Biennial Monitoring Report

For the Bridger–Teton National Forest

Bridger–Teton National Forest
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Title page caption: Left-side photo: View of Bridger Wilderness including two lakes sampled as part of the air program's long-term lake chemistry monitoring (Black Joe Lake is the long lake in the forefront, and Deep Lake is at the head of the next catchment and drains into Clear Lake); Right-side photos top to bottom: Forest Water Rights Coordinator Robertson conducting surveys in the Upper Green River Basin, looking down to the Green River, Green River Lake, and Square Top in the distance with haze created by smoke from fires across the west (2020); Wildlife Biologists DeLong (USDA Forest Service) and Fralick (Wyoming Game and Fish Department) conducting a wildlife survey; Air Quality Technician Porwoll conducting air quality monitoring.

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Acronym or Abbreviation	Full Term
AMs	Animal Months
ANC	Acid neutralizing capacity
AOP	Aquatic Organism Passage
ASQ	Allowable Sale Quantity
BAU	Bear Analysis Unit
BBS	Breeding Bird Survey
BMP	Best Management Practices
BTNF	Bridger Teton National Forest
BPS	Biophysical Setting
CASTNET	Clean Air Status and Trends Network
CCF	Hundred Cubic feet
Chl a	chlorophyll a
CLs	Critical loads
CRMP	Comprehensive River Management Plan
DIN	Dissolved Inorganic Nitrogen
eDNA	Environmental DNA
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FACTS	Forest Activity Tracking System
Fbm	board foot
ft3	Cubic Feet
FY	Fiscal Year
GTR	General Technical Report
GYA	Greater Yellowstone Area
LAU	Lynx Analysis Unit
IDS	Insect and Disease
IGBST	Interagency Grizzly Bear Strategy Study Team
IMPROVE	Interagency Monitoring of Protected Visual Environments
IN	Inorganic Nitrogen
INFORM	Interagency Fire Occurrence Reporting Modules
MBF	Thousand Board Feet
MPB	Mountain Pine Beetle
N	Nitrogen
NADP	National Atmospheric Deposition Program
NFMA	National Forest Management Act
NH3	Ammonia
NOM	Natural Organic Material
NOx	Oxidized Nitrogen
NRCS	Natural Resource Conservation Service

NRIS	Natural Resource Information Systems
NRM	Natural Resource Manager
NRLMD	Northern Rockies Lynx Management Direction
NVUM	National Visitor Use Monitoring
OMARD	Open motorized access route density
OSVUM	Over-snow vehicle Use Map
PCA	Primary Conservation Area
POSS	Point of Sale System
PTSAR	Periodic Timber Sale Accomplishment Report
RMR	Rocky Mountain Region
ROS	Recreation Opportunity spectrum
S	Sulfur
SNOTEL	Snow Telemetry
SUDS	Special Use Database Systems
SUP	Special Use Permit
SWE	Snowy Water equivalent
TC	Total Carbon
TDEP	Total Deposition Model
TIM	Timber Information Manager
TMARD	Total motorized access route density
TMO	Trails Management Objective
TN	total nitrogen
TP	total phosphorus
TRACS	Trail Assessment and Condition Surveys
USDA	U.S Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S Geological Survey
VCMQ	Vegetation Classification, Mapping, and Quantitative Inventory
WBP	Whitebark Pine
WCF	Watershed Condition Framework
WFDSS	Wildland Fire Decision Support System
WGFD	Wyoming Game and Fish Department
WPBR	White Pine Blister Rust
WSR	Wild and Scenic Rivers
WUI	Wildland Urban Interface

Summary of Findings and Results

In 2020 as the nation grappled with the Covid-19 pandemic, the Bridger-Teton National Forest (BTNF) likewise adjusted to address visitor and employee safety, while continuing management and monitoring activities. Visitors flocked to the BTNF, many for the first time, to enjoy outdoor spaces that provided a place of respite and relaxation during the pandemic. At least two million people visited the BTNF annually, and notably, the summer of 2020 saw a 30% increase in visitation compared with 2019. The increased use of BTNF persisted into the winter months. Top visitor activities on the BTNF remain hiking/walking, downhill skiing, snowmobiling, cross-country skiing, viewing natural features, and bicycling. Other highlights of the 2019–2020 monitoring period include: a shift to online sales of Christmas tree permits; an increase in timber sale volume sold in Fiscal Year 2020, greater than during any of the previous ten years; invasive plant species treated across approximately 11,500 acres, predominantly for cheatgrass control; and a collaborative restoration project, the Tri-Basin Fish Passage and Watershed Restoration, implemented to benefit cutthroat trout and other aquatic species.

Additionally, concerns on the BTNF were raised. Eutrophication of sensitive lakes and air pollution deposition (particularly in the Bridger, Teton, and Gros Ventre Wilderness Areas and the Wyoming Range) were identified as a result of local, regional, and long-distance transport of pollutants. Ongoing increases in tree mortality resulting from insects, diseases, and larger wildfires will likely lead to the need for more active reforestation and fuels reduction. The recent passage of the Great American Outdoors Act holds promise that the long-standing deferred maintenance backlog on developed recreation sites and a limited number of associated, primary access roads can begin to be addressed over the next five years.

In general, the monitoring results indicate that BTNF is meeting Forest Plan objectives (TABLE 1). Monitoring from 2019–2020 revealed that there are eight indicators (of 51 total) for which Forest Plan revision should be considered; these indicators are related to air quality, forest vegetation, recreation opportunities, and environmental stressors. Current Forest Plan direction is considered outdated and should be updated for these resources. There is only one indicator—recreation (trail miles maintained to standard)—for which current monitoring results indicate that Forest Plan objectives may not be adequately met, and four indicators—Wild and Scenic Rivers (watercraft use, miles with degraded water quality, and number of federal water projects authorized) and recreation (developed sites)—for which the current status is uncertain due to inadequate data or methodology. There were 13 indicators—related to air quality, forest vegetation, recreation, wilderness, and environmental stressors—for which management activities may warrant change to better meet Forest Plan objectives. There are 11 indicators for which changes to the monitoring program are warranted, including changing indicators and methodologies (TABLE 2).

Quantitative evaluation of indicators does not present a full picture of potentially critical issues that need addressing. A single indicator showing a downward or neutral trend may be enough to warrant management action or represent an opportunity for change. Conversely, the areas in which changes to the Forest Plan may be warranted are not necessarily considered to require urgent attention, as the associated stressors are long-term. The body of the report contains more details regarding specific management and monitoring recommendations as well as context for each recommendation.

Table 1. Quantitative summary of monitoring evaluation trends for all monitoring indicators (51 total).

	Yes	Uncertain	No
Forest Plan Objectives Met	46	4	1
Change to Forest Plan warranted	8	0	43
Change to management activities warranted	13	0	38
Change to monitoring program warranted	11	0	40
Focused assessment needed	0	0	51

Table 2. Summary of findings for all monitoring indicators.

Monitoring Question	Indicator	Do monitoring results demonstrate intended progress or trend toward Plan targets?	Based on the evaluation of monitoring results, may changes be warranted?	If a change may be warranted, where may the change be needed?
WTR-01: In what condition are the watersheds?	WTR-01-01: Multiple indicators from the Forest Service Watershed Condition Framework which includes both physical, biological, aquatic and terrestrial variables that affect watershed condition	Yes	No	N/A
AIR-01: Are air quality related values being impacted within wilderness areas and other areas of the Forest?	AIR-01-01: Lake water chemistry	Yes	Yes	Forest Plan; monitoring program
	AIR-01-02: Critical Load Exceedances from nitrogen deposition	Yes	Yes	Forest Plan; monitoring program
	AIR-01-03: Visibility	Yes	Yes	Forest Plan; management activities
ARE-01: Are native aquatic and riparian ecosystems maintaining or improving in relation to aquatic invasive/exotic species?	ARE-01-01: Miles of stream and acres of lake habitats that have aquatic invasive/ exotic species present	Yes	No	N/A
	ARE-01-02: Miles of stream and acres of lake habitats in which aquatic invasive/ exotic species have displaced native aquatic species	Yes	No	N/A
VEG-01: To what extent is vegetation being impacted by management activities and natural disturbance processes?	VEG-01-01: Acres in each biophysical setting affected by prescribed fire and mechanical treatments including timber harvest and other silvicultural activities	Yes	Yes	Forest Plan; management activities; monitoring program
	VEG-01-02: Acres affected by wildfire, both wanted and unwanted	Yes	Yes	Monitoring program

Monitoring Question	Indicator	Do monitoring results demonstrate intended progress or trend toward Plan targets?	Based on the evaluation of monitoring results, may changes be warranted?	If a change may be warranted, where may the change be needed?
VEG-02: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of candidate whitebark pine?	VEG-02-01: Acres treated for the purpose of sustaining or restoring whitebark pine	Yes	No	N/A
	VEG-02-02: Acres by forest size class	Yes	No	N/A
WDL-01: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the endangered Kendall Warm Springs dace?	WDL-01-01: Replicate relative abundance estimates	Yes	Yes	Monitoring Program
	WDL-01-02: Number and type of habitat improvement projects	Yes	No	N/A
	WDL-01-03: Channel width to depth ratios (including vegetation encroachment) using 1995 research as baseline	Yes	No	N/A
	WDL-01-04: Channel Temperature and Water Quality/Chemistry using 1978 report as baseline	Yes	No	N/A
WDL-02: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened Greater Yellowstone Area (GYA) grizzly bear?	WDL-02-01: Change from the 1998 baseline in secure habitat and motorized route density inside the PCA	Yes	No	N/A
	WDL-02-02: Change from the 1998 baseline in developed sites inside the PCA	Yes	No	N/A
	WDL-02-03: Change from the 1998 baseline in the number and acreage of commercial livestock grazing allotments and the number of sheep animal months inside the PCA	Yes	No	N/A
	WDL-02-04: Change from the 2008 baseline in secure habitat outside the PCA	Yes	No	N/A
WDL-03: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened Canada lynx and its critical habitat?	WDL-03-01: Acres of Forest-wide fuel treatments and vegetation projects reported in accordance with the required monitoring found in the Northern Rockies Lynx Management Direction	Yes	No	N/A
	WDL-03-02: Changes in lynx habitat as a result of moving towards the desired conditions for vegetation through vegetation management, prescribed fire, or natural disturbance	Yes	No	N/A

Monitoring Question	Indicator	Do monitoring results demonstrate intended progress or trend toward Plan targets?	Based on the evaluation of monitoring results, may changes be warranted?	If a change may be warranted, where may the change be needed?
WDL-04: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened yellow-billed cuckoo?	WDL-04-01: Acres of cottonwood overstory riparian habitat	Yes	Yes	Monitoring program
	WDL-04-02: Breeding Bird Survey (BBS) trend data for on-forest routes and incidental sightings	Yes	Yes	Monitoring program
WDL-05: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the proposed North American wolverine?	WDL-05-01: Acres open to over-snow vehicle use; Miles of groomed over-snow trails (e.g., motorized and non-motorized) (duplicate of recreation indicator RA-03-01 and RA-03-02)	Yes	No	N/A
	Indicator WDL- 05-02: Amount and seasonal variation of snowpack (duplicate of environmental stressors indicator (EVS-01-02)	Yes	Yes	Management activities; Forest Plan
FOC-01: Are forest management activities and/or natural events affecting aquatic conditions indicated by the status of a focal species?	FOC-01-01: Miles of stream enhanced	Yes	No	N/A
RA-01: Are developed recreation sites managed to standard?	RA-01-01: Number of developed sites maintained to standard	Uncertain: methodology inadequate	Yes	Monitoring program
RA-02: Are the amount and types of recreation opportunities provided meeting customer needs and expectations?	RA-02-01: Visitation estimates, visitor activities, and percent overall satisfaction (duplicate of econ indicator ECC-01-01)	Yes	Yes	Management activities; Forest Plan
	RA-02-02: Visitor numbers at ski areas, other resorts, and outfitter/guide services	Yes	Yes	Management activities; monitoring program
	RA-02-03: Estimated number of dispersed campsites	Yes	Yes	Management activities; monitoring program
	RA-02-04: Acres providing various classes of recreation opportunity (ROS)	Yes	No	N/A

Monitoring Question	Indicator	Do monitoring results demonstrate intended progress or trend toward Plan targets?	Based on the evaluation of monitoring results, may changes be warranted?	If a change may be warranted, where may the change be needed?
RA-03: Does the Forest road and trail system provide for motorized and non-motorized recreation opportunities in both summer and winter?	RA-03-01: Acres open to over-snow vehicle use (duplicate of wildlife indicator WDL-05-01)	Yes	Yes	Management activities; Forest Plan
	RA-03-02: Miles of groomed over-snow trails (e.g., motorized and non-motorized) (duplicate of wildlife indicator WDL-05-01)	Yes	Yes	Management activities
	RA-03-03: Miles of non-snow (summer) trails maintained for motorized and non-motorized use	Yes	Yes	Management activities
	RA-03-04: Trail miles maintained to standard	No	Yes	Management activities
	RA-03-05: Road miles maintained to standard	Yes	Yes	Management activities
WSR-01: Are the free-flowing conditions, water quality, and Outstandingly Remarkable Values for Wild and Scenic Rivers maintained and protected?	WSR-01-01: Watercraft use in Wild and Scenic Rivers	Uncertain: more data needed	Yes	Monitoring program
	WSR-01-02: Miles of WSR with degraded water quality	Uncertain: methodology inadequate	No	N/A
	WSR-01-03: Number of federal water projects authorized	Uncertain: more data needed	No	N/A
WLDN-01: Do management activities in designated wilderness areas preserve wilderness character?	WLDN-01-01: Trend in Wilderness character	Yes	Yes	Management activities
	WLDN-01-02: Wilderness stewardship performance score	Yes	Yes	Management activities
EVS-01: What stressors are impacting the plan area?	EVS-01-01: Extent of insect and disease infestation	Yes	No	N/A
	EVS-01-02: Amount of snowpack and spring runoff	Yes	Yes	Management activities; Forest Plan
	EVS-01-03: Extent of invasive species	Yes	No	N/A
ECC-01: Are multiple use opportunities on the Forest contributing to the prosperity of local communities?	ECC-01-01: Forest visitor numbers (duplicate of rec indicator RA-02-01)	Yes	No	N/A
	ECC-01-02: Availability and use of commercial recreation opportunities	Yes	No	N/A
	ECC-01-03: Availability and use of livestock grazing opportunities	Yes	No	N/A
	ECC-01-04: Amount of timber offered and produced (duplicate of TIM-01-02)	Yes	No	N/A
	ECC-01-05: Availability and use of firewood and other products for personal use	Yes	No	N/A

Monitoring Question	Indicator	Do monitoring results demonstrate intended progress or trend toward Plan targets?	Based on the evaluation of monitoring results, may changes be warranted?	If a change may be warranted, where may the change be needed?
TIM-01: Is timber harvest occurring in a manner which does not impair the productivity of the land?	TIM-01: Implementation of Best Management Practices during timber harvest and transport	Yes	No	N/A
	TIM-01-02: Amount of timber harvested relative to Allowable Sale Quantity as specified in the Forest Plan	Yes	No	N/A
	TIM-01-03: Areas of regeneration harvest of timber re-stocked with young trees within five years of final harvest	Yes	No	N/A

Introduction

Purpose

Monitoring and evaluation are continuous learning tools that form the backbone of adaptive management of our national forests. The purpose of the biennial monitoring evaluation report is to help the responsible official determine how well Forest Plan objectives are being met on the BTNF and whether changes are warranted in Forest Plan direction, management activities or the Forest Plan monitoring program based on new monitoring information or if additional focused assessment is needed. This report is a tool and a resource for the Forest Service to assess the condition of forest resources in relation to Forest Plan direction and management actions. It is also a tool and a resource for the public to learn more about how the Forest Service is managing forest resources. It is not a decision document.

The biennial monitoring evaluation report represents only one part of monitoring efforts on BTNF. It is targeted at evaluating the monitoring questions and indicators that were developed in 2016 and updated in 2020 to address new Forest Plan monitoring requirements under the 2012 planning rule. This is our second biennial evaluation report since a 2016 administrative change required forests to transition their monitoring programs to the direction provided in the 2012 planning rule. The 2012 planning rule monitoring requirements are available at: https://www.fs.usda.gov/detail/planningrule.

The Importance of Public Participation

BTNF is committed to adaptive management and recognized that the public plays an important role in keeping the monitoring plan relevant. The monitoring questions and indicators included in this report were developed with public participation in 2016 and updated in 2020. We informed the public of the availability of the 2019–2020 biennial monitoring report for BTNF by posting a full report on BTNF

website at: https://www.fs.usda.gov/main/btnf/landmanagement/planning. Additionally, an email was sent to key stakeholders, including tribes and cooperating agencies.

We will consider all substantive comments received and welcome an open and engaged dialogue and participation.

About Our Forest Plan Monitoring Program

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How Our Plan Monitoring Program Works

Monitoring and evaluation requirements have been established through the National Forest Management Act (NFMA) at 36 CFR 219. Additional direction is provided by the Forest Service in Chapter 30 – Monitoring – of the Land Management Handbook (FSH 1909.12). The BTNF monitoring program was updated in September 2016 for consistency with the 2012 planning regulations [36 CFR 219.12 (c) (1)]. The BTNF Forest Plan was administratively changed to include the updated monitoring program. Monitoring questions and indicators were selected to inform the management of resources on the plan area and not every plan component was determined necessary to track 36 CFR 219.12(a) (2). Public input on these monitoring questions and indicators was incorporated into the monitoring guide. The monitoring guide is part of the overall plan monitoring program and provides more specific direction for implementing the more strategic plan monitoring program and details monitoring methods, protocols, and roles and responsibilities. The monitoring guide is not part of the plan decision and is subject to change as new science and methods emerge. The monitoring guide is available at: https://www.fs.usda.gov/main/btnf/landmanagement/planning.

Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program. While implementation monitoring is important for tracking progress and accomplishments, it is effectiveness and validation monitoring that drive and support the adaptive management process. Effectiveness monitoring evaluates condition and trend relative to desired conditions. Validation monitoring tests hypotheses and provides information that might necessitate changes to desired conditions in the plan (e.g., is what we think the desired state should be really accurate?). In the context of forest planning there are three main monitoring goals:

- Are we implementing the Forest Plan implemented properly? Are we meeting our management targets and project guidelines? (implementation monitoring)
- Are we achieving our Forest Plan management goals and desired outcomes? (effectiveness monitoring)
- Does our hypothesis testing indicate we may need to change the Forest Plan? (validation monitoring)

Monitoring Evaluation

The following sections present the most current information for all monitoring questions and indicators contained within the Bridger Teton Forest Plan monitoring program. Monitoring questions are presented in order of how they address the eight monitoring categories required under the 2012 planning rule:

- Status of select watershed conditions
- Status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems (e.g., air, water, vegetation)
- Status of focal species to assess the ecological conditions required under 36 CFR 219.9
- Status of a select set of ecological conditions required under 36 CFR 219.9 to contribute to the recovery of federally threatened and endangered species, conserve proposed and candidate species and maintain a viable population of each species of conservation concern (At this time, SCC have not been identified for BTNF; therefore, the Forest Plan monitoring program will not address SCC)
- Status of visitor use, visitor satisfaction and progress toward meeting recreation objectives;
- Measurable changes in the plan area related to climate change and other stressors that may be affecting the plan area
- Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities
- Effects of each management system to determine that they do not substantially and permanently impact the productivity of the land (16 U.S.C. 1604(g)(3)(C)).

Question WTR-01: In what condition are the watersheds?

Indicator WTR-01-01: Multiple indicators from the Forest Service Watershed Condition Framework which includes both physical, biological, aquatic and terrestrial variables that affect watershed condition.

Summary of methodology

Watershed condition is assessed using the Watershed Condition Framework (WCF) (USDA Forest Service 2011); methodology can be found at: https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml. Each watershed is evaluated based on what has occurred in the watershed and by utilizing established procedures and metrics. A determination is then made of the condition class of the watershed. Each watershed is assigned a condition class: Class 1—Functioning Properly; Class 2—Functioning at Risk; or Class 3—Impaired Function. Current watershed condition classes on BTNF are available online (https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml). In addition to being assigned a condition class, each watershed was also assigned a conditional class rating. Ratings are a numerical value developed by taking a weighted average of individual scores of 12 national core indicators, which include physical, biological, aquatic and terrestrial variables. In 2011, all sixth-level watersheds on the BTNF were evaluated and assigned a class and rating using the Watershed Condition Framework. Current watershed condition classes for BTNF can be accesses via the Watershed Condition and Prioritization Interactive Map website: https://apps.fs.usda.gov/wcatt/.

Monitoring results

There are 171 sixth level watersheds on BTNF. Of these, there are 157 that are Functioning Properly and 14 that are Functioning at Risk. During 2019 and 2020, one watershed (Greys River-Spring Creek) on BTNF improved a condition class rating, while the remaining watersheds' condition class rating remained stable. In 2018, the Greys River-Spring Creek watershed was designated a priority watershed and restoration efforts were focused on this watershed. Numerous essential projects to improve the watershed were planned, implemented, and completed. Although there are remaining essential projects to be completed, completed projects have improved three indicators of the Watershed Condition Framework—habitat fragmentation, road maintenance, and soil erosion. Completed projects have improved the condition class rating for the Greys River-Spring Creek watershed from 1.34 to of 1.22.

Discussion and findings

Overall, watershed condition across BTNF is improving. Restoration and enhancement activities by the USFS improved the condition class rating of the Greys River-Spring Creek watershed.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Question AIR-01: Are air quality related values being impacted within wilderness areas and other areas of the forest?

Indicator AIR-01-01: Lake water chemistry

Summary of methodology

Long-term lake chemistry sampling in the Bridger Wilderness has been conducted every year since 1984 at Hobbs, Black Joe, and Deep Lakes. Inlet and outlet samples are collected three times per year (early summer, mid-summer, and fall), and hypolimnion and epilimnion samples are collected once per year (summer). Upper Frozen Lake is typically sampled once per year (since 1997) from the shore. The average number of samples taken per year is 25, not including replicates. The 2020 field season was disrupted by COVID-19 and a large wind event that prevented backcountry travel, thus samples were only collected during mid-summer. Sampling methodology is outlined in (Grenon et al. 2010). In the summer of 2020, four new analytes, total nitrogen (TN), total phosphorus (TP), total carbon (TC), and chlorophyll *a* (Chl *a*) were added to the water chemistry monitoring program in response to the concern over an increased risk for oligotrophic surface waters in the Bridger wilderness to trend towards eutrophication.

New science or information

Forest Service Region 4 contracted with E & S Environmental (2018-2019) to assess nitrogen (N) critical loads (CLs) for various ecosystem components including lake water acidification and surface water eutrophication. Critical loads are a quantitative estimate of exposure to one or more pollutants; they represent a threshold below which significant harmful effects on specified sensitive elements of the environment are not expected to occur. Different ecosystem components often have different CLs. The lake water acidification CLs in the assessment used synoptic and long-term lake chemistry data collected throughout the BTNF, and the surface water eutrophication CLs were based on work done by Nanus et al. 2017. The critical load assessment report is in the process of being published as a General Technical Report (GTR). Critical loads and exceedances of CLs for surface water acidification and eutrophication are discussed further in AIR-01-02.

The Environmental Protection Agency (EPA) has developed an online mapping tool called the Critical Load Mapper Tool (https://clmapper.epa.gov/). Users can view and download nitrogen (N) and sulfur (S) deposition data across the continental US as well as identify lakes that are exceeding CLs for acidification. The EPA plans to include eutrophication CLs in a future update.

Monitoring results

Due to a laboratory analysis issue discovered post hoc, lake chemistry analysis results from 2011-2014 are not valid. In 2015 lake chemistry analysis switched to the Rocky Mountain Research Station laboratory. The last trend analysis of the lake chemistry data was completed by Grenon et al. (2010). This assessment analyzed trends based on sample location, seasonality, and annual concentrations. Three trends (out of a possible 25) in acid neutralizing capacity (ANC) were found. From 1997 to 2008, ANC increased Upper Frozen Lake and decreased at the outlets of Black Joe Lake and Hobbs Lake in fall, indicating that ANC has been generally stable at the various locations (inlet, outlet, hypolimnion, and epilimnion). A decrease in ANC means the lake is trending towards acidification and buffering capacity is decreasing. Grenon et al. (2010) also found an increasing trend in nitrate (NO_3^-) at the inlets of Black Joe Lake and Deep Lake during the fall and an increasing trend in ammonium (NH_4^+) at Hobbs Lake during early and late summer from 2000 to 2010. Nitrate and ammonium ion concentrations were often near the lower detection limit, which is typically near zero for water chemistry samples. Lake chemistry trends will be re-evaluated for the next biennial monitoring report. In the summer of 2020, additional analytes were added to the lake sampling program—Chl *a*, TP, TN, and TC. Data on these new analytes will be available for the next biennial monitoring report.

Discussion and findings

Many high alpine lakes are sensitive to deposition of air pollutants because sparse vegetation and shallow soils limit a lake basin's ability to buffer chemical compounds from entering surface water. Acidifying pollutants (i.e., anions such as nitrate and sulfate) can cause episodic or long-term surface water acidification. Deposition from air pollutants can also serve as a nutrient (i.e., ammonium and phosphate) and affect the trophic state of surface waters, causing trends towards eutrophication. Many high alpine lakes on the BTNF are oligotrophic and sensitive to inputs of acids and nutrients. Acidification and eutrophication of surface waters can negatively affect aquatic ecosystems and their ability to support healthy native biota.

Grenon et al. 2010 found that ANC was mostly stable at the four long-term lakes sampled in the Bridger Wilderness (Hobbs, Deep, Black Joe, and Upper Frozen lakes). The most prominent trends were increases in nitrate at the inlets of Black Joe and Deep lakes during early fall and an increase in ammonium at Hobbs Lake during early and late summer. Modeled CL exceedances for nutrient enrichment show that the largest exceedances on the BTNF are likely occurring in the high alpine areas of the Bridger Wilderness.

Sensitive waterbodies are most influenced by local, regional, and long-distance transport of pollutants and dust from off-forest activities as well as climate change. Ground water influence, soil structure, and bedrock weathering can also affect lake water chemistry. Direct Forest Service activities are not likely to influence changes in lake chemistry at a broad scale. A change in management activities is not warranted. The air program monitoring strategy is under evaluation and modifying to align with current air quality issues and concerns.

Adaptive management considerations

To address the concern about surface water eutrophication, particularly in the Bridger Wilderness, four additional analytes (Chl *a*, TN, TP, and TC) were added to the long-term lake sampling protocol in the

summer of 2020. Additional measures to help track baseline conditions and changes in trophic state of aquatic resources on the BTNF are being assessed and considered.

New air quality management direction at the Forest level is warranted, but not urgent. The current Forest Plan does not address eutrophication, only acidification. The air quality language in the current plan is site-specific and outdated.

Indicator AIR-01-02: Critical Load exceedances from nitrogen deposition

Summary of methodology

Critical loads are a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur. Different ecosystem components (i.e., diatom vs lichen) have different CLs. When pollutant deposition and the CL are known, exceedances of the CL can be assessed.

Measured N deposition data

To measure nitrogen (N) deposition from air pollution, the BTNF uses the following long-term monitoring networks: National Atmospheric Deposition Program (NADP) data for wet N deposition information and trends, the Clean Air Status and Trends Network (CASTNET) data for dry N deposition information and trends, and U.S. Geological Survey (USGS) snowpack data for wintertime total N deposition. These monitoring networks provide information on the amount of N deposition occurring at a specific location.

Monitoring protocols are described in detail in the BTNF Monitoring Guide. There are four NADP sites representative of BTNF: Gypsum Creek (WY98, established 1984) located in the Upper Green River; Pinedale (WY06, established 1982) located North of Pinedale; Grand Teton National Park (WY94, established 2011); and South Pass City (WY 97, established 1985) located at the southern tip of the Wind River Range. There are two CASTNET sites representative of BTNF: YEL408, which is run by Yellowstone National Park, and PND165 in Pinedale, which is run by the EPA. There are eight USGS snow sampling sites in and around BTNF. In 2018, two new USGS high elevation remote sites were added at Hobbs Lake and Black Joe Lake outlet to replace the wintertime bulk deposition collection program that ended in 2016.

Modeled N deposition data

Nanus et al. (2017) modeled N deposition at a 400-m scale across the Greater Yellowstone Ecosystem (GYE), including the BTNF. This model was created to assess nitrate leaching and eutrophication CLs and exceedances in the GYE. A different model, the Total Deposition Model (TDEP), is a hybrid model that uses modeled and measured data to estimate nitrogen and sulfur deposition at a 4-km scale. The TDEP uses a 3-year rolling average and updates N and S estimates every 2-3 years. The latest TDEP layers are available through the EPA Critical Loads Mapper tool (https://www.epa.gov/air-research/critical-loads-mapper-tool).

New science and information

Region 4 Critical Load Assessment

USFS Region 4 air specialists worked with a contractor to assess CLs and exceedances of CLs on all 12 national forests in the Region. The following CLs were included in the assessment: surface water acidification, surface water eutrophication, lichen species richness, forage lichen abundance, tree species growth, and tree species probability of survival over 10 years. Total N deposition estimates

from the TDEP model (2015–2017) were used to assess CL exceedances from N deposition across the BTNF. The report was accepted as a GTR and will be published in 2021.

Monitoring results

Nitrogen deposition via NADP

Data from 2020 were not available at the time of this report. Deposition from NADP is measured from precipitation and does not include dry, fog, or cloud deposition. From 2018 to 2019, total wet inorganic nitrogen (IN) deposition at selected BTNF NADP monitoring sites ranged from 0.89 to 3.34 kg ha^{-1} $year^{-1}$; from 1982 to 2019, values ranged between 0.29 and 3.34 kg ha^{-1} $year^{-1}$ (TABLE 3). Ammonium made up a greater proportion of wet IN deposition than nitrate at all sites, sometimes twice as much.

Table 3. Annual wet deposition for nitrogen from ammonium (NH_4-N) and nitrate (NO_3-N) and total inorganic nitrogen in 2018 and 2019 at selected BTNF NADP monitoring sites.

Monitoring site	Year	Ammonium (NH_4-N)	Nitrate (NO_3-N)	Total Inorganic Nitrogen
WY98	2018	1.545	0.430	1.973
	2019	0.710	0.481	1.19
WY06	2018	0.647	0.381	1.028
	2019	0.495	0.394	0.888
WY94	2018	1.195	0.514	1.707
	2019	1.790	1.548	3.337
WY97	2018	0.594	0.413	1.007
	2019	0.540	0.458	0.997

Nitrogen deposition via CASTNET

CASTNET measures dry deposition and adds modeled wet N deposition on its website to provide an estimate of total N deposition at each site. N deposition is composed of dominant species of oxidized and reduced N. Oxidized N is typically a product of industrial sources, and reduced N is typically from agricultural sources and some vehicle emissions. At the time of this report, the CASTNET website data was updated through 2018. Dry deposition makes up slightly less than half to over half of total N deposition at the Yellowstone and Pinedale sites, respectively. At YEL408 and PND165, the largest component of measured dry deposition was from ammonia (NH_3). When ammonia deposits as wet deposition it is converted to ammonium. Combined with modeled wet ammonium (NH_4^+), reduced nitrogen accounted for over 55% of total N deposition at both sites between 2017 and 2019 (FIGURE 1, FIGURE 3). From 2017 to 2019, total estimated N deposition ranged from 2.83–4.33 kg N ha^{-1} yr^{-1} at YEL408 and 2.09–3.36 kg N ha^{-1} yr^{-1}at PND165 (FIGURE 2, FIGURE 4). Total annual N deposition tends to be lower at PND165. In addition to reduced and oxidized N, natural organic material (NOM) is also included in total N deposition amounts. Trends for individual N species were not analyzed.

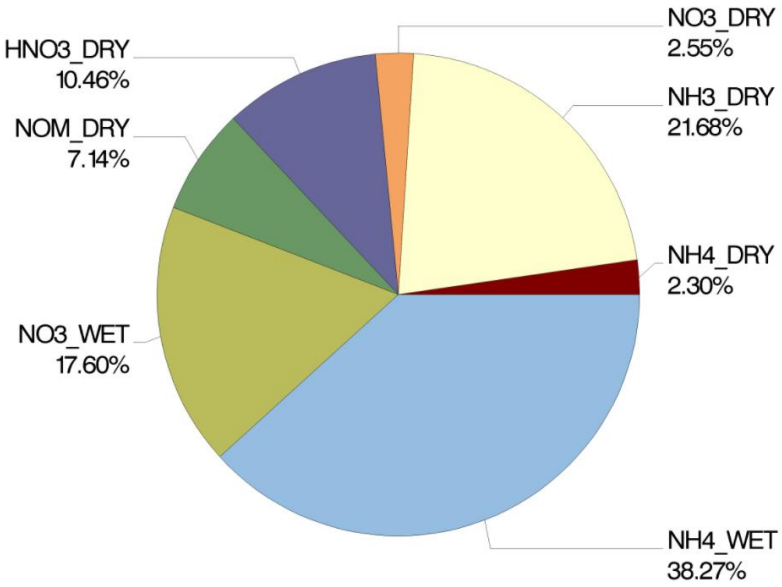

Figure 1. N deposition composition at the YEL408 CASTNET site, 2017–2019.
Source: https://www.epa.gov/castnet/castnet-site-locations.

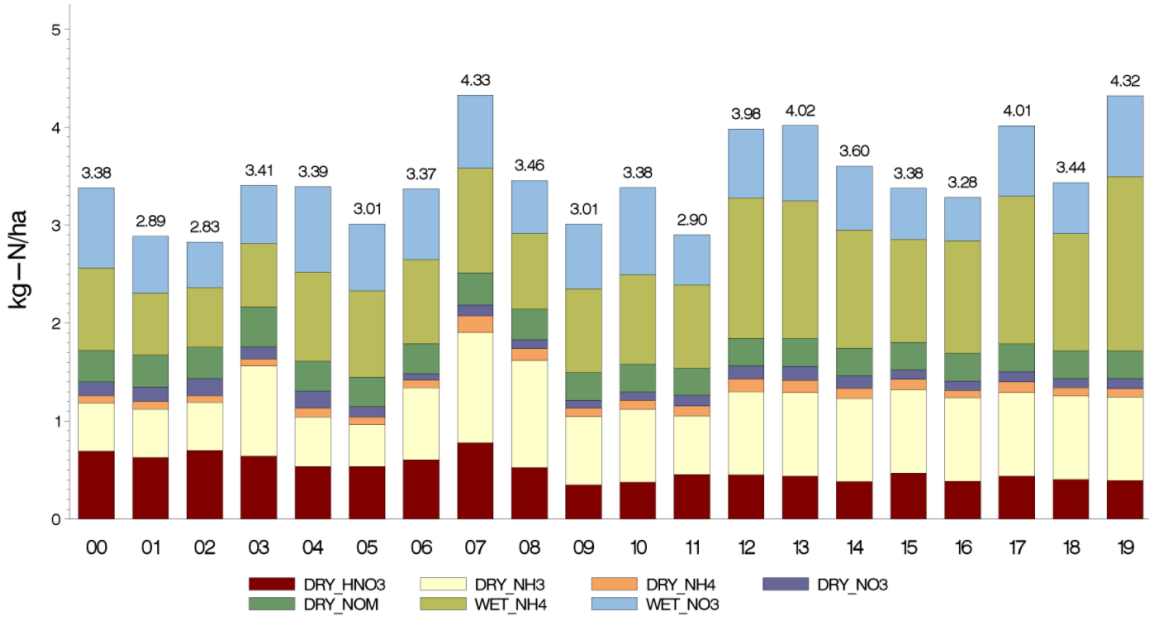

Figure 2. Total annual N deposition at the YEL408 CASTNET site.
Source: https://www.epa.gov/castnet/castnet-site-locations.

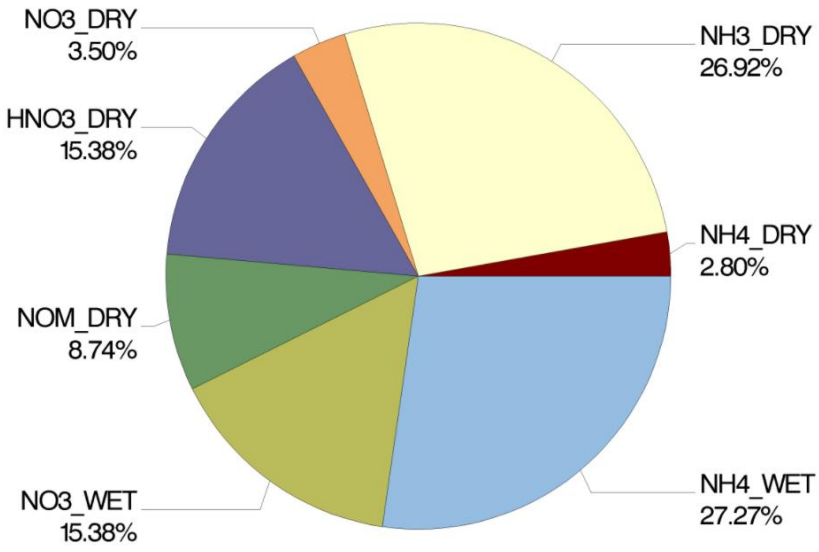

Figure 3. N deposition composition at the PND165 CASTNET site, 2017–2019.
Source: https://www.epa.gov/castnet/castnet-site-locations.

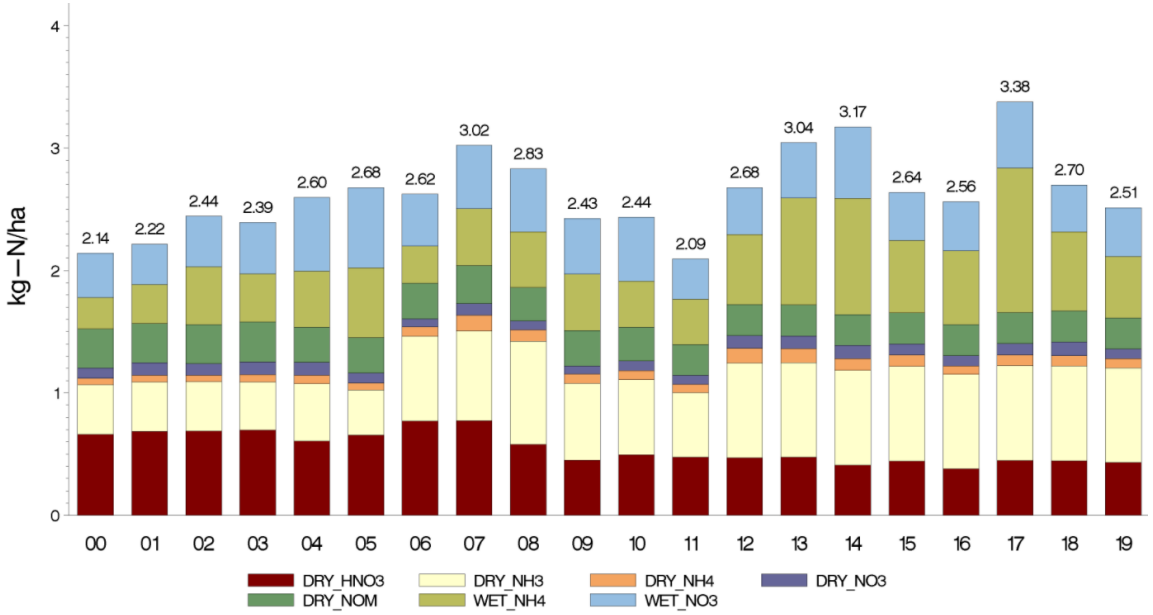

Figure 4. Total annual N deposition at the PND165 CASTNET site.
Source: https://www.epa.gov/castnet/castnet-site-locations.

Nitrogen concentration via USGS snowpack

The 2019 and 2020 snowpack surveys were disrupted by a furlough (2018–2019) and COVID-19, respectively. Currently, there are no updates to report since the 2018 biennial monitoring report.

There is a significant increasing trend ($p < 0.001$) in ammonium concentration for the Greater Yellowstone Area (GYA) sites and the entire Rocky Mountain Region (RMR) study area (FIGURE 5). Not all sites on and around BTNF exhibit increasing ammonium concentration trends. There is a significant decreasing trend ($p < 0.001$) in nitrate concentrations across the GYA and the RMR study area (FIGURE 6). This decreasing trend is apparent at all the sites on and around BTNF.

In 2018, ammonium deposition in the snowpack made up over 50% of dissolved inorganic nitrogen (DIN) deposition at all sites on BTNF and within the GYA (FIGURE 7). Nitrate concentrations were highest on BTNF in the Wind River Range. At both the Hobbs Lake and Elkhart sites, there were high amounts of DIN, ammonium, and nitrate deposition and concentrations. However, they were sampled one month after the other sites in the Wind River Range. In addition, there was over twice the snow water equivalent (SWE) at the Hobbs Lake, compared to the Elkhart site, which is seven miles to the southwest of Hobbs.

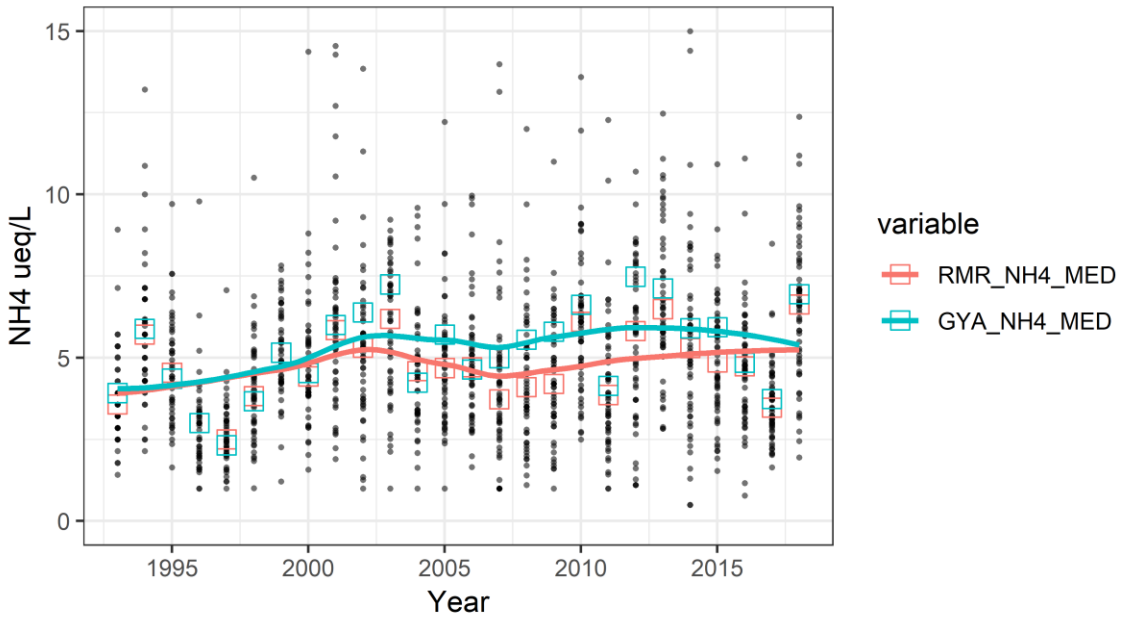

Figure 5. Trends in snowpack chemistry—ammonium concentrations, 1993-2018. An average of all sites in the Greater Yellowstone Ecosystem is shown in teal, and an average of all sites in the monitoring network is shown in red.

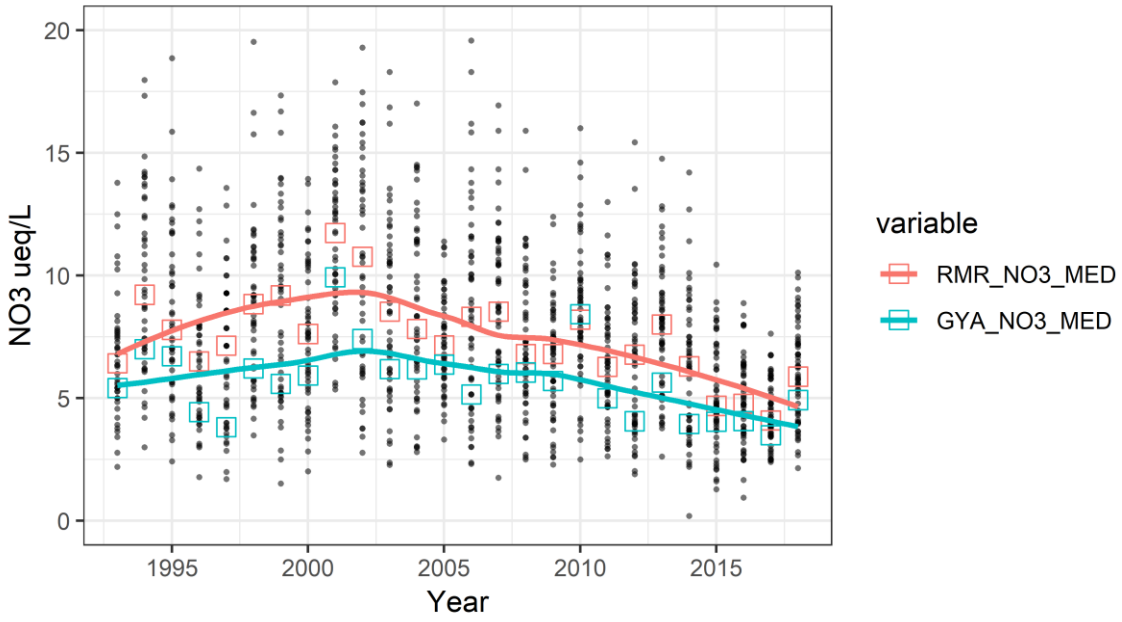

Figure 6. Trends in snowpack chemistry—nitrate concentrations, 1993-2018. An average of all sites in the Greater Yellowstone Ecosystem is shown in teal, and an average of all sites in the monitoring network is shown in red.

