X | X | X | 6 |
| 6) Crandall/Sunlight | X | X | X | X | X | X | 6 |
| 7) Shoshone | X | X | X | X | X | X | 6 |
| 8) Pelican/Clear | X | X | X | X | X | X | 6 |
| 9) Washburn | X | X | X | X | X | X | 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 | X | 5 |
| 14) Two Ocean/Lake | X | X | X | X | X | X | 6 |
| 15) Thorofare | X | X | X | X | X | X | 6 |
| 16) South Absaroka | X | X | X | X | X | X | 6 |
| 17) Buffalo/Spread Creek | X | X | X | X | X | X | 6 |
| 18) Bechler/Teton | | X | X | | X | | 3 |
| Total | 15 | 18 | 18 | 17 | 18 | 17 | |

***Observation Flights*** *(Bryn E. Karabensh, Interagency Grizzly Bear Study Team, U.S. Geological Survey)*

Fifty-four Bear Observation Areas (BOAs, Fig. 6) were established in 2014. In 2017, two rounds of observation flights were conducted: 54 BOAs were surveyed during Round 1 (1 Jun–31 Aug) and 40 during Round 2 (4 Jul–28 Aug). One BOA, 48B was flown once (round 2). Total duration of observation flight time was 105.5 hours for Round 1 and 79.04 hours for Round 2; average duration of individual flights was 1.96 hours (Table 13). Excluding dependent young, 371 bear sightings were recorded during observation flights. This included 19 radio-marked bears (4 females with young, 11 females without young, and 4 males), 280 solitary unmarked bears, and 72 unmarked females with young (Table 13). Our observation rate was 2 bears/hour for all bears. A total of 139 young (94 cubs, 35 yearlings, and 10 2-year-olds) were observed (Table 14). Observation rates for females with dependent young were 0.40 females with young/hour and 0.27 females with cubs/hour (Table 13).

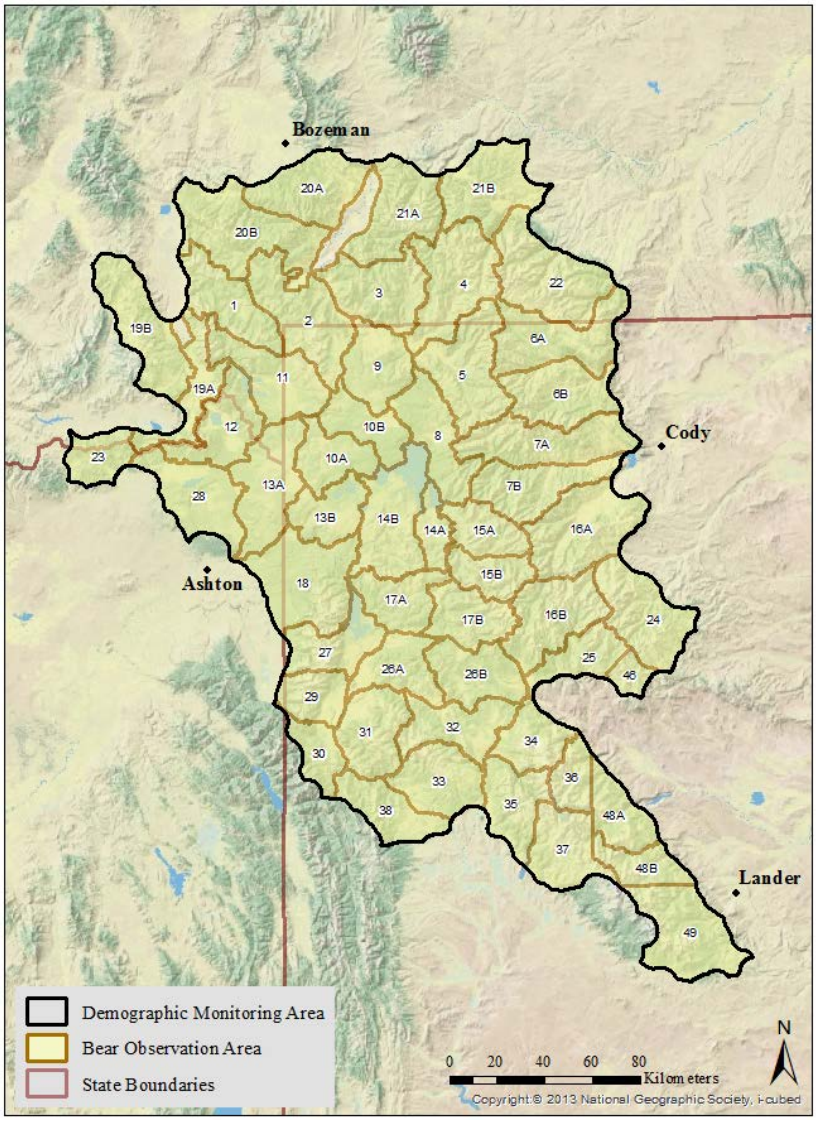



*Fig. 6. Grizzly bear observation areas for aerial surveys, Greater Yellowstone Ecosystem, 2017. Numbers represent the 54 Bear Observation Areas, with several larger areas split into 2 sections (A and B).*

**Table 13. Annual summary statistics for grizzly bear observation flights, Greater Yellowstone Ecosystem, 2002–2017.**

| Date | Observation period | Total hours | Number of flights | Average hours/flight | Bears seen | | | | | Observation rate (bears/hour) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Marked | | Unmarked | | Total number of groups | All groups | With young | With cubs |
| | | | | | Lone | With young | Lone | With young | | | | |
| 2002[a] | Round 1 | 84 | 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 | 1.8 | 0.49 | 0.4 |
| 2003[a] | 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 | 72 | 2.1 | 3 | 1 | 147 | 51 | 202 | 1.31 | 0.34 | 0.17 |
| 2004[a] | 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[a] | 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[a] | Round 1 | 89.3 | 37 | 2.4 | 2 | 1 | 106 | 35 | 144 | 1.61 | | |
| | Round 2 | 77 | 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[a] | Round 1 | 99 | 44 | 2.3 | 2 | 1 | 125 | 53 | 181 | 1.83 | | |
| | Round 2 | 75.1 | 30 | 2.5 | 0 | 4 | 96 | 20 | 120 | 1.6 | | |
| | Total | 174.1 | 74 | 2.4 | 2 | 5 | 221 | 73 | 301 | 1.73 | 0.45 | 0.29 |
| 2008[a] | 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[a] | Round 1 | 90.3 | 47 | 1.9 | 1 | 0 | 85 | 21 | 107 | 1.18 | | |
| | Round 2 | 93.6 | 47 | 2 | 2 | 0 | 157 | 34 | 193 | 2.06 | | |
| | Total | 183.9 | 94 | 2 | 3 | 0 | 242 | 55 | 300 | 1.63 | 0.3 | 0.15 |
| 2010[a] | Round 1 | 101.1 | 48 | 2.1 | 0 | 2 | 93 | 22 | 117 | 1.16 | | |
| | Round 2 | 93.3 | 46 | 2 | 0 | 0 | 161 | 41 | 202 | 2.17 | | |
| | Total | 194.4 | 94 | 2.1 | 0 | 2 | 254 | 63 | 319 | 1.64 | 0.33 | 0.2 |
| 2011[a] | Round 1 | 88.9 | 47 | 1.9 | 2 | 1 | 153 | 31 | 187 | 2.1 | | |
| | Round 2 | 71 | 35 | 2 | 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[a] | Round 1 | 95.4 | 48 | 2 | 4 | 2 | 178 | 35 | 219 | 2.3 | | |
| | Round 2 | 73.7 | 35 | 2.1 | 2 | 1 | 117 | 30 | 150 | 2.04 | | |
| | Total | 169.1 | 83 | 2 | 6 | 3 | 295 | 65 | 369 | 2.18 | 0.4 | 0.23 |
| 2013[a] | Round 1 | 97 | 48 | 2 | 2 | 1 | 152 | 44 | 199 | 2.05 | | |
| | Round 2 | 72.8 | 35 | 2.1 | 4 | 1 | 171 | 48 | 224 | 3.08 | | |
| | Total | 169.8 | 83 | 2.1 | 6 | 2 | 323 | 92 | 423 | 2.49 | 0.55 | 0.39 |
| 2014[a] | Round 1 | 104 | 52 | 2 | 2 | 2 | 170 | 47 | 221 | 2.13 | | |
| | Round 2 | 88.6 | 43 | 2.1 | 3 | 1 | 188 | 60 | 252 | 2.84 | | |
| | Total | 192.6 | 95 | 2 | 5 | 3 | 358 | 107 | 473 | 2.46 | 0.57 | 0.27 |
| 2015[a] | Round 1 | 104 | 52 | 2 | 4 | 1 | 126 | 34 | 165 | 1.59 | | |
| | Round 2 | 88.6 | 44 | 2 | 1 | 2 | 142 | 41 | 186 | 2.1 | | |
| | Total | 192.7 | 96 | 2 | 5 | 3 | 268 | 75 | 351 | 1.82 | 0.4 | 0.23 |
| 2016[a] | Round 1 | 106.8 | 53 | 2 | 5 | 3 | 133 | 36 | 177 | 1.66 | | |
| | Round 2 | 86.5 | 42 | 2.1 | 1 | 2 | 95 | 32 | 130 | 1.5 | | |
| | Total | 193.3 | 95 | 2 | 6 | 8 | 228 | 68 | 307 | 1.59 | 0.4 | 0.24 |
| 2017[a] | Round 1 | 105.5 | 54 | 1.95 | 7 | 2 | 153 | 36 | 198 | 1.88 | | |
| | Round 2 | 79 | 40 | 1.98 | 8 | 2 | 127 | 36 | 173 | 2.19 | | |
| | Total | 184.5 | 94 | 1.97 | 15 | 4 | 280 | 72 | 371 | 2 | 0.4 | 0.27 |

[a] Dates of flights (Round 1, Round 2): 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); 2013 (6 Jun–25 Jul, 7 Jul–20 Aug); 2014 (10 Jun–25 Jul, 7 Jul–29 Aug); 2015 (1 Jun–21 Jul, 1 Jul–31 Aug); 2016 (2 Jun–24 Jul, 7 Jul–28 Aug); 2017 (1 Jun–31 Aug, 4 Jul–28 Aug).

**Table 14. Size and age composition of grizzly bear family groups seen during observation flights, Greater Yellowstone Ecosystem, 2002–2017.**

| | | Females with cubs (number of cubs) | | | Females with yearlings (number of yearlings) | | | Females with 2-year-olds or young of unknown age (number of young) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Round | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| 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[b] | 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 |
| 2013[a] | Round 1 | 8 | 20 | 4 | 1 | 5 | 0 | 3 | 4 | 0 |
| | Round 2 | 11 | 21 | 3[c] | 2 | 7 | 0 | 0 | 5 | 0 |
| | Total | 19 | 41 | 7[c] | 3 | 12 | 0 | 3 | 9 | 0 |
| 2014[a] | Round 1 | 8 | 17 | 3 | 6 | 14 | 0 | 1 | 0 | 0 |
| | Round 2 | 1 | 15 | 8 | 11 | 18 | 3 | 2 | 2 | 1 |
| | Total | 9 | 32 | 11 | 17 | 32 | 3 | 3 | 2 | 1 |
| 2015[a] | Round 1 | 6 | 18 | 15 | 2 | 20 | 6 | 0 | 2 | 0 |
| | Round 2 | 9 | 22 | 12 | 2 | 24 | 6 | 2 | 0 | 4[d] |
| | Total | 15 | 40 | 27 | 4 | 44 | 12 | 2 | 2 | 4[d] |
| 2016[a] | Round 1 | 3 | 16 | 2 | 5 | 8 | 1 | 2 | 2 | 0 |
| | Round 2 | 8 | 11 | 6 | 2 | 4 | 1 | 1 | 1 | 0 |
| | Total | 11 | 27 | 8 | 7 | 12 | 2 | 3 | 3 | 0 |
| 2017[a] | Round 1 | 6 | 14 | 3 | 4 | 7 | 2 | 0 | 2 | 0 |
| | Round 2 | 5 | 20 | 2 | 5 | 3 | 0 | 1 | 1 | 1 |
| | Total | 11 | 34 | 5 | 9 | 10 | 2 | 1 | 3 | 1 |

[a] Dates of flights (Round 1, Round 2): 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); 2013 (6 Jun–25 Jul, 7 Jul–20 Aug); 2014 (10 Jun–25 Jul, 7 Jul–29 Aug); 2015 (1 Jun–21 Jul, 1 Jul–31 Aug); 2016 (2 Jun–24 Jul, 7 Jul–28 Aug); 2017 (1 Jun–31 Aug, 4 Jul–28 Aug).

[b] Includes 1 female with 4 yearlings.

[c] Includes 1 female with 4 cubs.

[d] Includes 1 female with 4 young of unknown age.

***Telemetry Location Flights*** *(Bryn E. Karabensh, Interagency Grizzly Bear Study Team, U.S. Geological Survey)*

Ninety-eight telemetry location flights were conducted during 2017, resulting in 275.1 hours of search time (excluding ferry time to and from airports; Table 15). Flights were conducted at least once during all months, with 79% of telemetry flights in May–November. During telemetry flights, 921 locations of bears equipped with radio transmitters were collected, 314 (34%) of which included a visual sighting. Seventy-six sightings of unmarked bears were also obtained during telemetry flights, including 64 solitary bears, 6 females with cubs, 5 females with yearlings and 1 female with 2-year-olds. Rate of observation for all unmarked bears during telemetry flights was 0.23 bears/hour; and 1.14 bears/hour for marked bears. The observations rate during telemetry flights for unmarked females with cubs was 0.02 females with cubs/hour.

In an effort to reduce flight time and costs associated with aerial telemetry and obtain higher-frequency data, we began deploying satellite GPS collars in 2012 using Argos and Iridium platforms. Since 2014, only Iridium satellite collars have been deployed. These GPS collars are different from those that store GPS locations onboard, which we have deployed since 2000, by providing the ability to download GPS location data via satellites. Only Iridium platforms were on the air in 2017. We deployed 26 Iridium GPS collars in 2017, obtaining over 110,000 GPS locations from 55 grizzly bears (newly and previously deployed GPS collars).

**Table 15. Summary statistics for radio-telemetry flights to locate grizzly bears, Greater Yellowstone Ecosystem, 2017.**

| | | | | Radioed bears | | | Unmarked bears observed | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Observation rate (no. of groups/hour) | |
| | | | | | | | | No. of females | | | | |
| Month | No. of hours | No. of flights | Mean no. of hours/flight | No. of locations | No. seen | Observation rate (no. of groups/hr) | Lone bears | With cubs | With yearlings | With young | All groups | Females with cubs |
| Jan | 3 | 1 | 3 | 10 | 0 | --- | 0 | 0 | 0 | 0 | --- | --- |
| Feb | 12.7 | 5 | 2.54 | 57 | 0 | --- | 0 | 0 | 0 | 0 | --- | --- |
| Mar | 12.2 | 3 | 4.07 | 60 | 5 | 0.41 | 0 | 0 | 0 | 0 | --- | --- |
| Apr | 25.2 | 8 | 3.15 | 87 | 31 | 1.23 | 3 | 0 | 0 | 0 | 0.12 | --- |
| May | 31.1 | 10 | 3.11 | 91 | 60 | 1.93 | 7 | 0 | 0 | 0 | 0.23 | 0.00 |
| June | 26.3 | 14 | 1.88 | 84 | 36 | 1.37 | 9 | 0 | 2 | 0 | 0.42 | 0.00 |
| July | 31.2 | 11 | 2.84 | 91 | 38 | 1.22 | 22 | 2 | 2 | 1 | 0.87 | 0.06 |
| Aug | 33.5 | 11 | 3.05 | 110 | 55 | 1.64 | 13 | 4 | 1 | 0 | 0.54 | 0.12 |
| Sept | 35.3 | 10 | 3.53 | 100 | 56 | 1.59 | 9 | 0 | 0 | 0 | 0.25 | 0.00 |
| Oct | 33.5 | 11 | 3.05 | 94 | 24 | 0.72 | 1 | 0 | 0 | 0 | 0.03 | --- |
| Nov | 23.2 | 10 | 2.32 | 95 | 9 | 0.39 | 0 | 0 | 0 | 0 | --- | --- |
| Dec | 7.9 | 4 | 1.98 | 42 | 0 | 0.00 | 0 | 0 | 0 | 0 | --- | --- |
| Total | 275.1 | 98 | 2.81 | 921 | 314 | 1.14 | 64 | 6 | 5 | 1 | 0.23 | 0.02 |

***Documented Grizzly Bear Mortalities and Estimated Percent Mortality for the Demographic Monitoring Area*** *(Mark A. Haroldson, Interagency Grizzly Bear Study Team, U.S. Geological Survey; and Kevin L. Frey, Montana Fish, Wildlife and Parks)*

Under the 2016 Conservation Strategy for grizzly bears in the GYE (Yellowstone Ecosystem Subcommittee 2016), IGBST is tasked with documenting grizzly bear mortalities occurring in the Demographic Monitoring Area (DMA), and evaluating mortality levels (Demographic Recovery Criterion 3). We evaluate mortalities for population segments within the DMA by deriving estimates of total mortality for independent-age (≥2 years old) females and independent-age males, which includes estimates of unknown/unreported mortalities (Cherry et al. 2002). We then determine the total annual mortality rate for these segments as a percent of their respective population estimates. For dependent-age bears (cubs and yearlings), we determine the percent of human-caused mortality relative to size of the population segment but do not include estimates of unknown/unreported mortality. Here, we report numbers of known and probably mortalities in the GYE, numbers by sex and age class inside and outside the DMA, and provide estimates of percent total mortality relative to population segments within the DMA.

We 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. Cases in which a carcass is physically inspected or when a management removal occurs are classified as "known" mortalities. Instances are classified as "probable" where evidence strongly suggests a mortality has occurred, but no carcass is recovered. When evidence is circumstantial, with no prospect for additional information, a "possible" mortality is designated. Possible mortalities are not included in the assessment of percent annual mortalities. We continue to tabulate possible mortalities because they provide an additional source of location information for grizzly bears and possible causes of mortalities in the GYE.

**2017 Mortality Results**

We documented 56 known and probable mortalities in the GYE during 2017, of which 1 likely died prior to 2015 (see Table 16, Unique #201724). We documented 4 additional mortalities during the spring of 2018 that occurred during the fall of 2017 (see Table 16, unique numbers 201805, 201806, 201807, and 201712). These 4 additional mortalities were confirmed early enough to include in this 2017 annual report. Of the 59 known and probable mortalities that occurred during 2017, 42 were attributable to human causes (Table 16, Fig. 7). Six of the 59 known and probable losses remain under investigation by U.S. Fish and Wildlife Service and state law enforcement agencies (Table 16). Specific information related to these mortalities is not provided because of ongoing investigations. However, the 6 mortality events that remain under investigation are included in the following summary. Seventeen (40.5 %) of the 42 human-caused losses were hunting related, including 2 mistaken identity kills by black bear hunters and 15 losses from reported self-defense kills. Two of the hunting-related, self-defense kills involved females accompanied by 3 cubs each. These 6 cubs were categorized as probable mortalities due to the uncertainty of their survival. Nine (21.4 %) of the 42 human-caused losses involved management removals due livestock depredations, whereas 12 (28.6%) were related to anthropogenic site conflicts. Other human-caused losses included vehicle strikes ($n$ = 3, 7.1%), and 1 bear (2.4%) that was maliciously shot and left near a road. We documented 8 natural mortalities (Table 16). Four of the natural mortalities were cubs lost from 4 different radio-marked females. Another cub was found killed by another bear at a cattle depredation site. In a separate event, the remains of an adult female likely killed by another bear were found near a domestic cow carcass. A radio-marked adult female died of natural causes shortly after emerging from her winter den in the backcountry of Yellowstone National Park. We classified this as a natural mortality although the specific cause of death was unknown. Lastly, an adult male likely died in an avalanche during late February or early March. We also documented 9 mortalities from undetermined causes, including the 2 known and 2 probable 2017 mortalities discovered during the spring of 2018 (Table 16). These include an adult male that likely died during late winter or early spring 2017 and was found on the banks of the Yellowstone River, a subadult male found dead in the Clark's Fork River, and 2 radio-marked

females, each with 2 cubs. One of these females died during October, the second likely died during November (found spring 2018). The remains of both females had been scavenged so that cause of death could not be determined. Evidence at both sites indicated that other grizzly bears, wolves, and coyotes had visited the sites. Finally, the remains of an unmarked bear that likely died during the fall of 2017 from an undetermined cause were discovered in May. This bear had also been cached and consumed by other bear(s).

We documented 2 incidents considered possible mortalities during 2017 (Table 16). Both were hunting-related events during which shots were fired at the bear involved. However, no evidence was present at either site to suggest the bears had been wounded in the incident.

We evaluated known and probable mortalities relative to population estimates only for the Demographic Monitoring Area (DMA). Of the 59 known and probable documented mortalities occurring in 2017, 54 occurred within the boundaries of the DMA (Table 17, Fig. 7). Sex determination for 1 reported mortality of an independent-age bear from 2017 is pending DNA results and may not be known until spring 2019. Once the sex for this bear is determined, 2017 mortality rates (Table 18) will be updated accordingly. Among independent-age bears of known sex, we documented 12 female mortalities within the DMA during 2017 (Table 17): 1 management removal, 5 radio-marked losses, and 6 reported losses (Table 18). Estimated total mortality for independent-age females was 8.4 % of the 2017 estimate for this segment of the population (Table 18). Twenty known and probable mortalities for independent-age males occurred within the DMA (Table 17): 10 management removals, 2 radio marked losses, and 8 reported losses (Table 17). Estimated total mortality for independent aged males was 13.2 % of the 2017 estimate for this segment of the population (Table 18). We documented 12 known and probable human-caused losses of dependent young in the DMA during 2017 (Table 18). Estimated human-caused mortality for dependent young was 5.5 % within the DMA (Table 18).

One documented mortality from 2012 remains under investigation, as do 3 from 2013, 3 from 2014, 6 from 2015, and 8 from 2016. No mortalities documented during 2009, 2010, or 2011 remain under investigation. Specific information pertaining to closed mortality investigations will be updated in the respective annual IGBST Mortality Lists 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 cannot release information that could compromise ongoing investigations.

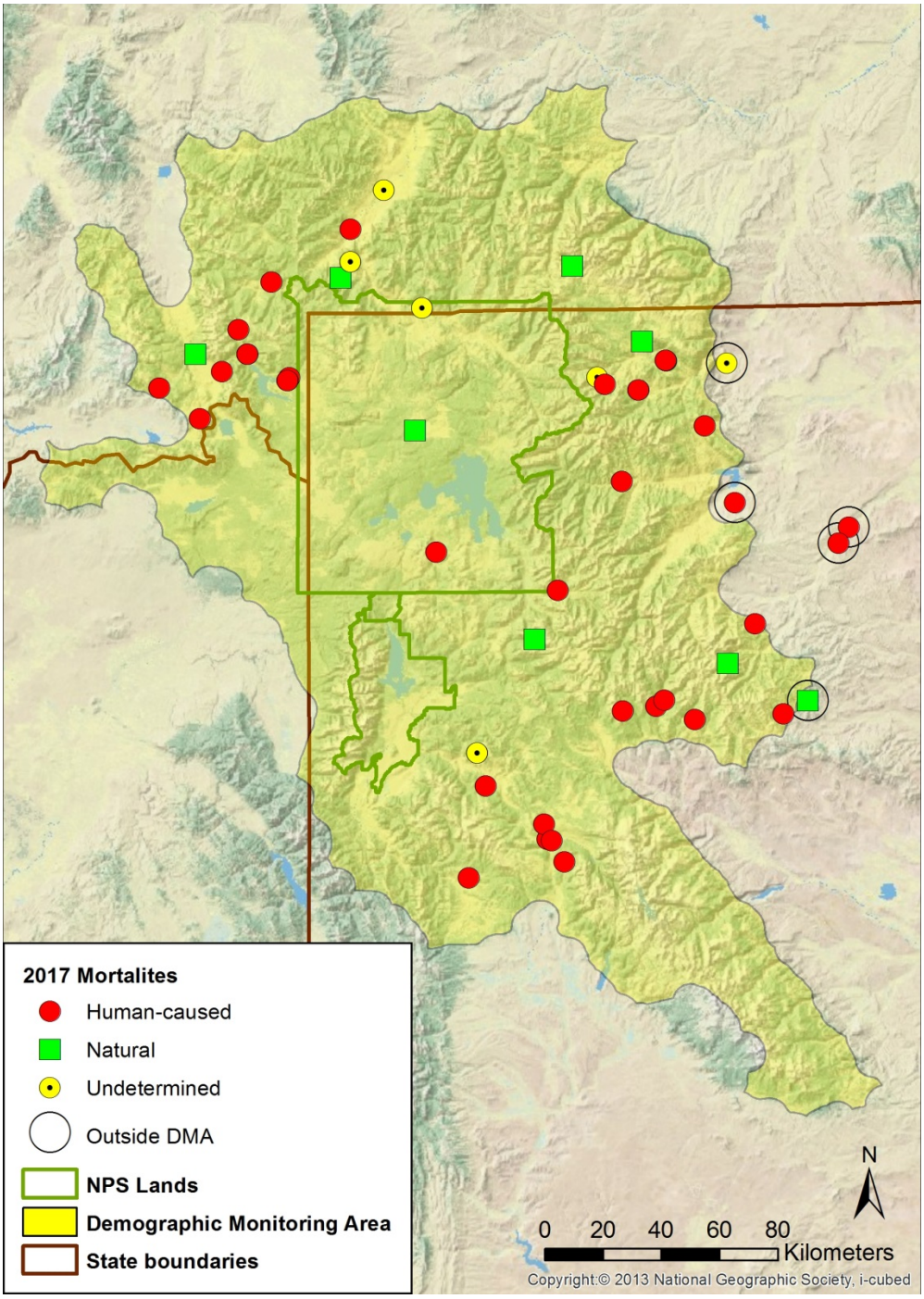



*Fig. 7. Distribution of 60 known and probable grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2017, including 1 mortality that likely occurred prior to 2015 and 4 bear deaths discovered during spring 2018 that occurred during fall 2017. Fifty-four of documented mortalities occurring in 2017 were within the Demographic Monitoring Area (DMA), of which 39 were attributed to human causes. Five mortalities were outside the DMA (black circles around symbols) with 3 of those attributed to human causes. Due to multiple bear mortalities at a specific location or separate mortalities occurring close to one another, not all 60 locations are visible on this map.*

**Table 16. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem, 2017.**

| Unique no. | Bear[a] | Sex[b] | Age[c] | Date | Location[d] | Monitoring area[e] | Certainty | Loss |
|---|---|---|---|---|---|---|---|---|
| 201701 | Unm | M | Subadult | 3/24/2017 | Greybull River, PR-WY | Outside DMA | Known | Human-caused, management capture and removal for goat depredation and frequenting ranch buildings. |
| 201702 | 877 | M | Subadult | 4/12/2017 | Dell Crk, PR-WY | Inside DMA | Known | Human-caused; management capture and removal of bear #877 for entering structures and obtaining food rewards. Bear was wearing and active collar when removed. |
| 201703 | Unm | M | Adult | 4/25/2017 | Yellowstone River, MT | Inside DMA | Known | Human-caused, road kill, US89-MT. |
| 201704 | | | | 2017 | WY | Inside DMA | Known | Under investigation. |
| 201705 | 777 | M | Adult | 5/20/2017 | Sheep Crk, CGNF-MT | Inside DMA | Known | Human-caused; mistaken identity kill of bear #777 by black bear hunter. Bear was not collared when killed. |
| 201706 | 871 | F | Adult | 5/21/2017 | Camp Crk, SNF-WY | Inside DMA | Known | Human-caused; mistaken identity kill of bear #871 by black bear hunter. Bear was wearing an active collar when killed; 2 yearlings were observed in the area of the mortality after she was killed. |
| 201707 | G220 | M | Subadult | 5/26/2017 | Wiggins Fork, SNF-WY | Inside DMA | Known | Human-caused; road kill, Forest Road 285, SNF-WY. |
| 201708 | 799 | F | Adult | 5/4/2017 | Alum Crk, YNP | Inside DMA | Known | Natural mortality of #799; specific mechanism unknown. Bear was wearing an active radio collar at time of death. Last active location was 4/29, first on mortality was 5/10. Estimated mortality date is midpoint. |
| 201709 | Unm | M | Adult | 4/1/2017 | Yellowstone River, MT | Inside DMA | Known | Undetermined cause; likely died late winter or early spring 2017. Found partially in Yellowstone River, advanced state of decomposition suggests in had been in the water for a long while. Estimated mortality date 4/1/2017. |
| 201710 | 824 | M | Adult | 7/9/2017 | West Goosewing Crk, BTNF-WY | Inside DMA | Known | Human-caused; management removal of bear #824 for cattle depredations, bear was wearing an active transmitter when captured. |
| 201711 | Unm | M | Yearling | 7/15/2017 | Gallatin River, MT | Inside DMA | Known | Human-caused; road kill, US191-MT. |

| Table 16. Continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 201712 | 825 | M | Adult | 7/21/2017 | Green River, BTNF-WY | Inside DMA | Known | Human-caused; management capture and removal of bear #825 for livestock depredations (cattle and sheep). |
| 201713 | G130 | M | Adult | 8/2/2017 | North Fork Owl Crk, PR-WY | Inside DMA | Known | Human-caused; management capture and removal of #G130 for cattle depredations. |
| 201714 | Unm | Unk | Cub | 8/2/2017 | Beartooth Crk, SNF-WY | Inside DMA | Known | Natural; cub found killed by another bear at cattle depredation site. |
| 201715 | | | | 2017 | WY | Inside DMA | Known | Under investigation. |
| 201716 | 866 | M | Subadult | 8/5/2017 | Gypsum Crk, BTNF-WY | Inside DMA | Known | Human-caused; management removal of bear #866 for cattle depredations. Was wearing a working ear transmitter when removed. |
| 201717 | Unm | F | Adult | 7/30/2017 | Buck Crk, PR-WY | Outside DMA | Known | Natural; remains of adult female found near cattle carcass, likely killed by another bear. |
| 201718 | Unm | M | Yearling | 8/10/2017 | Camp Crk, SNF-WY | Inside DMA | Known | Human-caused; management capture and live removal for habituation and bold behavior, likely offspring of #871 killed in May 2017. |
| 201719 | Unm | M | Yearling | 8/9/2017 | Camp Crk, SNF-WY | Inside DMA | Known | Human-caused; management capture and live removal for habituation and bold behavior, likely offspring of #871 killed in May 2017. |
| 201720 | 736 | M | Adult | 8/21/2017 | West Fork Madison, BDNF-MT | Inside DMA | Known | Human-caused; management removal of bear #736 for cattle depredations. Bear was wearing active collar when removed. |
| 201721 | 711 | M | Adult | 8/30/2017 | Antelope Crk, BDNF-MT | Inside DMA | Known | Human-caused; self-defense kill of bear #711 at site of bear killed calf. Bear was wearing active Iridium collar when killed. |
| 201722 | G205 | M | Subadult | 9/8/2017 | Heart Lake, YNP | Inside DMA | Known | Human-caused; management capture and removal of bear #G205 for bold behavior towards humans, repeated property damages, and obtaining food rewards. |
| 201723 | G213 | F | Subadult | 9/9/2017 | Greybull River, PR-WY | Outside DMA | Known | Human-caused; management capture and removal of bear #G213 for frequenting developed areas and habituated behavior. |

| Table 16. Continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 201724 | Unm | Unk | Adult | 2014 | Papoose Crk, SNF-WY | Inside DMA | Known | Undetermined cause; skull found, likely died prior to 2015. |
| 201725 | Unm | F | Adult | 9/10/2017 | Parque Crk, SNF-WY | Inside DMA | Known | Human-caused; reported self-defense kill by hunter of female accompanied by 2 yearlings. |
| 201726 | 904 | M | Subadult | 9/12/2017 | Mosquito Lake, BTNF-WY | Inside DMA | Known | Human-caused; management capture and removal of bear #904 for repeated cattle depredations. |
| 201727 | Unm | M | Subadult | 9/24/2017 | Green River, BTNF-WY | Inside DMA | Known | Human-caused; management capture and removal for cattle depredations. |
| 201728 | 903 | F | Adult | 9/25/2017 | Hebgen Ridge, CGNF-MT | Inside DMA | Known | Human-caused; hunting related, self-defense. Collared female bear #903 with 3 cubs. |
| 201729 | Unm | Unk | Cub | 9/25/2017 | Hebgen Ridge, CGNF-MT | Inside DMA | Probable | Human-caused; hunting related, 1st of 3 cubs of female killed in self-defense. |
| 201730 | Unm | Unk | Cub | 9/25/2017 | Hebgen Ridge, CGNF-MT | Inside DMA | Probable | Human-caused; hunting related, 2nd of 3 cubs of female killed in self-defense. |
| 201731 | Unm | Unk | Cub | 9/25/2017 | Hebgen Ridge, CGNF-MT | Inside DMA | Probable | Human-caused; hunting related, 3rd of 3 cubs of female killed in self-defense. |
| 201732 | Unm | M | Subadult | 10/6/2017 | Beaver Crk, CGNF-MT | Inside DMA | Known | Human-caused; hunting related, self-defense. |
| 201733 | Unm | F | Adult | 10/9/2017 | Open Crk, BTNF-WY | Inside DMA | Known | Human-caused; hunting related, self-defense, bear charged hunting guide and hunters while they were loading harvested elk onto pack mules. |
| 201734 | Unm | M | Adult | 10/8/2017 | Hoodoo Crk, SNF-WY | Inside DMA | Known | Human-caused; hunting related, self-defense. Old bear in poor condition behaved aggressively and repeatedly tried to enter camp. |
| 201735 | 228 | M | Adult | 10/14/2017 | Grayling Crk, PR-MT | Inside DMA | Known | Human-caused; management capture and removal of bear #228 for breaking into multiple buildings and obtaining food rewards. Wearing active collar when removed. |

| Table 16. Continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 201736 | Unm | F | Adult | 10/16/2017 | Bear Crk, SNF-WY | Inside DMA | Known | Human-caused; hunting related, self-defense kill of female accompanied by 2 yearlings. |
| 201737 | | | | 2017 | WY | Inside DMA | Known | Under investigation. |
| 201738 | 485 | F | Adult | 10/22/2017 | Duck Crk, PR-MT | Inside DMA | Known | Human-caused; self-defense kill of bear #485 at residence after bear broke into garage containing a harvested elk. Collared female with 3 cubs. |
| 201739 | Unm | Unk | Cub | 10/22/2017 | Duck Crk, PR-MT | Inside DMA | Probable | Human-caused; 1st of 3 cubs of female killed in self-defense at residence. |
| 201740 | Unm | Unk | Cub | 10/22/2017 | Duck Crk, PR-MT | Inside DMA | Probable | Human-caused; 2nd of 3 cubs of female killed in self-defense at residence. |
| 201741 | Unm | Unk | Cub | 10/22/2017 | Duck Crk, PR-MT | Inside DMA | Probable | Human-caused; 3rd of 3 cubs of female killed in self-defense at residence. |
| 201742 | G221 | M | Subadult | 10/23/2017 | Wiggins Fork, SNF-WY | Inside DMA | Known | Human-caused; reported self-defense kill of bear #G221 while hunters were leading pack string with harvested elk. |
| 201743 | Unm | F | Subadult | 10/25/2017 | Aspen Crk, SNF-WY | Inside DMA | Known | Human-caused; management of subadult female with head injury caused by gun shot. Captured for attempting to get grain out of horse trailer. |
| 201744 | 423 | F | Adult | 10/26/2017 | Little Sunlight Crk, SNF-WY | Inside DMA | Known | Human-caused; self-defense kill of bear #423 by elk hunter. Was not collared when killed. |
| 201745 | Unm | Unk | Cub | 10/26/2017 | Little Sunlight Crk, SNF-WY | Inside DMA | Probable | Human-caused; 1st of 3 cubs of female #423 killed in self-defense by elk hunter. |
| 201746 | Unm | Unk | Cub | 10/26/2017 | Little Sunlight Crk, SNF-WY | Inside DMA | Probable | Human-caused, 2nd of 3 cubs of female #423 killed in self-defense by elk hunter. |
| 201747 | Unm | Unk | Cub | 10/26/2017 | Little Sunlight Crk, SNF-WY | Inside DMA | Probable | Human-caused, 3rd of 3 cubs of female #423 killed in self-defense by elk hunter. |
| 201748 | 861 | F | Adult | 10/7/2017 | Haystack Fork, BTNF-WY | Inside DMA | Known | Undetermined cause; remains of bear #861 found with collar. No evidence of her 2 cubs. |

**Table 16. Continued**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 201749 | Unm | Unk | Cub | 10/7/2017 | Haystack Fork, BTNF-WY | Inside DMA | Probable | Undetermined cause; 1st of 2 cubs of #861. |
| 201750 | Unm | Unk | Cub | 10/7/2017 | Haystack Fork, BTNF-WY | Inside DMA | Probable | Undetermined cause; 2nd of 2 cubs of #861. |
| 201751 | 542 | M | Adult | 11/2/2017 | Carter Crk, PR-WY | Outside DMA | Known | Human-caused; management capture and removal of bear #542 for property damage and obtaining food rewards. Was not collared when removed. |
| 201752 | G225 | M | Subadult | 11/21/2017 | Clarks Fork Yellowstone, BLM-WY | Outside DMA | Known | Undetermined cause; #G225 found dead in Clarks Fork River by fisherman. Was not collared. |
| 201753 | Unm | Unk | Cub | 4/30/2017 | Lion Crk, CGNF-MT | Inside DMA | Probable | Natural; 1 cub of radio-collared female #857 lost between 4/22 and 5/10. Mortality date and location are approximate. |
| 201754 | Unm | Unk | Cub | 5/16/2017 | Butte Crk, BLM-MT | Inside DMA | Probable | Natural; 1 cub of radio-collared female #786 lost between 5/10 and 5/23. Mortality date and location are approximate. |
| 201755 | Unm | Unk | Cub | 5/28/2017 | Buffalo Fork, BTNF-WY | Inside DMA | Probable | Natural; 1 cub of radio-collared female #875 lost between 5/8 and 6/19. Mortality date and location are approximate. |
| 201756 | Unm | Unk | Cub | 8/26/2017 | Goose Crk, CGNF-MT | Inside DMA | Probable | Natural; 1 cub of radio-collared female #833 lost between 8/12 and 9/11. Mortality date and location are approximate. |
| 201757 | Unk | Unk | Unk | 9/29/2017 | Wall Crk, SNF-WY | Inside DMA | Possible | Hunting related self-defense by archery elk hunter. Bear was guarding an elk carcass and charged hunter; shots fired at the bear, no evidence found that the bear was hit. |
| 201758 | Unm | Unk | Yearling | 10/16/2017 | Bear Crk, SNF-WY | Inside DMA | Possible | Hunting related self-defense, hunter shot at yearling of female (mort # 201736) that was killed, no evidence found that the bear was hit. |

**Table 16. Continued**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 201805 | 857 | F | Adult | Fall, 2017 | MT | Inside DMA | Known | Under investigation. |
| 201806 | Unm | Unk | Cub | Fall, 2017 | MT | Inside DMA | Probable | Under investigation. |
| 201807 | Unm | Unk | Cub | Fall, 2017 | MT | Inside DMA | Probable | Under investigation. |
| 201812 | Unm | Unk | Adult | Fall, 2017 | Crevice Crk, YNP | Inside DMA | Known | Known, undetermined cause, found late May 2018, likely died Fall 2017. Had been cached and consumed by other bear(s). Samples collected for DNA determination of sex. |

[a] Number indicates bear number; Unm = unmarked bear; Mkd = previously marked bear but identity unknown.

[b] Unk = unknown sex.

[c] Cub = less than 1 year old; yearling = 1 to 2 years old; subadult = 2 to 4 years old; adult = 5 years or older; Unk = unknown age.

[d] BTNF = Bridger-Teton National Forest, BLM = Bureau of Land Management, CTNF = Caribou-Targhee National Forest, CGNF = Custer-Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park, Pr = private.

[e] Location relative to the Demographic Monitoring Area.

**Table 17. Counts of documented known and probably grizzly bear mortalities occurring in 2017 by sex, age class, and location relative to the Demographic Monitoring Area (DMA), Greater Yellowstone Ecosystem.**

| Area | Sex | Age class | | Total |
|---|---|---|---|---|
| | | Dependent (<2 years old) | Independent (≥2 years old) | |
| Inside DMA | Female | 0 | 12 | 12 |
| | Male | 3 | 20 | 23 |
| | Unknown | 18 | 1 | 19 |
| | Total | 21 | 32 | 54 |
| | | | | |
| Outside DMA | Female | 0 | 2 | 2 |
| | Male | 0 | 3 | 3 |
| | Unknown | 0 | 0 | 0 |
| | Total | 0 | 5 | 5 |

**Table 18. Annual estimates ( $\hat{N}$ ) and mortality statistics by population segment for grizzly bears in the Demographic Monitoring Area (DMA), Greater Yellowstone Ecosystem 2017. Population estimates for the DMA were derived using the most recent vital rates (IGBST 2012). Only human-caused losses are counted against the mortality threshold for dependent young.**

| Population segment | $\hat{N}$ | Human-caused loss | Sanctioned removals (a) | Radio-marked loss (b) | Reported loss | Estimated[a] reported + unreported loss (c) | Estimated total mortality (a + b + c) | Annual % mortality |
|---|---|---|---|---|---|---|---|---|
| Dependent young | 217 | 12 | | | | | | 5.5 |
| Females 2+ | 250 | 9 | 1 | 5 | 6[b] | 15[b] | 21[b] | 8.4[b] |
| Males 2+ | 250 | 18 | 10 | 2 | 8[b] | 21[b] | 33[b] | 13.2[b] |

[a] Unknown, unreported mortality estimated based on Cherry et al. (2002).
[b] Numbers may change pending DNA determination of sex for 1 reported mortality from 2017.

# MONITORING OF GRIZZLY BEAR FOODS

***Spring Ungulate Carrion Availability and Use by Grizzly Bears in Yellowstone National Park 1992–2016.*** *(Kerry A. Gunther, Travis C. Wyman, and Eric Reinertson, Yellowstone National Park)*

For Yellowstone grizzly bears (*Ursus arctos*), ungulate carrion is one of the highest energy food resources available during the spring season from March through May (Mattson et al. 1991, Mattson 1997, Green et al. 1997). To more fully understand patterns of spring carrion use by grizzly bears, the Interagency Grizzly Bear Study Team (IGBST) initiated a research study of carrion availability and scavenging by grizzly bears in 1985 (Green 1994). The study included the Firehole River, Heart Lake, Norris Geyser Basin, and Northern ungulate winter ranges in Yellowstone National Park (Fig. 8). The research study continued through 1990; data analysis and results were reported by Green (1994) and Green et al. (1997).

