Yellowstone Grizzly Bear Investigations 2021

Annual Report of the Interagency Grizzly Bear Study Team

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YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

Annual Report of the Interagency Grizzly Bear Study Team

2021

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
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2022

IGBST PARTNER WEBSITES

Interagency Grizzly Bear Study Team (U.S. Geological Survey):
https://www.usgs.gov/science/interagency-grizzly-bear-study-team

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

U. S. Forest Service:
https://www.fs.usda.gov/visit/know-before-you-go/bears

Yellowstone National Park and Grand Teton National Park (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:
https://fwp.mt.gov/conservation/wildlife-management/bear

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

Eastern Shoshone and Northern Arapaho Tribal Fish and Game Department:
https://windriver.org/venue/shoshone-arapaho-fish-game/

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Acronyms Used in the Report

AIC_c	Akaike Information Criterion
AM	Animal month
BAU	Bear Analysis Unit
BMS	Bear Management Subunit
BMU	Bear Management Unit
BOA	Bear Observation Area
DMA	Demographic Monitoring Area
ESA	Endangered Species Act
GPS	Global Positioning System
GYE	Greater Yellowstone Ecosystem
GBRZ	Grizzly Bear Recovery Zone
IGBST	Interagency Grizzly Bear Study Team
LCS	Large Carnivore Section
LDR	Lander Development Recommendations
NPS	National Park Service
OMARD	Open Motorized Access Route Density
PCA	Primary Conservation Area
SD	Standard Deviation
TMARD	Total Motorized Access Route Density
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USSES	USDA Sheep Experiment Station
WGFD	Wyoming Game and Fish Department
YCT	Yellowstone cutthroat trout
YES	Yellowstone Ecosystem Subcommittee

INTRODUCTION

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

This Report

This Annual Report summarizes results of grizzly bear (*Ursus arctos*) research and monitoring conducted in the Greater Yellowstone Ecosystem (GYE) by the Interagency Grizzly Bear Study Team (IGBST) during 2021. The research and monitoring program is focused on population estimation and demographics, food monitoring, and habitat monitoring. This report also presents a summary of grizzly bear management actions to address conflict situations and agency outreach efforts. The information presented in this report is a summary of annual data collections. Data, analyses, and summaries presented here supersede those published previously and may be subject to change contingent upon additional information, future publications, and the peer-review process.

Enhancements to Demographic Monitoring

Starting around 2018, we embarked on a multi-year effort to enhance several important aspects of our demographic monitoring program. Specifically, we addressed how counts of female grizzly bears with cubs-of-the-year (females with cubs) from systematic aerial surveys and opportunistic ground sightings are combined with demographic data to derive annual population estimates within the Demographic Monitoring Area, or DMA (Interagency Grizzly Bear Study Team 2021). Colloquially known as the "Chao2 technique," we addressed 2 limitations of the approach. First, as part of the original rule set to assign sightings to unique females with cubs, Knight et al. (1995) used a conservative distance of >30 km as a threshold, resulting in underestimation bias. Using telemetry locations of females with cubs collected during 1997–2019, we created 1,000 datasets for each of 5 levels of simulated number of females with cubs, simulated sightings by selecting among these locations, and evaluated the classification performance of alternative distance criteria (12–30 km). Under all scenarios, 12- to 16-km criteria maximized classification performance and minimized estimation bias; the 16-km criterion was optimal for current conditions and sampling efforts. Our second objective was to test generalized additive models (GAMs) as a flexible trend analysis technique and alternative to a model-averaging technique we have used since 2006 (Harris et al. 2007). We simulated 1,000 time series for each of 10 scenarios (10, 15, and 20% decline over periods of 5, 10, and 15 yrs, plus stability), applied GAMs, and assessed metrics associated with the posterior distribution of the instantaneous rate of change. We detected declines among >99.6% of replicates under the 15 and 20% decline scenarios and in 84.7–94.7% of replicates under the 10% decline scenario. From decline onset to first detection, periods ranged from 3.7 (20% decline over 5 yrs) to 11.1 (10% decline over 15 yrs), with 3.9–8.8 years mean duration of detection events. The GAM approach allows detection of directional changes in population trend, including early warning metrics, and stabilization after such changes.

The IGBST presented these findings to the Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee in 2020 and 2021 and produced a final report in April 2021 (Interagency Grizzly Bear Study Team 2021). These enhancements improved the accuracy of estimates and ability to detect changes in population trend and represents the best available science. As reflected in this report, 2021 represents the first year of IGBST implementation of these enhancements (see "***Estimating Number of Females with Cubs***"). By implementing these enhancements to the Chao2 technique, we note that the correction of underestimation bias due to the conservative distance criterion in the original Knight et al. (1995) rule set results in higher estimate of population abundance.

In addition to the enhancements of the Chao2 estimates, we are collaborating with researchers at the University of Montana to develop integrated population models, or IPMs. A key advancement of IPMs is that we can integrate the full suite of demographic data we collect on an annual basis. For example, besides the revised Chao2 and mark-resight estimates, the IPM approach incorporates known-fate data from radio-monitored bears. An important aspect of IPMs is that the integration of various data sources allows the simultaneous estimation of multiple demographic parameters with greater accuracy and precision. One goal is to explicitly link changes in population size over time with variation in vital rates and associated

environmental variables, thus providing managers with improved techniques for decision making. Additionally, the IPM framework may serve as a tool to examine how data collection can be streamlined or modified to increase the cost-effectiveness of the monitoring program. Prior to the potential implementation of an IPM approach for monitoring the GYE grizzly bear population, rigorous testing and evaluation of model results is essential. This process is nearing completion and our findings will be conveyed to the Yellowstone Ecosystem Subcommittee of the Interagency Grizzly Bear Committee.

Population Monitoring

We follow monitoring protocols and recovery criteria established in the 2017 supplement to the Grizzly Bear Recovery Plan (U.S. Fish and Wildlife Service 2017) and as initially developed under the 2016 Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016). In 2021, the Chao2 estimate based on implementation of the 16-km distance criterion and the GAM in lieu of model averaging was 84 females with cubs (i.e., cubs-of-the-year) within the DMA, from which we derived a total population estimate of 1,063 with a 95% confidence interval of 948 to 1,178 bears (see "***Estimating Number of Females with Cubs***"). This estimate is greater than those presented in previous years, but we emphasize this is a function of the enhancement of the Chao2 technique, as detailed in the previous section and our report (Interagency Grizzly Bear Study Team 2021), not an actual change in the population itself.

Total mortality rates for independent-age (2 years or older) females, independent-age males, and dependent young (cubs or yearlings) were 5.4, 8.1, and 2.5%, respectively. Referencing the total population estimate of 1,063 against mortality thresholds established in Table 2 of the 2016 Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016) as updated based on the 2021 tri-state memorandum of agreement, these estimates are below the corresponding thresholds of 10, 22, and 10%, respectively. Long-term mortality rates are also below these thresholds: retroactive application of the 16-km Chao2 GAM-based estimates indicates that mean total mortality rate for the period 2002–2021 was 5.0% (range = 1.0–7.8%) for independent females and 7.1% (range = 2.9–12.3%) for independent males. These data, particularly when considering the conservative nature of the Chao2 estimates (see section "***Estimating Number of Females with Cubs"***) and additional demographic data, indicate the population status within the DMA remains stable to increasing.

Food Monitoring

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. As we noted in the 2017 Annual Report (van Manen et al. 2018), we are no longer conducting surveys to document availability of winter-kill carcasses of large ungulates. However, we have added a new section to the report to assess ungulate consumption by grizzly bears in Yellowstone National Park (see section "***Grizzly Bear Consumption of Ungulates in Yellowstone National Park"***) and provide online references for herd statistics available through agency websites.

Besides IGBST surveys to index whitebark pine cone production, monitoring 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 the mortality rate in whitebark pine from all causes, including mountain pine beetle (*Dendroctonus ponderosae*).

Habitat Monitoring

In this report we also detail findings from monitoring programs implemented since the 2007 delisting rule: 1) changes in secure habitat, open motorized access route density, and total motorized route density inside the designated Grizzly Bear Recovery Zone (hereafter Recovery Zone; also referred to as the Primary Conservation Area or PCA in the 2016 Conservation Strategy); 2) changes in number and capacity of developed sites inside the Recovery Zone; and 3) changes in number of commercial livestock allotments, changes in the number of permitted domestic sheep animal months inside the Recovery Zone, and livestock allotments with grizzly bear conflicts during the last 5 years (Appendix A).

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 an independent research group responsible for collecting, managing, analyzing, and distributing information. To meet this need, agencies developed a Memorandum of Understanding and formed the IGBST, a science consortium 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 Tribe of the Wind River Reservation, Wyoming, and the Arapaho Tribe of the Wind River Reservation, Wyoming, formally joined the study team in 2009. 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, limits duplication of effort, and pools limited budgetary and personnel resources. Primary responsibilities of the IGBST are to: 1) conduct short- and long-term research projects addressing information needs for grizzly bear management; 2) monitor the grizzly bear population, including status and trend, numbers, reproduction, and mortality; 3) monitor grizzly bear habitats, foods, and impacts from 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 are on the IGBST website: https://www.usgs.gov/science/interagency-grizzly-bear-study-team.

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). Newly published studies reflect our investment into improvements of the monitoring program and continuing collaborations with several academic institutions. The enhancements to the Chao2 estimation technique we mentioned previously were detailed in a comprehensive report published by the IGBST in April 2021, titled "*A reassessment of Chao2 estimates for population monitoring of grizzly bears in the Greater Yellowstone Ecosystem.*" We submitted a corresponding manuscript to the journal *Ursus*, currently in press. In an article titled "*Conservation and management of the culture of bears,*" Kerry Gunther and Chris Servheen delved into the topic of bear culture, defined as behavioral traditions inherited through social learning (typically from mothers to offspring). In many portions of the world, bear culture is influenced by interactions with humans, often to the detriment of bears. The authors use bear management in Yellowstone National Park to demonstrate how long-term management to reduce maladaptive bear cultures related to humans has resulted in healthy bear populations and a low level of human–bear conflict. This finding was revealed in spite of a high number of Yellowstone National Park visitors recreating in close association with bears. Finally, IGBST members continue collaborations on studies relevant to the long-term grizzly bear research and monitoring program, including several studies on American black bears (*Ursus americanus*) on the Northern Range of Yellowstone National Park. Bowersock et al. (2021) used GPS locations of black bears to examine their responses to availability of food resources during spring. Findings indicate that whereas black bear movements were influenced by forage quality of vegetative food resources, they responded more opportunistically to seasonal availability of neonate elk. In a related study, Bowersock et al. (2022) compared characteristics of rub trees used by black and grizzly bears based on genetic analysis of collected hair samples. Few studies have examined rub tree use in areas where 2 bear species are sympatric, and this study provided new insights into this unique behavior.

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BEAR MONITORING AND POPULATION TREND

Marked Animals *(Mark A. Haroldson, Chad Dickinson, and Bryn E. Karabensh, U.S. Geological Survey, Interagency Grizzly Bear Study Team; Jeremy Nicholson, Idaho Department of Fish and Game; and Dan D. Bjornlie, Wyoming Game and Fish Department)*

During the 2021 field season, we captured 110 individual grizzly bears on 123 occasions (Table 1), including 44 females (28 adult), 64 males (42 adult), and 2 bears (1 yearling and 1 subadult) of unknown sex (Table 1). Both bears of unknown sex were captured at research trap sites and were released without handling. Sixty-four (58.2%) of the 110 individual bears were not previously marked. The percent of previously unmarked individual grizzly bears captured annually has remained relatively constant during the period 1998–2021, averaging 62%, with no evidence ($F = 0.260$, 1 df, $P = 0.615$) of a change in trend (Fig. 1). As we have noted in previous reports, this finding continues to support the notion that in this closed population, bears are recruiting into the population at a relatively constant rate. We would expect the number of new bears encountered annually to decline if individuals were not recruiting into the population.

We conducted research trapping efforts for a total of 539 trap days (1 trap day = 1 trap set for 1 day) in the GYE. During research trapping operations we had 49 captures of 41 individual grizzly bears for a trapping success rate of 1 grizzly capture for every 11.0 trap days.

One research capture (Bear #1049) occurred outside the Demographic Monitoring Area (DMA).

In addition to these research trapping efforts, the Wyoming Game and Fish Department (WGFD) conducted aerial capture efforts that resulted in 10 individual grizzly bear captures (5 males, 5 females) (Table 1). Aerial capture work began on June 27 and concluded on June 29, with 7.5 total flight hours. There were 64 management captures of 59 individual bears during 2021 (Tables 1 and 2), including 22 females (10 adults), and 36 males (19 adults), and 1 bear of unknown sex that was released without handling. Outside the DMA, there were 26 management captures of 26 individual (11 females, 14 males, and 1 yearling of unknown sex released without handling) bears. Nineteen individual bears (6 females, 13 males) were relocated because of conflict situations (Table 1). One subadult female (#1041, Table 1) was transported on 2 occasions. Four bears (subadult male #1022, subadult male #1028, subadult female #1043, and subadult male #1048) were removed after previous management capture and relocations attempts (Table 1). In total, there were 37 management captures that resulted in removals (14 females, 23 males) during 2021 (Table 1).

We radiomonitored 120 individual grizzly bears during the 2021 field season, including 60 females, 49 of which were adults (Tables 2 and 3). Seventy grizzly bears entered their winter dens wearing active transmitters. The status of 3 grizzly bears is unknown and will be resolved in 2022. Since 1975, 1,058 individual grizzly bears have been radiomarked in the GYE.

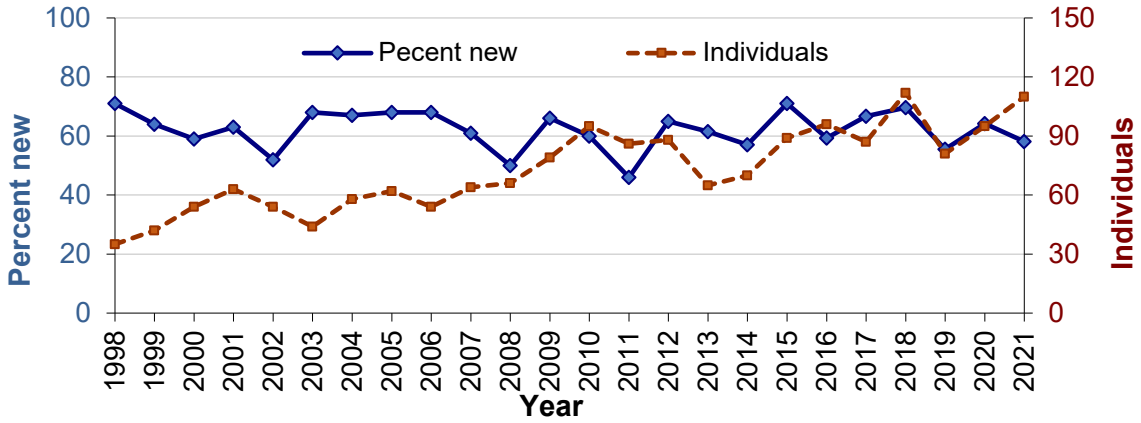

Fig. 1. Annual number of grizzly bears captured and percent previously unmarked individuals in the Greater Yellowstone Ecosystem, 1998–2021.

Table 1. Grizzly bears captured in the Greater Yellowstone Ecosystem, 2021.							
Bear	**Sex**	**Age**	**Date**	**General location[a]**	**Capture type**	**Release site[b]**	**Handler[c]**
202101	Female	Yearling	04/06/21	South Fork Shoshone River, PR-WY	Management	Removed (202101)	WGFD
1020	Male	Adult	04/11/21	Rawhide Crk, PR-WY	Management	Transported	WGFD
449	Male	Adult	04/17/21	Madison River, CGNF	Management	Removed (202104)	MTFWP
1021	Male	Adult	04/26/21	Rawhide Crk, PR-WY	Management	Transported	WGFD
202106	Female	Subadult	05/05/21	Gooseberry Crk, PR-WY	Management	Removed (202106)	WGFD
202107	Male	Subadult	05/05/21	Gooseberry Crk, PR-WY	Management	Removed (202107)	WGFD
1022	Male	Subadult	05/07/21	Snake River, PR-WY	Management	Transported	WGFD
1022	Male	Subadult	05/22/21	Snake River, PR-WY	Management	Removed (202112)	WGFD
202108	Male	Adult	05/11/21	Carbon County, PR-MT	Management	Removed (202108)	WS/MTFWP
639	Male	Adult	05/12/21	Grace Crk, SNF	Research	On site	WGFD
Unm202105	Unk	Yearling	05/13/21	Rock Crk, ST-MT	Management	On site	WS/MTFWP
1023	Male	Subadult	05/14/21	Cougar Crk, SNF	Research	On site	WGFD
885	Male	Adult	05/31/21	Belknap Crk, PR-WY	Research	On site	WGFD
1024	Male	Subadult	06/04/21	Antelope Crk, YNP	Research	On site	IGBST/YNP
1024	Male	Subadult	06/06/21	Antelope Crk, YNP	Research	On site	IGBST/YNP
1024	Male	Subadult	06/26/21	Cascade Crk, YNP	Research	On site	IGBST/YNP
1025	Female	Adult	06/05/21	Timber Crk, BLM-WY	Research	On site	WGFD
202115	Male	Subadult	06/05/21	Grinnell Crk, SNF	Management	Removed (202115)	WGFD
887	Male	Adult	06/06/21	Stephens Crk, YNP	Research	On site	IGBST/YNP
1026	Male	Adult	06/08/21	Rock Crk, SNF	Research	On site	WGFD
1027	Female	Adult	06/09/21	Belknap Crk, PR-WY	Research	On site	WGFD
749	Female	Adult	06/13/21	Stephens Crk, YNP	Research	On site	IGBST/YNP
Unm202107	Unk	Subadult	06/13/21	Gibbon River, YNP	Research	On site	IGBST/YNP
1028	Male	Subadult	06/14/21	Snake River, JDR	Management	Transported	GTNP
1028	Male	Subadult	09/21/21	Snake River, PR-WY	Management	Removed (202146)	WGFD
1029	Male	Subadult	06/15/21	North Fork Shoshone, SNF	Management	Transported	WGFD
981	Female	Subadult	06/16/21	Gibbon River, YNP	Research	On site	IGBST/YNP
Unm202108	Male	Adult	06/16/21	Antelope Crk, YNP	Research	On site	IGBST/YNP
1030	Male	Subadult	06/21/21	North Fork Shoshone, SNF	Management	Transported	WGFD
1031	Female	Adult	06/27/21	Jack Crk, SNF	Research	On site	WGFD
967	Male	Adult	06/27/21	Haymaker Crk, SNF	Research	On site	WGFD
1032	Female	Subadult	06/27/21	Betty Crk, SNF	Research	On site	WGFD
980	Female	Adult	06/28/21	Gibbon River, YNP	Research	On site	IGBST
476	Female	Adult	06/28/21	Boulder Crk, SNF	Research	On site	WGFD
635	Male	Adult	06/28/21	Robinson Crk, SNF	Research	On site	WGFD
1033	Male	Subadult	06/28/21	Gentian Crk, SNF	Research	On site	WGFD
1034	Female	Adult	06/29/21	Greybull River, SNF	Research	On site	WGFD
1035	Female	Adult	06/29/21	Francs Fork, SNF	Research	On site	WGFD
1036	Male	Adult	06/29/21	Anderson Crk, SNF	Research	On site	WGFD
538	Male	Adult	06/29/21	Dundee Crk, SNF	Research	On site	WGFD
881	Male	Adult	06/30/21	Cascade Crk, YNP	Research	On site	IGBST
970	Male	Adult	06/30/21	Cascade Crk, YNP	Research	On site	IGBST
1037	Male	Adult	07/02/21	Henrys Fork, CTNF	Research	On site	IDFG
800	Female	Adult	07/07/21	Slip and Slide Crk, CGNF	Research	On site	IGBST

Table 1. Continued

Bear	Sex	Age	Date	General location[a]	Capture type	Release site[b]	Handler[c]
556	Male	Adult	07/07/21	Henrys Fork, CTNF	Research	On site	IDFG
1038	Female	Subadult	07/10/21	Cream Crk, CGNF	Research	On site	IGBST
1038	Female	Subadult	08/24/21	Jesse Crk, CTNF	Research	On site	IDFG
202119	Male	Adult	07/10/21	Blaine Crk, PR-WY	Management	Removed (202119)	WGFD
906	Female	Adult	07/10/21	Jessie Crk, CTNF	Research	On site	IDFG
1039	Male	Subadult	07/12/21	Tosi Crk, BTNF	Management	Transported	WGFD
1040	Male	Subadult	07/13/21	Gypsum Crk, BTNF	Management	Transported	WGFD
1041	Female	Subadult	07/18/21	Tosi Crk, BTNF	Management	Transported	WGFD
1041	Female	Subadult	08/25/21	Tepee Crk, BTNF	Management	Transported	WGFD
902	Male	Adult	07/21/21	Cottonwood Crk, BDNF	Management	Removed (202122)	WS/MTFWP
886	Female	Adult	07/21/21	Sulfur Crk, PR-WY	Management	Transported	WGFD
G272	Female	Subadult	07/21/21	Sulfur Crk, PR-WY	Management	Transported	WGFD
1042	Female	Adult	07/22/21	Duck Crk, BLM-ID	Management	On site	WS/IDFG
1043	Female	Subadult	07/23/21	South Fork Fish Crk, BTNF	Management	Transported	WGFD
1043	Female	Subadult	10/10/21	Greybull River, PR-WY	Management	Removed (202163)	WGFD
908	Male	Adult	07/24/21	Cream Crk, CGNF	Research	On site	IGBST
202123	Male	Subadult	07/25/21	Badger Crk, PR-WY	Management	Removed (202123)	WGFD
706	Female	Adult	07/26/21	Henrys Fork, CTNF	Research	On site	IDFG
202124	Male	Subadult	07/28/21	Greybull River, PR-WY	Management	Removed (202124)	WGFD
202125	Female	Subadult	07/28/21	Greybull River, PR-WY	Management	Removed (202125)	WGFD
1044	Female	Adult	07/28/21	Crow Crk, WRIR	Research	On site	WGFD
1045	Male	Subadult	07/29/21	Wyoming Crk, CTNF	Research	On site	IDFG
1045	Male	Subadult	08/09/21	Wyoming Crk, CTNF	Research	On site	IDFG
1045	Male	Subadult	08/17/21	Wyoming Crk, CTNF	Research	On site	IDFG
202126	Male	Adult	07/30/21	Squaw Crk, PR-WY	Management	Removed (202126)	WGFD
713	Male	Adult	07/30/21	Bear Crk, CTNF	Research	On site	IDFG
1046	Female	Subadult	07/31/21	Little Twin Crk, BTNF	Management	Transported	WGFD
946	Male	Adult	08/02/21	Gros Ventre River, PR-WY	Management	Removed (202128)	WGFD
566	Male	Adult	08/03/21	Icehouse Crk, ST-ID	Management	Transported	IDFG
782	Male	Adult	08/05/21	Ingals Crk, CTNF	Research	On site	IDFG
898	Female	Adult	08/06/21	Camp Crk, SNF	Management	Removed (202130)	WGFD
913	Female	Adult	08/07/21	Wyoming Crk, CTNF	Research	On site	IDFG
913	Female	Adult	08/13/21	Wyoming Crk, CTNF	Research	On site	IDFG
1047	Male	Adult	08/07/21	Crow Crk, WRIR	Research	On site	WGFD
1048	Male	Subadult	08/07/21	Gros Ventre River, PR-WY	Management	Transported	WGFD
1048	Male	Subadult	08/28/21	Snake River, PR-WY	Management	Removed (202140)	WGFD
1049	Female	Adult	08/08/21	Red Crk, WRIR	Research	On site	WGFD
202131	Male	Adult	08/08/21	Willow Crk, PR-WY	Management	Removed (202131)	WGFD
912	Female	Adult	08/11/21	Eldridge Crk, CGNF	Research	On site	IGBST
202132	Female	Adult	08/11/21	Slab Crk, PR-WY	Management	Removed (202132)	WGFD
531	Female	Adult	08/14/21	Crow Crk, WRIR	Research	On site	WGFD
940	Male	Adult	08/14/21	East Dry Crk, CTNF	Research	On site	IDFG
1050	Male	Adult	08/15/21	Meadow Crk, PR-WY	Management	Transported	WGFD
890	Male	Adult	08/16/21	Wagon Crk, BTNF	Management	Removed	WGFD

Table 1. Continued

Bear	Sex	Age	Date	General location[a]	Capture type	Release site[b]	Handler[c]
1012	Female	Subadult	08/17/21	Bootjack Crk, CTNF	Research	On site	IDFG
202134	Female	Subadult	08/18/21	Fox Crk, BDNF	Management	Removed (202134)	WS
1051	Male	Subadult	08/19/21	Ingals Crk, CTNF	Research	On site	IDFG
202135	Male	Subadult	08/20/21	Warm Spring Crk, PR-WY	Management	Removed (202135)	WGFD
202136	Male	Subadult	08/20/21	Warm Spring Crk, PR-WY	Management	Removed (202136)	WGFD
G269	Male	Subadult	08/21/21	Upper Green, WY	Management	Removed (202137)	WGFD
424	Male	Adult	08/23/21	Ingals Crk, CTNF	Research	On site	IDFG
424	Male	Adult	08/24/21	Ingals Crk, CTNF	Research	On site	IDFG
424	Male	Adult	08/25/21	Ingals Crk, CTNF	Research	On site	IDFG
951	Male	Adult	08/24/21	South Fork Fish Crk, BTNF	Management	Removed (202138)	WGFD
560	Female	Adult	08/25/21	Trout Crk, SNF	Management	Transported	WGFD
G273	Female	cub	08/26/21	Bear Crk, PR-MT	Management	On site	WS/MTFWP
202141	Male	Adult	09/01/21	Meadow Crk, PR-WY	Management	Removed (202141)	WGFD
974	Female	Adult	09/04/21	Middle Fork Owl Crk, BLM-WY	Management	Removed (202143)	WGFD
864	Female	Adult	09/06/21	Bridge Crk, YNP	Research	On site	IGBST
1052	Male	Adult	09/09/21	Cascade Crk, YNP	Research	On site	IGBST
804	Male	Adult	09/09/21	Cascade Crk, YNP	Research	On site	IGBST
1053	Male	Adult	09/11/21	Gypsum Crk, BTNF	Management	Transported	WGFD
202145	Male	Adult	09/15/21	Clarks Fork Yellowstone, PR-WY	Management	Removed (202145)	WGFD
G274	Male	Adult	09/15/21	Arnica Crk, YNP	Research	On site	IGBST
953	Male	Adult	09/22/21	Flat Mountain Crk, YNP	Research	On site	IGBST
202153	Female	Adult	09/27/21	East Fork Wind River, SNF	Management	Removed (202153)	WGFD
1054	Female	Adult	10/02/21	Jasper Crk, YNP	Research	On site	IGBST
1017	Female	Subadult	10/01/21	Snake River, PR-WY	Management	Removed (202159)	WGFD
957	Female	Adult	10/05/21	Carbon County, PR-MT	Management	Removed (202161)	WS/MTFWP
202162	Female	Subadult	10/05/21	Carbon County, PR-MT	Management	Removed (202162)	WS/MTFWP
1055	Male	Adult	10/10/21	Greybull River, PR-WY	Management	Transported	WGFD
962	Female	Adult	10/16/21	Snake River, GTNP	Management	Removed (202166)	GTNP
202167	Male	Adult	10/18/21	Shoshone River, PR-WY	Management	Removed (202167)	WGFD
991	Male	Adult	10/22/21	Squaw Crk, PR-WY	Management	Removed	WGFD
202169	Female	Adult	10/26/21	Meeteetse Crk, PR-WY	Management	Removed (202169)	WGFD
1056	Male	Subadult	10/26/21	Meeteetse Crk, PR-WY	Management	On site	WGFD
1057	Male	Subadult	11/06/21	Snake River, BTNF	Management	On site	IGBST
1058	Male	Subadult	11/06/21	Snake River, BTNF	Management	On site	IGBST
Unm202125	Female	Subadult	11/06/21	Snake River, BTNF	Management	On site	IGBST

[a] BDNF = Beaverhead-Deerlodge National Forest, BLM = Bureau of Land Management, BTNF = Bridger-Teton National Forest, CTNF = Caribou-Targhee National Forest, CGNF = Custer Gallatin National Forest, GTNP = Grand Teton National Park, SNF = Shoshone National Forest, YNP = Yellowstone National Park, WRIR = Wind River Reservation, PR = private.

[b] Numbers in parentheses are assigned mortality numbers.

[c] IDFG = Idaho Department of Fish and Game; IGBST = Interagency Grizzly Bear Study Team, USGS; GTNP = Grand Teton National Park; MTFWP = Montana Fish, Wildlife and Parks; WS = Wildlife Services; WGFD = Wyoming Game and Fish Department; WRIR = Wind River Reservation, YNP = Yellowstone National Park.

Table 2. Annual number of grizzly bears monitored, captured, and transported in the Greater Yellowstone Ecosystem, 1980–2021.

Year	Number monitored	Individuals trapped	Total captures		Transported
			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
2018	106	112	57	72	27
2019	98	81	59	39	16
2020	104	95	72	41	13
2021	120	110	51	59	19

Table 3. Grizzly bears radiomonitored in the Greater Yellowstone Ecosystem, 2020.						
				Monitored		
Bear	Sex	Age	Offspring	Out of den	Into den	Current status
373	M	Adult		Yes	No	Cast
394	M	Adult		No	No	Cast - Died
409	F	Adult	3 cubs	Yes	Yes	Active
424	M	Adult		No	Yes	Active
460	M	Adult		Yes	Yes	Active
476	F	Adult	1 cub, lost	No	Yes	Active
481	F	Adult	2 cubs, 2 lost	Yes	Yes?	Active
499	F	Adult	None	Yes	Yes	Active
531	F	Adult	None seen	No	No	Cast
538	M	Adult		No	No	Cast
556	M	Adult		No	No	Cast
560	F	Adult	None seen	No	Yes	Active
566	M	Adult		No	No	Cast
635	M	Adult		No	No	Cast
639	M	Adult		No	Yes	Active
686	F	Adult	3 cubs, 2 lost (naturally), 1 unknown	Yes	No	Killed
695	M	Adult		Yes	No	Cast
706	F	Adult	3 cubs	No	No	Cast
713	M	Adult		No	No	Cast
727	M	Adult		Yes	No	Cast - died
734	F	Adult	2 cubs	Yes	Yes	Active
747	F	Adult	1 yearling, lost	Yes	Yes	Active
749	F	Adult	None	No	No	Cast
782	M	Adult		No	Yes	Active
800	F	Adult	None	No	Yes	Active
812	M	Adult		Yes	No	Cast
819	M	Adult		Yes	Yes	Active
864	F	Adult	None	No	Yes	Active
881	M	Adult		Yes	Yes	Active
883	F	Adult	None	Yes	Yes	Active
885	M	Adult		No	No	Cast
886	F	Adult	1 cub	No	Yes	Active
887	M	Adult		No	No	Cast
896	F	Adult	2 yearlings	Yes	Yes	Active
899	F	Adult	1 cub	Yes	No	Killed
906	F	Adult	None	No	Yes	Active
908	M	Adult		No	Yes	Active
909	F	Adult	2 2-yr-old, weaned	Yes	No	Cast
911	F	Adult	2 cubs, 2 lost	Yes	Yes	Active
912	F	Adult	None	No	Yes	Active
913	F	Adult	1 yearling, lost	Yes	Yes	Active
914	F	Adult	3 cubs, 3 lost?	Yes	No	Killed
917	M	Adult		Yes	No	Cast
926	F	Adult	2 cubs	Yes	Yes	Active
930	F	Adult	2 cubs	Yes	No	Cast
940	M	Adult		No	Yes	Active
948	F	Adult	3 cubs, 1 lost	Yes	Yes	Active
949	F	Adult	2 cubs	Yes	Yes	Active
952	F	Adult	2 yearlings, 1 lost	Yes	Yes	Active

Table 3. Continued.

Bear	Sex	Age	Offspring	Monitored		Current status
				Out of den	Into den	
953	M	Adult		No	Yes	Active
956	F	Adult	1 yearling	Yes	Yes	Active
962	F	Adult	1 cub, lost	Yes	No	Cast - removed
966	F	Adult	2 cubs, 2 lost	Yes	No	Cast
967	M	Adult		Yes	Yes	Active
969	F	Adult	None	Yes	No	Unknown
970	M	Adult		No	Yes	Active
974	F	Adult	None	Yes	No	Removed
976	F	Adult	1 cub, lost	Yes	Yes	Active
978	M	Adult		Yes	Yes	Probable battery failure
979	F	Adult	2 yearlings	Yes	No	Cast
980	F	Adult	None	Yes	Yes	Active
981	F	Subadult	None	Yes	Yes	Active
991	M	Adult		Yes	No	Removed
992	F	Subadult	None	Yes	No	Cast
994	M	Subadult		Yes	No	Cast
997	M	Adult		Yes	Yes	Active
999	F	Subadult	None	Yes	Yes	Active
1000	M	Subadult		Yes	No	Probable battery failure
1001	F	Subadult	Not observed	No	No	Cast
1002	M	Adult		Yes	No	Cast
1003	F	Adult	2 cubs, 2 lost	Yes	Yes	Active
1007	M	Adult		Yes	Yes	Active
1008	M	Adult		Yes	No	Cast
1009	F	Adult	None	Yes	Yes	Active
1010	M	Adult		Yes	No	Cast
1012	F	Subadult	None	Yes	Yes	Active
1013	F	Adult	1 yearling, lost	Yes	Yes	Active
1016	M	Subadult		Yes	Yes	Active
1017	F	Subadult	None	Yes	No	Removed
1018	F	Adult	1 2-yr-old, weaned	Yes	Yes	Active
1019	M	Adult		Yes	Yes	Active
1020	M	Adult		No	No	Cast
1021	M	Adult		No	No	Cast
1022	M	Subadult		No	No	Removed
1023	M	Subadult		No	Yes	Active
1024	M	Adult		No	Yes	Unknown
1025	F	Adult	None	No	Yes	Active
1026	M	Adult		No	No	Cast
1027	F	Adult	2 yearlings	No	Yes	Active
1028	M	Subadult		No	No	Removed
1029	M	Subadult		No	No	Unknown
1030	M	Subadult		No	Yes	Active
1031	F	Adult	None	No	Yes	Active
1032	F	Subadult	None	No	Yes	Active
1033	M	Subadult		No	Yes	Active
1034	F	Adult	2 yearlings	No	Yes	Active
1035	F	Adult	None	No	Yes	Active
1036	M	Adult		No	No	Cast
1037	M	Adult		No	No	Cast
1038	F	Subadult	None	No	Yes	Active
1039	M	Subadult		No	Yes	Active

Table 3. Continued.

Bear	Sex	Age	Offspring	Monitored		Current status
				Out of den	Into den	
1040	M	Subadult		No	Yes	Active
1041	F	Subadult	None	No	Yes	Active
1042	F	Adult	3 cubs, 3 lost?	No	Yes	Active
1043	F	Subadult	None	No	No	Removed
1044	F	Adult	None	No	Yes	Active
1045	M	Subadult		No	No	Cast
1046	F	Subadult	None	No	Yes	Active
1047	M	Adult		No	No	Cast
1048	M	Subadult		No	No	Removed
1049	F	Adult	None	No	No	Cast
1050	M	Adult		No	Yes	Active
1051	M	Subadult		No	Yes	Active
1052	M	Adult		No	Yes	Active
1053	M	Adult		No	Yes	Active
1054	F	Adult	2 cubs	No	Yes	Active
1055	M	Adult		No	Yes	Active
1056	M	Subadult		No	Yes	Active
1057	M	Subadult		No	Yes	Active
1058	M	Subadult		No	Yes	Active

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

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

Background

Under the 2017 Revised Demographic Criteria for the Greater Yellowstone Ecosystem, which were amended to the Grizzly Bear Recovery Plan (USFWS 1993, USFWS 2017), the 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 2021 findings for counts of unique females with cubs, and the total population estimate derived from numbers of females with cubs observed within the DMA.

Methods

Initially, we used a technique developed by Knight et al. (1995) to estimate the number of unique females with cubs and to tabulate sighting frequencies for each family. An important component of the original rule set was a distance criterion of >30 km to distinguish sightings as belonging to unique females with cubs. Findings from Schwartz et al. (2008), however, indicated the Knight et al. (1995) rule set underestimated the number of unique females with cubs and more so with increasing population size. In 2021, the IGBST conducted a comprehensive reassessment to address this underestimation and used extensive simulation analyses to evaluate a distance criterion that resulted in relatively unbiased estimates of the number of females with cubs (Interagency Grizzly Bear Study Team 2021; "Chao2 reassessment report"). An important outcome of the study was that a 16-km distance criterion resulted in more accurate estimates while minimizing the risk of overestimation; 2021 is the first year where we are implementing this change in the rule set.

Given the number of unique females with cubs observed from aerial and ground-based sightings, we then obtain a nonparametric, bias-corrected estimate (referred to as Chao2, which accounts for individual sighting heterogeneity) of the total number of females with cubs in the population ($\widehat{N}_{Chao2-16\,km}$) (Chao 1989, Wilson and Collins 1992, Keating et al. 2002, Cherry et al. 2007).

We subsequently estimate trend and rate of change (λ) based on the natural log (*Ln*) of the annual $\hat{N}_{Chao2}$ estimates. Here, we made an additional modification to our estimation procedures starting in 2021 by implementing another recommendation from the 2021 Chao2 reassessment report (IGBST 2021): whereas we previously used a model-averaging approach, we now use generalized additive models (GAMs) and first derivative values for trend detection. The GAMs are applied to 3-year moving averages of the raw $\widehat{N}_{Chao2-16\,km}$ estimates, based on recommendations from IGBST (2021:50–51), which reduces bias and increases power to detect change. This process smooths 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). Although some changes in previous estimates for unique females with cubs are expected with each additional year of data, retrospective adjustments to previous estimates are not done (Interagency Grizzly Bear Study Team 2006). Given the assumption of a reasonably stable sex and age structure, the trend for the females with cubs represents the rate of change for the entire population (Interagency Grizzly Bear Study Team 2006, Harris et al. 2007). It follows that estimates for specific population segments can be derived from the total number of females with cubs and the estimated stable age distribution for the population. Estimates for specific population segments and associated confidence intervals follow IGBST (2012), which uses vital rates during 2002–2011 and is based on data from within the DMA.

2021 Sightings of Females with Cubs

We documented 203 verified sightings of females with cubs during 2021 in the GYE. The majority of observations were obtained from aerial sources (64.5%, Table 4). We differentiated 73 unique females with cubs from the 203 sightings using the Knight et al. (1995) rule set with the revised 16-km distance criterion instead of 30-km for estimates of unique females with cubs. Three sightings (1.5%) of 3 unique females occurred outside the DMA (Fig. 2). Two of the females were only observed once outside the DMA. Therefore, we identified 71 unique females with cubs inside the DMA. The third female was initially observed once outside of DMA followed by 2 observations inside DMA. Fifty-one (25.1%)

observations from an estimated 16 unique females with cubs based on 16-km distance criterion occurred within the boundary of Yellowstone National Park.