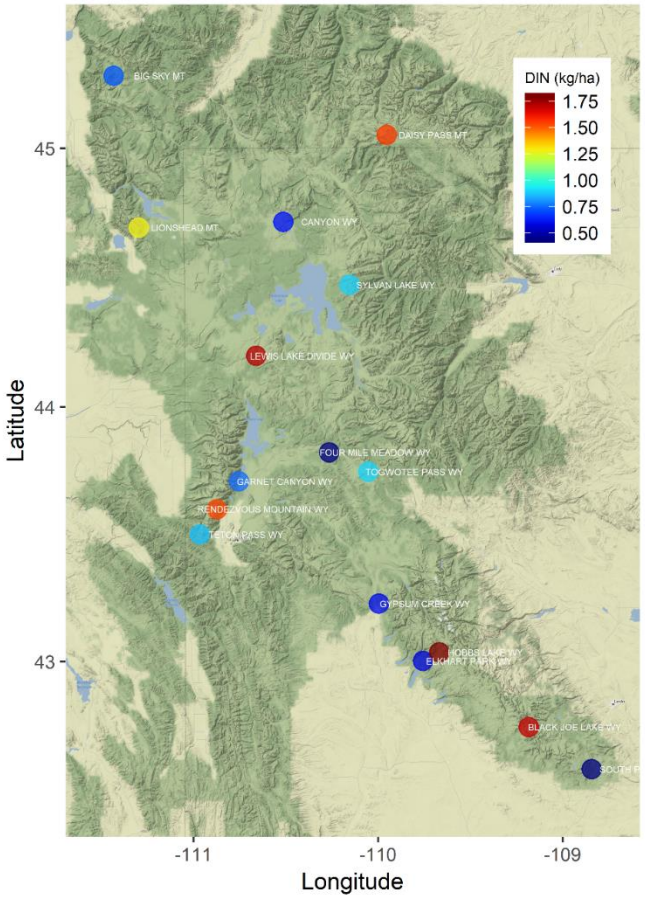

Figure 7. Total dissolved inorganic nitrogen (DIN) deposition in kg/ha at USGS snow sampling sites around the Greater Yellowstone Area (GYA) in 2018.

Nitrogen deposition and critical load exceedances from the R4 CL Assessment Report

It is important to note that the R4 CL assessment of CLs does not assess if CL exceedances are increasing or decreasing over time. The assessment assesses the risk for ecological effects due to N deposition by estimating CLs and CL exceedances based on the most current research and N deposition estimates from the TDEP model (2015-2017) at the time of the assessment (2018-2019).

Nanus et al. (2017) estimated that total nitrogen (TN), including organic N, ranged from 2.20 to 4.79 kg-N ha^{-1} yr^{-1} on BTNF (Nanus pers. comm. 2018). The TDEP (2015-2017) estimates that N deposition on the BTNF not including organic N, ranged from 2.4 to 6.8 kg-N ha^{-1} yr^{-1}.

Critical loads and exceedances for Lake acidification

Lake chemistry data was available for 203 lakes on the BTNF; these data were used to calculate CLs aimed to protect surface water ANC from decreasing below 50 µeq L^{-1}. Exceedances of the CLs were also calculated. Low CLs and high N deposition are two factors that increase the risk for surface water acidification and associated biological effects. Lakes with low CLs are found in all three Wilderness Areas on the BTNF. The most sensitive lakes are in the Bridger Wilderness. Twenty lakes (10% of the lakes) had CLs < 2 kg N ha^{-1} yr^{-1}, and 36 lakes (17.5%) had CLs ranging from 2 to 4 kg N ha^{-1}. These 56 lakes are considered sensitive due to low CLs. There are 61 lakes (30%) exceeding CLs. Lakes that are exceeding CLs are not necessarily acidified but are at a higher risk for biological effects associated with acidification; the risk increases with the magnitude of exceedance. Twenty-three lakes (11%) are exceeding CLs by a magnitude of 2-5 kg-N ha^{-1} yr^{-1}. Only 203 lakes were assessed, and there may be additional lakes on the BTNF that are experiencing CL exceedances and associated biological effects. Figures and tables for acidification CLs and exceedances can be found in **Appendix A**, Air Quality Supplemental Figures and Tables.

Critical loads and exceedances for surface water eutrophication

Nitrogen-based CLs to protect against the onset of surface water eutrophication on the BTNF were calculated using total (wet + dry) N deposition (TDEP) and nitrate leeching estimates from Nanus et al. 2017. CLs for eutrophication in the R4 assessment are based on threshold nitrate concentrations of 0.5 µmol L^{-1}, which is the level at which the diatom *Asterionella formosa* shows an increased growth response to nitrate inputs. This CL is sensitive to the early onset of trophic changes in surface waters. The higher the CL the lower the risk for eutrophication and associated biological effects. CLs were mapped across 14029.6 km^2 within the BTNF. Low CLs (< 2 kg N ha^{-1} yr^{-1}) covered 1,400 km^2 (10%) of the BTNF and were concentrated in the Teton and Bridger Wilderness areas. Nitrogen deposition was high enough to exceed the CLs described above on 12,682 km^2 (90.5%) of the Forest. The highest magnitudes of exceedance (> 4 kg N ha^{-1} yr^{-1}) were located in high alpine zones of the Teton and Bridger Wilderness Areas and in the Wyoming Range (355 km^2 total or 2.5% of the Forest). Exceedances of 2-4 kg N ha^{-1} yr^{-1} were mapped across 4665 km^2 (33%) of the Forest, including large portions of the Teton, Gros, Ventre, and Bridger Wilderness areas and the Wyoming Range. Areas with high magnitudes of exceedance are at an increased risk of experiencing effects associated with surface water eutrophication, including an increase in algae abundance and shifts in diatom communities. Figures and tables for eutrophication CLs and exceedances can be found in **Appendix A**, Air Quality Supplemental Figures and Tables.

Critical load exceedances for lichen species richness and abundance

Lichen CLs for species richness (3.5 kg N ha^{-1} yr^{-1}) and forage lichen abundance (2.0 kg N ha^{-1} yr^{-1}) were based on national research that applies one CL to each functional group, unlike surface water CLs, which varied across the landscape (Geiser et al. 2019). Due to uncertainties in the model, the CL was set at the load that protects against a >20% decline in either species richness or forage lichen abundance. Total N deposition exceeded CLs in lichen species richness and forage lichen abundance

on 80% (11196 km^2) and 100% (14029 km^2), respectively, of the BTNF. The highest magnitudes of CL exceedances for lichen species richness (associated with a 30-40% decline) were most widespread in the Teton Wilderness and the Wyoming Range. CL exceedances associated with 40%–50% declines in forage lichen abundance covered nearly all of the Teton Wilderness, the southern half of the Wyoming Range, and the high elevation portions of the Gros Ventre and Bridger Wilderness Areas. A small portion (17 km^2) of the Wyoming Range had CL exceedances associated with a 50%–80% decline in forage lichen abundance. It is important to note that CL exceedances of lichens were mapped for the entire BTNF, whereas epiphytic lichens used in these functional groups are not present throughout 100% of the BTNF, particularly in high alpine, shrubland, and grassland areas with little to no tree cover or areas where the climatic conditions are not suitable. Due to CL development methods and model evaluation, it is likely that the magnitudes of CL exceedances are overestimated. Figures and tables for eutrophication can be found in **Appendix A**, Air Quality Supplemental Figures and Tables.

Critical load exceedances for tree species growth and probability of survival over 10 years

Critical loads for tree species were based on national research that defines one CL for growth rate and one for probability of survival over 10 years for each individual tree species where the response curve is decreasing or a threshold as a response to N deposition (Horn et al. 2018; **Appendix A**, Air Quality Supplemental Figures and Tables). Critical load exceedances of nitrogen deposition associated with 1%, 5%, and 10% declines in growth rate and probability of survival were mapped across forests where the tree species were modeled dominant or codominant based on USFS Region 4 Vegetation Classification, Mapping, and Quantitative Inventory (VCMQ). Areas of tree occurrence that show high magnitudes of exceedance are at greater risk to experience declines in tree species growth rate and probability of survival over 10 years.

Six tree species on the BTNF had response curves to N deposition. Only three, Douglas-fir, quaking aspen, and balsam poplar, had decreasing or threshold curves in which N CLs could be estimated (**Appendix A**, Air Quality Supplemental Figures and Tables). Due to uncertainties in the model, declines in growth and probability of survival <1% are interpreted as not exceeding CLs. All exceedances were associated with <5% decline in growth rate or probability of survival with the exception of balsam poplar growth rate, for which some exceedances were associated with 5%–10% declines.

Nitrogen deposition on the BTNF does not exceed the CL associated with a decline in quaking aspen growth rate. Nitrogen deposition levels associated with a >1% decline in probability of survival for quaking aspen were exceeded on only 0.1km^2 of the BTNF area where this species is estimated to occur. Nitrogen deposition levels associated with a >1% decline in probability of survival for Douglas-fir were exceeded on 82% (827 km^2) of the area in which this species is estimated to have the dominant or codominant canopy cover. Balsam poplar was estimated as dominant on only 1.5 km^2 of the BTNF. No CL exceedances associated with >1% decline in balsam poplar probability of survival over 10 years occurred. N deposition exceedances associated with balsam poplar growth rate occurred on 50% or (0.8 km^2) of the area in which this species is modeled to be dominant or codominant.

Discussion and findings

Deposition from air pollutants occurs when the ambient air pollutants precipitate out (wet, dry, fog) and deposit onto the earth. Deposition from air pollution including nitrogen species can negatively impact ecosystem function and degrade key resources such as clean water and tree health. A CL is a measure that quantifies atmospheric deposition loading on the landscape (typically in kg ha^{-1} yr^{-1}), below which no harmful effects are known (Umweltbundesamt [UBA] 2004). Identifying CLs for aquatic and terrestrial resources can help inform management decisions. CLs for N deposition vary depending on the ecosystem component (i.e., diatoms vs lichens). Exceedances of N-based CLs have

been linked to surface water eutrophication, lake acidification, declines in lichen species and abundance, and declines in tree growth rate and probability of survival (Geiser et al. 2019; Horn et al. 2018; Lynch et al. 2019; Nanus et al. 2017).

Background (pre-industrial) inorganic nitrogen deposition in the northern Rockies forested ecosystems is estimated at approximately 1.0 kg N ha^{-1} yr^{-1} (Holland et al. 1999; Sverdrup et al. 2012). Total nitrogen deposition measured within the last two decades on the BTNF ranged between 0.78 and 4.33 kg ha^{-1} yr^{-1}, with wet deposition ranging from 0.29 to 3.34 kg N ha^{-1} yr^{-1}. Modeled estimates of N deposition tend to be higher for the BTNF ranging from 2.2 to 6.8 kg N ha^{-1} yr^{-1}. Nitrogen deposition from ammonium is increasing on the BTNF and contributes more to total inorganic N budgets than N from nitrate. The USFS R4 CL assessment indicates that many areas including wilderness areas on the BTNF are exceeding N CL for multiple sensitive ecosystem components. The N deposition models that were used to evaluate CL exceedances may overpredict N deposition; this would inflate the actual area in exceedance and the magnitude of exceedance. Nonetheless, this assessment can be used to understand where the highest risk for adverse ecosystem impacts due to N deposition are located on the BTNF. These areas include the Bridger, Teton, and parts of the Gros Ventre Wilderness Areas and the Wyoming Range. The Bridger Wilderness has the highest risk for changes in surface water acidification and eutrophication due to N CL exceedances.

USGS snowpack data showed a higher percentage of ammonium in the snowpack for all sites in and around BTNF. Overall, the snowpack sites in the GYA show increasing trends for ammonium deposition and decreasing trends for nitrate deposition. In addition, CASTNET and NADP showed higher proportions of reduced N (ammonium and ammonia) vs oxidized N (NOx) in the total N deposition measured at all sites. This likely reflects the success of rules and regulations limiting and decreasing NOx emissions. Reduced N air pollutants such as ammonia are not currently regulated.

Most N deposition on the BTNF is from local, regional, and long-distance transport of pollutants and not from BTNF activities. Permitted air pollution emissions have decreased over 50% in the last twenty years; however, nonpermitted emissions including agriculture and area emissions could be reduced to prevent further degradation.

Adaptive management considerations

The BTNF air quality monitoring program acknowledges that air pollution deposition concerns and issues change over time. The air quality monitoring program is currently being evaluated to meet shifting needs. In addition, BTNF air quality specialists work with multiple research scientists to understand air pollution deposition effects to the BTNF. Because most air pollution deposited on the BTNF originates off the forest, no change to management activities is warranted at this time.

New air quality management direction at the Forest level is warranted, but not urgent. The current Forest Plan lacks direction with regards to atmospheric deposition. The only reference to atmospheric deposition is that there is an “ongoing watershed study in the Green River Basin and Teton Wilderness”. Deposition needs to be assessed for both aquatic and terrestrial effects across the BTNF, not just in one watershed study. In addition, the current plan language is outdated and not inclusive.

Indicator AIR-01-03: Visibility

Summary of methodology

In 1977, amendments to the Clean Air Act required the EPA to issue regulations that would protect against and help remedy visibility impairment in all Class I Federal Areas. To aid in the implementation of visibility legislation, the Interagency Monitoring of Protected Visual Environments

(IMPROVE) program was initiated in 1985 to monitor current conditions and trends in visibility at all Class I areas. IMPROVE monitors collect ambient air samples in 24 hour cycles every three days throughout the calendar year. More information about the IMPROVE program including data can be found at http://vista.cira.colostate.edu/improve/ and http://views.cira.colostate.edu/fed/. There are two IMPROVE monitors on the BTNF: BOLA1, which is near Boulder Lake and BRID1, which is on the White Pine Ski Area. There is also an IMPROVE monitor in Yellowstone National Park (YELL2). BOLA1 and BRID1 reflect visibility in the Bridger Wilderness and YELL2 is representative of the Teton Wilderness. As part of the Regional Haze Rule, IMPROVE tracks the status and trends in visibility by focusing on the 20% clearest days, 20% haziest days, and with a new metric, 20% most impaired days. Impaired days focus on haze caused by anthropogenic emissions, while haziest days include both anthropogenic and natural haze such as haze caused by smoke from wildland fires.

Monitoring results

From 1989 to 2019, visibility at all three IMPROVE sites increased significantly on the clearest days (FIGURE 8–FIGURE 10). The clearest days occurred in December and January at all three sites. On the clearest days, over 60% of the haze budget is from ammonium sulfate and organic carbon.

The haziest days do not show any significant trends. The haziest days occurred from April through September, with April and May having the most impaired days at all three sites from 1989 to 2018. On the haziest days, organic carbon accounted for the largest portion of the haze budget followed by ammonium sulfate. The high organic carbon was likely due to wildfire smoke.

Visibility is getting clearer on the most impaired days. On the 20% most impaired days, ammonium sulfate contributed to the largest portion of the haze budget followed by organic carbon. On the most impaired days, ammonium sulfate made up nearly twice the proportion of the overall haze as that on the haziest days where organic carbon was the dominant contributor.

Visibility is also improving on the 20% clearest days. The largest contributors to the haze budget for the clearest days are from ammonium sulfate, organic carbon, and ammonium nitrate.

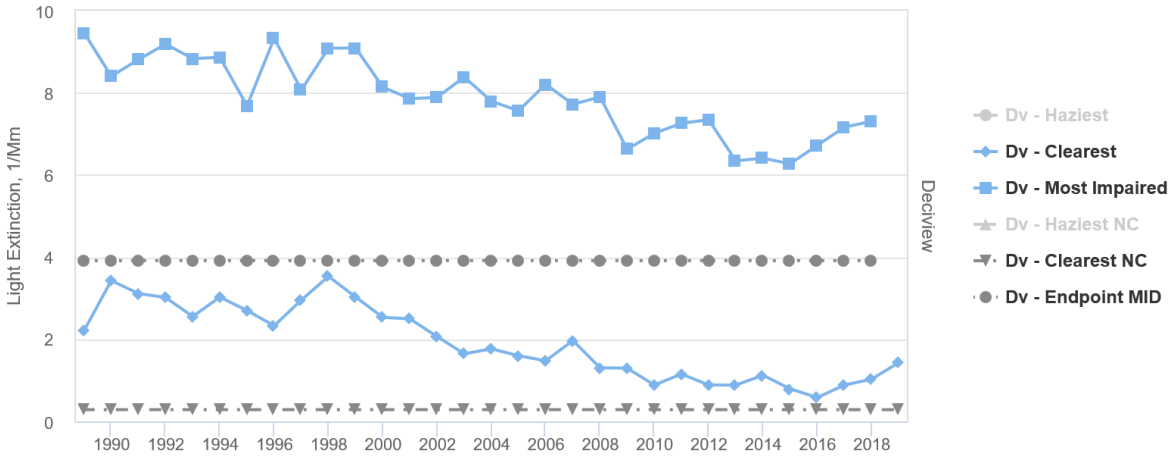

Figure 8. Deciview (Dv) Extinction Trends, Bridger IMPROVE site (Federal Land Manager Environmental Database 2021).

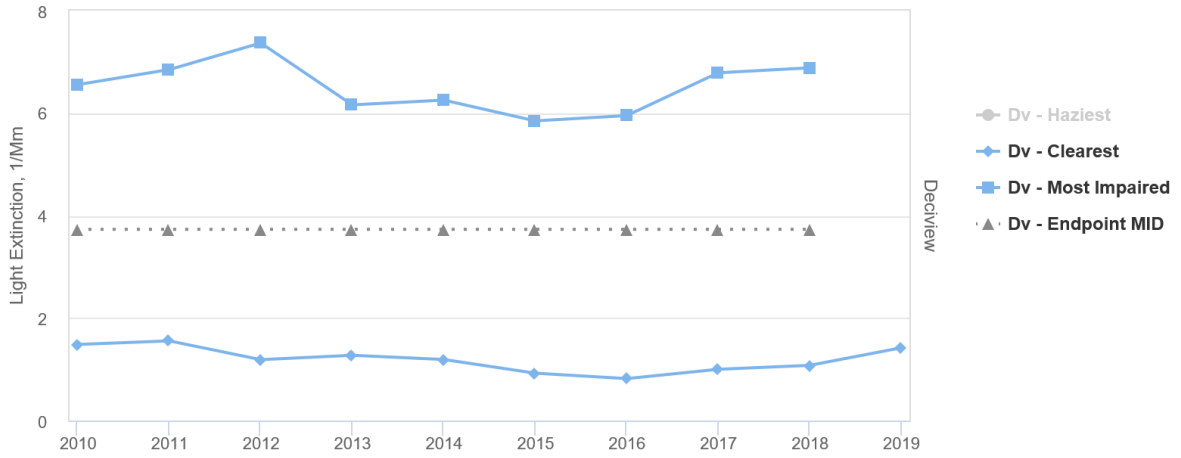

Figure 9. Deciview (Dv) Extinction Trends, Boulder Lake IMPROVE site (Federal Land Manager Environmental Database 2021).

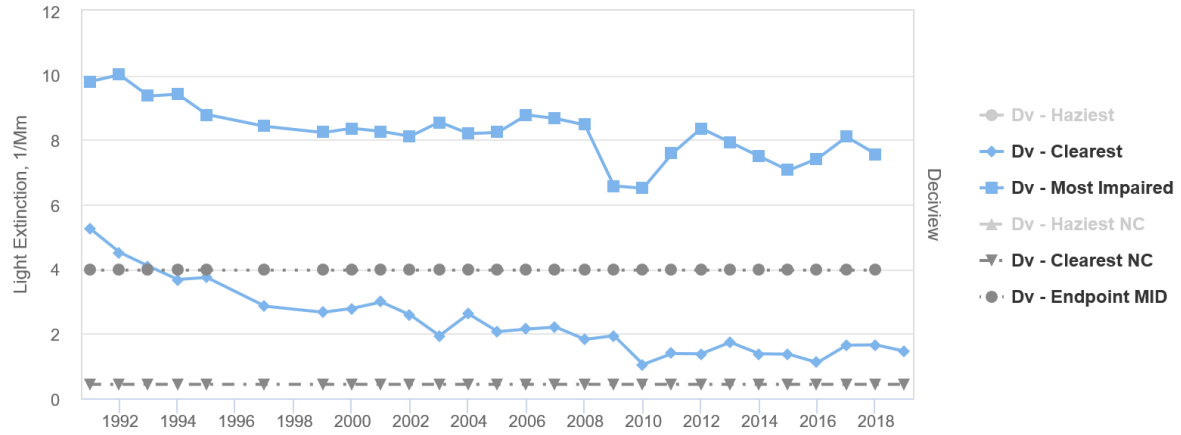

Figure 10. Deciview (Dv) Extinction Trends, Yellowstone IMPROVE site (Federal Land Manager Environmental Database 2021).

Discussion and findings

Visibility on BTNF continues to improve on the clearest and most impaired days, while the haziest days show no trends. The lack of trends on the haziest days likely reflects the variability of smoke from wildland fires which masks the effects of anthropogenic emission reductions. Timing, duration, and extent of wildland fire are difficult to control, and the ability to control for any given fire—in terms of its air quality impacts—is largely outside the scope of BTNF's Forest Plan. Prescribed burning can also temporarily degrade air quality and visibility by adding additional smoke and particulates. The BTNF complies with the direction from the Wyoming Smoke Management Plan and will continue to incorporate air quality considerations into prescribed burning plans and monitor air quality as necessary when conducting prescribed burns.

Adaptive management considerations

Based upon the monitoring results, no change to the monitoring program is warranted. In the current Forest Plan, there is only one standard that addresses smoke management in prescribed burning. The BTNF carries out prescribed burning in accordance with the Wyoming Smoke Management Plan.

Changes to both the Forest Plan and management activities may be warranted but are not considered urgent.

Question VEG-01: To what extent is vegetation being impacted by management activities and natural disturbance processes?

Indicator VEG-01-01: Acres in each biophysical setting affected by prescribed fire and mechanical treatments including timber harvest and other silvicultural activities

Summary of methodology

The Forest Activity Tracking System (FACTS) was queried for commercial timber harvest, pre-commercial thinning, non-commercial (fuels) thinning, and prescribed burning treatments for fiscal years 2015–2020 (Oct). FACTS is a part of the Forest Service's Natural Resource Manager (NRM) system; information about these databases is available at http://fsweb.nrm.fs.fed.us/. Results are separated into those that are primarily associated with commercial timber harvest (e.g., commercial thinning, improvement cut, sanitation cut, salvage cut, shelterwood establishment and removal, sanitation cut, clearcut) and fuels treatments (e.g., non-commercial thinning, prescribed burning). Treatments with a secondary objective of fuels were included in timber harvest.

Biophysical setting (BPS) is derived from the 2016 Remap LandFire Biophysical Conditions (https://www.landfire.gov/bps.php). BPS represents vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. Additional background information regarding historic burn treatments before 2015 were derived from FACTS and BTNF vegetation program records.

Monitoring results

Timber harvest treatments

TABLE 4 summarizes the extent of timber harvest and associated treatments by BPS types. In terms of location, treatments were concentrated in Rocky Mountain Mesic (405 ac), Rocky Mountain Aspen (111 ac), and Northern Rocky Mountain Subalpine (109 ac) BPS types (TABLE 4). FIGURE 11–FIGURE 13 illustrate the acres of each commercial timber harvest type within the three BPS types where timber activities are concentrated on the BTNF (2017–2020): Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland; Rocky Mountain Aspen Forest and Woodland; and Northern Rocky Mountain Subalpine Woodland and Parkland. The majority of acres were treated via salvage cuts and sanitation cuts.

Table 4. Total acres of timber harvest in all biophysical settings, 2017-2020.

Biophysical Setting	Acres Treated				
	2017	2018	2019	2020	Total
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	226	74	91	14	405
Rocky Mountain Subalpine-Montane Mesic Meadow	1	82	1	0	84
Rocky Mountain Aspen Forest and Woodland	1	20	87	3	111
Rocky Mountain Alpine/Montane Sparsely Vegetated Systems	0	0	0	0	0
Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	31	18	0	0	49
Northern Rocky Mountain Subalpine Woodland and Parkland	63	46	0	0	109

Biophysical Setting	Acres Treated				
	2017	2018	2019	2020	Total
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	13	5	2	0	20
Xeric Montane Douglas-fir Forest	0	3	0	0	3
Inter-Mountain Basins Montane Sagebrush Steppe	0	0	1	1	2
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	18	0	23	0	41
Rocky Mountain Lodgepole Pine Forest	30	18	0	0	48
Artemisia tridentata ssp. *vaseyana* Shrubland Alliance	1	1	0	0	2
Subalpine Douglas-fir Forest	0	2	0	0	2
Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	0	1	0	0	1
Northern Rocky Mountain Subalpine Deciduous Shrubland	0	0	0	0	0
Northern Rocky Mountain Subalpine-Upper Montane Grassland	0	1	0	0	1
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	0	0	0	0	0
Barren	0	0	0	0	0
Introduced Upland Vegetation-Perennial Grassland and Forbland	0	0	0	0	0
Rocky Mountain Bigtooth Maple Ravine Woodland	0	0	0	0	0
Western Cool Temperate Urban Shrubland	0	0	0	0	0
Inter-Mountain Basins Big Sagebrush Steppe	0	0	0	0	0
Western Cool Temperate Urban Herbaceous	0	0	0	0	0
Western Cool Temperate Urban Mixed Forest	0	0	0	0	0
Western Cool Temperate Developed Ruderal Shrubland	0	0	0	0	0
Rocky Mountain Foothill Limber Pine-Juniper Woodland	0	0	0	0	0
Western Cool Temperate Developed Ruderal Grassland	0	0	0	0	0
Western Cool Temperate Urban Evergreen Forest	0	0	0	0	0
Rocky Mountain Montane Riparian Forest and Woodland	0	0	0	0	0
Developed-Medium Intensity	0	0	0	0	0
Northern Rocky Mountain Conifer Swamp	0	0	1	0	1
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest	0	0	0	0	0
Inter-Mountain Basins Mixed Salt Desert Scrub	0	0	0	0	0
Rocky Mountain Alpine Dwarf-Shrubland	0	0	0	0	0
Developed-Roads	0	0	0	0	0
Developed-Low Intensity	0	0	0	0	0
Mesic Montane Douglas-fir Forest	0	0	0	0	0
Western Cool Temperate Urban Deciduous Forest	0	0	0	0	0
Snow-Ice	0	0	0	0	0
Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	0	0	0	0	0
Rocky Mountain Poor-Site Lodgepole Pine Forest	0	0	0	0	0
Rocky Mountain Subalpine/Upper Montane Riparian Forest and Woodland	0	0	0	0	0
Rocky Mountain Montane Riparian Shrubland	0	0	0	0	0
Grand Total	**384**	**271**	**206**	**18**	**879**

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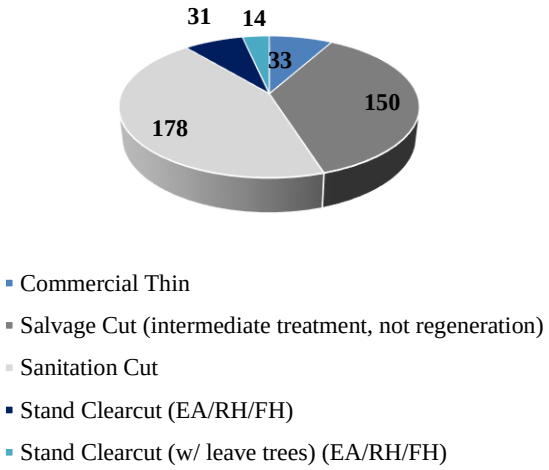

Figure 11. Total acres in Rocky Mountain Subalpine Dry-Mesic Spruce-Fire Forest and Woodland, by timber treatment type, FY17-20.

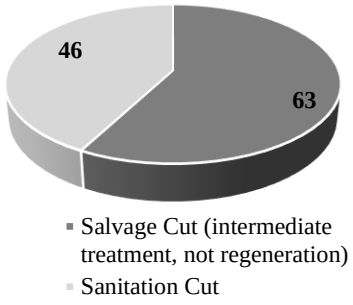

Figure 12. Total acres treated in Northern Rocky Mountain Subalpine Woodland and Parkland, by timber treatment type, FY17-20.

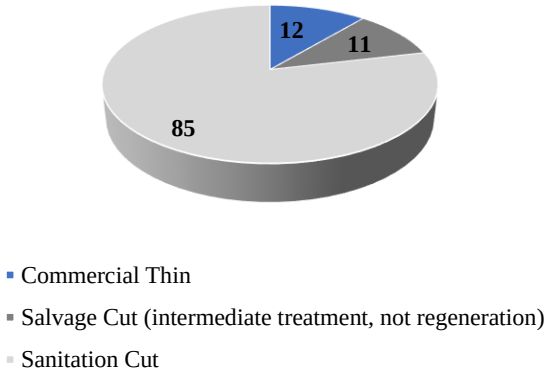

Figure 13. Total acres treated in Rocky Mountain Aspen Forest and Woodland, by timber treatment type, FY17-20.

Hazardous Fuels Treatments

Hazard fuels treatments include mechanical treatments (such as thinning, pruning and piling), timber harvest, prescribed burning, and managing wildland fires for resource benefit. While the primary purpose of hazardous fuels treatments is to reduce potential fire intensity through manipulation of the fuel complex, these treatments often have secondary objectives such as wildlife habitat improvement.

Mechanical Treatments

Based on FACTS reporting, 16,883 acres of mechanical fuels activities were completed in fiscal years 2019 and 2020 (FIGURE 14). Many of these projects included several different activities that overlap spatially; the actual footprint acreage treated is less than the reported fuels activities acres. Approximately 9,000 footprint acres were treated in 2019 and 2020. Herbicide treatments accounted for 5,403 acres of these accomplishments, and this acreage is also reported under Indicator EVS-01-03: Extent of invasive species. The objective of herbicide treatments is to reduce invasive species, most notably cheatgrass, a non-native species that is associated with more frequent fire return intervals and rapid large fire growth.

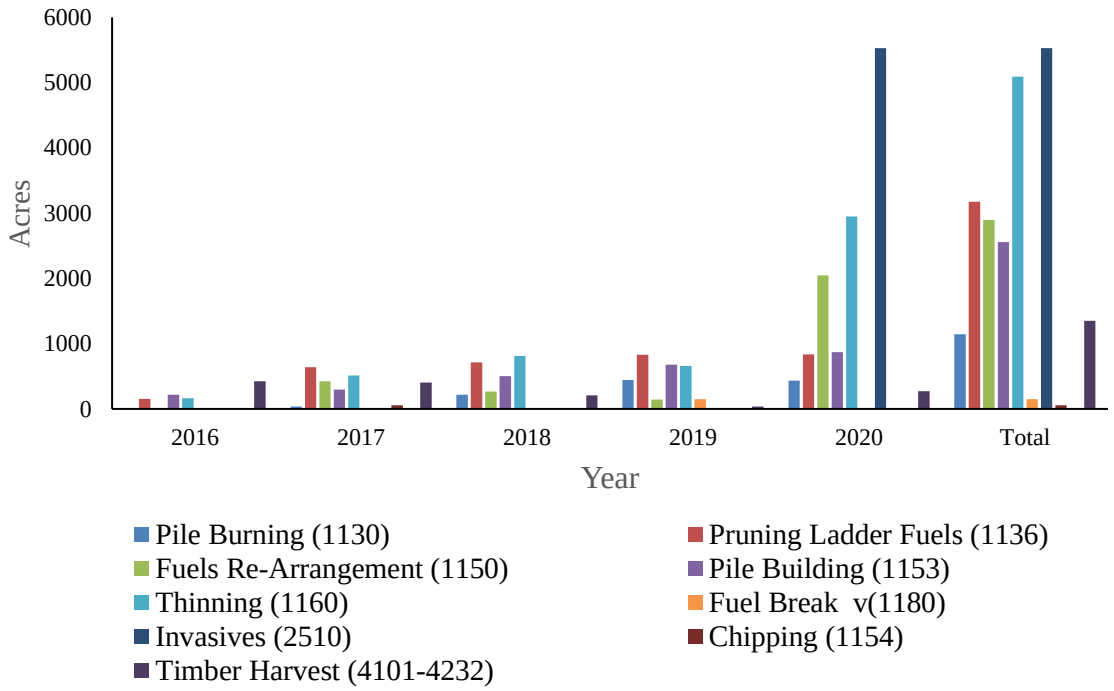

Figure 14. FACTs Fuels Activities, total acres of mechanical fuel treatments (2016-2020).

Landscape Burning

A total of 471 acres of landscape prescribed burning were implemented from 2019 to 2020. The acres treated with prescribed burning have fluctuated over the past 46 years (FIGURE 15). There was a large increase from 2002 to 2009, during which several large burns were successfully implemented, followed by a decrease from 2011 to 2020. The 46-year average for landscape prescribed burning is 1,752 acres per year. Confidence for the accuracy of the acres treated for both mechanical fuels treatment and prescribed burning is high.

Prescribed burning occurred in 919 acres between 2016 and 2020 (TABLE 5). The most common vegetation type in which burns were conducted was Inter-Mountain Basins Montane Sagebrush Steppe (40%), followed by Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland (26%) (TABLE 5).

Wildland Fire Managed for Resource Benefit

Wildland fire managed for resource benefit provides a significant contribution to hazardous fuels reduction and increased ecosystem resiliency. These accomplishments are addressed in VEG-01-02.

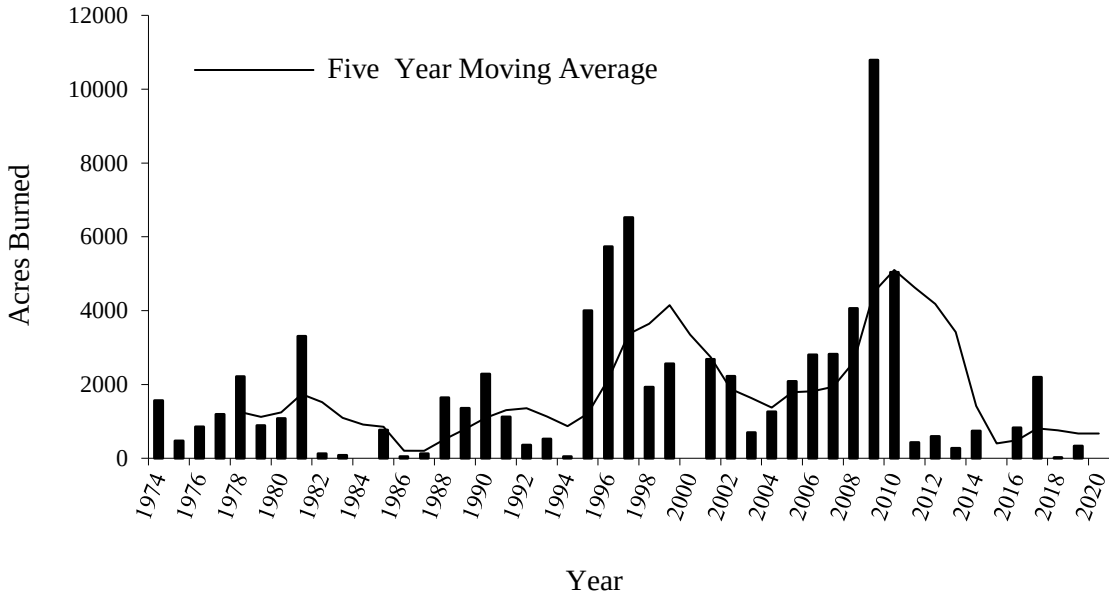

Figure 15. Acres treated via landscape prescribed burning on the BTNF per calendar year, 1974-2020.

Table 5. Vegetation types treated with landscape prescribed burning, 2016 to 2020.

Vegetation type	Acres
Inter-Mountain Basins Montane Sagebrush Steppe	369
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	242
Rocky Mountain Aspen Forest and Woodland	153
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	113
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	15
Rocky Mountain Subalpine-Montane Mesic Meadow	6
Rocky Mountain Subalpine/Upper Montane Riparian Systems	6
Rocky Mountain Montane Riparian Systems	5
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	2
Rocky Mountain Foothill Limber Pine-Juniper Woodland	2
Northern Rocky Mountain Conifer Swamp	2
Northern Rocky Mountain Subalpine Woodland and Parkland	2
Inter-Mountain Basins Sparsely Vegetated Systems	1
Rocky Mountain Lower Montane-Foothill Shrubland	1
Total	**919**

Note: spatial data for the Pole Creek prescribed burn is not available spatially at this time and is not included in this table.

Discussion and findings

Timber treatments

There are several reasons why timber treatments are concentrated in the Rocky Mountain Mesic, Rocky Mountain Aspen, and Northern Rocky Mountain Subalpine BPS types (TABLE 4). Many BPS types on the BTNF are only found on very few acres, lack high value timber species, or both. Consequently, these BPS types are not the focus of commercial harvest, as reflected in TABLE 4.

Sanitation and intermediate salvage treatments represent 85% of acres treated in the three BPS types, with the most acres treated during fiscal years 2017–2020. These BPS forest types are more susceptible to forest pest infestations and have suffered higher levels of mortality resulting from mountain pine beetle (MPB), spruce beetle, and wildfire. Sanitation, salvage, and commercial thinning treatments within the Rocky Mountain Aspen BPS were implemented to directly address a Forest Plan objective to reduce conifer encroachment and restore ecological function in aspen stands. Furthermore, salvage operations outside aspen stands are in alignment with Forest Plan objectives to address catastrophic events (e.g., beetle kill, wildfire) in a timely manner.

Hazardous Fuels

During 2019 and 2020, there was a decrease in prescribed fire and wildland fire, whereas mechanical treatment activity acres increased. Most of the mechanical acres were associated with continued implementation of several large, multiyear projects.

Based on national and local direction, mechanical fuels treatments near the Wildland Urban Interface (WUI) areas have been a main focus of fuels treatments during the past five years. The long-term goal is to treat these critical areas to allow more options for managing prescribed and wildland fires in the future.

The decrease in prescribed burn acres from 2011 to 2020 is likely due to a number of factors. The longer wildland fire season reduces the window for fire managers to conduct prescribed burning. The emphasis on mechanical treatment of WUI areas has limited staff capacity to plan and implement burns. Completion of these mechanical treatments will allow fire managers to implement several large landscape burns. Turnover in experienced burn managers has also contributed to some challenges with burn implementation. Lastly, mitigation and restrictions associated with the COVID-19 pandemic limited opportunities to conduct larger burns in 2020.

Management of unplanned ignitions is an important fuels management tool utilized on the BTNF. Since the 2004 amendment to the Forest Plan, the BTNF has the ability to manage unplanned ignitions for resource value, rather than immediately suppress all ignitions.

Prescribed burning during 2015–2020 has been focused in aspen and big sagebrush steppe, targeting conifer encroachment in aspen stands.

Adaptive management considerations

The current monitoring program indicators are considered appropriate, though there are some shortcomings. Vegetation treatment data is typically reported on a calendar year basis (e.g., uncontrolled fire), but some data is reported on a fiscal year basis (e.g., prescribed burning); therefore, these data sets cannot be easily compared. The Forest Service is currently modernizing reporting systems; reporting has moved from strictly tabular data to a combination of geospatial and tabular reporting. These changes should improve data collation and analysis.

BTNF is actively undertaking management activities to address forest restoration, but the current Forest Plan lacks direction specifically focused on forest restoration. Ongoing and expected future increases in tree mortality resulting from insects, diseases, and larger wildfires will likely lead to more acres of forest that require active restoration. Specific Forest Plan objectives will need to be identified to provide guidance on how to address these issues.

In terms of fuels treatment, no changes to the Forest Plan are warranted, but increasing opportunities to conduct more prescribed burning and managing wildland fire for resource benefit warrant consideration.

Indicator VEG-01-02: Acres affected by wildfire, both wanted and unwanted

Summary of methodology

The 2020 monitoring guide has revised this indicator to address only natural and human caused wildfires, both wanted and unwanted. This indicator is addressed using geospatial data derived from remote sensing, national vegetation databases, fire incident maps, and vegetation succession.

Timber stand mortality resulting from insect and disease is concurrently addressed and discussed under Indicator EVS-01-01. Spatial data on all unplanned fires over ten acres are archived in the Bridger–Teton GIS database. Additional supporting fire specific information is available through the National Fire and Aviation Data Warehouse. Wildfire data are not separated into natural or human-caused, so both are included as wildland fire disturbance.

Biophysical setting (BPS) is derived from the 2016 Remap LandFire Biophysical Conditions (https://www.landfire.gov/bps.php). BPS represents vegetation that may have been dominant on the landscape prior to Euro-American settlement and is based on both the current biophysical environment and an approximation of the historical disturbance regime. BPS with less than 100 acres were excluded from analysis.

New science or information

Additional techniques are under development for remote mapping of wildland fires and analyzing fire severity and vegetation recovery. The Forest Service is also in the process of aggregating all wildfire occurrence data in the newly adopted Interagency Fire Occurrence Reporting Modules (INFORM). This system provides a single, nationwide system of record for both federal and state agencies to report wildfires.

Monitoring results

Since 1954, approximately 671,059 acres on BTNF have burned in wildfires (FIGURE 16). Overall, there has been an increase in the number of acres burned per year, but a decrease in ignitions detected (FIGURE 17). The largest fire season occurred in 1988 with 270,000 acres burned; the next largest fire season occurred in 2012 with 107,000 acres burned (FIGURE 16).

From 2019 to 2020, approximately 655 acres burned in wildfires on the BTNF with lightning-caused fires accounting for 42% and human-caused fire for 58%. The long-term (1954-2020) average is 57% lightning-caused and 43% human-caused fires.

The acres burned in 2019 and 2020 were predominately in sagebrush BPS types (Swinging Bridge and Boulder) and Pilgrim Creek (Spruce fir and woodland). The acres burned by BPS type (TABLE 6) differs from the “wildfire acres burned” below because of differences in reporting. “Wildfire acres burned” is based on Forest Service reporting, which does not account for acres burned if the fire started on another jurisdiction. In terms of location, the majority of fires occurred Inter-Mountain Basins Montane Sagebrush Steppe (799 acres) (TABLE 6).

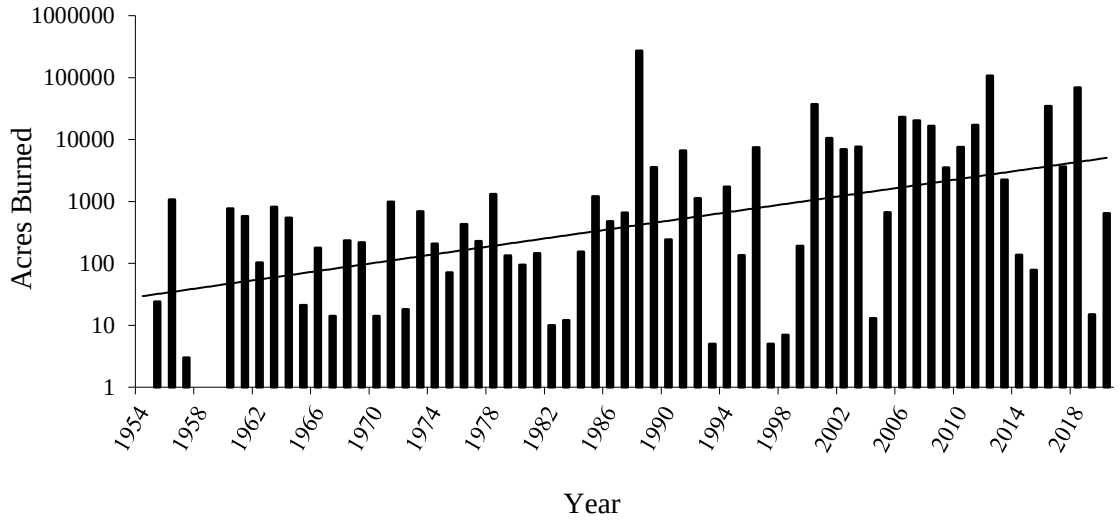

Figure 16. Wildfire acres burned in the BTNF per year, 1954-2020. Includes fire use and wildfire. Note logarithmic scale accounts for fires in 1988.

