United States Department of Agriculture

Summary and Conclusions of the 2020 and 2022 Biennial Monitoring Evaluation Report White River National Forest

Trappers Lake (2020), Photo by Cary Green, US Forest Service

Forest Service White River National Forest May 2024

Monitoring

The White River National Forest (WRNF) Land and Resource Management Plan – 2002 Revision (Forest Plan) was updated in 2016 following the 2012 Planning Rule to replace "Chapter 4 Monitoring and Evaluation" with "White River Forest Plan: Updated Monitoring Plan (Monitoring Plan)."

The purpose of the biennial monitoring evaluation report is to help the responsible official determine whether a change is needed in Forest Plan direction, such as plan components or other plan content that guide management of resources in the plan area. The biennial monitoring evaluation report represents one part of the Forest Service's overall monitoring program for this national forest unit. 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 Plan, in relation to management actions carried out in the plan area.

The biennial monitoring evaluation report is designed to help the Forest Service, public, tribal entities, other stakeholders, and federal, state, local governments anticipate key steps in the overall monitoring program. The biennial monitoring evaluation report is also intended to help people better understand reported results in relation to past monitoring reports, future monitoring reports, and the broader-scale monitoring strategy that is issued at the Forest Service regional level.

Monitoring Activities

The monitoring and evaluation plan contains 23 questions within eight resource categories.

i. Watershed conditions
ii. Ecological conditions
iii. Focal species
iv. Ecological conditions for at-risk species
v. Visitor use, visitor satisfaction, and recreation plan objectives
vi. Climate change measures and other stressors
vii. Forest Plan desired conditions and objectives
viii. Management and productivity of land (soils)

Twenty-three questions were addressed during the current evaluation period 2020 - 2022 with the most recent available data. This report incorporates 2020 and 2022 monitoring data evaluation. Each monitoring item includes 1) a summary of the monitoring question and its indicators; 2) an evaluation of the monitoring results, discussion, and findings; and 3) an adaptive management finding on whether recommendation options could be considered for future changes or not. The combined 2020 and 2022 Monitoring and Evaluation report can be found on the White River National Forest website (Managing the Land/Planning tab) located at https://www.fs.usda.gov/detail/whiteriver/landmanagement/?cid=fsbdev3_001228.

Summary of Findings and Results

Table 1 consists of the 2022 Monitoring Report summary of the findings and results. This table briefly describes if the monitoring results demonstrate intended progress toward plan targets, whether changes are warranted, and where changes may be needed in the Forest Plan, management activities and/or monitoring program.

Table 1. Summary of findings.

Monitoring Item	Year Updated	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]
1.1: Watershed Condition Framework Is the unit improving condition in priority watersheds?	2022	Yes, trend is watershed conditions maintained or improving.	No	N/A
1.2: Watershed Condition Class Is the unit maintaining or improving watershed condition class in non-priority watersheds?	2022	Uncertain (B) Watershed condition class slow to change over time. Data points every 6 years may not show trend.	No	N/A
1.3: National Best Management Practices Program Are Best Management Practices (BMPs) implemented, and are they effective at protecting water quality?	2022	Yes, trend is increased progress in effectiveness of BMPs in protecting water quality, but not at the 100% target effectiveness.	No	N/A
2.1: Air Quality What are the conditions and trends for visibility in Class I and selected Class II areas on the unit?	2021	Yes, trend is improved air quality in select Class I and II areas on the WRNF.	No	N/A

Monitoring Item	Year Updated	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]
2.2: Forest and Grassland Health What are the status and trends of insects and disease in and around the plan area?	2022	Yes, insects and diseases are at endemic levels in all forest cover types, with exception of Douglas-fir beetle which is trending upwards.	No	N/A
2.3: Ecosystem Health How are major vegetation types on the planning unit changing over time?	2023	Yes, lodgepole pine, spruce-fir, aspen and pinyon-juniper cover types are stable. Douglas fir mature structural stage trending downward.	No	N/A
3.1: Macro-invertebrates Is Forest management contributing to conditions that maintain or improve biological stream health trends for biotic macroinvertebrate communities?	2021	Unclear. Using analysis of random samples suggests that management practices are maintaining stream health. The random sampling methods may not capture local impacts or trends	Yes	Utilize not only random sampling but also a stratified sampling method of historic problematic areas. Also move from current indices to Colorado MMI
3.2: Red Squirrel What do red squirrel populations tell us about the extent and condition of mid to late successional forested ecosystems on the planning unit?	2021	Yes, population trend is positive.	No	N/A

Monitoring Item	Year Updated	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]
3.3: Pika What is the status of American pika populations as an indicator for alpine ecosystem integrity?	2021	Yes, population trend is stable.	No	N/A
3.4 Avian Species What are the status and trends of select avian species on the White River National Forest?	2021	Yes, population trends are positive for 5 of 8 species. Stable for other 3 species.	No	N/A
4.1: Cutthroat Trout What is the status and trend of cutthroat trout across the planning area?	2021	No	Yes	Increase bioassessment monitoring to biannually for Conservation Population Streams, to include MMI and TIV indices. Increase the priority and scope of conservation and restoration projects to maintain species viability within the planning area.
4.2 Amphibians What is the status and trend of boreal toads and northern leopard frogs being across	2021	Uncertain (B) Unable to establish a trend with data collected.	No	N/A

Monitoring Item	Year Updated	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]
the planning area?				
4.3 Lynx Habitat What is the status and trend of early successional conifer and late seral spruce-fir forests to promote recovery of Canada lynx?	2021	Yes, decline in late successional conifer and an increase in early successional conifer due to wildfire activity	No	N/A
5.1: Visitor Satisfaction and use. What are the status and trends of visitor satisfaction for recreational visits on the planning unit?	2022	Yes, trend in visitor use is increasing and visitor satisfaction is stable	No	N/A
5.2: Special Uses Administration What are the number and type of Special Use Permits administered to standard?	2022	Yes, trend is stable for special use permits administered to standard.	No	N/A
5.3: Sustaining Recreation Infrastructure How is the Forest trending towards implementing a sustainable program for recreation related infrastructure?	2022	Yes, trend is stable towards implementing a sustainable program for recreation related infrastructure.	No	N/A

