

North Star Ecological Protocol and Management Review

Christopher Monz, PhD

Utah State University, Department of Environment and Society

Recreation Resource Consulting, Inc.

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Introduction

Ecosystems are constantly changing due to anthropogenic and natural influences, over a wide range of temporal and spatial scales. Ecological monitoring helps to understand these changes by taking systematic, repeated measurements of key ecological indicators and using consistent methods over time, so long-term comparisons can be made. Monitoring is essential in natural, protected areas to evaluate the effectiveness of management actions and to assure that conservation values are maintained. Programs of monitoring can evaluate trend data to understand changes in ecosystem condition over time—due to both anthropogenic disturbances such as climate change and human use, and natural events such as fire or flooding. Monitoring data can help direct future research that determines causality between species and their environment. Monitoring also allows for the detection of undesirable change as an “early warning” to help initiate, where possible, a management intervention. It also allows for an ongoing evaluation of management actions under an adaptive, “learn by doing”, management framework.

Context for this Review

Natural area managers worldwide rely on monitoring programs to help direct and evaluate management actions and evaluate ecological health. Specifically in the USA, all federal agencies and many state and local land management agencies engage in programs of ecological monitoring. A premier example of a comprehensive program of protected area monitoring is the National Park Service Vital Signs program and summary guidance for the development of ecological monitoring programs in this context provides a basis for this review (Fancy, Gross, and Carter, 2009).

This document provides a peer review of the overall program of monitoring administered by the Pitkin County Open Space and Trails (OST) program. To understand the approach, I have reviewed over 114 documents provided by OST staff that detail the overall strategy and data collection and handling protocols. I have also engaged OST staff on several occasions to ask clarifying questions and assistance to make sure I have reviewed the full extent of the monitoring program. I have evaluated the program considering contemporary, state-of-the-art, management and monitoring approaches employed by parks and protected natural areas. Much of this commentary is based on my 30+ years of experience conducting ecological field research, assessment, monitoring and planning for sustainable management in parks and protected areas worldwide. A general reference for this knowledge is my textbook, *Wildland Recreation: Ecology and Management* (Hammit, Cole and Monz, 2015) and the recent literature.

It is also important to note that programs of monitoring are always customized to suit the specific needs of the intended protected area. As such, there are few absolutes in what makes a successful program. Success depends on a range of factors such as types of natural resources present, management needs and capabilities, and available budget. The overriding goal should always be to strive to provide accurate information that supports a management decision process. Indicator-based adaptive management strategies, where a suite of important indicators is measured consistently and compared to thresholds of acceptable conditions, have over a 30-year history of effectiveness.

As such, this review examines the program of monitoring at the North Star Nature Preserve to address the following overall key questions:

- Is there a suite of appropriate indicators being measured rigorously and at appropriate temporal intervals?
- Has the resulting data been reported in a defensible way (i.e., proper analysis and interpretation)?
- Are management strategies in place because of the above findings that will help assure ecological health and/or improvement?

Ecological Monitoring on the North Star Preserve

The program of ecological monitoring on the North Star Preserve is extensive and ambitious with fundamental ecosystem components of hydrology/geomorphology, vegetation and wildlife included (Table 1). The full monitoring program includes 17 different protocols to comprehensively assess the various ecosystem components at the spatial scale of the entire Preserve. This approach is well suited to North Star given that most of the Preserve (77%) is closed to visitor use with the overall goals of protecting and enhancing native habitat. For each ecosystem component a suite of indicators is monitored, time intervals for repeat measurements suggested and in general, reports and analyses are readily available in the Pitkin County website (links to specific reports available in Table 1). Overall, this approach represents a comprehensive program of ecological monitoring.

A detailed review of each individual protocol is beyond the scope of this review; however, the overall approach is exemplified in the most recent wildlife monitoring report (Colorado Wildlife Science 2024). Notable aspects of the protocol and reporting that address the key questions (above) are as follows:

- **Indicators and Time Intervals** - The plan specifies a three-to-five-year time interval for monitoring across all wildlife indicators and there is record of monitoring activities in accord with this schedule dating back to 2014. The protocol employs a range of standard, scientific techniques such as camera traps, transect and hexagonal sampling, and direct and indirect (wildlife sign) observational sampling. This diverse approach has the capability of measuring a wide range of important taxa, from small mammals through ungulates. The protocol also has the capability to capture species in a wide range of temporal scales, from residents through any unique, occasional species. The approach also includes a substantial effort at

monitoring avian species using protocols developed by the Bird Conservancy of the Rockies (McClaren et al 2019).