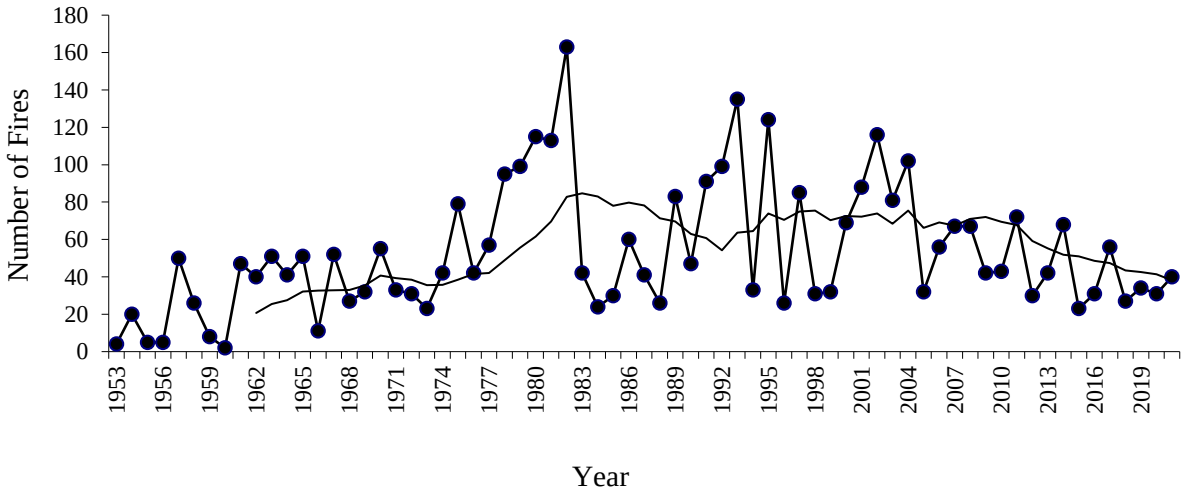

Figure 17. Number of wildfires on BTNF (natural and human caused), 1956-2020.

Table 6. Acres burned by wildfire on BTNF, by biophysical setting type, 2019 and 2020.

Vegetation Type	2019	2020	Total
Inter-Mountain Basins Montane Sagebrush Steppe	686	113	799
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	–	190	190
Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland	–	166	166
Rocky Mountain Subalpine-Montane Mesic Meadow	–	90	90
Rocky Mountain Aspen Forest and Woodland	13	42	55
Northern Rocky Mountain Subalpine Woodland and Parkland	–	18	18

Vegetation Type	2019	2020	Total
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	2	12	14
Rocky Mountain Montane Riparian Systems	5	6	11
Inter-Mountain Basins Big Sagebrush Shrubland - Wyoming Big Sagebrush	7	–	7
Open Water	6	0	6
Northern Rocky Mountain Montane-Foothill Deciduous Shrubland	–	4	4
Rocky Mountain Subalpine/Upper Montane Riparian Systems	2	1	3
Rocky Mountain Foothill Limber Pine-Juniper Woodland	1	0	2
Inter-Mountain Basins Sparsely Vegetated Systems	2	–	2
Northern Rocky Mountain Conifer Swamp	–	1	1
Rocky Mountain Alpine/Montane Sparsely Vegetated Systems	–	1	1
Rocky Mountain Lower Montane-Foothill Shrubland	–	0	0
Grand Total	**724**	**644**	**1368**

Discussion and findings

A variety of causes have led to an increase in acres burned by wildfire during the past 20 years. Large areas of the Forest burned in the late 1800's, and the late seral stands that have not seen disturbance are now receptive to stand-replacing fires. A policy of fire exclusion and suppression of fires at the minimum acreage until the early 1970's limited annual acreage burned along with moderate weather conditions from 1935 to 1985 that allowed for widespread fire suppression and containment of unplanned ignitions to relatively small areas.

Increasingly warmer and drier climate conditions from 1985 to 2020 have been conducive to more rapid-fire growth and have contributed to larger and more severe wildland fires.

The reason for the long-term decline in the number of documented fires is not clear. Many small fires are never discovered and documented. Many ignitions only burn a day or so before they self-extinguish and would not be recorded. With so many acres burning across BTNF over the last 20 years, there are large areas with low fuel loading, in which fires may not grow large enough to be detected. Another contributing factor may be the decreased use of low-level aerial fire detection (i.e., flying planes for fire reconnaissance) following lightning activity.

Analysis of disturbance and wildland fire trends is complicated by how we categorize fires based on cause: human versus natural. Human-caused unplanned ignitions are considered unwanted in the current Forest Plan and are suppressed. Nonetheless, we cannot discredit the ecological role they have played on the landscape. The two large, human-caused fires in 2018 (Roosevelt and Martin) together burned about 68,000 acres and have significantly changed the landscape. FIGURE 18 illustrates the role of wildland fire compared to other disturbance on the landscape.

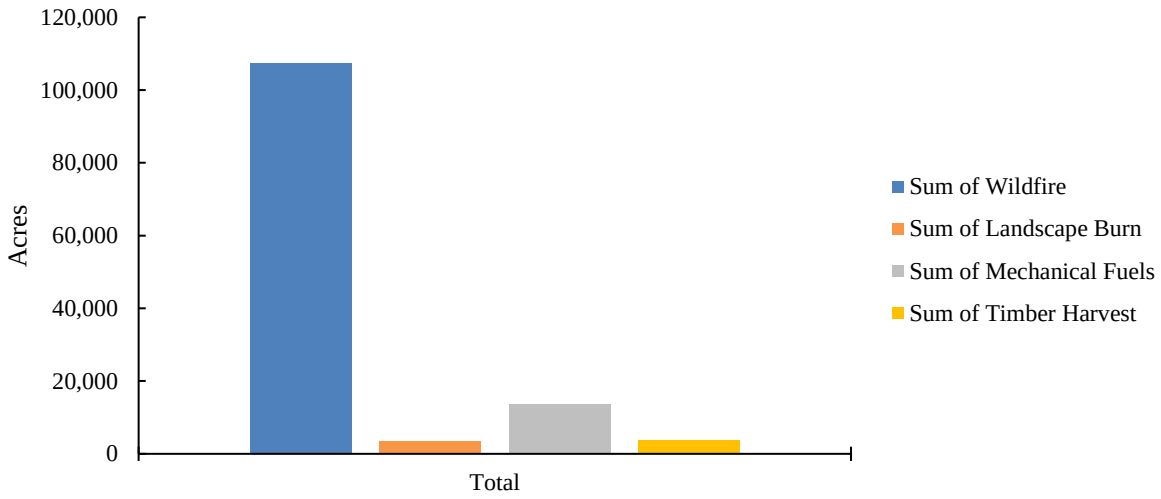

Figure 18. Total acres of disturbance by type, 2016-2020.

There have been several questions regarding how changing climate has influenced the size and severity of recent wildland fires. Additionally, current monitoring also indicates that the fire return intervals for fire regimes may be influenced by the changing climate.

Since 1974, BTNF has progressively incorporated more management for resource benefit of naturally occurring wildfire, rather than full suppression. From 1974 to 2004, fires were only managed in wilderness. The current Forest Plan was amended in 2004 to allow management for resource value of naturally ignited fires throughout the entire Forest. The Forest plan fire amendment is likely responsible for some of the increase in acres burned. To date, 44,500 acres have been managed for resource benefit since 2004 (FIGURE 19).

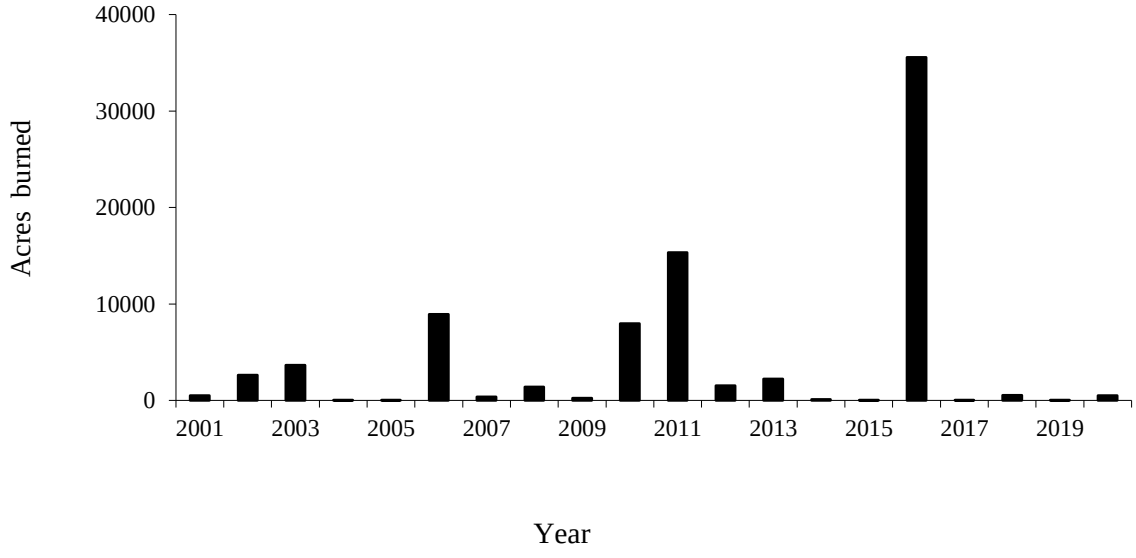

Figure 19. Wildfire acres burned for resource benefit in the BTNF per year, 2001-2020.

Adaptive management considerations

Data analysis and results from this second monitoring period elucidated shortcomings in both indicator methodology and intent. In regard to methodology, the acres disturbed by fire are separated into those treated via prescribed burning and those impacted by unplanned ignitions Based on the aggregation of wildfire as well as tree mortality data, it may not be useful—or even possible—to make the distinction between natural and anthropogenic processes. In general, the monitoring results that were available can provide basic status and trend information about how much of the landscape is impacted by wildfire, but they fail to fully address the acres impacted by all natural processes.

Because the current indicator does not address the effects of climate change, which can directly affect the size and intensity of fires, as well as post fire vegetation development, some consideration should also be taken to how and if this can be included in a revised indicator.

The monitoring results related to wildfire suggest that the 2004 Forest Plan amendment for fire management has increased flexibility for managers to appropriately manage wildland and prescribed fire. As such, no immediate changes to the Forest Plan are warranted. New and updated analysis tools such as the Quantitative Wildfire Risk Assessment, and updated vegetation and disturbance mapping can be used to prioritize treatments in terms of reducing the risk of unacceptable wildfires as well as appropriate application of wildland fire to achieve resilient landscapes.

Question VEG-02: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of whitebark pine?

Indicator VEG-02-01: Acres treated for the purpose of sustaining or restoring whitebark pine (WBP)

Summary of methodology

One of the Forest Service's corporate databases—the Forest Activity and Tracking System (FACTS)—was queried for all treatments occurring in whitebark pine stands (WBP), including timber harvest, thinning, planting, prescribed fire, and mechanical fuel treatments for Fiscal Years FY16-FY20. FACTS is a part of the Forest Service's Natural Resource Manager (NRM) system; information about these databases is available at http://fsweb.nrm.fs.fed.us/.

Monitoring Results

WBP restoration efforts on BTNF have primarily included the following activities: planting of seedlings to supplement natural regeneration; thinning/pruning to prevent spread of blister rust in five needle pines; and release treatments to increase growing space (i.e., removal of non-target vegetation) (TABLE 7). Survival rates for planted seedlings typically ranges from 70%–100%, but many have not yet been certified as successfully regenerated because the fifth-year seedling survival surveys are not yet complete. All existing survey data for WBP planting projects indicate the stands are above the percent threshold for being considered fully regenerated at this time. The pruning project implemented in FY18 to remove white pine blister rust infected limbs has not yet been surveyed and evaluated for success; post treatment surveys are forthcoming. Release treatments in FY16 have been surveyed post-treatment to indicate success of contract implementation. The 35 acres of WBP release treatment near Elkhart Park in FY19 will be surveyed post treatment in the coming years. In FY18, prescribed fire was used to treat 18 acres for the purpose of daylighting whitebark pine as part of a research study

with the Missoula Fire Science Laboratory. More information can be found on the Daylight Study online at the Researching Whitebark Pine Story Map.

Table 7. Summary of whitebark pine restoration treatments, FY16-FY20.

Fiscal Year	Plant Acres	Thin Acres	Release Acres	Prescribed Fire
FY16	78	0	188	0
FY17	108	0	0	0
FY18	0	40	0	18
FY19	165	0	35	0
FY20	0	0	0	0

Discussion and findings

Although there are existing data on WBP restoration treatments, the data lack the depth to provide meaningful trends in the success or failure of treatment implementation. Based on the data available, initial results indicate that WBP restoration treatments are being implemented successfully and are in alignment with the Forest Plan direction for desired future conditions in these stands. Future monitoring for these projects is outlined in their respective silvicultural prescriptions and identified as a need where these projects are planned. Results of future monitoring for these projects is forthcoming and will be reported in future biannual monitoring reports.

Adaptive Management Considerations

Based on the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator VEG-02-02: Acres by forest size class for whitebark pine

Summary of methodology

The BTNF Existing Vegetation dataset was utilized to quantify acres by forest size class for whitebark pine (WBP). In this regionally produced dataset, vegetation map types were characterized by map unit (dominant land cover), tree and shrub canopy cover class, and tree size class, using a field-based classification system and field keys, cross-walking existing vegetation information, and developing descriptions for the map units. The dataset was last updated in 2018 using the Vegetation Classification, Mapping, and Quantitative (VCMQ) inventory data. However, the 2018 dataset does not currently reflect vegetation changes from the Martin Fire or the Roosevelt Fire, which occurred in 2018. In terms of forest type, ‘WBP’ and ‘WBP mix’ are described in the WBP Range-Wide Restoration Strategy (Keane et al. 2012). ‘WBP’ includes the higher elevation climax WBP sites that exist on harsher upper subalpine forests and at tree line on relatively dry, cold slopes; other species, such as subalpine fir, spruce, and lodgepole pine, can occur on these sites but as scattered individuals. Conversely, ‘WBP mix’ includes WBP seral sites that exist on productive upper subalpine sites where they may be replaced by the more shade-tolerant subalpine fir and/or Engelmann spruce.

Monitoring Results

Table 8. Acres of whitebark pine by forest size class, 2012 & 2018.

Forest Type, Year	Size 2 (<5" dbh)	Size 3 (5 – 9.9" dbh)	Size 4 (10-19.9" dbh)	Size 5 (20-29.9" dbh)	Size 6 (30"+ dbh)	Total
2012	12,111	124,566	262,620	6,182	393	405,873
WBP	7,934	64,392	125,667	4,728	318	203,039
WBP, mixed	4,177	60,174	136,953	1,455	74	202,834
2018	12,108	124,377	262,336	6,182	393	405,397
WBP	7,936	64,267	125,514	4,728	318	202,763
WBP, mixed	4,173	60,110	136,822	1,455	75	202,634

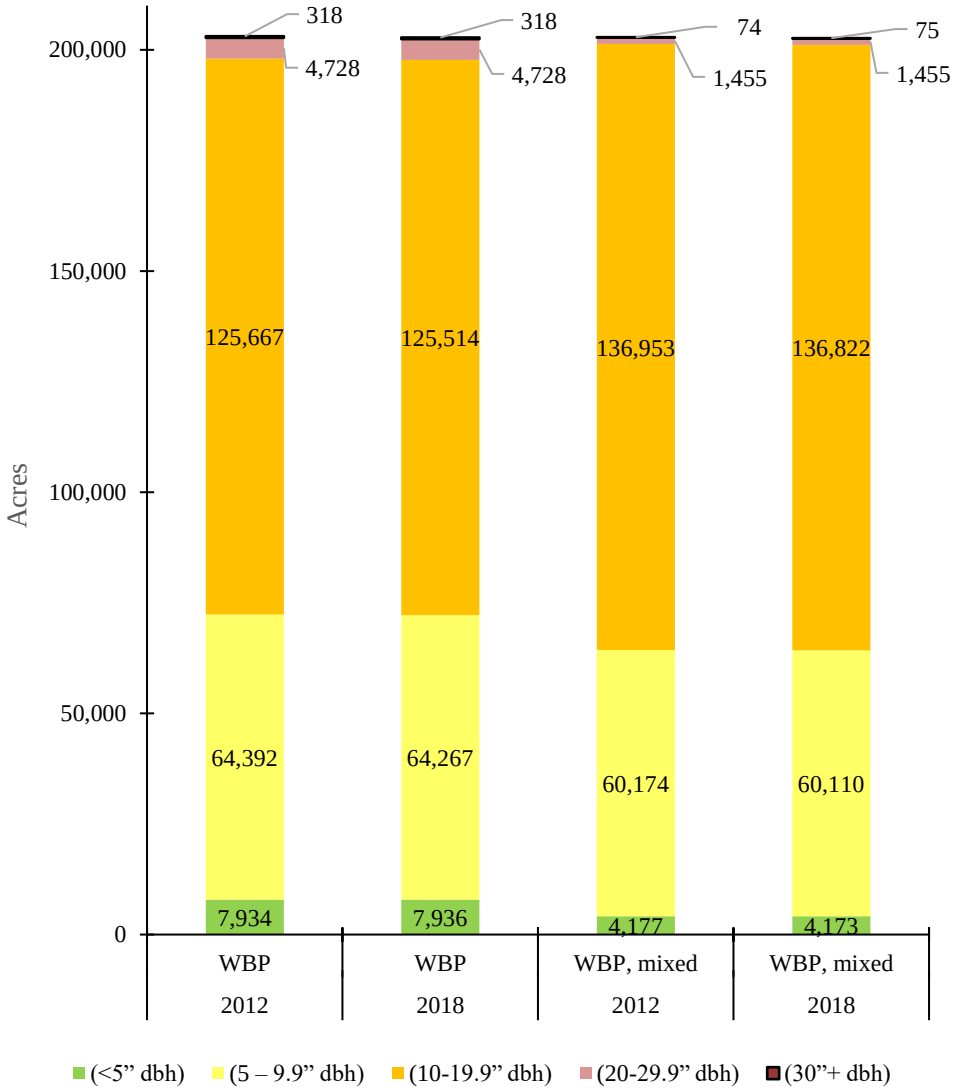

Figure 20. Comparison of acres of whitebark pine by forest size class, 2012 & 2018.

Discussion and findings

There has not been a substantial change in WBP size classes between 2012 and the latest dataset from 2018 (TABLE 8, FIGURE 20). In 2018, there was a slight decrease in acres (475 ac) in forest size class three (5-9.9" dbh) and four (10-19.9" dbh). This loss is likely due to mortality caused by wildfire and by white pine blister rust and pine beetle infestations. Wildfire areas with high burn severity may transition the WBP forest type to a grass/forb vegetation type. Future mapping of vegetation affected by the 2018 fires may show a shift in WBP to smaller size classes or a transition to different vegetation types, particularly for the Roosevelt fire where WBP forest types are more prevalent. An updated Existing Vegetation dataset will hopefully be available for inclusion in the next biannual monitoring report.

Adaptive Management Considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Question ARE-01: Are native aquatic and riparian ecosystems maintaining or improving in relation to aquatic invasive/exotic species?

Indicator ARE-01-01: Miles of stream and acres of lake habitats that have aquatic invasive/exotic species present

Summary of methodology

Presence/absence data of dreissenid mussels and New Zealand mud snails—aquatic invasive species that threaten ecosystem function on the BTNF—were collected using environmental DNA (eDNA) method protocols, which capture DNA expelled from these organisms in waterbodies. Lake sampling was limited to larger lakes where motorized boating is allowed because these areas are likely at greatest risk of infestation due to the presence of vectors for spread (i.e., boats coming from infested waters). Forest Service staff sampled lakes at launch ramps, inlets, outlets, docks, and any recreation site where hand-launching of watercraft appeared probable (FIGURE 21). River and streams were monitored opportunistically by visual observation. Some eDNA samples were collected from the Greys River in 2020. Additional samples are collected annually by WGFD partners.

Figure 21. Forest Service employee Cottle collecting monitoring samples by boat on Jackson Lake.

Monitoring results

In the ten lakes sampled in 2018 and nine sampled in 2019, no eDNA of the monitored species was detected. Lake samples collected in 2020 and those collected from the Greys River have yet to be analyzed (FIGURE 22). No positive reports were received from WGFD in 2019 or 2020.

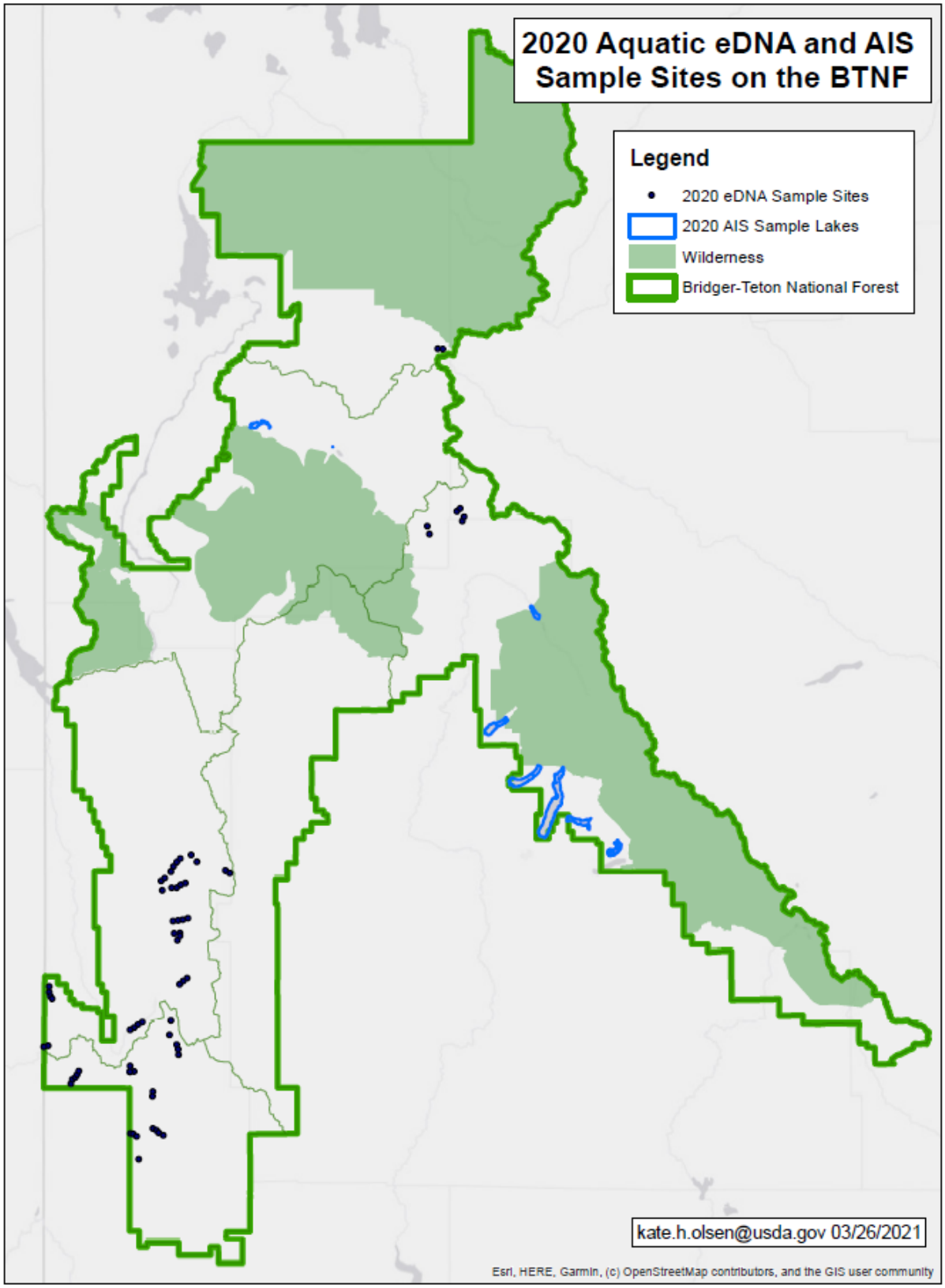

Figure 22. Map showing sites from across the BTNF that were sampled in 2020 for AIS (lake sites) or eDNA as part of the focal species monitoring program which can later be tested for AIS.

Discussion and findings

Failure to detect dreissenids and mud snail in large lakes where motorized boating occurs using the relatively sensitive method of eDNA analysis indicates that that these waters, and upstream waters, have a low probability of current infestations. However, there has been detection of aquatic invasive species downstream of the BTNF in the Snake River Drainage, and detection of New Zealand mud snails in the Salt River at the confluence of the Snake River immediately downstream of the Greys River Ranger District boundary. These recently discovered infestations could be inadvertently spread onto BTNF by recreational watercraft. Ongoing monitoring is planned for 2021 with the goal of limiting the spread of recently detected New Zealand mud snails.

The current monitoring effort is limited to dreissenid mussels and mud snails. Analysis of samples for other species (including non-native fish) is being considered for subsequent monitoring periods.

Adaptive management consideration

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted. Currently, WGFD is drafting Rapid Response Plans for actions to be taken in the case of future detection, and links to those documents will be included in the future.

Indicator ARE-01-02: Miles of stream and acres of lake habitats in which aquatic invasive/ exotic species have displaced native aquatic species

Summary of methodology

The magnitude of native aquatic species displacement by aquatic-invasive/ exotic species is determined by calculating the current invasion extent and adding the predicted rate of spread before anticipated treatments. It is assumed that the area of habitat occupied by invasive species is equal to the area in which native species have been displaced. Results will be used to estimate the cost of treatment alternatives.

Monitoring results

This indicator was not monitored in 2019–2020.

Discussion and findings

This monitoring was not conducted because there is no indication that target aquatic invasive species are currently present in BTNF lakes. As such, BTNF is meeting the Forest Plan objective to manage aquatic invasive species. If priority AIS are discovered in the future, then monitoring should be initiated.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Question FOC-01: Are forest management activities and/or natural events affecting aquatic conditions indicated by the presence/absence of a focal species?

Indicator FOC-01-01: Miles of stream enhanced

Summary of methodology

Miles of streams enhanced includes all stream miles on the BTNF in which restoration projects were carried out for the purpose of improving habitat for focal fish species. On the BTNF, focal species are limited to the four cutthroat trout subspecies, which include Colorado River, Bonneville, Yellowstone, and Snake River Finespot. Cutthroat trout habitat across their ranges is now only a small proportion of their historic habitat. Habitat loss is due to a number of factors including land use changes, nonnative invasions, and lack of connectivity. Although it is to a lesser degree than rangewide, habitat loss on the BTNF for these four subspecies is no exception (TABLE 9, FIGURE 23).

Table 9. Historic and current cutthroat trout stream miles and the percent of historic stream miles currently occupied.

	Historic (miles)	Current (miles)	Percent Occupied
Colorado River Cutthroat Trout	807.39	254.40	31.5
Bonneville Cutthroat Trout	112.55	98.91	87.9
Yellowstone Cutthroat Trout *	1591.27	1478.66	92.9

*Includes Yellowstone and Snake River Finespot

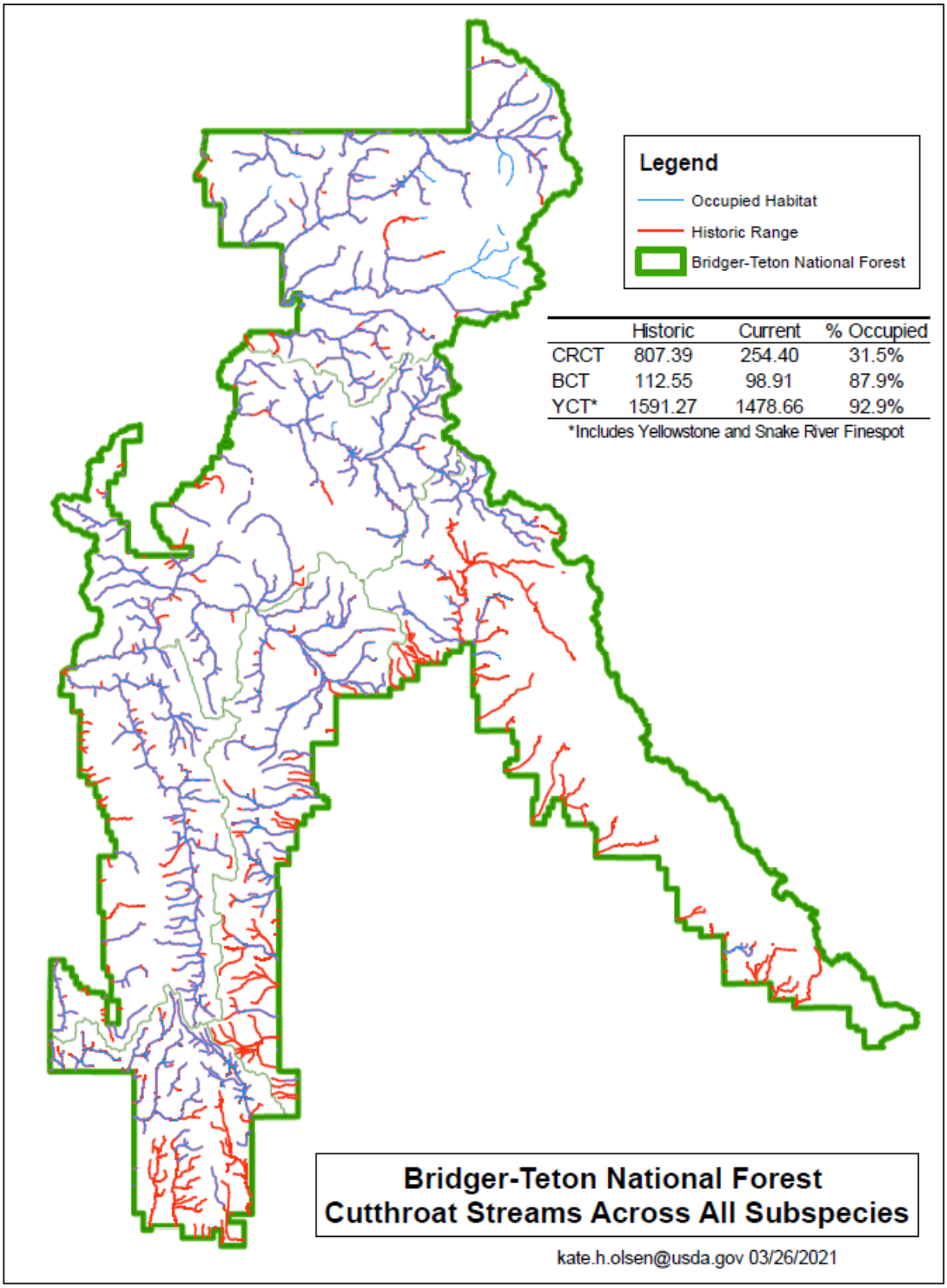

Figure 23. Bridger-Teton National Forest Cutthroat Streams across all subspecies.

Restoration work occurs across the forest every summer to combat all the threats to cutthroat trout. With a total of 23 miles of streams enhanced in 2019 and 28 miles in 2020, the Forest Service is constantly working to enhance cutthroat trout streams across the forest (TABLE 10).

Table 10. Total stream miles enhanced on the BTNF.

Project	Year	Stream Miles Enhanced
Little Clear Creek Culvert- LaBarge	2019	4
Greys River- TriBasin	2019	8.9
Roosevelt BAER	2019	3
Marten BAER	2019	4
Dime Lake Treatment	2019	3
	2019 Subtotal	**22.9**
Riverbend McNeel	2020	1
Greys Headwaters- TriBasin	2020	3.9
West Fork Greys- TriBasin	2020	5.2
Mink- TriBasin	2020	9
Clear Creeks- TriBasin	2020	8.4
	2020 Subtotal	**27.5**

Many of these restoration projects occurred as part of the Tri-Basin Fish Passage and Watershed Restoration Project, a collaboration between Trout Unlimited, the BTNF, and other partners. The Tri-Basin project area lies at the headwaters of three basins and encompasses three native cutthroat trout species distributions (Snake River, Bonneville, and Colorado River cutthroat). The large-scale project was initiated in 2018 and aims to protect, reconnect, and restore streams on BTNF lands associated with an upcoming commercial timber sale and its access routes (USDA Forest Service 2021).

Specifically, the project's goals are to 1) reconnect and restore streams within the project area for the benefit of Snake River cutthroat trout by replacing undersized and damaged culverts; 2) improve watershed conditions and water quality by reducing sedimentation and erosion from roads into waterways for the benefit of Snake River, Bonneville, and Colorado cutthroat trout; and 3) reduce maintenance needs for Forest Service roads by replacing undersized culverts with structures that have a larger flow and sediment transport capacity and by improving drainage and low water crossings (USDA Forest Service 2021).

Restoration activities include replacing an undersized culvert on the Greys River, near the confluence of Shale Creek, with a newly constructed bridge as well as replacing three undersized culverts on Mink Creek, Clear Creek, and the West Fork Greys River, which were identified as fish passage barriers. Other project activities that benefited fish habitat included road improvements to reduce sedimentation and erosion (USDA Forest Service 2021).

Monitoring results

A total of 50.4 stream miles were enhanced in 2019 and 2020, including 35.4 miles as part of the Tri-Basin Fish Passage and Watershed Restoration Project and 15 miles as part of Burned Area Emergency Response (BAER) and other projects (TABLE 10).

Discussion and findings

A new bridge on Greys River was installed (**ERROR! REFERENCE SOURCE NOT FOUND.** and **ERROR! REFERENCE SOURCE NOT FOUND.**), and three undersized stream culverts on Mink Creek, Clear Creek, and the West Fork Greys River were replaced with larger, better-aligned structures that allow cutthroat passage. The roads themselves were also improved, which benefits both forest and logging crews as well as trout by reducing sedimentation and erosion. Together, the improved streams will reconnect a total of 21.3 miles of habitat for Snake River fine spotted cutthroat trout and other native aquatic species in the upper Greys River and its tributaries (USDA Forest Service 2021).

These actions are anticipated to measurably improve fish passage, water quality, stream function, and aquatic habitat in the Tri-Basin area. Although construction is complete, monitoring is ongoing, and effects on fish populations may not be evident for several years.

Figure 24. Bridge foundation at the TriBasin bridge project site on the Greys River. The view is looking west into the Shale Creek and East Fork Greys River drainages. Both drainages were reconnected to the Greys River through culvert removal and bridge installation. The East Fork Greys River confluence with the Greys River is upstream roughly 25 meters. Photo credit: Kelly Owens USFS, 8/24/20.

Figure 25. USFS, Wyoming Game and Fish, Trout Unlimited, and volunteer crew standing on the completed TriBasin bridge after a day of willow planting at the project site. Photo credit: Leslie Steen, Trout Unlimited, 9/26/20.

Adaptive management considerations

Other monitoring activities related to focal species, such as surveying for cutthroat trout abundance and ecological conditions, are ongoing (FIGURE 24–FIGURE 25). However, these parameters were not carried forward as indicators due to lack of staff capacity and funding to conduct the level of monitoring necessary to assess trends in relative abundance. Furthermore, relative abundance may not be sufficient to adequately characterize whether forest management activities and/or natural events are affecting aquatic conditions indicated by the presence/absence of a focal species. It is recommended that future monitoring periods continue to incorporate aquatic organism passage surveys to describe ecological condition.

Figure 24. Focal Species Monitoring Crew chasing Yellowstone cutthroat trout (2019).

Figure 27. American Conservation Experience intern with the hydrology crew installing temperature loggers in Colorado River cutthroat trout habitat as part of Focal Species Monitoring Program (2019).

Figure 25. Aquatics Program Manager Barry releasing an adult Snake River fine spotted cutthroat trout at the TriBasin Divide project area in the Greys River. Photo credit: Josh Duplechian, Trout Unlimited.

Question WDL-01: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the endangered Kendall Warm Springs dace?

Indicator WDL-01-01: Replicate relative abundance estimates

Indicator WDL-01-02: Number and type of habitat improvement projects

Indicator WDL-01-03: Channel width to depth ratios (including vegetation encroachment) using 1995 research as baseline

Indicators WDL-01-04: Channel Temperature and Water Quality/Chemistry using 1978 report as baseline

Summary of methodology

Monitoring of Kendall Warm Springs Dace on BTNF relies primarily on Forest Service biennial relative abundance sampling and temperature monitoring, with support from Wyoming Game and Fish Department (WGFD) for habitat surveys and from US Geological Survey (USGS) for water quality. Kendall Warm Springs Dace populations are sampled biennially using a protocol for relative abundance estimates developed in the mid-1990s. Habitat improvement projects are tracked in a Forest Service corporate database. Quantitative and qualitative habitat analyses (e.g., functional vegetation type, channel width/depth ratios) were initiated on the BTNF in 2018 (FIGURE 26). Water quality is sampled annually and temperature loggers have periodically been deployed. Water chemistry has only been sampled periodically in dedicated studies to compare to periodic historic data collection efforts.

Figure 26. Biologists from WGFD and the USFS initiated a habitat sampling protocol attempting to capture habitat characteristics with the hope of comparing them to work completed in the 1990s. More rigorous habitat inventories are planned from summer of 2021.

Monitoring results

Relative abundance data from 1997 to 2019 suggest a decline in observed relative abundance (FIGURE 27). Comparisons of historic and recent temperature and water chemistry parameters at Kendall warm springs is shown in FIGURE 28 and TABLE 11**,** respectively.

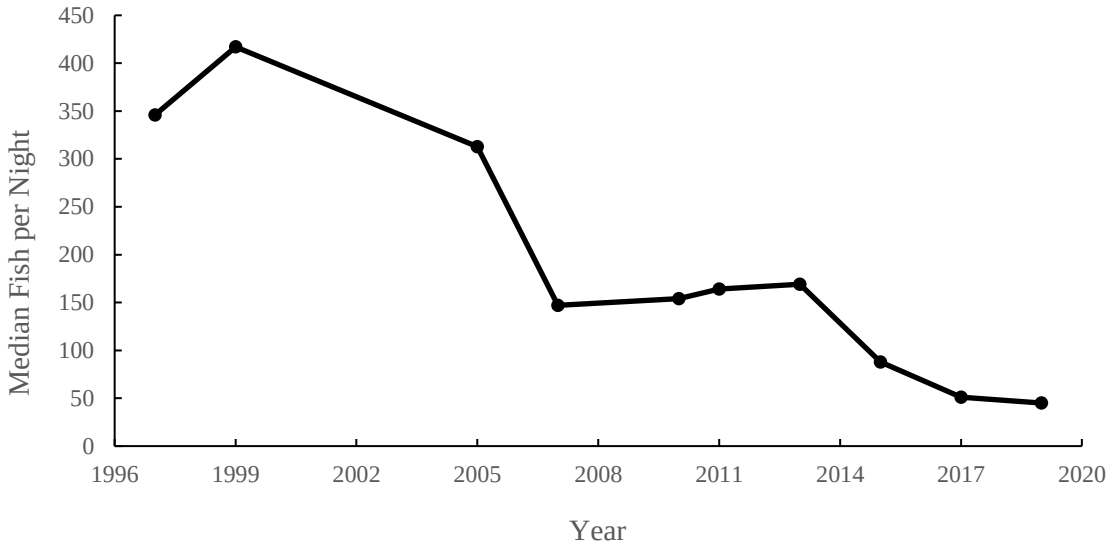

Figure 27. Relative Abundance of Kendall Warm Springs Dace by Median Number of Fish Captured per Night, 1997-2019.

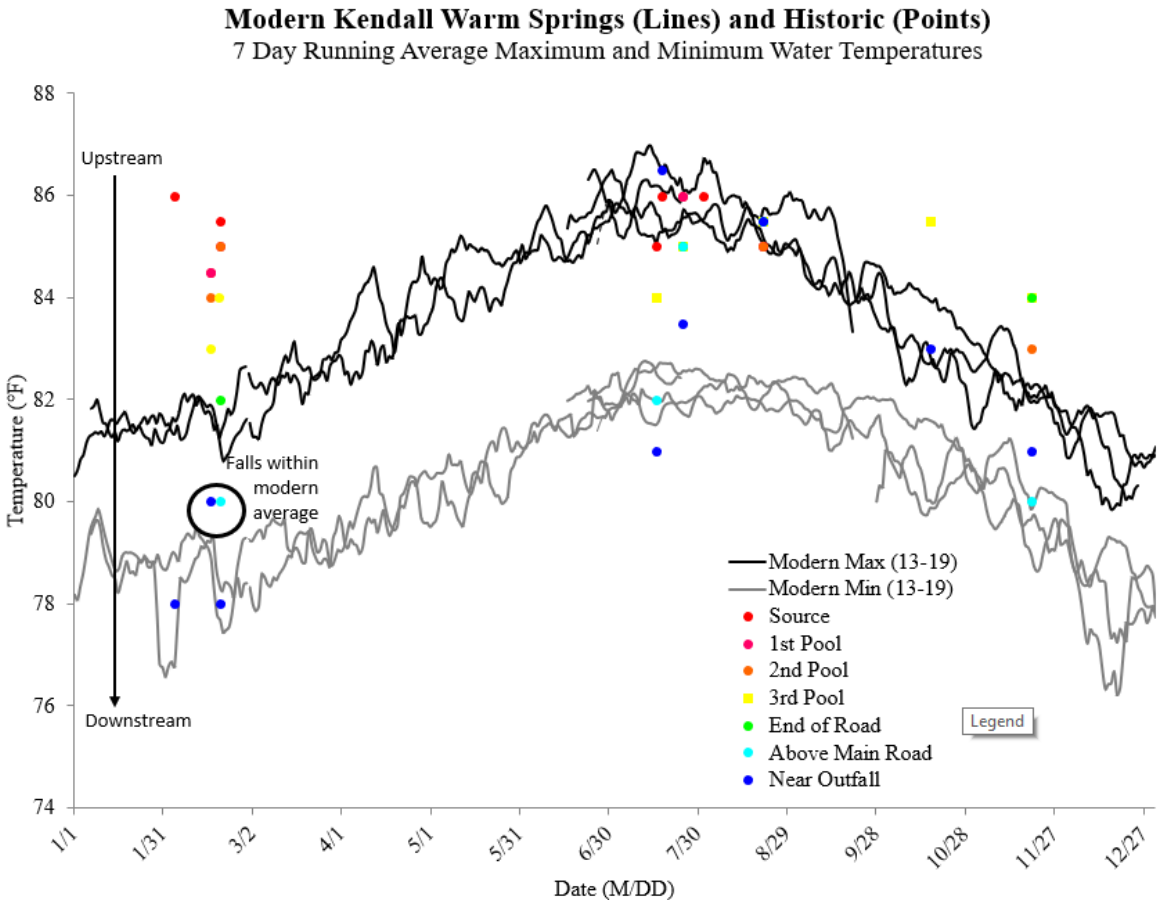

Figure 28. Historic and modern stream temperature at Kendall warm springs. 2013–2019.

Table 11. Historic and modern stream chemistry at Kendall warm springs.

Sample ID/ Location	Ca	Mg	Na	K	SO_4	Cl	NO^1	NO_3	F	Br	Mn	Fe	Sr	PO_4
Historic (1966–1976)														
Kendall Warm Springs (Sec.2cda, T.38N. R.110W.) [2,3] Date: 8/9/66	215	52	4.0	2.7	650	3.2	-	0.0	2.1	-	-	-	-	-
Kendall Warm Springs (Sec.2cda, T.38N. R.110W.) [2,3] Date: 9/24/76	220	46	2.3	2.8	650	2.3	-	0.2	0.4	-	-	-	-	-
Modern (10/6/2017)														
Kendall Sp. Lower[4]	210	46	1.9	2.8	550	1.1	<0.5	-	1.5	<1	<0.1	1.0	3.32	<150
Kendall WS Bridge[4]	220	50	1.8	2.8	620	1.2	<0.5	-	1.7	<1	<0.1	1.0	3.26	<150
Kendall WS 2nd Sp. Source[4]	210	49	1.8	2.8	630	1.2	<0.5	-	1.7	<1	<0.1	1.0	3.21	<150
Kendall WS 3rd Sp.[4]	210	49	1.9	2.8	640	1.2	<0.5	-	1.8	<1	<0.1	1.1	3.26	<150
Kendall Sp. 7[4]	220	50	1.8	2.9	650	1.1	<0.5	-	1.8	<1	<0.1	1.1	3.33	<150
Kendall WS 12[4]	210	50	1.8	2.9	570	1.2	<0.5	-	1.8	<1	<0.1	1.1	3.25	<150

[1] NO_2 + NO_3 as Nb
[2] Samples were taken from fast flowing zones as close to the vent as possible
[3] Breckenridge and Hinckley 1978
[4] US Geological Survey 2017

No habitat improvements, besides minor repairs to the ungulate exclosure fence, occurred in 2017–2018. In 2018, a habitat study was initiated on Kendall Warm Springs. Data was collected on physical and biological habitat components, including width, depth, type of vegetation in the channel, and amount of open water. On average, the riparian area was 10.5 m wider than the wetted width, which was an average of 13.5 m (FIGURE 29). The average depth was 9.0 cm, while the average max depth across the 30 transects was 16.7 cm.

