


Forest Service
U.S. DEPARTMENT OF AGRICULTURE

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Monitoring Guide for the Chugach National Forest Land Management Plan

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Contents

Introduction

In April 2020, Chugach National Forest published a revised land management plan (USDA Forest Service 2020) as required under the National Forest Management Act of 1976 (16 U.S.C. 1600) and 36 CFR Part 219 – Planning (2012 Planning Rule). The revised Chugach National Forest Land Management Plan (also referred to as the 2020 plan, or plan) included a framework for monitoring resource conditions to assess whether the current plan direction is achieving management goals for eight required topics defined by National Forest Management Act in the 2012 Planning Rule. This monitoring guide provides detailed direction on how to implement the Chugach National Forest Monitoring Program (appendix A of the 2020 plan). It should be noted that many protocols identified are based on the background work provided in the 2011 version of the monitoring guide (USDA Forest Service 2011).

The 2012 Planning Rule lays out the monitoring framework for the U.S. Forest Service regions and forests. Under the 2012 Planning Rule, each regional forester develops a broader scale monitoring strategy for monitoring questions that are identified within the region's land management plans: the monitoring questions are best answered at a geographic scale that is broader than the plan area. Each forest unit will address forest-level monitoring questions tied to the plan area and coordinate these questions with the region's broader scale monitoring strategy (36 CFR Part 219.12). The Forest Service Alaska Region is currently developing a broader scale monitoring strategy. Staff from Alaska Region national forests are working closely with regional office staff to coordinate broader monitoring program needs, such as those associated with climate change elements, to ensure incorporation of the best available scientific information into the protocols of this and future guidance.

The Chugach National Forest Monitoring Program (appendix A of the 2020 plan) contains questions and associated indicators for the eight required topics identified in the 2012 Planning Rule. These monitoring questions and indicators are selected to inform management of resources within the plan area, including by testing relevant assumptions, tracking relevant changes, and measuring management effectiveness (summarized in table 1). This monitoring guide adds detailed information to the 2020 land management plan monitoring program; it identifies measures for the monitoring indicators and describes measurement and analysis protocols that can be used to evaluate trends in key resource conditions. The monitoring guide is a framework for communicating and evaluating new and emerging resource issues, highlighting connections and overarching themes across program-level monitoring on forest lands, and establishing protocols for information gathering and sharing. Data collected, reported, and assessed from this program informs needs for change to management direction on the Chugach National Forest.

Table 1. Required topics, monitoring questions, and associated indicators for Chugach National Forest Monitoring Program (appendix A, 2020 land management plan, as modified under the 2022 Administrative Change)

Plan Required Topics	Monitoring Questions	Monitoring Indicators
Watershed Conditions (see chapter 1 of this guide)	Are management actions effective in maintaining or improving watershed integrity?	National Best Management Practices rating results Watershed Condition Classification ratings
Terrestrial Ecosystems and Focal Species (two 2012 Planning Rule topics combined) (see chapter 2 of this guide)	Are management strategies effectively controlling or preventing the spread of invasive species in aquatic and terrestrial systems?	Trends in distribution and abundance of four invasive terrestrial plant species (bird vetch, orange hawkweed, white sweetclover, and reed canarygrass) Trend in geographic range and number of waterbodies infested with *Elodea* spp.
Riparian, Wetland, and Aquatic Ecosystems (see chapter 3 of this guide)	Are management activities maintaining or improving aquatic habitat connectivity?	Percentage of human-associated aquatic organism passage barriers improved or restored
Ecological Conditions for At-risk species (see chapter 4 of this guide)	Are habitat conditions necessary to support populations of dusky Canada geese and Aleutian cress being maintained?	**Dusky Canada geese***:* Population trends of dusky Canada geese in the Copper River Delta Nesting success Nest depredation **Aleutian cress***:* Trend in known populations of Aleutian cress Tree and shrub encroachment into alpine habitat Persistence of snowpack in alpine terrain
Visitor use, visitor satisfaction, and progress toward meeting recreation objectives (see chapter 5 of this guide)	Are recreation opportunities and infrastructure achieving desired conditions, and are they sustainable?	Recreation facility occupancy rate Number of outfitter guide permits issued and administered, activities, locations Number of miles of trail maintained by volunteers and partners Number of recreation sites operated and maintained by volunteers and partners Total deferred maintenance forestwide
Climate change and other stressors (see chapter 6 of this guide)	Is climate change affecting key ecological functions of terrestrial and aquatic habitats within the national forest?	Changes in hydrographs on selected sites Tree and shrub encroachment in alpine tundra and recently deglaciated areas Changes in water temperature on selected sites Snow depth and season of snow cover

Plan Required Topics	Monitoring Questions	Monitoring Indicators
Desired conditions, including social, cultural, and economic sustainability (see chapter 7 of this guide)	Is the national forest providing a sustainable, predictable level of goods and services to communities? Is the presently existing character of the wilderness study, including areas recommended for wilderness, area being maintained?	**Section A): Desired Conditions Ecosystem Services** Trends in number of commercial recreation permits issued Trends in developed recreational facility use Trends in number of forest product permits issued Trends in sport fishing harvest Trends in number of permits issued for subsistence harvest Trends in number of mineral materials permits issued and locatable mineral plans of operation approved **Section B): Management Area 1 Wilderness Study Area Desired Conditions** Trends in the following four qualities of presently existing character: Wildness Natural conditions Undeveloped Outstanding opportunities for solitude or primitive, unconfined types of recreation
Productivity of the land (see chapter 8 of this guide)	Are management activities, as implemented, meeting and maintaining soil productivity, state water quality standards, and land management plan desired conditions, goals, and objectives?	Soil disturbance resulting from management activity

The 2012 Planning Rule also directs the forest supervisor to set the scope and scale of the monitoring program so that it gathers the necessary information to direct management and is within the financial and technical capabilities of the agency (36 CFR Part 219.12). Chugach National Forest staff developed the monitoring program and protocols to address the management needs and capacity challenges by closely tying the monitoring activities to existing program-level monitoring or tracking efforts. For example, the indicators of watershed conditions were selected from the Watershed Condition Classification ratings and Best Management Practices, both of which are U.S. Forest Service national monitoring programs with well vetted measurement protocols, data management frameworks, and reporting structures. Each of the 2020 plan required topics (table 1) were addressed through incorporating some aspect of existing program-level activities, thus reducing time needed for specialists to research, develop, review, and establish protocols and data management structures.

The monitoring construct detailed in this guide also enhances the ability to highlight connections across programs and foster efficient, interdisciplinary work and management. For example, the Watershed Condition Classification ratings require evaluation of 13 conditions across four process categories to evaluate watershed integrity and function, thus the ratings were selected as one plan monitoring indicator for the watershed conditions required topic. Several of these same conditions are also used as monitoring measures for the other required topics of the guide. In this way, the 2020 plan monitoring program is efficient by integrating conditions evaluated from one existing, established and documented national monitoring program into the required information needs of the Chugach National Forest Monitoring Program. This approach also fosters interdisciplinary integration through using conditions measured for aquatic resources to address questions in terrestrial ecology, at-risk species, recreation, and climate change program areas.

The monitoring guide is a framework that identifies measures to address each indicator and establishes protocols for collecting, reporting, and assessing the trends in the information. It is organized into eight chapters, tiered to the required topics identified in the 2020 plan monitoring program (see table 1), and includes this introduction and finishes with a description of the integration into the forest's program of work. Each of the eight chapters contain reporting intervals, assessment periods, and descriptions of the relationship of reported trends to plan management direction for the associated monitoring questions and indicators. The guide defines the temporal periods for reports (frequency) and intervals (frequency) for assessment of trends in the data separately, as directed in the 2012 Planning Rule. For some of the indicators, the reporting periods are shorter term, consisting of annual survey results for a single or suite of measures that correspond to existing program-level evaluations. Assessments periods are longer-term evaluations of the trends in the data from survey reports that relate back to efficacy of management direction. All the reporting and assessment information will be outlined in Chugach National Forest's biennial monitoring report, as appropriate, for each indicator defined in this guide.

The 2012 Planning Rule (36 CFR 219) directs the forest supervisor to evaluate monitoring information and produce a monitoring evaluation report biennially, beginning no later than two years after the effective date of land management plan approval. The biennial monitoring report is designed to provide the necessary information to help the responsible official determine a course of action based on the recommended management adjustments outlined in the reports and assessments over the life of the 2020 land management plan. The biennial monitoring report is not a decision document. Future management decisions with appropriate environmental documentation may occur based recommendations. Providing timely, accurate monitoring information to the responsible official and the public is a key requirement of the plan monitoring program.

Finally, the monitoring guide is flexible and can be modified to ensure that the best available scientific information is incorporated into the Chugach National Forest's monitoring actions and management decisions. The guide is supplemental to the 2020 plan and is not considered part of the plan decision. Therefore, a change to the monitoring guide is not considered a change to the land management plan and does not require public notice (USDA Forest Service, National Headquarters (WO). Washington DC. January 30, 2015; FSH 1909.12 – Land Management Planning Handbook, chapter 30, 32.4, page 32).

Chapter 1 Watershed Conditions

Overview

Watersheds and water resources within the Chugach National Forest provide a substantial contribution to social and economic sustainability as well as ecosystem services in southcentral Alaska. The national forest provides drinking water for communities, private residences, businesses and lodges, and visitors at campgrounds. Hydroelectric facilities within the national forest provide electricity to communities throughout southcentral Alaska. Watersheds and water resources also provide a large economic offset for food through fishing and hunting and are culturally important for subsistence. Mining operations within the national forest use water resources for wash plants and camp facilities. Much of the recreation use within the Chugach National Forest revolves around waterbodies and glaciers, including sightseeing, camping, fishing, and boating.

Properly functioning watersheds also provide many important ecosystem services. Functioning watersheds generally provide high quality water, recharge of streams and aquifers, moderation of climate variability, and long-term soil productivity. Additionally, a diversity of healthy watersheds are important to create and sustain resilient terrestrial, riparian, aquatic, and wetland habitats that support diverse populations of plants and animals capable of rapid recovery from natural and human disturbances.

The condition of watersheds and aquatic resources affect nearly every other natural resource, land access, forest infrastructure, and commercial and recreational interests across the forested landscapes. Forested communities and their public resource managers have long recognized the value of water resources, and thus watershed management is regulated and monitored under a range of connected state and federal laws. In recognition of the importance of comprehensive, quality management programs, the Forest Service developed and continually re-evaluates and updates nationwide programs to monitor and manage water quality and watershed condition on National Forest System lands. These programs consist of the best available science, and include current, vetted technical field protocols, data management structures, and periodic evaluation and reporting requirements. Monitoring actions and activities allowable by the 2020 Chugach National Forest Land Management Plan will adhere to these national programs to ensure consistency, support efficiency, and incorporate the best available information into the management of water resources.

Priority Management Questions, Associated Indicators, and Monitoring Methods

Watershed monitoring directly addresses four of the forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the “Watersheds and Aquatic Ecosystems” section of the plan (and correspond to 2020 plan component identification code FW-GL3-WAE-DC):

- Watersheds in the plan area have primarily free-flowing rivers and streams and unmodified lakes. Instream flows and lake levels are sufficient to maintain natural aquatic and riparian habitats, wildlife and fish populations and recreational needs, State of Alaska designated beneficial uses, and to support inherent watershed integrity.
- The quality of both surface and subsurface waters on and flowing from National Forest System lands sustains native terrestrial and aquatic species and ecosystems, meets federal and state water quality standards, and supports State of Alaska designated beneficial uses.

- Stream channel morphology, structure, complexity, and diversity are primarily within ranges characteristic of the stream process group and are consistent with disturbance regimes characteristic of the geographic area.
- Water follows natural flow paths and hydrologic connectivity is maintained. Roads, ditches, and trails do not disrupt hydrologic connectivity and do not act as an extension of the stream network.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in watershed function related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor watershed conditions:

Are management actions effective in maintaining or improving watershed integrity?

To address the monitoring question, Chugach National Forest staff selected two indicators to determine trends in watershed conditions. Table 2 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring watershed conditions.

Table 2. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring watershed conditions on Chugach National Forest

Indicators	Measures	Reporting Frequency	Assessment Frequency	Responsible Program Area	Staff Time
National Core Best Management Practices rating results	Implementation, effectiveness, and composite best management practices ratings	Annually	5 years	Aquatics	3 to 4 weeks annually 1 additional week every 5 years
Watershed Condition Classification ratings	Watershed condition ratings	Assessments only	5 years	Aquatics	4 to 5 weeks

Negative trends in the indicators for monitoring watershed conditions suggest that re-evaluation of the 2020 plan components and additional adaptive management approaches are needed. Chugach National Forest staff will work with our partners (State managers, private and nonprofit groups) to find solutions including changes in 2020 plan components (such as standards and guidelines) that will move actions toward meeting desired conditions. The following narrative describes the monitoring methods and metrics, data management plan, reporting intervals and anticipated results, and estimated annual cost associated with each indicator.

The Chugach National Forest Monitoring Program uses National Forest System watershed monitoring programs, including the technical measures, sampling protocols, and national databases used to monitor trends in water quality and watershed condition as indicators to address the priority management question. The National Best Management Practices for Water Quality Management on National Forest System Lands (USDA Forest Service 2012) is a technical guide for monitoring and management of water quality on National Forest System lands. The Watershed Condition Framework and Watershed Classification system was developed “to protect National Forest System watersheds by implementing practices designed to maintain or improve watershed condition…” (USDA Forest Service 2006). The Watershed Condition Framework and Watershed Condition Classification technical guides (USDA Forest Service 2011a, 2011b)

established a national process, protocols, and metrics for evaluating watershed condition and prioritizing restorative improvements. (See technical guidance at the end of this chapter.)

The measures and protocols from the technical guides were determined to be the most effective, efficient, and comprehensive approach to understand the trends in conditions of watershed integrity on the forest and to address the efficacy in management direction. Chugach National Forest watershed staff will conduct periodic evaluations of the implementation and effectiveness of best management practices and changes in watershed condition classification ratings resulting from management activities across the forest, following the methods employed when implementing these two programs (see table 2).

Climate change, though not specifically addressed within the watershed technical guides, will have affects and implications for watershed conditions. The most significant effects of climate change to watersheds will be increased temperatures and changes in the amount, timing, and type of precipitation, such as rain and snow across the Chugach National Forest landscape. These temperature and precipitation changes may influence overall watershed conditions and the effectiveness of best management practices by changing water quantity, water quality, wetlands and riparian areas, fire regimes, and insect infestations. For example, instead of snowfall in the late fall, peak rain events may become more common. These late season rainstorms, often occurring as rain-on-snow events, may cause flooding and result in the need for increasing buffer widths for project management or increasing the size of culverts to minimize bank erosion, road flooding, and fish habitat degradation. The *Climate Change Vulnerability Assessment for the Chugach National Forest and Kenai Peninsula* (Hayward et al. 2017) will serve as a reference and measure for these measures. Refer to chapter 6 of this monitoring guide (page 57) for assessment of possible implications of channel flow alternations on roads and associated infrastructure, and watersheds least and most and likely to be influenced by climate change.

Indicator: National Best Management Practices Rating Results

The phrase “best management practices” has been used by many resource and business management areas to describe those practices found to be most effective in achieving a desired outcome. Regarding water quality, best management practices are codified in the Clean Water Act as the method for controlling nonpoint source pollution. Examples of nonpoint source pollution include diffuse runoff from construction sites, roads, and trails. For the Forest Service National Best Management Practice Program, best management practices are defined as, “Methods, measures or practices selected by an agency to meet its nonpoint source control needs. Best management practices include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures” (36 CFR 219.19).

The National Best Management Practices Program was developed to improve agency performance and accountability in managing water quality consistent with the federal Clean Water Act and state water quality programs. Current Forest Service policy directs compliance with required Clean Water Act permits and state regulations and requires use of best management practices to control nonpoint source pollution to meet applicable water quality standards and other Clean Water Act requirements. The Forest Service strategy for control of nonpoint source pollution is to apply appropriate best management practices using adaptive management principles. This strategy involves applying approved best management practices, monitoring implementation and effectiveness of the best management practices, and using the monitoring results to inform and improve management activities. The Forest Service has a long history of working with states and other partners to carry out best management practices programs, including agreements with the U.S. Environmental Protection Agency and many states to monitor best management practices.

The National Core Best Management Practices are a nationally standardized set of general, non-prescriptive best management practices for a broad range of activities that occur on national forests and grasslands as specified in the National Core Best Management Practices Technical Guide (USDA Forest Service 2012). This broad range of activities includes management actions within the following categories: aquatic ecosystems, chemical uses, facilities, fire management, grazing management, minerals management, recreation management, roads management, vegetation management, and water uses. Implementation of the National Core Best Management Practices requires development of site-specific best management practices prescriptions based on site conditions and local and regional requirements to achieve compliance with State, Tribal, and national water quality goals. These site-specific best management practices prescriptions are developed based on existing State and Tribal best management practices, Forest Service regional guidance, land management plan guidance, and best management practices identified in project-level NEPA decisions.

The purpose of the best management practices monitoring rating system is to provide a method of measuring the performance of the Forest Service in applying best management practices and protecting water quality during land management activities on National Forest System lands. The rating outcomes to each National Core Best Management Practices monitoring evaluation track best management practices performance over time at multiple scales across the landscape. In addition, patterns may emerge that will help to identify strengths and weaknesses in best management practices implementation and effectiveness and needed changes in processes or procedures to address identified weaknesses.

Methods and Metrics (National Core Best Management Practices Rating Results)

The National Core Best Management Practices monitoring protocols are the nationally standardized set of procedures for monitoring the implementation and effectiveness of the National Core Best Management Practices as specified in the National Core Best Management Practices Monitoring Technical Guide (USDA Forest Service 2012) (see technical guidance at the end of this chapter). These monitoring protocols will be implemented by forest-level interdisciplinary teams on a subset (or pool) of the forest's projects and activities utilizing best management practices. Monitoring is forestwide with a minimum of 50 percent random selection from pools. Pool development and the timing of evaluations are described for each category activity in their associated national protocols. Monitoring occurs annually and activity categories are assigned by the Washington office and regional office to meet a statistically significant set of monitoring results within five years for each National Core Best Management Practices applied extensively in the region.

For each National Core Best Management Practices monitoring evaluation (that is, completion of a monitoring protocol at a selected site), best management practices implementation and effectiveness are rated separately. These separate ratings are combined to provide an overall best management practices performance rating for the evaluation. In this way, best management practices implementation and effectiveness can be tracked separately as well as overall best management practices performance.

Implementation Rating Categories

Implementation monitoring answers the question: "Were site-specific best management practices prescriptions implemented as planned or designed?" Implementation monitoring assesses planning (prescriptions in project planning documents plus translation of planned prescriptions into action documents such as contracts, permits, etc.) and operational execution of the planning (specified prescriptions plus corrective actions for those specified prescriptions and other issues identified during project or activity implementation). The implementation rating categories are defined in table 3.

Table 3. National protocol best management practices ratings definitions for implementation monitoring

Implementation Rating	Interpretation
Fully Implemented	Prescriptions are identified in project planning documents, All prescriptions are translated into action documents, All specified prescriptions are implemented fully, and All necessary corrective actions identified during the project are implemented fully.
Mostly Implemented	Prescriptions are identified in project planning documents, All prescriptions are translated into action documents, All specified prescriptions are implemented fully, and Some necessary corrective actions identified during the project are implemented fully.
Mostly Implemented	Prescriptions are identified in project planning documents, Some prescriptions are translated into action documents, All specified prescriptions are implemented fully, and All or Some necessary corrective actions identified during the project are implemented fully.
Marginally Implemented	Prescriptions are identified in project planning documents, All or Some prescriptions are translated into action documents, and Some specified prescriptions are implemented fully, and All or Some necessary corrective actions identified during the project are implemented fully.
Not Implemented	Prescriptions are identified in project planning documents, No prescriptions are translated into action documents, or No specified prescriptions are implemented fully, or No necessary corrective actions identified during the project are implemented.
No best management practices	Site-specific best management practices prescriptions were not developed or identified during project planning.

Effectiveness Rating Categories

Effectiveness monitoring answers the question: "Did the site-specific best management practice prescriptions as designed and implemented work to protect water quality?" Effectiveness monitoring assesses the prevention of pollutants moving into a waterbody and prevention of physical or other damage to a waterbody. The effectiveness rating categories are shown in table 4.

Table 4. National protocol best management practices ratings definitions for effectiveness monitoring

Effectiveness Rating	Interpretation
Effective	No pollutants reached the waterbody and there is no potential threat evident –and– No adverse effects to a waterbody from the project or activity (for example, physical disturbance)
Mostly Effective	Minor amounts of pollutants reached the waterbody or there is a potential threat evident –and/or– Waterbody received minor adverse effects from the project or activity –and/or– Impacts to water quality are temporary, lasting less than one year
Marginally Effective	Minor amounts of pollutants reached the waterbody or there is a potential threat evident –and/or– Waterbody received minor adverse effects from the project or activity –and/or– Impacts to water quality are prolonged, lasting more than one year
Marginally Effective	Major amounts of pollutants reached the waterbody or there is a potential threat evident –and/or– Waterbody received major adverse effects from the project or activity –and/or– Impacts to water quality are temporary, lasting less than one year
Not Effective	Major amounts of pollutants reached the waterbody or are very close to entering the waterbody –or– Waterbody received major adverse effects from the project or activity –and– Impacts to water quality are prolonged, lasting more than one year

Composite Best Management Practices Ratings

Once the ratings for best management practices implementation and effectiveness have been determined for an evaluation, a composite rating for that evaluation is determined. The composite effectiveness rating is a combination of the effectiveness rating scores (ranging from effective to not effective, table 4) overlapped with implementation ratings (ranging from fully to not implemented, table 3). Composite ratings range from excellent (projects rated as both effective and fully or mostly implemented) to poor (projects rated not effective or marginally or not implemented).

In table 5, the columns represent the "Implementation Rating" and the rows represent the "Effectiveness Rating"; projects lacking best management practices protocols are rated as "No Plan."

Table 5. Combined implementation and effectiveness ratings for the National Composite Best Management Practices evaluation The composite effectiveness rating is a combination of the effectiveness rating and the implementation rating scores, with composite ratings ranging from excellent (projects rated as both effective and fully or mostly implemented) to poor (projects rated not effective or marginally or not implemented).

Combined Scoring	Fully Implemented	Mostly Implemented	Marginally Implemented	Not Implemented	No Best Management Practices
Effective	Excellent	Excellent	Good	Good	No Plan
Mostly Effective	Good	Good	Fair	Fair	No Plan
Marginally Effective	Fair	Fair	Poor	Poor	No Plan
Not Effective	Poor	Poor	Poor	Poor	No Plan

Data Management Plan (National Core Best Management Practices Rating Results)

Forestwide best management practices field evaluations will be entered annually into the corporate Forest Service best management practices database. The ratings derived in the database for best management practices implementation and effectiveness are determined based on the combination of answer choices selected in the best management practices evaluation according to a "ruleset" developed individually for each National Core Best Management Practices Monitoring protocol. Routines consistent with the "ruleset" within the best management practices monitoring data management system will analyze the answers to the protocol questions and assign the ratings to each evaluation.

A brief written report, documenting and summarizing the annual review results with necessary corrective actions and adaptive management actions, will also be compiled annually.

Reporting Intervals and Plan Direction (National Best Management Practices Rating Results)

The forest hydrologist will use the established corporate Forest Service database that stores the results of the yearly best management practice reviews across the various activities on the Chugach National Forest. Annual data will be retrieved and reported for the 2020 plan biennial monitoring and evaluation reports and reassessments.

The results of the yearly best management practice ratings should help identify and provide trends over the life of the plan to see if plan components, such as standards and guidelines, or specific best management practices implemented are effective in meeting the 2020 plan desired conditions. For example, if results from the annual best management practices monitoring ratings indicate potential non-point source pollution is impacting waterways, then forest resource specialists would identify if these conditions resulted from a lack of best management practice implementation or effectiveness, and apply adaptive management for those activities and plan components to meet plan desired conditions.

Estimated Annual Cost (National Core Best Management Practices Rating Results)

The annual best management practice monitoring requires an interdisciplinary team of two to five resource specialists to complete the reviews across the forest. It is anticipated field reviews may take up to two weeks plus travel, annually, with less than one week of staff time to complete data entry and report writing. Pool development may take a few additional days annually. It is also anticipated that the five-year report, documenting and analyzing trends, may take an additional week of staff time for the forest hydrologist.

Indicator: Watershed Condition Classification Ratings

The Watershed Condition Framework (USDA Forest Service 2011a) which includes the Watershed Condition Classification program were developed to establish a national systematic process for determining and tracking watershed condition and strengthen the effectiveness of the Forest Service to maintain and restore the productivity and resilience of watersheds and their associated aquatic systems. The Watershed Condition Framework comprises six steps: a) classification of watershed condition; b) prioritization of watersheds for restoration; c) development of watershed restoration action plans for priority watersheds; d) implementation of the integrated restoration projects defined in those plans; e) tracking of restoration accomplishments; and f) monitoring and verification. Watershed Condition Classification, part a of the Watershed Condition Framework, uses a comprehensive set of twelve indicators that are surrogate variables representing the underlying ecological, hydrological, and geomorphic functions and processes that affect watershed condition and integrity.

The Watershed Condition Classification national protocol utilizes a wide array of indicators and attributes. The indicators are grouped according to four major process categories: (1) aquatic physical, (2) aquatic biological, (3) terrestrial physical, and (4) terrestrial biological. These categories represent ecosystem processes or mechanisms by which management actions can affect the condition and integrity of watersheds and associated resources. Each process category is represented by a set of indicators and each indicator is evaluated using a defined set of attributes. Additional details are available in the Watershed condition class rating technical guide (USDA Forest Service 2011b).

Core National Watershed Condition Indicators and Attributes (USDA Forest Service 2011b):

Process Category – Aquatic Physical

Indicator: Water Quality

Attributes: Impaired waters; Water quality problems

Indicator: Water Quantity

Attribute: Flow characteristics

Indicator: Aquatic Habitat

Attributes: Habitat fragmentation; Large woody debris; Channel shape and function

Process Category – Aquatic Biological

Indicator: Aquatic Biota

Attributes: Life form presence; Native species; Exotic and/or aquatic invasive species

Indicator: Riparian Vegetation

Attribute: Vegetation condition

Process Category – Terrestrial Physical

Indicator: Roads and Trails

Attributes: Open road density; Road and trail maintenance; Proximity to water; Mass wasting

Indicator: Soils

Attributes: Soil productivity; Soil erosion; Soil contamination

Process Category – Terrestrial Biological

Indicator: Fire Regime

Attribute: Fire regime condition

Indicator: Forest Cover

Attribute: Forest cover condition

Indicator: Rangeland Vegetation

Attribute: Rangeland vegetation condition

Indicator: Terrestrial Invasive Species

Attribute: Terrestrial invasive species condition

Indicator: Forest Health

Attributes: Insects and disease; Ozone

Methods and Metrics (Watershed Condition Classification Ratings)

As described in detail in the Watershed Condition Classification Technical Guide (USDA Forest Service 2011b), classification of watershed condition using the Watershed Condition Framework involves the application of a standard, national watershed condition model. The model classifies watersheds as "functioning properly," "functioning-at-risk," or "impaired function" based on the weighted integration of 24 quantitative and qualitative attributes composing 12 watershed condition indicators (listed above).

Using this model, all Chugach National Forest 6th-level (12-digit) hydrologic unit code watersheds are classified by each attribute into one of three condition classes: Class 1 (good, functioning properly); Class 2 (fair, functioning at risk); or Class 3 (poor, functionally impaired). Attribute ratings can be informed by datasets developed at national, regional and/or local scales. Attributes are rated using data from internal sources, such as landscape assessments, watershed restoration plans, hydrologic assessments, culvert surveys, and fire regime maps, along with data from external sources such as the Alaska Department of Conservation and Alaska Department of Fish and Game. The attribute scores for each indicator are then summed and averaged to produce an indicator score. Indicator scores for each ecosystem process category are then averaged to provide a process category score. The overall watershed condition class score is computed as a weighted average of the four process category scores (USDA Forest Service 2011b).

Five-year reassessments will be completed by forest level and district level interdisciplinary teams as directed by the Washington office and regional office. These five-year reassessments will allow Chugach National Forest staff to evaluate if forest management activities have been maintaining or improving watershed condition across the landscape.

Data Management Plan (Watershed Condition Classification Ratings)

The forest hydrologist will use the established corporate Forest Service database that stores the Chugach National Forest watershed condition classification ratings. Forestwide watershed condition classification individual attribute ratings, and the overall watershed condition classification ratings information, will be stored in the corporate Forest Service Watershed Classification and Assessment Tracking Tool and updated every five years during the five-year reassessment period, or annually as needed if particular watersheds conditions change.

Reporting Intervals (Watershed Condition Classification Ratings)

The results of the five-year reassessment of watershed condition classification ratings should help identify and provide trends over the life of the plan to see if plan components, such as standards and guidelines, are meeting the 2020 plan desired conditions. The results of the analysis will also provide trends and changes in in each of the attributes and measures complied into the composite watershed condition classification rating over the life of the plan. For example, if results from the watershed condition classification five-year reassessment shows a trend of watersheds changing from Class 1 (functioning properly) to Class 2 (functioning at risk) for a particular attribute such as water quality or soils, Chugach National Forest staff may need to re-evaluate plan components to meet desired conditions.