Results of the study indicated grizzly bear use of carcasses peaked in April, coincident with the peak in ungulate deaths (Green et al. 1997). Grizzly bears were more likely to use carcasses at higher elevations because they were closer to den sites and therefore more quickly discovered. Densities of competing scavengers such as coyotes (*Canis latrans*) and American black bears (*Ursus americanus*) were also lower at higher elevations, thereby reducing competition for carcasses (Green et al. 1997). Probability of carcass use by bears was also related to the amount of edible biomass (Green et al. 1997). Smaller carcasses were depleted rapidly, whereas larger carcasses remained available for longer time periods, allowing more time for discovery by grizzly bears. Black bears, coyotes, bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), ravens (*Corvus corax*), and magpies (*Pica pica*) were significant competitors with grizzly bears for available ungulate carrion. Mountain lions (*Puma concolor*) were a minor competitor for ungulates, but only on the northern winter range. Wolves (*Canis lupus*) would later become a competitor for ungulate carcasses after their reintroduction from 1995–1996. Due to the number of competing scavengers, elk (*Cervus elaphus*) carcasses were rapidly depleted and if not discovered by bears in ≤3 days had little to no edible biomass remaining. Bison (*Bison bison*) carcasses lasted longer and generally had edible biomass for up to 2 weeks before complete depletion by scavengers (Green 1994). Ungulate carcasses proximal to roads and major recreational developments were underutilized by grizzly bears (Green et al. 1997).

During spring, ungulates energy reserves are low and their mortality peaks (Green et al. 1997). Annual variability in carrion abundance is a function of winter weather (temperatures and snow depth, density, and moisture content) and ungulate population numbers (Servheen et al. 1986, Podruzny et al. 2012). Fall sport hunting of elk in states adjacent to Yellowstone National Park, and management reductions of bison both inside and outside of the park to prevent fence and other property damage and the spread of the disease brucellosis to cattle (White et al. 2015), could impact the abundance and distribution of spring carrion available for bears to scavenge.

Because grizzly bears showed preferential use of carrion as a spring food and the influence state and federal management objectives have over ungulate population's in the region, we transitioned the short-term research study (1985–1990) into a long-term monitoring program (1992–2016). For the long-term monitoring program, the survey routes described by Green (1994) were reduced in number and length and high-graded to establish routes with the greatest probability of detecting ungulate carcasses. We also reduced the frequency of the spring surveys from biweekly to once per spring season.

The long-term monitoring surveys begun in 1992 initially included 4 routes in the Norris Geothermal Geyser Basin, 8 in the geothermally influenced portions of the Firehole River drainage, and 3 in the geothermally influenced Witch Creek drainage in the Heart Lake region. In 1997, we added 13 survey routes on the Northern Ungulate Winter Range. In 2002, we added a survey route in the Mud Volcano Geyser Basin resulting in a total of 16 survey routes in geothermally influenced ungulate winter ranges in the parks interior, and 13 on the Northern ungulate winter range.

Completing the carcass surveys required approximately 90 person days per year and encounters with grizzly bears at carcasses were not uncommon. In addition, the development of

alternative methods to estimate carrion availability (e.g., snow-water equivalent measurements, Podruzny et al. 2012), meat consumption (e.g., stable nitrogen isotope measurements, Jacoby et al. 1999), and the contribution carrion has on bear body condition, (e.g., body condition indices, Sterling et al. 2008, Molnar et al. 2009, Sciullo et al. 2016; and bioelectrical impedance body fat measurements, Schwartz et al. 2014), potentially provide more efficient techniques than the carcass survey methods we used (Cherry 2007). Therefore, due to efficiency and staff safety considerations, the spring ungulate carcass monitoring surveys were discontinued after completion of the survey routes in the spring of 2016. Here, we present a summary of the long-term ungulate carcass monitoring surveys that were conducted during the 25-year period of 1992–2016.

**Monitoring Areas**

We surveyed 4 winter ranges in the parks interior that contained geothermally influenced soil. These winter ranges included the Firehole River area and the Norris Geyser Basin located in the west-central portion of Yellowstone National Park, the Heart Lake area (Witch Creek and Rustic Geyser Basin and associated thermal areas) in the south-central portion of the park, and the Mud Volcano Geyser Basin in central Yellowstone. The geyser basins we surveyed were relatively confined in space and ranged from approximately 2,100 to 2,500 m in elevation (Green 1994). Due to heat coming from the thermally influenced soil, these areas have significantly less snow accumulation than surrounding areas and contain some areas that remain free of snow all winter (Watson et al. 2009). The thermal influence also heats the air near the ground to temperatures that are adequate for some plant growth during winter (Despain 1990, Wattson et al. 2009). The absence of snow combined with growing plants allows ungulates to overwinter in these high-elevation areas that are surrounded by deep uninhabitable snows. Bison and elk are the primary ungulates wintering in the geothermally influenced winter ranges we surveyed.

We also surveyed the Northern Ungulate Winter Range. The Northern Range monitoring area lies in the northern third of the park (Houston 1982). The Northern Range is an extensive, low-elevation (1,500–2,400 m) area of the park in the Yellowstone and Lamar River drainages. The Northern Range contains 7 sympatric species of native ungulates including elk, bison, mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), bighorn sheep (*Ovis canadensis*), moose (*Alces alces*), and pronghorn (*Antilocapra americana*). Non-native mountain goats (*Oreamnos americanus*) are also present on the Northern Range. Northern Yellowstone elk migrate seasonally between a high-elevation summer range and a lower-elevation winter range that accumulates less snow (Houston 1982).

During severe winters, some of the ungulates wintering in these thermally influenced and low-elevation winter ranges die of malnutrition, and are consumed by grizzly and black bears that hibernate in these regions upon bear emergence from dens in spring.

**Methods**

We surveyed each route once for carcasses between 21 March and 15 June each year. Some routes were not completed some years due to the known presence of wolf dens along survey routes. Fresh snow that covered carcasses also precluded completion of some surveys some years. Because spring snow depths influence ungulate distribution and the area where we could survey, we used maps (1992–1999 data) or a GPS unit (2000–2016 data) to measure the distance traveled on each route each year. All carcasses that could be observed from the survey route were counted, regardless of distance from the route. At each carcass, we collected a site description (UTM location coordinates, elevation, aspect, slope, vegetation cover type, distance to forest/non-forest edge), carcass data (species, sex, age class, cause of death), and information about scavengers using the carcasses (percent of carcass consumed and evidence of scavenger species present from tracks, scat, and feeding sign). We were unable to calculate the actual biomass consumed by bears, wolves, or other large scavengers with our once-per spring season survey methodology. The number of carcasses observed per km of survey route was calculated as an annual index of carcass availability. We also recorded information on bear activity observed along our survey routes that was not associated with carcasses (e.g., tracks, scats, rub trees, traditional trails, evidence of feeding on non-Artiodactyla species). The number of bears and bear track sets observed per km of survey route were calculated as

an index of bear activity on the ungulate winter ranges.

**Results and Discussion**

During the 25-year (1992–2016) monitoring period we hiked 6,115 km of survey routes in 5 winter ranges and detected 1,275 ungulate carcasses, an average of 0.21 carcasses/km (Tables 19 and 20, Fig. 9). Observed carcasses included 797 elk, 418 bison, 44 mule deer, 10 pronghorn, and 6 bighorn sheep. No moose, whitetail deer, or mountain goat carcasses were detected during the surveys. The quantity of carcasses was low most years, averaging 32 ungulate carcasses per year (0.14 carcasses/km). However, exceptions occurred during pulse years in 1997, 1999, 2006, 2008, and 2011, which averaged 126 carcasses per year (0.43 carcasses/km). These pulse years were characterized by significantly more severe winters than average. Most (78%, $n$ = 999) of the carcasses were >75% consumed by scavengers when found. Only 3% ($n$ = 33) of the carcasses we observed were untouched by scavengers at the time of discovery. Evidence of grizzly and/or black bear scavenging was observed at 37% ($n$ = 156) of the bison carcasses, 20% ($n$ = 161) of the elk carcasses, and 11% ($n$ = 5) of the mule deer carcasses. None of the pronghorn or bighorn sheep carcasses had evidence of scavenging by bears.

We observed 68 grizzly bears and 838 sets of grizzly tracks along the survey routes, an average of 0.15 observations of grizzly bear activity per km surveyed; 165 feeding sites associated with grizzly tracks were also observed. We observed 24 black bears and 74 sets of black bear tracks, an average of 0.02 observations of black bear activity per km surveyed. In addition, we observed 1 bear, 75 sets of partial bear tracks, and 112 bear feeding sites for which we were unable to determine the species of bear.

**Thermally Influenced Interior Winter Ranges**

*Heart Lake*

The Heart Lake winter range was subjected to the most severe winters of the 5 ranges we monitored (Green 1994). A small group of elk, estimated at from 30 to 50 and possibly as many as 80 animals overwintered in this area some years. Bison did not overwinter in the Heart Lake area.

We surveyed 3 routes in the Heart Lake area annually, hiking a total of 447 km during the 25-year monitoring period. We found 35 elk carcasses, an average of 0.1 carcasses/km. No carcasses from other ungulate species were found. All of the elk carcasses were >75% consumed when discovered. Evidence of scavenging by grizzly and/or black bears was observed at 29% ($n$ = 10) of the carcasses. The species of scavenger could not be determined for 43% ($n$ = 15) of the carcasses. The late time period (~first week of May) of our Heart Lake Surveys made determination of the cause of death and identification of carcass scavengers difficult for elk that died during winter or early spring. Of the elk carcasses where age class could be determined ($n$ = 29), 69% were adults, 21% were yearlings, and 10% were calves (Tables 21–23). Of the elk carcasses where sex could be determined ($n$ = 11), 64% were male and 36% were female.

Thirty-four of the 35 elk carcasses were found from 1992 through 2001, an average of 3 carcasses per year (0.19 carcasses/km) during that time period. After 2001, only 1 carcass was found, an average of <0.1 carcasses per year (0.004 carcasses/km). The paucity of carcasses after 2001 may be related to reestablishment of gray wolves to the area. Wolves were extirpated from Yellowstone National Park in the 1920s (Weaver 1978). In the absence of wolves after extirpation, small numbers of elk were able to overwinter in the relatively narrow, confined, snow-free thermally influenced portion of the Witch Creek drainage at Heart Lake. The snow-free thermal area is surrounded by extensive regions with deep snows. Wolves were reintroduced into Yellowstone National Park in 1995 and 1996 (Bangs and Fritts 1996), and the Delta Pack denned at Heart Lake in the winter of 1996–1997. After recolonization of the Heart Lake area by wolves, continued use of the area as winter range by elk was likely tenuous due to the limited availability of snow-free escape terrain. When confronted by wolves, the relatively confined snow-free area adjacent to the narrow, shallow Witch Creek offered elk little chance of escape. We observed evidence of wolf predation and/or scavenging at 4 elk carcasses at Heart Lake in 1997 and 2 in 1998. After 2001 we no longer observed evidence of elk wintering in the Heart

Lake area. Evidence suggested the one elk carcass found after 2001 (found on the 2006 survey) was a late fall wolf-kill. We believe that the Heart Lake area is not a viable elk winter range in the presence of wolves. In addition to environmentally-caused vulnerability to predation, the lack of significant alternative winter prey (bison, moose, deer) for wolves in the Heart Lake area further magnified wolves' impact on the small, non-migratory elk population that overwintered there. With our survey methods, we were unable to determine whether the disappearance of elk from the Heart Lake area in winter after 2001 was due to the elimination of non-migratory elk through direct killing by wolves, or due to behaviorally mediated (fear-induced) changes in the spatial distribution of Heart Lake elk in winter, or both.

We observed 31 grizzly bears and 173 sets of grizzly bear tracks, an average of 0.46 observations of grizzly bear activity per km surveyed (Table 24). We also observed 52 non-carcass feeding sites, 50 scats or groups of scats, 8 rub trees, 2 daybeds, and 2 traditional trails that were associated with grizzly bear tracks. Four black bears and 25 sets of black bear tracks were observed, an average of 0.07 observations of black bear activity per km. Three scats or groups of scats and 1 non-carcass feeding site associated with black bear tracks were also observed. The number of observations of grizzly bears and their track sets outnumbered those of black bears every year we conducted the Heart Lake winter range surveys.

Even in the absence of wintering elk and associated overwinter mortality after 2001, grizzly bears continued to use the Heart Lake area in spring. From 1992 to 2001, when elk wintered at Heart Lake, we surveyed 177 km and observed 4 grizzly bears and 61 sets of grizzly bear tracks, an average of 0.37 observations of grizzly bear activity per km surveyed. From 2002 to 2016, in the absence of wintering elk, we surveyed 270 km and observed 27 grizzly bears and 123 sets of grizzly tracks, an average of 0.56 observations of grizzly bear activity per km surveyed.

During the monitoring period, we observed an increase in spring season grizzly bear activity that seemed to displace black bear activity from the Heart Lake area. Our grizzly bear activity index increased from 0.37/km during 1992–2001, to 0.56/km during 2002–2016. Concurrent with the increase in grizzly bear activity, our black bear activity index decreased from 0.14/km during 1992–2001 to 0.02/km during 2002–2016.

Primary spring grizzly bear feeding activities observed in the Heart Lake winter range included: 1) grazing grasses, sedges (*Carex* spp.), clover (*Trifolium* spp.) and dandelion (*Taraxacum* spp.); 2) digging onion-grass bulbs (*Melica spectabilis*); 3) digging spring beauty (*Claytonia lanceolata*) corms; 4) digging up pocket gophers (*Thomomys talpoides*) and their food caches of plant roots including onion-grass bulbs, yampa roots (*Perideridia gairdneri)*, spring beauty corms, and American bistort (*Polygonum bistortoides*) rhizomes; 5) ripping open logs for ants (*Formicidae*); 6) consuming geothermal soil; 7) digging earthworms (Lumbricidae); 8) scavenging elk carcasses; 9) digging grubs; and 10) digging thistle (*Cirsium* spp.) roots.

*Firehole River Area*

When our surveys began, an estimated 400 – 600 elk (Garrett et al. 1016) and 2,300 bison (Wallen et al 2015) over-wintered in the Firehole River/Norris Geyser Basin area. We surveyed 8 routes in the Firehole winter range annually, hiking a total of 1,889 km during the 25-year monitoring period. We found 318 bison and 117 elk carcasses, an average of 0.23 ungulate carcasses/km. No carcasses from other ungulate species were detected. Ninety-four percent of the elk carcasses and 63% of the bison carcass were >75% consumed when found. None of the elk carcasses and only 6% ($n$ = 19) of the bison carcasses were completely intact (un-scavenged) at the time they were discovered. Evidence of scavenging by grizzly and/or black bears was observed at 37% ($n$ = 119) of the bison and 18% ($n$ = 21) of the elk carcasses. Of the bison carcasses where age class could be determined ($n$ = 305), 63% were adults, 23% were yearlings, and 14% were calves. Of the bison carcasses where sex could be determined ($n$ = 219), 41% were male and 59% were female. Of the elk carcasses where age class could be determined ($n$ = 90), 53% were adults, 21% were yearlings, and 26% were calves. Of the elk carcasses where sex could be determined ($n$ = 66), 23% were male and 77% were female.

Of the 117 elk carcasses detected, 112 were found from 1992 to 2004, an average of 8.6 elk carcass per year (0.11 carcasses/km) during that

time period. After 2004, only 5 elk carcasses were found, an average of 0.4 elk carcasses per year (0.01 carcasses/km). The paucity of elk carcasses after 2004 may be related to reoccupation of the area by gray wolves which became established in the Firehole winter range in 1998, and continuously occupied the area thereafter (Smith et al. 2009). After reoccupation of the area by wolves, there was a >90% decrease in elk abundance on the Firehole winter range (Garrott et al. 2009*a,* 2016). In the absence of wolves prior to their reintroduction, the number of elk overwintering in the Firehole area appeared to be regulated by winter severity and available forage on the winter range (bottom-up trophic chain, Garrott et al. 2009*b*). However, after reoccupation of the area by wolves, elk numbers became limited primarily through adult predation by wolves and neonate predation by grizzly bears, black bears, and coyotes (top-down trophic chain, Garrott et al. 2009*b*).

We observed 12 grizzly bears and 345 sets of grizzly bear tracks, an average of 0.19 observations of grizzly bear activity per km surveyed. We also observed 58 non-carcass feeding sites, 12 scats or groups of scats, 9 rub tree's, 5 daybeds, and 1 traditional trail that were associated with grizzly bear tracks. Three sets of black bear tracks were observed, an average of <0.01 observations of black bear activity per km. The number of observations of grizzly bears and their track sets outnumbered those of black bears every year we conducted the Firehole winter range surveys.

Primary spring grizzly bear feeding activities identified in the Firehole River winter range included: 1) scavenging bison and elk carcasses; 2) digging spring beauty corms; 3) predation on Northern pocket gophers and kleptoparasitism of their food caches consisting primarily of onion-grass bulbs, yampa roots, spring beauty corms, and American bistort rhizomes; 4) grazing grasses and sedges; 5) digging earthworms; 6) consuming geothermal soil; 7) digging ant hills and ripping open logs for ants; and 8) flipping over bison fecal piles for invertebrates.

*Norris Geyser Basin*

We surveyed 4 routes in the Norris Geyser Basin winter range annually, hiking a total of 498 km during the 25-year monitoring period. We found 38 bison carcasses and 32 elk carcasses, an average of 0.14 carcasses/km. No carcasses from other ungulate species were found. Ninety-seven percent of the elk carcasses and 79% of the bison carcass were >75% consumed when we found them. None of the elk carcasses and only 3% ($n$ = 1) of the bison carcasses were completely intact at the time of discovery. Evidence of scavenging by grizzly and/or black bears was observed at 31% ($n$ = 12) of the bison and 16% ($n$ = 5) of the elk carcasses. Of the bison carcasses where age class could be determined ($n$ = 38), 47% were adults, 11% were yearlings, and 42% were calves. Of the bison carcasses where sex could be determined ($n$ = 21), 43% were male and 57% were female. Of the elk carcasses where age class could be determined ($n$ = 28), 46% were adults, 25% were yearlings, and 29% were calves. Of the elk carcasses that sex could be determined ($n$ = 17) 18% were male and 82% were female.

From 1992 to 2008, 37 bison and 31 elk carcasses were found, an average of 4 ungulate carcasses per year (0.20 ungulate carcasses per km). However, from 2009 to 2016, only 1 bison and 1 elk carcass were found on the survey, an average of 0.25 ungulate carcasses per year (0.01 ungulate carcasses per km). The decline in the number of elk carcasses we found may be related to the direct killing of elk by wolves after their reestablishment in the Gibbon River drainage, or by behaviorally mediated changes in the spatial distribution of elk that overwintered in the Norris Geyser Basin following reestablishment of wolves to the area (Garrott et al. 2009*a*). The decline in bison carcasses in recent years is likely due to changing patterns of seasonal bison movements. As numbers of bison increased, competition for limited grazing resources also increased resulting in a decrease in foraging efficiency (Geremia et al. 2015). Decreased foraging efficiency provides an impetus for bison to move (Geremia et al. 2015). At current population numbers, bison now vacate the Norris Geyser Basin earlier in the winter than in past years and so are less likely to die there from over-winter starvation. Bison may also have learned to use roads mechanically groomed for over-snow vehicles, as a means to migrate out of the Norris Geyser Basin in winter (White et al. 2015).

We observed 1 grizzly bear and 115 sets of grizzly bear tracks, an average of 0.23 observations

of grizzly bear activity per km surveyed. We also observed 10 non-carcass feeding sites that were associated with grizzly bear tracks. One set of black bear tracks was observed, an average of <0.01 observations of black bear activity per km. The number of observations of grizzly bears and their track sets outnumbered those of black bears every year we conducted the Norris Geyser Basin winter range surveys.

Primary spring grizzly bear feeding activities observed in the Norris Geyser Basin winter range included: 1) scavenging bison and elk carcasses; 2) digging earthworms; and 3) consuming geothermal soil.

*Mud Volcano*

We surveyed one route in the Mud Volcano winter range each year from 2002 to 2016 (15 years), hiking a total of 101 km. We found 9 bison carcasses and 1 mule deer carcass, an average of 0.10 ungulate carcasses per km. No carcasses of elk or other ungulate species were found. All of the carcasses were >75% consumed when found. Evidence of scavenging by grizzly and/or black bears was observed at 40% ($n$ = 4) of the carcasses. Of the bison carcasses where age class could be determined ($n$ = 9), 44% were adults and 56% were yearlings; 63% were male and 37% were female.

We observed 3 grizzly bears and 53 sets of grizzly bear tracks, an average of 0.55 observations of grizzly bear activity per km surveyed. We also observed 31 non-carcass feeding sites, 12 scats or groups of scats, 3 daybeds, and 1 traditional trail that were associated with grizzly bear tracks. One set of black bear tracks were observed, an average of 0.01 observations of black bear activity per km. The number of observations of grizzly bears and their track sets outnumbered those of black bears every year we conducted the Mud Volcano winter range surveys.

Primary spring grizzly bear feeding activities observed in the Mud Volcano winter range included: 1) digging onion grass bulbs; 2) digging up pocket gophers and their food caches of onion-grass bulbs, yampa roots, spring beauty corms, and American bistort rhizomes; 3) digging spring beauty corms; 4) grazing grasses and sedges; 5) scavenging bison carcasses; 6) digging earthworms; 7) consuming geothermal soil; and 8) flipping over bison fecal piles for invertebrates.

**Northern Ungulate Winter Range**

Counts of northern range elk decreased from ~19,000 in 1994 to 4,000 by 2013 following wolf restoration, while bison numbers increased from approximately 870 to 3,500 (Wallen et al. 2015). We surveyed 13 routes on Yellowstone's Northern Range each year from 1997 to 2016 (20 years), hiking a total of 3,180 km. We found 708 carcasses, including 614 elk, 52 bison, 43 mule deer, 10 pronghorn, and 6 bighorn sheep which equated to 0.22 ungulate carcasses/km of survey route. No carcasses of moose, whitetail deer, or mountain goat were found. Seventy-three percent of the bison, 79% of the elk, 95% of the mule deer, and all of the pronghorn and bighorn sheep carcasses were >75% consumed when found during our surveys. Only 1% of the elk, 6% of the bison, and 2% of the mule deer were completely intact when discovered. Evidence of scavenging by grizzly and/or black bears was observed at 40% ($n$ = 21) of the bison carcasses, 20% ($n$ = 125) of the elk carcasses, and 12% ($n$ = 5) of the mule deer carcasses. None of the pronghorn or bighorn sheep carcasses had evidence of bear scavenging. Of the bison carcasses where age class could be determined ($n$ = 49), 88% were adults, 10% were yearlings, and 2% were calves. Of the bison carcasses where sex could be determined ($n$ = 41), 61% were male and 39% were female. Of the elk carcasses where age class could be determined ($n$ = 524), 81% were adults, 9% were yearlings, and 10% were calves. Of the elk carcasses where sex could be determined ($n$ = 418), 43% were male and 57% were female.

The Northern Range elk population decreased following wolf reintroduction (White and Garrott 2013). Concurrent with that decline we detected a decrease in elk carcasses and an increase in bison and mule deer carcasses on the northern range. From 1997 to 2007, elk comprised 94%, bison 4%, and mule deer 1% of the carcasses found on the Northern Range transects. From 2008 through 2016, elk comprised 73%, bison 12%, and mule deer 12% of the Northern Range carcasses.

Regan (2016) analyzed the Northern Range carcass monitoring data collected in Yellowstone National Park during the period 1997–2012, and compared it to similar data collected on the Custer-Gallatin National Forest (CGNF) north of the park during the same time period. Road densities and

associated human activities were higher on the national forest than inside Yellowstone National Park. Grizzly bear use of ungulate carcasses decreased significantly as road density increased (Regan 2016). The amount of human activity at carcasses also appeared to reduce bear scavenging of ungulate carcasses (Regan 2016).

We observed 21 grizzly bears and 152 sets of grizzly bear tracks, an average of 0.05 observations of grizzly bear activity per km surveyed. We also observed 14 non-carcass feeding sites, 14 scats or groups of scats, 15 rub trees, 7 daybeds, and 8 traditional trails that were associated with grizzly bear tracks. Twenty black bears and 44 sets of black bear tracks were observed, an average of 0.02 observations of black bear activity per km. Four non-carcass feeding sites, 9 scats or groups of scats, 1day bed, 1 rub tree, and 1 traditional trail associated with black bear tracks were also observed. The number of observations of grizzly bears and their track sets outnumbered those of black bears every year we conducted the Northern Winter Range surveys.

Primary bear feeding activities observed on the Northern Ungulate winter range included: 1) scavenging bison, elk, and mule deer carcasses; 2) predation on pocket gophers and kleptoparasitism of their food caches containing onion-grass bulbs, yampa roots, spring beauty corms, and American bistort rhizomes; 3) digging spring beauty corms; 4) grazing grasses and sedges; 5) digging ant hills and ripping open logs for ants; 6) digging earthworms; 7) eating rosehips; 8) eating cow parsnip; 9) consuming geothermal soil; 10) digging thistle roots; and 11) flipping over rocks and bison fecal piles for invertebrates.

**Summary**

- We documented 5 pulse years with abundant ungulate carcasses and 20 years with relatively few carcasses present. Pulse years occurred during years with high snow-water equivalent (Podruzny et al. 2012) and winter severity (Green 1994) indices.
- Most ungulate carcasses within Yellowstone National Park were quickly depleted by scavengers. Seventy-eight percent of the ungulate carcasses we detected were >75% consumed when found. Only 3% of carcasses were completely intact when detected. Black bears, wolves, coyotes, bald eagles, golden eagles, ravens, and magpies were significant competitors with grizzly bears for ungulate carcasses during our monitoring period. Mountain lions were also a competitor, but primarily through predation on elk and deer rather than through scavenging.
- Probability of carcass scavenging by bears was related to ungulate size and biomass. Evidence of scavenging by grizzly and/or black bears was observed at 37% of bison, 20% of elk, 11% of mule deer, and 0% of pronghorn carcasses.
- Wolves appeared to have a significant impact on the number of elk that overwintered in the high-elevation, thermally influenced winter ranges we monitored. The number of elk overwintering in these areas likely increased after wolves were extirpated from Yellowstone National Park in the 1920s, but then declined after wolf reintroduction during 1995–1996. Data we collected was not sufficient to determine if the reduction in overwintering elk in these areas was caused by direct killing by wolves or from fear-induced, behaviorally mediated changes in the spatial distribution of elk in winter. Although wolves likely reduced the number of elk that died from overwinter starvation in thermally influenced ungulate winter ranges, grizzly bears continued to scavenge ungulate meat through usurping wolf-killed elk during the spring, summer, and fall seasons, and through predation on elk calves in spring and early summer.
- Following the reestablishment of wolves in the Heart Lake area, elk no longer over-wintered there. However, grizzly bears continued to use the area in spring, and we detected an increase in grizzly activity following the disappearance of overwintering elk from the Heart Lake area. Concurrent with that increase, we detected a decrease in black bear activity at Heart Lake . Grizzly bears appeared to be displacing black bears from the Heart Lake area during the spring season.
- Although the Mud Volcano and Heart Lake areas had the highest number of

observations of grizzly bears and their track sets per km surveyed, these areas had the fewest number of ungulate carcasses detected per km. This suggests that grizzly bears were not solely dependent on ungulate carcasses during spring, and that these areas contained other important food resources utilized by bears at that time of year.

- The Northern Range elk population and the number of spring elk carcasses we detected decreased following wolf reintroduction. Concurrent with the decline in Northern Range elk and elk carcasses, we detected an increase in the number of bison and mule deer carcasses on the northern range, suggesting that the number of bison and mule deer wintering on the Northern Range increased after the elk decline.
- During the period of wolf absence from the GYE (1920s through early 1990s), grizzly bears obtained most of the meat they ate in early spring following severe winters, through scavenging the remains of ungulates that died over winter from starvation. Very few ungulates were available to scavenge after mild winters. Following wolf reintroduction during 1995–1996, the number of elk and bison that died from severe winter conditions decreased, but meat usurped from wolf-killed ungulates became available throughout the spring, summer, and fall every year regardless of winter severity. After wolf reintroduction, ungulate meat is generally available to bears for scavenging on a more consistent basis annually and over a longer period of time.

**Table 19. Elk, bison, and mule deer carcasses found along surveyed routes and visitation of carcasses by bears, wolves, coyotes and unknown large carnivores, Yellowstone National Park, spring 1992 - 2016.**

| Survey area (no. of routes) | Elk | | | | | Bison | | | | | Mule deer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of carcasses | No. visited by species | | | | No. of carcasses | No. visited by species | | | | No. of carcasses | No. visited by species | | | |
| | | Bear | Wolf | Coyote | Unk | | Bear | Wolf | Coyote | Unk | | Bear | Wolf | Coyote | Unk |
| Northern Range (12) | 614 | 125 | 53 | 38 | 432 | 52 | 21 | 8 | 6 | 24 | 43 | 5 | 4 | 5 | 29 |
| Firehole (8) | 117 | 21 | 18 | 32 | 61 | 318 | 119 | 30 | 64 | 97 | 0 | 0 | 0 | 0 | 0 |
| Norris (4) | 31 | 5 | 1 | 5 | 23 | 39 | 12 | 5 | 6 | 18 | 0 | 0 | 0 | 0 | 0 |
| Heart Lake (3) | 35 | 10 | 6 | 9 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mud Volcano (1) | 0 | 0 | 0 | 0 | 0 | 9 | 4 | 0 | 0 | 5 | 1 | 0 | 0 | 0 | 1 |
| Total | 797 | 161 | 99 | 84 | 531 | 418 | 156 | 43 | 76 | 144 | 44 | 5 | 4 | 5 | 30 |

**Table 20. Pronghorn and bighorn sheep carcasses found along surveyed routes and visitation of carcasses by bears, wolves, coyotes and unknown large carnivores, Yellowstone National Park, spring 1992 - 2016.**

| Survey area (no. of routes) | Pronghorn | | | | | Bighorn sheep | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. of carcasses | No. visited by species | | | | No. of carcasses | No. visited by species | | | |
| | | Bear | Wolf | Coyote | Unk | | Bear | Wolf | Coyote | Unk |
| Northern Range (12) | 10 | 0 | 0 | 0 | 10 | 6 | 0 | 1 | 0 | 5 |
| Firehole (8) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Norris (4) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Heart Lake (3) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Mud Volcano (1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 10 | 0 | 0 | 0 | 0 | 6 | 0 | 1 | 0 | 5 |

**Table 21. Age classes and sex of elk and bison carcasses found, by area, along surveyed routes, Yellowstone National Park, 1992 - 2016.**

| | Elk | | | | | | Bison | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northern Range | Firehole | Norris | Heart Lake | Mud Volcano | Total | Northern Range | Firehole | Norris | Heart Lake | Mud Volcano | Total |
| **Age** | | | | | | | | | | | | |
| Adult | 426 | 48 | 13 | 20 | 0 | 507 | 43 | 191 | 18 | 0 | 4 | 256 |
| Yearling | 48 | 19 | 7 | 06 | 0 | 80 | 5 | 69 | 4 | 0 | 5 | 83 |
| Calf | 50 | 23 | 8 | 03 | 0 | 84 | 1 | 45 | 16 | 0 | 0 | 62 |
| Unknown | 90 | 27 | 3 | 6 | 0 | 671 | 3 | 13 | 1 | 0 | 0 | 17 |
| | | | | | | | | | | | | |
| **Sex** | | | | | | | | | | | | |
| Male | 181 | 15 | 3 | 7 | 0 | 206 | 25 | 89 | 9 | 0 | 5 | 128 |
| Female | 237 | 51 | 14 | 4 | 0 | 306 | 316 | 130 | 12 | 0 | 3 | 161 |
| Unknown | 196 | 51 | 14 | 24 | 0 | 285 | 11 | 99 | 18 | 0 | 1 | 129 |

**Table 22. Age classes and sex of mule deer and pronghorn carcasses found, by area, along surveyed routes, Yellowstone National Park, 2016.**

| | Mule deer | | | | | | Pronghorn | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Northern Range | Firehole | Norris | Heart Lake | Mud Volcano | Total | Northern Range | Firehole | Norris | Heart Lake | Mud Volcano | Total |
| **Age** | | | | | | | | | | | | |
| Adult | 12 | 0 | 0 | 0 | 0 | 12 | 6 | 0 | 0 | 0 | 0 | 6 |
| Yearling | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Calf | 6 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown | 23 | 0 | 0 | 0 | 1 | 24 | 4 | 0 | 0 | 0 | 0 | 4 |
| | | | | | | | | | | | | |
| **Sex** | | | | | | | | | | | | |
| Male | 2 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 0 | 0 | 3 |
| Female | 3 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 |
| Unknown | 38 | 0 | 0 | 0 | 1 | 39 | 6 | 0 | 0 | 0 | 0 | 6 |

**Table 23. Age classes and sex of bighorn sheep carcasses found, by area, along surveyed routes, Yellowstone National Park, 1992 - 2016.**

| | Bighorn Sheep | | | | | |
|---|---|---|---|---|---|---|
| | Northern Range | Firehole | Norris | Heart Lake | Mud Volcano | Total |
| **Age** | | | | | | |
| Adult | 6 | 0 | 0 | 0 | 0 | 6 |
| Yearling | 0 | 0 | 0 | 0 | 0 | 0 |
| Calf | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | | |
| **Sex** | | | | | | |
| Male | 4 | 0 | 0 | 0 | 0 | 4 |
| Female | 2 | 0 | 0 | 0 | 0 | 2 |
| Unknown | 0 | 0 | 0 | 0 | 1 | 0 |

**Table 24. Number of observations of grizzly, black, and unknown species of bears and their track sets, and indices of bear activity per km of survey route in spring on different winter ranges in Yellowstone National Park, 1992 2016.**

| Winter Range | Kilometers Surveyed | Ungulate Carcasses/km | Visual Observations | | | Track Sets | | | Bear Activity Index (sightings + track sets/km | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Grizzly | Black | Unknown | Grizzly | Black | Unknown | Grizzly | Black | Unknown |
| Heart Lake | 447.1 | 0.01 | 31 | 4 | 1 | 173 | 25 | 34 | 0.46 | 0.06 | 0.08 |
| Firehole River | 1,889.20 | 0.23 | 12 | 0 | 0 | 345 | 3 | 11 | 0.19 | <0.01 | 0.01 |
| Norris Geyser Basin | 497.5 | 0.14 | 1 | 0 | 0 | 115 | 1 | 3 | 0.23 | <0.01 | 0.01 |
| Mud Volcano | 101.1 | 0.1 | 3 | 0 | 0 | 53 | 1 | 5 | 0.55 | 0.01 | 0.05 |
| Northern Range | 3,179.90 | 0.22 | 21 | 20 | 0 | 152 | 44 | 22 | 0.05 | 0.02 | 0.01 |
| Total | 6,114.80 | 0.21 | 68 | 24 | 1 | 838 | 74 | 75 | 0.15 | 0.02 | 0.01 |

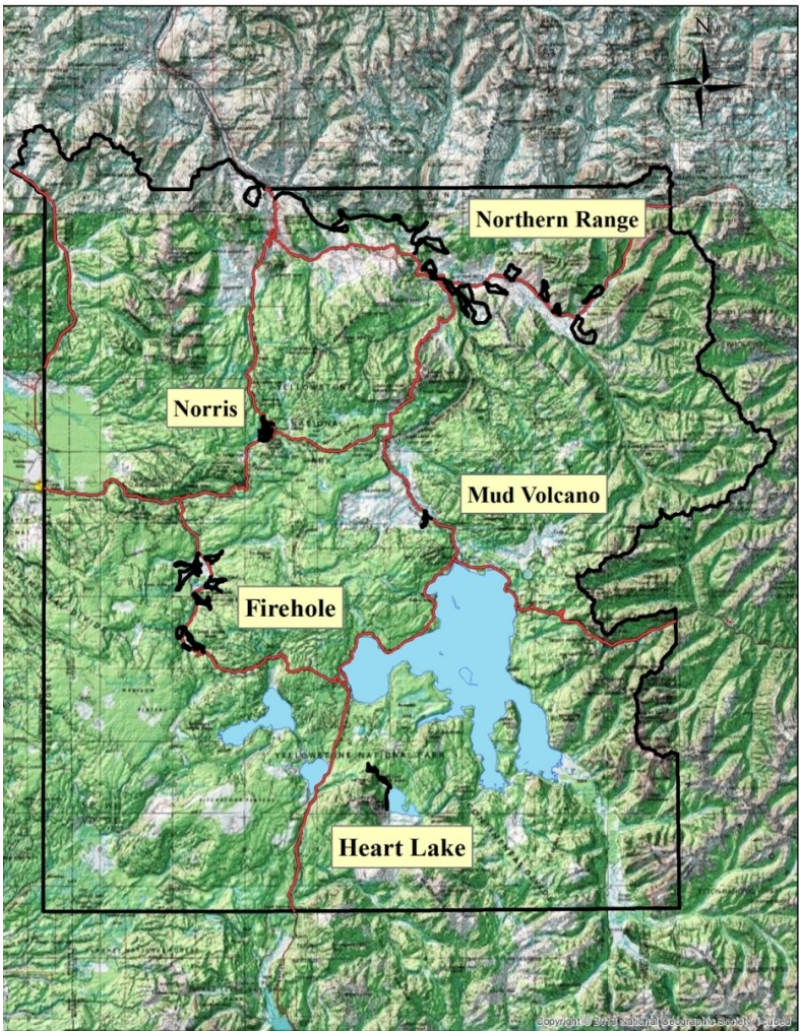



*Fig. 8. Spring ungulate carcass survey routes in 5 ungulate winter ranges, Yellowstone National Park, 1992–2016.*

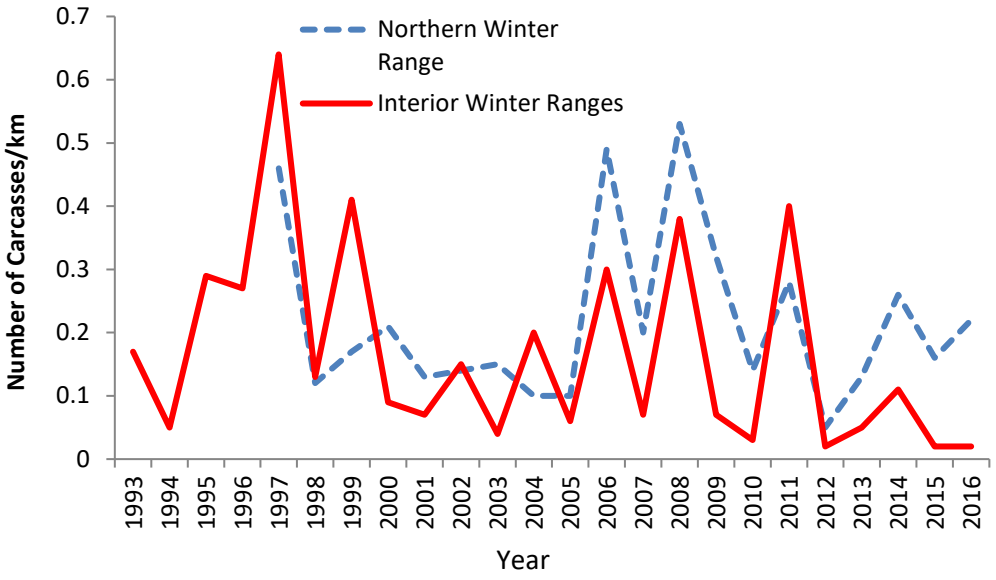



*Fig. 9. Annual ungulate carcasses/km found on spring survey routes on the northern winter range and interior winter ranges, Yellowstone National Park, 1992–2016.*

*The reintroduction of gray wolves in 1995-1996 restored the historic predator guild in the Greater Yellowstone Ecosystem. Grizzly bears now compete with black bears, wolves, coyotes, and mountain lions for ungulates through predation and scavenging. Bald eagles, golden eagles, ravens, and magpies also contribute toward the rapid depletion of ungulate carcasses on the landscape (photo courtesy of Dan Stahler/NPS)*

***Spawning Cutthroat Trout Availability and Use by Grizzly Bears in Yellowstone National Park***
*(Kerry A. Gunther, Eric Reinertson, Travis Wyman, Todd M. Koel, Patricia E. Bigelow, and Brian Ertel, Yellowstone National Park)*

In spring and early summer, grizzly bears with home ranges near Yellowstone Lake feed on spawning Yellowstone cutthroat trout (YCT, *Oncorhynchus clarkii*) during years when trout are abundant in tributary streams (Gunther et al. 2014). Bears also occasionally prey on cutthroat trout in other areas of the park, including Fan Creek (westslope cutthroat trout, YCT, or westslope × YCT hybrid) in the northwest section of the park and the inlet creek to Trout Lake (YCT or YCT × rainbow trout *O. mykiss* hybrids) located in the northeast section of the park.

Non-native lake trout (*Salvelinus namaycush*), whirling disease caused by an exotic parasite (*Myxobolus cerebralis*), and drought have substantially reduced the native YCT population in Yellowstone Lake and associated bear fishing activity (Haroldson et al. 2005; Koel et al. 2005, 2006). The combined effect of all these factors has reduced the Yellowstone Lake YCT population by 90% (Koel et al. 2010*a*). Because of the decline and past use of YCT as a food source by some grizzly bears, monitoring of the YCT population is a component of the habitat monitoring program of the 2016 Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016). The YCT population has been 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 (Fig. 10). Visual stream surveys are also conducted along the Trout Lake inlet creek in the northeast section of the park. In 2014, we added 4 Yellowstone Lake backcountry spawning streams to our YCT monitoring program, including 3 streams (Flat Mountain Creek, #1138, and #1141) on the west shore and 1 stream (Columbine Creek) on the east side of Yellowstone Lake. High turbidity and waters levels in Columbine Creek prevented accurate surveys most years, so this stream was dropped from backcountry surveys beginning in 2017.

**Yellowstone Lake**

*Fish Trap Surveys*

Historically, the number of spawning YCT migrating upstream were 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. 11; Koel et al. 2005). The fish trap was generally installed in May, the exact date depending on winter snow accumulation, weather conditions, and spring snow melt. Fish were counted by dip netting trout that entered the upstream trap box, visually as they swam through wooden chutes attached to the trap, or by swimming through an electronic counting box. 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 were not obtained during 2008–2014. In the fall of 2012, the remnants of the weir were removed, stream banks stabilized, and a suitable platform for an electronic sonar fish counter was installed. Installation and calibration of the sonar fish counter began in the summer 2013 and continued through 2014. In 2015, the sonar fish counter at the Clear Creek weir became operational. The sonar station is installed in mid to late-April and runs through mid-July. As of 10 May 2018, the count of spawning cutthroat trout that ascended Clear Creek in 2017 was not yet available, but will be reported in the 2018 IGBST annual report.