The total number of cubs observed during initial sightings of the 73 unique females with cubs was 137 and mean litter size was 1.88 (Table 5). There were 23 single cub litters, 36 litters of twins, and 14 litters of triplets (Table 5). Using only the initial sightings of all females with cubs observed within the DMA, there were a total of 134 cubs, with a mean litter size of 1.89.

2021 DMA Chao2 and Population Estimate

Excluding the 3 sightings (3 females) observed outside the DMA and sightings of 7 family groups based on telemetry only, which are not independent observations, we obtained 130 observations of 63 unique families (Table 6) within the DMA. Using the sighting frequencies, our estimate of the number of unique females with cubs within the DMA was $\hat{N}_{DMAChao2-16\,km}$ = 84. Applying the generalized additive model to Chao2 estimates based on the 16-km distance criterion for the time series 1997–2021 to account for trend, the estimate was $\hat{N}_{GAM}$= 84 females with cubs (95% CI = 77–92), by coincidence the same as the raw Chao2 estimate. This estimate exceeds the demographic criterion of a minimum of 48 females with cubs within the DMA, as specified in the 2017 Revised Demographic Criteria (USFWS 2017). Applying the 2002–2011 vital rates to the $\hat{N}_{GAM}$-produced estimates of the 3 primary population segments and a total population estimate for the DMA of 1,063 (Table 7).

Using GAMs, we applied the annual $\hat{N}_{Chao2-16\,km}$ estimates for the DMA during the period 2001–2021 (Table 6) to evaluate the trend for the female with cubs segment of the population (Fig. 3). We documented statistically significant positive population growth for 2021, as largely has been the case since 2002, with the exception of 2017–2019 (Fig. 3). Based on the first derivative (rate of change), the probability of population growth was 98%.

Table 4. Method of observation for female grizzly bears with cubs sighted in the Greater Yellowstone Ecosystem, 2021.

Method of observation	Frequency	%	Cumulative %
Fixed wing aircraft–incidental	13	6.4	6.4
Fixed wing aircraft–observation flight	41	20.2	26.6
Fixed wing aircraft–telemetry flight	75	36.9	63.5
Fixed wing aircraft–ferry time	0	0	63.5
Helicopter–other researcher	2	1.0	64.5
Ground sighting	68	33.5	98.0
Trap	4	2.0	100
Total	203	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 using the Knight et al. (1995) rule set with the revised 16-km distance criterion for differentiating unique females with cubs, Greater Yellowstone Ecosystem, 2020–2021.

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		
2020	72	234	17	44	10	1	139	1.93
2021	73	203	23	36	14	0	137	1.88

Table 6. Annual Chao2 estimates for the numbers of female grizzly bears with cubs in the Demographic Monitoring Area of Greater Yellowstone Ecosystem, 2020–2021. 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. Females with cubs sighted ≥3 times can be derived ($f_{3+} = m-(f_1 + f_2)$).

Year	$\hat{N}_{Obs}$	*m*	f_1	f_2	$\hat{N}_{Chao2}$	*n*	$n/\hat{N}_{Chao2}$
2020	72	65	32	14	98	178	1.82
2021	71	63	30	20	84	130	1.51

Table 7. Estimates and 95% confidence intervals (CI) for population segments and total grizzly bear population size derived using the GAM-based Chao2 estimate ($\widehat{N}_{GAM}$= 84) for females with cubs within the Demographic Monitoring Area, 2021.

Segment	Estimate	95% CI	
		Lower[a]	Upper[a]
Independent females (≥2 years old)	369	294	444
Independent males (≥2 years old)	369	288	451
Dependent young (cubs and yearlings)	325	293	356
Total	1,063	948	1,178

[a] Calculated using the delta method.

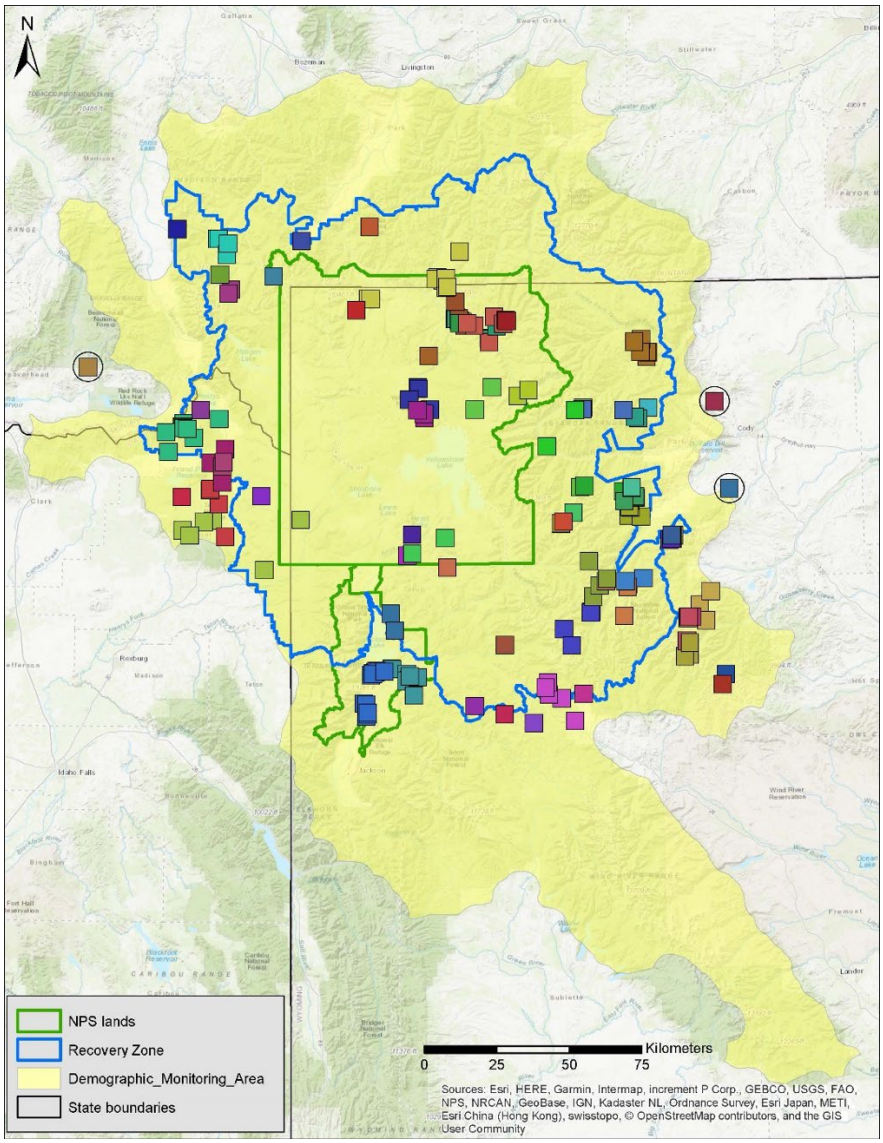

Fig. 2. Distribution of 203 sightings of 73 (indicated by colors) unique female grizzly bears with cubs observed based on the 16-km distance criterion in the Knight et al. (1995) rule set, Greater Yellowstone Ecosystem, 2021. Only sightings from females with cubs occurring within the Demographic Monitoring Area (DMA) are used for population estimation. During 2021, 3 sightings (black circles around symbols) from 3 unique females with cubs occurred outside the DMA. Two of these females were only observed outside the DMA.

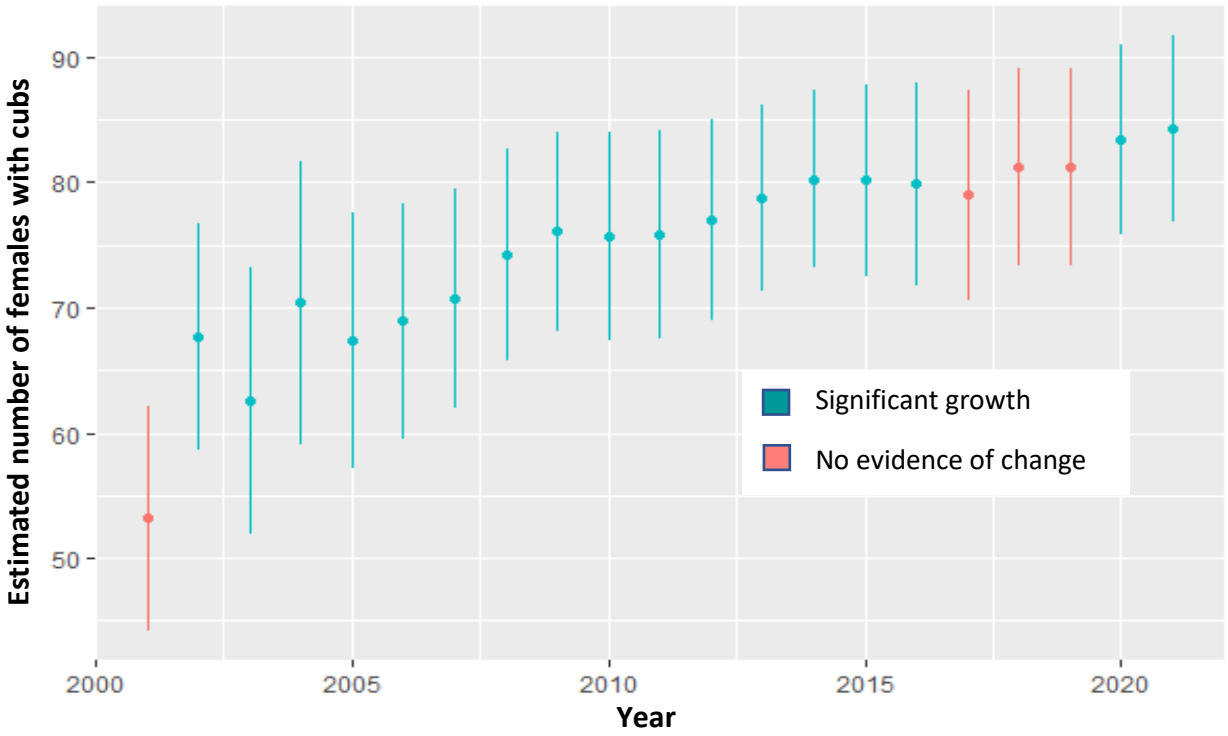

Fig. 3. Estimated number of unique female grizzly bears with cubs in the Greater Yellowstone Ecosystem, 2001–2021. Time series is based on generalized additive model of 3-year moving averages of Chao2 estimates derived based on applying a 16-km distance criterion in the Knight et al. (1995) rule set. Estimates for 2012–2021 were restricted to the Demographic Monitoring Area (DMA). Observations and standard errors in blue represent periods with statistically significant positive population growth based on first derivative values, whereas observations in red represent years without statistical evidence of growth (Interagency Grizzly Bear Study Team 2021).

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 2011–2012 to consider alternative approaches. A 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. 4).

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 meters (m) from sites where multiple observations of bears feeding occurred >1 year) from the mark-resight analyses. In place of this metric, counts of females with cubs only (marked and unmarked) from independent aerial census surveys of confirmed moth sites are added to the mark-resight estimate for a given 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. Peck (2016) reported on the poor ability of the mark-resight technique to detect declines of 1 and 2% in annual estimates of the number of females with cubs but moderate effectiveness to detect a 5% annual decline. Although the IGBST concluded that this technique was insufficient for effective monitoring of population trend, this method does produce relatively unbiased estimates. Because mark-resight estimates are used in our evaluation of Integrated Population Models, we continue to report these estimates.

2021 Mark-Resight Results

Similar to 2020, in 2021 we were only able to conduct 1 round of observation flights and no mark-resight estimation was feasible (Tables 8–10, Fig. 4). We did not conduct moth site-only flights to count females with cubs on army cutworm moth aggregation sites during 2021.

Table 8. Data used in mark-resight analysis on female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1997–2021, including number of radio-marked female grizzly bears available for sighting during observation flights (m), the number not sighted (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 from 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
2018	7	6	1	0	19
2019	8	6	2	0	16
2020[c]	No data for mark-resight estimation				
2021[c]	No data for mark-resight estimation				

[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.

[c] Mark-resight estimation was not feasible because of only 1 round of observation flights.

Table 9. Results from mark-resight analysis of female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1997–2019. 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 from 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
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
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
2018	19	7	81	78	45	137	0.04
2019	16	8	68	65	37	114	0.14
2020[a]				No estimate			
2021[a]				No estimate			

[a] Mark-resight estimation was not feasible because of only 1 round of observation flights.

Table 10. Three-year moving average for mark-resight estimates of female grizzly bears with cubs, Greater Yellowstone Ecosystem, 1998–2019. Estimates exclude females with cubs observed <500 m from 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
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
2015	74	72	68	47	112	0.03
2016	82	80	79	53	124	0.01
2017	80	77	73	52	123	0.01
2018	75	73	69	49	112	0.02
2019	Insufficient data for 3-year moving average					
2020	Insufficient data for 3-year moving average					
2021	Insufficient data for 3-year moving average					

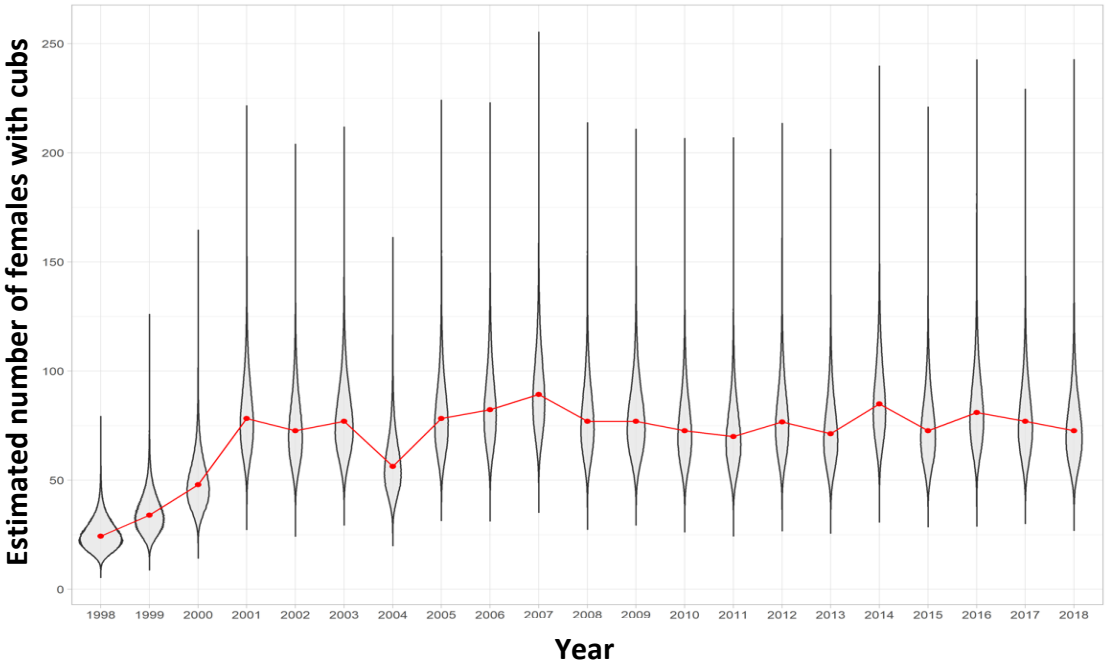

Fig. 4. Annual mark-resight estimates (3-year moving average [red dots], 95% inter quartile [gray area]) of the number of female grizzly bears with cubs (N_{FCOY}), Greater Yellowstone Ecosystem, 1998–2019. Estimates exclude females with cubs observed <500 m from army cutworm moth aggregation sites. No mark-resight estimates were obtained in 2020 and 2021.

Occupancy of Bear Management Units (BMU) by Females with Young *(Mark A. Haroldson and Bryn Karabensh, 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 bear management unit (BMU). The requirements specified in the Demographic Recovery Criteria (USFWS 2007*b*) state that 16 of the 18 BMUs must be occupied by females with young on a running 6-year sum with no 2 adjacent BMUs unoccupied. All 18 BMUs had verified observations of female grizzly bears with young during 2021 (Table 11). Eighteen of 18 BMUs contained verified observations of females with young in at least 5 years of the last 6-year (2016–2021) period.

Table 11. 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, 2016–2021.

Bear Management Unit	2016	2017	2018	2019	2020	2021	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	6
10) Firehole/Hayden	X	X	X	X	X	X	6
11) Madison	X	X	X	X	X	X	6
12) Henry's Lake	X	X	X	X	X	X	6
13) Plateau	X	X	X	X	X	X	6
14) Two Ocean/Lake	X	X	X	X	X	X	6
15) Thorofare	X	X	X	X	X	X	6
16) South Absaroka	X	X	X	X	X	X	6
17) Buffalo/Spread Creek	X	X	X	X	X	X	6
18) Bechler/Teton	X		X	X	X	X	5
Total	18	17	18	18	18	18	

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

Fifty-four Bear Observation Areas (BOAs, Fig. 5) were established in 2014. In 2021, 1 round of observation flights was conducted: 33 BOAs were surveyed during this 1 round (11 Jun–15 Aug). Total duration of observation flight time was 69.92 hours; average duration of individual flights was 2.1 hours (Table 12). Excluding dependent young, 297 bear sightings were recorded during observation flights. Of the 297 sightings, 12 were radio-marked bears (4 females with young, 3 females without young, and 5 males), 214 were solitary unmarked bears, and 71 were unmarked females with young (Table 12). Our observation rate was 4.25 bears/hour for all bears. A total of 143 young (82 cubs, 60 yearlings, and 1 2-year-old) were observed (Table 13). Observation rates for females with dependent young were 1.07 females with young/hour and 0.59 females with cubs/hour (Table 12).

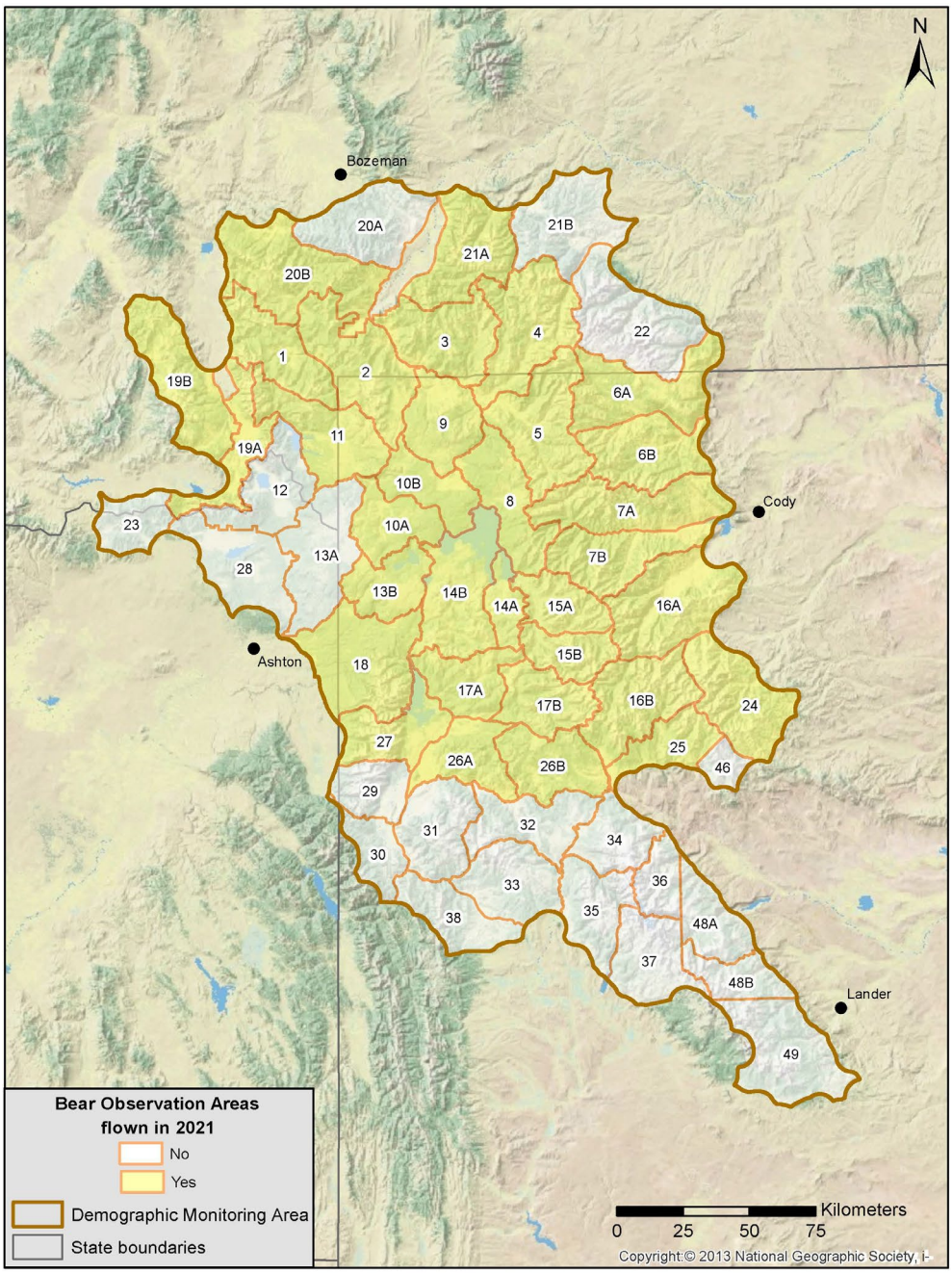

Fig. 5. Grizzly bear observation areas for aerial surveys, Greater Yellowstone Ecosystem, 2021. Areas in yellow were surveyed in 2021, areas in white shading were not surveyed. Numbers represent the 54 Bear Observation Areas, with several larger areas split into 2 subsections (A and B). Base map source: 2013 National Geographic Society, i-cubed, Washington, D.C.

Table 12. Annual summary statistics for grizzly bear observation flights, Greater Yellowstone Ecosystem, 2007–2021.

Year	Observation period	Total hours	Number of flights	Average hours/flight	Bears seen				Total number of groups	Observation rate (bears/hour)		
					Marked		Unmarked					
					Lone	With young	Lone	With young		All groups	With young	With cubs
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
2018[a]	Round 1	105.8	54	1.96	6	3	185	58	252	2.38		
	Round 2	73.6	40	1.84	1	1	105	35	142	1.93		
	Total	179.4	94	1.91	7	4	290	93	394	2.2	0.54	0.32
2019[a]	Round 1	107.8	54	2	7	4	183	56	251b	2.33		
	Round 2	91	42	2.17	9	1	188	43	242c	2.66		
	Total	198.8	96	2.07	16	5	371	99	493	2.48	0.52	0.21
2020[a]	Round 1	78.5	36	2.18	7	2	222	72	303	3.86		
	Round 2											
	Total	78.5	36	2.18	7	2	222	72	303	3.86	0.94	0.51
2021[a]	Round 1	69.92	33	2.12	8	4	214	71	297	4.25		
	Round 2											
	Total	69.92	33	2.12	8	4	214	71	297	4.25	1.07	0.59

[a] Dates of flights (Round 1, Round 2): 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); 2018 (12 Jun-13 Aug, 10 Jul-29 Aug); 2019 (4 Jun–6 Aug, 4 Jul–28 Aug); 2020 (10 Jun–16 Aug, not flown); 2021 (11 Jun–15 Aug, not flown).

[b] Includes observation of 3 cubs-of-the-year without adult female present

[c] Includes observation of 2 cubs-of-the-year without adult female present

Table 13. Size and age composition of grizzly bear family groups seen during observation flights, Greater Yellowstone Ecosystem, 2007–2021.

		Females with cubs (no. of cubs)			Females with yearlings (no. of yearlings)			Females with 2-year-olds or young of unknown age (no. of young)		
Year	Round	1	2	3	1	2	3	1	2	3
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
2018[a]	Round 1	7	24	10	5	7	2[b]	3	3	0
	Round 2	5	8	4	6	11	2	0	0	0
	Total	12	32	14	11	18	4	3	3	0
2019[a]	Round 1	11	10	2[c]	9	16	5	6	0	1
	Round 2	2	14	3	8	14	2	0	1	0
	Total	13	24	5	17	30	7	6	1	1
2020[a]	Round 1	10	29	1	12	18	2	0	2	0
	Round 2									
	Total	10	29	1	12	18	2	0	2	0
2021[a]	Round 1	10	21	10	9	21	3	1	0	0
	Round 2									
	Total	10	21	10	9	21	3	1	0	0

[a] Dates of flights (Round 1, Round 2): 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); 2018 (12 Jun-13 Aug, 10 Jul-29 Aug); 2019 (4 Jun–6 Aug, 4 Jul–28 Aug); 2020 (10 Jun–16 Aug); 2021 (11 Jun–15 Aug, not flown).

[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)*

Eighty-nine telemetry location flights were conducted during 2021, resulting in 296.3 hours of search time (excluding ferry time to and from airports; Table 14). Flights were conducted at least once during all months, with 76% of telemetry flights in May–November. During telemetry flights, 1,044 locations of bears equipped with radio transmitters were collected, 287 (28%) of which included a visual sighting. One hundred and twenty-two sightings of unmarked bears were also obtained during telemetry flights, including 111 solitary bears and 11 females with cubs. No females with yearlings or 2-year-old bears were observed during these flights in 2021. Rate of observation for all unmarked bears during telemetry flights was 0.41 bears/hour; and 1.08 bears/hour for marked bears. The observation rate during telemetry flights for unmarked females with cubs was 0.037 females with cubs/hour.

To reduce flight time and costs associated with aerial telemetry and obtain higher-frequency data, we began deploying satellite Global Positioning System (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 at will or on a fixed schedule. Only Iridium platforms were on the air in 2021. We deployed 39 Iridium GPS collars in 2021, obtaining over 140,400 GPS locations from 57 grizzly bears (newly and previously deployed GPS collars).

Table 14. Summary statistics for radio-telemetry flights to locate grizzly bears, Greater Yellowstone Ecosystem, 2021.

				Radio-marked bears			Unmarked bears observed					
								Number of females			Observation rate (no. groups/hour)	
Month	No. hours	No. flights	Mean no. hours/flight	No. locations	No. seen	Observation rate (no. groups/hr)	Lone bears	With cubs	With yearlings	With young	All groups	Females with cubs
Jan	8.7	2	4.4	57	0	---	0	0	0	0	---	---
Feb	8.5	2	4.3	55	0	---	0	0	0	0	---	---
Mar	15.9	6	2.7	101	6	---	0	0	0	0	---	---
Apr	21.6	7	3.1	94	31	---	0	0	0	0	---	---
May	32.6	9	3.6	98	51	---	9	1	0	0	0.28	0.03
June	28.6	8	3.6	88	49	1.71	14	0	0	0	0.49	0.00
July	41.0	12	3.4	111	61	1.49	49	7	0	0	1.20	0.17
Aug	28.7	12	2.4	96	29	1.01	21	2	0	0	0.73	0.07
Sept	29.8	11	2.7	96	26	0.87	16	1	0	0	0.54	0.03
Oct	32.4	7	4.6	89	19	0.59	1	0	0	0	0.03	---
Nov	37.7	9	4.2	102	11	0.29	1	0	0	0	0.03	---
Dec	10.8	4	2.7	57	4	0.37	0	0	0	0	---	---
Total	296.3	89	3.3	1044	287	0.97	111	11	0	0	0.37	0.04

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

Under the 2017 Revised Demographic Criteria for the Greater Yellowstone Ecosystem, which were amended to the Grizzly Bear Recovery Plan (USFWS 1993, USFWS 2017), the IGBST is tasked with documenting grizzly bear mortalities in the 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, including 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 bears (≤2 years old), 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 probable mortalities in the GYE, numbers by sex and age class inside and outside the DMA, and 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.

2021 Mortality Results

We documented 85 known and probable mortalities in the GYE during 2021, of which 7 (Table 15, #202105, #202113, #202120, #202127, #202129, #202139, and #202142) are estimated to have occurred prior to 2021. Two of these mortalities (#202105 and #202139) are under investigation, and 1 of these (#202139) occurred outside the DMA.

Of the 78 known and probable mortalities for bears that died during 2021 (Table 15, Fig. 6), 9 remain under investigation by the U.S. Fish and Wildlife Service and state law enforcement agencies (Table 15). Specific information related to these mortalities is not provided because of ongoing investigations. However, these 9 mortalities are included in the following summaries of all documented mortalities for bears that died during 2021.

Fifty-nine of the 78 known and probable mortalities occurring during 2021 were attributed to human causes. Among these 59, 20 (33.9%) were due to management removals for livestock depredations. Sixteen (27.1%) were related to anthropogenic site conflicts. Fourteen (23.7%) of the 59 human-caused losses were the result of reported self-defense kills, 13 from hunting-related incidents (including 3 females accompanied by 6 cubs), and 1 incident at a residence. Other human-caused losses included 3 (5.1%) mortalities from vehicle strikes, 3 (5.1%) bears that drowned in a cement-sided irrigation canal from which they were unable to escape, 2 (3.4%) illegal mortalities involving a female that was shot and her cub that died in a den as a result, and 1 (1.7%) management humane removal of a solitary yearling in poor condition that had been frequenting the vicinity of ranch outbuildings.

We documented 17 natural mortalities in 2021 (Table 15). One was an adult male found dead and presumed drowned in the Yellowstone River, all others were cubs. One cub was killed by another bear and the remaining 15 were probable losses from 9 different radio-marked females losing 1 to 3 cubs each.

We recorded 2 mortalities in 2021 for which cause of death was undetermined (Table 15). A radio-instrumented female was found dead in the Taylors Fork drainage in June and an adult male was found dead along the Lamar River in July. In both instances no indication of cause was evident.

We documented 1 possible mortality during 2021 (Table 15). This incident involved a female with cubs that charged an archery hunter who fired multiple pistol shots in the vicinity of the female. The hunter was not injured and no evidence that the female was wounded was found at the scene.

We evaluated known and probable mortalities relative to population estimates only for the DMA. Of the 78 known and probable documented mortalities occurring in 2021, 55 (70.5%) occurred within the boundaries of the DMA and 23 (29.5%) occurred outside (Table 16, Fig. 6). During 2021, we documented

12 mortalities of independent-age female bears within the DMA (Table 16). There were 4 management removals, 3 radio-marked losses, and 5 reported losses (Table 17). Estimated total mortality for independent-age females was 5.4% of the 2021 estimate for this segment of the population (Table 17). Twenty-one known and probable mortalities of independent-age males occurred within the DMA (Table 16). We documented 15 management removals, and 6 reported losses of independent-age males within the DMA (Table 16). Estimated total mortality for independent males was 8.1% of the 2021 estimate for this segment of the population (Table 17). There were 8 known or probable human-caused losses of dependent young documented in the DMA during 2021 (Table 17). Estimated human-caused loss for dependent young was 2.5% within the DMA (Table 17).

Specific information pertaining to closed mortality investigations since 2015 will be updated on the 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.

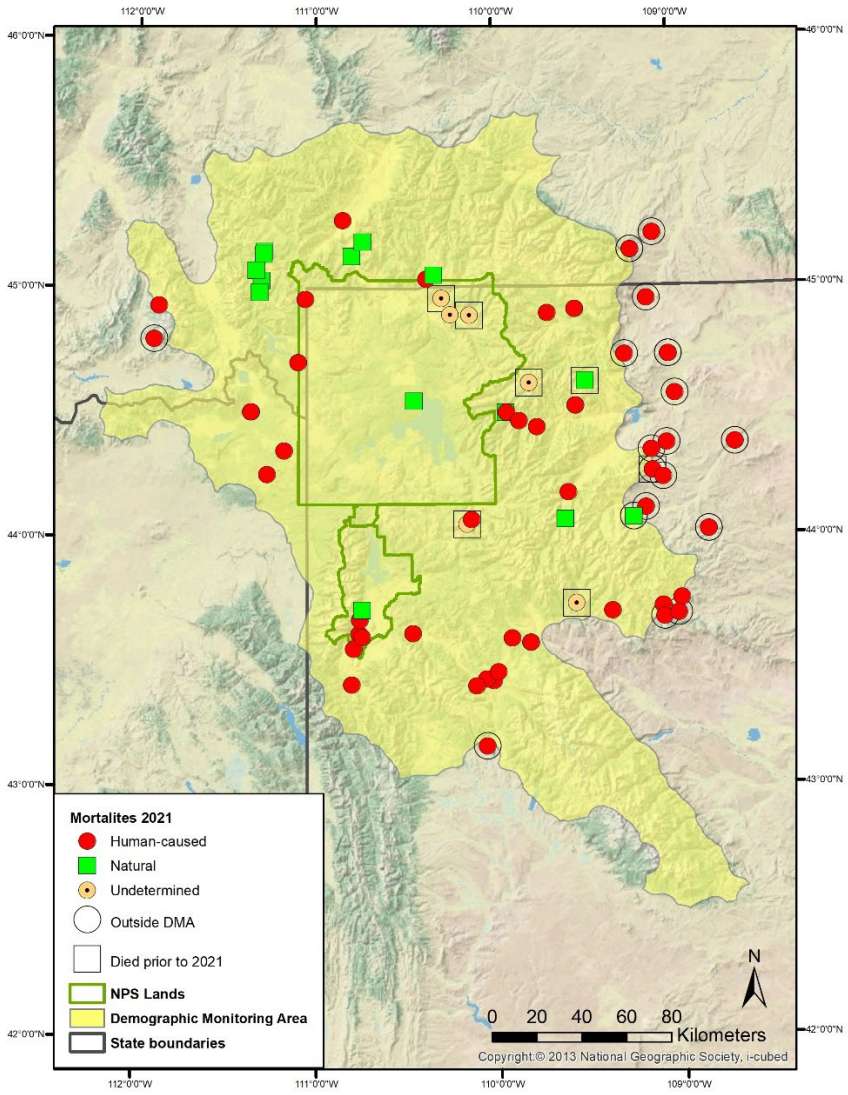

Fig. 6. Distribution of 85 known and probable grizzly bear mortalities documented in the Greater Yellowstone Ecosystem during 2021, including 7 mortalities that occurred prior to 2021 (black squares around symbols). Fifty-five of the documented mortalities occurring in 2021 were within the Demographic Monitoring Area (DMA), of which 38 were attributed to human causes. Twenty-three mortalities occurring in 2021 were outside the DMA (black circles around symbols), 21 of which were attributed to human causes. Due to multiple bear mortalities at a specific location or separate mortalities occurring close to one another, not all 82 locations are visible on this map. Base map source: 2013 National Geographic Society, i-cubed, Washington, D.C.

Table 15. Grizzly bear mortalities documented in the Greater Yellowstone Ecosystem, 2021.								
Unique #	**Bear[a]**	**Sex [b]**	**Age[c]**	**Date**	**Location[d]**	**Monitoring Area[e]**	**Certainty**	**Loss**
202101	Unm	F	Yearling	4/6/2021	South Fork Shoshone River, PR-WY	Inside DMA	Known	Human-caused, management removal (humane) of solitary yearling in poor condition that was frequenting the vicinity of ranch buildings.
202102	899	F	Adult	3/24/2021	Warm River, CTNF-ID	Inside DMA	Known	Human-caused, bear #899 was shot and killed between 3/14 (remote camera) and 3/24.
202103	Unm	M	Cub	3/24/2021	Baker Draw, CTNF-ID	Inside DMA	Known	Human-caused, probably died after #899 was killed, attributed to human-caused.
202104	449	M	Adult	4/17/2021	Madison River, CGNF-MT	Inside DMA	Known	Human-caused, management removal of bear #449 for human injury/fatality.
202105				2020	WY	Inside DMA	Known	UNDER INVESTIGATION
202106	Unm	F	Subadult	5/5/2021	Gooseberry Crk, PR-WY	Outside DMA	Known	Human-caused, management capture with probable sibling (Mort # 202107) and removal for cattle depredations.
202107	Unm	M	Subadult	5/5/2021	Gooseberry Crk, PR-WY	Outside DMA	Known	Human-caused, management capture with probable sibling (Mort # 202106) and removal for cattle depredations.
202108	Unm	M	Adult	5/11/2021	Carbon County, PR-MT	Outside DMA	Known	Human-caused, management capture and removal for cattle depredations.
202109	Unm	M	Yearling	5/20/2021	Heart Mountain Canal, PR-WY	Outside DMA	Known	Human-caused, drowned in Heart Mountain Canal.
202110	Unm	M	Yearling	5/20/2021	Heart Mountain Canal, PR-WY	Outside DMA	Known	Human-caused, drowned in Heart Mountain Canal.
202111	Unm	F	Cub	5/20/2021	Grinnell Crk, SNF-WY	Inside DMA	Known	Natural, cub killed by another bear.
202112	1022	M	Subadult	5/22/2021	Snake River, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #1022 for repeated property damage and obtaining food rewards in subdivisions.
202113	Unk	M	Adult	Spring 2020	Soda Butte Crk, YNP	Inside DMA	Known	Undetermined cause, remains (skull and vertebra) of an old adult male found by park visitor, estimated to have died spring of 2020.
202114	672	F	Adult	5/20/2021	Heart Mountain Canal, PR-WY	Outside DMA	Known	Human-caused, bear #672 drowned in Heart Mountain Canal. Female was lactating, yearlings found drowned on 5/20 (202109 and 202110) may be related.
202115	Unm	M	Subadult	6/5/2021	Grinnell Crk, SNF-WY	Inside DMA	Known	Human-caused, management removal for bold behavior around lodges and trailheads.
202116	653	M	Adult	6/5/2021	Gallatin River, YNP	Inside DMA	Known	Human-caused, vehicle strike of adult male #653 on Highway 191. Bear was not collared.

Table 15. Continued.