Estimated Annual Cost (Watershed Condition Classification Ratings)

The Watershed Condition Classification reassessment will occur every five years. The reassessment will consist of a small interdisciplinary team lead by the forest hydrologist, and is estimated to take 2 to 3 weeks with some additional time for data entry. The five-year report, documenting and analyzing trends, may take an additional week of staff time for the forest hydrologist.

Technical Guidance for Chapter 1

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 1, click here.

Chapter 2 Focal Species and Terrestrial Ecosystems

Overview

This chapter addresses two of the required topics under the 2012 Planning Rule: focal species and the condition of terrestrial ecosystems. Focal species are described as indicators of ecological integrity and provide insight into the condition of the ecosystems that they influence. Invasive plant species can displace native plant communities and impair ecological integrity of ecosystems in which they become established; therefore, focal species can be invasive species and their presence (or absence) and abundance can provide an indicator of condition for terrestrial ecosystems. Chugach National Forest staff chose to use invasive plants as focal species and indicators for the condition of terrestrial ecosystems. The invasive plants selected for monitoring are highly ranked species, indicating that they have a high threat potential to natural areas in Alaska (Carlson et al. 2008, Nawrocki et al. 2011). Species are ranked by a series of questions in four broad categories: ecosystem impacts, biological attributes, distribution, and control measures. Ecological impacts are given emphasis due to the wealth of natural areas in state and the interest of land managers in protecting those areas (Carlson et al. 2008). Chugach National Forest staff selected four invasive terrestrial plant species and one invasive aquatic plant species that have established infestations within the forest to serve as focal species and indicators of terrestrial ecological conditions.

Priority Management Questions, Associated Indicators, and Monitoring Methods

Terrestrial ecological condition monitoring addresses one of the forestwide desired conditions in the 2020 land management plan. The desired condition is found in the "Ecosystem Processes and Conditions" section of the plan (and corresponds to 2020 plan component identification code FW-GL3-EPC-DC):

- Native plants, fish, and wildlife are the dominant species inhabiting National Forest System lands, while the establishment and spread of nonnative invasive species is prevented or minimized and does not threaten ecosystem function.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in condition related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor focal species and the condition of terrestrial ecosystems:

Are management strategies effectively controlling or preventing the spread of invasive species in aquatic and terrestrial systems?

To address the monitoring question, the Chugach National Forest staff selected two indicators to determine trends in conditions for focal species and terrestrial ecosystems: 1) trends in the distribution and abundance of four highly invasive nonnative terrestrial plants—bird vetch (*Vicia cracca*), orange hawkweed (*Pilosella aurantiaca*), white sweetclover (*Melilotus albus*), and reed canarygrass (*Phalaris arundinacea),* and 2) trend in geographic range and number of waterbodies infested with the aquatic plant *Elodea* spp. Monitoring the distribution of these plant species will provide an indication of ecological integrity on the forest and terrestrial and aquatic conditions by measuring the species presence within

each geographic region (Kenai Peninsula, Prince William Sound, and Copper River Delta), 4th level hydrologic unit code, and across the plan area. Forestwide, about 94 percent of sites along roads, trails, and other locations of human caused disturbance have occurrences of nonnative plants. In contrast, less than 2 percent of terrestrial backcountry sites feature nonnative plants (DeVelice et al. 2012). Table 6 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring focal species and terrestrial ecosystems.

Table 6. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring focal species and terrestrial ecosystems on Chugach National Forest

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Trend in the distribution and abundance of four highly invasive terrestrial plants (bird vetch, orange hawkweed, white sweetclover, and reed canarygrass)	Trend in the number of monitoring polygons infested with one or more focal species Trend in the presence of one or more focal species within the Forest Inventory and Analysis grid across the Chugach National Forest . Forest Inventory and Analysis data will provide an overall estimate of terrestrial invasive plant occurrence across the Chugach Trend in the average percentage cover of focal species within monitoring polygons	Annually	5 Years 5 Years for FIA areas where data are available	Ecology	Annual field work: 45 days Annual data management: 14 days 5-Year data analysis: 10 days Forest Inventory and Analysis data across the Chugach National Forest are collected and analyzed by Pacific Northwest Research Station staff and will not require Chugach staff time
Trend in geographic range and number of waterbodies infested with *Elodea* spp.	1) Trend in geographic range of *Elodea* spp. 2) Trend in the number of waterbodies infested with *Elodea* spp.	Annually	5 years	Ecology	Annual Field Surveys: 20 days; Annual Data Management: 5 days; Five year analyses: 5 days

Positive trends in these indicators suggest that re-evaluation of the 2020 plan components and adaptive management approaches is needed. Strategies for determining what management changes are needed in the case of increasing ranges of these species are described for each type of ecosystem:

Terrestrial systems strategies for evaluating actions

- Increase efforts to survey and determine effective treatments for high priority invasive species infestations.
- Evaluate actions that may have contributed to increase in invasive species such as use of contaminated fill for trail and road maintenance, inadequate cleaning of machinery or gear, accidental spread by users of the forest lands, and inadequate revegetation efforts with native species.
- Prescribe additional mitigation measures.

Aquatic systems strategies for evaluating actions

- Determine vector(s) of spread.
- Prescribe additional mitigation measures such as working with the State of Alaska and affected partners to close or limit floatplane access in affected lakes.
- Prescribe more rigorous prevention protocols and specific methods such as prescriptive cleaning of gear, vehicles, boats, and floatplanes.
- Evaluate risk of treatment vs. risk to native aquatic resources from invasive species infestation.

The following narrative describes the monitoring methods and metrics, data management plan, reporting intervals and anticipated results, and estimated annual cost associated with each indicator.

Indicator: Trend in the distribution and abundance of four highly invasive terrestrial plants (bird vetch, orange hawkweed, white sweetclover, and reed canarygrass)

Methods and Metrics

Trends in the distribution and abundance of the four focal invasive terrestrial plant species (and potentially other highly ranked invasive plants that emerge) will be identified using a network of standardized monitoring polygons established across known areas of concentrated human use on the forest. Distribution will be documented by the presence or absence of focal species within the monitoring polygons over time; this metric will demonstrate whether the management strategies are effectively preventing the spread of focal species across the forest. Abundance will be documented through changes over time in the percentage cover of focal species being actively treated within infested monitoring polygons (across a subset of polygons in any given year), which will show whether targeted treatment efforts are effectively reducing the size and density of focal species infestations. Together, these two metrics will help guide management strategies by indicating whether they are effectively controlling or preventing the spread of focal invasive species on the Chugach National Forest.

Monitoring Polygons

Establishing a network of monitoring polygons will serve two key functions in our monitoring effort:

1) Provide a standardized framework around which monitoring and management efforts can be organized and prioritized. a network of standardized monitoring polygons

2) Provide consistent units that can be monitored or sampled at repeated intervals over the life of the 2020 plan. Spatial consistency in the monitoring polygons allows for establishing meaningful trends in the distribution and abundance of the focal species.

The current distribution of terrestrial focal species on the Chugach National Forest is closely tied to areas of concentrated human use, such as roads or trails (Duffy 2003, DeVelice, Hubbard, et al. 1999, DeVelice 2003). To capture the extent of human use on the forest, geospatial data on existing infrastructure and improvements will be obtained from internal U.S. Forest Service databases as well as other federal and state sources (table 7). These datasets serve as the foundation for developing the network of monitoring polygons, and the polygons will be refined in an iterative process as information is added over time. Linear features, such as highways, roads, trails, or powerlines will be buffered to create a polygon which encompass the general extent of human impact associated with that feature. Buffered features will then be segmented based on the distance along the linear feature, into individual monitoring polygons. For example, roughly 80 miles of the Seward Highway runs through the forest, and to develop monitoring polygons for this linear feature the highway centerline will be buffered by 75 feet and segmented into 1-mile sections, creating 80 individual monitoring polygons that are each 1 mile long by 150 feet wide (table 7). For non-linear features such as campgrounds, trailheads, cabins, or mineral material sites, monitoring polygons will be digitized to the outer extent of human impact associated with each feature. For example, the monitoring polygon representing a gravel pit would be digitized to the current outer edge of clearing or digging.

Table 7. List of monitoring polygon types developed using existing GIS data. The sources of the original GIS data are identified, and any adjustments (buffering, digitizing, or segmenting) made to the existing GIS data to create the individual monitoring units are explained. The total number of monitoring polygons on the Chugach National Forest within a given feature-type are listed.

Feature Type	Data Source	Monitoring Unit	Number of Monitoring Polygons
State highways	AKDOT roads, centerline data	1-mile segments of highway with a 75-feet buffer from the centerline	185
Forest Service MVUM roads	MVUM roads, corporate data – NRM	1-mile segments of road with a variable buffer based on MVUM classification: • MVUM I – 10 feet • MVUM II – 15 feet • MVUM III – 20 feet • MVUM IV – 25 feet • MVUM V – 30 feet	287
Trails	Transportation dataset, corporate data – NRM	1-mile segments of trail with a 5-feet buffer from centerline	716
Powerlines	Infrastructure dataset, corporate data – NRM	1-mile segments of powerlines with a 60-feet buffer	161
Infrastructure	Infrastructure dataset, corporate data – NRM	Footprint of ranger stations, utility sites, communication sites, and other forest administrative sites	69

Feature Type	Data Source	Monitoring Unit	Number of Monitoring Polygons
Recreation sites	Corporate data – NRM	Recreation site polygons that include campgrounds, picnic areas, and other areas of interest	83
Mineral material sites	AKDOT mineral sites – ArcGIS Online	Points from AKDOT provide the basis for digitizing material site footprint polygons	29
Airstrips	Corporate data – Chugach Y drive	Footprints of airstrips	28
Parking areas	Corporate data – Chugach Y drive	Parking area polygons	56
Special Use Permit sites	Special Use Permit Database	Point data and polygons from Recreation and Special Use programs	To be determined
Alaska Railroad track centerline	Alaska Railroad ArcGIS Hub	100-feet Buffer used in line with Alaska Railroad ownership width	117
Railroad owned areas	BLM derived basic ownership corporate data – NRM	Areas owned by Alaska Railroad within the Chugach National Forest boundary	3

GIS = geographic information system; MVUM = Motor Vehicle Use Map; NRM = Natural Resource Manager database; AKDOT = Alaska Department of Transportation; BLM = Bureau of Land Management.

After the initial round of GIS derived monitoring polygons have been developed, the individual data layers will be merged following a hierarchy established to determine which feature types supersede others. In this hierarchy, infrastructure features are prioritized, followed by recreation sites, parking areas, highways, roads, trails, mineral material sites, airstrips, powerlines, and lastly railroads. Topology rules will be enforced on the merged dataset to ensure no monitoring polygons overlap. Finally, the merged monitoring polygons will be clipped to the Chugach National Forest ownership layer.

While much of the forest's infrastructure has been mapped and documented in geospatial data, there are some important areas of human use that are not accurately mapped or documented. To account for these features and ensure they are included in the network of monitoring polygons, an ArcGIS Online application will be developed to solicit input from forest resource specialists and allow them to identify issues in the GIS derived monitoring polygons. This application allows specialists to place points, leave notes, or digitize features where the monitoring polygons are inaccurate, misplaced, or missing. The specialist input will be taken from the ArcGIS Online application and used to guide any necessary updates or additions to the monitoring polygons.

Once completed, the initial network of monitoring polygons should remain as consistent as possible throughout the life of the 2020 plan. Maintaining spatial consistency in the monitoring polygons between analysis periods is essential for making meaningful comparisons. However, the footprint of human use on the forest will inevitably change over the life of the plan, and the polygon network must be capable of modification to reflect these changes. Ecology program staff will review the polygon network annually and propose changes or additions to the monitoring polygon network. New monitoring polygons can be added at any time during the life of the plan and will be given a new unique identifier. For example, when

a new cabin is built, a new monitoring polygon should be established at the end of the year. Modifications that alter the location or area of a monitoring polygon should be made annually to monitoring polygons that have not yet been sampled during the analysis period. If a monitoring polygon has been sampled, any modifications should be held until the following analysis period. For example, if a trailhead parking area is expanded by 2 acres during the third year of the five-year analysis period, after initial sampling was completed, the monitoring polygon should not be updated until the end of the analysis period. Any modifications should be noted during subsequent sampling events but should not be added until the current analysis period is complete.

Sampling Frequency

Monitoring polygons will be assigned a visitation interval based on the likelihood that focal invasive species will occur within the polygon. The likelihood of infestation within a given monitoring polygon will be evaluated by considering the presence of focal species, current management activities, feasibility of access, and local propagule pressure. Based on this evaluation, monitoring polygons can be assigned to one of the three following visitation intervals:

- Annually: Monitoring polygons that will be visited annually include those with existing populations of focal invasive species, which are prioritized for management. This will also include areas with high potential propagule pressure, for example a highway segment next to a known focal species infestation, and those areas that are easily accessible during the ecology staff's existing program of work, such as the administrative offices and ranger stations.
- 2 to 5 Years: Monitoring polygons that will be visited on a 2 to 5 years cycle will not include known populations of focal species but will have a moderate likelihood of focal species introduction. Most monitoring polygons will fall into this visitation interval. Examples of monitoring polygon types on a 2 to 5 years visitation interval include, road accessible trails, campgrounds, mineral material sites, and Forest Service roads or parking areas. The objective will be to visit at least 75 percent of these monitoring polygons twice during the life of the plan.
- 5 to 10 Years: Monitoring polygons that will be visited on a 5 to 10 years cycle have the lowest likelihood of focal species being present. These monitoring polygons receive limited human use and occur in remote or difficult to access areas. Examples of monitoring polygons in the 5 to 10 years visitation interval include segments of powerline in remote areas without easy access from a road, or remote cabins or campsites in Prince William Sound. The objective will be to visit at least 10 percent of these low priority monitoring polygons twice during the life of the plan.

The assigned visitation interval is a recommendation to assist managers in organizing and prioritizing field work. Visitation frequency can be updated at any time over the life of the plan to account for changes in priorities or new infestations that are identified. Ecology staff should use the visitation interval classifications to organize and stagger sampling efforts such that their annual workload remains relatively consistent over the life of the plan. Structuring sampling efforts in this way, to be continuous rather than periodic, will improve consistency and ensure monitoring integrates more seamlessly into the ecology staff's existing program of work.

Data Collection

Field data collection within the monitoring polygon network will be completed primarily by the forest's ecology program. All field staff will receive training on the identification of the four focal invasive species as well as techniques for the ocular estimation of plant cover. Field data will be collected using a project specific data form developed in the ArcGIS Field Maps application. The development of this form is discussed further in the data management section below.

Presence/Absence Data

To determine the presence or absence of focal species within monitoring polygons, field staff will perform a survey of the entire monitoring polygon. Surveys will be conducted on foot, by bike, or from a slow-moving vehicle (traveling less than 15 mph). The intensity and duration of this survey may vary based on the size and location of the polygons, and will be documented by indicating survey type (see technical guidance at the end of this chapter). This protocol is being tested and will be updated in future versions of the monitoring guide based on results from field sampling and analyses.

Data on the presence of focal species may also be obtained from reliable outside sources. Partnering nonprofit groups and citizen scientists working on invasive species management on the forest collect annual data on the presence of focal species that can be incorporated into the presence/absence dataset used to track the distribution of focal species on the forest. The Alaska Center for Conservation Science compiles annual geospatial data on invasive species from various regional stakeholders and publishes it to the Alaska Exotic Plant Information Clearinghouse. This online database can be queried every five years and relevant data from the current analysis period may also be incorporated into the presence/absence dataset.

Cover Data

The percentage cover of focal species will only be determined for monitoring polygons that are currently infested and being treated. There are two methods used to determine the percentage cover of focal species depending on the treatment method being employed. For chemical treatments, the area treated within a monitoring polygon will be calculated using the volume of mixed herbicide applied from a calibrated sprayer. The calculated area treated will then be divided by the total area of the monitoring polygon to obtain the percentage cover of the treated focal species within the monitoring polygon. For manual or mechanical treatments, the determination of percentage of cover is done through ocular estimation. Field staff will use ESRI's ArcGIS Field Maps application to map the outer extent of the treated infestation within the monitoring polygon and will estimate the percentage cover of the focal species within this mapped area. The estimated percentage of cover will then be multiplied by the total mapped area to find the treated area. The calculated area treated will then be divided by the total area of the monitoring polygon to obtain the percentage cover of the treated focal species within the monitoring polygon.

Data Analysis

The objective of this analysis is to evaluate trends in the distribution and abundance of focal invasive plants on the Chugach National Forest. To develop the dataset for this analysis, all monitoring polygons with at least two sampling events over the five-year analysis period will be identified, and the first and last sampling events will serve as paired sequential samples in the analysis. This dataset will be used to estimate trends in the average number, sum cover, average cover, proportion, and percent dissimilarity of focal species forestwide, 4th level hydrologic unit code, and by geographic area.

The statistical difference between years in average number, sum cover, and average cover of focal species will be estimated using paired t-tests (Steele and Torrie 1960). For the proportion of samples, the McNemar's test will be used (Elzinga et al. 1998). Results considered to be "statistically significant" will be those where the calculated P value for an increase in number, cover, or proportion is less than 0.20. For percentage dissimilarity, a Sorensen distance (Beals 1984) greater than 0.20 will be considered "significant."

Data Management Plan

Data management will be a partnership between the Chugach National Forest's ecology and geospatial information services program areas. Monitoring polygons will be housed on the ArcGIS Online platform in a feature layer within the Chugach Land Management Plan Monitoring Program Hub. The geospatial information services program will assist ecology staff in making additions or updates to the monitoring polygons as needed. Each monitoring polygon will have a unique identifier automatically generated. All edits will be made to the feature layer in the ArcGIS Pro desktop application. Field data on presence and abundance of the focal species will be collected using a standardized form developed within the ArcGIS Field Maps application. The field data will contain both geospatial data on the location it was collected as well as attribute data on the species, percentage of cover, and treatment efforts. Field records will relate back to the monitoring features layer with a unique identifier. This would be a "one to many" relationship, so one monitoring polygon feature could relate back to multiple field records. These data will be uploaded from the mobile data collection device to the ArcGIS Online platform and stored in a feature layer housed on the Chugach Land Management Plan Monitoring Program Hub, where the data can be utilized in maps and web applications. The feature layer will be edited, and quality controlled in ArcGIS Pro. Data will be transferred annually from the feature layer into the Threatened, Endangered and Sensitive Plants – Invasive Species national database housed in the Forest Service Natural Resource Manager database system. Analysis for the monitoring plan will use the data stored in the feature layer and will be accessed and analyzed using ArcGIS Pro. Statistical analysis of the tabular data exported from the feature layer's attribute table will be conducted using Excel or R software. All tabular data and reports developed during the analysis periods will be stored on the shared Pinyon folder 2900Invasive_Species\Forest_Plan_Monitoring. All data will also be shared with the Alaska Exotic Plants Information Clearinghouse (the statewide invasive species portal).

Reporting Intervals

Data will be reported annually within the ArcGIS Online Hub and Threatened, Endangered and Sensitive Plants – Invasive Species database, as discussed in the data management plan. These data will be reported as part of the ecology program's normal survey and treatment operations. A status report identifying the monitoring polygons visited each year in addition to presence/absence data can be supplied to the inventory and monitoring coordinator on a yearly or biennial schedule. Data will be summarized and analyzed on a five-year rotation and supplied to the inventory and monitoring coordinator. The five year reports will consist of trend analysis across all polygons visited for both presence/absence as well as change in cover.

Estimated Annual Cost

Annual monitoring will occur under the ecology programs standard program of work for terrestrial invasive plant management. Some years may take additional technician level or volunteer work to visit and survey large or high numbers of polygons. Data entry, summaries, and analysis staff commitments will vary from year to year. Two GS-9 ecologists and two to six technicians will complete groundwork for

approximately 45 days per year. Data entry will likely take an additional 5 to 10 days for each of those positions. Biennial reporting will take 2 to 3 days for two GS-9 ecologists and one GS-12 ecologist. The five-year analysis will likely take two GS-9 ecologist positions and one GS-12 ecologist position 10 days every five years.

Groundwork will require other logistics that are accounted for in the standard program of work including vehicles, boats, and aircrafts, as well as travel time.

Indicators: Trend in geographic range and number of waterbodies infested with *Elodea* species

Methods and Metrics

The trends in geographic range and the number of waterbodies infested with *Elodea* species will be monitored by annual surveys in selected lakes and ponds that are determined to be vulnerable to *Elodea* infestation due to a variety of factors. The frequency with which all waterbodies will be surveyed will depend on funding availability and risk level for introduction. Surveys will be conducted using protocols currently under development by the Alaska Center for Conservation Science.

Waterbody Prioritization

Elodea is the first aquatic invasive plant known to occur in Alaska. It was introduced into Eyak Lake near Cordova sometime before 1982 and has since spread to multiple waterbodies across the Copper River Delta via boats, floatplanes, and natural flooding events. *Elodea* is also known to occur in several waterbodies across the state, from Fairbanks to the Kenai Peninsula. In many of these areas, this aquatic invasive plant is being actively treated or has been successfully eradicated.

The Chugach National Forest contains over 11,000 waterbodies; however, most of these waterbodies are too remote, too small for floatplane landings, or otherwise unsuitable for *Elodea* introductions. Chugach staff developed a waterbody prioritization tool that weighs several vectors (likely modes of *Elodea* spread) and habitat suitability, similar to other prioritization tools developed by other state, federal, and tribal agencies in Alaska (Trammell et al. 2016). However, the Chugach waterbody prioritization tool also includes the ability for resource specialists to provide additional input about waterbody usage to ensure that all waterbodies vulnerable to infestation are adequately prioritized.

Using the waterbody prioritization tool, the initial Chugach waterbody layer was reduced from over 11,000 waterbodies to approximately 3,000 by eliminating all waterbodies that are 1) not within a 3-mile buffer of all roads or trails, and 2) are not large enough to safely land on with a floatplane. Lake dimensions used to determine floatplane accessibility were taken from the description of waterweed (*Elodea*) invasion vulnerability in the Central Yukon Rapid Ecoregional Assessment (Trammell et al. 2016). Specialists reviewed this first cut of 3,000 waterbodies to ensure that any known waterbody that receives use via other access, such as user created trail or road, was not excluded.

To prioritize the approximately 3,000 remaining waterbodies, factors that would increase vulnerability to *Elodea* introduction were weighted to create a prioritization matrix and additional specialist input was solicited to rank waterbodies by “high”, “medium”, or “low” recreational use. Because recreational usage is somewhat subjective, reviewers were advised to consider fishing access, waterfowl hunting, big game hunting access, boating, and other uses. Usage was ranked relative to usage of other waterbodies on the Chugach. For example, Trail Lake with its ease of access along a state highway and floatplane hub would rank as “high” recreational use. Trout Lake is more remote but is still accessed by floatplanes and has a

public use cabin would rank as “medium” recreational use. Unnamed lakes not connected to the trail or road system that are not typically accessed for recreation would rank “low” recreational use. These values were then given a numerical weight and averaged with other waterbody vulnerability factors (table 8).

Table 8. Waterbody vulnerability factors and their weights used for *Elodea* monitoring prioritization

Waterbody Vulnerability Factor	Weight Potential
Aquatic plants present (no/yes)	0,1
Floatplane accessible (no/yes)	0,1
Floatplane landing frequency* (none, 1-5, 6-30, 31+)	0,1,2,3
Floatplanes originating from a waterbody infested with *Elodea** (no/yes)	0,1
Boat ramp presence (no/yes)	0,1
Road access (no/yes)	0,1
Trail access (no/yes)	0,1
Recreational usage (unknown/low/medium/high)	0,1,2,3

Floatplane data (Schwoerer 2020)

A significant vulnerability factor included in this prioritization exercise is habitat suitability for *Elodea* species, however not enough information is known for most waterbodies. As surveys are conducted, waterbodies that rank high due to the vulnerability factors listed in table 8 may be found to be unsuitable for *Elodea* establishment due to water turbidity and depth, as evidenced by a lack of aquatic vegetation anywhere in the waterbody. These waterbodies will be dropped from the monitoring list, as new waterbodies may be added based on new information about usage or new infestations arise.

Sampling Frequency

Waterbodies will be assigned a prioritization rank based on the likelihood of *Elodea* establishment. Ideally the highest ranked waterbodies would be sampled most frequently, but it is also important to include waterbodies that might not rank as high but still have at least one vulnerability factor. These lower ranked waterbodies would be sampled less frequently. Currently, the factors outlined in table 8 will provide numerical prioritization rankings using weighted averages. They should be assigned to one of the three following rank categories:

- High: Waterbodies that rank as having a high likelihood of introduction. These waterbodies receive frequent floatplane usage and/or have high recreational value, with habitat suitable for *Elodea* establishment.
- Moderate: Waterbodies have a moderate likelihood of *Elodea* establishment and will be in the top 30 in the vulnerability ranking. These waterbodies would have several vulnerability factors including floatplane use and/or moderate recreational usage.
- Low: Waterbodies that have a lower likelihood of *Elodea* establishment but would have at least one vulnerability factor such as trail or road access. These waterbodies receive limited human use and occur in remote or more difficult to access areas and would rank in the top 50 using the vulnerability ranking. It is likely unknown if suitable habitat for *Elodea* establishment exists in many of these waterbodies.

The sampling frequency with regards to prioritization rank is a recommendation to assist managers in organizing and prioritizing field work (table 9). Including some waterbodies that rank in the moderate to low categories is recommended to increase our knowledge of these waterbodies (habitat suitability and other factors), which may increase their ranking over time. Prioritization ranks should be updated regularly to account for new information such as habitat suitability or new infestations that are identified. Ecology staff should use the rank categories to organize and stagger sampling efforts such that their annual workload remains relatively consistent over the life of the plan. Structuring sampling efforts in this way, to be continuous rather than periodic, will improve consistency and ensure monitoring integrates more seamlessly into the ecology staff's existing program of work.

Table 9. Proposed sampling frequency using waterbody vulnerability rank categories

Prioritization Rank	Number of Waterbodies Sampled Per Year*	Total Sampled over the Planning Period*
High	5–10	75–150
Moderate	4–6	45–90
Low	1–4	15–60
Total sampled	10–20	135–300

* Based on 20 survey days per field season, these ranges allow for variability in waterbody size, budget, and program capacity.

Data Collection

Waterbody sampling will follow the Methodology for *Elodea* Detection in Alaska Lakes (Fulkerson, in process). Sample points will be predetermined in prioritized waterbodies. Sampling is a combination of visual inspection and systematically selected rake throw locations with overlapping observers to maximize *Elodea* detection potential.

Below are relevant excerpts from the draft methods (Fulkerson, in process) that will continue to be refined during the 2022 field season.

Sample Point Selection

Determining sampling points before field work commences lowers sampling bias, increases efficiency, and meets some statistical requirements for our study. The number of sample points per lake is still under investigation but we established reasonable constraints to the ability of a crew of three to sample one entire lake in one day or less and balanced with detection sensitivity. A field day included approximately 10 hours, with 1.5 hours spent on set-up and break-down of field gear (transporting gear to the lake and inflating and deflating boats), clean-up (decontaminating all equipment), and eDNA sample processing. Some examples of effort for lakes employing three observers are: Jewel Lake requires 3.5 hours, Birch Lake requires about 7 hours, and Silver Lake requires 9 hours. Lakes with a greater than 20 kilometers perimeter require up to three days to complete.

Sampling points were spaced at a minimum of 50 meters so that rake tosses and visual observations would not overlap and independence among sites was maintained. For the smallest lakes (<3 kilometers perimeter), we could sample all points using two or three observers in one day, therefore sampling 100 percent of the sites. However, the 50 meters sampling distance is significantly time intensive for larger lakes, so we adopted a minimum sampling requirement of at least 33 percent of all 50 meters sampling points. Therefore, the larger lakes sampling points were spaced at 100- to 150-m intervals around the lakeshore, which equated to 50 or 33 percent of the 50-m points, respectively. We used the Alaska Hydrography Database of lakes as the base for sample point generation. Using a customized toolbox

(*Elodea* Stations) for ArcMap, a sample site was randomly selected on the perimeter, then additional points were added based on the desired distance. The toolbox for ArcMap Pro is available from Alaska Center for Conservation Science upon request. The GPS latitude and longitude coordinates can then be exported to a GPS unit for field navigation.

Multiple Observers

Non-detection of *Elodea* at a lake could imply that the species does not occur at that lake or the species was not detected by the observer(s). Detection/non-detection surveys by multiple observers at the same sample point can be used to estimate species occupancy while accounting for imperfect detectability of species (MacKenzie et al. 2002, Tyer et al. 2003). For this method, multiple observers independently sample the same sample point in the same day but lagged by a time interval (for example, 15 minutes). From our study, when *Elodea* was sparse, it was detected by one but not all of the multiple observers sampling the same site independently. Even in heavily infested or long-term infested lakes, such as Eyak Lake in Cordova, detection rates of *Elodea* were still imperfect. Hence, using multiple observers increases the likelihood of detecting *Elodea*.

Experience level among observers was not related to detection probability. Overall a single observer can be used to sample a site, but using multiple observers increases the probability of detection. After sample point generation, observers will need coordinate visiting sample sites so that each site is sampled multiple times. At this time, we suggest three people sample one lake, where each observer samples about two-thirds of the sites, so that every sample site is visited by two observers and each site is sampled twice. Three observations at a single site can improve the detection probability but requires significantly more resources (time and personnel). With three observers surveying a lake, each observer samples about two-thirds of the sample sites, so that every sample site is visited by two observers. Each observer uses an independent GPS unit to navigate to the site to perform the sampling, then an additional observer samples the site a short time later, typically within 30 minutes to maintain sampling under the same environmental conditions.

