National Park Service
U.S. Department of the Interior

Glacier Bay National Park and Preserve
Alaska

Climate Monitoring Program in Glacier Bay National Park and Preserve

Environmental Assessment
May, 2015

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Note to Reviewers

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Gustavus, AK 99826
Email: glba_public_comments@nps.gov

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ACRONYMS AND ABBREVIATIONS

ANILCA	Alaska National Interest Lands Conservation Act
ARPA	Archeological Resources Protection Act
AVO	Alaska Volcano Observatory
CEQ	Council on Environmental Quality
CGPS	Continuous Global Positioning System
CFR	Code of Federal Regulations
COOP	Cooperative Observer Program
CWOP	Citizen Weather Observer Program
CUA	Commercial Use Authorizations
DO	NPS Director's Order
EA	Environmental Assessment
FAA	Federal Aviation Administration
FTS	Forest Technology Weather System
GLBA	Glacier Bay National Park and Preserve
GMP	General Management Plan
GOES	Geostationary Satellite Server
LIA	Little Ice Age
NEPA	National Environmental Policy Act
NPS	National Park Service
NHPA	National Historic Preservation Act
NRCS-SC	Natural Resource Conservation Service - Snowcourse Network
NRHP	National Register of Historic Places
NSF	National Science Foundation
NWS	National Weather Service
PBO	Plate Boundary Observatory

PRISM	Parameter-elevation Regressions on Independent Slopes Model
RAWS	Remote Automated Weather Station
SAO	Surface Airways Observation network
SCAN	Soil Climate Analysis Network
SNOTEL	Snowfall Telemetry network
SOD	Summary of the Day
SEAN	Southeast Alaska Network
TCP	Traditional Cultural Property
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United Stated Geologic Survey
WMP	Wilderness Visitor Use Management Plan
WRCC	Western Regional Climate Center
YTT	Yakutat Tlingit Tribe

1.0 INTRODUCTION

1.1 Purpose and Need

The National Park Service (NPS) is considering expansion of the Southeast Alaska Network (SEAN) Inventory and Monitoring Program's weather and climate monitoring system. Long-term placement of up to eight remote automated weather stations (RAWS) and two data-logging thermistors is being proposed for Glacier Bay National Park and Preserve (GLBA or "the park").

The SEAN Weather and Climate Inventory report (Davey et al. 2007) determined that, based on climate change considerations alone, a recommended monitoring strategy would entail placement of stations in the pure coastal zone, in the pure interior zone, at higher elevations closer to the location of what is currently quasi-permanent ice, and in transition regions such as drainage divides. Additionally, the report states that climate inventory and monitoring activities should be based on a set of guiding fundamental principles. Any evaluation of a weather/climate monitoring program begins with asking the following question: What is the purpose of weather and climate measurements?

Within the context of the climate monitoring proposed in GLBA, the following services constitute the main purposes of recording weather and climate observations (Davey et al. 2007):

- Consistently monitor climate over the long term to detect changes in environmental drivers affecting ecosystems, including both gradual and sudden events.
- Provide retrospective data to understand *a posteriori* changes in flora and fauna.
- Document for posterity the physical conditions in and near the park unit, including mean, extreme, and variable measurements (in time and space) for all applications.
- Provide measurements for real-time operational needs and early warnings of potential hazards (jokulhaups, landslides, mudflows, washouts, fallen trees, aircraft and watercraft conditions, rescue conditions, fog, restoration and remediation activities, etc.).
- Provide visitor education and aid interpretation of expected and actual conditions for visitors while they are in the park and for deciding whether and when to visit the park.

The report concludes that existing weather stations in the vicinity of GLBA do not provide adequate data for understanding climate change within the park. The reasons for this include coverage gaps that preclude the ability to assess weather and climate across a west-to-east coastal-to-interior gradient, a north-to-south fjord head-to-lower bay gradient, and an elevational gradient.

In addition, Arendt et al. (2009) state that data from high-elevation climate stations near icefields are very important to developing predictions of future climate change effects on glacially-influenced ecosystems, including effects on land-terminating and tidewater glaciers themselves.

Much of the Southeast Alaska region is remote and existing weather and climate station coverage is minimal. Currently there are only two climate/weather monitoring installations within GLBA:

on the outer coast at the Cape Spencer U.S. Coast Guard (USCG) station, and in the Bartlett Cove administrative area. Both stations are located near sea level.

Deployment of additional permanent weather stations within the park would allow the NPS to better achieve the goal of tracking climate and documenting how changes affect park resources. This information would contribute resource data for park management decisions and would also contribute to broader-scale climate monitoring and modeling efforts. Uplinked stations would also provide real-time weather conditions and improved forecasting that would enhance visitor and operational safety and planning.

The area's highly variable complex topography is a major controlling factor for surface climate. In GLBA, significant portions of mountainous areas hover close to freezing much of the year. Consequently, their ice mass balances are much more sensitive to small changes in temperature. This also affects the character of storms by increasing the ratio of rain to snow. The elevation of the rain/snow line, the manner of accumulation during winter and the timing of the spring snowmelt runoff pulse and summer ice loss, may all be affected by temperature change. Precipitation gauges along with other instrumentation located along the Gulf of Alaska and in GLBA would help the NPS monitor climatic conditions influencing icefields and fill in large coverage gaps that currently exist in the park and preserve.

The rate of ongoing deglaciation, soil thaw, plant colonization on newly exposed soils, marine and terrestrial wildlife habitat availability, and even food availability are closely tied to local temperatures. It is quite likely that the ranges of a number of plant and animal species are controlled by specific temperature thresholds. For example, some insect pests that cause widespread damage to coniferous trees are held in check by very cold temperatures each winter (Safranyik et al. 1975). Warmer winters could allow pests to expand into new regions or increase their local effects. Invasive terrestrial and aquatic plant and animal species originating in warmer regions can extend their ranges northward as temperatures rise.

The action alternative in this environmental assessment (EA) would expand the NPS monitoring program by establishing additional stations to collect basic climatological data including air and soil temperature, precipitation, relative humidity, wind speed and direction, solar radiation, and snow depth.

Weather and climate monitoring has been clearly established within the NPS as a fundamental data need for providing scientific support to internal and external park researchers and meeting the mandate of considering climate in park management as reflected in the NPS Climate Change Response Strategy (NPS 2010b).

Permanent RAWS stations are proposed for up to eight sites in the park and preserve. These unmanned stations, consisting of battery-powered weather instrumentation, would become part of the GLBA climate monitoring system providing baseline weather information and supporting climate trend analysis. HOBO data-logging thermistors would be co-located on existing structures (high-elevation NPS radio repeaters) at two locations in the park. Existing and proposed climate monitoring sites are shown in Figure 1-1.

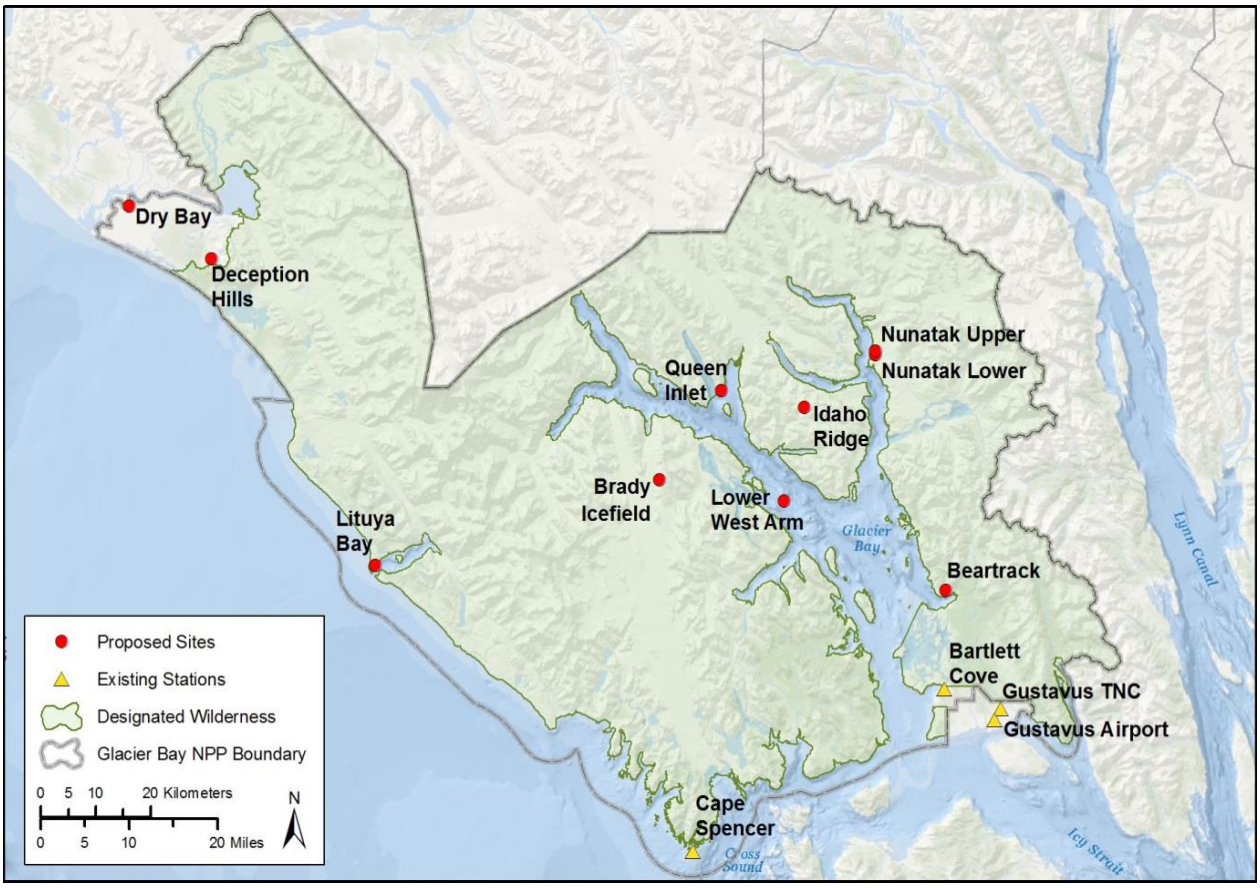

Figure 1-1. Project area: existing and potential climate monitoring station sites in GLBA.

