United States Department of Agriculture
Forest Service

2018 Biennial Monitoring Evaluation Report

Medicine Bow-Routt National Forests and Thunder Basin National Grassland

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Cover photo description: A high alpine lake on the Snowy Range Mountains

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Certification

The Record of Decision (ROD) for the Medicine Bow National Forest Land and Resource Management Plan (Medicine Bow Plan) was signed on December 29, 2003. The ROD for the Thunder Basin National Grassland (Grassland Plan) was signed on July 31, 2002 and the ROD for the Routt National Forest Land and Resource Management Plan (Routt Plan) was signed on February 17, 1998. These Plans are dynamic documents and may be changed or amended based on information provided in monitoring and evaluation reports. The conclusions and recommendations documented in these reports are intended to provide the information necessary to determine whether the Plans are sufficient to guide management of the Forests for the next year or whether the Plans need to be modified.

I have reviewed the 2018 Biennial Monitoring Evaluation Report for the Medicine Bow and Routt National Forests and Thunder Basin National Grassland. The Report was prepared by the Forest's interdisciplinary team (IDT) and indicates that, overall, Forest management is meeting the goals, objectives, standards and guidelines, and management area prescriptions prescribed in the Plans. My review validates that the monitoring and evaluation requirements outlined in Chapter 4 of the Plans have been met and that, with few exceptions, the Plans are sufficient to continue guiding management of the Forests.

Please note that a land and resource management plan amendment was completed for the Thunder Basin National Grassland plan after the monitoring data in this report was collected in 2018. The record of decision for the Thunder Basin National Grassland 2020 Plan Amendment was released on December 2, 2020. The amendment may have affected some monitoring requirements and will be addressed in subsequent biennial monitoring evaluation reports.

Please contact Mary Flores at the Medicine Bow-Routt National Forests and Thunder Basin National Grassland (mary.flores@usda.gov) 2468 Jackson Street, Laramie, Wyoming, 82070, or call (307) 745-2300, if you have any specific concerns, questions, or comments about this report.

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Forest Supervisor

Summary of Findings and Results

This is the first biennial monitoring evaluation report for the Medicine Bow-Routt National Forests and Thunder Basin National Grassland (Forests and Grassland) since the monitoring plan was revised in 2016[1]. This first report includes monitoring information for all monitoring items and indicators, regardless of their identified reporting cycle (i.e., frequency). This was done to provide a baseline upon which future monitoring reports can draw trends, base conclusions, and understand how management on the forest is interacting with the goals and objectives in the forest and grassland land and resource management plans. Although this report provides information for each of the 18 monitoring items, data were not available for all monitoring item indicators. Consequently, reporting for some monitoring items is more detailed than for others. The following eight tables provide summaries of this biennial monitoring evaluation report's findings.

Table 1. Status of select watershed conditions.

Monitoring item	Year of most recent data reported in this report	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?
1. Watershed conditions	2018	Yes (best management practices); no (watershed condition); uncertain (water quality,[1] native fish,[3] stream flow,[1] watershed projects[3])	No	N/A

Table 2. Status of select ecological conditions including key characteristics of terrestrial and aquatic ecosystems.

Monitoring item	Year of most recent data reported in this report	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?
2. Vegetation	2017	No (forest vegetation)	Maybe	Forest plan (desired conditions for habitat structural stages)
3. Riparian and wetland conditions	2017	Yes (groundwater dependent ecosystems); uncertain (riparian areas[1])	No	N/A
4. Sagebrush ecosystems	2017	Uncertain (greater sage-grouse habitat,[1] sagebrush bird communities[3])	Maybe	Forest/grassland plan (greater sage-grouse amendment desired conditions)

[1] The Medicine Bow-Routt National Forests and Thunder Basin National Grassland updated its monitoring program in May 2016 for consistency with the 2012 planning regulations [36 CFR 219.12 (c)(1)].

Table 3. Status of focal species to assess the ecological conditions required under § 219.9.

Monitoring item	Year of most recent data reported in this report	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?
5. Grassland focal species	2018	No (prairie dog colonies, plague); uncertain (associated species[3])	Maybe	Grassland plan (category 2 area locations, plague management components)
6. Forest focal species	2017	Uncertain[1,3]	Yes	Monitoring plan (pygmy nuthatch)
7. Alpine focal species	2017	Uncertain[1,3]	No	N/A
8. Wetland focal species	2017	Uncertain[1,3]	No	N/A

Table 4. Status of a select set of the ecological conditions required under § 219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern.

Monitoring item	Year of most recent data reported in this report	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?
9. Black-footed ferret habitat	N/A	No (see monitoring item 5)	Yes	Monitoring plan
10. Lynx habitat	2017	Yes	No	N/A

Table 5. Status of visitor use, visitor satisfaction, and progress toward meeting recreation objectives.

Monitoring item	Year of most recent data reported in this report	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?
11. Visitor satisfaction and use	2013	Uncertain[3]	No	N/A
12. Public access	2016	Uncertain[3]	No	N/A

Table 6. Measurable changes on the plan area related to climate change and other stressors that may be affecting the plan area.

Monitoring item	Year of most recent data reported in this report	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?
13. Stressors	2018	No (insects and disease); uncertain (climate change,[3] wildland fire,[3] habitat connectivity,[3] unauthorized off-highway vehicle use[3])	Maybe	Monitoring plan (monitor aquatic organism passage projects to indicate habitat connectivity)

Table 7. Progress toward meeting the desired conditions and objectives in the plan, including for providing multiple use opportunities.

Monitoring item	Year of most recent data reported in this report	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?
14. Socioeconomic contributions	2017	Uncertain[1,3]	No	N/A
15. Heritage	2017	Uncertain[1,3]	No	N/A

Table 8. Effects of each management system to determine that they do not substantially and permanently impair the productivity of the land.

Monitoring item	Year of most recent data reported in this report	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?
16. Soil	2017	Yes	Yes	Forest plan (threshold for project-level detrimental soil disturbance)
17. Forest regeneration	2017	No	No	N/A
18. Rangeland sustainability	2018	Uncertain (utilization,[1,2,3] weeds,[3] wild herbivores,[3] animal unit months[1,3])	Maybe	Monitoring plan (select additional indicators for administering rangeland to standard)

[1] More time/data are needed to understand status or progress of the plan component.

[2] Methods/results are inadequate to answer monitoring question.

[3] Monitoring indicators have a general, rather than direct, quantitative link with plan components. Additional indicators or information may be necessary to establish progress toward plan goals, objectives, or desired conditions.

An overarching finding of this monitoring report is the need to more directly connect monitoring indicators to plan content. Many of the indicators have a general, rather than direct, quantitative link with plan content or other regulatory requirements. Some results show opportunity to identify and monitor more specific information. Other results show forest success in meeting forest and grassland plan goals, objectives, and desired conditions. Taken together, the results and analysis contained in this report should facilitate consideration of needs for programmatic planning and monitoring on the forests and grassland. This report should spark discussion about tackling emerging, interconnected challenges such as climate change, increased wildland fire activity, and changing patterns in visitor use that affect all resources and uses of the forests and grassland.

1. Introduction

1.1 Purpose

The biennial monitoring evaluation report represents one part of the Forest Service's overall monitoring program for the Forests and Grassland. The biennial monitoring evaluation report is not a decision document—it evaluates monitoring questions and indicators presented in the plan monitoring program chapter of the forest and grassland plans (Chapter 4) in relation to management actions carried out on the forest and grassland unit. This report helps the responsible official determine whether a change to the forest plan, management activities, or monitoring program is needed, or whether a forest assessment may be needed based on the new information.

1.2 Objectives

Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program. This biennial monitoring evaluation report is the vehicle for disseminating this information.

In the context of forest planning there are three primary types of monitoring goals:

- Implementation monitoring: Are we implementing the forest and grassland plans properly? Are we meeting our management targets and project guidelines?
- Effectiveness monitoring: Are we achieving our forest and grassland plan management goals and desired outcomes?
- Validation monitoring: Does our hypothesis testing indicate we may need to change the forest or grassland plans?

With these three types of monitoring goals as a framework, the unit developed several objectives specific to the biennial monitoring evaluation report, including:

- Assess the current status of selected forest resources and trends in specific indicators.
- Document implementation of the plan monitoring program including monitoring activities and public participation in the monitoring effort.
- Evaluate relevant assumptions, changed conditions, management effectiveness, and progress toward achieving the selected desired conditions, objectives, and goals described in the forest and grassland plans.
- Document any scheduled monitoring actions that have not been completed and the reasons and rationale for why not.
- Present any new information not outlined in the current plan monitoring program indicators that is relevant to the evaluation of the selected monitoring questions.
- Present to the responsible official recommended opportunities, if any, to change the forest and grassland plans, management activities, or monitoring program, or to initiate an assessment to determine whether there is a preliminary need for change.

1.3 Public Participation

The unit offered a 30-day public comment period on the proposed changes to the monitoring plan beginning on March 16, 2016. The public was notified of the proposed changes by posting an informative document to the unit's webpage and by mailing paper copies of the document to known interested

parties, state agencies, and local governments; 10 comments were received. On May 9, 2016, a letter authorizing the monitoring changes was posted to the unit's webpage. This letter also included an overview of public comments received on the proposed changes as well as Forest Service responses.

This report will be available, along with past forest-wide monitoring reports and the 2016 monitoring program update, at the Forests and Grassland website at https://www.fs.usda.gov/main/mbr/landmanagement/planning. Feedback or questions regarding the results presented in this report may be submitted to Mary Flores, Renewable Resources Staff Officer, at mary.flores@usda.gov.

Future biennial monitoring evaluation reports will be posted to the unit's webpage as they become available. Active solicitation of public input on future reports will occur only if changes are proposed to monitoring plan components (e.g., monitoring questions, indicators).

1.4 About Our Forest Plan Monitoring Program

1.4.1 Roles, Responsibilities, and Partners

The forest monitoring program requires a coordinated effort of many people. For the data presented in this report, the Forest Service depends on the work of universities and other research institutions, citizen scientists, non-governmental organizations, neighboring landowners, grassland users, and Federal, State, and local agencies and governments. Partnerships with these groups are critical to producing reliable, informative data. While all data sources are listed and links to external websites included throughout, this report cannot provide sufficient credit to the Forest Service partners that make possible the success of the forest and grassland monitoring program.

1.4.2 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 MBRTB updated its monitoring program in May 2016 for consistency with the 2012 planning regulations [36 CFR 219.12 (c)(1)]. The unit administratively changed the forest and grassland plans to include the updated monitoring program. The unit has not otherwise revised the forest and grassland plans under the 2012 planning regulations.

In the monitoring program, monitoring questions and key indicators were identified to track select resources to inform progress toward desired conditions and objectives in the forest and grassland plans. The monitoring program does not include questions and indicators to track every plan component [36 CFR 219.12(a)(2)]. The monitoring program is structured based on the required monitoring elements at 36 CFR 219.12(a)(5). The monitoring program makes use of existing monitoring efforts and databases developed by the Forest Service and other cooperating agencies and organizations.

This biennial monitoring evaluation report provides monitoring results for quantitative variables where possible. Such data facilitates analysis of progress toward quantitative thresholds or targets in the forest and grassland plans. Where monitoring indicators are linked to qualitative goals, objectives, or desired conditions, this report's findings are less conclusive; however, even where monitoring data are not directly quantitatively linked to plan content, the results can provide valuable information to help Forest Service staff and the public interpret the status and condition of resources across the forests and grassland in the context of the forest and grassland plans.

1.4.3 Note on dates and data

Although data for this report were initially gathered in 2017 and 2018, report preparation was delayed until December 2020. While some additional data were gathered to complete the report during the editing and finalization phase, this report does not include data for years after 2018. Because data are limited to 2018 and before, and because the status and conditions of resources reflected in that data resulted from the forest and grassland plan direction existing at that time, any amendments to the forest and grassland plans since 2018, including the Thunder Basin National Grassland 2020 Plan Amendment, are not addressed in this report. The record of decision for the Thunder Basin National Grassland 2020 Plan Amendment was released on December 2, 2020. The amendment may have affected monitoring requirements related to shortgrass prairie ecosystems (monitoring item 5) and black-footed ferret (monitoring item 9). Any necessary changes to the monitoring program as a result of the amendment will be addressed in subsequent biennial monitoring evaluation reports.

2. Monitoring and Evaluation

The following sections present data and evaluations up to 2018 for all monitoring items in the MBRTB monitoring program. This section describes how monitoring data were collected and evaluated and displays summary data for each monitoring item. Each monitoring item includes 1) a summary of the monitoring question and its indicator(s); 2) a summary of the monitoring results; and 3) a discussion of the monitoring data. The discussion section for each monitoring item contains a brief analysis of whether the monitoring data indicate progress toward forest and grassland goals and objectives and a list of recommendations. Recommendations vary in specificity, but the recommendation lists are intended to identify issues in monitoring or management based on the monitoring results. The discussions and listed recommendations therein are not prescriptive, but rather intended to spark discussion and inform the responsible official.

While information is reported for each monitoring item, data were unavailable for some monitoring indicators. These data were not collected or collected but not reported for various reasons, including the discontinuity of the preparation of this report (see section 1.5.3). Indicators for which data were not reported include item 2, indicator 2 – macroinvertebrate sampling; item 9 – black-footed ferret habitat; item 12, indicator 4 – acres open to public access; item 13, indicator 1 – stream and lake temperature; and item 14, indicator 1 – recreation and minerals contributions to local economies. For some additional indicators, data were available for less than all applicable areas of the forests and grassland (for example, indicators for which the Thunder Basin National Grassland is not evaluated). In most cases, data will be updated for these indicators in the next biennial monitoring evaluation report. In some cases, data not reported can inform potential opportunities to refine the monitoring program.

2.1 Monitoring Item 1: Watershed Conditions

2.1.1 Monitoring Question and Background

- What are watershed conditions and trends on the planning unit?

This monitoring item addresses plan components associated with legal requirements such as the Clean Water Act (33 USC 1251) and goals and objectives such as protecting and improving watershed condition, maintaining and restoring aquatic ecosystem integrity, and conserving native fish. Table 9 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the

frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 9. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for watershed conditions.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.a, Objective 1, Strategy a **Routt:** Goal 1, Objective bullets 2, 3 **Thunder Basin:** Goal 1.a, Objective 1	1. Condition class: Number and percent of watersheds in each condition class	Forest Service Watershed Condition Framework data via the Watershed Condition Assessment Tracking Tool (WCATT) database	a) 5 years b) 5 years	Over the life of the plan, improve watershed condition in 20% of 5th level Hydrologic Unit Code watersheds. (Medicine Bow) Improve 20% of 6th Hydrologic Unit Code (sub-watershed) level watersheds from Class II to Class I, or from Class III to Class II. (Thunder Basin)
Medicine Bow: Goal 1, Subgoal 1.a, Objective 2-4, Strategy b **Routt:** Goal 1, Objective bullets 2, 3 **Thunder Basin:** Goal 1.a, Objective 1	2. Water quality: i) Number of streams on state threatened or impaired lists and state monitoring and evaluation lists ii) Macroinvertebrate sampling	i. Colorado Department of Public Health and Environment (CDPHE); Wyoming Department of Environmental Quality (WYDEQ) ii. Forest Service and WYDEQ	i. a) Annually b) 2 years ii. a) 5 Years b) 5 Years	Over the life of the plan, maintain or improve water quality by achieving an 80% reduction in the miles of State of Wyoming designated streams not fully supporting designated beneficial uses and by maintaining existing fully supporting designated beneficial uses in all streams, lakes, reservoirs, and open water bodies. (Medicine Bow)
Medicine Bow: Goal 1, Subgoal 1.b, Objective 1, Strategies k, m **Routt:** Goal 1, Objective bullets 6, 7 **Thunder Basin:** Goal 1.b, Goal 3.a, Objective 5	3. Presence/ absence of native fish species	Forest Service/Wyoming Game and Fish Department (WGFD)/Colorado Parks and Wildlife (CPW) survey data WYDEQ/WGFD invasive aquatic species data	a) Annually b) 2 years	

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.a, Objective 4 **Routt:** Goal 1, Objective bullets 2, 3 **Thunder Basin:** Goal 1.a, Objectives 1, 3, 4	4. Streamflow: i) Current versus historic flows ii) Number of water developments with streamflow or water body level protection provisions	i) United States Geological Survey (USGS) National Water Information System ii) Number of water development authorizations with streamflow or water body level protection provisions	i. a) Annually b) 2 years ii. a) Annually b) 3 years	Within 15 years, identify and then maintain, and/or improve stream flows for at least 10% of stream segments having instream flow concerns. (Medicine Bow) Within 15 years, identify, maintain, and/or improve stream flows for at least 10% of stream segments having high resource values within watersheds. (Thunder Basin)
Medicine Bow: Goal 1, Subgoal 1.a, Objective 1, Strategy a, Subgoal 1.b, Objective 2 **Routt:** Goal 1, Objective bullets 2, 3 **Thunder Basin:** Goal 1.a, Objectives 1, 2	5. Watershed projects: number and acres of watershed improvement projects completed or other projects that meet watershed improvement criteria as reported	Forest Service Watershed Improvement Tracking database (WIT)	a) Annually b) Annually	
Medicine Bow: Goal 1, Subgoal 1.a, Objective 2, Strategy c **Routt:** Goal 1 **Thunder Basin:** Goal 1.a, Objectives 1-4	6. Implementation and effectiveness of best management practices to protect water quality	Forest Service national best management practices program monitoring protocol and database	a) Annually b) Annually	

2.1.2 Monitoring Results

Indicator 1 – Watershed Condition Framework

The Watershed Condition Framework is a nationally consistent framework that is used to categorize watersheds in the National Forest System into different condition classes, prioritize restoration activities, and track progress towards achieving restoration goals. Class 1 watersheds have ecological structure, function, and composition comparable to natural wildland conditions. Class 2 watersheds are functioning at risk and Class 3 watersheds have highly impaired functions, because some physical, hydrologic, or biological thresholds have been exceeded in these watersheds. Exceedance of these thresholds can occur due to natural processes, such as wildland fire or large slope failures, but is more commonly caused by human-related disturbance, such as roads, overgrazing by livestock, or invasive terrestrial or aquatic species.

Monitoring data are reported every 5 years in the Forest Service Watershed Condition Assessment and Tracking Tool (WCATT). The Forests and Grassland first assessed watershed condition in 2010 when the

Forest Service adopted the Watershed Condition Framework and has since assessed watershed condition in 2013 and 2018 (Table 10).

Table 10. Forests and Grassland Watershed Condition Classification, 2010, 2013, and 2018.

Watershed Condition Class	2010	2013	2018
Functioning Properly (Class I)	81 watersheds	80 watersheds	80 watersheds
Functioning Properly (Class I)	960 square miles	929 square miles	929 square miles
Functioning Properly (Class I)	21.5% of forest	20.8% of forest	20.8% of forest
Functioning At-Risk (Class II)	175 watersheds	176 watersheds	176 watersheds
Functioning At-Risk (Class II)	3461 square miles	3492 square miles	3492 square miles
Functioning At-Risk (Class II)	77.5% of forest	78.1% of forest	78.1% of forest
Impaired Function (Class III)	2 watersheds	2 watersheds	2 watersheds
Impaired Function (Class III)	48 square miles	48 square miles	48 square miles
Impaired Function (Class III)	1% of forest	1% of forest	1% of forest

Assessment of watershed condition on the Forests and Grassland shows that conditions have remained nearly stable since 2010, with just one watershed changing condition during that time, moving from Class I to Class II between 2010 and 2013. Most watersheds on the forests and grassland have changed moderately from their natural physical, biotic, and chemical conditions with 78% of the watershed area rated as functioning at-risk (Class II). Approximately 21% of the watershed area was functioning properly (Class I), and 1%, including two watersheds, rated impaired function (Class III). Watersheds of each status are distributed across the forests and grassland.

The Watershed Condition Framework uses a set of 12 indicators to represent underlying ecological, hydrologic, and geomorphic functions and processes that affect watershed condition. Data from all watersheds on the Forests and Grassland were analyzed to determine the relative contribution of each of the 12 Watershed Condition Framework indicators to the departure from natural watershed conditions (Figure 1). Among the 12 indicators, roads and trails and aquatic biota contributed most to departure from natural watershed conditions, while terrestrial invasive species, rangeland vegetation, forest health, and fire regimes contributed least.

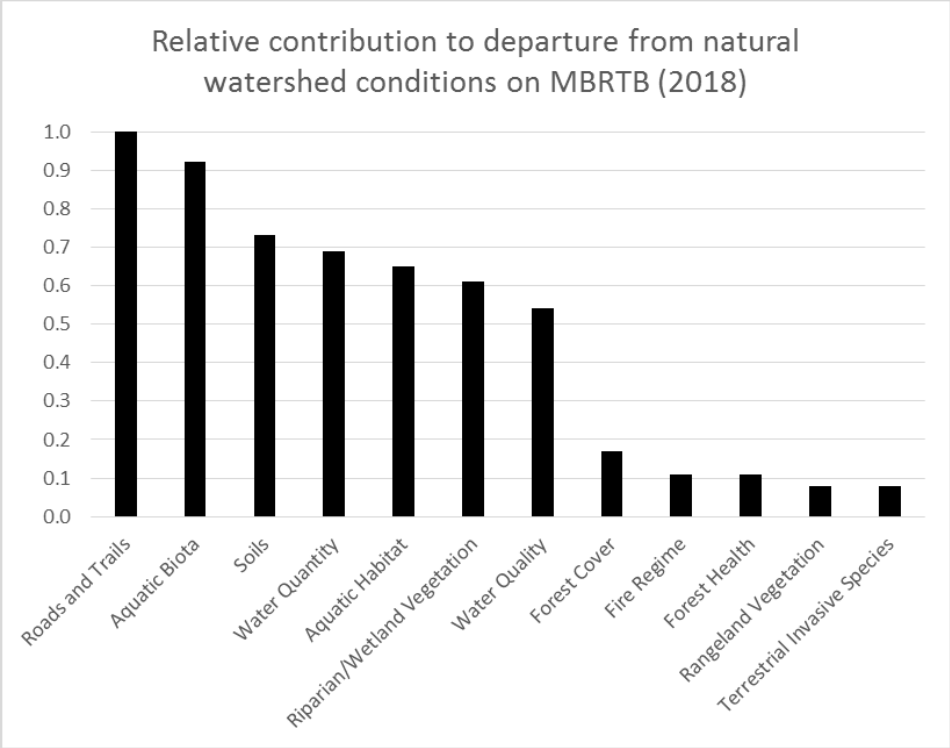

Figure 1. Relative contribution of the 12 Watershed Condition Framework indicators to departure from natural watershed conditions on the Forests and Grassland in 2018.

The Watershed Condition Framework process also involves a) prioritizing watersheds for restoration; b) developing watershed restoration action plans; c) implementing Watershed Restoration Action Plan projects to address the factors affecting watershed conditions; d) tracking accomplishments; and e) monitoring improvement of watershed conditions. The Forest has implemented a program to address all but the last step (monitoring) in this process.

Watershed Restoration Action Plans are a mechanism to document completion of management actions under the Watershed Condition Framework. Watershed Restoration Action Plans can be used to evaluate progress toward meeting forest and grassland plan goals and objectives related to maintaining and improving watershed conditions. Table 11 lists watersheds prioritized for restoration on the Forests and Grassland and progress toward developing and implementing Watershed Restoration Action Plans for each watershed. The unit completed two Watershed Restoration Action Plans in 2011, for Pelton Creek and Little Snake River – Whiskey Creek, and three more in 2017 and 2018, for East Fork Encampment River, Upper Middle Crow Creek, and Headwaters Elkhead Creek. Essential projects toward watershed restoration are ongoing in each of these 5 watersheds. Eight priority watersheds do not yet have Watershed Restoration Action Plans. More information about the Watershed Condition Framework and Watershed Restoration Action Plans is available at: https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml.

Table 11. Summary of Watershed Restoration Action Plan implementation

River Basin	Watershed	Watershed Restoration Action Plan Approval Date	Estimated Completion Date of Essential Projects
Powder-Tongue River Basin	Upper Duck Creek	Not completed	9/30/2022

River Basin	Watershed	Watershed Restoration Action Plan Approval Date	Estimated Completion Date of Essential Projects
Upper Cheyenne	Meadow Creek-Cheyenne River	Not completed	3/30/2025
North Platte	East Branch Willow Creek-Willow Creek	Not completed	9/30/2022
North Platte	Middle Douglas Creek	Not completed	9/30/2023
North Platte	Pelton Creek	9/23/2011	9/30/2020*
North Platte	East Fork Encampment River	7/12/2017	5/31/2018*
North Platte	Turpin Creek-Medicine Bow River	Not completed	9/30/2024
South Platte	Upper Middle Crow Creek	4/5/2018	9/30/2024*
Colorado Headwaters	Headwaters Rock Creek	Not completed	9/30/2022
Colorado Headwaters	Outlet Rock Creek	Not completed	9/30/2022
White-Yampa	Headwaters Elkhead Creek	2/1/2017	9/30/2026*
White-Yampa	Little Snake River – Whiskey Creek	12/15/2011	9/30/2021*
White-Yampa	North Fork Little Snake	Not completed	9/30/2024

* *Projects currently ongoing*

Indicator 2 – Water Quality

Water quality data on the Forest are collected by various Federal, State, and local governments, non-governmental entities, and individuals. The States of Colorado and Wyoming produce biennial comprehensive summaries of water quality conditions. A summary of the status of water quality across the Medicine Bow-Routt National Forests can be found in Table 12; streams with water quality problems that are affecting designated beneficial uses are listed in Table 13. Most surface waters on the forests and grassland are believed to be meeting all designated water quality uses, but because of sampling limitations, only a small subset of the waters have comprehensive data to support this conclusion (Table 3). Data for surface waters on the Thunder Basin National Grassland are unavailable and are not included in Table 12.

Table 12. Surface waters on the Medicine Bow-Routt National Forests that support designated uses.

River Basin and State	Water Body Name	Determination	Source
North Platte, WY	Bear Creek (Horse Creek)	Fully supports all designated uses.	WYDEQ, 2003
North Platte, WY	South Fork Little Laramie River	Fully supports all designated uses.	WYDEQ, 2004
North Platte, WY	Middle Fork Mill Creek	Fully supports all designated uses.	WYDEQ, 2004
North Platte, WY	Miller Lake	Fully supports all designated uses, except insufficient data to determine if fish consumption and contact recreation uses are supported.	WYDEQ, 2006
North Platte, WY	Hanging Lake	Fully supports all designated uses, except insufficient data to determine if fish consumption and contact recreation uses are supported.	WYDEQ, 2006
North Platte, WY	South Fork Hog Park Creek	Fully supports all designated uses.	WYDEQ, 2004
North Platte, WY	Smith North Creek	Fully supports all designated uses.	WYDEQ, 2004

River Basin and State	Water Body Name	Determination	Source
North Platte, WY	Encampment River	Fully supports all designated uses, except insufficient data to determine if contact recreation uses are supported.	WYDEQ, 2008
North Platte, CO	North Platte Tributaries within wilderness areas (except South Fork Big Creek)	Fully supports all designated uses	CDPHE, 2003
North Platte, CO	South Fork Big Creek	Fully supports aquatic life	CDPHE, 2003
North Platte, CO	Encampment River	Fully supports all designated uses	CDPHE, 2003
North Platte, CO	North Platte River—Camp Creek to Colo./Wyo. border	Fully supports all designated uses	CDPHE, 2003
North Platte, CO	North Platte River—Tributaries above Camp Creek	Fully supports all designated uses	CDPHE, 2003
North Platte, CO	Illinois River	Not fully supporting aquatic life	CDPHE, 2003
North Platte, CO	North Platte River—Tributaries Camp Creek to Colo./Wyo. border	Fully supports all designated uses	CDPHE, 2003
North Platte, CO	Michigan River	Fully supports all designated uses	CDPHE, 2003
Yampa, CO	Tributaries to Yampa River—Flattops Wildernes to Elk River	Fully supports all designated uses	CDPHE, 2003
Yampa, CO	East Fork Williams Fork in Flattops Wilderness	Fully supports all designated uses	CDPHE, 2001
Yampa, CO	East Fork Williams Fork River	Not assessed	CDPHE, 2001
Yampa, CO	Tributaries to Yampa River—in National Forest	Fully supports all designated uses	CDPHE, 2003; 2006
Yampa, CO	Elk River—mainstem and tributaries	Fully supports all designated uses	CDPHE, 2003
Little Snake, CO	Little Snake River Tributaries	Fully supports all designated uses (except where noted in Table X).	CDPHE, 2003

Most water quality monitoring occurs on streams where designated uses are known or suspected to be impaired; limited monitoring occurs on streams likely to meet all designated uses. Table 13 summarizes water bodies on the Forests and Grassland that the States of Colorado and Wyoming have determined or suspect to have water quality concerns. The table includes information about whether a water body is classified as threatened or impaired under the Clean Water Act, which designated uses are impaired, and the cause of impairment. Macroinvertebrate sampling did not occur during this monitoring cycle.

Table 13. Water quality impairments in water bodies occurring on the Forests and Grassland.

River Basin and State	Water Body Name	Ranger District	Threatened or Impaired[1]	Year first identified as T or I	Impaired Designated Use	Cause of Impairment
Powder River, WY	Little Powder River	Douglas	Impaired (TMDL needed; State 303(d) list; USEPA Category 5)	2002	Primary contact recreation	E. coli
North Platte, CO	South Fork Big Creek in Wilderness	Parks	Undetermined (State M&E list; USEPA Category 3)	2004	Aquatic life; drinking water	Metals--copper; E. coli

River Basin and State	Water Body Name	Ranger District	Threatened or Impaired[1]	Year first identified as T or I	Impaired Designated Use	Cause of Impairment
North Platte, CO	Grizzly Creek	Parks	Undetermined (State M&E list; USEPA Category 3)	2006	Aquatic life	Unknown
North Platte, CO	Little Grizzly Creek	Parks	Undetermined (State M&E list; USEPA Category 3)	2008	Recreation; drinking water; aquatic life	E. coli; Metals--iron (total recoverable)
North Platte, CO	Lake Creek	Parks	Undetermined (State M&E list; USEPA Category 3)	2008	Drinking water; aquatic life	pH; iron (total recoverable)
North Platte, WY	Bear Creek	Laramie	Undetermined (State M&E list; USEPA Category 3)	2010	Aquatic life; drinking water	Metals--copper
Yampa, CO	Bushy Creek	Yampa	Impaired (TMDL needed; State 303(d) list; USEPA Category 5)	2010	Aquatic life	Sediment
Yampa, CO	Little Morrison Creek	Yampa	Undetermined (State M&E list; USEPA Category 3)	2012	Aquatic life; drinking water	Zinc; iron (dissolved)
Yampa, CO	Lost Dog Creek	HPBE	Undetermined (State M&E list; USEPA Category 3)	2008	Aquatic life; drinking water	Mercury
Yampa, CO	Little Bear Creek	HPBE	Undetermined (State M&E list; USEPA Category 3)	2008	Drinking water; aquatic life	Copper; zinc
Yampa, CO	Walton Creek	HPBE	Undetermined (State M&E list; USEPA Category 3)	2010	Secondary water supply	Manganese
Little Snake, CO	Slater Creek	HPBE	Undetermined (State M&E list; USEPA Category 3)	2008	Aquatic life	Selenium
Little Snake, WY	West Fork Battle Creek	BCH	Impaired (TMDL completed; USEPA Category 4a)	2000	Coldwater fisheries; aquatic life	Metals
Little Snake, WY	Haggerty Creek	BCH	Impaired (TMDL completed; USEPA Category 4a)	<1988	Coldwater fisheries; aquatic life	Metals
South Platte, WY	North Branch North Fork Crow Creek	Laramie	Impaired (TMDL needed; State 303(d) list; USEPA Category 5)	2004	Contact recreation	E. coli
South Platte, WY	Middle Crow Creek	Laramie	Impaired (TMDL completed; USEPA Category 4a)	2004	Contact recreation	E. coli

[1] The U.S. Environmental Protection Agency (USEPA) categorizes water bodies according to condition. These categories correspond to state water quality lists, including the monitoring and evaluation (M&E) list, which indicates uncertainty about or insufficient information to make a use support determination, and the 303(d) list, referring to section 303(d) of the Clean Water Act and indicating the need for a total maximum daily load (TMDL) determination for certain pollutants. More information

about the Colorado Department of Public Health and Environment's river, lake, and stream water quality program is available at: https://cdphe.colorado.gov/rivers-lakes-and-streams. More information about the Wyoming Department of Environmental Quality's water quality assessment program is available at: http://deq.wyoming.gov/wqd/water-quality-assessment/.

Indicator 3 – Native Fish

Every 1-3 years, Forests and Grassland staff and partners conduct surveys for Colorado River cutthroat trout (genetic purity of 90% or greater) and mountain sucker, which have sensitive species status in the Forest Service Rocky Mountain Region. Presence or absence of native fish species is not currently monitored on the Thunder Basin National Grassland. In 2017, Colorado River cutthroat trout occupied 165.6 stream miles on the Routt National Forest and 85.1 stream miles on the Medicine Bow National Forest. Mountain sucker occupied 23.1 stream miles on the Routt National Forest and 20 stream miles on the Medicine Bow National Forest in 2017.