Rake Sampling

Sampling with a rake toss allows for a rapid sampling over a large area at a low cost (Johnson and Newman 2011). A sampling rake consists of two garden rake heads welded together and attached to a 10-meter rope. Rake samples were completed at each sampling point within the littoral zone where an observer tosses a rake as far as possible and retrieves the rake, allowing it to scrape and sample the submerged vegetation. Generally, the littoral zone is close to shore, less than 4.5 meters deep where sunlight can reach the lake bottom, and where plants can grow. The littoral zone is related to the slope of lake bed and varies in size from nonexistent in cliff drop areas to very wide, and can span acres in shallow lakes.

While sampling is preferably done from shore, sampling from a boat may be necessary in some situations (see “Rake Obstacles” section). Tossing the rake from a boat can be problematic because the boat is not fixed in position and during rake retrieval the observer pulls the boat toward the rake, limiting the amount of lake bottom sampled. One solution is to have two observers throw the rake in opposite directions and retrieve the rakes in sync to stabilize the boat in place. An alternative is to throw the rakes from the shore line within the littoral zone toward the middle of the lake. We have observed broken floating vegetation (including *Elodea*) and vegetation introduced by floatplanes to be driven to the shoreline by wave action or wind. Therefore, our reasoning is that the likelihood of establishment is highest within the rake sampling reach from shoreline in the littoral zone.

Observers navigate to the designated sample point and toss a rake from shoreline or while wading at about 0.5 meter depth, or to their personal comfort level. This always ensured the littoral zone was sampled.

Due to inaccuracies in the location of lake perimeters, sample points generated from geospatial data may be located in the water instead of on the lake shore. Rarely is it more than 20 meters from the shore. In these situations after reaching the sample point, observers sampled a new point that was orthogonal to the shore. At the sample point, the rake is thrown three times in different directions within the littoral zone. Vegetation brought to the surface is inspected for *Elodea*. At each sample point, the observer marked their GPS location to designate the actual sample point.

Rake Obstacles

There are situations where sampling from shoreline is impossible because of obstacles. For example, excessive shrub growth may prevent observers from reaching the lake shore, the lake shore has no public access, the shoreline is unsafe due to floating mats of vegetation, or there are steep drop offs from rocky shorelines. Other situations that impeded throwing rakes were snag hazards, such as high cover of submerged boulders or trees that prevented dragging the rake on the lake bottom. Lastly, sample points coincident with salmon spawning areas were either skipped or visually assessed to minimize disturbance of this habitat.

Our method for relocating obstructed sample points is to move within 10 meters to the left (counterclockwise when facing the water) of the original sample point if there was safe access. A primary decision of counterclockwise is chosen before the day begins so all observers make the same decision. If sampling to the left is still not accessible, then sampling to the right (clockwise) is used as the next option. If a sample location within 10 meters of the original sample point still cannot be accessed, then the last option is to drop the rake over the side of the boat, approximately 5 meters from shore orthogonal to the sample point and drag the rake for approximately one meter. The rakes were dropped three times within the 10 meters^2 grid, and these were noted as a “drop” sampling effort. Aquatic vegetation is still captured (where present) and adoption of this alternate sample method did not affect our probability to detect *Elodea* in moderately infested areas.

If downed trees impeded the throw of the rakes, we threw as many of the three rake directions as possible but accepted that some sites would only have one or two rake throws. If downed trees inhibited rake throws completely, then using the drop sampling effort was used. The observer used their best professional judgement to decide whether to use the drop method or reduce rake throws.

Strategic Search and Visual Observation

Visual observation includes searching for *Elodea* over the side of the boat at specified locations at sample points, and between sample points. We included a meandering search at strategically selected locations along the lakeshore using best professional judgement and including, but not limited to, access points, boat launches, floatplane docks, private property, and the leeward side of each lake. It is assumed these areas would have the highest probability of harboring incipient *Elodea* populations because they are vector points or collection sites from wind-blown fragments. The search method involved boating slowly, at a speed of less than 3 knots, around the areas while viewing over the side of the boat to inspect vegetation. Polarized sunglasses are essential for visual search. Drop or full rake tosses were used to inspect suspicious vegetation or areas.

Additionally, visual observation occurred between sample sites and within the sample site where the rakes are thrown. Visual observations should occur before rakes are thrown at the sample site. Rakes dragging on the lake bottom can stir up substrate and reduce visibility. Visual observation (exception below) had mixed success in detecting *Elodea*. At this time, we acknowledge that visual observation can provide valuable information, but should not replace the rake method in most circumstances.

Lakes that had high water clarity allowed the characterization of the substrate and identification of submerged aquatic plants. We replaced rake throws with visual observation when the substrate was identifiable, vegetation estimation was less than 25percent vegetation cover, and all vegetation could be identified to genus level (*Elodea* not visible).

Elodea Documentation

When *Elodea* was found, the infestation was mapped using GPS waypoints. We also estimated abundance of cover and total infestation area. Canopy cover of the 10 meters^2 grid was estimated by rake tine fullness in cover categories (0 percent, <25 percent, 26–50 percent, 51–75 percent, >75 percent) and averaged over the rake throws. Total infested area either equaled the survey area or was estimated when *Elodea* was not found on all three rake tosses. The average rake survey area was a half-circle covering approximately 6.07 meters^2 (0.014 acres).

Data Analysis

Because aquatic vegetation is difficult to sample over an entire waterbody, and *Elodea* distribution within a given waterbody can vary annually, it is not effective to monitor trends in *Elodea* distribution within infested waterbodies. While data collected using the sampling point protocol will provide some information on *Elodea* distribution, the primary data used to analyze for trends of *Elodea* expansion is simply presence or absence within the sampled waterbodies.

Trends in the geographic range of *Elodea* on the Chugach will be determined on an annual basis by compiling *Elodea* presence/absence data for all sampled waterbodies by geographic area. Currently, *Elodea* is only known to occur on the Copper River Delta; if the plant is found to be present in Prince William Sound or on the Kenai Peninsula, that may indicate an expansion of *Elodea's* geographic range in the plan area. However, if *Elodea* is detected in a waterbody not previously surveyed outside of the Copper River Delta, it may be an older introduction.

Trends in the number of waterbodies infested with *Elodea* will be determined by compiling newly collected presence/absence data from waterbodies and comparing to existing known *Elodea* presence/absence distributions on the Chugach. If *Elodea* is found in waterbodies previously determined to not have the plant, that is an indicator of *Elodea* expansion into new waterbodies. If *Elodea* is detected in a waterbody not previously surveyed, it will increase the number of known waterbodies but may not indicate that *Elodea* has been recently introduced.

Data Management Plan

Data management will be a partnership between Chugach National Forest ecology and GIS program areas. Monitoring waterbodies will be housed on the ArcGIS Online platform in a feature layer within the Chugach Land Management Plan Monitoring Program Hub. The GIS program will assist ecology staff in making additions or updates to the monitoring waterbodies as needed. Each waterbody will have a unique identifier automatically generated. All edits will be made to the feature layer in the ArcGIS Pro desktop application. Field data on presence or absence of *Elodea* will be collected using a standardized form

developed within ESRI's ArcGIS Field Maps application. The field data will contain both geospatial data on the location it was collected as well as attribute data. Field records will relate back to the monitoring features layer with a unique identifier. This would be a "one to many" relationship, where one monitoring feature could relate back to multiple field records. These data will be uploaded from the mobile data collection device to the ArcGIS Online platform and stored in a feature layer housed on the Chugach Land Management Plan Monitoring Program Hub, where the data can be used in maps and web applications. The feature layer will be edited and undergo quality control in ArcGIS Pro. Data will be transferred annually from the feature layer into the Forest Service national Threatened, Endangered and Sensitive Plants – Invasive Species (TESP/IS) database housed in the Natural Resource Manager system. Analysis for the monitoring plan will utilize the data stored in the feature layer and will be accessed and analyzed using ArcGIS Pro. All tabular data and reports developed during the analysis periods will be stored on the shared Pinyon Folder 2900Invasive_Species\Forest_Plan_Monitoring. Any new infestations of *Elodea* discovered during this monitoring effort will also be shared with the Alaska Exotic Plants Information Clearinghouse.

Reporting Intervals

Data will be reported annually within the ArcGIS Online hub and TESP/IS as discussed in the data management plan. These data will be reported as part of the ecology program's normal survey and treatment operations. A status report identifying the waterbodies visited each year in addition to presence/absence data can be supplied to the inventory and monitoring coordinator on a yearly or biennial schedule. Data will be summarized and analyzed on a five-year rotation and supplied to the inventory and monitoring coordinator. The five-year reports will consist of trend analysis across all waterbodies visited for presence/absence.

Estimated Annual Cost

Annual monitoring will occur under the ecology program's standard program of work for terrestrial invasive plant management. Some years may take additional technician or volunteer work to visit and survey large or high numbers of waterbodies. Staff time commitments for data entry, summaries, and analysis will vary from year to year. Two GS-9 ecologists and two to six technicians will complete groundwork for approximately 20 days per year. Data entry will likely take an additional 3 to 5 days for each of those positions. Biennial reporting will take 2 to 3 days for two GS-9 ecologists and one GS-12 ecologist. The five-year analysis will likely take two GS-9 ecologists and one GS-12 ecologist 5 days every 5 years.

Groundwork will require other logistics that are accounted for in the standard program of work including vehicles, boats, and aircrafts, as well as travel time.

Technical Guidance for Chapter 2

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 2, click here.

Chapter 3 Riparian, Wetland, and Aquatic Ecosystems

Overview

Functioning, intact aquatic ecosystems provide key habitats for native fish, invertebrates, wildlife, and plant species that serve a wide range of needs to forest communities as well as creating resilient, responsive ecosystems and sources of fresh water. One of the most important attributes of aquatic ecosystems is hydrologic connectivity through the riparian and wetland habitats to streams and rivers. Riparian and wetland aquatic habitats' connectivity contribute to the proper function of the Chugach National Forest's watersheds, supporting diverse populations of plants and animals capable of rapid recovery from natural and human disturbances. Properly functioning watersheds provide many important ecosystem services and affect nearly every other natural resource, land access, forest infrastructure, and commercial and recreational interests across the forested landscapes.

Aquatic ecosystem connectivity through the removal or modification of barriers that restrict or impede movement of aquatic organisms is a Forest Service priority for the Chugach National Forest, the Alaska Region, and the Forest Service nationwide. The success of the Chugach National Forest's aquatic organism passage program removing or modifying barriers is specifically identified as a regional and forest management priority, and additionally meets land management plan directives and national policy guidance. There are approximately 100 miles of National Forest System roads on Chugach National Forest managed lands, with approximately 140 Forest Service managed roads within or adjacent to forest lands under other ownership that will be updated and verified as part of this effort. These roads can have crossing structures that act as aquatic organism passage barriers to watersheds within the forest, reducing the ecological function and resilience of these watersheds.

Chugach National Forest staff selected aquatic organism passage barriers as indicators of hydrologic connectivity and aquatic ecosystem function to address the question of whether forest management is maintaining or improving aquatic habitat connectivity. In a combined effort, the forest engineering, aquatics, and geospatial information services programs are compiling a complete, systematic inventory of all road-stream crossings across the national forest. This aquatic organism passage work will identify, prioritize, implement, and monitor road-stream crossing replacements to meet the 2020 Chugach National Forest Land Management Plan goals (USDA Forest Service 2020).

Priority Management Questions, Associated Indicators, and Monitoring Methods

Monitoring for functioning, connected riparian and wetland aquatic habitats addresses three of the forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the "Watersheds and Aquatic Ecosystems" section of the plan (and correspond to 2020 plan component identification code FW-GL3-WAE-DC):

- Watershed services provided by lakes, ponds, rivers, streams, riparian areas, and wetlands sustain healthy populations of native fish and other aquatic organisms. Abiotic factors, including flow characteristics, channel shape and function, stream length, stream gradient, water turbidity, spawning gravels, and large wood, remain in a functional natural state, providing resilience to climate change and supporting native fish and aquatic organisms.

- Water follows natural flow paths and hydrologic connectivity is maintained. Roads, ditches, and trails do not disrupt hydrologic connectivity and do not act as an extension of the stream network.
- Perennial flowing streams and associated lakes support a community of native macroinvertebrates indicative of high aquatic ecosystem integrity.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored using a relevant question, associated indicators, and measures to show trends in condition related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor ecological conditions of riparian and wetland aquatic habitats.

Are management activities maintaining or improving aquatic habitat connectivity?

This monitoring question will help managers identify if plan components, such as standards and guidelines, are adequate in meeting plan desired conditions. For example, if it is determined that we are unable to eliminate barriers to hydrologic connectivity or aquatic species functions, there may be a need to revisit the plan to determine more effective ways to promote aquatic organism passage and connectivity. To address the monitoring question, Chugach National Forest staff selected one indicator, the percentage of aquatic organism passage barriers improved or restored, to determine trends in conditions for riparian and wetland aquatic habitats. Table 10 lists the indicator, measure, reporting frequency, analysis frequency, responsible program areas, and staff time required to monitor riparian and wetland aquatic habitats for hydrologic connectivity and aquatic ecosystem function to monitoring question.

Table 10.Indicator, measures, sampling and reporting frequency, and responsible program area for monitoring riparian and wetland aquatic habitats on Chugach National Forest

Indicator	Measure	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Percentage of human-associated aquatic organism passage barriers improved or restored	Counts of passage barriers	Biennially	Every 5 years, conduct a complete program analysis	Aquatics, engineering, and geospatial information services	Aquatics: 11 days per year Engineering: 5 to 10 days per year with geospatial and aquatics staff Geospatial information services: 10 days per year

Negative trends in this indicator will require re-evaluation of plan components associated with the monitoring protocols and methods to address negative trends related to removal, repair, or replacement of the human-associated aquatic organism barriers on the forest. Aquatic organism passage structures may require re-design, implementation, and reprioritization of alternatives to work towards solutions, including changes in plan components, which will lead to meeting desired conditions.

Indicator: Percentage of Human-associated Aquatic Organism Barriers Removed or Restored

The condition and status of all aquatic organism passages along the nearly 100 miles of National Forest System roads on the Chugach are currently being inventoried, with completion of this initial work expected in 2022. Based on results from the road-stream crossings inventory, a list of aquatic organism passage sites will be developed for removal, restoration, or replacement. These sites will be prioritized based on 1) safety conditions; 2) presence of anadromous fish species; and 3) the associated watershed condition priority ranking.

Methods and Metrics

The Chugach National Forest adopted an integrated approach for monitoring ecological function of aquatic and riparian systems using the number of mitigated stream crossing structures, specifically those that are aquatic organism passage barriers. Three program areas—engineering, geospatial information services, and aquatics—are involved in the approach. This integrated monitoring approach is designed to meet three integrated goals: (1) develop inventory of existing structural barriers within the plan area (to be completed in 2022); (2) provide status and condition data for stream crossings in a managed database; and (3) prioritize, track and report removal, restoration or replacement of structures that are aquatic organism passage barriers on the forest (table 11).

The monitoring effort will have tasks and protocols for each of these goals (see table 11 summary) that will allow staff to annually update status and develop biennial monitoring and five-year evaluation reports that describe the number of structures that are known passage barriers and the number of removed, restored, or replaced barriers and the success or failure to meet hydrologic connectivity. Field sampling and reporting protocols are described in detail for each program area and phase of the work from technical guides for engineering, geospatial information services, and aquatics (see technical guidance at the end of this chapter).

Development of the work plans to address the three established goals began during the summer of 2020. The geospatial information staff began gathering data from forest program areas and partners for the known number of crossing structures and their condition on the forest. This effort consisted of compiling, organizing, verifying, and assessing culvert inventory and aquatic organism passage survey data into one geodatabase (Ress 2022). This work continued on the forest in 2021 and completion is expected in 2022. These datasets will serve as the baseline of information that will be updated and appended over the life of the plan.

Table 11. Responsible program areas, tasks, and goals for the Chugach National Forest aquatic organism passage program

Goals	Engineering	Geospatial Information Services	Aquatics
Develop inventory of existing structural barriers (to be finalized in 2022)	Provide existing information to geospatial information staff for initial inventory. Provide structural survey protocol and content for integrated status and condition surveys. Work with other program areas to integrate data management and aquatics passage criteria.	Compile existing geospatial crossing condition datasets for existing passage and fish distribution.	Provide existing information to geospatial information staff for initial inventory. Provide aquatics passage protocol and content for integrated surveys.
Provide status and condition data (2021–2022)	Conduct integrated field crossing status and condition surveys. Provide survey data to integrated geospatial database.	Work with specialists to develop, manage, and adjust integrated tools for inventory tracking, data collection, sharing, and reporting;	Conduct integrated field crossing status and condition surveys. Provide survey data to integrated geospatial database.
Prioritize, track, and report progress of the removal, restoration, or replacement of structures (annual update, biennial report, 5-year evaluation)	Evaluate and score priority list of crossings for remediation. Work with Chugach staff and partners to complete remediation at agreed upon schedule.	Collaborate with the data stewards of internal and external partners to update the Chugach aquatic organism passage datasets.	Evaluate and score priority list of crossings for remediation. Work with forest and partners to complete remediation at agreed upon schedule. Provide biennial reports and a program review every 5 years for the life of the plan.

Goal 1. Develop Inventory of Structural Barriers (Year 2022)

This section describes the activities and estimated staff time necessary for the development of the inventory of structural barriers across the forest for each program area for initial geodatabase that will be finalized in 2022. All three program areas have a continuing role in conducting field surveys for site condition and status based on this foundational work.

Engineering

Initial inventory protocol development includes planning, staff training, coordination with geospatial and aquatics staff, development and revision of survey protocols, data entry, management, and technical trouble shooting. The engineering and aquatics programs conduct the road condition surveys on forest roads to determine the total number of passage and potential barriers using Engineering Road Condition Survey Protocols (Kapotak 2022) (see technical guidance at the end of this chapter) and data entry using the Electronic Road Log program (USDA Forest Service 2010). The field survey time is estimated to take 60 days. Protocol development and technical writing for the 2020 plan monitoring program is estimated to take 20 days.

Geospatial Information Services

This initial effort requires coordination with external and internal resource staff to develop the first baseline of crossing information within the plan area. This also includes development of the draft geodatabases and online applications, training time for forest staff, and review and revision of tools with specialist suggestions. Total time estimated for this effort is 35 days specialist time. Monitoring program coordination and tool development: 8 days in years 2021–2022. Description of the workflows and technical guidance are provided by GIS specialists (C. Ress 2022) (see technical guidance at the end of this chapter) and updated to include changes prior to each biennial monitoring and evaluation report (beginning 2022 and continuing every other year following).

Aquatics

Initial effort was needed for coordinating with geospatial staff on the inventory, review, and development of the aquatic organism passage field survey protocols with engineering staff. Additionally, time was needed to coordinate with inventory and monitoring program manager and write and review the protocols (2021–2022). Total time estimated for this effort is five days specialist time. Monitoring program coordination; two days each in years 2021 and 2022.

All program areas have a continuing role in conducting field surveys for site condition and status based on the work begun in 2021. Aquatics field staff will follow steps outlined for tablet field data collection and archive, using the field survey form developed jointly with the Tongass National Forest and Chugach National Forest aquatics staff (Ress and Britton 2022) (see technical guidance at the end of this chapter). The engineering and aquatics programs conduct the infrastructure surveys on National Forest System roads to determine the total number of passage and potential barriers using cooperative field teams that verify crossing location and numbers, assess the condition of crossings (with respect to function and safety), and determine if crossing are passage barriers and need repair.

Goal 2. Provide Status and Condition Data in Managed Database (Year 2022)

During year 2022, engineering staff and aquatics staff will complete the forestwide infrastructure surveys, then the database, data management, and reporting framework will be updated and finalized. Staff time and activities are described below for each program area for completing the program framework.

Engineering

The engineering and aquatics programs conduct the infrastructure surveys on forest roads to determine the total number of passage and potential barriers using Engineering Road Condition Survey Protocols (see technical guidance at the end of this chapter) and data entry protocols in the Electronic Road Logger User Guide (USDA Forest Service 2010). Engineering staff will finalize conducting the initial road conditions surveys and entering the data in 2022. Updating information in forest databases, data entry, and training field staff will take approximately 80 days. Land management plan technical review for biennial report, coordination with GIS for the geospatial database integration, and to coordinate that effort with aquatics and inventory and monitoring will take approximately 10 days.

Geospatial Information Services

This effort includes time to provide technical assistance, data stewardship, trouble shooting, and database updates and coordination time with aquatics and engineering (Ress 2022); approximately 28 days. Time for land management plan monitoring includes work to coordinate with inventory and monitoring and also engineering and aquatics for monitoring specific reports and information; approximately 10 days.

Aquatics

Aquatics staff will use the modified field survey protocol established on the Tongass National Forest, and field survey forms developed in conjunction with Tongass staff by the AOP working group (see Ress 2022). This work will require the same level of effort as in year 2021, with the addition of a fisheries technician to evaluate sites to finalize the priority ranking for removal, restoration, or replacement of aquatic organism passages. Monitoring program coordination will take approximately 2 days each in years 2021–2022.

Goal 3. Prioritize, Track, and Report Removal, Restoration, or Replacement of Structures

This section describes the staff time needed for annual updates, biennial reporting, and five-year evaluations at both the program and forest level through the life of the 2020 land management plan in support of the aquatic organism passage program.

Engineering

Annually, engineering staff will require program time to develop crossing structure designs, contracts administration, and management of installation. The time required for installation or removal of structures will vary depending on the contract dollar value, and the size and location of the site. Engineering staff time for plan monitoring and reporting is estimated to be 10 days in conjunction with the geospatial information services and aquatics staff.

Geospatial Information Services

This goal addresses time to provide technical assistance and training for the geospatial database and perform or automate the analyses, approximately five days. Separately, provide time to coordinate with inventory and monitoring, engineering, and aquatics staff for database work and reports specific to monitoring, approximately 10 days.

Aquatics

Aquatics program staff will require 25 days to administer the program-level field surveys (using field data collection and storage steps outlined in Ress and Britton 2022), analyses, and supervision of annual summer hires. It is anticipated that an additional 5 days are needed to collate the data related to meeting monitoring goals and requirements to report to the forest inventory and monitoring coordinator. In addition, and in support of the aquatics program manager preparing the biennial monitoring report, 3 days will be required for the forest hydrologist to review the data and acknowledge the draft report, and 6 days total for the two zone fisheries program managers to evaluate and review the data and acknowledge the draft report.

Data Management Plan

Data management will be a partnership between the forest’s engineering, aquatics, and geospatial program areas. Forest road condition data, including feature data such as culverts, are managed by the engineering program and are annually stored in the Natural Resource Manager database. Roads are evaluated by personnel with appropriate database permissions, downloaded from the database, updated with the Electronic Road Logger application, saved, and uploaded back into the Natural Resource Manager database.

Following the road condition and the culvert condition and status surveys, the crossing structures will be assessed and prioritized for removal, restoration, or replacement. Highest priority is based on public safety needs, regardless of organism passage status. Public safety risk is assessed and described using established engineering design, construction, and maintenance protocols for stream crossings outlined in the National Engineering Handbook (USDA Natural Resource Conservation Service 2007)

After any public safety risk sites are considered, the remaining crossings and passage conditions will be determined to be adequate (green), inadequate (red), or indeterminate (grey). The fisheries and aquatics data will be managed by the aquatic program manager and geospatial specialists in a Chugach geospatial aquatic organism passage barrier database. These data will be reviewed and added to the geospatial database by staff from those program areas with technical assistance from the geospatial information team.

Datasets will be reported in the Natural Resource Manager database using the Watershed Improvement Tracking application, a tool for national information sharing and accomplishment tracking, and will be periodically shared with two Alaska Department of Fish and Game databases: the Fish Passage Inventory Database, Inventory and Assessment; and the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes, and its associated atlas.

Reporting and Analysis Intervals

The Chugach's passage barrier program staff will annually evaluate the aquatic organism passage barriers remediated as a percentage of total and reported annually in the Natural Resource Manager database and in the Chugach geospatial passage barrier database. The biennial monitoring and evaluation report is developed using the number of barriers that are remediated during the reporting period (changing status from unknown or unpassable to passable) divided by the total barriers (full count of stream crossing structures from forest inventory) to yield the percentage of human-associated aquatic organism passage barriers improved or restored. Trends in these data will be evaluated on a five-year increment, based on the total number of barriers remediated annually over that period of time. Progress toward meeting public safety, fisheries habitat improvements, and functional watershed criteria of the 2020 plan will be reported. In a cooperative effort, engineering, aquatics, and geospatial programs will conduct the five-year evaluation to determine overall program effectiveness and any need for program revisions to accomplish the land management plan goals. The five-year joint engineering, aquatics, and geospatial program analyses over the life of the 2020 plan will provide quantitative reports providing status of the monitoring program in relation to plan direction and to see if plan components, such as standards and guidelines, are meeting the 2020 plan desired conditions. Work will be completed to align with Alaska Region and Chugach National Forest priorities' strategies.

Based on the five-year analytical report, the monitoring question, indicators, and methods will be evaluated for effectiveness and condition relative to 2020 plan direction. If the report indicates limited progress in the trend of remediated aquatic organism passage structures, and corrections are not possible within the existing program, recommendations will be provided in the analytical report that may include new engineering technologies and methods to adhere to plan direction. The monitoring direction in this guide may continue as established or be modified to meet the non-performing elements of the program.

Estimated Annual Cost

Land management plan monitoring reports and assessments rely on completion of the aquatics, engineering, and geospatial program level work for the aquatic organism passage program goals as described in table 11. Goals 1 and 2 are scheduled for completion in 2022.

Technical Guidance for Chapter 3

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 3, click here.

Chapter 4 Ecological Conditions for At-Risk Species

Overview

At-risk species include federally recognized threatened, endangered, proposed, and candidate species and species of conservation concern identified for the Chugach National Forest. Desired conditions for the 2020 plan include provisions that ensure ecological conditions necessary for diversity of plant and animal communities and contribute to the recovery, conservation, or maintenance of the viability of at-risk species. Forest Service staff identified two species of conservation concern on the Chugach for which habitat conditions will be monitored: dusky Canada geese (*Branta canadensis occidentalis*) and Aleutian cress (*Aphragmus eschscholtzianus*).

Dusky Canada Geese

Dusky Canada geese are a migratory waterfowl species that nests primarily within the Copper River Delta area and islands within Prince William Sound and Gulf of Alaska (USFWS 2014). Nesting habitat quality on the Copper River Delta has been declining due to hydrologic changes caused by the geologic uplift that occurred during the 1964 earthquake. While the Copper River Delta continues to serve as the primary nesting site for dusky Canada geese, predation of nests, juveniles, and adults has increased due to declining habitat quality with increased woody encroachment on the Copper River Delta. In cooperation with federal, state, and nongovernmental organization partners, the Chugach National Forest has been installing and maintaining artificial nesting structures that increase the availability of quality nesting habitat and improve nesting success. Additionally, the Chugach is testing specific habitat treatments designed to reduce avian predation on nests and juvenile geese. By monitoring numbers of geese nesting on the Copper River Delta, and the nesting success for both natural and artificial nest sites, the effectiveness of ongoing habitat enhancement measures can be evaluated. Changes in the population of nesting geese, or the nesting success rate, would trigger a re-evaluation of the quality and availability of natural and artificial nesting habitat, and may lead to a review of existing management strategies for sustaining this species of conservation concern.

Aleutian Cress

Aleutian cress (*Aphragmus* eschscholtzianus) is a small plant in the mustard family. This plant is distributed across Alaska, the Yukon Territory, British Columbia, and the Russian Far East (Chukchi Peninsula). It occurs in subalpine valleys, wet cliffs, ridges, and on fine gravel saturated by snowmelt. While its geographic distribution is widespread, this species has a habitat that is sensitive to management-related disturbance and recreational use as well as being vulnerable to the dynamic effects of climate change (Hayward 2017), see figure 6-22 in particular). On the Chugach National Forest, Aleutian cress is only known from a single location, on the Kenai Peninsula in the Palmer Creek valley. By monitoring trends in known populations of Aleutian cress, impacts to the population from management activities (for example, special use permits, mineral extraction, communication sites) and recreation can be evaluated. However, the greatest threat to the species may be loss of habitat due to climate warming. Changes in alpine wetlands, brought on by climate-induced reductions in snowpack, increased evapotranspiration rates and longer summer droughts may negatively impact this species' habitat. These same climatic trends are expected to support encroachment of woody shrubs and trees into the alpine tundra (Dial, et al. 2016) also potentially impacting Aleutian cress habitat.

Priority Management Questions, Associated Indicators, and Monitoring Methods

Monitoring ecological conditions for at-risk species addresses two of the forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the "Terrestrial Ecosystems" section of the plan (and corresponds to 2020 plan component identification code FW-GL3-TE-DC):

- Sufficient nesting habitat is maintained to support persistent populations of dusky Canada geese.
- Ecological conditions (alpine tundra on moist, boulder-strewn, solifluction slopes; wet mossy seeps; seepage areas among rocks; snow melt areas; and fine gravel saturated by snow melt) maintain viable populations of the Aleutian cress (*Aphragmus eschscholtzianus*) within the plan area. Forest Service management activities within these habitats are designed to minimize human impacts to the Aleutian cress.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in condition related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor ecological conditions for at-risk species:

Are habitat conditions necessary to support populations of dusky Canada geese and Aleutian cress being maintained?

To address the monitoring question, Chugach National Forest staff selected six indicators to determine trends in conditions for at-risk species. Table 12 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring at-risk species.