Monitoring Item	Year Updated	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]
6.1: Snowpack and Precipitation What is the status and trends of snowpack and precipitation in the planning area?	2022	Snow Water Equivalent Uncertain (B) Precipitation slight downward trend Temperature slight warming trend	No	N/A
7.1: Economic Contributions from Specific Programs What are the contributions from the range, timber, recreation, and minerals program from the National Forest or Grassland?	2022	Yes, direct income and labor contributions from the WRNF from highest to lowest: recreation, USFS Investments, Forest Products, Livestock, Minerals.	Yes	Change economic analysis interval to coincide with MVUM, every 5 years.
7.2. Heritage Program Stewardship To what extent have management activities on the Forest complied with Section 110 of the National Historic Preservation Act and provided quality heritage recreational experiences?	2022	Uncertain (B) unable to determine a trend at this time with the current data points.	No	N/A
7.3 – Travel Management Implementation What are the status and trends	2022	Yes, trend is stable for roads and trails.	No	N/A

Monitoring Item	Year Updated	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]
of roads and trails in the WRNF?				
7.4 - Wilderness What are the status and trends of the Wilderness Stewardship Performance elements?	2022	Yes, performance scores are stable or improving.	No	N/A
7.5 - Management Activity Bare Ground Recovery Are project level design criteria and mitigation measures addressing ground disturbing management activities meeting the direction to "…maintain or improve levels of soil organic matter on all lands" through bare ground rehabilitation projects?	2022	Yes, trend is stable for project level design criteria that address ground disturbing management activities.	No	N/A
8.1 - Soil Productivity Monitoring What are the status and trends of soil productivity?	2022	Yes, trend of soil productivity is stable with implementation of BMPs and design criteria.	No	N/A

[1]Interval of data collection is beyond this reporting cycle (A); or more time/data are needed to understand status or progress of the plan component (B); or methods/results are inadequate to answer monitoring question (C).

[2] see body of the report for more details regarding any specific recommendations/opportunities for change.

Summary of Findings

Watershed Conditions

1.1 Watershed Condition Class Framework (WCF) in Priority Watersheds.

The Forest has identified four priority watersheds for restoration with associated Watershed Restoration Action Plans (WRAPs) and restoration efforts are underway. Table 2 shows that significant progress has been made on the approved WRAPs; most of the remaining projects are either very large, expensive and time consuming, or are the responsibility of partner agencies, such as cutthroat trout reintroduction by Colorado Parks and Wildlife.

The USFS activities in the Lime Creek are complete, but one project remains that will be accomplished by Colorado Parks and Wildlife in 2024. Progress continues in the Swan River, funding was recently received to continue the remaining projects in 2023 and beyond. Funding for Turkey Creek projects was also received in late 2022, which will significantly increase the pace of project implementation in the next three years. Efforts in the Upper Eagle River at Camp Hale have been re-initiated with funding from the Collaborative Aquatic Landscape Restoration Program. Several issues are still outstanding. Prior to implementation, asbestos cleanup by the U.S. Army Corps of Engineers are needed. Discussions continue with the State Historic Preservation Office on how to best restore aquatic conditions at Camp Hale while honoring the historical significance of the World War II military base. The recent declaration of the Camp Hale – Continental Divide National Monument (CHCDNM) should not affect the restoration.

The Forest intentionally prioritized large-scale and expansive restoration in watersheds which include Camp Hale and the historic dredge boat mining in the Swan River. This was done to bring attention to these large projects, knowing that completion would take a decade or more. While progress is slow in these watersheds, the conditions are being improved with each essential project completed, consistent with the goal of improving watershed conditions.

1.2 Watershed Condition Class in Non-Priority Watersheds.

Watersheds in the highest Condition Class account for 78 percent of the total on the White River National Forest. Of the 22 percent of watersheds in Condition Class 2, most are impacted by roads, urbanization and/or invasive species. These current figures serve as a baseline for future biennial reporting.

Since the last monitoring period, wildfires occurred in Glenwood Canyon, Sylvan Lake Area, Ptarmigan area near Silverthorne, and near the Lake Christine Wildlife Area in Basalt, potentially affecting aquatic resources in the Colorado and Fryingpan rivers. Thunderstorms caused several post-fire debris flows that delivered significant amounts of sediment to the Colorado River, affecting Interstate 70 and closing the highway in Glenwood Canyon. The five affected sub-watersheds were Grizzly Creek, No Name Creek, Glenwood Canyon, Blue Creek-Roaring Fork River, and Mill Creek-Cattle Creek, all of which had at least 10 percent of the watershed burn. Only two watersheds had burn acreages and intensities that caused a change in ratings for Element 7.1 - Soil Productivity or Element 9.1 - Loss of Forest Cover. In both cases, the Element ratings dropped from Good to Fair, but neither caused the overall watershed rating to change. Glenwood Canyon remained in Condition Class 1 and Mill Creek-Cattle Creek remained in Condition Class 2.

Since these were natural events and vegetation and soil conditions will slowly recover, and the river will digest and redistribute the sediment deposits, conditions are expected to recover on their own. Recovery efforts should be accelerated by the sediment removal work in the Colorado River to protect Interstate 70 and by the planned soil amendment work to promote soil and vegetation recovery.

1.3 National Watershed Best Management Practices Program (BMPs).

The results shown in Figures 3 and 4 of the monitoring report suggest that the implementation and effectiveness of accepted BMPs have protected aquatic resources to a degree but are falling short of complete compliance. Implementation monitoring displays room for improvement, especially in the mostly implemented category with only 19% of projects monitored for BMPs. Effectiveness of the prescribed BMPs show that 72% of those applied were fully or mostly effective. While this is encouraging, the intent is for the practices to be 100% effective at protecting aquatic resources. More analysis is required to determine if the shortcoming is due to the efficacy of the BMP itself, or if the BMP was not precisely implemented.

Ecological Conditions

2.1 Air Quality.

IMPROVE monitoring results for both the haziest and clearest days indicate a decreasing trend in haze over time, particularly for the haziest days. The regression line for the haziest days shows a decrease in haze of -0.06 deciviews/year, while the same data for the clearest days show an improvement in visibility over time of -0.06 deciviews/year. Note that years with the most significant haze are periods of extreme drought and associated fire activity (i.e. 2002, 2012, and 2020). This long-term data set serves as the monitoring baseline going forward. It should be noted that while some Forest management activities can affect visibility, these measured values are influenced by activities well beyond and outside the control of the WRNF.