- Data Reporting and Presentation - Analysis of data and reporting results are presented in the 2024 Wildlife Monitoring report prepared by Colorado Wildlife Science. The report is extensive and very professional. Of note is that many of the findings present a long history of monitoring data, in some cases over a 20-year time frame (i.e., Great Blue Heron data presented on p. 22). This long-term trend data is arguably the most informative way to examine ecological condition quality and is very informative to management.
- Management Suggestions - The report concludes with thirteen points for future management of wildlife on the preserve. These suggestions include refinements of the monitoring process, species level management suggestions based on data trends, additional work to identify influential factors regarding observed species trajectories, and human use management (spatial buffers in proximity to dens and nests). All these suggestions are well-supported in the report, actionable and should be considered in the development of the new management plan in 2025.
- General Comments on Other Protocols - Overall the program of monitoring generally follows the same strategies as reported in the wildlife protocol, and thus appears to be of similar quality in terms of measurement indicators, data analysis, and management implications. Although each protocol appropriately has varying time intervals and management plan relevance, there are a few improvements to note. Several of the protocols, such as the noxious weeds, rare plants, and vegetation mapping several are approaching the end of a monitoring cycle and the time for remeasurement. A process should be developed to integrate the most current findings into the management plan revision. This could include a narrative in the revised management plan to explain the general relevance of monitoring data to date, and how it informs the current management plan. It does not need to be extensive but provides an opportunity to explain the context of the monitoring work.
- Documenting how some protocols, like measuring groundwater or channel morphology integrate into the broader management objectives is important and should be considered in the management plan revision. For example, expanding on how the current passive channel management approach was selected and what if any alternative actions would be considered to enhance habitat protection and visitor experience priorities.

Table 1. A summary of Ecological Monitoring on the NorthStar Preserve

<i>Protocol Type</i>	<i>Monitoring Interval (years) and most recent dates</i>	<i>Spatial Extent</i>	<i>Variables Measured</i>	<i>Most recent data (link)</i>
<u>Hydrology and Geomorphology</u>				
<i>Channel Morphology</i>	Every 10 years, Last completed 2017	Length of Roaring Fork River through North Star Nature Preserve (~1.75 miles)	Cross section, particle size, image analysis of channel (for channel migration rates)	2017 Fluvial Geomorphology and Aquatic Life Monitoring Report
<i>Groundwater</i>	Annually as needed 2021-2024	6 Wells across property, 3 near-river locations spanning 0.6 river miles	Depth to groundwater at network well locations	No report to date. Synthesized for Management Plan updates or as needed
<i>Macroinvertebrates</i>	Every 3-5 years. Completed 2017, 2023	Two locations approx. 1 mile apart: Upstream site in James H. Smith Parcel, Downstream site near takeout bridge.	Macroinvertebrate abundance by taxon: Multi-Metric Index (MMI)	2017 Fluvial Geomorphology and Aquatic Life Monitoring Report No report to date from 2023 sampling.
<i>Water Quality</i>	No interval defined. Completed 2017, 2023	Same as above.	Temperature, pH, hardness/alkalinity, heavy metals, nutrients, dissolved oxygen	Submitted to and stored on the Colorado River Watch Database: https://coloradoriverwatch.org/data/
<u>Vegetation</u>				
<i>Floristic Inventory</i>	Every 5-10 years. Completed 2018	Entirety of North Star Nature Preserve	Presence of plant species by coefficient of conservation	2019 Vegetation Type Map, Community Descriptions, and Floristic Inventory
<i>Noxious Weed Inventory</i>	Known infestations monitored annually; Every 5-10 years as part of plant inventory. Completed 2018	Entirety of North Star Nature Preserve	Presence and location of noxious weed infestations	2019 Vegetation Type Map, Community Descriptions, and Floristic Inventory
<i>Rare Plant Inventory</i>	Every 5-10 years Completed 2018	Entirety of North Star Nature Preserve	Federally listed, USFS/BLM sensitive species; CNHP tracked species. Presence and location	2019 Vegetation Type Map, Community Descriptions, and Floristic Inventory
<i>Vegetation Mapping</i>	Every 5-10 years Completed 2018	Entirety of North Star Nature Preserve	Location, extent and vegetation types in accord with U.S. National Vegetation Classification System	2019 Vegetation Type Map, Community Descriptions, and Floristic Inventory
<i>Line- Point Intercept</i>	Every 3-5 years Completed 2017, 2023	Three permanent transects, located in 3 different plant community types	Groundcover estimates by species	2023 North Star Vegetation Monitoring - Quantitative Data Transects and AGCI Monitoring Plots