Table 12. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring at-risk species on Chugach National Forest

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Population trends of dusky Canada geese in the Copper River Delta	Estimated population abundance (breeding ground index)	Annually	7 years	Wildlife	Report: specialist 1 day
Nesting success (dusky Canada geese)	Percentage of nest islands successfully hatching at least 1 egg	Annually	7 years	Wildlife	Report: specialist 2 days
Nest depredation (dusky Canada geese)	Proportion of nest islands depredated by avian and mammalian predators	Annually	7 years	Wildlife	Report: specialist 2 days

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Trends of known populations of Aleutian cress	Frequency of plant occurrences within permanently monumented plots	Biennial	10 years	Vegetation/ Ecology	Annual field work: 5 days Annual data management: 2 days 7-year data analysis: 10 days
Tree and shrub encroachment into alpine habitat (Aleutian cress)	Density of shrub ramets within permanently monumented plots. Vegetation monitoring tool, GTAC – link back to climate change vulnerability assessment predictions.	Biennial	7 years	Vegetation/ Ecology	Annual field work: 5 days Annual data management: 2 days 7-year data analysis: 10 days
Persistence of snowpack in alpine terrain (Aleutian cress)	SNOTEL and MODIS data -link back to climate change vulnerability assessment	Biennial	7 years	Vegetation/ Ecology	Annual field work: 2 days Annual data management: 2 days 7-year data analysis: 10 days

If negative trends are found during assessment of these indicators, the following management responses are needed:

Dusky Canada Geese Population in the Copper River Delta

- Initial actions would be to determine if the monitoring indicates a broad population decline, or a shift in nesting site selection, and subsequently to identify the ecological or management factors responsible for the decline.
- Population declines determined to be due to reduced nesting habitat quality or availability on the Copper River Delta would trigger a re-evaluation of existing habitat management strategies to better address important habitat needs.
- Population declines due to other factors such as mortality on wintering grounds or unintentional harvest during hunting seasons would trigger review of management strategies by federal, state and nongovernmental organization partners.

Nesting Success

- As part of the nest island program, nesting success and nest depredation on artificial nesting structures is monitored annually. We recommend that additional efforts are taken periodically to collect data on nest survival and depredation across the Copper River Delta, of both natural and artificial nesting structures, to reevaluate the effectiveness of habitat enhancement and predator deterrence measures. These data may then be used to determine if there are additional habitat management actions that could be implemented to help improve the reproductive success of this species.

Aleutian Cress

- If monitoring indicates a declining population due to management activities or recreation, mitigation measures to minimize impact to the population would be prescribed.
- If monitoring indicates a declining population due to climate-driven shrub expansion into alpine habitat, conditions will be reported and recommendations for management actions will be provided in the biennial monitoring and evaluation report.
- If monitoring indicates a declining population due to climate-driven loss of snowpack, this trend will be reported and recommendations for management actions will be provided in the biennial monitoring and evaluation report.

Indicators for Dusky Canada Geese

The 2020 land management plan states desired conditions of maintaining sufficient nesting habitat to support persistent populations of dusky Canada geese, and specifically lists an objective of maintaining 400 acres of low-predation-risk nesting habitat for dusky Canada geese. The plan additionally sets forth standards and guidelines that minimize disturbance to dusky Canada geese nesting habitat (April 15–June 30), molting and brood rearing habitat (July 1–August 15), and high use staging areas (September 1–October 31).

Nesting success rates for all waterfowl experience considerable annual variation with weather conditions and depredation rates being two of the biggest influences on nest success (Batt et al. 1992). Especially in years when alternative prey is at a minimum, predation on nesting dusky Canada geese and their nests can be very high from both mammalian predators (bear, wolf, coyote, wolverine, mink) and avian predators (eagles, ravens, jaegers). Our artificial nest island program provides secure nesting sites for dusky Canada geese, helping to deter avian and mammalian nest predators. Floating nest platforms are anchored in a pond away from shore, deterring mammalian predators from swimming to nest islands. Planted arial cover on the islands helps shelter nesting geese from avian predators as well.

The artificial nest island program meets the 2020 land management plan objective of maintaining at least 400 acres of low-predation-risk nesting habitat on an annual basis (corresponds to the 2020 plan component FW-GL3-TE-OBJ), which has shown to nearly double nest success of dusky Canada geese when compared to success rates of nests across natural nest sites (Maggiulli and Dugger 2011). The nest island program also plays a significant role in supporting persistent populations of dusky Canada geese. Years when dusky Canada geese populations have been low, the nest island program is an important factor in sustaining reproductive success.

The following monitoring indicators are described for dusky Canada geese nesting populations that use nesting habitats within Chugach National Forest lands (2020 plan). Population is defined for the Copper River Delta under the U.S. Fish and Wildlife Service breeding pair count (Pacific Flyway Council 2022).

Indicator: Population Trends of Dusky Canada Geese on the Copper River Delta

The U.S. Fish and Wildlife Service is an important partner with the Pacific Flyway's dusky geese management and produces an annual breeding ground index through aerial surveys each spring. Aerial breeding population surveys have been conducted annually on the Copper River Delta since 1979 and the current array of transects has been monitored since 1986 (Hodges and Eldridge 2007). This survey, plus a breeding survey on Middleton Island, was adopted as the official population index by the Pacific Flyway in 2008 (Pacific Flyway Council 2022). The current breeding population index includes adjustments for visibility and renesting on the Copper River Delta and adds adults counted on Middleton Island.

Methods and Metrics (Population Trends of Dusky Canada Geese)

Aerial surveys are conducted by the U.S. Fish and Wildlife Service during spring in early to mid-May when the majority of dusky Canada geese are incubating, but before green-up on the Delta impedes goose detectability. Divided into three strata based on goose density across the Copper River Delta survey area, transects are flown annually. In recent years, an amphibious Cessna 206 aircraft has been used, flying at an altitude of 38 meters and an airspeed of 160 kilometers per hour. Both the pilot and a right-seat observer counted all geese out to 200 meters. A 3-year average of the breeding ground index, which equates to estimated population abundance, is used to monitor the dusky Canada goose population goal of 20,000 birds as stated in the Pacific Flyways Dusky Canada Goose Management Plan (Pacific Flyway Council 2022). For biennial reporting, the Chugach wildlife program manager will extract aerial survey results from the U.S. Fish and Wildlife Service annual report (Marks and Wilson 2021). Detailed survey methods are included in the annual report, which can be obtained from the U.S. Fish and Wildlife Service, Alaska Region, Migratory Bird Management Office, 1011 E. Tudor Rd, Anchorage, AK 99503.

Indicator: Nesting Success of Dusky Canada Geese

The Forest Service monitors nesting success and depredation on artificial nest islands annually. This allows for assessment in trends of productivity. A nest is considered successful if at least one egg from a clutch hatched. The number of successful nests divided by the total number of used nests yields nesting success, defined as the proportion of nests that successfully hatched at least one egg. We recommend that efforts are also taken periodically to collect data on nesting success of natural nests across the Copper River Delta to assess the effectiveness of habitat enhancement and predator deterrence measures.

Methods and Metrics (Nesting Success of Dusky Canada Geese)

Monitoring of artificial nest islands occurs in June, after peak hatch, to minimize nest disturbance. All waterfowl nesting or roosting activity observed on a nest island is documented. If evidence of a dusky Canada goose nest is found, the total number of eggs and final nest fate are recorded. Nests are recorded as "successful" if there is evidence that at least one egg hatched (dried membrane, hatched egg shells, or caps). Nests are recorded as "failed" if there is evidence of an active nest bowl (down feathers) but no eggs or membranes are present, or if there is evidence of depredated eggshells in the nest or on the nest island. A nest is considered "abandoned" if there are cold eggs in a nest bowl without evidence of any hatched eggs. An "active" status is assigned to nests that are still being incubated (that is, female flushed from the nest or eggs are warm and covered). Active nests are rechecked during nest island maintenance in July to determine the final nest fate. An "unknown" status is assigned to nests if there in not enough evidence that clearly meets the above criteria for one of the categories.

Indicator: Nest Depredation of Dusky Canada Geese

Nest island monitoring provides an estimate of the rate of nest failure due to mammalian or avian predators. This rate includes abandoned nests caused by an interaction with a predator. Additional information on predator type can be determined if trail cameras are used to monitor nests.

Methods and Metrics (Nest Depredation of Dusky Canada Geese)

During nest island monitoring, each nest is scrutinized for any evidence of depredation. Evidence of nest depredation include: 1) sign of a female goose being attacked or killed, such as the presence of adult feathers or body parts, 2) sign of eaten eggs in the nest, such as crushed eggshells, or 3) the presence of down and nest material from the current nesting season but a completely empty nest bowl. Inferences can be made on what type of predator depredated a nest, but it is difficult and can be biased (Anthony et al. 2004). Nest cameras are an accurate way of distinguishing specific predator types (Meixell and Flint 2017) and we recommend that cameras continue to be used periodically to assess changes in predation pressures on dusky Canada geese nesting on the Copper River Delta as well as to evaluate predator differences on artificial nest islands compared to natural nest sites.

Data Management Plan (Dusky Canada Geese)

Field data will be collected on paper datasheets (see technical guidance at the end of this chapter). Raw datasheets will be proofed for accuracy and then cataloged and stored for future reference. Following completion of fieldwork, data will be entered into a spreadsheet and proofed to correct any data entry errors. All data will continue to be stored in the Microsoft Access master nest island database, which is backed up on two external hard drives as well as saved onto Pinyon under a current year dusky folder.

Reporting Intervals and Plan Direction (Dusky Canada Geese)

Nest island monitoring data and nest depredation data will be entered annually into a database; estimates of abundance from U.S. Fish and Wildlife Service surveys will be compiled from their annual report each year. All data will be summarized and included in the biennial monitoring report.

Estimated Annual Cost (Dusky Canada Geese)

Estimated cost of annual nest island monitoring includes two wildlife biologists, two seasonal technicians, and one intern for 1 week; per diem for all staff; 14 boat days, 14 truck days, 200 gallons of fuel, and miscellaneous field gear (waders, personal protective equipment, GPS units, datasheets). Estimated cost of annual nest island maintenance includes one wildlife biologist, two seasonal technicians, and one intern for 2 weeks; per diem for staff, 21 boat days, 21 truck days, and 200 gallons of fuel. Estimated cost of nest searches to assess nest survival and depredation across the Copper River Delta includes two wildlife biologists, two seasonal technicians, and one intern for one week; per diem for all staff; 14 boat days, 21 truck days, 400 gallons of fuel, and miscellaneous field gear (waders, personal protective equipment, GPS units, datasheets). Estimated time to summarize all data and include in the biennial monitoring report will requires specialist for 3 days.

Indicators for Aleutian Cress

The following monitoring indicators are described for Aleutian cress populations within Chugach National Forest lands (2020 plan).

- Include description of locations planned over next 15 years (life of the plan)
- Describe integrations of monitoring metrics across resource areas (such as, infrastructure, recreation, fish, and wildlife habitat)
- Describe frequency and duration of monitoring for each location (spatial and temporal scale)

Indicator: Trend of Known Populations of Aleutian Cress

The known distribution of Aleutian cress on the Chugach National Forest is limited to a single watershed on the Kenai Peninsula. Given the minute stature of this species and the limited scope of past floristic surveys in the alpine habitats of the forest, it is likely that additional populations that have not yet been identified exist on the forest. Until new populations are identified, this monitoring plan will establish trends for the known population; the results will be specific to the Palmer Creek watershed and may not be representative of Aleutian cress occurrences across the Chugach. If additional populations are found, forest ecologists will add additional sample locations to the monitoring protocol as time and funds allow.

Methods and Metrics (Aleutian Cress, Population Trends)

Aleutian cress is a small, rhizomatous plant that grows in clusters. The basal rosette of an individual plant is roughly the size of a quarter, and a dozen or more individual plants can be clumped into genets that cover an area no larger than the size of a fist. This growth habit makes individual plants very difficult to identify without causing damage, which precludes sampling methods that rely on counts of individuals. To assess population trends without counting individual plants, we will use frequency monitoring that relies on presence and absence data to calculate the percentage of possible plots within the sample area occupied by Aleutian cress (Vitt et al. 2016, Elzinga et al. 1998).

Field sampling would occur in the Palmer Creek valley biennially in July or August through 2035. Additional sites would be sampled similarly. Frequency does not rely on cover, so revisits do not need to coincide with the exact same growth form, allowing for more flexibility in visiting the site during the growing season.

Multiple study sites with known Aleutian cress will be permanently monumented for sampling in the Palmer Creek watershed. Baseline data will be collected in 2022 and used to pilot the monitoring protocol and establish the needed sample size and plot size. Variance in the 2022 samples will be used for a power analysis to determine the sample size necessary to estimate the average population size with a 90 percent confidence level. Population sampling will occur biennially at a random sampling of known sites following developed protocols (see technical guidance at the end of this chapter).

Aleutian cress population data will be analyzed at the watershed scale, with the option to categorize and summarize plot data based on proximity to recreational use or population size. If populations are found in other areas of the forest and are included in the sampling, the analysis can expanded forestwide.

Aleutian Cress Surveys

Surveys for additional populations of Aleutian cress will be opportunistic, occurring incidental to other field work conducted by the ecology program or in partnership with other entities. Aleutian cress exhibits a strong habitat preference for hydric alpine soils—a habitat type that is not overlay abundant on the Chugach.

Habitat suitability models developed for Aleutian cress indicate that only 1.6 percent of lands on the forest harbor potential habitat for this species (Hayward 2017). Using our understanding of this species habitat requirements, the search area can be highly refined to maximize the efficiency of survey efforts.

Indicator: Tree and Shrub Encroachment into Alpine Habitat

Monitoring tree and shrub expansion (encroachment) in alpine habitat will be done at two different scales:

1) Local scale: Site-specific monitoring of woody plant density in the Palmer Creek watershed will focus on the known sites where Aleutian cress occurs and will address habitat change and availability at a local scale.

2) Regional scale: Monitoring protocols for regional shifts in plant communities using the Landscape Change Monitoring System (described in detail in chapter 6 of this document; see table 14, Indicator: tree and shrub encroachment into alpine tundra and changes in recently deglaciated areas). This analysis will address habitat change and availability at a regional scale.

Methods and Metrics (Aleutian Cress, Tree and Shrub Encroachment)

To assess local trends in the cover of woody species, plots will be located at the same randomized locations used for population sampling of Aleutian cress. Rectangular plots will be anchored at the permanent monument and placed perpendicular to the slope. Each individual shrub stem within the plots will be counted and divided by the plot area to calculate shrub density within the plots. Detailed sampling methods can be found in the Aleutian cress monitoring protocol (see technical guidance at the end of this chapter).

Biennial sampling will measure changes in the number of woody shrubs in a given area and lay the groundwork for observing whether shrubs are encroaching in Aleutian cress alpine habitat.

At regional scales, the migration (encroachment) of tree and shrub communities into alpine habitat over time will be measured using Land Change Monitoring System data. These data and the methods and tools used to collect these data are described in detail in chapter 6 of this document (see table 14, Indicator: tree and shrub encroachment into alpine tundra and changes in recently deglaciated areas). The changes or transition of short shrub and forb alpine communities to tall shrub and tree communities will be measured with the Land Change Monitoring System and will be summarized to reflect the overall habitat suitability for Aleutian cress on the forest.

Indicator: Persistence of Snowpack in Alpine Terrain

Aleutian cress is classified as a facultative wet indicator species by the U.S. Army Corps of Engineers (Department of Defense, Army Corps of Engineers 2020) and the known habitat for this species on the forest is in alpine wetlands, rivulets, and shallow ponds, along small streams, as well as in seeps and wet mossy areas. The water that permeates these habitats is fed by snowpack and precipitation. Therefore, the persistence of snowpack is directly related the hydrology that creates the alpine wetland habitat on which Aleutian cress relies. This indicator will be addressed at two different scales:

1. Local Scale: To assess whether or not there are drying conditions where Aleutian cress occur in the Palmer Creek watershed, climate change indicator data for the Kenai Peninsula and photo points will be used.

2. Regional Scale: The climate change chapter of this monitoring guide quantifies changes in snowpack persistence forestwide. This information will be used to assess suitable habitat for the Aleutian cress on the Chugach National Forest.

Methods and Metrics (Aleutian Cress, Persistence of Snowpack in Alpine Terrain)

Snow-water equivalent is the amount of water that will be released from the snowpack and is used for forecasting the summer water supply. Data on the date of greatest snow-water equivalent and date of zero snow-water equivalent will be used to better understand the relationship between population changes and climate change variables. The source of the snow-water equivalent data will be the nearest SNOTEL/Snow Course sites on the Kenai Peninsula: Turnagain Pass, Resurrection Pass, and Pass Creek. These annual data points will be combined with historical data to provide a picture of the recent trends. The date of the greatest snow-water equivalent provides a picture of when the snowpack is the deepest. The date of zero snow-water equivalent provides a picture of when in the spring the snow has completely melted at the SNOTEL/Snow Course sites to let us know if snow is absent earlier in the year. Trend lines will be reported that include historical and annual snow-water equivalent data for the Turnagain Pass, Resurrection Pass and Pass Creek sites on the Kenai Peninsula.

Photo point methods follow Forest Service protocols (Hall 2002) “topic photography” guidelines, with the objective of capturing changes in the hydrology through photographs of the water source and ground cover. Elzinga et al. (1998) provide additional guidelines for monitoring rare plant habitat. The focus of the photographs should include groundcover, waterbodies (streams, ponds, rivulets), and seeps specific to each sample site (not each plot).

At the regional scale, changes in snow permeance and snowpack will be measured using Landscape Change Monitoring System data. These data and the methods and tools used to collect these data are described in detail in chapter 6 of this document (see table 14, Indicator: snow depth and season of snow cover). The changes in permanent snowpack measured with the Land Change Monitoring System for evaluating climate change will also be reported for Aleutian cress as permanent alpine snowpack is an important condition that allows this species to persist during warm, dry summer seasons.

Data Management Plan (Aleutian Cress)

The Aleutian cress population trend, shrub density, and photo point data will be collected using a project-specific form developed within the ArcGIS Field Maps application. Field data will be uploaded from the mobile data collection device to the ArcGIS Online platform and stored in a feature layer housed on the Chugach Land Management Plan Monitoring Program Hub. All field photos and tabular data or reports developed during the analysis periods will be stored on the shared Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Aleutian Cress. Data will be retrieved via request for folder permissions directed to the ecology program manager, and any changes to folder titles and files strings will be updated for this monitoring guide by the ecology program manager every 5 years in conjunction with the trend condition assessments.

Reporting Intervals and Plan Direction (Aleutian Cress)

Monitoring reports will be produced biennially. Developing meaningful inferences on Aleutian cress population trends, shrub encroachment, and snowpack persistence will require a minimum of 10 years of data. Analysis reports will be developed after adequate data has been generated to make meaningful inferences. However, in the interim, if disturbance from management activities is noted, mitigation measures or project design features will be identified to protect the plants and their habitat. Climate change inferences will include historical snow-water equivalent data to provide a picture of the trends in snowpack and snowpack persistence.

Estimated Annual Cost (Aleutian Cress)

Sampling in the Palmer Creek watershed will take one ecologist and two technicians approximately 3 days, every other year. Surveys of suitable habitat across the forest will be done opportunistically associated with other programs of work and will require approximately 2 to 5 days annually for two technicians. If additional occurrences are identified through survey efforts, depending on the ease of access, new sites would likely require an additional 3 days to sample every other year. The Palmer Creek watershed sites are accessed by vehicle and foot. An additional week for the forest or zoned ecologist would be needed for data entry, review, analysis and reporting, with additional support from a biometrician for statistical analysis.

Technical Guidance for Chapter 4

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 4, click here.

Chapter 5 Visitor Use, Visitor Satisfaction, and Progress Toward Meeting Recreation Objectives

Overview

The focus of monitoring visitor uses and recreation activities on the Chugach National Forest centers on sustainability of recreation facilities and providing desired recreation opportunities. One of the key ways to accomplish providing sustainable ranges of recreation opportunities is developing relationships and working effectively with partners and volunteers who help the Forest Service. Chugach National Forest staff chose indicators and measures of levels of recreation use, sustainability of recreation facilities, and how engaged the communities, partners, volunteers, and businesses are in providing shared stewardship of recreation opportunities and infrastructure. This information will be used to determine if effort is needed to develop different recreation opportunities and facilities, more or different partnerships, engage more volunteers, and evaluate the adequacy and overall sustainability of recreation facilities.

Priority Management Questions, Associated Indicators, and Monitoring Methods

Trends that show recreation facilities are being occupied and maintained at sustainable levels can indicate whether the Forest Service is making headway in providing desired and sustainable recreation facilities. Trends that show increased volunteerism and partner engagement will indicate that the Forest Service is accomplishing desired conditions of shared stewardship in providing sustainable recreation opportunities, along with accomplishing forestwide goals to foster collaborative relationships and contribute to social and economic sustainability.

Monitoring visitor use and recreation objectives addresses four of the forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the “Recreation” section of the plan (and correspond to 2020 plan component identification codes FW-GL1-REC-DC and FW-GL2-REC-DC):

- Access to winter recreation opportunities is maintained or enhanced through a collaborative effort between the Forest Service, local communities, other agencies, and partner organizations to provide plowing of parking lots and trail grooming (where authorized).
- Through partnerships between the Forest Service and organizations and communities, the Chugach National Forest offers opportunities for unparalleled outdoor recreation experiences that showcase the natural and cultural heritage of the Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas.
- Recreation sites and trail systems are economically and socially sustainable and are supported by communities and partners through shared infrastructure development and maintenance, delivery of information, and provision of recreation services.
- The number and location of recreation facilities reflect current and future public needs and demand, within Forest Service financial capabilities, and are consistent with forestwide recreation facility planning.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in condition related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor visitor use recreation objectives:

Are recreation opportunities and infrastructure achieving desired conditions, and are they sustainable?

To address the monitoring question, Chugach National Forest staff selected five indicators to determine trends in conditions for visitor use and recreation objectives. Table 13 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring visitor use and recreation objectives.

Table 13. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring visitor use and recreation objectives on Chugach National Forest

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Recreation facility occupancy rate	Percentage occupancy for fee campsites and cabins	Annually	5 years	Recreation	Reports: specialist 5 days; manager 1 day Analysis: manager 1 day
Number of outfitter guide permits issued and administered, types of guided activities, and locations	Number of outfitter guide permits issued and administered. General types of permitted activities. General locations of permitted activities.	Annually	5 years	Special Uses	Report: special uses team leader 1 day Analysis: special uses team leader 3 days
Number of miles of trails maintained by volunteers and partners	Accomplishment reporting: miles improved and maintained	Annually	5 years	Recreation	Report: manager 1 day Analysis: manager 1 day
Number of recreation sites operated by volunteers and partners	Number of recreation sites operated by Alaska Recreation Management	Annually	5 years	Recreation	Report: no additional outside of program Analysis: manager 1 day
Total forestwide deferred maintenance	Deferred maintenance funds for trails, trail bridges, and recreation sites	Annually	5 years	Recreation	Report: specialist 3 days, manager 1 day Analysis: manager 1 day

If negative trends are found during assessment of these indicators, the following management responses are needed:

- Re-evaluate the funding and priorities of the budget as well as staffing decisions and determine if additional resources (budget and employees) are needed to achieve sustainability, and review of any facilities that may need to be decommissioned.
- Determine if additional land management plan objectives are needed to focus effort on any aspect that is showing a negative trend.
- Determine if there is a limiting factor for negative trend in deferred maintenance (such as considerable decrease in appropriated funding for maintenance of facilities) that is beyond what is possible to change in the land management plan, budget, or staffing.
- Evaluate whether the desired conditions are reasonable or need to be realigned.

Indicator: Recreation Facility Occupancy Rate

Methods and Metrics

The online registration portal recreation.gov will be used to collect data needed to determine the occupancy rate for rental cabins.[1] Use data is pulled annually (January 1–December 31) from the recreation.gov website and analyzed to determine an annual weighted percent occupancy for each cabin during its operating season. The total operating days for a cabin are equal to the number of days the site is available for use. For most cabins this is 365 days per year, but there can be exceptions. For those days the site is occupied, the percent occupancy will be 100 percent, regardless of the group size. For those days the site is available, but not occupied (not reserved, or reservation cancelled), the percent occupancy will be one percent. To determine a final weighted percent occupancy for each cabin, use numbers are inserted into an occupancy calculator tool provided by the National Recreation Sites Data Entry Business Rules (see technical guidance at the end of this chapter).

For fee-use camp sites, occupancy rate will be determined by visitor use data provided by the contractor/concessionaire Alaska Recreation Management (referred to as ARM) via the ARM Portal Shared Workspace. Specific data analyzed will be number of sites occupied each night, not number of visitors at each occupied site. Use data for the concessionaire-run campgrounds is pulled annually (January 1–December 31) from the ARM Portal and analyzed to determine an annual weighted percent occupancy for each campsite during its operating season. In accordance with the National Recreation Sites Data Entry Business Rules, the operating season is the number of days each year the site is operated for public use and critical standards are being met; this includes Peak (76 to 100 percent occupied), High (41 to 75 percent occupied), Moderate (16 to 40 percent occupied), and Low (0 to 15 percent occupied) use levels. Days where the site is physically open but not being operated for use are not included in the operating season. If the site is not being managed to at least meet critical standards, it is not considered operational. Fees are collected and use data is reported via concessionaire from mid-May to mid-September (actual dates vary slightly year to year) when ARM manages the sites.[2]

[1] With the exception of Spencer Bench Cabin, which is reserved via the Alaska Railroad from June 1–September 14 and recreation.gov from September 15–May 31. Spencer Bench Cabin use data for the summer months is provided by the Alaska Railroad and incorporated into the data provided by recreation.gov.

[2] Campgrounds are regularly used outside of this time period; however, this use is difficult to account for accurately. For the purposes of this trend analysis the use data provided by the concessionaire allows for more accuracy and therefore is sufficient.

Data from ARM is analyzed to determine how many days during the period of operation each campground is at a particular use level; Peak, High, Moderate, Low. Use numbers are inserted into an occupancy calculator tool provided by the National Recreation Sites Data Entry Business Rules to determine a final weighted percent occupancy for each campsite.

Data Management Plan

The annual occupancy data for all rental cabins and fee-use campsites forestwide will be stored in the shared Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Recreation Site Occupancy Rate. This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the forest recreation program manager, and any changes to folder titles and files strings will be updated by the forest recreation program manager in the biennial monitoring and evaluation report for this guide.

Reporting

Data will be reported by the recreation data specialist to the recreation program manager annually. Trends in data will be analyzed every five years by the recreation data specialist and reported to the recreation program manager, who will assess the relationship to the 2020 plan guidance for visitor use and recreation objectives.

Estimated Annual Cost

In addition to regular program reporting, one week of work for one data specialist and 1 day of work for the recreation program manager will be required annually, with an additional 1 day needed every fifth year of the 15-year plan life.

Indicator: Number of Outfitter Guide Permits Issued and Administered, Types of Guided Activities, and Locations

Trends in the number of outfitter guide permits, activities and locations will be measured using the existing permit tracking system managed by the special uses program on the Chugach National Forest. This system provides a tool to determine the number of permits that are issued and administered each year, administration standards for each permit, and general categories of use types and locations.

Methods and Metrics

The Natural Resource Manager – Special Uses Data System is a mandated historical depository for all special use applications, authorizations, and administration data. This database will be used to annually pull reports on the number of outfitter guide permits issued and administered, the general types of permitted activities and associated locations. The collected data will be tracked by fiscal year on a spreadsheet so that five-year trends can be derived.

Data Collection Method 1 – Natural Resource Manager – Special Uses Data System User Views are reported in the form of Excel spreadsheets that will be pulled by no later than September 30 each year to collect the measure data.[3] To access User Views, select Business Areas, then select Special Uses. The User View reports that best address the monitoring questions include the following:

[3] To capture the measures as accurately as possible, the reports must be pulled before the start of the new fiscal year. Corporate Data Warehouse report in the Special Uses Data System can be pulled for the previous fiscal year but lumps all recreation uses 100-199 codes. It does not allow the user to query for use code 153 (outfitter guides). If needed, the Region 10 special uses data system coordinator can pull the Corporate Data Warehouse report.

- Activities: Report name: Outfitter and Guide Authorized Activities and Actual Use for ALL FYs. Query by Display All, Bill Period FY, bill Period, and RRFFDD like 1004 percent. This report will identify the general activity types. Categories for the general activity types are defined by the Alaska Region (Region 10) flat fee schedule. To make sure all winter activity types are fully captured, this report should also be pulled at the end of January of the following fiscal year, as this report's main purpose is to track billing through the calendar year and winter activities are typically entered by the end of January, as final use is not required for winter operators, until the end of the calendar year.
- Number of Outfitter and Guide Permits Issued and Administered: report Name: Miscellanies Info for Current Special Use Authorizations. Query by RRFFDD like 1004 percent, Use1 = 153, Status name = issued. This report will provide the number of outfitter guide permits issued and administered.
- Administer to Standard: report Name: Admin to Standard Authorization October 1 to September 30. Customize query by Current FY, Use1= 153, Status Name = Issued, and RRFFDD like 1004 percent (which will capture all 3 districts 10, 20, and 30), and To Standard = Y (yes). This report will list all permits meeting the Special Uses Data System Administered-to-Standard Measurement Elements. This report must be pulled annually and as close to September 30 as possible, no later than September 30.[4] This information will be helpful in answering monitoring question: Are the opportunities sustainable. This information may help to address trends in how many permits are fully administered to standard and may give insight to capacity needs.