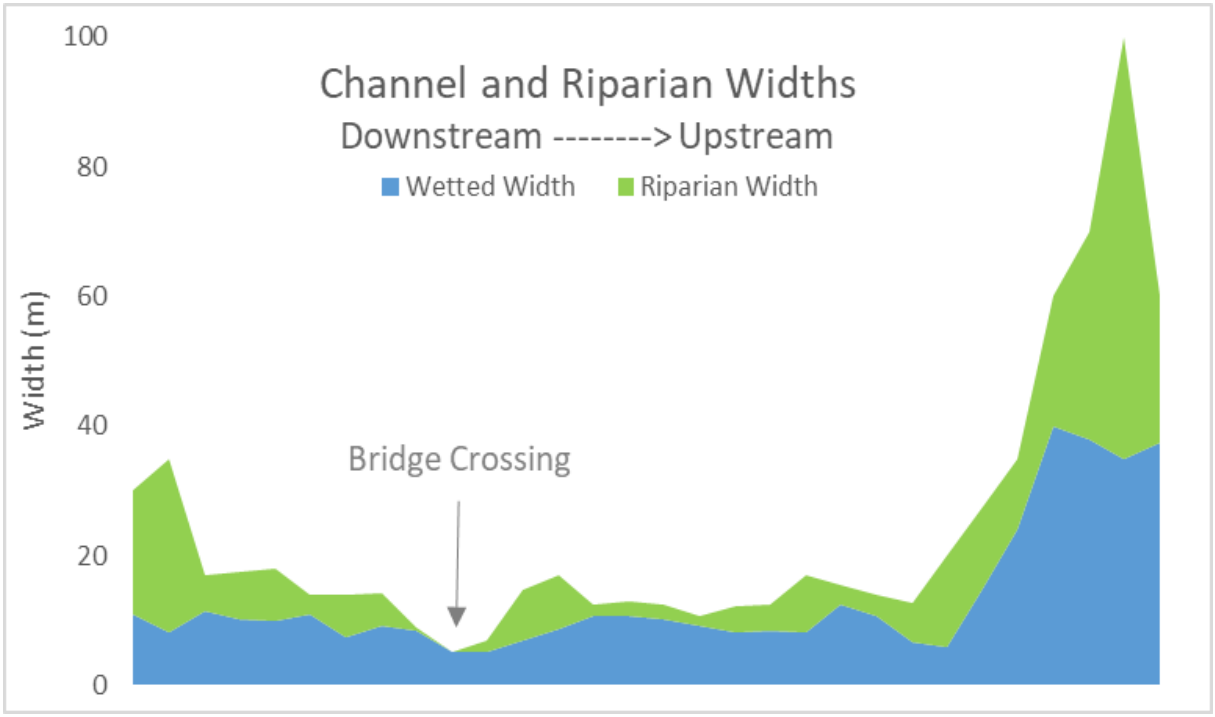

Figure 29. Channel and riparian width along Kendall Warm Springs.

The substate was primarily made up of gravels, with 56.2% between coarse and fine gravels, and fine materials, including sand and silt, making up an additional 33.1%. The remaining material included cobbles, boulders, and bedrock and account for only 10.4% of the substrate (TABLE 12).

Table 12. Substrate type, description, and percent of total substrate in Kendall Warm Springs.

Substrate Type	Description	Percent
Bedrock	Continuous rock that contributes to channel shape	7.1
Boulder	Basketball or larger sized rock	0.3
Cobble	Tennis ball to basketball	3.0
Coarse Gravel	Pea to tennis ball	37.4
Fine Gravel	Sand to pea	18.8
Sand	Grainy	7.6
Silt	Smooth	25.5
Clay	Smooth, but solid	0.0

Across transects, 71.7% of quadrants had a functioning thalweg, defined as having noticeable downstream flow, and 50.4% had vegetation. Most transects had multiple flow paths along the cross-section, and many of those areas identified as having flow were also vegetated. Submergent vegetation, present in 32.4% of quadrants, was the most common vegetation type, while only 7.5% of quadrants had emergent vegetation; 8.6% contained rhizomatous vegetation and only 2% had floating vegetation.

In 2021, the Forest Service plans to undertake a more rigorous habitat monitoring plan, with an effort to make the data comparable to the 1995 habitat study.

Discussion and findings

Since the inception of the relative abundance monitoring protocol in the mid-1990s (Gryska 1996), there has been an apparent decline in the relative abundance estimates of Kendall Warm Springs Dace leading to an overall reduction of roughly 90% in catch per unit effort since monitoring began (FIGURE 27). Despite variability and uncertainty in the raw capture data (Peterson et al.2020), this large and consistent decline in numbers of fish captured may indicate that overall population numbers may be following a similar trend (US Fish and Wildlife Service 2020).

Habitat analysis was initiated in summer of 2018, but at this time no conclusions can be drawn. Likewise, no conclusions about long term water temperature trends can be drawn from recent efforts to collect water temperature data. Currently, there does not seem to be significant differences between historic point-in-time temperature data and general stream temperatures within Kendall Warm Springs (FIGURE 28), but more data are needed. In 2017, USGS completed a water chemistry analysis showing only minimal differences between historic and modern stream chemistry (TABLE 11); however, the study did not offer an interpretation of the data. Unfortunately, the existing datasets are probably too narrow and short-term to assess a trend for the species.

Kendall Warm Springs Dace resides solely in a warm spring tributary to the Green River within BTNF; the thermal spring creek is less than 1,000 feet long (US Fish and Wildlife Service 2015). Despite the very limited distribution, BTNF has undertaken many management actions to improve and conserve habitat for the species in accordance with the recovery plan (US Fish and Wildlife Service 2015), including designation of the KWS special interest area, fencing, bridge replacement along the creek, and a swimming/bathing moratorium. As such, BTNF is actively engaging in management that

should increase species abundance and meet the Forest Plan objectives for Kendall Warm Springs Dace.

Adaptive management considerations

A new, more rigorous habitat monitoring protocol will be implemented in 2021, with the hope of additions to the 2018 work that will allow Forest Service biologists to compare their results with those of the original 1995 study.

Question WDL-02: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened Greater Yellowstone Area (GYA) grizzly bear?

Indicator WDL-02-01: Change from the 1998 baseline in secure habitat and motorized route density inside the Primary Conservation Area (PCA).

Indicator WDL-02-02: Change from the 1998 baseline in developed sites inside the PCA.

Indicator WDL-02-03: Change from the 1998 baseline in the number and acreage of commercial livestock grazing allotments and the number of sheep animal months inside the PCA.

Indicator WDL-02-04: Change from the 2008 baseline in secure habitat outside the PCA.

Summary of methodology

Grizzly Bear monitoring in the Greater Yellowstone Area is conducted collaboratively by the Interagency Grizzly Bear Strategy Study Team (IGBST). The monitoring information included below is also a part of their annual report available publicly at: https://www.usgs.gov/centers/norock/science/igbst-annual-reports.

Habitat standards are identified in the 2016 Conservation Strategy for the Grizzly Bear in the Greater Yellowstone Ecosystem and pertain to secure habitat, developed sites, and livestock grazing allotments (Interagency Grizzly Bear Committee 2016). Secure habitat is defined as more than 500 meters (1,640 ft) from an open or gated motorized access route or recurring helicopter flight line and must be greater than or equal to 10 acres in size. The standards demand that all three of these habitat parameters be maintained at or improved relative to conditions that existed in 1998. The 1998 baseline represents the best estimate of what was known to be on the ground inside the Primary Conservation Area (PCA) in 1998 and establishes a benchmark against which future improvements and/or impacts can be assessed. Metrics and analysis of each indicator are described in detail in Appendix E of the Conservation Strategy.

For indicator WDL-02-01, motorized access parameters that are monitored and reported include levels of secure habitat; open motorized access route density (OMARD), and total motorized access route density (TMARD) greater than 3.2 km/2.6 sq. km (2 mi/sq. mi). These are calculated using the

Motorized Access Model as described in Appendix E of the Conservation Strategy. Inside the PCA, these three parameters are measured and reported annually for each bear management subunit.

For indicator WDL-02-02, developed sites include all sites on public land developed or improved for human use or resource development. Changes in developed sites on BTNF inside the PCA are measured, tracked, and evaluated against 1998 levels. For indicator WDL-02-03, on federal lands inside the PCA, the number and acreage of commercial livestock grazing allotments and the number of sheep animal months (AMs) is monitored and reported annually relative to 1998 levels.

For indicator WDL-02-04, changes in secure habitat outside the PCA in areas deemed to be biologically suitable and sociably acceptable for grizzly bear occupancy are also reported to IGBST biennially. Although habitat standards apply only inside the PCA, the percent secure habitat outside this boundary is reported on even years per Bear Analysis Unit (BAU) against the 1998 baseline. There are five BAU on BTNF that fall within this category: Fremont, Green River, Gros Ventre, Hoback Range, and Snake River.

Monitoring results

Results of monitoring for parameters associated with indicators WDL-02-01 through WDL-02-04 are shown in TABLE 13–TABLE 16.

In 2018–2019, there were no reported changes in livestock grazing allotments inside the PCA.

Table 13. Percent per subunit of open motorized access route density (OMARD), total motorized access route density (TMARD), and secure habitat for the six Bear Management Unit subunits located in the PCA on BTNF, 1998 and 2019.

BMU Subunit Name	% OMARD (> 1 mi / mi2)			% TMARD (> 2 mi / mi2)			% Secure Habitat			Area (miles2) (excluding lakes)		
											Secure Habitat	
	1998	2019	% chg	1998	2019	% chg	1998	2019	% chg	Subunit	1998	2019
Buffalo/Spread Creek #1	11.5	11.0	-0.5	5.3	5.8	0.5	88.3	88.9	0.6	219.9	194.1	195.5
Buffalo/Spread Creek #2	15.6	15..9	0.4	12.7	8.9	-3.8	74.3	74.4	0.1	507.6	377.2	377.5
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 #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 #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
Mean for PCA & Total sq. miles	**5.1**	**2.9**	**0.0**	**3.1**	**2.5**	**-0.5**	**93.2**	**93.3**	**0.1**	**1677.8**	**1508.0**	**1509.6**

Table 14. Developed sites for the six Bear Management Unit subunits located in the PCA on BTNF, 1998 and 2019.

BMU Subunit Name	Summer Home Comp.		Developed Camp.		Trailheads		Maj. Dev. Sites and Lodges		Admin. or Maint. Sites		Other Developed Sites		Plans of Oper. for Minerals		Total Number of Sites	
	1998	2019	1998	2019	1998	2019	1998	2019	1998	2019	1998	2019	1998	2019	1998	2019
Buffalo/Spread Creek #1	0	0	1	1	1	1	0	0	0	0	2	2	0	0	4	4
Buffalo/Spread Creek #2	1	1	4	2	3	5	3	3	5	5	5	3	1	1	22	20
Thorofare #1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thorofare #2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	2
Two Ocean #1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
Two Ocean #2	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	2
Total in PCA	**1**	**1**	**6**	**4**	**4**	**6**	**3**	**3**	**9**	**9**	**7**	**5**	**1**	**1**	**31**	**29**

Table 15. Commercial livestock grazing allotments and sheep animal months inside the PCA on BTNF, 1998 and 2019.

Cattle/Horse Allotments				Sheep Allotments				Sheep Animal Months	
Active		Vacant		Active		Vacant			
1998	2019	1998	2019	1998	2019	1998	2019	1998	2019
9	6	0	1	0	0	0	0	0	0

Table 16. Percent secure habitat in BAUs outside the PCA on BTNF, 2008 and 2018.

Bear Analysis Unit (BAU)	Percent Secure Habitat				BAU Area[a] (Miles^2)
	2008 (Baseline)	2016	2018	% Change (2008–2018)	
Fremont	88.0	88.2	88.2	0.2	440.0
Green River	65.7	65.7	65.7	0.0	527.9
Gros Ventre	63.7	63.9	64.0	0.3	507.7
Hoback Range	58.9	58.9	58.9	0.0	292.9
Snake River	64.0	64.2	64.2	0.2	348.9
Mean Secure or Total sq. miles	**68.1**	**68.2**	**68.2**	**0.1**	**2117.4**

[a]Lakes greater than 1 mi^2 were excluded from secure habitat calculations and from total BAU area counts.

Discussion and findings

A 2006 Forest Plan amendment requires the monitoring and reporting of changes of Grizzly Bear secure habitat both in the PCA (annually) and outside the PCA in BAU (biannually). BTNF continues to meet the monitoring and reporting requirements. The 2006 amendment also requires that BTNF meet or exceed the habitat standards set within the PCA and outside PCA in BAU. Currently, on BTNF, all habitat standards within the PCA and outside PCA in the five BAU meet the 1998 baseline.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Question WDL-03: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened Canada lynx and its critical habitat?

Indicator WDL-03-01: Acres of fuel treatments and vegetation projects reported in accordance with the required monitoring found in the Northern Rockies Lynx Management Direction

Summary of methodology

The intent of this indicator is to track management activities involving exemptions for treating hazardous fuels within the WUI and pre-commercial thinning in lynx habitat on BTNF, per the US Fish and Wildlife Service's (USFWS) Biological Opinion for Northern Rockies Lynx Management Direction (NRLMD). The exemptions are codifie**d** as vegetation management standards VEG S1, S2, S5**,** and S6. **The** BTNF allocation per USFWS incidental take statement is as follows: VEG S5: 1,000 acres for whitebark pine restoration; VEG S1, S2, S5, and S6: 120,000 acres for hazardous fuels treatments within the WUI. To track management activities, vegetation treatments are queried from one of the Forest Service's corporate databases—the Forest Activity Tracking System (FACTS)—and compared against the forest's lynx habitat GIS and **l**ynx analysis unit (LAU) annually. FACTS is a part of the Forest Service's the Natural Resource Manager (NRM) system; information about these databases is available at http://fsweb.nrm.fs.fed.us/. Any deviations to the guidelines **require** a rationale; these are tracked and reported to USFWS. A full description of the analysis criteria is included in BTNF monitoring guide.

Monitoring results

Results of monitoring for parameters associated with indicator WDL-03-01 are shown in TABLE 17–TABLE 19.

Table 17. Use of the NRLMD exceptions to Standard VEG S5 (Pre-commercial Thinning), 2007–2020.

Project (Date, Location)	Research[1]	Genetic Testing[1]	Admin-istrative[1]	White Pine[1]	Whitebark Pine[1]	Aspen[1]	Total Allocated	Total Treated[2]	Veg S1 Met?
Buffalo Valley Fuels Mgmt. (4/8/10, Buffalo Fork West)	N/A, 0	N/A, 0	N/A, 0	N/A, 0	N/A, 17	N/A , 0	N/A	17, 17	Yes
Grouse Mtn. Whitebark Pine Restoration (5/6/12, Spread Creek East)	N/A, 0	N/A, 0	N/A, 0	N/A, 0	N/A, 53	N/A, 0	N/A	53, 53	Yes
Total Acres	N/A, 0	N/A, 0	N/A, 0	N/A, 0	1,000, 70	N/A, 0	1,000	70, 70	

[1] Acres allowed, Acres treated
[2] Acres overall, Acres in critical habitat

Table 18. Incidental Take summary on the BTNF for the use of exemptions and exceptions under the NRLMD, 2007–2020.

Acres of Lynx Habitat Treated		Acres of Lynx Habitat Treated Outside WUI		Acres of Lynx Habitat Treated Within WUI		Acres of Lynx Habitat in WUI Where Exceptions to Standard(s) are Applied		Forest Allocation per Incidental Take Statements (Acres)	Current Forest Balance (Acres)
Total	Critical Habitat	Total	Critical Habitat	Total	Critical Habitat	Total	Critical Habitat		
33,431	49,581	7,410	18,502	26,021	31,079	23,929	30,196	120,000	96,071

Table 19. Summary of all vegetation treatments in Lynx habitat on the BTNF, the use of NRLMD exemptions in WUI, exceptions to VEG S6 for treatment around administrative sites, for research sites and incidental removal during salvage operations, and rationale for deviating from any of the vegetation guidelines.

Project Name	Decision Date (Month & Year)	Project Location (LAU)	Acres of Habitat Treated			Acres of Habitat Treated Outside of WUI			Acres of Habitat Treated within WUI			Acres of Lynx Habitat Treated in WUI Where the 6% Cap Applies		Standard(s) Exempted for Treatment in the WUI	Rationale for applying Exemptions to Vegetation Standard(s)	Do any 2 Adjacent LAUs Exceed Standard VEG S1	Acres of Lynx Habitat Treated Where Exception to Veg S6 Applied		Justification for applying exception to *Vegetation S6* (admin. site, research, or incidental removal for salvage)	Rationale for deviating from any of the Vegetation Guidelines (i.e. G1, G4, G5, G10, G11).
			Mapped Lynx Habitat	Critical Habitat	Matrix	Mapped Lynx Habitat	Critical Habitat	Matrix	Mapped Lynx Habitat	Critical Habitat	Matrix	Mapped Lynx Habitat	Critical Habitat				Mapped Lynx Habitat	Critical Habitat		
Bryan Flats Fuels Reduction	Sep-08	Lower Hoback Middle	1201	2349	1148	528	1204	676	673	1145	472	673	1,145	S6	Fuels w/in WUI	No	0	0	NA	NA
Red Cliff Addition	Dec-09	Big Twin West, Big Twin East	463	1043	580	0	0	0	463	1043	580	463	1043	S6	Fuels w/in WUI	No	0	0	NA	NA
Hoback Jct Fuels Reduction	Mar-10	Fall Creek North, Fall Creek South, Lower Hoback Middle	2680	3682	1002	0	0	0	2680	3682	1002	1470	3,682	S6	Fuels w/in WUI	No	0	0	NA	NA
Pole Creek Prescribed Burn & East Fork Salvage	Apr-10	Hams Fork	4010	6550	2540	250	250	0	3,760	6,300	2540	3,760	6,300	S6	Fuels w/in WUI	No	0	0	NA	NA
Buffalo Fuels Management	Apr-10	Buffalo Fork West, Buffalo Fork Middle	718	1727	1009	72	86	14	646	1641	995	646	1,641	S6	Fuels w/in WUI	No	0	0	NA	NA
Grouse Mtn. Whitebark pine Restoration	May-12	Spread Creek East	53	639	586	53	639	586	0	0	0	0	0	none	NA	No	53	53	Research	NA
Hams Fork Vegetation Treatment	Sep-13	Hams Fork	1,780	8,682	6,902	1,445	8,347	6,902	335	335	0	0	0	none	NA	No	177	177	Incidental removal during salvage	NA
LaBarge Veg. Restoration	Dec-15	LaBarge Creek	4,802	7,716	2,914	4,802	7,716	2,914	0	0	0	0	0	none	NA	Yes	0	0	NA	NA
Skyline Fuels Reduction	Sep-16	Pine creek, Pole Creek	2,247	0	0	0	0	0	2,247	0	0	2,247	0	S6	Fuels w/in WUI	Yes	0	0	NA	NA
Teton-to-Snake	Sep-17	Fall Creek North, Fall Creek South	7,775	0	3,002	0	0	0	7,775	0	3,002	7,775	0	S6	Fuels w/in WUI	No	0	0	NA	NA
North Piney Post and Pole Commercial Thinning Project	Jan-18	South Beaver	61	61	0	10	10	0	51	51	0	0	0	none	NA	No	0	0	NA	NA
Togwotee Mountain Lodge Vegetation Management Project	Feb-19	Buffalo Fork Middle	250	250	0	0	0	0	250	250	0	250	250	S6	Fuels w/in WUI	Yes	0	0	NA	NA
Tri-Basin Salvage Harvest Project	Feb-19	Greys River South	250	250	0	250	250	0	0	0	0	0	0	none	NA	No	0	0	NA	NA
Monument Ridge Vegetation and Recreation Management	Oct-19	Lower Hoback Middle, Upper Hoback South	6,645	16,135	9,490	0	0	0	6,645	16,135	9,490	6,645	16,135	S6	Fuels w/in WUI	Yes	0	0	NA	NA
Middle Beaver Salvage Sale	Nov-19	Middle Beaver Creek	101	102	1	0	0	0	101	102	1	0	0	none	NA	No	0	0	NA	NA
Sledrunner Salvage Sale	Nov-19	Upper Hoback North	250	250	0	0	0	0	250	250	0	0	0	none	NA	No	0	0	NA	NA
Chall Creek Salvage Sale	Feb-20	Middle Beaver Creek	145	145	0	0	0	0	145	145	0	0	0	none	NA	No	0	0	NA	NA
Total Acres Treated			**33,431**	**49,581**	**29,174**	**7,410**	**18,502**	**11,092**	**26,021**	**31,079**	**18,082**	**23,929**	**30,196**	NA	NA	NA	**230**	**230**	NA	NA

Discussion and findings

In 2019 and 2020, no acres of pre-commercial thinning in lynx habitat were conducted. Therefore, in total the Bridger-Teton has used 70 of the 1000 acres allocated for NRLMD exceptions to Standard VEG S5 (Pre-commercial Thinning) in occupied lynx habitat (TABLE 17). Between 2018 and 2020, 7,442 ac of vegetation treatments in WUI were conducted (TABLE 18). With the exemptions granted for vegetation management standards, VEG S1, S2, S5, and S6 on the NRLMD Incidental Take Statement, BNTF still has 930 acres for whitebark pine restoration and over 96,000 acres available to utilize for WUI fuels treatments (TABLE 18 and TABLE 19, respectively). BTNF is in compliance with the NRLMD Incidental Take Statement and therefore meeting the objectives of the Forest Plan with regards to lynx habitat.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator WDL-03-02: Changes in lynx habitat as a result of moving towards the desired conditions for vegetation through vegetation management, prescribed fire, or natural disturbance.

Summary of methodology

This indicator will be used to determine changes in the amount of lynx habitat within each Lynx Analysis Unit (LAU) that is in an early stand initiation stage (i.e., from natural events, vegetation/fuels treatments, or any combination of these or other causes) and therefore unsuitable as winter snowshoe hare habitat. This is updated annually with timber management activities from fire history GIS data and FACTS. FACTS is a part of the Forest Service's NRM corporate databases.

Monitoring results

FIGURE 30 displays the percent of each Lynx Analysis Unit on the BTNF that was classified as an early stand initiation stage, and therefore, unsuitable as winter snowshoe hare habitat in 2019.

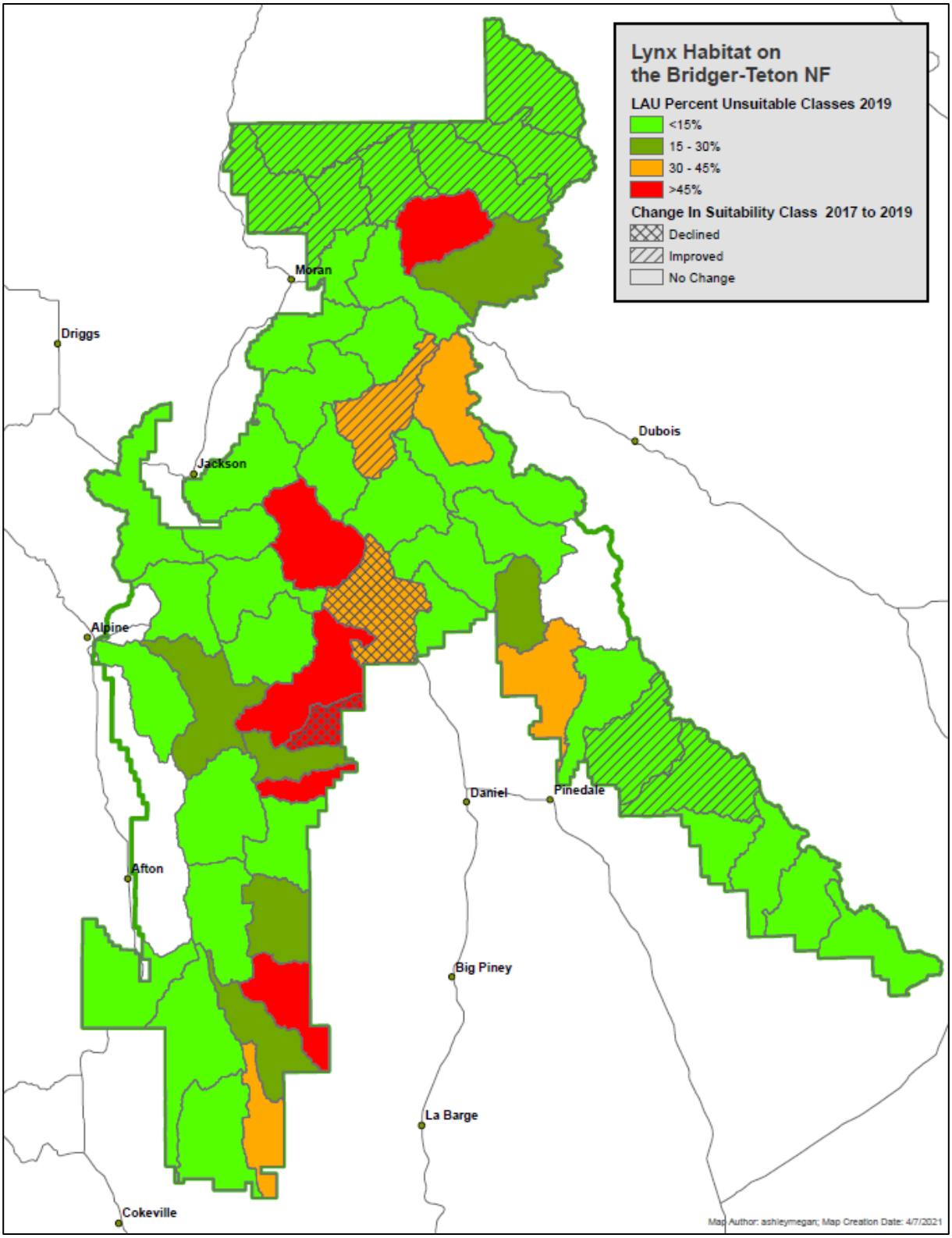

Figure 30. Percent unsuitable habitat for each Lynx Analysis Unit on BTNF, 2019.

Discussion and findings

On the BTNF, large fires have been the main driver in turning suitable lynx habitat into unsuitable habitat. For example, the Roosevelt Fire in 2018 was instrumental in changing the overall suitability of two LAU's from <15% unsuitable to >45% unsuitable (FIGURE 30). However, larges areas affected by the fires of 1988, four mainly on the Blackrock Ranger District just south of Yellowstone National Park, were recalibrated from unsuitable habitat to suitable in 2018 due to increased canopy cover resulting from 30 years of post-fire tree growth. Approximately 30 years of tree growth post-disturbance is considered adequate to reestablish continuous cover and provide winter snowshoe hare habitat.

No large fires occurred on the BTNF in 2019 and 2020. The total amount of habitat suitable for lynx continues to increase across the BTNF (FIGURE 30) due to continued natural forest recovery from the large 1988 fires.

BNTF continues to update lynx habitat annually, which is used for applying vegetation management standards during project development and review. As such, BTNF continues to meet the objectives of the Forest Plan in terms of lynx habitat management.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan or management activities are warranted.

New science or information: surveys and incidental sightings

Summary of methodology

A collaborative effort between the Bridger-Teton and Shoshone National Forests, Grand Teton National Park, the Forest Service National Carnivore Program, and the Rocky Mountain Research Station, and the National Genomics Center for Wildlife and Fish Conservation was initiated in 2015 to provide the most current understanding of mesocarnivore presence and distribution across components of BTNF, Shoshone National Forest, and Grand Teton National Park. From 2015 to 2017, the project used snow-track surveys, remote cameras, hair snares, scent lure, carrion baits, and molecular-based methods to document the presence of mesocarnivores at detection stations and along survey (snow-tracking) routes located within 8 x 8 km grid cells in prime lynx habitat (FIGURE 31 and FIGURE 32). In combination with historic detection data, this project has directly informed an ongoing, less-intensive but long-term mesocarnivore detection effort sourced out of the Rocky Mountain Research Station and conducted on BTNF in 2018.

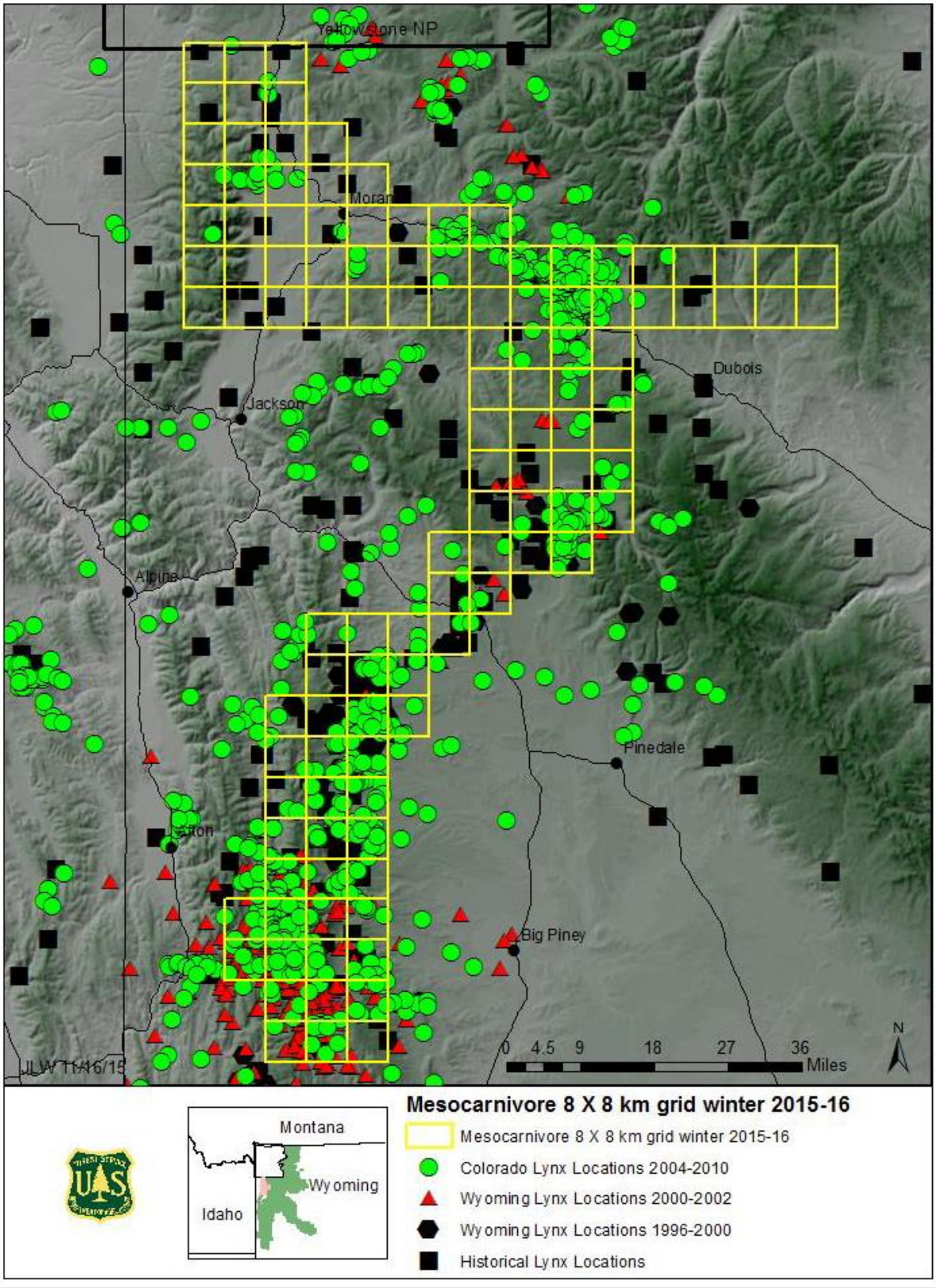

Figure 31. Historic lynx detections and survey grid for 2015–2016 south Yellowstone area mesocarnivore monitoring.

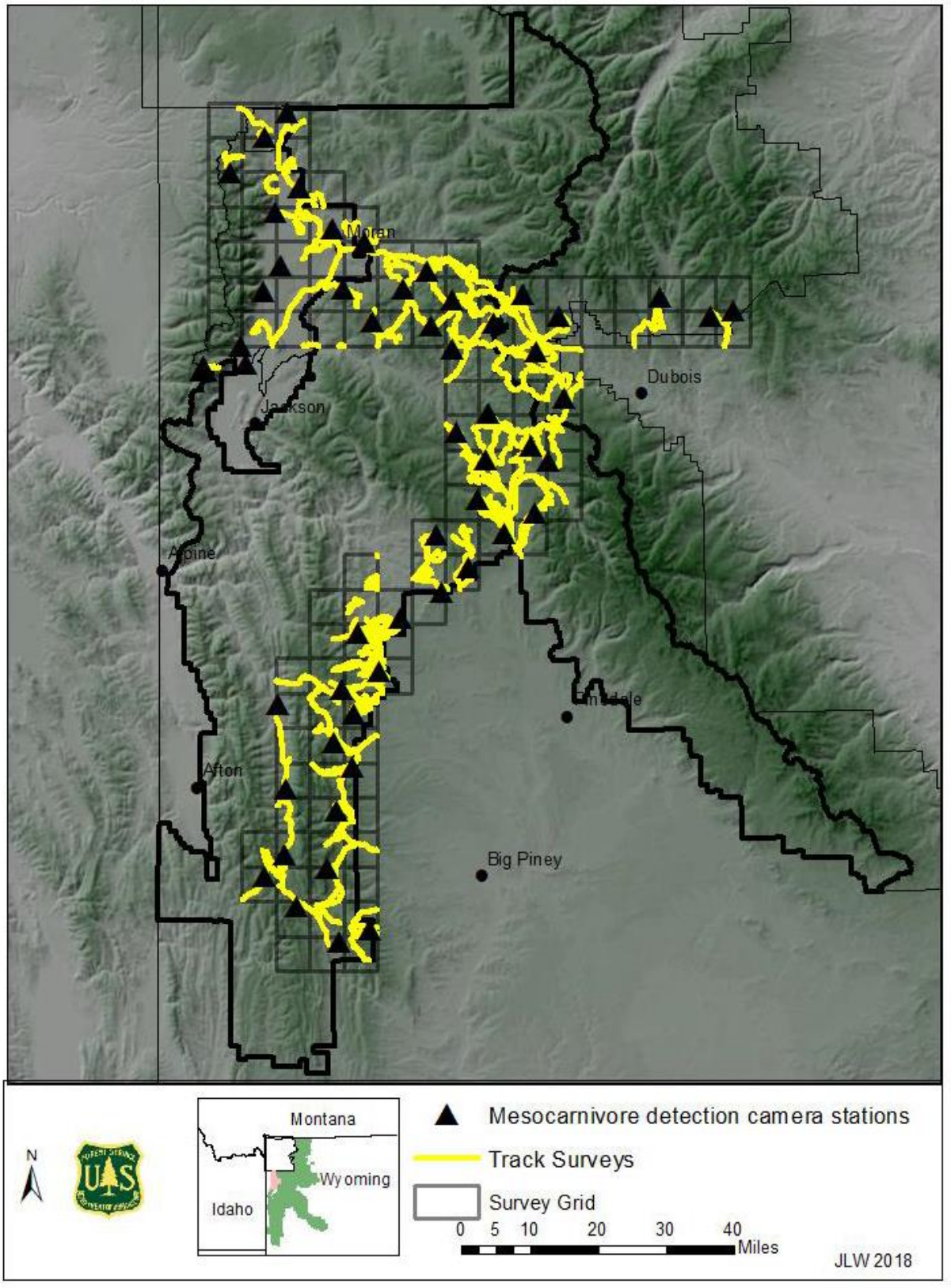

Figure 32. Distribution of mesocarnivore snow track surveys and camera/DNA stations, 2015-2017.

Monitoring results

No evidence of Canada lynx was found at detection stations or along survey routes in the study area from 2015 to 2017.

Discussion and findings

No evidence of Canada lynx was found in the study area over three winters of effort on a 1.9-million-acre survey grid, including approximately 4,000 miles of 195 independent snowmobile and ski-based track surveys, 54 cameras that were active for a total of 37,500+ camera nights, analysis of a subset of 374 DNA samples, and after review of over 230,000 trail camera photographs of wildlife. While there exists high quality lynx habitat in the GYA, these habitats are patchy. The probabilities of detection certainly varied over the survey area due to field reality. The survey effort was closely aligned with well-established lynx and other mesocarnivore detection protocols. The lack of detections strongly suggest that lynx are not present in the areas surveyed. The lack of detections will be included in future status assessment for this species.

Adaptive management considerations

Given their value in this monitoring period, incidental sightings, track surveys and eDNA should be added as a monitoring indicator for future monitoring periods. Based upon the monitoring results, no changes to the Forest Plan, or management activities are warranted.

Question WDL-04: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the threatened yellow-billed cuckoo?

Indicator WDL-04-01: Acres of cottonwood overstory riparian habitat

Indicator WDL-04-02: Breeding Bird Survey (BBS) trend data for on-forest routes and incidental sightings

Summary of methodology

BTNF Existing Vegetation dataset was utilized to quantify cottonwood habitat. In this regionally produced dataset, vegetation map types were characterized by map unit (dominant land cover), tree and shrub canopy cover class, and tree size class, using field-based classification system and field keys, cross-walking existing vegetation information, and developing descriptions for the map units. The dataset was updated in 2018 using the Vegetation Classification, Mapping, and Quantitative (VCMQ) inventory data. Number of habitat patches, total acres, mean habitat patch size and range are assessed. The USGS the Interactive Route Data Summary is queried for breeding bird survey route data (https://www.mbr-pwrc.usgs.gov/cgi-bin/rtena15a.pl?92&csrfmiddlewaretoken=3YKakk7LxT2ki6NSpl4mstudYCqdW02C). There are a total of five BBS Routes on BTNF: 92036 (Moose); 92052(Wilson); 92051 (Alpine); 92072 (Buckskin Mountain); 92071 (Soda Lake). In addition, the most current version of the Wyoming Natural Diversity Database is utilized to query any incidental sightings in or near BTNF.

Monitoring results

As of 2020, on BTNF, there are 83 cottonwood habitat patches, the mean patch size is 5 ac (range: 0.5-30 ac) and the total acres of habitat is 399 ac. Three incidental sightings have been documented near BTNF (FIGURE 33), and no reports via the five BBS routes.

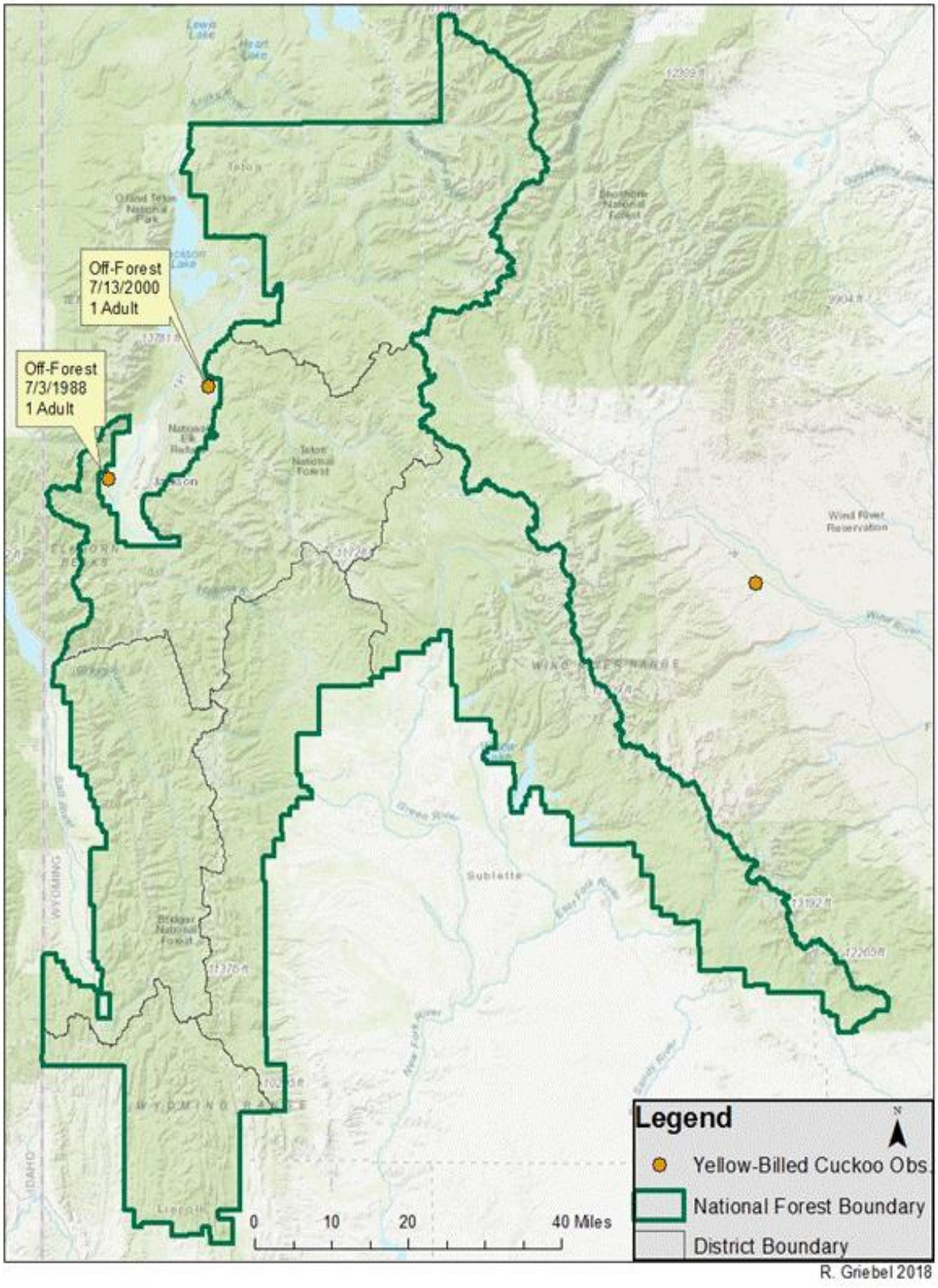

Figure 33. Yellow-billed cuckoo observations/recordings in or near BTNF.

Discussion and findings

In Wyoming, the yellow-billed cuckoo is dependent on large areas of woody, riparian vegetation that combine a dense shrubby understory for nesting and a cottonwood overstory for foraging. Destruction, degradation, and fragmentation of wooded, riparian habitats are threats to yellow-billed cuckoos in Wyoming. The species is extremely rare on BTNF, with few documented observations near the Forest boundary and none within the BTNF boundary. On BTNF, there is no designated critical habitat, there is a very limited amount of cottonwood overstory habitat and little opportunity to increase that amount through management actions. There were no recordings of yellow-billed cuckoos on any of the BBS routes that are located on BTNF and the few incidental sightings that have been recorded are along the Snake River off-forest. Given the limited opportunity for habitat management, BTNF is meeting Forest Plan objectives with regards to yellow-billed cuckoo.

Adaptive management considerations

Based upon the monitoring results, no changes to the Forest Plan or management activities are warranted, but changes to the monitoring program may be warranted because no yellow-billed cuckoos likely inhabit the BTNF. Consideration should be given to dropping this indicator and potentially adding an indicator(s) for amphibians and/or pollinators.

Question WDL-05: Are forest management activities and/or natural events affecting the ecological conditions that contribute to the recovery of the proposed North American wolverine?

Indicator WDL-05-01: Acres open to over-snow vehicle use and miles of groomed over-snow trails (e.g., motorized and non-motorized)

Indicator WDL-05-02: Amount and seasonal variation of snowpack

Summary of methodology

Acres open to over-snow vehicle use and miles of groomed over-snow trails is a duplicate of recreation indicators RA-03-01 and RA-03-02; see those sections for results of this indicator. Amount and seasonal variation of snowpack is a duplicate of environmental stressors indicator (EVS-01-02) and is also discussed in that section.

For amount and seasonal variation in snowpack, USGS SNOTEL data was queried. From the available SNOTEL sites, a subset of five sites scattered across the BTNF—all above 8500 feet—were selected to provide an index to assess snowpack in likely wolverine habitat: Togwotee Pass (9580’), Gros Venture Summit (8750’), Blind Bull Summit (8650’), Indian Creek (9425’), and Deer Park (9700’).