This Environmental Assessment (EA) analyzes the potential environmental impacts that could result from a No Action alternative and one action alternative. This EA has been prepared in accordance with the National Environmental Policy Act (NEPA) of 1969, regulations of the Council of Environmental Quality (CEQ) (40 Code of Federal Regulations 1508.9), and the NPS NEPA compliance guidance handbook (Director's Order (DO)-12, *Conservation Planning, Environmental Impact Analysis, and Decision-making*).

1.2 Background

The National Parks Omnibus Management Act, passed by Congress in 1998, directs the NPS

"to establish baseline [resource] information and to provide information on the long-term trends in the condition of National Park System resources."

The NPS established the Inventory and Monitoring Program to determine the status and trends in the condition of resources in park units nation-wide. Parks with significant natural resources are grouped into 32 networks, based on geography and shared natural resource characteristics. The network organization facilitates collaboration among parks, information sharing, and economics of scale in natural resources inventory and monitoring. Parks within these networks work together and share funding and professional staff to plan, design, and implement an integrated long-term monitoring program. A set of Vital Signs representing the overall health or condition

of park resources specific to each network was also identified. Climate has been identified as a Vital Sign for GLBA (Moynahan et al. 2008). Climate is a fundamental driver of ecological condition and the patterns of plant and animal communities found in Southeast Alaska park units. Managers must rely on more complete trend information in order to protect park resources over time.

Weather and climate are widely recognized as drivers of ecological structure, function, and condition (Davey et al. 2007). Changes in the physical environment, caused either by climate or other physical processes, can have significant impacts on the entire ecosystem. In order to properly monitor an ecosystem, the changes in the physical environment must be properly monitored and documented.

Climatic characteristics of the SEAN are influenced both by the area's complex topography and its proximity to the Pacific Ocean. Mean annual temperature and precipitation vary greatly across the region. Higher coastal mountains in GLBA can receive more than 10 m (400 inches) of precipitation in a single year.

In general, Alaska has a sparse dispersion of climate monitoring sites. There are a few permanent long-term climate monitoring sites in the GLBA region, though most of them are located around towns and cities such as Juneau, almost 60 km east of the park (Moynahan et al. 2008). Weather and climate information from the area immediately surrounding GLBA is currently collected from only four low-elevation sites near Gustavus, Bartlett Cove, and Cape Spencer (Figure1-1).

In the past, instrument stations maintained by the U. S. Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL) collected weather data from 24 sea-level sites throughout Glacier Bay. The CRREL network was reviewed in 2010 to determine which of these stations might be upgraded and included as part of the NPS monitoring program. Since it was determined that data from the CRREL stations would not satisfy NPS program standards, the project was discontinued, and all instrumentation removed.

Existing Climate and Weather Networks

A network of climate monitoring sites currently exists outside GLBA (Figure1-2). Most stations are associated with at least one of eight weather and climate networks (Moynahan et al. 2008). According to the climate inventory report (Davey et al. 2007), a climate or weather monitoring station need not necessarily be located within the unit boundaries to provide useful data and information regarding the park unit in question. An effective network could include some stations physically located within the administrative or political boundaries, and some stations located just outside (or even some distance away), but any "outside" stations would need to be *nearby* in behavior and representativeness. Existing networks include:

- National Weather Service (NWS) Cooperative Observer Program (COOP): The COOP network has been a foundation of the U.S. climate program for decades and continues to play an important role. Manual measurements are made by volunteers and consist of daily maximum and minimum temperatures, observation-time temperature, daily precipitation, daily snowfall, and snow depth. When blended with NWS measurements, the data set is

known as SOD, or "Summary of the Day." The quality of data from COOP sites ranges from excellent to modest.

- Citizen Weather Observer Program (CWOP): The CWOP network consists primarily of automated weather stations operated by private citizens who have either an internet connection and/or a wireless amateur (ham) radio setup. Data from CWOP stations are specifically intended for use in research, education, and homeland security activities. Although standard meteorological elements such as temperature, precipitation, and wind are measured at all CWOP stations, station characteristics (e.g., sensor types and site exposure) vary.

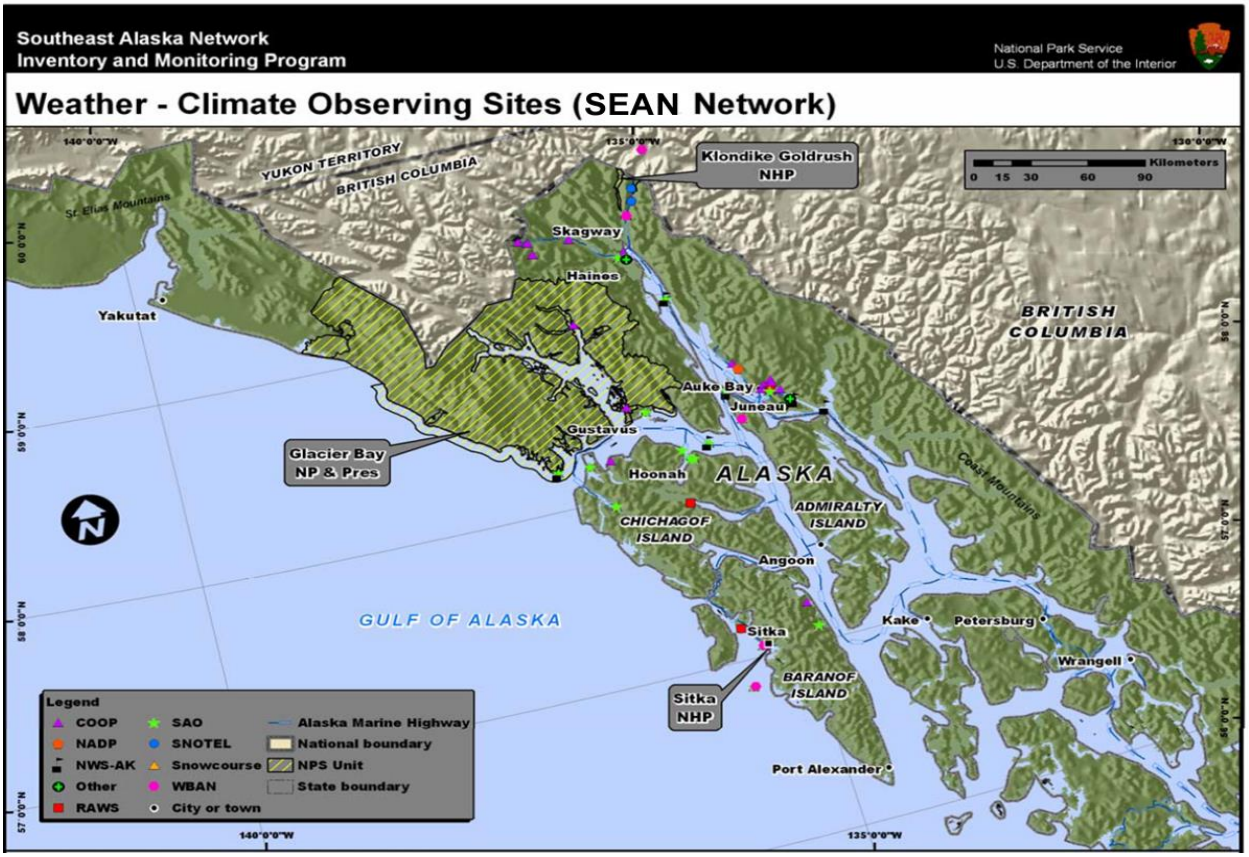

Figure 1-2. Existing climate and weather observing sites within and near (within 300 km) GLBA (Davey et al., 2007). Note that since creation of this figure, one new RAWS station has been added near the Gustavus airport.

- USDA/NRCS Snowcourse Network (Natural Resource Conservation Service-SC): The USDA/NRCS maintains a network of snow-monitoring stations in addition to SNOTEL (described below). These sites are known as snowcourses. These are all manual sites, measuring only snow depth and snow water content once or twice monthly from January to May. Data records for these snowcourses often extend back to the 1920s or 1930s, and the data are generally of high quality. Many of these sites have been replaced by SNOTEL sites, but several hundred snowcourses are still in operation nationwide.

- Remote Automated Weather Station (RAWS) Network: The RAWS network is administered through many public land management agencies, particularly the Bureau of Land Management (BLM) and the U.S. Forest Service. Hourly meteorology elements are measured and include air and soil temperature, wind, humidity, solar radiation, barometric pressure, fuel temperature, snow depth, and precipitation (when temperatures are above freezing). The fire community is the primary client for RAWS data. These sites are remote, and data typically are transmitted via Geostationary Operational Environmental Satellite (GOES). Some sites operate all winter. Most data records for RAWS sites began during or after the mid-1980s.

- National Weather Service (NWS) Surface Airways Observation (SAO) Network: These stations are usually located at major airports and military bases. Almost all SAO sites are automated. The hourly data measured at these sites include temperature, precipitation, humidity, wind, barometric pressure, sky cover, ceiling, visibility, and current weather. Most data records began during or after the 1940s, and these data are generally of high quality.

- NWS Alaska Region Network (NWS-AK): These stations are near-real-time stations managed by the NWS Alaska Region. NWS-AK stations are located close to important waterways throughout the SEAN. As a result, weather data from NWS-AK stations are used primarily in support of shipping activities in the Southeast Alaska region. Measured meteorological elements include temperature, wind, barometric pressure, and dewpoint temperature.

- U.S. Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS) Snowfall Telemetry (SNOTEL) Network: The USDA/NRCS maintains a network of automated snow-monitoring stations known as SNOTEL. The network was implemented originally to measure daily precipitation and snow water content. Many modern SNOTEL sites now record hourly data, with some sites now recording temperature and snow depth. Most data records began during or after the mid-1970s.