Indicator 4 – Streamflow

The United States Geological Survey (USGS) collects hydrologic data including streamflow at monitoring sites across the United Sates. The USGS National Water Information System database stores current and historical hydrologic monitoring data. The figures below show data from select USGS streamgages that collect data about streams flowing through the forests and grassland. Figures 2 and 3 show annual streamflow data including peak discharge and average daily discharge for the North Brush Creek streamgage in the Snowy Range mountains and the Encampment River streamgage station in the Sierra Madre mountains on the Medicine Bow National Forest. Figure 4 shows annual streamflow data for Fish Creek streamgage on the Routt National Forest. Figure 5 shows annual streamflow data for the Cheyenne River streamgage on the Thunder Basin National Grassland.

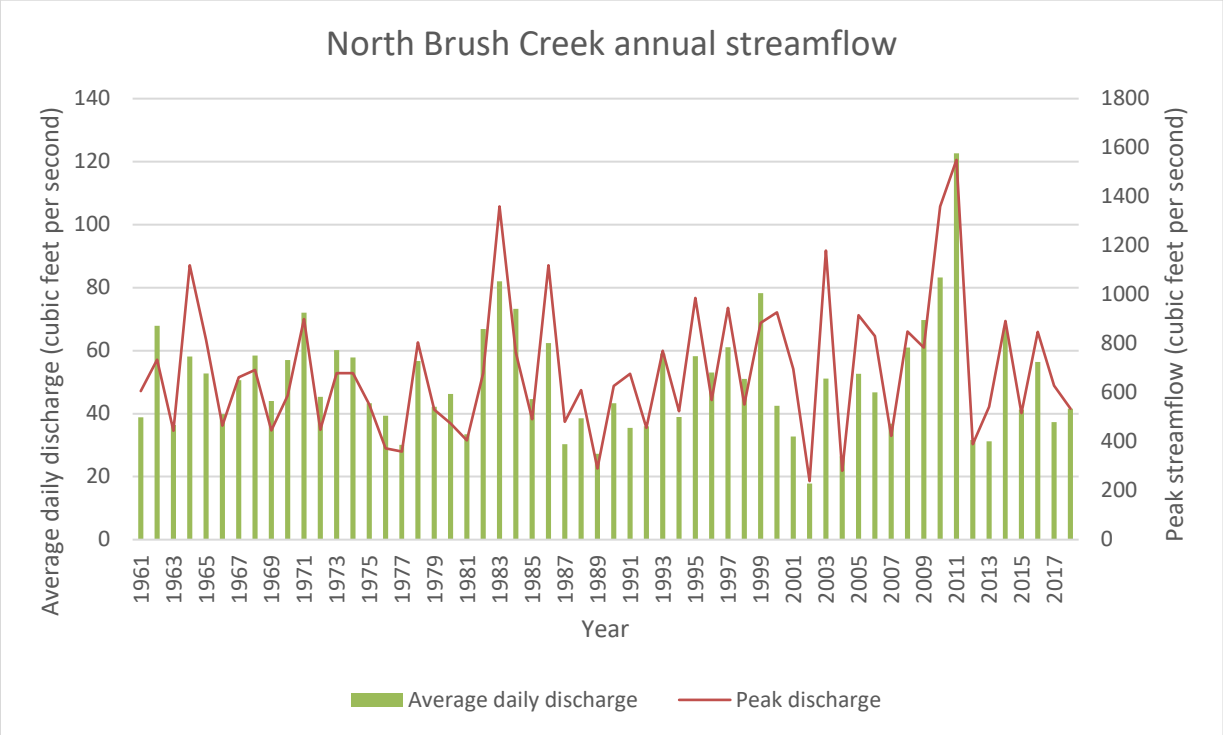

Figure 2. Annual average daily discharge and annual peak discharge at the North Brush Creek streamgage (USGS 06622700) on the Medicine Bow National Forest, 1961-2018.

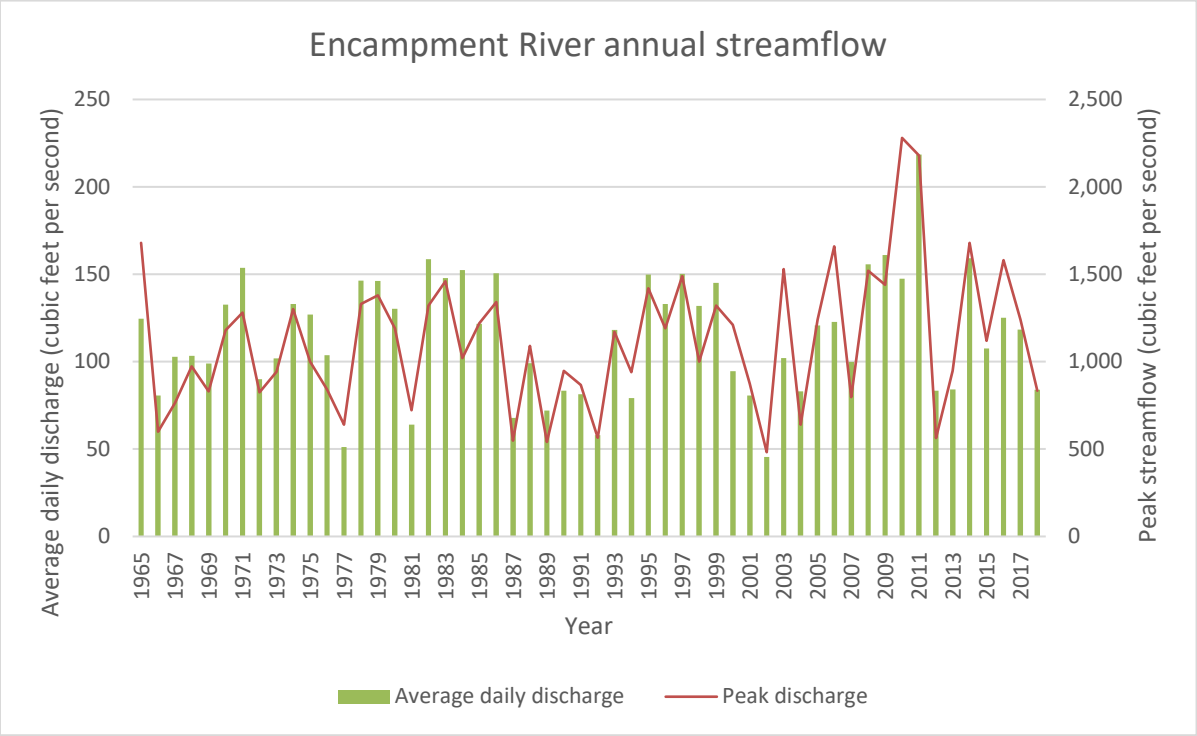

Figure 3. Annual average daily discharge and annual peak discharge at the Encampment River streamgage (USGS 06623800) on the Medicine Bow National Forest, 1965-2018.

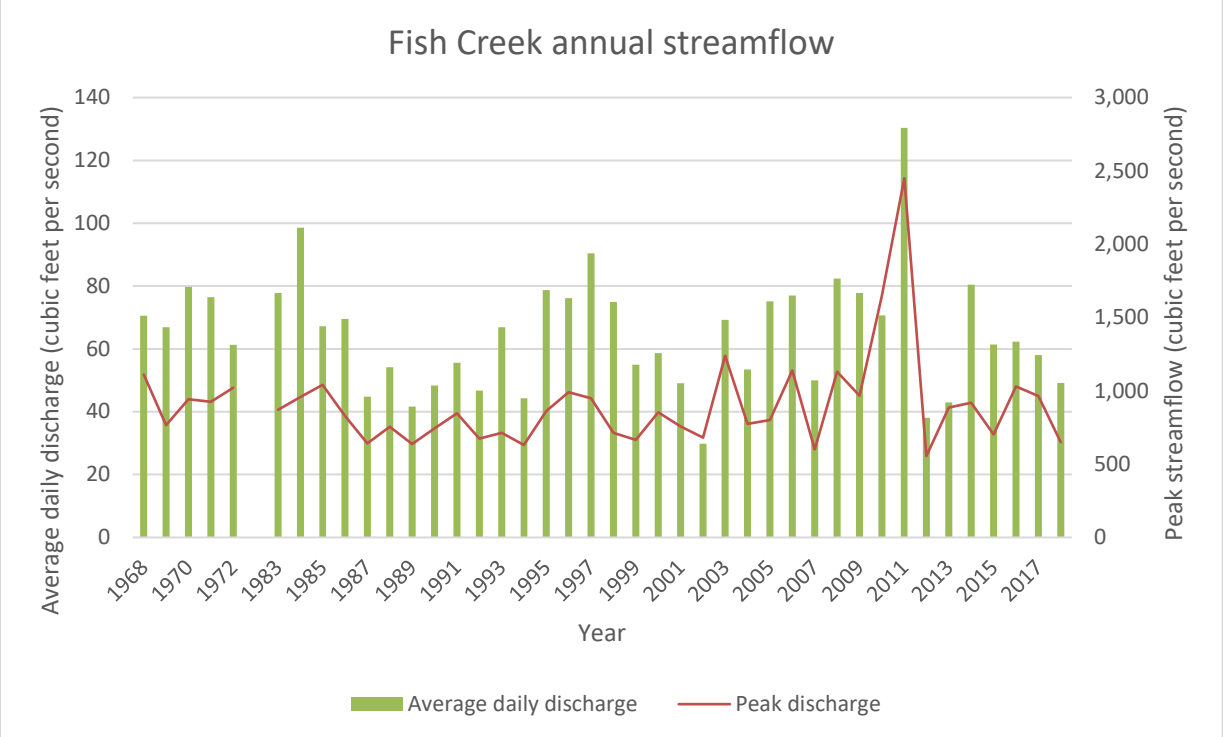

Figure 4. Annual average daily discharge and annual peak discharge at the Fish Creek streamgage (USGS 09238900) on the Routt National Forest, 1968-1972 and 1983-2018. Note the break in the horizontal axis.

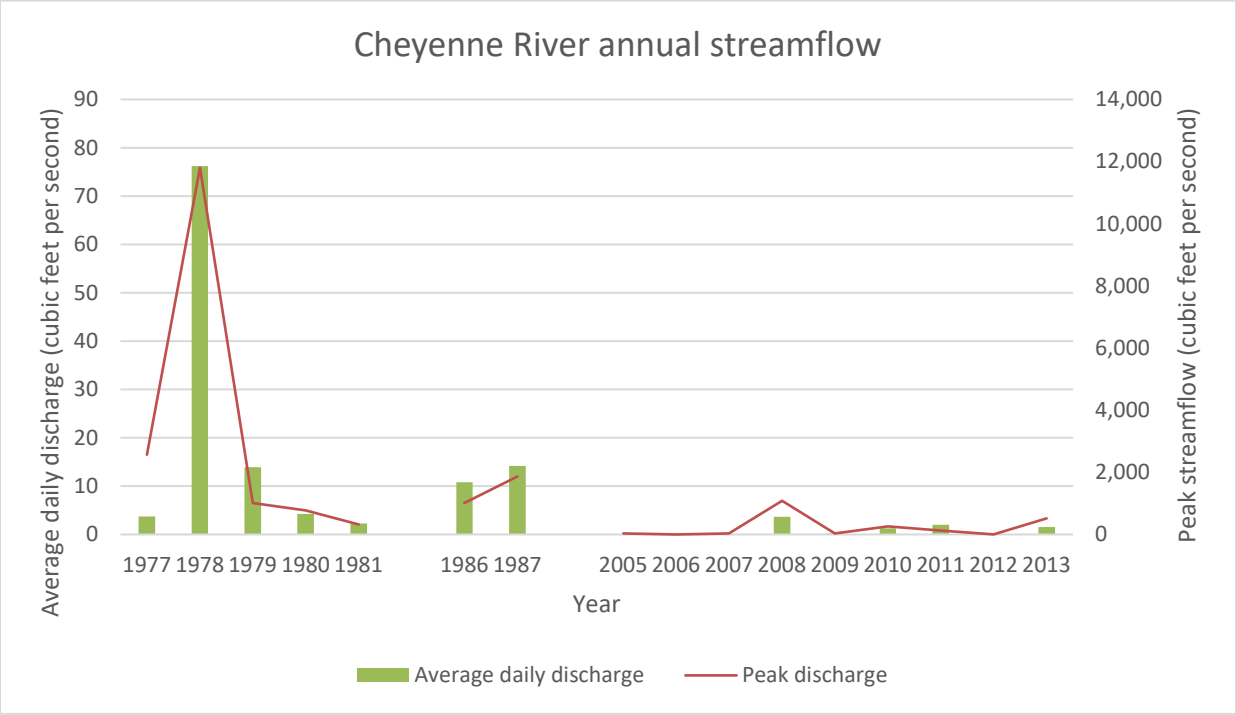

Figure 5. Annual average daily discharge and annual peak discharge at the Cheyenne River streamgage (USGS 06365900) on the Thunder Basin National Grassland, 1977-1981, 1986-1987, and 2005-2013. Note the breaks in the horizontal axis.

Minimum annual average daily discharge in the observation periods for the North Brush Creek, Encampment River, and Fish Creek streamgages occurred in 2002. Minimum annual peak discharge also occurred in 2002 at North Brush Creek and Encampment River streamgages, while minimum annual peak discharge at the Fish Creek streamgage occurred in 2012. Maximum annual daily discharge and maximum annual peak discharge occurred in 2011 for all three sites, except that maximum annual peak discharge at the Encampment River streamgage occurred in 2010.

Streamflow and water body level protections are provided by Forest Service land use authorization permits for water facilities and by State instream flow protection on streams where the States hold instream flow water rights. Data regarding Forest Service land use authorization permits for water facilities has not been updated since the previous Medicine Bow-Routt National Forests monitoring report in 2013. As reported in 2013, the forests had 318 land use authorizations for water facilities. 65 of those authorizations were for reservoirs and dams, with the remaining 253 for ditches, pipelines, wells, or spring developments. Four of the authorizations included some measure to protect or enhance streamflow on 23 streams. Eleven of the authorizations included some measure to protect lake levels on 13 lakes or reservoirs. Monitoring of streamflow and lake level protection measures indicated implementation had been successful.

In Wyoming, the only entity that can hold an instream flow water permit is the Wyoming Water Development Commission. The commission holds instream flow water permits in the Medicine Bow National Forest with 26 instream flow water permits on 98 miles of perennial stream, equating to approximately 6% of the total perennial stream miles (~1,583 miles) on the forest. As of 2020, no State

instream flow protections have been added to any streams on the forest since the last forest monitoring report in 2013.

In Colorado, the only entity that can hold an instream flow water right is the Colorado Water Conservation Board. In 2013, the water conservation board held 180 instream flow water rights on 693 miles of perennial stream in the Routt National Forest. Since 2013, the board acquired instream flow water rights for 2 additional stream segments of 5 miles for a total of 698 miles of perennial stream, equating to approximately 36% of the total perennial stream miles (~1,941 miles) on the forest.

Indicator 5 – Watershed projects

The Forest Service records projects that contribute to watershed improvement in the Watershed Improvement Tracking database. Select projects related to watershed improvement accomplished in fiscal years 2014-2018 are listed in Table 14. The types of activity reported include road decommissioning; culvert replacement and other road or trail crossing improvements; meadow, riparian area, spring, and wetland restoration; gully, ditch, and streambank restoration or improvement; and erosion control, hillside stabilization, and road and trail improvement. Road decommissioning and culvert replacement and other crossing improvements were the most common type of activity, occurring each of the 5 years.

Table 14. Select Watershed Improvement Tracking database projects on the Forests and Grassland, accomplished in fiscal years 2014-2018[2].

Year	Road decommissioning (miles)	Culvert replacement; other road/trail crossing (number of projects)	Meadow, riparian, spring, wetland restoration (number of projects)	Gully, ditch, streambank improvement (number of projects)	Erosion control; road and trail improvement (number of projects)
2014	33.4	7	7	3	6
2015	22.1	4	3	3	3
2016	39.7	5	7	5	2
2017	3.6	6	5	-	3
2018	12.8	4	-	-	-

Indicator 6 – Best management practices

The Forest Service uses a national best management practices monitoring program to track implementation of best management practices on forests and grasslands. Best management practices are tools and techniques to control or eliminate nonpoint source water pollutants that may result from Forest Service management actions. Data collected by the Forest Service Rocky Mountain Region for implementation of best management practices in fiscal years 2015-2016 shows that the Medicine Bow-Routt National Forests completed 19 best management practices monitoring evaluations and met goals

[2] Activity type codes selected include AOP Improvement-Road, Crossing Improvement-NonFish, Decommission, Decommission-Treatment Scale 1, Decommission-Treatment Scale 2, Decommission-Treatment Scale 3, Decommission-Treatment Scale 4, Dispersed Rec Site Improvement, Erosion Control, Fence-Exclosure, Gully Rehabilitation, Hillslope Protection, Meadow Restoration, Planting-Riparian, Restore Hydrologic Function, Riparian Improvement, Road Realignment, Road Repair, Spring Development, Spring Improvement, Spring Protection, Storage-Level 1, Streambank Stabilization, Trail Maintenance, Trail Realignment, Well Plugging, Wetland Restoration.

for monitoring of best management practices across types of management activities, including aquatic ecosystems, facilities, fire, minerals, range, recreation, roads, vegetation, and water use management. The Medicine Bow-Routt National Forests completed implementation and effectiveness monitoring on 17 activities and completed implementation monitoring only on 2 activities. Results of implementation monitoring showed that best management practices in 5 of 19 monitored activities were fully or mostly implemented. Results of effectiveness monitoring showed that best management practices in 11 of 16 monitored activities were effective or mostly effective. Composite scores for combined implementation and effectiveness monitoring showed that best management practices in 7 of 16 monitored activities were excellent or good (Figure 6). For more information about regional monitoring of best management practices, see the Best Management Practices Monitoring Summary Report, Rocky Mountain Region, Fiscal Years 2015 & 2016 (USDA Forest Service 2016).

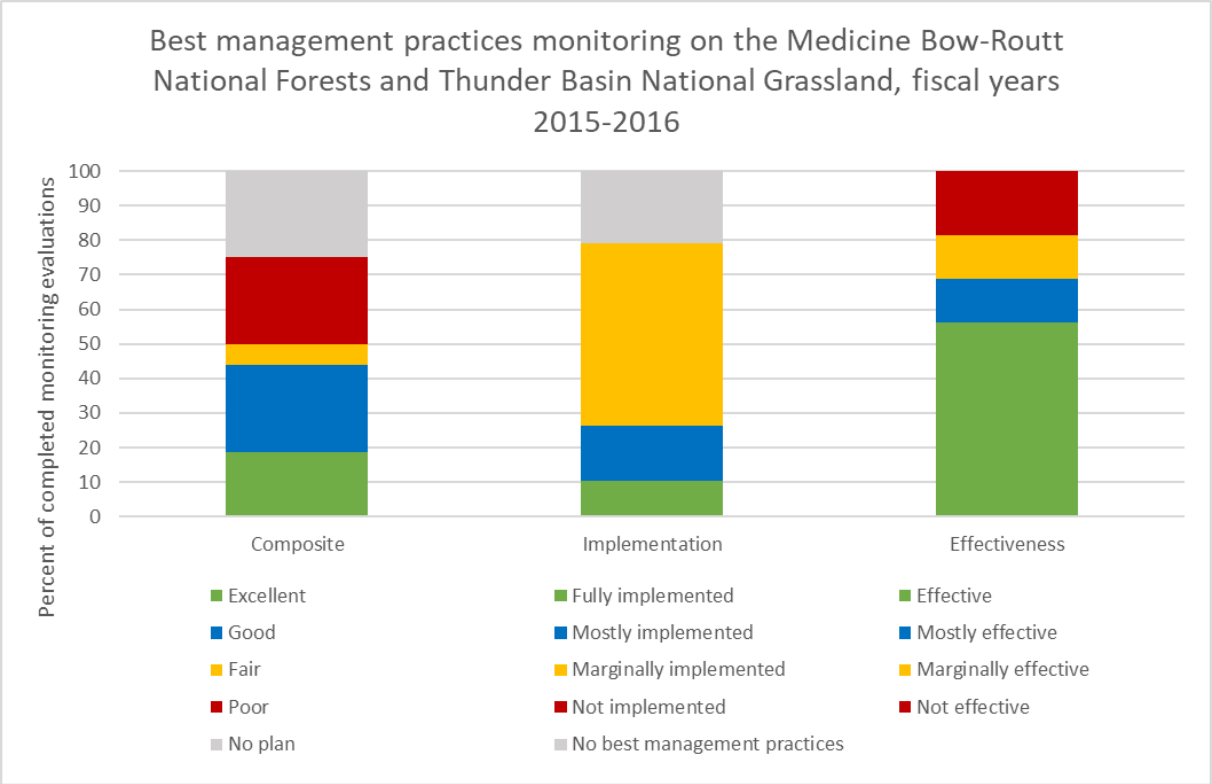

Figure 6. Monitoring results for best management practices monitoring for water quality management on the Forests and Grassland in fiscal years 2015-2016 (USDA Forest Service 2016).

2.1.3 Monitoring Discussion and Findings

Indicator 1 – Watershed Condition

Discussion: Watershed Condition Framework data since 2010 shows little change in overall watershed conditions across the Medicine Bow-Routt National Forests and Thunder Basin National Grassland. However, watershed conditions and certain ecosystem components (e.g., aquatic habitat), have changed substantially in individual watersheds over the life of the forest plan as a result of natural (e.g., fire, floods) and anthropogenic events (e.g., erosion and sedimentation due to irrigation ditch breaches, restoration efforts to restore native fish species).

Forest and Grassland staff have identified 13 priority watersheds for restoration. The unit has developed Watershed Restoration Action Plans for five of these priority watersheds and restoration efforts are underway. Since 2011, the Forest has not completed all essential restoration projects in a priority watershed, although East Fork Encampment River watershed restoration efforts are expected to be complete in 2018.

Progress toward forest and grassland plan goals and objectives: Prior assessments and analysis of the available Watershed Condition Framework and Watershed Restoration Action Plan information indicate that the Forest is behind schedule in meeting the two quantitative objectives in the forest and grassland plans related to improving watershed conditions on the Medicine Bow National Forest (Goal 1, Subgoal 1.a, Objective 1) and Thunder Basin National Grassland (Goal 1.a, Objective 1). These objectives are improvement in watershed condition of at least 20% of classified watersheds in the respective plan areas. No watersheds have improved in condition since the first assessment in 2010. The forests and grassland, however, are in the process of creating and implementing Watershed Restoration Action Plans in priority watersheds across the unit.

Recommendations:

- Convene a team to develop recommendations, action items and a schedule to achieve watershed condition objectives identified in the Forest Plans.
- Complete implementation of essential projects identified in the Watershed Restoration Action Plans (WRAPs).
- Focus future watershed restoration efforts on the critical factors having the most influence on watershed conditions.
- Prepare additional WRAPs to ensure a continuous “pipeline” of planning and implementation of essential projects necessary to restore watershed conditions.

Indicator 2 – Water quality

Discussion: The Forest Service will continue to work with State partners to monitor and manager water quality on the Forests and Grassland. Current data show 16 water bodies across the unit with potential water quality challenges because they are impaired or on State monitoring and evaluation lists.

Progress toward forest and grassland plan goals and objectives: The Forests and Grassland plans include a quantitative objective for water quality on the Medicine Bow National Forest (Goal 1, Subgoal 1.a, Objective 2). A full understanding of the proportion of fully supporting versus threatened and impaired water bodies is unavailable because the States of Colorado and Wyoming do not monitor all water bodies. Current data also does not indicate trends in water quality across the forests and grassland.

Recommendations:

- For future monitoring evaluation reports, track and discuss number of fully supporting versus threatened and impaired water bodies over time to assess change.

Indicator 3 – Native Fish

Discussion: Current data on miles of stream occupied by Colorado River cutthroat trout and mountain sucker will be used as a baseline to assess future trends of native fish occupancy and progress toward meeting desired conditions. The Forest Service and its partners will continue to monitor these populations and document changes in their presence or absence.

Progress toward forest and grassland plan goals and objectives: Forest and grassland-wide plan goals and objectives regarding native fish are non-quantitative. Habitat and population restoration activities for native fish are ongoing. Details about current and past native fish restoration projects are available at: https://www.fs.usda.gov/projects/mbr/landmanagement/projects.

Recommendations:

- Prepare a consolidated GIS layer, available in the corporate database, that shows where the known locations of native fish occur.

Indicator 4 – Streamflow

Discussion: Streamflow data for select USGS streamgages on the Medicine Bow-Routt National Forests show high interannual variability in streamflow, with no clear trends in average daily discharge or annual peak discharge. 2011 and 2002 were consistently the wettest and driest years across the forests in terms of streamflow since the 1960s.

The Cheyenne River streamgage on the Thunder Basin National Grassland shows significantly lower streamflow in the river for the 2000s and 2010s than in the 1970s and 1980s, because water was subject to diversion after the 1980s.

Stream flow protections on the Medicine Bow-Routt National Forests have not changed significantly since the last monitoring report for the forests in 2013. As of 2013, approximately 4% of Forest Service water facility land use authorizations on the forests included quantitative streamflow and lake level protections. As of 2020, State instream flow programs provide some level of stream flow protection to approximately 22.6% of the perennial streams on the forests, an increase of approximately 0.2% since 2013. It should be noted that the instream flow water rights are often junior to other water rights and instream flows specified in the instream flow water rights are not always met.

Progress toward forest and grassland plan goals and objectives: Objectives in the Medicine Bow forest plan and Thunder Basin grassland plan include improving streamflow in 10% of stream segments with instream flow concerns or high resource values. Data reported in this monitoring report are insufficient to analyze progress toward this forest and grassland plan objective.

Recommendations:

- Utilize streamflow protection provisions in future water facility land use authorizations.
- Assess causes of decline in streamflow at the Cheyenne River streamgage. Monitor effects of change in streamflow on vegetation, wildlife, and grassland uses.
- Monitor effects of high interannual variability in streamflow on forest resources, including aquatic species and forest uses.

Indicator 5 – Watershed projects

Discussion: The Watershed Improvement Tracking database shows information about activities that improved watershed condition on the forests and grassland. No trends are apparent in the data. More information is needed to relate activity data to watershed conditions.

Progress toward forest and grassland plan goals and objectives: The forest and grassland plans do not contain quantitative goals related to the number and acres or miles of watershed improvement activities.

Recommendations:

- Evaluate the utility of this monitoring indicator. Explore how data in the Watershed Improvement Tracking database can help inform forest and grassland plan monitoring.

Indicator 6 – Best management practices

Discussion: Best management practices monitoring results provide a baseline to understand future trends in the implementation and effectiveness of best management practices for water quality management on the forests and grassland.

Progress toward forest and grassland plan goals and objectives: Forest and grassland-wide plan goals and objectives regarding best management practices and water quality are non-quantitative. Goals for the Forests and Grassland for monitoring best management practices under the Forest Service national best management practices program in fiscal years 2015-2016 included monitoring one each of mechanical vegetation, aquatic ecosystems, facilities, rangeland, and roads management activities each year, and monitoring five additional activities in any resource management category each year. The Medicine Bow-Routt National Forests and Thunder Basin National Grassland monitored 19 total projects in 2015-2016, nearly meeting all monitoring goals. Staff on the forests and grassland monitored best management practices for activities in all specifically assigned resource management categories in 2015 and 2016.

Recommendations:

- Consider reporting best management practices monitoring data by type of management activity to better assess implementation and effectiveness by type of activity and type of best management practice.

2.2 Monitoring Item 2: Vegetation

2.2.1 Monitoring Question and Background

- How are major vegetation types on the planning unit changing over time?

Table 15 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 15. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for vegetation.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.c, Objectives 2-4 **Routt**: Goal 1 **Thunder Basin**: Goal 1.c, Objective 1	1. Cover type, ecological site conditions, age class, size class, and structural stages of (i) forest, (ii) shrubland, and (iii) grassland vegetation	i) Forest Service FSVeg corporate database; Forest Service FACTS corporate database; Forest Inventory and Analysis program ii) Sage-grouse habitat assessment framework iii) Forest Service rangeland vegetation surveys	i. a) 2 years b) 5-6 years ii. a) 5 years b) 5 years iii. a) Annually b) 2 years	Desired forest habitat structural stage distribution: 4% structural stage 1; 10% structural stage 2; 30% structural stage 3; 40% structural stage 4; and 16% structural stage 5. (Medicine Bow) Desired forest habitat structural stage distribution: 2% structural stage 1; 3% structural stage 2; 36% structural stage 3; and 60% structural stage 4. (Routt) See section 2.4.1 for desired vegetation conditions in sagebrush habitats. Targets for grassland vegetation structural stage distribution on the Thunder Basin National Grassland are local to geographic and management areas.

2.2.2 Monitoring Results

Indicator 1 – Vegetation structure, function, and composition

Forest vegetation

Changes in forest vegetation structure and condition are monitored through analysis of the Forest Service Field Sampled Vegetation (FSVeg) Spatial database. FSVeg is a national vegetation database storing baseline vegetation needed for project analysis and decision. Vegetation data stored in FSVeg is derived from photo interpretation techniques and high-resolution imagery based on 2001 conditions and previous stand exam data collected by Forest Service staff where available. Since the FSVeg database was initially populated, significant tree mortality has occurred across the Medicine Bow-Routt National Forests largely because of mountain pine beetle (*Dendroctonus ponderosae)* and spruce beetle (*D. rufipennis*).

To estimate and apply forest mortality rates across the Medicine Bow-Routt National Forests, the Forest Service Geospatial Technology and Applications Center developed and implemented a process to update the FSVeg database. This process used a sample of field survey and remote sensing information to reflect 2015 conditions on the forests. These updated mortality rates successfully accounted for vegetation loss but did not account for changes due to regeneration and ingrowth. Overall, because of the significant mortality events, the spatial and tabular data contained in the FSVeg database do not accurately reflect 2018 vegetation conditions.

The FSVeg database contains data about habitat structural stages on the Medicine Bow-Routt National Forests. Habitat structural stages describe the ecological function of stands based on tree size and canopy cover. Current data will be used to assess trends over time.

Tables 16 and 17 display changes in historical structural stages over time by comparing 2017 FSVeg data against forest data available at the time of forest plan revision for each forest. The tables also display the forest plans' desired conditions for habitat structural stage.

Table 16. Routt National Forest changes in habitat structural stage distribution since forest plan revision.

Habitat structural stage	Habitat structural stage description	1997 (data used in forest plan revision)	Forest plan desired habitat structural stage distribution	2017 (FSVeg Spatial)
1	Grass-forb; formerly trees	1.3%	2.0%	16.2%
2	Seedling	2.5%	3.0%	0.9%
3	Sapling-pole	35.4%	35.0%	40.8%
4	Mature; old growth	60.8%	60.0%	42.1%

Table 177. Medicine Bow National Forest changes in habitat structural stage distribution since forest plan revision.

Habitat structural stage	Habitat structural stage description	2003 (data used in forest plan revision)	Forest plan desired habitat structural stage distribution	2017 (FSVeg Spatial)
1	Grass-forb; formerly trees	3.0%	4.0%	6.3%
2	Seedling	6.1%	10.0%	4.1%
3	Sapling-pole	32.2%	30.0%	47.0%
4	Mature	47.1%	40.0%	42.6%
5	Old growth	11.6%	16.0%	-

*Areas of forest calculated as habitat structural stage 5 in 2003 were not calculated separately from habitat structural stage 4 in 2017.

Shrubland vegetation

Monitoring to detect long-term trends in shrubland vegetation structure, function, and composition are conducted as necessary to satisfy data requirements for designated management areas and indicate changes in vegetation over time.

The sage-grouse habitat assessment framework is a nested-scale habitat monitoring approach that provides detailed information about sagebrush ecosystems. Surveys of home range and site-scale sagebrush habitat across Medicine Bow-Routt National Forests and Thunder Basin National Grassland began in 2016. Surveys under the habitat assessment framework collect variables such as sagebrush cover, structural stage, understory composition and structure, and habitat patch connectivity. More information about the results of the habitat assessment framework inventory on the forests and grassland can be found in section 2.4.2.

Grassland vegetation

Monitoring of grassland vegetation is also conducted as necessary. Between 2013 and 2016, forest staff completed 72 cover frequency and 22 point-intercept transects on 7 sheep allotments and 1 cattle allotment on the Yampa Ranger District for the environmental assessment for rangeland management in the Pagoda analysis area. On the Brush Creek-Hayden Ranger District, forest staff completed 9 transects on 5 allotments in 2016 and 15 transects on 5 allotments in 2017. The Laramie Ranger District has initiated long-term vegetation trend studies on 7 allotments in association with the Pole Mountain vegetation management project, but results are not yet available.

Among the assessed Yampa Ranger District allotments, 5 were meeting or moving toward forest plan desired conditions, while 2 were not meeting desired conditions because of a substantial increase in noxious and invasive plant species. Little or no livestock grazing has occurred on these allotments for at least the six years prior to monitoring. Vegetation studies on the Brush Creek-Hayden Ranger District indicated that vegetation in all sampled allotments is meeting or trending toward forest plan desired conditions.

2.2.3 Monitoring Discussion and Findings

Indicator 1 – Vegetation structure, function, and composition

Discussion: Across the Medicine Bow-Routt National Forests, the mountain pine beetle and spruce beetle mortality events caused a decrease in the percentage of forest in mature and old growth timber habitat structural stages and an increase in the grass-forb habitat structural stage. In the Routt National Forest, however, 16.2% (155,822 acres) in structural stage 1 is much higher than expected and the 0.9% (8,706 acres) in structural stage 2 is much lower than expected. 2017 FSVeg data for the adjacent Medicine Bow National Forest do not show similarly unexpected proportions of structural stage 1 and 2. The reasons for the discrepancy in FSVeg are not clear, and given the magnitude of the apparent discrepancy, further investigation and resolution is warranted. Among other uses, habitat structural stage data is critical in determining habitat suitability for the at-risk Canada lynx (*Lynx canadensis*) and resolving the data discrepancies will be a priority for the forests.