Data Collection Method 2 (location) – Region 10 Outfitter and Guide Database (Survey 1,2,3 – actual use reporting) is a tool used for permit holders to report actual use, type of use, and location. This report will provide the general location by zones, Prince William Sound Zone and Kenia Peninsula Zone. The report will be pulled by the Chugach National Forest special uses data steward. It is best pulled at the end of the calendar year, for example fiscal year 2021 report is best pulled at the end of calendar year 2021 as actual use is reported at the end of the outfitters and guides season, which can run through the calendar year.

Data Management Plan

The annual forestwide trend analyses will be stored long term in the shared in the Pinyon folder file string 2300 Planning~SO/Forest Monitoring Data Management Plan/OG permit trends. This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the special uses service team leader, and any changes to folder titles and files strings will be updated by the special uses service team leader in the biennial monitoring and evaluation report.

Reporting Intervals and Anticipated Results

Data is entered into Natural Resource Manager – Special Uses Data System throughout the year by the special uses service team permit administrators. User Views (Excel spreadsheet) will be pulled annually at or just prior to the end of each fiscal year. Trends in data will be analyzed every five-years.

[4] Data pulls are a snapshot in time and totals can change day by day, depending on timing of data entry. To ensure the most current data is captures, the special uses service team leader will have to do a Global Refresh in Special Uses Data System before pulling reports.

Estimated Annual Cost

The report will require 1 day of work annually for the special uses service team lead, and an additional 2 days of work needed every fifth year of the 15-year plan life.

Indicator: Miles of Trails Maintained by Volunteers and Partners

Methods and Metrics

Trail performance measure accomplishment reporting (miles maintained, miles improved, miles meeting standard) is required to be completed every year and recorded in the Natural Resource Manager database Trails application. According to the trail performance measure accomplishment reporting guidelines (see technical guidance at the end of this chapter), miles maintained is defined as the miles of National Forest System trails where at least one maintenance task (annual or deferred) was completed to standard during the fiscal year. Miles improved is defined as the miles of National Forest System trails improved or constructed to standard (capital improvement) during the fiscal year. A separate maintenance accomplishment is recorded in the Natural Resource Manager database Trails application for each entity that performs the task that fiscal year (for example, force account, contractor, outfitter or guide, volunteer or partner), so as to reflect all work performed on a trail by all entities.

Work completed by volunteers and partners is tracked throughout the fiscal year by a designated trail data steward from each ranger district. The data steward monitors the status of fieldwork and enters all accomplishments into the Natural Resource Manager database Trails application by the national reporting deadline of October 31. Accomplishment reports are then pulled from the Natural Resource Manager database Trails application and analyzed to determine the number of miles maintained by volunteers and partners.

Data Management Plan

The annual accomplishment reporting data forestwide will be stored in the shared Chugach National Forest Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Trail Miles Maintained_Vols & Partners This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the forest recreation program manager, and any changes to folder titles and files strings will be updated by the forest recreation program manager in the biennial monitoring and evaluation report for this guide.

Reporting

Data will be reported in the Natural Resource Manager database by the district trail data steward, analyzed by the recreation data specialist, and reported to the recreation program manager annually. trends in data will be analyzed every five years by the recreation data specialist and reported to the recreation program manager, who will assess the relationship to the 2020 plan guidance for visitor use and recreation objectives.

Estimated Annual Cost

In addition to regular program reporting, 1 day of work for the recreation program manager will be required annually, with an additional 1 day needed every fifth year of the 15-year plan life.

Indicator: Number of Recreation Sites Operated by Volunteers and Partners

Methods and Metrics

The recreation sites operated by volunteers or partners is determined by counting the number of sites with current concessionaire special use permits and sites where volunteers operate the site or assist with recreation operations.

Data Management Plan

Data pertaining to the number of recreation sites operated by volunteers and partners forestwide will be stored in the shared Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Recreation Sites Operated_Vols & Partners. This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the forest recreation program manager, and any changes to folder titles and files strings will be updated by the forest recreation program manager in the biennial monitoring and evaluation report for this guide.

Reporting Intervals and Anticipated Results

Agreements will be reviewed by the recreation program manager and recorded annually in the shared Pinyon file, and any changes to folder titles and files strings will be updated by the forest recreation program manager in the biennial monitoring and evaluation report for this guide. Trends in data will be analyzed every five years by the recreation program manager, who will then assess the relationship to the 2020 plan guidance for visitor use and recreation objectives.

Estimated Annual Cost

There will be no additional annual cost needed to complete this reporting requirement beyond the regular program monitoring costs. One day of work for the recreation program manager will be needed every fifth year of the 15-year plan life.

Indicator: Total Forestwide Deferred Maintenance

Methods and Metrics

Total deferred maintenance for recreation sites and trails is determined by the following: 1) deferred maintenance carried over from previous year; 2) deferred maintenance added throughout the year; and 3) deferred maintenance completed throughout the year. Forestwide deferred maintenance totals will be calculated by combining the deferred maintenance totals of recreation sites and trails.

Recreation Sites

All developed recreation sites on the forest are inventoried, and a condition survey is completed for each, every five years in accordance with Developed Sites National Quality Standards and the Forest Service Manual, to determine whether the rec site is being maintained to standard for use by the public. During these surveys, all minor constructed site features (signs, fences, tables, gates, fire rings, etc.) and major features (buildings, drinking water systems, wastewater systems) are inventoried and inspected and deferred maintenance tasks needed to meet National Quality Standards are identified. Once completed, the condition surveys and inspections for minor constructed features and less complex recreation buildings (outhouses, cabins, woodsheds) are provided to the recreation data specialist, who enters the surveys and any maintenance needs into the Natural Resources Manager database Recreation Sites and Buildings applications. Condition surveys and inspections for drinking water systems, wastewater

systems, and more complex recreation buildings are entered into the corresponding Natural Resource Manager database Engineering applications by the forest facilities engineer. National costs have been established in Natural Resource Manager for many maintenance tasks; however, for tasks that require user-defined costs, estimates are provided by local experts familiar with the asset.

In order to report recreation site deferred maintenance accomplishments for minor constructed features and less complex recreation buildings, task lists showing all identified deferred maintenance needs for each recreation site on the forest are sent out to the districts' developed recreation crew lead at the beginning of the fiscal year. Tasks completed throughout the year are marked as such and sent to the recreation data specialist for entry into the Natural Resource Manager database Recreation Sites and Buildings applications. Tasks completed for drinking water systems, wastewater systems and more complex recreation buildings are entered into the corresponding Natural Resource Manager database Engineering applications by the forest facilities engineer as completed throughout the year. All completed tasks must be entered into Natural Resource Manager by the national deadline of October 31 in order to be included in the accomplishment reporting for that fiscal year.

Deferred maintenance totals for individual recreation sites will be reflected in Natural Resource Manager after the October 31 accomplishment reporting deadline. The recreation data specialist will analyze the Recreation Site Facility Condition Index (II_DRS_FCI_V) user view in Natural Resource Manager to determine the total deferred maintenance for recreation sites for that fiscal year.

Trails

All National Forest System trails are inventoried, and a trail assessment and condition survey is completed for each trail once every five years, in accordance with Trail National Quality Standards and the Forest Service Manual, to determine whether the trail is being maintained to standard and is fulfilling its intended purpose as outlined in the trail management objective. During the Trail Assessment and Condition Survey, information is collected about the trail and constructed features along the trail—including dimensions, material type and quantities—following standards and guideline detailed in the USDA Forest Service Trail Assessment and Condition Surveys 2011 User Guide. The recreation sites operated by volunteers or partners is determined by counting the number of sites with current concessionaire special use permits and sites where volunteers operate the site or assist with recreation operations. The current condition of the trail is evaluated, and deferred maintenance tasks are prescribed as needed to meet National Quality Standards and the expectations of the trail management objective. Once completed, the surveys and any prescribed deferred maintenance tasks are entered into the Natural Resource Manager database Trails application by a designated district trail data steward. National costs are automatically generated in Infra for each assigned task; with the exception of trail composite tasks and custom tasks, which are user-defined by local experts familiar with the trail and trail features.

Trail bridges are inventoried an inspected every five years in accordance with National Bridge Inspection Standards. Minor trail bridges can be inspected by anyone qualified to perform a Trail Assessment and Condition Survey; major trail bridges must be inspected by a certified trail bridge inspector; and complex trail bridges must be inspected by a certified trail bridge inspector who also meets bridge inspection team leader requirements per the National Bridge Inspection Standards. During the inspection process, information is collected about the trail bridge, including dimensions, component type and material type. The current condition of each trail bridge component is evaluated and rated, and any needed deferred maintenance tasks are prescribed by the inspector. Once completed, the inspections are provided to the recreation data specialist, who enters the evaluations and any maintenance needs into the Natural Resource Manager database Trail Bridges application. National costs are automatically generated in Infra for each assigned task.

Trail task accomplishments are entered into the Natural Resource Manager database Trails application by each districts' designated trail data steward as tasks are completed throughout the fiscal year. In order to report trail bridge deferred maintenance accomplishments, task lists showing all identified deferred maintenance needs for each trail bridge on the forest are sent out to the districts' trail data steward or trail crew lead at the beginning of the fiscal year. Tasks completed throughout the year are marked as such and sent to the recreation data specialist for entry into the Natural Resource Manager database Trail Bridge application. All completed tasks must be entered into Natural Resource Manager by the national deadline of October 31 in order to be included in the accomplishment reporting for that fiscal year.

Deferred maintenance totals for trails will be reflected in Natural Resource Manager after the October 31 accomplishment reporting deadline. The recreation data specialist will analyze the Trail Work Items (II_Trail_Work_Items_V) user view in Natural Resource Manager to determine the total deferred maintenance for trails for that fiscal year.

Data Management Plan

The total deferred maintenance data forestwide will be stored in the shared Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Total Forestwide Deferred Maintenance. This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the forest recreation program manager, and any changes to folder titles and files strings will be updated by the forest recreation program manager in the biennial monitoring and evaluation report for this guide.

Reporting Intervals and Anticipated Results

Data will be reported in Natural Resource Manager by the district trail data steward and the recreation data specialist, analyzed by the recreation data specialist and reported to the recreation program manager annually. Trends in data will be analyzed every five years by the recreation data specialist and reported to the recreation program manager, who will assess the relationship to the 2020 plan guidance for visitor use and recreation objectives. The recreation data specialist will review the deferred maintenance carried over from the previous year, the deferred maintenance added through the year, and deferred maintenance completed throughout the year. If the deferred maintenance tasks being completed is greater than the deferred maintenance added throughout the year, the result should be a positive trend of less total deferred maintenance.

Estimated Annual Cost

In addition to regular program reporting, 3 days of work for one data specialist and 1 day of work for the recreation program manager will be required annually, with an additional 1 day needed every fifth year of the 15-year plan life.

Technical Guidance for Chapter 5

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 5, click here.

Chapter 6 Climate Change and Other Stressors

Overview

Climate change has been identified as one of the greatest drivers of change in physical conditions that will force changes in ecological services provided by national forests. The *Climate Change Vulnerability Assessment for the Chugach National Forest and Kenai Peninsula* (Hayward 2017) discusses the consequences of modeled climatic changes associated with five key elements and the associated changes in ecological services they provide: 1) snowpack, glaciers, and winter recreation; 2) coastal landscapes and environments; 3) vegetation; 4) salmon; and 5) select wildlife species. Chugach National Forest staff used the climate change vulnerability assessment to guide the selection of monitoring indicators for climate change. The Chugach selected four indicators of physical conditions that are modeled to show changes due to climate change: 1) changes in hydrographs; 2) tree and shrub encroachment into alpine tundra and changes in recently deglaciated areas; 3) changes in water temperature; and 4) changes in snow depth and seasonality.

The requirement to monitor measurable changes on the plan area resulting from climate change and other stressors is unique in the 2012 Planning Rule in that it is not directly tied to specific management actions or implementation of plan components. The Chugach National Forest will use the trends in the four indicators compared to the predicted model changes for those indicators as a baseline for working with forest communities and partners to prioritize adaptive management approaches. An example of this approach would be adjusting engineering guidelines for stream crossing structural designs using the predicted 30-year future peak stream flow identified in existing climate change model scenarios. Current model data (such as USDA Forest Service Office of Sustainability and Climate resources) can be compared to empirical stream flow and precipitation events over the life of the plan to see if the changes in magnitude, duration, and timing of peak flow events fits predictions and design criteria. In this way, we address some of the uncertainty in modeled ecological conditions and can more precisely identify changes affected by climate change as well as opportunities for management strategies that facilitate adaptation and guide forest projects. Information from the four indicators identified in the 2020 plan monitoring program will also help to fill in important information gaps and provide early warnings of ecosystem response to climate change.

Priority Management Questions, Associated Indicators, and Monitoring Methods

The plan monitoring program must contain one or more monitoring questions and associated indicators to determine whether there are measurable changes in the plan area resulting from climate change and other stressors (FSH 1909.12 30, section 32.13e).We may not know enough to determine effective management actions or establish specific plan components, or there may not be appropriate actions to take to address changes to alterations due to climate change. This monitoring question may have a good link to the next environmental assessment for the future rather than current plan. It may require more than one planning period to determine potential management actions that may be effective. This monitoring question should provide information validating projections of the Chugach climate change vulnerability assessment (Hayward 2017). If projections are not validated, then we would need to ask why the climate assessment failed to identify or failed to correctly predict the impact of climate change on key ecological functions of terrestrial and aquatic habitats.

Monitoring Question

One priority management question was identified to monitor climate change and other stressors:

Is climate change affecting key ecological functions of terrestrial and aquatic habitats within the national forest?

To address the monitoring question, Chugach National Forest staff selected four indicators to determine trends in conditions for climate change. Table 14 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring climate change. Methods to address indicators are described in the following sections and are further elaborated in technical guides (see technical guidance at the end of this chapter). Technical guidance for chapter 6 includes a schematic of the interrelated bio-hydrologic attributes within a watershed context, focuses primarily on hydrograph change analysis, and includes a step-by-step procedure to download and utilize discharge data to assess hydrograph change.

Table 14. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring climate change on Chugach National Forest

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Changes in hydrographs on selected sites	Stream flow project – link back to climate change vulnerability assessment predictions with precipitation and water temperature	2 years reporting	7 years analysis	Aquatics: Hydrology	Reports: watershed specialist 40 days; manager 6 days Analysis: manager 14 days
Tree and shrub encroachment into alpine habitat and recently deglaciated areas	Changes in tree and shrub areas in alpine habitats and glacial boundaries in landscape change monitoring system datasets	2 years	7 years	Terrestrial Ecosystems	Report: Specialist-3 days; Manager-3 days; Analysis: Specialist 5 days; Manager 10 days
Changes in water temperature on selected sites	Temperature monitoring program, uploaded to StreamNet	2 years reporting	7 years analysis	Aquatics: Fisheries	Reports: specialist 60 days; manager 3 days Analysis: manager 10 days
Snow depth and season of snow cover	Snotel max depth and seasonal persistence	2 years reporting	7 years analysis	Aquatics: Hydrology	Reports: specialist 10 days; manager 3 days Analysis: manager 15 days

If negative trends are found during assessment of these indicators, the Forest Service management may consider changes in strategies to respond to changing ecological conditions. For example, an increase in the length and intensity of fire season would affect fuels treatment strategies; increased stream temperatures may lead to conservation strategies targeting thermal refugia; and increased peak flows due to rain-on-snow events will require replacements of undersized culverts.

Indicator: Changes in Hydrographs at Selected Sites

Warming air temperature and subsequent change in the amount and timing of snowfall and rainfall will result in changes in streamflow pattern. As outlined in the Chugach climate change vulnerability assessment (Hayward et al. 2017), indications of declining snow-day fraction and snow-water equivalent in late autumn (October and November), typically occurring at lower elevations (less than 1500 feet), may result in higher fall and early winter peak flows, earlier spring snowmelt, and reduced magnitude of summer flows in some watersheds. Hydrographs—graphs of flow rate (discharge) over time within a specific point in a channel—will be used to identify shifts in streamflow patterns from a range of glacial and snow (clearwater) watershed types that are known to have different hydrograph forms in Alaska (Curran and Biles 2021)

To evaluate changes in hydrographs, there are two main monitoring approaches: (1) assess discharge timing (annual phase change), magnitude (amplitude), and flashiness (short term, rapid spikes) of channel flow relative to mean discharge to interpret hydrograph shifts; and (2) use a new method of hydrograph recession analysis combined with stream temperature to assess flow change (see also, indicator: change in stream temperature) as a means to utilize additional sites incorporating a lower cost and less time intensive method for monitoring change (on-going project with Oregon State University). Generally, recession analyses in snow-dominated systems will be driven by snowmelt processes, whereas in rain dominated systems recession analysis highlights the link between baseflows and low-flow conditions providing a useful metric to characterize and monitor watersheds sensitivity to climatic changes including drought (Jachens, et al. 2020). Hence, on-going development of a new method is aimed to assess a possible transition of snowmelt to rain in watersheds based on evaluation of both temperature and baseflow analysis.

Methods and Metrics

Assessments of change in hydrographs will utilize both available on-line datasets and collection of new field data with use of new methods. Thus, analysis will include several methods and means of reporting. A technical guide is in development pending results of a flow methods study currently underway on the Chugach National Forest in partnership with the Tongass National Forest and Oregon State University (Anderson 2022). Work is anticipated to be completed and published in 2024.

Site Selection

To facilitate site selection, the hydrologic unit codes for the Chugach National Forest watersheds will be delineated into glacier or snow-dominated watersheds having either expected change or no expected change as indicated by the Chugach climate change vulnerability assessment (Hayward et al. 2017) and other watershed hydrology indicators (Sergeant et al. 2020). Where possible, a set of at least three channels will be selected from each of the four categories including: glacier no change, glacier change, clearwater no change, clearwater change (table 15). Site section will include on-going gaged streams operated by the U.S. Geological Survey. Additional non-gaged sites may be selected for recession analysis that will be monitored by the National Forest Service employees along with agency and university partners. Characteristics of monitoring sites including mean elevation, watershed area, and geology are to be summarized to aid in selection of sites having similar site attributes (table 16).

Table 15. List of current operating gaging stations and proposed recession analysis sites in the Chugach National Forest by watershed type and prediction of change in the climate change vulnerability assessment (Hayward et al. 2017). For each gage, the name, location, and U.S. Geological Survey (USGS) gage number location is listed. If multiple sites are listed, order is presented by stream size with largest streams first (Curran and Biles 2021 classification)

Dominant watershed type and typical characteristics of streams	No change predicted	Transition predicted
Glacier dominant / high elevation snow Peak flow in summer or fall	1) Glacier Creek at Alyeska Highway at Girdwood, USGS 152725024) (high elevation 3 B / glacial-transitional snow-dominant no change) 2) Six Mile Creek near Hope, USGS 15271000 (High elevation 3 B / glacial-transitional snow-dominant no change) 3) Wolverine near Lawing 15236900 (high elevation 3 C / glacial-dominant snow-dominant no change)	1) New site in glaciated tributary to Six Mile Creek near Hope is recommended. 2) New site 3) New site
Clearwater, including rain and snow dominated systems Peak flow summer or fall	1) Glacier River tributary near Cordova, USGS 15215900 (1B rain / glacial-transitional snow-transitional no change) 2) West Fork Olsen Bay Creek near Cordova, USGS 15219000 (tidal influence) (2A snow / clearwater-snow dominant no change)	1) New site west or north of Olson Creek is recommended 2) Grouse Creek at Grouse Lake outlet near Seward, USGS 15237730 (1B Rain / glacier-transitional snow – dominant no change) 3) New site on island site in western Prince William sound and/or Copper River delta is recommended

Table 16. Site characteristics summary for the nine Chugach National Forest gaging sites. Summary information is for attributes upstream of the gaging stations (Cooper Ress, geospatial information specialist input, confirmation of correct elevation, slope, and contributing area is needed, data are based on hydrologic unit code attributes, not gage area contributing attributes).

Station name and U.S. Geological Survey ID	Hydrologic unit code 10 name and number	Gage elevation gage, max. (m)	Aspect (deg.)	Average channel slope	FID Geologic feature Code	GEO type and code	Glacier overlap (%)	Contributing watershed (acres)	Lake or wetland proximity (m)
Grouse C At Grouse Lk Outlet Nr Seward AK 15237730	Resurrection River-Frontal Resurrection Bay 1902020205	77.5. (400) 1280	168	43.4 (this is too steep, confirm, maybe percent slope, 23.5)	2721	Kvs 510	0.15 (there are no glaciers in watershed)	9057256	576.6
Snow R Nr Seward AK 15243900	Snow River 1902030209	162.1	321	38.3	10070	Qu 100	0.25	4313560	101.3
Wolverine C Nr Lawing AK 15236900	Nellie Juan River 1902020122	366.2	186	35.0	2721	Kvs 510	0.38	3360493.25	1215.2
Cooper C At Mouth Nr Cooper Landing AK 15261000	Middle Kenai River 1902030214	140.4	154	30.8	2721	Kvs 510	0.002	9495817	1275.2
Kenai R At Cooper Landing AK 15258000	Upper Kenai River 1902030212	133.5	146	43.6	2435	Qu 100	0.03	4587569	0
Glacier R Trib Nr Cordova AK 15215900	Sheridan River 1902010415	88.9	273	29.4	7770	Tos 271	0.46	3135584.75	7588.0

Station name and U.S. Geological Survey ID	Hydrologic unit code 10 name and number	Gage elevation gage, max. (m)	Aspect (deg.)	Average channel slope	FID Geologic feature Code	GEO type and code	Glacier overlap (%)	Contributing watershed (acres)	Lake or wetland proximity (m)
Copper R At Million Dollar Bridge Nr Cordova AK 15214000	Allen Glacier-Copper River 1902010412	41.2	1	45.5	6903	Salt 102	0.49	9745031	170.1
Wf Olsen Bay C Nr Cordova AK 15219000	Port Gravina-Frontal Prince William Sound 1902020106	18.3	107	50.9	5698	Qu 100	0.004	3944451.25	2.3
Sixmile C Nr Hope AK 15271000	Sixmile Creek 1902030204	80.7	123	46.2	3128	Qu 100	0.022	6845969	781.2

Table 17. Year summary table for Glacier River Tributary (15215900) near Cordova for 2012.

Site name and year	Mean daily Q for the year (cfs)	Min daily Q (Julian day and amount, cfs)	Max. daily Q (month, day, and amount, cfs)	Sum of total daily stream flow (cumulative Q)	Max, and Min month Q	Sum of mean monthly Q	Flashiness Index (mean, max, min)	High and Low Pardé index (specify month)
Glacier2012	20.4	0.06 (January and December)	223.8 (September 16; day 260, spiked at 465 cfs)	7,464	20.4, 1.4 (March), 59.7 (Sept)	244.4	0.37, 0.47 (September), 0.28 (January)	0.06 (March) 2.9 (September)

Q = discharge, cfs = cubic feet per second, Min = minimum flow for year, Max = maximum flow for year.

Fieldwork and Data Collection

No field work is necessary for the U.S. Geological Survey gaging stations. Data collection for gaged sites will include compiling yearly summaries. Data is downloaded by hydrologic water year defined as the 12-month period between October 1 and September 30 of the following year. Accordingly, the 2022 water year started on October 1, 2021, and will end on September 30, 2022.

For non-gaged locations, field work will include selection of new sites, installation of monitoring devices (procedures currently being developed by Oregon State University partners), downloading of data from sites.

For both gaging stations and non-gaged locations, maintenance of databases will occur on a yearly basis and analysis of downloaded data and evaluation of trends will occur every seven years.

Data Analysis

Hydrographs will be interpreted to assess six predictions made by the Chugach climate change vulnerability assessment (Hayward et al. 2017) including:

- Has the magnitude of peak flows in the fall/early winter increased?
- Has the timing of the fall/early winter flows shifted to later in the year?
- Has the magnitude of peak flows in the spring changed?
- Has the timing of spring peak flows shifted to earlier in the year?
- Has the summer baseflow decreased in snowpack watersheds?
- Has the magnitude of summer peak flows changed in glacial watersheds?

For both U.S. Geological Survey gaged sites and a set of non-gaged sites, five main annual assessments of hydrograph change will include measures of: (1) mean daily and monthly flow for the year, (2) low flow amount and timing for the year, (3) peak daily flow and timing for the year, (4) summation of total daily and monthly flow for the year, and (5) flashiness index computations.

1) Mean daily flow, or qi is computed by averaging the discharge for each day, expressed as:

$$qi = \frac{1}{n}\sum_{i=1}^{n} x_i$$

2) Both the timing and the magnitude of minimum flows will be summarized seasonally.

Minimum flow = Low *(qi)*

3) Both the timing and the magnitude of maximum flows will be summarized seasonally for spring (March, April, May), summer (June, July, August), fall (September, October, November), and winter (December, January, February).

Peak flow = Max *(qi)*

4) Total daily flow will be summed monthly and yearly.

$$total\ qi = \sum_{i=1}^{n} q_i$$

5) Flashiness, or the frequency and rapidity of short-term changes in streamflow, will be evaluated by dividing the pathlength of flow oscillations for a time interval (i.e., the sum of the absolute values of day-to-day changes in mean daily flow) by total sum of the discharge during that time interval (Baker et al. 2004) where qi is daily discharge. The equation known as the Richards-Baker index (R-B Index). Here, the annual year as the time-period of interest.

$$R - B\ Index = \frac{\sum_{i=1}^{n} |qi - (qi - 1)|}{\sum_{i=1}^{n} qi}$$

Additionally, if temperature is recorded at gaging stations, maximum and minimum temperature is recorded and used in the stream temperature section (see indicator: change in stream temperature).

For comparison of site types (glacier versus snow-dominated), sites are normalized by dividing mean monthly streamflow by mean annual streamflow for each stream gage site, creating a series of dimensionless numbers known as Pardé coefficients. The Pardé coefficient (multiplied by 12) gives monthly values ranging from 0 (no flow that month) to 12 (all the flow for the year arrives in that month) and would all equal 1 if flow did not vary by month.

Along with evaluation of U.S. Geological Survey data, a method for evaluating functional relationships among discharge, stage, and temperature will also be developed for an additional set of streams (Oregon State University partner work, in progress). Using water height recession analysis plots, structural decay of flow and changes in slope that are present in traditional discharge recession analysis without the need for discharge measurements or rating curves. Recession analysis will be used to evaluate links between baseflows and low-flow conditions (Jachens et al. 2019).

Statistics and Interpretation

Summarized calculations will be presented with tables (for example, see table 17 above) and plots indicating yearly fluctuations of mean daily and monthly flow for the year, low flow and peak daily flow and timing for the year, summation of total daily and monthly flow for the year, flashiness index computations, and Pardé coefficients. Repeated measures of analysis of variance will be used to assess trends in seasonal peak and low discharge and changes in flashiness of channel flow relative to mean discharge. T-tests will be used to assess differences in glacier versus snow dominated watershed metrics. Simple linear regressions will be conducted to assess trends in hydrograph timing and magnitude. Analysis will be conducted using R statistical analysis software (R Core Development Team 2021 version).

Data Management Plan

The forest hydrologist will use the established corporate Forest Service database that stores the results of the yearly stream discharge reviews across the Chugach National Forest.

Reporting Intervals and Plan Direction

Data are collected and reported by the Forest Hydrologist on an biennial basis in the Forest Biennial Monitoring and Evaluation report.

Estimated Annual Cost

The total estimated annual costs consist of personnel and project costs for monitoring, project engineering design, contracting, installation, data compilation, and data analysis. This estimate includes collaboration between the National Forest Hydrologist with periodic assistance from a Pacific Northwest Research Station hydrologist or contract specialist. A total of 30 days per year is estimated to download data, conduct field work, and summarize data. Every seven years, a total of 60 days will be needed to download data, conduct, field work, run analysis, and write a summary report.

Indicator: Tree and Shrub Encroachment into Alpine Tundra and Recently Deglaciated Areas

Glacial recession and the encroachment of tall woody species into alpine tundra ecosystems represent climate-driven, directional changes in land cover that can be quantified to assess the impact of warming temperatures on vegetation composition across the plan area.

Changes to alpine vegetation are expected to be more pronounced in the sub-boreal region of the Chugach National Forest (Kenai Peninsula geographic area), while changes resulting from glacial recession are likely to be more evident in the maritime region (Prince William Sound and Copper River Delta geographic areas).

The spatial extent of alpine tundra across Kenai Peninsula geographic area is expected to decrease in the next 50 years (Hayward 2017). In a study examining vegetation change near treeline during a 40-year period, encroachment of tall woody vegetation into alpine tundra matched the observed warming trend, and tall shrub encroachment into alpine tundra was proceeding more rapidly than treeline advance. In the Kenai Mountains, tall shrub advance was estimated at a rate of 7.5 feet per year, while treeline advance was proceeding at a rate of 3.6 feet per year (Dial et al. 2016).

Within the coastal rainforest region (Prince William Sound and Copper River Delta geographic areas), the greatest climate-linked shift in vegetation composition will be associated with glacial retreat in mid to low elevations. Coastal glaciers are especially vulnerable to warming because average winter temperatures of the maritime environment are currently near freezing, and in the next 50 years, winter temperatures are projected remain well above freezing at lower elevations during the coldest winter months.

The area occupied by early seral shrublands and woodlands expanding into recently deglaciated terrain is expected to increase as glaciers recede. In upper elevations in the maritime environment, winter temperatures are projected to remain below freezing during the coldest months and a deeper snowpack is predicted (Hayward 2017), potentially limiting the amount of glacial retreat in higher elevations.