- Weather Bureau Army Navy (WBAN): This is a station identification system rather than a true weather/climate network. Stations identified with WBAN are largely historical stations that reported meteorological observations on the WBAN weather observation forms that were common during the early and middle parts of the twentieth century. The use of WBAN numbers to identify stations was one of the first attempts in the U.S. to use a coordinated station numbering scheme between several weather station networks, such as the COOP and SAO networks.

The Davey et al. report (2007) identifies station sites within GLBA that would be suitable for data harvest and describes the recommended approach for climate monitoring. This approach was adapted into the SEAN Vital Signs Monitoring Plan to augment the few existing regional stations, but is also designed to capture the three main environmental gradients found within GLBA boundaries:

1. West-to-east, from the Gulf of Alaska-dominated climate of the outer coast and transitioning to the more interior conditions of Glacier Bay proper.

2. North-to-south, from the heavily glaciated upper bay to the ice-free, forested lower bay.
3. Elevational, from sea level to higher-elevation icefields.

1.2.1 Park Purpose and Significance

The park was first established in 1925 as *Glacier Bay National Monument* by Presidential Proclamation under the Antiquities Act. The purpose of the monument was to preserve an area significant for the following reasons:

> "*-a number of tidewater glaciers of the first rank in a magnificent setting of lofty peaks, and more accessible to ordinary travel than other similar regions of Alaska.*
>
> *-a great variety of forest covering consisting of mature areas, bodies of youthful trees which have become established since the retreat of the ice which should be preserved in absolutely natural condition, and great stretches now bare that will become forested in the course of the next century*
>
> *-a unique opportunity for the scientific study of glacial behavior and of resulting movements and developments of flora and fauna and of certain valuable relics of interglacial forests*
>
> *-historic interest, having been visited by explorers and scientists since the early voyages of Vancouver in 1794 who left valuable records of such visits and explorations*"

The monument was subsequently expanded by Presidential Proclamations in 1939 and 1955. It was further expanded and re-designated *Glacier Bay National Park and Preserve* by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980. Approximately 2.7 of the park's 3.3 million terrestrial and marine acres were designated as wilderness. ANILCA Section 203 directs the NPS to administer the park pursuant to the provisions of the National Park Service Organic Act of 1916 and other pertinent legislation.

The 2010 Glacier Bay National Park and Preserve Foundation Statement states the legislative purpose of the park as "*to protect a dynamic tidewater glacial landscape and associated natural successional processes for science and discovery in a wilderness setting*". There are ten significance statements that are directed by legislation and guided by the knowledge acquired through management, research, and civic engagement. They define what is most important about GLBA's resources and values. Significance statements related to this project include:

1. GLBA fosters unique opportunities for scientific study of glacial landscapes and associated natural processes.
2. GLBA gathers and protects records of exploration, scientific endeavor, human use, and provides for understanding the landscape through human experience and study.
3. GLBA protects ecological integrity by preserving a diversity of large, contiguous, intact ecosystems that are strongly dominated by natural processes.

4. GLBA protects a natural biophysical landscape that is continually changing through large-scale natural disturbance, an evolving physical environment, and biological succession of plants and animals.
5. GLBA preserves one of the largest units of the National Wilderness Preservation System, encompassing more than 2.7 million acres of glacially-influenced marine, terrestrial, and freshwater ecosystems.
6. GLBA preserves one of the largest federally protected marine ecosystems in Alaska (nearly 600,000 acres) against which other less protected marine ecosystems can be compared.
7. GLBA lies within two Tlingit ancestral homelands that are of cultural and spiritual significance to living communities today.
8. GLBA provides diverse opportunities for visitors to experience a dynamic tidewater glacial landscape.

1.2.2 Laws, Regulations, and Policies

The following laws and associated regulations provided guidance for the development of this EA, design of the Preferred Alternative, analysis of impacts, and creation of mitigation measures to be implemented as part of the Preferred Alternative.

NPS Organic Act

The NPS Organic Act (1916) and the General Authorities Act (1970) prohibit impairment of park resources and values. The NPS 2006 Management Policies and Director's Order #55 use the terms "resources and values" to mean the full spectrum of tangible and intangible attributes for which the park was established and is managed, including the Organic Act's fundamental purpose and any additional purposes as stated in the park's establishing legislation. The impairment of park resources and values may not be allowed unless directly and specifically provided by statute. The primary responsibility of the NPS is to ensure that park resources and values will continue to exist in a condition that allows the American people to have present and future opportunities to enjoy them.

The evaluation of whether impacts of a preferred alternative would lead to an impairment of park resources and values is included in this EA. Impairment is more likely when there are potential impacts to a resource or value whose conservation is:

- necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park;
- essential to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or
- identified as a goal in the park's General Management Plan (GMP) or other relevant NPS planning documents.

NPS Omnibus Management Act

The NPS Omnibus Management Act of 1998 (P.L. 105-391, 112 Statute 3497) addresses resources inventory and management in Title II. Section 201 defines the purposes of this title to enhance and encourage scientific study in National Park system units. Section 202 authorizes and directs the Secretary of the Interior to assure management of NPS units is enhanced by a broad program of high-quality science and information. Section 205 states the Secretary may solicit, receive, and consider requests from Federal and non-Federal public or private entities for the use of NPS units for scientific study. Such proposals must be: 1) consistent with applicable laws and the NPS Management Policies, and 2) the study would be conducted in a manner as to pose no threat to park resources or public enjoyment of those resources.

Wilderness Act of 1964

The Wilderness Act of 1964 (Public Law 88-577, 16 USC §§ 1131-1136, 78 Stat. 890) established the National Wilderness Preservation System and identified the National Park Service as one of the four federal agencies responsible for protecting and preserving the nation's wilderness resource. The Wilderness Act defines wilderness as follows:

> *A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this chapter an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.*

Section 4(c) of the Wilderness Act defines prohibited uses as:

> *Except as specifically provided for in this Act, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this Act and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.*

ANILCA Section 1310(b) states:

> *The establishment, operation, and maintenance within any conservation system unit of new…facilities for weather, climate, and fisheries research and monitoring shall be permitted but only (1) after consultation with the Secretary, as appropriate, by the head*

of the Federal department or agency undertaking such establishment, operation, or maintenance, and (2) in accordance with such terms and conditions as may be mutually agreed in order to minimize the adverse effects of such activities within such unit.

NPS Management Policies

NPS Management Policies 2006 (NPS 2006a) addresses the importance of and need for weather and climate monitoring efforts in a number of sections:

Section 4.7.2 *Weather and Climate:* "parks containing significant natural resources will gather and maintain baseline climatological data for reference".

Section 4.2 *Studies and collections: "*The Service will encourage appropriately reviewed natural resource studies whenever such studies are consistent with applicable laws and policies. These studies support the NPS mission by providing the Service, the scientific community, and the public with an understanding of park resources, processes, values, and uses that will be cumulative and constantly refined… Studies include projects conducted by researchers and scholars in universities, foundations and other institutions, tribal colleges and organizations, other federal and state agencies, and Service staff".

Section 2.3.1.4 *Science and Scholarship:* "The collection and analysis of information about park resources will be a continuous process that will help ensure that decisions are consistent with park purposes."

Section 6.3.6 *Scientific Activities in Wilderness:* "The statutory purposes of wilderness include scientific activities, and these activities are encouraged and permitted when consistent with the Service's responsibilities to preserve and manage wilderness".

Section 6.3.6.1 *General Policy:* "The National Park Service has a responsibility to support appropriate scientific activities in wilderness and to use science to improve wilderness management. The Service recognizes that wilderness can and should serve as an important resource for long-term research into and study and observation of ecological processes and the impact of humans on these ecosystems. The National Park Service further recognizes that appropriate scientific activities may be critical to the long-term preservation of wilderness".

"Scientific activities are to be encouraged in wilderness. Even those scientific activities (including inventory, monitoring, and research) that involve a potential impact to wilderness resources or values (including access, ground disturbance, use of equipment, and animal welfare) should be allowed when the benefits of what can be learned outweigh the impacts on wilderness resources or values. However, all such activities must also be evaluated using the minimum requirement concept and include documented compliance that assesses impacts against benefits to wilderness. This process should ensure that the activity is appropriate and utilizes the minimum tool required to accomplish project objectives. Scientific activities involving prohibitions identified in section 4(c) of the Wilderness Act (16 USC 1133(c)) may be conducted within wilderness when the following occur:

- *The desired information is essential for the understanding health, management, or administration of wilderness, and the project cannot be reasonably modified to eliminate or reduce the nonconforming wilderness use(s); or if it increased scientific knowledge, even when this serves no immediate wilderness management purposes, provided it does not compromise wilderness resources or character. The preservation of wilderness resources and character will be given significantly more weight than economic efficiency and/convenience.*
- *Compliance with the National Environmental Policy Act (1969).*
- *All scientific activities will be accomplished in accordance with terms and conditions adopted at the time the research permit is granted.*
- *The project will not significantly interfere with other wilderness purposes (recreational, scenic, educational, conservation, or historical) over a broad area or for a long period of time.*
- *The minimum requirement concept is applied to the implementation of the project.*

The *minimum requirement* concept is used when making all decisions concerning management of wilderness, including administrative practices, proposed special uses, scientific activities, and equipment use (including weather stations) in wilderness. A two-step process is used:

1) Determine whether the proposed management action is needed, necessary for the purpose of wilderness, and does not pose a threat to wilderness resources and character.
2) Determine the techniques and type of equipment needed to ensure that impact to wilderness resources and values is minimized.

If a compromise of wilderness resource or character is unavoidable, only those actions that preserve wilderness character and/or have localized, short-term adverse impacts will be acceptable (NPS 2006). The full minimum requirement analysis for this proposal is included in Appendix A.

1.2.3 Relationship of Proposal to Other Planning Projects

The park manages its resources through several planning documents including the General Management Plan (GMP) (NPS 1984), Wilderness Visitor Use Management Plan (WMP) (NPS 1989), Vital Signs Monitoring Plan: Southeast Alaska Network (Moynahan et al. 2008), and the Glacier Bay National Park and Preserve Foundation Statement (NPS 2010a). The proposed project is consistent with these park plans.