Unique #	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Monitoring Area[e]	Certainty	Loss
202117	394	M	Adult	6/4/2021	Yellowstone River, PR-MT	Inside DMA	Known	Natural, bear #394 found dead in the Yellowstone River, bear was tagged but not wearing collar. Assumed natural mortality between 6/1 and 6/7.
202118	686	F	Adult	6/8/2021	Taylor's Fork, CGNF-MT	Inside DMA	Known	Known, undetermined cause, bear #686 died between 5/31 and 6/14 (midpoint 6/8), was wearing an active VHF collar, mortality discovered due to telemetry. Had 1 of 3 cubs left on 5/17.
202119	Unm	M	Adult	7/10/2021	Blaine Crk, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for cattle depredation.
202120	Unm	Unk	Cub	Summer/Fall 2020	Trout Peak, SNF-WY	Inside DMA	Known	Natural, cub found dead in remote location, remains suggest late summer/fall 2020 mortality
202121	727	M	Adult	7/8/2021	Lamar River, YNP	Inside DMA	Known	Undetermined cause, bear #727 found dead along Lamar River by fisherman, no obvious indication of cause, proximity to road (<1 km) maybe contributing factor.
202122	902	M	Adult	7/20/2021	Cottonwood Crk, BDNF-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #902 for cattle depredation.
202123	Unm	M	Subadult	7/25/2021	Badger Crk, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for cattle depredation.
202124	Unm	M	Subadult	7/28/2021	Greybull River, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for frequenting agricultural areas including a cornfield and cattle feedlot.
202125	Unm	F	Subadult	7/28/2021	Greybull River, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for frequenting agricultural areas including a cornfield and cattle feedlot.
202126	Unm	M	Adult	7/30/2021	Squaw Crk, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for cattle depredation.
202127	Unm	M	Adult	Fall 2020	Atlantic Crk, BTNF-WY	Inside DMA	Known	Undetermined cause, remains (skull and vertebra) of an old adult male found and reported, estimated to have died fall of 2020.
202128	946	M	Adult	8/2/2021	Gros Ventre River, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #946 for breaking into structures and obtaining food rewards.
202129	Unm	Unk	Subadult	Fall 2020	North Fork of Shoshone, SNF-WY	Inside DMA	Known	Undetermined cause, remains of subadult found and report, estimated to have died during the fall of 2020. Randomly generated sex = female.
202130	898	F	Adult	8/6/2021	Camp Crk, SNF-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #898 for cattle depredations.
202131	Unm	M	Adult	8/8/2021	Willow Crk, PR-WY	Inside DMA	Known	Human-caused, management capture and removal for sheep depredations.
202132	Unm	F	Adult	8/11/2021	Slab Crk, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for sheep depredations.

Table 15. Continued.

Unique #	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Monitoring Area[e]	Certainty	Loss
202133	890	M	Adult	8/16/2021	Wagon Crk, BTNF-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #890 for cattle depredations.
202134	Unm	F	Subadult	8/18/2021	Fox Crk, BDNF-MT	Outside DMA	Known	Human-caused, management removal for cattle depredations.
202135	Unm	M	Subadult	8/20/2021	Warm Spring Crk, PR-WY	Inside DMA	Known	Human-caused, management capture and removal for numerous property damages and food rewards.
202136	Unm	M	Subadult	8/20/2021	Warm Spring Crk, PR-WY	Inside DMA	Known	Human-caused, management capture and removal for numerous property damages and food rewards.
202137	G269	M	Subadult	8/21/2021	Wagon Crk, BTNF-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #G269 for cattle depredations.
202138	951	M	Adult	8/24/2021	South Fork Fish Crk, BTNF-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #951 for cattle depredations.
202139				2019	WY	Outside DMA	Known	UNDER INVESTIGATION
202140	1048	M	Subadult	8/28/2021	Snake River, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #1048 for repeated property damage and obtaining anthropogenic foods and livestock feed.
202141	Unm	M	Adult	9/1/2021	Meadow Crk, PR-WY	Inside DMA	Known	Human-caused, management capture and removal for cattle depredations.
202142	Unk	Unk	Adult	Spring 2019	Slough Crk, YNP	Inside DMA	Known	Undetermined cause, dead adult grizzly observed and photographed by park visitor during summer 2019. No remains found when the site was visited by park staff during 2021 (9/1). Randomly generated sex = male.
202143	974	F	Adult	9/4/2021	Middle Fork Owl Crk, BLM-WY	Outside DMA	Known	Human-caused, management capture and removal for bear #974 for repeated sheep depredations.
202144	Unm	F	Adult	9/10/2021	Libby Crk, SNF-WY	Inside DMA	Known	Human-caused, vehicle strike of adult female on Highway 14/16/20.
202145	Unm	M	Adult	9/15/2021	Clarks Fork Yellowstone , PR-WY	Outside DMA	Known	Human-caused, management capture and removal for frequenting agricultural areas including a corn maze and pumpkin patch.
202146	1028	M	Subadult	9/21/2021	Snake River, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #1028 for obtaining anthropogenic food rewards, property damages, and entering structures.

Table 15. Continued.

Unique #	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Monitoring Area[e]	Certainty	Loss
202147	Unm	F	Adult	9/21/2021	Table Crk, SNF-WY	Inside DMA	Known	Human-caused, self-defense kill of an adult female with 1 cub by archery elk hunter.
202148	Unm	Unk	Cub	9/21/2021	Table Crk, SNF-WY	Inside DMA	Probable	Human-caused, cub of mother killed in self-defense by hunter.
202149				2021	ID	Inside DMA	Known	UNDER INVESTIGATION
202150				2021	ID	Inside DMA	Probable	UNDER INVESTIGATION
202151				2021	ID	Inside DMA	Probable	UNDER INVESTIGATION
202152				2021	ID	Inside DMA	Probable	UNDER INVESTIGATION
202153	Unm	F	Adult	9/27/2021	East Fork Wind River, SNF-WY	Inside DMA	Known	Human-caused, management capture and removal for breaking into trailers, trucks, visiting camps, and attempted entry into an occupied tent.
202154				2021	WY	Inside DMA	Known	UNDER INVESTIGATION
202155	Unm	M	Adult	10/1/2021	Sage Crk, PR-WY	Outside DMA	Known	Human-caused, vehicle strike.
202156				2021	WY	Inside DMA	Known	UNDER INVESTIGATION
202157				2021	WY	Inside DMA	Known	UNDER INVESTIGATION
202158				2021	WY	Inside DMA	Known	UNDER INVESTIGATION
202159	1017	F	Subadult	10/2/2021	Snake River, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #1017 for repeated conflicts involving food rewards.
202160	Unm	F	Subadult	10/3/2021	Coyote Crk, CGNF-MT	Inside DMA	Known	Human-caused, self-defense kill by successful rifle elk hunters during processing of harvested elk.
202161	957	F	Adult	10/5/2021	Carbon County, PR-MT	Outside DMA	Known	Human-caused, management capture and removal of bear #957 for cattle depredations.
202162	Unm	F	Subadult	10/5/2021	Carbon County, PR-MT	Outside DMA	Known	Human-caused, management capture and removal for cattle depredations.
202163	1043	F	Subadult	10/10/2021	Greybull River, PR-WY	Outside DMA	Known	Human-caused, management capture and removal of bear #1043 for frequenting residential areas and obtaining food rewards. Was wearing working collar when removed.
202164	Unm	M	Adult	10/11/2021	Yellowstone River, PR-MT	Inside DMA	Known	Human-caused, self-defense kill when checking disturbance at poultry coup.
202165	390	M	Adult	9/29/2021	Atlantic Crk, BTNF-WY	Inside DMA	Known	Human-caused, self-defense kill of bear #390 at a harvested elk carcass.
202166	962	F	Adult	10/16/2021	Snake River, GTNP	Inside DMA	Known	Human-caused, management capture and removal of bear #962 for numerous conflicts involving property damage and obtaining anthropogenic food rewards.

Table 15. Continued.

Unique #	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Monitoring Area[e]	Certainty	Loss
202167	Unm	M	Adult	10/18/2021	Shoshone River, PR-WY	Outside DMA	Known	Human-caused, management removal of old adult male for frequenting developed areas and aggressive behaviors toward people.
202168	991	M	Adult	10/22/2021	Squaw Crk, PR-WY	Inside DMA	Known	Human-caused, management capture and removal of bear #991 for breaking into barn and accessing quarters from a butchered elk.
202169	Unm	F	Adult	10/26/2021	Meeteetse Crk, PR-WY	Outside DMA	Known	Human-caused, management capture and removal for cattle depredations.
202170				2021	WY	Inside DMA	Known	UNDER INVESTIGATION
202171	Unm	Unk	Cub	7/4/2021	Boulder Creek, SNF-WY	Inside DMA	Probable	Natural, radio-marked female #476 lost her cub between 6/28 and 7/11/2021.
202172	Unm	Unk	Cub	6/7/2021	Bridge Bay, YNP	Inside DMA	Probable	Natural, radio-marked female #481 lost 1st of 2 cubs between 5/25 and 6/21/2021.
202173	Unm	Unk	Cub	6/7/2021	Bridge Bay, YNP	Inside DMA	Probable	Natural, radio-marked female #481 lost 2nd of 2 cubs between 5/25 and 6/21/2021.
202174	Unm	Unk	Cub	6/12/2021	Buck Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #911 lost 1st of 2 cubs between 5/31 and 7/13/2021.
202175	Unm	Unk	Cub	9/9/2021	Buck Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #911 lost 2nd of 2 cubs between 7/13 and 10/20/2021.
202176	Unm	Unk	Cub	8/10/2021	Buffalo Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #948 lost 1 of 3 cubs between 7/31 and 8/21/2021.)
202177	Unm	Unk	Cub	6/6/2021	Taggart Crk, GTNP	Inside DMA	Probable	Natural, radio-marked female #962 lost her cub between 5/31 and 6/12/2021.
202178	Unm	Unk	Cub	6/1/2021	Francs Fork, ST-WY	Outside DMA	Probable	Natural, radio-marked female #966 lost 1st of 2 cubs between 5/26 and 6/8/2021.
202179	Unm	Unk	Cub	6/1/2021	Francs Fork, ST-WY	Outside DMA	Probable	Natural, radio-marked female #966 lost 2nd of 2 cubs between 5/26 and 6/8/2021.
202180	Unm	Unk	Cub	4/19/2021	Cedar Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #967 lost her cub between 4/7 and 5/1/2021.
202181	Unm	Unk	Cub	5/30/2021	Wapiti Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #1003 lost 1st of 2 cubs between 5/1 and 6/28/2021.
202182	Unm	Unk	Cub	5/30/2021	Wapiti Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #1003 lost 2nd of 2 cubs between 5/1 and 6/28/2021.

Table 15. Continued.

Unique #	Bear[a]	Sex[b]	Age[c]	Date	Location[d]	Monitoring area[e]	Certainty	Loss
202183	Unm	Unk	Cub	5/9/2021	Wapiti Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #686 lost 1st of 3 cubs between 5/1 and 5/17/2021, (midpoint 5/9/2021)
202184	Unm	Unk	Cub	5/9/2021	Wapiti Crk, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #686 lost 2nd of 3 cubs between 5/1 and 5/17/2021, (midpoint 5/9/2021)
202185	Unm	Unk	Cub	6/7/2021	Taylors Fork, CGNF-MT	Inside DMA	Probable	Natural, radio-marked female #686 died from undetermined causes between 5/31 and 6/14, probable loss of 3rd of 3 cubs after her death (midpoint 6/7/2021)
202186	Unm	F	Adult	9/9/2021	Shedhorn Crk, CGNF-MT	Inside DMA	Possible	Human-caused, archery elk hunter fired multiple pistol shots in the vicinity of an adult female with 2 cubs, no evidence found that that female was wounded.

[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 Demographic Monitoring Area (DMA).

Table 16. Counts of documented known and probable grizzly bear mortalities that occurred in 2021 by sex, age class, and location relative to the Demographic Monitoring Area (DMA), Greater Yellowstone Ecosystem.

Area	Sex	Age class: Dependent (<2 years old)	Age class: Independent (≥2 years old)	Total
Inside DMA	Female	4	12	16
	Male	1	21	22
	Unknown	17	0	14
	Total	22	33	55
Outside DMA	Female	0	10	10
	Male	2	9	11
	Unknown	2	0	2
	Total	4	19	23

Table 17. Annual population estimates ($\widehat{N}$) and mortality statistics by population segment for grizzly bears in the Demographic Monitoring Area (DMA), Greater Yellowstone Ecosystem 2021. Population estimates for the DMA were derived using the most recent vital rates (Interagency Grizzly Bear Study Team 2012) and revised Chao2 (Interagency Grizzly Bear Study Team 2021).

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[b]	325	8						2.5
Females 2+	369	12	4	3	5	13	20	5.4
Males 2+	369	21	15	0	6	15	30	8.1

[a] Unknown, unreported mortality estimated based on Cherry et al. (2002).

[b] Only human-caused losses are counted against the mortality threshold for dependent young.

MONITORING OF GRIZZLY BEAR FOODS

Grizzly Bear Consumption of Ungulates in Yellowstone National Park *(Kerry A. Gunther, Travis C. Wyman, and Eric G. Reinertson, Yellowstone National Park)*

Bison (*Bison bison*), moose (*Alces alces*), elk (*Cervus canadensis*), and deer (*Odocoileus* spp.) are consumed by grizzly bears through scavenging and predation and represent concentrated sources of protein and calories. Bears show preferential selection of ungulate meat over many other foods. Craighead et al. (1995) observed as many as 23 individual grizzly bears congregating at a single bison carcass in Yellowstone National Park.

Objectives for state and federal management of bison, elk, and deer populations in the GYE include recreational hunting and also to address disease, property damage, crop damage, and other factors. Such management could influence the number of ungulates on the landscape available to grizzly bears as food. To monitor broad-scale trends in grizzly bear consumption of ungulate meat, we record opportunistic sightings of grizzly bears throughout Yellowstone National Park. These records include the number of sightings where the observed bears consumed bison, moose, elk, mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), or mountain goat (*Oreamnos americanus*).

In 2021, we recorded 907 opportunistic sightings of grizzly bears, their tracks, and feeding sign in Yellowstone National Park. In 82 (9%) of these sightings, the observed grizzly bears fed on ungulate carcasses (Table 18). Grizzly bears were observed consuming ungulate carcasses from March through November (Fig. 7), with most use occurring in August (n = 23). Bison (41%, n = 34) and elk (40%, n = 33) were the species of ungulate most often consumed by grizzly bears. In contrast, black bears fed on ungulate carcasses in only 2 (<1%) of 784 opportunistic observations (Table 18). Interference competition from grizzly bears and wolves likely inhibits black bear use of many ungulate carcasses.

The number of opportunistic observations of grizzly bears feeding on ungulates in 2021 (n = 82) was similar to what we observed in 2020 (n = 84) and to the long-term average of 73.3 (± 32.6 SD [standard deviation]) recorded over the last 41 years (1981–2021) (Fig. 8). The proportion of the total number of opportunistic sightings where grizzly bears fed on ungulate carcasses in 2021 (9%) was equivalent to the long-term average of 9% recorded during 1981–2021 (Fig. 9).

A grizzly bear scavenges the carcass of a cow elk in Grizzly Lake as a black wolf watches from the shoreline. The bear usurped the carcass from the Eight Mile Wolf Pack in late September. (Photo courtesy of E. Stahler, National Park Service)

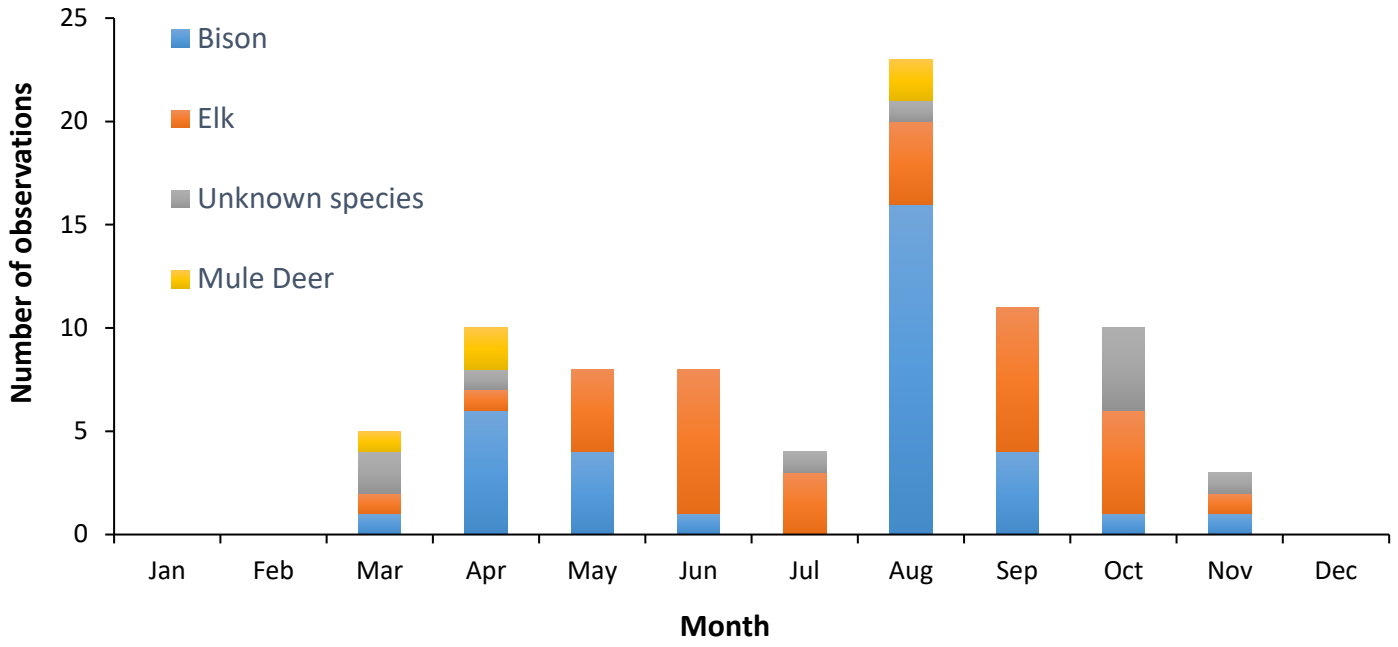

Fig. 7. Number of opportunistic observations of grizzly bears consuming ungulate meat by month in Yellowstone National Park, 2021.

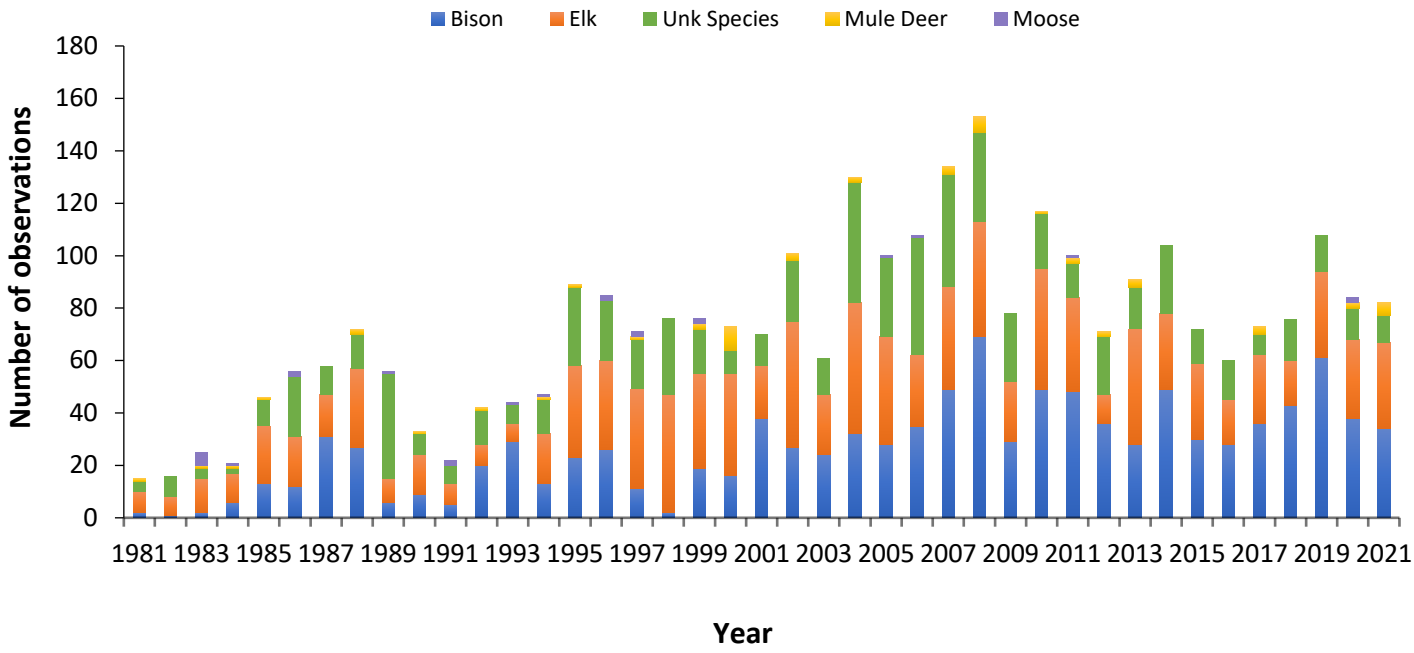

Fig. 8. Number of opportunistic observations of grizzly bears feeding on ungulate carcasses in Yellowstone National Park, 1981–2021.

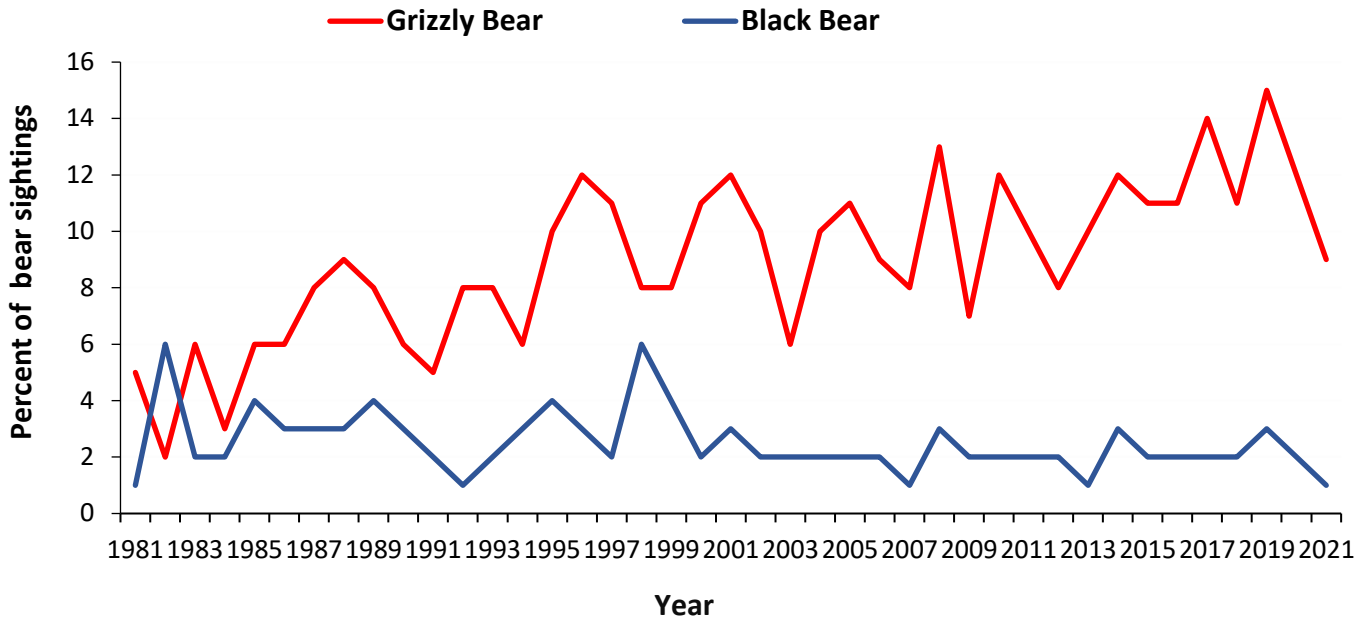

Fig. 9. Proportion of the total number of opportunistic observations of grizzly bears where the observed bears were feeding on ungulate carcasses, Yellowstone National Park, 1981–2021.

Table 18. Number of opportunistic observations of grizzly bears and black bears where the observed bear fed on ungulate carcasses, Yellowstone National Park, 2021.

Species of bear	Species of ungulate consumed									
	Bison	Moose	Elk	Mule Deer	White-tailed deer	Bighorn sheep	Mountain goat	Pronghorn	Unknown ungulate	Total
Grizzly	34	0	33	5	0	0	0	0	10	82
Black	0	0	1	0	0	0	0	0	1	2

Spawning Cutthroat Trout Availability and Use by Grizzly Bears in Yellowstone National Park *(Kerry A. Gunther, Eric G. Reinertson, Travis C. Wyman, Todd M. Koel, and Patricia E. Bigelow, 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 bouvieri*) during years when trout are abundant in tributary streams of Yellowstone Lake. Bears also occasionally prey on cutthroat trout in other areas of Yellowstone National Park, including Fan Creek (Westslope cutthroat trout, YCT, or Westslope × YCT hybrids) 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 substantially reduced the native YCT population in Yellowstone Lake in the late-1990s and 2000s (Koel et al. 2006). The combined effect of all these factors reduced YCT abundance by >90% in some spawning tributaries (Koel et al. 2006; 2019) and resulted in a noticeable decrease in bear fishing activity (Haroldson et al. 2005). Because of the YCT decline and associated trophic changes, as well as preferential use of YCT as a food source by grizzly bears in the Yellowstone Lake watershed, monitoring of the YCT population is a component of the habitat monitoring program of the 2016 Yellowstone Grizzly Bear Conservation Strategy (Yellowstone Ecosystem Subcommittee 2016). The YCT spawning population was historically monitored through counts at a fish trap located on Clear Creek on the east shore of Yellowstone Lake. The Clear Creek fish weir and trap are no longer operational. A long-term netting assessment program conducted annually in August is now used to monitor the status and trends of the YCT population lakewide (Koel et al. 2020). Visual stream surveys of North Shore and West Thumb tributaries of the lake have been conducted annually since 1989 (Fig. 12). Visual stream surveys are also conducted along the Trout Lake inlet creek in the northeast section of the park. In 2014, we began visual stream surveys along 3 Yellowstone Lake backcountry spawning streams (Flat Mountain Creek, stream #1138, and stream #1141) on the west shore of Yellowstone Lake.

Yellowstone Lake

Frontcountry 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, and Bridge Creek on the North Shore of Yellowstone Lake, and Sandy Creek, Sewer Creek, Little Thumb Creek, and stream #1167 in the West Thumb area are checked periodically to detect the presence of adult YCT (Fig. 10, 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 2 people walk 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 1 day per week until 2 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.

Ice-off on Yellowstone Lake occurred on 21 May 2021. Data collected in 2021 continued to indicate low numbers of spawning YCT in North Shore and most West Thumb tributary streams (Table 19). In North Shore streams, only 22 spawning YCT were counted. Eleven spawning YCT were counted in Bridge Creek, 9 in Lodge Creek, and 2 in Hatchery Creek. No spawning YCT were observed in Incinerator Creek or Wells Creek. No grizzly bear tracks and no evidence of bear fishing activity (i.e., observations of grizzly bears fishing or grizzly bear tracks associated with fish parts or bear scats containing fish parts) were observed along any of the monitored North Shore streams in 2021.

On West Thumb streams, 109 spawning YCT were counted, including 105 in Little Thumb Creek and 4 in Sandy Creek. No spawning YCT were observed in Sewer Creek or stream #1167. Grizzly bear tracks were observed along Little Thumb Creek and Sewer Creek. Bear tracks that could not be identified to species were observed along Sandy Creek and bear scats were observed along the banks of Little Thumb Creek and stream #1167. A black bear

was observed fishing along Little Thumb Creek. Evidence of grizzly bear fishing (fish parts associated with grizzly bear tracks) were also found on Little Thumb Creek.

The number of spawning YCT counted in North Shore (Fig. 11) and West Thumb (Fig. 12) streams has decreased significantly since 1989. Although the increased spawning activity observed in Little Thumb Creek in recent years is promising for YCT recovery, very few spawning YCT have been observed in all other North Shore and West Thumb tributary streams.

Backcountry Visual Stream Surveys

In 2021, we surveyed 3 backcountry tributary streams including Flat Mountain Creek, stream #1138, and stream #1141. Backcountry stream surveys followed the same methods used on frontcountry streams. In backcountry streams, we counted 10 spawning YCT, 6 in stream #1138, 2 in stream #1141, and 2 in Flat Mountain Creek. We observed grizzly bear and black bear tracks associated with fish parts along Flat Mountain Creek. Trail camera photos captured a grizzly bear fishing on stream #1138. We observed black bear tracks along Flat Mountain Creek.

Trout Lake

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). Counts and mean number of spawners are obtained using the methods previously described for Yellowstone Lake North Shore and West Thumb tributary streams.

We observed the first movement of spawning trout from Trout Lake into the inlet creek on June 10. The spawn lasted approximately 15 days with the last spawning trout observed in the inlet creek on June 24. During the once per week visual surveys, 154 spawning cutthroat trout (and cutthroat trout × rainbow trout hybrids) were counted, an average of 51 per visit during the spawning season (Table 19). We observed no evidence of grizzly bear or black bear fishing activity along Trout Lake or the inlet creek during the surveys. The number of fish observed per survey in the Trout Lake inlet creek has ranged from a low of 31 in 2004, to a high of 306 in 2010 (Fig. 13).

Outlook for Yellowstone Cutthroat Trout

The number of spawning YCT counted in all surveyed tributary streams of Yellowstone Lake reached an all-time low in around 2004 (Figs. 15-17). A Native Fish Conservation Plan/Environmental Assessment was completed in 2010 (Koel et al. 2010*a*, 2010*b*). The plan outlines an adaptive management program designed to protect the native YCT population through suppression of lake trout and other methods (Koel et al. 2020). As part of these management efforts, park fisheries biologists and private-sector (contracted) netters caught and removed 326,787 lake trout from Yellowstone Lake in 2021 (Gresswell et al. 2021, Koel et al. 2022). Since lake trout suppression efforts began in 1994, >4 million lake trout have been removed from the lake through suppression gillnetting. Population models indicate the removal program has slowed lake trout population growth and sent the population into decline beginning in 2012 (Syslo et al. 2020). Over the past decade, adult predatory lake trout (age 6+) have been reduced by more than 80% (Gresswell et al. 2021, Koel et al. 2022). Adult YCT (18–20”) now weigh twice what they did prior to the lake trout invasion, probably due to reduced competition, and juveniles are again recruiting into the YCT population (Koel et al. 2020). Spawning adult cutthroat trout are returning to some tributaries and bears are once again preying on YCT in a few streams. If the removal program results in a significant long-term reduction in predatory lake trout, managers hope that native YCT will reestablish at higher numbers than at present in Yellowstone Lake and its tributary streams. If the YCT restoration program is successful, YCT may once again become an important diet item for grizzly bears and other terrestrial, aquatic, and avian predators in the Yellowstone Lake watershed (Bergum et al. 2017).

A grizzly bear catches a Yellowstone cutthroat trout in a tributary stream of Yellowstone Lake in 2021. (NPS photo)

Table 19. Summary statistics for spawning cutthroat trout surveys, Yellowstone National Park, 2021.

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	Evidence of bear fishing[b]
North Shore Streams							
Lodge Creek	05/10/2021	06/08/2021	30	5	9	1.8	No
Hatchery Creek	05/24/2021	05/24/2021	1	1	2	1.0	No
Incinerator Creek			No Spawn				
Wells Creek			No Spawn				
Bridge Creek	05/10/2021	05/23/2021	14	3	67		No
West Thumb Streams							
1167 Creek			No spawn				
Sandy Creek	05/19/2021	05/23/2021	5	2	4	2.0	No
Sewer Creek			No spawn				
Little Thumb Creek	05/23/2021	06/23/2021	32	5	105	21.0	Yes
Total frontcountry[a]				16	131	8.2	
Backcountry Streams							
Flat Mountain Creek	05/30/2021	05/30/2021	1	1	2	2.0	Yes
Stream #1138	05/30/2021	06/13/2021	15	3	6	2.0	Yes
Stream #1141	05/30/2021	05/30/2021	1	1	2	2.0	No
Total backcountry				5	10	2.0	
Northern Range							
Trout Lake Inlet	06/10/2021	06/24/2021	15	3	154	51.3	No

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

[b] Includes direct observations of bears fishing, trail camera evidence of bears fishing, fish parts with associated bear tracks, or bear scats containing fish parts.

Fig. 10. Locations of Yellowstone Lake cutthroat trout spawning streams surveyed in 2021. Base map: Geographic Society, i-cubed, Washington, D.C.

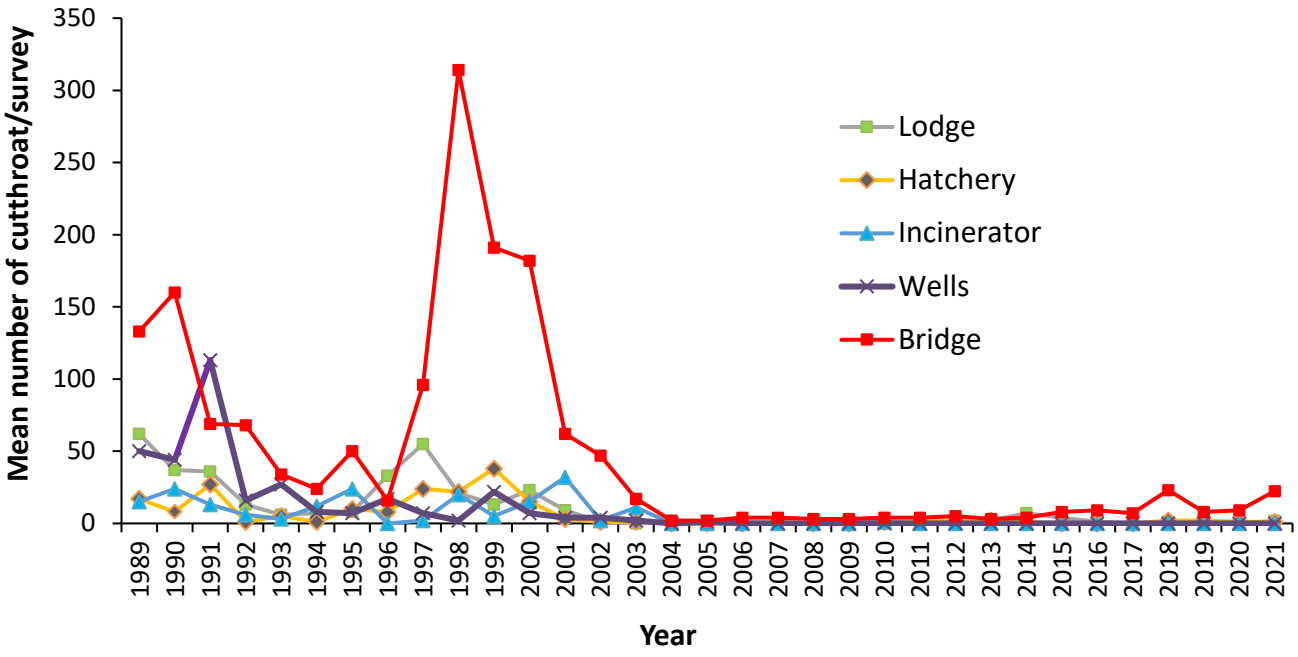

Fig. 11. Mean number of spawning Yellowstone cutthroat trout observed during weekly visual surveys of 5 North Shore spawning stream tributaries to Yellowstone Lake, Yellowstone National Park, 1989–2021.

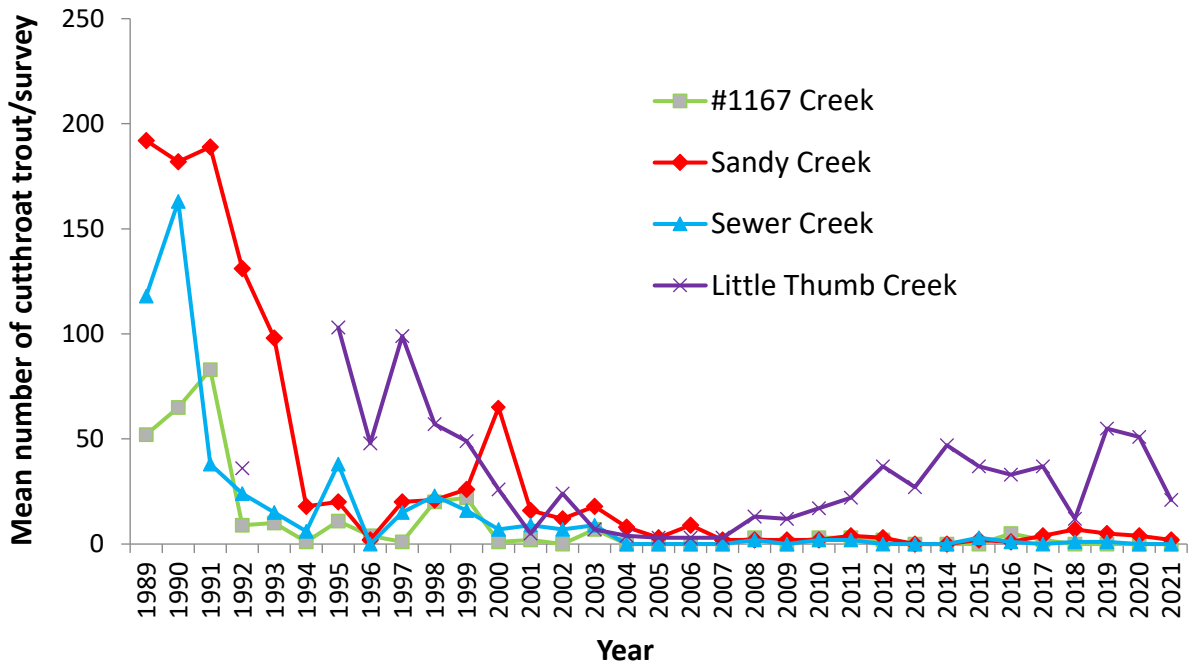

Fig. 12. Mean number of spawning Yellowstone cutthroat trout observed during weekly visual surveys of 4 West Thumb spawning stream tributaries to Yellowstone Lake, Yellowstone National Park, 1989–2021.

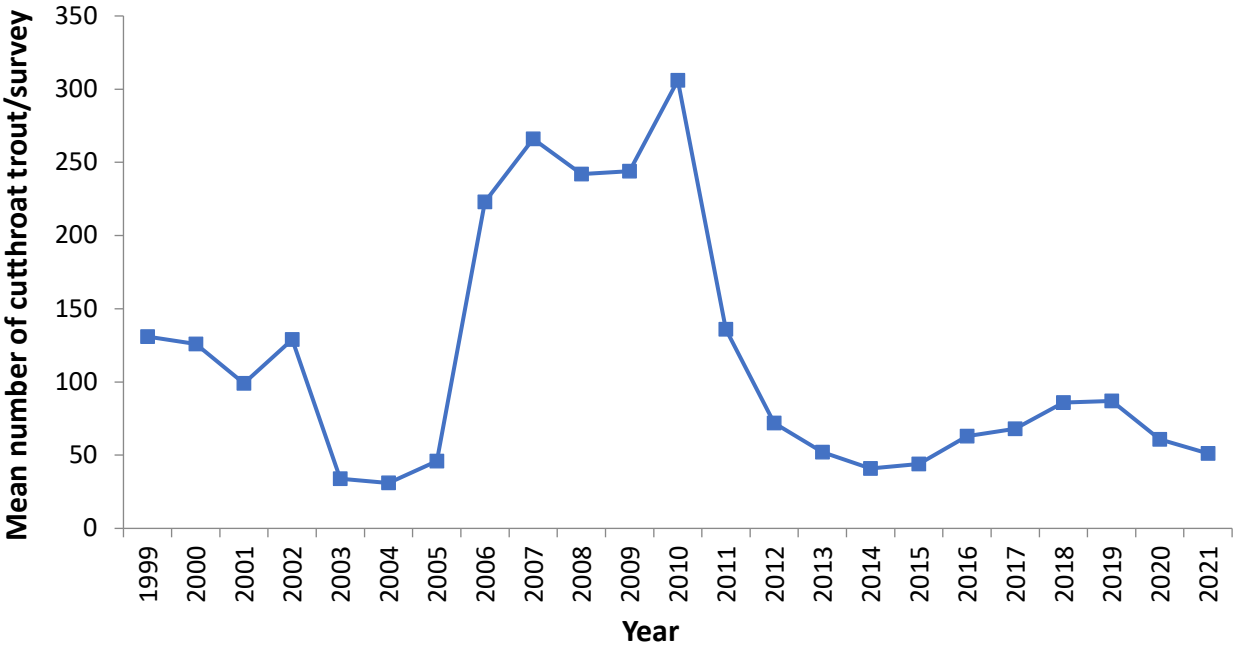

Fig. 13. Mean number of spawning Yellowstone cutthroat trout (including cutthroat × rainbow trout hybrids) observed during weekly visual surveys of the Trout Lake inlet creek, Yellowstone National Park, 1999–2021.