Broadscale change in vegetation cover will be summarized using the U.S. Forest Service Landscape Change Monitoring System—a remote sensing-based system developed for mapping and monitoring changes related to vegetation canopy cover, as well as landcover and land use. Data produced by Landscape Change Monitoring System extend from 1985 to the most recently completed growing year. The system summarizes annual change in seven discreet landcover types: trees, tall shrubs, shrubs, grass/forb, barren, snow and ice, and water. The Landscape Change Monitoring System is intended to provide a consistent monitoring method for applications including, but not limited to, post-disturbance monitoring, broad-scale vegetation cover change, and land cover and land use conversion trends monitoring (https://apps.fs.usda.gov/lcms-viewer/tutorials/LCMS_v2020-5_Methods.pdf). This dataset is currently available across the coastal portion of Alaska from Kodiak at the western extent through southeast Alaska.

Describing vegetation change across specific landscapes in which the Chugach climate change vulnerability assessment (Hayward et al. 2017) has predicted shifts in vegetation composition will help segregate directional temperature-driven vegetation change from change associated with expected disturbance cycles (such as flood, fire, wind, insects, avalanches). The Landscape Change Monitoring System assessment for climate-driven vegetation change can be focused on 1) tree and shrub encroachment into alpine tundra in the Kenai Mountains, and 2) vegetation change after glacial recession in the maritime rainforest.

Methods and Metrics

Chugach National Forest ecology staff will use the Alaska Region Land Change Monitoring System web reporting tool developed specifically for monitoring changes in vegetation cover. The tool use and protocols are described in the tool's user guide (Vaughan 2022). The following data layers will be used to summarize Landscape Change Monitoring System data to evaluate landcover and vegetation change:

- Chugach National Forest land type association
- Chugach National Forest ecosection, aggregated to biome (table 18)
- Chugach National Forest geographic areas (these are labeled "landscape areas" in geospatial information data, but referred to as "geographic areas" in the land management plan, see table 19)

Table 18. Data layers for the Landscape Change Monitoring System tool Chugach ecosections and biomes

Ecosection Name	Ecosection Code	Biome
Tasnuna River	M244Ac	boreal transition*
Western Kenai Mountains	M244Af	boreal transition
Eastern Kenai Mountains	M244Ag	boreal transition
Turnagain Arm	M244Ae	maritime rainforest
Lowe River	M244Ab	maritime rainforest
Copper River Delta	M245Ad	maritime rainforest
Copper River	M245Ae	maritime rainforest
Kenai Fjordlands	M245Aa	maritime rainforest
Prince William Sound Mainland	M245Ab	maritime rainforest
Prince William Sounds Islands	M245Ac	maritime rainforest
Chugach Icefields	M244Aa	icefields
St. Elias Icefields	M244Ad	icefields

* "boreal transition" is referred to as "sub-boreal" in the National Vegetation Classification and the Chugach National Forest Land Management Plan Final Environmental Impact Statement (USDA Forest Service 2019).

Table 19. Chugach National Forest geographic areas

Geographic Area	Biome approximation
Kenai Peninsula	Boreal transition (sub-boreal)
Prince William Sound	Maritime
Copper River Delta	Maritime

Note: Geographic area and landscape area are equivalent terms. The plan uses the term geographic area, but the Chugach geospatial information data layer is labeled landscape area.

Change in area (acres) will be evaluated in five-year time steps starting from 1985 (see table 20).

Table 20. Change measures to be evaluated for each biennial monitoring and evaluation report

Indicator	Measure (acres)	Data Layer	Summary Units
Tree and tall shrub encroachment into alpine	Change in forest Change in tall shrub Change in shrub	Geographic area Ecological subsection FIA data plots	• Forestwide • Kenai Peninsula geographic area • Ecological subsections • 30 mountain sideslopes
Glacial recession	Change in ice and snow surface area	Biome (aggregated subsections)	• Maritime rainforest • Boreal transition • Icefields

Data Management Plan

The data are collected and summarized as part of the Alaska Region Landscape Change Monitoring System remote sensing data processing and use program supported through the Geoinformation Technology Assistance Center. Precomputed zonal statistics will be developed by summarizing annual Landscape Change Monitoring System data developed for Southeast Alaska and select feature classes determined by the region (for example, Tongass National Forest Land Type Associations, ecological domains, district, national forest, or regional boundaries). Precomputed zonal statistics allow for faster summary operations and an enhanced user experience. Each year, new annual data will need to be updated, and the database refreshed. Zonal summary data will likely be stored as a GeoJSON (Geographic JavaScript Object Notation) file format. A GeoJSON file allows for very quick data lookups and display in a web-based format. A web hosting environment for the JSON file is currently being researched with ArcGIS Online and USDA-VDC as being the most likely places for it to be stored.

Reporting Intervals and Plan Direction

Reports will include summaries of information and trends will be by area (acres) of Landscape Change Monitoring System landcover change in 5-year increments; and cumulative change since 1985. Snow and ice will be summarized using the land type association categories for alpine summits and glaciers: change in tall shrub and tree cover, by cover class and cumulatively (tree plus tall shrub to account for forest replacement of tall shrub at treeline). Periodic trend evaluations will be completed at 7 year intervals and compared to predicted models for change. These evaluations will include description of “hotspots of change” or areas with rapid change detected relative to the geographic area and plan area. This summarized change information can be used to lay a foundation for discussions with partners and forest communities regarding change and adaptive approaches to management.

The following anticipated changes were described in the Climate Change Vulnerability Assessment for the Chugach National Forest (Hayward et al. 2017) and the Chugach National Forest Land Management Plan Final Environmental Impact Statement (USDA Forest Service 2019).

Tree and tall shrub advance into alpine tundra in the Kenai Mountains

In non-glaciated alpine environments: Anticipate that tall shrub cover is increasing, gradually replacing shrub, grass/forb, and barren classes in alpine environments. Anticipate that tree encroachment is occurring more slowly than tall shrubs advance. In areas where treeline is advancing, trees will replace tall shrubs, shrubs, or grass/forb classes.

Succession after glacial recession

Glacial recession can be segregated into tidewater/low elevation recession and upper elevation glacier recession (or lack of recession where snowpack is deeper).

Tidewater/low elevation glaciers in maritime conditions

- Reduced cover of snow and ice, increased cover of saltwater (where glacial ice is not grounded, or where it is grounded below sea level);
- Where ice retreats on land we expect reduced cover of snow and ice and increased cover of grass/forb, shrubs, tall shrubs, trees.

Glaciated alpine environments

- Scenario 1: Reduced cover of snow and ice, increased cover of grass/forb, shrub, tall shrub. More pronounced in Kenai Peninsula geographic area (sub-boreal, rain shadow, less precipitation)
- Scenario 2: No reduction of snow and ice (increased snow pack may limit glacial retreat in some areas, particularly higher elevation maritime environments).

Estimated Annual Cost

This work will be completed using remotely sensed information from the Landscape Change Monitoring System, which is funded, updated, and managed under federal partnerships nationally, so the cost of using the information is minimal. Staff time to collect, review, analyze and report data using a summary tool developed for Alaska Region 10 will take a forest specialist approximately 10 days and program manager approximately three days every other year. Periodic assessments of the data trends, including identification of hot spots of change and comparison of trends to predicted patterns will take a program manager approximately 15 days every 7 years.

Indicator: Changes in Water Temperature at Selected Sites

Although climate change is known to effect water temperature in freshwater ecosystems that support Pacific salmon (*Oncorhynchus* spp.) and other cold-water fishes (Schindler, Rogers and Scheuerell 2005) some Alaskan groundwater streams with relatively stable temperatures exist and are considered refugia. Resilient watersheds are better able to continue delivery of ecosystem services when subjected to ecological change, including impacts resulting from a warming climate. To assess both resilient streams and those prone to change, stream temperature will be monitored in rain, snow, and glaciated watersheds. Monitoring is facilitated by the Kenai Peninsula Zone and Prince William Sound Zone aquatics programs that currently maintains a network of water and air temperature loggers on aquatic habitats on the Chugach National Forest.

The Western Alaska and Northwest Boreal Landscape Conservation Cooperatives along with the U.S. Geological Survey Alaska Climate Science Center convened a 2-day workshop in Anchorage in November 2012 assembling scientists interested in Alaska's water temperature monitoring. Lacking common attributes, workshop organizers were unable to catalog and map water temperature monitoring sites at the workshop due to inconsistent formatting among agencies and a lack of digital metadata. Workshop organizers and participants prioritized a need for a more comprehensive inventory of project metadata and attributes for current and past stream and lake temperature monitoring efforts facilitating the Alaska Online Aquatic Temperature Site (AK-OATS) with standardization of metadata attributes across dozens of data sources. At a minimum, metadata requirements include the following attributes: unique site identifier, data source agency or organization name and contact information, datum, latitude, longitude, and sample frequency. For any new sites, investigators are strongly encouraged to submit project metadata to AK-OATS (http://aknhp.uaa.alaska.edu/aquatic-ecology/akoats/).

The Chugach National Forest stream temperature network was initiated in 2009 in close coordination with the Forest Service's Pacific Northwest Research Station and the University of Alaska Anchorage. The AK-OATS database is currently maintained by the University of Alaska Anchorage. In 2019, the network had approximately 40 active sites and 22 retired sites. As of January 2021, the network had a total of 32 active sites and 30 retired sites. This Alaska stream temperature monitoring system uses a set of standards to begin building robust datasets suitable for regional analyses (Mauger et al. 2014). The temperature database for the Chugach National Forest will be available late in 2022 (Becky Shaftel, personal communication, January 10, 2022).

Methods and Metrics

To facilitate the tracking of changing channel temperature, hydrologic unit codes for the Chugach National Forest watersheds will be delineated into glacier, snow, snow transitioning to rain, and lake and groundwater-dominated categories using the Chugach climate change vulnerability assessment (Hayward et al. 2017). Hydrograph evaluation will include three main steps: (1) choose a set of channels from glacier, snow, snow to rain transitioning, and groundwater-dominated watersheds; (2) compile yearly summaries, and (3) conduct an evaluation every seven years to determine if stream temperature is changing. Assessment of temperature changes will include assessments of timing (annual phase change), amount or magnitude (amplitude) of change, and flashiness (short term, rapid spikes) of channel temperature relative to mean temperature to interpret temperature shifts.

Fieldwork and Data Collection

Deployment of data loggers will continue to follow the regional standardized procedure for stream temperature data logger site selection, placement, and maintenance, and follow standards for data quality assurance, data management, and data sharing. Standard practices include minimum data logger accuracy at plus or minus 0.25° C including a temperature range of minus 4° to 37° C, and data collection intervals of 1.0 hours. Specific details of temperature logger placement can be found in technical guidance at the end of this chapter. Currently a total of 44 streams are monitored for stream temperature when including the six U.S. Geological Survey gaged streams along with the 38 streams that are monitored solely for temperature (table 21). Minimally, a subset of 18 streams will be selected from the total available set of 44 streams to conduct analysis and evaluate temperature change based upon several climate predictions (Hayward et al. 2017). The subset selection will be based on consideration of environmental gradients including elevation, slope, stream size, and wetlands and lake association (table 21).

Table 21. List of current operating gaging stations with stream temperature and loggers measuring only temperature in the Chugach National Forest by Kenai or Prince William Sound region with watershed type. For each gage, the name, location, and U.S. Geological Survey (USGS) gage number and location is listed. Sites where stream temperature is measured are also listed with shortname (if known), and position.

Dominant watershed type	No change predicted: Site, code, lat. long. position (description by either Hayward et al. 2017 or Sergeant et al. 2020)	Transition predicted Site, code, lat. long. position (description by either Hayward et al. 2017 or Sergeant et al. 2020)
Glacier dominant/ high elevation snow	1) Miles River at Million Dollar Bridge near Cordova USGS 15214000 2) McKinley Island (McKis) 60.46480, -145.19308 3) Ibeck Creek (Ibeck) 60.58703, -145.47194 in Copper River Delta 4) Stellar Jay Creek (StJay) 60.44131, -148.67931(* coastal tributary) 5) Center Creek 60.704125, -149.245394 6) Bench Creek (has lake upslope) 60.686819, -149.22996	1) Glacier River tributary near Cordova, USGS 15215900 (glacier transitional to snow transitional to glacier)
Clearwater, snow dominated	1) Six Mile Creek near Hope, USGS 15271000 2) Jackpot River, Jackp, 60.41748, -148.24494 (Hayward et al. 2017, snow – dominant to transitional) 3) Glacier Creek at Alyeska Highway at Girdwood, USGS 15272502 4) West Fork Olsen Bay Creek near Cordova, USGS 15219000 (tidal influence) 5) 18 Mile (ET.Mi) 60.46014, -145.29443 6) Blackhole Creek (Black) 60.44743, -145.24216 7) Olsen Creek Freshwater(OlsFW) 60.75960, -146.17516 8) Olsen Creek Intertidal(OlsIT) 60.75960, -146.17587 9) Middle Arm Eyak (EyakL) 60.55586, -145.64279 10) Tiedeman South (TiedS) 60.42549, -145.47253 11) Rich Hate Me Pond (RHM) 60.47793, -145.38228 12) Rude River Side Channel (RudeR) 60.66271, -145.60803 13) Resurrection Creek 60.918092, -149.64687 14) Quartz Creek 60.508065, -149.682522 15) South Fork Williwaw Creek 60.786012, -148.886457	1) Martin Lake Cabin (60.38340, -144.58941) 2) Little Martin River (60.39660, -144.60601) 3) Martin Lake Inlet (Marti) 60.33978, -144.52231 4) Cabin Lake Outlet (Ot.Ca) 60.52648, -145.46089 5) Sheep River (Sheep) 60.71648, -145.90128 6) Koppen Creek (Koppe) 60.70664, -145.59693 7) Erb Creek Freshwater (ErbFW) 60.37680, -148.15289 (Hayward et al. 2017, clearwater; snow change dominant to transitional) 8) Hells Hole Tributary (Hells) 60.71769, -146.38672 9) Eagle Creek (Eagle) 60.45725, -146.56613 (snow-dominant by Hayward et al. 2017, rain-dominant by Sergeant et al. 2020) 10) Stump Lake Outlet (Stump) 59.87278, -147.45234 (rain-dominant Sergeant et al. 2020, snow-dominant Hayward et al. 2017)

Dominant watershed type	No change predicted: Site, code, lat. long. position (description by either Hayward et al. 2017 or Sergeant et al. 2020)	Transition predicted Site, code, lat. long. position (description by either Hayward et al. 2017 or Sergeant et al. 2020)
Lakes and groundwater systems Very little fluctuation in temperature expected	1) Solf Lake Fish Pass, SolfF, 60.43149, -146.72932 (snow-dominant by Hayward, rain-dominant by Sergeant) 2) 25 Mile (TF.Mi) 60.44257, -145.12059 3) Hatchery Creek (Hatch) 60.59154, -145.63434 4) North Fork Williwaw 60.787269 -148.886173 5) Clear Creek (Clear) 60.56538, -144.77759 6) Dave's Creek 7) Solf Lake Inlet (SolfI) 60.41499, -147.72842 8) Salmon Creek (Salmo) 60.45448, -145.17387 60.50692, -149.67839 9) North Fork Williwaw Creek 10) Chickaloon River 60.633078, -149.886287 11) Crescent Creek 60.498342, -149.687591 12) Juneau Creek 60.488684, -149.880327	No sites with transition expected

Data Analysis

Four main questions associated with temperature data will be interpreted to assess predictions made by the Chugach climate change vulnerability assessment (Hayward et al. 2017) including:

- Is spring stream temperature increasing earlier in the season?
- Is stream temperature increasing in the summer?
- Are winter temperatures increasing at some sites?
- What are differences in air temperature and stream temperature relationships for glacier, snow-dominated, and lake/groundwater systems?

1) Mean daily stream temperature, or ti is computed by averaging the hourly temperature measurements, xi, for each day.

$$ti = \frac{1}{n}\sum_{i=1}^{n} x_i$$

2) The timing of minimum stream temperature will be summarized seasonally.

Minimum temperature = Low (ti)

3) Both the timing and the magnitude of maximum stream temperature will be summarized for seasonally for spring, summer, fall, and winter.

Peak temperature = Max (ti)

4) Flashiness, or the frequency and rapidity of short-term changes in both stream temperature and air temperature, will be evaluated by dividing the pathlength of temperature oscillations for a time interval (i.e., the sum of the absolute values of day-to-day changes in mean daily flow) by total sum of the temperature during that time interval following a discharge fluctuation approach (Baker et al. 2004) where ti is average daily temperature. The equation known as the Richards-Baker index. Here, the annual year as the time-period of interest.

$$R - B\ Index = \frac{\sum_{i=1}^{n} |ti - (ti - 1)|}{\sum_{i=1}^{n} ti}$$

Data Summaries and Analysis

Mean daily stream temperatures obtained (or calculated as the average of the daily maxima and minima) for each year in a temperature time-series meeting the 300-day criterion will be described and analyzed. The calendar year average of these values will be used as the estimate of annual stream temperature. Similar summaries will be constructed for each year's seasonal periods; spring (March, April, May), summer (June, July, August), autumn (September, October, November), and winter (December, January, February). As a minimum threshold, a total of 75 days of temperature measurements during a seasonal period are required for the analysis (Adelfio 2019). Because of a general concern that climatic extremes will change faster than mean conditions (Jentsch et al. 2007), each year's minimum weekly average temperature and the maximum weekly average temperature from the 7-day rolling averages of daily means will also be summarized.

Statistics and Interpretation

Data will be summarized yearly in tables. Every seven years, plots of seasonal, mean monthly temperature for the time series year, low temperature, and peak daily temperature and timing will be evaluated. Repeated measures of analysis of variance will be used to assess differences in seasonal peak and low and changes in flashiness of channel flow relative to mean discharge to assess differences in water temperatures for cool/snow-dominant and warm/rain-transitional differences in glacier versus snow dominated watersheds. Simple linear regressions will be conducted to assess trends in hydrograph timing and magnitude over time. Analysis will be conducted using R statistical analysis software (R Core Development Team 2021 version).

Partnerships

The Forest Service hydrologist, along with technician support, will download water temperature data logger outputs from various sites on the Chugach National Forest and add data to existing corporate databases such as the Aquatics Qualification System in Natural Resources Manager, and also, transfer databases to the University of Alaska Anchorage.

A team led by University of Alaska Anchorage is working on a regional water temperature sensitivity analysis covering freshwaters in Bristol Bay, Cook Inlet, Kenai, Prince William Sound, and Copper River watersheds (publication expected in 2022).

Data Management Plan

The forest hydrologist will use the established corporate Forest Service database that stores the results of the yearly stream temperature reviews across the Chugach National Forest. Data will be submitted to University of Alaska partners.

Reporting Intervals and Estimated Annual Cost

No results of monitoring are anticipated in 2020–2021. The first interval of reporting is expected in 2024 and the first report will be in 2029. The total estimated annual costs consist of personnel and project costs for monitoring and project engineering design, contracting and installation. This estimate includes collaboration between the Chugach National Forest hydrologist and University of Alaska Anchorage partners. A total of 50 days per year is estimated to download data, conduct field work, and summarize data. Every seven years, a total of 31 days will be needed to download data, conduct, field work, run analysis, and write a summary report.

Indicator: Snow Depth and Season of Snow Cover

Changes in duration of snow cover, snow depth, and snow-water equivalent are important mechanisms whereby climate change impacts hydrology, ecology, and ecosystem services, especially areas influenced by seasonal snow cover. Further, change in snowpack is expected to increase alpine plant establishment and increase albedo leading to further reductions in snowpack and increases in the snow free period. Specifically, mean monthly near-surface air temperatures are anticipated to exceed freezing throughout the entire year by 2050, contributing to a 20 to 40 percent reduction in mean snowpack snow-water equivalent below 500 meters elevation on the Prince William Sound (Littell et al. 2018). Further, in the highest elevations of the wilderness study area (500 to1500 meters), a seasonal reduction in snow-water equivalent is projected for late autumn (October and November), but annual snow-water equivalent is anticipated to remain within plus or minus 10 percent of historical condition (Littell et al. 2018).

On the Chugach National Forest, existing partnerships and current databases will be used to evaluate change in snow depth and seasonality. Snow telemetry and snow course datasets and the Landscape Change Monitoring System will be used within the context of the Chugach climate change vulnerability assessment (Hayward et al. 2017) to assess change in snow depth and seasonality over time. The U.S. Forest Service produced Landscape Change Monitoring System is used for mapping and monitoring changes related to vegetation canopy cover, as well as land cover and land use. Data produced by the Landscape Change Monitoring System extend from 1985 to the most recently completed growing year.

The available snow survey and water supply forecasting normals are site-specific measures of central tendency (either the median or average) for a data type, such as snow-water equivalent. The statistics are calculated over a 30-year period and updated each decade, in agreement with World Meteorological Organization standards. This 30-year reference period was chosen to characterize the current hydroclimatology at each station. The most recent medians and averages have been updated to include data for the water years 1991–2020. The National Water and Climate Center also provides medians and averages for the 1981–2010 and 1971–2000 reference periods for stations with sufficient data.

The Chugach climate change vulnerability assessment (Hayward et al. 2017) along with the Scenarios Network for Alaska and Arctic Planning (http://www/snap.uaf.edu), a program within the University of Alaska, helped establish a set of specific monitoring questions. Although rapid change in snowline is expected over time, high inter-year variability is expected. Three specific questions regarding change in snow depth and seasonality include:

- Is the snow-day fraction decreasing from October to March between sea level and 500 meters and 1000 meters as predicted?
- Is the snow-water equivalent decreasing in late autumn (October and November) as predicted at lower elevations (below 1500 meters).
- Compared to 1971–2000, is the percentage of the landscape that is snow dominant (permanent snow packs) being reduced?

Methods and Metrics

Snow telemetry and snow course datasets, both collected by the USDA National Resource Conservation Service, will be evaluated on a biennial basis. Information, currently collected at 15 sites on the Chugach National Forest (table 22), will be associated with projections from the Chugach climate change vulnerability assessment (Hayward et al.2017) to assess snow depth change over time. Also, information collected will be associated with any updates from the Scenarios Network for Alaska and Arctic Planning (SNAP) program that stores the results of the yearly snow data reviews across the various activities on the Chugach National Forest.

Along with snow telemetry and snow course datasets, data estimates for indicator: tree and shrub encroachment into alpine tundra and changes in recently deglaciated areas will be used to quantify changes in the percentage of the snow-dominant landscape. Estimates of tree and shrub encroachments, will likely use the Landscape Change Monitoring System, and these estimates can be subtracted from regions that are snow dominant.

Table 22. Chugach National Forest SNOTEL site information

Site and Station ID	Elevation (feet)	Hydrologic Unit Code	Latitude, Longitude	Region-County
Mt. Eyak 1073	1405	190202010200	60.55, -145.74	Valdez-Cordova
Esther Island 1071	50	190202011605	60.8 -148.09	Valdez-Cordova
May Creek 1096	1610	190201031603	61.35 -142.71	Valdez-Cordova
Mt. Alyeska 1103	1540	190203020702	60.96 -149.09	Anchorage
Turnagain Pass 954	1880	190203020406	60.78 -149.18	Kenai Peninsula
Grandview 956	1100	190203021001	60.61 -149.06	Kenai Peninsula
Grouse Creek Divide 964	700	190203020902	60.26 -149.34	Kenai Peninsula
Summit Creek 955	1400	190203020401	60.62 -149.53	Kenai Peninsula
Cooper Lake	1200	190203021205	60.39 -149.69	Kenai Peninsula

Source:
https://www.wcc.nrcs.usda.gov/snow/snow_map.html#:~:text=https%3A//www.nrcs.usda.gov/wps/portal/wcc/home/quicklinks/predefinedMaps/

Data Downloading and Report Generation

A step-by-step procedure to download and utilize snowpack data to assess change in snowpack depth and timing is included on the Natural Resources Conservation Service National Water and Climate Center website: https://www.nrcs.usda.gov/wps/portal/wcc/home/quicklinks/predefinedMaps/.

The forest hydrologist will summarize snowpack assessments from the National Water and Climate Center. Also, results of the indicator tree and shrub encroachment into alpine tundra and changes in recently deglaciated areas will be used to assess changes in percentage snow cover of permanent snow. Associated maps highlighting areas of snowline change will be developed with a geospatial information specialist.

Statistics and Interpretation

Data will be summarized yearly in tables. Every seven years, plots of snow-day fraction, snow-water equivalent and percentage of the landscape that is snow dominant will be evaluated with repeated measures of analysis of variance. Simple linear regressions will be conducted to assess trends. Analysis will be conducted using R statistical analysis software (R Core Development Team 2021 version).

Data Management Plan

The forest hydrologist will use the established corporate Forest Service database that stores the results of the yearly stream discharge reviews across the Chugach National Forest.

Estimated Annual Cost and Reporting Intervals

No results of monitoring are anticipated in 2020–2021. The first interval of reporting is expected in 2024 and the first report will be completed in 2029. The total estimated annual costs consist of personnel costs for monitoring. This estimate includes collaboration between the forest hydrologist and research staff with the Scenarios Network Alaska and Arctic Planning program for any updates in forecasting models (such as those presented in Hayward et al. 2017 and Littell et al. 2018); and collaboration with a geospatial information specialist. A total of 4 days per year is estimated to download and summarize data. Every seven years, a total of 6 days will be needed to download climate data, discuss changes in snow pack projections based on the SNAP run analysis, and write a summary report.

Technical Guidance for Chapter 6

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 6, click here.

Chapter 7 Desired Conditions, Including Social, Cultural, and Economic Sustainability

This chapter provides monitoring protocols for two program areas on the forest that will address the monitoring need for the 2012 Planning Rule required topic "Desired Conditions, Including Social, Cultural, and Economic Sustainability." The chapter is separated into two sections to address the different regulatory framework and structure associated with the Nellie Juan College Wilderness Study Area from other forest products and services that contribute to social and economic stability of communities, multiple use management of the plan area, or plan components related to social, cultural, and economic sustainability. Each section has a different monitoring question that is addressed in the described measures and protocols. Section A focuses on opportunities for multiple uses of goods and services the forest provides for communities and covers a wide range of ecological services. Section B focuses on monitoring the presently existing character elements described in the *Nellie Juan-College Fiord Wilderness Study Area Existing Character Baseline Report* (USDA Forest Service 2021).

Chapter 7, Section A: Desired Conditions Ecosystem Services

Communities adjacent to the national forest rely on a variety of commodities and business opportunities for economic, social, and cultural sustainability. Trends in the number of forest use permits that are issued for a variety of commodities and business opportunities can indicate how much the Forest Service is able to contribute to these aspects of sustainability and meeting the desired conditions of making these commodities and services available to the local communities.

Chapter 7, Section A: Priority Management Questions, Associated Indicators, and Monitoring Methods

Monitoring for sustainable goods and services addresses six forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the "Social and Economic Sustainability," "Recreation," and "Ecosystem Services" sections of the plan (and correspond to 2020 plan component identification codes FW-GL2-SOCIAL-DC, FW-GL2-REC-DC, and FW-GL3-ES-DC).

- Healthy salmon stocks and quality fish habitat support all types of fisheries uses across the national forest; the amalgamation of commercial, sport and subsistence use of the fisheries resources benefits local, regional, and national economies.
- Sustainable levels of goods and services, such as recreation and tourism opportunities; established fisheries; minerals extraction and energy generation; forest products; outfitter and guide services; and ecosystem stewardship opportunities are available to communities. These goods and services contribute to the local economy through generation of jobs and income while creating a variety of products for use, both nationally and locally.
- The Forest Service encourages a diverse array of recreation opportunities by permitting businesses to provide guided recreation activities for visitors to the Chugach National Forest.
- Wild, renewable resources provided by the national forest are sustained by ecological processes, are accessible to users, and contribute to the livelihood and lifestyles of both rural and non-rural Alaska residents.

- National Forest System lands continue to provide habitat for native and desired nonnative wildlife species, helping to support populations capable of sustaining hunting opportunities.
- Forest products are available and accessible for harvest for cultural, personal, and commercial use in a sustainable manner. Timber harvest meets multiple-use goals of providing wood products for commercial and private use, wildlife habitat enhancement, improving forest health, or achieving a land management plan desired condition.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in condition related to forest management over the life of the plan.

Monitoring Question

One priority management question was identified to monitor sustainable goods and services:

Is the national forest providing a sustainable, predictable level of goods and services to communities?

To address the monitoring question, Chugach National Forest staff selected six indicators to determine trends in conditions for sustainable goods and services. Table 23 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring sustainable goods and services.

Table 23. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring sustainable goods and services on Chugach National Forest

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Trends in number of commercial recreation permits issued	Number of outfitter guide permits issued and administered	Annually	5 years	Special Uses	Report: special uses lead 1 day Analysis: 2 days.
Trends in developed recreational facility use	Percentage occupancy for fee campsites and cabins	annually	5 years	Recreation	Report: specialist and manager 1 day each Analysis: manager 1 day
Trends in sport- fishing harvest	Number of fish harvested in the Chugach National Forest.	Annually	5 years	Resources: Fisheries	Report: specialist 4 days Analysis: manager 4 day

Indicators	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Trends in number of forest product permits issued	Special forest products and fuel/sawlog permits	Biennially	Biennially	Resources: timber	Report: specialist 5 days annually Analyses completed concurrently
Trends in number of permits issued for subsistence harvest	Number of harvest permits issued for each federal subsistence hunt or fishery, and harvest reports.	Annually	5 years	Subsistence	Report: specialist 3 days annually Analysis: 3 days
Trends in number of mineral materials permits issued and locatable mineral plans of operation approved	Number of Mineral material contracts and number of locatable minerals plans of operation	Biennially	5 years	Minerals and Mining	Report: specialist 2 days annually Analysis: 5 days

If negative trends are found during assessment of these indicators, the following management responses should be considered:

- Re-evaluate the funding and priorities of the budget as well as staffing decisions and determine if additional resources (budget and employees) are needed for issuance of permits that are showing a negative trend.
- Determine if additional land management plan objectives are needed to focus effort on any aspect that is showing a negative trend.
- Determine if there is a limiting factor for making these resources available to the local communities that is beyond what is possible to change in the land management plan, budget, or staffing (for example, no additional locations available for mineral material pit development, therefore less material available).