Forest Inventory and Analysis size class data reflect structural stage patterns shown by the FSVeg data, including both the decline in lodgepole pine because of bark beetle disturbance and the high number of saplings and pole timber.

Long-term vegetation trend data on shrubland and grassland ecosystems across the forests and grassland will continue to be collected as funding and work capacity allow. The initial inventory for the sage-grouse habitat assessment framework provides baseline data for future evaluation of trends in key shrubland health indicators across the forest. Allotment vegetation monitoring for the Pole Mountain vegetation management project will allow the Laramie Ranger District to show over time whether vegetation treatments are successful in moving the project area toward forest plan desired conditions.

Progress toward forest and grassland plan goals and objectives: FSVeg data shows that mature and old growth stands in the forests have declined in area to less than outlined in the desired conditions in the forest plans. The proportion of forest in habitat structural stages 4 and 5 has declined by more than 15% in each forest since forest plan revision. On the Medicine Bow National Forest, the proportion of the forest in habitat structural stage 3 is greater than desired, while on the Routt National Forest, the proportion of the forest in structural stages 1 and 3 is greater than desired (but see the discussion above regarding issues with the calculations for structural stages 1 and 2).

Recommendations:

- Evaluate the need to change desired conditions related to habitat structural stages in the forest plans based on major changes to forest vegetation structure resulting from bark beetle disturbance.
- Resolve the apparent discrepancy in the FSVeg data for structural stages 1 and 2 on the Routt National Forest. If examination of the database does not resolve this issue, a random field sample of non-harvested structural stage 1 units may be necessary.
- Consider increasing the level of stand exam forest inventory to update FSVeg with ground-based data prior to the next forest plan revision. Forest inventory is essential to determine regeneration and ingrowth because remote sensing applications are not currently effective at providing this information.
- Explore opportunities to expand use of Forest Inventory and Analysis data to inform management and forest plan monitoring, including integration of Forest Inventory and Analysis metrics with other monitoring indicators, such as forest stressors (section 2.13).
- Continue to fund and ensure capacity for shrubland and grassland vegetation inventory and monitoring. Build capacity for grassland vegetation monitoring on the Thunder Basin National Grassland to begin to identify long-term trends in key grassland health indicators.

2.3 Monitoring Item 3: Riparian and Wetland Conditions

2.3.1 Monitoring Question and Background

- How are riparian and wetland conditions in the planning unit meeting or moving towards desired conditions, as described in the Forest and Grassland Plans?

This monitoring item addresses plan components needed to comply with legal requirements, and conserve and restore wetland and riparian ecosystems. Executive Order 11990 directs that impacts to wetlands should be avoided, minimized, or mitigated where practicable. Section 404 regulations of the Clean Water Act protect wetlands and only allow impacts though the issuance of permits if the wetland values can be replaced in-kind. Groundwater-dependent ecosystems such as fens and springs on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland cannot be replaced in-kind. Specific forest and grassland plan goals and objectives associated with wetland and riparian systems include allowing for multiple uses and protecting water quality; maintaining and restoring riparian and wetland habitat, biodiversity, and watershed function; and protecting rare communities such as fens. Table 18 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 18. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for riparian and wetland conditions.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.a, Objective 3 Routt: Goal 1, Objective bullet 2 Thunder Basin: Goal 1.a, Objectives 2, 3	1. Riparian structure, function, composition	Proper functioning condition assessment Multiple Indicator Monitoring	a) Annually b) 2 years	80% of riparian areas are in Proper Functioning Condition

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.a, Objective 3 Routt: Goal 1, Objective bullet 2 Thunder Basin: Goal 1.a, Objective 1	2. Groundwater-dependent ecosystems structure, function, composition	Groundwater-dependent ecosystems protocol Peatland sampling data	a) Annually b) 2 years	

2.3.2 Monitoring Results

Monitoring is part of an iterative process for achieving planning goals and objectives associated with riparian and wetland systems that involves:

a. The identification and mapping of riparian and wetland resources using spatial datasets.
b. Qualitative or rapid assessment of baseline conditions.
c. Prioritization and implementation of quantitative monitoring protocols and management actions such as restoration.
d. Analysis and adaptive management.

The following data results from activities associated with both the assessment of baseline conditions and the implementation of quantitative monitoring protocols.

Indicator 1 – Riparian structure, function, and composition

The proper functioning condition assessment is a qualitative and rapid assessment protocol to establish baseline riparian area conditions across the forests and grassland. The proper functioning condition assessment characterizes riparian conditions (i.e., lotic systems, or those generally associated with flowing water) based on 17 hydrologic, vegetative, and geomorphic indicators (USDI, 2015). The proper functioning condition assessment classifies riparian areas into one of 3 categories: (1) proper functioning condition, (2) functional - at risk, or (3) nonfunctional. A riparian area is in proper functioning condition when it has adequate vegetation and land form to dissipate stream energy associated with high flows, capture sediment and aid in floodplain development, improve flood water retention and ground-water recharge, develop roots that stabilize streambanks, and maintain channel characteristics. Properly functioning riparian systems provide associated values such as habitat for fish and wildlife. A riparian area is functional - at risk when it has limited functionality and a hydrologic, vegetative, or geomorphic attribute that makes it susceptible to impairment. A riparian area is nonfunctional when its vegetation, landform, or woody material is inadequate to dissipate high stream flows and erosion, poor water quality, or other issues result. Proper functioning condition is a general management goal for riparian areas because of the risks to values and the unsustainability of riparian areas classified as functioning - at risk.

Since 1995, forest and grassland staff have conducted proper functioning condition surveys every 1-3 years on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland. Proper functioning condition assessments establish baseline data to inform later management actions and monitoring. Results from proper functioning condition assessments 127 different riparian areas on the forests and grassland indicate that approximately 60% of areas assessed since 1995 are in proper functioning condition Figure 7.

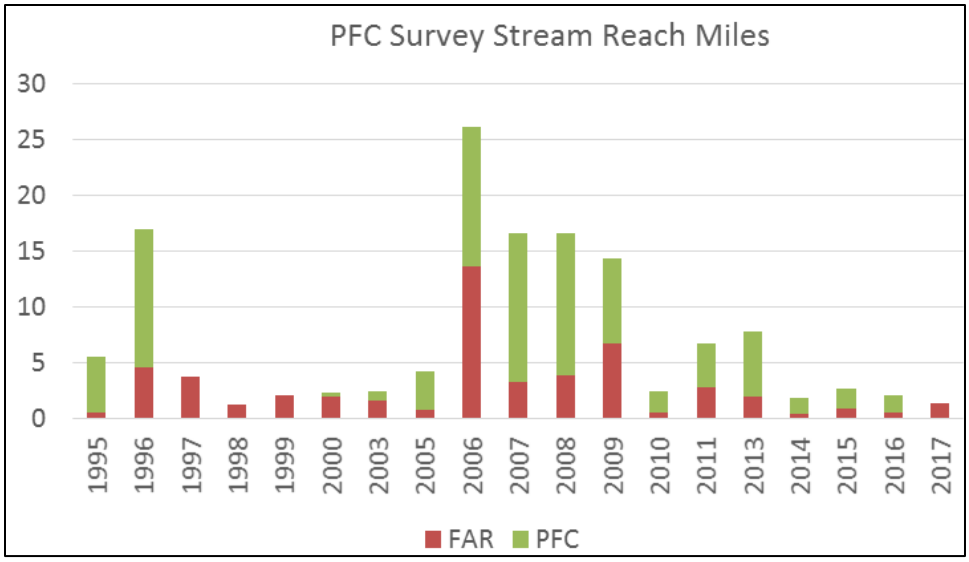

Figure 7. The annual distribution of proper functioning condition and functional - at risk (FAR) ratings by stream mile on the Forests and Grassland.

The graph shows baseline conditions collected over time on 127 different stream reaches across the Forests and Grassland; the assessment data do not indicate trends in riparian area conditions at specific locations over time. The y-axis represents number of stream miles. Note the variable assessment interval on the x-axis.

Table 19 shows the distribution of assessed riparian areas meeting and not meeting the 17 proper functioning condition assessment indicators. Assessed riparian areas on the forests and grassland generally scored poorly on indicator 4, with only 57% of those areas expanding or having achieved potential extent. Additionally, only 72% of surveys found an adequate amount of stabilizing riparian vegetation present to protect banks and dissipate energy during moderately high flows. These surveys noted bare ground absent of riparian vegetation or ground with drought-tolerant or upland vegetation instead of riparian vegetation. Assessed riparian areas also scored poorly on indicator 2 (beaver dam stability) and indicator 3 (channel dimension, pattern, and profile expected for its landscape setting and potential). Assessed riparian areas scored relatively high on indicators 6-10 (riparian vegetation age class, riparian vegetation composition, obligate and facultative species present, bank vegetation root mass, and riparian vigor).

Table 19: Proper functioning condition assessment indicator metrics for riparian areas assessed between 1995 and 2017 on the Forests and Grassland.[3]

#	Item Short Description	Yes	Y/N	No	N/A	% Yes	% Y/N	% No
1	Bankfull flooding	94	11	12	10	80	9	10
2	Beaver dams	35	5	40	47	44	6	50
3	*Stream geometry**	80	13	33	1	63	10	26
4	Riparian extent	73	12	42	0	57	9	33
5	Upland impacts	89	12	26	0	70	9	20

[3] The percent column in the table does not include “not applicable” answers in the percent calculation. A “no” answer to any of the three items in red indicates stream and riparian area concerns.

#	Item Short Description	Yes	Y/N	No	N/A	% Yes	% Y/N	% No
6	Riparian vegetation age class	110	9	8	0	87	7	6
7	Riparian vegetation composition	117	4	6	0	92	3	5
8	Obligate and facultative species present	105	12	10	0	83	9	8
9	Bank vegetation root mass	101	14	12	0	80	11	9
10	Riparian vigor	109	8	10	0	86	6	8
11	*Bank vegetation cover**	92	16	19	0	72	13	15
12	Instream wood source	39	1	2	85	93	2	5
13	High flow dissipation	99	13	13	2	79	10	10
14	Point bar re-vegetation	62	8	10	47	78	10	13
15	Lateral movement	110	4	8	5	90	3	7
16	*Vertical stability**	103	6	18	0	81	5	14
17	Water and sediment in balance	89	13	25	0	70	10	20

The Multiple Indicator Monitoring protocol is a quantitative monitoring approach for riparian areas used where proper functioning condition assessments have identified concerns. The Multiple Indicator Monitoring protocol primarily informs adaptive management of livestock management practices that are affecting riparian conditions. Currently, forest and grassland staff are applying the Multiple Indicator Monitoring protocol to 45 stream reaches on the Routt National Forest and four stream reaches on the Medicine Bow National Forest. From 2011-2017, staff collected data from 217 short-term Multiple Indicator Monitoring surveys and 74 long-term Multiple Indicator Monitoring surveys. Short-term indicators of stream and riparian condition include sedge height and bank trampling. Long-term indicators include bank stability and greenline stability rating. Summary Multiple Indicator Monitoring data across monitored sites indicate average sedge height is 10.3 inches, average bank trampling is 8%, average stream stability is 68%, and average greenline stability rating (an estimator of vegetative contribution to bank stability) is 5.3 (Table 20). On average, pre-grazing bank trampling attributed to wildlife is 5% and post-grazing bank trampling attributed to livestock is 10%.

Table 20. Multiple indicator monitoring protocol summary statistics for four key riparian condition indicators on the Medicine Bow-Routt National Forests, 2011-2017.

	Sedge height (in)	Bank trampling (%)	Bank stability (%)	Greenline stability rating
Average	10.3	8	67.9	5.3
Standard deviation	3.9	9.3	20.5	1.6
Number of sites	217	217	217	74
Z-score (95%)	1.98	1.98	1.98	2.021
Confidence interval (95%)	0.5	1.3	2.8	0.4
Threshold	6 in	15-20%	74% reference	15% baseline

At the project-specific scale, Multiple Indicator Monitoring data are typically used for setting specific rangeland adaptive management thresholds. For example, Multiple Indicator Monitoring data from two sensitive stream reaches (Slater and Crawford Creeks) between 2011 and 2017 revealed increases in greenline stability rating following the removal of 108 cow-calf pairs. The Multiple Indicator Monitoring data showed bank trampling stayed less than 20%, sedge height stayed greater than 6 inches, and bank

stability averaged 75%. Another Multiple Indicator Monitoring protocol site was recently established at the Beaver Creek grazing allotment on the Routt National Forest to monitor the success of adaptive management in limiting upstream loss of riparian and wetland area. Beaver Creek is an example of a channel that is outside the expected range of sinuosity, gradient, and width/depth ratio, within a riparian area that is contracting as a result of head-cutting moving upstream (Figure 8). Multiple Indicator Monitoring data will be used to inform future management of the Beaver Creek riparian area.

Figure 8. Riparian area at Beaver Creek in the northwest Flat Tops, CO in 1993 (left) and 2016 (right). In 1993, Beaver Creek was a sinuous channel in a sedge-dominated, wide riparian area. In 2016, Beaver Creek was a straight channel with unstable banks and head-cutting, which has left raw banks composed of thistle, hounds tongue, and toadflax.

Indicator 2 – Groundwater-dependent ecosystems structure, function, and composition

The Forests and Grassland recently began using the Forest Service groundwater-dependent ecosystems level I inventory to identify, map and record observations of groundwater-dependent ecosystems (USDA, 2015). Identification of springs occurs opportunistically during project-level surveys to identify protection zones or vegetative buffers for water resources. Full level I inventory occurs subsequently during a site revisit with an interdisciplinary team to collect vegetative, soil, and hydrologic data. These level I data are stored in the Springs Online database of the Springs Stewardship Institute. The Springs Online database provides a standard agency-wide repository for data collected using the groundwater-dependent ecosystems levels I, II, and III field guides. The Springs Online database is available at: http://springsdata.org/index.php.

In addition to opportunistically locating groundwater-dependent ecosystems during project work, a dedicated crew, supervised by the Rocky Mountain Research Station, deployed over two field seasons in 2015 and 2016 to conduct groundwater dependent ecosystems level I inventories. Targeted sites included fens, large wetland complexes, springs, and kettle lakes. The crew surveyed approximately 320 sites across the Medicine Bow-Routt National Forests, half of which were located at the Glacier Lakes Ecosystem Experiment Site.

Inventory data indicate approximately 10 sites that warrant revisits because of resource concerns, including head-cutting of outlet channels, heavy grazing, and poor vegetation composition. The follow-up surveys where resource concerns exist may indicate a need for further monitoring and adaptive management and restoration actions. Additionally, many opportunities exist to validate approximately 200 springs identified by the Springs Stewardship Institute and 20 fens or large wetland complexes identified from past projects without resource concerns.

To assist with locating groundwater-dependent ecosystems during project work, a peatland prediction model was developed for the Routt National Forest. This model predicted over 4,500 peatlands across

the forest. Forest staff field-checked many of these predicted peatlands over the last five years, and approximately 25 likely fens have been documented.

2.3.3 Monitoring Discussion and Findings

Indicator 1 – Riparian structure, function, and composition

Discussion: The most common reasons riparian areas on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland are not in proper functioning condition are: a) sinuosity, gradient, and width/depth ratio are not in balance with the landscape setting and b) the riparian area is not expanding or has not achieved potential extent (e.g., Figure 8).

The proper functioning condition assessment results also indicate beaver dams are a vital component of healthy riparian areas. Of the 63% of reaches where beaver play a role in stream and riparian function, only 44% of beaver dams were stable. Though beaver populations fluctuate over time, the low percentage suggests a decrease in beaver populations. This apparent decrease was also observed in a rangeland management analysis on the Yampa Ranger District.

In some cases, Multiple Indicator Monitoring data has helped to inform changes to rangeland management, such as using exclusion areas, reducing livestock numbers, reducing season of use, redistributing livestock, altering allotment boundaries, resting allotments, closing allotments, or planting.

Progress toward forest and grassland plan goals and objectives: Proper functioning condition assessment data show that approximately 60% of assessed riparian areas are in proper functioning condition. Among assessed areas, this is less than the objective of 80% in the Medicine Bow forest plan Goal 1, Subgoal 1.a, Objective 3 and Thunder Basin grassland plan Goal 1.a, Objectives 2 and 3; however, riparian areas most prone to disturbance are prioritized for assessment, and the proportion of all streams in proper functioning condition is likely greater than the 60% shown in the monitoring results. Nevertheless, the absolute number of riparian areas assessed as functioning - at risk indicates significant opportunities to improve riparian area health across the forests and grassland.

Recommendations:

- Update proper functioning condition assessments and databases. As riparian conditions change from initial proper functioning condition assessments in the 1990s, it may be necessary to update data for or fully reassess a riparian area when the first assessment is insufficient or in question or major ecological disturbances such as wildfires have occurred.
- Increase sample size. A larger sample of riparian areas for proper functioning condition assessment and Multiple Indicator Monitoring protocol across the forests and grassland is necessary to improve understanding of whether the landscape is meeting or moving toward forest and grassland plan desired conditions and objectives. When conducting PFC assessments for projects, use a representative sample of riparian areas throughout the watershed rather than prioritizing areas both prone to disturbance. Techniques for representative sampling might include generalized random tessellation stratified (GRTS) sampling.
- Link management goals and objectives to Multiple Indicator Monitoring protocol by selecting sites from which collected data will inform monitoring questions.
- Use photopoints for greenline or bankfull line monitoring in the MIM protocol. Store photopoints in ArcGIS Online.

Indicator 2 – Groundwater-dependent ecosystems structure, function, and composition

Discussion: To better assess wetland condition trends, baseline groundwater-dependent ecosystems data are being collected across the Medicine Bow-Routt National Forests and Thunder Basin National Grassland. Efforts to complete a comprehensive inventory across the forests and grassland would require extensive data entry and hundreds of partial and full groundwater-dependent ecosystems level I inventories in the field. Surveys conducted between 2015 and 2017 are in the process of being entered into the groundwater-dependent ecosystems database. Future high priority level 1 inventories are scheduled in tandem with project work for the 2018-2020 field seasons. Additionally, lower priority inventories will continue during the field season as priority work is completed each summer.

Groundwater-dependent ecosystem monitoring data can begin to inform adaptive management. Whereas some small-scale wetland restoration, such as rehabilitating large ruts from illegal off-road motorized vehicle use, is ongoing, groundwater-dependent ecosystems inventory can provide baseline data to help identify less-obvious degradation and the rate at which changes occur. For example, degradation of wetland conditions may occur as a result of the lowering of water tables or changes in vegetation composition from down-cutting streams.

Progress toward forest and grassland plan goals and objectives: Forest and Grassland goals and objectives for groundwater-dependent ecosystems focus on avoiding any loss of rare wetlands. Forest and grassland plan components are adequate. The analysis did not identify the need to change any of the forest goals, objectives, standards, or guidelines related to riparian and wetland conditions in the forest and grassland plans.

Recommendations:

- Validate existing data in Springs Online database for the forests and grassland. Approximately 200 spring locations identified by the Springs Stewardship Institute were incorporated during the creation of the database and need validation. An export of geospatial data and notes from the Springs Online database to the Forests and Grassland master geodatabase may assist with data validation.
- Validate peatland prediction polygons on the Routt National Forest. With the collection of validation data, the peatland prediction model may be refined and extended to predict peatlands the Medicine Bow National Forest and Thunder Basin National Grassland.

2.4 Monitoring Item 4: Sagebrush Ecosystems

2.4.1 Monitoring Question and Background

- How are environmental stressors and management activities affecting ecological function and integrity of sagebrush ecosystems on the planning unit?

The greater sage-grouse (*Centrocercus urophasianus*) is an at risk-species that has been the subject of much management attention since the U.S. Fish and Wildlife Service found the species warranted for listing under the Endangered Species Act in 2010 as a result of fragmentation of sagebrush habitats across its range. State and federal agencies subsequently engaged in planning actions to implement protections for sagebrush habitats, and the U.S. Fish and Wildlife Service removed the species' warranted for listing status in 2015. These planning efforts included the 2015 Forest Service greater sage-grouse plan amendments, which amended the forest and grassland plans for the Forests and Grassland. This monitoring item addresses the 2015 plan amendments associated with the Greater Sage-grouse Record of Decision for Northwest Colorado and Wyoming (available online:

https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd567900.pdf) to track the status of greater sage-grouse populations and overall sagebrush ecosystem health. Table 21 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 181. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for sagebrush ecosystems.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b, Objectives 1, 5, Strategies a, j; Goal 1, Subgoal 1.c **Routt:** Goal 1, Objective bullets 6-7 **Thunder Basin:** Goal 1.b, Objectives 2, 4, 5, 7; Goal 1.c, Objective 1 **Greater Sage-grouse Northwest Colorado Plan Amendment:** GRSG-GEN-DC-001; GRSG-GEN-DC-002; GRSG-GEN-DC-003 **Greater Sage-grouse Wyoming Plan Amendment:** GRSG-GRSGH-DC-001; GRSG-GRSGH-DC-002	1. Suitable habitat for greater sage-grouse	Interagency Greater sage-grouse habitat monitoring framework Sage-grouse habitat assessment framework	a) 5 years b) 5 years	In greater sage-grouse habitat management areas, including all seasonal habitat, 70% or more of lands capable of producing sagebrush have from 10 to 30% sagebrush canopy cover and less than 10% conifer canopy cover. Additional quantitative desired conditions for sagebrush habitats appear in Table 1 in the plan amendments for northwest Colorado and Wyoming. Plan components describing soft and hard triggers for adaptive management based on sage-grouse population counts include GRSG-AM-ST-010 and GRSG-AM-ST-011 in the northwest Colorado plan amendment and GRSG-GRSGH-ST-004 and GRSG-GRSGH-ST-005 in the Wyoming plan amendment.
Medicine Bow: Goal 1, Subgoal 1.b, Objective 5 **Routt:** Goal 1, Objective bullet 6 **Thunder Basin:** Goal 1.b, Objectives 2, 4, 5	2. Diversity, richness, distribution of sagebrush bird communities	Interagency Greater sage-grouse habitat monitoring framework Forest Service Natural Resource Manager Colorado Parks and Wildlife Wyoming Game and Fish Department Wyoming Natural Diversity Database Colorado Natural Heritage Program Bird Conservancy of the Rockies eBird	a) Annual b) 2 years	

2.4.2 Monitoring Results

Indicator 1 – Greater sage-grouse habitat

The greater sage-grouse monitoring framework developed by the Interagency Greater Sage-grouse Disturbance and Monitoring Sub-team and adopted in the record of decision for the greater sage-grouse plan amendments in 2015 provides a protocol to monitor the implementation of the plan amendments, habitat characteristics, and greater sage-grouse populations at several scales. Within this framework, the Forests and Grassland monitor sagebrush habitat characteristics at the allotment scale using the sage-grouse habitat assessment framework. The habitat assessment framework is a nested-scale habitat monitoring approach that provides detailed information about sagebrush ecosystems.

Allotment scale surveys under the habitat assessment framework collect data on variables such as sagebrush cover, height and shape; herbaceous cover and height; and the availability of preferred forb species. These surveys are used to classify areas of habitat as suitable, marginal, or unsuitable. While the habitat assessment framework provides quantitative ranges for each habitat variable to classify it as suitable, marginal, or unsuitable, a surveyor provides a qualitative overall classification that takes into consideration local ecological context. In general, the quantitative ranges for suitable habitat in the habitat assessment framework correspond to the desired conditions in Table 1 in the northwest Colorado and Wyoming plan amendments.

Forest and grassland staff conducted habitat assessment framework surveys on 87 grazing allotments from 2016-2017. Of the 87 grazing allotments, 45 allotments (52%) were suitable habitat based on habitat assessment framework indicators, 25 (29%) were marginal habitat, six (7%) were unsuitable habitat, five (6%) had no habitat present, and two (1%) were unclear as to condition (Figure 9). Assessments for four allotments (5%) were incomplete and in need of additional information.

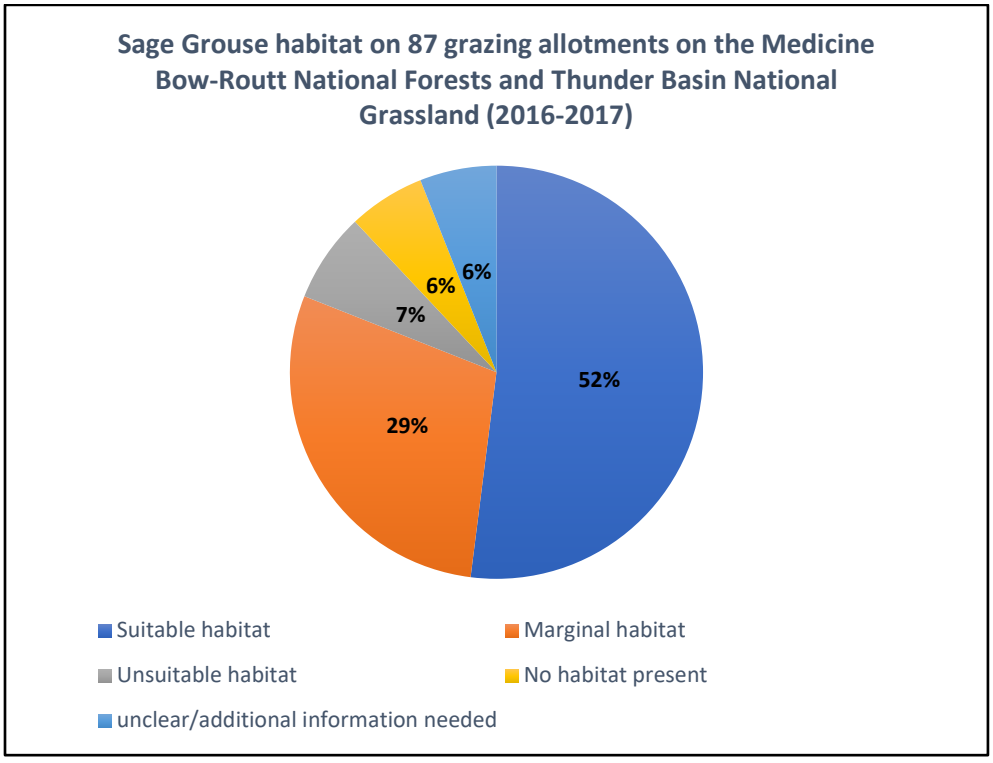

Figure 9. Greater sage-grouse habitat suitability on 87 grazing allotments on the Forests and Grassland, based on the sage-grouse habitat assessment framework.

Indicator 2 – Diversity, richness, distribution of sagebrush bird communities

The greater sage-grouse monitoring framework developed by the Interagency Greater Sage-grouse Disturbance and Monitoring Sub-team guides population monitoring at the range-wide and management zone scale. Greater sage-grouse populations are monitored in northwest Colorado by Colorado Parks and Wildlife, and across the state of Wyoming by Wyoming Game and Fish Department. Population monitoring tracks male greater sage-grouse bird counts in leks. Wyoming statewide greater sage-grouse male bird counts grew from approximately 20,000 to nearly 54,000 from 2014-2017. Male bird counts in the Northwest Colorado and North Park populations were between approximately 3,600 and 6,700 birds during the same period (Figure 10).

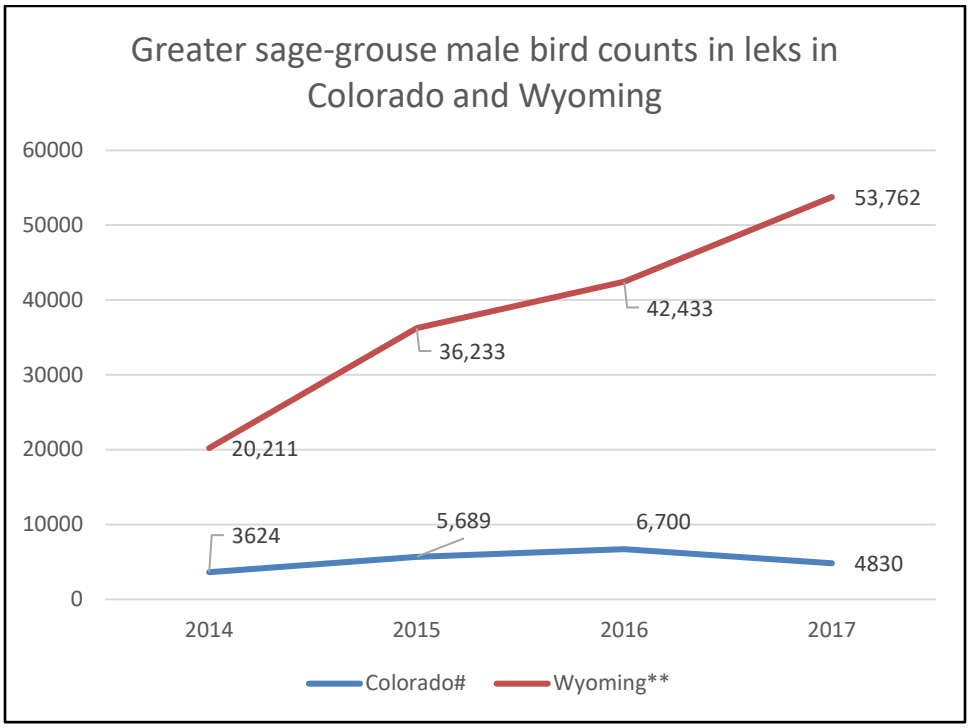

Figure 10. Greater sage-grouse male bird counts in leks in northwest Colorado and across Wyoming. The State of Colorado reports high annual male lek count. The State of Wyoming reports a 3-year peak male lek count.

Data for other sagebrush birds on the forests and grassland, such as Brewer's sparrow (*Spizella breweri*), sagebrush sparrow (*Artemisiospiza nevadensis*), and sage thrasher (*Oreoscoptes montanus*), show opportunistic observations but are insufficient to determine population trends. Brewer's sparrow and sage thrasher are relatively common with several hundred Brewer's sparrows and more than 80 sage thrashers recorded on and near the Thunder Basin National Grassland since 2014 in the citizen science birding database eBird (https://ebird.org/home) and the Wyoming Natural Diversity Database (https://www.uwyo.edu/wyndd/). Sagebrush sparrow is less common, with one observation recorded in the Wyoming Natural Diversity Database since 2014.

2.4.3 Monitoring Discussion and Findings

Indicators 1 and 2

Discussion: Habitat and population trends are healthy and have not approached thresholds outlined in the plan amendments or determined by each state. It should be noted, however, that the habitat

assessment framework values used to calculate whether surveyed allotments provided suitable habitat were generated from other regions within the greater sage-grouse range and may not fully reflect whether local conditions are truly suitable for greater sage-grouse occupation. Particular incongruence may occur in areas rated as marginal that may already be achieving full site capability for sagebrush cover and structure because of naturally dry conditions. These sites are incapable of achieving the reference values used to determine a suitable site under the habitat assessment framework.

Progress toward forest and grassland plan goals and objectives: The habitat assessment framework survey results show that 52% of surveyed allotments across the forests and grassland are suitable greater sage-grouse habitat. Suitable habitat, as defined and assessed under the habitat assessment framework, approximates the desired conditions for sagebrush ecosystems in Table 1 of the greater sage-grouse plan amendments for northwest Colorado and Wyoming. However, the desired conditions in the plan amendments are based on range-wide metrics and may not accurately reflect suitable habitat conditions in the northwest Colorado and Wyoming portions of the greater sage-grouse range.

In addition to the desired conditions, the greater sage-grouse plan amendments provide for adaptive management via soft and hard triggers. In Colorado, these triggers are based on habitat loss or population decline. In Wyoming, these triggers are based on number of active leks, habitat availability, and population trends based on annual lek counts. In both Colorado and Wyoming, the triggers and management responses are determined collaboratively among the State wildlife agencies, the Forest Service, and working groups composed of stakeholders.

Recommendations:

- Consider developing monitoring protocols for other birds associated with sagebrush ecosystems such as Brewer's sparrow, sagebrush sparrow and sage thrasher.
- Modify plan desired conditions for sagebrush habitat characteristics. The desired conditions in Table 1 of the greater sage-grouse plan amendments for northwest Colorado and Wyoming should be modified collaboratively with the state wildlife management agencies to reflect local capabilities.

2.5 Monitoring Item 5: Grassland Focal Species

2.5.1 Monitoring Question and Background

- What is the status of black-tailed prairie dog populations as an indicator for short-grass prairie ecosystem integrity?