2.2 Forest and Rangeland Health.

Insect and disease trends across the Forest for the most part are stable. Douglas-fir beetle impacts have nearly doubled since 2020 and are visible throughout the lower valley watersheds on the WRNF. Subalpine fir and aspen have also seen an increase in the amount of mortality across the landscape but are still considered at normal levels. Insects and disease are a normal function of Forest ecology and shape the structural composition of the Forest. There are not currently any damaging agents increasing to outbreak levels in any one forest vegetation component. Current rates of insect and disease impact are less than 30 percent on lynx analysis units (LAU) across the Forest. It has been determined that no changes to the Forest Plan or monitoring program are warranted at this time based on the current monitoring data.

2.3 Ecosystem Health.

Spruce-fir forests are the largest vegetation component and are generally stable. Aspen and lodgepole pine vegetation have declined slightly but are starting to stabilize. Overall, all vegetation across the forest has seen a slight increase in disturbance events and is regenerating at acceptable levels. This is a normal progression of forest successional ecology. No changes to the Forest Plan or monitoring program are warranted at this time based on the current monitoring data.

Spruce-fir, aspen and lodgepole pine forests are generally stable across the Forest with the majority of the Forest in younger to mature forest structure. Lodgepole pine experienced about a 15% decline in younger to mature forest structure, most likely due to wildfire events and to a minor degree timber harvest which occurred during the 2018-2022 timeframe. Lodgepole pine is slowly starting to recover from the 2004-2013 mountain pine beetle outbreak as stands of seedling/saplings begin to move into younger structural stage forest. Douglas-fir forests continue to be affected by Douglas-fir beetle. Almost all of the Douglas-fir cover type occurs on steep slopes and is not managed through timber harvest or fuels treatments. Pinyon-juniper forests are stable. Natural processes will continue to occur affecting the mature structural stage components of this forest type. Overall, all vegetation across the Forest is regenerating at acceptable levels. This is a normal progression of forest successional ecology. It has been determined that no changes to the Forest Plan or monitoring program is warranted at this time based on the current monitoring data.

Status of Focal Species

3.1 Macro-invertebrates.

Condition/Status Across the Forest.

One way to assess biological impairment of streams using macroinvertebrate data is to evaluate Shannon's Diversity Index ("Diversity" hereinafter) and the Hilsenhoff Biotic Index (HBI), metrics calculated by contractor on behalf of the Forest. The State of Colorado has established benchmarks for these two metrics for cold water streams. If a site has either metric below the benchmarks, that site/stream might be considered impaired. While this is not a perfect measure of impairment, it can be applied uniformly to our macro data over time and provides some indication of important macro community characteristics and thus the watershed conditions that they reflect.

By this measure, an average of 16% of samples collected each year could be considered to reflect "impaired" conditions by either the diversity or HBI metrics. It's important to remember that samples are collected from discrete sites, mere tens- or hundreds of feet in length, to represent generally miles of stream. There will be variation in condition between sites within particular streams, for example, which is an entirely natural phenomenon. The randomization of site selection is the means to overcome this site-specific variation as for every "poor" condition site randomly selected in an otherwise healthy stream, there will be other sites with better than average conditions and thus bias should balance out at the Forest scale. When measuring a complicated set of conditions at many sites over a large area and temporal scale, the conditions measured at every site at every time will not all be ideal, even in a high habitat quality system. This 16% might then be considered the background rate of sampling lower quality habitat conditions at any given place and time. We're also dealing with small sample sizes, so while 13% of samples from MIS sites sampled in 2013 could be considered impaired, that was only one site out of the eight samples collected that year. The use of other metrics including the Colorado Multi-Metric Index (MMI) to assess impairment might alter the estimated level of impaired sites, but the Forest has only recently begun to calculate this metric more widely.

Interestingly, the percentage of samples considered impaired may be increasing. Because observable, watershed- or stream- scale evidence of disturbance at many of these "impaired" sites is absent, it's likely that increases in the rate of impairment might reflect changes in the physical environment, temperatures, precipitation, stream discharge, and even landscape-scale nutrient cycling, more so than effects of forest management. For example, there is little data to support that forest management has altered the conditions of the East Maroon Creek watershed, and yet a site in that stream is showing up on the "impaired" list. Historic management activities associated with impairment, e.g. road development, grazing, or timber harvest are not occurring there. Consequently, at this point specific environmental mechanism(s) driving impairment is thus not clear.

Trend Analyses

A possible trend in the percentage of "impaired" sites has already been discussed. Other trends of interest can be described by sampling the same sites repeatedly over time to see if those repeated sampling events illustrate changes in metrics that reflect changes in habitat conditions. The status or condition at each site is of less interest in this analysis than a change in those conditions, whatever their starting point. Twenty-seven Focal Species sites have been sampled at least five times over five separate years, producing 185 samples (average = 7.7 samples per site). To examine change at the Forest scale, data from these repeatedly sampled sites were aggregated by year and trends over time were examined. Site level trends examined change over time at each site to see if lumping the data masked site-level changes. Trends were considered statistically significant if the p-value for the slope was less than 0.1.

Metric: Shannon's Diversity Index

At the Forest level, there was no trend in macroinvertebrate community diversity. That is, at these sites where at least five samples have been collected, diversity has not changed to a significant degree between 2003 and 2021. At the site level, diversity declined at a single site. A field visit to that site suggested that natural changes to site-scale habitat related to beaver activity was likely responsible for the reduction in diversity at that site.

Mayflies, stoneflies, and caddisflies (collectively termed EPT due to their scientific names: (Ephemeroptera, Plecoptera, & Tricoptera, respectively) are taxa sensitive to environmental disturbance. As disturbance increases, the prevalence of these taxa tends to decrease. At the Forest level, the number of EPT taxa did not change significantly over time. When considering the conditions at the individual site over time, the number of EPT taxa declined to a significant degree at 3 of 27 Focal Species sites. As discussed above the decline at one of the sites may have been due to a response in the change of beaver activity. With only a potential shift at two individual sites, there is not enough evidence to support a need for change in forest management practices.