New science or information

Snow-track and camera trap survey efforts and incidental sightings were also included.

Monitoring results

Results of monitoring for parameters associated with indicator WDL-05-02 are shown in TABLE 20.

Table 20. Snow depths and snowpack duration at five SNOTEL sites, 2016, 2018, and 2020.

2016	Blind Bull Summit	Deer Park	Gros Ventre Summit	Togwotee Pass	Indian Creek	AVG
First Day ≥ 60" of Snow Depth	2/16/2016	3/30/2016	N/A	2/16/2016	3/16/2016	N/A
Last Day ≥ 60" of Snow Depth	4/30/2016	5/2/2016	N/A	5/2/2016	4/16/2016	N/A
Total Days Between First and Last Day	75	34	0	77	32	43.6
2018	**Blind Bull Summit**	**Deer Park**	**Gros Ventre Summit**	**Togwotee Pass**	**Indian Creek**	**AVG**
First Day ≥ 60" of Snow Depth	1/12/2018	N/A	4/3/2018	12/24/2017	2/27/2018	N/A
Last Day ≥ 60" of Snow Depth	5/21/2018	N/A	4/4/2018	5/29/2018	4/25/2018	N/A
Total Days Between First and Last Day	130	0	2	157	58	69.4
2020	**Blind Bull Summit**	**Deer Park**	**Gros Ventre Summit**	**Togwotee Pass**	**Indian Creek**	**AVG**
First Day ≥ 60" of Snow Depth	1/13/2020	N/A	N/A	1/9/2020	2/7/2020	N/A
Last Day ≥ 60" of Snow Depth	5/9/2020	N/A	N/A	5/28/2020	4/25/2020	N/A
Total Days Between First and Last Day	118	0	0	141	79	67.6

Wolverine detections on or near the BTNF are summarized in FIGURE 34 and FIGURE 35 and in TABLE 21.

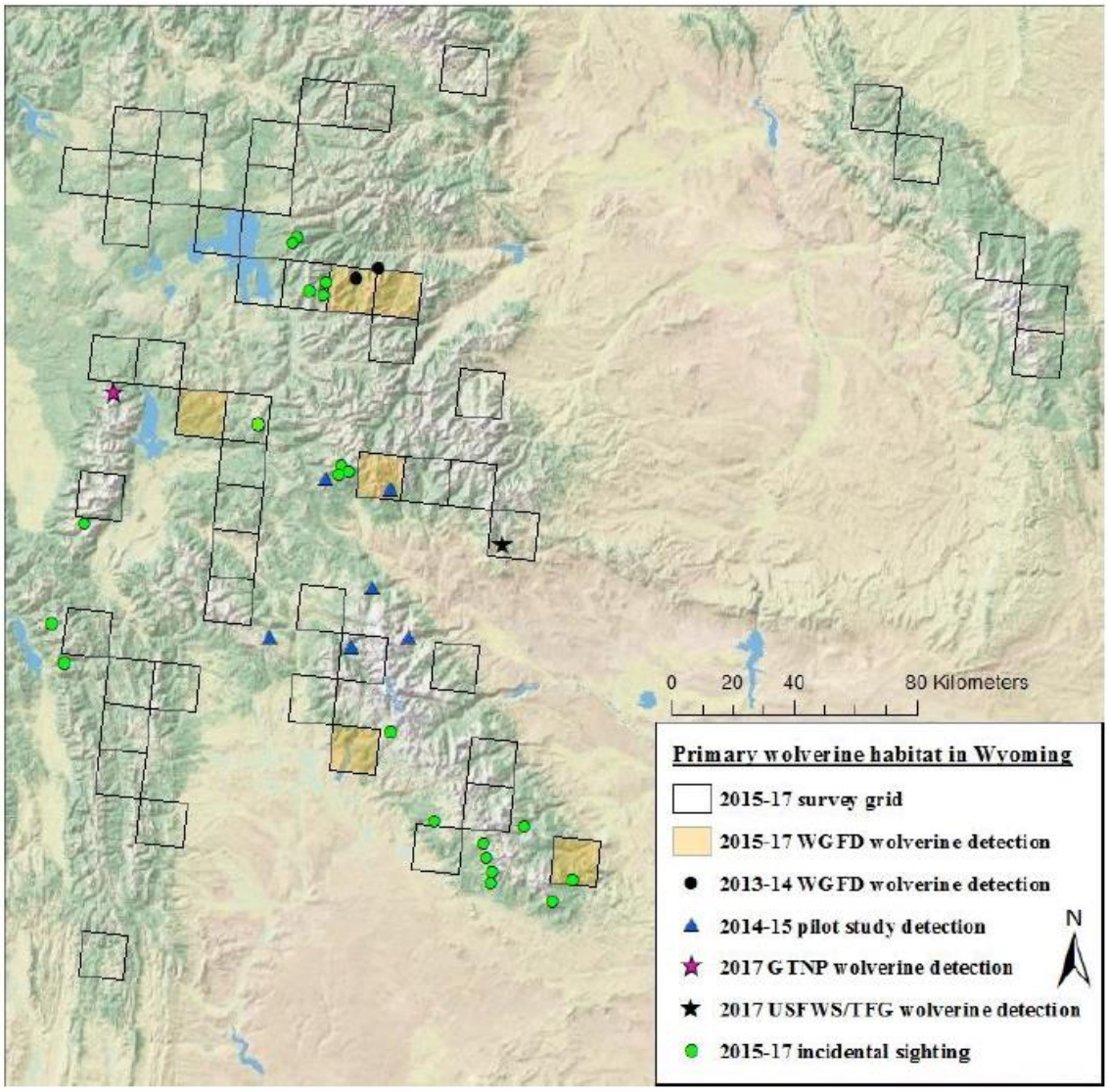

Figure 34. Incidental sightings and survey results for wolverine in Wyoming, 2013-2017. From Bjornlie et al 2017.

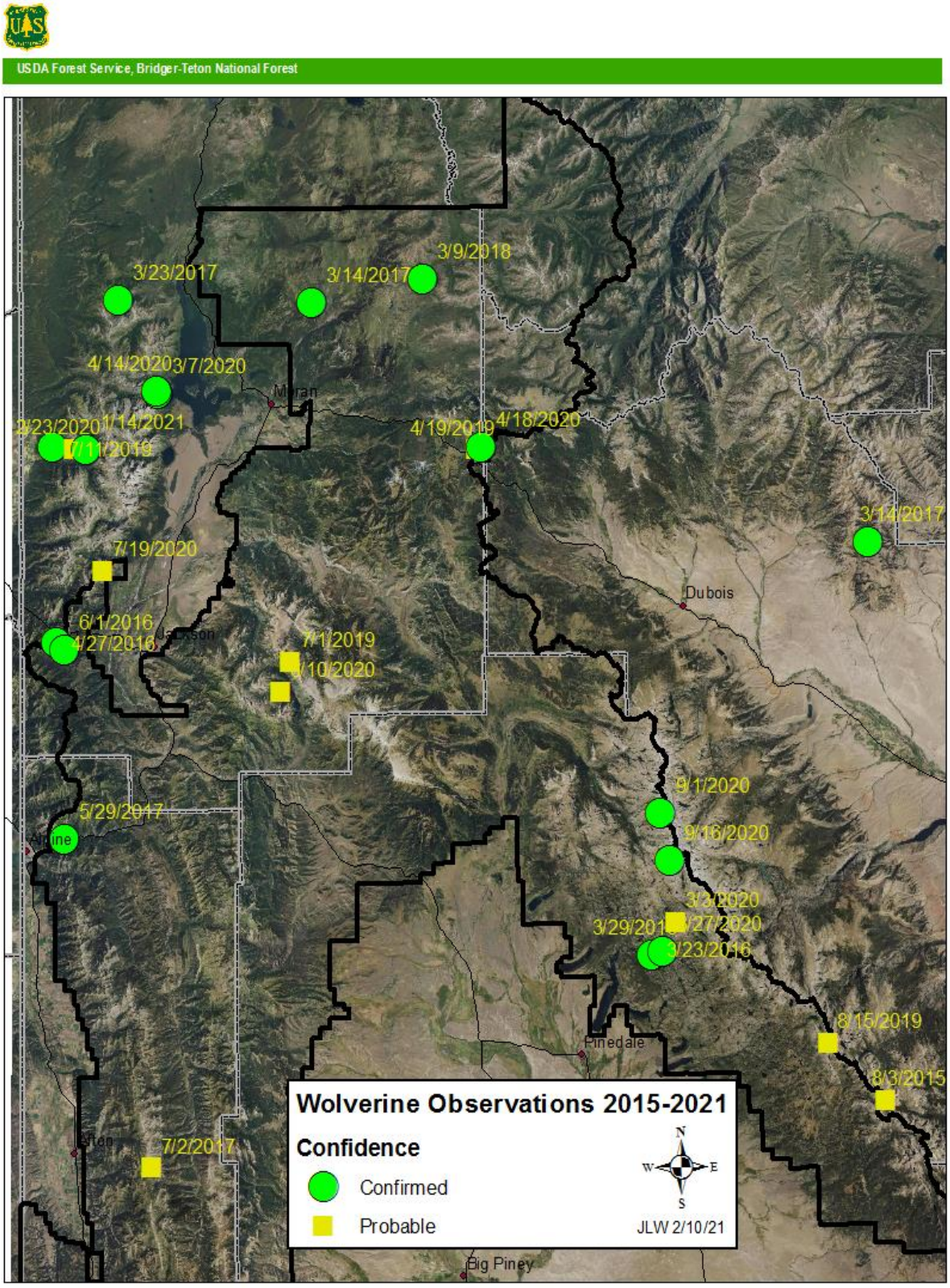

Figure 35. Wolverine observations in and around BTNF, 2015-2021 (from BTNF records).

Table 21. Wolverine observations on or near the BTNF, 2015–2021 (from BTNF records).

Date	Location	Confidence	Verified by tracks?	Verified by photos?	Verified by eDNA?	Verified by DNA?
			2015–2018			
8/3/2015	Texas Pass	Probable	No	No	No	No
3/23/2016	Miller Park	Confirmed	Unknown	Yes	No	Yes
3/29/2016	Miller Park	Confirmed	Unknown	Yes	No	Yes
4/27/2016	Edelwiess Bowl, Teton Pass	Confirmed	Yes	No	No	No
6/1/2016	Mt Elly, Teton Pass	Confirmed	Yes	Yes	No	No
3/14/2017	Whetstone Creek	Confirmed	Unknown	Yes	Unknown	Unknown
3/14/2017	Trail Ridge east of Crow Creek, Wind River Range	Confirmed	Unknown	Yes	Unknown	Unknown
3/23/2017	Forellen Divide	Confirmed	No	Yes	No	Yes
5/29/2017	Cottonwood Creek	Confirmed	No	Yes	No	No
7/2/2017	South Crow Creek, Greys	Probable	No	No	No	No
3/9/2018	Two Ocean Pass	Confirmed	Yes	No	No	Yes
			2019			
4/19/2019	Togwotee Pass	Very High	High Probability	No	No	No
7/1/2019	West Fork Crystal Creek	Probable	No	No	No	No
7/11/2019	near Targhee ski area	Confirmed	No	No	No	No
8/15/2019	Sheila Lake	Probable	No	High Probability	No	No
			2020			
2/23/2020	Peaked Mtn	Probable	No	No	No	No
3/3/2020	Seneca Lake	Probable	High Probability	No	No	No
3/7/2020	Moran Bay	Confirmed	No	Yes	No	No
3/27/2020	Eklund Lake	Confirmed	Yes	No	Yes	No
4/14/2020	Moran Creek Inlet	Confirmed	No	Yes	No	No
4/18/2020	Togwotee Pass	Confirmed	Yes	Yes	Yes	No
6/10/2020	Bunker Creek	Probable	No	No	No	No
7/19/2020	Rendezvous Bowl JHMR	Probable	No	No	No	No
9/1/2020	Tourist Creek	Confirmed	Yes	No	No	No
9/16/2020	Knapsack Col	Confirmed	No	Yes	No	No
			2021			
1/14/2021	South Bowl S of Targhee	Confirmed	Yes	No	No	No

Discussion and findings

The Wyoming Game and Fish Department (WGFD), as part of the Multi-state Wolverine Working Group, initiated the Western States Wolverine Conservation Project to assess current distribution and identify conservation actions (Welander 2015). During the winters of 2015–16 and 2016–17, WGFD documented ≥6 unique wolverines at 6 of 51 camera stations (Bjornlie et al. 2017). Individuals were documented in the Wind River and Absaroka Mountains. All detections were in areas where wolverines have been documented either historically or as part of a pilot effort (2015) to evaluate

techniques to detect wolverines in the state. However, wolverines were not detected in Yellowstone National Park or the Wyoming, Salt, or Teton Mountains, all of which also have documented historical presence.

On the BTNF, winter recreation has changed little over the last 20 years in regard to miles of groomed trails and acres open to snowmobile travel, which are expected to remain at current levels into the foreseeable future; however, advances in snowmobile technology have increased access and use of steep terrain areas.

Climate-induced changes that reduce suitable habitat, especially snowpack, will have negative impacts on wolverine populations. Wolverines depend on high-elevation forests and alpine habitats, which are likely to contract gradually in the future. Wolverines have low reproductive rates that may decline further with loss of spring snow associated with preferred den sites (Halofsky et al. 2018). The duration of deep snowpack (>60 inches) has been tracked at five high elevation sites on BTNF since 2016, which is not sufficient time to establish a trend (TABLE 20).

Adaptive management considerations

Based upon the monitoring results, no changes to the Forest Plan, or management activities are warranted.

Question RA-01: Are developed recreation sites managed to standard?

Indicator RA-01-01: Number of developed sites maintained to standard

Summary of indictor and methodology

Developed recreation sites include a variety of constructed facilities such as campgrounds, picnic areas, major trailheads, and interpretive sites. Each recreation site is inventoried on a five-year cycle to assess annual maintenance needs (to prevent deterioration), deferred maintenance (infrastructure needing repair/replacement), and desired capital improvements (enhancement needed to meet increased demand and/or resource protection). A site is managed to standard if the site has a facility condition index of 90% or higher, meaning it is in good condition. This information was generated using the national online Recreation Facility Toolkit, selecting the Recreation Site FCI List, and then filtering for sites on BTNF.

Monitoring results

The Facility Condition Index report shows that 197 developed sites (86%), out of a total of 228 sites, are managed to standard.

Discussion and Findings

BTNF completed a Recreation Site Analysis in 2015 to prioritize limited funding at particularly important sites as well as to identify changes in operations or maintenance that would improve important developed recreation sites. Recreation site data was updated as part of this analysis but has not been significantly updated since. Thus, no real change is being reported for this indicator compared with the 2019 biennial monitoring report. Since 2015, improvement in site condition has occurred at some sites where fees are charged and re-invested or where grant and partner funding has been obtained. However, overall site maintenance and improvement is not keeping pace with recreation demand and continued deferred maintenance needs. Additionally, lower priority sites often

hold meaning for some members of the public and cannot be easily decommissioned to focus more attention on other sites.

Adaptive management considerations

Based upon the monitoring results, no changes to the Forest Plan are warranted. With regard to management activities, the BTNF is actively working toward addressing known site conditions issues with priority placed on those sites determined to be signature sites and those sites deemed necessary for resource protection. The recent passage of the Great American Outdoors Act holds promise that long-standing deferred maintenance backlog can begin to be addressed over the next five years.

Question RA-02: Are the amount and types of recreation opportunities provided meeting customer needs and expectations?

Indicator RA-02-01: Visitation estimates, visitor activities, and percent overall satisfaction

Summary of methodology

Visitation estimates, visitor activities, and percent overall satisfaction are collected every five years via the National Visitor Use Monitoring (NVUM). Information about the visitor use monitoring program and Forest results can be found at: https://www.fs.usda.gov/about-agency/nvum/. NVUM provides information that is valid and applicable at the national, regional and forest level, but it is not designed to be accurate at the district or site level. Estimating visitation is notoriously difficult because of the large number of National Forest access points, difficulty of developing an accurate stratified sampling scheme, and highly variable nature of recreation use both spatially and temporally. The limitations of data are described in detail in each Forest's 5-year NVUM report.

Results from the most recent NVUM survey conducted from 10/1/2017 to 9/30/2018 are presented.

Monitoring results

Table 22. Visitation estimates and 90% confidence interval, 2003-2018, NVUM.

	2003	2008	2013	2018
National Forest visits[1]	2.671 million +/- 23.2%	2.182 million +/- 20.1%	1.623 million +/- 11.4%	2.19 million +/- 13.9%
Site visits	3.15 million +/- 19.8%	2.369 million +/- 19.7%	1.951 million +/- 10.4 %	2.777 million +/- 13.6%

[1] A *national forest visit* is the entry of one person upon a national forest to participate in recreation activities for an unspecified period of time; a national forest visit can be composed of multiple *site visits*.

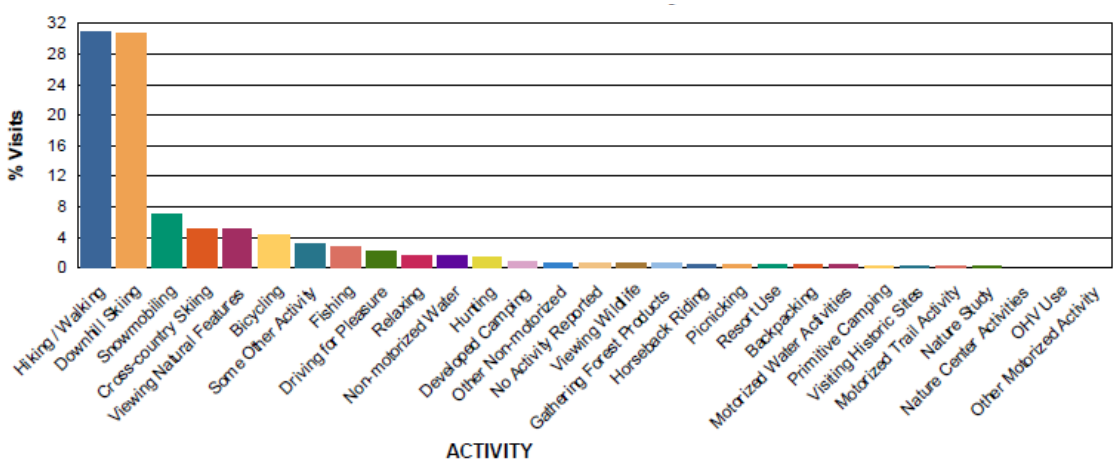

Figure 36. Primary visitor activities, 2018, NVUM.

Table 23. Percent overall satisfaction, 2018, NVUM.

Satisfaction Element	Satisfied Survey Respondents (%)[1]		
	Developed Sites[2]	Undeveloped Areas (GFAs)	Designated Wilderness
Developed Facilities	99.1	76.7	88.4
Access	88.0	81.1	87.1
Services	96.7	81.8	87.1
Feeling of Safety	99.7	94.0	98.7

[1]The proportion of satisfaction ratings scored by visitors as good (4) or very good (5) and indicates the percent of all visitors that are reasonably well satisfied with agency performance.
[2]Developed sites category includes both developed overnight and day use sites.

Discussion and findings

Visitation estimates over 5-year NVUM intervals should not be interpreted as clear trends in use. Problems in 2013 obtaining actual use data to help validate survey data likely contributed to lower visitation estimates on BTNF than expected (TABLE 22). Based on actual use in specific areas, BTNF visitation is likely at least two million people annually and is growing. Notably, the summer of 2020 saw a significant increase in use due largely to the covid-19 pandemic (30% or more, based on trail counter and camping data, compared with 2019). Increased use has persisted into the winter months and all indications are that use will continue to remain high post-pandemic.

Although visitors come from nearly every state in the US and a small percent come from foreign countries, the vast majority of visitors live in the three counties that encompass or are adjacent to BTNF, with nearly 75% travelling less than 50 miles for their visit and about 48% visiting more than 50 times annually. This information suggests that BTNF plays a vital role in serving local communities, contributing directly to residents' quality of life and supporting the local economy.

Visitation trends on BTNF likely mirror local population growth, since the vast majority of visitors reside in the counties that encompass or are adjacent to the Forest. From 2010-2018, Teton County, Wyoming's population grew 11% and adjacent counties with more affordable housing experienced even more rapid growth. Lincoln and Sublette Counties have also seen population growth but at lower

levels due to declines in the energy market. Overall, the counties with the closest ties to the BTNF grew 11% between 2010 and 2018 (Headwater Economics).

On BTNF, top visitor activities have remained relatively constant, with hiking/walking, downhill skiing, snowmobiling, cross-country skiing, viewing natural features, and bicycling being top draws (FIGURE 36). Downhill skiing is reported both by recreationists at developed ski resorts as well as by backcountry skiers/snowboarder in places like Teton Pass. Downhill skiing, snowmobiling, and cross-country skiing stand out as the activities visitors engage in at much higher rates than the national average. The primary activities reported by visitors are consistent with the values attributed to BTNF and reinforce the branding of the Forest as a unique wildland destination, especially in winter.

Visitor reports of satisfaction are generally high, since participants choose to visit voluntarily and many know what to expect, especially given the high percent of local and repeat visitors (TABLE 23). However, the satisfaction level for undeveloped areas (general forest areas) declined compared with previous monitoring cycles. The one consistent element across all categories generating lower satisfaction levels in 2018 was “road condition”.

Adaptive management considerations

Based upon the monitoring results, no change to the monitoring program is warranted. However, increasing visitation combined with changing demographics and economies, as well as evolving technology and visitor desires, is contributing to growing concern about visitor impact and social conflict in some areas of BTNF. Welcoming a growing population to connect with BTNF in a manner that addresses current inequities in inclusion for under-represented populations and sustains the attributes of the land and the experiences people value will be a key future challenge. Addressing this challenge will require new management actions and updated Forest Plan direction. Management decisions regarding visitor use within the Forest typically require recreation data that is valid at the project or site scale. However, generating this information will require substantially more investment in monitoring than the Forest currently has funding or capacity to perform.

Indicator RA-02-02: Visitor numbers at ski areas, other resorts, and outfitter-guide services

Summary of methodology

This indicator captures a subset of the total visitor use occurring on BTNF that is authorized under special use permits (SUP). Unlike NVUM visitor estimates, SUP data is based on actual use reported by the permittees, thus data accuracy is higher. Outfitter and guest resort data was queried from the Forest Service’s Special Use Database System (SUDS). Skier visits are tracked by each permittee (via lift ticket sales) and reported to BTNF each year.

Monitoring results

Table 24. Total skier visits at ski resorts, BTNF, 2013-2020.

Resort	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
JH Mountain Resort	563,631	546,125	560,400	558,390	634,500	715,100	578,147
Snow King Mtn. Resort	37,200	35,434	40,901	38,967	41,285	42,481	42,318
White Pine Ski Area	14,934	15,000	12,385	13,842	15,034	17,170	11,306

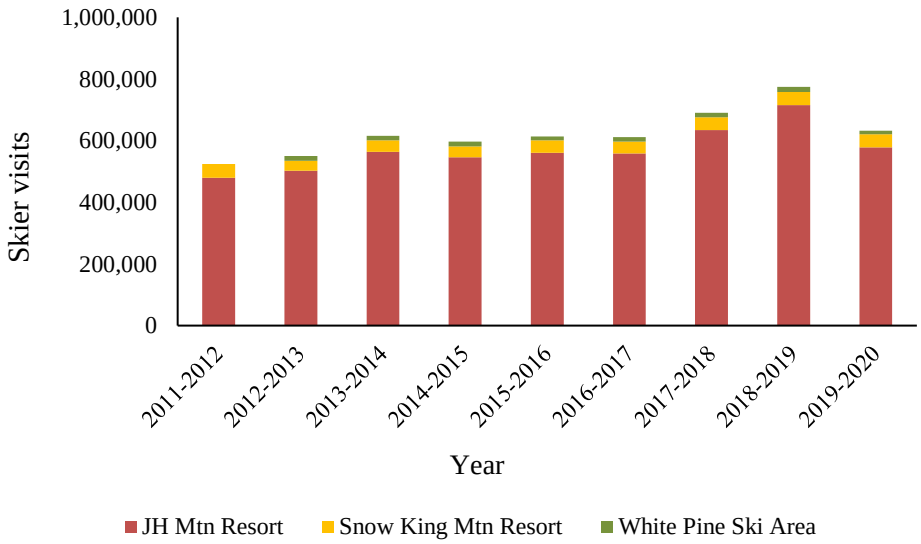

Figure 37. Total skier visits by ski resort, 2011-2020.

Table 25. Room nights at guest resorts, BTNF, 2012–2020.

Resort Name	2012	2018	2019	2020
Togwotee Lodge	18,859	14,698	14,388	11,461
Turpin Meadow Ranch	2,745	1,901	1,871	2,103
Heart 6 Ranch	No data	624	609	809
Big Sandy Lodge	563	790	247	234
Half Moon Lake Lodge	1,231	N/A (closed in 2018)	216	426
Lakeside Lodge	1,218	3,144	3,829	3,707
White Pine Cabins	No data	No data	145	307

Table 26. Number of service days (actual use) provided by outfitter-guides, 2013-2020.

Season	2013	2014	2015	2016	2017	2018	2019	2020
Summer/fall outfitted use (includes pack trips, hunting, hiking/backpacking, rafting, fishing, bicycling, OHV tours, wagon rides, youth camps, etc.)	178,403	176,206	171,536	187,836	184,953	178,617	184,213	132,348
Winter outfitted use (includes skiing, snowmobiling, snowshoeing, avalanche education)	10,337	11,341	11,829	12,568	22,643	24,462	24,381	19,210

Discussion and findings

Visitation at ski areas on BTNF increased 26% in the five years between 2013 and 2018 (TABLE 24). The decline in visitation in 2019-2020 was due to the pandemic which shuttered resorts in March. Industry data suggests that increased visitation is not necessarily due to an increase in new users, but rather to existing skiers/snowboarders visiting more frequently. The increase in visitation has been largely driven by Jackson Hole Mountain Resort, which had made major investments in marketing to national and international guests (FIGURE 37). In contrast, Snow King and White Pine ski areas cater more to local skiers/snowboarders and have shown an overall upward use trend but with more variability, likely associated with the length and quality of the winter season. To remain viable, ski

areas are diversifying their services to appeal to visitors during summer months. Current monitoring results does not capture the increased summer visitation ski areas are experiencing.

Guest ranch use has been highly variable on BTNF, likely due to changing ownership and downturns in the economy (TABLE 25). The exception is Togwotee Lodge, which has sustained consistent use, likely due to its location as a premier snowmobile destination.

The BTNF supports the largest outfitter-guide program in the Intermountain Region and one of the largest in the nation, however outfitting still accounts for only a small portion of the total visitor use on BTNF. Summer use has slowly increased since 2013 except during 2020 where the pandemic resulted in a downturn. The notable change is associated with the winter season where there was a 136% increase in use between 2013 and 2019 (TABLE 26). This is likely due to the increasing popularity and diversification of winter activities combined with relatively consistent quality snow on BTNF. Within the outfitting industry, one apparent trend is the acquisition of businesses by larger corporations who have the finances to invest more in the operation and can weather losses that may occur due to yearly fluctuations. The trend in both summer and winter outfitter use is likely to continue upward at a slow rate since actual use is less than the amount of use authorized and there continues to be demand for existing outfitted services and high interest in new services.

Adaptive management considerations

This indicator includes useful metrics and should be retained. Effort should be made towards also capturing summer use at ski/mountain resorts as they transition to offering year-round services.

With respect to outfitting demand, the Forest Service is implementing 'Special Use Modernization' to help remove barriers to outdoor services that require special use permits. BTNF has also strived to respond to changing public desires by offering some new services, issuing temporary use permits, and working with permittees to modify authorizations as businesses transfer to new operators.

Indicator RA-02-03: Estimated number of dipersed campsites

Summary of methodology

For campgrounds operated by BTNF, site occupancy data is collected by BTNF recreation staff and is recorded in the Forest Service's Point of Sale System (POSS). For sites operated by a concessionaire under special use permit, site occupancy is reported in annual use reports. Site occupancy is collected only in developed campgrounds and other developed sites where a fee is charged and there are facilities and services provided for visitors such as picnic tables, fire rings or grills, restrooms, water, on-site hosts, and garbage service. The estimated number of dispersed sites is determined by a combination of on-the-ground inventory/mapping data and review of google map imagery.

Monitoring results

Table 27. Occupancy at developed recreation sites, BTNF, 2015-2020.

	2015	2016	2017	2018	2019	2020
FS-operated campgrounds	Average occupancy for all campgrounds is estimated to currently be 47.5% (based on 2015 data) Occupancy is generally higher at campgrounds in the Pinedale area					
Concession operated campgrounds	50%	62%	73%	53%	59%	102%
Granite Hot Springs (number of visitors)	32,009	28,101	25,666	30,556	25,852	21,203

Table 28. Estimated number of dispersed campsites.

	2020 Estimate
North Zone (Jackson/Blackrock area)	140 Designated sites (e.g., Shadow Mtn., Curtis, Spread/Toppings, Pacific Creek, Buffalo Valley); Approximately 164 dispersed sites
South Zone (Pinedale, Greys, Big Piney, Kemmerer area)	Data not yet available

Discussion and findings

There has generally been an upward trend in camping on BTNF (TABLE 27). The year 2017 saw high occupancy levels due to the Great America Solar Eclipse which attracted many people to western Wyoming, however, this increase paled in comparison with 2020 which was often described as the "eclipse every day for months on end". Campground occupancy clearly reflects the increased use in 2020. Camping in dispersed sites (TABLE 28), where no services are offered, saw much of the increased use where limited data suggests increases of 100% to 160% between 2019 and 2020. The upward trend is unevenly distributed across BTNF, with the Jackson and Blackrock areas experiencing a more rapid increase in camping use, partly due to overflow from the adjacent National Parks. All areas in the Forest have experienced an increase in people seeking sites that accommodate larger RVs, sites that accommodate large groups, and year-round parking areas for self-contained vans/campers.

BTNF offers approximately 42 developed campgrounds and 652 recreation sites. Historically, visitors had plenty of opportunities to find available sites. For the most part, visitors still can find an available site without advanced reservations, however popular sites in the Pinedale area and sites north of Jackson near the National Parks now fill early in the day during the peak summer season.

Adaptive management considerations

The dataset to consistently report campground occupancy is not aggregated in one place and there is no standardized protocol for data collection or storage. This made data aggregation challenging and reduced confidence in data accuracy. BTNF is working to standardize its data collection protocols to improve this dataset for future monitoring periods. Given the importance of dispersed camping in the BTNF, it is important to begin collecting more accurate information to demonstrate changes over time. A dispersed camping inventory protocol has been drafted with the intent of inventorying all dispersed sites in a consistent manner.

In terms of addressing the increased use of campgrounds, BTNF generally considers potential expansion of developed site capacity when an entire campground's occupancy approaches 70%. In response to the upward trends in the Jackson and Blackrock area, expansion of certain campgrounds is being considered. BTNF is also preparing specific information to assist people with large RVs find accommodations. Additionally, more guard stations have been renovated to make them available for rental (e.g., Sherman, Green River Lakes Lodge).

Indicator RA-02-04: Acres providing various classes of recreation opportunity (ROS)

Summary of methodology

Recreation Opportunity Spectrum (ROS) is used to inventory, evaluate and develop plan direction for recreation settings and opportunities. National protocols have been developed to categorize and map areas within the National Forest System. This effort was completed on BTNF in 2006 and is the process of being updated. Data is queried from BTNF corporate GIS. There are six broad settings (TABLE 29).

Monitoring results

Table 29. Acres in each Recreation Opportunity Spectrum setting, BTNF, 2020.

ROS	Class Description	Acres
Primitive	Opportunity for isolation from man-made sights, sounds, and management controls in an unmodified natural environment. Only facilities essential for resource protection are available. A high degree of challenge and risk are present. Visitors use outdoor skills and have minimal contact with other users or groups. Motorized use is prohibited.	Wilderness: 1,137,335 Non-Wilderness: 279,242
Semi-primitive non-motorized	Some opportunity for isolation from man-made sights, sounds, and management controls in a predominantly unmodified environment. Opportunity to have a high degree of interaction with the natural environment, to have moderate challenge and risk and to use outdoor skills. Concentration of visitors is low, but evidence of users is often present. On-site managerial controls are subtle. Facilities are provided for resource protection and the safety of users. Motorized use is prohibited.	Wilderness: 158,819 Non-Wilderness: 1,147,083
Semi-primitive motorized	Some opportunity for isolation from man-made sights, sounds, and management controls in a predominantly unmodified environment. Opportunity to have a high degree of interaction with the natural environment, to have moderate challenge and risk and to use outdoor skills. Concentration of visitors is low, but evidence of other area users is present. On-site managerial controls are subtle. Facilities are provided for resource protection and the safety of users. Motorized use is permitted.	289,214
Roaded Natural	Mostly equal opportunities to affiliate with other groups or be isolated from sights and sounds of man. The landscape is generally natural with modifications moderately evident. Concentration of users is low to moderate, but facilities for group activities may be present. Challenge and risk opportunities are generally not important in this class. Opportunities for both motorized and non-motorized activities are present. Construction standards and facility design incorporate conventional motorized uses.	356,149
Rural	Area is characterized by a substantially modified natural environment. Opportunities to affiliate with others are prevalent. The convenience of recreation sites and opportunities are more important than a natural landscape or setting. Sights and sounds of man are readily evident, and the concentration of users is often moderate to high. Developed sites, roads, and trails are designed for moderate to high uses.	55,015
Urban	Area is characterized by a substantially urbanized environment, although the background may have natural-appealing elements. High levels of human activity and concentrated development, including recreation opportunities are prevalent. Developed sites, roads and other recreation opportunities are designed for high use.	6,001

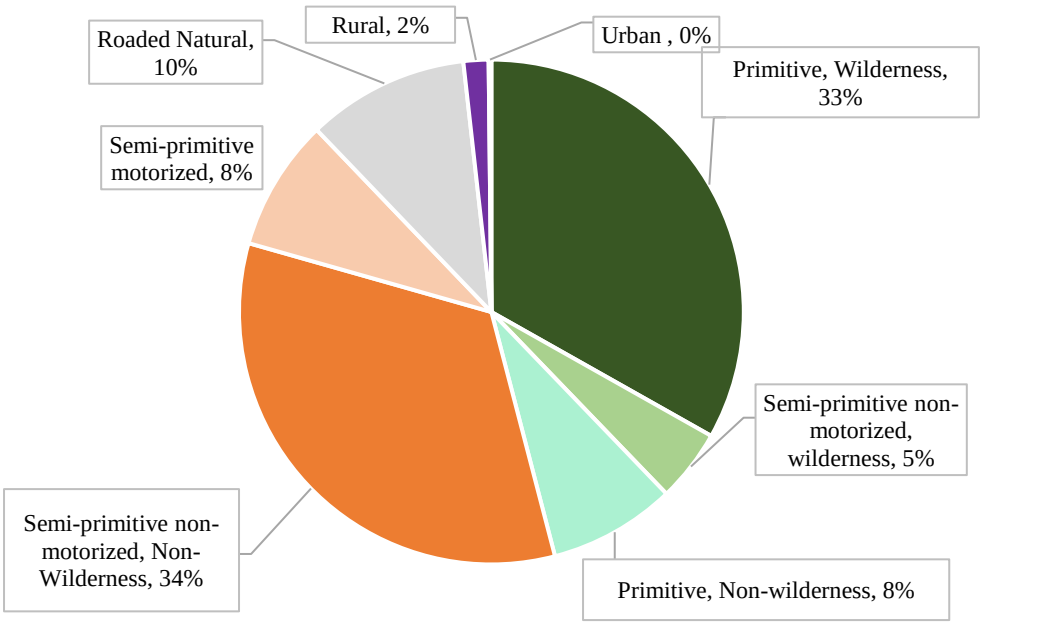

Figure 38. Percentage of BTNF acreage by Recreation Opportunities Spectrum setting, 2018.

Discussion and findings

BTNF is dominated by land that offers primitive or semi-primitive opportunities, including approximately 38% wilderness (TABLE 29, FIGURE 38). Rural and urban settings are present in localized areas (e.g., recreation residence tracts, ski resorts) and thus occupy relatively small acreage. Categorization of areas in the six different settings tends to be relatively stable over time.

With increasing human use and development, there is a tendency for areas to transition from a primitive or semi-primitive setting to a more developed setting (e.g., roaded–natural or rural). Development of roads and physical structures are examples of activities that quickly change the setting; however, more subtle activities, such as increased visitor use with subsequent increased managerial presence can result in a primitive setting becoming semi-primitive. Once human uses have become established, it is difficult to move the other direction. Moving an area to a more developed setting can sometimes expand the mix of desired recreation opportunities and help accommodate high use by providing the infrastructure that makes a site more resistant to impact.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan or management activities are warranted.

Question RA-03: Does the Forest road and trail system provide for motorized and non-motorized recreation opportunities in both summer and winter?

Indicator RA-03-01: Acres open to over-snow vehicle use

Summary of methodology

BNTF corporate GIS of over-snow vehicle use and miles of groomed over-snow trails was queried in 2018. The calculation reflects the acres open to over-snow vehicle use (including cross-country use) plus the acres associated with designated over-snow vehicle trails that exist within restricted areas.

Monitoring results

Currently, 1,839,514 acres are currently open to over-snow vehicle use, which amounts to 54% of BTNF (total acreage of BTNF is approximately 3,402,684 acres, based on 2011 Land Status Report). There has been no change since the last monitoring report.

Discussion and findings

The trend in areas open to over-snow vehicle use on BTNF has been relatively stable since 1990, while winter recreation use (both motorized and non-motorized) has exponentially increased. Areas are generally open to over-snow vehicle, except within Congressionally designated areas that prohibit such use (e.g., wilderness) and where management decisions have been made to restrict over-snow vehicle use to protect natural resources (e.g., wintering wildlife) or reduce conflict with non-motorized use or other land uses (e.g., ski resorts). Additionally, not all acres open to over-snow vehicle use are necessarily usable; some terrain is simply too steep (e.g., cliffs, rock outcrops) and some terrain may not have the snow-cover to be usable in a drought year.

A framework for managing over-snow vehicle use is found in the National Travel Management Rule (2015). The rule requires publication of an over-snow vehicle use map (OSVUM) based on local management decisions made in accordance with the National Environment Policy Act. The BTNF published an OSVUM for the Jackson and Blackrock Ranger Districts in 2016, reflecting past management decisions but it was withdrawn in December 2017 under legal challenge. The Jackson and Blackrock Ranger Districts currently manage winter over-snow vehicle use in accordance with the Teton Division Winter Travel Map with accompanying Forest special orders. Other districts have forest special orders that apply to specific closure areas but do not have an overall Winter Travel Map that displays areas open to over-snow vehicle use.

Adaptive management considerations

Eventually, every Ranger District on the BTNF will need to publish an OSVUM that complies with the requirements found in subpart c of the National Travel Management Rule. Updating the Forest Plan provides an opportunity to develop more direction on desired winter settings. This direction would help frame subsequent site-specific management decisions to provide winter recreation opportunities (considering the right use in the right location), protect wintering wildlife, and minimize conflict among different uses.

Indicator RA-03-02: Miles of groomed over-snow trails (motorized and non-motorized)

Summary of methodology

Eventually, data regarding snow trails would be queried from INFRA databases, however this information needs to be updated and is currently inaccurate. Instead, to calculate groomed trail mileage, BTNF winter travel routes were digitized and stored in BTNF corporate GIS.

Monitoring results

Total miles of groomed over-snow trails are 668 miles, with 630 miles of groomed motorized trail and 38 miles of groomed non-motorized trail.

Discussion and findings

BTNF offers one of the largest networks of winter trails in the Intermountain Region. The miles of groomed trails are higher than what was reported in 2019, however, this is the result of more accurate calculations. BTNF partners with Wyoming State Trails to groomed motorized trails throughout BTNF, including the popular Continental Divide Snowmobile Trail which spans multiple districts. State snowmobile permitting fees support trail grooming. Groomed snowmobile trails are increasingly used for both motorized and non-motorized recreation activities.

The amount of groomed non-motorized trail on BTNF has been increasing, due to support of partner organizations and special use permittees. Both White Pine Ski Resort and Turpin Meadows Ranch maintain groomed trails. JH Ski and Snowboard Club maintains a Nordic ski training facility at Trail Creek which is partially located on National Forest System lands. Teton County Parks and Recreation Department grooms many trails and pathways in Jackson Hole, including two trails on BTNF which are used primarily for non-motorized activities, but are open to snowmobile use. Friends of Pathways grooms about 7.5 miles of single-track trail in Cache Creek. BTNF grooms one ski trail on Salt River Pass. Non-motorized trails are generally groomed for Nordic skiing but are used for a variety of activities, including snow-showing, walking, running and fat biking.

Adaptive management considerations

BTNF currently offers an extensive network of groomed snow trails, thus there is no compelling need to greatly expand the network, especially given wildlife concerns. However, with increased winter recreation use, there is likely some opportunity for more resorts and guest ranches to offer a diversity of winter activities, including those dependent on groomed trails. Walking or running on packed trails and fat biking are fast-growing activities, suggesting a potential need for more single-track grooming. Future challenges center on sustaining the funding necessary to support grooming operations and managing the increasing diversity of different uses occurring on groomed trails so that conflict is minimized.

Indicator RA-03-03: Miles of non-snow (summer) trails maintained for motorized and non-motorized use

Description of methodology

Forest Service classifies trails as either *system* or *non-system*. System trails are defined as those trails necessary for the protection, administration and use of National Forest System land. They are included in BTNF's transportation system, eligible to receive maintenance funds and often have some level of design and construction effort. In contrast, non-system trails are typically trails created by human use

or animals and not considered part of the BTNF transportation system. This indicator only includes system trails. Mileage is queried from INFRA trails database, which was updated on BTNF as part of a national focus on updating trail data quality. INFRA is a part of the Forest Service's NRM corporate databases.

Monitoring results

There are 2,807 total miles of summer trails on BTNF, of which 2,545 are non-motorized and 262 miles are motorized.

Discussion and findings

BTNF provides one of the largest summer trail networks within the Intermountain Region. Compared to the national average (62%), the portion of non-motorized trails on BTNF is high (91%). This is a result of the relatively high portion of BTNF that are wilderness and roadless backcountry areas where roads cannot be constructed and access is primarily via non-motorized trails. Furthermore, motorized trails must be designated through a travel management process. Total miles of trail have been increasing on BTNF for several reasons: 1) more accurate GPS inventories; 2) planning efforts have added existing non-system trails to the system or converted roads to motorized trails to address changing public desires and resource issues and 3) projects have added trails for summer operations at resorts.

Adaptive management considerations

In general, BTNF is meeting the Forest Plan objective to provide trail-based recreation. The interest in trail-based recreation is growing, but also evolving. As a result, some trails could be removed from the system in favor of other trails with higher public interest. Strategic trail assessments could be used to help inform decisions about the future trail system to ensure its economic, environmental, and social sustainability. Specific to motorized trails, area-specific travel management planning is needed where decisions pre-date the 2005 National Travel Management Rule to reflect changes in motor vehicle technology and the growing interest in trail-like experiences.

Indicator RA-03-04: Miles of trail maintained to standard

Summary of methodology

Trail miles maintained to standard includes all system trails (see RA-03-03) that meet quality standards and have been maintained in accordance with a specific maintenance cycle associated with each trail's management objective (TMO). Trails are classified from Class 1-5 by how developed they are. Class 1 trails are minimally developed, such as those with natural fords instead of bridges in wilderness areas, and are designed to provide a challenging recreation opportunity, usually in a natural and unmodified setting. Conversely, Class 5 trails, such as those found at visitor centers or high-use recreation sites, are fully developed, have gentle grades, and are often paved. To meet standard a trail needs to have been maintained per its maintenance cycle (e.g., annually, every 3 years, every 5 years) and meet the standards associated with the trail's management objective. Percentage of trail system maintained to standard is reported annually in INFRA Trails database and is partially informed by Trail Assessment and Condition Surveys (TRACS) completed for a subset of trails. INFRA is a part of the Forest Service's NRM corporate databases.

Monitoring results

A query of INFRA data for 2020 showed that an estimated 7.7% of BTNF system trails are maintained to standard.