1.3 Impact Topics

Issues and concerns with this project are grouped into distinct impact topics to aid in analyzing environmental consequences, which allows for a standardized comparison of alternatives based on the most relevant information. The impact topics were selected on the basis of GLBA park

staff knowledge of potentially affected resources, federal laws, regulations and orders, and NPS Management Policies. A brief rationale for selecting or dismissing each topic is provided below.

1.3.1 Impact Topics Selected

Wilderness Character
Wilderness character qualities could be affected by placement of installations that would remain indefinitely. In addition, wilderness character could be affected by sights and sounds of aircraft and motorized boats transporting equipment to the sites for installation and future maintenance or repair. Knowledge that monitoring stations are present within wilderness may diminish wilderness visitors' experience. Inasmuch as climate data can help protect wilderness character, the lack of such information could also impact wilderness character.

Wildlife
Installation of weather monitoring equipment could temporarily displace wildlife in the immediate vicinity. Wildlife could also be disturbed by motor vessels, aircraft, and human presence at the instrumentation sites during annual maintenance trips at least once each year. Wildlife habitat could be reduced by RAWS installations.

Vegetation
Vegetation would be trampled during installation and maintenance of some weather stations. Small areas of vegetation could require periodic clearing, impacting existing vegetation within the footprint of each station. The potential exists for invasive species to be transported to weather station sites on equipment, clothing, and footwear.

Visitor Experience
Encountering a weather station could have a detrimental effect on the visitor's recreational experience. Visitors could consider the weather stations intrusions on the scenic integrity of the backcountry and designated wilderness. Visitors could hear motor vessel or aircraft noise during construction, annual maintenance, and unscheduled repair trips to some stations. Weather stations would be visible, thus posing an unnatural visual intrusion in pristine environments. Intrusions could include the actual visibility of the tower or glare reflected off the equipment.

Soundscape
Noise intrusions would occur during installation and maintenance of the weather stations due to presence of field crews, motorized and human-powered boats, and the aircraft used for site access. These noise intrusions could disrupt or mask natural sounds.

Cultural Resources
Cultural resources, including sites eligible for listing in the National Register of Historic Places (NRHP), such as Traditional Cultural Properties (TCPs), historic sites, and archeological sites, could be affected by climate station site selection, station installation or servicing.

1.3.2 Impact Topics Dismissed

Executive Order 12898, "Environmental Justice"

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations" requires all federal agencies to incorporate environmental justice into their missions by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs and policies on minorities and low-income populations and communities. The EA alternatives would have no health or environmental effects on minorities or low-income populations or communities.

Soils

Although many weather station sites were selected so that the weather towers could be installed on bedrock, small areas of soil, where it exists, could be compacted by the installation activities. Station sites that are accessed on foot could show signs of trailing, but this would be temporary. Station maintenance would not occur frequently enough to maintain noticeable trailing.

Floodplains and Wetlands

No proposed monitoring station sites are located in or adjacent to any floodplains, wetlands or riparian areas**.**

Threatened and Endangered Species

The humpback whale (endangered) and Steller sea lion (endangered distinct population segment) are both found in marine waters of the park. Climate station sites are terrestrial, so installation and maintenance activities would cause minimal disturbance to these species. Short duration, infrequent disturbance could occur to specific individual animals during motor vessel travel to the stations. The NPS has determined that the preferred action is not likely to affect humpback whales or Steller sea lions.

Subsistence

Effects on subsistence uses and resources are addressed in detail in the ANILCA Section 810 Evaluation (Appendix B).

1.4 Permits and Approvals Needed to Implement Project

Wilderness: A minimum requirement/minimum tool analysis has been conducted for new proposed weather stations located in designated wilderness. Results for this analysis are included in Appendix A.

Wildlife: National Marine Fisheries Service consultation and permitting for access to known marine mammal haulout areas (Lone Island) according to the Marine Mammal Protection Act. NPS would consult with the U. S. Fish and Wildlife Service regarding potential impacts to breeding migratory birds on Lone Island.

U.S. Coast Guard: A Memorandum of Understanding (MOU) or other approval to co-locate monitoring equipment on the Lituya Bay range marker and to incorporate equipment into the Deception Hills communications array.

2.0 ALTERNATIVES

The Council on Environmental Quality (CEQ) regulations for implementing NEPA require Federal agencies to explore and objectively evaluate all reasonable alternatives to the Preferred Alternative and briefly discuss the rationale for eliminating any alternatives that were not considered in detail. This chapter describes the No Action Alternative, the Preferred Alternative, and the Environmentally Preferable Alternative. There are two alternatives considered but dismissed from further analysis.

2.1. Alternative A: No Action.

Under the No Action alternative, no additional RAWS climate monitoring stations would be established in the park or preserve. Climate effects would be monitored using data from four existing monitoring stations: a NOAA station in Bartlett Cove, and RAWS and NWS stations at Gustavus and Cape Spencer (Figure 2-1).

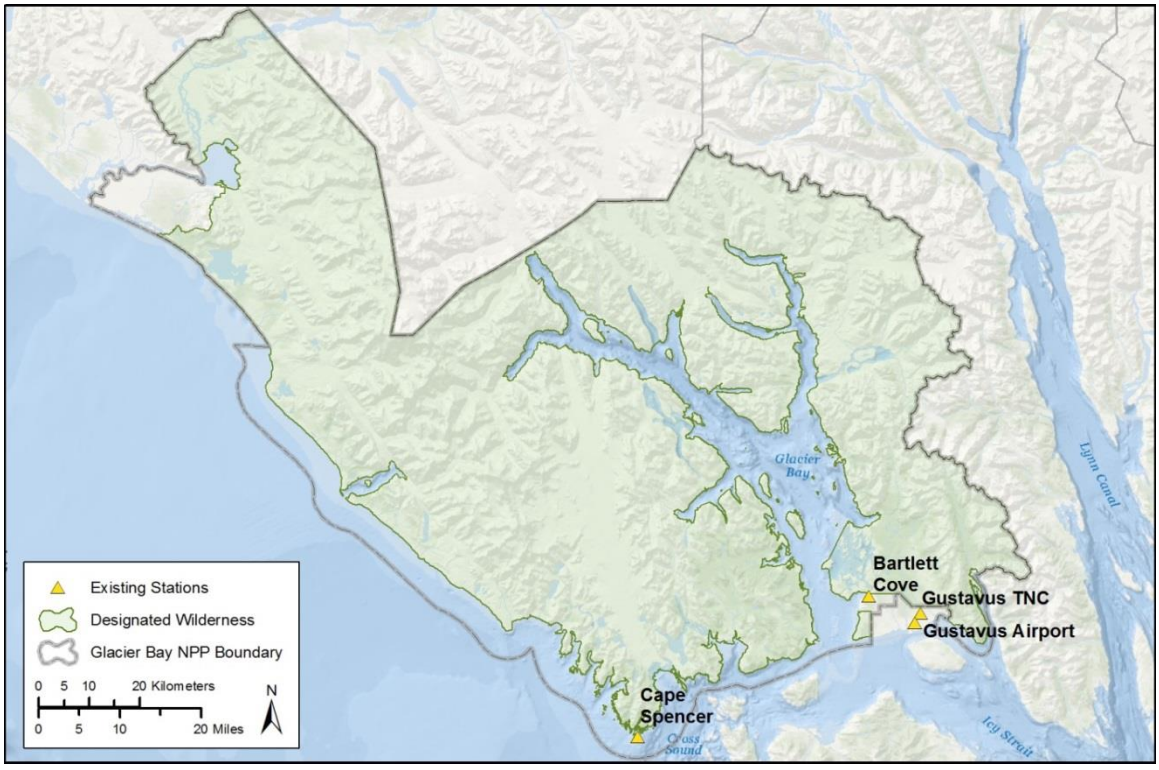

Figure 2-1. Climate monitoring station sites proposed under Alternative A.

2.2 Alternative B: Expand climate monitoring program to ten sites (Preferred Alternative).

This alternative would expand the existing observational network to include ten additional instrument sites within GLBA. Of these ten stations, eight would include complete RAWS instrumentation, and two would consist of a HOBO data-logging thermistor attached to existing

NPS radio repeaters. Eight of the sites would be located within designated park wilderness (Figure 2-2).