*Front Country Visual Stream Surveys*

Beginning as early as mid-April depending on snowpack and ice-off, several streams including Lodge Creek, Hatchery Creek, Incinerator Creek, Wells Creek, Bridge Creek, and unnamed stream #1090 on the North Shore of Yellowstone Lake, and Sandy Creek, Sewer Creek, Little Thumb Creek, and unnamed stream #1167 in the West Thumb area are checked periodically to detect the presence of adult YCT (Andrascik 1992, Olliff 1992). Once adult YCT are found (i.e., onset of spawning), weekly surveys of YCT 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, a minimum of two people walked from the stream mouth to the upstream extent that fish have

been observed in past years, and record the number of adult YCT counted. Sampling continues one day per week until two consecutive weeks when no trout are observed in the creek (i.e., end of spawn). The length of the spawning season is calculated as 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.

The ice went off of Yellowstone Lake on 23 May 2017. Data collected in 2017 continued to show low numbers of spawning YCT in North Shore and most West Thumb tributary streams (Table 24). In North Shore streams, only 33 spawning YCT were counted. Thirty spawning YCT were counted in Bridge Creek and 3 in stream #1090. No spawning YCT were observed in Lodge Creek, Hatchery Creek, Incinerator Creek, or Wells Creek. No evidence of bears or bear fishing activity (i.e., observations of bears fishing, fish parts, bear scats containing fish parts) was observed along any of the monitored North Shore streams in 2017.

On West Thumb streams, 124 spawning YCT were counted, including 112 in Little Thumb Creek, 7 in Sandy Creek and 5 in stream #1167. No spawning YCT were observed in Sewer Creek. Both black and grizzly bears were observed looking for fish along Little Thumb Creek, and, using a trail camera, we detected one black bear successfully catching a fish. We did not observe evidence of successful fish predation by grizzly bears. In addition, grizzly bear activity including tracks, scat, and digging were observed along Sandy Creek, Sewer Creek, and stream #1167, however there was no evidence of fishing along these creeks. Black bear activity without evidence of fishing was also observed along Sandy Creek and stream #1167.

The number of spawning YCT counted in the North Shore (Fig. 12) and West Thumb (Fig. 13) streams has decreased significantly since 1989. Although the increased spawning activity in Little Thumb Creek in recent years is promising, very few spawning YCT have been observed in all other North Shore and West Thumb streams.

*Backcountry Visual Stream Surveys*

In 2017, we surveyed 3 backcountry tributary streams including Flat Mountain Creek, unnamed stream #1138, and unnamed stream #1141. Backcountry stream surveys followed the same methods used on frontcountry streams. In backcountry streams, 131 spawning YCT were counted. Seventy-seven spawning YCT were counted in Flat Mountain Creek, 28 in stream #1141, and 26 in stream #1138. Evidence of grizzly bear predation on YCT was found along streams #1138 and #1141. No conclusive evidence of bear fishing activity was observed along Flat Mountain Creek, although grizzly bear tracks and trout eggs were found along the stream indicating that bears likely fished that creek as well.

**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 YCT (and cutthroat × rainbow trout hybrids). Once spawning trout are detected (i.e., onset of spawning), weekly surveys of adult trout in the inlet creek are conducted. On each sample day, two people walk from the stream mouth to the upstream extent that fish have been observed in past years, and record the number of adult trout counted. Sampling continues one day per week until two consecutive weeks when no trout are observed in the creek. The length of the spawning season is calculated as 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 2017, the first movement of spawning trout from Trout Lake into the inlet creek was observed on 14 June. The spawn lasted approximately 28 days with the last spawning trout observed in the inlet creek on 11 July. During the once per week visual surveys, 342 spawning cutthroat (and cutthroat trout × rainbow trout hybrids) were counted, an average of 68 per visit during the spawning season (Table 24). The number of fish observed per survey has ranged from a low of 31 in 2004, to a high of 306 in 2010 (Fig. 14). No evidence of grizzly bear or black bear fishing activity was observed along Trout Lake or the inlet creek during the surveys in 2017.

## Outlook for Cutthroat Trout

The number of spawning YCT counted in all surveyed tributary streams of Yellowstone Lake reached a nadir in approximately 2004 (Figs. 15–17). A Native Fish Conservation Plan/Environmental Assessment was completed in 2011 (Koel et al. 2010*b*). The plan outlines a program of management efforts designed to protect the native YCT population through suppression of lake trout and other methods. As part of these management efforts, park fisheries biologists and private-sector (contracted) netters caught and removed 396,950 lake trout from Yellowstone Lake in 2017. Population models indicate the removal program has slowed lake trout population growth and likely started to send the population into decline (Syslo et al. 2011, Gresswell et al. 2015). If the removal program results in a significant long-term reduction in predatory lake trout, native YCT will likely reestablish at higher numbers in Yellowstone Lake and its tributary streams and once again become a more important diet item for grizzly bears in the Yellowstone Lake watershed. In 2017, we documented grizzly bears fishing for YCT in un-named streams #1138 and #1141, and a black bear fishing in Little Thumb Creek, suggesting that the YCT population may be increasing at least in some streams. Evidence of bears fishing for YCT indicates that the Lake Trout removal program may be beginning to show signs of success.

**Table 24. Summary statistics for spawning cutthroat trout surveys, Yellowstone National Park, 2017.**

| Stream | Start of spawn | Last day of spawn | Duration of spawn (days) | Number of surveys during spawning period | Number of fish counted | Average no. fish/survey |
|---|---|---|---|---|---|---|
| North Shore | | | | | | |
| Lodge Creek | | | No spawn | | | |
| Hatchery Creek | | | No spawn | | | |
| Incinerator Creek | | | No spawn | | | |
| Wells Creek | | | No spawn | | | |
| Bridge Creek | 05/24/2017 | 05/30/2016 | 7 | 2 | 30 | 15.0 |
| #1090 | 05/25/2017 | 05/25/2016 | 1 | 1 | 3 | 3.0 |
| West Thumb | | | | | | |
| 1167 Creek | 05/17/2017 | 05/30/2017 | 14 | 3 | 5 | 1.7 |
| Sandy Creek | 05/23/2017 | 05/30/2017 | 8 | 2 | 7 | 3.5 |
| Sewer Creek | | | No spawn | | | |
| Little Thumb Creek | 06/06/2017 | 06/19/2017 | 14 | 3 | 112 | 37.3 |
| Total frontcountry[a] | | | | 11 | 157 | 14.3 |
| Backcountry | | | | | | |
| Flat Mountain Creek | 05/22/2017 | 06/05/2017 | 15 | 3 | 77 | 25.7 |
| #1141 Creek | 05/29/2017 | 06/05/2017 | 8 | 2 | 28 | 14.0 |
| #1138 Creek | 05/22/2017 | 06/05/2017 | 15 | 3 | 26 | 8.7 |
| Columbine Creek | | | Not surveyed | | | |
| Total backcountry | | | | 8 | 131 | 16.4 |
| Northern Range | | | | | | |
| Trout Lake Inlet | 06/14/2017 | 07/11/2017 | 28 | 5 | 342 | 68.4 |

[a] Total for North Shore and West Thumb streams that had a spawn.


*Fig. 10. Locations of Yellowstone Lake cutthroat trout spawning streams surveyed in 2017.*

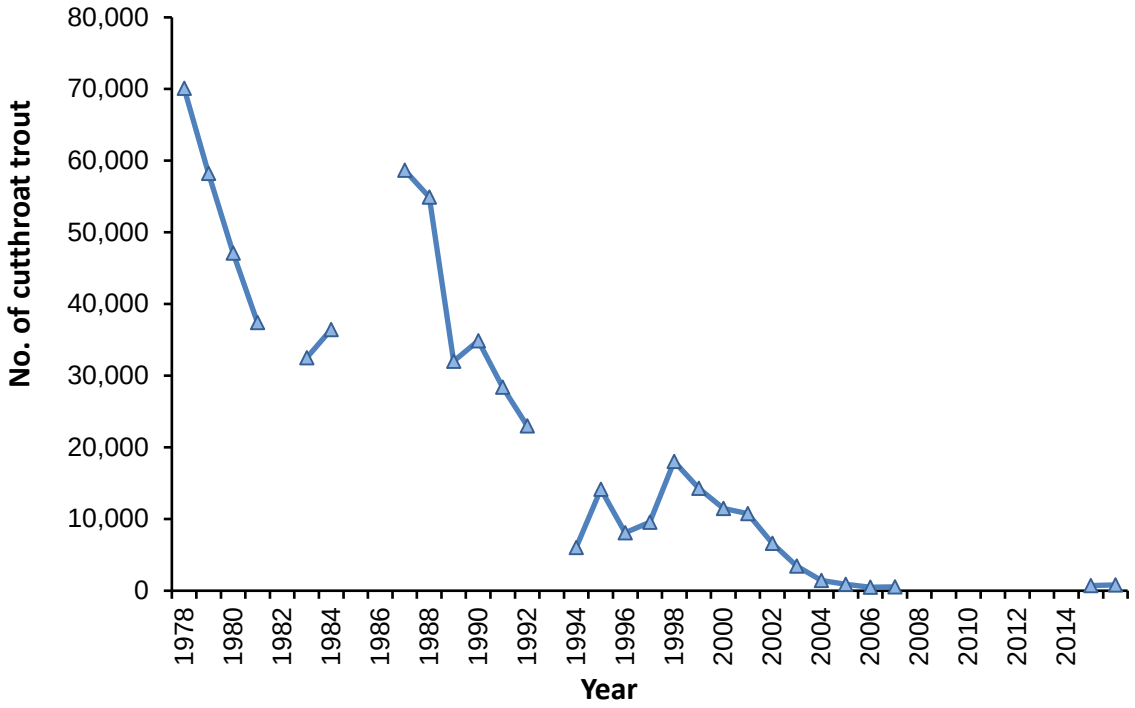



*Fig. 11. Number of spawning cutthroat trout counted at the Clear Creek fish trap on the east shore of Yellowstone Lake, Yellowstone National Park, 1977–2017.*

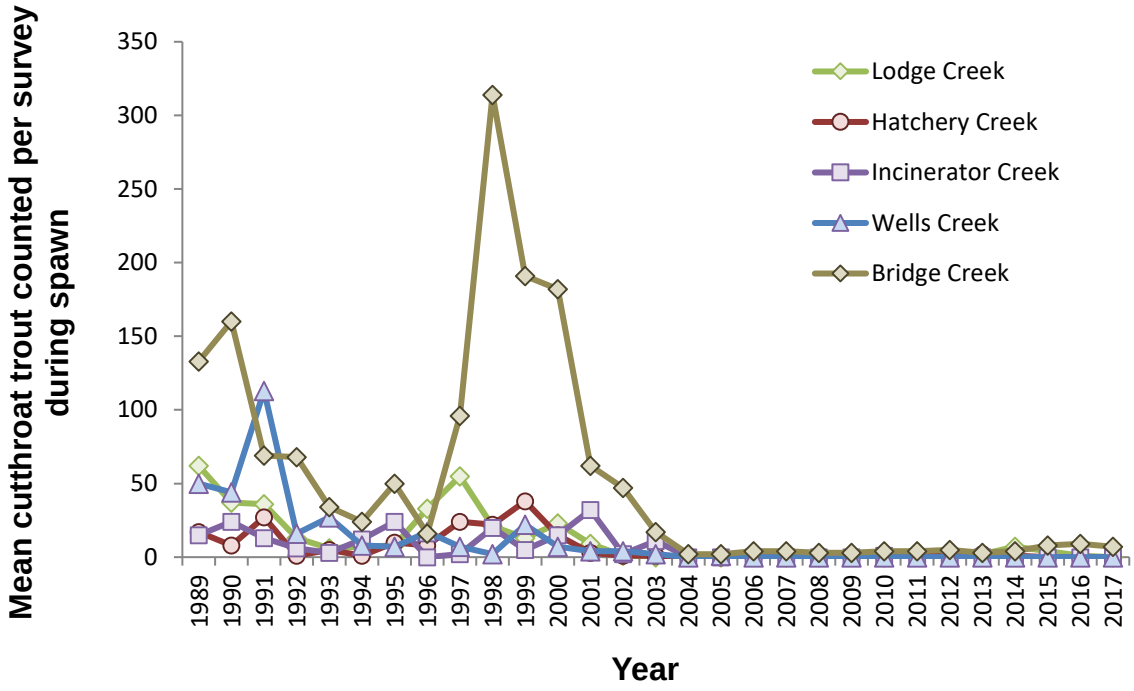



*Fig. 12. Mean number of spawning cutthroat trout observed during weekly visual surveys of 5 North Shore spawning stream tributaries to Yellowstone Lake, Yellowstone National Park, 1989–2017.*

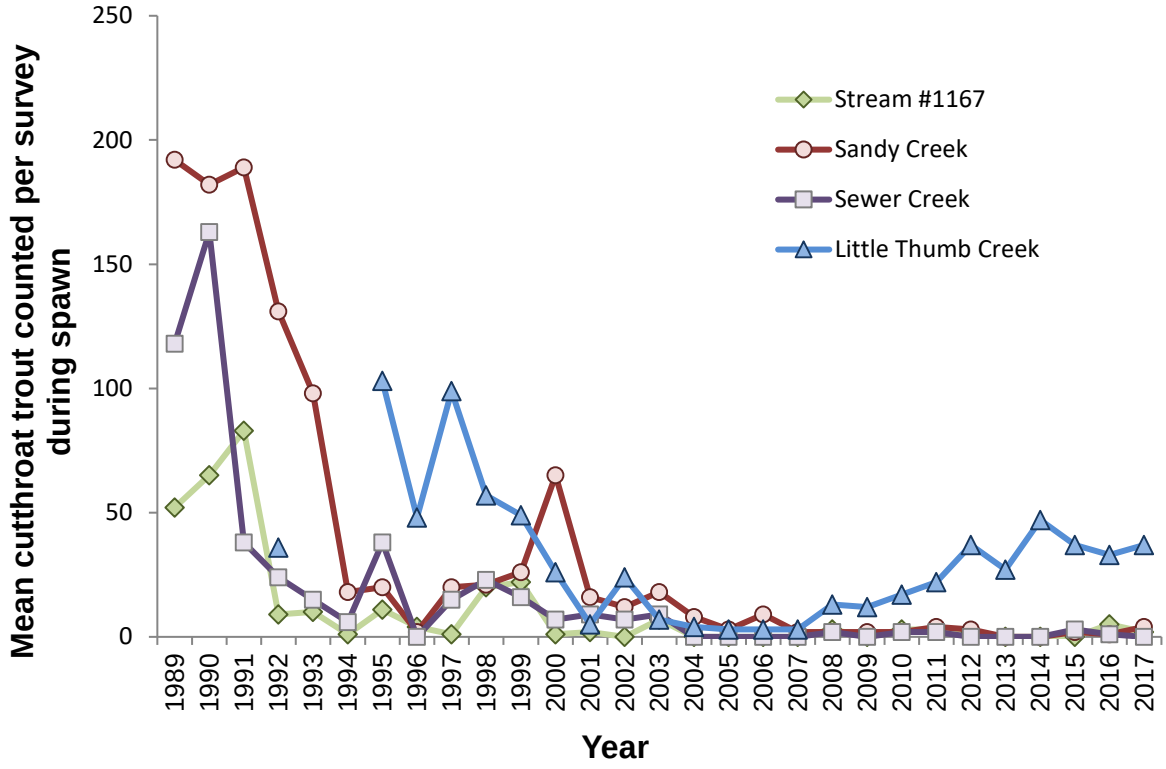



*Fig. 13. Mean number of spawning cutthroat trout observed during weekly visual surveys of 4 West Thumb spawning stream tributaries to Yellowstone Lake, Yellowstone National Park, 1989–2017.*

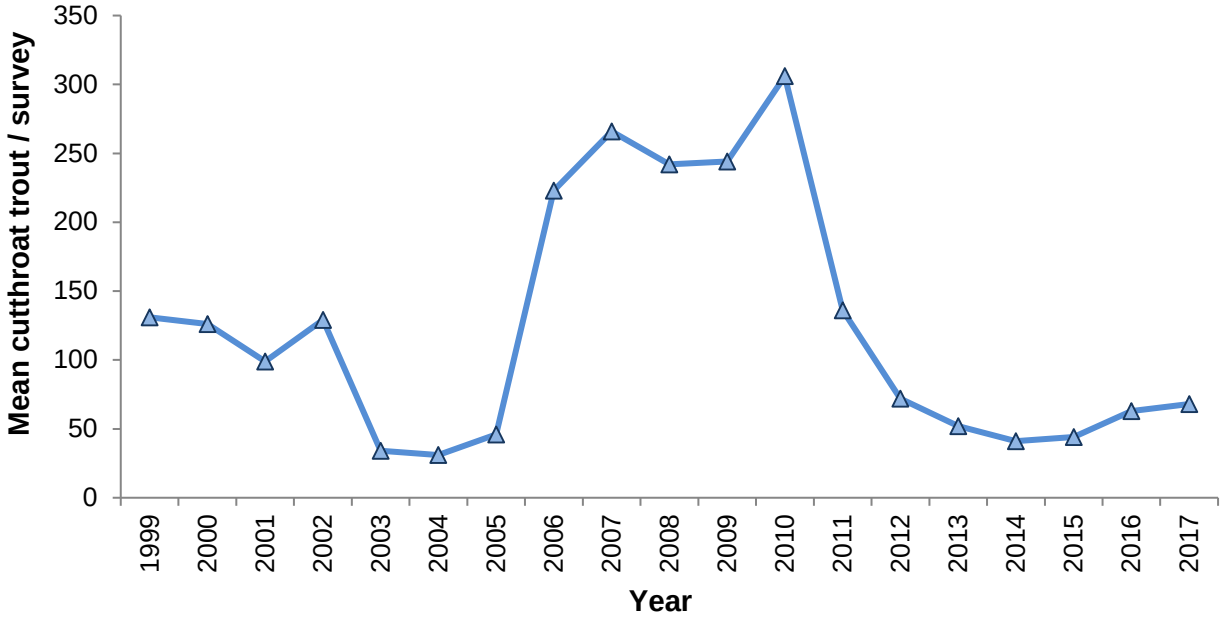



*Fig. 14. Mean number of spawning cutthroat trout (including cutthroat × rainbow trout hybrids) observed during weekly visual surveys of the Trout Lake inlet creek, Yellowstone National Park, 1999–2017.*

***Grizzly Bear Use of Insect Aggregation Sites***
*(Daniel D. Bjornlie, Wyoming Game and Fish Department; and Mark A. Haroldson, Interagency Grizzly Bear Study Team, U.S. Geological Survey)*

Army cutworm moths (*Euxoa auxiliaris*) were first recognized as an important food source for grizzly bears in the GYE during the mid-1980s (Mattson et al. 1991*b*, French et al. 1994). Early observations indicated that moths, and subsequently bears, showed specific site fidelity. These sites are generally high alpine areas dominated by talus and scree adjacent to areas with abundant alpine flowers. Because insects other than army cutworm moths may be present and consumed by bears (e.g., ladybird beetles [Coccinellidae family]) as well, we generally refer to such areas as "insect aggregation sites." Within the GYE, observations indicate army cutworm moths are the primary food source at these 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. However, 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 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. However, this technique overlooked small sites due to the inability to create polygons around sites with fewer than 3 locations. During1997–1999, 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 and 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).

We developed a new technique in 2000 (D. Bjornlie, Wyoming Game and Fish Department, unpublished data) that delineates sites by buffering only the locations of bears observed actively feeding at insect aggregation sites by 500 m; this distance was used to account for error in aerial locations. The borders of the overlapping buffers at individual insect sites are dissolved to produce a single polygon for each site. These sites are identified as "confirmed" sites. Because these polygons are only created around feeding locations, the resulting site conforms to the topography of the mountain or ridge top where bears feed and does not include large areas of non-talus habitat that are not suitable for cutworm moths. Records from the grizzly bear location database from July 1 through September 30 of each year are then overlaid on these polygons and enumerated. This new technique substantially decreased the number of sites described in prior years, in which locations from both feeding and non-feeding bears were used. Therefore, we use this technique for the annual analysis completed for all years. Areas suspected as insect aggregation sites but dropped from the list of confirmed sites using this technique, and 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. New observations of grizzly bears actively feeding in previously undocumented areas will be added as possible sites and monitored for future use. In addition, as new observations of actively feeding bears are added along the periphery of 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.

Analysis of grizzly bear use of insect aggregation sites in 2017 resulted in an additional 163 observations of actively feeding grizzly bears on previously identified confirmed sites. In

addition, there were observations of actively feeding grizzly bears at 5 previously undocumented sites so 5 possible new sites were added in 2017. Thus, there were 31 confirmed sites and 19 possible sites for 2017.

Overall insect aggregation site use by grizzly bears in 2017 ($n$ = 296) was higher than 2016 ($n$ = 217), but still slightly below peak the years of 2012–2014 (Table 25). The number of grizzly bears observed on sites and the percentage of confirmed sites with documented use by grizzly bears varies from year to year, suggesting that some years have higher moth activity than others (Fig. 15), which may be due to variable snow conditions or the number of moths migrating from the plains. In 1993, a year with unusually high snowpack, the percentage of confirmed sites used by bears (Fig. 15) and the number of observations recorded at insect sites (Table 25) were very low. In all other years, the percentage of insect aggregation sites used by grizzly bears varied between 50% and 80% (Fig. 15).

The greater use of insect aggregation sites by grizzly bears in 2017 is also apparent when bears observed only during regularly conducted observation flights (see "***Observation Flights***") are included (Fig. 16). Because effort, as measured by hours flown, in the bear management units containing all confirmed insect aggregation sites has remained consistent since 1997, the change in the number of grizzly bears using insect aggregation sites suggests this increase was not due to change in observation effort (Fig. 16). The increase in reported observations of grizzly bears using insect aggregation sites from ground-based observers and our increased use of GPS collars with satellite technology has resulted in the need to censor these locations to prevent a bias in comparisons with previous years. Therefore, the number of aerial telemetry locations and observations from Table 25 reflect this change and may differ from previous annual reports.

The IGBST maintains an annual list of unique females observed with cubs (see Table 5 in "***Estimating Number of Females with Cubs***"). Since 1986, 1,169 initial sightings of unique females with cubs have been recorded, of which 327 (28.0%) have occurred at (<500 m, $n$ = 305) or near (<1,500 m, $n$ = 22) insect aggregation sites (Table 26). In 2017, 12 of the 58 (20.7%) initial sightings of unique females with cubs were observed at insect aggregation sites; lower than the mean of 28.5% for the previous five years (2012–2016, Table 26).

Survey flights at or near (<1,500 m) insect aggregation sites contribute to the count of unique females with cubs; however, the contribution from these flights is typically low, with a 10-year mean of 13.0 initial sightings/year since 2008 (Table 26). If these sightings are excluded, a similar trend in the annual number of unique sightings of females with cubs is still evident (Fig. 17), suggesting that other factors besides observation effort at insect aggregation sites are responsible for the increase in sightings of females with cubs over time.

*Grizzly bears foraging on army cutworm moths, Shoshone National Forest, Wyoming. (photo courtesy of Josh Westerhold)*

**Table 25. Summary statistics for grizzly bear use of confirmed insect aggregation sites, Greater Yellowstone Ecosystem, 1986–2017.**

| Year | Number of confirmed sites[a] | Number of sites used[b] | Number of aerial telemetry locations | Number of ground or aerial observations |
|---|---|---|---|---|
| 1986 | 4 | 2 | 7 | 5 |
| 1987 | 5 | 3 | 3 | 17 |
| 1988 | 5 | 3 | 11 | 28 |
| 1989 | 9 | 7 | 9 | 41 |
| 1990 | 14 | 11 | 9 | 77 |
| 1991 | 16 | 12 | 12 | 169 |
| 1992 | 17 | 11 | 6 | 107 |
| 1993 | 18 | 3 | 1 | 2 |
| 1994 | 18 | 9 | 1 | 31 |
| 1995 | 20 | 11 | 7 | 39 |
| 1996 | 21 | 14 | 21 | 67 |
| 1997 | 22 | 15 | 17 | 83 |
| 1998 | 25 | 21 | 10 | 182 |
| 1999 | 25 | 14 | 26 | 156 |
| 2000 | 25 | 13 | 48 | 95 |
| 2001 | 26 | 18 | 23 | 127 |
| 2002 | 27 | 20 | 30 | 251 |
| 2003 | 27 | 20 | 9 | 163 |
| 2004 | 27 | 16 | 2 | 134 |
| 2005 | 29 | 19 | 16 | 197 |
| 2006 | 29 | 16 | 15 | 146 |
| 2007 | 29 | 19 | 19 | 161 |
| 2008 | 29 | 22 | 17 | 179 |
| 2009 | 31 | 23 | 9 | 170 |
| 2010 | 31 | 18 | 3 | 132 |
| 2011 | 31 | 19 | 9 | 162 |
| 2012 | 31 | 22 | 16 | 252 |
| 2013 | 31 | 22 | 25 | 295 |
| 2014 | 31 | 24 | 11 | 343 |
| 2015 | 31 | 21 | 13 | 210 |
| 2016 | 31 | 19 | 10 | 207 |
| 2017 | 31 | 21 | 20 | 276 |
| Total | | | 435 | 4504 |

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

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

**Table 26. Initial sightings of unique females with cubs on or near insect aggregation sites, Greater Yellowstone Ecosystem, 1986–2017.**

| Year | Number of unique females with cubs[a] | Number of sites with an initial sighting[b] | Initial sightings | | | |
|---|---|---|---|---|---|---|
| | | | Within 500 m[b] | | Within 1,500 m[c] | |
| | | | *n* | % | *N* | % |
| 1986 | 25 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 13 | 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 | 4 | 4 | 16.0 | 5 | 20.0 |
| 1991 | 24 | 7 | 13 | 54.2 | 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 | 8 | 24.2 |
| 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 | 9 | 24.3 | 10 | 27.0 |
| 2001 | 42 | 7 | 13 | 31.0 | 13 | 31.0 |
| 2002 | 52 | 11 | 18 | 34.6 | 18 | 34.6 |
| 2003 | 38 | 11 | 20 | 52.6 | 20 | 52.6 |
| 2004 | 49 | 11 | 17 | 34.7 | 17 | 34.7 |
| 2005 | 31 | 5 | 7 | 22.6 | 8 | 25.8 |
| 2006 | 47 | 11 | 15 | 31.9 | 16 | 34.0 |
| 2007 | 50 | 10 | 17 | 34.0 | 17 | 34.0 |
| 2008 | 44 | 7 | 11 | 25.0 | 14 | 31.8 |
| 2009 | 42 | 4 | 6 | 14.3 | 7 | 16.7 |
| 2010 | 51 | 7 | 9 | 17.6 | 9 | 17.6 |
| 2011 | 39 | 6 | 7 | 17.9 | 7 | 17.9 |
| 2012 | 49 | 6 | 13 | 26.5 | 13 | 26.5 |
| 2013 | 58 | 8 | 14 | 24.1 | 15 | 25.9 |
| 2014 | 50 | 11 | 21 | 42.0 | 23 | 46.0 |
| 2015 | 46 | 7 | 11 | 23.9 | 13 | 28.3 |
| 2016 | 50 | 7 | 13 | 26.0 | 17 | 34.0 |
| 2017 | 58 | 7 | 12 | 20.7 | 12 | 20.7 |
| Total | 1,169 | | 305 | | 327 | |
| Mean | 36.5 | 6.1 | 9.5 | 24.1 | 10.2 | 25.9 |

[a] Initial sightings of unique females with cubs; see Table 5.

[b] Insect aggregation site is defined as a 500-m distance 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 may be of bears traveling to and from insect aggregation sites.

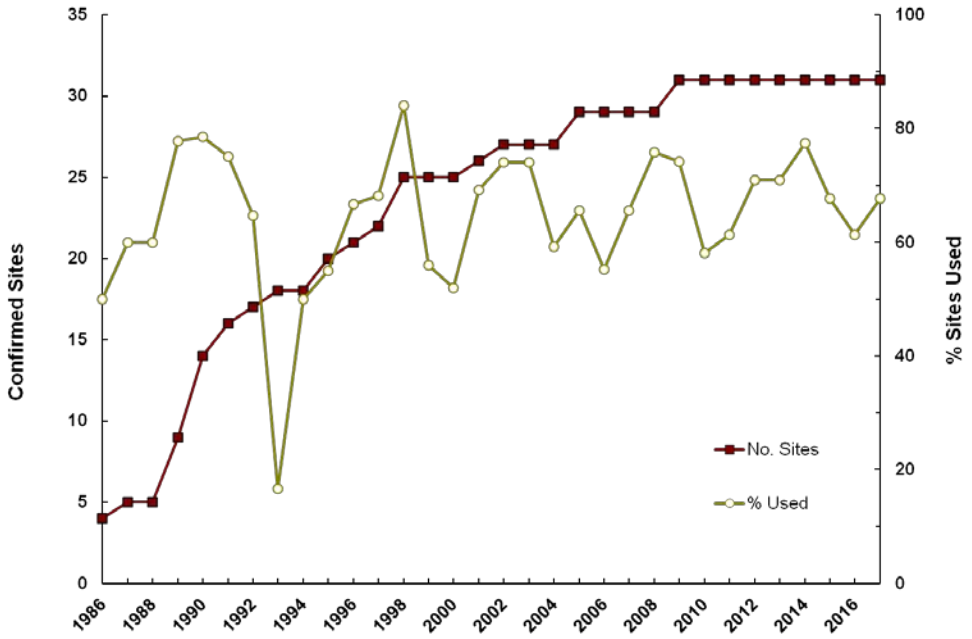



*Fig. 15. Annual number of confirmed insect aggregation sites and percent of those sites at which telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986–2017.*

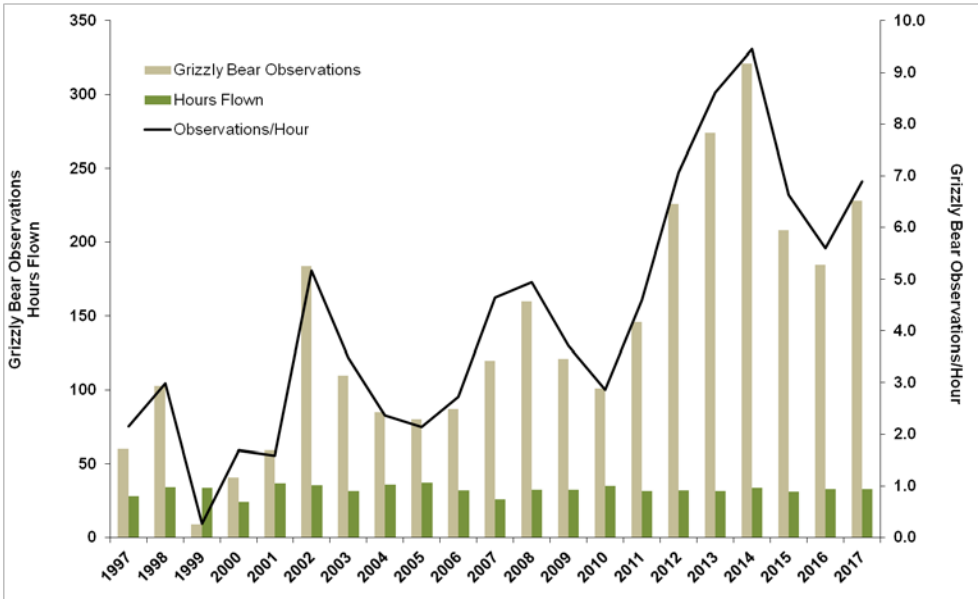



*Fig. 16. Number of grizzly bears observed (tan bars) on insect aggregation sites during observation flights only, hours flown (green bars) for these bear management units (BMU), and grizzly bear observations per hour (black line) during observation flights of BMUs containing all known insect aggregation sites, Greater Yellowstone Ecosystem, 1997–2017.*

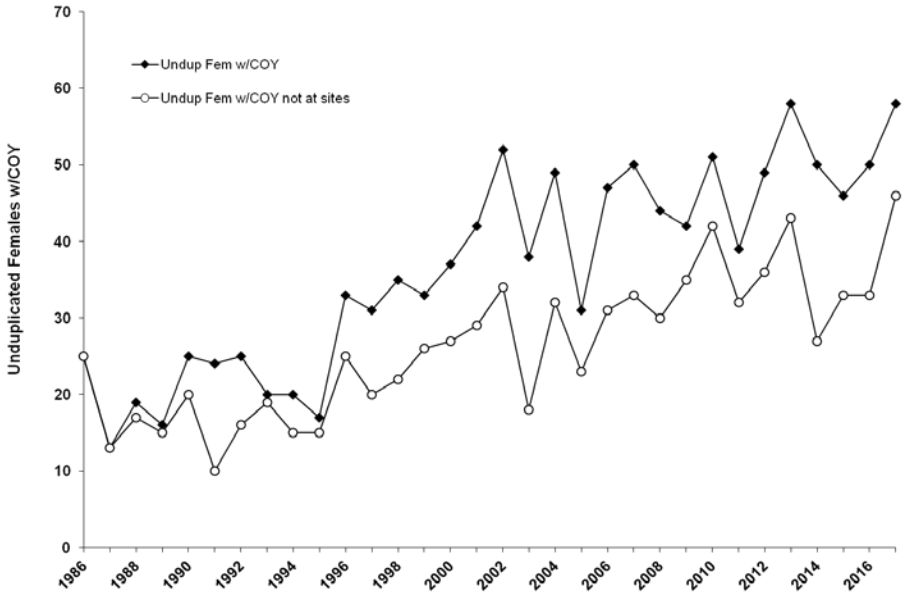



*Fig. 17. Total number of unique females with cubs (Unduplicated Females w/COY) observed annually in the Greater Yellowstone Ecosystem and the number of unique females with cubs not found within 1,500 m of known insect aggregation sites, 1986–2017.*

***Whitebark Pine Cone Production*** *(Mark A. Haroldson, Interagency Grizzly Bear Study Team, U.S. Geological Survey)*

Whitebark pine (*Pinus albicaulis*) surveys on 21 established transects indicated above-average cone production during 2017 (Fig. 18). Overall, the mean number of observed cones/tree was 23.0 (Table 27), which was above the overall average of 16 for the period 1980–2017 (Fig. 19). Cone production was above average on 12 transects and below average on 9 (Table 28).

We continue to monitor tree mortality caused by mountain pine beetle (*Dendroctonus ponderosae*) in stands that contain our cone production transects. During 2017 we did not observe any additional beetle-caused mortality among individual trees surveyed since 2002. Total mortality on these transect trees since 2002 remains at 75.8% (144/190) with 100% (19/19) of transects containing beetle-killed trees. Although tree mortality from mountain pine beetle is still occurring, the rate of loss among our cone production transects has slowed (Fig. 20). These findings suggests that at least in the vicinity of these transects, the current beetle outbreak has likely run its course. Six of the 7 transects established during 2007 also exhibited beetle-caused mortality among transect trees.

**Table 27. Summary statistics for whitebark pine cone production surveys, Greater Yellowstone Ecosystem, 2017.**

| Total | | | Trees | | | | Transect | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cones | Trees | Transects | Mean cones | SD | Min | Max | Mean cones | SD | Min | Max |
| 4,269 | 185 | 21 | 23.01 | 27.89 | 0 | 177 | 203.29 | 148.99 | 38 | 572 |

*Grizzly bear digging whitebark pine cones from a red squirrel midden. (photo courtesy of Jake Davis/www.revealedinnature.com)*

| Table 28. Results of whitebark pine cone production surveys, Greater Yellowstone Ecosystem, 2017. | | | | |
|---|---|---|---|---|
| Transect | Number of cones | Number of trees | Mean number of cones/tree | SD |
| A | 61 | 5 | 12.2 | 26.2 |
| B | 176 | 10 | 17.6 | 10.8 |
| C | 154 | 10 | 15.4 | 7.4 |
| D1 | 57 | 10 | 5.7 | 5.3 |
| F1 | | -----Transect retired in 2008----- | | |
| G | 171 | 9 | 19.0 | 20.3 |
| H | | -----Transect retired in 2008----- | | |
| J | 54 | 10 | 5.4 | 4.2 |
| K | 378 | 7 | 54.0 | 21.5 |
| L | 181 | 8 | 22.6 | 18.6 |
| M | 140 | 10 | 14.0 | 10.2 |
| N | 295 | 10 | 29.5 | 54.5 |
| P | 40 | 10 | 4.0 | 5.5 |
| Q1 | 38 | 10 | 3.8 | 4.7 |
| R | | -----Transect retired in 2009----- | | |
| S | | -----Transect retired in 2010----- | | |
| T | | -----Transect retired in 2008----- | | |
| U | | -----Transect retired in 2016----- | | |
| U1 | 528 | 10 | 52.8 | 46.1 |
| AA | 129 | 10 | 12.9 | 13.2 |
| CSA | 173 | 10 | 17.3 | 19.0 |
| CSB | 572 | 10 | 57.2 | 40.7 |
| CSC | 280 | 10 | 28.0 | 20.4 |
| CSD | 135 | 10 | 13.5 | 10.4 |
| CSE | 111 | 2 | 55.5 | 9.2 |
| CSF | 229 | 4 | 57.3 | 9.4 |
| CSG | 367 | 10 | 36.7 | 18.9 |

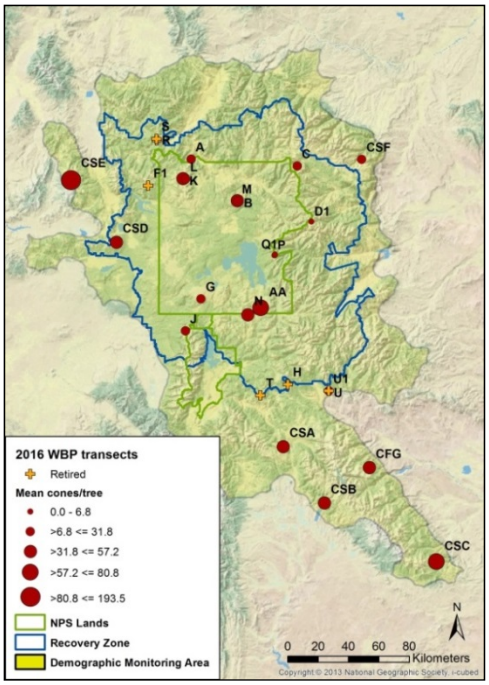



*Fig. 18. Locations and mean number of cones/tree for 21 whitebark pine cone production transects, Greater Yellowstone Ecosystem, 2017. Labels reflect transect identifiers (see Table 28).*

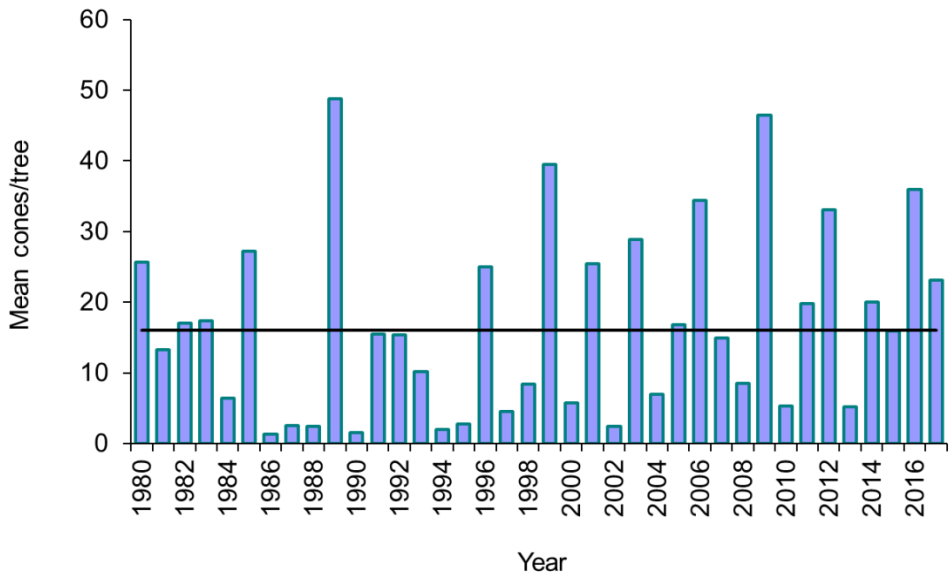



*Fig. 19. Annual mean number of cones/tree observed along whitebark pine cone production transects, Greater Yellowstone Ecosystem, 1980–2017. The overall average for the time period (16 cones/tree) is shown as a solid line.*

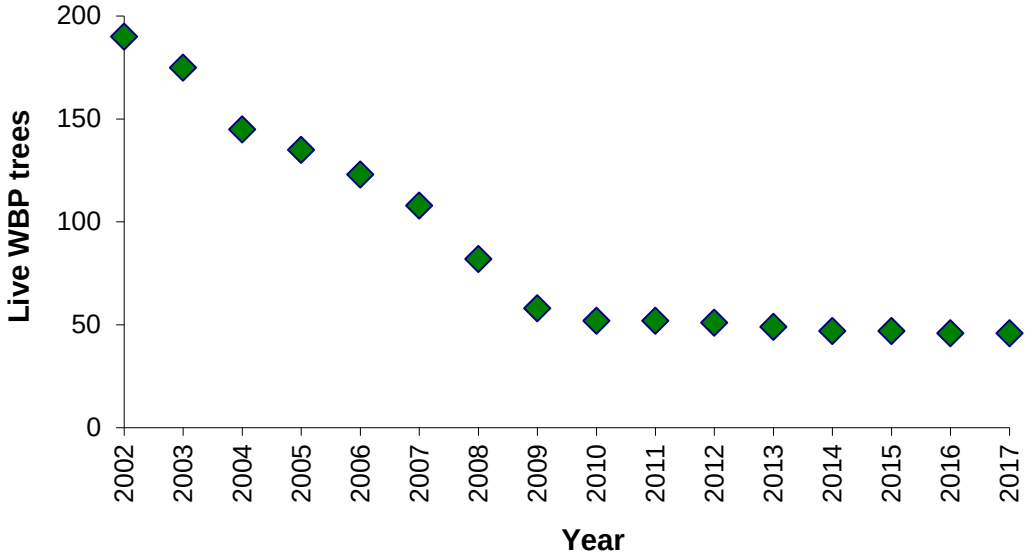



*Fig. 20. Number of live whitebark pine (WBP) trees on cone production transects among 190 individual trees monitored since 2002, Greater Yellowstone Ecosystem, 2002–2017.*

# HABITAT MONITORING

***Grand Teton National Park Recreational Use***
*(Katharine R. Wilmot, Grand Teton National Park)*

In 2017, total visitation in Grand Teton National Park was 4,969,347 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 3,317,000. Backcountry user nights totaled 40,193. Long and short-term trends of recreational visitation and backcountry user nights are shown in Table 29 and Fig. 21.