The ratio of disturbance intolerant taxa to the total number of taxa sampled can be related to the prevalence of fine sediment and stream temperatures. As fine sediments and stream temperatures increase, the percentage of intolerant taxa in the community decreases. At the Forest level, the percentage of intolerant taxa has not changed over time. No changes were evident at any of the 27 sites with repeated sampling. Forest management practices therefore appear to be maintaining intolerant taxa in streams across the Forest.

The Hilsenhoff Biotic Index (HBI) reflects responses in macroinvertebrates to organic nutrient pollution. When excessive nutrients occur in a stream, more tolerant taxa of macroinvertebrates are more abundant, thereby increasing the HBI. At the Forest level, HBIs haven't changed since 2003. The HBI decreased at 2 of 27 sites on the Forest, suggesting that excess nutrients have declined at those sites since 2003.

The prevalence of fine sediment (particles less than 6 mm in diameter) in streams is an important aquatic habitat characteristic relevant to both aquatic macroinvertebrate and fish populations. Physical disturbances in a watershed, including impacts to streambanks, contributes to fine sediment levels. At the Forest level, fine sediment levels in streams haven't changed to a statistically significant degree since 2003. Fine sediment levels declined at 1 of the 15 sites with at least five repeated samples.

3.2 Red Squirrel.

The population trend for red squirrel moving in a positive direction for the WRNF. This was also the case for the GMUG NF as well as BCR 16. There are no changes recommended to this monitoring program or Forest Plan direction at this time.

3.3 Pika.

Overall, early results indicate that pika are well-distributed, and trends are fairly stable across the WRNF. Precise occupancy estimates and trends will be analyzed when a final report is provided by Rocky Mountain Wild. We expect that this will be discussed in the next WRNF monitoring report. There are no changes recommended to this monitoring program or Forest Plan direction at this time.

3.4 Avian Species.

For avian species on the WRNF, three showed a positive population trend, two showed a stable trend, and four did not have enough data to determine a high confidence of a population trend either way. There were no species that showed a negative population trend. Both the red-breasted nuthatch and the ruby crowned kinglet showed a positive population trend, and these species are generally associated with mature conifer habitat.

The WRNF is the only stratum that showed a positive population trend for the Virginia's warbler. Since this species was just added to the Regional Forester's sensitive species list, the Forest was encouraged to see this positive population trend. The WRNF will continue to work with its partners at Bird Conservancy of the Rockies to find the best species to analyze from the vast about of bird survey data that the organization continues to collect.

The status for ecological conditions for at-risk species

4.1 Colorado Native Cutthroat Trout (CRN).

As discussed in the macroinvertebrate section above, bioassessment analysis of randomly selected stream sites has not evidenced decline in stream conditions. The metrics used for that analysis include the Shannon's Diversity Index (diversity) and the Hilsenhoff Biotic Index (HBI). Although these metrics are proven means of analysis, the Colorado Multi-Metric Index (MMI) is more widely used, periodically adjusted, better conceptualized, and more easily conveyed than the Diversity and HBI indices.
The Multi-Metric Index was developed as a rapid "bioassessment tool for Colorado composed of separate indices calibrated to respond to stressors affecting aquatic communities" for individually defined Biotypes (CDPHE Policy Statement 10-1, 2020). The White River National Forest almost entirely lies within the Mountain Biotype. A MMI score less than or equal to 40 indicates an aquatic life impairment, while an MMI score of 48 or greater indicates attainment of the aquatic life threshold.
Similarly, Tolerance Indicator Values (TIVsed) have been established for fine sediment in Colorado mountain streams. This metric accounts for the amount of fine sediment being transported and deposited in streams and rivers. Increases in fine sediment indicate excessive erosion, and instream sedimentation which is detrimental for both aquatic macroinvertebrates and trout.

From a water quality standpoint, if a MMI score for a stream on the White River National Forest is less than 40 then the stream is considered impaired for aquatic life. If the individual score is 48 or greater, then the stream is attaining or suitable for use of aquatic life. The range between 40 and 48 indicates that although the stream may not be impaired there is likely a water quality issue that may be reducing suitability. Unfortunately, in the twenty some years that macroinvertebrate data has been collected the calculation of MMI scores is both sparse and inconsistent.

Straight Creek Site Str10582 is a bioassessment monitoring site approximately 560 feet away from the sterile wetland adjacent to CDOT Pond 5. Although bioassessment data has been collected five times since 2005, MMI scores were only established for 2006, 2007, 2020. There were respectively 86, 77 and 25. Obviously between 2006-2007 the stream was in good condition and functioning well above the aquatic life impairment threshold of 40. From the 2020 MMI score of 25 it is unknown what caused the precipitous crash in the macroinvertebrate community, but referring back to the water quality data discussed above, it seems there may be a strong correlation between contaminant concentrations and the instream impairment for aquatic life.

4.2 Amphibians.

The data were largely collected by Forest personnel though data for some years included those which CPW collected on the Forest. It's important to note that most of these data were collected in the post-Bd era and that the population monitored thus has been substantially reduced from its pre-Bd size and distribution. The spatial distribution of toads across the Forest provides some indication of the size of the population and changes in that distribution could suggest that the population was expanding or contracting. Similarly, the spatial distribution of toads could reflect the availability of suitable habitat patches and changes could reflect changes in the availability or suitability of habitat. One proxy for spatial distribution is the percentage of sites visited that can be observed to

be currently occupied by any life stage of toads. Random surveys are particularly helpful in this regard, as the higher percentage of surveys conducted that find toads, the larger the implied spatial distribution.

As would be expected, targeted sites were far more likely to be occupied than random sites. It was also apparent that the percentage of occupied sites was related to the number of surveys conducted in a given year (grey fill). Years with high numbers of surveys tended to have lower percentages of occupancy as more sites were surveyed, many of them inevitably unoccupied. Likewise, if only two sites were surveyed and both contained toads, occupancy was 100% which somewhat distorts the implication of a large spatial distribution. If toads were once widespread across the Forest, they are not now and therefore many plausible habitats are unoccupied, so far as our sampling has indicated. The relatively flat trendline for random surveys (green dotted line) indicated that those surveys only found about 21% of surveyed sites to be occupied and that that percentage did not appear to have changed significantly since 1998. This suggested that toads' spatial distribution is likely limited as only about one out of five plausible locations definitively hosts toads, and that status has remained essentially the same since 1998.