Black-tailed prairie dogs (*Cynomys ludovicianus*) are a keystone species for grassland and prairie ecosystems on the Thunder Basin National Grassland. Black-tailed prairie dogs live in colonies that provide habitat for at-risk species such as mountain plover (*Charadrius montanus*), burrowing owl (*Athene cunicularia*), swift fox (*Vulpes velox*), and raptors, including ferruginous hawk (*Buteo regalis*) and golden eagle (*Aquila chrysaetos*). Black-tailed prairie dogs are also a Forest Service Region 2 sensitive species and a Thunder Basin National Grassland Plan management indicator species. Since 2001, plague (a disease caused by the bacterium *Yersinia pestis*) has caused several landscape-scale mortality events in prairie dog colonies on the grassland and has become a major driver of prairie dog colony extent. Monitoring of black-tailed prairie dogs, species associated with prairie dog colonies, and plague supports implementation of the Black-tailed Prairie Dog Conservation Assessment and Management Strategy, first developed as part of the 2009 amendment to the grassland plan and subsequently updated in 2015 (available online at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd493991.pdf). Black-tailed prairie dogs do not inhabit the Medicine Bow-Routt National Forests, and data collected for this

monitoring question applies to the Thunder Basin National Grassland only. Table 22 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 192. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for grassland focal species.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Thunder Basin: Goal 1, Subgoal 1.b, Objectives 1-7 Black-tailed Prairie Dog Conservation Assessment and Management Strategy	1. Prairie dog town extent, density, and occupancy; current versus historic population levels	Forest Service surveys Thunder Basin Grassland Prairie Ecosystem Association surveys	a) 3 years (unless a plague epizootic occurs, then annually) b) 3 years (unless a plague epizootic occurs, then annually)	Category 1: 18,000 acres Category 2: 9,000 acres Category 3: 6,000 acres Within permitted coal mine areas: 2,000 acres Use of rodenticides and other prairie dog control tools is contingent on cumulative colony extent in category areas.
Thunder Basin: Goal 1, Subgoal 1.b, Objectives 1-7 Black-tailed Prairie Dog Conservation Assessment and Management Strategy	2. Sylvatic plague extent/changes	Forest Service surveys; Thunder Basin Grassland Prairie Ecosystem Association surveys	a) 3 years (unless a plague epizootic occurs, then annually) b) 3 years (unless a plague epizootic occurs, then annually)	
Thunder Basin: Goal 1, Subgoal 1.b, Objectives 1-7 Black-tailed Prairie Dog Conservation Assessment and Management Strategy	3. Associated species occupancy (mountain plover, burrowing owl, swift fox, raptors)	Forest Service surveys Wyoming Natural Diversity Database Wyoming Game and Fish Department	a) Annually, except 3 years for raptors b) Annually, except 3 years for raptors	

2.5.2 Monitoring Results

Indicators 1 and 2 – Prairie dog colony extent and plague

Records for black-tailed prairie dog colony extent on the Thunder Basin National Grassland date to the 1970s. A grassland-wide inventory conducted in 1979 and 1980 for the 1981 Thunder Basin prairie dog management plan showed 23,123 acres on 161 colonies. This inventory and subsequent monitoring efforts have often included colonies on State and private lands within the Thunder Basin National Grassland administrative boundary, though surveys have primarily focused on colonies occurring on National Forest System land. Since 2016, the Forest Service has conducted colony monitoring in partnership with the Thunder Basin Grassland Prairie Ecosystem Association, which has led collation and analysis of data collected via systematic grid survey.

While not all parts of the grassland are surveyed every year, colonies seldom go more than 1-3 years without detection and mapping. Grassland-wide data show general trends in colony extent, if not the true extent of colonies in any single year. In Management Area 3.63 – Black-footed Ferret Reintroduction Habitat, a management unit in which colonies are abundant and typically occur in large complexes,

colony monitoring has occurred annually since 2001 to track progress toward grassland plan desired conditions (Table 23; note that some records contain evident issues and may be incomplete, including for management area 3.63, e.g., in 2001 and 2002).

Colony extent data indicate annual fluctuation in prairie dog populations. The colony extent decline in 2001 was the first landscape-scale plague epizootic on the Thunder Basin National Grassland, though a more localized epizootic occurred on the eastern edge of the grassland in the mid-1990s. Continued plague-caused mortality prevented sustained colony growth until approximately 2011. Colonies then grew to a peak of more than 76,000 acres in management area 3.63 and surrounding areas (not all areas of the grassland were surveyed for prairie dog colonies at that time) in 2017 before another epizootic caused colony extent to decline rapidly.

Table 23. Observed black-tailed prairie dog colony extent on the Thunder Basin National Grassland and Management Area 3.63 – Black-footed Ferret Recovery Habitat, 2001-2018.

Year	Colony extent (acres) on the Thunder Basin National Grassland[a]	Colony extent (acres) in Management Area 3.63[b]
2001	22,451	12,014
2002	4,394	2,856
2003	5,643	945
2004	9,237	2,875
2005	15,427	6,168
2006	5,100	1,080
2007	3,304	1,568
2008	3,932	2,121
2009	2,947	1,876
2010	4,947	3,538
2011	9,868	5,886
2012	17,791	10,970
2013	23,259	15,382
2014	26,439	16,040
2015	29,397	18,316
2016	36,463	25,075
2017	76,155[c]	31,521[c]
2018	1,154	250

[a] Data shown are raw observations. Survey locations and total area surveyed were not consistent from year to year, and data may not represent the true extent of black-tailed prairie dog colonies in any year. All reported numbers are approximate. Results of colony mapping efforts may include observations from state and private land intermingled with National Forest System land within the Thunder Basin National Grassland administrative boundary.

[b] Calculations for colony extent in management area 3.63 are based on 2018 surface ownership and management unit boundaries.

[c] Data for 2017 represents the full extent of colonies prior to the epizootic that began that year.

The Black-tailed Prairie Dog Conservation Assessment and Management Strategy established category areas with separate objectives for total prairie dog colony extent. The 2015 update to the strategy set the grassland-wide colony extent objective at 35,000 acres, with 18,000 acres in the category 1 area, 9,000 acres in category 2 areas, and 6,000 acres in category 3 areas, each of which is associated with

specific management direction in the strategy. The strategy set an additional 2,000-acre colony objective in permitted coal mine areas but does not include direction to guide management of colonies in those areas. Colonies grew in each category area between 2015 and 2017 (2016 data for categories 2 and 3 is incomplete) and declined following the epizootic that began in 2017 (Table 24). The permitted coal mine areas were not surveyed after 2015.

Table 24. Observed black-tailed prairie dog colony extent in Category 1, 2, and 3 areas and in permitted coal mine areas, 2015-2018.

Year	Category 1 (acres)	Category 2 (acres)	Category 3 (acres)	Coal mine permit areas (acres)
2015 strategy objective	18,000	9,000	6,000	2,000
2015	18,212	2,550	8,041	65
2016a	24,432	777	5,765	-
2017a	30,878	4,737	12,666	-
2018a	250	4	23	-

[a] Prairie dog colony surveys for 2016-2018 focused on Management Area 3.63 – Black-footed Ferret Reintroduction Habitat and surrounding areas. Areas permitted for coal mining, most category 3 areas, and the Highway 450 category 2 area were not surveyed in 2016-2018. 2016 data is also incomplete for the Dugout Creek, Miller Hills, and Vest Draw category 2 areas and the portion of category 1 south of the Cheyenne River.

Indicator 3 – Associated species

Thunder Basin National Grassland staff typically collect observation data of at-risk species while conducting wildlife surveys across the grassland annually. While sampling for survey locations is often opportunistic or nonrandom, anecdotally, observations of several species, including mountain plover, burrowing owl, swift fox, and some raptors, are associated with prairie dog colonies. Raw numbers of observations for burrowing owl, mountain plover, and swift fox have generally increased when the total extent of prairie dog colonies on the grassland has increased (Figures 11, 12, and 13); note the general increase in number of associated species observed as prairie dog colonies increased in extent between 2012 and 2016, prior to the plague epizootic). The survey record for raptors on the grassland is incomplete; because raptor surveys are resource intensive, only segments of the grassland can be surveyed each year.

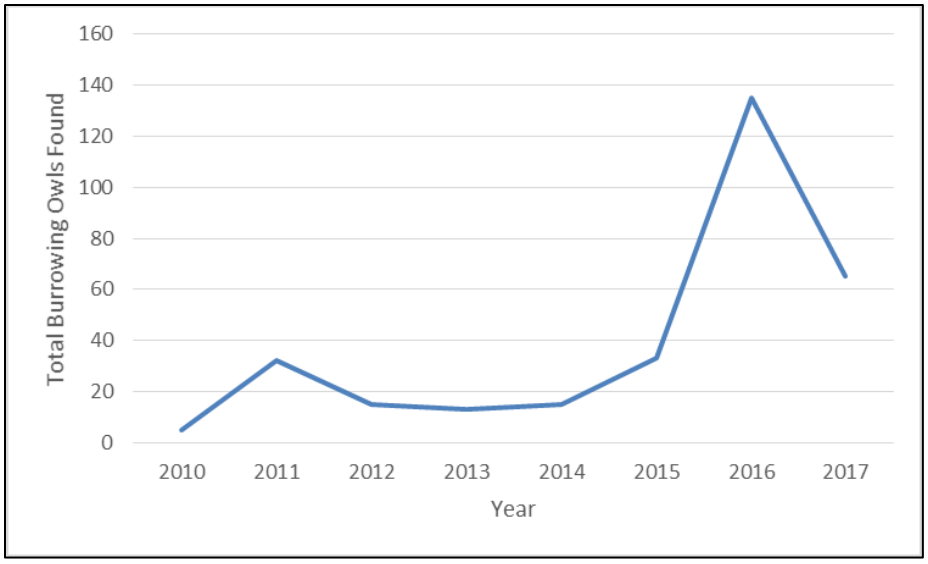

Figure 21. Total number of burrowing owls observed on the Thunder Basin National Grassland in Forest Service surveys, 2010-2017.

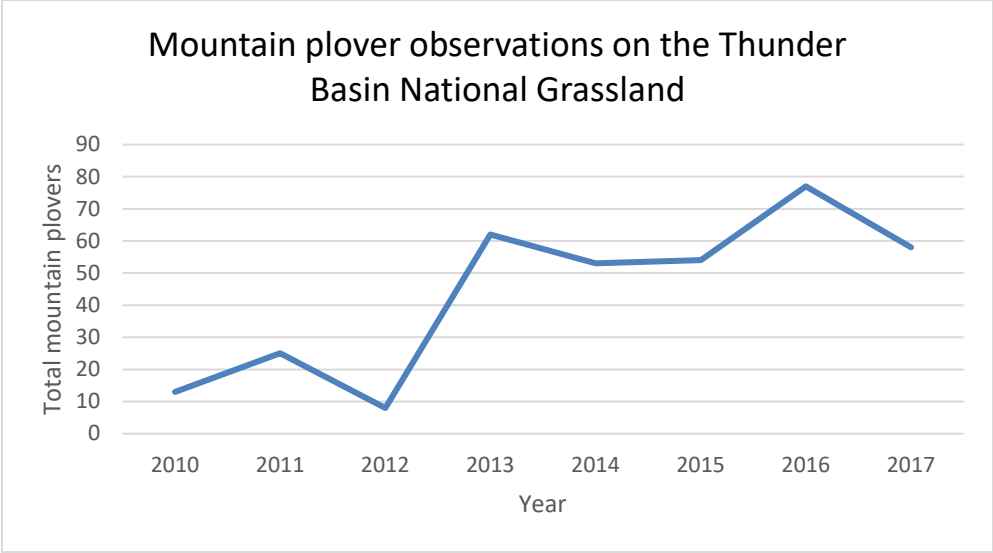

Figure 32. Total number of mountain plovers observed on the Thunder Basin National Grassland in Forest Service surveys, 2010-2017.

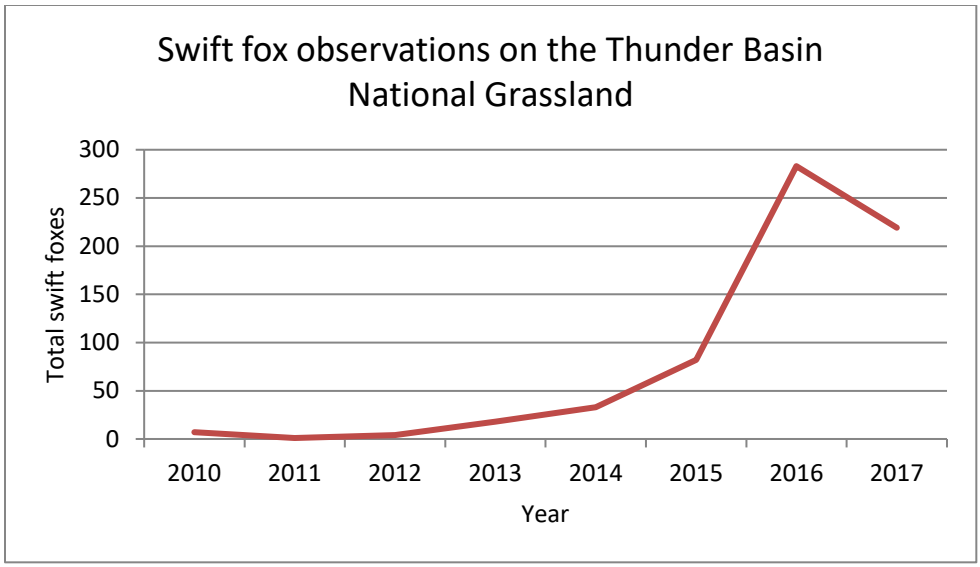

Figure 43. Total number of swift foxes observed on the Thunder Basin National Grassland in Forest Service surveys, 2010-2017.

2.5.3 Monitoring Discussion and Findings

Indicators 1, 2, and 3

Discussion: Observation data for prairie dog colonies show that prairie dog colony extent fluctuates annually on the grassland and that plague has become a critical driver of colony extent since 2001. Raw associated species observation data show a local correlation with colony growth and decline. The apparent volatility of prairie dog and associated species populations warrants further investigation into plague's ecological dynamics and plague management techniques to prevent plague events that cause departure from grassland plan desired conditions.

Progress toward forest and grassland plan goals and objectives: Monitoring data show that prairie dog colony extent was meeting the objective for the category 1 area until the 2017 epizootic. While data since 2016 are incomplete for category 2 and 3 areas, colony observations for the sample area met or nearly met the category 3 objective, while colony area was consistently below the objective for the category 2 areas. The location of category 2 areas may need to be reevaluated based on these results, which indicate a possible discrepancy between the colony extent objective and maximum potential habitat suitability for prairie dog colonies in those areas, especially considering the simultaneous exceedance of the category 1 and category 3 objectives. Permitted coal mine areas contained few colonies or were not surveyed.

Recommendations:

- Develop a systematic sampling method for mapping prairie dog colony extent across the grassland, especially for less-frequently surveyed portions of the grassland. Continue coordinating mapping efforts with the Thunder Basin Grassland Prairie Ecosystem Association and other partners.
- Consider developing a preemptive method for tracking plague activity in prairie dog colonies. Consider developing a plague management strategy and plan components associated with managing plague.

- Consider developing systematic survey protocols for species associated with prairie dog colonies, including burrowing owl, mountain plover, and swift fox, to rigorously track populations of these at-risk species and better understand their relationship with prairie dog colony extent and risk-factors such as plague.
- Relate monitoring results for prairie dog colonies and associated species to grassland plan desired conditions for short-grass vegetation.

2.6 Monitoring Item 6: Forest Focal Species

2.6.1 Monitoring Question and Background

- What do red squirrel, golden-crowned kinglet, pygmy nuthatch, and common flicker populations tell us about the extent and condition of mid to late successional forested ecosystems on the planning unit?

The 2012 planning rule requires forests to monitor focal species that can indicate changes in key characteristics of ecological integrity (36 CFR 219.12). Birds and small mammals are excellent focal species for evaluating ecological trends and conditions because they are generally conspicuous during the breeding season, and responsive to their environment at multiple scales. Red squirrel (*Tamiasciurus hudsonicus*), golden-crowned kinglet (*Regulus satrapa*), pygmy nuthatch (*Sitta pygmaea*), and northern flicker (*Colaptes auratus*) populations are indicative of forest structure in montane and subalpine ecosystems on the Medicine Bow-Routt National Forests. These ecosystems are not prevalent on the Thunder Basin National Grassland. Table 25 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 25. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for forest focal species.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b **Routt**: Goal 1, Objective bullets 6 and 7	1. Extent, density, and occupancy of red squirrels	Bird Conservancy of the Rockies	a) Annually b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.b **Routt**: Goal 1, Objective bullets 6 and 7	2. Change in occupancy and density of monitored bird species; diversity, species richness, distribution, and trends of mid to late successional forest bird communities	Bird Conservancy of the Rockies	a) Annually b) 2 years	

2.6.2 Monitoring Results

Indicators 1 and 2 – Red squirrels and mid- to late-successional forest bird species

Bird Conservancy of the Rockies has monitored birds, including golden-crowned kinglet, pygmy nuthatch, and northern flicker, on the Medicine Bow-Routt National Forests consistently since 2010. Bird Conservancy of the Rockies additionally monitors some conspicuous small mammal species including red squirrel. Forest Service staff on the Medicine Bow-Routt National Forests do not formally monitor these species and track incidental observations only. Bird Conservancy of the Rockies monitoring data is used to estimate the density of breeding birds and their occupancy across the landscape. Evaluating both density and occupancy is important for understanding population trends and distribution across the landscape and potential changes in ecological conditions (BCR, 2018). Bird Conservancy of the Rockies data is available online at: http://rmbo.org/v3/avian/ExploretheData.aspx. Tables 26 - 32 show Bird Conservancy of the Rockies monitoring data for red squirrel, golden-crowned kinglet, pygmy nuthatch, and northern flicker on the Medicine Bow National Forest from 2010-2017 and the Routt National Forest from 2011-2017. Bird Conservancy of the Rockies surveys did not detect pygmy nuthatch on the Routt National Forest from 2011-2017.

Table 26. Number, density, and occupancy of red squirrels on the Medicine Bow National Forest in Bird Conservancy of the Rockies surveys, 2010-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2010	70	41.79	0.653
2011	65	36.84	0.648
2012	141	32.8	0.852
2013	72	48.96	0.606
2014	142	27.47	0.894
2015	182	50.97	0.854
2016	40	55.16	0.613
2017	104	15.07	0.85

Table 207. Number, density, and occupancy of red squirrels on the Routt National Forest in Bird Conservancy of the Rockies surveys, 2011-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2011	86	38.15	0.765
2012	208	64.71	0.863
2013	70	22.6	0.73
2014	142	56.61	0.843
2015	70	30.76	0.536
2016	21	8.66	0.502
2017	114	49.51	0.916

Table 28. Number, density, and occupancy of golden-crowned kinglets on the Medicine Bow National Forest in Bird Conservancy of the Rockies surveys, 2010-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2010	8	2.46	0.238
2011	2	1.22	0.076
2012	8	1.92	0.172
2013	0	0	0
2014	0	0	0
2015	6	6.01	0.211
2016	3	1.48	0.148
2017	0	0	0

Table 29. Number, density, and occupancy of golden-crowned kinglets on the Routt National Forest in Bird Conservancy of the Rockies surveys, 2011-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2011	2	1.16	0.294
2012	7	3.12	0.258
2013	1	0.27	0.01
2014	11	4.41	0.23
2015	8	9.12	0.186
2016	1	0.86	0.184
2017	31	30.23	0.487

Table 30. Number, density, and occupancy of pygmy nuthatches on the Medicine Bow National Forest in Bird Conservancy of the Rockies surveys, 2010-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2010	0	0	0
2011	0	0	0
2012	14	1.9	0.07
2013	4	0.32	0.067
2014	4	0.91	0.075
2015	6	0.82	0.034
2016	3	0	0.051
2017	3	0.48	0.056

Table 31. Number, density, and occupancy of northern flickers on the Medicine Bow National Forest in Bird Conservancy of the Rockies surveys, 2010-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2010	30	2.93	0.73
2011	29	2.67	0.472
2012	34	4.49	0.686
2013	38	1.9	0.542
2014	40	1.9	0.755
2015	67	2.76	0.604
2016	50	2.84	0.788
2017	71	4.43	0.971

Table 212. Number, density, and occupancy of northern flickers on the Routt National Forest in Bird Conservancy of the Rockies surveys, 2011-2017.

Year	Observations	Density (number of individuals per square kilometer)	Occupancy (proportion of survey cells occupied)
2011	35	2.59	0.74
2012	47	4.74	0.668
2013	38	1.09	0.573
2014	27	1.25	0.618
2015	60	2.3	0.86
2016	41	2.16	0.942
2017	35	1.89	0.606

2.6.3 Monitoring Discussion and Findings

Indicators 1 and 2 – Red squirrels and mid- to late-successional forest bird species

Discussion: Monitoring results vary annually with no clear trend.

Progress toward forest and grassland plan goals and objectives: Results do not indicate a noticeable change in late successional forest from 2010 to 2017.

Recommendations:

- Evaluate the benefit of retaining pygmy nuthatch as a focal species.
- To obtain trends in bird populations based on limited survey data, consider monitoring bird species with an average percent coefficient of variation of estimates for density and occupancy of less than 50%.
- Relate monitoring results for forest focal species to forest plan desired conditions for mid- to late-successional forest vegetation.

2.7 Monitoring Item 7: Alpine Focal Species

2.7.1 Monitoring Question and Background

- What is the status of American pika, American pipit, and brown-capped rosy finch populations as indicators for alpine ecosystem integrity?

The 2012 planning rule requires forests to monitor focal species that can indicate changes in key characteristics of ecological integrity (36 CFR 219.12). Birds and small mammals are excellent focal species for evaluating ecological trends and conditions because they are generally conspicuous during the breeding season, and responsive to their environment at multiple scales. American pika (*Ochotona princeps*), American pipit (*Anthus rubescens*), and brown-capped rosy finch (*Leucosticte australis*) populations are indicative of alpine ecosystem integrity on the Medicine Bow-Routt National Forests. The Thunder Basin National Grassland does not contain alpine ecosystems. Table 33 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 223. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for alpine focal species.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b **Routt:** Goal 1, Objective bullets 6, 7	1. Extent, density, and occupancy of American pika	Bird Conservancy of the Rockies; Forest Service wildlife surveys; citizen science	a) Annually b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.b **Routt:** Goal 1, Objective bullets 6, 7	2. Change in occupancy and density of monitored bird species; diversity, species richness, distribution, and trends of alpine bird communities	Bird Conservancy of the Rockies	a) Annually b) 2 years	

2.7.2 Monitoring Results

Indicator 1 – American pika

The American pika has been a species of interest for biologists on the Medicine Bow-Routt National Forests since 2009, when staff on the forests began monitoring 27 known locations of pika in an administrative study. This study has continued through citizen science and volunteer efforts. Some of the initial monitoring sites have been removed from the Medicine Bow National Forest, but all 19 locations on the Routt National Forest continued to be monitored. Monitoring results show that pika have been present at established sites during 83% of visits to those sites, and pika presence increases as elevation increases (Table 34 and Figure 14). Figure 14 shows survey results from the Routt National Forest only, but pika continue to be found in high elevation, rocky talus habitats on the Medicine Bow National Forest when surveyed. The USDA Forest Service Natural Resource Manager Wildlife database contains over 390 occupied pika locations found across the Medicine Bow-Routt National Forests.

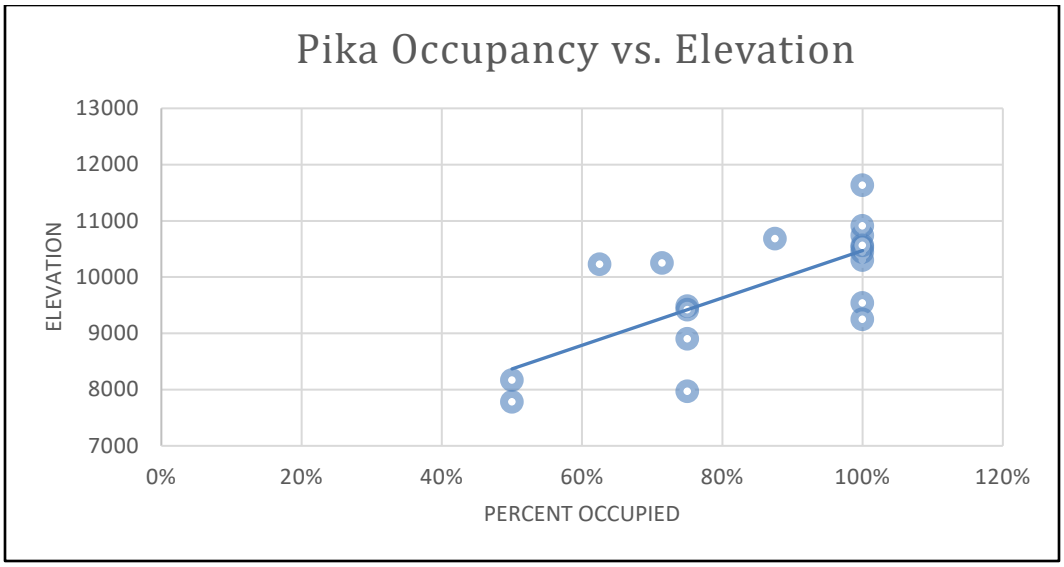

Figure 54. American pika occupancy versus elevation on the Routt National Forest.

The Bird Conservancy of the Rockies has monitored American pika since 2015 (Table 36).

Table 34. Bird Conservancy of the Rockies American pika observations on the Medicine Bow-Routt National Forests, 2015-2017.

Year	Medicine Bow NF Observations	Routt NF Observations	Total # of Observations
2015	3	5	8
2016	1	0	1
2017	0	18	18

Indicator 2 – Alpine bird species

The American pipit and brown-capped rosy finch are small, sparrow-sized birds that depend on alpine habitats. American pipit nests on the ground in alpine areas and winters in large open fields at lower elevations, while brown-capped rosy finch is often found in talus slopes. Since 2008, Bird Conservancy of the Rockies has surveyed for these species on the Medicine Bow-Routt National Forests. Forest Service staff on the forests do not formally monitor these species and track incidental observations only. Surveys detect both species regularly on the Routt National Forest, while only a few scattered observations occur on the Medicine Bow National Forest. Figure 15 shows estimates of density for American pipit and brown-capped rosy finch on the Routt National Forest. Estimates for American pipit have a large standard error for all years, while estimates for brown-capped rosy finch have slightly more statistical significance. Estimates for neither species show significant trends in number observed across years.

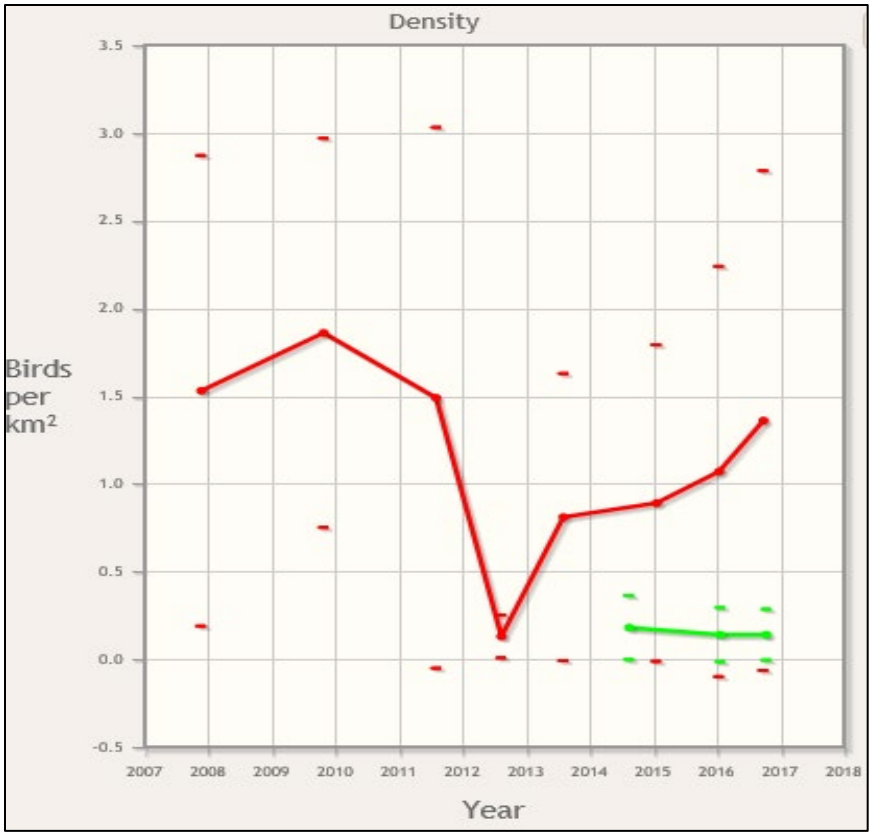

Figure 65. Density estimates for brown-capped rosy finch (green) and American pipit (red) in the Routt National Forest based on Bird Conservancy of the Rockies survey data (http://rmbo.org/v3/avian/ExploretheData.aspx).[4]

2.7.3 Monitoring Discussion and Findings

Indicators 1 and 2 – American pika and alpine bird species

Discussion: The results of American pika monitoring on the Routt National Forest show that pika occupancy increases at higher temperatures, indicating the importance of high elevation habitat. Similarly, based on 2008 re-surveys of historical American pika sites, Colorado Parks and Wildlife determined that pika in Colorado are doing well relative to pika in other states because of the effects of climate change on pika habitat at lower elevations, for example, in the Great Basin. Colorado's high elevation mountains with extensive talus fields receive more moisture and cooler summer-time temperatures, allowing pika to thrive.

The low detectability and high uncertainty regarding American pipit and brown-capped rosy finch detections is likely a result of the small amount of alpine tundra habitat available on the Medicine Bow-Routt National Forests. Few Bird Conservancy of the Rockies survey points on the forests contain American pipit and brown-capped rosy finch habitat.

Progress toward forest and grassland plan goals and objectives: Results do not indicate a noticeable change in alpine ecosystems from 2008 to 2017.

[4] Dots above and below the density estimate line indicate standard error.

Recommendations:

- Utilize volunteers and citizen science to track observations when feasible to gather more information on alpine tundra obligate breeding birds.
- To obtain trends in bird populations based on limited survey data, consider monitoring bird species with an average percent coefficient of variation of estimates for density and occupancy of less than 50%.

2.8 Monitoring Item 8: Wetland Focal Species

2.8.1 Monitoring Question and Background

- What is the status of amphibian assemblages on the planning unit?

The 2012 planning rule requires forests to monitor focal species that can indicate changes in key characteristics of ecological integrity (36 CFR 219.12). Amphibians are focal species for wetland and riparian habitats. Boreal toad (*Anaxyrus boreas boreas*), boreal chorus frog (*Pseudacris maculata*), tiger salamander (*Ambystoma tigrinum*), northern leopard frog (*Lithobates pipiens*), and wood frog (*Lithobates sylvaticus*) populations are indicative of wetland ecosystem integrity on the Medicine Bow-Routt National Forests. Chytrid fungus (*Batrachochytrium dendrobatidis*) causes the disease chytridiomycosis in amphibians and is likely responsible for population declines in some species, including boreal toad. Current amphibian population and chytrid fungus survey efforts do not include the Thunder Basin National Grassland. Table 35 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 35. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for wetland focal species.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b **Routt:** Goal 1, Objective bullets 6 and 7 **Thunder Basin:** Goal 1.b, Objectives 1-7	1. Boreal toad; presence/absence of chytrid fungus	Forest Service, Wyoming Game and Fish Department, and Colorado Parks and Wildlife surveys	a) Annually b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.b **Routt:** Goal 1, Objective bullets 6 and 7 **Thunder Basin:** Goal 1.b, Objectives 1-7	2. Diversity, abundance, and distribution of amphibian species; presence/absence of chytrid fungus	Rocky Mountain Amphibian Project	a) Annually b) 2 years	

2.8.2 Monitoring Results

Indicator 1 – Boreal toad

Boreal toad is a Forest Service Rocky Mountain Region sensitive species and the rarest amphibian on the Medicine Bow-Routt National Forests. The Routt National Forest contains 7 known currently occupied breeding sites, and the Medicine Bow National Forest contains 4. Boreal toads do not inhabit the Thunder Basin National Grassland. Known boreal toad breeding sites are sampled annually (up to 3 times) in cooperation with the Wyoming Game and Fish Department, Colorado Parks and Wildlife, and other partners. Surveyors monitor number of adults, juveniles, and tadpoles; length and weight information on adults and juveniles; and presence of chytrid fungus on adults. Table 36 displays the results of the boreal toad monitoring effort in 2017. Chytrid fungus was present in at least four of the known occupied boreal toad breeding sites across the forests.

Table 236. Known occupied boreal toad breeding sites on the Medicine Bow-Routt National Forests in 2017.

Forest	Number of sites monitored	Number of sites with annual reproduction for last three years	Number of sites with semi-annual reproduction for last three years	Number of sites with no toads for last three years	Number of sites positive for chytrid fungus	Number of sites negative for chytrid fungus
Routt NF	7	2	3	2	3	4
Medicine Bow NF	4	2	2	0	1*	1*

*** Not all boreal toad sites on the Medicine Bow National Forest were surveyed for chytrid fungus.**

Indicator 2 – Amphibian assemblages

Amphibian species monitoring on the Medicine Bow-Routt National Forests has also been conducted by the Rocky Mountain Amphibian Project, a long-term amphibian monitoring program that began in 2011 on the Medicine Bow-Routt National Forests (excluding the Laramie Peak unit). The Rocky Mountain Amphibian Project uses an occupancy-based sampling design that allows estimation of the percent of wetlands on the forests occupied by each amphibian species. Information collected on 17 sites from 2012 to 2015 has been averaged to provide a baseline estimate of occupancy (Table 37 and Figures 16 and 17.) Because of a limited number of detections, occupancy estimates were not assessed for boreal toad on both forests and for northern leopard frogs and tiger salamanders on the Medicine Bow National Forest.