Discussion and findings

BTNF is challenged to sustainably maintain and manage an extremely large and growing network of summer trails. Nationally, only 25% of the Forest Service trail system is maintained to standard with an estimated trail maintenance backlog of $314 million in fiscal year 2012 (Government Accountability Office 2013). The percent of system trails maintained to standard dropped significantly compared to the previous monitoring report. However, this appears to be largely related to lack of data entry and not a substantive decline in trail condition. That said, the percent of the BTNF trail system maintained to standard is likely less than the national average of 25%. This is due to a relatively large trail system compounded by chronic funding shortages for maintenance activities and lack of staff capacity. Partners and volunteers play a significant role is assisting BTNF with trail maintenance funding and implementation, but this still require agency support to ensure quality work and perform some tasks that cannot feasibly be implemented by partners. A major wind event in September 2020 obliterated many miles of trail and added another obstacle to maintaining trails to standard. Clearing all of the downfall will likely require work throughout the 2021 summer season.

Adaptive management considerations

In 2017, the Forest Service released the National Strategy for a Sustainable Trail System (http://www.fs.fed.us/recreation/programs/trail-management/strategy/index.shtml) and efforts are underway to implement this strategy. In addition, recent legislation (i.e., National Trails Stewardship Act PL 114-245, 2016) aims to increase volunteer and partner involvement in trail maintenance. BTNF has recently hired more field trails staff using funds generated under the Federal Land Recreation Enhancement Act. Improving the percent of the trail system maintained to standard will require implementation of the National Trails Strategy, completing strategic trail assessments to ensure limited funding is being put in the right places, investing in staff capacity and skill development, staff training around INFRA data, and cultivating more long-term partnerships to reduce maintenance backlogs.

Indicator RA-03-05: Miles of road maintained to standard

Summary of methodology

Miles of road maintained is obtained from documented work performed by the road crew. As such, accurate numbers are dependent on road crew foreman work records and not information stored in INFRA databases.

Monitoring results

In 2020, the BTNF road crew maintained 247 miles of road to standard, which is approximately 16% of the total open road system available for public use per the Motor Vehicle Use Maps.

Discussion and findings

The Bridger-Teton National Forest offers 1,540 miles of open road to facilitate public access to the Forest. The road crew reported 247 miles of road graded with 47 culverts maintained, seven culverts replaced, and seven cattle guards maintained. New road base was added on three roads and major washouts or slumps were repaired on five roads. Priority grading and repair projects are identified by the individual districts with emphasis given to maintaining some key roads on every district and addressing major safety hazards, especially where forest roads provide access to inholdings.

Adaptive management considerations

With limited funds and one road crew, the Forest works closely with Sublette and Lincoln Counties through cooperative agreements to maintain additional road miles and is striving to expand partnerships with other counties and entities. Passage of the Great American Outdoor Act provides a

new funding mechanism to address the significant deferred maintenance backlog associated with roads but implementation is dependent on the ability to execute agreements, particularly with Counties.

Question WSR-01: Are the free-flowing conditions, water quality, and Outstandingly Remarkable Values for Wild and Scenic Rivers maintained and protected?

The Wild and Scenic Rivers Act requires that managers protect and enhance a Wild and Science River's (WSR) free-flowing condition, water quality, and outstandingly remarkable values. BTNF published a Comprehensive River Management Plan (CRMP) in 2014 to provide direction for managing and monitoring designated WSR segments (USDA Forest Service 2014). Three indicators are presented here to provide a coarse-scale assessment of free-flow, water-quality, and outstandingly remarkable values. Additional finer-scale monitoring is identified as part of the CRMP to provide a more complete picture of trends in conditions for outstandingly remarkable values.

Indicator WSR-01-01: Watercraft use in Wild and Scenic Rivers

Summary of methodology

All the Snake River Headwaters WSRs have an outstandingly remarkable value related to recreation. Watercraft use is used as an indicator to assess trends in this value. As outlined in the 2014 CRMP, monitoring should be conducted by counting total number of watercraft observed passing by a selected location per standardized unit of time (typically an 8-hour day) within the Wild and Scenic River (WSR) corridor during the primary use season (USDA Forest Service 2014). For WSR rivers located in designated Wilderness or Wilderness Study Areas, watercraft use should be recorded as presence or absence on each monitoring day. The best available data is from the Snake River WSR, particularly the canyon stretch. The data presented here is compiled from whitewater outfitting reports along with boat check-in at the West Table boat ramp. These numbers do not present a complete picture of total use but do suggest trends over the years.

Monitoring results

Table 30. Number of outfitted rafts and people 2010-2020, Snake River.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
People	75,526	70,231	81,358	85,503	81,542	87,672	92,986	87,102	93,624	84,735	56,730
Rafts	8,149	7,438	9,444	10,154	9,778	10,493	10,853	9,486	9,969	9,167	6,611

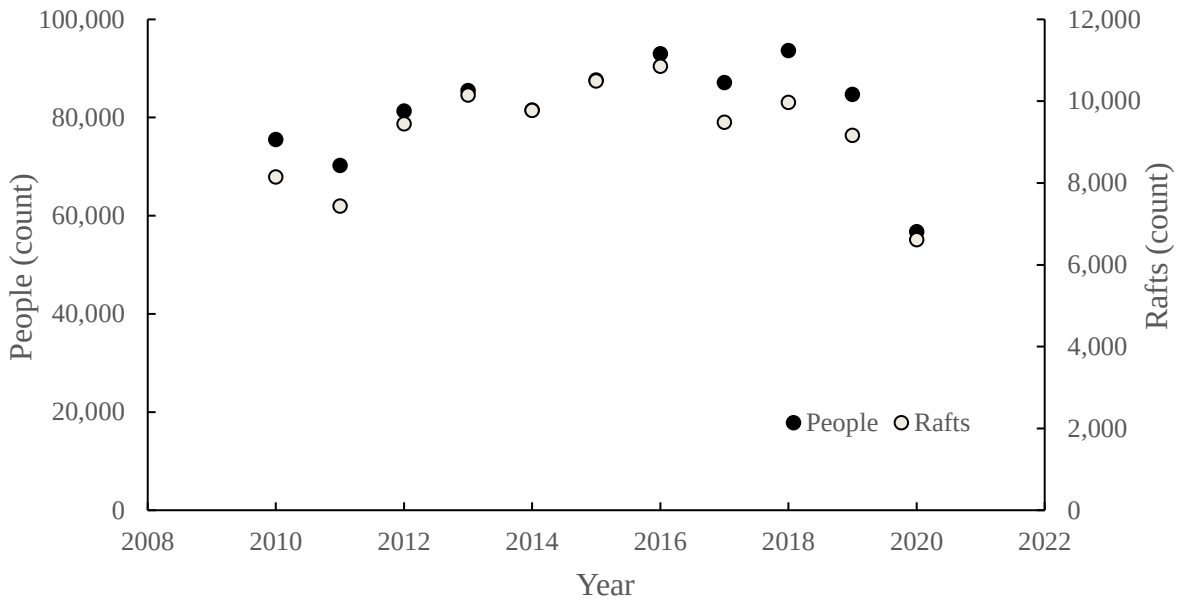

Figure 39. Trend in outfitted rafts and people per year on the Snake River, 2010–2020.

Table 31. Total boats per season and people checked-in at West Table boat ramp, 2012–2020.

	2012	2013	2014	2015	2016	2017	2018	2019	2020
People	21,475	25,514	24,093	18,453	23,077	15,762	17,762	18,200	18,585
Boats	3,401	4,278	3,852	3,159	4,399	3,185	3,462	3,552	4,025

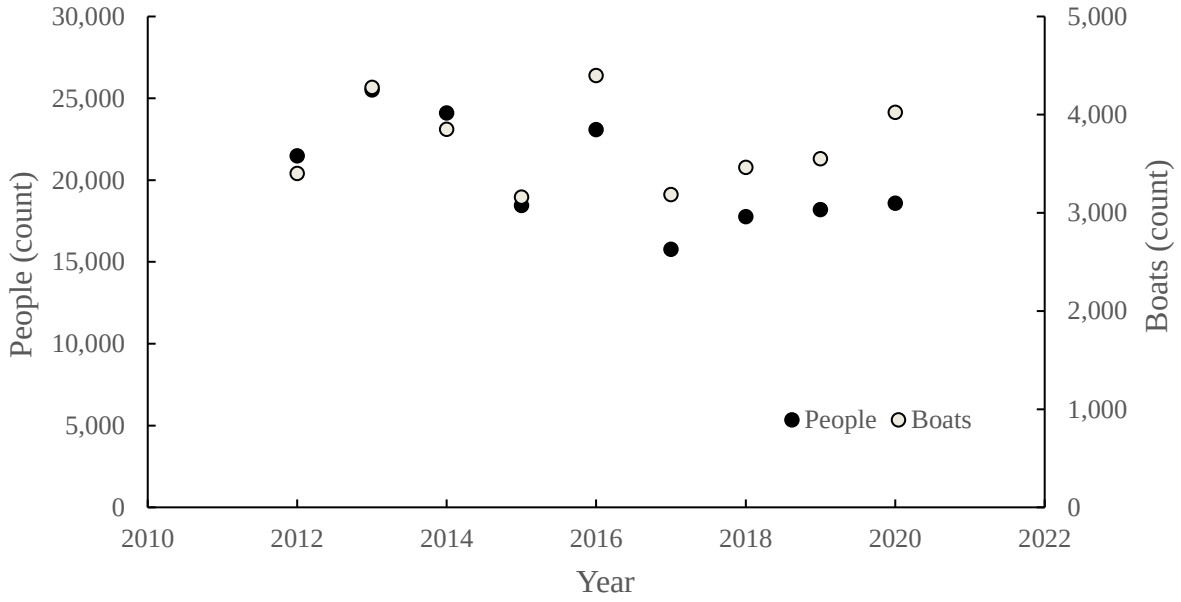

Figure 40. Trend in total boats and people per year at West Table boat ramp, 2012–2020.

Discussion and findings

On the Snake River, BTNF established boat capacities to address commercial whitewater, float fishing, and instructional river use and a permit system is in place to manage guided organizational river use and groups over 15 people. This has stabilized the rapid growth in whitewater river use that occurred in the mid-1990's (TABLE 30 and FIGURE 39). Whitewater rafting use on the Snake River is currently managed within established capacity, but float fishing use is increasing. As a result, boat capacity trigger points are sometimes exceeded, necessitating a reduction in the number of boats allowed per day the following year.

The most reliable information about non-commercial boat use on the Snake River comes from the data collected at West Table boat ramp which is where most river trips in the canyon originate. As TABLE 31 and FIGURE 40 illustrate, there is variability over the years likely associated with weather patterns – e.g., some years high water levels or cooler, wet summers reduce non-commercial use. Use records in 2020 present an interesting story. Outfitted use was down 33% due to the need to comply with public health measures during the coronavirus pandemic. However, non-commercial use increased 2% compared with 2019 and the number of boats checked-in increased 13% as people flocked to outdoor spaces that provided safe distancing during the pandemic.

Data on watercraft use for other WSRs is not consistently recorded so no findings or trends can be reported. Wilderness WSR monitoring has not produced any observations of boating activity on segments of wild rivers. Pack rafting certainly occurs on some wild rivers but the current use is so low and variable, it has not been directly observed.

Adaptive management considerations

Recreation use is highly variable requiring numerous consistently gathered data points to draw conclusions. BTNF currently lacks sufficient staff capacity to adequately monitor watercraft use on all designated rivers in the Upper Snake River headwaters. Camera technology is being tested to improve the efficiency of data collection and has potential to improve the accuracy and reliability of monitoring. Despite the obstacles, monitoring watercraft use offers the best indicator to assess whether visitor use is being managed within estimated capacities.

Indicator WSR-01-02: Miles of WSR with degraded water quality

Summary of methodology

Data on water quality is currently obtained from Wyoming's Integrated 305 (b) and 303 (d) Report, which is produced biennially by the Wyoming Department of Environmental Quality Water Quality Division and provides a summary of water quality conditions in the State of Wyoming. This report is required of each state per the Clean Water Act and is reviewed by the Environmental Protection Agency (EPA). Reports are available online at (http://deq.wyoming.gov/WQD/water-quality-assessment/).

Monitoring results

The 2020 Integrated Report does not list any WSR on the BTNF as having degraded water quality. This assessment is based on current and historic readily available data that is subject to credible data standards established by the WDEQ.

Discussion and findings

The Integrated 305(b) and 303(d) report reports provide coarse level information. Ideally, more localized water quality sampling would be done for WSRs. A citizen science effort is currently underway to collect water quality samples on the WSRs. There are also some research projects

underway to assess water quality as part of a clean water initiative in Teton County, Wyoming stemming largely from on-going water quality concerns in lower Flat Creek and Fish Creek, which are tributaries to WSRs. These efforts are not intended to support on-going monitoring but will provide a more detailed snapshot of water quality for the WSRs. Results from these efforts are not yet available.

Adaptive management considerations

None recommended.

Indicator WSR-01-03: Number of federal water projects authorized

Summary of methodology

Section 7(a) is a key provision of the Wild and Scenic Rivers Act that directs federal agencies to protect the free-flowing condition, water quality and outstandingly remarkable values of designated wild and scenic rivers. It requires evaluation of any federally assisted water resources projects. A water resources project is defined as any dam, water conduit, reservoir, powerhouse, transmission line, or other project works under the Federal Power Act, or other construction of developments which would affect the free-flowing characteristics of a wild and scenic or congressionally authorized study river (36 CFR 297). Water resources projects also include water diversion projects; fisheries habitat and watershed restoration/enhancement projects; bridges and other roadway construction/ reconstruction projects; bank stabilization projects; channelization projects; levee construction; recreation facilities such as boat ramps and fishing piers; and activities that require a 404 permit from the U.S. Army Corps of Engineers. Section 7 documentation and finding are reviewed and approved, denied, or modified by the Regional Forester. The BTNF has established a small team to evaluate Section 7 proposals. The data presented here was generated by reviewing documentation stored in Forest Service files for submitted proposals.

Monitoring results

Table 32. Water resource projects evaluated under Section 7(a) of the WSR, BTNF 2010-2020.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gros Ventre River	1					1	1	2	1	1	1
Hoback River				1			1	1			1
Blackrock Creek											
Buffalo Fork River						1					
Snake River		1					3				1
Crystal Creek				1				1			
Pacific Creek								1			
TOTAL	**1**	**1**	**0**	**2**	**0**	**2**	**5**	**5**	**1**	**1**	**3**

Discussion and findings

Most of the water resource projects requiring a Section 7(a) determination are associated with proposed bank stabilization projects located on private lands within Wild and Scenic River corridors. Others are associated with highway projects. Out of the 21 projects evaluated to date (TABLE 32), three were generated by the Forest Service for road bridge or boat ramp projects while the rest were generated by private landowners or WYDOT. No significant trends are apparent; the higher number of projects within the Gros Ventre Corridor reflects the larger private inholdings in that corridor. There are currently two active Section 7 reviews that will not be finalized until sometime in 2021.

Adaptive management considerations

None recommended.

Question WLDN-01: Do management activities in designated wilderness preserve wilderness character?

The 1964 Wilderness Act requires that managers preserve wilderness character. For the purposes of monitoring, wilderness character is defined as a holistic concept based on the interaction of the following: 1) biophysical environments primarily free from modern human manipulation and impact; 2) personal experiences in natural environments relatively free from the encumbrances and signs of modern society; and 3) symbolic meanings of humility, restraint, and interdependence that inspire human connection with nature.

All four federal land agencies with wilderness stewardship responsibilities have worked together to develop a national interagency monitoring framework and technical guides for wilderness character monitoring (Landres and others 2015). Wilderness stewardship performance has been reported annually since 2005 for each Wilderness while baseline assessments of wilderness character were completed for each Wilderness in 2019. Wilderness stewardship performance scores monitor progress on performance elements that reflect major work items for each Wilderness, while Wilderness character monitoring reflects outcomes on the ground, some of which are beyond a manager's control (e.g., air pollution). Together, these two coarse level indicators can be used to assess trends in the state of each Wilderness relative to requirements in the Wilderness Act.

Indicator WLDN-01-01: Trend in wilderness character

Summary of methodology

This indicator monitors trend in Wilderness character based on a minimum of 15 measures selected for each Wilderness. Some measures are required for every Wilderness administered by the Forest Service while others are selected based on what is most relevant to the individual Wilderness. The measures assess trends in the five qualities of wilderness character: untrammeled, natural, undeveloped, opportunities for solitude, and other features of value. Protocols for each measure are described in the Wilderness Character Monitoring Guide (Landres et.al. 2021). Data for each measure is stored in the interagency wilderness character monitoring database (https://wc.wilderness.net/) with data for some annually reported measures stored in the Forest Service Infra database. Trends are assessed every five years.

The following measures shown in TABLE 33 have been selected to assess trends in wilderness character for each Wilderness on the BTNF.

Table 33. Measures selected to monitor trends in wilderness character for Bridger, Teton and Gros Ventre Wilderness.

	Indicator	Bridger Wilderness	Teton Wilderness	Gros Ventre Wilderness
Untrammeled Quality	Actions *authorized* by the Federal land manager that intentionally manipulate the biophysical environment	Number of authorized actions and persistent structures designed to manipulate plants, animals, pathogens, soil, water, or fire		
	Actions *not authorized* by the Federal land manager that intentionally manipulate the biophysical environment	Number of unauthorized actions and persistent structures by agencies, organizations, or individuals that manipulate plants, animals, pathogens, soil, water, or fire		
Natural Quality	Plants	Acres of nonindigenous plant species		
	Animals	Index of nonindigenous aquatic animal species		
	Air and Water	Extent of waterbodies with impaired water quality		
		Deposition of nitrogen		
		Amount of haze		
	Ecological Processes	Number of animal unit months of commercial livestock use	Watershed condition class	Number of animal unit months of commercial livestock use
Undeveloped Quality	Presence of non-recreational structures, installations, and development	Index of authorized non-recreational physical development		
	Presence of inholdings	Acres of inholdings		
	Use of motor vehicles, motorized equipment, or mechanical transport	Index of administrative authorizations to use motor vehicles, motorized equipment or mechanical transport		
		(not selected for Bridger Wilderness)	%of emergency incidents using motor vehicles, motorized equipment, or mechanical transport	
Opportunities for solitude or a primitive and unconfined type of recreation	Remoteness from sights and sounds of human activity *inside* wilderness	Trend in visitation		
		Index of recreation sites within primary use areas	Acres of wilderness away from travel routes, developments inside wilderness	Index of recreation sites within primary use areas
	Remoteness from sights and sounds of human activity *outside* the wilderness	Acres of wilderness away from adjacent travel routes and developments outside the wilderness		
	Facilities that decrease self-reliant recreation	Index of NFS developed trails	Number of authorized constructed recreation facilities	
	Management restrictions on visitor behavior	Index of visitor management restrictions		
Other features of value Quality	Deterioration or loss of integral cultural features	Required if relevant. Measures related to this quality were not selected for the Bridger, Teton, and Gros Ventre Wildernesses. The fact that measures were not selected for this quality does not diminish the importance of these landscapes to native peoples or their historical relevance. Monitoring cultural resources still occurs outside of the WCM effort.		
	Deterioration or loss of other integral features of value			

Monitoring results

Clear trends in wilderness character cannot be established since 2019 represents the baseline assessment. The first trend report will be available in 2024. However, since many attributes of wilderness character have been monitored for years, some preliminary observations on trends can be made where legacy data exists.

Bridger Wilderness – the data suggests some improvement in the natural quality (less permitted livestock use). However, there has been a steady decline in undeveloped quality (due to increasing emergency authorizations for motorized use due to SAR incidents), a declining trend in the natural quality (decline in air quality due to haze) and decline in opportunities for solitude (due to increasing visitation and increasing number of campsites).

Teton Wilderness – the preliminary data suggests some improvement in the untrammeled quality (less authorized actions). However, there is a declining trend in aspects of the natural quality (slight decline in air quality due to haze), a slight decline in the undeveloped quality (due to increasing emergency authorizations for motorized use due to SAR incidents) and a slight decline in the opportunities for solitude (due to increasing visitation).

Gros Ventre Wilderness – the preliminary data suggests some improvement in the untrammeled quality (less authorized actions), improvement in the natural quality (due to less fish stocking and less permitted livestock grazing) and some improvement in the opportunities for solitude (due to declining number of recreation sites). However, there is a declining trend in aspects of the natural quality (slight decline in air quality due to haze) and a decline in the opportunities for solitude or primitive and unconfined recreation (due to slight increase in visitation and increase in recreation facilities associated with food storage structures) since the time of designation.

Discussion and findings

In the absence of more definitive data, the preliminary data suggests that wilderness character is generally being maintained in all three Wildernesses. In some respects, wilderness character has improved on the BTNF. However, clear opportunities exist to make further improvements, such as removing obsolete structures and helping visitors be better prepared so that the need for search and rescue is reduced. Other aspects will be more challenging to address, notably around increasing visitation, declining air quality, and the increasing number of proposals to address wildlife, fisheries, or aging infrastructure that involve some type of motorized use or trammeling action.

Adaptive management considerations

Existing Wilderness management plans date from the mid-1990s and need to be updated. This is particularly true for the Bridger Wilderness where changes in visitor use trends and associated impacts have resulted in concern over trailhead parking congestion, campsite impacts, human waste, and loss of solitude. This concern is particularly acute in the corridor from Elkhart Park Trailhead north to Titcomb Basin and in the corridor from the Big Sandy Trailhead north to Jackass Pass, which serves as the primary access to the Cirque of the Towers within the Popo Agie Wilderness, Shoshone National Forest.

Indicator WLDN-01-02: Wilderness stewardship performance score

Summary of methodology

This indicator monitors trend in Wilderness Stewardship Performance based on 10 elements. From 2005 to 2014, all Wilderness were scored on the same elements as part of the 10-Year Wilderness

Stewardship Challenge leading up to the 50th anniversary of the Wilderness Act. Starting in 2015, the scoring system was modified with some elements required for every Wilderness administered by the Forest Service while others selected based on what is most relevant to the individual Wilderness. The elements track performance on aspects of the full interdisciplinary wilderness management task. Every element is scored on a 10-point scale based on the level of accomplishment. Protocols for scoring each of the 10 elements are described in the regularly updated Wilderness Stewardship Performance Guidebook (USDA Forest Service 2020). Data for the 10 elements of wilderness stewardship performance are stored in the Forest Service Infra database for Wilderness and are reported annually.

The following elements shown in TABLE 34 have been selected to track stewardship performance for each Wilderness on the BTNF.

Table 34. Wilderness Stewardship Performance elements for the Bridger, Teton, and Gros Ventre Wildernesses.

	Bridger Wilderness	Teton Wilderness	Gros Ventre Wilderness
Invasive Species		X	X
Air Quality Values	X		
Natural Role of Fire	X	X	X
Fish and Wildlife		X	
Recreation Sites	X		X
Trails	X	X	X
Agency Management Actions	X	X	X
Opportunities for Solitude	X	X	X
Outfitters and Guides	X	X	X
Workforce Capacity	X	X	X
Education	X	X	X
Wilderness Character Baseline	X	X	X
Reporting requirements	Bonus points for (1) completing a certified boundary and map of record and (2) submitting the performance report by due date		

Monitoring results

The Wilderness Stewardship Performance scores for each Wilderness are shown in TABLE 35. The reported scores are out of a total of 104 possible points. A score of 60 or greater constitutes a "wilderness administered to standard".

Table 35. Wilderness Stewardship performance scores 2015-2020, BTNF.

	2015	2016	2017	2018	2019	2020
Bridger Wilderness	58	44	50	58	74	48
Teton Wilderness	32	50	54	60	62	60
Gros Ventre Wilderness	62	62	60	60	62	62

Discussion and findings

The Intermountain Region includes 48 separate Wildernesses. With an average score of 36.9 in the Region, Wildernesses on the Bridger-Teton National Forest have typically scored higher than average. That said, there are some inconsistencies in how the scoring has been interpreted over time on the Forest and within the Region. The Forest is working to resolve this issue. Additionally, there is always room for improvement to meet the scoring requirements. Stewardship grants have been awarded to make progress on invasive species management in the Teton and Gros Ventre Wildernesses and on the Wilderness Character element for all three Wildernesses. These efforts are partly responsible for the improved scores along with sustained effort by wilderness rangers, fire staff, outfitter-guide permit administrators, and air quality technicians to keep up with performance tasks.

Adaptive management considerations

Baseline results from wilderness character monitoring has highlighted concern over increased visitation, trammeling actions, emergency authorizations for SAR incidents, and invasive species. With these concerns, more attention needs to be placed on implementing the national minimum protocol for monitoring opportunities for solitude across all three Wildernesses. Attention also needs to be placed on completing tasks related to “agency management actions” and reinvigorating the education program. However, available funding and workforce capacity to accomplish these actions are limited, and not anticipated to change in the near future.

Question EVS-01: What stressors are impacting the plan area?

Indicator EVS-01-01: Extent of insect and disease infestation

Summary of methodology

Insect and Disease (IDS) dataset is a compilation of forest insect, disease, and abiotic damage mapped by aerial detection surveys on forested areas in the United States. The State and Private Forestry division of the USDA Forest Service publishes insect and disease survey maps; BTNF Aerial Detection Survey Maps can be found at: https://www.fs.usda.gov/detailfull/r4/forest-grasslandhealth/?cid=fseprd571329&width=full

Monitoring Results

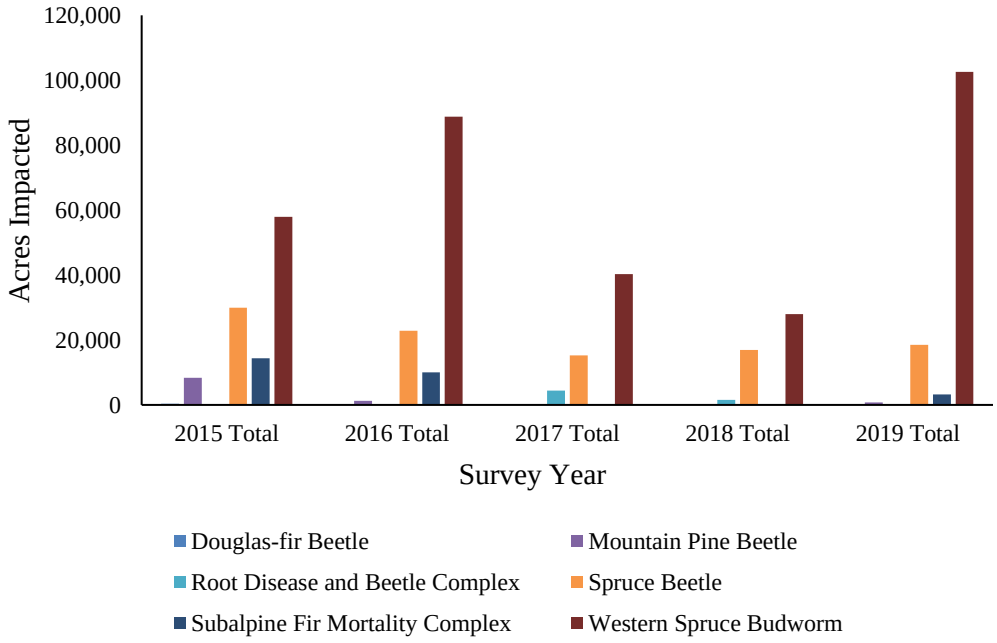

Figure 41. Acres impacted by insect infestation and disease, 2015-2019.

The following three biotic stressors represent the largest level of infestation and resulting mortality on BTNF: mountain pine beetle (MPB), spruce beetle, and western spruce budworm (FIGURE 41).

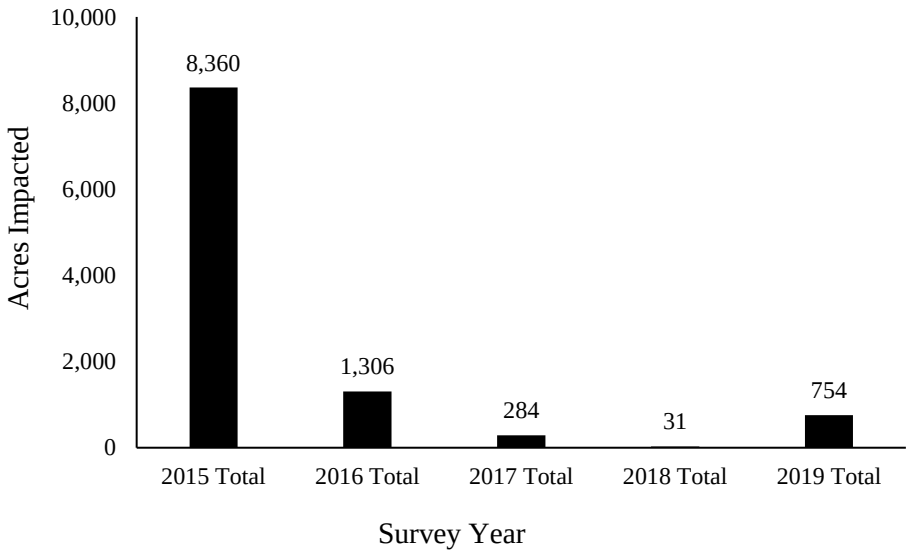

Figure 42. Acres infested by mountain pine beetle, 2015-2019.

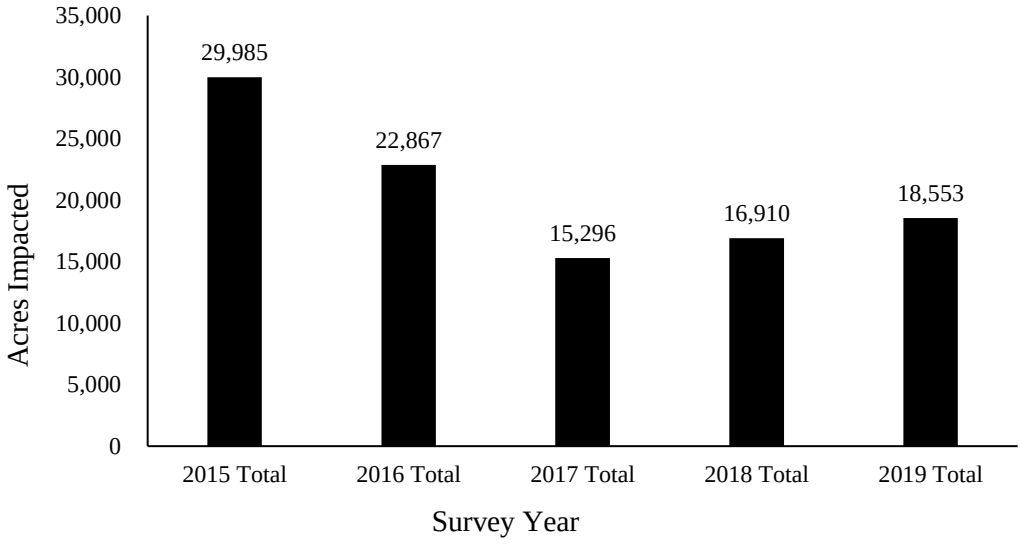

Figure 43. Acres infested by spruce beetle, 2015-2019.

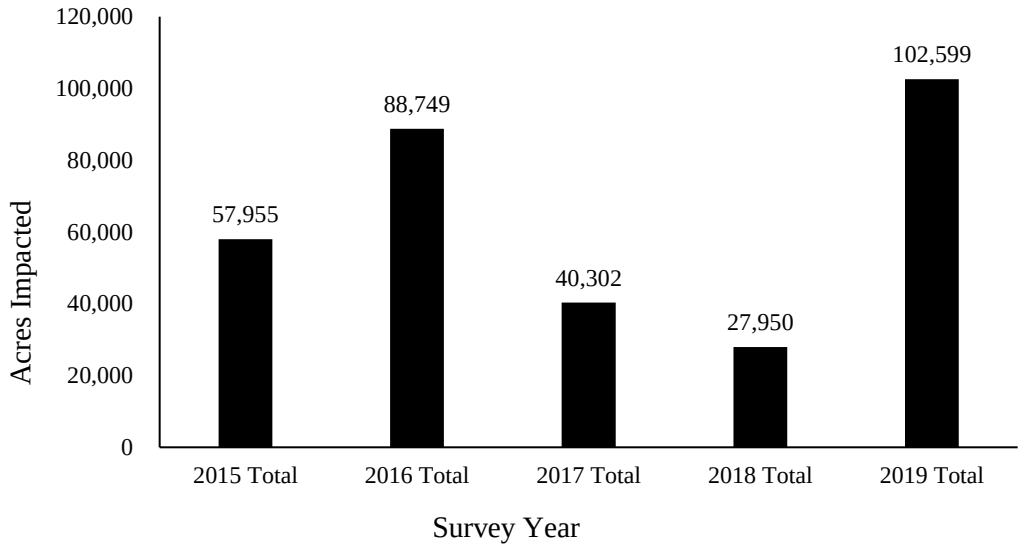

Figure 44. Acres infested by western spruce budworm, 2015-2019.

Discussion and findings

Mountain pine beetle, spruce beetle, and western spruce budworm

Continuing a declining trend observed in the 2018 monitoring report, acres infested by mountain pine beetle have dropped sharply to a baseline level of less than 1,000 acres impacted per year from 2017 to 2019 (FIGURE 42). On the BTNF, MBP infestations peaked in 2009–2010 and this latest monitoring data supports the likelihood that the current epidemic cycle for this stressor has likely ended in Wyoming. However, the resultant tree mortality to lodgepole pine stands was extensive.

Unlike the MBP epidemic, which peaked in 2009, spruce beetle infestations declined by sixty percent from 2014 to 2017, followed by an increase of approximately ten percent in both 2018 and 2019 (FIGURE 43). More than 100,000 acres of spruce and mixed conifer stands on the BTNF were impacted by spruce beetle infestations in years around the most recent peak in 2014, resulting in extensive infestations in higher elevation, Engelmann spruce stands. Overall, for western Wyoming, over 730,000 acres have been affected by spruce beetle since 1996, leaving large densities of standing dead spruce trees in higher elevations.

Western spruce budworm infestations on the BTNF have fluctuated in recent years with a peak of more than 100,000 acres impacted in 2019 (FIGURE 44). This stressor has had large impacts in western Wyoming forests with increasing health challenges to the spruce-fir, Douglas fir, and mixed conifer stands on the BTNF. Larval feeding can decrease growth, kill the tops of trees, or kill trees outright if heavy defoliation occurs across multiple years. Defoliation of large areas can degrade the scenic character of forested areas.

These recent epidemics have left large swaths of tree mortality which presents significant management challenges, namely increased hazardous fuel loads and degrading wood fiber that rapidly decreases in commercial value.

Additional stressors

Although not presenting a significant acreage impact on BTNF, two additional stressors continue to have substantial ecological and forest management impacts: white pine blister rust (WPBR) and dwarf Mistletoes. WPBR detections are increasing in western Wyoming. Western Wyoming is notorious for periodic episodes of high white pine blister rust occurrence. Whitebark pine (WBP) stands do not make up a large portion of BTNF forests; however, WBP are an important component of high elevation forests and are important to many wildlife species.

As for dwarf mistletoe, it consists of several species of native parasitic plants locally common in BTNF lodgepole pine and Douglas fir stands. The pathogens can slow growth, deform, and eventually kill trees. They are persistent and spread slowly within and adjacent to trees by exploding berries that shoot sticky seeds. Impacts can be severe on young trees growing adjacent to infected trees. Although not easily detected through aerial survey, field reports from BTNF timber staff suggest that many of the younger, overstocked, lodgepole pine stands on BTNF are currently infested with dwarf mistletoe.

Addressing stressors through management activities

Current management activities are working to restore forested stands to a healthy, and functioning conditions. BTNF conducts salvage sale operations to remove dead and dying timber. This limits the loss of commercial timber value, reduces fuel loads that could influence severity of wildfire and reduces stand densities that help to limit the spread of insect and disease infestations. A variety of silvicultural treatments are being implemented on the BTNF to reduce fuel continuity, restore stands to a healthy cohort of trees, and increase landscape diversity that, in turn, will help reduce future spread of insect and disease infestations. Lastly, forest health projects employing insecticide and pheromone repellent treatments along with thinning and pruning have recently been implemented in targeted areas such as developed recreation sites and highly valued whitebark pine stands.

Adaptive Management Considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator EVS-01-02: Amount of snowpack and spring runoff

Summary of methodology

Snowpack data were from SNOTEL stations, which are managed by the Natural Resource Conservation Service (NRCS) and are publicly available at https://www.wcc.nrcs.usda.gov/basin.html. Snow water equivalent (SWE) is the quantity of water contained within the snowpack. Percent of median SWE is the percent of the value lying at midpoint in a frequency distribution of measured SE values. Medians are based on values from 1981 through 2010. Steam discharge data were obtained from the United States Geological Survey (USGS) stream gauges and are publicly available at https://waterdata.usgs.gov/wy/nwis/rt. Provisional data were used for a portion of mean stream discharge calculations. Data are presented in water years, which begins October 1st and ends September 30th.

New science or information:

The Intermountain Region published a Climate Change Vulnerability Assessment in 2018 that discusses the most recent information on climate change science and how it is being adapted into management of National Forest System Lands (Halofsky et al. 2018).

Monitoring results

TABLE 36–TABLE 37 and FIGURE 45–FIGURE 46 display snowpack and streamflow data from SNOTEL stations within or overlapping the BTNF.

Table 36. Percent of median snow water equivalent, 2019-2020.

Basin	Water	Dec 1	Jan 1	Feb 1	Mar 1	Apr 1	May 1
Pacific Creek	2019	102	99	88	123	117	123
	2020	80	94	105	103	120	119
Buffalo Fork	2019	90	89	91	128	111	113
	2020	109	93	103	124	119	108
Gros Ventre	2019	90	77	79	113	98	98
	2020	110	85	94	111	109	118
Hoback	2019	112	85	81	118	115	101
	2020	96	86	103	104	113	128
Greys River	2019	113	90	86	109	103	115
	2020	97	92	116	127	122	136
Salt River	2019	116	90	86	108	107	137
	2020	104	95	120	130	126	149
Snake	2019	103	82	83	118	110	113
	2020	88	84	103	105	111	113
Sweetwater	2019	91	66	80	110	98	86
	2020	78	77	73	70	78	64
Upper Green at Warren Bridge	2019	97	77	74	107	93	89
	2020	104	79	90	103	101	108
Upper Green-West Side	2019	112	89	84	109	99	98
	2020	95	89	111	122	114	116
Newfork River	2019	107	81	86	117	121	114
	2020	107	80	92	95	94	87
Big Sandy	2019	89	65	79	114	101	87
	2020	60	62	65	57	66	41
Green above Fontenelle	2019	102	82	82	109	100	99
	2020	96	82	99	107	104	106
Hams Fork	2019	101	77	84	94	96	91
	2020	92	85	106	109	107	92
Smiths and Thomas Forks	2019	117	82	87	98	100	98
	2020	100	86	112	114	114	104

Table 37. Percent of mean stream discharge, 2019-2020.

USGS Stream Gauge	Year	Apr	May	Jun	Jul	Aug	Sep	Oct
Buffalo Fork AB Lava Creek	2019	99	80	94	89	85	106	117
	2020	90	125	108	79	80	–	–
Gros Ventre at Kelly	2019	121	72	103	104	94	108	107
	2020	90	117	111	97	98	–	–
Snake near Alpine	2019	129	108	99	96	89	120	101
	2020	92	124	104	81	73	73	87
Greys River	2019	114	80	97	96	95	106	101
	2020	94	122	100	87	94	96	–
Salt River AB reservoir near Etna	2019	92	120	97	93	99	109	92
	2020	119	128	115	104	93	94	119
Sweetwater River	2019	79	65	91	88	63	90	91
	2020	60	46	35	–	–	–	–
Green River at Warren Bridge	2019	95	59	97	105	83	96	106
	2020	75	86	104	88	64	60	–
Pine Creek AB Fremont	2019	96	62	114	102	71	70	117
	2020	134	109	106	70	60	32	21
New Fork Near Big Piney	2019	126	88	113	98	87	94	104
	2020	87	79	82	68	66	79	–
Green River near LaBarge	2019	116	85	101	93	77	93	115
	2020	–	–	–	–	–	–	–
Smith's Fork near Border	2019	86	78	105	97	99	103	102
	2020	87	93	80	68	76	78	–
Hams Fork Below Pole Creek	2019	78	55	91	79	60	140	179
	2020	90	74	49	–	–	–	–

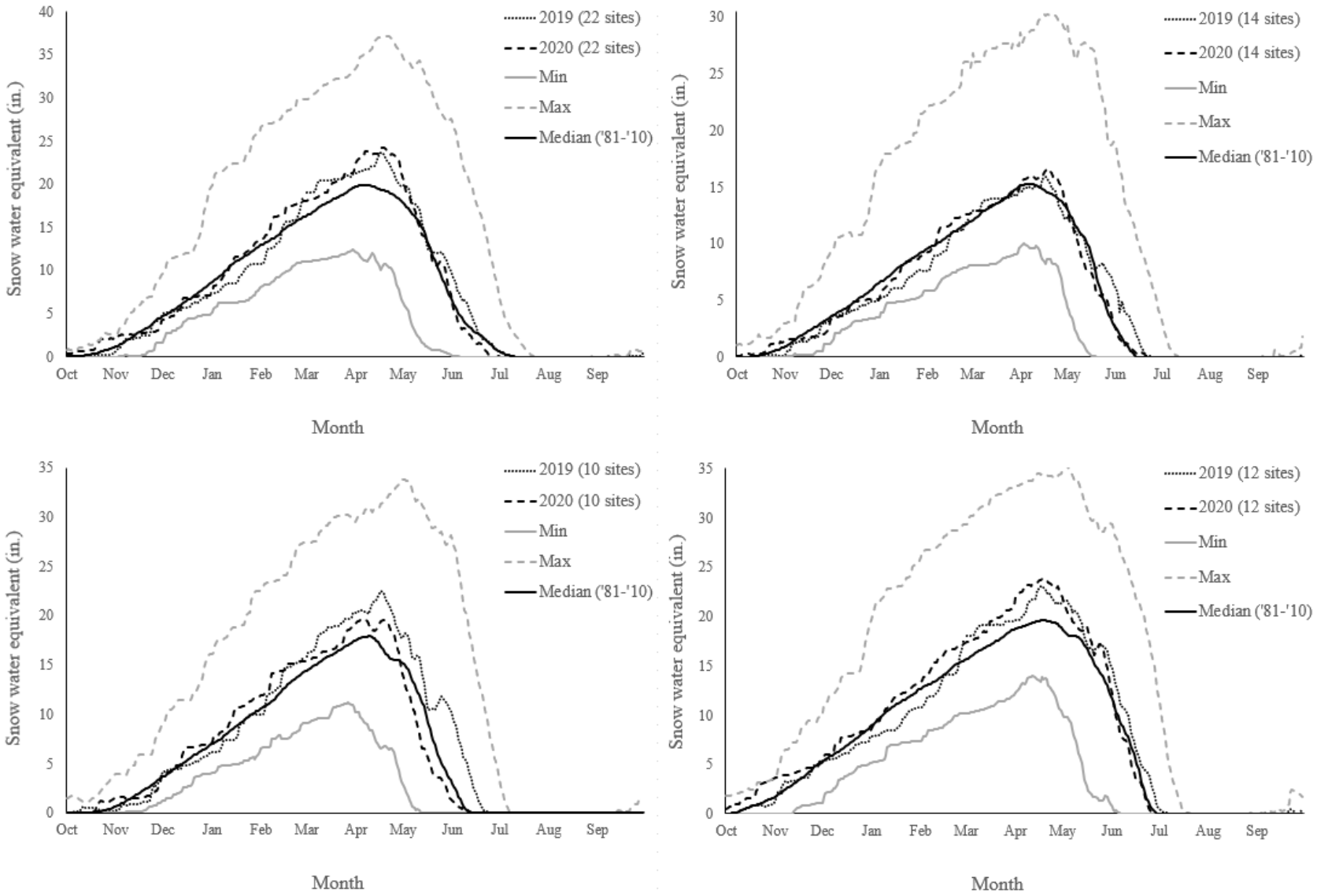

Figure 45. Snow water equivalent in inches for the Snake (top left), Upper Green (top right), Upper Bear (bottom left), and Yellowstone (in Wyoming, bottom right) basins (2019, 2020, min, max, and median) (NRCS 2021).