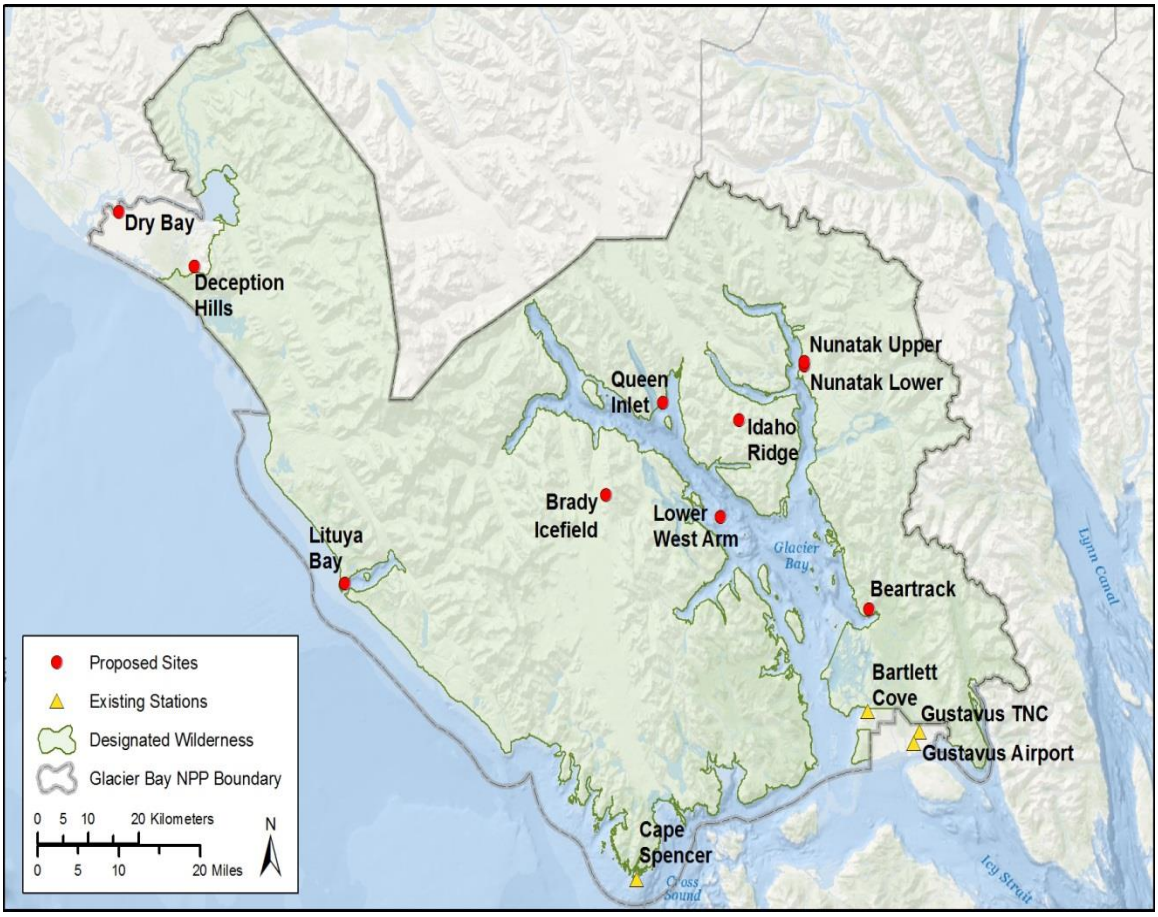

Figure 2-2. Climate monitoring station sites proposed under Alternative B.

Each proposed RAWS station would collect basic weather observations including air and soil temperature, precipitation, relative humidity, wind speed and direction, solar radiation, and snow depth, and transmit these observations hourly via satellite. These observations would be posted to the Western Regional Climate Center web site or comparable data repository in near real-time. The two thermistor sites would record and store temperature information only, and the data would be collected annually. Due to the adaptive nature of weather station installation, station descriptions provided here are as accurate as possible, but as sites are installed, minor details may change (for example, guy wires angled in different configurations depending on bedrock availability).

The Dry Bay, Lower West Arm, Queen Inlet, Nunatak Lower, Nunatak Upper, and Brady Icefield RAWS stations would each host a 10-foot-tall tri-leg tower supporting all the sensors and the collective data-logger. Towers would be taped or painted dull colors to blend in with surrounding vegetation and rock. At each station, tower mounts would support temperature, relative humidity, solar radiation, wind speed and direction, and snow depth sensors, a GPS antenna, and a GOES satellite transmission antenna. A steel equipment enclosure located near the base of the structure would house the data-logger and GOES transmitter. Also at the base

would be two boxes, each housing three starved electrolyte-type Optima™ 12-volt batteries that provide power to the station. A 33" by 21" by 2" solar panel rated for 50 watts, mounted on the tower, would keep the batteries charged. In some cases, a fuel cell at the base of the tower would replace the solar panel. The ground footprint of the entire installation, not including guy wires and any potential fencing to prevent wildlife damage, would be approximately 15-20 square feet (~4'x4'). The tower would typically be anchored with three guy wires bolted to the ground. Tower components would be assembled on site.

At Deception Hills, instrumentation would be incorporated into a USCG communications facility scheduled to be constructed during summer 2014. The Lituya Bay sensors would either be attached to a 4"-diameter pipe extending approximately five feet above the framework of the existing USCG navigational range marker (one of the two range makers on shore inside the entrance to Lituya Bay assist entering and departing vessels) or placed on a 10-foot-tall tri-leg tower (as described above) located within the maintained clearing between the range markers.

Each RAWS station would include a GOES satellite link that, in addition to reporting weather data in near-real-time, would allow sensor performance and battery status to be monitored. Each station would also store data internally to ensure data security even in the event of a real-time communication failure. The RAWS station described here is the standard configuration successfully deployed and maintained by NPS Inventory and Monitoring Programs throughout Alaska. Figure 2-3 shows the precipitation gage anchored on a second low post near ground level, but it would more likely be mounted directly to the cross-arm near the top of the tower.

Each RAWS station would be visited once each year in order to perform routine maintenance and inspection. In some cases, failure of sensors or other unanticipated repairs could require an additional visit to specific stations.

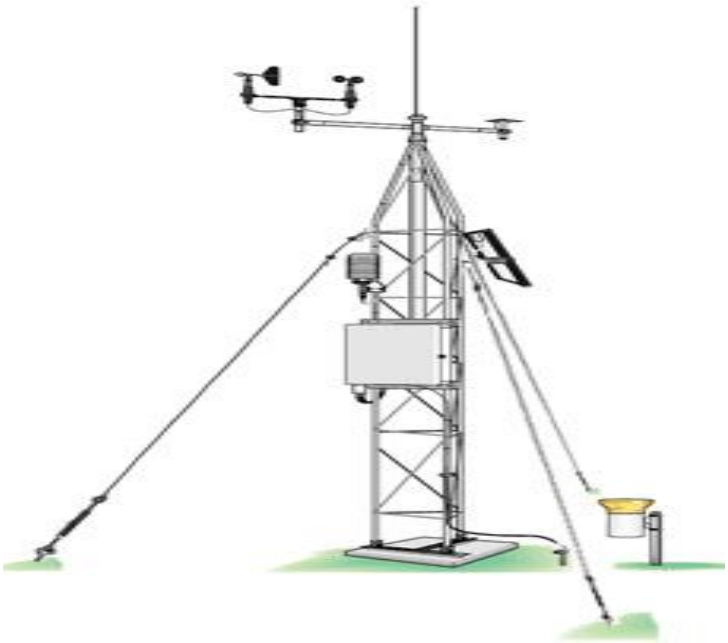

Figure 2-3. Example of a typical RAWS station (http://www.campbellsci.com/).

At the existing Beartrack and Idaho Ridge NPS radio repeater sites, small, self-contained HOBO data-logging thermistors (Onset model U23-400 equipped with radiation shields) would be affixed to the repeater structure. These models are 4"x1.5" in size (Figure 2-4). Data-loggers would either be downloaded or replaced during radio repeater maintenance visits. No additional aircraft landings to service the thermistors would occur.

Figure 2-4. HOBO data-logging thermistor.

When less intrusive technological improvements (i.e. wireless instruments, portable instruments, remote sensing) become available that can duplicate existing data collection methods or components, the existing station equipment will be removed. Stations that do not meet the data criteria of the NPS climate monitoring program or are determined to be duplicated by stations in other locations outside the park will be removed. Park management will monitor and ensure that this review takes place within 5 years. As part of this operational review, a NPS proposal to establish an additional climate monitoring station (along with the potential for removal of others) could be considered, in which case a separate NEPA environmental effects analysis would be required.

A weather station can be installed in a few hours by two people once all the components are onsite. Transporting the weather station to a deployment site would typically require one or two loads using motorized boats and carrying smaller loads to the site on foot. The Dry Bay station site is accessible by motor vehicle on an established soft-surface road. The Deception Hills and Lituya Bay sites would require coordination with the USCG. Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield would require use of a helicopter. Weather station installation would probably occur in June, July, or August. Hand tools would be used for wilderness weather station assembly and installation. Some sites could require the use of anchor bolts in rock. Bolt holes would be drilled by hand. Should hand-drilling prove to be unreasonably difficult and/or time-consuming as determined by NPS staff, other options (including a battery-powered motorized rock drill) may be used to assure successful installation and minimal net impact to wilderness character.

Each RAWS station would require one scheduled annual maintenance visit. Unanticipated failure of station sensors or components could require an additional visit. Maintenance activities would be confined to a single day and would primarily occur from June through August. Typically, access would be via motor vessel to a nearby beach followed by a hike on foot, although the Deception Hills, Brady Icefield, Beartrack, and Idaho Ridge stations would require helicopter landings. Approximately six hours would be required to replace sensors as necessary and perform other routine maintenance including periodic vegetation clearing. The Beartrack and

Idaho Ridge thermistors would be downloaded when the NPS radio repeaters are serviced. No additional trips to these instrument sites would be authorized. Installation sites proposed under Alternative B include:

Site	Elevation	Location	Access	Land/Water Status	Concurrent Land Uses
Lituya Bay	< 20' above sea level	N58.6271 W137.6579	Motor vessel, fixed-wing floatplane, foot	Preserve (non-wilderness)	USCG aid to navigation
Dry Bay	Low	N59.1676 W138.4841	Motor vehicle (ORV)	Preserve (non-wilderness)	ORV trail system
Deception Hills	~2,214'	N59.0924 W138.2165	Helicopter	Preserve (non-wilderness)	Seismic sensor, communication array
Queen Inlet	~1,040'	N58.9173 W136.5844	Motor vessel, foot	Wilderness	None
Lower West Arm Low-elevation	20-50' above sea level	See Figure 2-5	Motor vessel, foot	Wilderness	None
Nunatak Lower	< 20' above sea level	N58.9781 W136.1003	Motor vessel, foot	Wilderness (eligible wilderness waters)	None
Nunatak Upper	~1,000'	N58.9836 W136.1003	Motor vessel, foot	Wilderness (eligible wilderness waters)	Historic photo site at summit
Beartrack	~2,368'	N58.6129 W135.8668	Helicopter	Wilderness	NPS radio repeater
Idaho Ridge	~3,774'	N58.894 W136. 3216	Helicopter	Wilderness	NPS radio repeater
Brady Icefield	3,000-4,000'	See Figure 2-6	Helicopter and/or fixed-wing ski-plane, foot	Wilderness	None

Lower West Arm Low-elevation

The exact location for this station has not been determined. There are two potential sites for this monitoring station: Lone Island and Hugh Miller Island (Figure 2-5). Both sites are less than 100' elevation above sea level along the West Arm of Glacier Bay proper. Lone Island's full exposure to West Arm weather conditions makes it an exceptional low-elevation monitoring site that could provide important safety information. The Hugh Miller Island site may provide similar quality data though how similar is unknown; it is expected that Lone Island observations would be ideal.