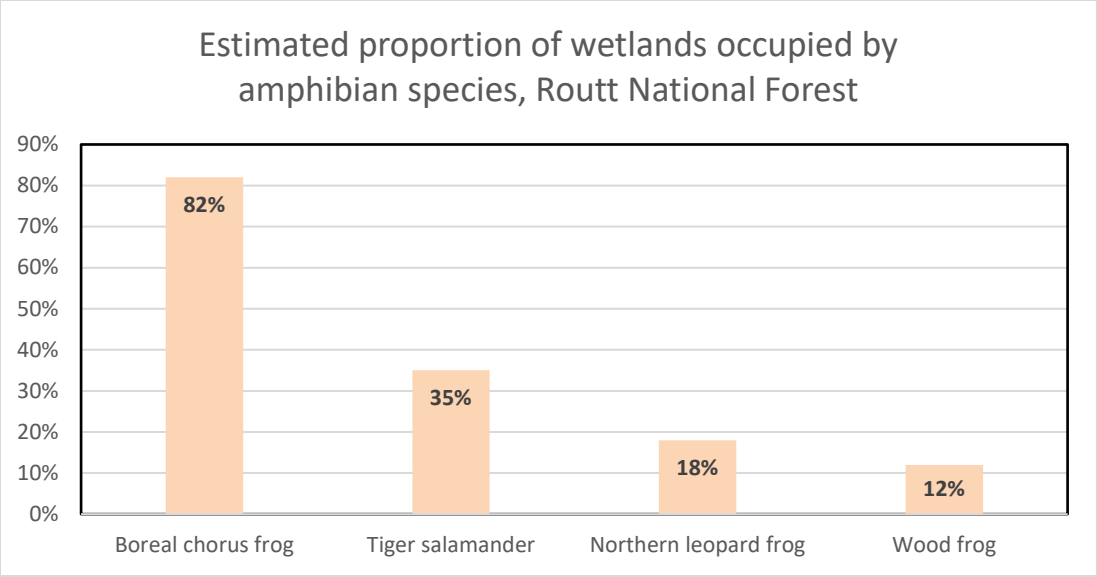

Figure 7. Estimated proportion of wetlands occupied by amphibian species on the Routt National Forest, 2012-2015.

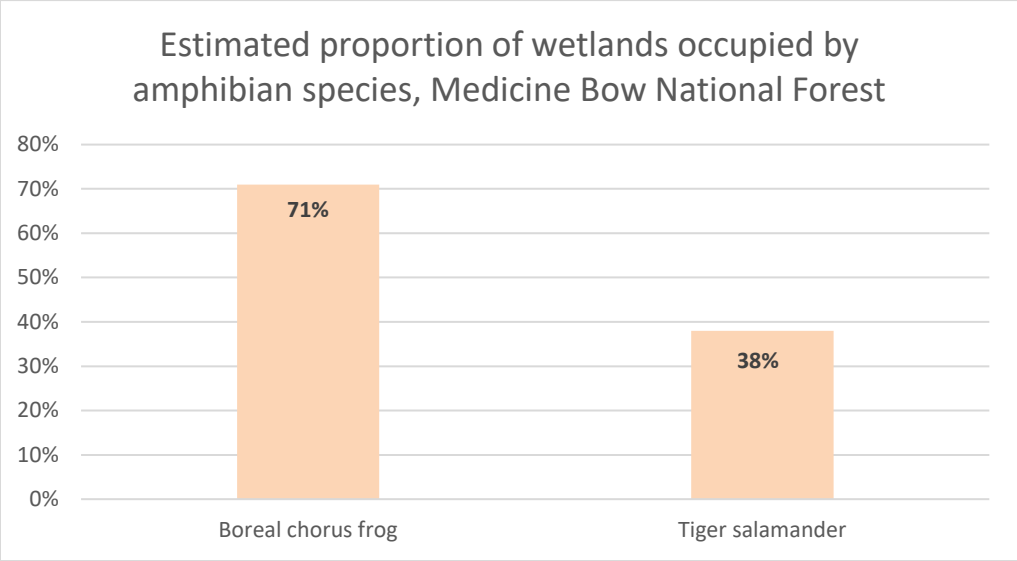

Figure 17. Estimated proportion of wetlands occupied by boreal chorus frog and tiger salamander on the Medicine Bow National Forest, 2012-2015.

The Rocky Mountain Amphibian Project also monitors presence of chytrid fungus on amphibians at survey sites. Chytrid fungus was present at 19 of 35 sites between 2012 and 2015.

Table 37. RMAP sites with Chytrid Fungus

Forest	Positive	Negative	Unknown
Routt	7	4	6
Med Bow	12	5	1

2.8.3 Monitoring Discussion and Findings

Indicators 1 and 2 – Boreal toad and amphibian assemblages

Discussion: The Forest Service will continue to work with partners to annually sample known boreal toad breeding sites on the Medicine Bow-Routt National Forests. Because of its remote location, forest staff will continue to sample the Spike Lake site on the Routt National Forest every three years. In cooperation with the Wyoming Game and Fish Department, boreal toads will be tracked with radio transmitters at the Ryan Park breeding site on the Medicine Bow National Forest in 2018.

The Forest Service will continue to work with partners to annually resample Rocky Mountain Amphibian Project sites. An analysis of all data collected through 2017 is expected by spring 2019.

Progress toward forest and grassland plan goals and objectives: Results do not indicate noticeable changes in wetland ecosystems on the forests.

Recommendations:

- Consider expanding amphibian monitoring efforts to the Thunder Basin National Grassland.
- Relate results of amphibian monitoring to desired conditions for wetland ecosystems in the forest and grassland plans.

2.9 Monitoring Item 9: Black-footed Ferret Habitat

2.9.1 Monitoring Question and Summary

- What is the status and trend of suitable habitat to support the recovery of the black-footed ferret on the planning unit?

Wild black-footed ferrets (*Mustela nigripes*) are not present on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, and no reintroductions of the species have taken place. For information regarding the status of suitable habitat to support black-footed ferret, which is an obligate of prairie dog colonies, see monitoring item 5 (section 2.5).

2.10 Monitoring Item 10: Lynx Habitat

2.10.1 Monitoring Question and Background

- What is the availability of early successional conifer and late seral spruce-fir forests to promote recovery of Canada lynx?

This monitoring item addresses regulatory requirements associated with the Southern Rockies Lynx Amendment (USDA Forest Service 2008). The Southern Rockies Lynx Amendment contains several management standards intended to conserve habitat for Canada lynx (*Lynx canadensis*), a threatened species under the Endangered Species Act. Table 38 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 38. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for lynx habitat.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b, Objective 5, Strategies f, j, q; Goal 1, Subgoal 1.c **Routt**: Goal 1 **Southern Rockies Lynx Amendment:** VEG O1; VEG O2; VEG S1; VEG S2; VEG S5; VEG S6	1. Extent and condition of early successional and late seral spruce-fir forests; habitat connectivity; dense horizontal cover	Forest Service FSVeg Spatial database Project impacts or mitigation Forest Service FACTS database U.S. Fish and Wildlife Service Future FWS Recovery plan	a) Annually b) 2 years	Vegetation objectives for lynx include providing a mosaic of habitat conditions through time that support dense horizontal cover, and high densities of snowshoe hare and providing winter snowshoe hare habitat in both the stand initiation structural stage and in mature, multi-story conifer vegetation. Standards VEG S1, VEG S2, VEG S5, and VEG S6 contain thresholds for vegetation management in lynx habitat.

2.10.2 Monitoring Results

Indicator 1 – Early successional and late seral spruce-fir forests

Standard VEG S1 in the Southern Rockies Lynx Amendment states that if more than 30 percent of lynx habitat in a lynx analysis unit (an area approximating the size of the home range of a female lynx) is in an unsuitable condition, then vegetation management projects shall not move additional acres into a stand initiation stage. The lynx amendment provides exceptions for different types of management in lynx analysis units with greater than 30% unsuitable condition as long as the number of acres treated remains below a threshold or cap. These thresholds are:

- 3% of lynx habitat across the Medicine Bow-Routt National Forests for fuel management projects in the wildland urban interface (WUI);
- 1% of lynx habitat in any lynx analysis unit for pre-commercial thinning; and
- 0.5% for all exceptions for pre-commercial thinning and multi-story management excluding exception 5 of standard VEG S5 and exception 4 of standard VEG S6.

Monitoring of habitat conditions and activities ensures that the forests do not exceed these caps. The Southern Rockies Lynx Amendment is available online at: https://www.fs.usda.gov/detail/r2/landmanagement/planning/?cid=stelprdb5199567.

The Medicine Bow-Routt National Forests recently re-mapped Canada lynx habitat in the Forest Service FSVeg Spatial corporate database to capture changes to forest structure resulting from fire, bark beetle, and other disturbances (see monitoring item 2 for more information about the FSVeg Spatial database). Lynx habitat analysis in 2011 over predicted the amount of dead lodgepole pine. A 2017 mapping update

shows 13 of 33 total lynx analysis units exceeding standard VEG S1 and zero lynx analysis units approaching unsustainable conditions. Activity tracking in lynx analysis units is collected and reported annually to the United States Department of the Interior Fish and Wildlife Service. Table 39 shows project acres accounted for under the 3%, 1%, and 0.5% exemptions and exceptions in the lynx amendment.

Table 39. Southern Rockies Lynx Amendment thresholds, allowable acres for treatment, and acres treated on the Medicine Bow-Routt National Forests.

Standards with exemptions and exceptions	Cap under exemption/exception	2011 mapping (allowable acres under cap)	2017 mapping (allowable acres under cap)	Project tracking since 2008 (acres treated)
VEG S1, VEG S2, VEG S5, VEG S6 WUI Exemption	3% of lynx habitat in combined forest units	38,819	38,901	5,648
VEG S5 Exception 5	1% of lynx habitat in any lynx analysis unit	12,940	12,967	763
VEG S5, VEG S6 Exceptions	0.5% of lynx habitat in combined forest units	6,470	6,483	697

2.10.3 Monitoring Discussion and Findings

Indicator 1 – Early successional and late seral spruce-fir forests

Discussion: The 2017 update to the FSVeg Spatial database generated relatively small changes to the maximum allowable acres for treatment under the three different thresholds for exemptions and exceptions. The mapping update did not change the forests' status in remaining below these thresholds.

Progress toward forest and grassland plan goals and objectives: Mapping and activity tracking indicate that the Medicine Bow-Routt National Forests have remained below the management thresholds for each exemption and exception for vegetation management in the Southern Rockies Lynx Amendment. The forests have treated approximately 15%, 6%, and 11% of maximum allowable acres in each of the three treatment thresholds.

Recommendations:

- Ensure spatial data regarding proportion of suitable and unsuitable habitat in lynx analysis units is updated as changes to habitat occur as a result of wildland fire, vegetation management, and other disturbances or stressors.

2.11 Monitoring item 11: Visitor Satisfaction and Use

2.11.1 Monitoring Question and Background

- What are the status and trends of visitor satisfaction for recreational visits on the planning unit?

This monitoring question address forest and grassland plan goals and objectives associated with recreation and visitor use. Table 40 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 240. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for visitor satisfaction and use.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 2, Subgoal 2.a, Objectives 1-4, Strategies a-g **Routt:** Goal 2, Objective bullets 1-3 **Thunder Basin:** Goal 2.a, Objectives 1-7, 9	1. Visitor satisfaction; number of visitors; changes in demand	Forest Service National Visitor Use Monitoring program	a) 5 Years b) 5 years	

2.11.2 Monitoring Results

Data on visitation, visitor satisfaction, and changes in recreation demand is collected through visitor survey methods by the Forest Service National Visitor Use Monitoring Program every five years. The most recent two survey periods available for the Routt National Forest were 2007 and 2012, and the most recent survey periods available for the Medicine Bow National Forest and Thunder Basin National Grassland, which are evaluated together, were 2008 and 2013. Figures 18 and 19 show changes in number of visitors and visitor satisfaction during these two most recent survey periods. Table 41 shows change in visitor activities and demand between 2007/2008 and 2012/2013.

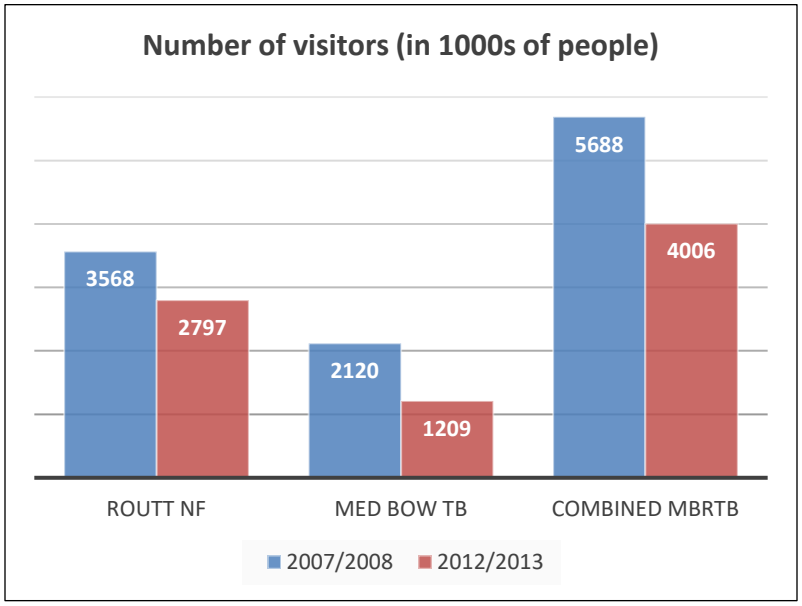

Figure 18. Number of visitors to the Medicine Bow-Routt National Forests and Thunder Basin National Grassland.[5]

[5] Data for the Routt National Forest was collected in 2007 and 2012. Data for the Medicine Bow National Forest and Thunder Basin National Grassland was collected in 2008 and 2013. Values shown are in the middle of the range of estimated values at the 90th percentile confidence interval; estimates within the bounds of this confidence interval may be up to 18% greater or less than the values shown.

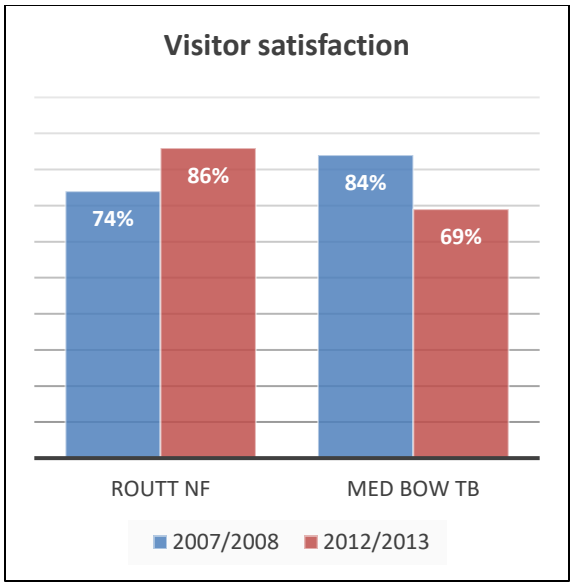

Figure 19. Visitor satisfaction on the Forests and Grassland. Data for the Routt National Forest was collected in 2007 and 2012.

Data for the Medicine Bow National Forest and Thunder Basin National Grassland was collected in 2008 and 2013. Values shown are in the middle of the range of estimated values at the 90th percentile confidence interval; estimates within the bounds of this confidence interval may be up to 18% greater or less than the values shown.

Table 41. Visitor activity and demand

Forest and Year	Top activities by percent participation
Routt (2007)	1. Downhill Skiing (67.4%)
Routt (2007)	2. Viewing Natural Features (46.8%)
Routt (2007)	3. Relaxing (44.3%)
Routt (2007)	4. Viewing Wildlife (33.7%)
Routt (2007)	5. Hiking/Walking (19%)
Routt (2012)	1. Downhill Skiing (49.8%)
Routt (2012)	2. Hiking/Walking (38.4%)
Routt (2012)	3. Viewing Natural Features (27.9%)
Routt (2012)	4. Viewing Wildlife (21.6%)
Routt (2012)	5. Relaxing (21.1%)
Medicine Bow and Thunder Basin (2008)	1. Viewing Natural Features (48.6%)
Medicine Bow and Thunder Basin (2008)	2. Hiking/Walking (43.8%)
Medicine Bow and Thunder Basin (2008)	3. Viewing Wildlife (41.6%)
Medicine Bow and Thunder Basin (2008)	4. Relaxing (34.9%)
Medicine Bow and Thunder Basin (2008)	5. Driving for Pleasure (27.4%)
Medicine Bow and Thunder Basin (2013)	1. Viewing Wildlife (35%)
Medicine Bow and Thunder Basin (2013)	2. Viewing Natural Features (34%)
Medicine Bow and Thunder Basin (2013)	3. Hiking/Walking (32.5%)

Forest and Year	Top activities by percent participation
Medicine Bow and Thunder Basin (2013)	4. Driving for Pleasure (31.7%)
Medicine Bow and Thunder Basin (2013)	5. Relaxing (28.2%)

2.11.3 Monitoring Discussion and Findings

Discussion: In general, the Medicine Bow-Routt National Forests and Thunder Basin National Grassland experienced a decrease in the number of visitors between 2007/2008 and 2012/2013. The five-year cycle of the National Visitor Use Monitoring program inventory continued in 2017 for the Routt National Forest and 2018 for the Medicine Bow National Forest and Thunder Basin National Grassland.

Progress toward forest and grassland plan goals and objectives: The forest and grassland plans do not contain quantitative goals related to number of visitors, visitor satisfaction, or visitor activities.

Recommendations:

- Report more survey cycles to better understand trends in visitor use.
- To be responsive to monitoring item 13, indicator 6 (section 2.13.1), consider identifying indicators to provide information about visitor use impacts on resources and discuss the relationship between visitor use and stresses and disturbances to forest and grassland ecosystems.

2.12 Monitoring Item 12: Public Access

2.12.1 Monitoring Question and Background

- What level of access to and across the planning unit is provided to the public?

This monitoring item addresses forest and grassland plan goals and objectives to provide access to the public and improve the safety and economy of forest roads, trails, and facilities. Table 42 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 252. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for public access.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 2, Subgoal 2.a, Objectives 1-4, Strategies b, e, f; Goal 4, Subgoal 4.a, Objectives 1, 2, 4, 7, Strategies a-c **Routt:** Goal 2, Objective bullet 3 **Thunder Basin:** Goal 2.a, Objectives 1-7; Goal 4.a, Objectives 1-4; Goal 4.b	1. Change in miles of trail by trail type; change in miles of road by road type 2. Change in number of developed recreation sites 3. Change in number of sites accessible for people with disabilities 4. Change in acres that are open to public access	Forest Service Infrastructure (INFRA) database	a) Annually b) 2 years	

2.12.2 Monitoring Results

Indicators 1, 2, 3, and 4

The last evaluation of public access indicators occurred in 2016. 2016 data for public access monitoring indicators is shown in Table 43. While the precise number of acres of National Forest System land open to public access on the forests and grassland is unavailable, there was no change since the previous monitoring cycle.

Table 263. Miles of trail, miles of road, number of developed recreation sites, and accessible building rate on the Forests and Grassland, 2016.

Indicator	Value
Miles of trail	2,310
Miles of road[a]	3,901
Number of developed recreation sites of Development Scale 2-5	224
Accessible building rate	38.8%

[a] Calculated based on the length of road in the 2016 motor vehicle use map overlapping National Forest System land on the forests and grassland.

2.12.3 Monitoring Discussion and Findings

Indicators 1, 2, 3, and 4

Discussion: Monitoring results showed no significant change in any indicators since the previous monitoring cycle. Current data will serve as a baseline for future trends.

Progress toward forest and grassland plan goals and objectives: The forest and grassland plans do not contain quantitative goals related to public access.

Recommendations:

- When applicable, relate changes in public access to other monitored stressors or disturbances on the forests and grassland.

2.13 Monitoring Item 13: Stressors

2.13.1 Monitoring Question and Background

- What stressors are impacting the planning unit? Can any trends in these stressors be related to climate change?

This monitoring question addresses the various goals and objectives in the forest and grassland plans related to minimizing the impacts of stressors and disturbances on forest uses and ecosystem integrity. Stressors include climate change, invasive species, habitat fragmentation, visitation, and unauthorized use, and disturbances include insects, disease, and fire. Table 44 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 274. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for stressors.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoals 1.a, 1.b, and 1.c **Routt:** Goal 1, Objective bullet 4 **Thunder Basin:** Goals 1.a, 1.b, 1.c	1. Climatic Variables: timing, type and amount of precipitation; changes in air temperature; snowpack depth and persistence; changes in stream/lake temperature	National Oceanic and Atmospheric Administration National Centers for Environmental Information National Environmental Modeling and Analysis Center Climate by Forest Natural Resources Conservation Service Snow Telemetry (SNOTEL) Desert Research Institute/University of Idaho Google Earth Engine	a) Annually b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.c, Objective 3, Strategies f, g; Goal 3, Subgoal 3.a, Objective 1 **Routt:** Goal 1 **Thunder Basin:** Goal 1.c	2. Extent of insect and disease outbreaks	Forest Health Monitoring	a) Annually b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.c, Objective 4, Strategies i, j; Goal 3, Subgoal 3.a, Objective 1 **Routt:** Goal 1, Objective bullet 7 **Thunder Basin:** Goal 1.c, Objectives 3-6	3. Extent of invasive species infestations	Forest Service Natural Resource Manager Threatened, Endangered, and Sensitive Plants – Invasive Species database Forest Service rangeland survey data County weed and pest district management program data	a) Annually in key areas b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.b, Strategy b; Goal 1, Subgoal 1.c, Objectives 1, 2, Strategies a, c-e **Routt:** Goal 1 **Thunder Basin:** Goal 1.c, Objective 1	4. Extent and severity of wildfires; dozer fire line constructed	Wildland Fire Decision Support System (WFDSS) Monitoring Trends in Burn Severity (MTBS) National Interagency Fire Center (NIFC) Local Forest Service fire and fuels datasets	a) Annually b) 2 years	

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.b, Objectives 1, 3, 5, Strategies a, d, j, m, o, p; Goal 4, Subgoal 4.a, Objective 4, Strategies a, b **Routt:** Goal 1, Objective bullet 6 **Thunder Basin:** Goal 1.b, Objectives 2, 4, 6; Goal 1.c, Objective 2; Goal 4.a, Objectives 1, 2	5. Habitat fragmentation (roads and infrastructure per square mile)	Forest Service roads and trails datasets Wyoming Density and Disturbance Calculation Tool for greater sage-grouse habitat	a) 5 years b) 5 years	Decommission at least 150 miles of designated roads that will be determined through project level analyses and approval. (Medicine Bow) In greater sage-grouse priority habitat management areas, limit the density of activities related to oil and gas development or mining activities to no more than an average of one pad or mining operation per 640 acres. (Wyoming) In greater sage-grouse priority habitat management areas, do not authorize surface disturbing activities unless all existing discrete anthropogenic disturbances cover less than 5% of the suitable habitat in the surrounding area. (Wyoming)
Medicine Bow: Goal 2, Subgoal 2.a, Objectives 1-4, Strategies a-g **Routt:** Goal 2, Objective bullets 1-3 **Thunder Basin:** Goal 2.a, Objectives 1-7, 9	6. Number of visitors by activity type	Forest Service National Visitor Use Monitoring program	a) 5 years b) 5 years	
Medicine Bow: Goal 2, Subgoal 2.a, Strategy d; Goal 4, Subgoal 4.a, Strategy b **Routt:** Goals 1, 2 **Thunder Basin:** Goal 4.a, Objective 2; Goal 4.b, Unauthorized Uses Objective 1	7. Unauthorized off-highway vehicle use	Forest Service Law Enforcement and Investigations Management Attainment Reporting System (LEIMARS) database incidents Forest Service maps of unauthorized routes	a) Annually b) 2 years	

2.13.2 Monitoring Results and Discussion

Indicator 1 – Climatic variables

Climate varies widely from the prairie and sagebrush steppe of the Thunder Basin National Grassland to the alpine tundra and subalpine forests of the Medicine Bow-Routt National Forests. All districts across the forests and grassland work closely with local, State, and other Federal agencies to monitor temperature, snowpack, and precipitation. Data on temperature and precipitation trends is provided by the National Environmental Modeling and Analysis Center Climate by Forest application and the United States Department of Commerce National Oceanic and Atmospheric Administration National Centers for Environmental Information. Figure 20 shows historical and projected annual average daily maximum temperature for the Medicine Bow Mountains ecoregion on the Medicine Bow-Routt National Forests. Figure 21 shows historical and projected annual average daily maximum temperature for the Southern Powder River Basin-Scoria Hills ecoregion, which contains portions of the Thunder Basin National Grassland.

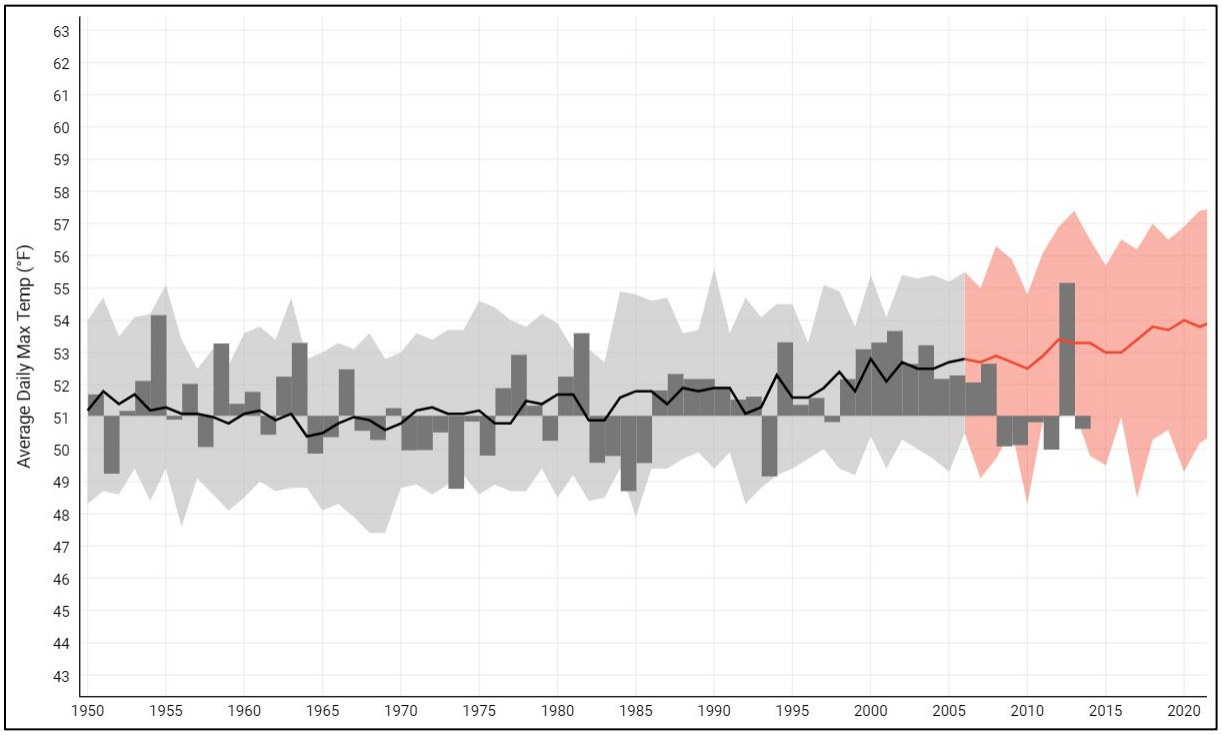

Figure 80. Annual average daily maximum temperature in the Medicine Bow Mountains ecoregion.[6]

[6] Gray bars represent observed historical temperatures 1950-2013, extending positively or negatively from the horizontal line representing the average daily maximum temperature from 1961-1990. The red range shows the range of climate model projections assuming global emissions of greenhouse gases continue increasing (representative concentration pathway 8.5); the red line is the weighted mean of all projections at each time step. The black line and gray range are a historical simulation using the same model used to produce the projections shown by the red range and line.

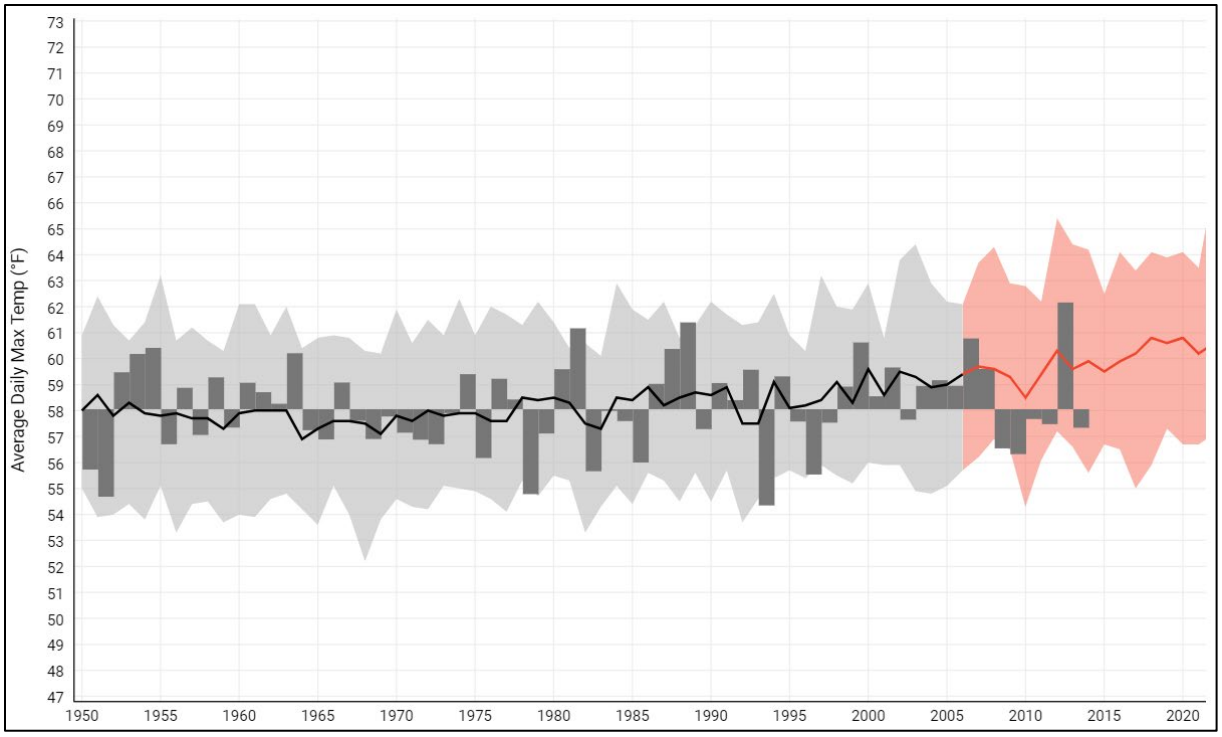

Figure 91. Annual average daily maximum temperature in the Southern Powder River Basin-Scoria Hills ecoregion.[7]

Warming trends are particularly evident during winter months. Average winter temperatures in the Upper Platte watershed have increased approximately 2.5 degrees Celsius since 1950 (Figure 22).

[7] Gray bars represent observed historical temperatures 1950-2013, extending positively or negatively from the horizontal line representing the average daily maximum temperature from 1961-1990. The red range shows the range of climate model projections assuming global emissions of greenhouse gases continue increasing (representative concentration pathway 8.5); the red line is the weighted mean of all projections at each time step. The black line and gray range are a historical simulation using the same model used to produce the projections shown by the red range and line.

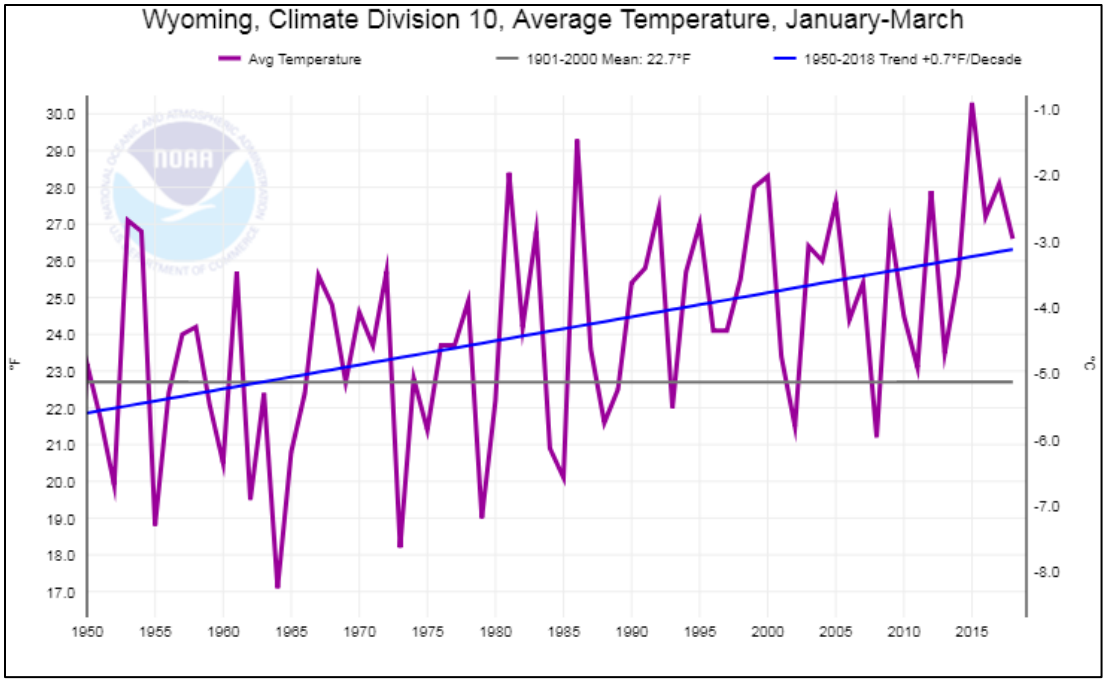

Figure 102. Average temperature January-March in the Upper Platte watershed.