The visual decline in occupancy at targeted sites (yellow dotted line) was likely influenced by increased sampling effort since about 2017. Between about 2005 and 2015, generally only few surveys were conducted and those few tended to occur at the most reliably productive sites, as evidenced by the fact that targeted surveys during that period occurred at sites that were nearly all occupied. Another possible explanation is that sub-populations at known sites are blinking out, but the data do not suggest that that is the case – HUC SPATIAL ANALYSIS.

The number of adult toads observed would seem to be a reliable indicator of population size, but that number appeared to be related to the number of surveys conducted. Random surveys have not counted a lot of adult toads, again suggesting that the spatial distribution of toads is sparse. Targeted surveys of known hotspots were much more productive in terms of adult toads found and the more surveys that were conducted, the more toads tended to be found. Twenty-nine percent of surveys conducted were targeted surveys and they produced 87% of the adult toads found. This suggests that where toads are still found, there may be many toads, but that there aren't many places like that known on the Forest in the current era. Also consider that once a random site that produces toads was identified, subsequent surveys became targeted surveys as they surveyed known-occupied habitat, thereby enlarging the pool of targeted surveys. Concurrently, as random surveys have targeted the most obvious potential habitat patches over the years, the random locations surveyed were progressively smaller or more isolated or potentially in less suitable habitat.

To mitigate the effect of the number of surveys conducted on the number of adult toads found, the number of adult toads per site is informative. Random sites discovered to hold toads tended to not have very many, averaging around one each, and this was what we found in some of these sites. The number of adult toads found during targeted surveys of known sites has remained more or less the same since 1998, averaging about five. This suggests that sub-populations are small and have remained small. Including counts and estimates of tadpoles and sub-adult toads, the number of juvenile toads per site varied but remained approximately the same over time.

The factors that contribute to yearly fluctuations are not known. A known-unknown is the effect of persistent and at times acute drought on the toad population. Surveys in 2018 and 2020 for example, both very dry, early runoff years, noted desiccated wetlands at known sites where it was not clear whether reproductive efforts were successful. It's equally plausible that breeding occurred earlier in the year and was therefore missed by surveys, that breeding aggregations didn't occur at all as the habitat was temporarily unsuitable (i.e. dry), or if eggs and tadpoles simply failed to survive (or be counted) when the habitat dried out.

The number of juveniles of any species is always higher than the number of adults as many progeny don't survive to adulthood. The number of juvenile toads at a given site can fluctuate wildly, from single digits to thousands, which makes the data hard to see given the scale. Random surveys only infrequently observed juvenile toads and generally not many of them. The ongoing advance of Bd could be another factor.

4.2 Lynx Habitat.

Mapping and activity tracking indicate that the WRNF is in full compliance with the SRLA. For each exemption and exception, the WRNF has stayed well below the management thresholds set out in the SRLA. The WRNF is meeting the vegetation standards and the respective caps for treatments under the WUI cap of 3%, pre-commercial thinning cap of 1%, and the remaining 0.5% for projects that may occur under pre-commercial thinning or multi-story management. The total acres for these caps did increase somewhat from 2011 to the new mapping for 2017.

Since 2018, the WRNF has had several large wildfires. The wildfires on the Forest that burned between 2018 and 2020 affected a total of 24,638 acres of lynx habitat. The largest fire was the Grizzly Fire in 2020. Twenty-five percent of the Quartzite LAU is currently in unsuitable condition due to the Grizzly Fire. Additional field work is still needed to verify the condition of some of these acres, as well as assess natural vegetation regeneration.

Visitor use, visitor satisfaction, and progress toward meeting recreation objectives

5.1 Visitor Satisfaction and Use.

National Visitor Use Monitoring is the standardized protocol across all Forest units within the National Forest System. While survey methods do not capture 100% of visitation, they provide a statistically valid representation of visitation. General consistencies from 2017 and 2022 are indicated, leading to the conclusion that surveys methods are accurate.

Visitation continues to grow dramatically. In 2022, the White River National Forest was by far the most visited Forest in the National Forest System, and is a popular international travel destination. Opportunities for outdoor recreation within the White River National Forest are seemingly endless, visitation continues to rise, and visitor satisfaction is generally high.

Downhill skiing accounts for the majority of White River National Forest Visits and hiking/walking is the second most popular activity. Other main purposes of visits have shifted slightly over time; relaxing, bicycling, some other activity, other non-motorized and viewing natural features are the only other activities with greater than 10% participation. Overall data indicate that the Forest should continue to manage for high-use and increasing demand for year-round recreation opportunities, including managing the facilities that support these visits such as trails, roads, trailheads, and developed recreation sites.

5.2 Recreational Special Uses Administration.

In past years, Administered to Standard has been identified as an accomplishment target for Regions and Forests as part of the annual National Budget Direction. Table 21 below identifies the specific program administered by WRNF from FY2020-FY2022 including the number of permits, diversity of uses authorized, regional target accomplishment, as well as number of permits administered to standard.

White River National Forest- Meeting Forest Plan Goals and Objectives for Recreation Special Uses Administration:

With the exception of number of service days authorized, the table above provides information on the indicators identified in the Forest Plan Monitoring Plan for Special Uses Administration- Permits Administered to Standard, and Types of Permits. Findings with respect to each of these indicators are listed below.

Number of Permits Administered to Standard- The number of permits administered to standard alone does not supply much information for use to assess the Forest's program delivery or its success in meeting the Forest Plan goal and objective; however, when we allow for the regional target to act as a proxy for that assessment, we can

better assess the Forest's program. From 2020-2022 the WRNF exceeded the annual target provided by the Regional Office for recreation special uses. This is a good indicator that the WRNF has prioritized this accomplishment and is aware of how this accomplishment contributes to the Forest's ability to meet the Forest Plan goal and objective for special uses administration.