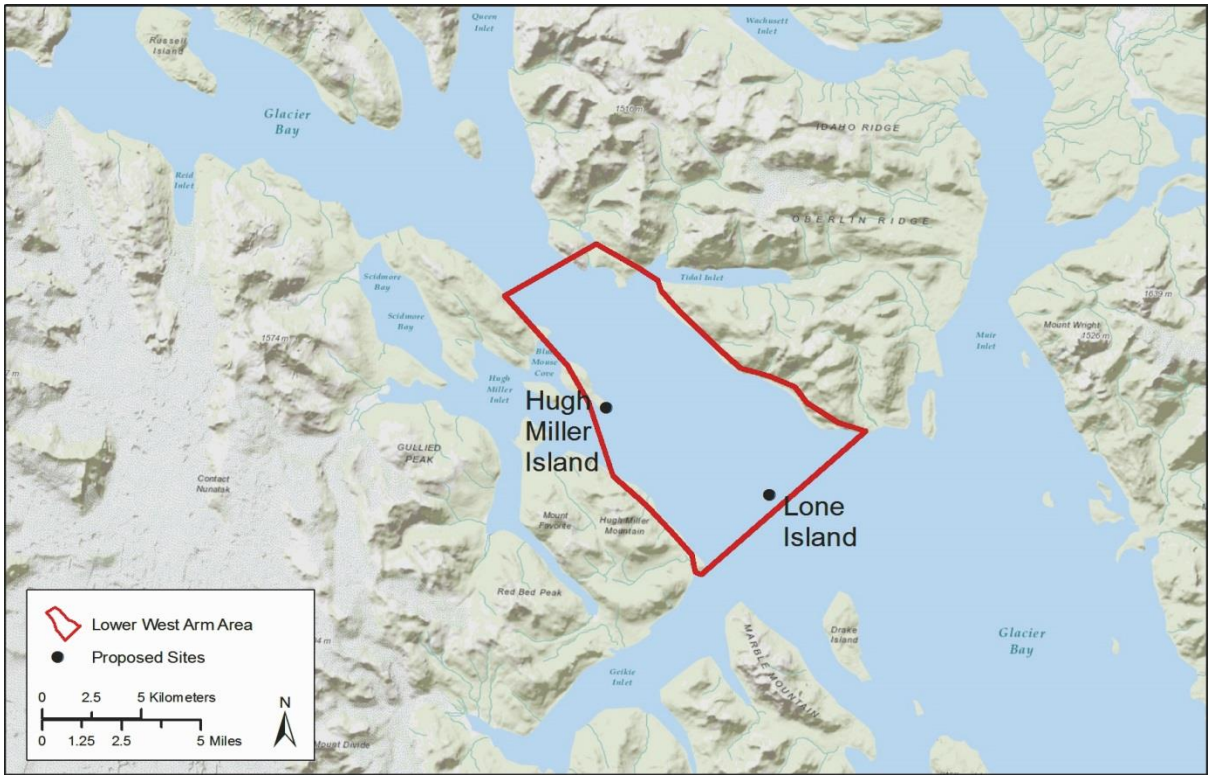

Figure 2-5. Potential sites for the proposed Lower West Arm Low-elevation station.

Brady Icefield

The exact location for the RAWS installation has not been identified, but would be selected from several candidate sites 3,000-4,000 feet in elevation that offer bedrock outcrops expected to be relatively free of deep snow accumulation throughout the year (Fig. 2-6). A station on the Brady Icefield station would directly measure conditions on a large icefield that has a major influence on land-terminating and tidewater glaciers in GLBA (Davey et al. 2007). Notably, access to the Brady Icefield site would typically be via helicopter (access via fixed-wing ski-plane could be possible if conditions allow).

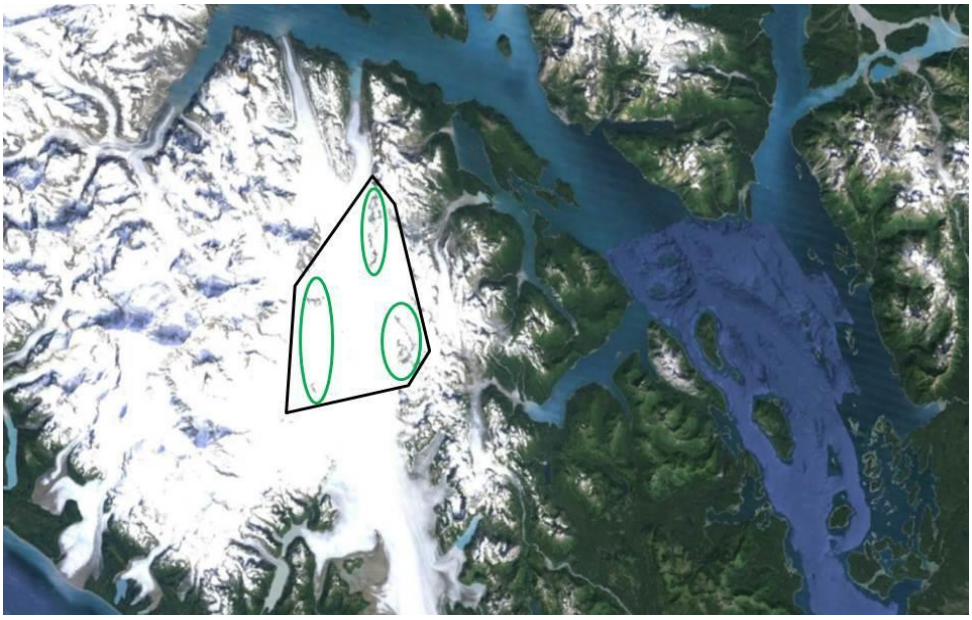

Figure 2-6. Potential sites for the proposed Brady Icefield station.

2.3 Mitigation Measures:

Wilderness

To minimize impacts on wilderness values the stations would be as compact as possible. Aircraft landings at Beartrack, Idaho Ridge, and Brady Icefield would be minimized by coordinating with other missions. Mitigation measures as described under Visitor Experience and Soundscape would also apply to Wilderness areas.

Wildlife

To the extent possible, installation and maintenance activities would be timed to avoid sensitive periods such as bird nesting seasons. Clearing of woody vegetation would not occur from April 15 to July 15 to protect nesting migratory birds unless an on-site nest search is conducted by a qualified biologist that determines that no migratory birds or nests would be disturbed. Installation and maintenance of a Lone Island station would not occur from May 1 through September 30 to protect colonies of nesting seabirds. Marine mammals would not be disturbed at haul-out sites without appropriate consultation with and/or permitting by the National Marine Fisheries Service and the U. S. Fish and Wildlife Service. Where necessary, equipment would be shielded or fenced to prevent damage by bears or other wildlife. Guy wires would be installed in ways that minimize risks to flying birds.

In addition to meeting all Federal Aviation Administration and NPS helicopter policy and aircraft requirements, mitigations for both fixed-wing and helicopter flights to the Lituya Bay, Beartrack, Idaho Ridge, Deception Hills, and Brady Icefield sites would include:

- Maintenance of a recommended 1.5 km vertical or horizontal distance from mountain goats (Cote 1996, Hurley 2004, Cote et al. 2013). Pilots would not hover over, circle, harass, or pursue wildlife in any way.
- Where feasible, flight paths would avoid known bald eagle nests and a minimum quarter-mile clearance would be maintained from all active eagle nests. All nests are considered active March 1- May 31, and occupied nests are considered active through August 31.
- In compliance with the Migratory Bird Treaty Act, helicopter activity would be scheduled to avoid sensitive bird migration or nesting periods in the project areas. Aircraft approach routes would avoid known seabird colonies.

Vegetation

Surface disturbance to lichen-covered rock would be minimized. Rocks with lichen cover would be left in their original locations when possible or left with lichen surfaces facing upward. Where other vegetation is present, care would be taken to minimize disturbance (e.g., stepping on rocks where possible rather than on plants, and clearing the minimum amount of vegetation necessary).

In order to minimize the possibility of introducing invasive plants, mud, dirt, and plant material would be removed from project equipment, footwear, and clothing prior to traveling to the weather station sites. Weather station sites would be monitored for the presence of invasive species during annual maintenance visits.

Visitor Experience

Travel routes would be as efficient as possible to minimize disturbance to visitors. Whenever possible, access would be limited to foot travel or motor vessel through non-wilderness waters. Signs would be posted on the weather station equipment explaining its purpose and listing a person to contact if visitors who happen upon the site have questions.

Where possible, station towers would be sited so as not to protrude beyond the silhouette/horizon of nunataks or ridges, as viewed from the water. In general, all equipment would be as concealed by topography/vegetation as possible while still allowing for effective operation. To further reduce visibility of an installation on Lone Island, a monopole would replace the more visible tri-leg tower, an ultrasonic wind speed sensor would replace the conventional spinning-cup anemometer, and a fuel cell could replace the solar panel.

Soundscape

In order to reduce adverse noise impacts to recreational users, aircraft would maintain a minimum altitude of 2,000-2,500 feet above the ground surface except during landing and takeoff, or when visibility is limited by cloud cover, pursuant to Federal Aviation Administration (FAA) Advisory Circular (AC91-36C) “Visual Flight Rules (VFR) Near Noise Sensitive Areas.”

Cultural Resources

Archeological site clearance would be conducted concurrent with installation of equipment, as necessary. Ground disturbance would be minimized. If archaeological features are encountered during equipment installation, work would cease immediately and the Superintendent and park Cultural Resource Specialist would be notified. Procedures would be followed as per Director's Order 28 and the guiding regulations in 36 CFR 800.13. No further action would take place until the NPS provides clearance.