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*; moths) were first recognized as an important food source for grizzly bears in the GYE during the mid-1980s (Mattson et al. 1991*b*, French et al. 1994). Early observations indicated that moths, and subsequently bears, showed specific site fidelity. These sites are generally high alpine areas dominated by talus and scree adjacent to areas with abundant alpine flowers. Because insects other than 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 the discovery of bears feeding at insect aggregation sites, numerous bears have been observed at or near these sites. Observability is high because of lack of tree cover and number of bears using the sites. 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.

Our knowledge of these sites has increased over time, and techniques for monitoring grizzly bear use of these sites have changed. We developed a technique in 2000 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 errors 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 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. Areas suspected as insect aggregation sites but dropped from the list of confirmed sites, and sites with only 1 observation of an actively feeding bear or multiple observations in a single year, are termed "possible" sites and will be monitored in subsequent years for additional observations of actively feeding bears. These sites may then be added to the confirmed sites list. When the status of a site is changed to confirmed, analysis is done on all data back to 1986 to determine the historical 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 those 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.

As with 2020, only 1 round of grizzly bear observation flights was flown in 2021. Thus, the number of hours flown over insect aggregation sites was again reduced compared to pre-2020 flight totals. However, unlike 2020, most observation flights (81%) were conducted with a secondary observer in addition to the pilot.

Analysis of grizzly bear use of insect aggregation sites in 2021 resulted in 215 observations of actively feeding grizzly bears on previously identified, confirmed sites. In addition, there was an observation of actively feeding grizzly bears at 2 sites previously classified as possible and 1 observation of actively feeding grizzly bears at a previously undocumented site. Thus, 1 previous possible site was reclassified to 'confirmed,' 1 possible site was merged with a nearby confirmed site due to overlapping site polygons, and 1 new possible site was added in 2021, bringing the number of sites to 35 confirmed and 19 possible.

Overall, the number of locations with grizzly bears on insect aggregation sites in 2021 (n = 357) was the highest recorded since the beginning of the monitoring period in 1986 (Table 20). This number includes all grizzly bear locations from aerial observation flights, telemetry flights, and observations made during flights for other species. The number of grizzly bears documented on sites and the percentage of confirmed sites with documented use by grizzly bears varies from year to year, suggesting that moth numbers may be greater in some years than others (Fig. 14), 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. 14) and the number

of observations recorded at insect aggregation sites were very low (Table 20). In all other years, the percentage of insect aggregation sites used by grizzly bears varied between 47 and 83% (Fig. 14).

However, when we control for the amount of observation effort by including only bears observed during regularly conducted observation flights (see "***Observation Flights***"), the number of bears observed using insect aggregation sites per hour of flights has shown an overall increasing trend since these flights began in 1997 (Fig. 15). Whereas the number of bears observed in 2021 was near the average for the previous 10 years, the number of hours flown was 45% lower than years in which 2 rounds of flights were conducted. Thus, the number of observations per hour flown was actually higher in 2021 than in any previous year (Fig. 15).

Table 20. Summary statistics for grizzly bear use of confirmed insect aggregation sites, Greater Yellowstone Ecosystem, 1986–2021.

Year	Number of confirmed aggregation 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	13	13	169
1992	18	12	6	108
1993	19	3	1	2
1994	19	9	1	32
1995	21	12	7	40
1996	23	15	21	68
1997	24	16	17	84
1998	27	22	9	185
1999	27	14	26	156
2000	27	13	49	97
2001	28	18	23	128
2002	30	21	33	256
2003	30	20	9	163
2004	30	16	2	134
2005	32	19	16	198
2006	32	17	15	147
2007	32	19	19	162
2008	32	23	16	181
2009	34	23	12	170
2010	34	18	3	136
2011	35	22	10	165
2012	35	24	20	253
2013	35	23	27	297
2014	35	24	11	343
2015	35	21	13	211
2016	35	20	11	208
2017	35	21	20	279
2018	35	20	18	267
2019	35	29	20	335
2020	35	27	19	325
2021	35	23	30	327
Total			536	5,794

[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] An aggregation site was considered used if ≥1 location or grizzly bear observation was documented within the site during July–September of that year.

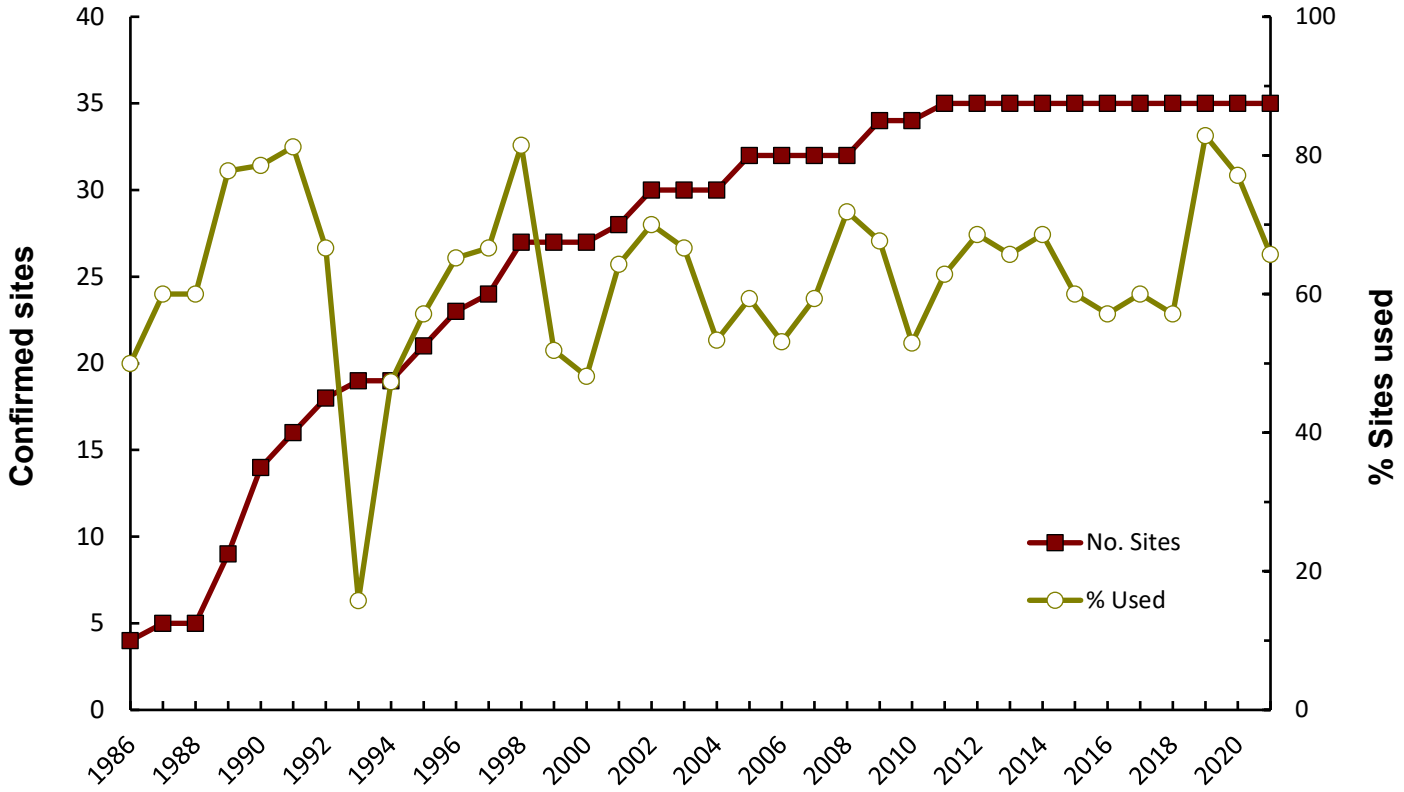

Fig. 14. Annual number of confirmed insect aggregation sites and percent of those sites at which telemetry relocations of marked bears or visual observations of unmarked bears were recorded, Greater Yellowstone Ecosystem, 1986–2021.

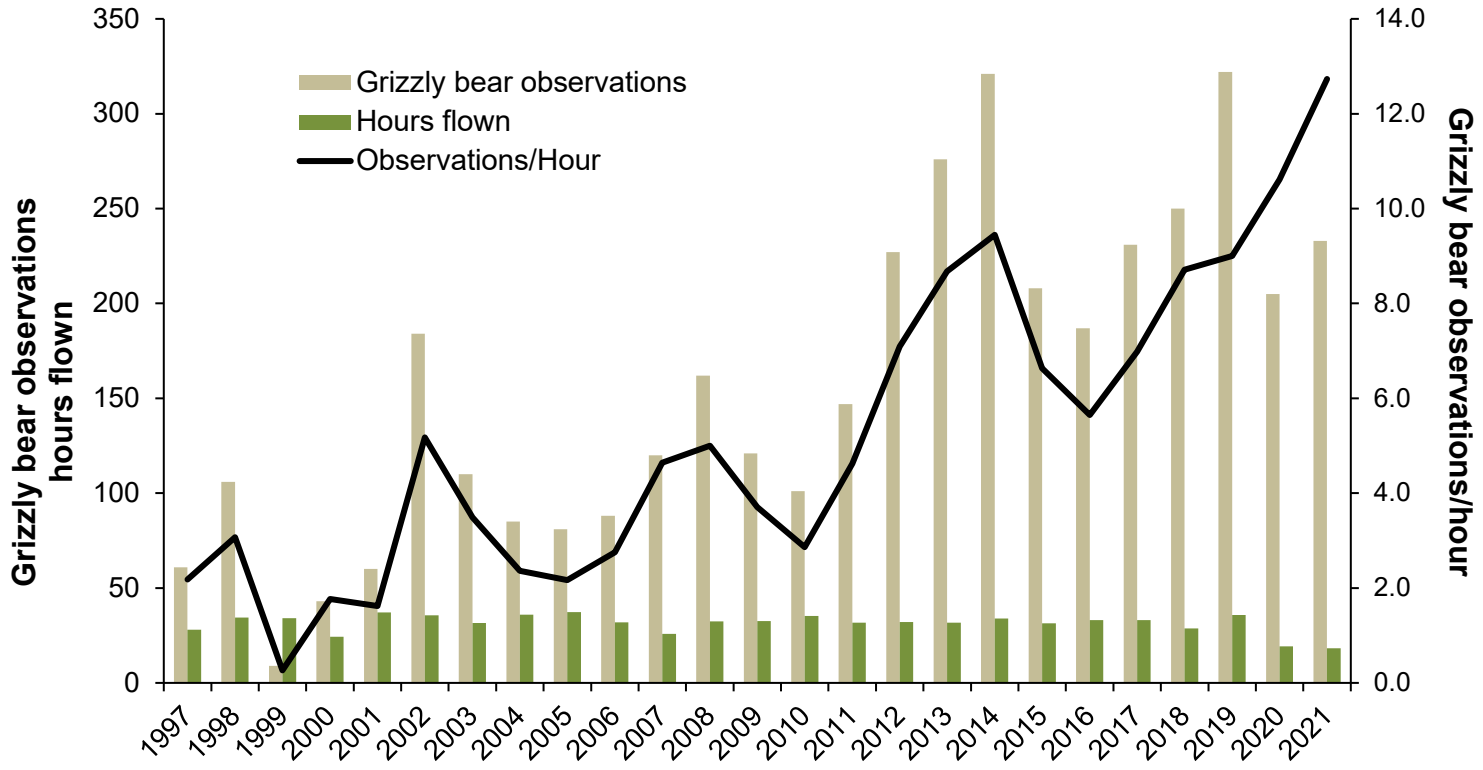

Fig. 15. Number of grizzly bears observed (tan bars) on insect aggregation sites during observation flights only, survey hours (green bars) for these bear management units (BMU), and grizzly bear observations per survey hour (black line) during observation flights of BMUs containing all known insect aggregation sites, Greater Yellowstone Ecosystem, 1997–2021.

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 slightly above average cone production for 2021 (Fig. 16). Overall, the mean number of cones per tree,18.9 (Table 21), was similar to the long-term average of 17 cones per tree for the period 1980–2020 (Fig. 17). For the second consecutive year, cone production was generally higher on northern transects and lower on southern transects (Fig. 1, Table 2).

Occasional tree mortality caused by mountain pine beetle (*Dendroctonus ponderosae*) may still occur in stands that contain the cone production transects. During 2021, we observed 1 additional beetle-caused mortality of a transect tree that had been surveyed since 2002. Total mortality on transect trees since 2002 is now 76.3% (145/190) with 100% (19/19) of transects containing beetle-killed trees. Cumulative loss among the original 190 trees has been minimal for most of the last decade (Fig. 18). Similar to findings reported by the Greater Yellowstone Whitebark Pine Monitoring Working Group, these data support the interpretation that the mountain pine beetle outbreak has run its course.

Table 21. Summary statistics for whitebark pine cone production surveys, Greater Yellowstone Ecosystem, 2021.

Total			Trees				Transect			
Cones	Trees	Transects	Mean cones	SD	Min	Max	Mean cones	SD	Min	Max
3,641	193	21	18.9	35	0	195	173.4	225	0	811

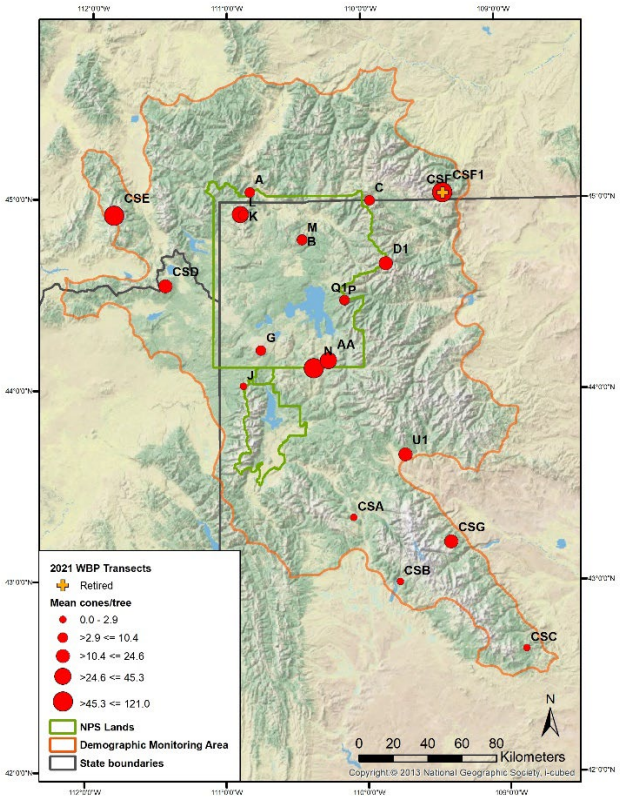

Fig. 16. Locations and mean number of cones per tree for 21 whitebark pine cone production transects, Greater Yellowstone Ecosystem, 2021. Labels reflect transect identifiers (see Table 22). Base map source: 2013 National Geographic Society, i-cubed, Washington, D.C.

Table 22. Results of whitebark pine cone production surveys, Greater Yellowstone Ecosystem, 2021.

Transect	Number of cones	Number of trees	Mean number of cones/tree	SD
A	23	4	5.8	4.3
B	51	10	5.1	3.3
C	42	10	4.2	4.6
D1	122	10	12.2	10.0
G	104	10	10.4	9.4
J	12	10	1.2	2.6
K	251	7	35.9	27.0
L	88	10	8.8	8.1
M	43	10	4.3	4.1
N	811	10	81.1	64.2
P	29	10	2.9	4.7
Q1	57	10	5.7	7.6
U1	179	10	17.9	5.3
AA	453	10	45.3	24.9
CSA	0	10	0.0	2.0
CSB	13	10	1.3	2.8
CSC	2	10	0.2	1.0
CSD	127	10	12.7	15.6
CSE	242	2	121.0	12.0
CSF		-----Transect retired in 2019-----		
CSF1[a]	746	10	74.6	53.4
CSG	246	10	24.6	19.7

[a] Retired transect CSF replaced with CSF1 in 2020.

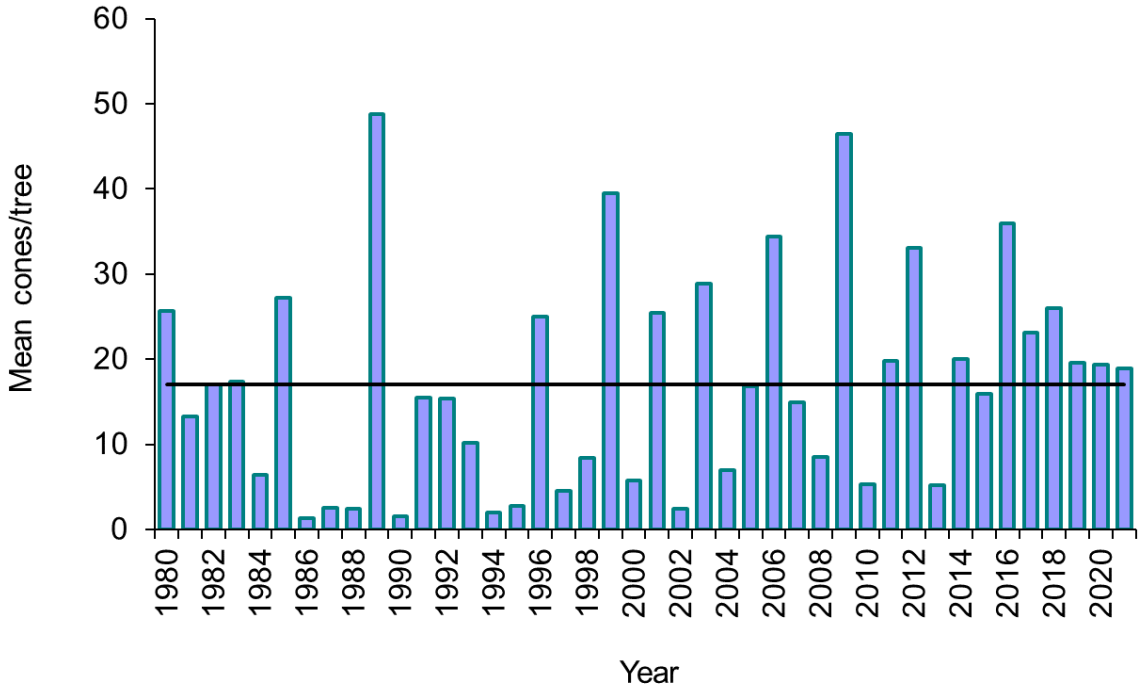

Fig. 17. Annual mean number of cones per tree observed along whitebark pine cone production transects, Greater Yellowstone Ecosystem, 1980–2021. The overall average for the time period (17 cones per tree) is shown as a solid line.

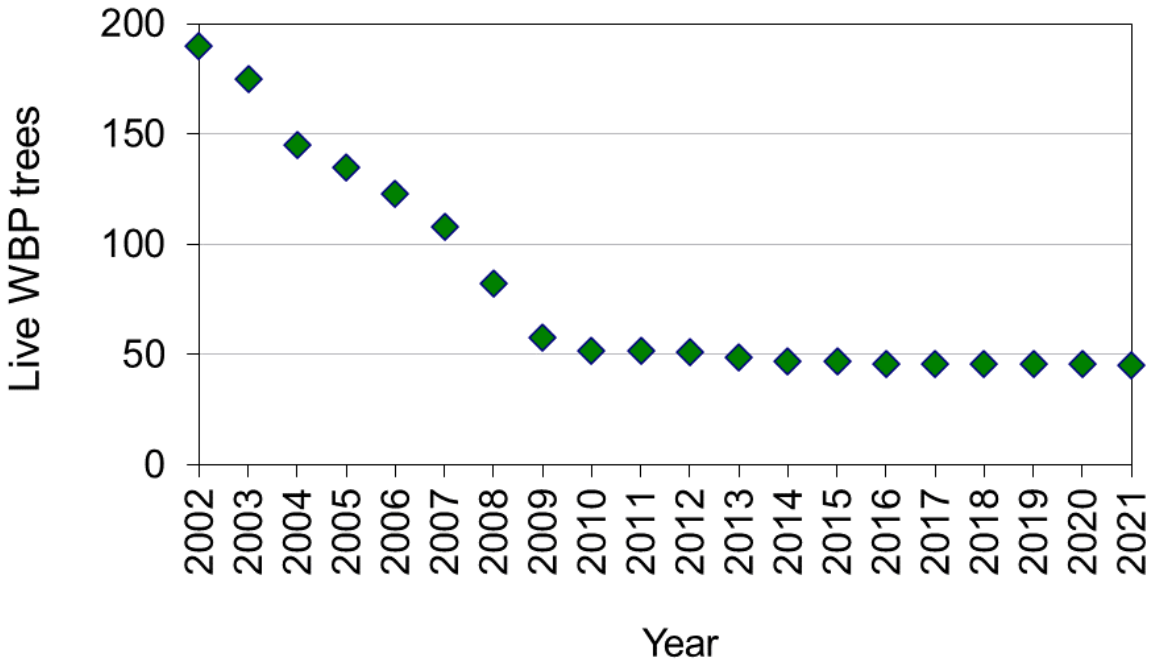

Fig. 18. Number of live whitebark pine (WBP) trees on cone production transects among 190 individual trees monitored since 2002, Greater Yellowstone Ecosystem, 2002–2021.

Ungulate Herd Statistics *(Dan J. Thompson, Wyoming Game and Fish Department; Jeremy M. Nicholson, Idaho Department of Fish and Game; Jeremiah Smith, Montana Fish, Wildlife and Parks; Kerry A. Gunther, National Park Service; and Katharine R. Wilmot, National Park Service)*

We provide the following agency web links for readers as a resource to obtain statistics and data regarding the status, distribution, and harvest of ungulate herds within the Greater Yellowstone Ecosystem:

Idaho Department of Fish and Game:
https://idfg.idaho.gov/sites/default/files/seasons-rules-big-game-2022-elk.pdf

Montana Fish, Wildlife and Parks:
https://fwp.mt.gov/binaries/content/assets/fwp/conservation/elk/2021-montana-elk-count-completed.pdf
(under Elk Population Status for HD 313)

Wyoming Game and Fish Department:
https://wgfd.wyo.gov/Hunting/Harvest-Reports/2021-Harvest-Report

https://wgfd.wyo.gov/Hunting/Job-Completion-Reports/2021-Big-Game-Job-Completion-Reports

Grand Teton National Park
https://www.nps.gov/grte/learn/nature/vital-signs.htm

Yellowstone National Park
Bison: http://ibmp.info/library.php (under Winter Operations and Status/Surveillance/Harvest Plans)

RECREATION MONITORING

Grand Teton National Park *(Justin K. Schwabedissen and Katharine R. Wilmot, Grand Teton National Park)*

Grand Teton National Park encompasses 125,452 ha of occupied grizzly bear habitat in the Greater Yellowstone Ecosystem. Most of the land in Grand Teton National Park is undeveloped and 52% of the area is designated as recommended or potential wilderness and managed as wilderness per National Park Service policy (National Park Service 2006). In addition, 33% of Grand Teton National Park is included in the Grizzly Bear Recovery Zone established by the U.S. Fish and Wildlife Service (USFWS 1993).

Grand Teton National Park manages visitors and bears in the same manner as Yellowstone National Park, using 3 broad zones: developed areas, road corridors, and backcountry (see Yellowstone Recreation Report below). Backcountry camping in Grand Teton National Park requires a permit and is managed by a quota system.

In 2021, total visitation in Grand Teton National Park was 5,473,101 visits, including recreational, commercial (e.g., Jackson Hole Airport), and incidental (e.g., traveling through the park on U.S. Highway 89/191 but not recreating) use. Over the past decade, total visitation has increased by 40%.

Recreational visits alone totaled 3,885,230, which is the highest number of recreation visits on record (Table 23) and exceeded the previous record set in 2018 by 394,079 visits. Similar to Yellowstone National Park, most of Grand Teton National Park's recreational visitation occurred from May through October with visits peaking in July.

In 2021, Grand Teton National Park had the highest number of backcountry user nights on record (44,435) and the highest number of overnight stays in frontcountry campgrounds (386,660). Long- and short-term trends of recreational visitation and backcountry user nights are shown in Table 24 and Fig. 19.

Due to slight revisions in the data, visitor use numbers in this report may differ from previous reports. The data in this report are consistent with publicly available data (found at: https://irma.nps.gov/STATS/Reports/Park/GRTE).

Table 23. Ten highest years for recreational visits to Grand Teton National Park, 1979–2021.

Rank	Year[a]	Recreational visits
1	2021	3,885,230
2	2018	3,491,151
3	2019	3,405,614
4	2017	3,317,000
5	2020	3,289,638
6	2016	3,270,076
7	2015	3,149,921
8	2014	2,791,392
9	1998	2,757,060
10	1996	2,733,439

[a] Grand Teton National Park did not differentiate between recreational and non-recreational visits until 1979.

Table 24. Average annual recreational visitation and average annual backcountry use nights in Grand Teton National Park by decade from 1951 through 2019.		
Decade	**Average annual recreational visitation[a]**	**Average annual backcountry use nights**
1950s	1,102,518	Data not available
1960s	2,326,580	Data not available
1970s	2,689,306	Data not available
1980s	1,728,218	22,614
1990s	2,362,833	28,592
2000s	2,497,899	27,515
2010s	3,007,602	33,400

[a] Grand Teton National Park did not differentiate between recreational and non-recreational visitation until 1979. In 1983 and 1992, the park updated methods for counting visitation. These updates may be the cause of some large fluctuations in visitation numbers between years. Therefore, park-wide visitation data are not strictly comparable between years of different counting methods.

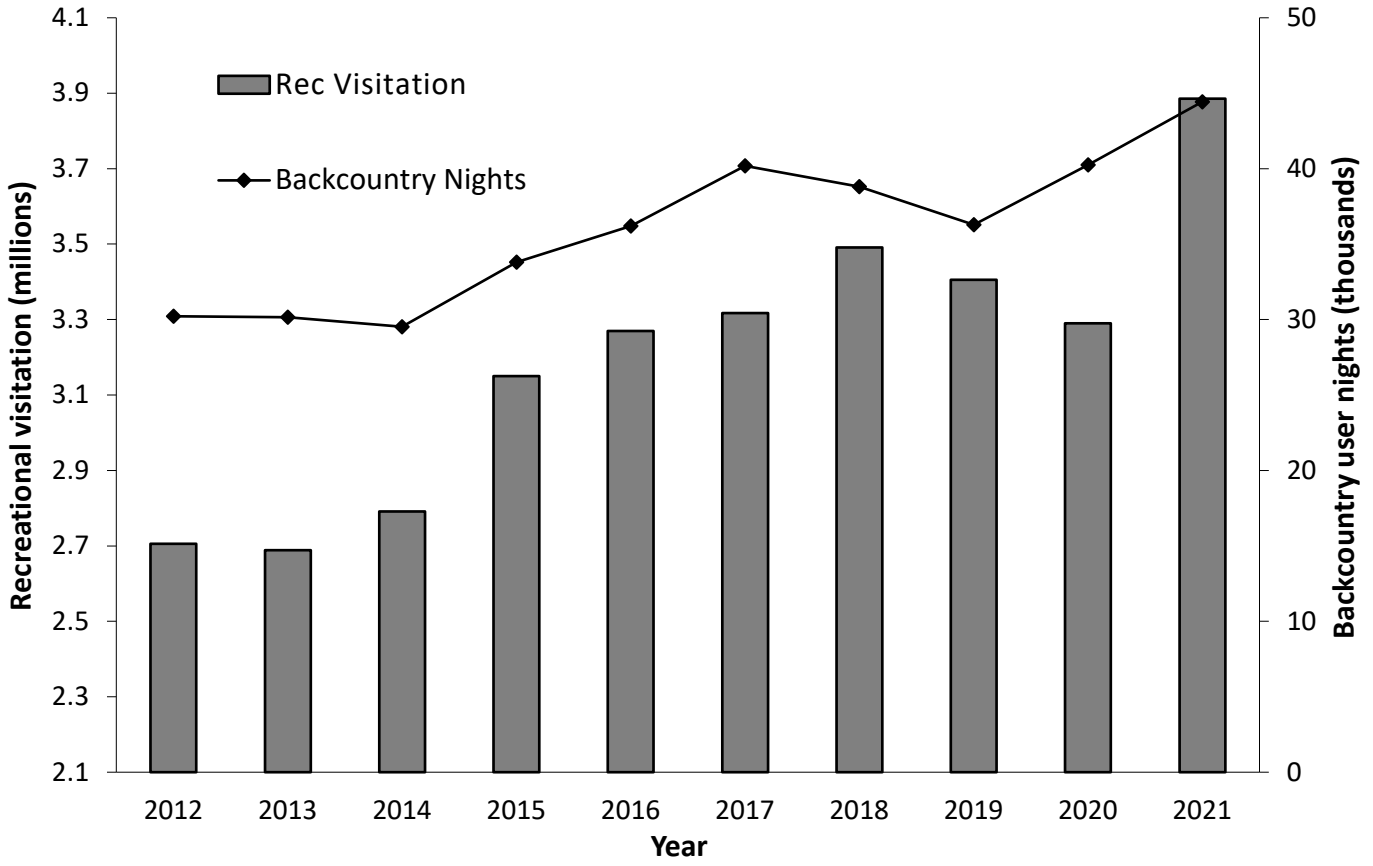

Fig. 19. Trends in recreational visitation and backcountry user nights in Grand Teton National Park, 2012–2021.

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

Yellowstone National Park encompasses 899,139 ha in the core of occupied grizzly bear habitat in the GYE. Most (~99%) of the habitat in the park is relatively pristine, undeveloped land; 92% of the park has been recommended for wilderness designation and by National Park Service policy, is managed so as not to preclude that designation in the future (National Park Service 1974, 2006). Only ~1% of the park's natural landscape has been significantly altered through construction of roads, buildings, and developments. Yellowstone National Park is located entirely within the boundaries of the Yellowstone Ecosystem Grizzly Bear Recovery Zone established by the U.S. Fish and Wildlife Service (USFWS 1993).

The National Park Service is mandated to preserve the cultural and natural resources of Yellowstone National Park unharmed for the benefit and enjoyment of future generations. This mandate requires providing recreational experiences for visitors on a landscape shared with grizzly bears. Visitor activities are carefully regulated to ensure minimal effects to free-ranging grizzly bears and their habitat. Visitors and bears in the park are managed in 3 broad zones: developed areas, road corridors, and backcountry/proposed wilderness. Each zone has different strategies for managing the human-bear interface (Table 25). Human activities are prioritized in developed areas, road corridors are managed for use by both people and bears, and bears are generally given priority in backcountry areas.

Recommended wilderness status protects 92% of the grizzly bear habitat in Yellowstone National Park from construction of roads and developments. To reduce disturbance of bears in important backcountry habitat and to prevent displacement of bears from high-quality food resources, Yellowstone National Park has designated 16 Bear Management Areas encompassing 464,638 acres (21% of Yellowstone National Park) of the highest quality bear habitat within the park. Recreational activity is limited within Bear Management Areas through a variety of seasonal trail, campsite, and area closures, no off-trail travel requirements, and time-of-day use restrictions implemented during the active bear season.

Backcountry recreation related disturbance of bears is further reduced by implementing a designated backcountry campsite system in the park. The designated backcountry campsite system limits the number of people and parties that can camp in the backcountry each night, thereby reducing the frequency of encounters with bears. In addition, by making overnight recreational activity more predictable to bears, the designated backcountry campsite system reduces the potential for confrontations at campsites. The danger of bear-human confrontations decreases if grizzly bears know where to expect people (Herrero 2002). Bear-resistant food storage devices (food hanging poles or bear-proof food storage lockers) are provided at every designated backcountry campsite, thereby reducing the frequency that bears obtain human foods, cause conflicts in campsites, and need to be killed in subsequent management actions.

Total visitation to Yellowstone National Park in 2021 was 6,189,608 visits (https://irma.nps.gov/STATS/Reports/Park/YELL), including recreational and non-recreational use. Recreational visits in 2021 totaled 4,860,537 the busiest year on record (Table 26). In 2021, visitation for the months of May, June, July, August, and September were the busiest on record. July was also the most visited month in Yellowstone National Park's history and the first time that visitation exceeded 1 million visits in a single month. Most of the park's recreational visitation in 2021 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 2021, there were 4,613,995 recreational visits (95%) during those peak months, an average of 25,076 recreational visits per day. Park visitors spent 557,915 overnight stays in roadside campgrounds, and 43,298 overnight stays in remote backcountry campsites in the park.

Average annual recreational visitation has increased from 7,378 visits/year during the late 1890s to 3,779,045 visits/year during 2010–2019 (Table 27, Fig. 20). Except for the 2020–2021 COVID pandemic years, the average number of overnight stays in roadside campgrounds in the park also increased considerably in the last decade (Table 27, Fig. 21). Although total park recreational visitation has increased steadily over time, the average number of overnight stays in backcountry areas, the most important bear habitat in the park, has been relatively stable, ranging from 39,280 to 45,615 overnight stays per year per decade (Table 27, Fig. 22). The number of overnight stays in the backcountry is limited by the number and capacity of designated backcountry campsites in the park.

Table 25. Management zone, proportion of park within the management zone, and management prescription for the visitor-bear interface in Yellowstone National Park.

Management zone	Area	Management prescription
Developments	2,212 ha (5,467 acres) (<1% of park)	• Managed for people to the exclusion of bears • Bears conditioned to human foods are removed (euthanized or sent to zoos) • Visitors are given priority when visitor and bear activities are not compatible
Road corridors	654 ha (1,617 acres) (<1% of park)	• Managed for transportation and bear viewing • Bears tolerated in roadside habitats for foraging and other natural behaviors • Habituation of bears to people is expected • Bears conditioned to human foods are removed
Wilderness and undeveloped lands	886,552 ha (2,190,718 acres) (~ 99% of park)	• Managed primarily for bears and other wildlife • Overnight visitation is capped by a limited number of designated backcountry campsites • Most recreational day use is <5 km (3 miles) from roads • Implementation of seasonal recreational closures for high use bear areas • Bears are generally given priority in recreation management decisions where bear and human activities are not compatible • Bears conditioned to human foods are removed

Table 26. Ten highest years for recreational visits to Yellowstone National Park, 1895–2021.

Rank	Year	Visitation
1	2021	4,860,537
2	2016	4,257,177
3	2017	4,116,525
4	2018	4,114,999
5	2015	4,097,710
6	2019	4,020,287
7	2020	3,806,306
8	2010	3,640,184
9	2014	3,513,484
10	2012	3,447,727

Table 27. Average annual recreational visitation, auto campground overnight stays, and backcountry campsite overnight stays by decade, Yellowstone National Park, 1895–2021.

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	3,779,045	720,875	41,637
2020s	4,333,422	503,101[g]	41,246

[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] Several National Park Service campgrounds were closed for a portion of 2020 due to COVID safety concerns; the Norris Campground was closed in 2020 and 2021.

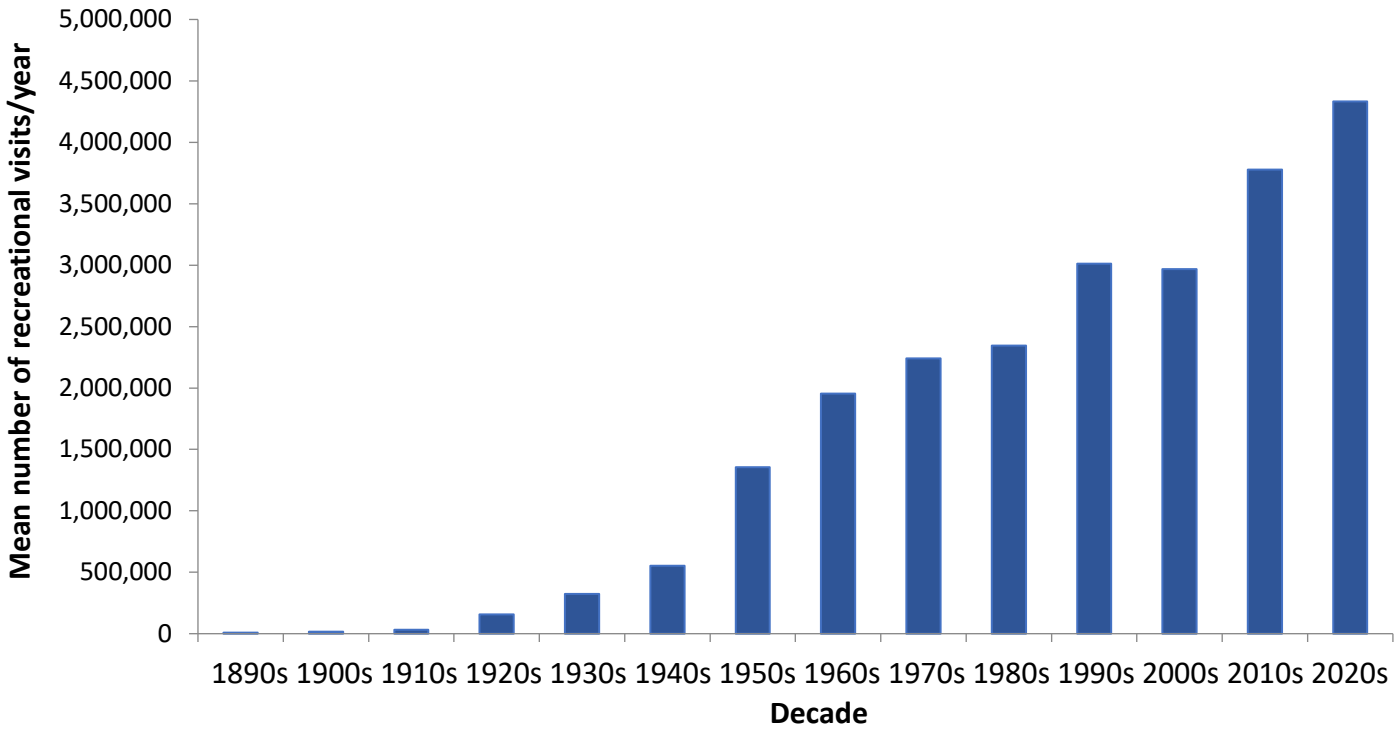

Fig. 20. Average annual number of recreational visits per year by decade, Yellowstone National Park, 1895–2021.