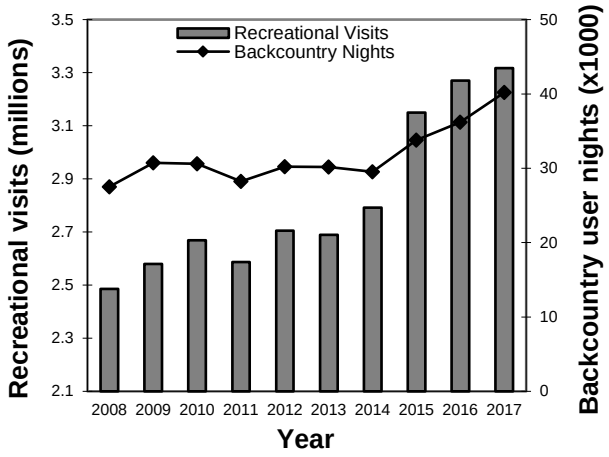



*Fig. 21. Trends in recreational visitation and backcountry user nights in Grand Teton National Park during 2008–2017 (https://irma.nps.gov/Stats).*

**Table 29. Average annual recreational 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 recreational 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 |
| 2008–2017 | 2,824,532 | 31,716 |

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

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

Total visitation to Yellowstone National Park was 5,359,473 visits in 2017 (https://irma.nps.gov/Stats/SSRSReports/Yell/Yellowstone) including recreational and non-recreational use. Recreational visits in 2017 totaled 4,116,525 the second busiest year on record and the 3nd straight year that recreational visitation has topped the 4 million mark. Since 2008, annual visitation to Yellowstone has increased by 34%. Nine of the top 10 visitation years have occurred in the last decade (Table 30). Most of the park's recreational visitation occurred during the 6-month period from May through October, the same period that all sex and age classes of grizzly bears are out of their winter dens and active on the landscape. In 2017, there were 3,953,912 recreational visits (96%) during those peak months, an average of 21,489 recreational visits per day. Park visitors spent 721,455 overnight stays in developed roadside campgrounds, and 43,078 overnight stays in remote backcountry campsites in Yellowstone Park.

Average annual recreational visitation has increased each decade from an average of 7,378 visits/year during the late 1890s to 3,012,653 visits/year in the 1990s (Table 31, Fig. 22). Average annual recreational visitation decreased slightly during 2000–2009, to an average of 2,968,037 visits/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 high for visitation, with the first 8 years of the decade all ranking among the top 10 highest years for visitation. Although total park recreational visitation has increased steadily over time, the average number of overnight stays in backcountry campsites has been relatively stable, ranging from 39,280 to 45,615 overnight stays/year (Table 31, Fig. 23). The number of overnight stays in the backcountry is limited by both the number and capacity of designated backcountry campsites in the park. The average number of overnight stays in developed roadside campgrounds in the park has increased considerably since 2009 (Table 31, Fig. 24).

**Table 30. Ten highest years for visitation to Yellowstone National Park, 1895–2017.**

| Rank | Year | Visitation |
|---|---|---|
| 1 | 2016 | 4,257,177 |
| 2 | 2017 | 4,116,525 |
| 3 | 2015 | 4,097,710 |
| 4 | 2010 | 3,640,184 |
| 5 | 2014 | 3,513,484 |
| 6 | 2012 | 3,447,727 |
| 7 | 2011 | 3,394,321 |
| 8 | 2009 | 3,295,187 |
| 9 | 2013 | 3,188,030 |
| 10 | 2007 | 3,151,343 |

**Table 31. Average annual recreational visitation, auto campground overnight stays, and backcountry campsite overnight stays by decade, Yellowstone National Park, 1895–2016.**

| Decade | Average annual number of recreational visits | Developed campground average annual overnight stays | Backcountry campsite average annual overnight stays |
|---|---|---|---|
| 1890s | 7,378[a] | Data not available | Data not available |
| 1900s | 17,110 | Data not available | Data not available |
| 1910s | 31,746 | Data not available | Data not available |
| 1920s | 157,676 | Data not available | Data not available |
| 1930s | 300,564 | 82,331[b] | Data not available |
| 1940s | 552,227 | 139,659[c] | Data not available |
| 1950s | 1,355,559 | 331,360 | Data not available |
| 1960s | 1,955,373 | 681,303[d] | Data not available |
| 1970s | 2,240,698 | 686,594[e] | 45,615[f] |
| 1980s | 2,344,485 | 656,093 | 39,280 |
| 1990s | 3,012,653 | 647,083 | 43,605 |
| 2000s | 2,968,037 | 624,450 | 40,362 |
| 2010s | 3,706,896[g] | 721,455[g] | 42,098[g] |

[a] Data from 1895–1899. During 1872–1894, visitation was estimated to be not fewer than 1,000 and no 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 the years 2010–2017.

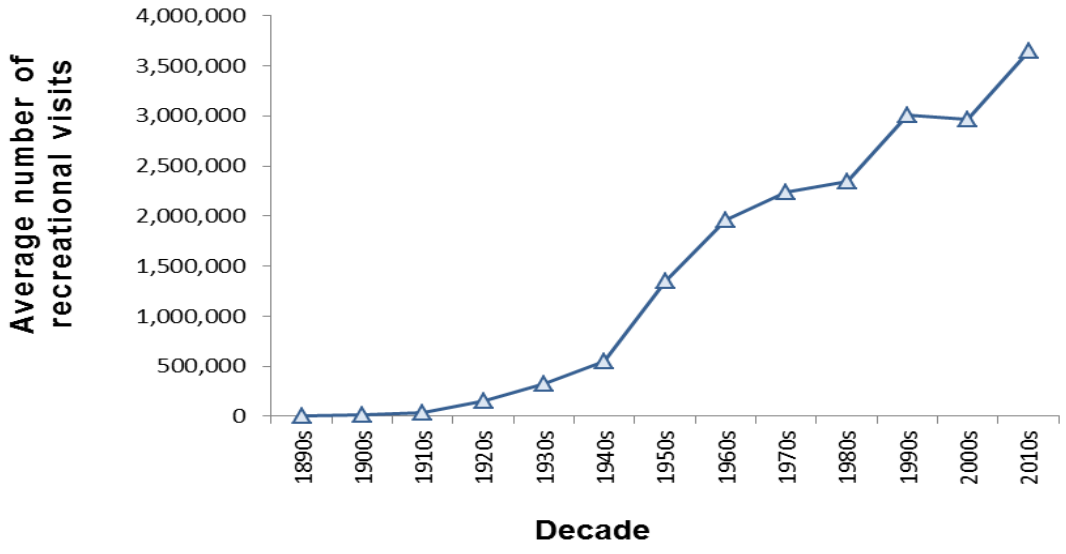



*Fig. 22. Average annual number of recreational visits by decade, Yellowstone National Park, 1895–2017.*

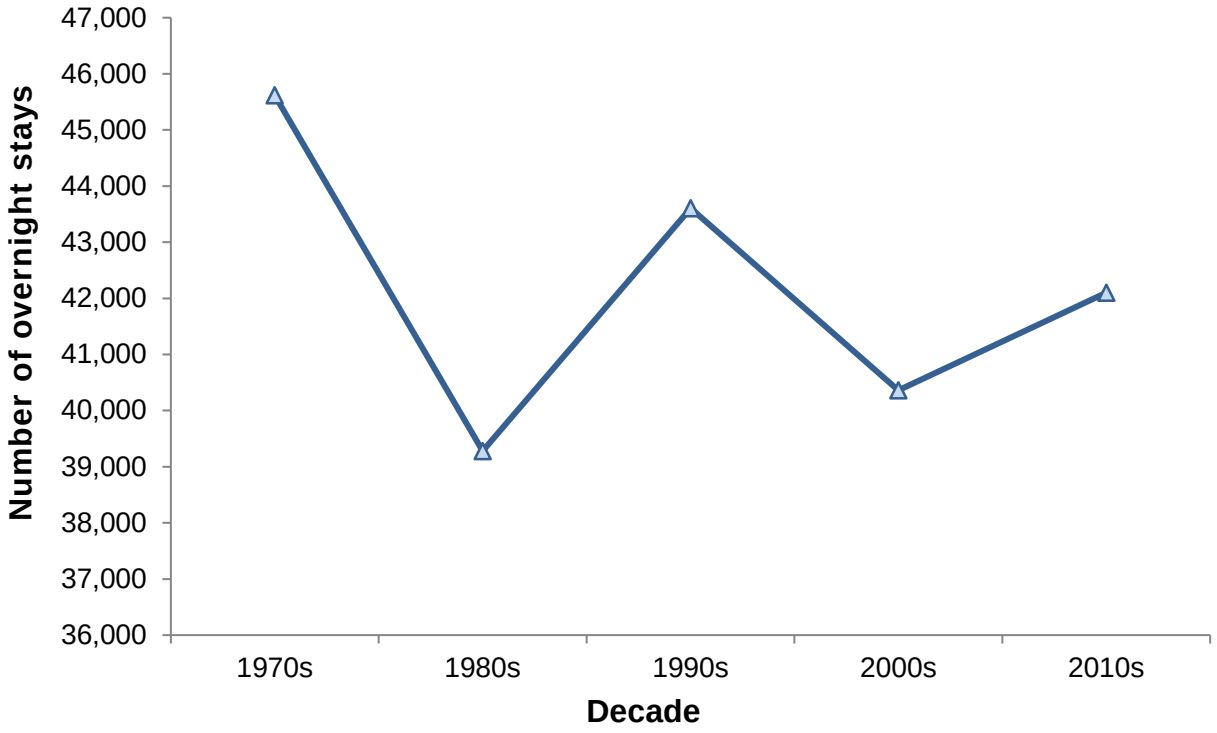



*Fig. 23. Average annual number of overnight stays in backcountry campsites by decade, Yellowstone National Park, 1972–2017.*

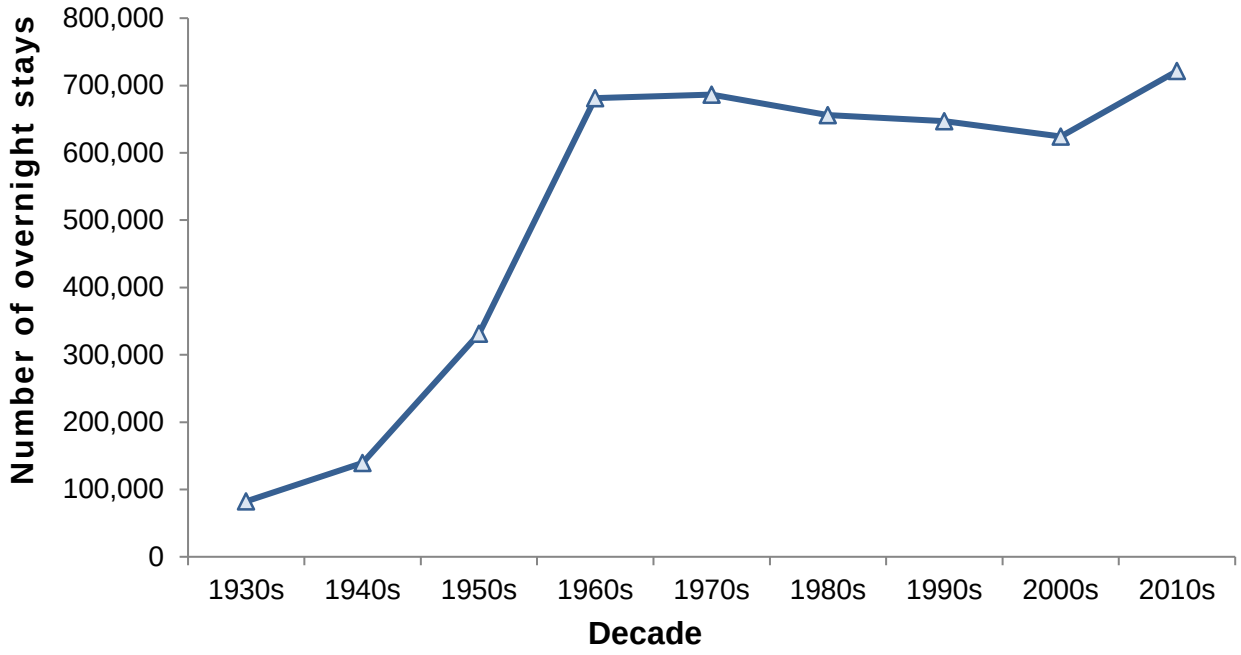



*Fig. 24. Average annual number of overnight stays in roadside campgrounds by decade, Yellowstone National Park, 1930–2017.*

# HUMAN-GRIZZLY BEAR CONFLICTS IN THE GREATER YELLOWSTONE ECOSYSTEM

***Human-Grizzly Bear Conflicts in Grand Teton National Park*** (Katharine R. Wilmot, Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway)

No human-grizzly bear conflicts were recorded and no management actions were taken on grizzly bears in Grand Teton National Park in 2017. However, management of nonfood-conditioned, human-habituated bears required considerable effort to prevent conflicts from occurring. Grizzly bears were hazed out of a developed area 1 time and off of park roads 23 times. Grand Teton National Park recorded a minimum of 446 bear jams (171 grizzly, 210 black, 65 species not recorded), created when habituated bears frequented roadsides and the outskirts of other developments and drew crowds of onlookers. Grizzly bear jams peaked in June and black bear jams peaked in September. The park's Wildlife Brigade managed most of these jams, as well as enforced food storage regulations at campgrounds, picnic areas, and other developments. Wildlife Brigade volunteers contributed almost 9,000 hours towards this important bear conservation and public education program.

Grand Teton National Park hosted 143 bear safety programs park-wide. These presentations highlighted safety in bear country and concluded with a bear spray (inert) demonstration. The program was well received, with over 4,217 visitors attending over the summer. Grand Teton National Park continued its partnership with the Grand Teton National Park Foundation to cost-share expenses for the purchase and installation of bear-resistant food storage lockers. Fifty-two bear boxes (30 $ft^3$) were installed in 2017, bringing the total number of bear boxes in campgrounds and other developed sites to 651. Three of the parks 6 roadside campgrounds, including Jenny Lake, Signal Mountain, and Lizard Creek Campgrounds, have a food storage locker in each site.

*Adult female grizzly and yearling crawl under a livestock fence near Grand Teton National Park. (photo courtesy of Jake Davis/www.revealedinnature.com)*

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

To effectively allocate resources for implementing management actions designed to prevent human-grizzly bear conflicts, Yellowstone National Park managers need baseline information regarding the types, causes, locations, and recent trends of conflicts. To address this need, all reported human-grizzly bear conflicts are recorded annually. Conflicts are grouped into broad categories using standard definitions described by Gunther et al. (2012).

There were 3 human-grizzly bear conflicts reported in Yellowstone National Park in 2017 (Table 32, Fig. 25). On August 26, at 17:30 hrs. subadult male grizzly bear G-205 aggressively walked into Backcountry Campsite 8H1 at Heart Lake, huffing at the 3 occupants who were eating dinner. The backpackers backed out of the campsite and the bear ate their dinner and other food including 3 freeze-dried dinners, 3 sandwiches, 4 cliff bars, and a bag of candy. The second conflict occurred on August 31 when grizzly bear G-205 tore up the pit toilet at backcountry campsite 8H1. The third conflict occurred on September 27 when an unmarked female grizzly bear with one yearling tore up an inflatable raft and 2 sleeping bags at backcountry campsite 4G3 at Grebe Lake. The raft had been used to remove non-native fish from the lake and had a strong fish odor. The raft and sleeping bags had been stored under a tarp awaiting helicopter transport out of the backcountry.

The annual number of human-bear conflicts occurring in Yellowstone National Park is generally low, but can vary widely from year to year and is dependent on the availability of natural bear foods, grizzly bear population numbers, park visitation, park staffing levels, the number of bears involved in conflicts outside of the park that are captured and released near the parks' boundaries by other agencies, as well as other factors. The number of conflicts in YNP have decreased significantly after efforts to prevent bears from obtaining anthropogenic foods were implemented in the late 1960s and early 1970s (Fig. 26).

During 2017, there were 3 known grizzly bear mortalities in the Yellowstone National Park portion of the GYE. On June 8, radio collared 14-year-old female grizzly bear #799 was discovered dead in Hayden Valley. The carcass was too decomposed to determine the exact cause of death. On September 9, 4 year-old male grizzly bear G-205 was captured and killed because of his involvement in human-bear conflicts on the Shoshone National Forest in 2015 and at Heart Lake, Yellowstone National Park in 2016 and 2017. Grizzly G-205 had been captured on the Shoshone National Forest in 2015 for exhibiting bold behavior towards people. At that time he was relocated to the Caribou–Targhee National Forest a short distance from the Yellowstone National Park boundary. Sometime after being translocated, G-205 entered the park, and in the summer of 2016, ripped into 4 tents and tore up sleeping bags and pads at Heart Lake Backcountry Campsites. Due to concerns for visitor safety, park managers attempted to capture and remove G-205 from Heart Lake in 2016, but were not successful in capturing him. After being involved in 2 more bear-human conflicts in the Heart Lake area, grizzly G-205 was successfully captured in 2017 and subsequently killed. In late May of 2018, the remains of an unmarked dead grizzly bear that had likely died in the fall of 2017, and had been scavenged by other bears, was found in the Crevice Creek drainage. The carcass was too decomposed to determine the cause of death.

Trends in causes of grizzly bear mortality inside Yellowstone National Park have changed over time. From the late 1950s through the 1970s most grizzly mortality in the park was due to human causes (Fig. 27), primarily management removals of bears involved in human-bear conflicts. In recent decades (1980–2017) most grizzly mortality in the park is from natural causes, primarily old age and intraspecific strife and predation.

Although grizzly bears caused few conflicts in the park, considerable management effort was dedicated to preventing conflicts (Table 33). Ninety-one large mammal wildlife carcasses likely to attract grizzly bears were removed from visitor use areas. In an effort to prevent the need to capture and relocate or remove bears, grizzly bears were hazed out of human use areas 24 times. Grizzly bears were hazed out of park developments 12 times, off of primary roads 11 times, and away from front-country trails 1 time. In addition, as part of the park's strategy for preventing bears from obtaining human foods, 102 bear-proof food

storage lockers were purchased with donations raised by the Yellowstone Forever Foundation and installed in roadside campgrounds and backcountry campsites. With the installation of 91 food storage lockers in roadside campgrounds in 2017, 762 (40%) of the parks 1,891 campground campsites now have bear-proof food storage lockers. Six of the parks 11 campgrounds, including Pebble Creek, Slough Creek, Tower Falls, Indian Creek, Norris, and Lewis Lake, have food storage lockers in every campsite. As part of the program some food storage lockers have also been installed in the Mammoth (99% of sites), Canyon (40% of sites), Bridge Bay (20% of sites), Grant (20% of sites), and Madison (16% of sites) Campgrounds. It is the park's goal to provide visitors with bear-proof food storage lockers in every roadside campsite. In addition, nine food storage lockers were installed in backcountry campsites in 2017 to replace broken food poles. All 301 designated backcountry campsites in Yellowstone National Park currently have a food storage device (food hanging pole or bear-proof food storage locker). Two additional food storage lockers were installed in the Youth Conservation Corps work crew campsite at Canyon Village.

Although there were few conflicts in Yellowstone National Park, management of non-food conditioned, human-habituated bears required considerable management effort. Habituation is the waning of a bear's response to people (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. 2005) such as fleeing from park visitors that are not a threat. Habituation allows bears to access and use habitat in areas with high levels of human activity, thereby increasing habitat effectiveness (Herrero et al. 2005). Habituation most commonly occurs in national parks where there are few human-caused bear mortalities, and exposure to humans is frequent and predictable and does not result in negative consequences for bears. Despite their reputation, bears will readily habituate to people, human activities, roads, vehicles, traffic, and buildings. The large areas of non-forested habitat in Yellowstone National Park, combined with habituation of bears to park visitors has created exceptional bear viewing opportunities, resulting in significant growth of bear viewing as a local industry. Bear viewing is now one of the primary activities of visitors to Yellowstone National Park (Taylor et al. 2014, Richardson et al. 2015), and contributes millions of dollars to the economies of gateway communities annually (Richardson et al. 2014). In 2017, 190 roadside traffic-jams caused by visitors stopping to view habituated grizzly bears along roadsides were reported in Yellowstone National Park. Thousands of visitors viewed bears at these bear jams. Park staff responded to 136 (72%) of the grizzly bear jams and spent over 484 personnel hours managing habituated bears, the traffic associated with bear jams, and the visitors that stopped to view and photograph habituated bears. On average, 3.6 hours of park staff time were spent managing each grizzly bear jam in 2017.

Visitation to Yellowstone National Park has increased almost every decade and a new record high for visitation was recorded in 2016. Visitation in 2017 was the second busiest ever recorded (see "***Yellowstone National Park Recreational Use***"). Since 2008, annual visitation to Yellowstone has increased by almost 40 percent. As visitation increases, park managers should expect an increasing number of bears to become habituated to people and a higher level of habituation among those bears, thereby causing more bear jams and jams of longer duration (Haroldson and Gunther 2013). As the level of habituation increases, the distance at which bears allow visitors to approach before fleeing will also become shorter, resulting in interactions at closer distances. Therefore, concurrent with increasing visitation, park managers should anticipate the need for increased staff time and infrastructure (e.g., housing, vehicles, and equipment) dedicated to the management of visitors at bear jams.

**Table 32. Number of incidents of human-grizzly bear conflict reported in Yellowstone National Park, 2017.**

| Conflict type | Number of conflicts |
|---|---|
| Property damage – without food reward | 2 |
| Property damage – with food reward | 1 |
| Human injury | 0 |
| Human fatality | 0 |
| Total conflict incidents | 3 |

**Table 33. Number of management actions taken to reduce the potential for conflicts with grizzly bears in Yellowstone National Park, 2017.**

| Management action | Number of incidents |
|---|---|
| Bear warnings posted | 15 |
| Temporary area closures | 23 |
| Wildlife carcass removal | 91 |
| Bear-jam management | 136 |
| Management hazing | 24 |
| Attempt capture – unsuccessful | 0 |
| Capture, mark, and release on site | 0 |
| Capture and relocate | 0 |
| Capture and remove | 1 |
| Capture for humane reasons | 0 |
| Total management actions | 290 |

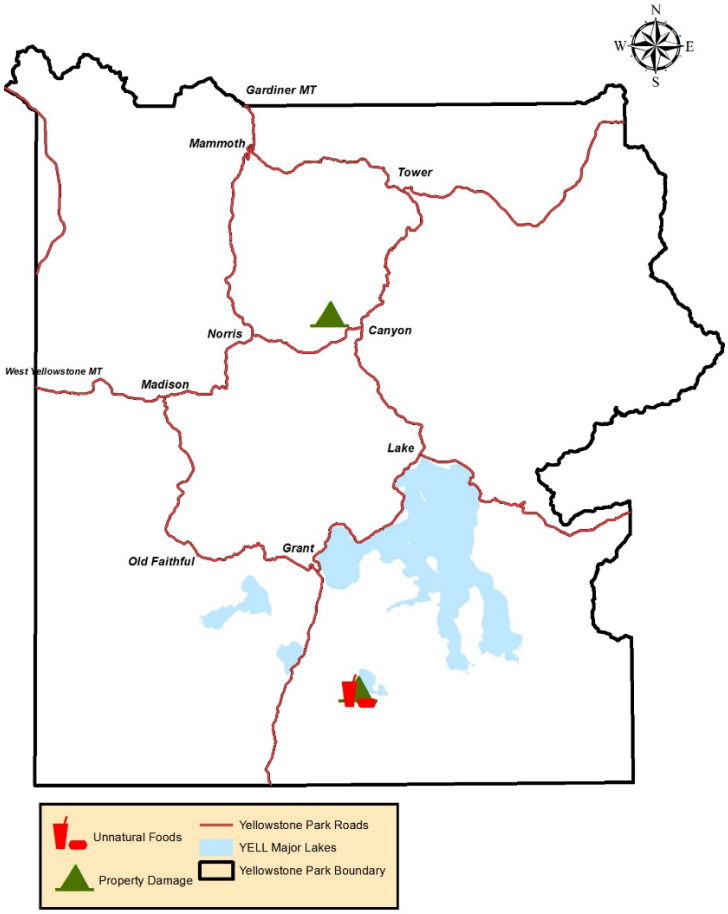



*Fig. 25. Locations of human-grizzly bear conflicts, Yellowstone National Park, 2017.*

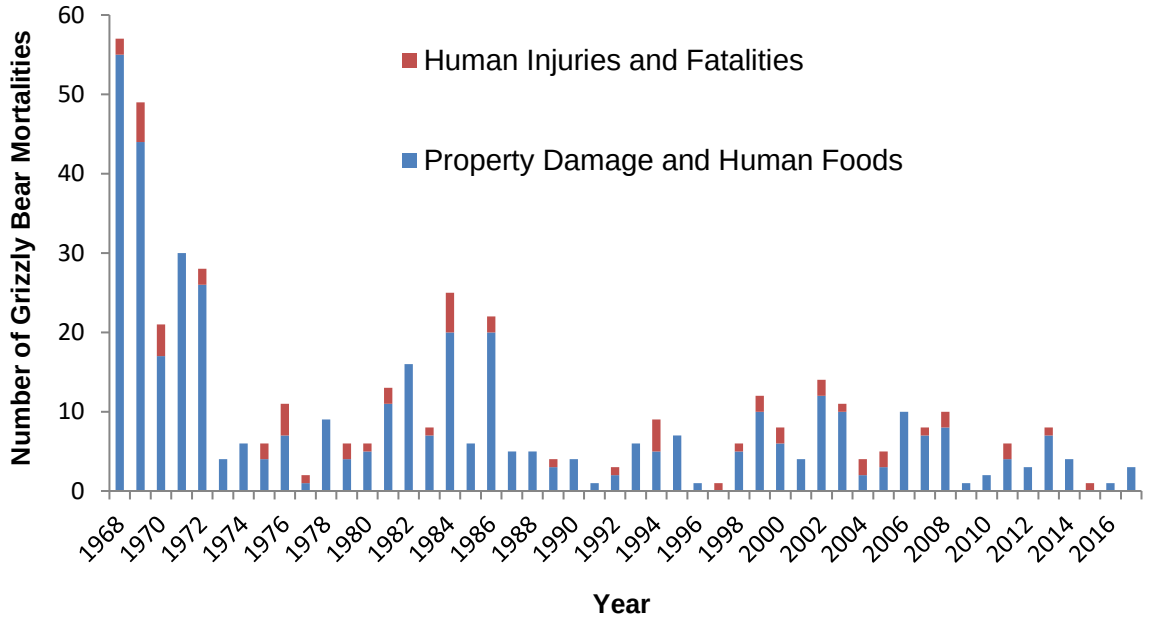



*Fig. 26. Number of human-grizzly bear conflicts, Yellowstone National Park, 1968–2017.*

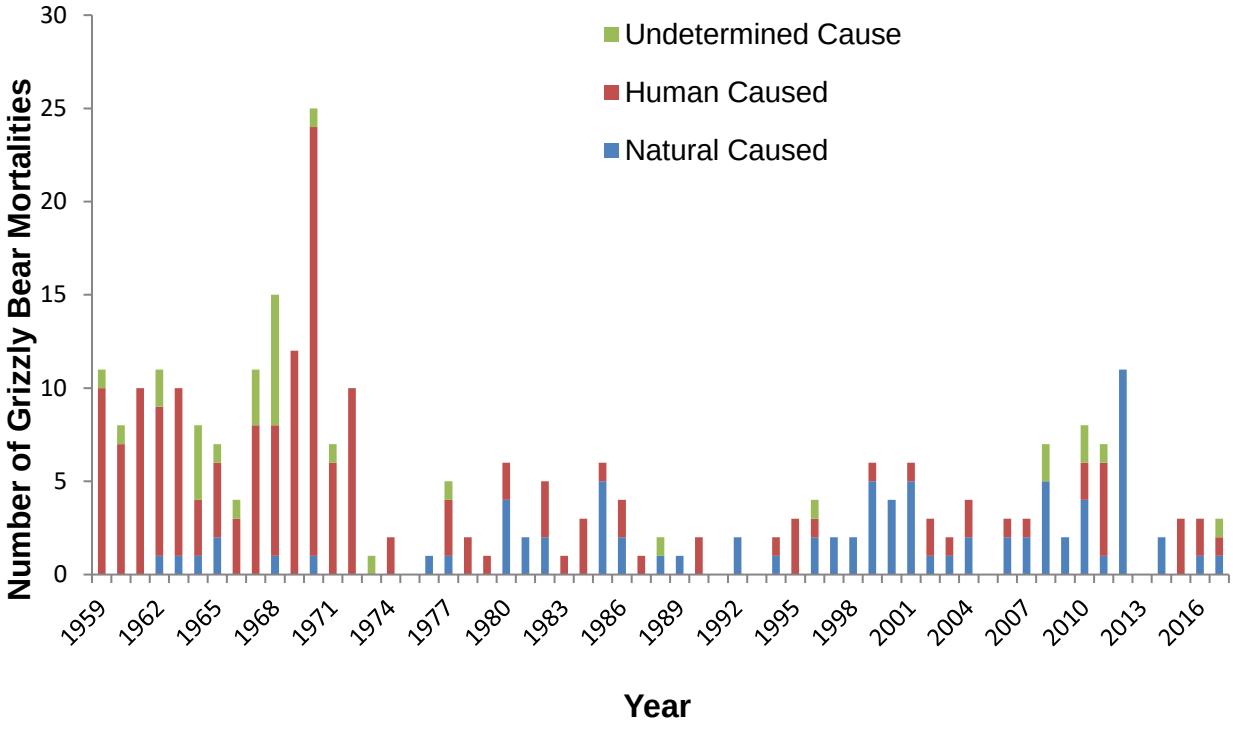



*Fig. 27. Number of known and probable grizzly bear mortalities, Yellowstone National Park, 1959–2017.*

*Inflatable raft used by native fish restoration crew that was torn up by an adult female grizzly bear accompanied by one yearling at backcountry campsite 4G3 at Grebe Lake, Yellowstone National Park, 27 September 2017.*

***Human-Grizzly Bear Conflicts in Idaho*** *(Jeremy M. Nicholson and Curtis Hendricks, Idaho Department of Fish and Game)*

Conflicts are incidents where bears injure people, cause public safety concerns, damage property, obtain anthropogenic foods, kill or injure livestock and require an agency response. Idaho Fish and Game (IDFG) personnel responded to eight human-grizzly bear conflicts during 2017 (Table 34). Two people were charged in separate events in 2017. On August 31, a hiker was charged on the Continental Divide Trail. He deployed his bear spray and avoided injury. On September 5, a hunter was charged by a female grizzly bear with yearlings in the Willow Creek drainage (two interactions in the same general area for this one bear). He did not deploy bear spray but avoided injury. Additionally, we responded to 2 bears that were causing public safety concerns, 1 bear that obtained anthropogenic food, 2 bears that caused property damage but did not obtain a food reward, and 1 bear that caused property damage and obtained a food reward. There were no documented grizzly mortalities in the Idaho portion of the GYE in 2017.

There has been an increasing trend in the number of conflicts in the Idaho portion of the Greater Yellowstone Ecosystem (GYE) since 2005 (Fig. 28). This trend is expected given the increase in bear numbers and expansion of occupied range in Idaho in recent years. The mean annual number of conflicts since 2005 is 14 but varies greatly from year to year and is dependent on natural food abundance, livestock use patterns, availability of unsecured anthropogenic foods, outreach and education effort, and other factors. The majority of the conflicts in Idaho have occurred inside the Demographic Monitoring Area (DMA), with very few occurring outside DMA (Fig. 29).

The IDFG allocates a significant amount of resources each year to provide bear outreach and education in the Idaho Portion of the GYE. A seasonal education technician is employed during the peak conflict period, generally May through September. The primary purpose of the position is to work with the region's bear biologist to respond to conflicts, provide education to local communities, present education programs in campgrounds, and attend public events throughout the region with our bear education trailer. Through the efforts of IDFG personnel and volunteers, around 10,000 residents, recreationists, and hunters are provided with information on how to live and recreate in bear country each year. Continued education efforts have resulted in an increase in the use of bear-resistant garbage containers and attractants being properly secured.

In 2017, the IDFG, The Nature Conservancy, and the Greater Yellowstone Coalition completed a fencing project in Island Park to minimize grizzly bear-cattle conflicts on the 310 acre Duck Creek Ranch. This property includes approximately 50 acres of fen and other wetland habitat. Over the last 15 years, cattle and wildlife using the wetland have fallen into bogs and have been killed or scavenged by grizzly bears and other predators (see photo on page 77). Confirmed grizzly bear depredations in 2015 and 2016 prompted an effort to construct a fence that would exclude cattle from the wetland and decrease grizzly bear activity on the ranch. A 4,100-feet jack fence was constructed around the wetland and completed in July 2017. In 2017, the landowner did not have any cattle loss due to entrapment and predation.

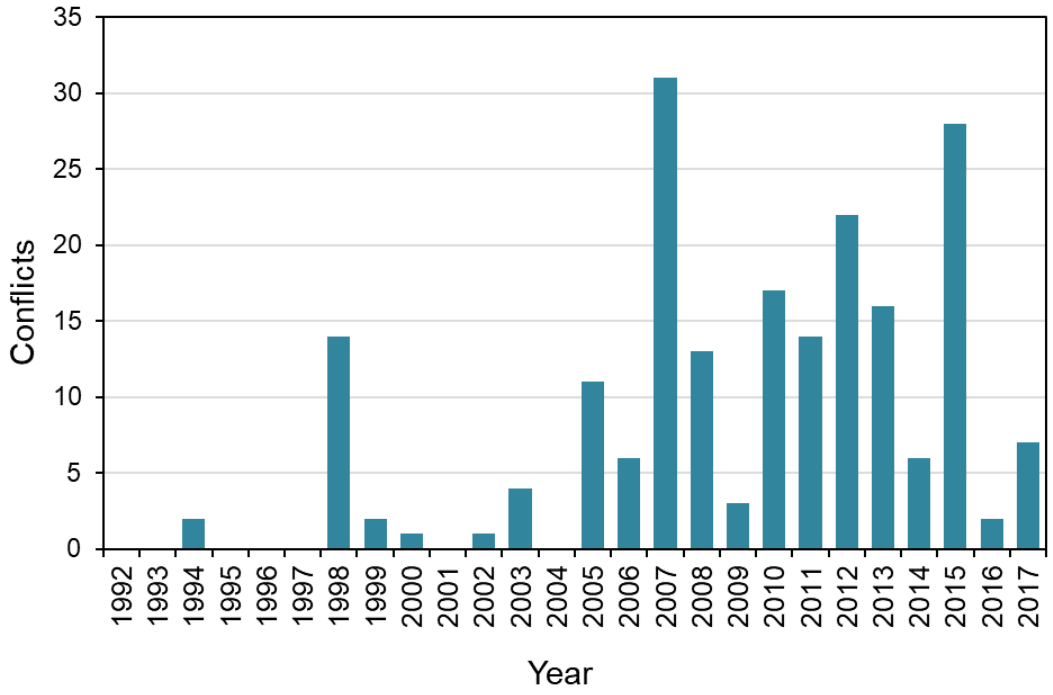



*Fig. 28 Number of documented human-grizzly bear conflicts in the Idaho portion of the Greater Yellowstone Ecosystem, 1992–2017.*

**Table 34. Human-grizzly bear conflicts in the Idaho portion of the Greater Yellowstone Ecosystem, 2017.**

| Conflict type | Number of conflicts |
|---|---|
| Encounter situations | 2 (charging incidents) |
| Public safety threat | 2 |
| Anthropogenic foods | 1 |
| Property damage – without food reward | 2 |
| Property damage – with food reward | 1 |
| Livestock – cattle | 0 |
| Livestock – poultry | 0 |
| Livestock – sheep | 0 |
| Beehives/orchards | 0 |
| Total | 8 |

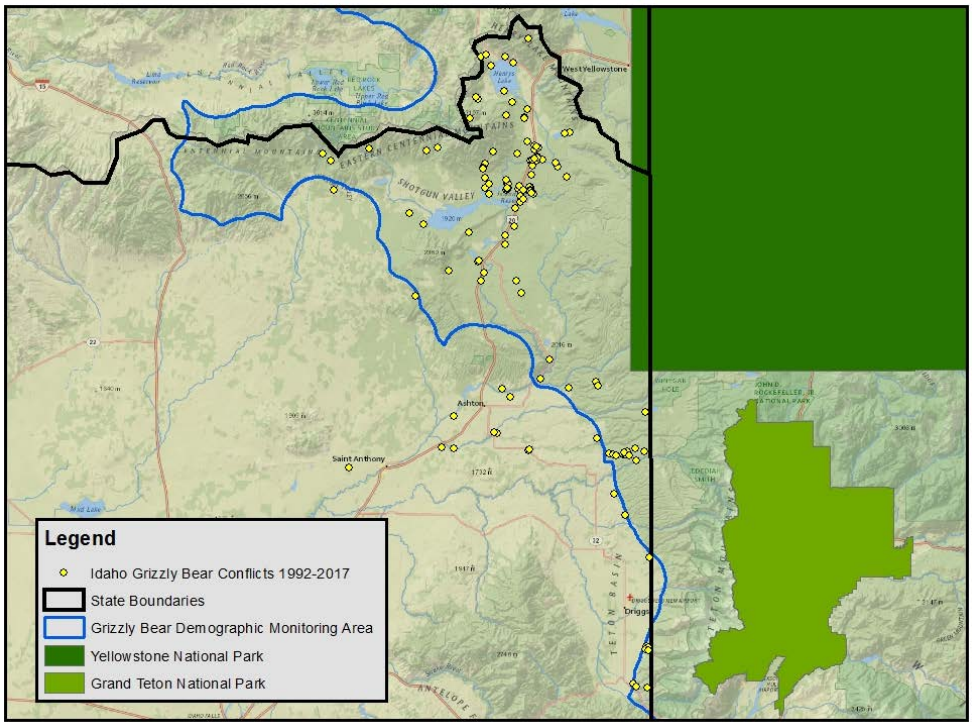



*Fig. 29. Number of documented human-grizzly bear conflicts within and outside the Demographic Monitoring Area in the Idaho portion of the Greater Yellowstone Ecosystem, 1992–2017.*

*Cow elk trapped in a bog on the Duck Creek Ranch in Island Park, Idaho.*

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

During 2017, Montana Fish, Wildlife and Parks (MFWP) personnel investigated 76 human-grizzly bear conflicts in Montana's portion of the Greater Yellowstone Ecosystem (GYE). Incidents in which grizzly bears cause public safety concerns, property damage, livestock depredations, human injuries, obtain anthropogenic foods, or grizzly bear mortalities are considered conflicts that require agency response, which may involve management action. These conflicts usually vary from a bear being involved in a single incident to multiple incidents involving one or more bears over a period of time, before the conflicts can be resolved. The mean annual number of conflicts over the previous 10 years is 75. There were 76 reported and investigated human-grizzly bear conflicts in 2017 (Table 35). Most conflicts (67%) occurred on public land (Table 36). Annual efforts by MFWP continue to reduce conflicts, increase public safety, and reduce bear mortalities in areas of historic high conflicts, in new geographic areas, and at individual sites.

With the grizzly bear population expanding in occupied range and numbers, conflicts are occurring in a larger geographic area on public and private land in MFWP Region 3 (Fig. 31) and MFWP Region 5 (Fig. 32). Additionally, grizzly bear conflicts and confirmed grizzly bear sightings or tracks are now occurring annually in the geographic area between the GYE and the Northern Continental Divide Ecosystem (NCDE).

Three people were injured during encounter situations with grizzly bears in Montana's portion of the GYE, during 2017. Two of these injuries were related to elk hunting during the fall season. Three grizzly bears were killed in backcountry self-defense situations during the fall season and one other grizzly bear was killed in a reported self-defense situation at a private land residence. During 2017, the most common conflict type was *livestock depredation* on public and private land. Cattle depredations were the second most common conflict type in 2016 and was the most common conflict type in 2015. During 2017, the majority of the livestock depredations continued to occur on private land in the greater Red Lodge area and on public land in Gravelly Mountains. These areas began having annual livestock depredation conflicts in 2011. These areas now experience yearly depredations due to north and west expansion of grizzly bears in Montana's portion to the ecosystem. The majority (53%) of the 2017 livestock depredations occurred on public lands. In the Red Lodge area, 94% of the livestock depredations occurred on private land beyond the Demographic Monitoring Area (DMA). These and other conflicts will likely remain a management challenge. During 2017, the most common conflict type was at or near developed sites with bear searching for or obtaining unnatural (anthropogenic) foods, with some having associated property damage.

Historically, anthropogenic food-related conflicts were the most common type of human-bear conflict, which was also the main cause for bear captures, relocations, and mortalities. For more than 20 years, extensive effort has been made on private and public land to secure attractants and reduce these conflicts. Early in the recovery program this was a primary management emphasis for the Yellowstone grizzly bear population. Bears near developed sites often investigate the possibility of obtaining anthropogenic foods. In Montana and throughout the ecosystem, information and education programs, sanitation efforts, and experience have helped reduce the number of bears obtaining anthropogenic foods, thereby reducing the need for management actions involving capture, relocation, or sometimes removal. These efforts will need to continue to reduce conflicts, reduce mortalities, and maintain social tolerance of grizzly bears. There has been a 30% increase in conflicts during the most recent 10-year period compared with the previous 10 years. During 1998–2007, 531 human-grizzly bear conflicts were investigated. From 2008 through 2017, there were 760 reported and investigated human-grizzly bear conflicts in the Montana portion of the GYE (Fig. 30). This increase is attributed to the increase in grizzly bear population numbers, the expansion of occupied grizzly bear range, and the increase in human population and activity. However, if taken into consideration the 2011 U.S. Census data of increase in human population (25%), the increase in GYE grizzly bear population (32%) and the increase in overall bear distribution in Montana's portion of the GYE, conflicts have been occurring at a relatively constant rate. Conflict reduction efforts have been successful on public and private lands.

**Table 35. Human-grizzly bear conflicts in Montana portion of the Greater Yellowstone Ecosystem, 2017.**

| Conflict type | Number of conflicts |
|---|---|
| Encounter situations | 15 (3 human injuries) |
| Livestock – cattle | 41 (37 cattle killed, 4 injured) |
| Livestock – sheep | 0 |
| Livestock – swine | 1 |
| Property damage | 7 (3 vehicle related) |
| Anthropogenic foods | 1 |
| Anthropogenic foods with property damage | 4 |
| Near developed sites-safety concerns | 7 |
| Total | 76 |

**Table 36. Private and public land grizzly bear conflicts in Montana portion of the Greater Yellowstone Ecosystem, 2017.**

| Jurisdiction | Number of conflicts |
|---|---|
| Private | 34 (45% of total) |
| State | 1 |
| County or local jurisdiction | 0 |
| Federal jurisdiction | 2 |
| Bureau of Land Management | 2 |
| Custer Gallatin National Forest | 13 |
| Beaverhead Deerlodge National Forest | 24 |
| U.S. Fish and Wildlife Service – National Wildlife Refuge | 0 |
| Total | 76 |

Historically, livestock depredations by grizzly bears have been relatively low in southwest and southcentral Montana. However, as bears expanded their distribution farther away from the core of biological suitable habitat, livestock depredations have greatly increased on private and public lands in these areas. The relatively recent (since 2011) increase in livestock depredations have been on the outer edge of the DMA or beyond the DMA boundary on the northeast or west of the ecosystem in Montana. During 1998–2007, there were 24 livestock-related conflicts investigated in southwest/southcentral Montana. This conflict type increased to 174 investigated livestock related conflicts during 2008–2017; 50 of these 174 depredations were in 2015, mostly attributed to 1 adult female bear.