Six indicators were selected for monitoring from a broad range of program areas that represent a range of goods and services provided by Chugach National Forest to the communities it serves. Positive or stable trends will indicate the Forest Service is making these commodities available; negative trends may indicate funding, staffing shortages, or change in priorities for funding and staffing; or possibly the availability of the resources may be changing (such as mineral materials), which may affect the long-term sustainability of making the good or service available to the local community.

Indicator: Commercial Recreation Permits

The reported information will be used for two areas for monitoring: as an indicator of services provided by the Chugach as described in this chapter, as well as an indicator of recreation services described in chapter 5 for the indicator: number of outfitter guide permits issued and administered, types of guided activities, and locations.

Methods and Metrics (Commercial Recreation Permits)

See chapter 5, indicator for trends in number of outfitter guide permits issued and administered, types of guided activities and locations: Methods and Metrics.

Data Management Plan (Commercial Recreation Permits)

See chapter 5, indicator for trends in number of outfitter guide permits issued and administered, types of guided activities and locations: Data Management Plan.

Reporting Intervals (Commercial Recreation Permits)

See chapter 5, indicator for trends in number of outfitter guide permits issued and administered, types of guided activities and locations: Reporting Intervals and Anticipated Results.

Estimated Annual Cost (Commercial Recreation Permits)

The combined staff time needed for this indicator in both chapter 5 and this chapter is about 1 day of work for the special uses service team lead annually, with an additional 2 days needed every fifth year of the 15-year plan life.

Indicator: Developed Recreational Facility Use

Methods and Metrics (Developed Recreational Facility Use)

The reported information will be used for two areas for monitoring: as an indicator of services provided by the Chugach as described in this chapter, as well as an indicator of recreation services described in chapter 5 for the indicator: recreational facility occupancy rate.

The online registration portal recreation.gov will be used to collect data needed to determine the occupancy rate for rental cabins.[5] Use data is pulled annually (January 1–December 31) from the recreation.gov website and analyzed to determine an annual weighted percent occupancy for each cabin during its operating season. The total operating days for a cabin are equal to the number of days the site is available for use. For most cabins this is 365 days per year, but there can be exceptions. For those days the site is occupied, the percent occupancy will be 100 percent, regardless of the group size. For those days the site is available, but not occupied (meaning not reserved, or reservation cancelled), the percent occupancy will be 1 percent. Use numbers are inserted into an occupancy calculator tool provided by the National Recreation Sites Data Entry Business Rules (https://www.recreation.gov/use-our-data) to determine a final weighted percent occupancy for each cabin.

[5] With the exception of Spencer Bench Cabin, which is reserved via the Alaska Railroad from June 1–September 14 and recreation.gov from September 15–May 31. Spencer Bench Cabin use data for the summer months is provided by the Alaska Railroad and incorporated into the data provided by recreation.gov.

For fee-use camp sites, occupancy rate will be determined by visitor use data provided by the contractor/concessionaire Alaska Recreation Management (referred to as ARM) via the ARM Portal Shared Workspace. Specific data analyzed will be number of sites occupied each night, not number of visitors at each occupied site. Use data for the concessionaire-run campgrounds is pulled annually (January 1–December 31) from the ARM Portal and analyzed to determine an annual weighted percent occupancy for each campsite during its operating season. In accordance with the National Recreation Sites Data Entry Business Rules, the operating season is the number of days each year the site is operated for public use and critical standards are being met; use levels include Peak (76 to 100 percent occupied), High (41 to 75 percent occupied), Moderate (16 to 40 percent occupied), and Low (0 to 15 percent occupied). Days where the site is physically open but not being operated for use are not included in the operating season. If the site is not being managed to at least meet critical standards, it is not considered operational. Fees are collected and use data is reported via concessionaire from mid-May to mid-September (actual dates vary slightly year to year) when ARM manages the sites.[6] Data from ARM is analyzed to determine how many days during the period of operation each campground is at a particular use level; Peak, High, Moderate, and Low. Use numbers are inserted into an occupancy calculator tool provided by the National Recreation Sites Data Entry Business Rules, https://www.recreation.gov/use-our-data, to determine a final weighted percentage occupancy for each campsite.

Data Management Plan (Developed Recreational Facility Use)

The annual occupancy data for all rental cabins and fee-use campsites forestwide will be stored in the shared Pinyon file 2300 Planning~SO/Forest Monitoring Data Management Plan/Recreation Site Occupancy Rate. This is also the location where future trend analyses will be stored long term. Data will be retrieved via request for folder permissions to the forest recreation program manager. In addition, the recreation program manager will provide updates to file strings and data storage locations in the biennial monitoring and evaluation report.

Reporting Intervals and Plan Direction (Developed Recreational Facility Use)

Data will be analyzed by the recreation data specialist and reported to the recreation program manager annually. Trends in data will be analyzed every five years by the recreation data specialist and reported to the recreation program manager, who will assess the relationship to the 2020 plan guidance for visitor use and recreation objectives.

Estimated Annual Cost (Developed Recreational Facility Use)

In addition to regular program reporting, 1 day of work for one data specialist and the recreation program manager will be required annually, with an additional 1 day needed every fifth year of the 15-year plan life.

Indicator: Forest Product Permits

The 2020 land management plan desired conditions addressed in this monitoring program describe sustainable levels of goods and services including forest products. Additionally, the plan also states these goods and services contribute to the local economy through the generation of jobs and income while creating a variety of products for use both nationally and locally. Forest products must also be made available and accessible for harvest for cultural, personal and commercial use in a sustainable manner (2020 plan component identification codes FW-GL2-SOCIAL-DC, FW-GL2-REC-DC, and FW-GL3-ES-DC).

[6] Campgrounds are regularly used outside of this time period; however, this use is difficult to account for accurately. For the purposes of this trend analysis the use data provided by the concessionaire allows for more accuracy and therefore is sufficient.

The Forest Service provides a variety of forest products including fuelwood, sawtimber, ferns, mushrooms, wildflowers, seedlings, Christmas trees, burls, berries, cones, conks, and other non-timber, plant-based products harvested for commercial sale.

All commercial forest products removed from the National Forest requires a permit. Noncommercial forest products, such as personal use fuelwood, do not require a permit unless dictated by resource conditions.

Methods and Metrics (Forest Product Permits)

The number of commercial forest products permits issued by the Forest Service will be used to monitor if sustainable amounts of forest products are being permitted to community residents. The Natural Resource Manager database includes the Timber Information Manager (TIM) application that will be used to collect and compile data on the number of forest product permits issued annually. Data will be compiled annually and analyzed to determine the number of permits utilized over that period and compared to previous data. When permits are issued by the Forest Service, they are entered into TIM as part of the administration of the permit per national direction. These permits are issued for a set amount of a forest product (for example firewood), and the amount for each permit is determined by the availability of the product and management direction. For example, an area may have a large number of hazardous trees near high use areas that are compromised due to disease. The forest may issue more permits for firewood cutting in this area to encourage removal of the trees and enhance a safe visitor experience.

Data Management Plan (Forest Product Permits)

Data stored in TIM consists of compiled total number of permits issued by the Chugach National Forest for forest products each year. This information can be subdivided into special forest products and fuelwood/sawlogs. The terrestrial ecology programs enter and manage these data across the national forest. Data are stored and maintained in two places: 1) in the hardcopy applications for permits received from the public and filed at the District Offices for the area in which they are issued; and 2) in the Natural Resource Manager database TIM application.

Reporting Intervals and Plan Direction (Forest Product Permits)

It is anticipated that special forest products permits will remain at levels around four to six permits each year with some variance depending on markets, weather, and other factors. Free use permits for fuelwood are expected to remain variable as the spruce beetle outbreak and supply from non-Forest Service ownerships increases the availability. From 2015 to 2020, there have been between 115 and 460 permits issued for annual totals between 370 and 1340 cords.

The zone silviculturist/forester will assess the trends in permits annually and describe the relationships, recommendations, and interannual variability in the biennial monitoring and evaluation report. Annual data within or near the expected and historic range for each forest product (for example firewood) should be considered sustainably available. Significant departure from this range should be examined for root cause and management prescriptions or recommendations provided.

Estimated Annual Cost (Forest Product Permits)

These data are regularly collected and tracked as part of the program of work across the forest for timber management. Compilation and analysis of these data, along with documentation of findings, is expected to require one resource specialist about 5 days each year.

Indicator: Sport Fishing Harvest

Number of fish harvested and caught (total fish harvested and released) by species are monitored annually in each of seven Kenai Peninsula Zone and three Prince William Sound Zone freshwater sport fisheries (table 24). Additionally, sport fishing effort, estimated in number of anglers per year and days fished per year, are tracked for each of the ten systems.

Methods and Metrics (Sport Fishing Harvest)

The sport fish harvest and effort data are publicly available annual estimates provided by the Alaska Department of Fish and Game Alaska Sport Fishing Survey (2022). The survey is a statistically robust annual mail survey conducted since 1977 that provides yearly estimates (including error) of number of anglers, days fished, catch by species, and harvest by species for many saltwater and freshwater fisheries statewide. This post-fishing season mailed survey uses a stratified sampling design to randomly sample sportfishing households who have purchased Alaska State fishing licenses in the specific year. Estimates of participation and harvest generated from this survey are designed to be within 15 percent of the actual values 95 percent of the time. Annual Alaska Sport Fishing Survey results are available in September of the following year. Sport fish harvests from locations within the Kenai Peninsula Zone are reported in Alaska Sport Fishing Survey southcentral Alaska area PF and L; sport fish harvests from locations within the Prince William Sound Zone are reported in Alaska Sport Fishing Survey southcentral Alaska area J (table 24).

Table 24. Locations and species monitored for Kenai Peninsula Zone and Prince William Sound Zone sportfish harvest and catch

Location	Species
Kenai Peninsula Zone[1]	
Russian River	Coho salmon, pink salmon, sockeye salmon, Dolly Varden, rainbow trout
Resurrection Creek	Chum salmon, coho salmon, pink salmon
Sixmile Creek	Chum salmon, coho salmon, pink salmon, Dolly Varden, rainbow trout
Quartz Creek	Dolly Varden, rainbow trout
Crescent Lake	Arctic greyling, rainbow trout
Kenai Lake	Dolly Varden, rainbow trout
Twentymile River	Coho salmon, pink salmon, Dolly Varden
Prince William Sound Zone[2]	
Alaganik Slough	Coho salmon, sockeye salmon, Dolly Varden
Eyak River	Coho salmon, pink salmon, sockeye salmon, cutthroat trout
Ibeck Creek	Coho salmon, cutthroat trout, Dolly Varden

1 – Alaska Sport Fishing Survey areas PF and L.

2 – Alaska Sport Fishing Survey area J.

Data Management Plan (Sport Fishing Harvest)

Each year, harvest and participation data are downloaded as excel files from the Alaska Department of Fish and Game Alaska Sport Fishing Survey website (https://www.adfg.alaska.gov/sf/sportfishingsurvey/). Annual harvest and catch (number of fish) for each location and species, as well as annual number of anglers and number of days fished for each location are tracked in a excel spreadsheet stored in a shared Pinyon folder, managed by Kenai Peninsula Zone and Prince William Sound Zone aquatics programs.

Reporting Intervals (Sport Fishing Harvest)

Annually, the Kenai Peninsula Zone and Prince William Sound Zone aquatics programs report the number of fish harvested and caught by species by location, the number of anglers participating in the sport fishery by location and number of days fished in each location to the forest inventory and monitoring coordinator. Zone fish biologists will assess the trends in sport fish harvest and catch for each location and species, as well as sport fish participation by location, and describe the relationships to the 2020 plan guidance for providing fisheries services every five years.

Estimated Annual Cost (Sport Fishing Harvest)

Downloading, formatting, and reporting sport fish harvests will require a professional fish biologist (GS-9 or GS-11) to spend 2 days of time per year for each zone (4 days total, annually).

Indicator: Subsistence Harvest Permits

Methods and Metrics (Subsistence Harvest Permits)

One role that the subsistence program of the Chugach National Forest serves is to implement the rural preference granted by Alaska National Interest Lands Conservation Act Title VIII to rural residents residing within the boundaries of the Forest. One aspect of implementing this preference is issuing harvest permits for federal hunts and fisheries to rural residents that qualify for them. The pool of qualified rural residents for a federal hunt or fishery is determined by the Federal Subsistence Board and varies with each hunt or fishery depending on a specific Customary and Traditional Use Determination. Permits represent demand and opportunity to harvest subsistence resources. The accompanying harvest reports represent effort and harvest. Both are tracked by the U.S. Fish and Wildlife Service’s Office of Subsistence Management’s Federal Subsistence Permit System database.

Table 25 and table 26 represent the harvest events (federal hunts and fisheries) that currently take place on the Chugach National Forest, for which permits are issued and harvest is reported. The harvest events and the qualifying communities associated with each event are subject to change depending on actions by the Federal Subsistence Board.

Table 25. Federal subsistence permitted hunts taking place within the Chugach National Forest

Harvest Event	Wildlife Species	Location	Customary and Traditional Use Determination
FM0601	Moose	Unit 6C	Residents of Units 6A, 6B, and 6C
FM0603	Moose	Unit 6C	Residents of Units 6A, 6B, and 6C
FM0607	Moose	Unit 6B, 6C	Native Village of Eyak
FM0004	Moose	Unit 7 remainder	Residents of Chenega Bay, Cooper Landing, Hope, and Tatitlek
FD0605	Deer	Unit 6	Native Village of Chenega
FD0607	Deer	Unit 6	Native Village of Tatitlek
FG0604	Mountain goat	Unit 6D	Residents of Units 6C and 6D
DG0703	Mountain goat	Unit 7	Residents of Chenega Bay, Cooper Landing, Hope, Nanwalek, Ninilchik, Port Graham, Seldovia, and Tatitlek
FC0702	Caribou	Unit 7	Residents of Cooper Landing and Hope

Table 26. Federal subsistence permitted fisheries taking place within the Chugach National Forest

Harvest Event	Fish Species	Location	Customary and Traditional Use Determination
FFPW01	Fish: Household – Chinook, chum, sockeye, Arctic Char, grayling, whitefishes	Fresh waters of the Prince William Sound area excluding the Copper River	Residents of the Prince William Sound area
KKTCI3	Fish: Household – sockeye	Russian River – dipnet	Residents of Cooper Landing, Hope, Ninilchik
KKTCI2	Fish: General – Chinook, sockeye, coho, rainbow trout, Dolly Varden, pink, lake trout	Kenai River – rod and reel	Residents of Cooper Landing, Hope, Ninilchik

Data Management Plan (Subsistence Harvest Permits)

The measure of this indicator is the number of permits issued for each federal hunt and fishery, and harvest data from those permits. Data are stored and maintained by the Federal Subsistence Permit System that is maintained by the U.S. Fish and Wildlife Service's Office of Subsistence Management based in Anchorage. The Chugach National Forest Subsistence Program issues permits to qualified rural residents through this database and enters data from returned harvest reports.

Reporting Intervals (Subsistence Harvest Permits)

Permits are issued throughout the year by Chugach subsistence program staff. Data from the Federal Subsistence Permit System are available immediately as permits are issued. Harvest data is generally not available until after the specific season has ended. Generally, data have been entered and are available by the end of February for all of the previous year's harvest of fish and wildlife.

A report of permits issued by the Federal Subsistence Board for fish and wildlife and associated harvest will be produced annually by Chugach subsistence program staff and distributed for review to the Chugach's wildlife program manager, both in-season managers (Cordova and Seward district rangers), and the resources and planning staff officer. At five-year intervals, the number of permits issued and harvest of fish and wildlife will be analyzed to determine direction of trends for number of permits issued and total harvest (by species/hunt, and area) to determine any impacts of management or assessment actions.

Estimated Annual Cost (Subsistence Harvest Permits)

Reporting will be accomplished by one professional resource staff member's time for 3 days, annually, and an additional 3 days at the end of each five-year analysis period.

Indicator: Mineral Materials Permits and Locatable Plans of Operation

Measures for minerals services provided by the forest are the locatable minerals plans of operation and mineral materials contracts that are managed in accordance with CFR 36 228 Subpart A Locatable Minerals and Subpart C Disposal of Mineral Materials along with FSM 2800 Chapter 2810 – Mining Claims and Chapter 2850 – Mineral Materials.

Methods and Metrics (Minerals Permits)

The status and trends in these measures can be determined by evaluating and counting the number of minerals plans of operation and the number of minerals and materials contracts issued each year on the forest.

Data Management Plan (Minerals Permits)

This information is stored in the Natural Resource Manager database. Electronic project files are kept in Chugach National Forest shared Pinyon filing system and hard copies of the project files are maintained by the minerals program staff at the Seward Ranger District office.

Reporting Intervals (Minerals Permits)

Data are collated and entered annually by the minerals program leader. Trends in this indicator will be assessed using the number of executed minerals material contracts and approved plans of operations every five years. Mineral material contracts and plans of operations are totaled by the federal fiscal year, beginning on October 1 and ending on September 30 of the following year.

Below are data reported for years 2020 and 2021 as an example. This information was reported from fiscal years 2020 and 2021, thus covering the time period from October 1, 2019 to September 30, 2021.

2020–2021:

82 Mineral Material Contracts issued
4 Locatable Mineral Plans of Operation approved

Estimated Annual Cost (Minerals Permits)

Issuing and tracking these permits and contracts are major tasks for the minerals program, requiring about half of the minerals program manager's annual time (131 days) and part of one physical science technician's annual time (90 days), as well as a seasonal field technician (80 days) for field review and tracking. Additional program costs include a field going vehicle, boats or flights for periodic contract and

plan monitoring (these are part of the annual staff budget and program of work). For the 2020 plan monitoring program, reports will be sent every other year, with one analytical period to review trends and provide recommendations every five years. This will take about 2 days of the mineral program manager's time every other year, and about 5 days every five years.

Technical Guidance for Chapter 7, Section A

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 7A, click here.

Chapter 7, Section B: Management Area 1, Wilderness Study Area Desired Conditions

Monitoring the conditions of the Nellie Juan-College Fiord Wilderness Study Area (hereafter referred to as wilderness study area) requires consideration of some unique circumstances. The wilderness study area was established by Section 704 of the Alaska National Interest Lands Conservation Act (ANILCA; Public Law 96-487) and is not designated wilderness. U.S. Forest Service Alaska Region policy states that until Congress acts on any recommendations from the land managers, "the wilderness study area will be managed so as to maintain its presently existing character" (USDA Forest Service 2015). Monitoring of presently existing character elements is described in the *Nellie Juan-College Fiord Wilderness Study Area Existing Character Baseline Repor*t (USDA Forest Service 2021). The information presented in this guide follows specific guidance in the baseline report. For that report, Chugach National Forest staff selected four monitoring indicators with seven measures that are similar in nature to those used for monitoring wilderness character for designated wilderness (Landres, Boutcher and Mejicano 2019). The monitoring protocols for the seven measures selected deviates from the national protocol where agency data sources are not applicable or not available, and in such cases tiers to U.S. Forest Service Alaska Region monitoring programs and have been reviewed by program area experts for efficacy (detailed under the protocols for those applicable measures). Therefore, the monitoring program considers the management direction specific to this unique area and is adapted to focus on the existing conditions outlined in the baseline report (USDA Forest Service 2021).

Chapter 7, Section B: Priority Management Questions, Associated Indicators, and Monitoring Methods

The 2020 land management plan describes four conditions toward which management of the land and resources in the wilderness study area should be directed. These desired conditions describe how visitors should experience the forest and how resources should be functioning and set a threshold as well as specific conditions that Chugach National Forest staff will need to monitor to implement the 2020 plan. The desired conditions are found in the "Management Area 1 Wilderness Study Area" section of the plan (and correspond to 2020 plan component identification code MA1-DC):

- Visitors to the wilderness study area find outstanding opportunities for solitude, remoteness, closeness to nature, and self-reliance in a natural environment of coastal rainforests and tidewater glaciers.
- Visual and noise impacts from the use of authorized motorized equipment are minimized. Evidence of recreation use is generally only apparent at popular sites.

- Ecosystems function primarily without direct human manipulation. The landscape is undeveloped and appears primarily influenced by the forces of nature.
- Prevention and early detection of invasive terrestrial and aquatic species is emphasized, and treatments are implemented where appropriate.

Chugach National Forest staff determined attributes of these conditions could be feasibly measured and monitored—using relevant questions and associated indicators and measures—to show trends in condition related to forest management over the life of the plan.

In addition, objectives in the 2020 plan describe several specific targets the Chugach will attain during the life of the plan. Monitoring the baseline conditions of the Nellie Juan-College Fiord Wilderness Study Area, as described in the baseline condition report (USDA Forest Service 2021), addresses the monitoring question in the 2020 plan.

Monitoring Question

One priority management question was identified to monitor conditions of the wilderness study area:

Is the presently existing character of the wilderness study area, including areas recommended for wilderness, being maintained?

Implicit in the monitoring question is that the forest develops measures that provide evidence of any changes or trends to the existing character of the wilderness study area. Chugach National Forest staff identified indicators for which this guide describes measures that can be compiled and evaluated periodically to ascertain trends in the existing character of the wilderness study area as described in the baseline report (USDA Forest Service 2021). These indicators show how authorized activities over a five-year period can affect different characteristics of the wilderness study area. They also measure how well the management area 1 components are guiding management actions to maintain the wilderness study area's presently existing character and potential for inclusion in the National Wilderness Preservation System.

Table 27 lists the indicators and measures, sampling and reporting frequency, and responsible program area for monitoring the presently existing character elements described in the baseline report (USDA Forest Service 2021).

If negative trends are found during assessment of the indicators described in table 27, specialists from the responsible program area should review the characteristics being degraded and determine if a land management plan amendment is needed to add new plan components to better maintain the wilderness study area's presently existing character and potential for inclusion in the National Wilderness Preservation System.

Table 27. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring the presently existing character of the wilderness study area

Indicators (definition)	Measures	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Trends in wildness (actions authorized by the federal land manager that intentionally manipulate the biophysical environment)	Number of authorized actions and persistent structures designed to manipulate plants, animals, pathogens, soil, water, or fire	Annually	5 years	Wilderness	Data specialist: 1 day annually plus an additional 1 day every 5 years Program manager: 1 day annually plus an additional 1 day every 5 years
Trends in natural conditions (ecological processes)	Miles of impaired streams Watershed condition class rating Marine debris deposition	5 years	5 years	Aquatics: Hydrology Wilderness	Forest hydrologist: 1 day annually plus an additional 1 day every 5 years Recreation program manager: 1 day annually plus an additional 1 day every 5 years Wilderness program manager: 1 day annually plus an additional 1 day every 5 years
Trends in undeveloped (presence of non-recreational structures, installations, and developments)	Index of authorized non-recreational physical development Index of motorized vehicle use authorizations	5 years	5 years	Wilderness	Data specialist: 1 day annually plus an additional 1 day every 5 years Program manager: 4 days annually plus an additional 3 days every 5 years
Trends in opportunities for solitude or primitive, unconfined recreation (remoteness from sights and sounds of human activity inside the wilderness study area)	Index of encounters; index of recreation sites within primary use areas	Annually	5 years	Wilderness	Data specialist: 2 days annually Program manager: 4 days annually plus an additional 6 days every 5 years

Indicator: Wildness

Wildness indicates the degree that an ecosystem's processes are natural and primarily free from managerial intervention. Measurement of wildness can be done by monitoring the administrative actions in the wilderness study area that intentionally manipulate the biophysical environment. Activities that intentionally change or control ecological systems inside the wilderness study area may affect wildness, regardless of what instigated the action or if the action benefits other conditions of the area's character.

Methods and Metrics

The measure of wildness will be done by tracking the actions and persistent structures authorized by the federal land manager that intentionally manipulate plants, animals, pathogens, soil, water, or fire (table 28).

Data used for the baseline assessment of this measure require personal communication with Chugach National Forest resource specialists, including special uses service team, fisheries, and others. Most authorized manipulations in the past have been for long-lasting structures and actions, allowing for streamlined tracking. Authorized manipulations are tracked to reflect any intentional manipulations to the biophysical environment and are tracked through permitting processes on the forest such as special use authorizations, various local reporting documents, and communication with local staff. The nature of authorizing actions results in a formal written record that allows for comprehensive data collection. This measure includes actions tied to ecological recovery from the *Exxon-Valdez* oil spill. Unauthorized manipulations not tracked due to a generally low number of annual actions and difficulty finding relevant data.

Steps

1) The wilderness manager will coordinate annually with the forest environmental coordinator and the special uses program manager to compile the decision notices and permits specific to the wilderness study area on the Glacier Ranger District.

2) Notices will be reviewed for consistency for the definition of wildness (USDA Forest Service 2021), and the total number of authorizations will be added for each year.

3) Glacier Ranger District houses and updates the tracking spreadsheet for the wilderness study area

4) Information is reported in the biennial monitoring and evaluation report.

5) Trend analyses are completed relating back to the baseline character of wildness, as described in the existing character baseline report (USDA Forest Service 2021).

Data Management Plan

The wilderness program manager will update the "authorized manipulations" spreadsheet at the end of each fiscal year and load to the forestwide shared database for the wilderness study area existing conditions used in the baseline report (USDA Forest Service 2021) and maintained on the Pinyon folder in 2320Wilderness\GRD\8 wilderness character\CNF wc monitoring reports\Data storage. At this time, the wilderness program manager will make note of any management action that is considered an intentional manipulation of the biophysical environment and track of trends by updating the associated graph in spreadsheet and use graph and/or table for reporting in the forestwide database.

Reporting Intervals and Plan Direction

The wilderness program manager will collect and update the tracking databases annually, providing information to the forest inventory and monitoring coordinator for the biennial monitoring and evaluation report. Trend analyses are a comprehensive analysis that will describe the desired conditions stated in the 2020 Plan, discussing if there are changes in wildness, review the implications any changes have on current management, and provide recommendations and rationale for any changes in management (if needed). The wilderness program manager will complete this analysis every five years of the 2020 plan life, with the first evaluation completed for years 2020–2024, reported in 2025.

Estimated Annual Cost

In addition to regular program reporting, 1 day of work for one data specialist and the wilderness program manager will be required annually, with an additional 1 day needed every fifth year of the 15-year plan life.

Indicator: Natural

Natural indicates the integrity of local ecosystems and their freedom to change and develop without human manipulation.

Methods and Metrics

Three measures are used to assess the natural condition of the wilderness study area: 1) miles of impaired streams; 2) watershed condition ratings; and 3) marine debris deposition.

Miles of Impaired Streams

The miles of impaired streams measure will allow staff to assess the quantity of streams inside the study area with impaired water quality. Water impairment in the wilderness study area most commonly stems from water and soil contamination from historic mine development. Miles of impaired stream are documented through the Alaska Department of Environmental Conservation Water Quality Inventory, Monitoring and Assessment Reports, or State 303(d) data, and will be reviewed and verified by the forest hydrologist at five-year intervals.

Watershed Condition Class Rating

Watershed condition class ratings will allow staff to assess the wilderness study area's watersheds functional level. Functional watersheds are fundamental in sustaining both terrestrial and aquatic life in western Prince William Sound. Water quality can be compromised by a variety of factors, including deposition of airborne pollutants, oil spills, and contamination from mining.

To assess trends in the function of the wilderness study area's watersheds, Chugach staff will monitor attributes of the watershed condition class rating information, following the national protocol outlined in the Watershed Condition Classification Technical Guide (USDA Forest Service 2011) described in chapter 1 of this document.

Marine Debris Deposition

The marine debris measure will allow staff to assess trends in marine debris deposition in the wilderness study area. Monitoring shows that marine debris deposition is pervasive in near-shore environments of the wilderness study area, including in beach meadows, forest soils, and freshwater streams and lagoons, where it is deposited by storms and tides. Various forms of plastic comprise most of the marine debris.

The pervasiveness and abundance of marine debris creates potential for leaching of plastics into freshwater sources, and monitoring shows marine debris is chewed and ingested by terrestrial and marine wildlife and used by birds in nesting material. These effects on the natural quality of the wilderness study area also impact visitor enjoyment of impacted areas.

Data are gathered by the nonprofit organization Gulf of Alaska Keeper, a Chugach National Forest partner who has conducted marine debris deposition monitoring in the wilderness study area since 2005. Gulf of Alaska Keeper shares data annually with the Chugach National Forest for the purpose of monitoring. Gulf of Alaska Keeper crew members visit the selected monitoring sites each year and follows an established protocol of data collection at each site. Data are then analyzed and documented in an annual report and shared with the wilderness program manager.

Data Management Plan

Miles of Impaired Streams

The wilderness program manager and forest hydrologist will review the measure description from the existing character baseline report (USDA Forest Service 2021). They will update this measure when the Alaska Department of Environmental Conservation releases report updates every five years. Measure value can be affected by either local monitoring data or 303(d) data. List value as “miles of impaired streams.”