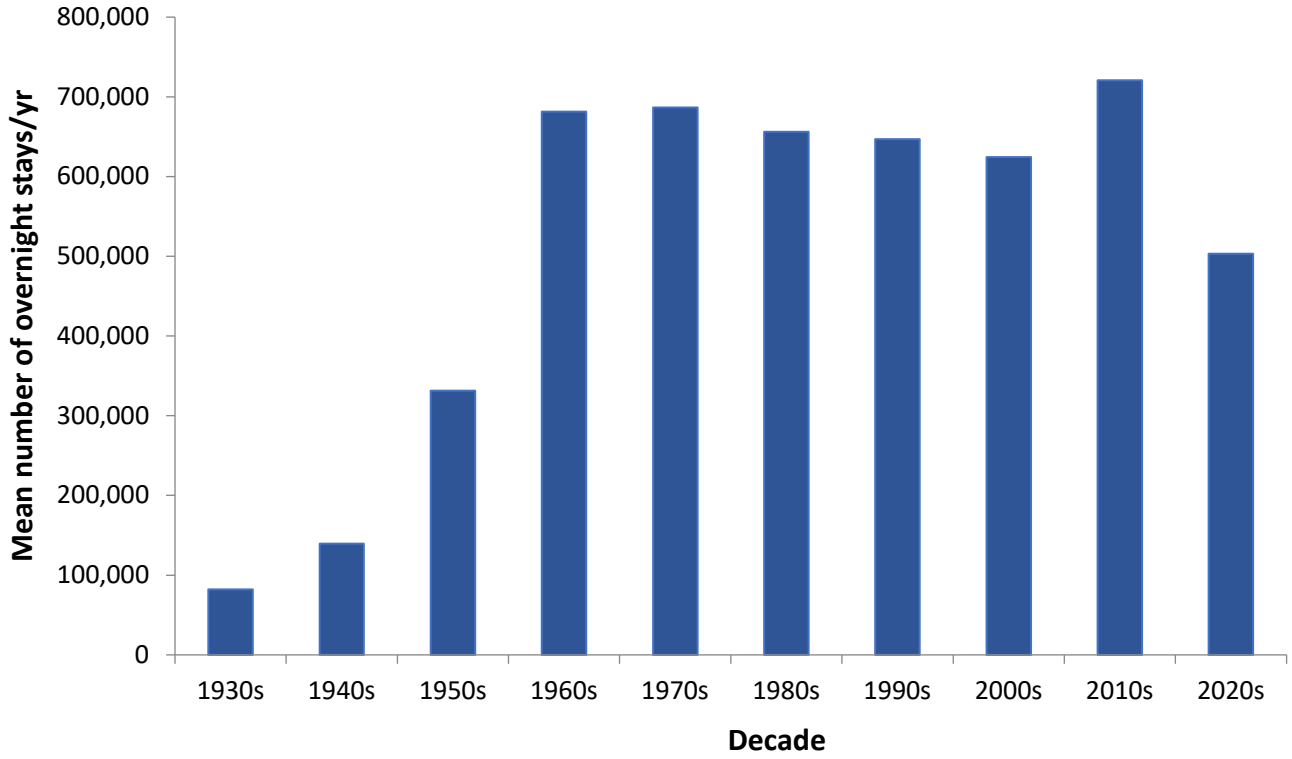

Fig. 21. Average annual number of overnight stays in roadside campgrounds per year by decade, Yellowstone National Park, 1930–2021. Several National Park Service campgrounds were closed for a portion of the spring and early summer of 2020 due to COVID safety concerns; the Norris Campground was closed the entire summer in 2020 and 2021.

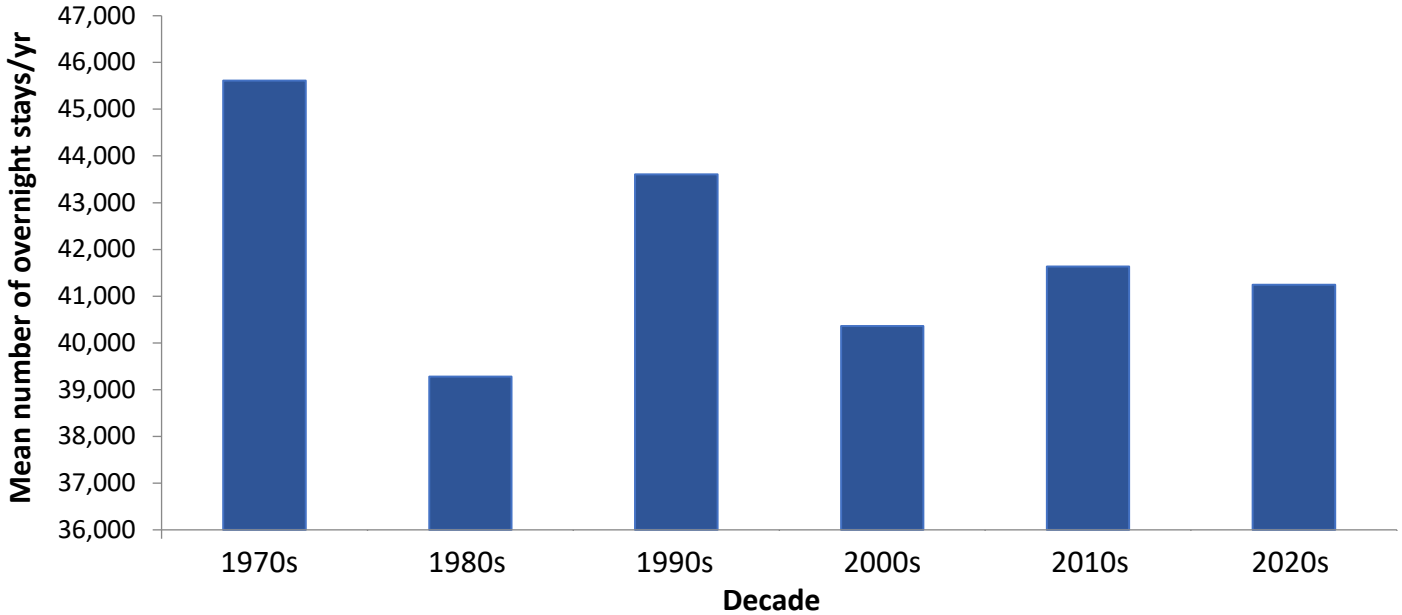

Fig. 22. Average annual number of overnight stays in backcountry campsites and dispersed camping zones per year by decade, Yellowstone National Park, 1972–2021

HUMAN-GRIZZLY BEAR CONFLICTS IN THE GREATER YELLOWSTONE ECOSYSTEM

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

Five human-grizzly bear conflicts were recorded in Grand Teton National Park and the John D. Rockefeller, Jr. Memorial Parkway in 2021 and 2 grizzly bear management actions were taken. Of the 5 human-grizzly bear conflicts, 4 incidents involved grizzly bears obtaining garbage while the fifth incident involved a grizzly bear attempting to enter an unoccupied residential structure. In response to these incidents, bear management staff initiated 2 management actions, including relocating 1 grizzly bear away from developed areas and removing a second grizzly bear for escalating conflict behavior in the park and on private lands south of the park.

Management of nonfood-conditioned, human-habituated bears required considerable effort to minimize human-bear conflicts. Grizzly bears were hazed out of developed areas on 22 occasions and off park roadways 42 times. Grand Teton National Park recorded a minimum of 478 bear jams (232 grizzly bear, 243 black bear, and 3 occasions where bear species could not be determined), which resulted when habituated bears frequented roadway corridors drawing crowds of wildlife watchers. Grizzly bear jams peaked in June and black bear jams peaked in September. The park's Wildlife Brigade, a team of 2 seasonal employees and 29 volunteers, managed many of these bear jams and enforced food storage regulations at campgrounds, picnic areas, and other developments. In addition, this team routinely staffed a bear education trailer at a popular park turnout, educating thousands of visitors on how to safely recreate in bear country and use bear spray. Wildlife Brigade volunteers contributed over 9,500 hours toward bear conservation and public education efforts within the park. Complementing the efforts of the Wildlife Brigade, interpretative staff provided bear safety information and bear spray demonstrations at park visitor centers.

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 (i.e., bear boxes). One hundred and 4 bear boxes, each with a 30-cubic-foot capacity, were installed in 2021, bringing the total number of bear boxes in park campgrounds and other developed sites to 1,015. Five of the parks 6 frontcountry campgrounds, including Gros Ventre, Jenny Lake, Signal Mountain, Colter Bay, and Lizard Creek Campgrounds, have a bear box at each campsite.

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

Management Strategy

Yellowstone National Park's management strategy for reducing grizzly bear-human conflicts and human causes of grizzly bear mortality places significant emphasis on prevention of bear-human conflicts rather than post conflict management (e.g., capture and translocations) of bears involved in conflicts. This strategy is accomplished by: 1) providing park visitors with information on how to hike, camp, recreate, and store anthropogenic bear attractants in a manner that reduces the chances of bear-human conflicts, 2) providing park visitors with bear-proof infrastructure (e.g., bear-resistant garbage cans, dumpsters, and food storage devices, etc.) so that food and garbage storage regulations are easy and convenient to comply with, 3) rigorously enforcing food and garbage storage regulations through food and garbage security patrols in frontcountry developed areas, roadside campgrounds, and backcountry campsites, and, 4) fostering, through removal of human food conditioned bears, a population of bears in the park that don't seek anthropogenic attractants.

Occasionally, park visitors fail to store food or garbage appropriately, park staff fail to detect or correct improperly stored anthropogenic attractants, or grizzly bears simply outsmart park visitors and Yellowstone National Park staff or defeat food storage infrastructure and obtain human food rewards. In incidents where bears specifically seek out anthropogenic attractants or behave aggressively toward people, injure people, or damage property in their attempts to gain access to human foods (offensive aggression), the bears are generally killed, even if it is their first offense. However, in relatively benign incidents where bears inadvertently happen upon unsecured food, the bears are generally left to roam free on the landscape. In addition, no action is taken against bears that injure people in defensive reactions to surprise encounters occurring in backcountry areas (defensive aggression). Although killing bears conditioned to human foods after just 1 aggressive conflict with people may seem severe, on a long-term basis this management strategy results in considerably fewer bear-human conflicts overall, and equally important, considerably fewer bears being killed in management actions to address conflicts. This management strategy promotes and favors occupation of available habitat by bears that do not seek anthropogenic foods. In contrast, tolerance of human food conditioned bears can promulgate a population where conflict behaviors become so pervasive resulting in the development of a tradition or culture in a large segment of the population.

Bears exhibit social learning behavior (Gilbert 1999, Mazur and Seher 2008, Morehouse et al. 2016). Human food-conditioned bear foraging behavior is often transmitted through social learning from mother bears to cubs, and from their grown female offspring to their cubs and future cubs (Cole 1976, Gilbert 1999, Mazur and Seher 2008). Cubs learn foods by watching their mothers and sharing their mother's food during the 1.5-3.5 years spent under her care (Meagher and Fowler 1989, Gilbert 1999). Yellowstone National Park managers attempt to break the chain of learned conflict behavior passed from mothers to offspring and adult female offspring to future offspring (Cole 1976, Meagher and Fowler 1989). Breaking the sequence of learned conflict behaviors is important so that conflict behavior, such as damaging property or injuring people to obtain anthropogenic foods, does not become a traditional behavior that persists across multiple generations of matriarchal linages in a large segment of the bear population (Mazur and Seher 2008). Once a conflict bear has been removed, the next bear to reoccupy that habitat, area, or general range may be an immigrating subadult that exhibits wild behaviors rather than human food-conditioned conflict behaviors (Cole 1976, Meagher and Fowler 1989). If the next bear to occupy the area exhibits conflict behaviors, it is also removed. With a foundation of bear-proof infrastructure, effective educational efforts, and enforcement of food storage regulations, eventually the area will be re-occupied by a dispersing subadult from another area exhibiting wild behaviors. By consistently implementing this strategy over the long term, a population of bears once dominated by a culture of conflict behaviors, such as bears in Yellowstone National Park from the 1930s–1960s (Cole 1971, 1976, Meagher and Phillips 1983, Schullery 1992, Wondrak Biel 2006), can be converted to and maintained as a population composed of individuals exhibiting primarily wild behaviors (Cole 1976), such as bears in Yellowstone National Park from the 1980s to the present (Meagher and Phillips 1983, Gunther 1994, Garshelis et al. 2017). The removal of bears conditioned to human foods and exhibiting conflict behaviors allows young bears that are not conditioned to human foods to recruit into and progressively replace conflict bears in the local population (Cole 1976, Meagher and Fowler 1989). Occasional removal of food-conditioned bears will still sometimes be

necessary, as bear innovators periodically reestablish conflict behaviors (Mazur and Seher 2008).

The described management strategy has been highly successful at reducing grizzly bear-human conflicts and management removals of grizzly bears on national park lands where humans are temporary visitors and their activities are highly controlled (Meagher and Phillips 1983, Gunther 1994, Garshelis et al. 2017, White et al. 2017). For example, during the last decade (2012-2021), there were >39.4 million recreational visits to Yellowstone National Park. These visitors spent >6.8 million overnight stays in roadside campgrounds and >400,000 overnight stays in remote backcountry campsites. Given the high level of human recreational activity in Yellowstone National Park during the last 10 years, grizzly bears undoubtedly had some opportunities to come into conflict with people. Despite intense efforts to prevent bears from obtaining human foods, on any given night there were likely a few bear-resistant dumpsters with broken latches, several coolers left out overnight in roadside campgrounds, or food that was not properly stored in backcountry campsites. However, under the parks strategy of aggressively removing bears conditioned to human foods and promoting occupation of habitat by bears that are not conditioned to human foods, few bears in the park sought anthropogenic attractants or tested bear-proof infrastructure. During 2012–2021, there were 26 ($\bar{x}$ = 2.6 ± 2.0 SD/year) documented incidents in the park where grizzly bears obtained human foods or damaged property while attempting to access anthropogenic attractants. In response to the 26 incidents, 2 ($\bar{x}$ = 0.2 ± 0.4 SD/year) independent age grizzly bears were killed in management actions. These numbers are remarkable considering Yellowstone National Park currently receives >4 million recreational visits per year and has a high density of grizzly bears throughout much of the park.

Limiting management removals of bears to sustainable rates while operating under the park's aggressive bear management strategy requires significant investment of resources into conflict prevention. To effectively allocate resources for implementing management actions designed to prevent grizzly bear-human conflicts, Yellowstone National Park managers need baseline information regarding the types, causes, locations, and recent trends of conflicts. To address this need, all reported grizzly bear-human conflicts are recorded annually. Conflicts are grouped into broad categories using standard definitions (Table 28).

Human-Bear Conflicts

There were 4 human-grizzly bear conflicts reported in Yellowstone National Park in 2021 (Table 29). On May 28 at approximately 6 a.m., a man out birding alone on the Beaver Ponds trail was injured by a female grizzly bear accompanied by a yearling. The incident occurred approximately 1.5 miles from the trailhead that originates behind the Mammoth Hotel. The man saw the bear approximately 25 yards in front of him and began backing away but tripped and fell down. Immediately after falling, the adult bear charged and bit him on the right thigh several times, inflicting deep puncture wounds and tearing his skin. The bear also clawed his side leaving scratch wounds and bruises. The bear then left and after a few minutes the man got up, called 911, and hiked out to the trailhead where he was transported by ambulance to the Livingston Hospital. The Beaver Ponds Trail was closed for several days after the incident. Because the adult bear was defending its yearling, no action was taken against the bear.

On May 30 between midnight and 1 a.m., a vehicle driving between DeLacy Creek Trailhead and East Divide saw a female grizzly bear with 1 cub of the year crossing the road approximately 10 – 20 meters in front of their car. When the bears saw the vehicles lights, the adult bear charged at the front of the car. The driver swerved to avoid the bears, but the bear hit and dented the driver side front and rear doors. The bear then ran off and they did not see it again. No action was taken against the bear.

On September 1 at approximately 333:30 p.m., 2 backpackers arrived at backcountry campsite 6D1 at the confluence of Mountain Creek and the Yellowstone River and found an adult grizzly bear in the core camp digging up and eating food scraps that had been left in the campfire ring. The backpackers were able to contact the Central Backcountry Office via an In-Reach satellite communications device and were assigned an alternative campsite several miles away. Backcountry campsite 6D1 was closed, bear warnings were placed on 4 nearby campsites, and monitoring of the area was increased. No action was taken against the bear.

Early on the morning of October 18, a grizzly bear damaged a bear-resistant plastics recycling can at the Sheepeater Cliff picnic area. The bear tore the bear-resistant plastics recycling can which was attached to a 6-inch-thick concrete base out of the ground and bent the can. The bear was unable to get the bear-proof hood off of the can, so did not get at any of the recycled plastic bottles inside. Muddy bear paw prints left on the can clearly identified the bear responsible as a grizzly.

Several of the other recycling containers at the picnic area had muddy bear paw prints on them. Because the bear did not obtain a food reward, no action was taken against the bear.

Many factors including the availability of natural bear foods, grizzly bear population numbers, and park visitation influence the annual number of bear-human conflicts in Yellowstone National Park. The annual number of conflicts in the park decreased substantially after efforts to prevent bears from obtaining anthropogenic foods were implemented in the late 1960s and early 1970s (Fig. 23, Meagher and Phillips 1983, Gunther 1994, Garshelis et al. 2017).

Grizzly Bear Mortality

During 2021, there were 2 known grizzly bear mortalities in the Yellowstone National Park portion of the GYE. On June 4 at 11:32 p.m., radio collared grizzly bear #653, a 13-year-old male, was hit and killed by a vehicle at milepost 22 on Highway #191. Bear #653 ran out into the road in front of an oncoming vehicle traveling at 55+ mph and was hit and killed.

On July 12, a fisherman found the carcass of 22-year-old male grizzly bear #727. The bear was lying next to the Lamar River near the mouth of Amethyst Creek. The carcass was infested with maggots and too old to determine the exact cause of death. However, there was no evidence that the bear died from anything other than natural causes.

Trends in causes of grizzly bear mortality inside Yellowstone National Park have changed considerably over time. From the late 1950s through the 1970s, most grizzly mortality in the park was due to human causes (Fig. 24), primarily management removals of bears involved in bear-human conflicts (Craighead et al. 1988). Over the last 4 decades (1980–2021), most grizzly mortality in the park is from natural causes, primarily complications of old age and intra- and inter-specific strife and predation.

Management Actions

Although grizzly bears caused few conflicts in the park in 2021, park staff dedicated considerable management effort toward preventing conflicts from occurring (Table 30). In response to grizzly bear activity in visitor use areas, park staff posted bear warning signs at 18 locations and implemented temporary trail or area closures at 19 locations. To prevent grizzly bears from being attracted into visitor use areas by wildlife carcasses, park staff removed 105 large mammal carcasses from developments, roadside campgrounds, road corridors, trails, backcountry campsites, and other visitor use areas. Wildlife carcasses removed from visitor use areas included 32 elk, 31 bison, 28 mule deer, 5 black bear, 4 coyotes, 2 pronghorn, 1 bighorn sheep, 1 grizzly bear, and 1 bobcat. To discourage grizzly bears from entering areas of concentrated visitor use, park staff hazed grizzlies out of human use areas 51 times. Staff hazed grizzly bears out of primary road corridors 41 times and out of park developments 10 times. In addition, as part of the park's strategy for preventing bears from obtaining human foods, 187 bear-proof food storage lockers (30 ft^3) were purchased with donations raised by the Yellowstone Forever Foundation and installed in roadside campgrounds and backcountry campsites. With the installation of 185 food storage lockers in roadside campgrounds, 1,162 (61%) of the park's 1,907 roadside campground campsites now have bear-proof food storage lockers. Seven of the parks 11 campgrounds, including Pebble Creek, Slough Creek, Tower Falls, Mammoth, 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 Canyon Village (91% of sites), Madison (59% of sites), Bridge Bay (57% of sites), and Grant Village (7% of sites) campgrounds. It is the park's goal to provide visitors with bear-proof food storage lockers in every roadside campsite in the park. In addition, 2 food storage lockers were installed in backcountry stock campsite 1G5 to replace a broken food-hanging pole. All 300 designated backcountry campsites in Yellowstone National Park currently have a food storage device (food hanging poles in 260 campsites and bear-proof food storage lockers in 40 campsites). When camping in non-designated sites in dispersed camping zones, backcountry campers are required to use IGBC approved hard-sided food storage canisters or rig their own food-hanging device.

Management of Roadside Bear Viewing

In 2021, considerable effort was dedicated to management of roadside bear-viewing opportunities. Staff and visitors reported 342 roadside traffic-jams caused by visitors stopping to view human-habituated (but not food conditioned) grizzly bears along park roads. Thousands of visitors viewed bears at these bear jams. Park staff responded to 221 (65%) of the grizzly bear jams and spent 964 personnel hours managing habituated grizzly bears, the traffic associated with the bear jams, and the visitors that stopped to view and photograph habituated grizzly bears along roads. On average, park personnel spent 4.4 staff-hours managing

each grizzly bear jam in 2021. The objectives of managing visitors at roadside bear-viewing opportunities include: 1) keeping visitor behavior as predictable as possible to bears, 2) keeping visitors at least 100 m from bears, and 3) preventing visitors from feeding, approaching, encircling, or following roadside bears. The habituation of some bears to people combined with the presence of large areas of non-forested habitat in Yellowstone National Park, has created exceptional bear viewing opportunities, resulting in significant growth of bear viewing as a local industry in park gateway communities. 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 park gateway communities annually (Richardson et al. 2014).

Table 28. Definition of terms used in human-bear conflict management in Yellowstone National Park.

Term	Definition
Human-bear conflict	Incidents where bears injured or killed people, damaged property, obtained human foods, garbage, or other anthropogenic attractants, or killed livestock.
Property damage – without food reward	Incidents where bears damaged property including vehicles, buildings, tents, and camping equipment, etc., but did not obtain human-food rewards.
Anthropogenic food reward	Incidents where grizzly bears obtained human related foods including garbage, groceries, grease, pet foods, livestock feed or other edible human-related attractants.
Human injury	Incidents where bears injured 1 or more people, including minor scratches, bites, and contusions.
Human fatality	Incidents where bears killed people intentionally or unintentionally in offensive encounters or during defensive reactions to encounters.
Livestock depredation	Incidents where bears killed or injured domestic horses, mules, burro's, donkeys, or llamas.

Table 29. Number of incidents of human-grizzly bear conflict reported in Yellowstone National Park, 2021.

Conflict type	Number of conflicts
Property damage–without food reward	2
Anthropogenic food reward	1
Human injury	1
Human fatality	0
Livestock depredation[a]	0
Total conflict incidents	4

[a]There are no cattle or sheep grazing allotments inside of Yellowstone National Park. Horses, mules, and llamas used as riding or pack stock are the only domestic livestock in the park that can potentially be killed by grizzly bears. Forty commercial outfitters have contracts to provide stock day rides and overnight pack trips in the park. In 2021, 1,606 stock animals (horses, mules, llamas) spent 5,269 nights in Yellowstone National Park's backcountry.

Table 30. Number of management actions taken to reduce the potential for conflicts with grizzly bears in Yellowstone National Park, 2021.

Management action	Number of incidents
Bear warnings posted	18
Temporary area closures implemented	19
Wildlife carcass removal from visitor use areas	105
Bear-jam management	221
Management hazing	51
Attempt capture–unsuccessful	0
Captured, marked, and released on site	0
Captured and relocated	0
Captured and removed (euthanized or live placement in zoo)	0
Captured for humane reasons	0
Total management actions	414

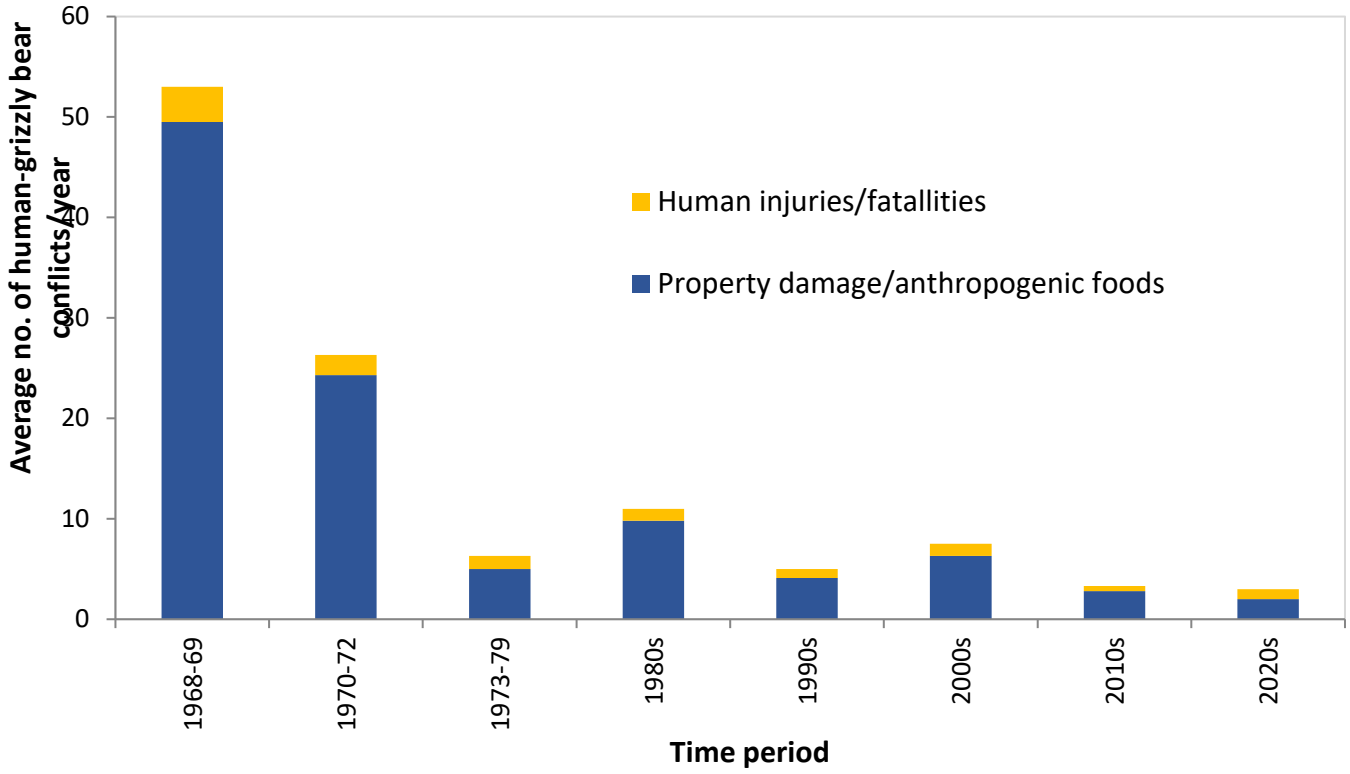

Fig. 23. Average number of human-grizzly bear conflicts per year by time period, Yellowstone National Park, 1968–2021.

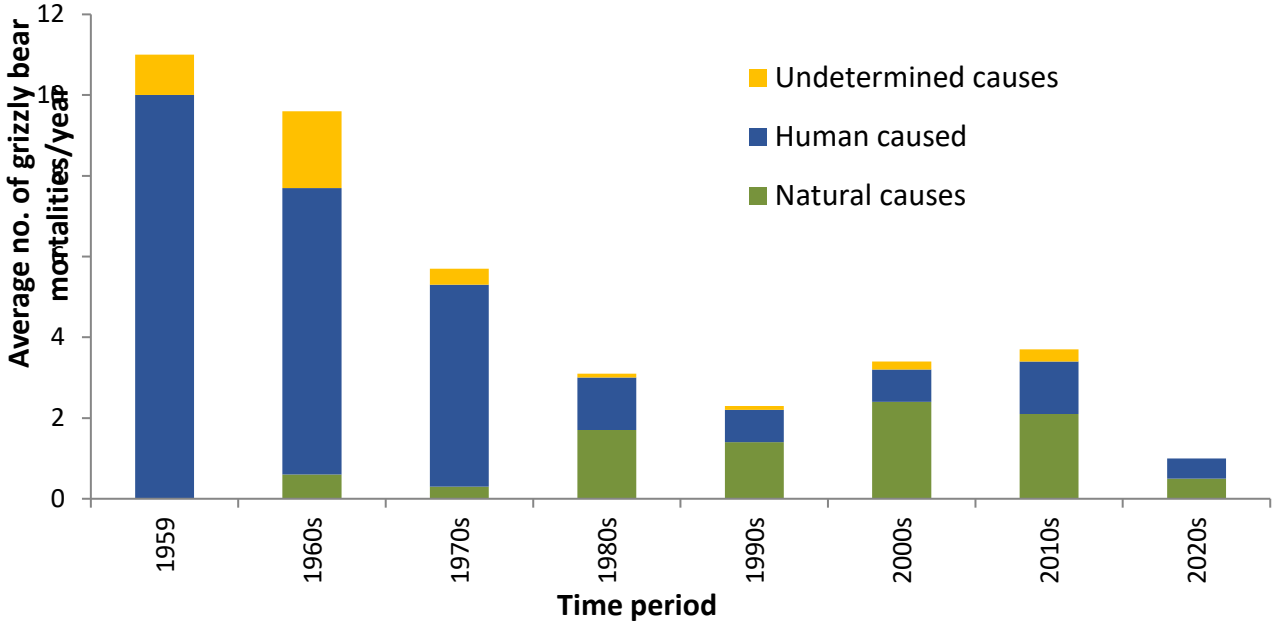

Fig. 24. Average number of known and probable grizzly bear mortalities per year by time period, Yellowstone National Park, 1959–2021.

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

The Idaho Department of Fish and Game responded to 48 human-grizzly bear conflicts in 2021 (Table 31, Fig. 25). Conflicts have consistently occurred in Idaho's portion of the Greater Yellowstone Ecosystem since 2005 (Fig. 26). Since 1992, the vast majority (93%) of conflicts have occurred inside the DMA (Fig. 27). Only 1 conflict occurred outside the DMA in 2021.

Table 31. Human-grizzly bear conflicts in the Idaho portion of the Greater Yellowstone Ecosystem, 2020.

Conflict type	Number of conflicts
Human injury	1
Encounter situations	5
Public safety threat (habituated, near developed site, etc.)	18
Anthropogenic foods	14
Property damage–without food reward	3
Livestock depredation–cattle	5
Human-caused bear mortality	2
Total	48

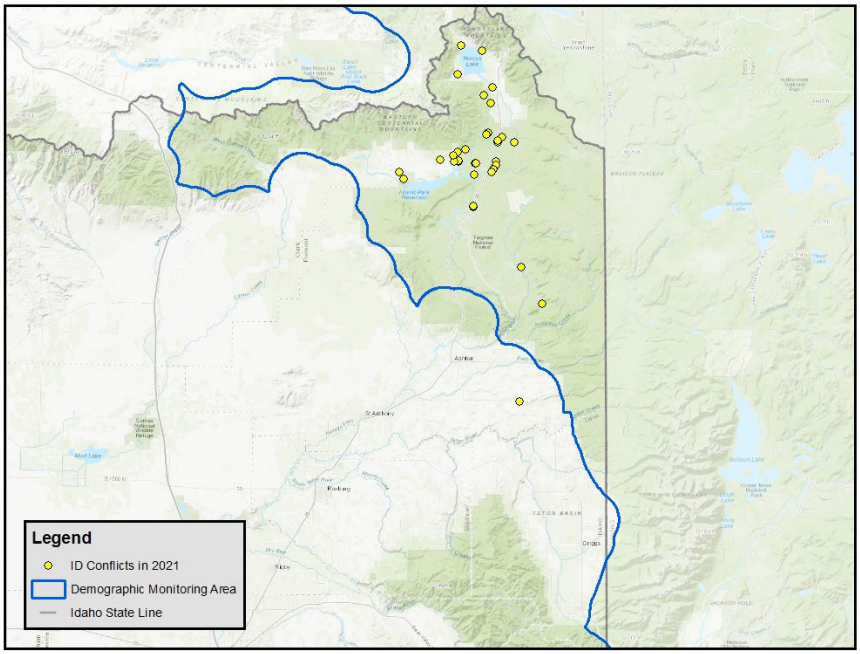

Fig. 25. Locations of human-grizzly bear conflicts in the Idaho portion of the Greater Yellowstone Ecosystem, 2021. Base map source: 2013 National Geographic Society, i-cubed, Washington, D.C.

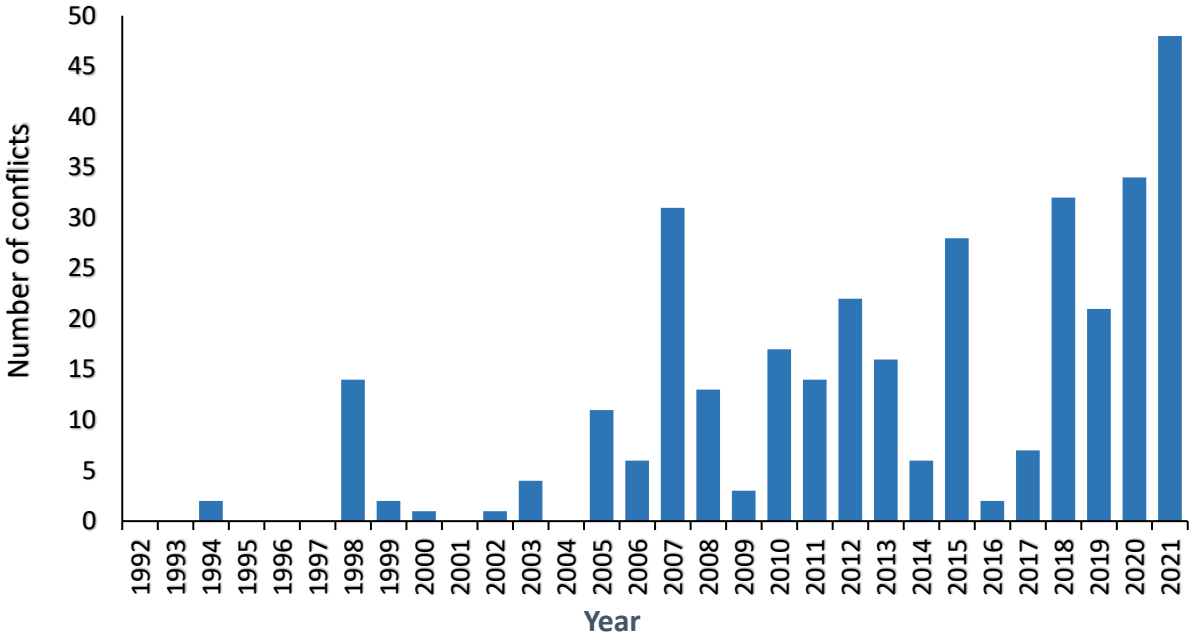

Fig. 26. Number of documented human-grizzly bear conflicts in the Idaho portion of the Greater Yellowstone Ecosystem, 1992–2021.

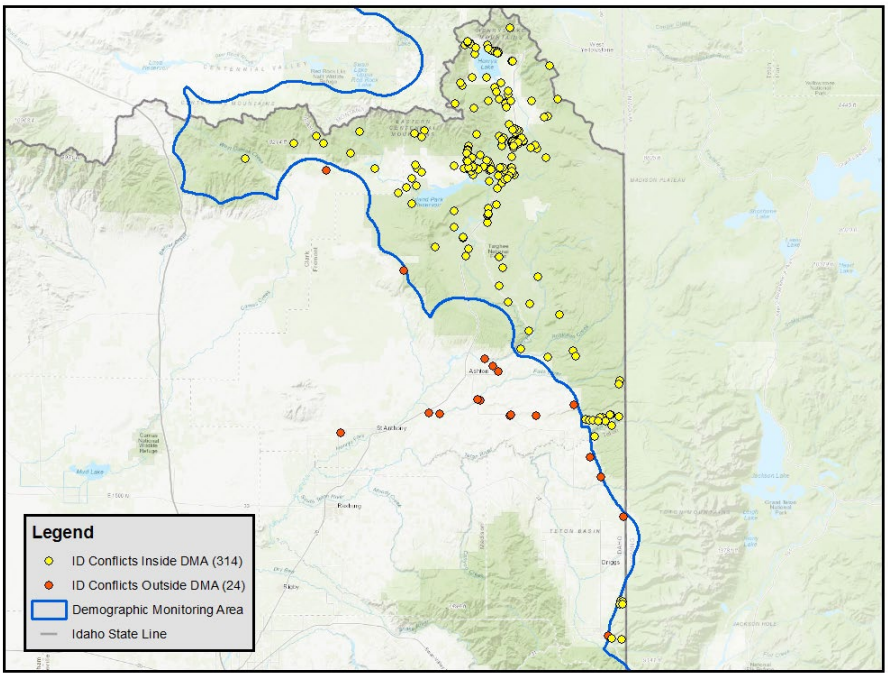

Fig. 27. Location of documented human-grizzly bear conflicts inside and outside the Demographic Monitoring Area in the Idaho portion of the Greater Yellowstone Ecosystem, 1992–2021. Base map source: 2013 National Geographic Society, i-cubed, Washington, D.C.

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

During 2021 in Montana's portion of the Greater Yellowstone Ecosystem, there were a total of 128 investigated human-bear conflicts and 10 documented grizzly bear mortalities. The number of conflicts is shown by type in Table 32 and annual variation in conflicts and grizzly bear mortalities are shown in Fig. 28. For 2012–2021, the average number of grizzly bear conflicts was 88.4 per year and 9.4 grizzly bear mortalities per year.

Table 32. Human-grizzly bear conflict types in Montana portion of the Greater Yellowstone Ecosystem, 2021.