During 2017, there were 3 management captures of grizzly bears, with 1 of the captures occurring on private land (Fig. 33). The long-term average over the previous 20 years is 4.5 management captures per year. Two of the 2017 grizzly bear captures were due to livestock (cattle) depredations, which involved 1 adult male, and 1 non-target, adult female.

One of the adult male bears was captured and released on site on public land within the DMA and was subsequently lethally removed for continued livestock depredations. One adult male was captured and removed for repeated property damage on private land within the DMA. This male bear was 27 years old and his teeth were in extremely poor condition.

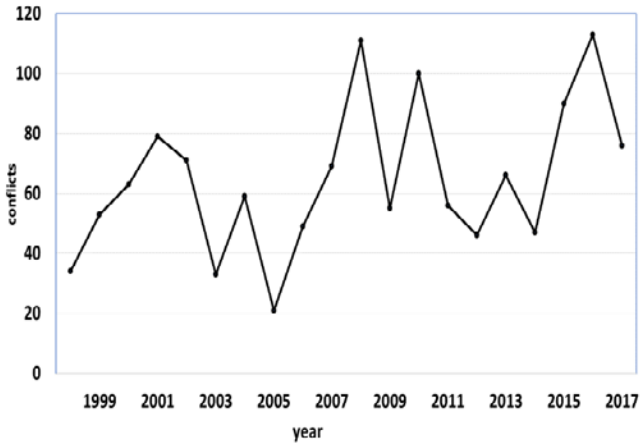



*Fig. 30. Annual variation in total human-grizzly bear conflicts in Montana portion of the Greater Yellowstone Ecosystem, 1998–2017.*

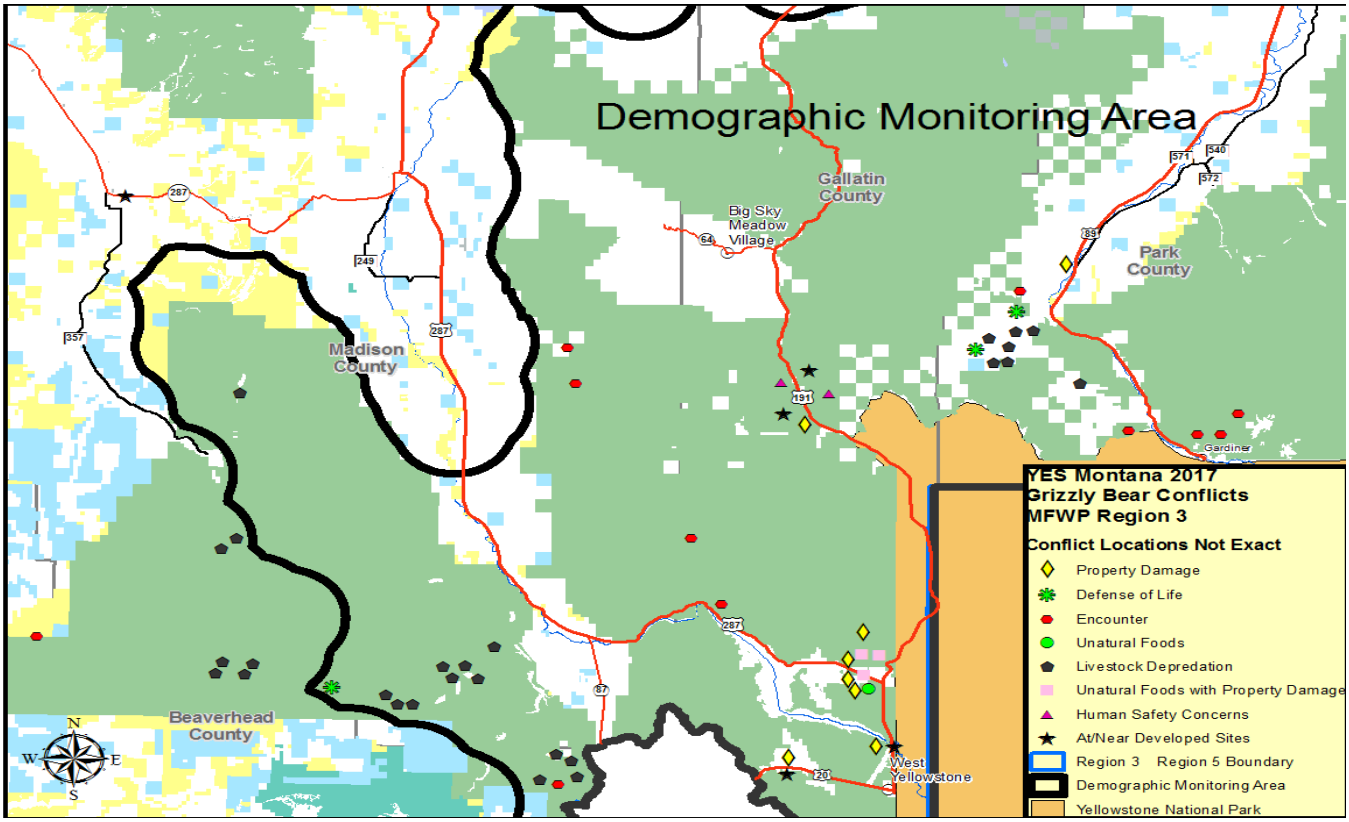



*Fig. 31. Locations of human-grizzly bear conflicts in Montana FWP Region 3 portion of Greater Yellowstone Ecosystem, 2017.*

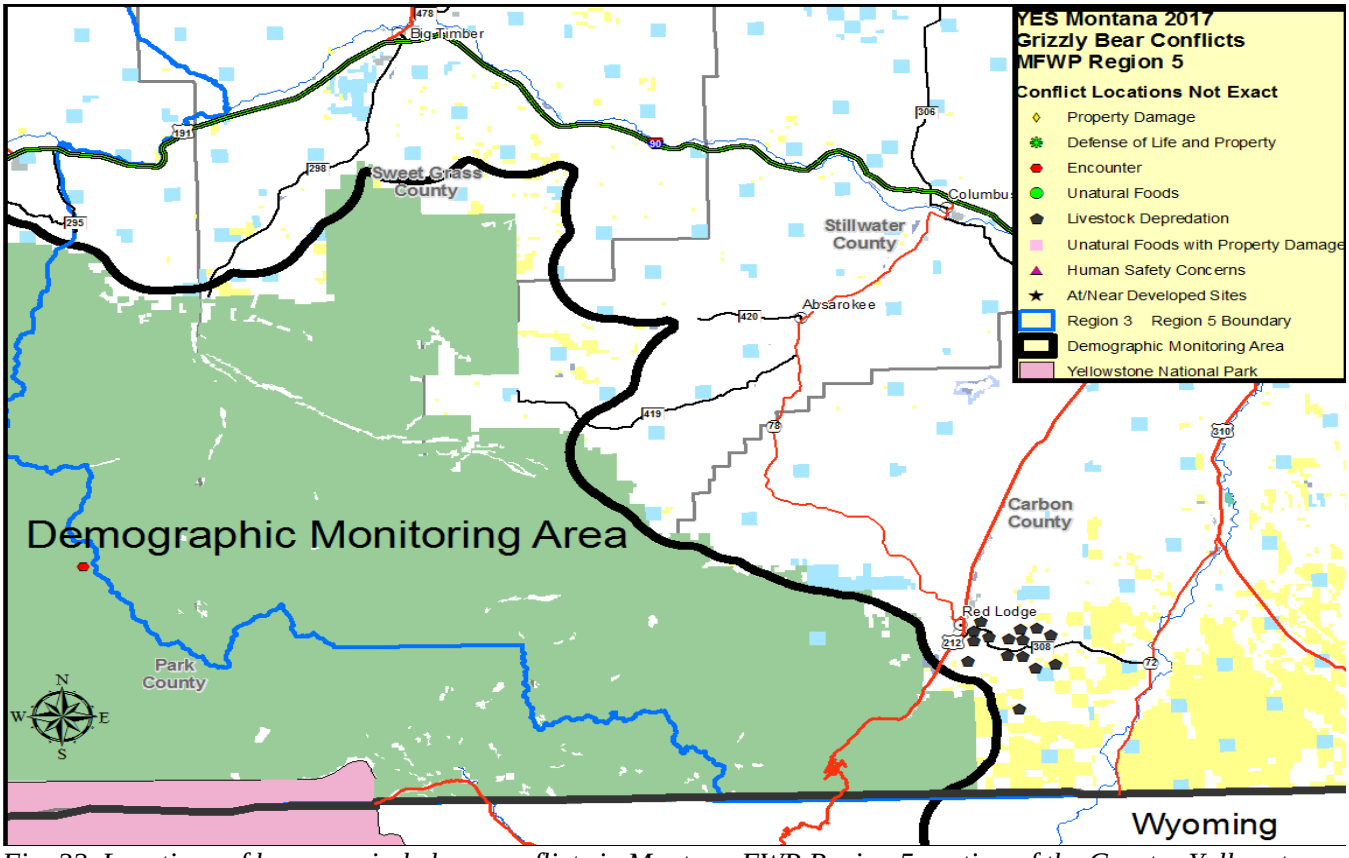



*Fig. 32. Locations of human-grizzly bear conflicts in Montana FWP Region 5 portion of the Greater Yellowstone Ecosystem, 2017.*

During 2017, there were 16 known or probable grizzly bear mortalities in the Montana portion of the GYE (Fig. 34). Two of the known mortalities and 3 probable mortalities occurred on private land. One old aged male was removed through management actions and the other 4 were defense of life (DL) situations, where a female was killed at a house and her 3 cubs were classified as probable mortalities. It is difficult to determine if cubs of the year will survive and are normally listed as probable mortalities.

There were 11 mortalities on various jurisdictions of public lands. Of the 11 mortalities on public land, 1 subadult male, 1 adult male and 1 adult female grizzly involved close encounters and defense of life (DL) incidents on public land within the DMA. The adult female killed in the DL incident had 3 cubs at her side, which were listed as probable mortalities. Of the other mortalities on public land, 2 males were struck and killed by vehicles on federal highways, 1 mistaken ID male by a black bear hunter, 1 decomposed male found in the Yellowstone River, and 1 management removal male. All 2017 mortalities are shown in Table 16. The adult male DL mortality on public land is currently under investigation.

Even as the Yellowstone grizzly bear population has been expanding throughout the entire ecosystem, Montana's long-term mortality trend has remained nearly constant since 1992, averaging 5 bear mortalities per year. Comparing time periods of 1998–2007 to 2008–2017, bear mortalities associated with anthropogenic foods have decreased from 45% to 12% of the total annual mortality in Montana, indicating that sanitation and education efforts have been successful. However, grizzly bear encounters resulting in human injuries and DL-related bear mortalities have increased from 14% of the average annual bear mortality during 1998–2007 to 44% during 2008–2017. Additionally, management removals because of livestock depredations have increased from 5% to 18% of average annual mortality during these same time periods. The increase in overall mortality and shifts in causes of mortality can be partially attributed to Yellowstone grizzly bear expansion in population numbers and distribution. The trend of grizzly bear mortalities due to management actions compared with all other mortality causes is shown in Fig. 35. Evidence of grizzly bear expansion was again documented during 2017 and the expectation is that grizzly bears will continue to expand their range into areas beyond the DMA, potentially resulting in an increase of conflicts and bear mortalities.

The 2017 summer climatic conditions were similar to 2015 and 2016, resulting in slightly higher precipitation during the summer months and relatively cooler temperatures. A relatively mild spring and early summer allowed for early-stage plant growth and blossoms or setting fruit buds. This resulted in the availability of berry fruits persisting for late summer and fall foraging. Whitebark pine cone production was slightly above average in the GYE during 2017 (see "***Whitebark Pine Cone Production***"). Bears were also feeding on vegetative roots, grazing, and scavenging animal carcasses during the summer and fall months.

Grizzly bear conflict numbers ($n$ = 76) during 2017 were near the 10-year average ($n$ = 75). There is always great variation in yearly conflict numbers. During the last 10 years, yearly conflicts have varied from 46 to 113. The number of 2017 conflicts did not correlate to food stress for bears but was mostly related to a high number of livestock depredation conflicts on private and public land inside and outside the DMA, which were mostly attributed to a small number of bears involved in multiple conflicts. Grizzly bear conflicts in late summer and fall involving anthropogenic foods or being near developed sites were much lower in 2017. This can be partially related to good availability of natural, higher-quality foods. However, during 2017 this was likely not the over-riding cause of conflict. A major factor now contributing to high conflict numbers is a high density of bears in relatively small geographic areas, resulting in conflict clusters. Bears in these areas are also habituated to human presence and activities, which leads to investigating food sources near people. Occasional management removal of conflict bears reduces conflict clusters, although there are multiple bears in these areas, the percentage of bears involved in human conflicts is low. Field investigations indicated grizzly bears were using all habitat types (heavy shaded timber, wet areas, and open areas) during the summer months. This feeding strategy allows bears to find adequate vegetative and protein food sources.

However, during 2017, grizzly bears caused a relative high number of livestock depredations[1], which occurred on private land in marginal habitat and public land in quality habitat. Summer vegetative foods were adequate in these shaded and mesic areas, as high-quality fall foods (e.g., berries, roots, seeds, carcasses) were in good quantity. No single factor can be attributed to low or high conflicts during a given year and it is always a combination of multiple factors.

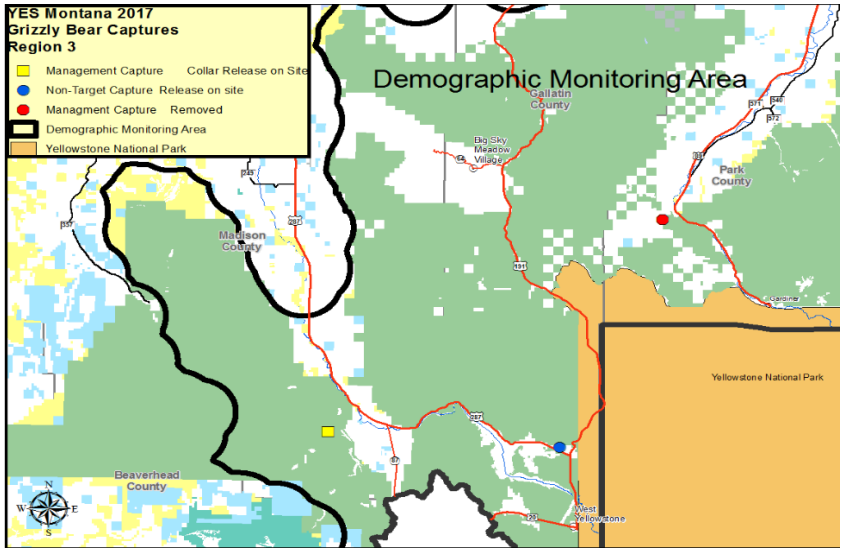



*Fig. 33. Locations of grizzly bear management captures in Montana portion of Greater Yellowstone Ecosystem, 2017.*

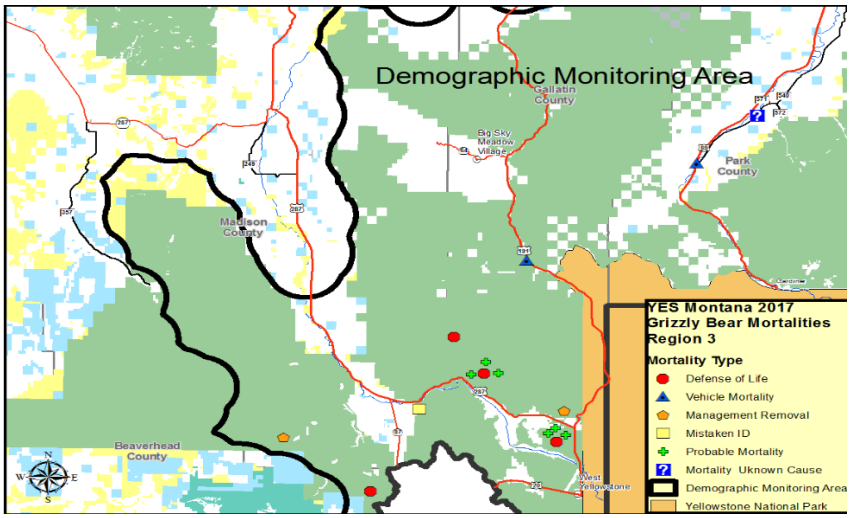



*Fig. 34. Locations and causes of grizzly bear mortalities in Montana portion of Greater Yellowstone Ecosystem, 2017.*

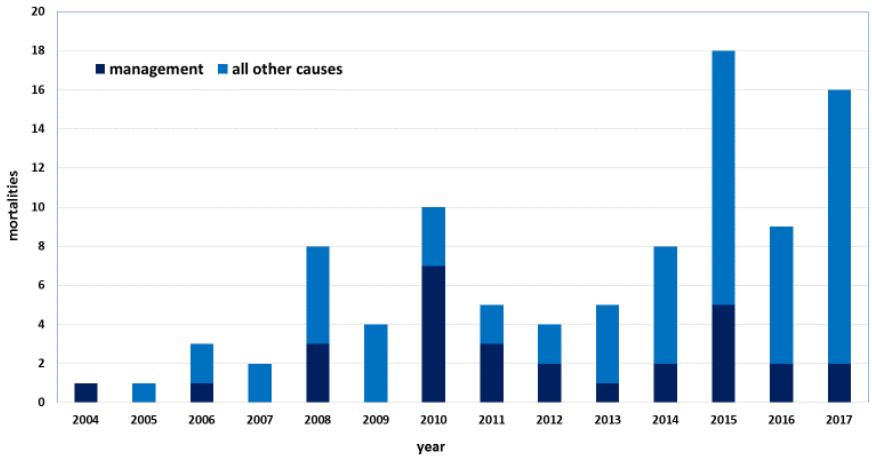



*Fig. 35. Number of management removals and other mortalities in Montana portion of Greater Yellowstone Ecosystem, 2004–2017.*

Natural food availability, climate conditions, bear numbers, individual bear behavior, previous bear removals, management efforts and human activities all factor into the annual variation in human-bear conflicts. Extensive efforts are made to reduce all types of conflicts and we have observed a measured success in the reduction of sanitation and anthropogenic food-related conflicts and associated bear mortalities. During 2017, only one conflict was related to garbage with the remaining anthropogenic conflicts mostly related to domestic animal feeds.

Conservation Strategy funding from the U.S. Fish and Wildlife Service provided since the initial 2007 delisting of the Yellowstone grizzly bear population has allowed the acquisition of 346 bear-resistant refuse containers for placement on private and public land within the Primary Conservation Area. Since 2006, MFWP and local community efforts have distributed and placed 398 bear-resistant garbage containers in the upper Yellowstone River-Gardiner area, Cooke City, and upper Boulder River area, which has greatly reduced garbage related conflicts in these areas. Additionally, with the formation of a Bear Aware Council, representing private businesses, community developments, and agencies, there are now 70% of home-owner associations (HOA) requiring bear-resistant garbage containers. In the remaining 30% of the HOAs, there is many volunteering to use bear-resistant containers. Sanitation companies Republic Services and L&L Site Services are providing bear-resistant garbage containers in the Big Sky area. This sanitation effort will greatly help reduce black bear and grizzly bear conflicts in this portion of Gallatin and Madison counties.

The most difficult conflict type to prevent is surprise encounter. Such encounters can lead to human injuries and are currently trending to be the leading cause of grizzly bear mortalities in the Montana portion of the GYE. During 2017, there were 3 human injuries due to a surprise encounter with a bear. Two of the people injured were elk hunting and one person was hiking/investigating a cattle carcass. All victims required medical treatment. Montana Fish, Wildlife and Parks continues to distribute bear conflict information to hunters through hunter (archery and rifle) education classes, license holders, postcards, letters, personal contacts, newspapers, 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 and random occurrence of surprise encounters, it is impossible to completely prevent these types of conflicts. The largest future challenge will be to effectively address bear management situations on lands beyond recognized suitable habitat and the DMA.

[1]*Livestock Depredation Investigations: MFWP has a statewide legal memorandum of understanding (MOU) with USDA/Aphis-Wildlife Services (WS) to be the lead investigators on wildlife-caused livestock depredations and predator control. When possible, MFWP will coinvestigate grizzly-caused livestock depredations. For livestock producers incurring depredation losses due to grizzly bears, WS field specialists must verify the loss as a confirmed or probable depredation for the producer to be reimbursed for the livestock loss by the state Livestock Loss Board. In consultation with MFWP, WS may attempt capture of offending bear(s). If WS captures a grizzly bear, MFWP determines whether the bear is to be released, translocated, or removed.*

***Human-Grizzly Bear Conflicts in Wyoming***
*(Brian DeBolt, Zach Turnbull, Luke Ellsbury, Michael Boyce, Sam Stephens, Dustin Lasseter, Phil Quick, Zach Gregory and Daniel J. Thompson; Large Carnivore Section, Wyoming Game and Fish Department)*

Human-bear interactions and conflicts in Wyoming are typically a result of bears seeking unnatural foods in association with people and property, close encounters with humans, or when bears depredate livestock. The number and location of human-bear conflicts is influenced by unsecured unnatural attractants (e.g., human foods, garbage), natural food distribution and abundance, bear density and distribution, and human and livestock use patterns on the landscape.

The preferred resolution to minimize human-bear conflicts in Wyoming is through preventative measures or to secure the bear attractant. In addition, the Wyoming Game and Fish Department manages grizzly bears in accordance with state and federal law, regulation, and policy. Capturing bears in areas where they may come into conflict with people and relocating them to remote locations is a common practice throughout the world. Relocating bears achieves several social and conservation functions: 1) reduces the possibility of property damage, livestock damage, or human interactions in areas where the potential for conflict is high; 2) reduces the potential for bears to become food conditioned or human habituated, which often results in destructive and dangerous behaviors; 3) allows bears the opportunity to forage on natural foods and remain wary of people; and 4) may prevent removing bears from the population, which may be beneficial in meeting population management objectives. The practice of relocation has served as an integral conservation tool to provide for recovery for GYE grizzly bears for multiple decades. Removal refers to lethal or live removal (e.g., placement with a zoo or other captive bear facility) from the population.

During 2017, the Department captured 30 grizzly bears in 31 capture events in an attempt to prevent or resolve conflicts (Fig. 36). Most captures were lone grizzly bears of all age classes, including 7 females and 23 males (1 male was captured in 2 separate conflicts). Nineteen (61%) of the 31 capture events were in Park County, 8 (26%) occurred in Sublette County, 2 (6%) in Fremont County, 1 (3%) in Teton county, and 1 (3%) in Hot Springs County.

Of the 31 capture events, 12 captures were a result of bears killing livestock (primarily cattle), 6 were captured for obtaining pet, livestock food, or damaging fruit trees. Two bears were non-target captures, and 11 bears were captured for frequenting developed sites, residential areas, or livestock production areas. Of the 31 capture events, there were 15 relocation events, 3 bears were released on site because they were non-target captures or part of a family group, and 13 bears were removed from the population. All relocated grizzly bears were released on U.S. Forest Service lands in or adjacent to the Primary Conservation Area (Fig. 37). Of the 15 relocation events, 8 (53%) bears were released in Park County, 2 in Fremont County (13%), and 5 (33%) were released in Teton County (Table 37).

Eleven of the 13 bears removed from the population were lethally removed, and 2 orphaned yearling grizzly bears that became habituated to human activities were placed into a zoo facility (Table 37). While each situation is unique, grizzly bears were removed 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 (e.g., orphaned cubs, poor physical condition, human safety concern). Removals occur after much deliberation and ultimate decisions take into account multiple factors unique to each conflict situation. Attempts to obtain locations on marked grizzly bears through aerial telemetry were made approximately every 14 days.

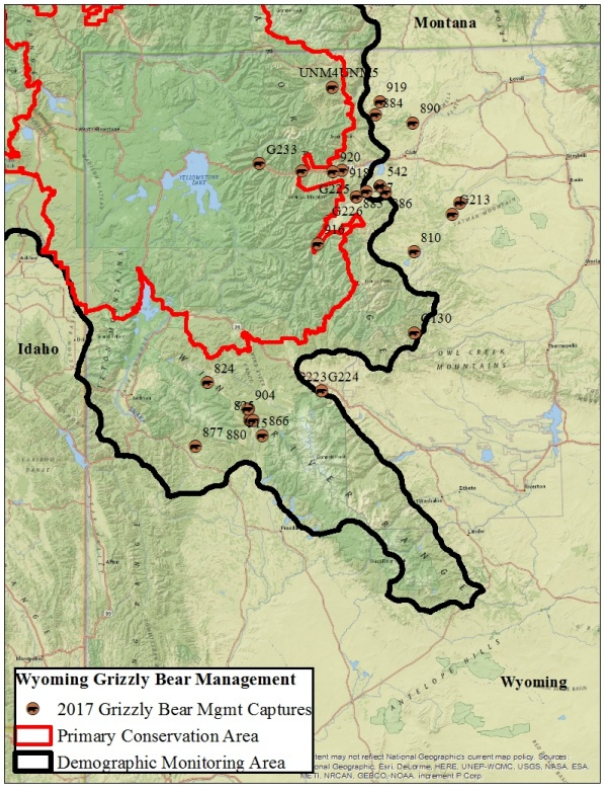



*Fig. 36. Management capture locations (n = 31) of grizzly bears captured, relocated, or released on site in conflict management efforts in Wyoming portion of the Greater Yellowstone Ecosystem, 2017. Grizzly bears with "G" in front of their number were marked but not fitted with radio collars (typically because they were too young to be collared). Grizzly bears identified with "NA" were grizzly bears removed from the population without being given an identification number. Because of the mapping scale, some locations are combined at one symbol. A complete list is provided in Table 37.*

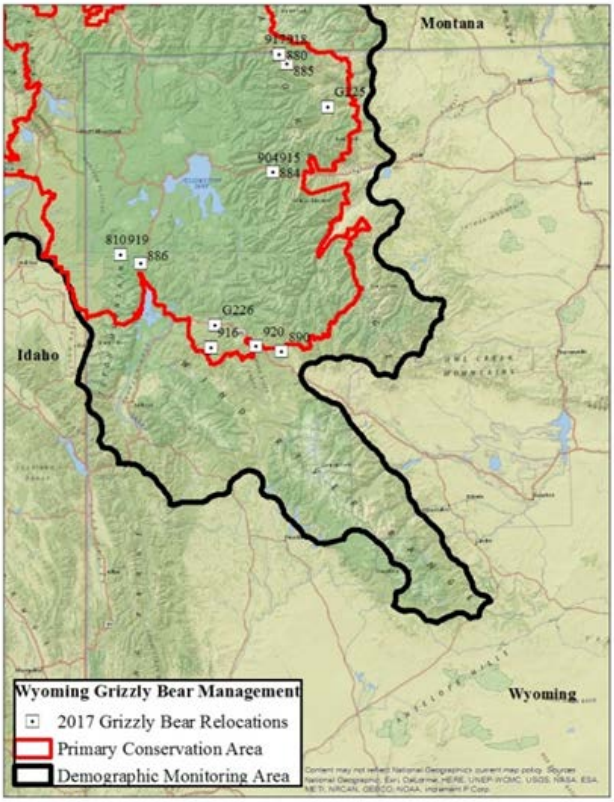



*Fig. 37. Release locations (n = 18; 15 relocated, and 3 released on site) for grizzly bears captured, relocated, or released on site in conflict management efforts in Wyoming portion of the Greater Yellowstone Ecosystem, 2017. Grizzly bears with "G" in front of their number were ear-marked but not fitted with a radio collar upon release, typically because they were too young to be collared. Because of the mapping scale, some locations are combined at one symbol. A complete list is provided in Table 37.*

**Table 37. Summary of grizzly bear conflict management captures in Wyoming portion of the Greater Yellowstone Ecosystem, 2017. Grizzly bears identified with "NA" were removed from the population without receiving an identification number.**

| Date | ID | Capture county | Relocation site | Release county | Reason for capture |
|---|---|---|---|---|---|
| 3/24/2017 | NA | Park | | | Removed for goat depredation and frequenting ranch buildings |
| 4/12/2017 | 877 | Sublette | | | Removed for frequenting developed areas and multiple food rewards |
| 4/22/2017 | G223 | Fremont | On site; Wind River; Private | Fremont | Cattle depredation; released on-site to join family group |
| 4/23/2017 | G224 | Fremont | On site; Wind River; Private | Fremont | Cattle depredation; released on-site to join family group |
| 4/29/2017 | 884 | Park | Mormon Creek; Shoshone National Forest | Park | Non-target capture at a garbage conflict |
| 5/9/2017 | G225 | Park | Painter Gulch; Shoshone National Forest | Park | Frequenting developed areas |
| 5/10/2017 | 885 | Park | Pilot Creek; Shoshone National Forest | Park | Frequenting developed areas |
| 5/10/2017 | G226 | Park | Blackrock Creek; Shoshone National Forest | Teton | Frequenting developed areas |
| 5/22/2017 | 886 | Park | John D. Rockefeller Parkway | Teton | Frequenting calving pasture and harassing cattle |
| 6/2/2017 | 890 | Park | Long Creek; Shoshone National Forest | Fremont | Frequenting agricultural areas and developed sites |
| 7/9/2017 | 824 | Teton | | | Removed for repeated cattle depredations |
| 7/19/2017 | 904 | Sublette | Mormon Creek; Shoshone National Forest | Park | Removed for repeated cattle depredations |
| 7/21/2017 | 825 | Sublette | | | Removed for repeated cattle depredations |
| 7/21/2017 | 880 | Sublette | Fox Creek; Shoshone National Forest | Park | Cattle depredations |
| 8/2/2017 | G130 | Hot Springs | | | Removed for repeated cattle depredations |
| 8/5/2017 | 866 | Sublette | | | Removed for repeated cattle depredations |
| 8/11/2017 | 810 | Park | Grassy Lake; Bridger Teton National Forest | Teton | Breaking into grain shed |
| 8/11/2017 | UNM4 | Park | | | Live removal to zoo for human habituation and bold behavior |
| 8/11/2017 | UNM5 | Park | | | Live removal to zoo for human habituation and bold behavior |
| 9/9/2017 | G213 | Park | | | Removed for repeated conflict history |
| 9/12/2017 | 904 | Sublette | | | Removed for repeated cattle depredations |
| 9/14/2017 | 915 | Sublette | Mormon Creek; Shoshone Forest | Park | Cattle depredation |

**Table 37. Continued.**

| Date | ID | Capture county | Relocation site | Release county | Reason for capture |
|---|---|---|---|---|---|
| 9/24/2017 | UNM6 | Sublette | | | Removed for repeated cattle depredations |
| 9/27/2017 | 916 | Park | Spread Creek; Bridger-Teton National Forest | Teton | Breaking into chicken coop |
| 9/30/2017 | 917 | Park | Fox Creek; Shoshone National Forest | Park | Frequenting developed areas |
| 9/30/2017 | G233 | Park | On site; Shoshone River; private | Park | Non-target capture |
| 10/3/2017 | 918 | Park | Fox Creek; Shoshone National Forest | Park | Frequenting residential areas |
| 10/17/2017 | 919 | Park | Grassy Lake; JDR Memorial Parkway | Teton | Frequenting developed areas |
| 10/25/2017 | NA | Park | | | Removed for bold behavior and property damage |
| 11/2/2017 | 542 | Park | | | Removed for food rewards and conflict history |
| 11/3/2017 | 920 | Park | Wind River; Shoshone National Forest | Fremont | Frequenting developed areas and acquiring livestock feed |

Wyoming Game and Fish Department personnel investigated and recorded 186 human-grizzly bear conflicts in 2017 (Table 38, Fig. 38). As a result of numerous and diligent education and conflict prevention efforts, the general pattern of conflicts is relatively steady within currently occupied habitat (Fig. 39). However, as occupied grizzly bear range has expanded, conflicts continue to occur in areas further from the Primary Conservation Area and outside the DMA, often on private lands. Bears are increasingly coming into conflict with people in areas where grizzly bears have not been present in recent history. Although the joint efforts of the Wyoming Game and Fish Department, U.S. Forest Service, non-governmental organizations, and particularly the public have resulted in reducing conflicts through education and attractant storage in many areas, the number of grizzly bear conflicts in Wyoming were high in 2017. Bears frequent lower elevations and developed areas regularly during the non-denning period. Grizzly bear-cattle depredation was the most frequent type of conflict documented in 2017. The annual variation in livestock depredation incidents is not easily explained. Although most human-bear conflicts are correlated with natural food abundance, the number of cattle and sheep killed annually do not follow the same pattern. As grizzly bears expand further into human-dominated landscapes outside the DMA, the potential for conflict between bears and humans increases, resulting in negative outcomes for both grizzly bears and people. The Wyoming Game and Fish Department continues to explore and enable multiple options to reduce grizzly bear-livestock conflicts.

The majority of conflicts in Wyoming occurred on public lands outside of the Primary Conservation Area (Figs. 39 and 40). The increasing distribution of grizzly bears is reflected in the annual documentation of conflicts further from this area and continued expansion outside the DMA. As bears expand and occupy habitats commonly used by humans, there is a greater potential for conflicts to occur. Education and conflict-prevention efforts are used anywhere bears and people coexist, and management actions will be a function of human values and effects on the grizzly bear population in those areas.

**Table 38. Type and number of human-grizzly bear conflicts in Wyoming portion of the Greater Yellowstone Ecosystem, 2016.**

| Conflict type | Number | Percent (%) |
|---|---|---|
| Cattle | 138 | 74 |
| Property damage | 10 | 5 |
| Animal death | 7 | 4 |
| Garbage | 7 | 4 |
| Pet-livestock-birdfeed | 6 | 3 |
| Aggression toward human | 5 | 3 |
| Human injury | 5 | 3 |
| Fruit trees | 3 | 2 |
| Unsecured attractant | 2 | 2 |
| Properly stored game | 1 | <1 |
| Animal injury | 1 | <1 |
| Sheep | 1 | <1 |
| Total | 186 | 100 |

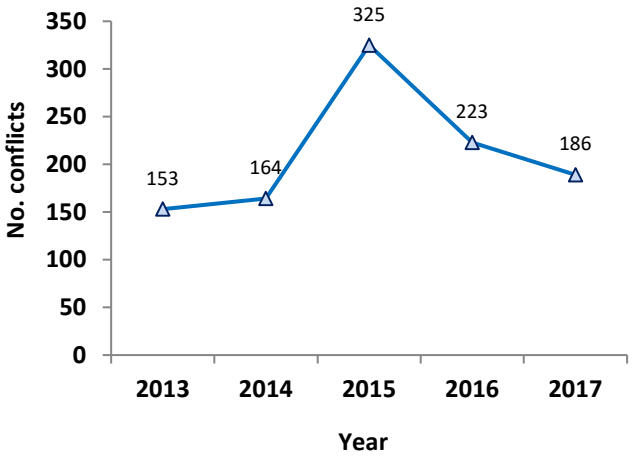



*Fig. 38. Number of human-grizzly bear conflicts in Wyoming portion of the Greater Yellowstone Ecosystem, 2013–2017.*

Long-term trends in the number of conflicts is likely a result of grizzly bears increasing in numbers and distribution and expanding into areas used by humans, including livestock production, on public and private lands. As the GYE grizzly bear population continues to grow and expand into less suitable habitat, bears are more likely to encounter food sources such as garbage, pet food, livestock and livestock feed, and myriad other attractants, resulting in increased property damage and threats to human safety. Conflict prevention measures such as attractant storage, deterrence, and education are the highest priority for the Wyoming Game and Fish Department. In general, there is an inverse relationship between social tolerance and biological suitability for bear occupancy in areas further from the Primary Conservation Area 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 used for long-term conflict resolution.

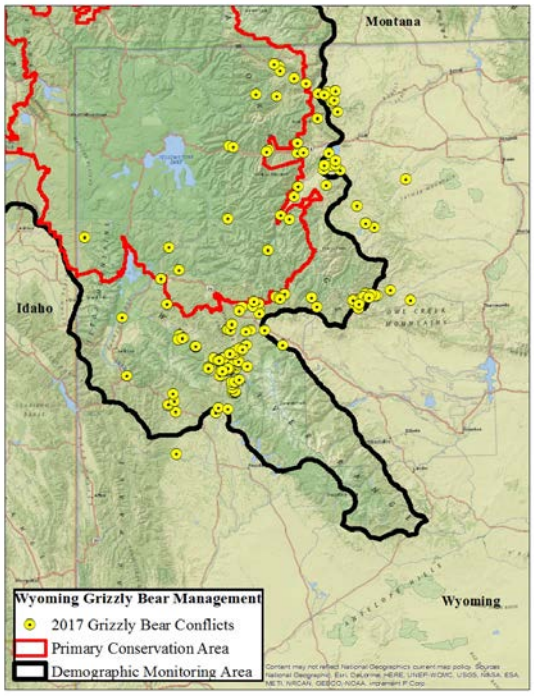



*Fig. 39. Location of human-grizzly bear conflicts in Wyoming portion of the Greater Yellowstone Ecosystem outside of National Parks (n = 186) in relation to the Grizzly Bear Recovery Zone/Primary Conservation Area and the Demographic Monitoring Area, 2017.*

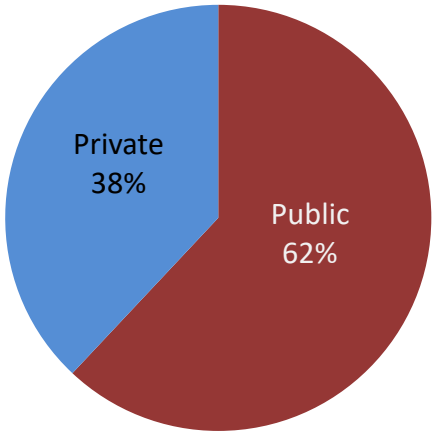



*Fig. 40. Percent of human-grizzly bear conflicts on private and public lands in Wyoming portion of the Greater Yellowstone Ecosystem, 2017.*

***Human-Grizzly Bear Conflicts on the Wind River Reservation*** (*Pat Hnilicka, Lander Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service; and Art Lawson, Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department*)

No depredations of livestock were reported or documented on Wind River in 2017. No grizzly bears were removed or transported to or from Wind River in 2017 for any purpose, including human conflicts.

*Extensive damage to camper caused by grizzly bear trying to gain access to human foods. (photo courtesy of Brian DeBolt/WGFD)*

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

In an effort to make scientifically based decisions regarding the bear safety recommendations provided to park visitors, Yellowstone National Park managers are interested in the relative risk of grizzly bear attack on the public recreating in the park. To address this need, we recorded information on human-bear interactions in the park. Because the risk of a bear attack varies depending on visitor location and activity, we grouped human-bear interactions into 5 broad categories including: 1) frontcountry developments, 2) road-side corridors, 3) backcountry campsites, 4) backcountry trails, and 5) off-trail backcountry areas. We considered all encounters where the person believed the grizzly bear was aware of the person's presence as an interaction.

**Human-Bear Interactions within Developed Frontcountry Sites**

Bears enter frontcountry developments in the park for a variety of reasons including travel, foraging for natural foods, avoiding more dominant bears, and seeking human foods or garbage. However, since implementation of a new bear management program in 1970, it is rare for bears to obtain food rewards in park developments. Under the park's Bear Management Plan, frontcountry developments are managed for people and bears are actively excluded through hazing, capture and relocation, or capture and removal.

*Activity of Bears in Frontcountry Developed Sites*

In 2017, there were 24 incidents reported where grizzly bears were known to enter park developments (Table 39). The activity of the bear was reported in 22 of the 24 incidents. In 77% ($n$ = 17) of the incidents the bears foraged for natural foods within the developments, and in 18% ($n$ = 4) it appeared that the bear was just traveling through the development. In 5% ($n$ = 1) of the incidents, bears investigated sources of anthropogenic attractants (human food or garbage) but did not damage property or obtain a food reward.

*Reactions of Bears to the Presence of People in Frontcountry Developments*

Grizzly bears were known to have encountered people in 18 of the 24 incidents where they entered developments and the bears' reaction was recorded in 16 of these incidents (Table 40). Bears reacted with a flight response in 69% ($n$ = 11) of the incidents, in a neutral manner in 25% ($n$ = 4), and with a warning signal in 1 (3%) encounter. Bears did not display aggressive behavior or attack people in any of the 18 encounters that occurred within developments.

**Human-Bear Interactions along Roads**

Bears frequent habitat adjacent to roads in the park for many reasons including traveling, foraging for natural foods, avoiding more dominant bears, and occasionally seeking human food handouts. In the past (1910–1969), bears commonly panhandled along park roads for food handouts from park visitors (Schullery 1992). Strict enforcement of regulations prohibiting the hand feeding of bears for recreational purposes since 1970 has mostly eliminated this behavior in park bears. However, bears are still regularly observed near park roads traveling and foraging for native foods. Unlike park developments that are managed solely for people and bears are actively excluded, under the park's Bear Management Plan, roadside habitats are managed for both human and bear uses. Although bears are not allowed to remain or linger on the paved road, roadside pull-outs, road shoulder, or adjacent drainage ditch, they are tolerated in roadside meadows and are not actively discouraged from using roadside habitats to forage for natural foods.

*Bear Activity along Roadsides*

In 2017, 190 reports of grizzly bears using habitat adjacent to park roads were recorded (Table 41). The primary activity of roadside bears was recorded in 181 of these reports. In the majority of these incidents, the roadside bears' primary activity was traveling (57%, $n$ = 103) and foraging for natural foods (36%, $n$ = 66). Other activities reported included bedded/sleeping (3%, $n$ = 5), playing (2%, $n$ = 3), swimming (1%, $n$ = 2), courtship (<1%, $n$ = 1), and nursing young (<1%, $n$ = 1).

*Bear Reactions to the Presence of People Along Roadsides*

Bears were noticeably aware of the presence of people in 129 of the 190 reports of bear activity along roads. The reaction of bears to people was reported for 125 of these 129 roadside encounters (Table 40) and were classified as neutral in 71% ($n$ = 89) and a flight response in 26% ($n$ = 32) of the incidents. Grizzly bears displayed curious behavior and walked towards people in 2% ($n$ = 3) of the roadside encounters. In 1 incident an adult female grizzly traveling down the road bluff charged visitors when her 3 cubs could not climb up the steep snowbanks to get out of the road corridor.

**Human-Bear Interactions in Backcountry Areas**

Bears are generally given priority in recreation management decisions where bear and human activities are not compatible in backcountry areas of the park. Yellowstone National Park implements seasonal closures and restrictions on recreational use of backcountry areas during periods when bear activity is concentrated on specific foods in predictable locations. In addition, short-term closures of backcountry trails, campsites, and off-trail areas to recreational use are implemented when human activities conflict with natural bear activities and behaviors.