Service Days Authorized- At this time, WRNF does not maintain a database for gathering or tracking the total amount of service days authorized; however, NVUM data show that the WRNF is the most highly visited Forest in the country with an estimated 18 million Forest visits. A good portion of these visits occur at the Forest's ski areas that are authorized under a special use permit but those visitors leave the ski areas and enjoy the National Forest either on their own or participating in events or hiring an outfitter guide to enhance their Forest experience. SUDS data show that the WRNF administers one of the largest outfitter and guide and recreation event programs in the Rocky Mountain Region. The WRNF has not only a great number of service days authorized for outfitting and guiding use, but also supports a great number of visitor opportunities through its recreation event and ski area programs.

Types of Permits- With respect to recreation and lands uses, the WRNF demonstrates a wide variety of special use authorizations. They include outfitter guides, recreation events, recreation residences, resorts, concession, winter recreation area, shelters, and snow play to name a few. Furthermore, the Forest has maintained that variety of uses for many years, indicating a willingness to continue providing those opportunities into the future. There are no changes recommended to this monitoring program or Forest Plan direction at this time.

5.3 Sustaining Recreation Infrastructure.

The White River National Forest manages developed recreation sites through a combination of concessionaires (private companies) and force-account (Forest Service employees), and through both fee and non-fee sites. Site condition surveys document and track a recreation site being "managed to standard," annual operations and maintenance, and help with future planning of replacements of developed recreation sites features and amenities. These are also useful to understanding the amount of deferred maintenance, where recreation fees may or may not provide enough funding to address deferred maintenance.

The findings disclosed in Table 22 provide a baseline for future evaluations, and shows that 6 % (20 of 339) recreation sites on the WRNF are permanently closed. The permanent recreation site closures reduce the amount of overall developed recreation infrastructure and focus concessionaire and force-account capacity on supporting a sustainable recreation program.

Another tool to implementing a sustainable program for recreation related infrastructure is through Recreation Site Analysis (RSA). RSA looks at the totality of operating and maintaining sites and deferred maintenance, but also broadens the goals to consider how recreation sites contribute to social stability, environmental integrity, and economic viability for the Forest and its communities. This is a tool that provides future prioritization, including a range of options including expansion and/or reductions in services of recreation sites, closing sites, shifting operational responsibility to other stakeholders, etc.

Status of climate change measures and other stressors

6.1 Snowpack and Precipitation

Snow water equivalent values for 2019 through 2022 are higher than the mean, with the exception of 2021 (Figure 55). There is variation between mean annual values, but there is no significant trend between 2007 to 2022. Precipitation trends show a slight downtrend below the mean, although this may be attributed to annual variations (Figure 56). There is a clear warming temperature trend shown in Figure 57. These data will be used as a baseline for subsequent monitoring studies.

Progress toward meeting Forest Plan desired conditions and objectives

7.1: Economic Contributions from Specific Programs

The economic contributions values in the monitoring report are heavily affected by actual use of natural resources from the Forest (i.e., demand) and other local, national, and global economic conditions (e.g., prices, trade patterns, population change, etc.) that are beyond the scope of Forest Service control. The sphere of influence is limited to the supply of certain material inputs through forest planning and budget allocations.

The 2022 economic contribution modeled estimates for labor and income provide a snapshot of the *outcome* of forest resource uses, and validate the important role the Forest plays in the local economy; however, they are not for use in isolation, nor should they be treated as monitoring "data". It is inadvisable to draw year-on-year inferences from model outputs through time series analysis. Due to advancements in modelling approaches, changes in the underlying economy and differences in data collection across years, these results should not be used to identify trends or make assumptions about changing economic contributions. Therefore, it is not appropriate to rely on these findings as a metric in the Biennial Monitoring Evaluation Report.

Furthermore, results for future two-year periods will not capture economic contributions in their entirety due to the mismatch in reporting cycle of recreation visitation. The National Visitor Use Monitoring (NVUM) program, which supplies recreation visitation data, samples every National Forest on a five-year cycle. The WRNF was sampled in 2017 and again in 2022. Not until 2027 will "fresh" recreation data be available again. Given that the WRNF is one of the most highly visited Forests in the nation, and that recreation spending plays an outsized role in supporting local jobs and labor income, biennial reporting of IMPLAN estimates will frequently miss a key component of the Forest's overall economic contributions. Consideration should be given to align the economic activity report on the same five-year timeframe as recreational visitors use data within the WRNF monitoring program.

A more appropriate data set for tracking the Forest Service's influence on the economic sustainability of the region over time is the collective *program outputs* that serve as the raw data for the IMPLAN model. Number of visitors, barrels of oil, volume of forest products, dollars spent on Forest Service salaries, etc. – These indicators are more directly under the control of the Forest Service and can be compared year by year to track our changing contributions to the local economy. The following is a summary of program areas comparing 2016 and 2022 data points.

Recreation: The WRNF hosted an estimated 12.3 million visitors in 2017. By 2022, visitation to the WRNF had increased by 20 percent to 14.7 million. In both years, the majority of visitors reported "Downhill Skiing" as their main activity (although many of these visitors also engaged in other activities while on the Forest, such as hiking, viewing natural features, or cross-country skiing). In 2022, a far greater proportion of the downhill skiers (29% vs 11%) were local visitors on day trips, while the proportion of nonlocal skiers who stayed overnight dropped from 67 to 31 percent. ("Local" visitors are defined as those who travel less than 50 road miles from their home to the recreation site).

Minerals and Energy: The primary minerals and energy resources produced by the WRNF are crude oil, natural gas, and natural gas liquids. Production of each of these three resources has fluctuated and fallen since 2016, with the 2022 values lower than the 2016 values by 19.3 percent (crude oil), 38.4 percent (natural gas), and 29.5 percent (natural gas liquids). The number of jobs supported by these commodities are low relative to other resources on the WRNF, amounting to 15 jobs in 2022.

Forest Products: Softwood sawtimber harvest volumes vary widely from year to year, with 2022 being an exceptionally high year for timber volume removed due to task orders within the long-term stewardship contract

nearing termination and the contractor increasing capacity in order to meet termination timelines. There is no hardwood harvesting on the WRNF. The fuelwood volumes reported here are not included in the economic contribution values because the firewood is gathered for personal (not commercial) use. The material in the "All Other" category consists mostly of biomass forest products utilized by the bioenergy plant in Gypsum, Colorado. Biomass feedstock has grown steadily since 2016 due to annual awards and implementation of long-term stewardship task orders focusing on small diameter material utilization.