Conflict type	Number of conflicts
Livestock - cattle	55 (55 cattle killed or injured)
Livestock - sheep	2 (6 sheep killed)
Livestock - poultry	1 (3 poultry killed)
Other property loss	2
Anthropogenic foods	9
Anthropogenic foods with property damage	3
At developed sites–safety concerns	29
Bear mortalities	10 (5 management, 2 others, and 3 defense of life)
Encounters and human injuries	15 (resulting in 2 human injuries and 1 fatality)
Management action (other)	2
Total	128

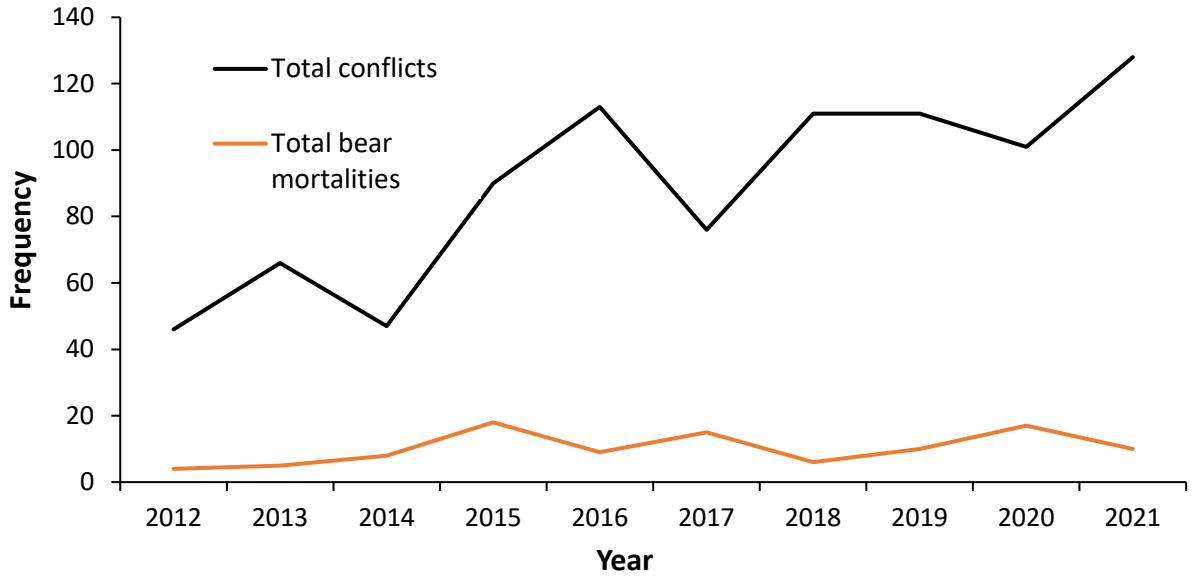

Fig. 28. Frequency of total grizzly bear conflicts and bear mortalities in Montana portion of the Greater Yellowstone Ecosystem, 2012–2021.

The distribution of grizzly bear conflicts by land jurisdiction is shown in Table 33. During 2021, the largest percentage (44%) of conflicts occurred on private land.

The trend in close encounters that can lead to human injuries or defense of life grizzly bear mortalities from 2012 through 2021 are shown in Fig. 29. The yearly average of these conflicts is 11.7 close encounters, 2.4 human injuries, and 2.8 defense of life grizzly bear mortalities. During 2021, there were 15 close encounters resulting in 2 human injuries, 1 human fatality, and 3 grizzly bear mortalities.

Cattle depredations are increasing as grizzly bear numbers and geographic distribution increases. The annual variation and overall increases in Montana Fish, Wildlife and Parks Region 3 and Region 5 are shown in Fig. 30. From 2012 through 2021, the yearly average for the geographic portions are 18.3 depredations in Region 3 and 16.2 in Region 5. During 2021, there were 48 documented cattle depredations in Region 3 and 7 in Region 5.

Fig. 31 displays a map of all 2021 conflict types and grizzly bear mortalities showing the distribution of management efforts and grizzly bear distribution. There is annual variation in these distributions and the numbers of conflicts in any geographic area.

Table 33. Total conflicts by land jurisdiction in Montana portion of the Greater Yellowstone Ecosystem, 2021.

Jurisdiction	Number of conflicts
Private	56
State	2
County or local government	8
Federal	0
Bureau of Land Management	0
Custer Gallatin National Forest	18
Beaverhead-Deerlodge National Forest	44
USFWS–National Wildlife Refuge	0
Total	128

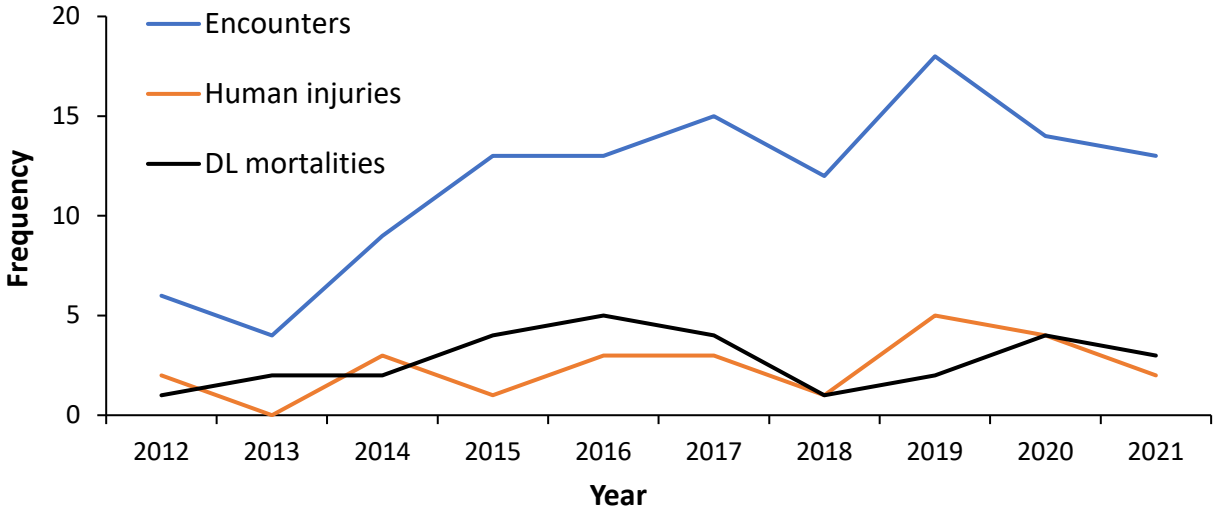

Fig. 29. Frequency of bear encounters, resulting human injuries and defense of life (DL) bear mortalities in Montana portion of the Greater Yellowstone Ecosystem, 2012–2021.

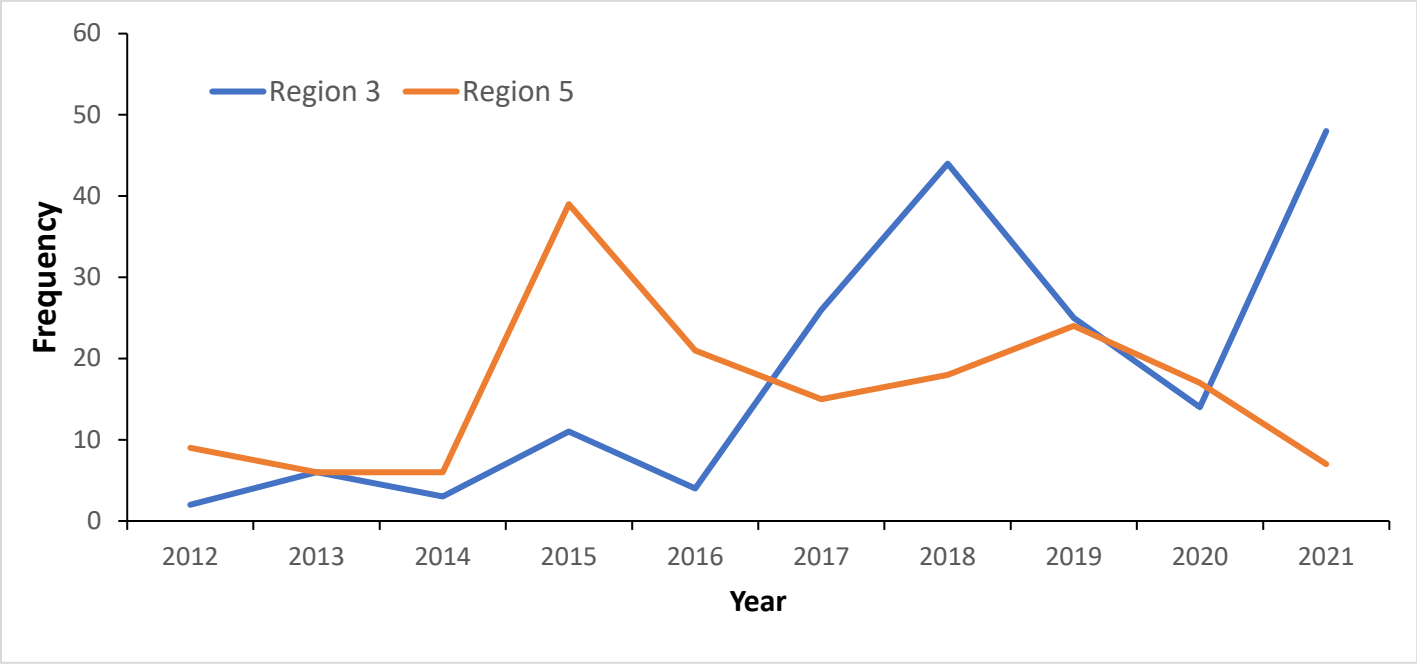

Fig. 30. Frequency of cattle depredation conflicts in Montana portion of the Greater Yellowstone Ecosystem, 2012–2021.

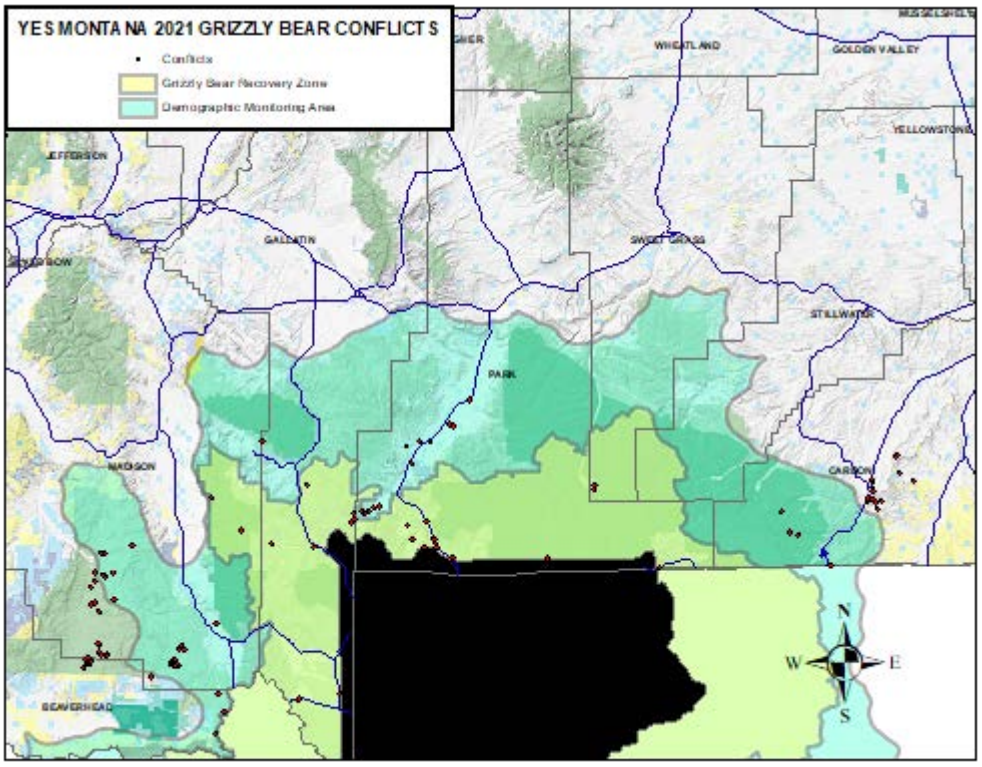

Fig. 31. Locations of all conflict types and grizzly bear mortalities in Montana portion of the Greater Yellowstone Ecosystem, 2021. Base Map: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community.

Human-Grizzly Bear Conflicts in Wyoming *(Brian DeBolt, Luke Ellsbury, Michael Boyce, Scott Stingley, Kyle Garrett, Gage Metzen, Clint Atkinson, Ken Mills, Phil Quick, Zach Gregory, Ryan Kindermann, Sean Ryder, Rebecca Lyon, and Daniel J. Thompson; Large Carnivore Section, Wyoming Game and Fish Department)*

In Wyoming, grizzly bear conflicts are defined as "interactions between grizzly bears, people and their property, resulting in damage to pets, livestock or bees, non-natural food rewards, animal caused human injury or death, and human caused injury or death to an animal other than legal hunting or a management action." Human-grizzly bear interactions and conflicts in Wyoming are a result of an abundance of bears seeking unnatural foods in association with people and property, close encounters with humans, or when bears kill livestock. Proactive prevention is the goal of the Wyoming Game and Fish Department (WGFD) in minimizing conflicts. However, the number and location of human-grizzly bear conflicts is influenced by the availability of unsecured, unnatural attractants (e.g., human foods and garbage), seasonal distribution and abundance of natural foods, grizzly bear density and distribution, and human and livestock use patterns on the landscape.

Management techniques used to reduce human-grizzly bear conflicts globally are deployed by the WGFD, including the capture and relocation of problem individuals. Relocation achieves several social and conservation functions: a) it reduces the chance of property damage, livestock damage, or human interactions in areas where the potential for conflict is high; b) it reduces the potential for grizzly bears to become food conditioned and/or human habituated, which often results in destructive and/or dangerous behaviors; c) it allows grizzly bears the opportunity to forage on natural foods and remain wary of people; and d) it could prevent removing grizzly bears from the population which may be beneficial in maintaining recovery criteria and population management objectives.

In addition to capture and relocation, the WGFD also removes grizzly bears (lethally or by live placement in a zoo or other facility) in response to human-grizzly bear conflicts, when necessary, as part of routine management operations. All grizzly bear management actions were conducted in coordination with the U.S. Forest Service and the U.S. Fish and Wildlife Service. The decision to relocate or remove a grizzly bear is made after considering a number of factors including the age and sex of the animal, behavioral traits, health status, physical injuries or abnormalities, type of conflict, severity of conflict, known history of the animal, human safety concerns, availability of suitable relocation sites, and population management objectives. Grizzly bears are relocated or removed in accordance with Federal and State law, regulation, and policy.

In 2005, the Wyoming Legislature enacted House Bill 203, which created Wyoming Statute §23-1-1001 which requires the WGFD to:

a) Upon relocating a grizzly bear or upon receiving notification that a grizzly bear is being relocated, the Department shall provide notification to the county sheriff of the county to which the grizzly bear is relocated within 5 days of each grizzly bear relocation and shall issue a press release to the media and sheriff in the county where each grizzly bear is relocated;

b) The notice and press release shall provide the following information:

i) the date of the grizzly bear relocation;

ii) the number of grizzly bears relocated; and

iii) the location of the grizzly bear relocation, as provided by commission rule and regulation;

c) no later than January 15 of each year the Department shall submit an annual report to the Joint Travel, Recreation, Wildlife, and Cultural Resources Interim committee. The annual report shall include the total number and relocation area of each grizzly bear relocated during the previous calendar year. The Department shall also make available the annual report to the public.

Subsequently, the Wyoming Game and Fish Commission promulgated Chapter 58 Notification of Grizzly Bear Relocation Regulation to further direct the implementation of Wyoming Statute §23-1-1001.

Grizzly Bear Management Captures, Relocations, and Removals

During 2021, the WGFD captured 45 individual grizzly bears in 49 capture events in an attempt to prevent or resolve conflicts; 4 bears (1022, 1041, 1043, and 1048) were each captured twice (Fig. 32 and Table 34). Of the 45 individual captures, 17 were female and 32 were male grizzly bears. Most captures were adult males (n = 19).

Of the 49 capture events, 23 captures were a result of grizzly bears killing livestock (primarily cattle), 17 were captures involving bears that obtained food rewards (pet, livestock food, garbage, fruit trees), or were frequenting developed sites or human populated areas unsuitable for grizzly bear occupancy. Two grizzly bears were captured for damaging corn fields, and 1 bear was captured because it was extremely emaciated and was humanely euthanized. Six grizzly bears were captured that were not implicated in the specific conflict (labeled "non-target" captures). Some non-target grizzly bears are relocated to focus trapping efforts toward the "target" individual or for human safety and some are released on site. Of the 49 capture events, 21 (43%) were in Park County, 10 (21%) were in Sublette County, 6 (12%) were in Fremont County, 7 (14%) were in Teton County, and 5 (10%) were in Hot Springs County (Fig. 32 and Table 34).

Of the 49 capture events, there were 19 relocation events (Fig. 33 and Table 34). All relocated grizzly bears were released on U.S. Forest Service lands in or adjacent to the Primary Conservation Area/Recovery Zone (Fig. 33). Of the 19 relocation events, 11 were conducted in Park County (58%), 6 (32%) in Teton County, 1 (5%) in Sublette County, and 1 (5%) in Fremont County (Fig. 33 and Table 1). The Sublette County relocation was a non-target grizzly bear (2-year old female #1041) relocated a short distance instead of on site to focus capture efforts toward the target bear involved in the conflict.

Grizzly bears are removed from the population due to a history of previous conflicts, a known history of close association with humans, or if they are deemed unsuitable for release into the wild (e.g., orphaned cubs, poor physical condition, or human safety concern). Of the 45 grizzly bears captured, 30 bears were removed from the population. Of these 30, 17 (57%) were outside of the Demographic Monitoring Area, which is the area considered suitable for the long-term viability of grizzly bears in the Greater Yellowstone Ecosystem. Removal of grizzly bears in Wyoming is dependent upon authorization from the U.S. Fish and Wildlife Service after careful and thorough deliberation, taking into account multiple factors unique to each conflict situation.

Notification to the County Sheriff and the Media

Within 5 days after releasing a grizzly bear, the county sheriff was notified by e-mail and a press release was distributed to all local media contacts in the county where the grizzly bear was released. The media release contained: the date of the relocation, the number of grizzly bears relocated, the location of the grizzly bear relocation, the reason the grizzly bear was relocated, and additional bear safety and conflict avoidance information.

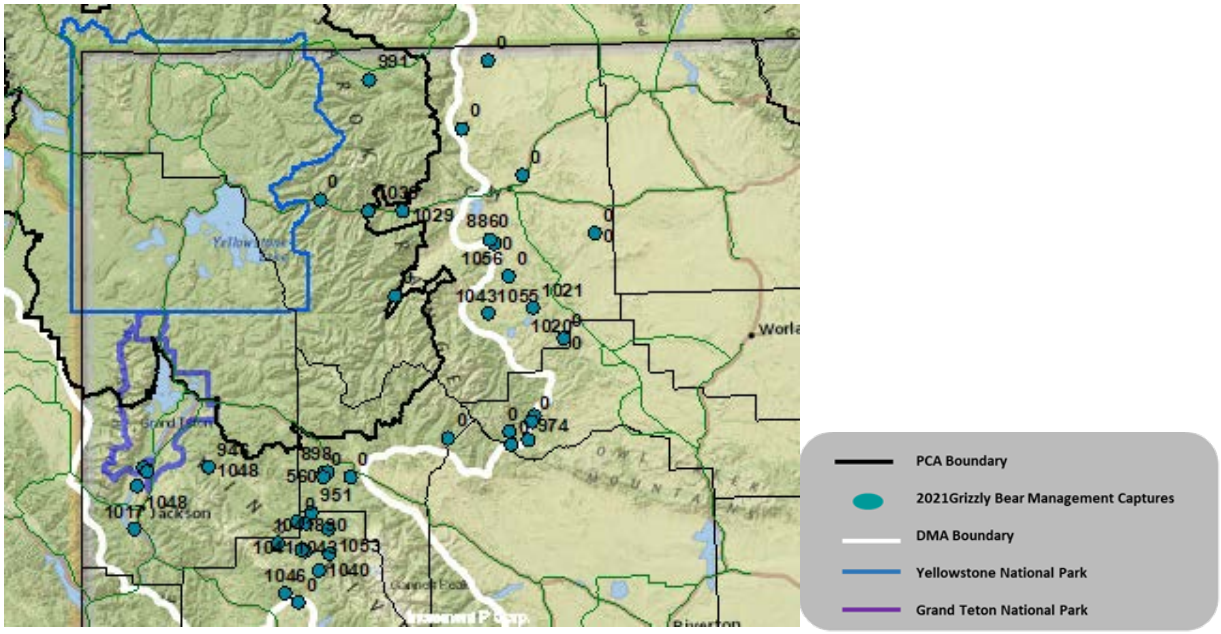

Fig. 32. Management capture locations (n = 49) for grizzly bears in 2021. Grizzly bears with "G" in front of their number were marked but not fitted with radio collars (typically because they were too young to be collared). Grizzly bears identified with "0" were grizzly bears removed from the population without being given an identification number. The mapping software combines some locations at this scale and locations/grizzly bear numbers at or very near the same coordinates are not always distinct on the map, but are listed in Table 34.

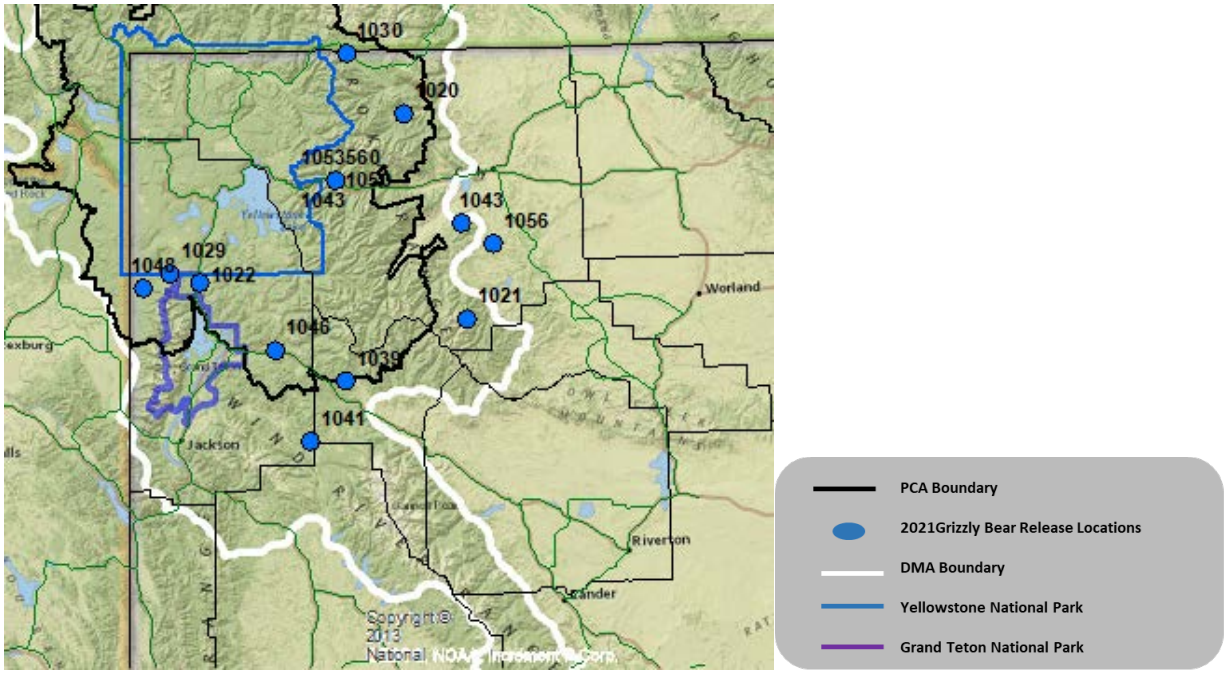

Fig. 33. Release locations (n = 19) for grizzly bears captured and relocated in conflict management efforts for 2021. Grizzly bears with "G" in front of their number were marked but not fitted with radio collars (typically because they were too young to be collared). The mapping software combines some locations at this scale and locations/grizzly bear numbers at or very near the same coordinates are not always distinct on the map, but are listed in Table 34.

Table 34. Summary of grizzly bear conflict management captures in Wyoming portion of the Greater Yellowstone Ecosystem, 2021. Grizzly bears identified with "N/A" were removed from the population without receiving an identification number.

Date	ID	Capture county	Relocation site	Release county	Reason for capture
4/6/2021	N/A	Park			Humane removal, no conflict. Called in as a sick bear hanging around a ranch housing area
4/11/2021	1020	Park	Sunlight Creek	Park	Non-target capture at the site of a cattle depredation
4/26/2021	1021	Park	Jojo Creek	Park	Non-target capture near area of cattle depredation
5/5/2021	N/A	Park			Captured and removed for cattle depredation
5/5/2021	N/A	Park			Captured and removed for cattle depredation
5/7/2021	1022	Teton	Sheffield Creek	Teton	Captured and relocated after 3 attempts to haze from residential areas, displaying habituated behavior and receiving food rewards
5/22/2021	1022	Teton			Removed for frequenting residential areas and receiving food rewards. bear was relocated 5/7/21 and returned 5/21/21
6/5/2021	N/A	Park			Captured and removed for bold behavior around guest lodges and trailheads, including following horseback riders on several occasions
6/15/2021	1029	Park	Grassy Lake	Teton	Relocated for frequenting a guest lodge and eating hay in the feed bunks with horses
6/21/2021	1030	Park	Fox Creek	Park	Relocated for frequenting developed site and chasing a dog through a group of people
7/10/2021	N/A	Park			Captured and removed for cattle depredation
7/11/2021	1039	Sublette	Long Creek	Fremont	Non-target capture while trying to mitigate cattle depredation
7/13/2021	1040	Sublette	Fivemile Creek	Park	Captured and relocated for cattle depredation
7/17/2021	1041	Sublette	Buffalo Meadow	Sublette	Non-target capture while trying to mitigate cattle depredation
7/21/2021	G272	Park	Bailey Creek	Teton	Non-target capture while trying to mitigate cattle depredation. Relocated with mother (886)
7/21/2021	886	Park	Bailey Creek	Teton	Non-target capture while trying to mitigate cattle depredation
7/23/2021	1043	Fremont	Fivemile Creek	Park	Captured and relocated for cattle depredation
7/25/2021	N/A	Sublette			Removed for multiple cattle depredations on private land; killed 6 yearling cattle in 14 days
7/28/2021	N/A	Park			Removed for frequenting agricultural areas including a corn field and a cattle feedlot
7/28/2021	N/A	Park			Removed for frequenting agricultural areas including a corn field and cattle feedlot
7/30/2021	N/A	Park			Captured and removed for multiple cattle depredations
7/31/2021	1046	Sublette	Buffalo Fork	Teton	Non-target capture while trying to mitigate cattle depredation, relocated because near house/property
8/2/2021	946	Teton			Removed for breaking into structures and obtaining food rewards (grain, garbage); previously captured/relocated for cattle depredation
8/6/2021	898	Fremont			Removed for repeated cattle depredations, at least 6 calves killed in 11 days
8/7/2021	1048	Teton	Boone Creek	Teton	Relocated for obtaining unsecured grain for several nights at ranch

Table 34. Continued.					
Date	**ID**	**Capture county**	**Relocation site**	**Release county**	**Reason for capture**
8/8/2021	N/A	Hot Springs			Captured and removed for multiple sheep depredations
8/11/2021	N/A	Hot Springs			Captured and removed for sheep depredations
8/15/2021	1050	Hot Springs	Fivemile Creek	Park	Relocated for cattle depredation
8/16/2021	890	Sublette			Removed for repeated cattle depredation
8/20/2021	N/A	Fremont			Removed for significant property damage and food rewards. Removed with sibling male
8/20/2021	N/A	Fremont			Removed with male sibling for numerous, repeated food rewards and property damage
8/21/2021	G269	Sublette			Removed for cattle depredation
8/24/2021	951	Sublette			Removed for repeated cattle depredation
8/25/2021	1041	Sublette	Fivemile Creek	Park	Relocated for cattle depredation
8/26/2021	560	Fremont	Fivemile Creek	Park	Relocated for cattle depredation
8/28/2021	1048	Teton			Removed for repeated conflicts involving property damage, livestock feed and garbage; previously relocated for accessing livestock feed
9/1/2021	N/A	Hot Springs			Captured and removed for cattle depredation
9/4/2021	974	Hot Springs			Captured and removed for sheep depredations
9/11/2021	1053	Sublette	Fivemile Creek	Park	Captured for cattle depredation, relocated
9/15/2021	N/A	Park			Frequenting housing areas, feeding in pumpkin patch, also close to cattle feedyard; bear removed.
9/21/2021	1028	Teton			Removed for repeated conflicts involving property damage, livestock feed and garbage; previously captured and relocated by Grand Teton National Park for obtaining human food at campsite
9/27/2021	N/A	Fremont			Captured near trailhead, numerous conflicts associated with breaking into trailers, trucks visiting camps, attempted entry into occupied tent; removed for human safety and multiple food rewards
10/1/2021	1017	Teton			Captured and removed for repeated conflicts involving garbage, compost and livestock feed and damage; previously captured and relocated for habituated behavior in campground
10/10/2021	1055	Park	Carter Mountain	Park	Non-target capture while trapping for 1043
10/10/2021	1043	Park			Captured and removed for frequenting residential areas and obtaining food rewards of livestock feed
10/18/2021	N/A	Park			Captured and removed for frequenting developed areas near and in the town of Cody, poor condition, and aggressive behavior toward people rafting the river
10/22/2021	991	Park			Captured and removed for breaking into a barn through the wall
10/26/2021	N/A	Park			Captured and removed for cattle depredations; this bear had 2 yearlings. One yearling (1056) captured and released on site
10/26/2021	1056	Park	Meeteetse Creek	Park	Captured with mother for cattle depredations; released on site

Department personnel investigated and recorded 280 human-grizzly bear conflicts in 2021 (Table 35, Fig. 34). As a result of vigilant education and conflict prevention efforts, the general pattern of conflicts is relatively steady within currently occupied habitat (Fig. 35). However, as occupied grizzly bear range has expanded, conflicts continue in areas farther from the Recovery Zone 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 WGFD, 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 distribution of grizzly bear conflicts in Wyoming continues to expand with the population. 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 2021. The annual variation in livestock depredation incidents is not easily explained. Although most human-bear conflicts are correlated with natural food abundance, the numbers of cattle and sheep killed annually do not follow the same pattern. As grizzly bears expand farther 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 WGFD continues to explore and use multiple options to reduce grizzly bear-livestock conflicts and expand our education and outreach efforts (see Bear Wise Wyoming Report, Appendix C).

Nearly half of the grizzly bear conflicts in Wyoming occurred on private lands and the majority were outside of Recovery Zone. The increasing distribution of grizzly bears is reflected in the annual documentation of conflicts farther from suitable habitat 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.

Long-term trends in the number of conflicts are 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. There is also growing potential for roadside bear problems. Some people engage in unethical wildlife viewing practices, often resulting in habituated or food-conditioned grizzly bears. These situations will continue to spark difficult challenges for bear managers in the future. As the GYE grizzly bear population has exceeded its biological carrying capacity, it continues to grow and expand into less suitable habitat. Therefore, bears are more likely to encounter food sources such as garbage, pet food, livestock and livestock feed, and a myriad of other attractants, resulting in increased property damage and threats to human safety. Conflict prevention measures such as attractant storage, deterrence, and education are a priority for the WGFD. Nevertheless, conflict management is often reactive. Even with the most stringent food and attractant control, the increasing and expanding grizzly bear numbers will lead to conflicts between bears and people. Especially in areas where females are teaching their young to be unafraid of humans, there will be young bears venturing out and struggling to find food and survive. This fact emphasizes the importance for bears to be afraid of humans, and for people to recognize that habituated bears are not healthy for the population and may need relocated or euthanized.

In general, there is less social tolerance and biological suitability for bear occupancy in areas farther from the Recovery Zone 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 applicable for long-term conflict resolution and conservation of grizzly bears.

Table 35. Type and number of human-grizzly bear conflicts in Wyoming portion of the Greater Yellowstone Ecosystem, 2021.		
Conflict type	**Number**	**Percent (%)**
Cattle	161	57.3
Pet-Livestock-Birdfeed	29	10.3
Garbage	29	10.3
Sheep	17	6.1
Property damage	11	3.9
Beehive	7	2.5
Other	7	2.5
Aggression toward humans	5	1.8
Animal death	4	1.4
Animal injury	3	1.1
Fruit trees	2	0.7
Unsecured attractant	2	0.7
Poultry	2	0.7
Total	280	100.0

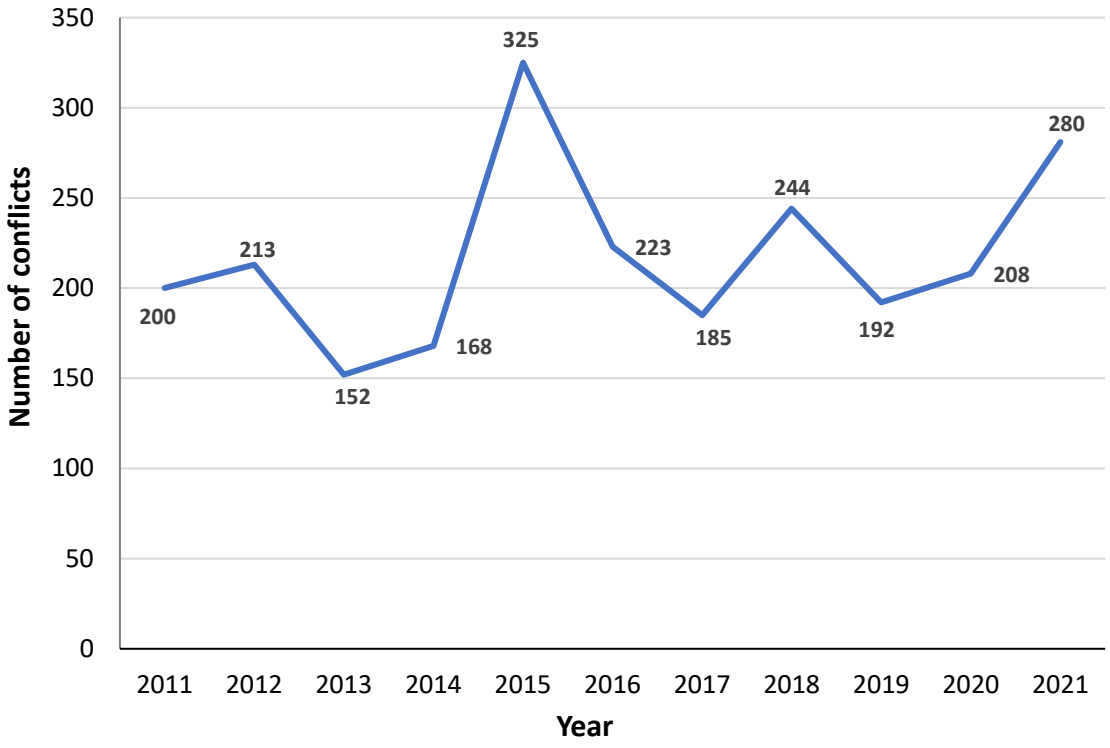

Fig. 34. Number of human-grizzly bear conflicts in Wyoming portion of the Greater Yellowstone Ecosystem, 2011–2021.

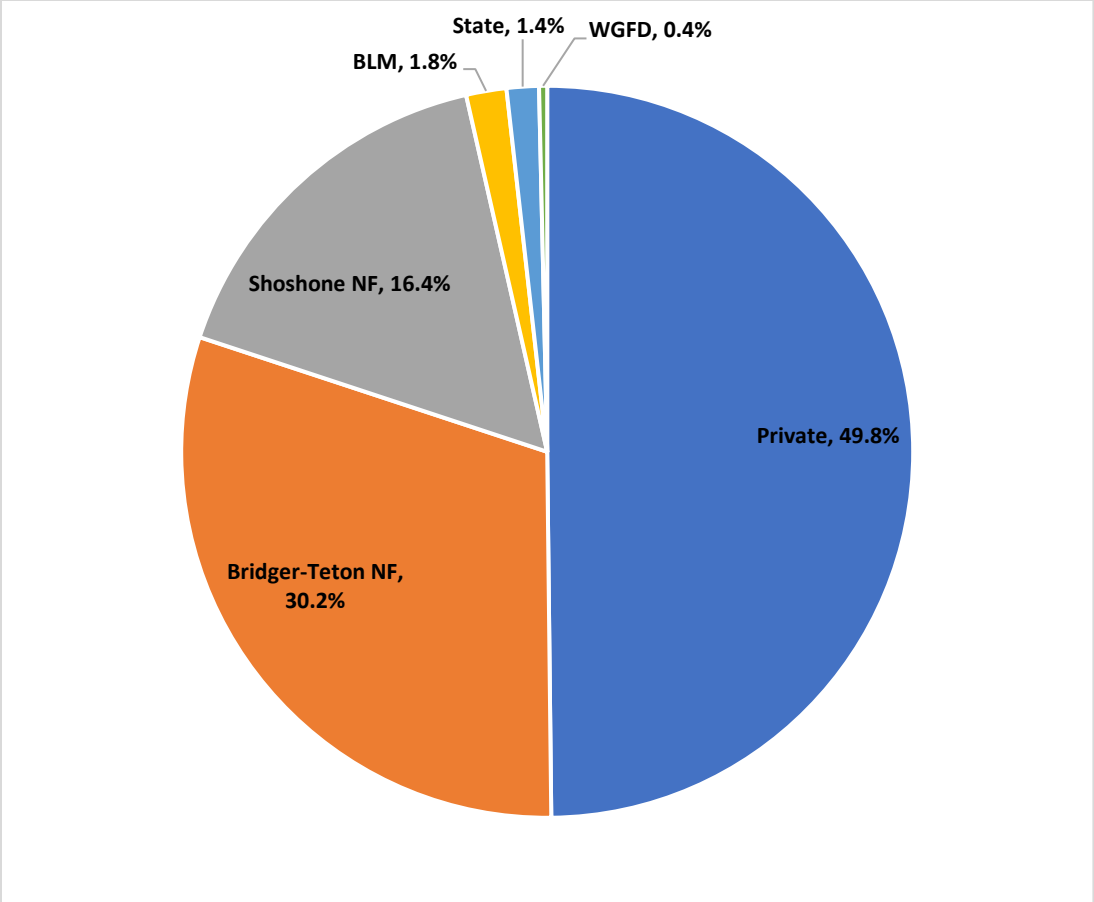

Fig. 35. Percent of human-grizzly bear conflicts on private and public lands in Wyoming portion of the Greater Yellowstone Ecosystem, 2021

Human-Grizzly Bear Conflicts on the Wind River Reservation (*Patrick 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 encounters were reported on the Wind River Reservation in 2021 (Fig. 36). Encounters occur when bears and people meet and are both aware of each other's presence, but with no ensuing conflict.

Three conflicts were reported in 2021. Conflicts are defined as incidents where bears cause a human safety issue (habituated, in developed areas), damage property, kill or injure livestock, obtain human foods or garbage, or injure people.

In June, a group of 3 individuals were reportedly charged by a grizzly bear to within 20 yards in Washakie Park. No physical contact was made. A thorough search by personnel did not find any evidence to support the claims and suspected this is to be a faulty report.

In August, a beef calf was depredated in the Crow Creek area by a collared adult male grizzly bear. No other documented losses occurred, and no further action was taken.

In October, a female grizzly bear and 2 yearlings visited a remote homestead over a 4-night period, rummaging a burn-barrel. Landowner secured attractants and bear group departed with no further incident.