Precipitation timing and type vary across the forests and grassland. Overall, long term precipitation trends have remained relatively flat (Figures 23 and 24). However, the last 30 years have seen more extreme dry and wet years.

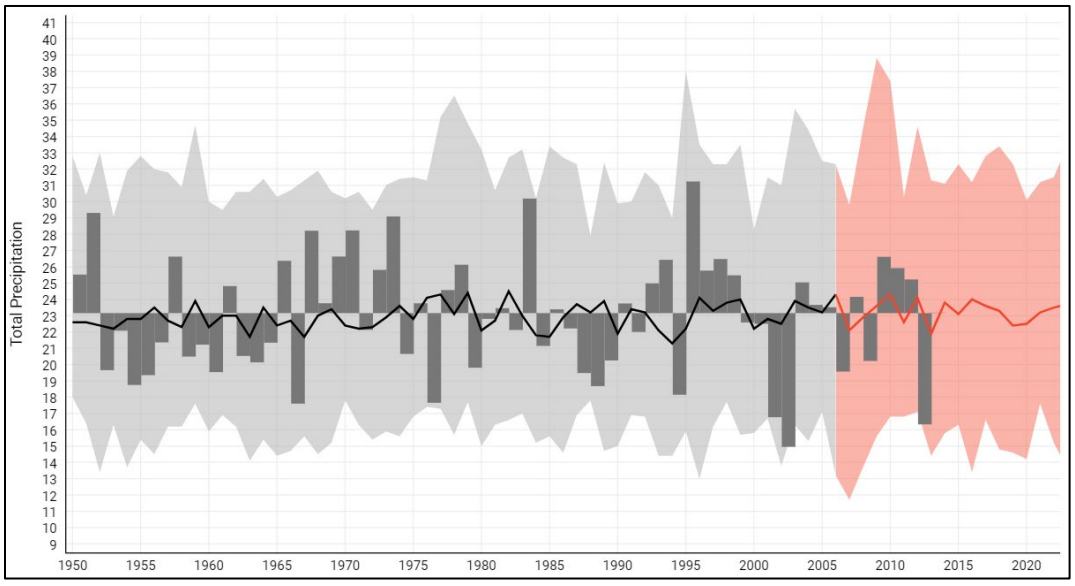

Figure 113. Average annual precipitation in the Medicine Bow Mountains ecoregion. The unit for the vertical axis is inches.[8]

[8] Gray bars represent observed historical precipitation 1950-2012, extending positively or negatively from the horizontal line representing the average annual precipitation from 1961-1990. The red range shows the range of climate model projections

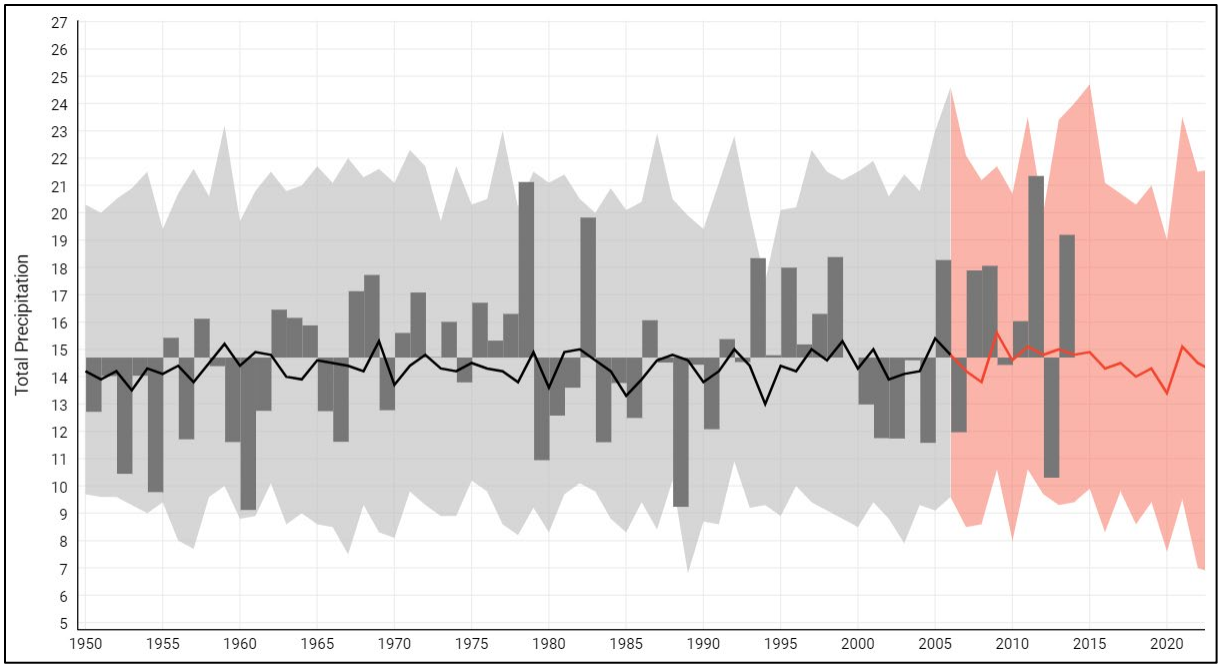

Figure 124. Average annual precipitation in the Southern Powder River Basin-Scoria Hills ecoregion. The unit for the vertical axis is inches.[9]

Snowpack information produced by the United States Department of Agriculture Natural Resources Conservation Service through snow telemetry (SNOTEL) monitoring highlights significant interannual variation in snowpack and timing of runoff and release. Annual time series snowpack data for the years 2014-2018 and 1998-2002 in the Laramie and North Platte river basins shows a shift backwards in average date of peak from April 26 in 1998-2002 to April 11 in 2014-2018 (Figures 25 and 26).

assuming global emissions of greenhouse gases continue increasing (representative concentration pathway 8.5); the red line is the weighted mean of all projections at each time step. The black line and gray range are a historical simulation using the same model used to produce the projections shown by the red range and line.

[9] Gray bars represent observed historical precipitation 1950-2013, extending positively or negatively from the horizontal line representing the average annual precipitation from 1961-1990. The red range shows the range of climate model projections assuming global emissions of greenhouse gases continue increasing (representative concentration pathway 8.5); the red line is the weighted mean of all projections at each time step. The black line and gray range are a historical simulation using the same model used to produce the projections shown by the red range and line.

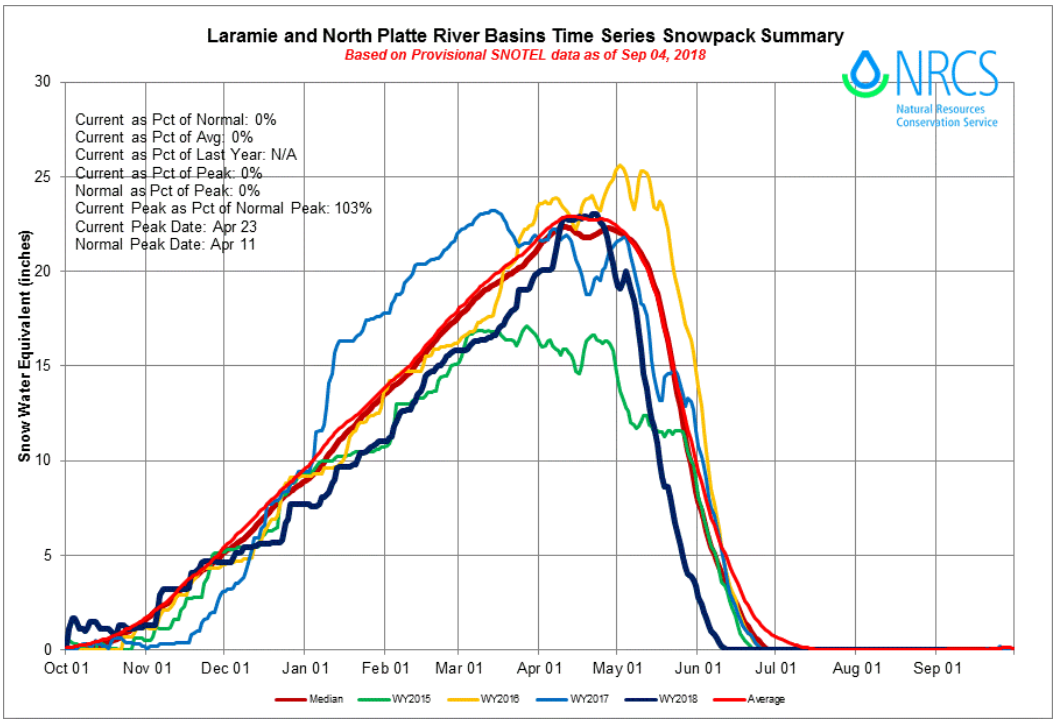

Figure 25. Snowpack trends for the Laramie and North Platte river basins, 2014-2018.

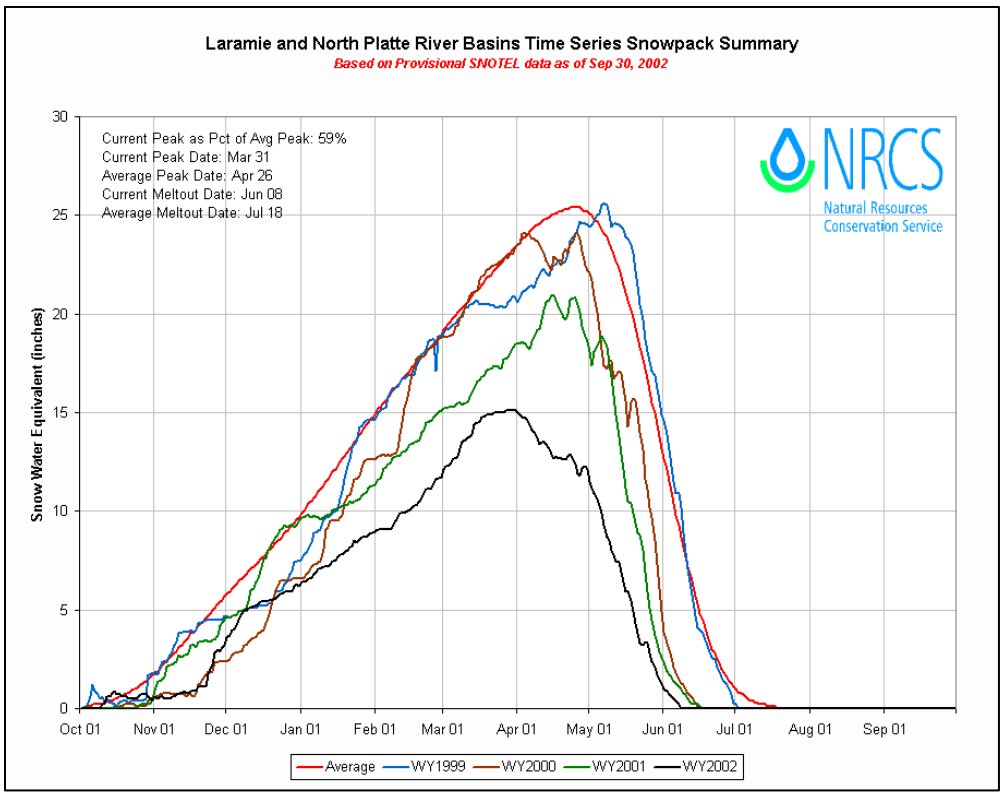

Figure 26. Snowpack trends for the Laramie and North Platte river basins, 1998-2002.

Some portions of the Thunder Basin National Grassland experience localized "flash droughts," which affect several grassland uses. Grassland staff work closely with the United States Department of Agriculture Farm Service Agency and Natural Resources Conservation Service to monitor for localized drought conditions. In addition, one grazing association collects very detailed precipitation, temperature, and soil moisture data. Trends in precipitation and primary productivity for the Thunder Basin National Grassland were analyzed using the Desert Research Institute and University of Idaho's Climate Engine. The Climate Engine links gridded climatic datasets (i.e., PRISM and gridMET) and remote sensing datasets (i.e., LANDSAT and MODIS) to Google Earth Engine, facilitating analysis of climate trends and land use change at broad scales. Remote sensing datasets can be used to measure primary productivity in an area with metrics such as the Normalized Difference Vegetation Index (NDVI). The analysis shows that at the scale of the grassland, there are no discernible trends in NDVI or precipitation over the last 35 years (Figure 27).

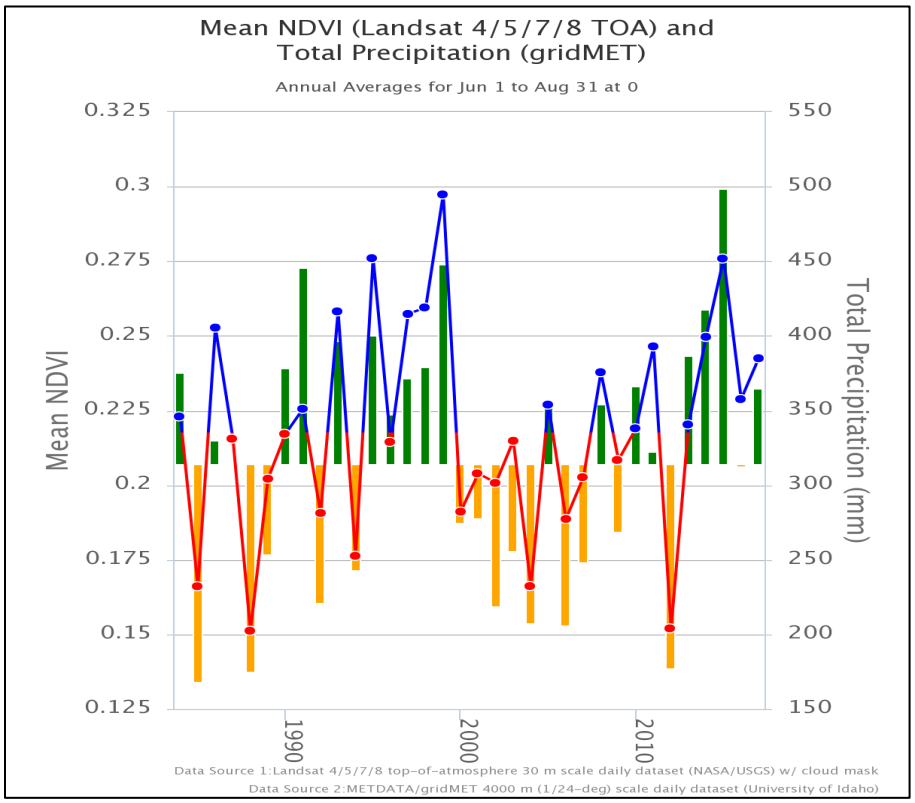

Figure 27. Area averaged summer Normalized Difference Vegetation Index (NDVI) and precipitation for the Thunder Basin National Grassland, 1984-2017.[10]

[10] The blue and red line represents total precipitation per year, with blue points greater than and red points less than the average annual total precipitation for the period of observation (1984-2017). The green and orange bars represent average annual NDVI, with green bars greater than and orange bars less than the average annual NDVI for the period of observation. Data and analyses are available from the Desert Research Institute and University of Idaho's Climate Engine (available at: http://.climateengine.org).

Indicator 2 – Insects and disease

Insect and disease outbreaks are monitored through the Forest Health Monitoring program. Aerial surveys conducted over the Medicine Bow-Routt National Forests since 1998 indicate tree mortality resulting from insects and disease. Most insect and disease related morality on the Medicine Bow-Routt National Forests over the past two decades has been caused by mountain pine beetle and spruce beetle. Bark beetle-caused mortality on the forests has declined since peaks in activity during the 2000s and early 2010s. Acres affected by mountain pine beetle peaked in 2008 on both forests (Figure 28). Mountain pine beetle activity is at endemic levels after large epidemics affected approximately 3.5 million acres in Wyoming and 3.4 million acres of pine (*Pinus* spp.) trees in Colorado beginning in the late 1990s. No mountain pine beetle-caused mortality was observed on the Routt National Forest in 2016-2017, and mountain pine beetle on the Medicine Bow National Forest affected less than 100 acres per year in 2016-2017, occurring predominantly in limber pine (*Pinus flexilis*).

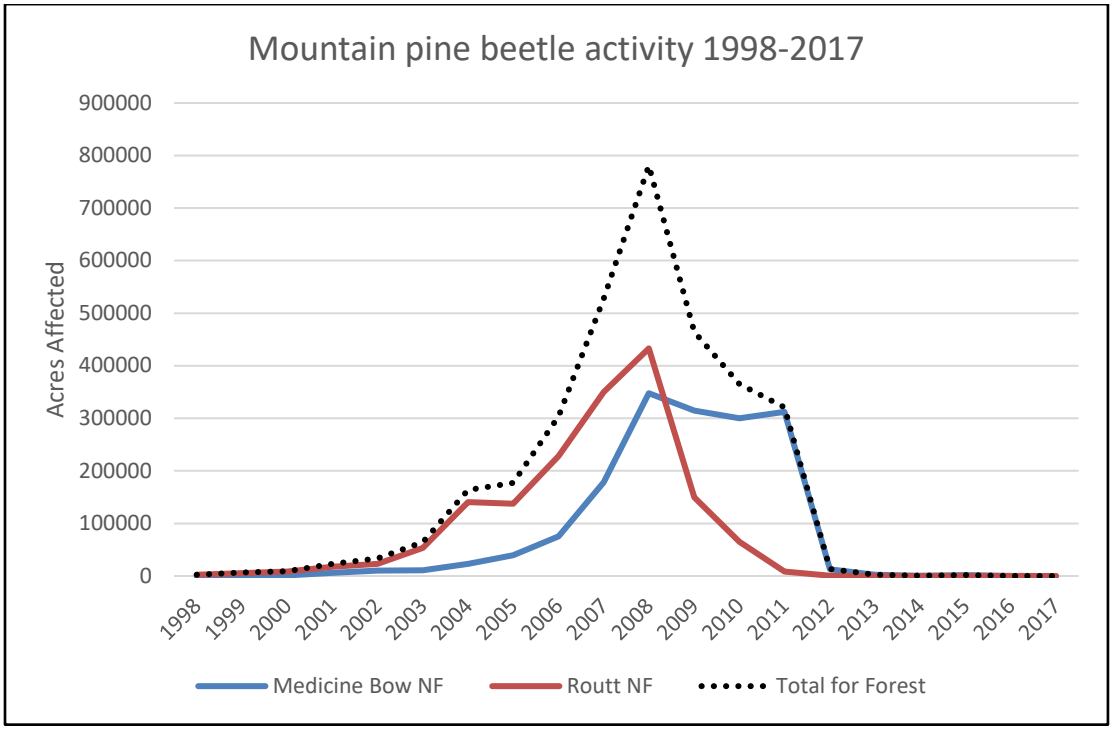

Figure 28. Acres of forest affected by mountain pine beetle on the Medicine Bow-Routt National Forests, 1998-2017.

Spruce beetle activity peaked twice on the Medicine Bow National Forest in 2006 and 2011 and three times on the Routt National Forest in 2003, 2006, and 2011 (Figure 29). Spruce beetle-caused mortality declined after 2011 on both forests as large green trees become less abundant. In 2017, spruce beetle-killed trees were observed on approximately 1,200 acres on the Medicine Bow National Forest in areas not previously impacted and 306 acres of the Routt National Forest not previously impacted.

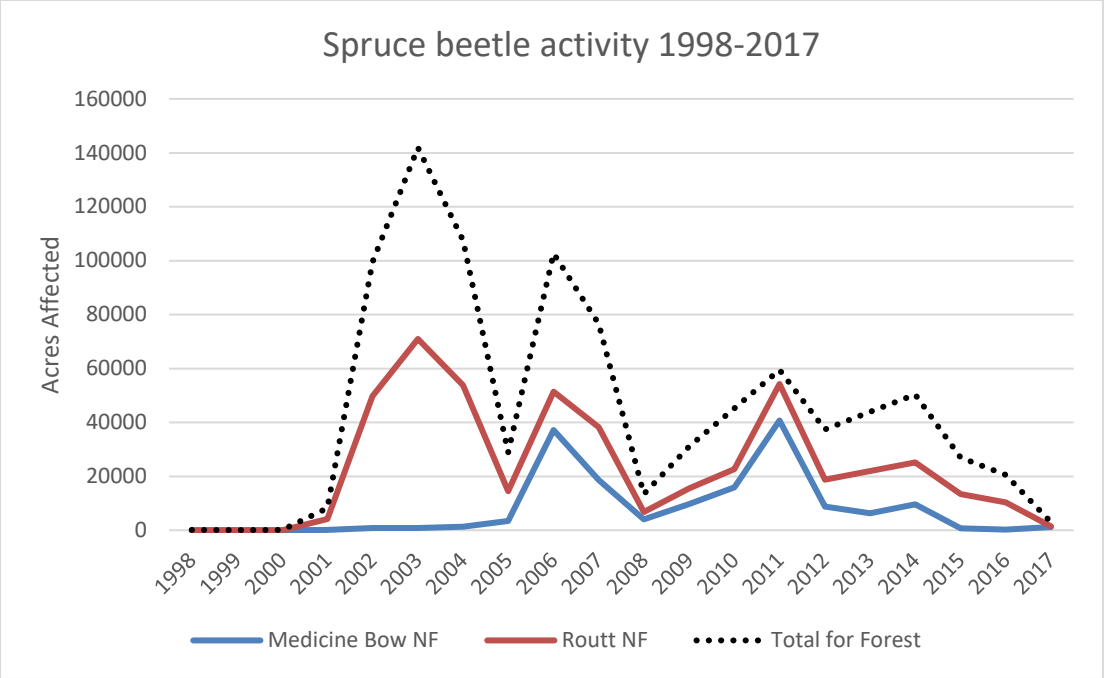

Figure 29. Acres of forest affected by spruce beetle on the Medicine Bow-Routt National Forests, 1998-2017.

Other insects and diseases have affected the forests to a lesser degree than mountain pine beetle and spruce beetle. Subalpine fir (*Abies lasiocarpa*) decline because of bark beetles is widespread across Wyoming's high elevation spruce-fir forests, but the intensity of tree mortality is more scattered rather than the stand-level, bark beetle-caused mortality observed in associated Engelmann spruce. Subalpine fir is typically killed by western balsam bark beetles (*Dryocoetes confuses*), and mortality may also be associated with root disease fungi. In 2017 across Wyoming, aerial surveys detected over 15,000 acres of stands with varying intensity of subalpine fir mortality as a result of western balsam bark beetle and associated fungi. In Colorado, aerial surveys detected 50,000 acres of subalpine fir mortality statewide.

White pine blister rust is a non-native disease caused by the fungus *Cronartium ribicola* that affects limber pine on the Medicine Bow-Routt National Forests. While white pine blister rust is not visible during aerial surveys and forest-wide impacts have not been quantified, the disease has ecological and forest management implications. The Southern Rockies Rust Resistance Trial test site was established at the Pole Mountain Work Center in 2013 and continues to be monitored. This study is a cooperative effort with the Rocky Mountain Research Station and Colorado State University with a goal to locate and develop genetically resistant strains of limber pine for future limber pine restoration projects.

Douglas-fir beetle (*Dendroctonus pseudotsugae*) is active in Colorado and Wyoming but has caused limited mortality on the Medicine Bow-Routt National Forests. The Routt National Forest does not contain pure stands of Douglas-fir (*Pseudotsuga menziesii*), but aerial surveys showed scattered Douglas-fir mortality in portions of the Flat Tops in the Yampa Ranger District. In Wyoming, Douglas-fir beetle is active at endemic levels, with 230 acres affected statewide in 2017.

Indicator 3 – Invasive species

See monitoring item 18, section 2.18 for results and discussion of data regarding invasive species.

Indicator 4 – Wildland fire

Wildland fire occurs regularly on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland. The Wildland Fire Decision Support System is a national interagency database that provides information about fire management planning, fire modeling, and current and historical fire incidents. Figure 30 shows number of incidents on the Forests and Grassland and acres burned in those incidents from 2000-2018, based on fire incident data contained in the Wildland Fire Decision Support System. The data from the Wildland Fire Decision Support System does not include all fires that occurred on the forests and grassland during that time period, especially smaller incidents, but shows general trends in area burned, with prominent large fire years in 2002, 2012, and 2018. The forests and grassland experienced 6 fires that burned more than 20,000 acres from 2000-2018, including the Arapaho fire in 2012, the Beaver Creek fire in 2016, and the Badger Creek, Britania Mountain, Ryan, and Silver Creek fires in 2018. In addition, four fires that burned more than 10,000 acres occurred in 2002, and 1 fire larger than 10,000 acres occurred in 2012 (Table 45).

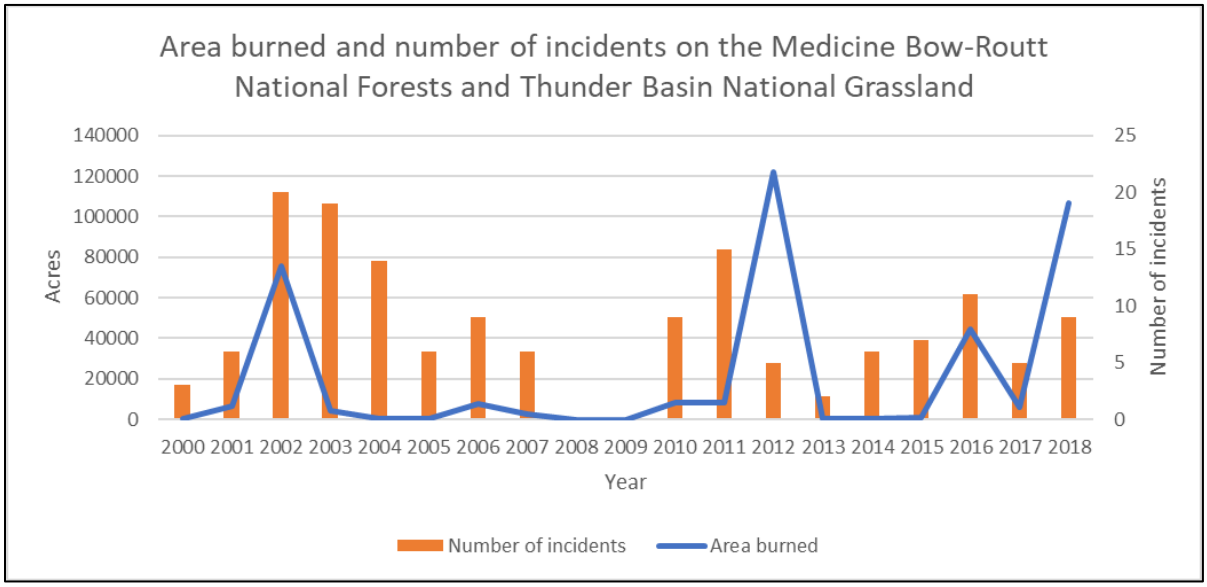

Figure 130. Area burned and number of incidents on the Forests and Grassland in the Wildland Fire Decision Support System, 2000-2018.

Many incidents burned across jurisdictional boundaries, and area burned may include acres on non-National Forest System land. Not all fires that occurred on the forests and grassland are contained in the Wildland Fire Decision Support System national dataset.

Table 285. Years with fire incidents greater than 10,000 acres on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, 2000-2018.

Year	Number of fires burning more than 10,000 acres
2002	4
2012	2
2016	1
2018	4
Total	**11**

Monitoring Trends in Burn Severity is an interagency program that maps burn severity of wildland fires across the United States. The program uses satellite imagery from the interagency Landsat program to measure changes in light reflectance between pre- and post-fire images. Monitoring Trends in Burn Severity provides maps and estimates of burned area in low, moderate, and high severity categories. Figure 31 shows burn severity for each of the 11 fires that burned more than 10,000 acres on the Medicine Bow-Routt National Forests between 2000 and 2018. Three of those fires, including Hinman and Burn Ridge in 2002 and Beaver Creek in 2016, burned at high severity in more than 25% of the burn area. Six fires, including Hinman and Burn Ridge in 2002, Beaver Creek in 2016, and Badger Creek, Silver Creek, and Ryan in 2018, burned at moderate and high severity in more than 40% of the burn area.

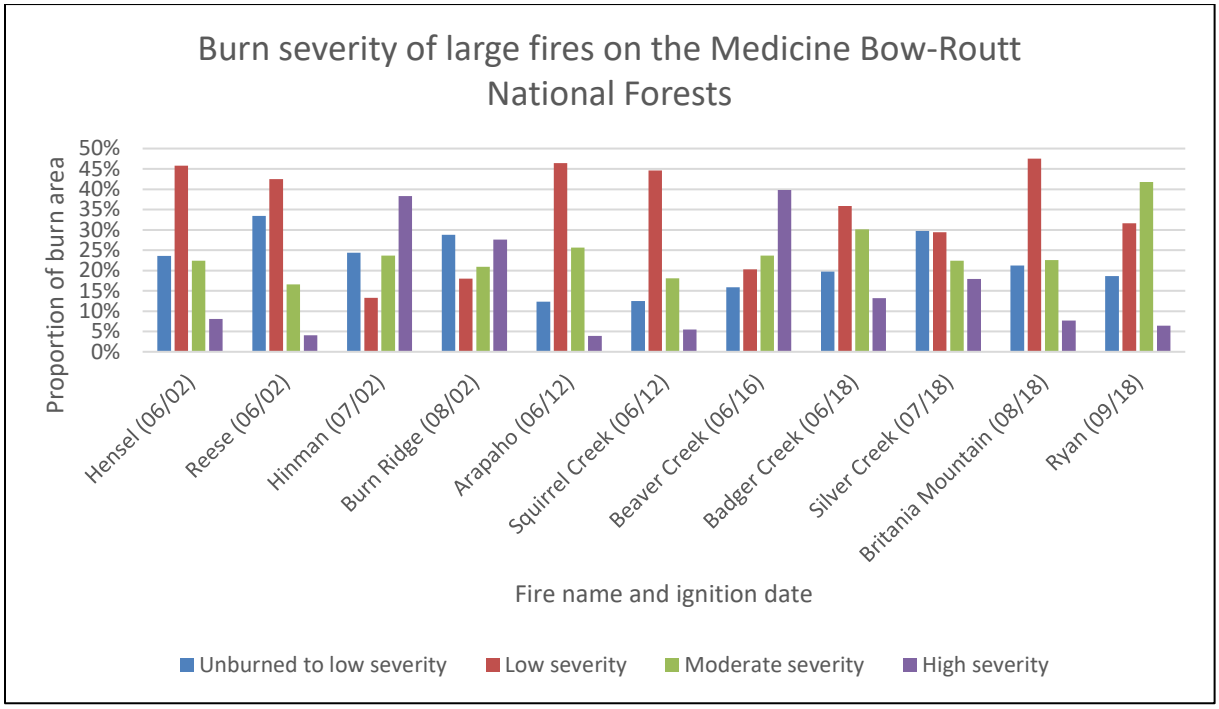

Figure 141. Proportion of burn areas in unburned to low, low, moderate, and high severities in fires larger than 10,000 acres on the Medicine Bow-Routt National Forests, 2000-2018.[11]

The Forest Service and other fire management agencies track the amount of fire line created by bull dozers on fire incidents. Miles of dozer line created during suppression efforts for select large fire incidents are shown in Table 46.

Table 46. Miles of dozer line created during suppression efforts for the Arapaho, Squirrel Creek, Beaver Creek, Badger Creek, Ryan, and Silver Creek fires.

Fire name	Miles of dozer line
Arapaho (2012)	103.1
Squirrel Creek (2012)	13.7

[11] As measured by the Monitoring Trends in Burn Severity program. Proportions do not add to 100% where pre- or post-fire reflectance imagery contained clouds, snow, shadows, smoke, large water bodies, etc. Proportion of burn area showing increased greenness is not depicted and was less than 500 acres in all burn areas except Reese.

Fire name	Miles of dozer line
Beaver Creek (2016)	35.9
Badger Creek (2018)	8.8
Ryan (2018)	20.8
Silver Creek (2018)	68.9

Indicator 5 – Habitat fragmentation

Roads can affect connectivity of habitat. Road density varies across the Medicine Bow-Routt National Forests and Thunder Basin National Grassland. The following maps depict road density as heat maps, showing areas of higher and lower road density within the administrative forest and grassland boundaries based on the 2016 motor vehicle use map road systems (Figures 32, 33, 34 and 35).