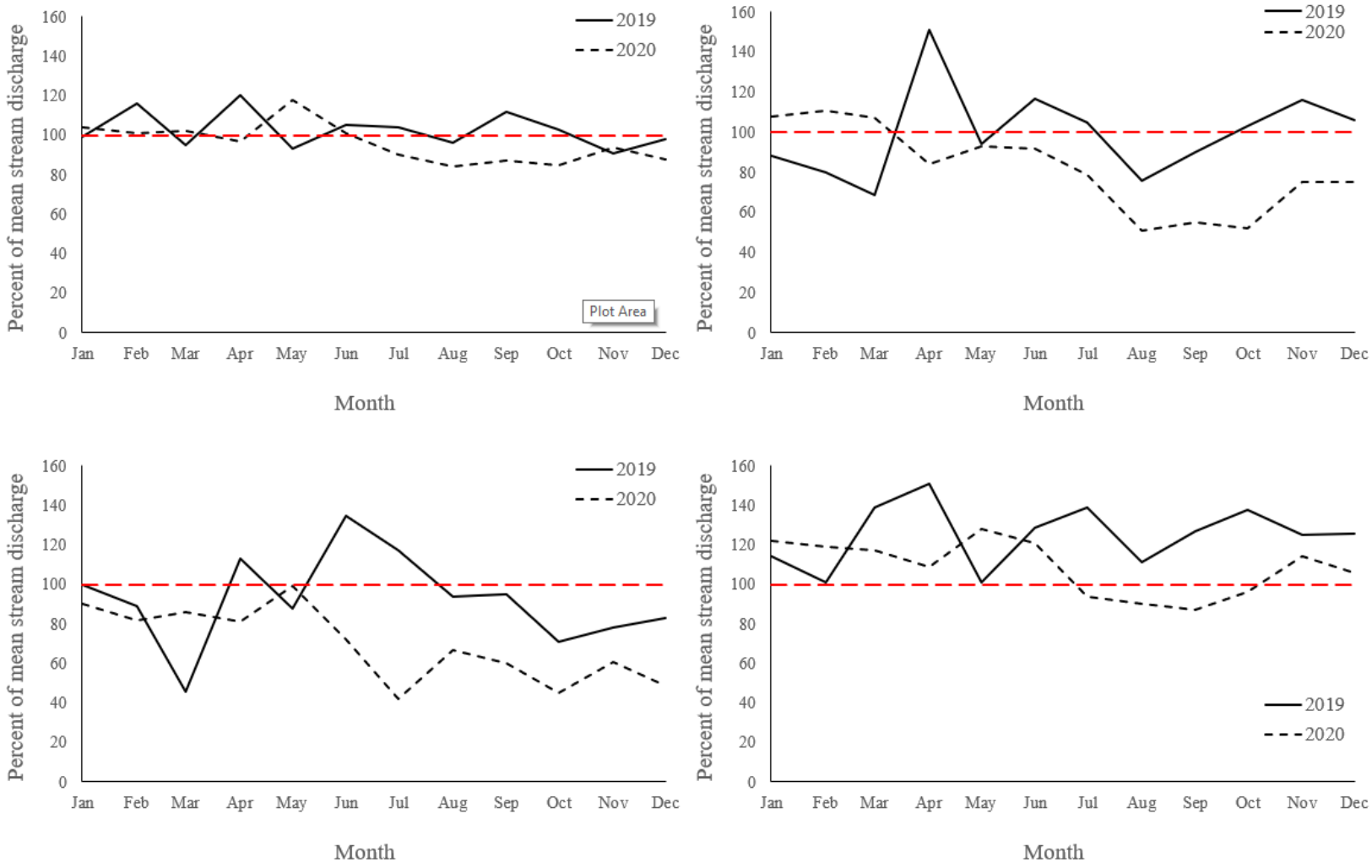

Figure 46. Percent of mean stream discharge by month for the Snake (top left), Upper Green (top right), Upper Bear (bottom left), and Upper Yellowstone (bottom right) basins (2019, 2020). Red line indicates 100 percent of the monthly mean based on values from 1981 to 2010 (NRCS 2021).

Discussion and findings

Long term climate data throughout the Intermountain Region indicates a drying trend with decreased snowpack and decreased stream discharge (Halofsky et al. 2018). In 2019, percent of median SWE values for the majority of basins on the BTNF were generally below average in January and February but increased to near or above average in March, April, and May (TABLE 36). In 2020, percent of median SWE values showed greater variability, but values for the majority of basins on the BTNF were below 100% of median values in December and January but increased to at or above 100% of median values in February, March, April, and May (TABLE 36).

In 2019 and 2020, the SWE in four basins overlapping the BTNF (Snake, Upper Green, Upper Bear, and Yellowstone) was generally near the median (based on values from 1981 to 2010) throughout the majority of the year and rose above the median in late winter and spring (approx. Feb–May) at all basins expect upper green (FIGURE 45).

In 2019, percent of mean stream discharge values for the majority of basins on the BTNF were below 100% of mean values from April through August but increased to above 100% of mean values in September and October. In 2020, percent of mean stream discharge values for the majority of basins on the BTNF were below 100% of mean values throughout the year. The exception is a few sites that had above-mean values for a few months in spring/late spring (Buffalo Fork, Gros Ventre, Snake, Greys, Salt, and Pine Creek). It should be noted that 2020 data were not available for all months at several sites (TABLE 37).

In 2019, percent median stream discharge was at or above 100 percent of the monthly mean based on values from 1981 to 2010 in one of four basins overlapping the BTNF (Upper Yellowstone) throughout the year. In the Upper Bear basin, values were at or below the mean from September to March, but increased above the mean in April, June, and July. In the remaining basins (Snake and Upper Green), values fluctuated above and below the mean. In 2020, stream discharge was near or below the mean for all or the majority of the year in three basins (Upper Green, Upper Bear, and Snake); in the Upper Yellowstone basin, values dipped below the mean in summer (Jul-Oct) but were near or above the mean for the reminder of the year (FIGURE 46).

Data collected as a result of the monitoring plan provide insight regarding short term stressors to the plan area (i.e., stressors on annual forage production). There should be no stress to trees as a result of decreased snowpack and stream discharge during this biennial monitoring period. Long-term data are available and summarized in the Forest Service's Climate Change Vulnerability and Adaptation in the Intermountain Region (Halofsky et al. 2018).

Adaptive management considerations

Based upon the long-term trend outlined in (Halofsky et al. 2018), there is a need to assess how management activities on BTNF are contributing to climate change and how these might be most effectively addressed, which may result in a need to change the Forest Plan and certain management activities, though no specific recommendations are being made at this time. No changes to monitoring program are warranted.

Indicator EVS-01-03: Extent of invasive species

Summary of methodology

Total infested acreage and cheatgrass infested acreage were derived from BTNF corporate GIS, which includes data from annual treatment and inventory reports submitted by Teton, Sublette, and Lincoln

Counties Weed and Pest agencies and inventory data collected by BTNF staff and citizen scientists. Data within the Forest Service's Natural Resource Information System (NRIS) is not accurate. Acreage listed in year ranges (1995-2005, 2006-2018, 2012–2020) represent within-range cumulative treatment areas reported and excludes between-year). Total acres infested as of 2020 is corrected for overlap of multiple inventories across year ranges. Spatial information is colored by year range to illustrate potential spread (FIGURE 47).

In 2020, approximately 11,501 acres of invasive plant species were treated on the BTNF, of which 10,664 acres were cheatgrass infestations. Aerial spraying of herbicides to treat cheatgrass was accomplished by partnering agencies and substantially increased the invasive species acreage treated on the BTNF in 2020. The current inventory of invasive plant species, including cheatgrass, on the BTNF is 35,393 acres. Of this number, 10,664 acres are infested with cheatgrass (FIGURE 47–FIGURE 49).

Monitoring results

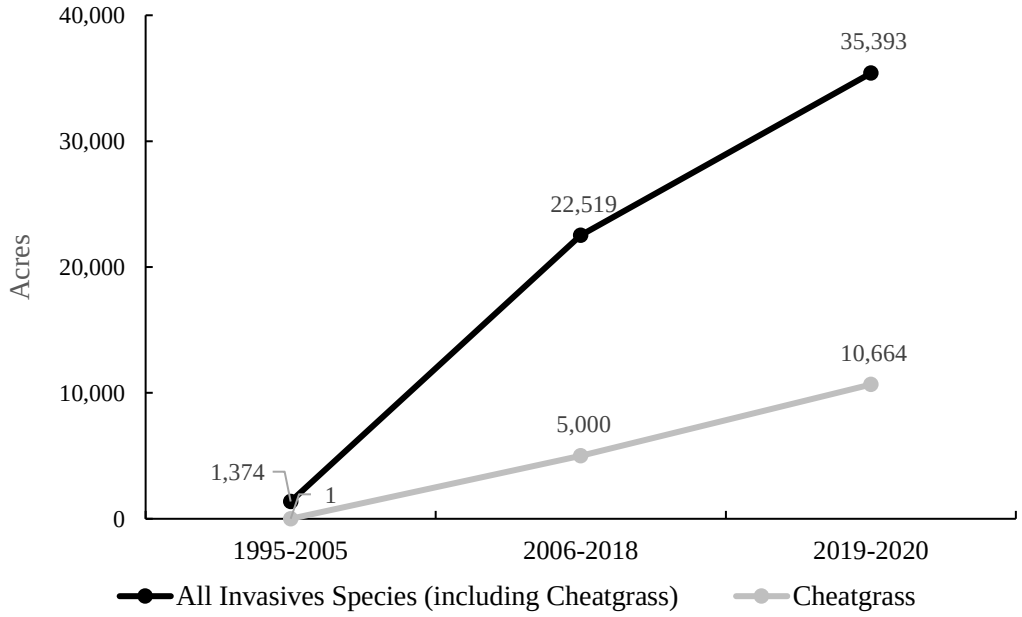

Figure 47. Inventory of all known invasive plant species and cheatgrass acreage on the BTNF, 1995 – 2020.

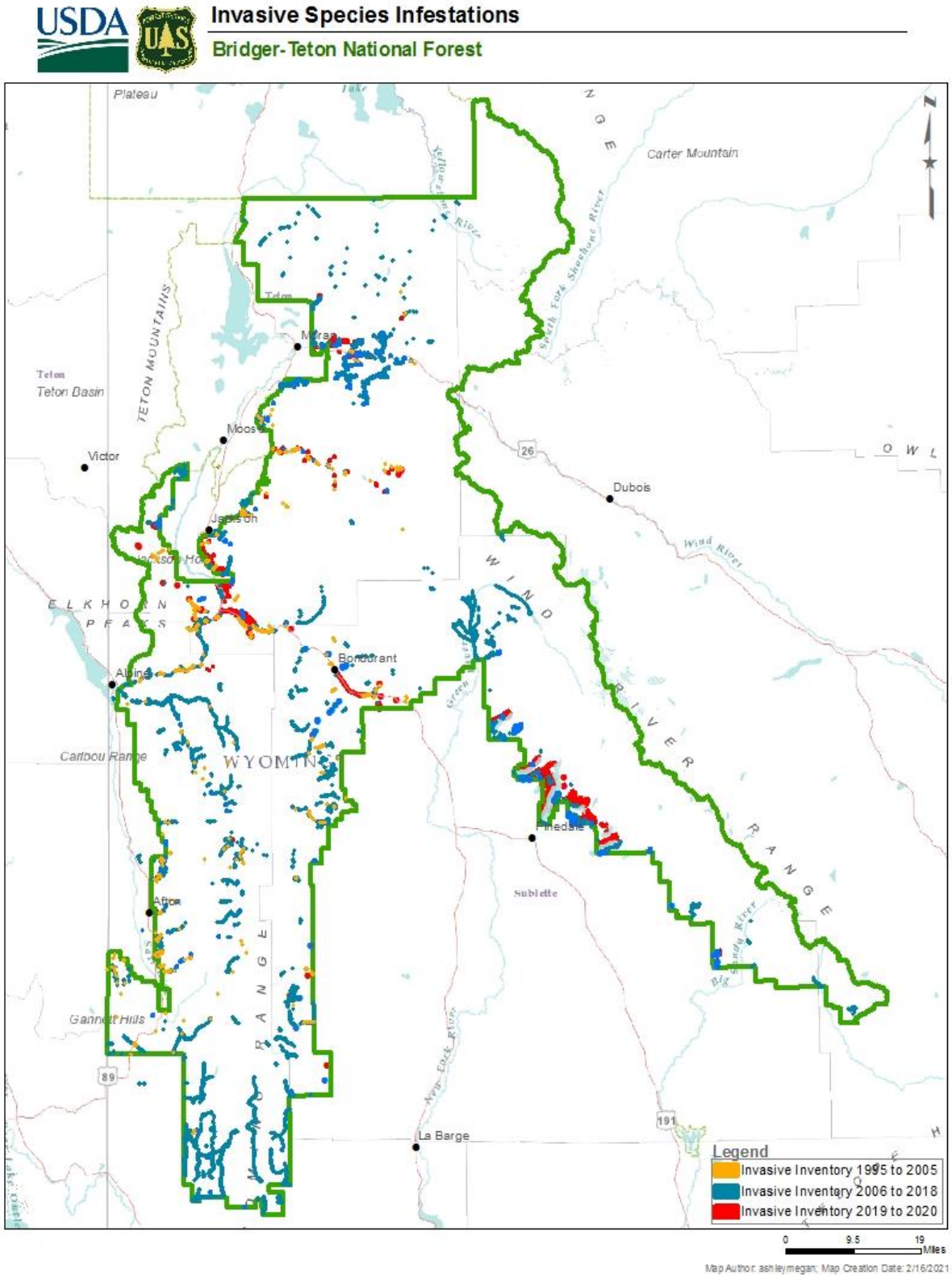

Figure 48. Invasive Species Infestations, 1995–2020.

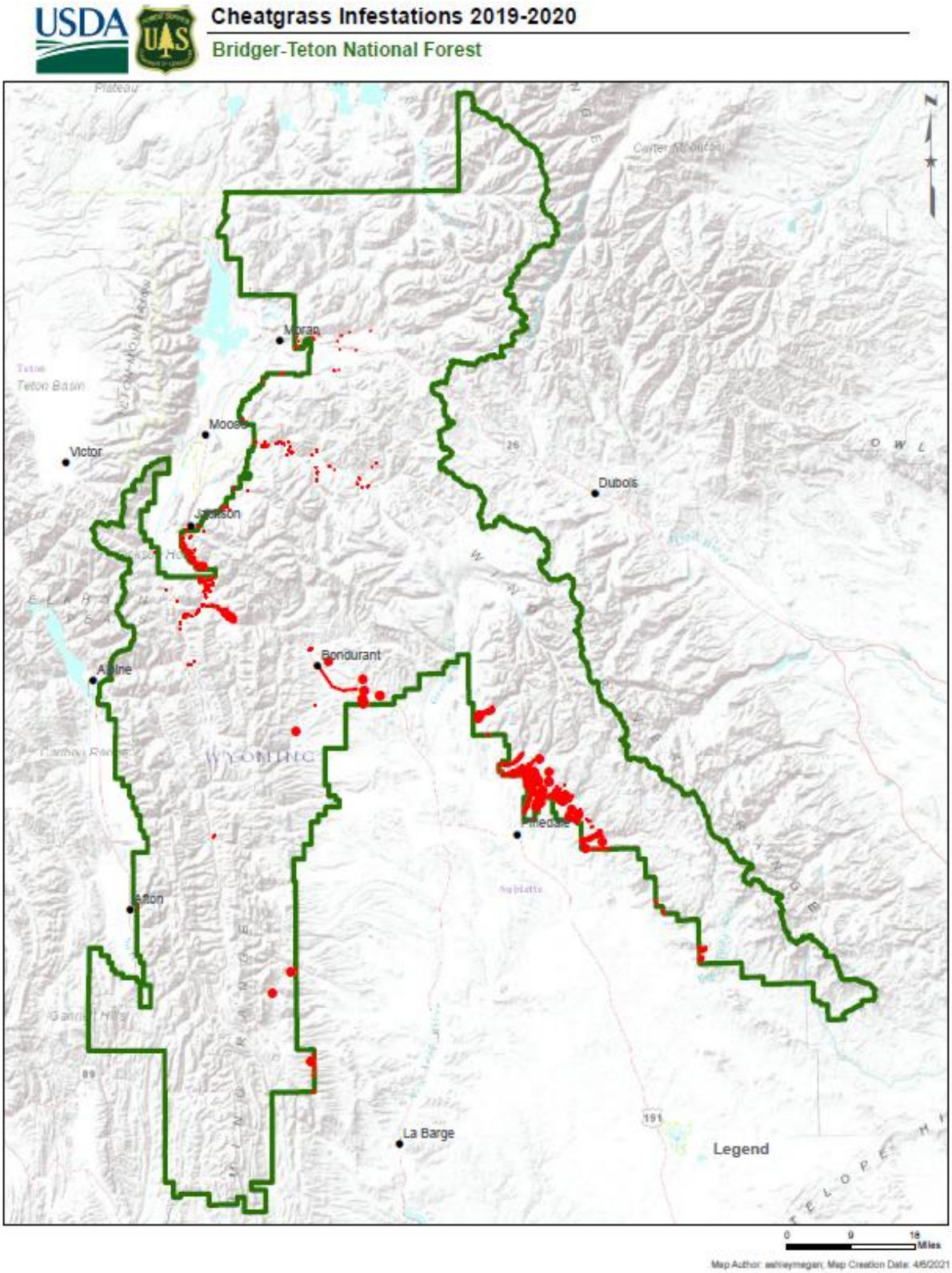

Figure 49. Cheatgrass Infestations, 2019–2020.

Discussion and findings

The extent of invasive species is rapidly increasing on BTNF, particularly cheatgrass (FIGURE 47–FIGURE 49). This inference must be tempered, however, with the probability that many infestations went undetected or unreported prior to 2006. The increased acreage is likely at least partially due to improved inventory of existing infestations, rather than expansion of existing infestations and introduction of new ones, particularly for cheatgrass, which likely infested more than one acre prior to 1995 (FIGURE 47). Furthermore, net acreage is likely an overestimation because inventories are total—rather than net—acres; invasive plant infestations are patchy, with large areas within each inventory that may be uninfested.

Despite some uncertainty about infestation trend due to methodology, it is clear that cheatgrass is expanding on BTNF. Of particular concern is the recent expansion of cheatgrass on south-aspect slopes in the Wind River and Gros Ventre ranges (FIGURE 49). Widespread invasion cheatgrass in the Intermountain West has drastically altered native plant communities, accelerating fire return intervals and negatively impacts habitat for key species (e.g., greater sage grouse) (Brooks et al. 2004; Mack et al. 2000). Though previous disturbances such as fire, recreation, and grazing may have combined to allow invasive species establishment, climate change is likely a contributing factor in increased vulnerability of south-aspects and low elevation areas to new infestations.

Adaptive management considerations

Efforts are currently underway to improve implementation of monitoring protocols. On June 6, 2020, the Forest Supervisor O'Connor signed a decision for the Invasive Plant Management Project that allowed for more management options to treat invasive plants, including aerial spraying outside of Wilderness Areas. Based upon expectations associated with these efforts, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Question ECC-01: Are multiple use opportunities on the Forest contributing to the prosperity of local communities?

Indicator ECC-01-01: Forest visitor numbers

This is a duplicate indicator of RA-02-01 and discussed in that section.

Indicator ECC-01-02: Availability and use of commercial recreation opportunities

This is a duplicate indicator of RA-02-02 and discussed in that section

Indicator ECC-01-03: Availability and use of livestock grazing opportunities

Summary of methodology

Data were derived from the Natural Resource Manager (NRM) database Range Module. Information about these databases is available at http://fsweb.nrm.fs.fed.us/. 'Number of head months permitted' represents the maximum occupancy (livestock numbers and season of use) allowable under current permit provisions. 'Number of head months billed' represents the actual occupancy (livestock numbers and season of use) applied for and authorized in a given grazing season. A head month is the basic unit of occupancy (e.g., one cow/calf, ewe/lamb pair or yearling/cow/ewe for one month) for which the permit holder is charged a grazing fee.

Monitoring results

The number of head months applied for and billed for cattle and horse permits in 2020 was approximately 80% of the number of head-months available under conditions of maximum permitted occupancy (TABLE 38). The number of head months applied for and billed for sheep & goat permits in 2020 was approximately 60% of the number of head-months available under conditions of maximum permitted occupancy (TABLE 38).

Table 38. Active livestock grazing allotments, FY2020.

	Number of Active Allotments	Number of Head-months permitted (Maximum Permitted Occupancy)	Number of Head-months billed (Actual Authorized Occupancy)
Cattle & Horse	58	107,976	86,681
Sheep & Goat	35	116,541	69,479

Discussion and findings

Though some of the difference between maximum and billed or authorized head months results from non-use for resource protection (involuntary non-use due to resource issues), the majority is attributable to non-use for the personal convenience of the permittee. With regard to existing permit holders, this is an indication that the number of head months offered exceeds the number of head months desired / consumed.

Interest from livestock producers who are not current permit holders on BTNF allotments has varied over the years, but has not been tracked in reportable form. Some of this interest takes the form of inquiries about temporary accommodation of producers who have run out of forage in their own or leased pastures. Others inquire as to availability of vacant allotments and forage reserves with the intent of receiving authorization under ten-year term-permits.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator ECC-01-04: Amount of timber offered and produced

This is a duplicate indicator of TIM-01-02 and discussed in that section.

Indicator ECC-01-05: Availability and use of firewood and other products for personal use

Summary of methodology

BTNF offers permits annually for a variety of non-commercial forest products with the majority of permits issued for firewood, post and poles, and Christmas trees. Data on the availability and use of firewood and other non-commercial forest products such as fence posts and poles are tracked in the Periodic Timber Sale Accomplishments Report (PTSAR) by quarter for each fiscal year (FY). PTSAR tracks forest product volumes in various categories, including the regular program funded with appropriations, the Salvage Sale Fund, personal use permits and small commercial sales. Permit data for individual forest products, such as firewood cords and Christmas trees sold, are entered and tracked in the Timber Information Manager (TIM) database. TIM is the Forest Service's database of record for sales of forest products and exists within the Natural Resource Manager (NRM) system. Data is reported for five years to show a trend in volume sold and permits offered (TABLE 39, FIGURE

50). Hundred cubic feet (CCF) and thousand board feet (MBF) are the industry standard units of measure for convertible timber products offered and sold. A cubic foot (ft^3) is a unit of volume of a cube with sides one foot in length whereas a board foot (fbm)—a measure to predict the amount of lumber produced from a round log—is a one-foot length of a board one foot wide and one inch thick.

Monitoring results

Table 39. Volumes sold for non-commercial (personal use) forest products, FY16-FY20.

Fiscal Year	Non-commercial products thousand board feet (MBF)	Non-commercial products hundred cubic feet (CCF)
FY16	5,506	9,401
FY17	4,897	8,364
FY18	4,714	8,057
FY19	5,214	8,886
FY20	4,926	8,409

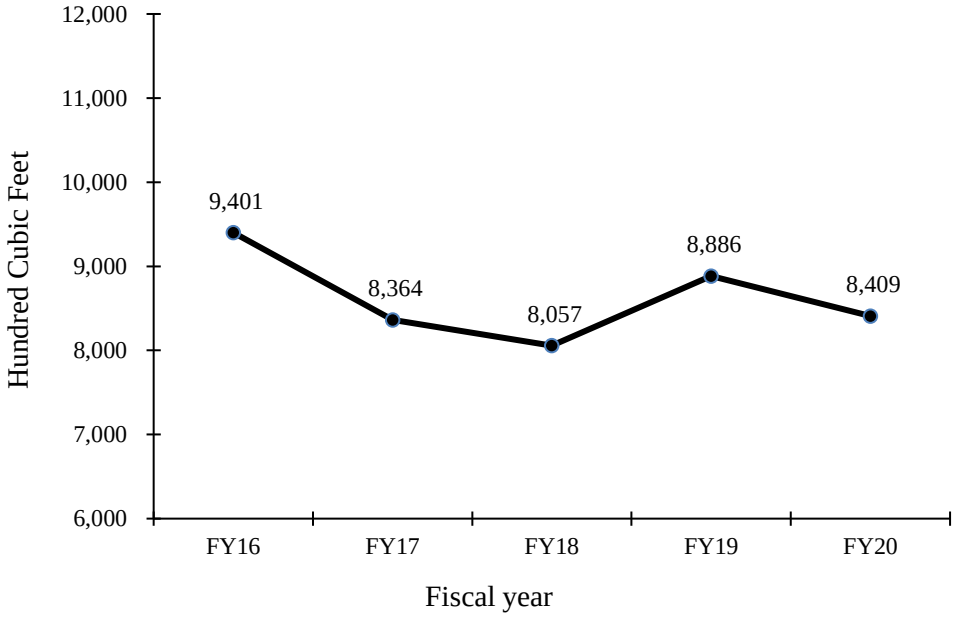

Figure 50. Volume of non-commercial forest products, FY16-FY20.

Discussion and findings

BTNF offers permits annually for non-commercial forest products. Traditionally these permits are issued in-person at Ranger District offices and through third party vendors such as local grocery stores and visitor centers. However, in 2020, due to the Covid-19 pandemic, the BTNF went to mainly online permit sales with in-person sales by appointment only at Ranger District offices.

The current Forest Plan goal is to provide access to an average of 2.5 cords of firewood per firewood-gathering household per year and offering commercial-timber-harvest residual material whenever possible. Using an annual goal of 2.5 cords per firewood-gathering household, the BTNF sold enough firewood permits to supply an annual average of 4,030 households in surrounding communities during the five-year period FY16-FY20 (FIGURE 51). Furthermore, residual wood fiber generated from commercial timber sales is offered to the public for firewood gathering once timber sale units have

been completed and accepted as complete by BTNF timber sale administration staff. This has increased firewood gathering opportunities on the Kemmerer, Big Piney, and Pinedale Ranger Districts, where the majority of commercial timber harvest occurs. The monitoring results indicate that the Forest Plan goals associated with this indicator are being maintained.

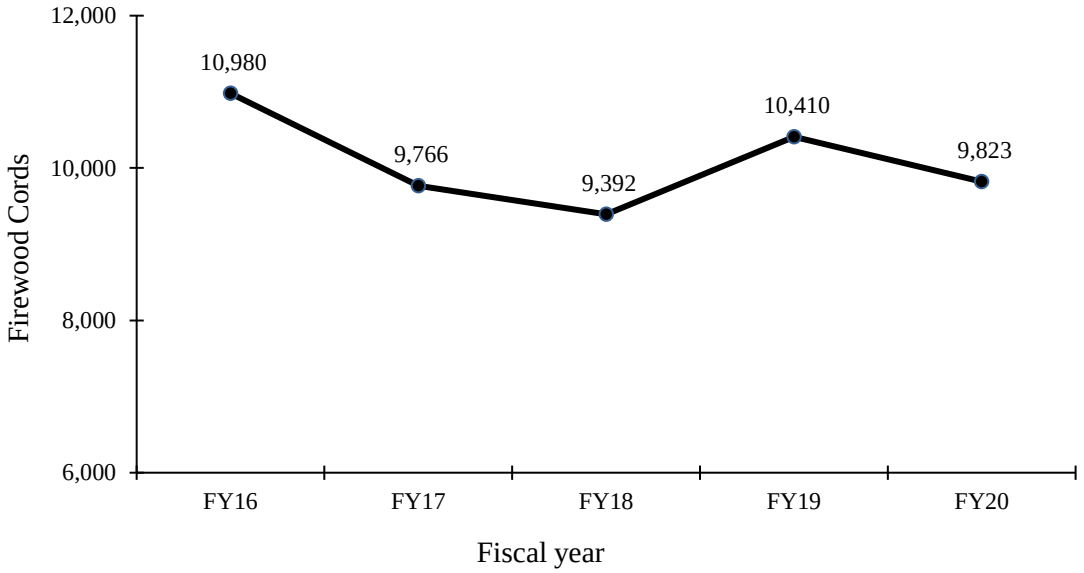

Figure 51. Non-Commercial Firewood Cords Sold, FY16-FY20.

Another stated goal in the current Forest Plan is to provide opportunities for the public to get personal use Christmas trees. Christmas tree permits are typically sold and entered in TIM October through December of each calendar year, which corresponds to the 1st quarter of the fiscal year reported. Typically, the BTNF averages around 3,000 Christmas Tree permits sold annually. However, 3,532 permits were sold in FY21, a twenty percent increase from the previous year (FIGURE 52). This increase is likely due to the Covid-19 pandemic, as recreation on public lands across the nation increased dramatically as the public turned to outdoor activities as a way to recreate while satisfying social distancing health mandates required by many state and local governments. The BTNF also instituted online permit sales since the pandemic began, increasing opportunities for members of the public to obtain permits through a contactless purchase. The BTNF plans to continue with online permit sales for calendar year 2021 and will continue monitoring these sales and the overall impact on the Christmas tree permits sold.

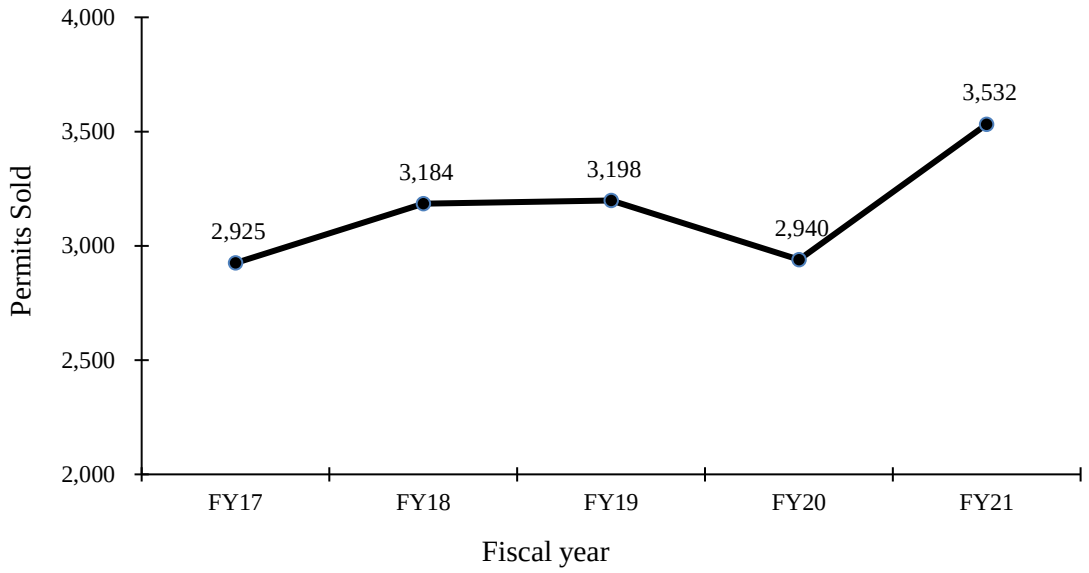

Figure 52. Personal Use Christmas Tree Permits Sold, FY17-FY21.

Adaptive Management Considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted. After falling from a peak of more than 10,000 CCF sold annually FY12-FY14, use of non-commercial forest products appears to have stabilized somewhat over the past five years. These trends will continue to be assessed in the next biennial monitoring report.

Question TIM-01: Is timber harvest occurring in a manner which does not impair the productivity of the land?

Indicator TIM-01-01: Implementation of Best Management Practices during timber harvest and transport

Summary of methodology

The Forest Service has national standards for water quality best management practices (BMP), including required monitoring (USDA Forest Service 2012). An interdisciplinary team (e.g., botany, recreation, timber, wildlife, engineering) assesses BMP for whether prescriptions were implemented as intended and effective in meeting water quality objectives. BMP monitoring is required for approximately seven projects annually on each National Forest. Random project selections in FY 17-18 did not include any timber harvest or transport projects.

Monitoring results

Given the random nature of BMP site selection, formal BMP monitoring was not completed for a timber harvest project in FY 17 or FY18. However, the watershed program staff reviewed the Big Springs Timber Sale harvest and participated in a Timber Sale Administration Exam in FY18. BTNF required BMPs were implemented and buffers around riparian areas during timber harvest were maintained.

Discussion and findings

Implementation of BMPs and adherence to riparian buffers alleviates impacts to water resources. Despite not being documented in a formal evaluation, the results of the Big Springs Timber Sale harvest review suggest that timber harvest is occurring appropriately and effectively on the Bridger Teton National Forest and that Best Management Practices are being implemented. A timber harvest and/or transport project will likely be randomly selected in the near future and results would be reported in following biennial monitoring report.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator TIM-01-02: Amount of timber harvested relative to the Allowable Sale Quantity (ASQ) as specified in BTNF Forest Management Plan (1990)

Summary of methodology

Data on timber volumes sold is tracked in the Periodic Timber Sale Accomplishments Report (PTSAR) by quarter for each fiscal year (FY) (October 1 – September 30). PTSAR tracks forest product volumes in various categories, including appropriated funds, Salvage Sale funds, personal use permits and small commercial sales. In addition, PTSAR reports sale progress such as advertisement, bid opening and award, including identification of status such as ongoing, delays, no-bids and re-offered volume. Data are reported for five years to show a trend in sales and volume offered. Hundred cubic feet (CCF) and thousand board feet (MBF) are the industry standard units of measure for convertible timber products offered and sold. A cubic foot (ft^3) is a unit of volume of a cube with sides one foot in length whereas a board foot (fbm)— a unit of measure intended to predict volume of sawn lumber—is a one-foot length of a board one foot wide and one inch thick.

In the current Forest Plan, allowable sale quantity (ASQ) estimates the potential commercial timber volume that may be produced on BTNF lands considered suitable for timber harvest. This model-derived quantity has not been updated since the Forest Plan adoption in 1990.

Monitoring results

Table 40. Timber volumes offered and sold in relation to Allowable Sale Quantity, FY16-FY20.

Fiscal year	Timber offered thousand board feet (MBF)	Timber sold as % of timber offered	Timber sold (MBF)	Timber sold as % of ASQ	Forest Plan ASQ (MBF)	Timber offered thousand cubic feet (CCF)	Timber sold thousand cubic feet (CCF)
FY16	5,307	100%	5,307	25%	21,300	9,311	9,311
FY17	6,954	100%	6,954	33%	21,300	12,998	12,998
FY18	5,278	59%	3,120	15%	21,300	10,558	6,223
FY19	618	52%	319	1%	21,300	1,660	859
FY20	7001	100%	7001	33%	21,300	12,282	12,282

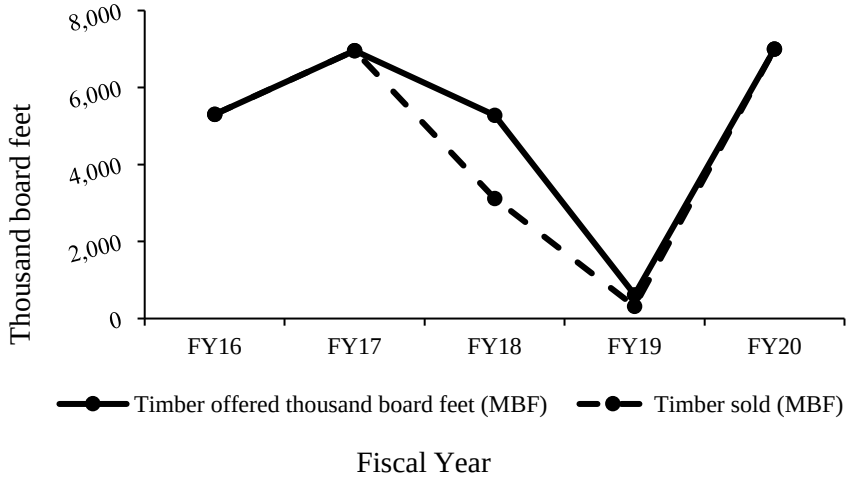

Figure 53. Comparison of timber volumes offered and sold in the BTNF, FY16-FY20.

Discussion and findings

Timber volume offered may vary from the ASQ due to factors that include, but are not limited to timber volume targets assigned by the regional forester that may not be in alignment with the Forest's ASQ; natural disturbances such as wildfires; local industry capacity; and funding. Currently, the regional forester assigns BTNF an annual commercial timber target of approximately 14,000 CCF, or approximately 7,500 MBF. This target is currently below BTNF estimated ASQ identified in the Forest Plan.

Success of timber sales sold on BTNF have fluctuated from FY16-FY20 (TABLE 40, FIGURE 53). Specifically, FY18 had no-bid sales that resulted in BTNF not meeting its annual target for commercial timber sold, and in FY19 the BTNF only offered 618 MBF. However, following these two years the BTNF sold more timber sale volume in FY20 than in any of the previous ten years. The outlook is promising to sustain a similar level of timber harvest into the future due to the following factors: 1) increased mortality from insect, disease, and wildfire resulting in increased salvage sale opportunities; 2) neighboring forests producing less timber due to project litigation and Endangered Species Act (ESA) issues; and 3) increased demand from local industry for a variety of timber products that includes fence posts and poles, commercial firewood, commercial house logs, and some saw timber.

Furthermore, the Intermountain Region combines the volumes for non-commercial forest products (i.e., personal use firewood) with the commercial timber volume sold. Reporting on personal use firewood is included in the Economic Contribution to Communities indicator ECC-01-05. Non-commercial forest product volumes, combined with commercial volumes sold under traditional timber sales, has allowed BTNF to meet and exceed annual timber targets and contribute to Forest ASQ.

Adaptive management considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Indicator TIM-01-03: Areas of regeneration harvest of timber re-stocked with young trees within five years of final harvest

Summary of methodology

Data are generated from stocking surveys conducted in stands where a regeneration harvest has occurred. A regeneration harvest is defined as a final removal cut within a cycle of silvicultural prescriptions and is utilized to establish a new cohort of trees. Success or failure of adequate stocking in stands treated with a regeneration harvest is determined five years post-harvest and is tracked in one of the Forest Service's corporate databases—the Forest Activity Tracking System (FACTS). FACTS is a part of the Forest Service's the Natural Resource Manager (NRM) system; information about these databases is available at http://fsweb.nrm.fs.fed.us/.

Monitoring Results

Regeneration treatments implemented on the BTNF requiring a five-year post-harvest restocking certification FY16-FY20 include even-aged coppice cut, two-aged coppice cut (with reserves), patch clearcut (with leave trees), stand clearcut, and stand clearcut (with leave trees). Acres of regeneration harvest for the past five years and associated restocking certification five years post-harvest are shown in (TABLE 41). In FY16 and FY18, all acres surveyed five-year post regeneration harvest met adequate restocking. However, in FY17 and FY20, 45%-68% of acres surveyed five years post regeneration harvest did not meet adequate restocking and are planned for additional plantings in the next few years.

Table 41. Acres of regeneration treatments implemented timber sales, FY16-FY20.

Fiscal Year	Total Acres of Regeneration Harvest 5 Years Old	Acres with Adequate Restocking	Acres with Inadequate Restocking	Percent Acres with Inadequate Restocking
FY16	108	108	0	0%
FY17	315	102	213	68%
FY18	36	36	0	0%
FY19	0	0	0	0%
FY20	84	46	38	45%

Discussion and findings

In FY17, 68% of acres surveyed in the South Cottonwood Timber Sale and Halverson Timber Sale did not meet adequate stocking requirements. In FY20, 45% of acres surveyed in the Nylander Timber Sale did not meet adequate stocking requirements. All acres currently not meeting adequate restocking requirements five years post-harvest are scheduled for additional planting to ensure reforestation goals are met. The current Forest Plan states if natural regeneration fails to meet the prescribed standards for the forest cover type, then trees will be planted. Therefore, BTNF is meeting Forest Plan objectives for forest regeneration.

Adaptive Management Considerations

Based upon the monitoring results, no changes to the monitoring program, Forest Plan, or management activities are warranted.

Conclusion

In general, the monitoring results indicate that BTNF is meeting Forest Plan objectives, but there are areas where changes may be warranted (TABLE 2, TABLE 42). No urgent need to change the Forest Plan surfaced, but, in a few areas—namely air quality, forest vegetation (prescribed fire and mechanical treatments), recreation opportunities (amount and types of opportunities, acres open to over-snow vehicle use), and environmental stressors (amount of snowpack and spring runoff)—it was noted that the current Forest Plan direction is outdated and doesn't reflect current understanding of these issues. Given it has been over 30 years since the plan was adopted, this is not surprising. Both existing conditions and best available science have progressed substantially in the last 30 years and will be incorporated in the Forest Plan. Furthermore, there are a few topics—air quality, forest vegetation (prescribed fire and mechanical treatments), recreation (amount and types of opportunities, Forest road and trail system), wilderness, and environmental stressors (amount of snowpack and spring runoff)—for which management activities may warrant changes to better meet Forest Plan objectives.

The monitoring results suggest that, in regard to trails, BTNF is not adequately meeting its Forest Plan objective to provide for user safety and convenience. There is a pressing need to address the low percentage of trails that meet standard. Current appropriated funding levels severely limit our ability to conduct trail maintenance, but BTNF is actively working with partners to reduce the maintenance backlog. There are other aspects of recreation and access where changes to management activities are warranted, including publishing Over Snow Vehicle Use Maps (OSVUM), conducting winter travel planning, modernizing Special Use Permit reporting, conducting campground use planning, improving wilderness campsite conditions, conducting visitor use planning, and partnering with Counties and private entities to increase road maintenance capacity.

Table 42. Summary of monitoring evaluation findings for all monitoring questions.

Planning area where change may be warranted	Monitoring area	Monitoring evaluation findings
Forest plan		
	Air Quality	The current Forest Plan lacks direction for eutrophication and atmospheric deposition. Deposition needs to be assessed for both aquatic and terrestrial effects across the BTNF. Plan should more comprehensively address smoke management in prescribed burning, and the language updated.
	Vegetation	The current Forest Plan lacks direction specifically focused on forest restoration. Ongoing and expected future increases in tree mortality resulting from insects, diseases, and larger wildfires will likely lead to more acres of forest that require active restoration. Specific Forest Plan objectives will need to be identified to provide guidance on how to address these issues.
	Recreation	Address the challenge of increasing visitor use, which will require new management actions and updated Forest Plan direction.
	Environmental Stressors	Assess how management activities on BTNF are contributing to climate change and how these can be most effectively addressed.

Planning area where change may be warranted	Monitoring area	Monitoring evaluation findings
Management activities		
	Air quality	Include management activities to addresses smoke management in prescribed burning.
	Vegetation	Increase opportunities to conduct prescribed burning and managing wildland fire for resource benefit.
	Recreation	Continue working toward addressing known site conditions issues. Reduce maintenance backlogs. Conduct visitor use planning. Continue to modernize Special Use Permit reporting. Conduct campground use planning. Publish Over Snow Vehicle Use Maps (OSVUM). Conduct winter travel planning.
	Wilderness	Update existing Wilderness management plans. Focus on implementing the national minimum protocol for monitoring opportunities, completing tasks related to “agency management actions”, and updating the education program.
	Environmental Stressors	Assess how management activities on BTNF are contributing to climate change and how these might be most effectively addressed.
Plan monitoring program		
	Air quality	Continue to assess and consider additional measures to help track baseline conditions and changes in trophic state of aquatic resources on the BTNF. Continue evaluating and updating air quality monitoring program to meet shifting air pollution deposition concerns and issues over time.
	Vegetation	Vegetation treatment datasets need to be updated to facilitate comparison. Monitoring results fail to fully address the acres impacted by all natural processes and the current indicator does not address the effects of climate change, which can directly affect the size and intensity of fires, as well as post fire vegetation development. Consideration should be taken to how and if this can be included in a revised indicator.
	Wildlife	Implement a new, more rigorous habitat monitoring protocol for Kendall Warm Springs Dace in 2021 to allow for comparison with the original 1995 study. Remove yellow-billed cuckoo as an indicator as this species is not likely to occur on the BTNF.
	Recreation	Collect data to capture summer use at ski/mountain resorts as they transition to offering year-round services. Standardize data collection for recreation sites.
	Wild and Scenic Rivers	Improve capacity to adequately monitor watercraft use on all designated rivers. Use new

Planning area where change may be warranted	Monitoring area	Monitoring evaluation findings
		technology to improve the accuracy and reliability of monitoring

This monitoring evaluation illustrates the need to embrace adaptive approaches in the management of National Forest Lands. BTNF is attentive to the need to change management strategies based upon monitoring results and emerging science. We will continue to strive to adapt our management and monitoring to best care for the land and serve people.

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Appendix A:
Air Quality Supplemental Figures and Tables

Table A-1. Number and percent of sampled waterbodies on the BTNF by the critical load (CL) category (kg N ha-1 yr-1) that would protect surface water ANC from decreasing below 50 µeq L-1 or 20 µeq L-1.

ANC Threshold (µeq L^{-1})	National Forest	Number of sites sampled	Critical Load Category (kg N ha^{-1} yr^{-1})									
			< 2		2-4		4-6		6-8		> 8	
			#	%	#	%	#	%	#	%	#	%
ANC=50	Bridger-Teton	203	20	9.9	36	17.7	32	15.8	25	12.3	90	44.3
ANC=20	Bridger-Teton	203	3	1.5	12	5.9	28	13.8	37	18.2	123	60.6

Table A-2. Number and percent of sampled waterbodies on the BTNF by the magnitude of critical load (CL) exceedance (kg N ha^{-1} yr^{-1}) that would protect surface water ANC from decreasing below 50 µeq L^{-1} or 20 µeq L^{-1}.