<i>Modified Whittaker Plots</i>	Every 3-5 years Completed 2017, 2023	Two plots, located in 2 additional, distinct plant communities: Aspen Forest and wetland transition.	Groundcover species at various spatial scales; species richness and cover	2023 North Star Vegetation Monitoring - Quantitative Data Transects and AGCI Monitoring Plots
<i>Wetland and riparian habitat mapping: Functional Assessment</i>	No interval defined. Completed 2014	Entirety of North Star Nature Preserve	Location and spatial extent of riparian habitat; functional assessment	2015 Ecological Communities and Fluvial Geomorphology Baseline Report – North Star Nature Preserve
<i>Wildlife: General</i>				
<i>Multiple Species Inventory and Monitoring (MSIM) Terrestrial Visual Encounter Surveys (TVES)</i>	Every 3-5 years. Completed 2014, 2017, 2021	Two 10-hectare focal areas (5approx... 50 acres covering diverse habitats) Map on page 60 of 2024 report	Overall biological diversity, species of concern, relative abundance	2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons
<i>Camera and infrared detector stations, for Rare and Nocturnal Mammals</i>	Every 3-5 years. Completed 2014, 2017, 2021			2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons
<i>Wildlife: Birds</i>				
<i>Point-Transect, for Songbirds</i>	Every 3 years. Completed 2020.	16 sampling points distributed evenly across the Entirety of North Star Nature Preserve	Species richness, species diversity, relative abundance, bird densities, sensitive species ratios	2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons
<i>Broadcast surveys, visual nest surveys and TVES, for Diurnal Raptors (Accipiter emphasis)</i>	Every 3-5 years. Completed 2014, 2017, 2021	Two 10-hectare focal areas (same as TVES above)	Presence and distribution of diurnal raptor species, nesting activity	2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons
<i>Broadcast and encounter Surveys, for Nocturnal Raptors (Owl emphasis)</i>	Every 3-5 years. Completed 2014, 2017, 2021	9 monitoring points along one 2,122m transect traversing the Preserve	Presence and distribution of owl and nocturnal bird species, nesting activity	2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons
<i>Great Blue Herons</i>	As Needed, completed 2018.	Entirety of North Star Nature Preserve, focused study only where nesting occurs	Heron Colony presence/size, nest productivity	2024 North Star Nature Preserve Wildlife Monitoring Report: 2020-2021 Field Seasons

Integration with Management Actions

Overall management strategies are detailed in the *North Star Nature Preserve Management Plan (2020)*, with some of these actions predating this planning process. Several of the monitoring reports provide support for these actions as well as additional, often species-specific actions (i.e., previous comments on wildlife monitoring report). In addition, extensive details of 23 natural resource and recreation-related actions are summarized with the current status in the *North Star 2020 Management Plan Action Tracker* document, which indicates that 80% of the actions suggested are either ongoing or complete (OST 2025). These documents suggest that there is an extensive interplay between the

management plan and ongoing monitoring efforts and that actions suggested are being implemented. Noteworthy actions include noxious weed management, restoration and regeneration of native groundcover and tree species which supports habitat for wildlife and allowing beaver dam formation in accord with natural processes. Significant recreation management actions are also identified and include facility development (which concentrates visitor activities in a manageable way) enforcement, education, buffers around sensitive resources, and site closure when necessary.