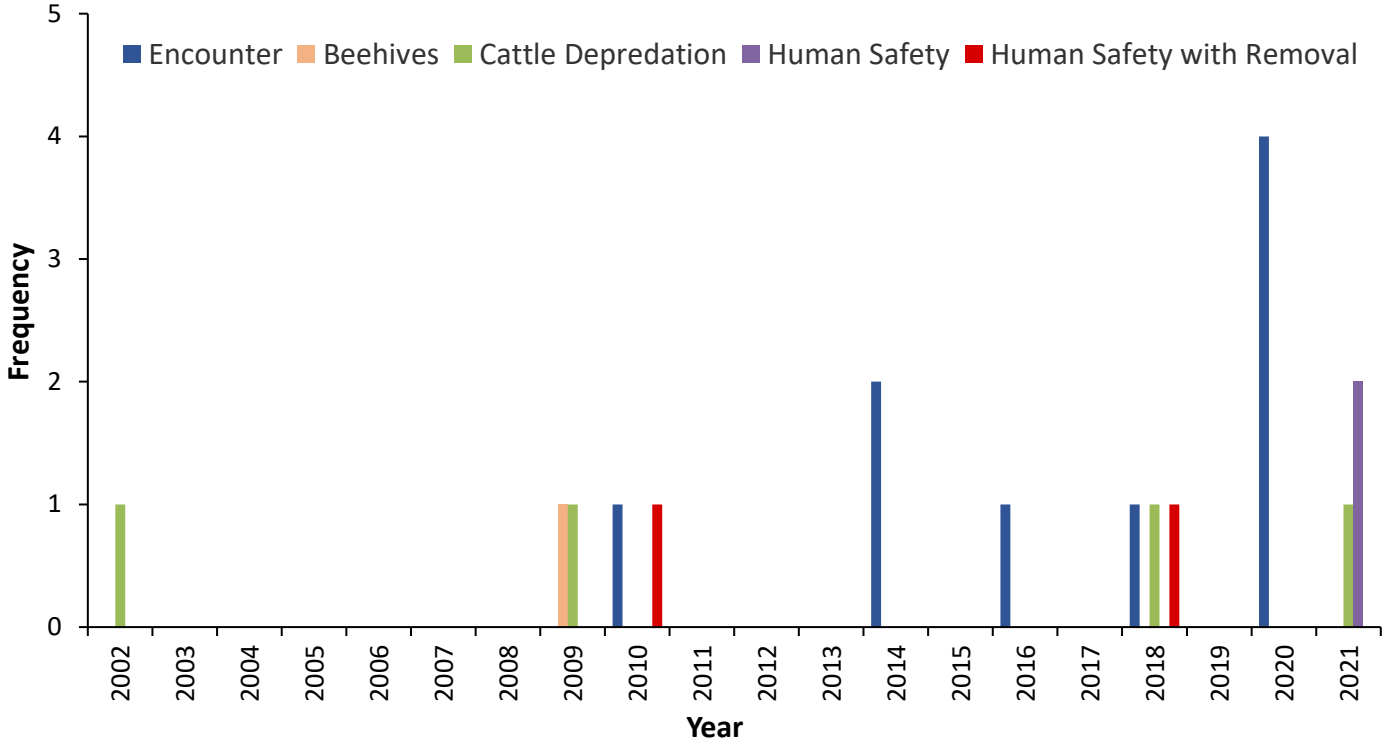

Fig. 36. Reported grizzly bear encounters and conflicts in the Wind River Reservation of the Greater Yellowstone Ecosystem, 2021.

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

Knowledge of the relative risk of bear attack assists park managers in prioritizing bear safety messages for different types of recreational activities occurring in Yellowstone National Park. Knowing the probability of attack for different recreational activities also provides managers with quantitative information on the significance of risk when making decisions on implementing voluntary versus regulatory mechanisms designed to reduce the frequency of bear attacks. To address this need, we recorded information on human-bear interactions in Yellowstone National Park. Because the risk of bear attack varies depending on visitor location and activity, we grouped human-bear interactions into 5 broad categories based on the locations where they occurred, including: 1) frontcountry developments, 2) road corridors, 3) backcountry campsites, 4) backcountry trails, and 5) off-trail backcountry areas. We considered all human-grizzly bear encounters where the person involved believed that the bear was mutually aware of their 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, and avoiding more dominant bears. In addition, human food conditioned bears sometimes enter park developments seeking human foods or garbage. However, since implementation of a new bear management program in 1970, it is rare for bears to obtain anthropogenic 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 2021, there were 33 reported incidents where grizzly bears entered park developments (Table 36). The bear's primary activity was reported in 30 of the incidents. In 58% (n = 18) of the incidents, bears foraged for natural foods within developments and in 39% (n = 12) it appeared the bears were just traveling through the development.

Reactions of Bears to the Presence of People in Frontcountry Developments

Grizzly bears were known to have encountered people in 22 of the 33 incidents where they entered developments and the bears' reaction was recorded in 20 of those incidents (Table 37). Bears reacted with neutral behaviors in 70% (n = 14) of the encounters and a flight response in 25% (n = 5). In 1 incident a bear charged toward the people it encountered but did not make contact. Grizzly bears did not injure any visitors within park developments in 2021.

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 discarded food scraps or human food handouts. In the past (1910–1969), bears commonly panhandled along park roads for food handouts from visitors (Schullery 1992). Strict enforcement of regulations prohibiting the feeding of bears 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 strategy, 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 as long as park visitors maintain a 90-m (100-yard) distance from them and do not feed them.

Bear Activity along Roadsides

In 2021, 342 reports of grizzly bears frequenting habitat along park roads were recorded (Table 38). The primary activity of roadside bears was recorded in 337 of these reports. In most of these incidents, primary bear activity was foraging for natural foods (74%, n = 249) or traveling (24%, n = 81). Other activities reported included swimming (1%, n = 3), bedded/sleeping (1%, n = 3), and courtship (<1%, n = 1).

Bear Reactions to the Presence of People Along Roadsides

Grizzly bears were noticeably aware of the presence of people in 232 of the 342 reports of bear

activity along roads. The reaction of bears to people was reported for 229 of these 232 roadside encounters (Table 37). Bears reacted with neutral behaviors in 76% (n = 175) of the encounters and a flight response in 22% (n = 50). Grizzly bears displayed curious behavior and walked toward people in <1% (n = 1) of the roadside encounters. In 3 incidents (1%) grizzly bears charged toward people during roadside encounters. In 2 of those incident's bears broke off the charge and veered away and in 1 incident the bear attacked and damaged a vehicle that had people inside. Grizzly bears did not injure any visitors along park roads in 2021.

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, trails, campsites, and off-trail areas are sometimes temporarily closed to recreational use for short periods when human activities conflict with natural bear activities and behaviors in backcountry areas.

Activity of Bears in Occupied Backcountry Campsites

Bears occasionally enter designated backcountry campsites while the campsites are occupied by recreational users. In 2021, there were 8 incidents reported where grizzly bears entered occupied backcountry campsites (Table 39). Primary activity of bears was reported for all 8 incidents and included walking through the core campsite (n = 3), foraging on native foods in the campsite (n = 2), investigating the tent (n = 1), sitting by the tent (n = 1), and eating food scraps from the fire ring (n = 1).

Bear Reactions to the Presence of People in Backcountry Campsites

In 7 of the 8 incidents where grizzly bears entered occupied backcountry campsites, the campers believed the bears were aware of the campers' presence. The bears' reaction was reported in all 7 of those incidents. In 4 incidents the bears exhibited flight responses after being detected; in 2 incidents bears reacted in a neutral manner, in 1 incident the bear rubbed on the tent, sniffed the tent, then made huffing noises and left after the campers yelled at the bear (Table 37). Grizzly bears did not injure any visitors in backcountry campsites in 2021.

Bear Reactions to Encounters with People on Backcountry Trails

In 2021, there were 32 reports of incidents where people encountered grizzly bears on backcountry trails (Table 37). The bears reaction to the encounters were reported in 31 of the incidents. Grizzly bears reacted to encounters with people along backcountry trails with neutral behaviors in 39% (n = 12), flight behaviors in 36% (n = 11), approaching people in 3% (n = 1), making huffing noises in 3% (n = 1), charging without making contact in 16% (n = 5), and charging, making contact and injuring someone in 3% (n = 1).

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

In 2021, there were 13 reports of people encountering grizzly bears while traveling off-trail in backcountry areas (Table 37). The bears reaction to the encounters were reported in 12 of the incidents. Grizzly bear reactions to these encounters included fleeing (n = 6), neutral response (n = 3), and charging without making contact (n = 3). Grizzly bears did not attack or injure any people in off-trail encounters in 2021.

Risk of Bear Attack

Almost all bear attacks occur in backcountry areas and most backcountry attacks involve people who surprise bears while hiking. We evaluated the risk of being injured by a bear by comparing the number of bear-inflicted human injuries to the number of reported backcountry encounters with bears. From 1991 to 2021, the years for which we had backcountry encounter data, there were 2,173 reported encounters between grizzly bears and backcountry recreationists. In 24 of those encounters, grizzly bears attacked and injured people. Therefore, the risk of being injured by a grizzly bear was 1 attack for every 91 backcountry encounters. This estimate is likely biased high, because benign encounters where bears flee or behave in a neutral or unaggressive manner are less likely to be reported than injurious encounters.

Another method to evaluate the risk of bear attack is to compare the number of people injured while engaged in different types of recreational activities to the number of park visitors that participate in those activities. Bear-inflicted human injury data for 1979–2021 likely provide a reasonably accurate evaluation of the current risk of bear attack in the park. Prior to 1979,

most injuries involved bears that were conditioned to human foods and garbage. In 1970, Yellowstone National Park implemented a new bear management program. The foundation of the program was to reduce bear-human conflicts by preventing bears from becoming conditioned to human foods, garbage, and other anthropogenic attractants (Meagher and Phillips 1983). By 1979, sources of anthropogenic attractants had been made bear-proof, most human food conditioned bears had been removed from the park population (killed or sent to zoos), and bear-human conflicts declined significantly thereafter.

From 1979 to 2021, grizzly bears injured (n = 34) or killed (n = 5) a total of 39 recreationists in Yellowstone National Park. During1979–2021, 131,601,950 recreational visits were made to the park. The injury rate was 1 visitor injured for every 3.4 million recreational park visits. However, not all visitors had equal exposure to the risk of grizzly bear attack. For visitors that remained within frontcountry areas (e.g., developments, along roadsides, and on boardwalk trails) while in the park, there was 1 injury per 65.8 million visits. For visitors that camped overnight in roadside campgrounds there was 1 injury per 28.2 million overnight stays. For visitors that camped overnight in remote backcountry campsites or dispersed camping zones, there was 1 injury per 1.8 million overnight stays. Backpackers injured while hiking (not while in campsites) incurred the greatest risk, with 1 injury for every 259,617 backcountry recreation days (data on backpacker recreation days only available from 1992–2021; 5 permitted backpackers injured while hiking in 1,298,083 backcountry recreation days). Yellowstone National Park does not collect records of the number of day-use recreationists hiking in the backcountry. However, the risk of grizzly bear attack for day-hikers is likely similar to the risk incurred by overnight backpackers injured while hiking.

Summary

Grizzly bears reacted aggressively toward people in only 4% (13 of 299 with reported outcomes) encounters reported in Yellowstone National Park in 2021 (Table 40). What we observed in 2021 is similar to long-term results for 1991–2021 (Table 41). In 7,033 encounters between grizzly bears and people reported from 1991–2021, bears reacted with neutral behaviors in 59% (n = 4,117), by fleeing in 34% (n = 2,379), curious behaviors in 3% (n = 218), and with stress, bluster, or warning behaviors in 1% (n = 43) of reported encounters. Grizzly bears reacted with aggression without contact in 4% (n = 252) of the reported encounters. Less than 1% (n = 24) of the 7,033 reported encounters between people and grizzly bears in Yellowstone National Park during 1991–2021 resulted in human injuries. All those injuries occurred in backcountry areas. Attacks occurred at a slightly higher rate during off-trail interactions (2%, 7 attacks in 453 reported encounters) than during on-trail interactions (1%, 17 attacks in 1,501 encounters). During 1991–2021, there were no grizzly bear attacks during interactions in areas where human presence was predictable and could be expected by bears, such as along primary roads (0 attacks in 4,165 encounters), within developments (0 attacks in 698 encounters), and in designated backcountry campsites (0 attacks in 216 encounters). Despite their ferocious reputations, 31 years of monitoring human-bear interactions in Yellowstone National Park suggests that grizzly bears are tolerant of people in most encounters and injured people in <1% of all reported interactions occurring in the park. However, in rare incidents where contact was made, injuries were sometimes severe or fatal. We recommend that all backcountry recreationalists in Yellowstone National Park and the Greater Yellowstone Ecosystem carry a bear deterrent. Although the type of deterrent to carry is a personal choice, bear spray has proven easy to use and highly effective at stopping or reducing the length and severity of bear attacks (Herrero and Higgins 1998, Smith et al. 2008, 2020).

Table 36. Activity of bears that entered frontcountry developments, Yellowstone National Park, 2021.

Activity of bear while inside development	Number of incidents
Not reported or unknown	2
Travel through	12
Forage for natural foods	18
Investigate anthropogenic foods but no food reward and no property damage	0
Investigate and damage property but no food reward	0
Investigate and obtain anthropogenic foods	0
Aggressively approach/posture toward people	1
Attack people	0
Total	33

Table 37. Reactions of grizzly bears to encounters with people, Yellowstone National Park, 2021.

Reaction of bear	Development	Along roadside	Backcountry campsite	On trail	Off trail	Total
Not reported/not known	2	3	0	1	1	7
Flight response						
Run away	3	15	2	7	3	30
Walk away	2	35	2	4	3	46
Adult climb tree	0	0	0	0	0	0
Cubs climb tree/adult remain	0	0	0	0	0	0
Flight behavior subtotal	5	50	4	11	6	76
Neutral behaviors						
No overt reaction	14	174	2	12	2	204
Stand up on hind legs	0	1	0	0	1	2
Circle down wind	0	0	0	0	0	0
Neutral behavior subtotal	14	175	2	12	3	206
Curious behaviors						
Walk toward-curious	0	1	0	1	0	2
Follow mobile person	0	0	0	0	0	0
Investigate vehicle	0	0	0	0	0	0
Curious behavior subtotal	0	1	0	1	0	2
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	1	1	0	2
Pop jaws/teeth clacking noises	0	0	0	0	0	0
Stood ground watched/stared	0	0	0	0	0	0
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	0	0	1	1	0	2
Aggressive behaviors						
Growl	0	0	0	0	0	0
Aggressive approach	0	0	0	0	0	0
Stalk	0	0	0	0	0	0
Run toward/aggressive charge	1	3	0	5	3	12
Aggressive behavior subtotal	1	3	0	5	3	12
Attack behaviors						
Defensive attack	0	0	0	1	0	1
Predatory attack	0	0	0	0	0	0
Attack unknown cause	0	0	0	0	0	0
Attack behavior subtotal	0	0	0	1	0	1
Total	22	232	7	32	13	306

Table 38. Primary activity of grizzly bears along roadsides, Yellowstone National Park, 2021.

Activity of bear	Number of incidents
Not reported/unknown	5
Traveling	81
Foraging natural foods	249
Courtship	1
Swimming	3
Nursing young	0
Playing	0
Bedded/sleeping	3
Investigating vehicles/seeking anthropogenic foods; no food reward	0
Obtain anthropogenic foods	0
Damage property	0
Aggressive approach/posture toward people	0
Attack people	0
Other	0
Total	342

Table 39. Primary activity of grizzly bears that entered occupied backcountry campsites, Yellowstone National Park, 2021.

Activity of bear	Number of incidents
Not reported/unknown	0
Walked past edge of campsite	0
Walked through core camp	3
Forage native foods	2
Investigate tent without damage/no food reward	1
Investigate food pole without food reward	0
Investigate food storage locker without food reward	0
Attempt to get human foods (not successful)	0
Damage property	0
Obtain food scraps from fire-ring	1
Investigate latrine (buried human feces/toilet paper)	0
Lay down/rest in campsite	1
Aggressive approach/posture toward people in campsite	0
Attack people	0
Total	8

Table 40. Grizzly bear reactions reported in 299 interactions with people in different location settings, Yellowstone National Park, 2021.

Location of encounter	Reaction of bear											
	Flee		Neutral behavior		Curious		Stress/agitation		Aggression without contact		Attack	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Park development	5	25	14	70	0	0	0	0	1	5	0	0
Roadside corridor	50	22	175	76	1	<1	0	0	3	1	0	0
Backcountry campsite	4	57	2	29	0	0	1	14	0	0	0	0
Backcountry trail	11	35	12	39	1	3	1	3	5	16	1	3
Backcountry off-trail	6	50	3	25	0	0	0	0	3	25	0	0
Total	76	25	206	69	2	1	2	1	12	4	1	<1

Table 41. Grizzly bear reactions to interactions with people (*n* = 7,033) in different location settings, Yellowstone National Park, 1991–2021.

Location of encounter	Reaction of bear											
	Flee		Neutral behavior		Curious		Stress/agitation		Aggression without contact		Attack	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Park development	334	48	335	48	17	2	3	<1	9	1	0	0
Roadside corridor	965	23	3,072	74	53	1	11	<1	64	2	0	0
Backcountry campsite	90	42	96	44	19	9	2	1	9	4	0	0
Backcountry trail	740	49	474	32	113	8	24	2	133	9	17	1
Backcountry off-trail	250	55	140	31	16	4	3	1	37	8	7	2
Total	2,379	34	4,117	59	218	3	43	1	252	4	24	<1

Visitor Compliance with Bear Safety Recommendations in Yellowstone National Park

(Kerry A. Gunther, Eric G. Reinertson, and Travis C. Wyman, Yellowstone National Park)

Improvements in information and education efforts aimed at recreational safety in bear country are paramount in the face of significant increases in visitation to Yellowstone National Park. Two human behaviors that can reduce the risk of bear attack include hiking with large party sizes (Herrero 2002) and carrying bear deterrent spray to deter bears that react aggressively to encounters (Herrero and Higgins 1998, Smith et al. 2008). To reduce the risk of bear attack in Yellowstone National Park, park managers distribute safety information to visitors recommending that backcountry recreationists traveling by foot maintain group sizes of ≥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 people and the proportion that carry bear spray or use other deterrents, such as firearms, or warning devices such as bear bells.

Data were collected by Bear Management Office staff and by instructors and students from Ecology Project International. Due to time, budget, and staffing constraints, we only conducted opportunistic surveys in 2021. 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. We conducted our surveys 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, saddlebags, panniers, or carried under coats would likely not be retrievable fast enough for use during surprise encounters with bears.

In 2021, we surveyed 2,387 people in 791 groups at 23 different backcountry trails and 1 boardwalk trail. Our surveys included 1,987 backcountry day hikers, 327 people on boardwalk trails, 15 overnight backpackers, 17 stock day riders, 7 overnight stock riders, and 34 day-use bicyclists.

Day Hikers

Yellowstone National Park contains >1,600 km (1,000 miles) of backcountry hiking trails accessible from 92 trailheads located throughout the park. We surveyed 1,987 day-hikers traveling in 632 groups on 23 different trails. Average party size was 3.1 people (Table 42). The most common (mode) group size and the median group size were 2 people per party. Fifty-one percent (n = 319) of day hiking parties had less than the recommended party size of 3 people and 10% (n = 64) hiked alone. Of the 1,987 day-hikers, 452 (23%) carried bear spray, 36 (2%) had bear bells, and 3 (<1%) carried firearms (Table 43). Of the 632 groups of day hikers, 329 (52%) had at least 1 member that carried bear spray, 29 groups (5%) had at least 1 person with bear bells, and 3 groups (1%) had at least 1 person carrying a firearm.

Overnight Backpackers

Yellowstone National Park has 300 designated backcountry campsites. We surveyed 15 backpackers in 6 groups on 4 different trails. Average party size was 2.5 people (Table 42). The most common group sizes (mode) were 1 and 4 people per party. The median group size was 3 people per party. Fifty percent (n = 3) of the backpacking groups had less than the recommended party size of 3 people and 33% (n = 2) hiked alone. Of the 15 backpackers, 8 (53%) carried bear spray. None of the backpackers observed carried bear bells or firearms (Table 44). Of the 6 groups of backpackers, 5 (83%) had at least 1 person in the party that carried bear spray.

Stock Day Riders

We surveyed 17 stock day-riders in 4 groups (Table 42) on 2 trails. Average party size was 4.3 people. The most common group size and the median group size were 4 people per party. None of the day-riders carried bear spray or bear bells (Table 43). One day-rider carried a firearm.

Stock Overnight Riders

We surveyed 7 people in 1 group that were riding stock on an overnight camping trip (Table 42). Two (11%) of the overnight stock riders carried bear spray and 1 (6%) carried a firearm. None of the overnight stock-rider's carried bear spray or firearms. Two of the overnight stock-riders had bear bells.

Day Use Bicycle Trail Riders

Yellowstone National Park contains 13 designated bike trails. One of the 13 trails provides'

access to a designated backcountry campsite. We surveyed 34 people in 12 groups riding bicycles on day trips on 1 trail. Average party size was 2.8 people (Table 43). The most common group size (mode) and the median group size were 2 people per party. Six (18%) of the bicyclists carried bear spray. None of the bicyclists carried bear bells or firearms (Table 43). Four (33%) of the 12 bicycle groups had at least 1 member that carried bear spray.

Boardwalk Trails

Yellowstone National Park contains approximately 15 miles of boardwalk trails. Boardwalk trails are short trails found near park roads that contain interpretive signs providing visitors with information about geysers or other natural features. Boardwalks provide a stable walking surface with gentle grades or steps to get up and down hills, allowing use by visitors of wide-ranging of ages, physical abilities, and hiking experience. Park regulations prohibit stock animals and overnight camping on or along boardwalk trails. We surveyed 327 people in 136 groups on 1 boardwalk trail. Average party size was 2.4 people (Table 42). The most common group size (mode) and the median group size were both 2 people. Eighty-two percent (n = 111) of the groups of boardwalk users had fewer than the recommended party size of 3 and 14% (n = 19) hiked alone. Only 7% (n = 22) of the individuals surveyed carried bear spray (Table 46). Ten percent of the groups (n = 14) surveyed had at least 1 person in the party that carried bear spray. None of the people observed walking on a boardwalk trail carried bear bells or firearms.

Use of Bear Spray

In 2021, 4 incidents inside Yellowstone National Park where people deployed bear spray during encounters with grizzly bears were reported. On June 20 at approximately 2 a.m., 2 backpackers sleeping in their tent at backcountry campsite 3L1 at the confluence of Cache Creek and the Lamar River were awakened when an animal began pushing against their tent. The male occupant vocalized to get the animal to leave. Instead of leaving, the animal began huffing at which point the man realized it was a bear. The man then told the bear to "move along, we ain't got nothing for you." The bear responded by huffing louder and clicking its jaw. After telling the bear to "take a hike," the bear responded by pushing its nose against the wall of the tent and taking a few loud sniffs. The bear was given a firmer verbal warning as the man unholstered both his bear spray and a .41 magnum revolver loaded with bear loads. The man said he then used his "dad voice" to try to get the bear to move on. The bear responded by pounding its front paws on the ground at which point the man's wife also began yelling at the bear. After about 2–3 minutes they could no longer hear the bear, so they open the tent door and peered out. The bear which was approximately 8 feet off to the side of the tent clacked its teeth and charged. The man had his pistol in his right hand and bear spray in his left hand, so sprayed left-handed with his left arm just partially outside of the tent door. Because his left arm was somewhat blocked by the tent door, he couldn't spray directly at the bear, which was farther to his left, toward the middle of the side of the tent. The man stated that upon hearing the bear spray discharge from the canister (the man didn't think he hit the bear with the spray) the bear turned and left. The couple spent the rest of the night standing back-to-back scanning the perimeter of the campsite with their headlamps, then hiked out at about 5 a.m. Backcountry Campsite 3L1 was closed for a week after the incident. Because no one was injured and the bear did not obtain a food reward, no action was taken against the bear.

On July 16 at approximately 1:30 p.m., a day-hiker, hiking by himself, encountered a female grizzly bear accompanied by 1 cub, about 3 miles down the trail from the Cygnet Lakes Trailhead. The adult bear was about 40 feet off to the side of the trail. Upon seeing the bears, the man turned around and began hiking back to the trailhead. After hiking back for about 2 minutes he yelled "Hey Bear." Immediately after yelling, he heard branches cracking then saw the adult bear standing up on 2 legs about 40 feet in front of him. The bear dropped back down to 4 legs and charged, then stopped after just 4 or 5 steps and turned around and began to leave. The man fired about a 1 second blast of bear spray toward the retreating bear but did not think he hit it with the spray. Not wanting to encounter the bear again on the trail, the man attempted to hike cross-country off-trail back to the trailhead. However, he got lost in the post-fire fallen trees and new forest regrowth, so called 911 for rescue when he had cell service at the top of a hill. No action was taken against the bear.

On July 24 at approximately 10:30 a.m., an adult male trail runner, encountered a female grizzly with 2 cubs-of-the-year on the Bechler River Trail. The bears were about 50 yards from him when he first saw them. The man yelled at the bears to get them to leave. After he yelled, the adult bear charged towards him. He pulled out his bear spray and sprayed toward the bear. He did not think he hit the bear with the spray as the

bear was too far out of range. The bear turned and ran back to its cubs, then immediately turned back and charged toward the man again. The man waited until the bear was about 10 yards away, then sprayed the bear directly in the face. The bear immediately turned and ran back to her cubs, gathered them up, and ran away. Bear warnings were posted on the Bechler River Trail. No action was taken against the bear.

On September 5 at approximately 8 p.m., an adult male trail runner encountered a grizzly bear on the Lamar River Trail. The bear initially turned and ran away, then reversed course and charged at the man. The trail runner pulled out his bear spray and sprayed the bear when it was about 30 feet from him. Upon being hit with the spray the bear turned and ran away, then again reversed course and charged the man a second time. The trail runner sprayed the bear again, and the bear stopped the charge at about 20 feet, then turned around and ran off and did not come back. Bear warnings were posted on the Lamar River Trail. No action was taken against the bear.

Discussion

In 2021, overnight backpackers had the highest level of compliance with the park's bear spray recommendation; 53% of individual backpackers carried bear spray and 83% of backpacking groups had at least 1 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 11 years surveys have been conducted (Tables 44 and 49). 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 permitting process, backpackers receive face-to-face verbal information about bears and bear spray from the ranger issuing the permit and are required to watch a safety video containing information on hiking and camping in bear country and how to use bear spray. Backpackers also receive the "Beyond Roads End" booklet containing information on use of bear spray and safety recommendations for 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). Although the average party size for backpackers was 2.5 people per group, 50% of the backpacking groups had less than the recommended party size of 3 people and 33% (n = 2) hiked alone. A high percentage of surveyed backpackers did not follow the park's recommended group size of 3 or more people for hiking in bear country. The most common party size (mode) for overnight backpackers during all 11 years of the study has been 2 people per party (Table 45).

Only 23% of day hikers carried bear spray in 2021, however, 52% of day hiking groups had at least 1 member that carried bear spray. Fewer than 25% of day hikers have carried bear spray in each of the 11 years surveys have been conducted (Table 43). Permits are not required for day hiking so day hikers may not receive the same level of bear safety information as backpackers. Visitor's day hiking in the national park can seek and obtain bear safety information from the Yellowstone National Park web page, park app, park newspaper, day hike trip planning handouts, safety cards and brochures, and from rangers at visitor centers. However, the only bear safety information day-hikers receive 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 trailhead information sign. The most frequently observed group size 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. Because most (68%) grizzly bear attacks in Yellowstone National Park involve day hikers (32 of 47 backcountry attacks since 1970), the low level of compliance with bear safety recommendations among day hikers is a concern of park managers.

None of the of the overnight stock riders or day-riders surveyed in 2021 carried bear spray. Bear spray is not very useful while in the saddle, as deploying it from horseback could result in the rider being bucked-off 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 making them less likely to charge and initiate contact with a person on horseback during a surprise encounter. In addition, unlike humans, when charged by bears, horses have enough speed and agility to outrun bears, thus providing an added margin of safety if 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.

Only 6 of the 34 bicyclists we encountered on our surveys carried bear spray. Bicyclists incur greater risk of surprise encounters because bicycles are fast and relatively quiet, therefore increasing the odds of surprise encounters.

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. Only a small proportion of all types of recreationists openly carried firearms in the 11 years we conducted our surveys. Firearms were openly carried by <1% of the recreationists we observed in 2021. Stock day-riders (6%) had the highest frequency of firearms carry. Recreationists riding horses often carry firearms for euthanizing injured stock; however, if these firearms were carried in saddle bags or pannier's 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 carried by 2% of all recreationists surveyed in Yellowstone National Park in 2021. Overnight stock-riders' (29%) had the highest frequency of bear bell use. The low use of bear bells likely reflects their lack of demonstrated effectiveness as an auditory warning device (Herrero 2002). Although bear bells may provide some benefit in alerting bears to the presence of approaching hikers (Jope 1985), they are generally not considered effective at preventing surprise encounters when hiking in strong winds, near fast moving water, or in dense brush or forest which muffles the bells sound (Herrero 2002).

Almost all bear attacks in Yellowstone National Park occur in backcountry areas and most backcountry attacks involve people who surprise grizzly bears while hiking. The risk of being injured by a grizzly bear while hiking in the park's backcountry is approximately 1 injury for every 259,617 backcountry recreation days. Yellowstone National Park recommends that all backcountry recreationists carry bear spray and know how to use it. (NPS photo – D. Schneider)

Table 42. Group size characteristics for different types of recreational activities in Yellowstone National Park, 2021.

Type of recreational activity	Total people	Total groups	Average group size	Median group size	Mode group size
Boardwalk trail (foot travel walking)	327	136	2.4	2	2
Day hiker (e.g., day use foot travel-hiker, angler, photographer)	1,987	632	3.1	2	2
Overnight backpacker (foot travel camping overnight)	15	6	2.5	3	1, 4
Stock–day use	17	4	4.3	4	4
Stock–overnight use	7	1	7.0	7	7
Day bicycle trip	34	12	2.8	2	2
Total	2,387	791	3.0	2	2

Table 43. Number and percent (%) of people and groups of recreationists surveyed that carried bear spray, firearms, or bear bells, Yellowstone National Park, 2021.

	Type of recreation/mode of travel						
	Boardwalk trail	Day hiker	Day use bicycle	Overnight backpacker	Stock day use	Stock overnight use	Total (all types)
Total people surveyed	327	1,987	34	15	17	7	2,387
(# of parties surveyed)	136	632	12	6	4	1	791
People with bear spray							
Total	22	452	6	8	0	0	488
Percent	6.7	22.7	17.6	53.3	0	0	20.4
Parties with bear spray							
Total	14	329	4	5	0	0	352
Percent	10.3	52.1	33.3	83.3	0	0	44.5
People with firearms							
Total	0	3	0	0	1	0	4
Percent	0	0.2	0	0	5.9	0	0.2
Parties with firearms							
Total	0	3	0	0	1	0	4
Percent	0	0.5	0	0	25.0	0	0.5
People with bear bells							
Total	0	36	0	0	0	2	38
Percent	0	1.8	0	0	0	28.6	1.6
Parties with bear bells							
Total	0	29	0	0	0	1	30
Percent	0	4.6	0	0	0	100	3.8

Table 44. Percent (%) of people engaged in different types of backcountry recreational activities that carried bear spray, Yellowstone National Park, 2011–2021.

Year	Overnight backpackers	Day hiker	Boardwalk	Stock day use	Stock overnight use	Bicycle day use
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	14	<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
2018	47	21	1	0	25	0
2019	75	21	2	14	0	50
2020	64	19	Not surveyed	0	11	4
2021	53	23	7	0	0	18
2011–2021 combined data	55	18	1	5	27	16

Table 45. Percent (%) of groups engaged in different types of backcountry recreational activities that had at least 1 member that carried bear spray, Yellowstone National Park, 2011–2021.

Year	Overnight backpackers	Day hiker	Boardwalk	Stock day use	Stock overnight use	Bicycle day use
2011	64	34	Not surveyed	0	50	Not surveyed
2012	73	27	0	67	50	0
2013	82	33	0	33	60	0
2014	73	29	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
2018	81	46	3	0	50	0
2019	92	51	4	50	0	60
2020	84	44	Not surveyed	0	50	13
2021	83	52	10	0	0	33
2011–2020 combined data	83	41	3	19	50	25

Table 46. Group size characteristics for different types of recreational activities, Yellowstone National Park, 2011–2021.

Type of recreational activity	Total people	Total groups	Average group size	Median group size	Mode group size
Boardwalk	9,758	3,480	2.8	2	2
Day hiker (e.g., day foot travel- hiker, angler, photographer)	19,221	6,457	3.0	2	2
Overnight backpacker (overnight-foot travel)	1,238	412	3.0	2	2
Horse–day use	137	26	5.3	5	1, 3
Horse–overnight use	129	24	5.4	5	2
Day bicycle trip	87	37	2.4	2	2
Total	30,604	10,448	2.9	2	2

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Appendix A

2021 Grizzly Bear Habitat Monitoring Report

Grizzly Bear Habitat Modeling Team, Greater Yellowstone Ecosystem

Background

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 *2016 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 Plan Amendment; USDA 2006a, b). Likewise, the Superintendents' Compendia incorporated the Strategy habitat standards into the legal plans for the 2 respective national parks in the GYE.

The Conservation Strategy and the habitat standards therein provide management direction for a recovered grizzly bear population once it has been removed from federal protection under the Endangered Species Act (ESA). In June 2017, the USFWS removed the Yellowstone grizzly population from the federal list of endangered and threatened wildlife (Federal Register 2017) for the second time. In August 2018, a coalition of nonprofits and Native American tribes challenged the delisting rule in court. In September 2018, a U.S. District Court of Montana reinstated Endangered Species Act protections for the GYE grizzly bear population (Federal Register 2019). In December 2018, the USFWS, along with the states of Idaho, Montana, and Wyoming, each filed for an appeal of the September court decision. In July 2020, the U.S. Court of Appeals for the 9th Circuit upheld the decision to vacate the delisting rule. Regardless of the legal status of the Yellowstone grizzly bear, land managers throughout the GYE are committed to abiding by habitat standards identified in the Conservation Strategy for the long-term protection and health of the grizzly bear population.

Introduction

The primary intent of habitat standards established in the Conservation Strategy is to preserve adequate and secure habitat to sustain a viable grizzly bear population into the foreseeable future. Three distinct habitat standards were enumerated in the Conservation Strategy pertaining to 1) secure habitat (roadless areas), 2) human development, and 3) commercial livestock grazing. All 3 factors are surrogate measures of human presence (or absence) on the land. Research identifies humans as the driving factor of grizzly bear mortality and displacement in occupied areas across the landscape. These standards impose measurable sideboards on levels of human activity to reduce the negative impacts of human presence. The standards call for no net loss in secure habitat, and no net increase in the number of human developed sites and livestock grazing allotments with respect to that which existed in 1998. The delineation of 1998 as a meaningful baseline is predicated on evidence that habitat conditions at that time, and for the preceding decade, contributed to the 4–7% annual growth of the Yellowstone grizzly bear population observed between 1983 and 2001. Habitat standards apply only within the Grizzly Bear Recovery Zone (GBRZ)[1] located at the core of the GYE (Fig. A1).

[1] The Grizzly Bear Recovery Zone (GBRZ) is a term used when the Yellowstone grizzly bear population is protected as a threatened species under the ESA. The same area is referred to as the Primary Conservation Area (PCA) when the bear is de-listed or removed from federal protection. The GBRZ term is used in this 2021 report to reflect the current protected status of the Yellowstone grizzly bear population.

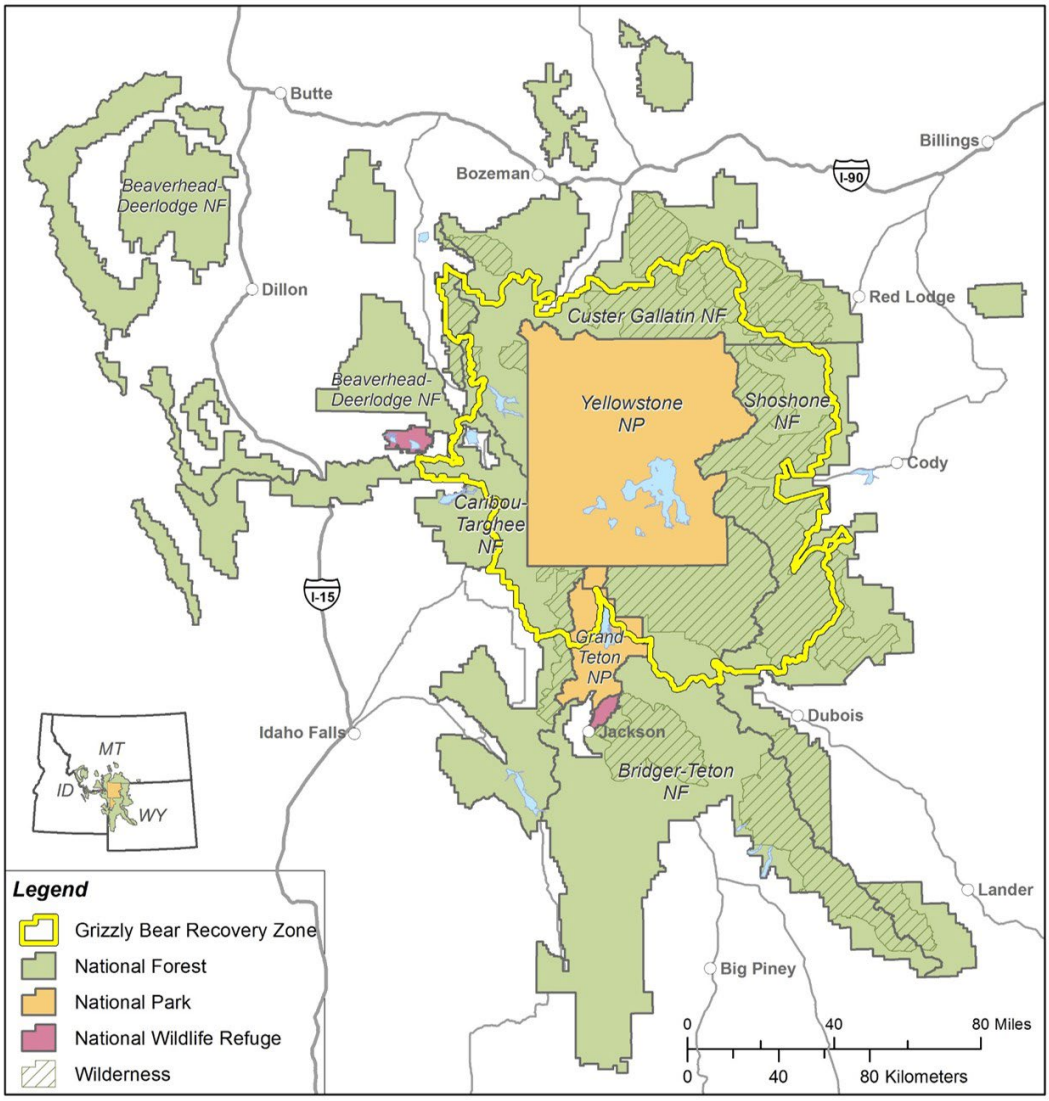

Figure A1. Federal lands comprising the Greater Yellowstone Ecosystem and the Grizzly Bear Recovery Zone (GBRZ).