ANC Threshold (µeq L^{-1})	National Forest	Number of sites sampled	No Exceedance		Magnitude of Exceedance (kg N ha^{-1} yr^{-1})									
					< 1		1-2		2-5		> 5		Total Exceedance	
			#	%	#	%	#	%	#	%	#	%	#	%
ANC=50	Bridger-Teton	203	142	70.0	22	10.8	16	7.9	23	11.3	0	0	61	30.0
ANC=20	Bridger-Teton	203	185	91.1	8	3.9	6	3.0	4	2.0	0	0	18	8.9

Table A-3. Area[1] (km^2) and percent of area in surface water eutrophication critical load categories (kg N ha^{-1} yr^{-1}) BTNF using a water nitrate concentration of 0.5 µmol/L. "Area" represents BTNF lands where surface waters may exist and not total area of surface water.

National Forest	Forest Area	Critical Load Category (kg wet N ha^{-1} yr^{-1})											
		<1		1-2		2-3		3-4		4-5		>5	
	km^2	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
Bridger-Teton	14029.6	363.5	2.6	1040.6	7.4	7220.8	51.5	5402.4	38.5	1.9	0	0.0	0

Table A-4. Area[1] (km^2) and percent of area for the BTNF by the magnitude of surface water eutrophication exceedance. "Area" represents BTNF lands where surface waters may exist and not total area of surface water.

National Forest	Forest Area	No Exceedance		Magnitude of Exceedance (kg wet N ha^{-1} yr^{-1})										Total Area and Percent in Exceedance	
				< 1		1-2		2-3		3-4		>4			
	km^2	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
Bridger-Teton	14029.6	1347.9	9.6	3164.0	22.6	4498.3	32.1	3230.2	23.0	1434.6	10.2	354.6	2.5	12681.7	90.4

Table A-5. Area[1] (km^2) and percent of the BTNF by critical load (CL) exceedance category that results in various percent declines of lichen species richness. The CL, 3.5 kg N ha^{-1} yr^{-1}, is associated with a 20% decline in lichen species richness.

National Forest	Forest Area	Exceedance Category (decline in species richness)								Total Area and percent in Exceedance	
		No Exceedance		20-30%		30-40%		40-50%			
	km^2	km^2	%	km^2	%	km^2	%	km^2	%	km^2	%
Bridger-Teton	14029.0	2832.8	20.2	10387.4	74.0	808.8	5.8	0.0	0.0	11196.2	79.8

Table A-6. Tree species mapped area (km²) and percent of the BTNF within different exceedance categories. CL exceedance categories represent the percent decline in either growth rate or probability of survival over 10 years. Categories >1% are considered in exceedance. The "vegetation mapped area" represents the area where a tree species has a dominant/codominant canopy cover.

Tree species	Category	Vegetation Mapped Area	Percent Decline in Probability of Survival or Growth Rate								Total Area and Percent in Exceedance	
			No exceedance < 1%		1-5%		5-10%		> 10%			
		km²	km²	%	km²	%	km²	%	km²	%	km²	%
Douglas-fir	Prob Survival	1010.8	184.0	18.2	826.8	81.8	0.0	0.0	0.0	0.0	826.8	81.8
Quaking Aspen	Growth Rate	698.4	698.4	100.0	0	0.0	0	0.0	0	0.0	0	0.0
Quaking Aspen	Prob. Survival	698.4	698.3	100.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Balsam Poplar	Growth Rate	1.5	0.8	50.0	0.6	36.8	0.2	13.2	0.0	0.0	0.8	50.0
Balsam Poplar	Prob. Survival	1.5	1.5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

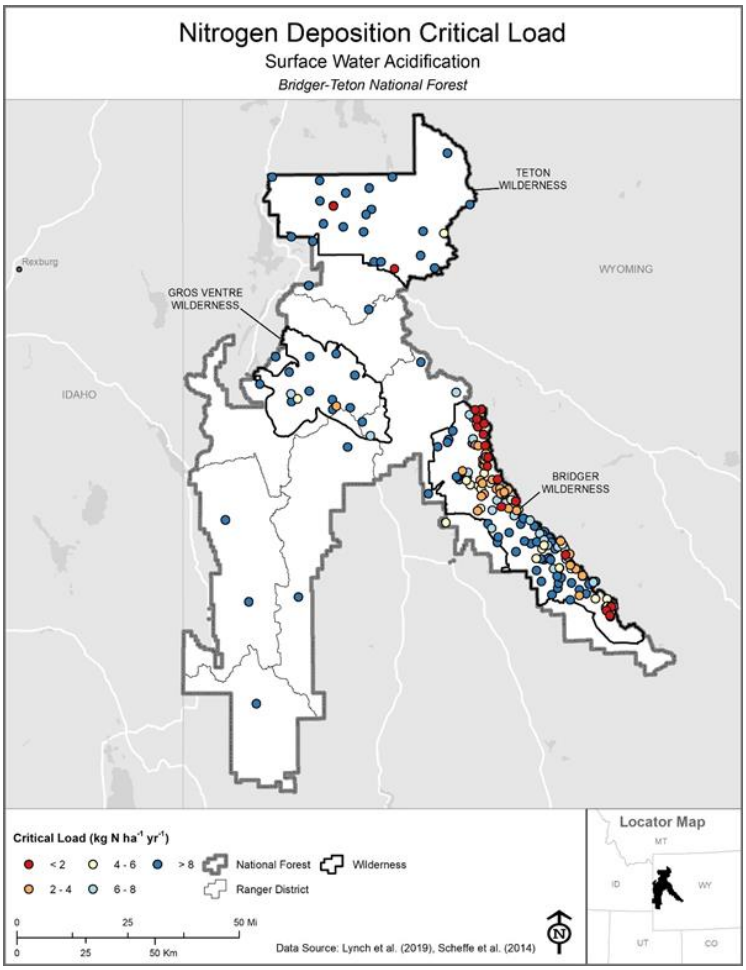

Figure A-1. Total nitrogen (N) deposition critical loads that protect surface water acidification from decreasing below 50 µeq L^{-1} at lake or stream sample sites located within the Bridger-Teton National Forest.

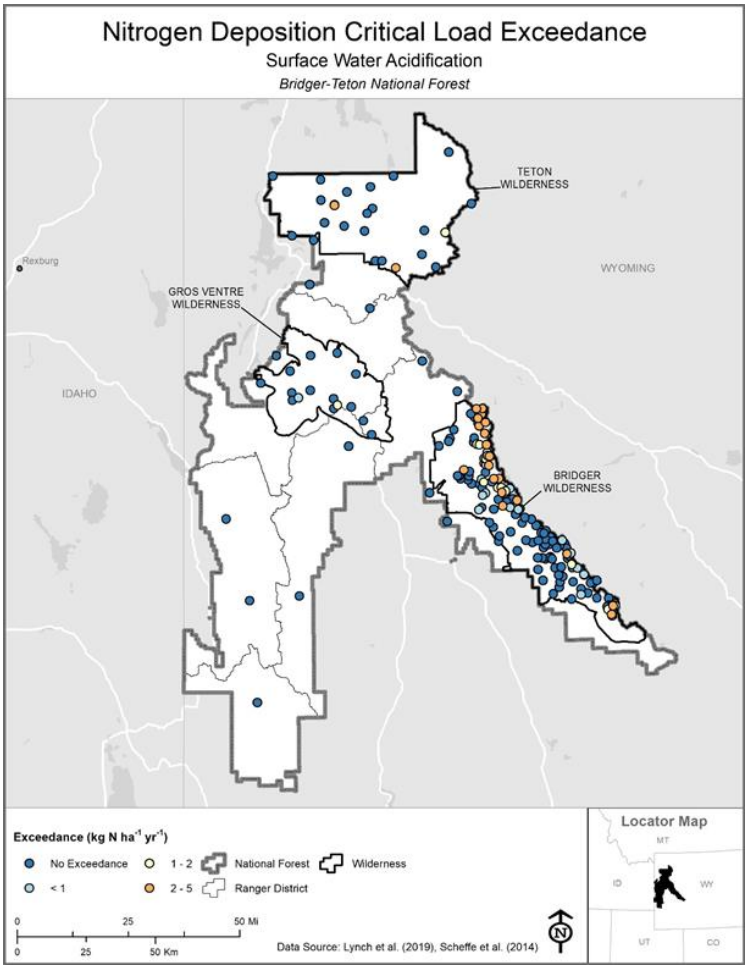

Figure A-2. Exceedances of the critical loads for nitrogen (N) deposition that protect surface water acidification decreasing below 50 µeq L^{-1} at lake or stream sample sites on the Bridger-Teton National Forest.

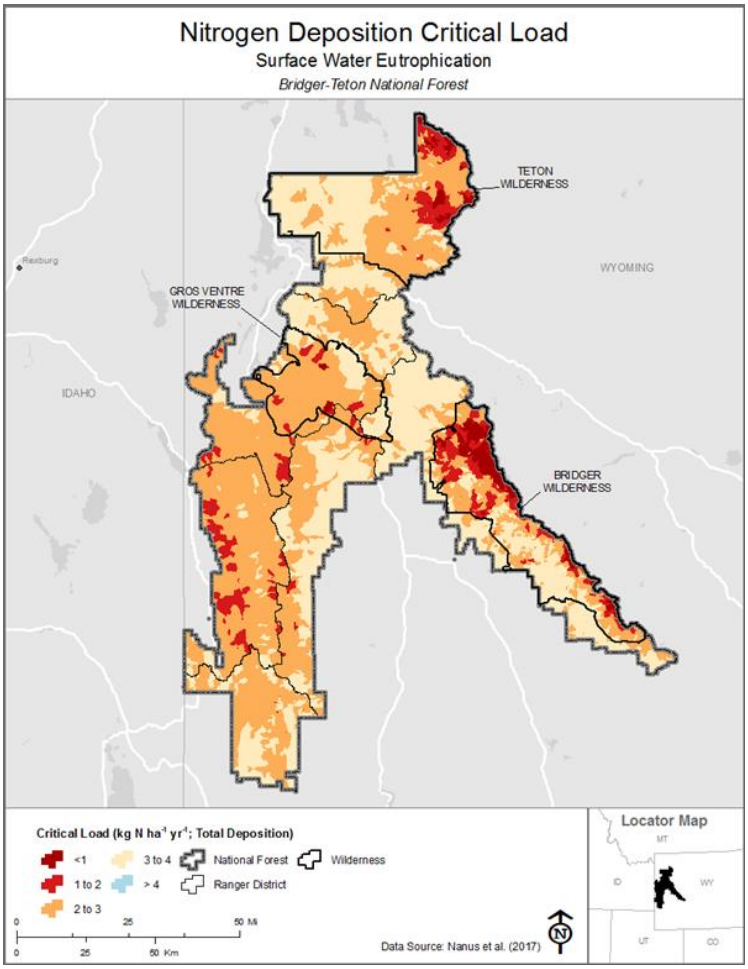

Figure A-3. Total nitrogen (N) deposition critical loads CLs to protect against the onset of surface water eutrophication on the Bridger-Teton NF Bridger-Teton National Forest.

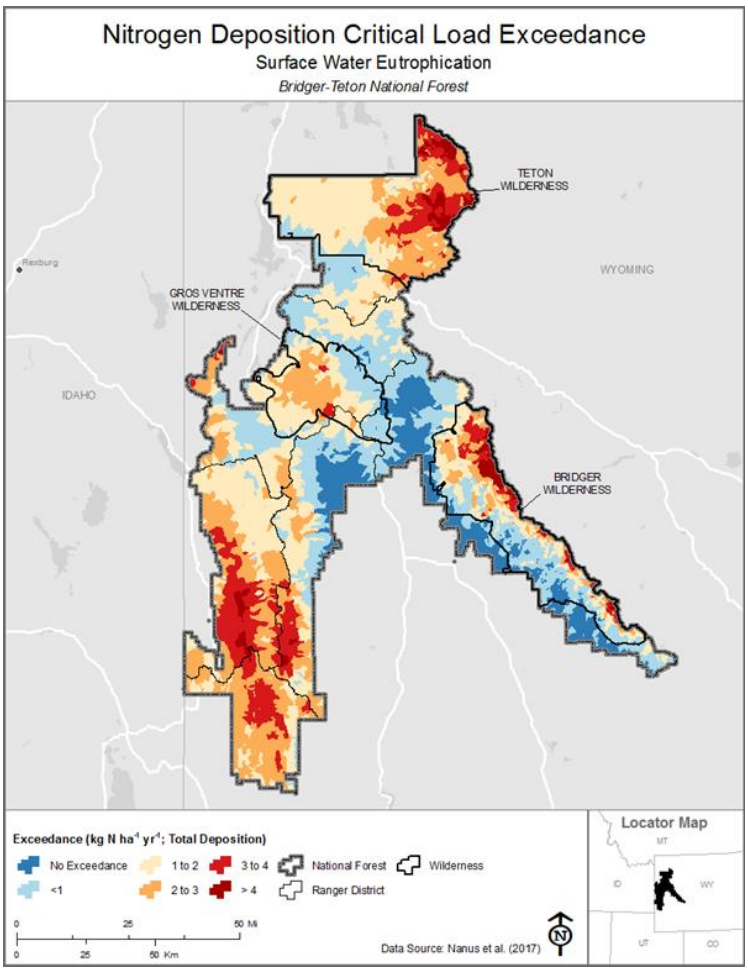

Figure A-4. Exceedances of critical loads for total nitrogen (N) that protect against surface water eutrophication within the Bridger-Teton National Forest. Based on a threshold nitrate concentration of 0.5 µmol L^{-1}.

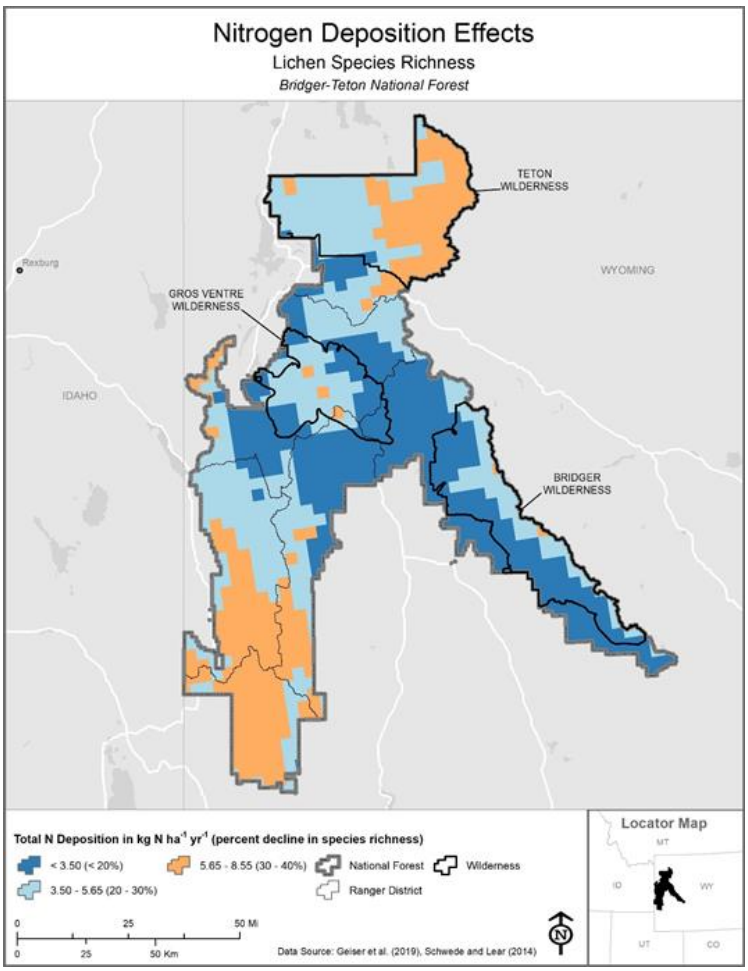

Figure A-5. Total nitrogen (N) deposition (average 2015 – 2017) and the estimated effect to lichen species richness within the Bridger-Teton National Forest. The critical load (CL) that protects against a > 20% decline in lichen species richness is 3.5 kg N ha^{-1} yr^{-1}. Areas with total N deposition above the CL represent locations of CL exceedance. The colors represent different magnitudes (kg N ha^{-1} yr^{-1}) of the exceedance and the associated percent declines in lichen species richness (e.g., 30-40%).

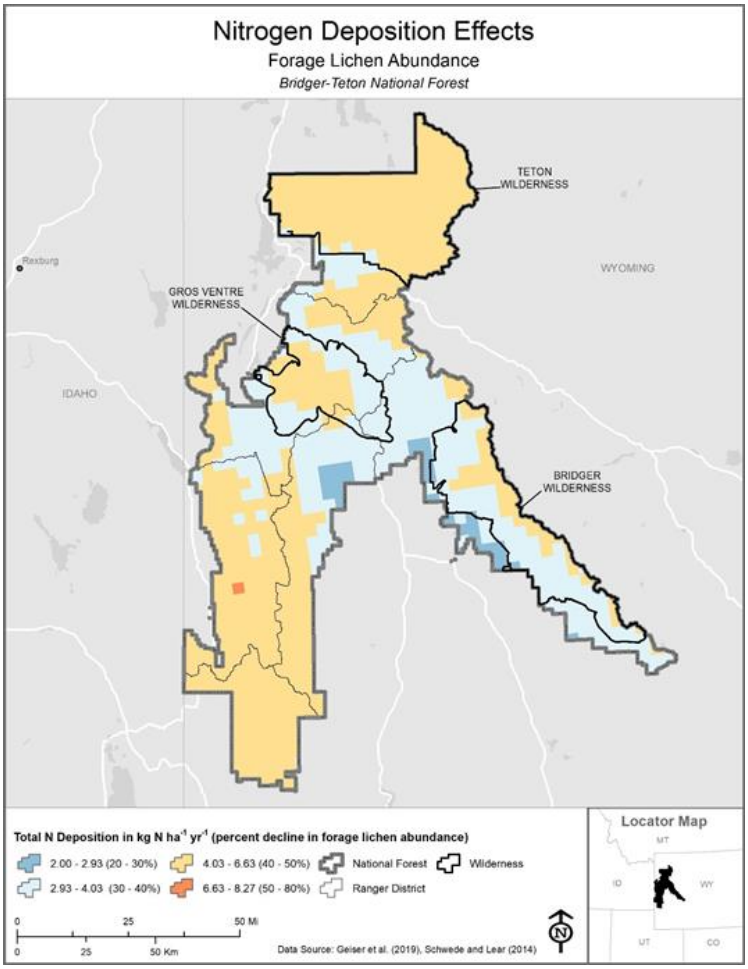

Figure A-6. Total nitrogen (N) deposition (average 2015 – 2017) and the estimated effect to forage lichen abundance within the Bridger-Teton National Forest. The critical load (CL) that protects against a > 20% decline in forage lichen abundance is 2.0 kg N ha^{1} yr^{-1}. Areas with total N deposition above the CL represent locations of CL exceedance. The colors represent different magnitudes (kg N ha^{-1} yr^{-1}) of the exceedance and the associated percent declines in forage lichen abundance (e.g., 30-40%).

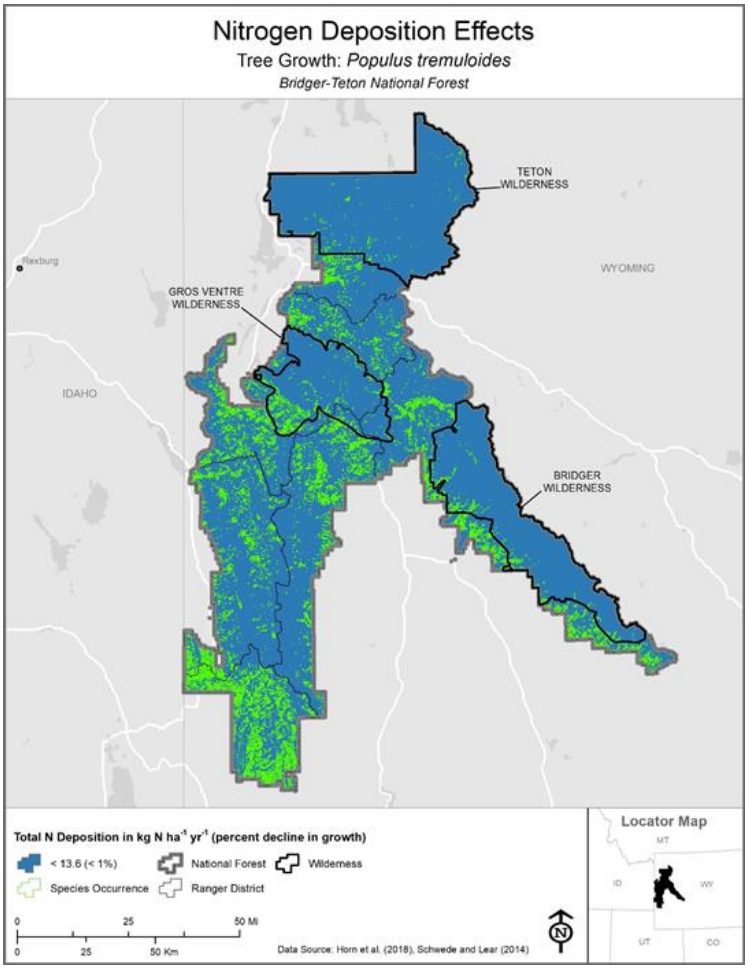

Figure A-7. Total nitrogen (N) deposition and percent declines in growth rate for quaking aspen within the Bridger-Teton National Forest. The entire Forest is below the N deposition (13.6 kg ha^{-1} yr^{-1}) associated with a >1% decline in growth rate for quaking aspen. Species occurrence represents the area where the species canopy cover is modeled as dominant or codominant on the Forest. Estimated N deposition is the average of 2015–2017.

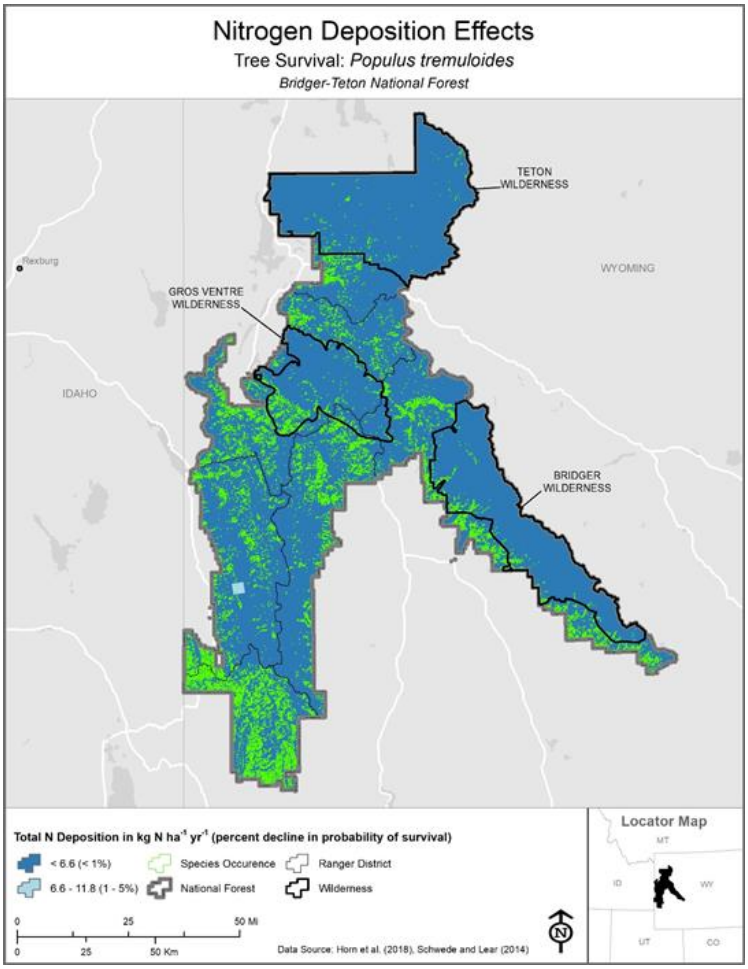

Figure A-8. Total nitrogen (N) deposition percent decline in probability of survival over 10 years for quaking aspen within the Bridger-Teton National Forest. The deposition load associated with a > 1% decline in probability of survival is 6.6 kg N ha^{-1} yr^{-1}. Species occurrence represents the area where the species canopy cover is modeled as dominant or codominant on the Forest. Only 0.1 km^2 in the Wyoming Range is associated with a > 1% decline in survival. Estimated N deposition is the average of 2015–2017.

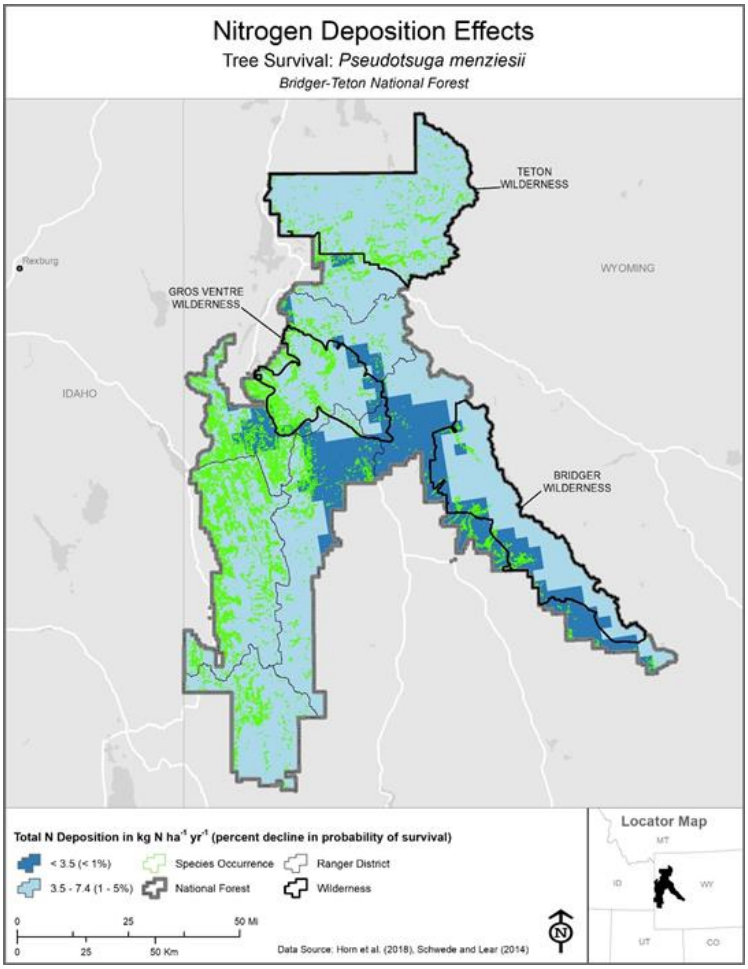

Figure A-9. Total nitrogen (N) deposition and percent declines in probability of survival over 10 years for Douglas-fir within the Bridger-Teton National Forest. The deposition load associated with a > 1% decline in probability of survival is 3.5 kg N ha^{-1} yr^{-1}. Species occurrence represents the area where the species canopy cover is modeled as dominant or codominant on the Forest. Estimated N deposition is the average of 2015 – 2017.

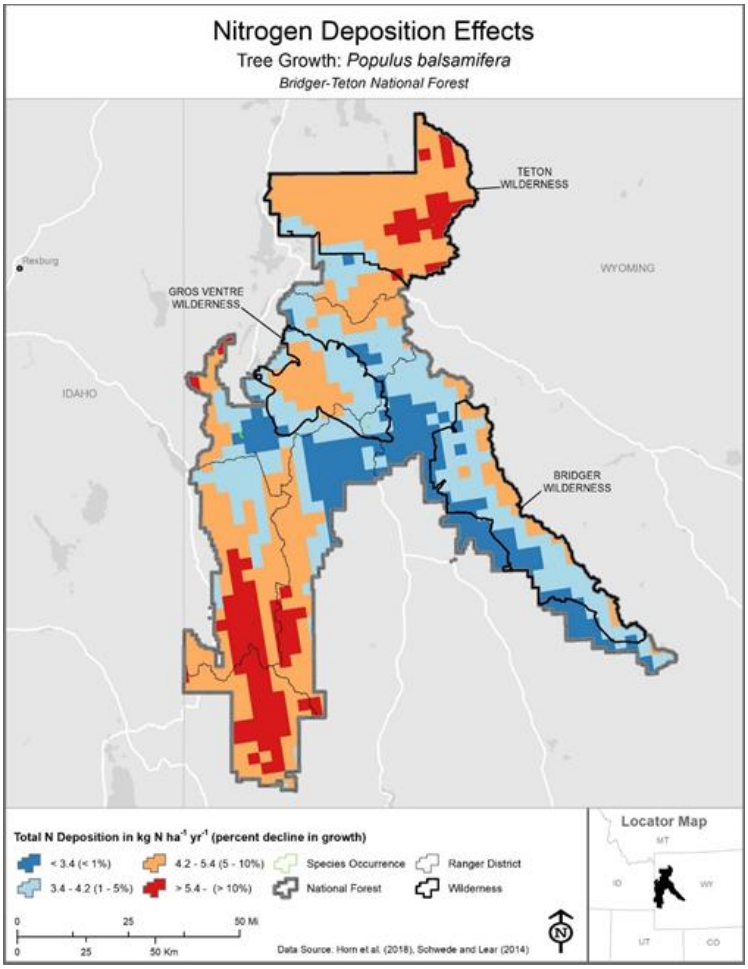

Figure A-10. Total nitrogen (N) deposition and percent declines in growth rate for balsam poplar within the Bridger-Teton National Forest. The deposition load associated with a > 1% decline in growth rate is 3.4 kg N ha^{-1} yr^{-1}. Species occurrence represents the area where the species canopy cover is modeled as dominant or codominant on the Forest. Balsam poplar is sparsely located (1.5 km^2) in the central and northern portions of the Forest and is difficult to see on the map. N deposition is associated with 1-5% and 5-10% declines in growth rate. Estimated N deposition is the average of 2015–2017.

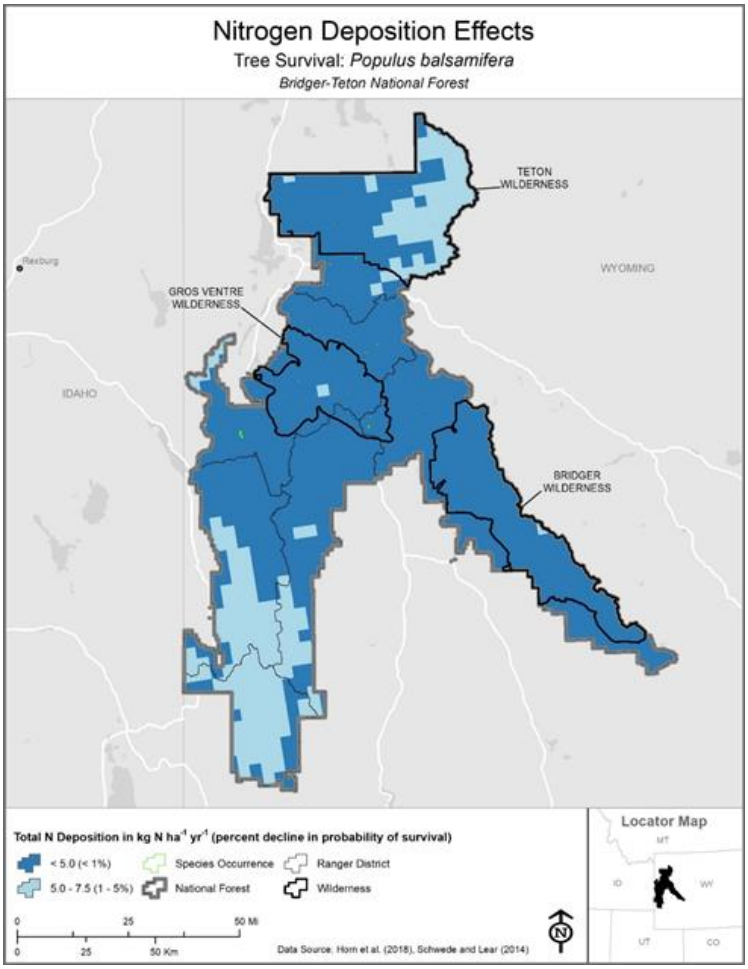

Figure A-11. Total nitrogen (N) deposition and percent decline in probability of survival over 10 years for balsam poplar within the Bridger-Teton National Forest. The deposition load associated with a > 1% decline in probability of survival is 5.0 kg N ha-1 yr-1. Species occurrence represents the area where the species canopy cover is modeled as dominant or codominant on the Forest. Balsam poplar is sparsely located (1.5 km2) in the central and northern portions of the Forest and is difficult to see on the map. All modeled occurrences are associated with <1% decline. Estimated N deposition is the average of 2015–2017.

Table A-7. Nitrogen deposition loads (kg N ha-1 yr-1) that protect against declines of 1%, 5% and 10% in tree growth rate and probability of survival (over 10 years) for species found within the BTNF. Critical loads (CLs) were not calculated for species with an increasing or flat response to N deposition.

					TLs that Protect Against Various Percent Declines in Tree Growth and Survival		
Common Name	**Species Name**	**Form of Response to N Deposition**		**CL**	**1%**	**5%**	**10%**
Subalpine fir	*Abies lasiocarpa*	Growth	Increasing	---	---	---	---
		Survival	Flat	---	---	---	---
Engelmann spruce	*Picea engelmannii*	Growth	Decreasing[1]	---	---	---	---
		Survival	Threshold[1]	---	---	---	---
Lodgepole pine	*Pinus contorta*	Growth	Flat	---	---	---	---
		Survival	Flat	---	---	---	---
Balsam poplar	*Populus balsamifera*	Growth	Decreasing	3.3	3.4	4.2	5.4
		Survival	Threshold	3.7	5.0	7.5	10.2
Quaking aspen	*Populus tremuloides*	Growth	Threshold	11.1	13.6	17.5	21.3
		Survival	Threshold	4.2	6.6	11.8	18.4
Douglas-fir	*Pseudotsuga menziesii*	Growth	Increasing	---	---	---	---
		Survival	Threshold	2.0	3.5	7.4	13.2

[1]Model not used because high correlation between variables increased uncertainty of deposition effects

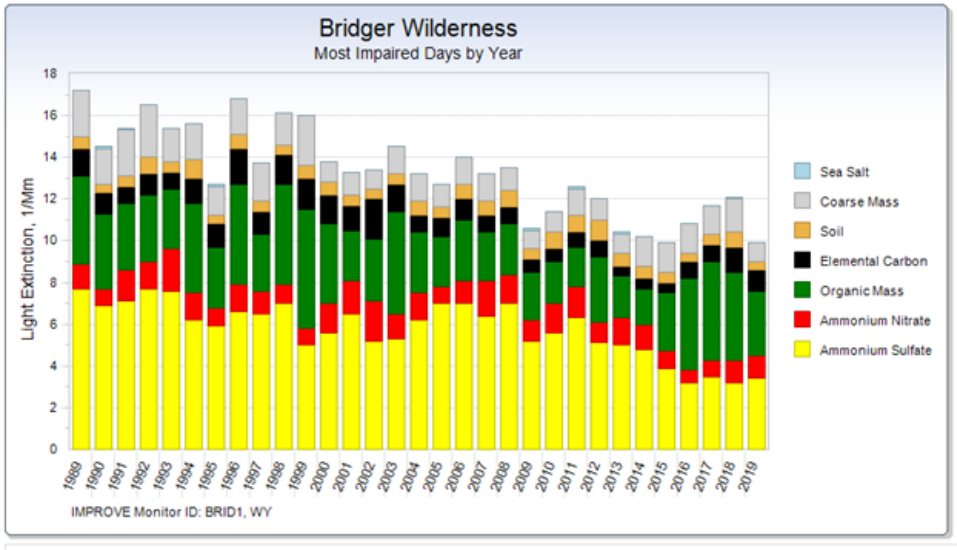

Figure A-12. Most impaired days by year at the Bridger IMPROVE site (Federal Land Manager Environmental Database 2021).

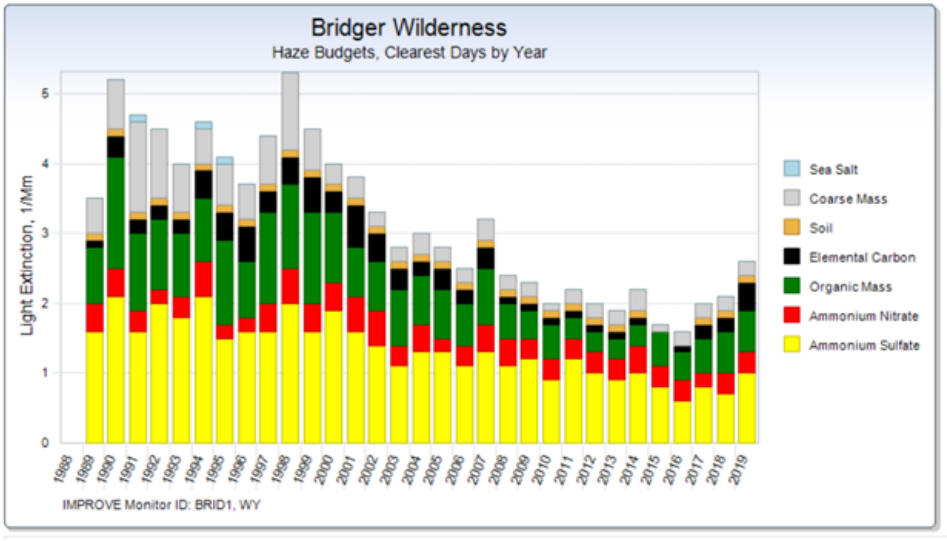

Figure A-13. Clearest days by year at the Bridger IMPROVE site (Federal Land Manager Environmental Database 2021).

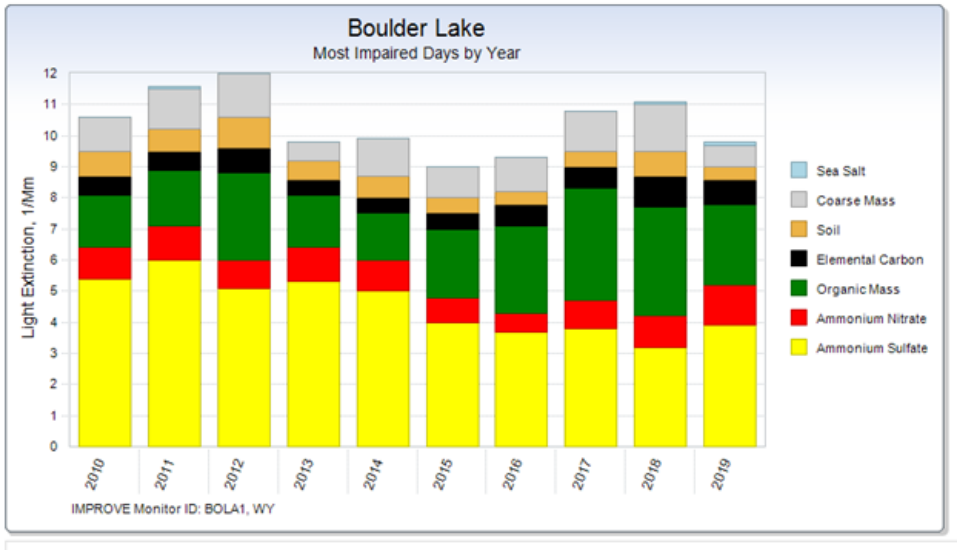

Figure A-14. Most impaired days by year at the Boulder Lake IMPROVE site (Federal Land Manager Environmental Database 2021).

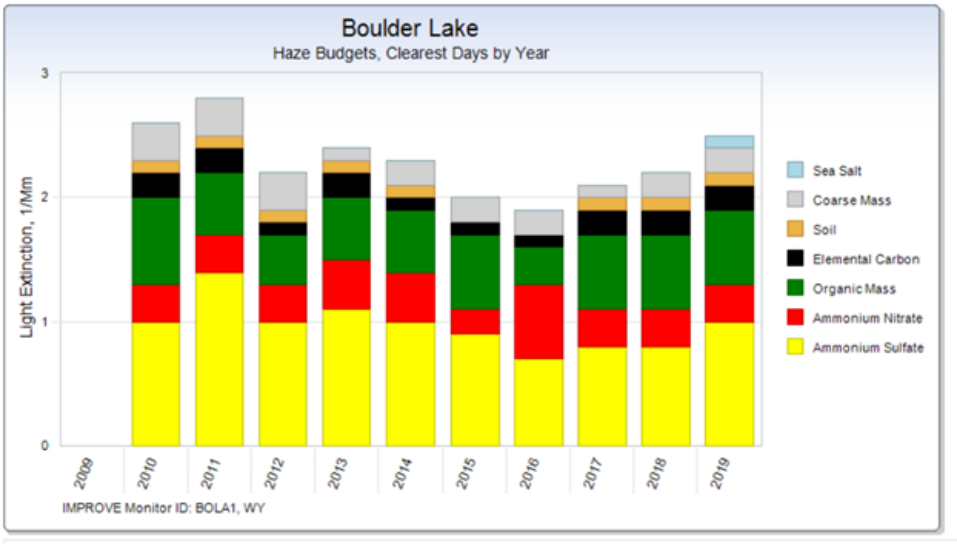

Figure A-15. Clearest days by year at the Boulder Lake IMPROVE site (Federal Land Manager Environmental Database 2021).

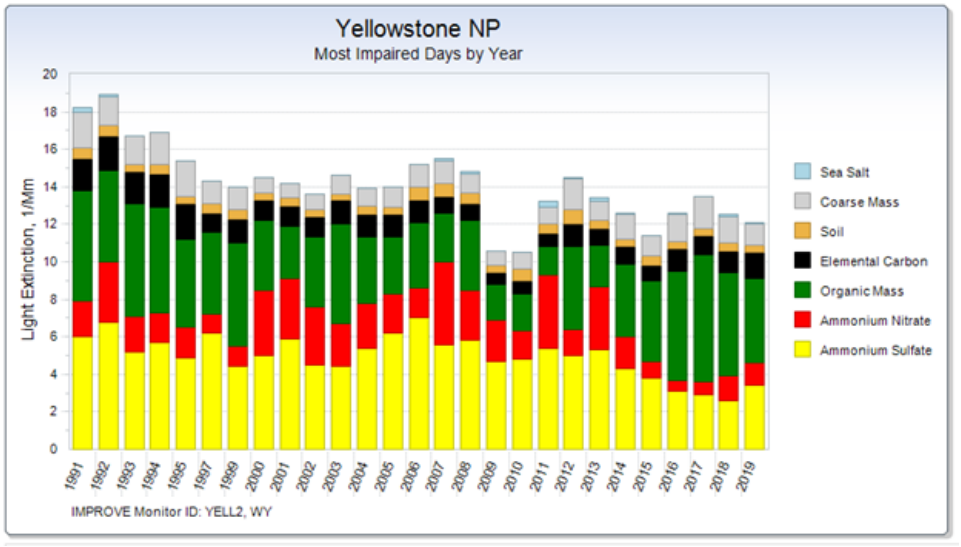

Figure A-16. Most impaired days by year at the Yellowstone IMPROVE site (Federal Land Manager Environmental Database 2021).

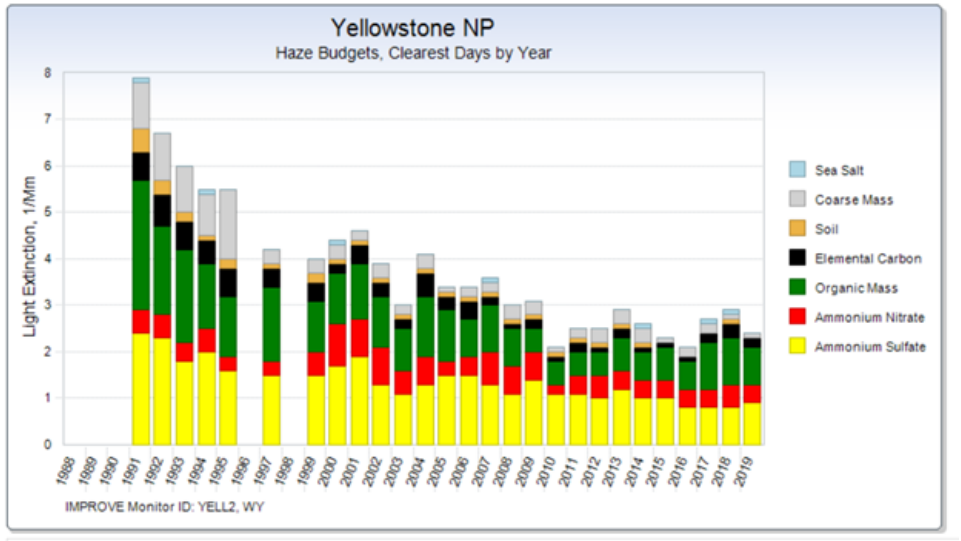

Figure A-17. Clearest days by year at the Yellowstone IMPROVE site (Federal Land Manager Environmental Database 2021).