It should also be noted that the overall landscape design of facility locations and areas designated for recreation use aligns well with established recreation ecology theory and management principles. Specifically, recreation use is spatially limited in the Preserve with approximately 23% of the overall land area managed with defined public access, with most of the land closed to use for habitat and species protection. This strategy of confining use to a limited spatial extent where visitors can be accommodated and managed well has been shown to be highly effective at limiting overall ecological disturbance (Hammitt et al., 2015).

Although the above actions are commendable and appropriate, a suggestion for improvement is to clearly link monitoring indicators to each management action listed in the Action Tracker, where appropriate. This allows for a clear determination of the efficacy of management actions and is an important component of any adaptive management framework—to learn what actions are helping achieve overall management goals. Much of what is being measured in various protocols likely overlap with the needed indicators, but clarifying how success or failure of actions will be measured is important for managers and the public.

Conclusions and Recommendations for Future Monitoring

Overall, there are no significant issues and concerns with the monitoring program as it addresses a wide range of ecosystem components. The program is robust enough to identify major trends in ecological conditions, particularly the effects on wildlife and plant species of concern as they are manifest on the Preserve. Several areas of possible further development should be considered as the program progresses, that largely consist of a better articulation of some of the important aspects such as desired future conditions and clarifying the direct linkages with the monitoring indicators. Contemporary adaptive management also defines thresholds of acceptability that are effectively limits to the extent of ecological change that would be tolerated before a management intervention should be considered. Developing clear thresholds for a limited set of indicators and a suite of possible management actions that are feasible in the future would likely help in the broad acceptance of the monitoring program as providing clear guidance as to when an action will be taken.

- Monitoring is extensive and robust with an extensive program across all major ecosystem characteristics and components. I note that key habitat types such as Aspen Forest, riparian shrublands, emergent wetlands, and riparian woodlands are

all monitored via multiple means that includes vegetation mapping and assessment and a management indicator species approach that employs key species in each habitat as an indicator of quality. This is a useful approach given that all species cannot be continuously monitored.

- For future development suggestions include:
 - There are numerous ways to organize a monitoring program with arguably the most important attributes being a clear communication to stakeholders and the public, the efficacy of the program in informing management decisions and overall operational and financial feasibility. These priorities should inform future development of the monitoring program at the North Star Nature Preserve.
 - OST should consider developing an overall monitoring program summary document that states specific goals of the program, and clearly lists indicators, time intervals for monitoring and other relevant information. This process may result in adopting a limited set of ecological indicators from the existing protocols that are highly relevant to management and could be measured on a frequent basis with minimal cost. Additional assessments such as an expert analysis of elk habitat quality examining forage, cover and water access could be conducted via rapid assessment. These indicators should also allow for the evaluation of management actions. The more extensive inventory, assessment and mapping approaches could also occur, perhaps on a less frequent basis.
 - In reference to the previous suggestion, an option is to organize the priority indicators by levels of spatial and temporal scale. This strategy could include several indicators each at the a) landscape-longer time interval scale; b) visitor use area-more frequent time interval; c) focused issue/species of concern location scale-as needed sampling interval.
 - In the management planning context, it is helpful to develop thresholds for key indicators with connections to management actions should thresholds be approached or exceeded. This type of approach may be more achievable with a limited suite of indicators that are tied directly to human uses (recreation) of the Preserve to understand and manage possible undesirable ecological change due to these activities. The current monitoring process focuses well on assessing broad indicators of ecological health but lacks specificity on how recreation is affecting the corridors and adjacent areas where recreation is occurring.

- Although each preserve is unique and thus requires a planning and monitoring process that feasibly meets management objectives, OST may find it helpful to review the planning documents available from Jefferson County Open Space (i.e., Mesas Region Management Plan 2017). While many of the open space areas discussed in the plan are larger than the North Star Preserve, the plan provides a clear four step planning and adaptive management process, with both broad spatial

scale and species-specific monitoring. OST would perhaps find both support for the existing processes and perhaps a few new ideas for future planning.

- Integration with the ongoing Visitor Use Management plan may be beneficial. VUM typically uses an indicator based adaptive management approach and an integrated approach may be efficient and effective. As also mentioned previously, the indicators selected in this process would be helpful in identifying human caused changes in the specific locations where recreation use is occurring, which is currently not specifically monitored.

Literature Cited

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