Watershed Condition Class Rating

The forest hydrologist will use the established corporate Forest Service database that stores the watershed condition classification ratings across the various activities on the Chugach National Forest.

Forestwide watershed condition classification individual attribute ratings and the overall watershed condition classification ratings information will be stored in the corporate Forest Service Watershed Classification and Assessment Tracking Tool and updated every five years during the five-year reassessment period, or annually as needed if particular watersheds conditions change.

Marine Debris

Gulf of Alaska Keeper compiles and shares the data annually with the Chugach National Forest. The wilderness program manager will review the Marine Debris Data Reporting Protocol and store the data in the appropriate spreadsheet (2320Wilderness\GRD\8 wilderness character\CNF wc monitoring reports\Data storage). The Chugach National Forest wilderness staff will analyze the data for trends every five years.

Reporting Intervals and Anticipated Results

The results of both watershed condition measures are updated in five-year reassessments for water quality and watershed condition. The forest hydrologist and wilderness manager will coordinate, evaluate information, and provide updated reports to the forest inventory and monitoring coordinator at each five-year reassessment interval. The results of the marine debris measure are reported annually based on information from the Gulf of Alaska Keeper organization.

Estimated Annual Cost

This monitoring work ties to the watershed condition assessments under the watershed program (staff time needs are described in chapter 1) as well as managing partnership agreements with the Gulf of Alaska Keeper for marine debris collection. Time for coordination is needed for acquiring and reporting the information for the wilderness program manager (2 days annually) and the forest hydrologist (1 day annually).

Indicator: Undeveloped

The undeveloped indicator is defined as the degree to which the wilderness study area is without permanent improvements or authorizations for mechanized transport and motorized equipment (such as helicopter or chainsaw use).

Methods and Metrics

A combination of two measures will be used to determine trends in the status of this indicator: 1) an index of non-recreational structures or facilities; and 2) an index of administrative authorizations for motorized equipment and mechanized forms of transport.

Data used for this measure require personal communication between the wilderness program manager and Chugach National Forest resource specialists, including special uses service team, fisheries, minerals, and others. Historically, most authorized developments have been for long-lasting structures and motorized equipment and mechanical transport associated with fish hatcheries, fisheries enhancements, communication sites, and research projects. Authorized developments are tracked to reflect the degree to which management actions may affect the undeveloped quality of the wilderness study area.

Index of Authorized Non-Recreational Physical Development

This measure provides a comprehensive assessment of the various types of non-recreational physical developments that may be present in the wilderness study area. These developments can range from scientific instruments to hatcheries and communications sites. Monitoring the development and removal of non-recreational sites depicts trends in human activities that may affect the study area's existing character and potential for inclusion in the National Wilderness Preservation System. Weighted values[7] (when applicable to the data) are assigned to different development types to help describe trends (table 28 and figure 1).

Table 28. Summary of authorized non-recreational installations and their assigned values, and the physical development index calculation procedure

Physical Installation Type	Assigned Value
A small-scale installation: navigation aids, weather cameras, communications equipment, radio collars on animals, and others.	2
A moderate-size development: small dam, weir, fish ladder, small mine, and others.	5
A large-scale development: large dam, roads, mines, utilities, and others.	10

[7] The weighted value system for monitoring installation trends was developed by Tongass National Forest for use in their wilderness areas. The Chugach National Forest has adopted this same value system for use in the wilderness study area to maintain regional consistency.

Index of Administrative Authorizations to use Motor Vehicles, Motorized Equipment, or Mechanical Transport.

Motorized equipment and mechanized transport are authorized for various purposes in the wilderness study area. These uses are categorized as administrative or special provision authorizations, and are linked to the maintenance of research sites, communication sites, and recreational resources, amongst other purposes. Monitoring trends in the uses depicts trends in human activities that have a bearing on the study area's existing character and potential for inclusion in the National Wilderness Preservation System. As with the index of non-recreational development, weighted values are assigned to different uses and types of equipment to help describe trends (table 29).

Table 29. Weighting system for calculation of motor vehicle use index[8]

Equipment Type	Inherent Weight
Battery hand power tool, bicycle. hand truck. wheelbarrow	1
Air compressor, brush cutter, electro-shocker, generator, leaf blower, motorized winch, portable pump, welder	2
Air tanker, all-terrain vehicle, chainsaw. concrete equipment, fixed-wing aircraft, floatplane, helicopter, motorized watercraft, power auger, rock drill, snow machine, truck	3
Heavy equipment	4

Data Management Plan

Index of Authorized Non-Recreational Physical Development

1) Update the associated spreadsheet annually, located in local files (2320Wilderness\GRD\8 wilderness character\CNF wc monitoring reports\Data storage).

2) For each new year of reporting, duplicate the tab for previous year in Excel spreadsheet.

3) Edit index values accordingly. Values will automatically calculate updated value. Add updated values to the graph to visualize change in trends.

Index of Administrative Authorizations to use Motor Vehicles, Motorized Equipment, or Mechanical Transport

1) Update the associated spreadsheet annually, located in local files (2320Wilderness\GRD\8 wilderness character\CNF wc monitoring reports\Data storage).

2) For each new year of reporting, duplicate the tab for previous year in Excel spreadsheet.

3) Edit index values accordingly. Values will automatically calculate updated value. Add updated values to the graph to visualize change in trends.

[8] The weighting system for calculation of motor vehicle use index is a scoring system used nationally (Wilderness Character Monitoring Guide Technical Guide: Gen. Tech. Rep. RMRS-GTR-406. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 364 p).

Reporting Intervals and Anticipated Results

The wilderness program manager will collect and update the tracking databases annually, providing information to the forest inventory and monitoring coordinator for the biennial monitoring and evaluation report. Trend analyses are a comprehensive analysis that will describe the desired conditions stated in the land management plan, discuss if there are changes in the undeveloped indicator, review the implications any changes may have on current management, and provide recommendations and rationale for any changes in management (if needed). The wilderness program manager will complete this analysis every five years over the life of the 2020 plan, with the first evaluation completed for years 2020–2024 to be reported in 2025.

Estimated Annual Cost

In addition to regular program reporting, 4 days of work for the wilderness program manager and 1 day of work for a data specialist will be required annually, with an additional 3 days for the wilderness program manager needed every fifth year of the 15-year plan life.

Indicator: Outstanding Opportunities for Solitude or Primitive, Unconfined Types of Recreation

Solitude or opportunities for primitive and unconfined recreation is described as the opportunity for visitors to experience remoteness from sights and sounds of human activity inside the wilderness study area.

Methods and Metrics

A combination of two measures will be used to determine trends in the status of this indicator: 1) an index of encounters; and 2) an index of recreational sites within primary use areas.

By monitoring for encounters within the wilderness study area, Chugach staff can evaluate study area visitation and the capacity of the setting to allow for escape from the sights and sounds of human activity. Monitoring trends in recreation site use depicts trends in human activities that may impact other qualities of the area's existing character. Field surveys for both measures will be collected annually following the 2019 Solitude Monitoring Plan and Protocol and the 2018 Recreation Site Monitoring Protocol instructions (see technical guidance at the end of this chapter).

Data Management Plan

Information for both measures is collected during field surveys conducted in the study area. For solitude monitoring, surveys are conducted using Survey123. Data are uploaded to ArcGIS during surveys, then migrated to an Access database by the wilderness program manager by the end of each fiscal year, as described in the monitoring plan (see technical guidance at the end of this chapter). The Solitude Monitoring Access Database is stored in local files (2320Wilderness\GRD\5 solitude\Solitude Plans Protocols and Database\Final Solitude Monitoring Project).

For recreation site monitoring, surveys are conducted using ArcGIS Collector and migrated to an Access database by the wilderness program manager by the end of each fiscal year, as described in the 2018 Recreation Site Database User Guide (see technical guidance at the end of this chapter). The Recreation Site Access Database is stored in local files (2320Wilderness\GRD\6 recreation sites\Recreation Site monitoring\Rec Site Database\Access Database).

Reporting Intervals and Anticipated Results

Information for both measures will be surveyed annually and assessments will be completed every five years. The wilderness program manager will coordinate with the forest inventory and monitoring coordinator to provide baseline values for the biennial monitoring and evaluation report. Assessment of trends and management activities will be completed every five years by the wilderness program manager and provided to the forest inventory and monitoring coordinator for inclusion in the forestwide monitoring assessment.

Estimated Annual Cost

Index of Encounters

In addition to regular program reporting, 2 days of work for the wilderness program manager and 1 day of work for a data specialist will be required annually, with an additional 3 days needed for the wilderness program manager every fifth year of the 15-year plan life.

Index of Recreation Sites within Primary Use Areas

In addition to regular program reporting, 2 days of work for the wilderness program manager and 1 day of work for a data specialist will be required annually, with an additional 3 days needed for the wilderness program manager every fifth year of the 15-year plan life.

Technical Guidance for Chapter 7, Section B

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 7B, click here.

Chapter 8 Productivity of the Land

Overview

Healthy soil, as indicated by soil quality, provides the foundation for all land-dwelling organisms. Soils regulate and purify water, store carbon, cycle nutrients, provide suitable habitat for plant roots and soil dwelling organisms, and physically support man-made structures and human activities. If soil quality decreases, the entire ecosystem supported by the soil will be negatively affected and productivity will decrease. Monitoring soil quality gives an indication of the overall health of the entire ecosystem and provides information on the effects of management activities to soil resources.

Soil productivity is directly associated with soil quality and can be inferred by detrimental soil disturbance. Monitoring detrimental soil disturbance after activities measures the impacts of those activities on soil quality, which will help identify changes needed in the land management plan. For example, if the results of soil quality monitoring show high levels of detrimentally burned soils after pile burning, then the Forest may want to identify an additional standard that limits the size and spacing of brush piles. Conversely, if the detrimental disturbance resulting from mechanical thinning is very low on the slopes identified, the forest may want to loosen mechanical operations standards and guidelines.

Priority Management Questions, Associated Indicators, and Monitoring Methods

Monitoring soil quality addresses two of the forestwide desired conditions in the 2020 land management plan. The desired conditions are found in the "Soils" section of the plan (and correspond to 2020 plan component identification code FW-GL3-SOIL-DC):

- Long-term soil quality and site productivity on lands dedicated to growing vegetation are not impaired; support the regeneration, growth, and successional pathways of native plant communities; and are resilient to climate change.
- Soils retain key properties (such as bulk density, porosity, presence of forest floor and A horizons, and effective ground cover) that support ecosystem integrity and provide resilience against ground-disturbing activities, including those that compact soil and reduce porosity, affect water flow and aeration, displace surface soils, and cause nutrient and organic matter losses. Areas with sensitive and highly erodible soils or land types with mass failure potential are not destabilized as a result of management activities.

Monitoring Question

One priority management question was identified to monitor soil conditions:

Are management activities, as implemented, meeting and maintaining soil productivity, state water quality standards, and land management plan desired conditions, goals, and objectives?

This monitoring question will help identify whether plan components, such as standards and guidelines, are adequate in meeting plan desired conditions for managing the integrity of forest soils.

The water quality aspect of this monitoring question will be inferred from detrimental soil disturbance (particularly erosion) and will also be evaluated using best management practices monitoring, which is discussed in Chapter 1 Watershed Conditions.

To determine whether management activities are maintaining soil productivity, Chugach National Forest staff will evaluate the amount and degree of detrimental soil conditions resulting from management activities where soil disturbance occurs. Table 30 lists the indicator and measures, sampling and reporting frequency, and responsible program area for monitoring soil productivity.

Table 30. Indicators, measures, sampling and reporting frequency, and responsible program area for monitoring soil productivity on Chugach National Forest

Indicator	Measure	Reporting Frequency	Analysis Frequency	Responsible Program Area	Staff Time
Soil disturbance resulting from management activity (as defined in Alaska Region Soil Quality Standards)	Percentage of activity areas in detrimental soil condition	Biennial	7 years	Soils	Overlap with best management practices and soils program combined time is two specialists, 10 days annually (field), plus 5 days annually (office)

The evaluation criteria for soil quality will be compliance with Alaska Region (Region 10) Soil Quality Standards, and compliance with the 2020 plan standards and guidelines.

Alaska Region Soil Quality Standards describe detrimental soil conditions (table 31) that indicate decreased soil quality (USDA Forest Service 2006). The soil quality standards stipulate that no more than 15 percent of an activity area should have detrimental soil conditions in order to preserve long-term soil productivity. If detrimental soil conditions exceed 15 percent of an activity area during assessment of this indicator, mitigation must occur to meet the soil quality standards and comply with other federal law, policy, and regulation (such as the Clean Water Act of 1972). If practices, standards, and guidelines are not sufficient for regularly meeting soil quality standards they may need to be revised.

Table 31. Indicators of detrimental soil conditions from Alaska Region Soil Quality Standards

Type	Description of Detrimental Soil Condition
Compaction	Bulk density greater than root restriction initiation values for the particle size class (see Figure 618-A2, National Soil Survey Handbook, Part 618. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054240#600)
Displacement	Mechanical removal of forest floor and 50 percent of topsoil over an area greater than 5 feet wide and 100 square feet
Puddling and rutting	Ruts greater than 6 inches deep and 10 feet long
Mass movement	Large masses of soil or rock that fall, slide, or flow downslope as a result of management activities
Erosion	Erosion of 50 percent or more of the topsoil or humus-enriched surface layer in an area greater than 100 square feet in size

Type	Description of Detrimental Soil Condition
Severely burned	Forest floor and most woody debris are consumed to bare soil or rock in an area greater than 100 square feet in size. Fine roots and organic matter are consumed in upper one-half inch of mineral soil
Lack of ground cover	Less than 85 percent ground cover on slopes less than 72 percent gradient, or less than 95 percent ground cover on slopes over 72 percent gradient, in an area greater than 100 square feet in size
Thick or dense slash	Accumulation of thick or dense slash on the soil surface in an area greater than 100 square feet. Wood chip mulch may also be detrimental to soil functions depending on the thickness of the chip layer and ecological conditions of the site
Altered wetness	Significantly wetter or dryer than natural conditions (perennially flooded or drained), which alters site function. Cannot affect more than 5 percent of an activity area

Indicator: Detrimental Soil Disturbance

Locations for monitoring soil quality are chosen based on ground-disturbing activities across the forest, data from previous monitoring efforts, and current knowledge gaps about management activities and best management practices. Examples of locations for monitoring include areas of heavy equipment use for a variety of activities like timber harvest, stream restoration, and wildlife enhancement projects, off-highway vehicle use, and prescribed fire. The frequency and duration of monitoring may vary depending on management activities and monitoring needs. Many locations would only require monitoring once, but in some cases long term monitoring with repeated site visits might be required in order to evaluate soil recovery and long-term impacts. If previous ground disturbance has occurred in the area of interest, existing detrimental soil conditions should be evaluated prior to commencement of future ground-disturbing activities, followed by post-activity monitoring to evaluate detrimental conditions created by the new activity. Visual assessment of detrimental soil conditions could be done during other routine monitoring like best management practices monitoring or sale administration.

Methods and Metrics

The Forest Soil Disturbance Monitoring Protocol is the method used by soil scientists within the Forest Service to monitor detrimental soil conditions (Page-Dumroese, A. and Rice 2009). Region 10 uses a modified version of this protocol to monitor soil quality that was reviewed by the Forest Soil Disturbance Monitoring Protocol statistician and found to be consistent with the protocol (Landwehr 2009). The protocol involves completion of randomly located field transects to evaluate detrimental soil conditions. Some detrimental soil conditions may be detectable using aerial photos or other remotely sensed data depending on size and severity of disturbance, canopy cover, and date of disturbance compared to date of remote data collection. Often the infrequency of remote data collection limits its use for soil monitoring purposes. Photo point monitoring can be used to monitor recovery of soils after disturbance.

Instructions for Completion of Soil Disturbance Transects

1) Determine the activity areas to be sampled. An activity area is the total area of ground surface impacted by an activity (for example, timber sale unit, stand, or plant association). It must be a feasible unit for sampling and evaluation and excludes facilities and long-term infrastructure such as mines, developed recreation sites, administrative sites, utility corridors, designated waste disposal sites, rock quarries, specified transportation facilities and dedicated trails.

2) Stratify each activity area by management system (for example, harvest system, operator) and soil conditions (slope class, soil drainage class, etc.) as needed. Stratification will reduce variability in the data and provide more specific information about factors affecting detrimental soil conditions. Create polygons for each stratified area.

3) Create random transects 100 feet long in each stratified activity area. In larger activity areas, one transect per 2 acres is recommended, while one transect per acre can be used in smaller activity areas. A minimum of five transects per activity area is needed to develop an activity area sample. A few more transects than necessary should be created in case unforeseen field conditions prohibit the use of a given transect. Listed below is one method of generating random transects, but other methods may be used.

   - Use a GIS tool to create random points in each polygon. These will be the starting points for transects. They should be at the appropriate density (example: one point per 2 acres). ArcGIS tool: Toolbox > Data Management Tools > Sampling > Create Random Points
   - Select an azimuth between 0 and 360 degrees for each transect using a random number generator or table. Document the azimuth for each transect.
   - Using the random points as starting locations and azimuths for transect direction, create a 100-feet-long line representing each transect. If the resulting transect crosses a road, unit boundary, slope strata boundary, or stream, select a new azimuth.

4) In the field, make observations of detrimental soil conditions along the randomly placed transect lines. The distance to the start of the disturbance should be documented, as well as the distance across the disturbance (along the line transect) and the type of disturbance. Document disturbance to the nearest foot.

   Temporary roads, which create detrimental soil conditions, are usually measured directly instead of with transects. If temporary roads are measured directly, transects should be located to avoid crossing them. In some cases, two or more of the Region 10 values of severity will apply to the same soil disturbance. For example, detrimental displacement, erosion, and lack of ground cover could all apply to a disturbed area. In this case only one will be documented by using a dichotomous key (Landwehr 2009) to determine which value of severity will be assigned to the soil disturbance.

   For each transect, record the following: date of sampling, unit number, transect number, slope angle measured at the beginning and end of each transect and averaged, azimuth, management/harvest system, and any special circumstances related to soil disturbance on the transect.

   General site information should also be recorded, including objectives for the area, purpose for completing transects, dominant soils, undisturbed organic mat thickness, landform description, smooth or broken slopes, weather, and soil conditions (snow cover, green brush, etc.), date of ground disturbing activity, and any other relevant information.

Statistics

On National Forest System lands in Alaska, analyzing detrimental soil conditions by transect frequency almost always results in data that is skewed to the left of a standard distribution curve (indicating a large number of null values) (Landwehr 2009). The data do not have a normal, bell shaped distribution because many transects will have little to no detrimental conditions, while a few will be more heavily disturbed. In order to utilize parametric statistics, detrimental soil conditions should be analyzed using the activity area means (Landwehr and Nowacki 1999). After plotting mean detrimental soil conditions by activity area frequency to assure normal distribution, use parametric statistics to calculate the mean, standard deviation, standard error, and 90 percent confidence intervals (Howes, Hazard and Giest 1983) for the management activity. Additional samples should be collected if the standard error is more than 10 percent of the mean.

Data Management Plan

Data sources used for soil monitoring include field samples and transects, aerial photos, best management practices for soil and water monitoring, and forestwide databases. The forest soil scientist will enter and store monitoring data in spreadsheets and GIS layers on a local drive. The data will be synthesized into biennial reports.

Reporting Intervals and Plan Direction

Soil Quality Standards have been developed to protect the soil resource and define threshold values for indicators of detrimental soil conditions that affect long term productivity. During soil quality monitoring, the amount, degree, and type of detrimental soil conditions are documented and evaluated. Current Region 10 Soil Quality Standards state that the productivity of an activity area becomes significantly impaired when more than 15 percent of the area has detrimental soil conditions. Ideally, existing best management practices, standards and guidelines will maintain soil quality when properly implemented. However, limited data may exist about a given management activity, it’s effects under different soil conditions, and the best mitigation strategy. Thus, it is important to monitor soil quality to evaluate the effects of management activities on soil, as well as the effectiveness of current best management practices. Every seven years the forest soil scientist will review the previous soil reports and provide recommendations for changes in the monitoring criteria or management activities as needed to meet the desired conditions of the plan. If monitoring consistently indicates a decrease in soil quality below acceptable levels despite proper implementation of best management practices (BMP) standards and guidelines then the guidance may need to be revised to adequately protect soil resources and maintain desired conditions.

Estimated Annual Cost

Annually, two professional resource staff members for two weeks of fieldwork, one professional resource staff member for one week of office work, plus 2 days technical support, 10 days of 4 by 4 vehicle use, materials and supplies, and personal protective equipment. There will be some overlap with soil program work and possibly with best management practices monitoring.

Technical Guidance for Chapter 8

Technical guides and monitoring protocols are stored on SharePoint, in folders organized by chapter. To access technical guidance for chapter 8, click here.

Summary: Monitoring in the Forest Program of Work

This monitoring guide provides the protocols for 36 unique indicators that were selected as suitable for defining trends in resource conditions managed by the Chugach National Forest and directed by the 2020 land management plan. Each of these indicators has one or more measures, or aspects quantified by field surveys or censuses, which provide information for those indicators under the responsible forest program areas conducting the monitoring efforts (summarized in the tables that follow). Many of the measures described are part of reporting requirements that meet other law, regulation, or U.S. Forest Service policies for the forest program areas, thus taking advantage of existing baseline information, reports, data management systems, and protocols and thus requiring less staff time for reporting and assessment. In this way, the approach we have adopted for the Chugach National Forest monitoring program is efficient, fosters integration, and is compliant with other law.

Connections to the Forest Program of Work

The 2012 Planning Rule highlights the adaptive approach to management, and the protocols and processes outlined in this guide adhere to that direction. Protocols described within this guide lay the framework for the first Chugach National Forest biennial monitoring and evaluation report that was completed May 15, 2022 and required under the 2012 Planning Rule. Because some of the protocols are tiered to existing program monitoring efforts, the first report contained completed assessments for a few of the program areas including recommendations, while others reported progress for new protocol development and field testing results (if applicable).

The 2012 Planning Rule specifies that each of the selected indicators undergoes at least one in-depth review or analysis of the trends of the indicators relative to the desired conditions of the plan during the life of the plan. These can vary in timing due to the temporal variance and frequency of the information being collected. The analysis frequency is identified for the indicators throughout this guide using a 15-year plan life to guide the assessment timing. These periods require more staff time and involvement to reviewing previous biennial reports and changing conditions, develop a longer temporal trend description, and link the information back to management direction or recommendations for changes. We therefore identify these “analysis of trends” periods separately with the biennial monitoring reports. The following tables list the estimated staff time needed for completion of the monitoring report and analysis, and also the connections with program-level tracking effort that are part of each forest program.

Chapter 1

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Watersheds: Best Management Practices and Watershed Condition Class Ratings	Hydrology	Both monitoring efforts require involvement of all program areas at some point over the plan life.	Best Management Practices: Teams of two to five specialists forestwide, 10 days annually for survey, forest hydrologist, five days for data entry and reporting.	Best Management Practices: Every five years, an additional five days staff time for Forest hydrologist. Watershed Condition Class ratings: only completed every five years, three to seven team members three weeks of staff time plus additional week of Forest Hydrologist time for reporting.

Chapter 2

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Invasive and Focal Species (both aquatic and terrestrial species)	Ecology	Botany	Annual program surveys and data entry: two to six technicians, 80 days. Annual reports, 15 days for program managers with an additional five days for biennial reporting and formatting for the Forest Ecologist	Trend analyses completed every five years, three zone and forest program managers 15 days to complete in addition to regular program work.

Chapter 3

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Riparian and Watershed Function	Aquatics, Fisheries Engineering	Hydrology, GIS	Condition surveys (Engineering and Fisheries): 10 days annually, data entry and analysis (fisheries and aquatics): 10 days; GIS data management: 10 days. Biennial report: forest and zone program managers will take approximately six days	Five year analytical periods, approximate staff time for all three programs: 10 days, including joint workshop

Chapter 4

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
At-Risk Species				
Dusky Canada goose	Wildlife	Ecology	Dusky Canada Goose annual surveys: four staff plus vehicles, boats, and travel costs: four weeks. Biennial reporting development: biologist will take approximately 3 days.	Dusky Canada Goose: Trends will be assessed every five years in conjunction with the partner's report and the forest biennial report. Approximate staff time, five days.
Aleutian Cress	Botany		Aleutian Cress: surveys, three staff three days every other year, data entry and reporting, additional five days.	Aleutian Cress: trends to be evaluated every 10 years, with any disturbance noted during annual surveys and mitigated.

Chapter 5

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Visitor Use	Recreation	None	Recreation: annual reports are developed from forest databases, requiring one week of technician time and 1 to 2 days for the Recreation program manager.	Recreation: every five years, trends in data will be re-evaluated.
Special Uses	Special Uses		Special uses: this work is also part of regular program activities. Compiling data and reporting for plan monitoring requires one staff day annually.	Special uses: this work is also part of regular program activities. Compiling data and reporting for plan monitoring requires two additional staff days every five years

Chapter 6

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Climate Change				
Stream flow, temperature, snow	Hydrology	Fisheries	Stream flow, temperature, and snow: annually 30 staff days for data collection, analysis and reporting. *Note that all three of these metrics are part of current forest aquatics program efforts.	Stream flow, temperature, and snow: seven year trend analysis and report, 30 staff days.
Vegetation	Ecology	Botany	Vegetation: biennially, two forest staff approximately 15 days	Vegetation: every 7 years, additional 15 days for one forest program manager

Chapter 7A

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Multiple Uses				
Commercial recreation	Special Uses	Recreation	Commercial and Developed Recreation: this work is part of the annual programs reporting for Special Uses and Recreation. Compiling and reviewing the data for biennial reports will require two forest staff days annually. Forest products: tracking forest product information is part of the annual program work. Compiling information and reporting for the program will require five staff days annually. Subsistence: tracking this information is part of the regular program work. Plan reporting and data management will require 6 staff days annually. Sport fish: tracking this information is part of the regular program work. Plan reporting and data management will require 3 staff days annually. Minerals: tracking this information is part of the regular program work. Plan reporting and data management will require 2 staff days annually.	Commercial and Developed Recreation: this work is part of the annual programs reporting for Special Uses and Recreation. Trend analyses are completed every five year, requiring an additional three staff days. Forest Products: trend analyses are completed as part of the biennial report evaluations. Subsistence: trend analyses are completed as part of the subsistence program with trends reported for land management plan monitoring objectives every five years. Sport Fish: trend analyses are completed as part of the Fisheries program with trends reported for land management plan monitoring objectives every five years requiring three staff days. Minerals: trend analyses are completed as part of the minerals program with trends reported for plan monitoring objectives every five years requiring staff two days.
Developed recreation	Recreation	Special Uses		
Forest products	Forestry	None		
Sport fish	Fisheries	None		
Subsistence	Subsistence	Fisheries, Wildlife		
Minerals	Minerals	None		

Chapter 7B

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Wilderness Study Area	Wilderness	Recreation, Hydrology	Four indicators are monitored as part of the wilderness program annually. Compiling information for the land management plan biennial report will require four staff days annually.	Data trends are assessed every three years for the Wilderness program and will be analyzed every five years for plan monitoring. This will require an additional four days of staff time for compilation and analyses.

Chapter 8

Monitoring Topic (abbreviated chapter title)	Lead Forest Program	Related Forest Programs	Biennial Tracking or Reporting Effort (staff time)	Effort for Analysis of Trends (staff time)
Soils	Soils	Hydrology, Fisheries	Monitoring soil conditions is part of the regular soils program, that includes ten days of staff time annually, and may overlap with Best Management Practices monitoring.	Trends in soils conditions will be evaluated every seven years with respect to land management plan monitoring.

Maintaining Adaptive and Current Management Approaches

One of the great challenges discussed during the development of the plan monitoring protocols in this guide is the utility of the existing databases. Chugach National Forest staff highlighted issues with the lack of clear metadata, impediments in accessibility of the information, unclear direction regarding how previous information has been added, and lack of flexibility to provide needed content and descriptions.

The “Data Management” section in each chapter of this guide describes where information will be housed, updated, and tracked for each program area. Many of the database links are currently being updated or will change with required updates and revised data management protocols. Each program manager—in addition to providing the biennial monitoring and evaluation report content to the forest inventory and monitoring coordinator every other year—will review the protocols of this monitoring guide and update relevant references to technical guides, file strings, and data management procedures. This will be a part of each report for the program area. The inventory and monitoring coordinator will provide updated content templates for the biennial monitoring and evaluation report to each responsible program area six months prior to the reporting completion date every other year (beginning May 15, 2022). Templates will include topic headings that will solicit updated and revised protocols, rationale, and file strings for each program area.

Finally, with the rapid evolution of the ArcGIS Online tools, applications, and resources, nearly every forest program area has or is in the progress of developing geospatial tracking tools and resources for monitoring their progress. Some examples are highlighted in chapters 3 and 6 of this guide with the aquatic organism passage assessment and prioritization tools and the Landscape Change Monitoring System monitoring tools, respectively. One of the first steps in implementing the monitoring program and adding to this monitoring guide will be the development of a forest-level integration tool, such as the ArcGIS Online Hub platform, which will allow Chugach staff to store, share, communicate, visualize, and report their accomplishments in a georeferenced format across all eight required topics of the plan monitoring program. While these tools are a work in progress and will not be completed for the first biennial monitoring and evaluation report, they are an approach that will allow incorporation of the best available science and information sharing across U.S. Forest Service lands.

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