Grazing: Grazing on the WRNF has been steady or growing for the past six years. Between 2016 and 2022, the number of cattle and horses grazing on the Forest as measured in Animal Unit Months (a standard unit referring to the forage necessary to sustain a 1000-pound animal for one month) increased by 8.3 percent. Over the same period, grazing by sheep and goats increased by 6.6 percent.

Forest Service Expenditures: Total expenditures by the WRNF have fluctuated over the last six years with a sharp rise in 2018 and 2020, and a return to near 2016 levels in 2022. This has primarily been due to variability in Non-Salary expenses, since Salary expenditures have been nearly flat for the entire period. The number of Permanent Full Time Employees (FTEs) has grown by 13.2 percent since 2016, while the number of "Other than Permanent" FTEs has decreased significantly in recent years from a high of 117 in 2018 to a low of 31 in 2022. "Other than Permanent" FTEs trending downward can be attributed to low unemployment rate, high cost of living on the WRNF and flat budgets with higher inflation. The WRNF had a difficult time recruiting "Other than Permanent" FTEs in 2020 and 2022.

Payments to States and Counties: The Secure Rural Schools program provides critical funding for schools, roads, and other municipal services to more than 700 counties across the U.S. and Puerto Rico. However, 73 counties have elected not to receive Secure Rural Schools payments and instead to receive 1908 Act (amended) 25% payments, in which 25% of gross receipts generated on Forest Service lands during the fiscal year are distributed to counties. The White River contains both kinds of counties, and so disburses both types of payments annually. All segments of Payments to States and Counties have increased over time. Compared to 2016, the jump is particularly notable in Secure Rural Schools Act (SRS) and 25% Fund Payments, although the increase in Payments in Lieu of Taxes have been substantial as well (+56% growth).

7.2 – Heritage

The Heritage Program Plan was in progress, along with a Predictive Model. No Section 110 field survey was completed due to only having two people in the Heritage Department and the additional duties of working on the proclamation for the new National Monument, Sweetwater Lake property acquisition, and Hanging Lake trail rebuild projects. Being able to complete survey work alone would have brought us over 45 points.

With the addition of two more people in the Heritage Department in 2023, more opportunity for improving our "Heritage Managed to Standard" was thought to be possible, but we were essentially limited to two field going staff for the field season. Maintaining a constant staffing level of at least four people is essential for meeting our targets.

7.3 - Travel Management Implementation

While there is significant variation in miles of road decommissioned each year based on available funding and priorities, the WRNF has been averaging above target for road decommissioning for the lifetime of the TMP.

On average over the last 5 years, the WRNF is assigned and has met the following trails accomplishments/targets each year. "Trails maintained to standard" =478 miles; and "Trails Improved to Standard" = 12 miles. Non-system trails continue to be decommissioned or closed as recreation staff comes upon unauthorized trails.

WRNF continues to focus maintenance on existing system roads and trails that are important for access to all resource areas and key to our community's sense of place. Road maintenance on the WRNF is performed through various mechanisms, including Force Account (Road Crew), Contracts, Agreements, and Partnerships with County Cooperators. Trail maintenance on WRNF is and has been predominately done with youth corps, partner, non-profit and volunteer organizations. The WRNF continues to work on validating road and trail data to provide the public with the most accurate data.

Monitoring Item 7.4 – Wilderness

Performance measure upward reporting began in FY 2016, with targets based on the initial WSP scores submitted in FY 2015 that began the new WSP process. Annual performance assumes slow-but-steady incremental improvement in scores, estimated at a 5-point increase per year. This progression of scores also assumes the continued support of national funding.

2016 WRNF was successful in WSP project submissions in the initial rollout of WO internal funding for projects for the following: $47k for "*Indigenous Cutthroat Trout Conservation Monitoring and Invasive Species Removal*" as well as $39.5k for "*Flat Tops Wilderness Recreation Site and Solitude Monitoring Project"*. Both projects elevated WSP scores in the Flat Tops and Holy Cross Wilderness Areas respectively.

Overall, scoring improved in 2016 from the initial 2015 scores for all wilderness areas with exception for the Maroon Bells-Snowmass Wilderness (MBSW) which dropped two points due to limited workforce capacity and issues related to high use challenges in this wilderness area. Ptarmigan Peak and Eagles Nest continue to be "Well Below Standard Performance= < 30 points".

2017 WRNF was once again successful in WSP project submissions for 37.7k for "*Holy Cross Wilderness Solitude and Recreation Site Inventory".* It is expected that this project will further elevate Holy Cross Wilderness area scoring in both the solitude and recreation site elements.

The overall scoring improved for all wilderness areas except for the MBSW and the Hunter Frying Pan which both remained the same as in 2016. Holy Cross scores increased from a 42 to a "60" in 2017 which brought this wilderness area up to meeting baseline performance or "at or above standard performance = 60-69 points". The only WRNF wilderness area that remains at "Well Below Standard Performance= < 30 points" in 2017 is Ptarmigan Peak.

2018 WRNF was successful in a WSP project submission for $38.9 k for "*Eagles Nest Wilderness Solitude Monitoring & Trail Assessment*". At the time of this report, 2018 WSP upward reporting had not been finalized. It is expected that overall scores will continue to increase and that the WSP project work will continue to elevate the Eagles Nest Above the current "Below Standard Performance = 30- 49 points".

2022 WSP scores have been mostly flat or slightly declining for the last two years as there has been a lack of National funding for WSP projects along with post-pandemic increases in wilderness visitation and. The Flat Tops Wilderness is the only wilderness on the Forest "At or Above Standard Performance" with a score of 60 as the Holy Cross has dropped back to a score of 58 which matches the score of the Maroon Bells-Snowmass. The Hunter-Fryingpan (score of 44) and Ptarmigan Peak (score of 36) both continue to be "Below Standard Performance".