Annual Monitoring Requirements inside the GBRZ

In compliance with annual habitat monitoring protocol, this report summarizes habitat changes incurred annually inside the GBRZ 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 habitat, and 4) 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 GBRZ. Current status of secure habitat and motorized route densities 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 status of livestock allotments is annually reported against 1998 levels for each national forest and park unit inside the GBRZ. The 1998 habitat baseline represents the most current and accurate information available documenting habitat conditions inside the GBRZ during 1998. National Forest Service and National Park Service personnel continue to improve the quality of their information to more accurately reflect what was on the landscape in 1998.

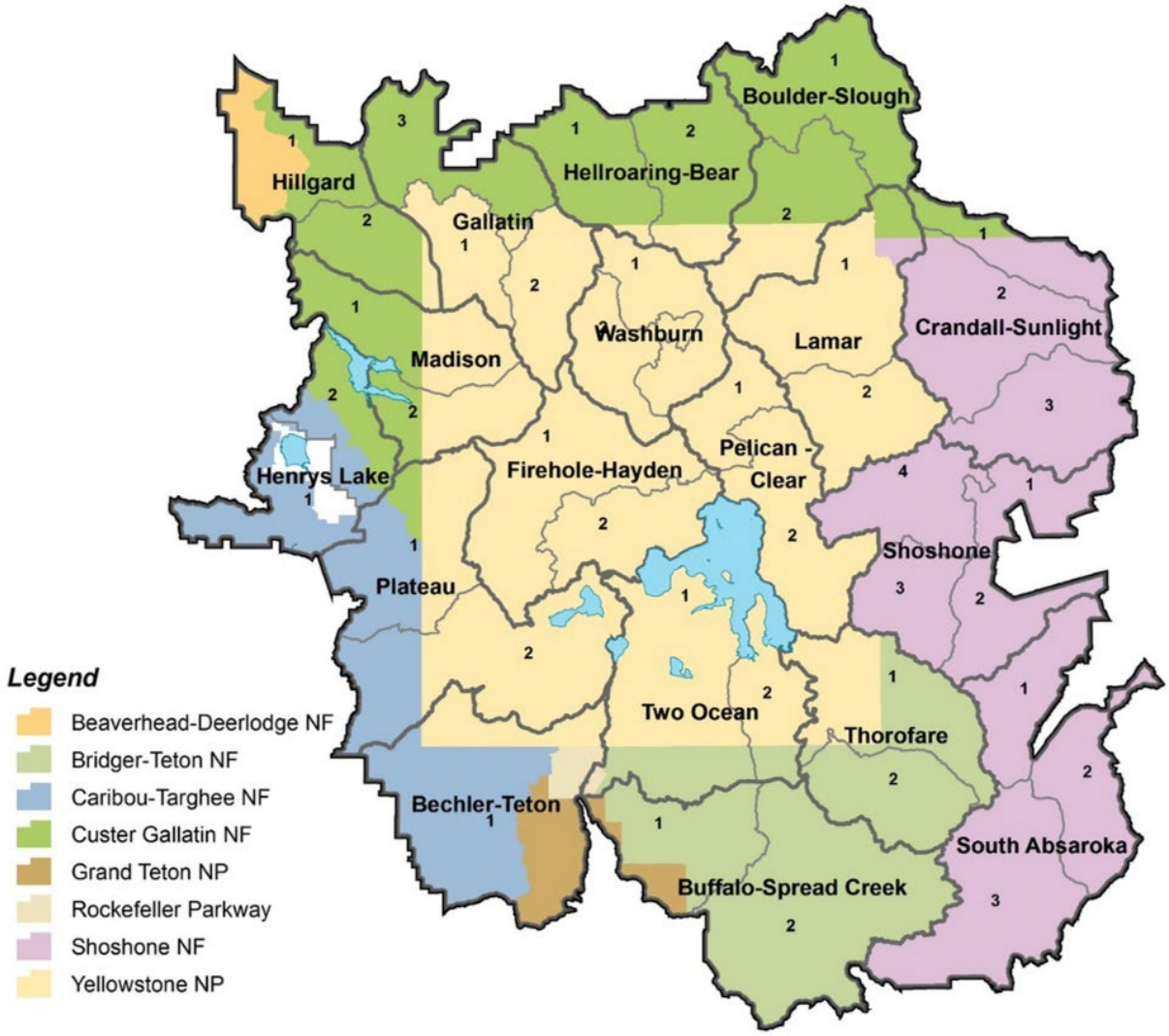

Figure A2. Bear Management Units and subunits comprising the Grizzly Bear Recovery Zone in the Greater Yellowstone Ecosystem.

Monitoring of Livestock Grazing

The habitat standard for livestock allotments identified in the Conservation Strategy requires there be no net increase in the number or acreage of active commercial livestock grazing allotments and no increase in permitted sheep animal months on federal lands inside the GBRZ 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 GBRZ. 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 covered 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 grazing on vacant allotments is typically on a temporary basis to resolve resource issues or other management 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 animal months are derived by multiplying the number of permitted sheep by 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 GBRZ are tracked through time to evaluate adherence to the habitat standard at 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 2021 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 GBRZ 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 GBRZ have largely been phased out since 1998. In 1998 there were11 active sheep allotments on public lands inside the GBRZ, amounting to 148,368 acres (600 km^2). Since 1998, there has been a 98% net reduction in the acreage grazed by sheep on public lands inside the GBRZ. Of the 11 actively grazed sheep allotments, 8 have been permanently closed and 2 were converted to cattle allotments in 2003 that remain active today (the Beartooth and Pearson allotments on the Shoshone National Forest). The only active sheep allotment remaining on public lands inside the GBRZ today is the Meyers Creek allotment located on the Caribou-Targhee National Forest and part of the USDA Sheep Experiment Station (USSES). Although "active," the Myers Creek has not been issued a grazing permit since the Willow Creek fire in 2008. Consequently, there has been no domestic sheep grazing on public lands inside the GBRZ for the past 14 years. (Table A1)

Change in livestock allotments during 2021

During 2021 there were no reported changes in livestock grazing allotments on federal lands inside the GBRZ.

Table A1. Number of commercial livestock grazing allotments and sheep animal months (AMs) inside the GBRZ in 1998 and 2021.

Administrative unit	Cattle allotments				Sheep allotments				Sheep animal months	
	Active		Vacant		Active		Vacant			
	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021
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[a]
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 GBRZ	72	55	13	7	11	1	10	0	23,090	1.970
Total acres in GBRZ	661,770	456,068	67,846	31,679	148,368	3,504	77,066	0		
Total area in GBRZ (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 GBRZ, did not request a permit in 2021.

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 grazing allotments and forage reserves on national forest land within the GYE. Livestock-grizzly bear conflicts associated with outfitters in backcountry settings, and conflicts occurring on private or state lands are not included in this report.

Livestock conflicts in 2021

In 2021, a total of 158 grizzly bear conflicts associated with livestock depredation on U.S. Forest Service lands were reported inside the GYE (Fig. A4). These conflicts occurred on 28 distinct commercial grazing allotments distributed throughout the ecosystem. All but 2 of the 158 incidents in 2021 involved cattle depredations and accounted for the injury or mortality of at least 6 cows, 20 yearlings, and 85 calves. Two incidents on the Beaverhead-Deerlodge National Forest involved sheep depredations outside of the GBRZ. Conflicts were reported on 4 national forests in the GYE including the: Beaverhead-Deerlodge (n = 42), Bridger-Teton (n = 84), Custer Gallatin (n = 2), and the Shoshone National Forests (n = 30). Approximately 96% (n = 151) of the conflicts occurred outside the GBRZ. Of the 158 livestock-related conflicts, 49% (n = 77) occurred on the Upper Green River cattle allotment

located outside the GBRZ on the north portion of the Bridger-Teton National Forest. During 2021, management actions in direct response to livestock depredations on public lands led to the removal of 6 grizzly bears (3 adult males, 1 subadult male, 1 adult female, and 1 subadult female). The subadult female was outside of the Demographic Monitoring Area on the Bufiox allotment on the Beaverhead-Deerlodge National Forest. An adult male was also removed from the Maverick Basin allotment on the Beaverhead-Deerlodge National Forest. One subadult and 2 adult males were removed from the Upper Green River allotment on the Bridger-Teton National Forest. One adult female was removed from the Warm Springs allotment on the Shoshone National Forest. All removals were in response to persistent cattle depredations and none of the removals occurred inside the GBRZ.

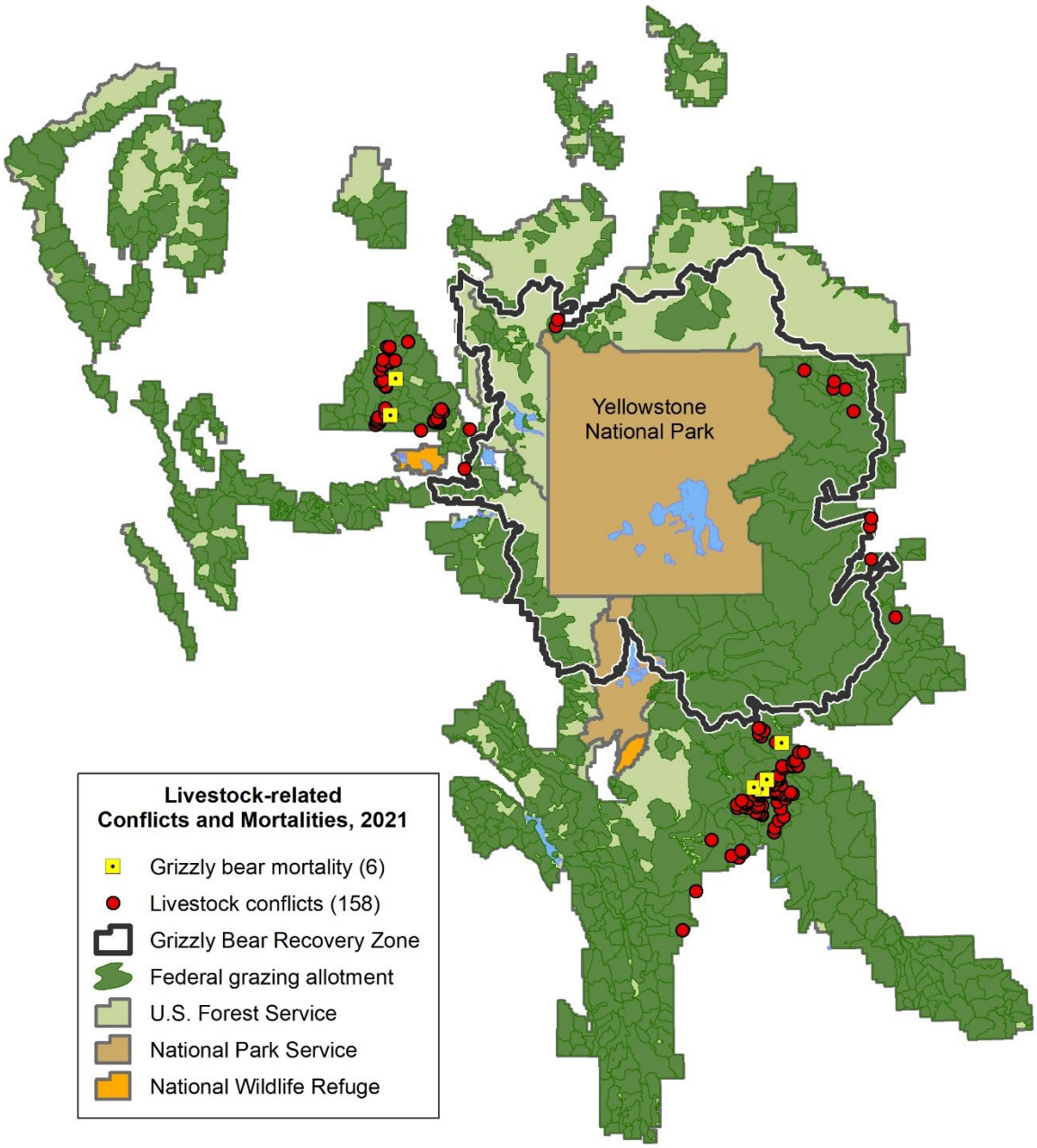

Figure A3. Grizzly bear conflicts and mortalities related to commercial livestock grazing on federal lands in the Greater Yellowstone Ecosytem during 2021.

Recurring livestock conflicts 2017–2021

Livestock conflicts are considered 'recurring' when cattle and/or sheep depredation incidents involving grizzly bears are reported on a given allotment in 3 or more years during the preceding 5-year period. During 2017–2021, 596 livestock conflict incidents were reported on grazing allotments on national forest lands inside the GYE (Table A2). Approximately 94% (n = 563) of these conflicts occurred outside the GBRZ. Of the 596 conflicts, 55% (n = 328) occurred on the Upper Green River cattle allotment located outside the GBRZ on the Bridger-Teton National Forest. Eighteen allotments experienced recurring conflicts: 7 on the Beaverhead-Deerlodge National Forest, 4 on the Bridger-Teton National Forest, 0 on the Caribou-Targhee National Forest, 0 on the Custer Gallatin National Forest, and 7 on the Shoshone National Forest (Table A2). Over the past 5 years, 31 grizzly bears were removed from the population due to persistent livestock depredation on U.S. Forest Service allotments. These 31 management removals included 3 females (2 adult, 1 subadult) and 27 males (22 adult, 5 subadult) and 1 adult of unknown gender. The subadult female was removed outside of the Demographic Monitoring Area, and no removals occurred within the GBRZ. Twenty-one (68%) of the 31 management-sanctioned grizzly bear removals were due to cattle depredations on the Upper Green River allotment.

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 (2017–2021)	Recurring conflicts
		2017	2018	2019	2020	2021		
Beaverhead–Deerlodge National Forest								
Anderson/cox	29,826	0	1	0	0	0	1	No
Antelope Basin	4,430	0	0	0	0	1	1	No
Barnett	6,454	0	0	0	1	0	1	No
Bufiox	13,077	3	1	0	3	5	12	Yes
Burnt Creek	2,992	0	0	1	0	2	3	No
Cliff Lake Bench	2,279	0	0	0	1	0	1	No
Clover Meadows	10,398	0	1	0	1	2	4	Yes
Coal Creek	5,186	0	0	0	0	1	1	No
Conklin	3,654	1	0	0	0	0	1	No
Elk Mountain	4,415	0	0	0	1	0	1	No
Eureka Basin	11,617	1	5	1	0	7	14	Yes
Hidden Lake Bench	6,609	1	0	0	2	0	3	No
Lobo Cascade	11,941	0	1	0	0	0	1	No
Long-pole	9,603	0	0	0	0	1	1	No
Lyon Wolverine	16,188	0	1	0	0	0	1	No
Maverick Basin	4,161	0	0	0	0	1	1	No
North Saddle	3,454	2	1	1	0	0	4	Yes
Red Rock	3,909	0	0	0	1	1	2	No
Standard Creek	12,833	0	0	4	0	0	4	No
Upper Ruby	44,395	2	5	0	2	7	16	Yes
Warm Springs	22,518	1	0	0	1	3	5	Yes
West Fork	53,096	8	13	13	1	11	46	Yes
Wigwam Trail	12,742	0	1	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 (2017–2021)	Recurring conflicts
		2017	2018	2019	2020	2021		
Bridger-Teton National Forest								
Badger Creek	7,254	0	0	1	0	0	1	No
Beaver-Horse	25,389	0	0	0	0	1	1	No
Beaver-Twin	22,030	0	0	1	2	4	7	Yes
Fisherman Creek	47,629	0	0	1	1	1	3	Yes
Green River (Drift)	1,003	1	0	0	0	0	1	No
Jack Creek	18,673	0	0	0	1	0	1	No
Noble Pasture	762	0	4	1	0	0	5	No
Roaring Fork	8,416	1	0	1	0	0	2	No
Salt Creek	10,005	1	0	0	1	0	2	No
Sherman C&H	8,287	1	0	0	0	1	2	No
Union Pass	23,800	0	0	0	2	0	2	No
Upper Green River	125,671	69	72	57	55	77	328	Yes
Upper Gros Ventre	67,497	4	3	0	2	0	9	Yes
Caribou-Targhee National Forest								
High Five	21,943	0	1	0	0	0	1	No
Squirrel Meadows	28,797	1	0	1	0	0	2	No
Custer Gallatin National Forest								
Hogan Creek	1,522	0	0	0	1	0	1	No
Tom Miner / Ramshorn	14,609	0	0	0	0	2	2	No
Wigwam	2,762	2	0	2	0	0	4	No
Shoshone National Forest								
Basin	73,119	0	0	0	1	1	2	No
Bear Creek	33,672	1	0	0	0	0	1	No
Bench (Clarks Fork)	28,751	0	4	0	0	0	4	No
Crandall	18,641	0	0	3	3	0	6	No
Dick Creek	9,569	0	0	0	2	0	2	No
Dunoir	52,875	0	1	1	0	0	2	No
Fish Lake	12,743	2	3	0	2	0	7	Yes
Ghost Creek	11,579	0	0	1	2	2	5	Yes
Greybull	34,641	0	0	0	0	1	1	No
Hardpan / Table Mountain	17,575	0	0	0	1	2	3	No
Horse Creek	29,980	1	0	0	0	0	1	No
Kirwin	17,588	0	0	0	1	0	1	No
Lake Creek	21,399	0	0	0	0	1	1	No
North Absaroka	146,766	0	0	0	2	0	2	No
Rock Creek	16,833	0	0	0	0	1	1	No
Salt Creek	8,263	1	0	0	1	5	7	Yes
Table Mountain	13,895	1	3	4	0	1	9	Yes
Union Pass	39,497	1	4	0	3	5	13	Yes

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 (2017–2021)	Recurring conflicts
		2017	2018	2019	2020	2021		
Warm Springs	16,875	3	2	3	1	8	17	Yes
Wind River	44,158	0	1	5	1	3	10	Yes
Wood River	4,049	0	0	0	1	0	1	No
Total conflicts		**109**	**128**	**102**	**99**	**158**	**596**	

[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 GBRZ

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 GBRZ be maintained at or below levels existing in 1998. Administrative site expansions are exempt from mitigation if such developments are deemed necessary for enhanced management 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 GBRZ are not counted against this standard.

Changes in developed sites since 1998

The number of distinct developed sites known to exist in 1998 is 594. 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 1 or more sites of equivalent human use within the same subunit. Today, the number of known developed sites on public lands inside the GBRZ is 576, accounting for a net decrease of 17 sites between 1998 and 2021. From 1998 to the present, the number of developed sites has remained at or below 1998 counts for all subunits inside the GBRZ except for the Hilgard #2 subunit, which increased by a count of 1. 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 1 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. Table A3 shows a comparison of developed site counts between 1998 and 2021.

Changes in developed sites in 2021:

There were no reported changes to developed sites within the GBRZ in 2021. Refer to Table A3 for 1998 and current counts of developed sites per bear management subunit.

Future review of developed sites

Since 2007, when the grizzly bear habitat standards were first implemented, the number of visitors on public lands throughout the GYE has increased significantly. In Yellowstone National Park alone,

annual visitation increased by more than 40% during the period 2008–2018, surpassing 4 million visitors per year since 2016 (National Park Service website). However, the habitat standards have not proved to be flexible enough to allow managers the ability to adequately respond to such extraordinary increases in visitation. In direct response to this administrative challenge, federal land managers requested that the 1998-based habitat standards be re-evaluated. Consequently, a placeholder was added to the 2016 Conservation Strategy that called for an interagency technical team (Developed Sites Technical Team) to be established. The team was tasked with recommending changes to the habitat standard and application rules that would provide managers the needed flexibility for authorizing new infrastructure to accommodate the demands of increased public visitation and aging infrastructure. Imposed constraints require that these recommendations strike a balance between management needs and habitat protection and adhere to the original intent of the 1998 habitat standards. The YES committee gathered public comment on the recommended changes to the habitat standard and application rules in 2021.

Table A3. *Number of developed sites in 1998 and 2021 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	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021
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	0	0	6	6	0	0	18	18
	YNP	0	0	0	0	0	0	0	0	1	1	0	0	0	0		
Hellroaring-Bear #1 [4]	CGNF	0	0	4	4	12	12	0	0	3	3	8	8	8	8	37	37
	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		

Table A3. *Number of developed sites in 1998 and 2021 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	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021
Henrys Lake #1	CTNF	2	2	3	3	1	1	0	0	3	3	11 [4]	11	1	0	21	20
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

Table A3. *Number of developed sites in 1998 and 2021 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	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021	1998	2021
South Absaroka #2	SNF	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	2
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**	**67**	**64**	**161**	**162**	**28**	**28**	**117**	**114**	**169**	**164**	**28**	**21**	**594**	**577**

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 comprising 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.

[4] The Slip & Slide trailhead site was appended in 2020 as an exempted addition to the 1998 Baseline. This baseline correction added 1 count to the CGNF, Hellroaring-Bear subunit #1, "Trailhead" category, causing the total baseline counts to go from 593 to 594 (1998) and 576 to 577 (2020). The trailhead existed prior to 1998 and was acquired through a land exchange.

Monitoring Secure Habitat and Motorized Access inside the GBRZ

Habitat standards identified in the Conservation Strategy require that there be no net loss in grizzly bear secure habitat with respect to levels that existed in 1998 for each of the 40 subunits inside the GBRZ. The sole exception to the 1998 baseline applies to 3 subunits identified in the 2007 Conservation Strategy (Gallatin #3, Henrys Lake #2, and Madison #2) as "*in need of improvement*" above 1998 levels. In 2016, new baseline values were established that hold these 3 subunits to improved levels of secure habitat. These increased levels were achieved in 2016 with full implementation of the Gallatin National Forest 2006 Travel Management Plan. New threshold values raise the baseline bar for these 3 subunits and supersede 1998 values for secure habitat.

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

The Conservation Strategy does not impose mandatory standards on motorized route density; however, changes in this parameter are monitored and reported annually for tracking purposes. The monitoring protocol requires that secure habitat, open motorized access route density (OMARD), and total motorized access route density (TMARD) be reported annually against baseline levels per subunit inside the GBRZ. OMARD is a measure of the density of routes open to public motorized use at least 1 or more days during the non-denning portion of the year when grizzly bears are considered active (March 1–November 30). TMARD is a measure of the density of roads and trails that are open to the public and/or administrative personnel for motorized use on 1 or more days during the active season. Route densities are reported as the percent area of each subunit where OMARD >1 mi/mi^2 (>0.62 km/km^2) and TMARD >2 mi/mi^2 (>1.2 km/km^2). Thus, although TMARD is a measure of total route density, values are typically lower than OMARD because the threshold density is at a higher level. Table A4 shows historical and current values of secure habitat and motorized route density. Routes that are gated closed to the public yearlong but accessible to administrative personnel detract from secure habitat and contribute to TMARD only.

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 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 motorized access. Decommissioned roads do not detract from secure habitat and do not contribute to OMARD or TMARD.

Permanent changes in secure habitat since 1998 (inside GBRZ)

The standard calling for "no net loss" in secure habitat with respect to 1998 baseline levels has been consistently met in all 40 subunits inside the GBRZ since it was initially formalized in the 2007 Conservation Strategy. For the 3 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 GBRZ. This gain is comparable in size to the area of Yellowstone Lake. The greatest improvement in secure habitat is the 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 (6 %) and Madison #2 (1.0%) was achieved by road closures

commissioned for implementation of the Gallatin Travel Management Plan. Values achieved with full implementation of the Gallatin Travel Management Plan constitute new baselines against which future change will be measured (Table A4 footnote). 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 1.4% since 1998. All gains in secure habitat throughout the GBRZ were achieved by the decommissioning of motorized routes on public lands. Permanent changes in secure habitat, OMARD, and TMARD inside the GBRZ are reported with respect to baseline levels in Table A4.

Permanent changes in secure habitat during 2021 (inside GBRZ)

The Custer Gallatin National Forest decommissioned administrative NFSR 2545 (Moonlight Connection, 1.2 miles) following completion of its use for the Lonesomewood project in Henry's Lake #2 subunit. This increased secure habitat in the subunit to 72.9%, an increase of 0.3% from the previous year.

The Custer Gallatin National Forest added Lost Wolverine Road to their road system as NFSR 3219-C (2.2 miles) under a special use permit to allow access to a private land inholding in Lamar #1 subunit. This addition due to statutory rights is allowable under the Conservation Strategy application rules and will be adopted into the baseline. The subunit is 89.6% secure habitat.

Table A4. 1998 and 2021 percent areas of open motorized access route density (OMARD, total motorized access route density (TMARD), and secure habitat per bear management subunit inside the Grizzly Bear Recovery Zone of the Greater Yellowstone Ecosystem.

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	2021	% chg	1998	2021	% chg	1998	2021	% chg		1998	2021
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	10.9	-0.6	5.3	5.6	0.3	88.3	89.0	0.7	219.9	194.1	195.6
Buffalo/Spread Creek #2	15.6	15.0	-0.5	12.7	9.5	-3.2	74.3	81.8	7.5	507.6	377.2	412.2
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	9.8	-1.9	82.3	82.7	0.4	316.2	260.3	261.4
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	17.8	-5.4	15.8	12.1	-3.7	77.0	80.3	3.4	184.7	142.2	148.7
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	31.3	0.1	45.4	46.0	0.6	191.2	86.8	88.0
Henry's Lake #2 *	49.9	40.6	-9.4	35.2	28.1	-7.1	45.7	52.0	6.3	140.2	64.1	72.9
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	10.0	0.2	3.8	4.1	0.3	89.4	89.6	0.2	299.9	268.1	268.6
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

Table A4. *1998 and 2021 percent areas of open motorized access route density (OMARD, total motorized access route density (TMARD), and secure habitat per bear management subunit inside the Grizzly Bear Recovery Zone of the Greater Yellowstone Ecosystem.*

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	2021	% chg	1998	2021	% chg	1998	2021	% chg		1998	2021
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
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
GBRZ Mean / Total Area	**12.7**	**10.9**	**-1.8**	**6.7**	**5.2**	**-1.5**	**85.6**	**87.4**	**1.8**	**9,025**	**7,724**	**7,889**

**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 (mile^2) 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, 2021 (inside GBRZ)

Reductions in secure habitat below baseline levels are allowed on a temporary basis inside the GBRZ when associated with authorized federal projects. In these cases, adherence to the "one percent" application rule and other provisions must be met. The 1% 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 1 temporary project to be active in a particular subunit at any given time. Five projects involving potential reductions in secure habitat within the GBRZ were operational in 2021 (Table A5). Below are brief summaries of these Forest Service projects.

Yale Creek Wildland-Urban-Interface: The Yale Creek Fuels Reduction Project was authorized to reduce hazardous fuels and produce a timber product on 3,161 acres of public lands interfacing with private lands in the Yale Creek and Shotgun subdivisions in the north portion of the Ashton-Island Park Ranger District on the Caribou-Targhee National Forest. One temporary road (1.7 miles) was used in 2021. It is important to note that this project will not meet the 3-year temporary project rule for the secure habitat standard. The first temporary road was constructed in 2019 and temporary road use will continue through 2024. An error was made in the contracting process, meaning the government is legally obligated to allow harvest for 6 years instead of ceasing it at 3 years.

Black Mountain Salvage Project: Authorized by the Black Mountain CE (2019), the purpose of this project is to salvage 138 acres of wind-thrown mature lodgepole pine on the Madison-Pitchstone Plateau of the Ashton-Island Park Ranger District on the Caribou-Targhee National Forest. One temporary road 0.2 miles in length was used in 2021.

Budworm Response Project: This fuel reduction and salvage-sanitation silvicultural project was authorized under the Budworm Response Project Finding of No Significant Impact. During FY2019, 13 temporary roads (20 total road segments ranging 0.023–0.86 miles in length) were created to support the Sugarloaf Timber Sale on the Shoshone National Forest within the Crandall/Sunlight #2 subunit. All but one of these temporary roads were closed during 2019 and 2020. The remaining temporary road should be closed and barricaded during summer 2022. One gated administrative road also remained open to contractor use during 2021.

Wolf Creek Salvage Project: This timber sale was authorized under the 2015 Long Creek Project EA and Decision Notice and is located within the South Absaroka #3 subunit near the Wolf Creek Trailhead on the Shoshone National Forest. The sale consists of live and dead sawtimber. Operations began in summer of 2020 and continued in 2021. The purchaser is using NFSR 513.3C. This is a gated administrative road and therefore already affects secure habitat.

Knob Hill Salvage Project*:* Timber harvest for this project was authorized under the 2018 Lava Mountain Project EA and Decision Notice. This project on the Shoshone National Forest is outside of the GBRZ, but within 500 meters of the Buffalo/Spread Creek #2 BMU subunit. Timber sale operations began in the autumn of 2020. The sale purchaser opened a decommissioned road, extended it, and constructed 3 additional temporary roads for logging operations. Project temporary roads used in 2021 totaled 1.3 miles. The sale will resume operations in summer of 2022 and will likely conclude in 2026. In future years, the existing temporary roads may be extended further to access several more harvest units.

Table A5. *Secure habitat affected by temporary projects inside the Grizzly Bear Recovery Zone, 2021.*

Project Name and National Forest	BMU Subunit	Secure Habitat (miles^2)					Project Status
		Allowed reduction below Baseline [a]	Baseline	2021 (without project)	2021 (with project)	Reduction in Secure Habitat	
Knob Hill Salvage Shoshone N.F. outside the GBRZ	Adjacent to Buffalo/Spread Creek #2	3.8	377.2	412.2	412.2	0	Open
Budworm Response Project Shoshone N.F.	Crandall-Sunlight #2	3.2	260.3	261.5	261.4	0.1	Open
Yale Creek WUI Caribou-Targhee N.F.	Henry's Lake #1	1.9	86.8	88	87.2	0.8	Open
Black Mountain Salvage Caribou-Targhee N.F.	Plateau #1	3.7	197.0	202	202	0	Open
Wolf Creek Salvage Shoshone N.F.	South Absaroka #3	3.4	190.3	190.3	190.3	0	Open

[a] The maximum allowed temporary reduction in secure habitat below baseline is 1% of the area of the largest subunit within the BMU.

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Appendix B

Monitoring Whitebark Pine in the Greater Yellowstone Ecosystem – 2021 Annual Report

The 2021 whitebark pine monitoring report was not yet available at time of publication of the IGBST 2021 annual report. Once finalized, it can be obtained in digital format from the Greater Yellowstone Inventory & Monitoring Network website (https://www.nps.gov/im/gryn/reports-publications.htm) and the Natural Resource Publications Management website (https://www.nps.gov/im/publication-series.htm). If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Appendix C

2021 Wyoming Bear Wise Wyoming Project Update

Introduction

The Bear Wise Community 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 2021. Past accomplishments are reported in the 2006 - 2020 annual reports of the Interagency Grizzly Bear Study Team (IGBST) and in the 2011-2020 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 Area (GYA) 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 GYA. The North Fork 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 16 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. To broaden the scope of the program, this work was rebranded as the Bear Wise Wyoming Program.

Cody Project Update

The Cody Bear Wise Community Program continues to utilize 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 2021 are as follows:

1. 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 Bureau of Land Management, National Fish and Wildlife Foundation. 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, 1,567 domestic livestock carcasses have been removed from private lands.

2. Gave presentations to the County Commissioners and Park County Landfill on the Carcass Management program updating them on progress and success.

3. The Carcass Management program utilized grant funding from the National Fish and Wildlife Foundation. This funding is from restitution of federal wildlife violations and will be used to reduce human-bear conflicts.

4. In the Cody Region, Large Carnivore Section (LCS) maintained 10 permanent electric fences that were built in 2020. The fences are around bee apiaries that have been in the same place long term. These project were completed in cooperation with USDA wildlife service non-lethal specialist and funding to do livestock conflict prevention.

5. LCS personnel held trainings, and coordination efforts with Guardian Air Rescue

6. Numerous informational presentations were given that focused on human-bear conflict prevention to students at the following schools: Powell High School, Cody high, middle, and elementary schools, Basin Middle school, and Lovell elementary school.

7. With funding from the Western Bear Foundation and Safari Club International, 300 canisters of bear spray were purchased. The cans of bear spray were given free of charge to hunters and anglers in late August. Giveaways were held in Cody, Jackson, and Lander.

8. A "Working in Large Carnivore Country" workshop was conducted for the Park County Weed and Pest District, Park County Search and Rescue, and Rocky Mountain Power.

9. A permanent electric fence was erected in 2018 at the Park County Landfill. To ensure the fence is in good working order WGFD personnel spent several days repairing and maintaining the fence in 2021. The partnerships with Wyoming Outdoorsmen, BLM, Park County Commissioners, Western Bear Foundation, and Greater Yellowstone Coalition were vital in making this project a reality.

10. Regional Hunters Ed classes, and numerous other public outreach events were held in Cody, Powell, Meeteetse, Thermopolis, Wapiti, and Burgess Junction.

Pinedale Area Update

In 2011, a Bear Wise Community effort was initiated targeting residential areas north of Pinedale, Wyoming where the occurrence of human-bear conflict has increased in recent years. Accomplishments for the Pinedale area in 2021 are as follows:

1. Hunting in Bear Country presentations were given to hunter safety classes throughout the region in an effort to educate future sportsmen and women and increase safety potential.

2. LCS personnel provided range rider safety training to local cowboys and ranches that have a high potential of encounters with grizzly bears and livestock.

3. Bear safety presentations were given to the USFS, and other groups throughout Sublette County.

4. LCS personnel provided training for regional fisheries crews and local Sublette County Conservation District employees.

5. LCS personnel attended and participated in the Sublette County Conservation District's spring Expo providing Information and education to attendees.

Objectives for 2021 included continued expansion of the program into the 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 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 and continued federal legal protection. The future success of the Bear Wise program lies in continued community interest and individual participation in proper attractant management.

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 2020, 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.

1. 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. 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.

2. Public service announcements were broadcast on local radio stations in Jackson throughout the spring, summer, and fall of 2021. The announcements focused on storing attractants so they are unavailable to bears and hunting safely in bear country.

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

4. 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.

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

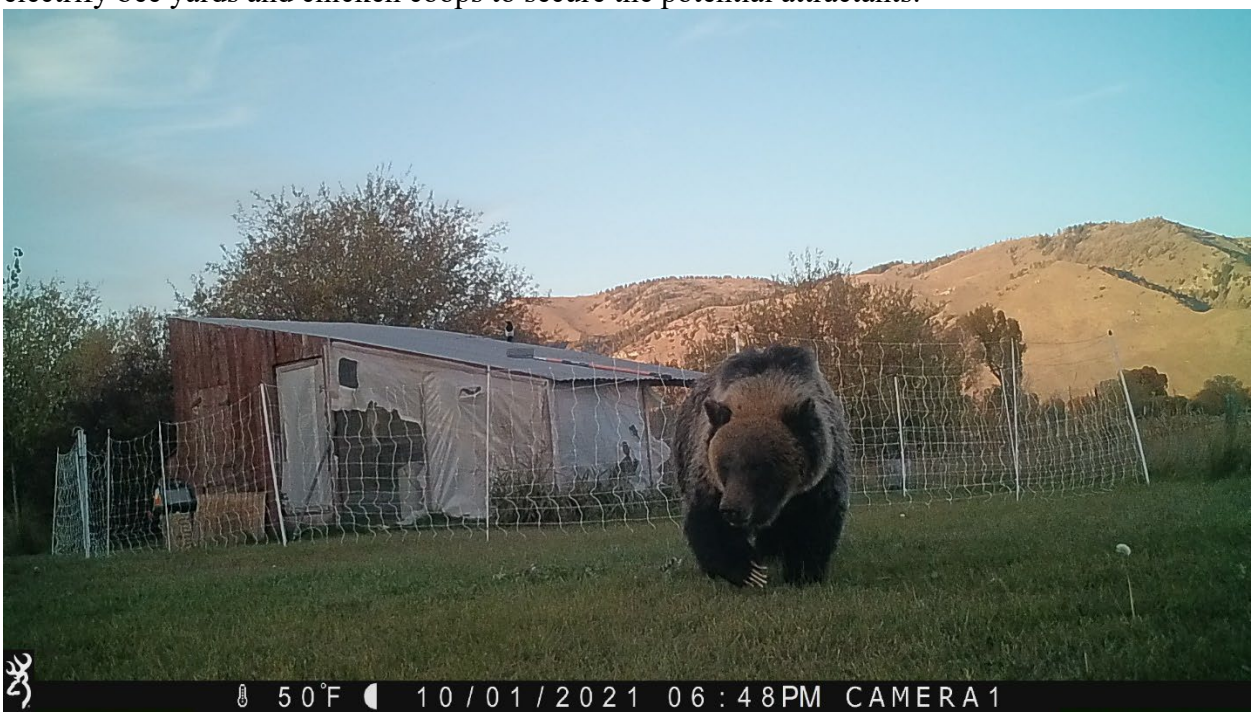
6. LCS personnel continued to work with a Jackson catering company, Roots Kitchen & Cannery. They have been involved in picking apples from trees that have been identified as a source of bear conflict by WGFD.

7. 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.

8. 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.

9. LCS personnel assisted hunting outfitters and with the installation and maintenance of electric fence systems around their field camps located in the Bridger-Teton National Forest. Annually, personnel meet with hunters and outfitters to reduce to conflict potential between humans and grizzly bears.

10. LCS personnel worked extensively with the Apiarists in Teton County. They worked together to electrify bee yards and chicken coops to secure the potential attractants.



11. 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.

12. Consultations were conducted at multiple businesses and residences where recommendations were made regarding sanitation infrastructure and compliance with the Bear Conflict Mitigation and Prevention Lander Development Recommendations (LDR).

13. Bear Aware educational materials were distributed to school groups, campground hosts, hunters, and numerous residents in Teton County.

14. Several newspaper interviews were conducted regarding conflict prevention in the Jackson area.

15. 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.

16. LCS personnel worked with a Jackson sanitation company and Jackson residents on placing new bear resistant garbage cans in several Jackson neighborhoods.

17. LCS personnel sat in on and participated in numerous meetings working with Teton County to develop new land development restrictions (LDR). These will take effect in 2022. The purpose is to help work toward reducing bear human conflicts at homes in Teton County.

Objectives for the Bear Wise Jackson Hole program in 2021 were 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 LDR. 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 LDR 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 the conflict issues are resolved. The Bear Wise Jackson Hole Program will convey the importance of compliance and strive to maintain public support for the LDR 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

2021 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.

   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.

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.

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 DVD's entitled 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

The primary link to other publications, annual reports, and peer reviewed literature for the Yellowstone population of grizzly bears is summarized on the U.S. Geological Service web site at https://www.usgs.gov/science/interagency-grizzly-bear-study-team.

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.

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