*Activity of Bears in Occupied Backcountry Campsites*

Bears occasionally enter designated backcountry campsites while the campsites are occupied by recreational users. In 2017, there were 6 incidents reported where grizzly bears entered occupied backcountry campsites (Table 42). The bears' primary activity was reported for 5 of the incidents. Reported activities of bears in occupied campsites included foraging on native foods ($n$ = 1), walking through the core campsite ($n$ = 1), investigating the fire-ring without getting a food reward ($n$ = 1), and investigating the tent without causing damage or getting a food reward ($n$ = 1). In 1 incident a grizzly bear aggressively entered a campsite with the apparent intent of running the campers off of their food while they were eating dinner.

*Bears Reactions to the Presence of People in Backcountry Campsites*

In all 6 of the incidents where grizzly bears entered occupied backcountry campsites, the campers believed that the bear knew people were present in the campsite. The bears' reaction was reported in 5 of these incidents. Bears had a flight response in 4 of the encounters (Table 40). In 1 incident a grizzly bear aggressively entered a campsite and walked towards the occupants huffing while they were eating dinner. The campers backed off and the grizzly ate their dinner as well as other food and candy.

*Bears Reactions to Encounters with People on Backcountry Trails*

In 2017, there were 31 incidents where people encountered grizzly bears on backcountry trails where the bear was aware of the human presence (Table 40). Reactions of bears to the encounters were reported for all 31 of these incidents. Grizzly bears reacted to encounters with people along backcountry trails with flight behaviors in 52% ($n$ = 16), neutral behaviors in 35% ($n$ = 11), curious behaviors in 6% ($n$ = 2), and by charging without making contact in 6% ($n$ = 2). No people were physically attacked by grizzly bears during encounters on backcountry trails in the park in 2017.

*Bear Reactions to Encounters with People in Off-Trail Backcountry Areas*

In 2017, there were 14 incidents where people encountered grizzly bears while traveling off-trail in backcountry areas, where they believed the bear was aware of their presence (Table 40). The reaction of the bears to the encounters were reported in all 14 of the incidents and included fleeing (57%; $n$ = 8), neutral behaviors (36%; $n$ = 5), and curious behavior (7%, $n$ = 1). Grizzly bears did not attack people in any of the off-trail encounters in Yellowstone National Park in 2017.

**Summary**

Grizzly bears instill fear in many Yellowstone National Park visitors and when they attack people in the park, it generates world-wide news further spreading their ferocious reputation.

However, grizzly bears rarely reacted aggressively toward people during encounters in Yellowstone National Park in 2017 (Table 43). Results in 2017 are similar to overall results from the entire period we have monitored human-bear interactions in the park (1991–2017, Table 44). In the 6,010 encounters between grizzly bears and people from 1991 to 2017, where the bears reaction was reported, bears reacted with neutral behaviors in 57% (*n* = 3,454), by fleeing in 35% (*n* = 2,081), curious behaviors in 3% (*n* = 201), and with stress, bluster, or warning behaviors in <1% (*n* = 34) of the incidents. Grizzly bears reacted with aggression without contact in 4% (*n* = 219) of the encounters. Less than 1% (*n* = 21) of the 6,010 reported encounters between people and grizzly bears in Yellowstone National Park from 1991–2017 resulted in an attack. All attacks occurred in backcountry areas. Attacks occurred at a higher rate during off-trail interactions (2%, 7 attacks in 407 reported encounters) than during on-trail interactions (1%, 14 attacks in 1,407 encounters). During the study period, there were no bear attacks during interactions in areas where human presence was expected and predictable, such as along primary roads (0 attacks in 3,377 encounters), within developments (0 attacks in 626 encounters), and in designated backcountry campsites (0 attacks in 193 encounters). Despite their ferocious reputations, 27 years of human-bear interactions data in Yellowstone National Park suggests that grizzly bears are quite tolerant of people in most encounters.

**Table 39. Activity of bears that entered frontcountry developments, Yellowstone National Park, 2017.**

| Activity of bear while inside development | Number of incidents |
|---|---|
| Not reported or unknown | 2 |
| Travel through | 4 |
| Forage for natural foods | 17 |
| Investigate anthropogenic foods but no food reward and no property damage | 1 |
| Investigate and damage property but no food reward | 0 |
| Investigate and obtain anthropogenic foods | 0 |
| Attack people | 0 |
| Other | 0 |
| Total | 24 |

*There were 51 reported human-grizzly bear encounters in Yellowstone National Park's backcountry in 2017, 31 occurred on trails, 14 in off-trail areas, and 6 in campsites; despite their ferocious reputations, none of these encounters resulted in bear attacks. (photo courtesy of Brian Ertel)*

**Table 40. Reactions of grizzly bears to encounters with people, Yellowstone National Park, 2017.**

| Reaction of bear | Development | Along roadside | Backcountry campsite | On trail | Off trail | Total |
|---|---|---|---|---|---|---|
| Not reported/not known | 2 | 4 | 1 | 0 | 0 | 7 |
| **Flight response** | | | | | | |
| Run away | 5 | 6 | 3 | 6 | 7 | 27 |
| Walk away | 6 | 26 | 1 | 10 | 1 | 44 |
| Adult climb tree | 0 | 0 | 0 | 0 | 0 | 0 |
| Cubs climb tree/adult remain | 0 | 0 | 0 | 0 | 0 | 0 |
| Flight behavior subtotal | 11 | 32 | 4 | 16 | 8 | 71 |
| **Neutral behaviors** | | | | | | |
| No overt reaction | 4 | 89 | 0 | 8 | 5 | 106 |
| Stand up on hind legs | 0 | 0 | 0 | 2 | 0 | 2 |
| Circle down wind | 0 | 0 | 0 | 1 | 0 | 1 |
| Neutral behavior subtotal | 4 | 89 | 0 | 11 | 5 | 109 |
| **Curious behaviors** | | | | | | |
| Walk towards-curious | 0 | 3 | 0 | 2 | 1 | 6 |
| Follow mobile person | 0 | 0 | 0 | 0 | 0 | 0 |
| Investigate vehicle | 0 | 0 | 0 | 0 | 0 | 0 |
| Curious behavior subtotal | 0 | 3 | 0 | 2 | 1 | 6 |
| **Stress/agitation/warning signals** | | | | | | |
| Salivate | 0 | 0 | 0 | 0 | 0 | 0 |
| Sway head side to side | 0 | 0 | 0 | 0 | 0 | 0 |
| Make huffing noises | 0 | 0 | 0 | 0 | 0 | 0 |
| Pop jaws/teeth clacking noises | 0 | 0 | 0 | 0 | 0 | 0 |
| Stood ground watched/stared | 1 | 0 | 0 | 0 | 0 | 1 |
| Slap ground with paw | 0 | 0 | 0 | 0 | 0 | 0 |
| Flatten ears/erect spinal hairs | 0 | 0 | 0 | 0 | 0 | 0 |
| Stiff legged walk/hop | 0 | 0 | 0 | 0 | 0 | 0 |
| Stress/warning behavior subtotal | 1 | 0 | 0 | 0 | 0 | 1 |
| **Aggressive behaviors** | | | | | | |
| Growl | 0 | 0 | 0 | 0 | 0 | 0 |
| Aggressive approach | 0 | 0 | 1 | | | |
| Stalk | 0 | 0 | 0 | 0 | 0 | 0 |
| Run towards/aggressive charge | 0 | 1 | 0 | 2 | 0 | 4 |
| Aggressive behavior subtotal | 0 | 1 | 1 | 2 | 0 | 4 |
| **Attack behaviors** | | | | | | |
| Defensive attack | 0 | 0 | 0 | 0 | 0 | 0 |
| Predatory attack | 0 | 0 | 0 | 0 | 0 | 0 |
| Attack unknown cause | 0 | 0 | 0 | 0 | 0 | 0 |
| Attack behavior subtotal | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 18 | 129 | 6 | 31 | 14 | 198 |

**Table 41. Primary activity of grizzly bears along roadsides, Yellowstone National Park, 2017.**

| Activity of bear while inside development | Number of incidents |
|---|---|
| Not reported/unknown | 9 |
| Traveling | 103 |
| Foraging natural foods | 66 |
| Mating | 1 |
| Swimming | 2 |
| Nursing young | 1 |
| Playing | 3 |
| Bedded/sleeping | 5 |
| Investigating vehicles/seeking anthropogenic foods; no food reward | 0 |
| Obtain anthropogenic foods | 0 |
| Damage property | 0 |
| Attack people | 0 |
| Other | 0 |
| Total | 190 |

**Table 42. Primary activity of grizzly bears that entered occupied backcountry campsites, Yellowstone National Park, 2017.**

| Activity of bear | Number of incidents |
|---|---|
| Not reported/not known | 1 |
| Walked past edge of campsite | 0 |
| Walked through core camp | 1 |
| Forage native foods | 1 |
| Investigate tent without damage | 1 |
| Investigate food pole | 0 |
| Investigate fire ring | 1 |
| Attempt to get human foods (not successful) | 0 |
| Damage property | 0 |
| Obtain anthropogenic foods | 1 |
| Investigate latrine (buried human feces/toilet paper) | 0 |
| Lay down/rest in campsite | 0 |
| Aggressive approach/posture towards people in campsite | 0 |
| Attack people | 0 |
| Total | 6 |

**Table 43. Grizzly bear reactions to interactions with people (*n* = 191) in different location settings, Yellowstone National Park, 2017.**

| Location of encounter | Reaction of bear | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flee | | Neutral behavior | | Curious | | Stress/agitation | | Aggression without contact | | Attack | |
| | Number | % | Number | % | Number | % | Number | % | Number | % | Number | % |
| Park development | 11 | 69 | 4 | 25 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 |
| Roadside corridor | 32 | 26 | 89 | 71 | 3 | 2 | 0 | 0 | 1 | 1 | 0 | 0 |
| Backcountry campsite | 4 | 80 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 20 | 0 | 0 |
| Backcountry trail | 16 | 52 | 11 | 35 | 2 | 6 | 0 | 0 | 2 | 6 | 0 | 0 |
| Backcountry off-trail | 8 | 57 | 5 | 36 | 1 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 71 | 37 | 109 | 57 | 6 | 3 | 1 | <1 | 4 | 2 | 0 | 0 |

**Table 44. Grizzly bears reactions to interactions with people (*n* = 6,010) in different location settings, Yellowstone National Park, 1991–2017.**

| Location of encounter | Reaction of bear | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flee | | Neutral behavior | | Curious | | Stress/agitation | | Aggression without contact | | Attack | |
| | Number | % | Number | % | Number | % | Number | % | Number | % | Number | % |
| Park development | 302 | 48 | 296 | 47 | 17 | 3 | 3 | <1 | 8 | 1 | 0 | 0 |
| Roadside corridor | 764 | 23 | 2,497 | 74 | 50 | 1 | 9 | <1 | 57 | 2 | 0 | 0 |
| Backcountry campsite | 82 | 42 | 88 | 46 | 16 | 8 | 1 | <1 | 6 | | 0 | 0 |
| Backcountry trail | 707 | 50 | 440 | 31 | 105 | 7 | 20 | 1 | 121 | 9 | 14 | 1 |
| Backcountry off-trail | 226 | 56 | 133 | 33 | 13 | 3 | 1 | <1 | 27 | 7 | 7 | 2 |
| Total | 2,081 | 35 | 3,454 | 57 | 201 | 3 | 34 | <1 | 219 | 4 | 21 | <1 |

***Visitor Compliance with Bear Spray and Hiking Group Size Bear Safety Recommendations in Yellowstone National Park*** *(Kerry A. Gunther, Eric Reinertson, and Travis C. Wyman, Yellowstone National Park)*

Large party sizes have been shown to reduce the risk of a bear attack (Herrero 2002). In addition, bear spray has proven to be effective as a deterrent during surprise encounters when the person involved has time to deploy it (Herrero and Higgins 1998, Smith et al. 2008). To reduce the risks of bear attacks in Yellowstone National Park, safety information distributed to visitors recommends that backcountry recreationists traveling by foot maintain group sizes of at least 3 people and carry bear spray. To evaluate visitor compliance with these safety recommendations, we conduct annual surveys to determine the proportion of recreationists that hike in groups of 3 or more people and the proportion that carry bear spray or use other deterrents, such as firearms, or warning devices, such as bear bells. Although it is legal to carry firearms inside Yellowstone National Park, it is illegal to discharge them within the park, so they are not considered a viable bear deterrent. Although bear bells may provide some benefit in alerting bears to the presence of approaching hikers (Jope 1982), they are generally not considered effective at preventing surprise encounters when hiking in strong winds, near rushing water, or in dense brush or forest (Herrero 2002).

Due to time, budget, and staffing constraints, we conducted opportunistic surveys. While working on other bear research, monitoring, and management projects throughout the park, we recorded how many recreationists that we encountered at trailheads and on trails and boardwalks were carrying bear spray or other deterrents. We also recorded information on group size and type of recreational activity. We grouped recreational activity into 6 broad categories: 1) day hikers (including anglers and photographers), 2) overnight backpackers, 3) boardwalk trail users, 4) stock (horse or mule) day-riders, 5) stock overnight-riders, and 6) day-use bicyclist trail riders. Our surveys were conducted visually. We recorded the presence of bear spray and other deterrents that were visible and therefore quickly retrievable. Bear spray or other deterrents stored in backpacks, saddle bags, paniers, or carried under coats would likely not be retrievable fast enough for use during surprise encounters with bears.

In 2017, we surveyed 3,741 people in 1,282 groups at 42 different backcountry trails and 4 boardwalk trails. Our surveys included 2,534 backcountry day hikers, 1,031 people using boardwalk trails, 160 overnight backpackers, 7 stock day-riders, 7 day-use bicyclists, and 2 overnight stock riders.

**Day Hikers**

Yellowstone National Park contains >1,000 miles of backcountry hiking trails accessible from 92 trailheads located throughout the park (Yellowstone National Park 2014). We surveyed 2,534 day hikers traveling in 832 groups on 39 different trails. Average party size was 3.0 people per group (Table 45). The most common group size (mode) and the median group size were 2 people per party. Fifty-six percent of day hiking parties had less than the recommended party size of 3 people and 12% hiked by themselves. Of the 2,534 day hikers, 523 (21%) carried bear spray, 48 (2%) had bear bells, and 8 (<1%) carried firearms (Table 46). Of the 832 groups of day hikers, 383 (46%) had at least 1 member that carried bear spray, 37 groups (4%) had at least 1 person wearing bear bells, and 6 groups (1%) had at least one person carrying a firearm.

**Overnight Backpackers**

Yellowstone National Park has 301 designated backcountry campsites (Yellowstone National Park 2014). We surveyed 160 backpackers in 60 groups on 18 different trails. Average party size was 2.7 people per party (Table 45). The most common group size (mode) and the median group size were 2 people per party. Sixty-three percent ($n$ = 38) of the backpacking groups had less than the recommended party size of 3 people and 22% ($n$ = 13) hiked alone. Of the 160 backpackers, 99 (62%) carried bear spray, 3 (2%) had bear bells, and 2 (1%) carried firearms (Table 48). Of the 60 groups of backpackers, 56 (93%) had at least 1 person in the party that carried bear spray, 3 groups (5%) had at least 1 person wearing bear bells, and 1 group (2%) had at least one person carrying a firearm.

**Stock Day-Riders**

We surveyed 7 stock day-riders in 1 group on the Slough Creek trail. None of the day-riders carried bear spray, bear bells, or firearms (Table 46).

**Stock Overnight-Riders**

We surveyed 2 people in 1 group that were riding stock and camping overnight on the Slough Creek trail. None of the overnight stock riders carried bear spray, bear bells, or carried firearms (Table 46).

**Day Use Bicycle Trail Riders**

Yellowstone National Park contains 13 designated bike trails. One of the 13 trails has access to a designated backcountry campsite. We surveyed 14 people in 4 groups riding bicycles on day trips on 3 different trails. Three (21%) of the 14 bicyclists carried bear spray; none of the bicyclists carried bear bells or firearms (Table 46). Two of the 4 groups (50%) of bicyclists had at least one member that carried bear spray.

**Boardwalk Trails**

Yellowstone National Park contains approximately 15 miles of boardwalk trails (Yellowstone National Park 2014). Boardwalk trails are short trails found near park roads that contain interpretive signs providing visitors with information about geysers or other natural features. Boardwalks are constructed to provide a stable walking surface with gentle grades or steps to get up and down hills, allowing use by visitors of a wide-range of ages, physical abilities, and backcountry hiking experience. Stock animals and overnight camping are not allowed on boardwalk trails. We surveyed 1,031 people in 385 groups on 4 different boardwalk trails. Average party size was 2.7 people per group (Table 45). The most common group size (mode) and the median group size were both 2 people per party. Sixty-four percent ($n$ = 246) of the groups of boardwalk users had less than the recommended party size of 3 people and 21% ($n$ = 81) hiked alone. Only 1% ($n$ = 11) of the individuals surveyed carried bear spray (Table 46). Three percent of the groups ($n$ = 10) surveyed had at least one person in the party that carried bear spray. None of the people or groups observed on boardwalk trails had bear bells or carried firearms.

**Discussion**

In 2017, overnight backpackers had the highest level of compliance with the park's bear spray recommendation; 62% of individual backpackers carried bear spray; 93% of backpacking groups had at least one member that carried bear spray. Overnight backpackers have had the highest proportion of individuals and groups traveling on foot that carried bear spray during all 7 years surveys have been conducted (Table 47 and 48). Among people traveling by foot, backpackers have also had the highest proportion of groups where at least one member carried bear spray during all 7 years of surveys (Table 46). We suspect the high level of compliance by this type of recreationist is due to the methods used to convey bear safety information to overnight backpackers. In Yellowstone National Park, permits are required for camping in the backcountry. During the permit process, backpackers are given face-to-face verbal information about bears and bear spray from the ranger issuing the permit and are also required to watch a safety video containing information on hiking and camping in bear country and how to use bear spray. Backpackers are also given the "Beyond Roads End" safety booklet containing information on bear spray and hiking and camping in bear country. Surveys indicate that Yellowstone National Park visitors retain verbal information from uniformed park staff better than written information from signs or brochures (Taylor et al. 2014). In addition, we speculate that many backpackers may have a higher level of experience in bear country than many day hikers. The most common party size observed (mode) among backpackers was 2 people per party, indicating that many backpackers did not follow the park's recommended group size of 3 people for hiking in bear country. The most common party size (mode) for overnight backpackers during all 7 years of the study has been 2 people per party (Table 49).

Twenty-one percent of day hikers carried bear spray, however, 46% of day hiking groups had at least one member that carried bear spray. Fewer than 25% of day hikers carried bear spray in each of the 7 years surveys have been conducted

(Table 47). Permits are not required for day hiking so day hikers may not receive the same level of bear safety information as backpackers, such as the verbal safety information from a park ranger. Visitor's day hiking in Yellowstone National Park can seek and obtain bear safety information from the Yellowstone National Park web page, park newspaper, day hike trip planners, safety cards and brochures, and from rangers at visitor centers. However, the only bear safety information day hikers are exposed to if they do not seek it out themselves is from signs posted at trailheads. We speculate that many day hikers that arrive at trailheads without bear spray are unlikely to go obtain bear spray before starting their hikes even after reading the sign. We also suspect that many day hikers in Yellowstone National Park may have a lower level of experience in bear country than many backpackers have. The most frequently observed group size (mode) among day hikers was 2 people per group indicating that many day hikers did not comply with the recommended group size of 3 for hiking in bear country. Since most grizzly bear attacks in Yellowstone National Park involve day hikers (26 of 40 backcountry attacks since 1970), getting more day hikers to carry bear spray or hike in groups of 3 or more people is a priority for park managers.

In 2017, the most common group size encountered on boardwalk trails was 2 people per party and only 1% of boardwalk hikers carried bear spray. Recreationists on boardwalk trails have had very low compliance with bear safety recommendations each year surveys have been conducted (Tables 45–47). However, only 2 grizzly bear attacks in the last 48 years have occurred on or near boardwalk trails, therefore the risk of attack during this type of recreational activity is very low.

None of the day-use or overnight use stock riders surveyed in 2017 carried bear spray. Bear spray is not very useful while in the saddle, as deploying it from horseback may result in the rider being thrown from their horse. In general, people riding stock are less likely to be involved in surprise encounters and bear attacks. Horses usually sense a bear's presence before a person does (Herrero 2002), alerting the rider and reducing the chances of surprise encounters at close distances. The large size of horses is also more intimidating to bears. In addition, unlike humans, when charged by bears, horses have enough speed and agility to outrun bears, thus providing an added margin of safety as long as the rider can stay in the saddle. Although stock users are less likely to have surprise encounters with bears, bear spray is useful and encouraged for carry by stock groups for use during rest stops along the trail and when in camp.

Forty-three percent of the bicycle groups we observed on trails carried bear spray. Bicyclists incur greater risk of surprise encounters because bicycles are fast and relatively quiet.

Although some backcountry recreationists in Yellowstone National Park carry firearms, and it is legal to do so, it is illegal to discharge them within the park, so they are not considered a viable bear deterrent. Firearms were openly carried by <1% of the recreationists we observed in 2017. Backpackers (1%) had the highest frequency of firearms carry. Firearms were openly carried by only a small proportion of all types of recreationists in the 7 years of the survey. Recreationists riding horses often carry firearms for euthanizing injured stock, however if these firearms were carried in saddle bags or panniers they would not have been visible during our surveys and would not have been readily available as a bear deterrent during surprise encounters.

Bear bells were used by approximately 1% of all recreationists surveyed in Yellowstone National Park in 2017. Backpackers (2%) and day hikers (2%) had the highest frequency of bear bell use. The low use of bear bells likely reflects the lack of demonstrated effectiveness as an auditory warning device (Herero 2002).

**Table 45. Group size characteristics for different types of recreationalists surveyed in Yellowstone National Park, 2017.**

| Type of recreational activity | Total people | Total groups | Average group size | Median group size | Mode group size |
|---|---|---|---|---|---|
| Boardwalk trail (foot travel walking) | 1,031 | 385 | 2.7 | 2 | 2 |
| Day hiker (day use foot travel-hiker, angler, photographer, etc.) | 2,534 | 832 | 3.0 | 2 | 2 |
| Overnight backpacker (foot travel camping overnight) | 160 | 60 | 2.6 | 2 | 2 |
| Stock – day use | 7 | 1 | 7.0 | 7 | 7 |
| Stock – overnight use | 2 | 1 | 2.0 | 2 | 2 |
| Day bicycle trip | 7 | 3 | 2.3 | 2 | 1, 2, 4 |
| Totals | 3,741 | 1,282 | 2.9 | 2 | 2 |

**Table 46. Number and percent (%) of people and groups of recreationalists surveyed that carried bear spray, firearms, or bear bells, Yellowstone National Park, 2017.**

| | Type of recreation/mode of travel | | | | | | |
|---|---|---|---|---|---|---|---|
| | Boardwalk trail | Day hiker | Day use bicycle | Overnight backpacker | Stock – day use | Stock – overnight use | Totals (all types) |
| Total people surveyed | 1,031 | 2,534 | 7 | 160 | 7 | 2 | 3,741 |
| (# of parties surveyed) | (385) | (832) | (3) | (60) | (1) | (1) | (1,282) |
| **People with bear spray** | | | | | | | |
| Total | 11 | 523 | 3 | 99 | 0 | 0 | 636 |
| Percent | 1.1 | 20.6 | 42.9 | 61.9 | 0 | 0 | 17.0 |
| **Parties with bear spray** | | | | | | | |
| Total | 10 | 383 | 2 | 56 | 0 | 0 | 451 |
| Percent | 2.6 | 46.0 | 66.7 | 93.3 | 0 | 0 | 35.2 |
| **People with firearms** | | | | | | | |
| Total | 0 | 8 | 0 | 2 | 0 | 0 | 10 |
| Percent | 0 | 0.3 | 0 | 1.2 | 0 | 0 | 0.3 |
| **Parties with firearms** | | | | | | | |
| Total | 0 | 6 | 0 | 1 | 0 | 0 | 7 |
| Percent | 0 | 0.7 | 0 | 1.6 | 0 | 0 | 0.5 |
| **People with bear bells** | | | | | | | |
| Total | 0 | 48 | 0 | 3 | 0 | 0 | 51 |
| Percent | 0 | 1.9 | 0 | 1.8 | 0 | 0 | 1.4 |
| **Parties with bear bells** | | | | | | | |
| Total | 0 | 37 | 0 | 3 | 0 | 0 | 40 |
| Percent | 0 | 4.4 | 0 | 4.8 | 0 | 0 | 3.1 |

**Table 47. Percent (%) of people engaged in different types of backcountry recreational activities that carried bear spray, Yellowstone National Park, 2011–2017.**

| Year | Overnight backpackers | Day hiker | Boardwalk | Stock day-use | Stock-overnight use | Day-use bicycle |
|---|---|---|---|---|---|---|
| 2011 | 53 | 15 | Not surveyed | 0 | 60 | Not surveyed |
| 2012 | 47 | 11 | 0 | 9 | 44 | 0 |
| 2013 | 60 | 16 | 0 | 11 | 22 | 0 |
| 2014 | 48 | 13 | <1 | 0 | 35 | 33 |
| 2015 | 50 | 14 | <1 | Not surveyed | 14 | 0 |
| 2016 | 52 | 19 | <1 | 0 | 100 | 0 |
| 2017 | 62 | 21 | 1 | 0 | 0 | 43 |
| 2011–2017 combined data | 54 | 16 | 1 | 5 | 36 | 14 |

**Table 48. Percent (%) of groups engaged in different types of backcountry recreational activities that had at least one member that carried bear spray, Yellowstone National Park, 2011–2017.**

| Year | Overnight backpackers | Day hiker | Boardwalk | Stock day-use | Stock-overnight use | Day-use bicycle |
|---|---|---|---|---|---|---|
| 2011 | 64 | 33 | Not surveyed | 0 | 50 | Not surveyed |
| 2012 | 73 | 27 | 0 | 67 | 50 | 0 |
| 2013 | 82 | 33 | 0 | 33 | 67 | 0 |
| 2014 | 73 | 28 | 1 | 0 | 60 | 67 |
| 2015 | 100 | 35 | 2 | Not surveyed | 100 | 0 |
| 2016 | 79 | 43 | 2 | 0 | 100 | 0 |
| 2017 | 93 | 46 | 3 | 0 | 0 | 67 |
| 2011–2017 combined data | 80 | 36 | 2 | 23 | 59 | 17 |

**Table 49. Group size characteristics for different types of recreationalists surveyed, Yellowstone National Park, 2011–2017.**

| Type of recreational activity | Total people | Total groups | Average group size | Median group size | Mode group size |
|---|---|---|---|---|---|
| Boardwalk | 5,791 | 2,162 | 2.7 | 2 | 2 |
| Day hiker (e.g., day foot travel- hiker, angler, photographer) | 11,879 | 4,052 | 2.9 | 2 | 2 |
| Overnight backpacker (overnight-foot travel) | 740 | 271 | 2.7 | 2 | 2 |
| Horse – day use | 77 | 13 | 5.9 | 5 | 3 |
| Horse – overnight use | 81 | 17 | 4.8 | 5 | 2 |
| Day bicycle trip | 50 | 23 | 2.2 | 2 | 2 |
| Totals | 18,618 | 6,538 | 2.8 | 2 | 2 |

# Literature Cited


Andrascik, R. 1992. Lake area-Bridge Bay spawning survey. Pages 29–35 *in* R. Andrascik, D. G. Carty, R. D. Jones, L. R. Keading, B. M. Kelly, D. L. Mahoney, and S. T. Olliff. Annual project report for 1991, Fishery and Aquatic Management Program, Yellowstone National Park. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Yellowstone National Park, Wyoming, USA.

Bangs, E. E., and S. H. Fritts. 1996. Reintroducing the gray wolf to central Idaho and Yellowstone National Park. Wildlife Society Bulletin 24:402–413.

Bjornlie, D. D., and M. A. Haroldson. 2011. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 33–35 *in* C. C. Schwartz, M.A Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2010. U.S. Geological Survey, Bozeman, Montana, USA.

Blanchard, B. M. 1985. Field techniques used in the study of grizzly bears. Interagency Grizzly Bear Study Team report. National Park Service, Bozeman, Montana, USA.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference: a practical information-theoretic approach. 2nd edition. Springer-Verlag, New York, New York, USA.

Chao, A. 1989. Estimating population size for sparse data in capture-recapture experiments. Biometrics 45:427–438.

Cherry, S., M. A. Haroldson, J. Robison-Cox, and C. C. Schwartz. 2002. Estimating total human-caused mortality from reported mortality using data from radio-instrumented grizzly bears. Ursus 13:175–184.

Cherry, S., G. C, White, K. A. Keating, M. A. Haroldson, and C. C. Schwartz. 2007. Evaluating estimators for numbers of females with cubs-of-the-year in the Yellowstone grizzly bear population. Journal of Agricultural, Biological, and Environmental Statistics 12(2):195–215.

Cherry, S. 2007. Monitoring ungulate carcasses and spawning cutthroat trout. Pages 55–62 *in* C. C. Schwartz, M. A. Haroldson, and K. West editors. Yellowstone Grizzly Bear Investigations: annual report of the Interagency Grizzly Bear Study Team, 2006. U.S. Geological Survey, Bozeman, Montana, USA.

Craighead, J. J., K. R. Greer, R. R. Knight, and H. I. Pac. 1988. Grizzly bear mortalities in the Yellowstone Ecosystem, 1959–1987. Report of the Montana Department of Fish, Wildlife and Parks; Craighead Wildlife Institute; Interagency Grizzly Bear Study Team; and National Fish and Wildlife Foundation.

Despain, D. G. 1990. Yellowstone vegetation: consequences of environment and history in a natural setting. Roberts Rinehart, Inc. Publishers, Boulder Colorado, USA.

French, S. P., M. G. French, and R. R. Knight. 1994. Grizzly bear use of army cutworm moths in the Yellowstone ecosystem. International Conference on Bear Research and Management 9:389–399.

Garrott, R. A., P. J. White, M. S. Becker, and C. N. Gower. 2009a. Apparent competition and regulation in a wolf-ungulate system: interactions of life history characteristics, climate, and landscape attributes. Pages 519–540 *in* R. A. Garrott, P. J. White, and F. G. R. Wilson, editors. The Ecology of Large Mammals in Central Yellowstone, Sixteen Years of Integrated Field Studies. Elsevier/Academic Press, Boston, Massachusettes, USA.

Garrott, R. A., P. J. White, and J. J. Rotella. 2009b. The Madison headwaters elk herd: transitioning from bottom-up regulation to top-down limitation. Pages 489–517 *in* R. A. Garrott, P. J. White, and F. G. R. Wilson, editors. The Ecology of Large Mammals in Central Yellowstone, Sixteen Years of Integrated Field Studies. Elsevier/Academic Press, Boston, Massachusetts, USA.

Garrott, R.A., P.J. White, C. Gower, M.S. Becker, S. Dunkley, K.L. Hamlin, and F.G.R. Watson. 2016. Wolf effects on Elk Inhabiting a High Risk Landscape: the

Madison Headwaters Study. Yellowstone Science 24(1):82-84.
Geremia, C., P. J. White, R. L. Wallen, and D. W. Blanton. 2015. Seasonal distributions and movements. Pages 67–82 *in* P. J. White, R. L. Wallen, and D. E. Hallac, editors. Yellowstone Bison, conserving an American Icon in modern Society.
Green, G.I. 1994. Use of spring carrion by bears in Yellowstone National Park. Thesis, University of Idaho, Moscow, Idaho, USA.
Green, G. I, D. J. Mattson, and J. M. Peek. 1997. Spring feeding on ungulate carcasses by grizzly bears in Yellowstone National Park. Journal of Wildlife Management 61:1040–1055.
Gresswell, R.E., C.S. Guy, M.J. Hansen, M.L. Jones, J.E. Marsden, P.J. Martinez, and J.M. Syslo. 2015. Lake trout suppression in Yellowstone Lake: Science Review Panel. Interim Scientific Assessment, 2014 Performance Year. A Report to the Superintendent. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, USA. YCR-2015-0x.
Gunther, K. A., B. Aber, M. T. Bruscino, S. L. Cain, M. A. Haroldson, and C. C. Schwartz. 2012. Grizzly bear-human conflicts in the Greater Yellowstone Ecosystem. Pages 48–52 *in* F. T. van Manen, M. A. Haroldson, and K. West, editors. Yellowstone Grizzly Bear Investigations: annual report of the Interagency Grizzly Bear Study Team, 2011. U.S. Geological Survey, Bozeman, Montana, USA.
Gunther, K. A., R. R. Shoemaker, K. L. Frey, M. A. Haroldson, S. L. Cain, F. T. van Manen, and J. K. Fortin. 2014. Dietary breadth of grizzly bears in the Greater Yellowstone Ecosystem. Ursus 25:61–73.
Haroldson, M. A., and K. A. Gunther. 2013. Roadside bear viewing opportunities in Yellowstone National Park: characteristics, trends, and influence of whitebark pine. Ursus 24:27–41.
Haroldson, M. A., K. A. Gunther, D. P. Reinhart, S. R. Podruzny, C. Cegelski, L.Waits, T. C. Wyman, and J. Smith. 2005. Changing numbers of spawning cutthroat trout in tributary streams of Yellowstone Lake and estimates of grizzly bears visiting streams from DNA. Ursus 16:167–180.
Haroldson, M. A., M. Ternent, G. Holm, R. A. Swalley, S. R. Podruzny, D. Moody, and C. C. Schwartz. 1998. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 1997. U.S. Geological Survey, Biological Resources Division, Bozeman, Montana, USA.
Harris, R. B., G. C. White, C. C. Schwartz, and M. A. Haroldson. 2007. Population growth of Yellowstone grizzlies: uncertainty, correlation, and future monitoring. Ursus 18:167–177.
Herrero, S. 2002. Bear attacks: their causes and avoidance. Revised edition. Lyons and Burford, New York, New York, USA.
Herrero, S., and A. Higgins. 1998. Field use of capsicum spray as a bear deterrent. Ursus 10:533–537.
Herrero, S, T. Smith, T. D. DeBruyn, K. A. Gunther, and C. A. Matt. 2005. Brown bear habituation to people: safety risks and benefits. Wildlife Society Bulletin 33:362–373.
Higgs, M. D., W. A. Link, G. C. White, M. A. Haroldson, and D. D. Bjornlie. 2013. Insights into the latent multinomial model through mark-resight data on female grizzly bears with cubs-of-the-year. Journal of Agricultural, Biological, and Environmental Statistics 18:556–577.
Hopkins, J. B., S. Herrero, R. T. Shideler, K. A. Gunther, C. C. Schwartz, and S. T. Kalinowski. 2010. A proposed lexicon of terms and concepts for human-bear management in North America. Ursus 21:154–168.
Houston, D. B. 1982. The Northern Yellowstone elk: ecology and management. Macmillan Publishing Co., Inc. New York City, New York, USA.
Jacoby, M. E., G. V. Hilderbrand, C. Servheen, C. C. Schwartz, S. T. Arthur, T.A. Hanley, C. T. Robbins, R. Michener. 1999. Trophic relations of brown and black bears in several western North American ecosystems. Journal of Wildlife Management 63:921–929.
Jope, K. L. 1982. Interactions between grizzly bears and hikers in Glacier National Park,

Montana. Final Report, Contract #PX 1430-1-0623. Cooperative Park Studies Unit, Oregon State University, Corvallis, Oregon, USA.

Jope, K. L. 1985. Implications of grizzly bear habituation to hikers. Wildlife Society Bulletin 13:32–37.

Keating, K. A., C. C. Schwartz, M. A. Haroldson, and D. Moody. 2002. Estimating number of females with cubs-of-the-year in the Yellowstone grizzly bear population. Ursus 13:161–174.

Knight, R. R., B. M. Blanchard, and L. L. Eberhardt. 1995. Appraising status of the Yellowstone grizzly bear population by counting females with cubs-of-the-year. Wildlife Society Bulletin 23:245–248.

Koel, T. M., J. L. Arnold, P. E. Bigelow, P. D. Doepke, B. D. Ertel, and M. E. Ruhl. 2010*a*. Yellowstone Fisheries and Aquatic Sciences: Annual Report, 2008. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, USA. YCR-2010-03.

Koel, T. M., J. L. Arnold, P. E. Bigelow, and M. E. Ruhl. 2010*b*. Native fish conservation plan for Yellowstone National Park. Environmental Assessment. National Park Service, U.S. Department of the Interior, Yellowstone National Park. December 16, 2010. 232 pp. + Appendices.

Koel, T. M., P. E. Bigelow, P. D. Doepke, B. D. Ertel, and D. L. Mahony. 2005. Nonnative lake trout result in Yellowstone cutthroat trout decline and impacts to bears and anglers. Fisheries 30(11):10–19.

Mattson, D. J. 1997. Use of ungulates by Yellowstone grizzly bears (*Ursus arctos*). Biological Conservation 81:161–177.

Mattson, D. J., B. M. Blanchard, and R. R. Knight. 1991*a*. Food habits of Yellowstone grizzly bears. Canadian Journal of Zoology 69:1619–1629.

Mattson, D. J., C. M. Gillin, S. A. Benson, and R. R. Knight. 1991*b*. Bear feeding activity at alpine insect aggregation sites in the Yellowstone ecosystem. Canadian Journal of Zoology 69:2430–2435.

Mattson, D. J., G. I. Green, and R. Swalley. 1999. Geophagy by Yellowstone grizzly bears. Ursus 11:109–116.

McCullough, D. R. 1982. Behavior, bears, and humans. Wildlife Society Bulletin 10:27–33.

Mealey, S. P. 1975. The natural food habits of free ranging grizzly bears in Yellowstone National Park, 1973–1974. Thesis, Montana State University, Bozeman, Montana, USA.

Molnar, P. K., T. Klanjscek, A. E. Derocher, M. E. Obbard, and M. A. Lewis. 2009. A body composition model to estimate mammalian energy stores and metabolic rates from body mass and body length, with application to polar bears. The Journal of Experimental Biology 212:2313–2323.

Olliff, S. T. 1992. Grant Village spawning stream survey. Pages 36–43 *in* R. Andrascik, D.G. Carty, R.D. Jones, L.R. Keading, B.M. Kelly, D.L. Mahoney, and S.T. Olliff. Annual project report for 1991, Fishery and Aquatic Management Program, Yellowstone National Park. U.S. Fish and Wildlife Service, Fisheries Assistance Office, Yellowstone National Park, Wyoming, USA.

Peck, C. P. 2016. Defining and assessing trend using mark-resight estimates for the number of female grizzly bears with cubs-of-the-year in the Greater Yellowstone Ecosystem. Final report to the Interagency Grizzly Bear Study Team, Department of Mathematical Sciences, Montana State University, Bozeman, Montana, USA.

Peck, C. P., F. T. van Manen, C. M. Costello, M. A. Haroldson, L. A. Landenburger, L. L. Roberts, D. D. Bjornlie, and R. D. Mace. 2017. Potential paths for male-mediated gene flow to and from an isolated grizzly bear population. Ecosphere 10.1002/ecs2.1969.

Podruzny, S. R., K. A. Gunther, and T. Wyman. 2012. Spring ungulate availability and use by grizzly bears in Yellowstone National Park. Pages 29–31 *in* F. T. van Manen, M.A. Haroldson, and K. West, editors. Yellowstone Grizzly Bear Investigations: annual report of the Interagency Grizzly Bear Study Team, 2011. U.S. Geological Survey, Bozeman, Montana, USA.

Regan, B. S. 2016. Grizzly bear scavenging and carrion monitoring summaries across two management jurisdictions of the Northern

Yellowstone Winter Range (1997–2012). Thesis, Montana State University, Bozeman, Montana, USA.
Reinhart, D. P. 1990. Grizzly bear habitat use on cutthroat trout spawning streams in tributaries of Yellowstone Lake. M.S. Thesis, Montana State University, Bozeman, Montana, USA.
Richardson, L., K. A. Gunther, T. Rosen, and C. C. Schwartz. 2015. Visitor perceptions of roadside bear viewing and management in Yellowstone National Park. The George Wright Forum 32:299–307.
Richardson, L., T. Rosen, K. A. Gunther, and C. C. Schwartz. 2014. The economics of roadside bear viewing. Journal of Environmental Management 140:102–110.
Schwartz, C. C., M. A. Haroldson, S. Cherry, and K. A. Keating. 2008. Evaluation of rules to distinguish unique female grizzly bears with cubs in Yellowstone. Journal of Wildlife Management 72:543–554.
Schwartz, C. C., M. A. Haroldson, G. C. White, R. B. Harris, S. Cherry, K. A. Keating, D. Moody, and C. Servheen. 2006. Temporal, spatial, and environmental influences on the demographics of the Yellowstone grizzly bear. Wildlife Monographs 161.
Schwartz, C. C., J. K. Fortin, J. E. Teisberg, M. A. Haroldson, C. Servheen, C. T. Robbins, and F. T. van Manen. 2014. Body and diet composition of sympatric black and grizzly bears in the Greater Yellowstone Ecosystem. Journal of Wildlife Management 78:68–78.
Sciullo, L., G. W. Thiemann, and N. J. Lunn. 2016. Comparative assessment of metrics for monitoring the body condition of polar bears in western Hudson Bay. Journal of Zoology.
Servheen, C., R. Knight, D. Mattson, S. Mealey, D. Strickland, J. Varley, and J. Weaver. 1986. Report to the IGBC on the availability of foods for grizzly bears in the Yellowstone ecosystem. U.S. Fish and Wildlife Service, Grizzly Bear Recovery Office, Missoula, Montana, USA.
Smith, D. W., D. R. Stahler, and M.S. Becker. 2009. Wolf recolonization of the Madison headwaters area in Yellowstone. Pages 283–303 *in* R. A. Garrott, P. J. White, and F. G. R. Wilson, editors. The Ecology of Large Mammals in Central Yellowstone, Sixteen Years of Integrated Field Studies. Elsevier/Academic Press, Boston, Massachusettes, USA.
Smith, T. S., S. Herrero, and T. D. DeBruyn. 2005. Alaskan brown bears, humans, and habituation. Ursus 16:1–10.
Smith, T. S., S. Herrero, T. D. Debruyn, and J.M. Wilder. 2008. Efficacy of bear deterrent spray in Alaska. The Journal of Wildlife Management 72:640–645.
Sterling. I., G. W. Thiemann, and E. Richardson. 2008. Quantitative support for a subjective fatness index for immobilized polar bears. Journal of Wildlife Management 72:568–574.
Syslo, J. M., C. S. Guy, P. E. Bigelow, P. D. Doepke, B. D. Ertel, and T. M. Koel. 2011. Response of non-native lake trout (*Salvelinus namaycush*) to 15 years of harvest in Yellowstone Lake, Yellowstone National Park. Canadian Journal of Fisheries and Aquatic Science 68:2132–2145.
Taylor, P. A., K. A. Gunther, and B. D. Grandjean. 2014. Viewing an iconic animal in an iconic National Park: bears and people in Yellowstone. The George Wright Forum 31:300–310.
Ternent, M., and M. Haroldson. 2000. Grizzly bear use of insect aggregation sites documented from aerial telemetry and observations. Pages 36–39 *in* C. C. Schwartz and M. A. Haroldson, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team,1999. U.S. Geological Survey, Bozeman, Montana.
U.S. Fish and Wildlife Service. 2017. Final Rule removing the Greater Yellowstone Ecosystem population of grizzly bears from the federal list of endangered and threatened wildlife <https://www.fws.gov/mountain-prairie/es/species/mammals/grizzly/GYE%20final%20rule%20to%20FR%202017%2006%2001.pdf>
van Manen, F. T., M. A. Haroldson, D. D. Bjornlie, M. R. Ebinger, D. J. Thompson, C. M. Costello, and G. C. White. 2016. Density dependence, whitebark pine, and vital rates of grizzly bears. Journal of Wildlife Management 80:300–313.