2.4 The Environmentally Preferable Alternative

As stated in Section 2.7 (D) of the NPS DO-12 Handbook, "The environmentally preferable alternative is the alternative that will best promote the national environmental policy expressed in NEPA (Section 101(b))". In sum, the environmentally preferred alternative is the alternative that not only results in the least damage to the biological and physical environment, but that also best protects, preserves, and enhances historic, cultural, and natural resources. Alternative A (No Action) is the environmentally preferred alternative because no new adverse impacts to the environment would occur from installation of new weather stations. However, a program of climate monitoring would provide valuable data that could be used to enhance future management actions designed to protect park resources.

2.5 Alternatives and Actions Considered but Dismissed

1. Expand the climate monitoring program using existing CRREL instrumentation along with RAWS upgrades.

From 1999 until 2011, 24 sea level weather instrument stations maintained by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL) collected data at sites surrounding Glacier Bay (Figure 2-7). As the NPS climate and weather monitoring program developed, the initial proposal was to maintain all 24 CRREL stations as well as upgrading several selected stations to "full RAWS" capability.

In October 2010, a preliminary review of the CRREL project determined that data was neither available nor reliable for the purposes of evaluating which stations might have the most merit for NPS upgrade and maintenance as part of its Weather and Climate Vital Sign Program. Since it was determined that data from the CRREL stations would not satisfy NPS program standards, all CRREL equipment was removed from the park in 2011 and 2012.

The subsequent approach to achieve adequate distribution of monitoring equipment resulted in a proposal for 12 RAWS stations located at the following locations:

1. Gloomy Knob
2. Lone Island
3. North Muir Inlet
4. Brady Icefield
5. South Muir Inlet
6. Tidal Inlet
7. Queen Inlet
8. Johns Hopkins Inlet
9. Willoughby Island
10. East Adams Inlet
11. Dry Bay
12. Lituya Bay

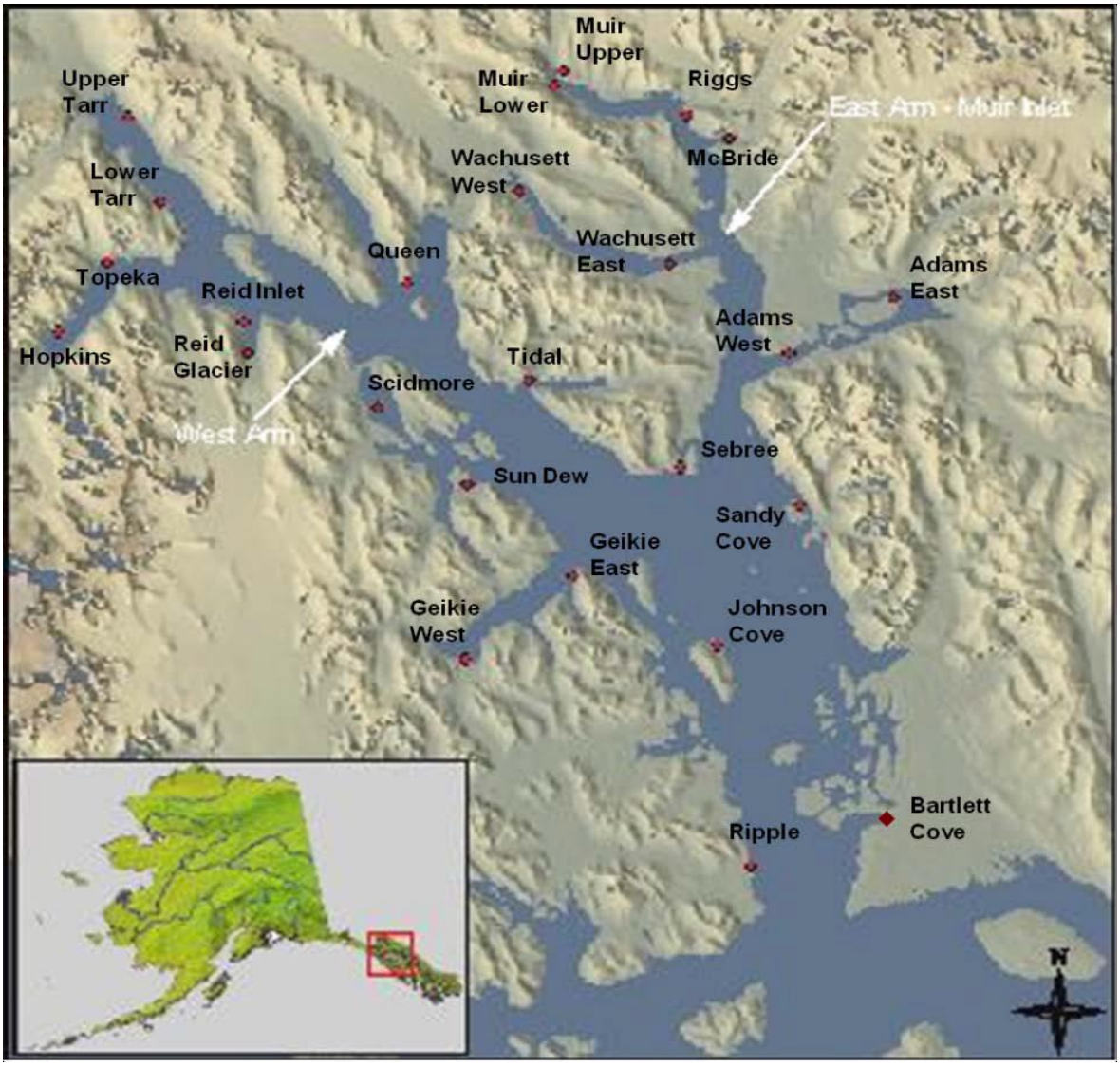

Figure 2-7. Locations of CRREL weather instrument stations.

As the NPS continued to incorporate wilderness character concerns into the program site selection, the number of monitoring sites was narrowed down to include fewer sites. Alternative B includes these site locations.

2. Expand the climate monitoring program to nine new locations within GLBA (no stations on the Brady Icefield or Lone Island).

This alternative would establish climate stations at the locations identified in Alternative B with the exception of Brady Icefield and Lone Island. Expansion of the network to the outer coast, a robust maintenance schedule, and quality-controlled data would provide a more complete record than previous monitoring efforts. Without an icefield location, however, it would be difficult to accurately predict the effects of future climate change on the volume of glaciers. The majority of the tidewater glaciers in GLBA form at high elevation on the Brady Icefield. Given variation in

local and regional climate, employing data from another site to assess or predict changes in glacial volume or mass within GLBA runs the risk of resulting in spurious conclusions.

For example, while other sites in proximity to quasi-permanent ice within GLBA such as Reid Inlet knob and locations on Grand Pacific Glacier were considered, they are at much lower elevation, likely below the zone of glacier formation, and would therefore be of limited value in predicting changes in glacial volume loss or gain (see Arendt et al. 2009). Without additional monitoring of climate at a high-elevation site where icefields form, it would be difficult to accurately predict the effects of future climate change on the volume of glaciers within GLBA. It is believed that no other high-elevation location within or outside of GLBA can accomplish these objectives.

The Lower West Arm area monitoring station would not be located on Lone Island. Hugh Miller Island or another site would be selected to reduce potential impacts to visitor experience and wildlife. Lone Island's full exposure to West Arm weather conditions makes it an exceptional low-elevation monitoring site that could also provide important safety information. It is not known how closely the Hugh Miller Island site could approach the quality of the observations for these purposes; it is expected that Lone Island observations would be ideal. This alternative (precluding inclusion of a Brady Icefield and or Lone Island station in the climate monitoring network) was dismissed because the ability to consider those sites is essential to achieving the comprehensive climate monitoring objectives.

Table 2-1 summarizes the No Action and Preferred alternatives. Table 2-2 compares the potential environmental impacts associated with the No Action and Preferred alternatives. Potential impacts are provided for each environmental resource topic. Chapter 4, *Environmental Consequences*, of this EA contains a detailed discussion of the potential impacts by resource topic.

Table 2.1 Summary of Alternatives

Installation Type	Alternative A: No Action	Alternative B: Expand to 10 Sites
RAWS:		
Bartlett Cove	+	+
Gustavus TNC	+	+
Gustavus Airport	+	+
Cape Spencer	+	+
Lituya Bay		+
Deception Hills		+
Dry Bay		+
Queen		+
Nunatak Lower		+
Nunatak Upper		+
Lower West Arm Low-elevation		+
Brady Icefield		+
HOBO thermistor:		
Beartrack		+
Idaho Ridge		+
Costs:		
Installation	$0	$131,300
Annual Maintenance	$0	$28,700
Lifecycle (5 years operating)	$0	$274,800

Table 2-2. Summary of Alternative Impacts

Impact Topic	Alternative A: No Action	Alternative B: Expand to ten additional sites
Wilderness	No impacts to wilderness character would occur. *Long-term adverse cumulative impacts due to lack of climate effects information.*	Temporary adverse impacts to wilderness character at eight locations during installation. Long-term adverse impacts to wilderness character from station presence and annual maintenance activities at eight additional installation locations.
Wildlife	No impacts to wildlife would occur. *Long-term adverse cumulative impacts due to lack of climate effects information.*	Temporary adverse impacts to wildlife and long-term adverse impacts to terrestrial wildlife habitat from displacement of individuals and loss of habitat during installation and maintenance activities. Negligible wildlife impacts at Lituya Bay, Deception Hills, Beartrack, and Idaho Ridge if sensor equipment is mounted on existing structures. Direct impacts to harbor seals possible at Lone Island; spring and fall use patterns at this site are unknown, but believed by park staff to be minimal.
Vegetation	No impacts to vegetation would occur. *Long-term adverse cumulative impacts due to lack of climate effects information.*	Long-term adverse impacts to vegetation in some locations due to installation footprint, anchoring, and trampling during installation and maintenance activities. Negligible vegetation impacts at Lituya Bay, Deception Hills, Beartrack, and Idaho Ridge if sensor equipment is mounted on existing structures.
Visitor Experience	No impacts to visitor experience would occur. *Long-term adverse cumulative impacts due to lack of climate effects information.*	Periodic short-term temporary adverse impacts to visitors who see a station or see/hear noise associated with installation or maintenance activity at ten sites. The magnitude of visual intrusion would depend on the visitor's activity and distance from stations. A helicopter could be heard and/or seen during visits to vicinities of proposed Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield stations. The Hugh Miller Island and Lone Island stations would be visible to vessels and/or kayakers transiting the West Arm of Glacier Bay.
Soundscape	No impacts to soundscape would occur.	Additional noise from motor vessels would occur during station installation and annual maintenance at the Lituya Bay, Lower West Arm, Queen, and Nunatak Lower and Upper sites. Helicopter noise would occur during visits to the Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield stations. Fixed-wing aircraft noise could occur during visits to the Lituya Bay and Brady Icefield stations.
Cultural Resources	No impacts to cultural resources would occur. *Long-term adverse cumulative impacts due to lack of climate effects information.*	Negligible impacts to the cultural landscape at ten new station locations.