7.5 - Status of Bare Ground Recovery

Bare ground data has been collected by contractors that supply's the base imagery for a visual comparison of vegetation ground cover at several ski areas. These bare ground data have been utilized to compare before and after implementation to determine if projects are maintaining or improving levels of soil organic matter. Soil

organic transects data on ski area projects have been collected by Forest Service personnel and contractors to document depth of soil O and/or A horizons prior to ground disturbance activities. After ground disturbance, soil organic transects where collected and we determined that soil organic matter was less than at prior implementation levels so mitigation measures and design criteria will be utilized to go back to long-term soil organic matter levels. Bare ground on timber projects has been observed on landings, multiple pass skid trails and temporary roads that have not been closed – these bare ground areas do not exceed 15% of the project areas, but efforts to rehabilitate the bare ground remain active. There was no quantitative analysis to determine total bare ground on the WRNF, but it is known to exist in more actively managed project areas, in particular ski resorts and timber sales. Adherence to design criteria and best management practices should keep soil erosion and bare ground to minimal levels that fall within tolerances for acceptable loss.

Status of land productivity (soils)

8.1 - Soil Productivity Monitoring

Soil disturbance monitoring guidelines provide reliable monitoring methods that are repeatable and used to evaluate soil conditions across the Forest. These methods should be regularly reviewed to ensure adaptive management considerations are met. These evaluations are used to identify detrimental compaction, displacement, puddling, erosion, effective ground cover, and overall soil quality as well as identifying and predicting soils that are susceptible to disturbances. Continued monitoring also identifies project sites with significant disturbance needing restoration to reestablish soil productivity. Finally, continued monitoring of sites where soil restoration has occurred will improve continued decision making for future monitoring and restoration.

Timber
A variety of timber projects were implemented throughout the Forest between 2019 and 2022 on the WRNF. They include salvage, sales, ski area settlement, fuelwood, and fuel reduction. Some of these timber projects had little to no impact on the soil resource due to helicopter logging on ski resort special use permit areas. However, most of the ski area settle projects used conventional logging treatments that have a local impact on soils via skid trails and landings.

Conventional timber treatments can leave some compaction, displacement, and removal of ground cover, and increased potential for erosion; however, the area of the designated landings and ski-trails for each of the timber sales do not reach greater than 15% of the activity area. These effects to soils are short-term because they are mitigated through restoration activities such as de-compaction, lopping and scattering, as well as slash and seeding. Other timber projects include salvage treatments from mountain pine beetle-killed trees and hand treatments which do not cause much ground disturbance nor effect to soil productivity. Overall, the timber harvest activities during the monitoring period did not substantially and permanently impair the productivity of the lands on the WRNF.

Ski Resorts
The WRNF has eleven ski areas that are developed and operated by the private sector to provide opportunities for intensively managed outdoor recreation activities during all seasons of the year. Construction activities to build facilities, summer use recreation, and winter recreation infrastructure has occurred on the majority of ski resorts on WRNF between 2019 and 2022. Ground disturbance occurs in a greater scale with ski area development through activities such as vegetation clearing and grading which results in temporary and permanent impairment of the productivity of soils. Implementation of soil management requirements and project design criteria minimalizes erosion and loss of soil organic material from ski area projects. The footprint from past management activities on the ski areas does exist, as there is an array of unintentional bare ground still remaining. As new intentional bare ground is being created, mitigation of existing bare ground would occur through revegetation and rehabilitation. Soil productivity in the Management Area 8.25 (Ski areas) is maintained through following project design criteria and Forest Service Handbook direction.

Other Management Activities
Range developments and livestock grazing has continued to occur through 2019 – 2022; however, no additional projects are currently proposed. Impacts from livestock grazing to soils has been minimal due to the spread-out impacts that livestock have on the landscape; however, when there are impacts local to streams and waterbodies, there have been documented instances where soil erosion has occurred rapidly.

Oil and gas developments and their impacts on soil have not been monitored during the monitoring period.

Conclusion

Progressing trends
The following monitoring items and associated resources have been determined to be progressing and/or trending toward Forest Plan targets.

1.1: Watershed Condition Framework
1.3: National Best Management Practices Program
2.1: Air Quality
2.2: Forest and Grassland Health
2.3: Ecosystem Health
3.2: Red Squirrel
3.3: Pika
3.4: Avian Species
4.3: Lynx Habitat
5.1: Visitor Satisfaction and use
5.2: Special uses Administration
5.3: Sustaining Recreation Infrastructure
6.1: Snowpack and Precipitation
7.1 Economic Contributions from Specific Programs
7.2: Heritage Program Stewardship
7.3: Travel Management Implementation
7.4: Wilderness
7.5: Management Activity Bare Ground Recovery
8.1: Soil Productivity Monitoring

Uncertain trends

The following monitoring items and associated resources have uncertainties in progressing and/or trending toward Forest Plan targets.

1.2: Watershed Condition Class
Watershed Condition Framework (WCF) data are updated every six years and are a snapshot of the watershed condition at that time; they are not a particularly sensitive baseline comparison. WCF metrics may need to be updated annually to better track numeric or categorical changes in each watershed to better determine that non-priority watersheds are in a maintained or improving watershed condition class.

3.1: Macro-invertebrates
Using analysis of random samples suggests that management practices are maintaining stream health. The random sampling methods may not capture local impacts or trends.

4.1: Cutthroat Trout
There are currently uncertainties in comparing monitoring data for Colorado River Native Cutthroat trout prior to 2016 and data collected during this monitoring period. Forest biologists will use the current monitoring data collected for inventory and monitoring of Colorado River Native Cutthroat trout throughout the life of the Forest Plan. As additional data are collected in future monitoring periods, the status and trend of Colorado River Native Cutthroat trout can be determined across the planning area.

4.2: Amphibians
More sampling is needed to determine trends across the Forest. Sampling generally has focused where amphibians have been found in past surveys noting their presence.

6.1: Snowpack and Precipitation
Snow Water Equivalent: More time/data is needed to understand status or progress of the plan component.

7.2: Heritage
2022 was the first monitoring year data were analyzed. Previous years were not accounted for due to lack of staffing. Staffing increased, as did the Heritage Program accomplishments, but still fell short of standards. With increased staffing, expectations are that heritage survey requirements will be brought up to standard.