Watson, F. G. R., W. B. Newman, T. N. Anderson, R. E. Lockwood, and R. A. Garrott. 2009. Effects of Yellowstone's unique geothermal landscape on snow pack. Pages 53–66 *in* R. A. Garrott, P. J. White, and F. G. R. Wilson, editors. The Ecology of Large Mammals in Central Yellowstone, Sixteen Years of Integrated Field Studies. Elsevier/Academic Press, Boston, Massachusettes, USA.

Weaver, J. 1978. The wolves of Yellowstone. Natural Resources Report 14. U.S. Department of Interior, National Park Service, Washington D.C., USA.

White, P. J., D. E. Hallac, R. L. Wallen, and J. R. White. 2015. Brucellosis-a nonnative disease hindering the restoration of Yellowstone bison. Pages 19–43 *in* P. J. White, R. L. Wallen, and D. E. Hallac. Editors. Yellowstone bison: conserving an American icon in modern society. Yellowstone Association, Yellowstone National Park, Wyoming, USA.

White, P. J., and R. A. Garrott. 2013. Predation, wolf restoration and the transition of Yellowstone elk. Pages 69–93 *in* P. J. White, R. A. Garrott, and G. E. Plumb, editors. Yellowstone's Wildlife in Transition. Harvard University Press, Cambridge, Massachusetts, USA.

White, P. J., K. A. Gunther, and F. T. van Manen, editors. 2017. Yellowstone grizzly bears: Ecology and conservation of an icon of wildness. Yellowstone Forever. 273pp.

Wilson, R. M., and M. F. Collins. 1992. Capture-recapture estimation with samples of size one using frequency data. Biometrika 79:543–553.

Yellowstone Ecosystem Subcommittee. 2016. 2016 Conservation Strategy for the grizzly bear in the Greater Yellowstone Ecosystem. Interagency Grizzly Bear Committee, Missoula, Montana, USA. <http://igbconline.org/wp-content/uploads/2016/03/161216_Final-Conservation-Strategy_signed.pdf>

Yellowstone National Park. 2014. Yellowstone resources and issues handbook, 2014. U.S. Department of the Interior, National Park Service, Yellowstone National Park, Wyoming, USA.

# Appendix A

## 2017 Grizzly Bear Habitat Monitoring Report

**Grizzly Bear Habitat Modeling Team, Greater Yellowstone Ecosystem**

**Prepared by: Lisa A. Landenburger, U.S. Forest Service and U.S. Geological Survey**

This report is the collective response from the National Forests and National Parks within the Greater Yellowstone Ecosystem (GYE) to monitoring and reporting obligations established in the *Final Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Area* (Yellowstone Ecosystem Subcommittee 2016). The Conservation Strategy requires annual monitoring and reporting to evaluate federal adherence of habitat standards for the Yellowstone grizzly bear population. These monitoring requirements and habitat standards were formalized for the 6 national forests (now 5) in the *Forest Plan Amendment for Grizzly Bear Habitat Conservation for the Greater Yellowstone Area National Forests, Record of Decision* (herein referred to as Forest Service Amendment; USDA 2006). Likewise, the Superintendents' Compendia (Grand Teton National Park 2007 and Yellowstone National Park 2007) incorporated the Strategy habitat standards into legal plans for the 2 respective national parks in the GYE.

Habitat standards and monitoring protocol identified in the Conservation Strategy went into effect in 2007 when federal protections under the Endangered Species Act (ESA) were removed for the Yellowstone population. However, the legal status of the Yellowstone grizzly bear remains a contentious issue and the delisting rule was challenged and overturned in a Montana District Court in 2009. The 2009 ruling was upheld by the 9$^{th}$ Circuit Court of Appeals in 2011, and Federal protections were restored to the Yellowstone population as a threatened species under the ESA. Concerns raised by the courts were addressed when the Interagency Grizzly Bear Study Team (IGBST) conducted comprehensive studies to evaluate the adaptive response of Yellowstone grizzly bears to changing food resources (IGBST 2013; Bjornlie et al. 2014; Costello et al. 2014, 2016; Gunther et al. 2014; Schwartz et al. 2014*a*, *b*; Ebinger et al. 2016; van Manen et al. 2016). The U.S. Fish and Wildlife Service subsequently determined that the GYE population of grizzly bears has recovered and no longer meets the definition of a Threatened or Endangered species. Consequently, in March 2016, the U.S. Fish and Wildlife Service proposed a rule to once again remove the Yellowstone population from the Federal list of endangered and threatened wildlife (Federal Register 2016). The final rule was published 30 June 2017.

### Introduction

The intent of habitat standards established in the 2016 Conservation Strategy is to preserve adequate secure habitat for grizzly bears and reduce negative impacts of human presence in occupied habitat throughout the core area of the GYE. Three distinct habitat standards were enumerated pertaining to motorized access, human development, and commercial livestock grazing. All three factors are known to contribute to grizzly bear mortality and displacement in occupied areas across the landscape. The three habitat standards specifically call for no net decrease in secure habitat (a metric for the absence of motorized access), and no net increase in the number of human developed sites and grazing allotments from that which existed in 1998. The 1998 baseline is predicated on evidence that habitat conditions at that time, and for the preceding decade, contributed to the 4–7% annual population growth of the

Yellowstone grizzly bear population observed between 1983 and 2001. Habitat standards apply only within the Primary Conservation Area (PCA)[1], which is located at the core of the GYE (Fig. A1).

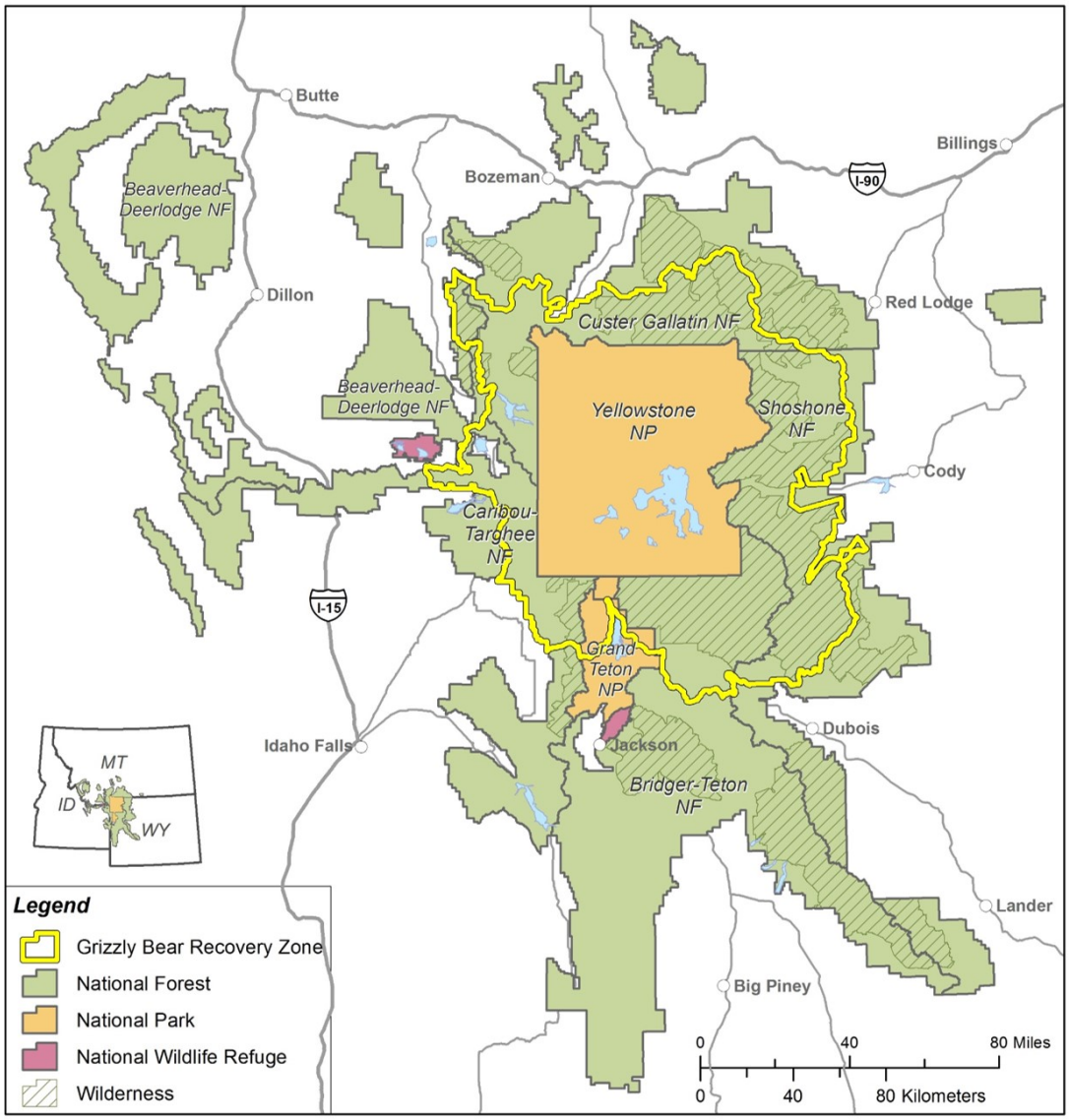



*Fig. A1. Federal lands comprising the Greater Yellowstone Ecosystem (GYE) and the Primary Conservation Area (PCA).*

## Annual Monitoring Requirements inside the PCA

In compliance with annual habitat monitoring protocol, this report summarizes habitat changes incurred annually inside the PCA and compares current habitat status with that of 1998 for the following monitored parameters: 1) number and acreage of commercial livestock grazing allotments and permitted domestic sheep animal months, 2) number of developed sites, 3) percent secure, and 4) habitat motorized access route densities. In addition, all incidental and recurring grizzly bear conflicts associated with livestock allotments occurring on public land are summarized annually for the ecosystem, both inside and outside the PCA. Current status of the 4 monitored habitat parameters, except for livestock allotments, are evaluated, summarized, and reported against 1998 levels annually for each of the 40 subunits within the 18 Bear Management Units (BMU; Fig. A2). The number and

[1] The Primary Conservation Area (PCA) is a term used when the Yellowstone grizzly bear population is not under federal protection. The same area is referred to as the Grizzly Bear Recovery Zone (GBRZ) when the bear is listed under federal protection. The PCA term is used in this 2017 report to reflect the current status of the Yellowstone grizzly bear population.

status of livestock allotments is reported annually for each national Forest and Park unit. The 1998 habitat baseline represents the most current and accurate information available documenting habitat conditions inside the PCA during 1998. Forest and Park personnel continue to improve the quality of their information to more accurately reflect what was on the landscape in 1998.

Additional habitat monitoring for spawning cutthroat trout, insect aggregation sites, and whitebark pine cone production are reported in the section "***Monitoring of Grizzly Bear Foods"*** found in the main body of this IGBST annual report.

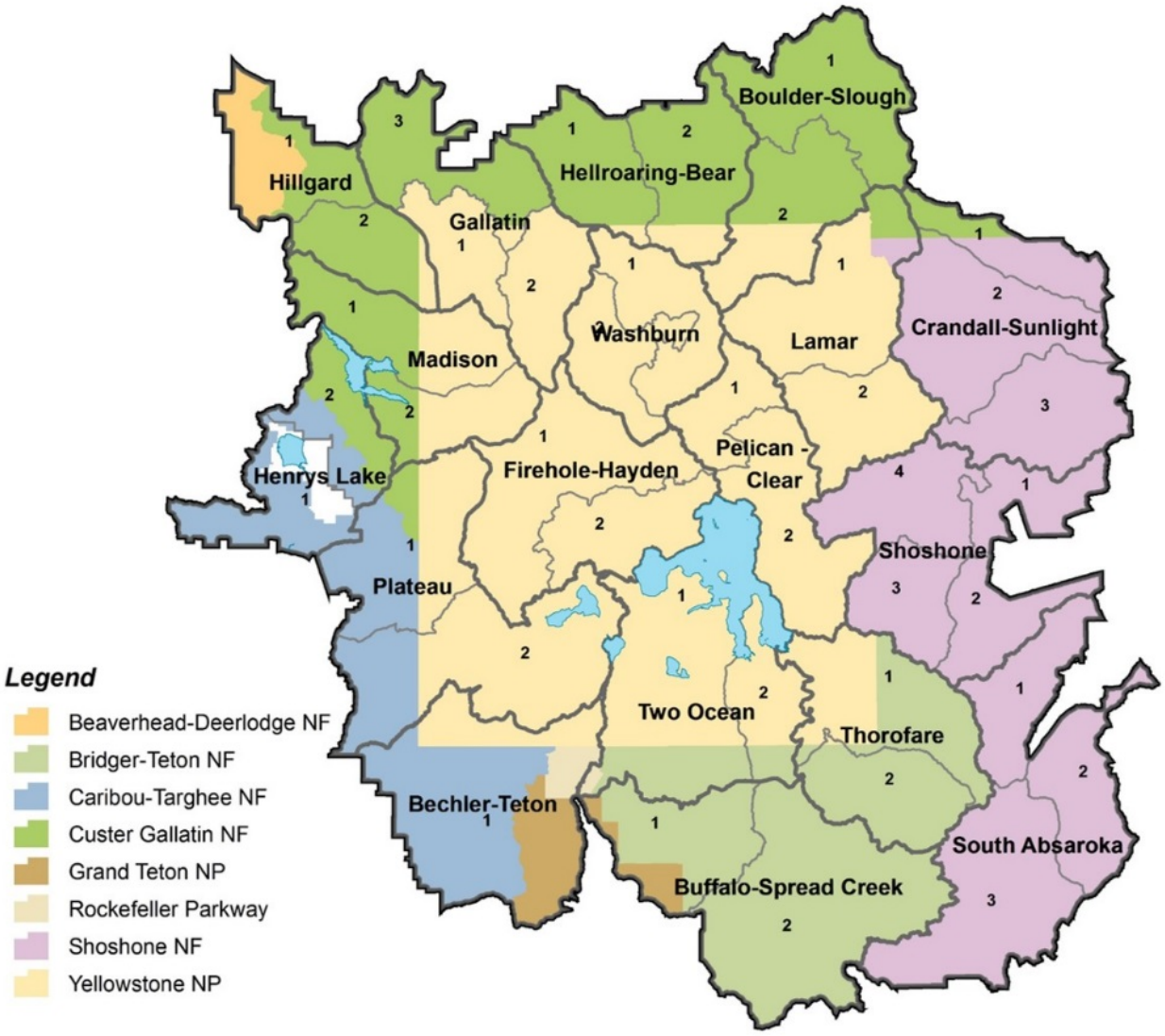



*Fig. A2. Bear Management Units (BMUs) and subunits comprising the Primary Conservation Area in the GYE.*

## Monitoring of Livestock Grazing

The habitat standard for livestock allotments identified in the Conservation Strategy requires that there be no net increase in the number or acreage of active commercial livestock grazing allotments and no increase in permitted sheep animal months (AMs) on Federal lands inside the PCA from that which existed in 1998. Changes in active and vacant livestock allotments cited in this report account for all commercial grazing allotments occurring on Federal lands within the PCA. Livestock grazing on private inholdings and horse grazing associated with recreational use and backcountry outfitters are not covered by the grazing standard and 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 on a year-by-year basis when a permittee chooses not to graze livestock or when management seeks a resolution to grazing conflicts. Vacant allotments are those without an active permit, but which may be grazed periodically by other permittees at the discretion of the land management agency. Such reactivation of vacant allotments is typically on a temporary basis to resolve resource issues or other concerns. Vacant allotments can be assumed non-grazed unless otherwise specified. A closed allotment is one that has been permanently deactivated such that commercial grazing will not be permitted to occur anytime in the future. Sheep AMs are derived by multiplying the number of permitted sheep times the number of months of permitted grazing on a given allotment. Existing sheep allotments are to be phased out as opportunity arises with willing permittees.

Commercial grazing allotments on public lands inside the PCA are tracked through time to evaluate adherence to the habitat standard which holds us to 1998 levels or lower. The number of commercial livestock allotments, by itself, is not a meaningful metric of change because individual allotments can be combined or divided without affecting the overall footprint of commercially grazed land. Likewise, allotment boundaries can be reconfigured or modified over time to enclose smaller or larger areas. Thus, the total acreage of grazed lands constitutes a more meaningful metric of overall change on the landscape. See Table A1 for 2017 status of livestock allotments compared against the 1998 baseline.

### Change in cattle allotments since 1998

Since 1998, the total acreage of active cattle grazing on public lands inside the PCA has been reduced by 32% (213,673 acres, 865 $km^2$). Approximately 93% of this net reduction was the result of permanent closures, and 7% was from active allotments that were vacated. With closure of the only cattle allotment inside Grand Teton National park in 2011, there currently is no livestock grazing occurring on National Park lands inside the GYE. (Table A1)

### Change in sheep allotments since 1998

Domestic sheep allotments on public lands inside the PCA have largely been phased out since 1998. During 1998 there was a total of 11 active sheep allotments on public lands inside the PCA, amounting to 600 $km^2$ (148,368 acres). Since 1998, there has been a 98% net reduction in the acreage grazed by sheep on public lands inside the PCA. Of the 11 actively grazed sheep allotments, 8 have been permanently closed and 2 were converted in 2003 to cattle allotments that remain active today (Pearson and Beartooth allotments on the Shoshone National Forest). Today, only 1 sheep allotment remains active on public lands inside the PCA: the Meyers Creek

allotment on the Caribou-Targhee National Forest. The Myers Creek allotment, part of the USDA Sheep Experiment Station (USSES), has consistently been issued a no-use permit since 2008. Consequently, there has been no domestic sheep grazing on public lands inside the PCA for the past 10 years. (Table A1)

### Change in livestock allotments during 2017

During 2017 there was only 1 reported change in livestock grazing allotments inside the PCA. A small parcel of privately owned cattle/horse pasture land was newly acquired by the US Forest Service in the fall of 2016. The 28-acre parcel, acquired via the Jackson Hole Land Trust (JHLT), occurs on the Blackrock Ranger District of the Bridger-Teton National Forest and adjoins the Hatchet Resort to the east and US Highway 26/287 to the north. Prior to the Forest Service land acquisition, the property was grazed under JHLT ownership. In 2017, under USFS ownership, a temporary special use permit for summer cattle grazing was issued. Situated at the base of Togwotee Pass, this relatively undisturbed pasture has no prior history of livestock-grizzly bear interactions. Until an environmental assessment can be conducted, the long-term grazing status of the property is undetermined. However, the intent is to issue the same special use permit in 2018. Consequently, for tracking purposes only, this 28-acre pasture is temporarily being tracked as the “Hatchet” cattle allotment and is accounted for in the 2017 cattle allotment acreage in Table A1. No other changes to the number, status, or acreage of commercial livestock allotments were reported to occur on federal lands inside the PCA during 2017.

*Table A1. Number of commercial livestock grazing allotments and sheep animal months (AMs) inside the Primary Conservation Area in 1998 and 2017.*

| Administrative unit | Cattle allotments | | | | Sheep allotments | | | | Sheep animal months | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Active | | Vacant | | Active | | Vacant | | | |
| | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 |
| Beaverhead-Deerlodge National Forest | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bridger-Teton National Forest | 9 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Caribou-Targhee National Forest [a] | 11 | 7 | 1 | 1 | 7 | 1 | 4 | 0 | 14,163 | 1,970 |
| Custer-Gallatin National Forest | 23 | 14 | 10 | 5 | 2 | 0 | 4 | 0 | 3,540 | 0 |
| Shoshone National Forest | 25 | 25 | 0 | 0 | 2 | 0 | 2 | 0 | 5,387 | 0 |
| Grand Teton National Park | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total count in PCA | 72 | 55 | 13 | 7 | 11 | 1 | 10 | 0 | 23,090 | 1.970 |
| Total acres in PCA | 661,770 | 456,040 | 67,846 | 31,679 | 148,368 | 3,504 | 77,066 | 0 | | |
| Total area in PCA ($km^2$) | 2,678 | 1,846 | 275 | 128 | 600 | 14 | 312 | 0 | | |

[a] The Meyers Creek allotment, the only active sheep grazing unit remaining inside the PCA, took a "no use" permit in 2017.

## Livestock Conflicts throughout the GYE

Conflicts between grizzly bears and livestock have historically led to the capture, relocation, and removal of grizzly bears in the GYE. This section summarizes the reported grizzly bear conflicts associated with livestock grazing on sheep and cattle/horse grazing allotments and forage reserves on national forest land within the GYE. Livestock-grizzly bear conflicts associated with outfitters in backcountry situations, and conflicts occurring on private or state lands are not included in this report.

### Livestock conflicts in 2017

In 2017, a total of 110 grizzly bear conflicts associated with livestock grazing on U.S. Forest Service lands were reported inside the GYE (Fig. A3). These conflicts occurred on 23 distinct commercial grazing allotments throughout the ecosystem. All livestock-related incidents in 2017 involved cattle depredations and accounted for the injury or mortality of at least 9 cows and 91 calves or yearlings. Conflicts were reported on each of the 5 National Forests in the GYE including the: Beaverhead-Deerlodge ($n$ = 2), Bridger-Teton ($n$ = 77), Caribou-Targhee ($n$ = 1), Custer-Gallatin ($n$ = 2), and the Shoshone ($n$ = 10). Approximately 4% ($n$ = 4) of the conflicts occurred inside the PCA. Of the 110 livestock-related conflicts, 63% ($n$ = 69) occurred on the Upper Green River cattle allotment located outside the PCA on the north portion of the Bridger-Teton National Forest. Management actions in direct response to livestock-related conflicts on public lands led to the removal of 6 male grizzly bears (3 adult, 3 subadult) during 2017. The mortality of an additional adult male grizzly bear occurred at the site of a dead calf when the bear was shot on the West Fork allotment of the Beaverhead-Deerlodge National Forest. Four of the 6 grizzly bear management removals were due to cattle depredation conflicts on the Upper Green River allotment.

### Recurring livestock conflicts 2013–2017

Allotments with ‘recurring’ conflicts are those where grizzly bear-livestock conflicts occurred in 3 or more years during the past 5-year period. During the past 5 years (2013–2017), 481 livestock-related conflicts occurred on grazing allotments on national forest lands within the GYE (Table A2). Approximately 6% ($n$ = 27) of these conflicts occurred inside the PCA. Of the 481 conflicts, 64% ($n$ = 309) occurred on the Upper Green River cattle allotment located outside the PCA on the Bridger-Teton National Forest. Ten allotments had recurring conflicts: 1 on the Beaverhead-Deerlodge, 3 on the Bridger-Teton, and 6 on the Shoshone (Table A2). Over the past 5 years, 22 grizzly bears were removed from the population because of persistent livestock-related conflicts on U.S. Forest Service allotments. These 22 management removals included 4 females (3 adult, 1 subadult) and 18 male (13 adult, 5 subadult) grizzly bears. In addition, two adult male grizzly bears were fatally shot in self-defense at sites of livestock depredation. Seventeen (77%) of the 22 management sanctioned grizzly bear removals were due to cattle depredations on the Upper Green River allotment. More information on specific mortality incidents is documented in Table 16 under the section “***Documented Grizzly Bear Mortalities in the GYE and Estimated Percent Mortality for the Demographic Monitoring Area”***.

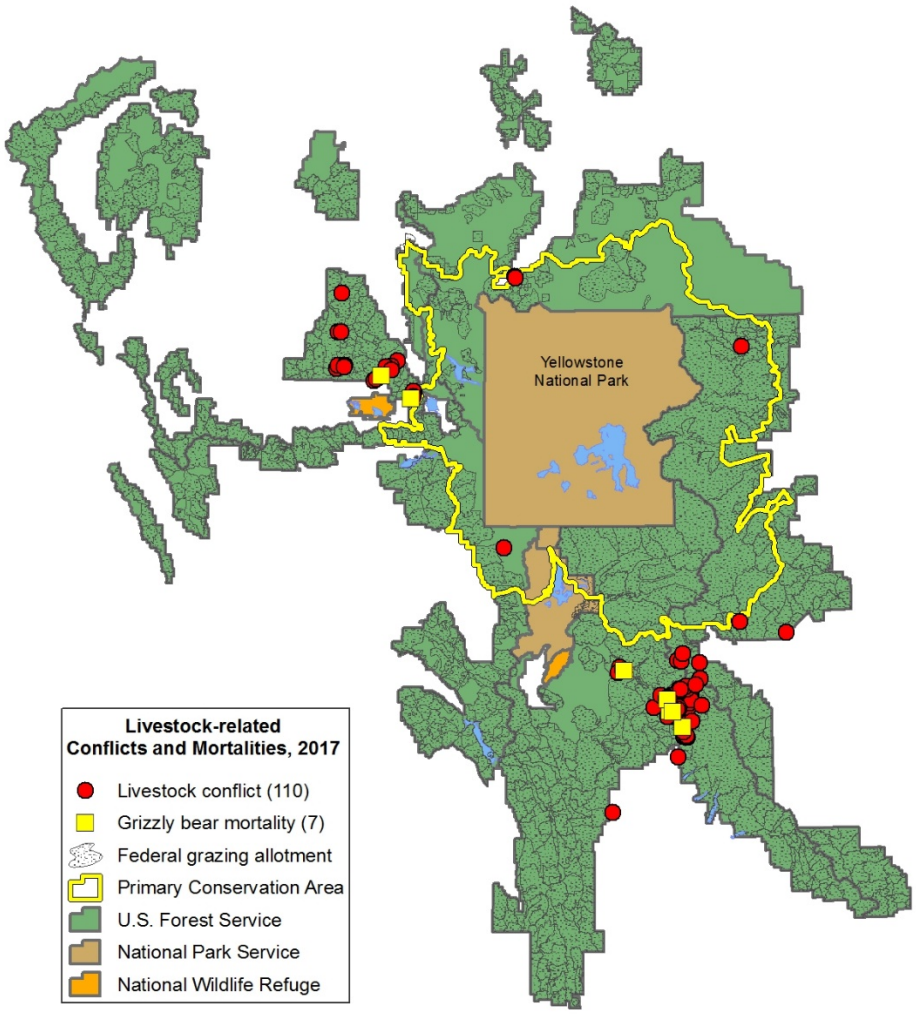



*Fig. A3. Grizzly bear conflicts and mortalities related to commercial livestock grazing on Federal lands in the GYE during 2017.*

*Table A2. Commercial livestock allotments on public lands with documented grizzly bear conflicts during the past 5 years. Allotments with conflicts in 3 or more of the past 5 years are considered to be recurring conflicts.*

| U.S. Forest Service allotment name | Total acres | Livestock-related conflicts | | | | | Total conflicts (2013–2017) | Recurring conflicts |
|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | | |
| Beaverhead–Deerlodge National Forest | | | | | | | | |
| Antelope Basin | 4,430 | 0 | 0 | 2 | 0 | 0 | 2 | No |
| Barnett | 6,454 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Bufiox | 13,077 | 0 | 0 | 0 | 0 | 3 | 3 | No |
| Clover Meadows | 10,398 | 0 | 0 | 1 | 0 | 0 | 1 | No |
| Conklin | 3,654 | 0 | 0 | 0 | 0 | 1 | 1 | No |

*Table A2. Commercial livestock allotments on public lands with documented grizzly bear conflicts during the past 5 years. Allotments with conflicts in 3 or more of the past 5 years are considered to be recurring conflicts.*

| U.S. Forest Service allotment name | Total acres | Livestock-related conflicts | | | | | Total conflicts (2013–2017) | Recurring conflicts |
|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | | |
| Eureka Basin | 11,617 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| Hidden Lake Bench | 6,609 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| North Saddle | 3,454 | 0 | 0 | 0 | 1 | 2 | 3 | No |
| Poison Basin | 6,863 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Red Tepee | 8,256 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Upper Ruby | 44,395 | 1 | 0 | 0 | 0 | 2 | 3 | No |
| Warm Springs | 22,518 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| West Fork | 53,096 | 0 | 0 | 4 | 2 | 9 | 15 | Yes |
| Bridger-Teton National Forest | | | | | | | | |
| Salt Creek | 10,005 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| Fish Creek [a] | 76,217 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Green River (Drift) | 1,003 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| Lime Creek | 4,973 | 0 | 0 | 5 | 1 | 0 | 6 | No |
| New Fork-Boulder | 10,976 | 2 | 0 | 0 | 0 | 0 | 2 | No |
| Noble Pasture | 762 | 1 | 0 | 1 | 0 | 0 | 2 | No |
| North Cottonwood | 28,177 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Pot Creek | 4,499 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Redmond/Bierer Cr | 7,109 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Roaring Fork | 8,416 | 0 | 0 | 0 | 0 | 1 | 1 | No |
| Rock Creek | 5,148 | 1 | 2 | 0 | 0 | 0 | 3 | No |
| Sherman C&H | 8,287 | 1 | 1 | 0 | 1 | 1 | 4 | Yes |
| Tosi Creek | 14,090 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Upper Green River | 131,94 | 40 | 66 | 80 | 54 | 69 | 309 | Yes |
| Upper Gros Ventre | 67,497 | 1 | 1 | 5 | 0 | 4 | 11 | Yes |
| Wagon Creek | 182 | 1 | 0 | 1 | 0 | 0 | 2 | No |
| Caribou-Targhee National Forest | | | | | | | | |
| Ching Creek | 3,911 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Grandview | 43,478 | 0 | 0 | 2 | 0 | 0 | 2 | No |
| Squirrel Meadows | 28,797 | 0 | 0 | 0 | 1 | 1 | 2 | No |
| Custer-Gallatin National Forest | | | | | | | | |
| Wigwam | 2,762 | 0 | 0 | 0 | 1 | 2 | 3 | No |
| Shoshone National Forest | | | | | | | | |
| Basin | 73,119 | 0 | 0 | 1 | 0 | 0 | 1 | No |
| Bear Creek | 33,672 | 1 | 0 | 1 | 0 | 1 | 3 | Yes |
| Beartooth | 30,317 | 2 | 3 | 1 | 0 | 0 | 6 | Yes |
| Beartooth Highway | 9,350 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Bench (Clarks Fork) | 28,751 | 0 | 8 | 3 | 4 | 0 | 15 | Yes |
| Crandall | 30,089 | 1 | 0 | 0 | 0 | 0 | 1 | No |

*Table A2. Commercial livestock allotments on public lands with documented grizzly bear conflicts during the past 5 years. Allotments with conflicts in 3 or more of the past 5 years are considered to be recurring conflicts.*

| U.S. Forest Service allotment name | Total acres | Livestock-related conflicts | | | | | Total conflicts (2013–2017) | Recurring conflicts |
|---|---|---|---|---|---|---|---|---|
| | | 2013 | 2014 | 2015 | 2016 | 2017 | | |
| Deep Lake | 6,486 | 0 | 1 | 0 | 0 | 0 | 1 | No |
| Dick Creek | 9,569 | 0 | 0 | 1 | 0 | 0 | 1 | No |
| Dunn Creek | 4,520 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Fish Lake | 12,743 | 0 | 0 | 0 | 0 | 2 | 2 | No |
| Ghost Creek | 11,579 | 0 | 0 | 0 | 3 | 0 | 3 | No |
| Horse Creek | 29,980 | 0 | 1 | 0 | 2 | 1 | 4 | Yes |
| Lake Creek | 21,399 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Parque Creek | 13,528 | 0 | 2 | 4 | 0 | 0 | 6 | No |
| Piney | 14,287 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Ramshorn | 16,005 | 0 | 0 | 1 | 0 | 0 | 1 | No |
| Reef Creek | 11,449 | 0 | 0 | 0 | 3 | 0 | 3 | No |
| Rock Creek | 16,833 | 0 | 1 | 0 | 0 | 0 | 1 | No |
| Salt Creek | 8,263 | 0 | 0 | 0 | 5 | 1 | 6 | No |
| South Absaroka Trans | 152,256 | 1 | 0 | 0 | 0 | 0 | 1 | No |
| Sunshine | 2,152 | 0 | 0 | 1 | 0 | 0 | 1 | No |
| Table Mountain | 13,895 | 0 | 0 | 0 | 4 | 1 | 5 | No |
| Trout Creek | 12,799 | 0 | 0 | 0 | 1 | 0 | 1 | No |
| Union Pass | 39,497 | 2 | 0 | 0 | 0 | 1 | 3 | No |
| Warm Springs | 16,875 | 2 | 1 | 2 | 3 | 3 | 11 | Yes |
| Wiggins Fork | 37,653 | 0 | 1 | 2 | 1 | 0 | 4 | Yes |
| Wind River | 44,158 | 0 | 3 | 4 | 1 | 0 | 8 | Yes |
| **Total conflicts** | | **64** | **91** | **122** | **94** | **110** | **481** | |

[a] The Fish Creek and Union Pass grazing units on the Bridger-Teton National Forest are forage reserves that are grazed only occasionally as a short-term solution to reduce conflict, protect resources, or compensate for natural landscape hazards (i.e., fire) in other grazing areas.

## Monitoring of Developed Sites inside the PCA

Habitat standards identified in the Conservation Strategy require that the number of developed sites and capacity of human-use of developed sites on public lands inside the PCA be maintained at or below levels existing in 1998. 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. Developed sites include all sites or facilities on public land with infrastructure intended for human use and which accommodates administrative needs and public recreational use. Examples of developed sites include, but are not limited to, campgrounds, trailheads, lodges, administrative structures, 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. Developments on private lands inside the PCA are not counted against this standard.

For a complete itemized list of developed sites comprising the 1998 baseline per subunit, please refer to Supplemental Table S1 linked to this report (available online only: Table S1 Developed Sites 1998 Baseline and Current Status).

**Changes in developed sites since 1998**

The number of distinct developed sites known to exist in 1998 is 592. In the intervening years, a number of sites have been condemned or permanently closed and dismantled. New sites that were built have been mitigated for by closing one or more sites of equivalent human use within the same subunit. Today, the number of known developed sites on public lands inside the PCA is 575, accounting for a net decrease of 14 sites between 1998 and 2017. From 1998 to the present, the number of developed sites have remained at or below 1998 counts for all subunits inside the PCA except for the Hilgard #2 subunit, which increased by a count of one. This increase occurred in 2005 when the Taylor Falls/Lightning trailhead, originally located in subunit #1 of the Hilgard BMU, was moved from one side of a road to the other, placing it in subunit #2 of the Hilgard BMU. In this case, the loss in one subunit yielded a gain in the other. Although this transfer technically accounted for an increase in developed sites on Hilgard #2, it was determined to have no detrimental effect on grizzly bears and did not violate the intent of the developed site standard. Please refer to Table A3 for a comparison of developed site counts between 1998 and 2017.

**Changes in developed sites in 2017:**

During 2017 there were no changes in the number of developed sites on federal lands inside the PCA.

**Future review of developed sites**

Visitor use in National Parks and Forest Service lands in the GYE has increased significantly since 1998. This increased visitation has the potential to negatively impact natural resources in fragile areas of high use. A multi-agency review of the 1998 habitat baseline has been proposed in the 2016 Conservation Strategy to identify potential solutions to alleviate administrative pressures in a way that allows for strategic management of grizzly bear habitat with minimal deviations from the baseline. This re-evaluation effort will be completed by the end of calendar year 2018 and released for public review.

*Table A3. Number of developed sites in 1998 and 2017 on public lands per bear management subunit in the Greater Yellowstone Ecosystem.*

| Bear management subunit | Admin unit [1] | Summer home complexes | | Developed campgrounds | | Trailheads | | Major developed sites [2] | | Administrative or maintenance sites | | Other | | Plans of operation [3] | | Total count developed sites in PCA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 |
| Bechler-Teton #1 | CTNF | 0 | 0 | 1 | 1 | 5 | 5 | 2 | 2 | 4 | 4 | 16 | 16 | 0 | 0 | 58 | 58 |
| | GTNP | 0 | 0 | 8 | 8 | 3 | 3 | 1 | 1 | 3 | 3 | 9 | 9 | 0 | 0 | | |
| | YNP | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | | |
| Boulder-Slough #1 | CGNF | 0 | 0 | 1 | 1 | 7 | 7 | 0 | 0 | 1 | 1 | 3 | 3 | 8 | 2 | 20 | 14 |
| Boulder-Slough #2 | CGNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 9 | 9 |
| | YNP | 0 | 0 | 1 | 1 | 3 | 3 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | | |
| Buffalo-Spread Creek #1 | BTNF | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 18 | 18 |
| | GTNP | 0 | 0 | 1 | 1 | 7 | 7 | 2 | 2 | 1 | 1 | 3 | 3 | 0 | 0 | | |
| Buffalo-Spread Creek #2 | BTNF | 1 | 1 | 4 | 2 | 3 | 5 | 3 | 3 | 5 | 5 | 5 | 3 | 1 | 1 | 22 | 20 |
| Crandall-Sunlight #1 | CGNF | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 5 | 5 | 0 | 0 | 23 | 23 |
| | SNF | 0 | 0 | 2 | 2 | 5 | 5 | 1 | 1 | 1 | 1 | 5 | 5 | 0 | 0 | | |
| Crandall-Sunlight #2 | CGNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 18 |
| | SNF | 0 | 0 | 5 | 5 | 4 | 4 | 1 | 1 | 2 | 2 | 5 | 5 | 1 | 1 | | |
| Crandall-Sunlight #3 | SNF | 0 | 0 | 2 | 2 | 3 | 3 | 0 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 11 | 11 |
| | WG&F | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | |
| Firehole-Hayden #1 | YNP | 0 | 0 | 1 | 1 | 5 | 5 | 1 | 1 | 6 | 6 | 13 | 13 | 0 | 0 | 26 | 26 |
| Firehole-Hayden #2 | YNP | 0 | 0 | 1 | 1 | 3 | 3 | 1 | 1 | 2 | 2 | 8 | 8 | 0 | 0 | 15 | 15 |
| Gallatin #1 | YNP | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 4 |
| Gallatin #2 | YNP | 0 | 0 | 2 | 2 | 5 | 5 | 1 | 1 | 12 | 12 | 1 | 1 | 0 | 0 | 21 | 21 |
| Gallatin #3 | CGNF | 0 | 0 | 2 | 2 | 9 | 9 | 0 | 0 | 1 | 1 | 6 | 6 | 0 | 0 | 18 | 18 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Hellroaring-Bear #1 | CGNF | 0 | 0 | 4 | 4 | 11 | 11 | 0 | 0 | 3 | 3 | 8 | 8 | 8 | 8 | 36 | 36 |
| | YNP | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | | |
| Hellroaring-Bear #2 | CGNF | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 4 | 4 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | | |
| Henrys Lake #1 | CTNF | 2 | 2 | 3 | 3 | 1 | 1 | 0 | 0 | 3 | 3 | 10 | 10 | 1 | 0 | 20 | 19 |

*Table A3. Number of developed sites in 1998 and 2017 on public lands per bear management subunit in the Greater Yellowstone Ecosystem.*

| Bear management subunit | Admin unit [1] | Summer home complexes | | Developed campgrounds | | Trailheads | | Major developed sites [2] | | Administrative or maintenance sites | | Other | | Plans of operation [3] | | Total count developed sites in PCA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 |
| Henrys Lake #2 | CGNF | 5 | 5 | 3 | 3 | 4 | 4 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 18 | 18 |
| | CTNF | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | | |
| Hilgard #1 | BDNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 14 | 11 |
| | CGNF | 0 | 0 | 0 | 0 | 6 | 5 | 1 | 1 | 2 | 2 | 2 | 2 | 0 | 0 | | |
| Hilgard #2 | CGNF | 0 | 0 | 0 | 0 | 4 | 5 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 9 | 10 |
| | YNP | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Lamar #1 | CGNF | 0 | 0 | 2 | 2 | 7 | 7 | 0 | 0 | 6 | 6 | 3 | 3 | 8 | 8 | 37 | 36 |
| | SNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| | YNP | 0 | 0 | 1 | 1 | 5 | 5 | 0 | 0 | 3 | 3 | 2 | 1 | 0 | 0 | | |
| Lamar #2 | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 4 | 4 |
| Madison #1 | CGNF | 0 | 0 | 1 | 1 | 11 | 11 | 0 | 0 | 1 | 1 | 8 | 7 | 0 | 0 | 21 | 20 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Madison #2 | CGNF | 8 | 8 | 2 | 2 | 1 | 1 | 1 | 1 | 4 | 4 | 5 | 5 | 0 | 0 | 25 | 25 |
| | YNP | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | | |
| Pelican-Clear #1 | YNP | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| Pelican-Clear #2 | YNP | 0 | 0 | 1 | 1 | 4 | 4 | 1 | 1 | 4 | 4 | 3 | 3 | 0 | 0 | 13 | 13 |
| Plateau #1 | CGNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | CTNF | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | | |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | |
| Plateau #2 | CTNF | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 7 | 7 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | | |
| Shoshone #1 | SNF | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 5 | 0 | 0 | 9 | 8 |
| Shoshone #2 | SNF | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| Shoshone #3 | SNF | 2 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 3 |
| Shoshone #4 | SNF | 3 | 3 | 3 | 2 | 3 | 3 | 6 | 6 | 0 | 0 | 8 | 9 | 0 | 0 | 23 | 23 |
| South Absaroka #1 | SNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| South Absaroka #2 | SNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 |

*Table A3. Number of developed sites in 1998 and 2017 on public lands per bear management subunit in the Greater Yellowstone Ecosystem.*

| Bear management subunit | Admin unit [1] | Summer home complexes | | Developed campgrounds | | Trailheads | | Major developed sites [2] | | Administrative or maintenance sites | | Other | | Plans of operation [3] | | Total count developed sites in PCA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 | 1998 | 2017 |
| South Absaroka #3 | SNF | 1 | 1 | 3 | 3 | 4 | 4 | 1 | 1 | 1 | 1 | 5 | 4 | 0 | 0 | 15 | 14 |
| Thorofare #1 | BTNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | | |
| Thorofare #2 | BTNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 2 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Two Ocean Lake #1 | BTNF | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 13 |
| | GTNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | | |
| | YNP | 0 | 0 | 2 | 2 | 3 | 3 | 1 | 1 | 3 | 3 | 2 | 2 | 0 | 0 | | |
| Two Ocean Lake #2 | BTNF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 4 | 4 |
| | YNP | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | | |
| Washburn #1 | YNP | 0 | 0 | 2 | 2 | 8 | 8 | 2 | 2 | 7 | 7 | 6 | 6 | 0 | 0 | 25 | 25 |
| Washburn #2 | YNP | 0 | 0 | 1 | 1 | 6 | 6 | 0 | 0 | 1 | 1 | 4 | 4 | 0 | 0 | 12 | 12 |
| **Total count in GBRZ** | | **24** | **24** | **68** | **65** | **160** | **161** | **28** | **28** | **117** | **114** | **167** | **162** | **28** | **21** | **592** | **575** |

***Note:*** The 1998 baseline values in this table may vary from those tabulated in the 2007 Conservation Strategy since corrections have been made with time. The numbers in this table represent the best estimates currently available for developed sites on public lands inside the Grizzly Bear Recovery Zone of the Greater Yellowstone Ecosystem.