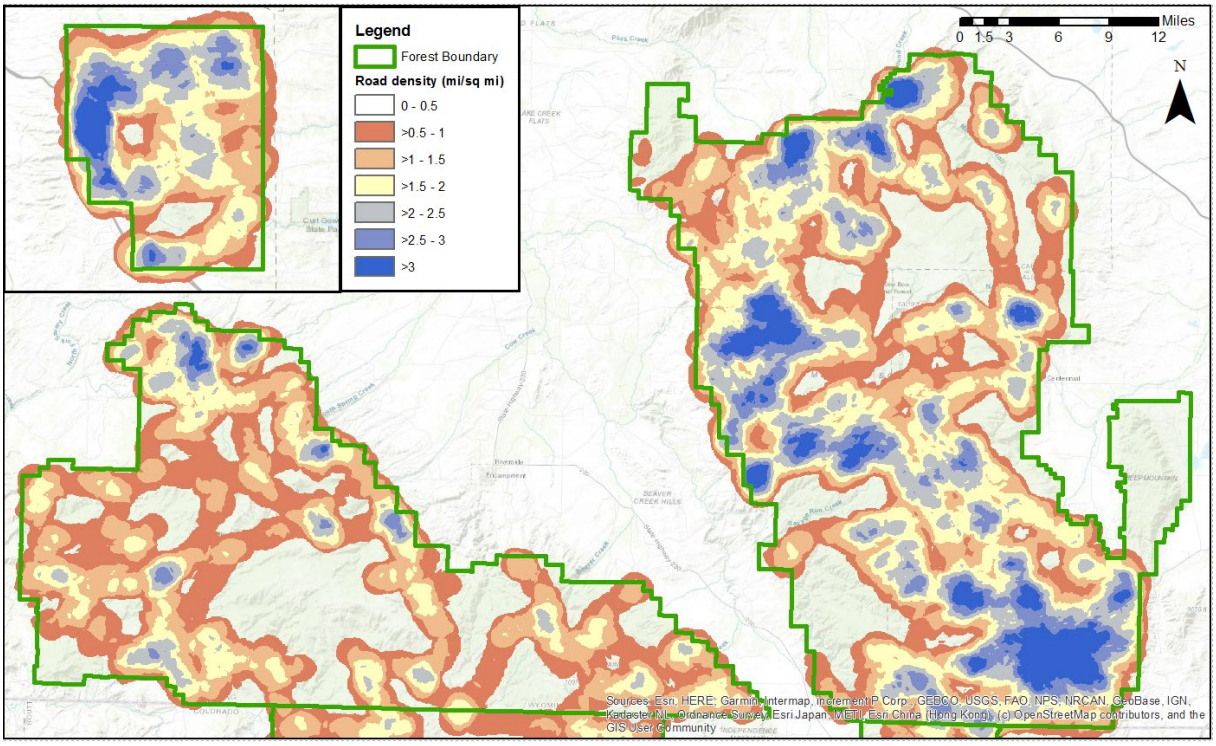

Figure 152. Road density on the Snowy Range, Sierra Madre, and Pole Mountain portions of the Medicine Bow National Forest. The inset map depicts the Pole Mountain unit.[12]

[12] Blue colors represent higher road densities, while red colors and no color in the road density layer represent lower road densities. Road densities were calculated per 0.6-acre pixel using miles of road within a 1-mile radius based on the 2016 motor vehicle use map.

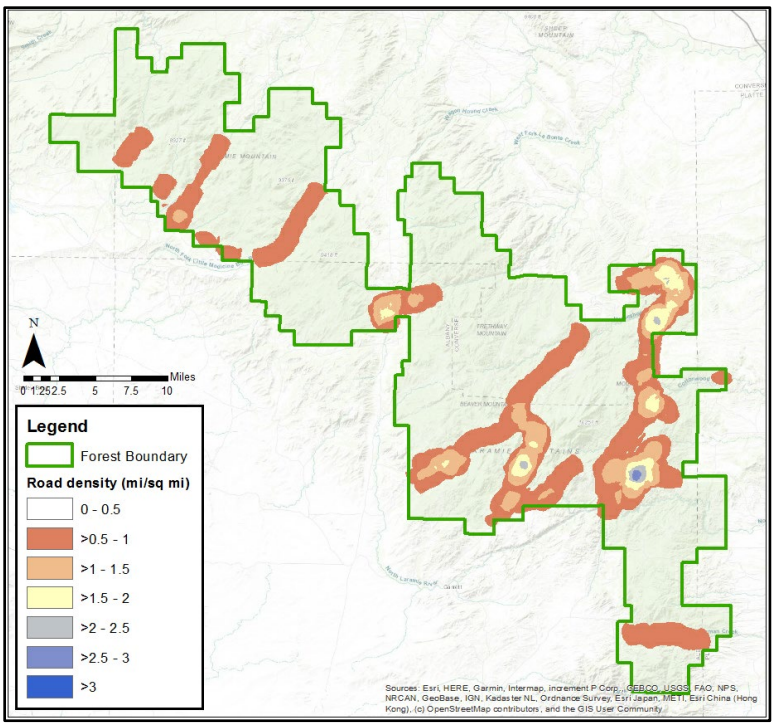

Figure 163. Road density on the Laramie Peak unit of the Medicine Bow National Forest.[13]

[13] Blue colors represent higher road densities, while red colors and no color in the road density layer represent lower road densities. Road densities were calculated per 0.6-acre pixel using miles of road within a 1-mile radius based on the 2016 motor vehicle use map.

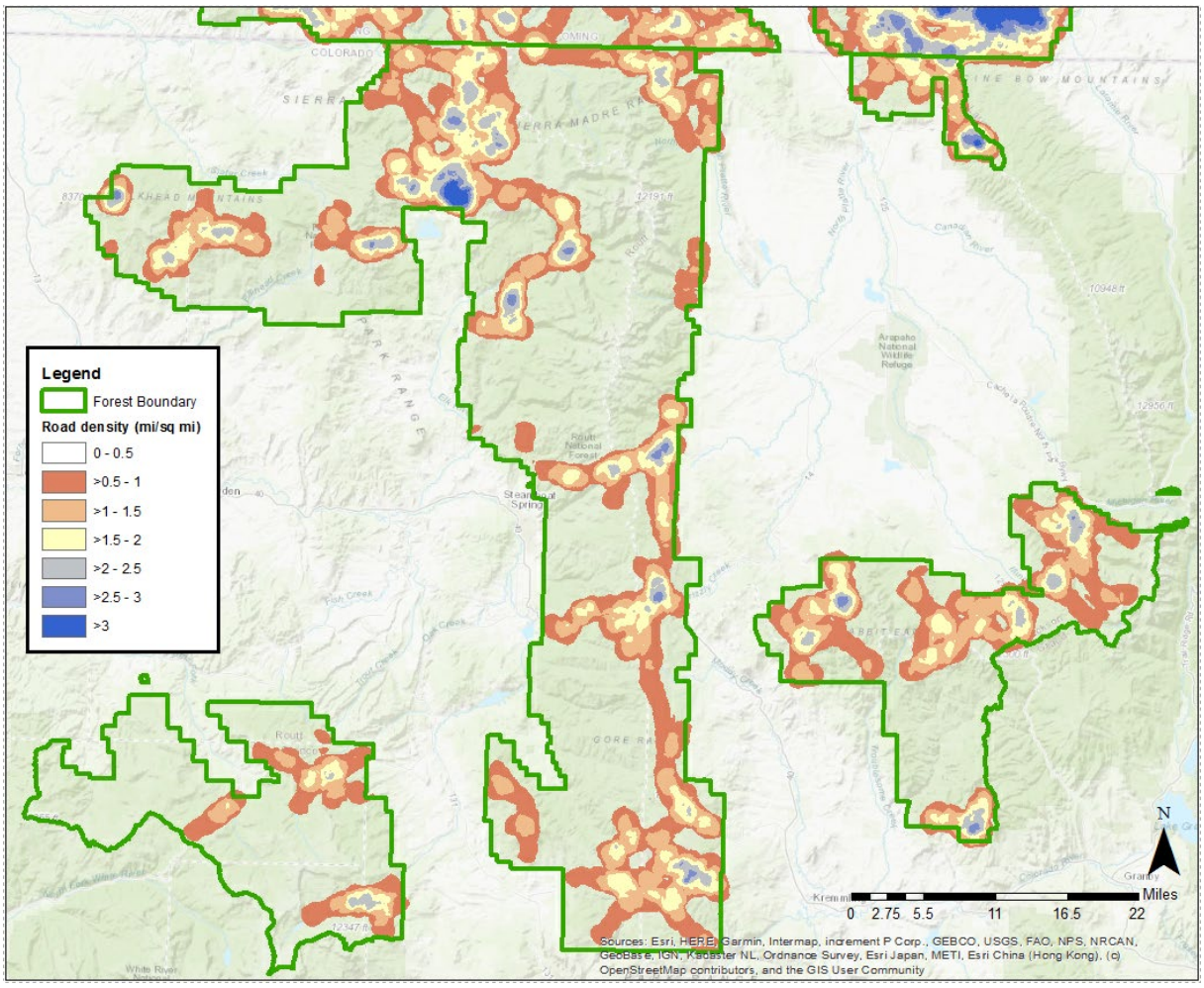

Figure 174. Road density on the Routt National Forest.[14]

[14] Blue colors represent higher road densities, while red colors and no color in the road density layer represent lower road densities. Road densities were calculated per 0.6-acre pixel using miles of road within a 1-mile radius based on the 2016 motor vehicle use map.

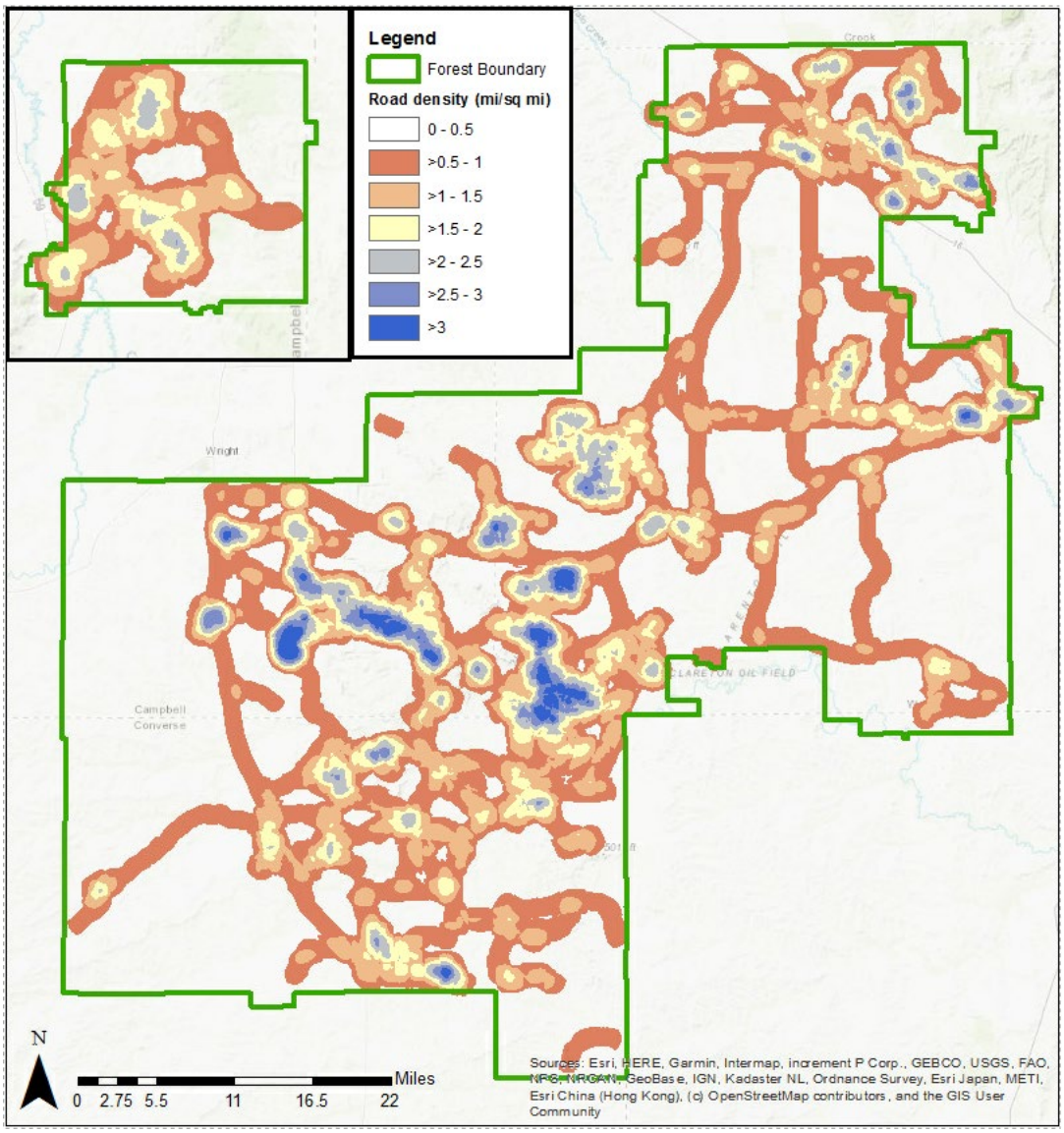

Figure 185. Road density on the Thunder Basin National Grassland. The inset map depicts the Spring Creek unit of the grassland.[15]

As shown in the road density maps, the Medicine Bow National Forest has higher average road density than the Routt National Forest and Thunder Basin National Grassland, with more than 12% of the forest having greater than 2 miles of road per square mile, and more than 2% having greater than 3 miles of road per square mile (Table 47). The Snowy Range mountains in the Medicine Bow National Forest have the highest road densities across the forests and grassland, with more than 25% having greater than 2 miles of road per square mile, and more than 5% having greater than 3 miles of road per square mile.

[15] Blue colors represent higher road densities, while red colors and no color in the road density layer represent lower road densities. Road densities were calculated per 0.6-acre pixel using miles of road within a 1-mile radius based on the 2016 motor vehicle use map.

Table 297. Road density on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland.

Location	Area with 1-2 miles of road per square mile	Area with 2-3 miles of road per square mile	Area with greater than 3 miles of road per square mile
Medicine Bow National Forest	27.0%	10.3%	2.4%
Routt National Forest	16.2%	2.4%	0.1%
Thunder Basin National Grassland	18.4%	3.4%	0.6%

The Wyoming Density and Disturbance Calculation Tool provides a method for quantitatively measuring habitat fragmentation and disturbance for greater sage-grouse and other species that rely on sagebrush habitat in Wyoming. The Density and Disturbance Calculation Tool is a project-level tool for determining whether activities that disturb sagebrush habitats will cause exceedance of thresholds for density and number of disturbances under the State of Wyoming Executive Order 2019-3 for Greater Sage-grouse Core Area Protection. These thresholds for disturbance are reflected in guidelines in the 2015 Forest Service greater sage-grouse plan amendments, which indicate that oil and gas development and mining activities should average no more than one pad or mining operation per 640 acres in greater sage-grouse priority habitat management areas and surface disturbing activities should not exceed 5% of suitable habitat in priority habitat management areas. The Density and Disturbance Calculation Tool also buffers project areas according to methods identified in the Wyoming sage-grouse executive order for calculating density and number of disturbances.

The Density and Disturbance Calculation Tool can use the total of all priority habitat management areas on the forest and grassland as a "project area." Though the metrics the tool calculates are designed to be meaningful at the project level, it provides a rough representation of disturbance at the landscape scale. The analysis is primarily limited to a representation of disturbance on the Thunder Basin National Grassland, where over 94% of priority habitat management areas on the forests and grassland are located. Small areas of the Medicine Bow-Routt National Forests, totaling approximately 17,200 acres, are priority habitat management areas. The approximately 12,600 acres of priority habitat on the Routt National Forest are not included in this analysis because the Density and Disturbance Calculation Tool is limited to greater sage-grouse habitat in Wyoming.

Using all priority habitat management areas on the forest and grassland as the "project area," the Density and Disturbance Calculation Tool shows that the assessment area contains 0.18 oil and gas development and mining disruptions per 640 acres and 1.31% of suitable habitat is disturbed (Table 48). Note that the assessment area includes buffers around the project area; as a result, the calculated density and number of disturbances includes disturbances outside of National Forest System land. The project area is roughly 279,000 acres, with an additional approximately 248,200 acres of buffers included in the assessment area.

Table 48. Acres of surface disturbing activities and density of oil and gas development and mining disruptions in greater sage-grouse priority habitat management areas and buffer areas on the Medicine Bow National Forest and Thunder Basin National Grassland. The surface disturbing activities shown occur in suitable habitat within priority habitat management areas and buffers.

Type of disturbance	Amount of disturbance in assessment area
Surface disturbing activities total acres	6,492.2
Surface disturbing activities proportion	1.31%

Type of disturbance	Amount of disturbance in assessment area
Oil and gas and mining disruptions total count	140
Oil and gas and mining disruptions per 640 acres	0.18

Indicator 6 – Forest visitation

See monitoring item 11, section 2.11, for results and discussion of data regarding visitation to the forest and grasslands.

Indicator 7 – Unauthorized off-highway vehicle use

The Forest Service maintains information about law enforcement incidents and violations in the Law Enforcement and Investigations Management Attainment Reporting System database. Unauthorized off-highway vehicle use warnings, incident reports, and violations are shown in Table 49 by ranger district. Unauthorized off-road activity warnings, incident reports, and violations are shown in Table 50.

Table 49. Illegal off-highway vehicle activity warnings, incident reports and violations on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland per fiscal years 2014-2018.

Ranger district	Report type	2014	2015	2016	2017	2018
Brush Creek-Hayden	Incidents/warnings	91	13	13	9	5
Brush Creek-Hayden	Violations	40	1	9	13	3
Douglas	Incidents/warnings	69	10	4	1	8
Douglas	Violations	8	1	1	2	0
Laramie	Incidents/warnings	239	34	31	58	18
Laramie	Violations	164	26	41	20	6
Hahns Peak/Bears Ears	Incidents/warnings	1412	91	31	46	19
Hahns Peak/Bears Ears	Violations	354	21	20	17	6
Parks	Incidents/warnings	60	22	5	2	2
Parks	Violations	14	1	1	4	2
Yampa	Incidents/warnings	44	22	1	2	1
Yampa	Violations	20	5	3	2	2

Table 300. Illegal off-road activity warnings, incident reports and violations on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, fiscal years 2014-2018.

Ranger district	Report type	2014	2015	2016	2017	2018
Brush Creek-Hayden	Incidents/warnings	8	18	27	13	21
Brush Creek-Hayden	Violations	1	2	19	17	7
Douglas	Incidents/warnings	33	13	4	2	39
Douglas	Violations	1	2	1	3	11
Laramie	Incidents/warnings	64	32	26	59	8
Laramie	Violations	69	22	31	28	1
Hahns Peak/Bears Ears	Incidents/warnings	110	171	32	68	47
Hahns Peak/Bears Ears	Violations	28	27	28	31	15
Parks	Incidents/warnings	31	25	7	4	4

Ranger district	Report type	2014	2015	2016	2017	2018
Parks	Violations	5	0	1	8	3
Yampa	Incidents/warnings	14	21	4	3	6
Yampa	Violations	4	3	4	5	3

Figures 36 and 37 display the unauthorized motorized use data graphically by incident type and by Ranger District.

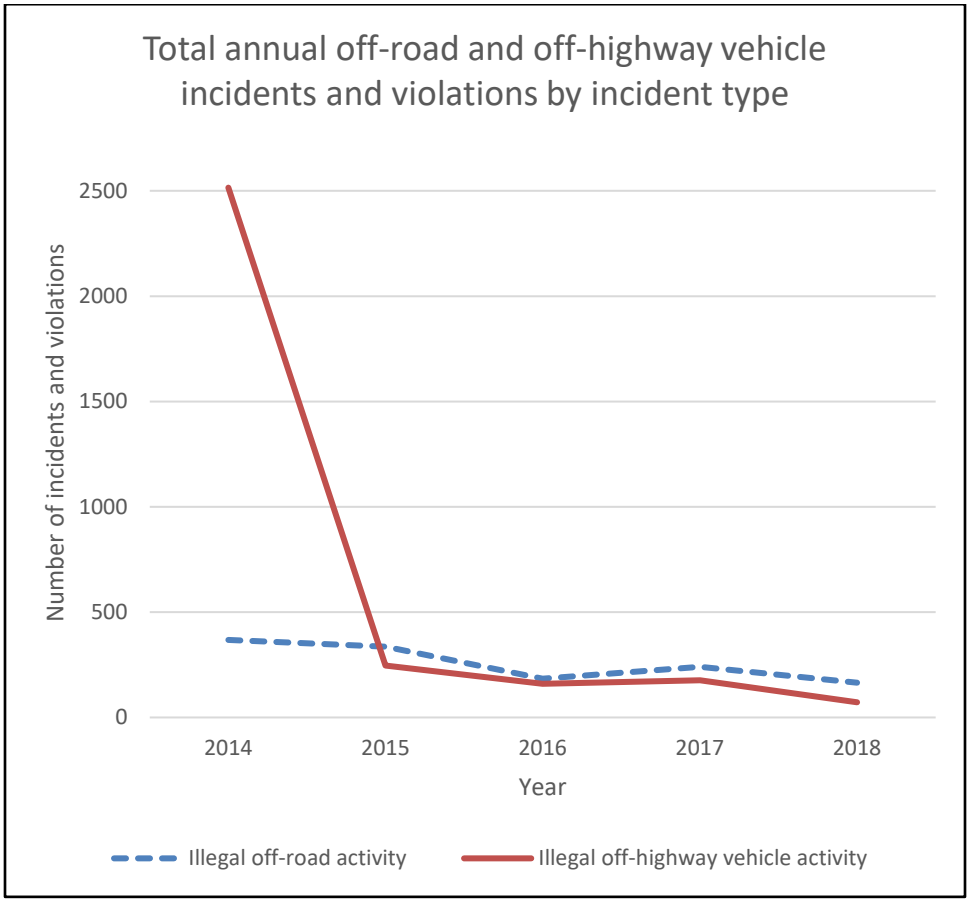

Figure 36. Illegal off-road and off-highway vehicle activity warnings, incident reports and violations on the Forests and Grassland, by incident type, fiscal years 2014-2018.

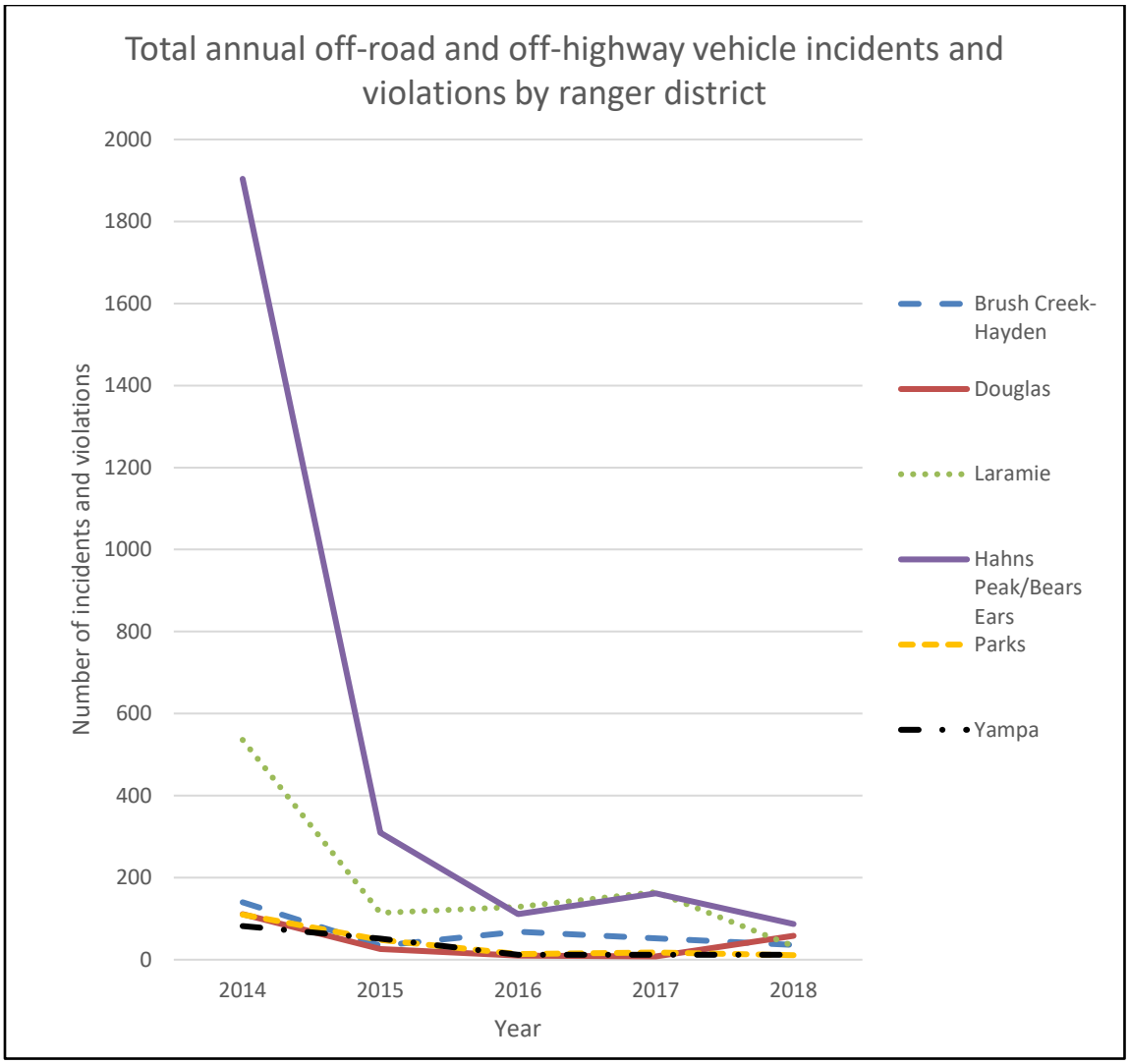

Figure 37. Illegal off-road and off-highway vehicle activity warnings, incident reports and violations on the Forests and Grassland, by Ranger District, fiscal years 2014-2018.

2.13.3 Monitoring Discussion and Findings

Indicator 1 – Climatic variables

Discussion: Observed trends in temperature and extreme precipitation events show that continued monitoring of climatic stressors will be critical to understanding the effects of climate change on forest and grassland resources. While more data is needed to establish definitive trends in peak snowpack and timing of release, the available data for the forests is consistent with existing research.

Primary productivity largely tracks precipitation trends. A significant divergence (i.e., if primary productivity declined in relationship to precipitation over time) would indicate large scale degradation resulting from stressors such as overgrazing or climate change. It should be noted, however, that the coarse resolution of the analysis of primary productivity and precipitation on the grassland precludes any meaningful assessment of allotment scale management or fine to mid-scale impacts. The NDVI may also reflect primary productivity of noxious weeds. Annual allotment monitoring for utilization, production,

and range readiness monitoring can supplement this coarse-scale analysis by indirectly indicating changes in climatic stressors.

Progress toward forest and grassland plan goals and objectives: While trends in climatic variables do not directly relate to any quantitative goals and objectives, stressors can affect all components of the forest and grassland plan because of their broad and cascading consequences. Effects to any specific goals and objectives as a result of monitoring data are not evident currently.

Recommendations:

- Monitor and report stream and lake temperature data to understand effects of climate change on aquatic resources.

Indicator 2 – Insects and disease

Discussion: Monitoring data show that insect and disease mortality, especially as a result of mountain pine beetle and spruce beetle activity, has declined after affecting large portions of both forests in the 2000s and early 2010s. Bark beetle activity has likely declined because they affected most susceptible trees across the forest. Young pine and spruce trees that were not affected may cause stands to become susceptible to bark beetles in the future as the individual trees grow.

Progress toward forest and grassland plan goals and objectives: Widespread bark beetle-caused mortality on the Medicine Bow-Routt National Forests has caused departure from Medicine Bow National Forest plan Goal 1, Subgoal 1.c, Strategy f, to "limit mortality from insect and disease outbreaks in management areas where primary emphasis is timber production or developed recreation." Other components of Subgoal 1.c include engaging in vegetation management and other restoration activities in areas where insect and disease mortality has caused a departure from specific area or resource management objectives.

Recommendations:

- Monitor and report interactions between insect and disease activity and other stressors and disturbances to understand relationships among them. Develop an understanding of causes of epidemic versus endemic bark beetle activity.
- Report quantitative data about levels of non-bark beetle insect and disease mortality. Track the potential for emerging insect or disease epidemics.

Indicator 4 – Wildland fire

Discussion: The Medicine Bow-Routt National Forests and Thunder Basin National Grassland experienced relatively large fire years in 2002, 2012, and 2018, with fires greater than 10,000 acres occurring in each of those years and 2016. The number of incidents greater than 10,000 acres per year increased from 2012-2018, indicating a possible relationship with the trends in climatic variables discussed in indicator 1 of this section.

Monitoring Trends in Burn Severity data for large fires on the forests does not show any clear trends. However, burn severity data for smaller fires and fires older than 2002 was not include and may provide further understanding of changes in burn severity on the forests over time.

Dozer line data for large fires on the forests provides some baseline data against which data for future fires can be compared.

Progress toward forest and grassland plan goals and objectives: Fire extent and severity and the amount of dozer fire line created during suppression efforts are not directly related to any forest plan

goals or objectives. However, because fire is a critical driver of forest and grassland ecosystems, these indicators can show trends that may affect the management of many other resources on the forests and grassland.

Recommendations:

- Consider reporting monitoring data for smaller and older fires to provide a larger dataset from which trends in fire extent and severity might be drawn.

Indicator 5 – Habitat fragmentation

Discussion: The Medicine Bow National Forest has a higher road density than the Routt National Forest and Thunder Basin National Grassland. Because the analysis used the Forest Service motor vehicle use map, however, the analysis precludes roads closed to the public that, though they likely receive less traffic than public roads, may affect habitat connectivity. The motor vehicle use map also does not include roads on private and state lands within the forest and grassland administrative boundaries. This particularly affects the calculated road density within the Thunder Basin National Grassland administrative boundary, where greater than half of the surface area is non-National Forest System land.

The Wyoming Density and Disturbance Calculation Tool for greater sage-grouse management showed that at the scale of priority habitat management areas on the forests and grassland, 1.31% of suitable habitat is disturbed and the area has 0.18 oil and gas and mining developments per 640 acres. At the landscape scale, these are less than the 5% and 1 per 640 thresholds for projects in the greater sage-grouse plan amendments. Note that this metric does not indicate progress toward or away from forest and grassland plan components, because compliance with these thresholds is assessed at the project scale; rather the results of the Density and Disturbance Calculation Tool are intended to provide information about habitat connectivity in sagebrush ecosystems on the landscape.

Progress toward forest and grassland plan goals and objectives: Guidelines for number and density of disturbances in greater sage-grouse habitat are assessed at the project level. The monitoring indicators in this report do not provide information regarding decommissioning of roads (Medicine Bow forest plan, goal 4, subgoal 4.a, objective 4); however, information regarding road densities provides a baseline from which management toward improved habitat connectivity can be assessed.

Recommendations:

- Report project-level results of the Wyoming Density and Disturbance Calculation Tool to show whether development and disturbance are approaching thresholds set in the greater sage-grouse plan amendments in certain locations of high use within priority habitat management areas.
- Consider assessing density of non-road disturbance in forest ecosystems.
- Consider providing monitoring information about aquatic organism passage projects to show results of management for aquatic habitat connectivity.

Indicator 7 – Unauthorized off-highway vehicle use

Discussion: Overall, unauthorized motorized use data show that fiscal year 2014 had significantly more off-highway vehicle incidents on the forests and grassland than fiscal years 2015-2018. Data for 2015-2018 do not indicate apparent trends in the number of incidents and warnings. In 2014-2017, the Hahns Peak/Bears Ears Ranger District on the Routt National Forest and the Laramie Ranger District on the Medicine Bow National Forests had more incidents and warnings than each of the other four ranger districts.

Progress toward forest and grassland plan goals and objectives: The forests and grassland do not have quantitative goals or objectives related to illegal off-road and off-highway vehicle activity or unauthorized roads and trails. Management of unauthorized roads and trails is typically addressed through travel management decisions and plans.

Recommendations:

- Monitor and report total miles of unauthorized roads and management actions regarding unauthorized roads.

2.14 Monitoring Item 14: Socioeconomic Contributions

2.14.1 Monitoring Question and Background

- How are management activities on the planning unit affecting local employment and income?

This monitoring question addresses forest and grassland planning goals and objectives associated with social and economic sustainability. Table 51 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 311. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for socioeconomic contributions.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 2, Subgoal 2.c; Goal 3, Subgoal 3.a **Routt:** Goal 3, Objective bullets 1-3 **Thunder Basin:** Goal 2.c	1. Range, timber, recreation, and minerals contributions to local employment and income	Forest Service IMPLAN model	a) Annually b) 2 years	

2.14.2 Monitoring Results and Discussion

Indicator 1 – Contributions to local economies

Economic contributions are calculated using the Forest Service IMPLAN (IMpact analysis for PLANning) model. IMPLAN calculates economic contributions based on program outputs, such as volume of timber harvested by industry or livestock stocking numbers. IMPLAN uses these outputs to estimate direct contributions (in terms of jobs and labor income) from economic activity and secondary or indirect contributions generated in other sectors such as transportation and construction. This section discusses economic contributions from range and timber activities on the forests and grasslands. Data for recreation and minerals was unavailable for this monitoring cycle.

To model the contributions of livestock grazing on the forests and grassland to local agriculture sector economies, IMPLAN took total authorized animal unit months for cattle and sheep grazing as a model input. In 2017, rangelands on the forests and grassland contributed approximately 600 jobs, $16.4

million in total labor income, and $38.3 million in gross domestic product (GDP) to local economies (Table 52).

Table 322. Modeled annual average employment, labor income, and gross domestic product (GDP) contributions from cattle and sheep grazing on the Forests and Grassland, 2017.[16]

Employment (number of jobs)	Labor income	Contribution to GDP
600	$16,400,000	$38,300,000

* Employment is the total full- and part-time wage, salaried, and self-employed jobs in the region.

** Labor income includes the wages, salaries, and benefits of workers who are paid by employers and income paid to proprietors.