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

[2] Major developed areas such as Grant, Lake, Fishing Bridge, Old Faithful, Canyon, and Mammoth in YNP and are comprised of a combination of recreation and administrative facilities. All buildings and facilities at a given major developed area are tracked collectively as a single developed site.

[3] A single plan of operation may have multiple mining claims and not all plan sites have active projects.

## Monitoring Secure Habitat and Motorized Access inside the PCA

Habitat standards identified in the Conservation Strategy require that grizzly bear secure habitat be maintained at or improved upon levels existing in 1998 for each of the 40 subunits inside the PCA. The sole exception to the 1998 baseline applies to the 3 subunits identified in the 2007 Conservation Strategy (Gallatin #3, Henrys Lake #2, and Madison #2) as needing improved levels above 1998 conditions. The new baseline for these 3 subunits, formalized in the Gallatin Cleanup Amendment of 2015, are established at secure habitat levels achieved with full implementation of the Gallatin National Forest 2006 Travel Management Plan. New threshold baselines established in 2016 raise the bar for these 3 subunits and supersede 1998 baseline values for secure habitat.

Secure habitat serves as a metric of the level of human presence in grizzly bear habitat and is based entirely on proximity to motorized routes (roads and trails). Secure habitat is defined as any contiguous area ≥10 acres in size and more than 500 m from an open or gated motorized route. Lakes larger than 1 square mile (2.59 $km^2$) in size are excluded from habitat calculations.

The monitoring protocol established in the 2016 Conservation Strategy and Forest Plan Amendment requires that secure habitat, open motorized access route density (OMARD), and total motorized access route density (TMARD) be reported annually per subunit inside the PCA. Values for secure habitat are compared against 1998 baseline levels inside the PCA to ensure adherence to the secure habitat standard. 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 effectively restricted. Road decommissioning can range from complete obliteration of the road prism to physical barriers permanently and effectively blocking all access points to motorized traffic. Any route open to motorized used by the public during any portion of the non-denning season (March 1 through November 30) detracts from secure habitat and contributes to OMARD and TMARD. Routes that are gated to the public yearlong but which may potentially be accessed by administrative personnel detract from secure habitat and contribute to TMARD only.

The Conservation Strategy and Forest Plan Amendment do not impose mandatory standards on motorized route density; however, changes in this parameter are monitored and reported annually. OMARD is reported per subunit at thresholds >1 mile/$mi^2$ (>0.62 km/$km^2$) and TMARD at levels >2 miles/$mi^2$ (>1.2 km/$km^2$). OMARD is measured only for the non-denning season March 1–November 30. Gated routes that effectively prohibit public motorized access for the entire non-denning season do not count toward OMARD but do contribute toward TMARD. All motorized routes open to the public and or administrative personnel contribute to TMARD. Decommissioned routes that are managed for long-term closure to all motorized use do not contribute to OMARD or TMARD and do not detract from secure grizzly bear habitat.

### Permanent changes in secure habitat since 1998

The standard for “no net loss” in secure habitat with respect to 1998 baseline levels has been consistently met in all 40 subunits inside the PCA since it was initially formalized in the 2003 Conservation Strategy. For the 3 impoverished subunits identified in the 2007 Conservation

Strategy as in need of improvement above 1998 levels (Gallatin #3, Henrys Lake #2, and Madison #2), new baseline thresholds ensure that secure habitat will be maintained well into the future at levels higher than what was attained in 1998. Since 1998 a net gain of approximately 131 miles$^2$ (339 km$^2$) in secure habitat has been attained inside the PCA. This gain is comparable in size to that of Yellowstone Lake. The greatest improvement in secure habitat is a 17.2 % increase occurring on the Gallatin #3 Bear Management Subunit (BMS) on the Custer-Gallatin National Forest. The gain in secure habitat for this subunit, as well as Henrys Lake #2 (5.8%) and Madison #2 (1.0%) achieved by implementation of the Gallatin Travel Management Plan will constitute new baselines against which future change will be measured. Other notable gains in secure habitat, range from 3.4% on the Hellroaring-Bear #1 subunit to 13.4% on the Hilgard #1 subunit. Changes in secure habitat, when averaged over all 40 subunits, account for a mean gain of 1.5% since 1998. All gains in secure habitat throughout the PCA were achieved by the decommissioning of motorized routes on public lands. Permanent changes in secure habitat, OMARD, and TMARD inside the PCA are reported with respect to baseline levels in Table A4.

**Permanent changes in secure habitat during 2017**

During 2017 several changes in the motorized access on public land yielded minor changes to secure habitat.

- *Crandall-Sunlight #3*: A 2017 reported roads correction changes the temporary status of a 0.4-km project road to that of a permanent level 1 gated system road identified as 945.2B in the Little Sunlight area on the Shoshone National Forest. An additional 2.5 km of motorized roads in the Little Sunlight area was permanently closed in 2017. Closed roads comprises: a) approximately 1.8 km of motorized access along Little Sunlight trail that was ripped and water-barred and b) 0.7 km of roads to the south in vicinity of Sulphur Lake, which was permanently closed with the strategic placement of large boulders. Collectively, these changes in road configuration had no measurable change in OMARD or TMARD but accounts for a decrease of approximately 0.1% in secure habitat for the Crandall-Sunlight #3 subunit. The total percentage of secure habitat for the subunit (81.2%) remains an improvement of the 80.4% reported in 1998.
- *Henrys Lake #1*: Approximately 0.7 km of motorized roads were newly constructed or acquired in the Ashton-Island Park Ranger District of the Caribou-Targhee National Forest during 2017. A short segment (<0.2 km) of two-tracked motorized road came under Forest Service ownership when 67 acres of high-priority grizzly bear habitat was purchased by the US Forest Service. Under Forest Service ownership, the newly acquired road in the vicinity of Duck Creek, 10 km west of Henrys Lake, will be gated and closed to public motorized use and only accessible for administrative purposes. In addition to the Duck Creek road, a 0.6-km length of new road was constructed on the northwest side of Henry's Lake to provide access to the Johnson private property inholding. The Johnson property road will be gated with use only by the landowner. Collectively, the increase in motorized access within the Henrys Lake #1 subunit results in a 0.1% increase in TMARD, and a net decrease of approximately 0.1% in secure habitat. In this particular case, no mitigation is required for the loss in secure habitat because resulting secure levels remain above baseline levels. Likewise, no mitigation is required for roads obtained through a land acquisition.

| Bear management subunit | % OMARD (subunit % > 1 miles / mile$^2$) | | | % TMARD (subunit % > 2 miles / mile$^2$) | | | % Secure Habitat | | | Area (miles$^2$) (excluding major lakes) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Subunit | Secure Habitat | |
| | 1998 | 2017 | % chg | 1998 | 2017 | % chg | 1998 | 2017 | % chg | | 1998 | 2017 |
| Bechler/Teton | 17.0 | 17.0 | -0.1 | 5.8 | 5.8 | 0.1 | 78.1 | 78.1 | 0.0 | 534.3 | 417.0 | 417.2 |
| Boulder/Slough #1 | 3.2 | 3.3 | 0.0 | 0.3 | 0.4 | 0.1 | 96.6 | 96.6 | 0.1 | 281.9 | 272.2 | 272.4 |
| Boulder/Slough #2 | 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 | 11.5 | 11.4 | -0.1 | 5.3 | 6.1 | 0.8 | 88.3 | 88.6 | 0.4 | 219.9 | 194.1 | 194.9 |
| Buffalo/Spread Creek #2 | 15.6 | 16.0 | 0.5 | 12.7 | 9.2 | -3.5 | 74.3 | 74.4 | 0.1 | 507.6 | 377.2 | 377.5 |
| Crandall/Sunlight #1 | 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 | 16.6 | 16.0 | -0.6 | 11.7 | 9.6 | -2.1 | 82.3 | 82.7 | 0.4 | 316.2 | 260.3 | 261.5 |
| Crandall/Sunlight #3 | 19.2 | 18.5 | -0.6 | 10.6 | 9.1 | -1.5 | 80.4 | 81.2 | 0.8 | 221.8 | 178.3 | 180.1 |
| Firehole/Hayden #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 | 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 | 2.5 | -1.0 | 0.5 | 0.1 | -0.4 | 96.3 | 97.0 | 0.7 | 127.7 | 122.9 | 123.9 |
| Gallatin #2 | 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 | 27.4 | -18.5 | 22.9 | 12.5 | -10.4 | 55.3 | 72.5 | 17.2 | 217.6 | 120.2 | 157.7 |
| Hellroaring/Bear #1 | 23.1 | 18.4 | -4.7 | 15.8 | 12.1 | -3.7 | 77.0 | 80.4 | 3.4 | 184.7 | 142.2 | 148.5 |
| Hellroaring/Bear #2 | 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 | 31.2 | 31.2 | 0.0 | 45.4 | 46.0 | 0.6 | 191.2 | 86.8 | 88.0 |
| **Henry's Lake #2 *** | 49.9 | 40.6 | -9.4 | 35.2 | 28.3 | -6.9 | 45.7 | 51.8 | 6.1 | 140.2 | 64.1 | 72.6 |
| Hilgard #1 | 29.0 | 13.3 | -15.7 | 15.3 | 4.4 | -10.9 | 69.8 | 83.1 | 13.4 | 201.2 | 140.3 | 167.2 |
| Hilgard #2 | 21.0 | 16.1 | -4.9 | 13.6 | 4.6 | -8.9 | 71.4 | 80.2 | 8.8 | 140.5 | 100.4 | 112.7 |
| Lamar #1 | 9.9 | 9.7 | -0.1 | 3.8 | 4.0 | 0.2 | 89.4 | 89.9 | 0.5 | 299.9 | 268.1 | 269.6 |
| Lamar #2 | 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 | 29.5 | 20.3 | -9.2 | 12.5 | 7.5 | -5.0 | 71.5 | 80.7 | 9.2 | 227.9 | 162.9 | 183.9 |
| **Madison #2 *** | 33.7 | 32.0 | -1.7 | 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 | 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 | 0.4 | 0.4 | 0.0 | 94.1 | 94.1 | 0.0 | 251.6 | 236.7 | 236.7 |

| Bear management subunit | % OMARD (subunit % > 1 miles / mile²) | | | % TMARD (subunit % > 2 miles / mile²) | | | % Secure Habitat | | | Area (miles²) (excluding major lakes) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Subunit | Secure Habitat | |
| | 1998 | 2017 | % chg | 1998 | 2017 | % chg | 1998 | 2017 | % chg | | 1998 | 2017 |
| Plateau #1 | 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 | 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 | 1.1 | 1.0 | -0.1 | 98.5 | 98.5 | 0.1 | 122.2 | 120.3 | 120.4 |
| Shoshone #2 | 1.3 | 1.1 | -0.2 | 0.7 | 0.6 | -0.2 | 98.8 | 99.0 | 0.1 | 132.4 | 130.9 | 131.0 |
| Shoshone #3 | 3.9 | 2.8 | -1.1 | 2.1 | 1.5 | -0.6 | 97.0 | 97.8 | 0.8 | 140.7 | 136.5 | 137.6 |
| Shoshone #4 | 5.3 | 5.3 | 0.0 | 2.9 | 2.7 | -0.2 | 94.9 | 94.9 | 0.0 | 188.8 | 179.1 | 179.1 |
| South Absaroka #1 | 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 | 99.9 | 99.9 | 0.0 | 190.6 | 190.3 | 190.3 |
| South Absaroka #3 | 2.4 | 2.4 | 0.0 | 2.7 | 1.7 | -1.1 | 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 | 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 | 100.0 | 100.0 | 0.0 | 180.1 | 180.1 | 180.1 |
| Two Ocean/Lake #1 | 3.5 | 3.6 | 0.2 | 0.3 | 0.5 | 0.2 | 96.3 | 96.3 | 0.0 | 371.9 | 358.3 | 358.2 |
| Two Ocean/Lake #2 | 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 | 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 | 1.1 | 1.1 | 0.0 | 92.0 | 92.0 | 0.0 | 144.1 | 132.6 | 132.6 |
| **PCA mean / total area** | **12.7** | **10.9** | **-1.8** | **6.7** | **5.2** | **-1.5** | **85.6** | **87.0** | **1.4** | **9,025** | **7,724** | **7,855** |

**As of 2016, three subunits (Gallatin #3, Henrys Lake #2, and Madison #2) have new secure habitat baselines established at thresholds achieved with full implementation of the 2006 Gallatin National Forest Travel Management Plan. These 3 subunits were identified in the 2007 Conservation Strategy as needing improved secure habitat levels above 1998 conditions. New baseline thresholds established in 2016 raise the bar for these 3 subunits and supersede 1998 baseline values for secure habitat.*

| **Travel Plan Baselines** (supersedes 1998 thresholds) | | |
|---|---|---|
| **Bear management subunit** | **% Secure habitat baseline** | **Area (mile²) Secure habitat** |
| Gallatin #3 | 70.7 | 153.9 |
| Henrys Lake # 2 | 51.7 | 72.5 |
| Madison #2 | 67.5 | 100.9 |

**Temporary Changes to Secure Habitat, 2017**

Reductions in secure habitat below 1998 baseline levels are allowed on a temporary basis inside the PCA when associated with authorized Federal projects. In these cases, adherence to the one percent application rule and other provisions established to consolidate and reduce detrimental effects must be met. The one percent rule states that any temporary loss of secure habitat below baseline values within a given BMU cannot exceed 1% of the total acreage of the largest subunit within that BMU. Application rules allow only one temporary project to be active in a particular subunit at any given time. During 2017 only 1 project involving temporary reductions in secure habitat was operational inside the PCA and a second project was brought to closure (Table A5). Below is a brief summary of these three Forest Service projects.

***North Island Park Wildland Urban Interface (NIPWUI):*** The NIPWUI project was initiated in 2017 to reduce hazardous fuels on public lands interfacing with private lands near Henrys Lake Reservoir in the north portion of the Ashton-Island Park Ranger District on the Caribou-Targhee National Forest. The NIPWUI project authorized two separate timber harvest sales (Meadow Creek and Bighorn) in the two Henry Lakes bear management subunits. The Meadow Creek timber sale entailed construction of approximately 0.6 km of temporary roads during 2017 in each of the two subunits of the Henrys Lake BMU. Due to the configuration of project roads with respect to existing roads within close proximity, there was no measurable reduction in secure habitat in either subunit (Table A5). No temporary roads were constructed in the Bighorn timber units during 2017. All temporary roads and skid trails associated with the NIPWUI project will be completely obliterated and the landscape restored after timber harvesting activities are completed.

***Beem Gulch and Company Timber Sales:*** The *Beem Gulch and Company* timber sales were both authorized for the Crandall-Sunlight #3 subunit on the Shoshone National Forest as part of the *Sunlight Vegetation Project* decision. Both sales were within close proximity of each other and were therefore considered part of the same timber project. The Beem Gulch Timber Sale was opened in December 2012, and although most harvesting activities were completed in 2013, Forest Service Road 101.7B was reconstructed and left open to provide access for firewood piles to be sold. This road in the Little Sunlight Creek area was closed by ripping and installing water bars in 2017. Activity with the Company Timber Sale was initiated in 2015 and logging activities were completed in 2016. Final closure and restoration operations associated with the Beem Gulch and Company timber sales was completed in 2017.

***Table A5.*** *Secure habitat affected by temporary projects inside the Primary Conservation Area, 2017*

| Project Name and National Forest | BMU Subunit | Secure Habitat (miles$^2$) | | | | | Project Status 2017 |
|---|---|---|---|---|---|---|---|
| | | Allowed change below Baseline [a] | Baseline | 2017 without project | 2017 with project | Area affected [b] | |
| NIPWUI Project Caribou-Targhee N.F. | Henrys Lake #1 | 1.9 | 86.8 | 88.0 | 88.0 | 0 | Active |
| | Henrys Lake #2 | | 72.5 [c] | 72.6 | 72.6 | | |
| Beem Gulch-Company Bridger-Teton N.F. | Crandall-Sunlight #3 | 3.2 | 178.3 | 180.1 | 180.1 | 0 | Closed |

[a]The maximum allowed temporary reduction in secure habitat below baseline is 1% of the area of the largest subunit within the BMU. [b]The area affected is the amount of secure habitat that is temporarily lost due to road construction associated with a project.
[c]Secure habitat baseline value for Henrys Lake #2 is based on 2006 Gallatin Travel Plan conditions rather than 1998 conditions.

## Literature Cited


Bjornlie, D.D., F.T. van Manen, M.R. Ebinger, M.A. Haroldson, D.J. Thompson, and C.M. Costello. 2014. Whitebark pine, population density, and home-range size of grizzly bears in the Greater Yellowstone Ecosystem. PloS ONE doi 10.1371/journal.pone.0088160.

Costello, C.M., F.T. van Manen, M.A. Haroldson, M.R. Ebinger, S.L. Cain, K.A. Gunther, and D.D. Bjornlie. 2014. Influence of whitebark pine decline on fall habitat use and movements of grizzly bears in the Greater Yellowstone Ecosystem. Ecology and Evolution 4:2004–2018.

Costello, C.M, S. Cain, S. Pils, L. Frattaroli, M.A. Haroldson, and F.T. van Manen. 2016. Diet and macronutrient optimization in wild ursids: a comparison of grizzly bears with sympatric and allopatric black bears. PLoSONE doi:10.1371/journal.pone.0153702.

Ebinger, M. R., M A. Haroldson, F. T. van Manen, C. M. Costello, D. D. Bjornlie, D. J. Thompson, K. A. Gunther, J. K. Fortin, J. E. Teisberg, S. R. Pils, P. J. White, S. L. Cain, and P. C. Cross. 2016. Detecting grizzly bear use of ungulate carcasses using global positioning system telemetry and activity data. Oecologia 181:695–708.

Federal Register. 2016. Endangered and threatened wildlife and plants; removing the Greater Yellowstone Ecosystem population of grizzly bears from the Federal List of Endangered and Threatened Wildlife, Proposed Rule (March 11, 2016). FR 81:13174–13227. U.S. Fish and Wildlife Service, Department of the Interior. (https://www.gpo.gov/fdsys/pkg/FR-2016-03-11/pdf/2016-05167.pdf)

Gunther, K.A., R. Shoemaker, K. L. Frey, M. A. Haroldson, S.L. Cain, F.T. van Manen, and J. Fortin. 2014. Diet breadth of grizzly bears in the Greater Yellowstone Ecosystem. Ursus 25:60–72.

Interagency Grizzly Bear Study Team. 2013. Response of Yellowstone grizzly bears to changes in food resources: a synthesis. Report to the Interagency Grizzly Bear Committee and Yellowstone Ecosystem Subcommittee. Interagency Grizzly Bear Study Team, U.S. Geological Survey, Northern Rocky Mountain Science Center, Bozeman, Montana, USA. (http://igbconline.org/wp-content/uploads/2016/02/131202_IGBST_FoodSynReport.pdf)

Schwartz, C.C., J.K. Fortin, J.E. Teisberg, M.A. Haroldson, C. Servheen, C.T. Robbins, and F.T. van Manen. 2014. Body and diet composition of sympatric black and grizzly bears in the Greater Yellowstone Ecosystem. Journal of Wildlife Management 78:68–78.

Schwartz, C.C., J. Teisberg, J. Fortin, M.A. Haroldson, C. Servheen, C. Robbins, and F.T. van Manen. 2014. Use of isotopic sulfur to determine whitebark pine consumption by Yellowstone bears: a reassessment. Wildlife Society Bulletin 38:182–187.

U.S. Department of Agriculture Forest Service. 2006. Forest plan amendment for grizzly bear habitat conservation for the greater Yellowstone area National Forests final environmental impact statement, Record of Decision. 63 pp. (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5187774.pdf)

U.S. Fish and Wildlife Service. 2016. Conservation strategy for the Grizzly bear in the Greater Yellowstone Area. (http://igbconline.org/wp-content/uploads/2016/03/161216_Final-Conservation-Strategy_signed.pdf)

van Manen, F.T., M.A. Haroldson, D.D. Bjornlie, M.R. Ebinger, D.J. Thompson, C.M. Costello, and G.C. White. 2016. Density dependence, whitebark pine, and vital rates of grizzly bears. Journal of Wildlife Management 80:300–313.

# Appendix B

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship and Science

# Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

*2017 Annual Report*

Natural Resource Data Series NPS/GRYN/NRDS—*in press*

# Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem

## *2017 Annual Report*

Natural Resource Data Series NPS/GRYN/NRDS—*in press*

Authors

Greater Yellowstone Whitebark Pine Monitoring Working Group
Bozeman, Montana 59715

Prepared by

Erin Shanahan
Greater Yellowstone Inventory and Monitoring Network
National Park Service
2327 University Way, Suite 2
Bozeman, Montana 59715

Editor

National Park Service
Flagstaff, AZ

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner.

Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols. This report received formal peer review by subject-matter experts who were not directly involved in the collection, analysis, or reporting of the data, and whose background and expertise put them on par technically and scientifically with the authors of the information.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, U.S. Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the U.S. Government.

This report is available from https://science.nature.nps.gov/im/units/gryn/index.cfm (accessed April 23, 2018) and the Natural Resource Publications Management website (https://www.nature.nps.gov/publications/nrpm/; accessed April 23, 2018). To receive this report in a format optimized for screen readers, please email irma@nps.gov.

Please cite this publication as:

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2018. Monitoring whitebark pine in the Greater Yellowstone Ecosystem: 2017 annual report. Natural Resource Data Series NPS/GRYN/NRDS—*in press*. National Park Service, Fort Collins, Colorado.

# Appendix C

**2017 BEAR WISE WYOMING PROJECT UPDATE**

## Introduction

The Bear Wise Community Wyoming Program is a proactive initiative that seeks to minimize human-bear (black and grizzly) conflicts, minimize management-related bear mortalities associated with preventable conflicts, and to safeguard human communities in northwest Wyoming. The overall objective of Bear Wise is to promote individual and community ownership of ever-increasing human-bear conflict issues, moving toward creating a social conscience regarding responsible attractant management and behavior in bear habitat. This project seeks to raise awareness and proactively influence local waste management infrastructures with the specific intent of preventing conflicts from recurring. Strategies used to meet the campaign's objectives are: 1) minimize accessibility of unnatural attractants to bears in developed areas; 2) employ a public outreach and education campaign to reduce knowledge gaps about bears and the causes of conflicts; and 3) employ a bear-resistant waste management system and promote bear-resistant waste management infrastructure.

This report provides a summary of program accomplishments in 2017. Past accomplishments are reported in the 2006–2016 annual reports of the Interagency Grizzly Bear Study Team (IGBST) and in the 2011–2016 Annual Job Completion Reports of the Wyoming Game and Fish Department (WGFD).

## Background

In 2004, a subcommittee of the IGBST conducted an analysis of causes and spatial distribution of grizzly bear mortalities and conflicts in the Greater Yellowstone Ecosystem (GYE) for the period of 1994–2003. The analysis identified that the majority of known, human-caused grizzly bear mortalities occurred due to agency management actions in response to conflicts (34%), self-defense killings, primarily by big game hunters (20%), and vandal killings (11%). The report made 33 recommendations to reduce human-grizzly bear conflicts and mortalities with focus on 3 actions that could be positively influenced by agency resources and personnel: 1) reduce conflicts at developed sites; 2) reduce self-defense killings; and 3) reduce vandal killings (Servheen et al. 2004).

To address action number 1, the committee recommended that a demonstration area be established to focus proactive, innovative, and enhanced management strategies where developed site conflicts and agency management actions resulting in relocation or removal of grizzly bears had historically been high. Spatial examination of conflicts identified the Wapiti area in northwest Wyoming as having one of the highest concentrations of black bear and grizzly bear conflicts in the GYE. The North Fork of the Shoshone River west of Cody was then chosen as the first area composed primarily of private land to have a multi-agency/public approach to reducing conflicts at developed sites.

In 2005, the Department began implementation of the Bear Wise Community Program. Although the program's efforts were focused primarily in the Wapiti area, the Department initiated a smaller scale project in Teton County to address the increasing number of black and grizzly bear conflicts in the Jackson, Wyoming area. For the last 12 years, the Bear Wise Community Programs in Northwest Wyoming have deployed a multi-faceted education and outreach campaign in an effort to minimize human-bear conflicts and promote proper attractant management. Although a wide array of challenges remain and vary between communities, many accomplishments have been made and progress is expected to continue as Bear Wise efforts gain momentum. In an effort to broaden the scope of the program, this work was rebranded as the Bear Wise Wyoming Program.

**Wapiti Project Update**

The Wapiti Bear Wise Community Program continues to use radio, television and print media, mass mailings, and the use of signing on private and public land to convey the educational messages surrounding human-bear conflict prevention. Conflict prevention information is also disseminated through public workshops and presentations and by contact with local community groups, governments, the public school system, and various youth organizations. To compliment educational initiatives, the program uses an extensive outreach campaign that assists the community in obtaining and utilizing bear-resistant products and implementing other practical methods of attractant management. Ongoing efforts and new accomplishments for 2017 are as follows:

- The Carcass Management Program continues to provide a domestic livestock carcass removal service for livestock producers located in occupied grizzly bear habitat within Park County, Wyoming. The program has been traditionally funded by the Park County Predator Management District and Wyoming Animal Damage Management Board. In addition to those donors, the program received contributions from Park County Commissioners, Wyoming Outdoorsmen, and the Memorial Bear Fund. The program provides livestock producers and owners with an alternative to the use of on-site carcass dumps, which are a significant bear attractant and indirectly contribute to numerous human-bear conflicts. Since June 2008, 978 domestic livestock carcasses have been removed from private lands.

- Recommendations concerning the proper storage of garbage and other attractants are provided to the Park County Planning and Zoning Commission for new developments within the greater Cody area. The Coordinator reviews proposed developments on a case-by-case basis, attends monthly meetings, and contacts applicants directly to discuss conflict prevention measures. To date, these comments have been adopted as either formal recommendations or as a condition of approval for 22 new developments within Park County.

- In the Cody Region, Large Carnivore Section personnel erected 19 temporary electric fences around bee apiaries to minimize conflicts. There were also several electric fences temporarily placed around apple orchards and other larger seasonal attractants to deter bear conflicts.

- Our Bear Wise Wyoming Coordinator filmed an interview for Eastman's Hunting TV discussing how to safely recreate and hunt in bear country in addition to stressing proper game retrieval techniques in bear country. The two part episode aired in December and had large viewership on the Outdoor Channel.

- In the spring, Large Carnivore Section personnel conducted 11 "Living in Large Carnivore Country" workshops across Wyoming. The objective of these workshops is to reach out to the public and give them the opportunity to learn how to live with bears, mountain lions, and wolves. In 2017 we gave presentations and hands-on demonstrations to 187 attendees.

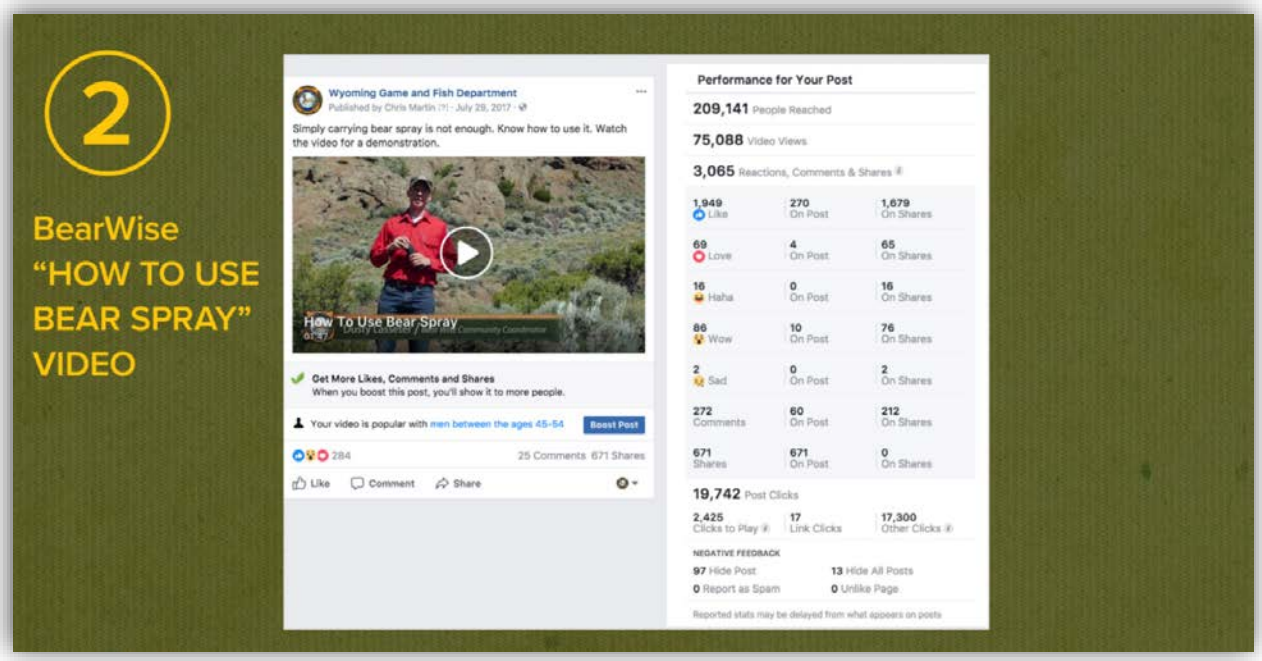
- This year with grants from Wyoming Outdoorsmen, Bowhunters of Wyoming, Rocky Mountain Elk Foundation, and Western Bear Foundation the Department was able to purchase 200 cans of bear spray to be distributed to sportsmen. Hundred cans of bear spray were distributed to licensed hunters at the Cody Wyoming Game and Fish Check Station and 100 cans were distributed similarly at Jackson Hole and Greater Yellowstone Visitor Center. Sportsmen were asked to voluntarily fill out a short survey to gather a better understanding how the Bear Wise program can better meet constituent needs.


- A public service announcement (PSA) was recorded by WGFD personnel on "Staying Safe in Bear Country" and broadcast over the radio in the spring of 2017 on the Bighorn Basin Radio Network. Large Carnivore Section personnel also participated in several radio interviews.

- Grant funding was secured to erect a permanent electric fence around the Park County Landfill. Funding came from Wyoming Outdoorsmen, Bureau of Land Management, Park County Commissioners, and the Greater Yellowstone Coalition. The electric fence will be installed in early 2018, with help from Western Bear Foundation volunteers removing the existing fence.

- After completing several short video PSAs about recreating in bear country, they were used on the Department Facebook page. In 2017, 3 of the top 10 viewed Facebook posts were Bear Wise PSAs that we created, resulting in thousands of individuals viewing these proactive announcements to reduce the potential for conflicts.

- Educational black bear/grizzly bear identification materials were distributed to individuals and to local sporting goods stores in the Cody, Pinedale, and Lander areas and mailed to black bear hunters who registered bait sites with the Department in areas surrounding the GYE.




- Numerous informational presentations were given that focused on human-bear conflict prevention to audiences including the Park, Fremont, Hot Springs, and Big Horn County public school systems, homeowners associations, Boy Scouts, 4-H members, DANO Youth Camp (named after Danny (Dano) Ostrum), Paint Rock Hunter Management Program, guest ranches, and college students. Frequent one-on-one contacts were made during the 2017 conflict season in areas where the occurrence of human-bear conflicts has historically been high.

- A "Working Safely in Bear Country" workshop was conducted for the Park County Weed and Pest District, Bureau of Land Management, West Park Hospital, 307 Health Center, Rocky Mountain Power, and Bighorn Forest Service employees.

- A booth containing information on bear identification, attractant storage, hunting and recreating safely in bear country, and the proper use of bear spray was staffed at the Lander Winter Fair, Cody RV Show, Dubois Museum Days, Powell Outdoor Safety Day, and Wyoming Outdoorsmen Banquet.

- By using the bear trailer, bear safety booths, educational workshops, and giving 45 additional requested presentations, the Bear Wise program directly reached approximately 3,500 people in northwest Wyoming. While the level of interaction differed from person to person it added awareness to public on bear safety and proactive measures to lessen conflicts. Efforts such as these also stimulate discussions among different segments of the public regarding bear safety and conflict resolution.

- A seasonal mailing containing human-bear conflict prevention information and the availability of conflict prevention resources was delivered to residents in and around Dubois.


*Large Carnivore Section personnel meet with the public at Pinedale's Rendezvous Days.*

- The new 2017 Antelope, Deer, and Elk hunting regulations have a section on being Bear Aware. Specifically, there is information regarding game retrieval and handling, how to react to an aggressive/defensive bear encounter, how to properly use bear spray, and what to do if a bear comes into camp.

- Western Bear Foundation received a grant to put in 4 bear boxes for campsites in occupied bear habitat. The bear boxes were put on Game and Fish commission managed lands to prevent human-bear conflicts and provide campers with the means to securely store attractants. Department personnel volunteered time in kind to properly place the bear boxes.

*Joe Kondelis from Western Bear Foundation and Miles Proctor from WGFD Habitat and Access mix cement to place a bear box.*

**Pinedale Area Update**

In 2011, a Bear Wise Community effort was initiated targeting residential areas north of Pinedale, where human-bear conflicts have increased in recent years. Accomplishments for the Pinedale area in 2017 are:

- The Department hosted a "Living in Lion, Bear, and Wolf Country" workshop in Pinedale. Approximately 15 people attended the workshop.

- Bear safety presentations were given to the Boy Scouts of America at "Camp Newfork".

- Presented bear safety and carnivore biology information at Pinedale Science Camps at Green River Lake.

- Hunting in Bear Country presentations were given to hunter safety classes throughout the Region.

- Multiple bear safety presentations were given to a variety of constituents in the Pinedale area: staff members of the Sublette County Chamber of Commerce and Sublette County Visitor's Center, Pinedale and Big Piney Ranger District United States Forest Service Personnel and the Pinedale office of the Bureau of Land Management, Sublette County weed and pest personnel, Search and Rescue volunteers, and multiple other discussions with livestock producers and recreationists of bear habitat.

- The Department hosted a bear safety booth at Pinedale's Rendezvous Days Celebration,

contacting hundreds of participants over a 3-day period. Pinedale's Rendezvous Days attracts approximately 10,000 people over the 4-day event and Department employees contact an estimated 1,000 constituents.

- Large Carnivore Section personnel hosted a bear booth at the Sublette County Conservation District's "Spring Expo" and reached approximately 200 people.

**Jackson Hole Project Update**

The Bear Wise Jackson Hole program continues educational and outreach initiatives in an effort to minimize human-bear conflicts within the community of Jackson and surrounding areas. In 2016, the program's public outreach and educational efforts included the use of signage, public workshops and presentations, distribution of informational pamphlets, promoting awareness about bear spray, carcass and fruit tree management, and utilizing our bear education trailer.

- A bear education trailer was purchased in August 2010 with funding contributions from the Department, Grand Teton National Park, Bridger Teton National Forest and Jackson Hole Wildlife Foundation. Two bear mounts (1 grizzly bear and 1 black bear) have been placed in the trailer along with other educational materials. The bear mounts were donated to the Department through a partnership with the United States Taxidermist Association and the Center for Wildlife Information. The trailer was displayed and staffed at various events and locations including Teton National Park, Jackson Elk Fest, Fourth of July Parade and the National Elk Refuge Visitor Center.

- Public service announcements were broadcast on 4 local radio stations in Jackson for a total of 6 weeks throughout the spring, summer, and fall of 2016. The announcements focused on storing attractants so they are unavailable to bears and hunting safely in bear country.

- Numerous educational talks were presented to various groups including homeowner's associations, guest ranches, youth camps, Jackson residents, tourists, school groups and Teton County employees.

- Door flyers with detailed information about attractant storage and bear conflict avoidance were distributed in Teton County residential areas where high levels of bear/human conflicts were occurring.

- A considerable amount of time was spent removing ungulate and livestock carcasses from residential areas and ranches in the Jackson Region.

- Worked with the residents at a north Jackson subdivision and a property management company to pick apples from 70 crab apple trees that were a significant bear attractant.

- Refrigerator magnets featuring tips about proper attractant management were distributed to Teton Village homeowners, Aspens Property Management and Jackson Hole Mountain Resort lodging.

- Numerous personal contacts were made with private residents in Teton County. This has proven to be a useful way to establish working relationships with residents and maintain an exchange of information about bear activity in the area.

- A booth containing information on bear identification, attractant storage, hunting and recreating safely in bear country, and the proper use of bear spray was staffed at the Jackson Hole Antler Auction and Kids Fishing Day.

- Assisted hunting outfitters and with the installation and maintenance of electric fence systems around their field camps and located in the Bridger-Teton National Forest.

- Assisted Teton County Transfer Station staff with the installation and maintenance of an electric fence enclosure around their dead animal pit.

- Assisted an apiary owner with the installation and maintenance of an electric fence around his bee hives.

- Assisted the Wyoming Game and Fish Department's Fisheries Division with the installation of two electric fences around their field camps at Brooks Lake.

- Signage detailing information on hunting safely in bear country, bear identification, recent bear activity, and proper attractant storage were placed at USFS trailheads and in private residential areas throughout Teton County.

- Consultations were conducted at multiple businesses and residences where recommendations were made regarding sanitation infrastructure and compliance with the Bear Conflict Mitigation and Prevention Land Development Regulations.

- Bear Aware educational materials were distributed to campground hosts in the Caribou-Targhee National Forest, hunters, and numerous residents in Teton County.

- Several radio and newspaper interviews were conducted regarding conflict prevention in the Jackson area.

- Educational black bear/grizzly bear identification materials were distributed to black bear hunters who registered bait sites with the Wyoming Game and Fish Department in the Jackson region.

- Worked with a Jackson sanitation company and the Jackson Hole Wildlife foundation on placing new bear resistant garbage cans at Teton Village homes.

**Continuing Efforts**

Objectives for 2018 include continued expansion of the program into other areas of the state where human-bear conflicts continue to be a chronic issue and the continuation of current educational and outreach efforts in the Cody area with specific focus on areas that have not adopted proper attractant management methods. The Department is also working to assist the U.S. Forest Service with providing bear proof storage and meat poles at targeted areas in the Region.

The Wapiti and Pinedale area Bear Wise Community programs face the ongoing challenges of: 1) the absence of ordinances, regulations, or laws prohibiting the feeding of bears; 2) limited educational opportunities and contact with portions of the community due to a large number of summer-only residents and the lack of organized community groups and; 3) decreased public tolerance for grizzly bears due to record numbers of human-bear conflicts. The future success of the Bear Wise program lies in continued community interest and individual participation in proper attractant management.

Objectives for the Bear Wise Jackson Hole program in 2018 will be focused on supporting Teton County and local waste management companies with projects that will help disseminate information and achieve compliance with the recently adopted Teton County Bear Conflict Mitigation and Prevention Land Development Regulations. In addition, more work will be done to identify areas within the city limits of Jackson and Star Valley communities where better attractant management and sanitation infrastructure is needed.

The recent implementation of the Teton County Bear Conflict Mitigation and Prevention Land Development Regulations has greatly reduced the amount of available attractants on the landscape and is a tremendous step forward for the Bear Wise Jackson Hole program. The new challenges faced by the Department will be achieving full compliance with this regulation, even in years with low conflict when it may appear that conflict issues are resolved. The Bear Wise Jackson Hole Program will convey the importance of compliance and strive to maintain public support for the Land Development Regulations through public outreach and education projects. In order for the Jackson program to be successful, the program must continually identify information and education needs within the community while being adaptive to changing situations across different geographic areas. This will require the Department to coordinate with other government agencies and local non-government organizations working across multiple jurisdictions to develop a uniform and consistent message. If this level of coordination is achieved, the Department will be more effective in gaining support and building enthusiasm for Bear Wise Jackson Hole, directing resources to priority areas, and reaching all demographics.

**Literature Cited**

Servheen C., M. Haroldson, K. Gunther, K. Barber, M. Bruscino, M. Cherry, B. DeBolt, K. Frey, L. Hanauksa-Brown, G. Losinski, C. Schwartz, and B. Summerfield. 2004. Yellowstone mortality and conflict reduction report: presented to the Yellowstone Ecosystem Subcommittee (YES) April 7, 2004

**Information and Education**

**2017 Accomplishments**

1) Electronic and Print Media
   a) As per Wyoming Statute, grizzly bear relocation from one county to another must be announced through local media and to the local sheriff of the county into which the bear was relocated. Each announcement is posted in a timely fashion to the web page. In 2017, 15 notifications were distributed and posted on the website.
   b) Personnel issued multiple educational news releases throughout the season informing readers and listeners of bear safety, behavior, conflict avoidance, food storage and natural food availability.
   c) Personnel conducted multiple radio, print, and television interviews regarding bear safety and information on grizzly bear ecology and conservation throughout Wyoming. Information is widely disseminated in this manner.

2) Grizzly Bear Management Web Page
   a) The grizzly bear management web page continues to be maintained and updated on a regular basis in order to provide timely information to the public regarding grizzly bear management

activities conducted by the department. The web page contents include various interagency annual reports and updates and links to other grizzly bear recovery web sites. Based on public comment the Bear Wise Wyoming page has been updated to contain additional information in multiple formats in order to reach the varied stakeholders taking into account the different perceptions and use of media formats in order to reach the widest breadth of the public possible.

b) Beginning April 2017, weekly updates of ongoing management activities related to depredations, research, trapping and monitoring, and information and education were posted to the department's website. A total of 22 weekly updates were posted from April 20, 2017 through October 20, 2017.

3) Hunter Education
   a) Every hunter education class in Wyoming is required to discuss how to hunt safely in bear country. To assist instructors, most have been provided inert bear spray canisters for demonstration purposes and DVDs titled *Staying Safe in Bear Country, A Behavioral Based Approach to Reducing Risk*. A section on bear safety is included in the student manual. Approximately 5,000 students are certified each year.

**Publications**

Data, annual reports, and peer-reviewed literature for the Yellowstone population of grizzly bears are available from IGBST's web site: https://www.usgs.gov/science/interagency-grizzly-bear-study-team?qt-science_center_objects=3#qt-science_center_objects.

For information specific to the Wyoming Game and Fish Department's grizzly bear management program; including links to publications, reports, updates, and plan visit: https://wgfd.wyo.gov/Wildlife-in-Wyoming/More-Wildlife/Large-Carnivore/Grizzly-Bear-Management

For additional information about the Wyoming Bear Wise Program contact:

Bear Wise Coordinator
Dusty Lasseter
(307) 272-1121
dustin.lasseter@wyo.gov