To model forest contributions to the logging and sawmill economic sectors from timber harvest on the forests, IMPLAN took the annual volume harvested by industry as the model input. Annual harvest is derived from harvest acres reported as completed in the Forest Service Forest Activity Tracking System (FACTS) database. In 2014-2017, timber harvest on the Medicine Bow-Routt National Forests averaged 53,197 centum cubic feet annually, including 42,345 centum cubic feet of sawtimber, 7,767 centum cubic feet of poles and other non-saw products, 1,330 centum cubic feet of other biomass products, and 1,756 centum cubic feet of fuelwood. These timber products contributed 261 jobs and approximately $10.3 million in labor income and $13.3 million in GDP to the local economy (Table 53).

Table 333. Modeled annual average employment, labor income, and gross domestic product (GDP) contributions from timber harvest on the Medicine Bow-Routt National Forests, 2014-2017.[17]

	Employment (number of jobs)	Labor income	Contribution to GDP
Direct	145	$6,623,512	$6,653,804
Indirect	116	$3,644,054	$6,613,142
Total	**261**	**$10,267,566**	**$13,266,946**

* Employment is the total full- and part-time wage, salaried, and self-employed jobs in the region.

** Labor income includes the wages, salaries, and benefits of workers who are paid by employers and income paid to proprietors.

2.14.3 Monitoring Discussion and Findings

Indicator 1 – Contributions to local economies

Discussion: IMPLAN model results provide a baseline against which future forest and grassland contributions to local economies can be compared.

Actual contributions of forest and grassland rangelands to local agriculture sector and downstream economies depends on myriad environmental stressors and disturbances and external economic factors that influence livestock stocking rates and weight gain.

To model contributions to the economy from timber harvest, IMPLAN used the annual volume harvested by industry rather than volume sold by the Forest Service. In the 4-year period from 2014-2017, an

[16] Data includes direct effects, which benefit employees and owners in the industry, and indirect effects, including upstream and downstream industries and industries receiving spent wages.

[17] Effects are split into direct effects, which benefit employees and owners in the industry, and indirect effects, including upstream and downstream industries and industries receiving spent wages.

average of 64% of the amount of timber sold was harvested annually. Timber offer is expected to increase in 2018, but the amount that will contribute to the economy is based on the level of harvest.

Progress toward forest and grassland plan goals and objectives: Monitoring results show contributions to the local economy from the livestock grazing and timber harvesting on the forests and grasslands. Data provide a baseline and do not indicate deviation from forest or grassland plan goals and objectives.

Recommendations:

- Provide additional data to understand trends in contributions to local economies and model contributions from recreation and mineral uses.

2.15 Monitoring Item 15: Heritage

2.15.1 Monitoring Question and Background

- To what extent have we managed our heritage assets?

Table 54 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 34. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for heritage resources.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 2, Subgoal 2.b, Objectives 4, 5 **Routt:** Goal 2, Goal 3 **Thunder Basin:** Goal 2.b, Heritage Sites Objectives 1-5	1. Number of stewardship activities conducted; monitoring of priority heritage assets	Forest Service Natural Resource Manager Heritage database	a) Annually b) 2 years	

2.15.2 Monitoring Results and Discussion

The forest has a monitoring schedule for its priority heritage assets. Each priority asset is scheduled to be monitored every 5 years. In 2017, 14 sites were monitored. In 2017, the Medicine Bow National Forest conducted stewardship activities at the Centennial Work Center, which is listed in the National Register of Historic Places, to renovate and restore the interior conditions of the site and mitigate safety issues.

Recommendations:

- Report site monitoring results to present changes in status and condition of heritage assets across the forests and grassland.

2.16 Monitoring Item 16: Soil

2.16.1 Monitoring Question and Background

- What changes in soil properties have been observed in the planning unit?

This monitoring item addresses soil quality standards and guidelines directed by Forest Service Manual 2520, Region 2 Supplement No. 2509.18-92-1 (USDA-USFS, 1992) and located in the Medicine Bow-Routt National Forests and Thunder Basin National Grassland land and resource management plans that seek to protect long-term soil productivity by limiting the extent of detrimental soil impacts that may result from forest management activities such as timber harvest, livestock grazing, and pile burning. Table 55 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 355. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for soils management.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.a; Goal 2, Subgoal 2.b, Objective 3; Goal 4, Subgoal 4.a, Strategy a **Routt:** Goal 1, Objective bullet 1 **Thunder Basin:** Goal 1.a, Objective 1	1. Extent of soil disturbance including detrimental soil compaction, detrimental displacement, detrimental erosion	National Forest Soil Disturbance Monitoring Protocol Natural Resources Conservation Service bulk density test	a) Annually b) 2 years	Manage land treatments to limit the sum of severely burned and detrimentally compacted, eroded, and displaced land to no more than 15% of any land unit. (Medicine Bow and Routt, forest-wide soils standard 5) Achieve a 20% reduction in acres of eroded or disturbed soils by Forest Service permitted or management actions. (Thunder Basin)

2.16.2 Monitoring Results

Indicator 1 – Soil disturbance

The National Forest Soil Disturbance Monitoring Protocol is used to collect soil disturbance data for Forest Service management activities with the potential to impact soil productivity and stability. The National Forest Soil Disturbance Monitoring Protocol is a systematic and nationally standardized protocol used to categorize soil disturbance into categories ranging from soil disturbance class 0 (minimal disturbance) to 3 (significant disturbance). Data collected include soil surface texture, rock content, cover, slope steepness and mass wasting susceptibility, and disturbance hazard ratings such as erosion and compaction. Metrics in the monitoring protocol correlate to quantitative thresholds for detrimental soil disturbance found in the forest plans. The forest plans prohibit severely burned and detrimentally compacted, eroded, and displaced land to no more than 15% of any activity area. Regional Forest Service Handbook guidance defines detrimentally compacted, eroded, and displaced soil as:

- **Detrimental compaction:** A 15% increase in bulk density from the average undisturbed density or bulk density values that exceed the following threshold values: 1.25 grams per cubic centimeter for silt and clay; 1.3 grams per cubic centimeter for silty clay, silty clay loam, and silt loam; 1.4 grams per cubic centimeter for loam and clay loam; 1.5 grams per cubic centimeter for sandy loam, sandy clay loam, and sandy clay; and 1.6 grams per cubic centimeter for sand and loamy sand.

- **Detrimental displacement:** The removal of soil from a continuous area of 100 square feet or more.
- **Detrimental erosion:** The general loss of soil from the soil surface (sheet erosion) or erosion channels greater than 1 inch deep (rills and gullies). (R2 FSH 2509.18, chapter 2, section 2.05)

Soil resource conditions were monitored on numerous timber sale units, range allotments, wildland fire burn scars, and pile burning units during the 2015-2017 field seasons. Pre- and post-activity soil disturbance monitoring occurred on the Routt National Forest, while only pre-activity monitoring occurred on the Medicine Bow National Forest. Soil monitoring data is unavailable for the Thunder Basin National Grassland. Activity units were evaluated to determine if desired conditions for soil indicators were met. Additionally, the Natural Resources Conservation Service protocol for bulk density sampling was used to evaluate levels of detrimental soil compaction. On the Routt National Forest, 44 total units were monitored both pre- and post-activity, with 1,804 total observation points. Soil was detrimentally disturbed in 11.95% of these observation points (Table 56).

One of nine units monitored for planning or pre-timber harvest condition had a detrimental soil disturbance level above 15% across the entire unit. As a result, this unit was later dropped during the planning process to mitigate cumulative effects. In the summer of 2016, one unit of burn piles associated with the Blacktail timber sale were monitored.

During the summer of 2016 and 2017, range allotment monitoring was conducted for the Black Mountain, California Park, Colton Floyd, East Elkhead, Pagoda, and Slater Park analysis areas. The Pagoda range surveys identified high levels of disturbance in the upper tributaries of Beaver Creek; in some transects disturbance values were as high as 20-25%. However, these units as a whole did not exceed the 15% detrimental disturbance threshold in the forest plan. Transects in the Colton and California Park allotments show similar trends. Initial transects in the stewardship allotment of Slater Park are showing that an area recently excluded from grazing through adaptive management measures is experiencing less soil disturbance than the areas currently actively grazed.

Table 366. Results from National Forest Soil Disturbance Monitoring Protocol on the Routt National Forest, 2015-2017.

Project name and number of units	Proportion soil disturbance class 0	Proportion soil disturbance class 1	Proportion soil disturbance class 2	Proportion soil disturbance class 3	Detrimentally disturbed portion	Number of observation points
504AA – 1 unit	15%	46%	29%	10%	15%	41
Bear Draw – 3 units	10.6%	61.6%	22%	5.3%	13%	123
Big Red Park – 2 units	12.5%	57%	19.5%	4.5%	9.5%	82
Black Mountain – 1 unit	15%	61%	20%	5%	10%	41
Blacktail – 2 units	11%	34.3%	16%	3.5%	10%	82
Burn Piles – 1 unit	0%	54%	34%	12%	15%	41
California Park – 1 unit	12.9%	60%	18.5%	8.4%	12.8%	410
Colton Floyd – 3 units	9%	64.5%	22%	5%	13.5%	123

Project name and number of units	Proportion soil disturbance class 0	Proportion soil disturbance class 1	Proportion soil disturbance class 2	Proportion soil disturbance class 3	Detrimentally disturbed portion	Number of observation points
East Elkhead – 3 units	12%	58.6%	25%	4%	12.3%	123
Grizzly Roads – 1 unit	15%	59%	17%	10%	12%	41
Pagoda – 10 units	22.2%	50.8%	13.9%	13.1%	13.5%	410
Slack Weiss – 3 units	11.3%	56%	24.3%	8%	12.3%	123
Slater Park – 2 units	22%	54%	22%	0%	5%	82
Wheatley – 2 units	13.5%	67%	12%	7.5%	13.5%	82

Staff on the Medicine Bow-Routt National Forests also monitor wildland fire impacts to soils using a soil burn severity metric derived from remote imagery and field verification. In the summers of 2016 and 2017, wildland fires burned more than 30,000 acres of the Routt National Forest. Most areas burned in a mosaic pattern trending toward a moderate to low soil burn severity. High burn severities where the fire consumed most organic material, killed roots, and oxidized surface soils were limited to areas where overall fire residence times were high, allowing full consumption of coarse wood and stumps. Some moderate soil burn severity where duff and litter fully consumed with no or little soil color change occurred where fuel loading was less than 5-15 tons per acre.

2.16.3. Monitoring Discussion and Findings

Indicator 1 – Soil disturbance

Discussion: Results from pre-timber harvest monitoring in the Bear Draw, Big Red Park, Slack Weiss, and Wheatley analysis areas support findings from past monitoring efforts that pre-existing impacts can be widespread and persistent where past management activities have occurred. More aggressive overstory removal prescriptions (for example, clearcuts or shelterwood harvests) result in the greatest amount of soil disturbance, often 15% or greater in localized areas of concentrated use. Thinning prescriptions tend to result in less soil impact but may result in more than 15% detrimental soil disturbance in some cases, especially where multiple entries have occurred. Soil impacts from skid trails, landings, and other disturbances associated with harvest activities can last for more than 30 years. Pre-harvest samples will be compared to post implementation monitoring results, but initial levels show that areas of concentrated use like main skid trails and landings are generally in a detrimentally compacted condition post-harvest. More samples are needed to confirm these results.

Results from post-timber harvest monitoring indicate that impacts to soil can be widespread and persistent. Units without designated skid trails were found to be more disturbed than those with designated skid trails.

Burn pile monitoring in other areas has shown that the soil where piles are burned can be barren decades after the burn is complete. Previous monitoring on the Medicine Bow National Forest showed that in some areas seeded piles recovered both faster and better than non-seeded piles.

Forest soil disturbance monitoring shows that concentrated use areas in livestock grazing allotments such as watering holes and salt licks can commonly exceed disturbance thresholds when livestock do not move through the area quickly enough to prevent compaction and other soil disturbance.

Results of soil burn severity monitoring on the Routt National Forest are consistent with previous monitoring efforts to characterize soil burn severity associated with fire in the region.

Progress toward forest and grassland plan goals and objectives: Forest plan standards and guidelines were met for all management activities reviewed over the monitoring period, even though detrimental soil disturbance occurred locally within project areas. Monitored units were protected from soil erosion by having adequate soil cover levels and effective erosion control measures consistent with the guidance set forth in the forest plans. Soil productivity was maintained in all units by retaining organic material onsite and by adopting erosion control measures in appropriate areas. Certain impacts, however, can be expected to take a significant amount of time to recover. Adopting the recommended changes below to land management activity planning and implementation will help continue to protect the soil resource.

Recommendations:

- Leverage additional data sources such as National Agriculture Imagery Program remote sensing data, stocking data, photo-point methods, and sale and administration implementation notes to effectively support soil resource monitoring and assess the relationship between stocking rates and soil disturbance.
- Ensure use of on-site soil monitoring prior to timber harvest to evaluate ground disturbance from previous activities and ensure effective analysis of cumulative effects to watersheds.
- When designing timber harvest activities, avoid large, contiguous areas of displaced soils, especially where harvester trails diverge from primary skid trails. Strategically utilize old roads and footprints from skid trails, landings, and burn piles.
- Refine the regional soil quality guideline for 15% detrimental soil disturbance in an activity area. Larger-scale planning efforts will require a better method of vetting projects for this standard. The standard should be tied to static watershed boundaries instead of redefining an activity area for every new project.
- Ensure livestock are utilizing all forage made available to them in allotment management plans. Stocking numbers are skewed if livestock congregate in preferred areas like watering holes and utilize less than all forage available in an allotment.
- Coordinate planning for pile burning with the soil scientist and botanist to address burn pile size limitations and effective reestablishment of vegetation after burning.

2.17 Monitoring item 17: Forest Regeneration

2.17.1 Monitoring Question and Background

- To what extent has regeneration been successful following timber harvest on the planning unit?

This monitoring item addresses regulatory requirements under the National Forest Management Act of 1976 and section 36 CFR 219.27 of the 2012 planning rule that require stands harvested for timber to be adequately restocked within 5 years of final harvest. Table 57 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 377. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for forest regeneration.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.c**;** Goal 2, Subgoal 2.c, Objective 1 **Routt:** Goal 1	1. Percent of harvest areas restocked after 5 years	Forest Service stocking surveys	a) Annually b) 2 years	Ensure that timber will be harvested only where there is assurance that the harvested area can be adequately restocked within 5 years after harvest. (16 USC § 1604(g)(3)(E)(ii))

2.17.2 Monitoring Results

Indicator 1 – Harvest areas restocked

The process for monitoring 5-year restocking success is based on scheduling and recording the results of regeneration (restocking) surveys in the Forest Service Activity Tracking System (FACTS) database. A stand is only considered adequately stocked if the regeneration code has been recorded in the database. If a regeneration survey indicates a lack of seedlings, a district can schedule planting or seeding with scheduled regeneration surveys to monitor restocking success. Table 58 shows the number of acres on the Medicine Bow-Routt National Forests that received final regeneration harvests in 2009-2012 on which restocking was required by 2014-2017.

On the Medicine Bow National Forest as of 2017, 609 acres of the 626 acres receiving final harvests (97.3%) between 2009 and 2012 were adequately restocked. Of the 17 acres that were not adequately restocked, 14 acres have been planted in 2014 and are expected to be certified in 2019.

On the Routt National Forest as of 2017, 5,277.2 acres of the 5,826.6 acres receiving final harvests (90.6%) between 2009 and 2012 were adequately restocked. Of the 549.4 acres that were not adequately restocked 92.9 acres were planted in 2017 and are expected to be certified by 2020.

Table 58. Restocking after 2009-2012 final timber harvest on the Medicine Bow-Routt National Forests.

Forest	Year of final harvest	Acres harvested	Acres not adequately stocked 5 years after harvest	% of acres restocked 5 years after harvest	Non-stocked acres planted
Medicine Bow	2009	292	14	95.20%	14 (4.8%)
Routt	2009	3,252.50	301	90.70%	64.9 (2.0%)
Medicine Bow	2010	53	0	100%	N/A
Routt	2010	1,478.1	123.4	91.70%	28.0 (1.9%)
Medicine Bow	2011	257	3	98.80%	0
Routt	2011	573.4	29	94.90%	0
Medicine Bow	2012	24	0	100%	N/A
Routt	2012	522.6	96	81.60%	0
Medicine Bow	Totals for all years	626	17	97.30%	14 (2.2%)
Routt	Totals for all years	5,826.60	549.4	90.60%	92.9 (1.6%)

2.17.3 Monitoring Discussion and Findings

Indicator 1 – Harvest areas restocked

Discussion: Regeneration surveys for acres inadequately stocked and not replanted are scheduled for 2018. These include 3 acres on the Medicine Bow National Forest and 456.5 acres on the Routt National Forest. The 3 acres on the Medicine Bow National Forest are anticipated to meet stocking requirements as a result of natural regeneration. The 456.5 acres on Routt National Forest are a result of oversights due to employee turnover. If the 2018 surveys show inadequate stocking in any locations, planting will be considered.

Progress toward forest and grassland plan goals and objectives: Data from regeneration surveys shows that 0.5% of acres receiving final harvest on the Medicine Bow National Forest between 2009 and 2012 have not been certified as adequately restocked in the FACTS database. On the Routt National Forest, 9.4% of acres receiving final harvest between 2009 and 2012 have not been certified as adequately restocked.

Recommendations:

- Based on regeneration surveys, look for trends that indicate recurring problems with restocking efforts and schedule follow up treatments, including planting as needed.
- Diligently schedule 5th-year regeneration surveys to ensure no future regeneration survey oversights.

2.18 Monitoring Item 18: Rangeland Sustainability

2.18.1 Monitoring Question and Background

- Are we providing adequate forage for domestic livestock, wild ungulates, and small herbivores commensurate with availability, capability, and sustainability?

This monitoring item addresses plan components intended to ensure the sustainable use of rangelands, provide for multiple uses, and conserve wildlife species. Table 59 lists forest and grassland plan goals and objectives, monitoring indicators, data sources and partners, the frequency of data collection and reporting, and any quantitative targets or thresholds related to this monitoring item.

Table 59. Selected forest and grassland plan goals and objectives, data sources, and adaptive management thresholds for rangeland sustainability.

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.c; Goal 2, Subgoal 2.c, Objective 2 **Routt:** Goal 1 **Thunder Basin:** Goal 2.c, Livestock Grazing Objectives 1-2	1. Utilization of forage	Forest Service rangeland survey data Forest Service Natural Resource Manager INFRA database	a) Annually in key allotments; all allotments monitored once every 5 years b) 5-6 years	30-55% utilization if rangeland condition is satisfactory and 0-45% utilization if rangeland condition is unsatisfactory, depending on type of management. (Medicine Bow, Routt)

Forest and grassland plan goals and objectives	Indicators	Data sources, protocols, partners	Frequency of: a) data collection b) reporting	Targets, thresholds, triggers
Medicine Bow: Goal 1, Subgoal 1.c, Objective 4, Strategies i, j; Goal 3, Subgoal 3.a, Objective 1 **Routt:** Goal 1, Objective bullet 7 **Thunder Basin:** Goal 1.c, Objectives 3-6	2. Extent of invasive species in capable rangelands	Forest Service Natural Resource Manager Threatened, Endangered, and Sensitive Plants – Invasive Species database Forest Service rangeland survey data County weed and pest district management program data	a) Annually in key areas b) 2 years	
Medicine Bow: Goal 1, Subgoal 1.b; Goal 2, Subgoal 2.c, Objective 3, Strategy f **Routt:** Goal 1 **Thunder Basin:** Goal 1.b	3. Select wildlife population trends	Forest Service Natural Resource Manager Wildlife database Colorado Parks and Wildlife hunting statistics Wyoming Game and Fish Department Colorado Natural Heritage Program Wyoming Natural Diversity Database	a) Annually b) 2 years	
Medicine Bow: Goal 2, Subgoal 2.c, Objective 2, Strategies c-e **Routt:** Goal 3 **TBNG:** Goal 2.c, Livestock Grazing Objectives 1-2	4. Animal unit months permitted for each allotment	Forest Service Natural Resource Manager Range INFRA database Forest Service grazing statistical report	a) Annually b) 2 years	

2.18.2 Monitoring Results

Indicator 1 – Utilization of forage

Annual monitoring of utilization is used to ensure standards and management practices in grazing allotments are implemented and to identify any needed changes to management. Utilization standards in the Medicine Bow National Forest and Routt National Forest plans include guidelines for utilization based on rangeland condition and type of management. The Thunder Basin National Grassland does not manage vegetation utilization on allotments. On the forests, allowable vegetation utilization is up to 55% in rest rotation management systems on satisfactory rangeland, with lower utilization allowed in season-long and deferred rotation systems and where rangeland condition is unsatisfactory, with up to 30% utilization in a season-long management system on unsatisfactory rangeland. Rangeland condition classification is based on the status of ecological indicators, such as soil erosion, litter, or vegetation species composition.

Utilization data indicates 780,000 acres were administered to standard across the Medicine Bow-Routt National Forests (total approximately 2.3 million acres).

Indicator 2 – Noxious weeds

Forest and grassland staff treat noxious weeds annually. Treated weed species include black henbane (*Hyoscyamus niger*), bull thistle (*Cirsium vulgare*), butter and eggs (*Linaria vulgaris*), Canada thistle (*Cirsium arvense*), cheatgrass (*Bromus tectorum*), common mullein (*Verbascum thapsus*), common tansy (*Tanacetum vulgare*), corn chamomile (*Anthemis arvensis*), Dalmatian toadflax (*Linaria dalmatica*), field bindweed (*Convolvulus arvensis*), gypsyflower (*Cynoglossum officinale*), hardheads (*Acroptilon repens*), hound's tongue (*Cynoglossum* spp.), houndstongue hawkweed (*Hieracium cynoglossoides*), leafy spurge (*Euphorbia esula*), nodding plumeless thistle (*Carduus nutans*), oxeye daisy (*Leucanthemum vulgare*), Pacific reedgrass (*Calamagrostis nutkaensis*), Russian olive (*Elaeagnus angustifolia*), saltcedar (*Tamarix ramosissima*), spotted knapweed (*Centaurea stoebe* ssp. *micranthos*), and whitetop (*Cardaria draba*), among others. Table 60 shows the number of acres treated from 2014-2018.

Table 380. Total acres of noxious weed treatment on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, 2014-2018.[18]

Year	Acres
2014	1,200
2015	1,790
2016	4,430
2017	5,130
2018	6,600

Noxious weed inventory is not conducted outside of treatment areas. However, long-term trend studies on the Yampa Ranger District have indicated that noxious weeds are increasing in some allotments.

Indicator 3 – Ungulates and small herbivores

Colorado Parks and Wildlife and the Wyoming Game and Fish Department monitor wild ungulate populations. Table 61 shows Colorado Parks and Wildlife post-hunt population estimates for elk (*Cervus canadensis*) and moose (*Alces alces*) populations in data analysis units overlapping the Routt National Forest. Population estimates for these herds increased each year from 2015-2018 for both species. Population estimate reports and more information about the Colorado Parks and Wildlife data are available at https://cpw.state.co.us/thingstodo/Pages/Statistics.aspx. Wyoming Game and Fish Department wild ungulate population estimates are unavailable for this monitoring reporting cycle.

Table 391. Colorado Parks and Wildlife post-hunt population estimates for elk data analysis units 2, 3, 6, 7, and 8 and moose data analysis units 1, 3, 6, and 9.[19]

Species	2015	2016	2017	2018
Elk	78,750	79,830	82,440	86,660
Moose	1,100	1,290	1,320	1,360

[18] Calculated acres count treatment areas multiple times if they received successive treatments or were treated for multiple types of weeds. All calculated acres are approximate.

[19] Data analysis units are combinations of game management units that represent relatively discrete herds.

Population trend information for small herbivores on rangelands on the forests and grasslands is limited to monitoring of black-tailed prairie dog colonies on the Thunder Basin National Grassland. See section 2.5 for information about monitoring of prairie dogs and associated species on the grassland.

Indicator 4 – Animal Unit Months

Tables 62 and 63 show number of livestock and permitted animal unit months on the forests and grassland. Grazing on the Thunder Basin National Grassland is permitted to the three grazing associations on the grassland.

Table 402. Number of stock and permitted animal unit months on the Medicine Bow-Routt National Forests, 2017.[20]

Number of Permits	Cattle	Permitted animal unit months - cattle	Horses	Permitted animal unit months - horses	Sheep	Permitted animal unit months - sheep	Total stock	Total animal unit months
143	31,856	96,388	185	564	74,597	46,261	106,638	143,213

Table 413. Number of stock and permitted animal unit months on the Thunder Basin National Grassland, 2017.[21]

Number of Permits	Cattle	Permitted animal unit months - cattle	Horses	Permitted animal unit months - horses	Sheep	Permitted animal unit months - sheep	Total stock	Total animal unit months
3	21,158	142,010	149	724	4,930	7,324	26,426	150,058

2.18.3 Monitoring Discussion and Findings

Indicators 1, 3, and 4

Discussion: Population data for elk and moose in Colorado Parks and Wildlife data analysis units overlapping the Routt National Forest shows increases in population estimates for each year during the observation period.

Existing data on number of livestock and permitted animal unit months will serve as a baseline for future trends and progress towards desired conditions.

Progress toward forest and grassland plan goals and objectives: Reported data are insufficient to indicate trends informing progress toward forest and grassland plan content.

Recommendations:

- Report additional information about rangeland not administered to standard. Consider selecting more detailed monitoring indicators to reveal additional information about why allotments may

[20] The Range INFRA database uses a factor of 1.32 to calculate animal unit months.

[21] The Range INFRA database uses a factor of 1.32 to calculate animal unit months.

not meet standards and guidelines or other factors contributing to the failure to be administered to standard.

- Provide population estimates for large ungulates in Wyoming. Consider including additional large ungulate species.
- Consider exploring the relationship between prairie dog colony extent monitoring data (section 2.5) and the other monitoring indicators in this section related to forage availability and use for livestock and wild ungulates.
- Consider monitoring and reporting information about non-use of permitted animal unit months to understand drivers and stressors affecting livestock grazing.

Indicator 2 – Noxious weeds

Discussion: Inventory and control of noxious and invasive weeds are a multidisciplinary concern. Continued implementation and effectiveness monitoring of applications will be necessary to direct management decisions for prevention and reduction in infestations. Increased logging activity, recreation, and other disturbances may cause an increase in the extent of noxious weed infestations. Historically, disturbed areas such as roads, trails, logging activities, prescribed burns and wildfire have been the locations most susceptible to infestation. In the past decade, weeds have been increasing in coniferous stands that have experienced high tree mortality due to the pine beetle epidemic. The extent of invasive species infestations will depend on how quickly these stands recover and the frequency and intensity of wildfire in these stands.

Progress toward forest and grassland plan goals and objectives: The forest and grassland plans do not have quantitative goals related to noxious weed treatment, and the monitoring data do not indicate a change in noxious weed prevalence in the observation period.

Recommendations:

- Monitor and report effectiveness of noxious weed treatments.
- Monitor the relationship between noxious weed and other changing ecological processes, such as climate and wildland fire.

3. Conclusion

This data presented in this biennial monitoring evaluation report for the Medicine Bow-Routt National Forests and Thunder Basin National Grassland shows successes, challenges, and opportunities for improvement in the context of the forest and grassland plans and the 2016 plan monitoring program. The results of this report show success in meeting quantitative targets or thresholds in the forest and grassland plans for best management practices monitoring for water quality, groundwater dependent ecosystems, disturbance in lynx habitat, and detrimental soil disturbance (Table 64). Results for other indicators show where plan targets have not been achieved, including in improvement of watershed condition, desired conditions for forest habitat structural stages, prairie dog colony area targets, limitation of insect and disease disturbance, and post-harvest restocking success. Some of these achievement gaps are minor or are the result of oversights, such as in post-harvest restocking, while others are the results of major, naturally-occurring ecosystem disturbances that the Forest Service has historically had little power to manage, including bark beetle outbreaks in coniferous forests and sylvatic plague in prairie dog colonies.

These major disturbances present opportunities to evaluate the adequacy of the forest and grassland plans and to explore novel options for responding to these changed conditions. For example, desired conditions for forest habitat structural stage may need to be re-evaluated in the wake of the widespread bark beetle-caused mortality with consideration of the trends in interrelated stressors such as climate and wildland fire. On the grassland, goals for prairie dog colony management may need to be re-evaluated in the context of plague, and plan content directed at managing plague may need to be developed.

Other potential opportunities to adjust the forest and grassland plans are evident in the desired conditions for sagebrush habitat and the project-level guideline for detrimental soil disturbance. The desired conditions for sagebrush habitat in the 2015 greater sage-grouse plan amendments for northwest Colorado and Wyoming are designed based on greater sage-grouse range-wide habitat requirements and may not be adequate for priority habitat management areas on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, which lies at the eastern edge of the species' range. This has caused much of the assessed habitat to be classified as marginal or unsuitable (and thus not meeting the desired condition) despite being at its maximum capacity for suitability of the various habitat characteristics. The soil disturbance guideline has caused issues related to the scale at which the threshold applies in larger project areas.

Table 424. Monitoring indicators for which monitoring results indicate progress or trend toward forest and grassland plan goals, objectives, desired conditions, standards, or guidelines, or other regulatory thresholds. Indicators for which progress or trend is uncertain have been sorted according to the most relevant reason (Table 1 (Summary) may indicate more than one reason for uncertainty).

Monitoring results indicate progress or trend toward plan content	Monitoring indicator
Yes	• Best management practices (item 1) • Groundwater dependent ecosystems (item 3) • Lynx habitat (item 10) • Soil (item 16)
No	• Watershed condition (item 1)

Monitoring results indicate progress or trend toward plan content	**Monitoring indicator**
	• Forest vegetation (item 2) • Prairie dog colonies and plague (item 5) • Insects and disease (item 13) • Forest regeneration (item 17)
Uncertain – More time or data are needed to understand status or progress of the plan component	• Water quality (item 1) • Stream flow (item 1) • Riparian areas (item 3) • Greater sage-grouse habitat (item 4) • Habitat connectivity (item 13)
Uncertain – Results are inadequate to answer monitoring question	• Range utilization (item 18)
Uncertain – Monitoring indicators or the data presented have a general rather than direct quantitative link with plan components	• Native fish (item 1) • Watershed projects (item 1) • Sagebrush bird communities (item 4) • Prairied dog colony associated species (item 5) • Forest, alpine, and wetland focal species (items 6, 7, and 8) • Visitor satisfaction and use and public access (items 11 and 12) • Climate change and wildland fire (item 13) • Unauthorized off-highway vehicle use (item 13) • Contributions to local economies (item 14) • Heritage assets (item 15) • Noxious weed treatments (item 18) • Wild herbivores (item 18) • Animal unit months (item 18)

Table 64 also shows that the connection between many of the data presented and plan content is uncertain. In many cases, this is because of a lack of data or enough time to evaluate trends; many of the data provide a baseline against which future monitoring reports can be compared. In other cases, the connection between the data collected should be better established, either through more in-depth analysis of the data and its implications, or through modification of the indicators or monitoring question. In many cases, this may be difficult due to the age of the forest and grassland plans (more than 17 years old for each, as of the end of 2020). The forest and grassland plans were revised under a different planning rule than the 2016 monitoring program, which may cause a disconnect between current monitoring and management focus and the broad goals and objectives of the plans.

Clear opportunities to adjust the monitoring program are evident in the indicators for forest focal species and black-footed ferret. Other potential locations to evaluate addition indicators could be for habitat connectivity and rangeland sustainability (Table 65). While these four indicators are examples of potential changes to the monitoring program, this pilot biennial monitoring evaluation report should provide a starting point for review of the monitoring program and its connection to the forest and grassland plans.

Table 435. Potential changes to monitoring program based on monitoring results.

Monitoring indicator	Potential changes to monitoring program
Forest focal species (item 6)	Pygmy nuthatch is uncommon on the Medicine Bow-Routt National Forests and populations may not be suitable as a monitoring indicator due to lack of data. In general, consider monitoring bird species with an average percent coefficient of variation of estimates for density and occupancy of less than 50%.
Black-footed ferret (item 9)	Wild black-footed ferrets (*Mustela nigripes*) are not present on the Medicine Bow-Routt National Forests and Thunder Basin National Grassland, and no reintroductions of the species have taken place. A monitoring item specific to black-footed ferret may not be useful in addition to monitoring item 5, which monitors black-footed ferret habitat extent in terms of black-tailed prairie dog colony extent.
Habitat connectivity (item 13)	Consider reporting monitoring results about the success of aquatic organism passage projects to identify progress toward habitat connectivity objectives for aquatic habitats. This monitoring indicator may also be appropriate under item 13 because of its connection to the stress of climate change (increased water temperatures) on many aquatic species populations.
Rangeland sustainability	Consider adding monitoring indicators to this monitoring item to provide additional understanding of progress in managing rangeland to standard.

Interdisciplinary Team Members

Table 446. Interdisciplinary Team Members

Resource Represented	Team Member
Monitoring Program Team Leaders	Melissa Martin / Tait Rutherford
GIS Specialist	Alex Gonzales
Soils	Randy Tepler
Air Quality and Fisheries	Vacant
Hydrology (North Zone) Hydrology (South Zone)	Dave Gloss Liz Schnackenberg
Botany (North Zone) Botany (South Zone)	Katie Haynes Marti Aitken
Archeology	Kolleen Kralick
Visuals	Jeff Tupala
Recreation	Scot Rogers
Lands/Minerals	Nathan Haynes
Wildlife	Steve Kozlowski
Fuels/Fires	Vern Bentley
Engineering	Dana Bardsley
Rangeland Management	Geri Proctor
Silviculture	Christie Schneider / Mark Westfahl

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