3.0 AFFECTED ENVIRONMENT

This chapter describes the existing environment and current conditions of important resources and values in Glacier Bay National Park and Preserve. Resources described are based on impact topics as defined above, including wilderness character, wildlife, vegetation, visitor experience, soundscape, and cultural resources. These resources have the potential to be affected by an expanded climate monitoring program. As the proposed climate station sites are widely scattered and quite diverse, this chapter first gives a general overview of the park followed by site-specific resource descriptions. Additional detailed information about Glacier Bay National Park and Preserve may be found in the 1984 GMP, the 1989 WMP, and through the NPS park website at http://www.nps.gov/glba/index.htm

Information about the NPS Vital Signs Monitoring Plan is available through the SEAN website at http://science.nature.nps.gov/im/units/sean/0_About.aspx

3.1 Brief Overview of Glacier Bay National Park and Preserve

GLBA is situated at the southern reaches of a coastal, mountainous, wilderness landscape that includes the fourth-largest area of glacial ice on earth. The park protects and preserves extensive icefields, alpine glaciers, fjords, and tidewater glaciers that emanate from mountain ranges rising abruptly from the coast. A long history of glacial activity and of tectonic activity along an active crustal plate boundary has produced a complicated and dynamic geography and geology. A great diversity of bedrock types, geomorphic features, surface ages, and local climates has allowed the development of myriad habitat types in terrestrial, freshwater and marine environments (Davey et al. 2007).

3.2 Wilderness: The park and preserve comprise approximately 3.3 million acres of land and water, approximately 2.7 million acres of which were designated as wilderness with the passage of ANILCA in 1980. These lands are managed as wilderness under the Wilderness Act of 1964 as well as the provisions of ANILCA. The park protects 53,000 acres of marine wilderness waterways in five areas: the Beardslee Islands, western portions of Dundas Bay, the Hugh Miller/Scidmore complex, Adams Inlet, and Rendu Inlet. The waters of Muir Inlet and Alsek Lake have also been classified as “eligible” for wilderness designation (Figure 3-1). The NPS manages eligible areas to maintain their wilderness character.

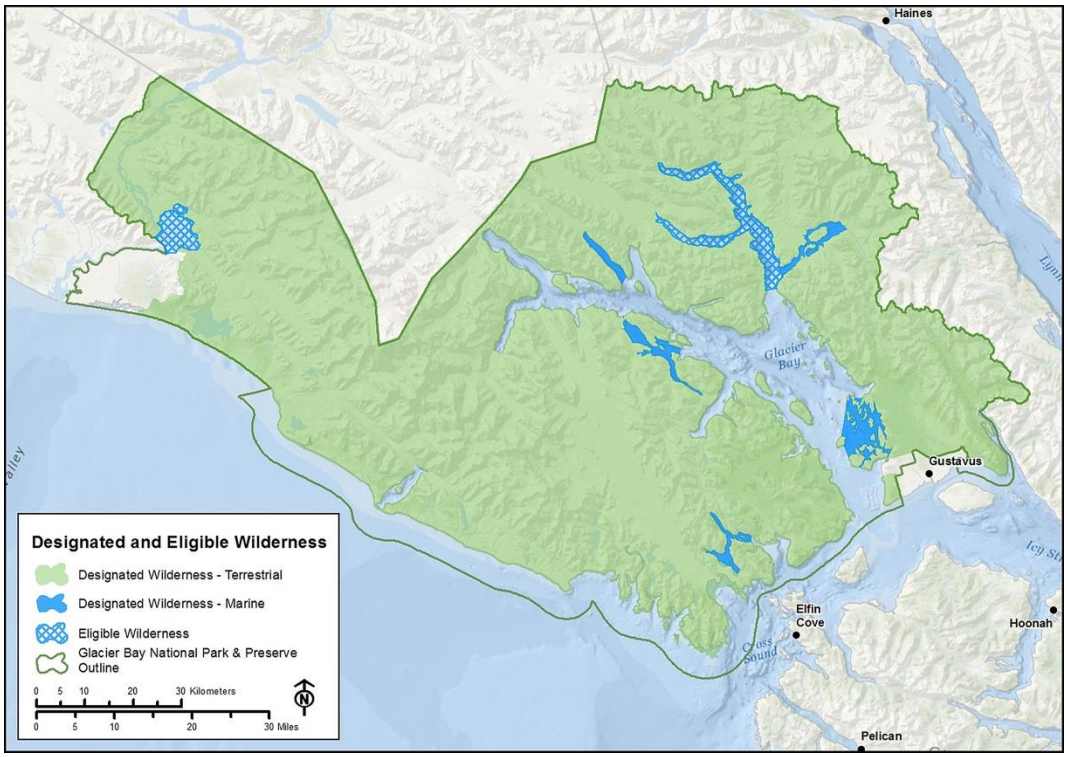

Figure 3-1 Wilderness Designations in Glacier Bay National Park

With its many glaciers and mountain snowfields, expanse of temperate rainforest, pristine coastal beaches, fjords, diverse plant communities, and terrestrial and marine wildlife, including threatened and endangered species, the Glacier Bay wilderness encompasses a large, intact ecosystem with few lasting impacts from human intrusion. Although the Huna Tlingit lived in Glacier Bay for centuries, and non-native trappers, miners, and fishermen lived and worked throughout the park, little evidence of human settlement or activity is noticeable to the typical visitor. Existing developments within wilderness include two NPS radio repeaters above Beartrack Cove and atop Idaho Ridge, severely deteriorated remains of indigenous and historic structures that are largely hidden from public view, scattered permitted scientific instrumentation, and navigational markers and facilities. Visitor use is largely confined to waterways and a narrow band of coastline. Other than some social trailing at popular destinations, there is little evidence of litter or other recent human use (e.g., trash, cut branches, campfires). The Glacier Bay wilderness provides unique opportunities for visitors to experience solitude and unconfined recreation in a largely pristine environment. With the exception of commercial and sport harvest of marine fish and shellfish, sport harvest of freshwater fish and the potential for human-caused climate modification, ecological processes proceed for the most part without interference from humans.

3.3 Wildlife: GLBA includes over 600,000 acres of marine waters. GLBA is one of only a handful of large conservation areas in the world that include extensive saltwater habitat. It is also the largest marine area managed by the NPS, with approximately 1,180 miles of coastline. Due to wide tidal fluctuations, the marine photic zone continuously receives dissolved nutrients from depth, while large surface inputs of fresh water and extended summer daylengths sustain phytoplankton growth. These conditions stimulate high levels of phytoplankton and zooplankton

production which support an abundance of forage fishes and other marine vertebrate predators. Capelin, Pacific herring, sandlance, crabs, clams, urchins, and other shellfish are abundant in park marine waters. In turn, these resources support diverse marine mammals including harbor seals, Steller sea lions, humpback whales, killer whales, harbor porpoises, and a rapidly expanding population of northern sea otters.

There are over 300 streams in GLBA, a third of which are newly formed since glaciers have receded. Many maturing streams with a connection to the ocean host Pacific salmon runs. About 30 species of land mammals occur throughout the park and preserve, including moose, black and brown bear, wolf, coyote, porcupine, river otter, marten, ermine, wolverine, mountain goat, marmots, and squirrels. Black bears are most common in the forested regions while brown bears predominate in open habitats. Moose occur widely throughout much of the park, mountain goats occupy high elevations in many areas, and deer are found in low abundance on certain islands and in some areas of old-growth forests. Small mammals include voles, shrews, and bats.

About 274 species of birds have been recorded from the park and nearby areas. Seabirds, including glaucous-winged gulls, black-legged kittiwakes, murrelets, pigeon guillemots, cormorants, and puffins breed along the marine coast in many areas. Many species of migratory passerines, shorebirds, raptors, and waterfowl pass through or breed in the park and preserve (Davey et al. 2007). Glacial outwashes and islands in Glacier Bay provide nesting habitat for black oystercatchers and plovers as well as a variety of gulls and terns.

3.4 Vegetation: Vegetation in the park follows a path of successional sequences determined by the length of time an area has been free of ice, and the proximity of seed sources. Pioneer communities of lichens, mosses, seral forbs, and *Dryas* are found on sites that became ice-free about 50 years ago. Areas deglaciated between 50 and 100 years ago typically support open and closed willow and alder shrub communities; young forests grow on sites exposed by ice between 100-300 years ago; and a mature community mosaic of old-growth forests with muskegs are found in areas that remained ice-free during the Little Ice Age (Chapin et al. 1994). On the west side of the park there are several ancient refugia plant communities left isolated by past ice age advances (NPS 1984).

3.5 Visitor Experience: The majority of visitors reach the park on cruise ships, smaller tour vessels, or private boats. Those seeking a more independent experience enjoy kayaking, hiking, mountaineering, wildlife viewing, and fishing. Opportunities for solitude are widely available, and a primitive and unconfined type of recreation can be expected in most areas. Most camping and hiking activity occurs along the coastlines of Glacier Bay and Dundas Bay. Limited mountaineering and ice climbing occur in the remote and rugged Fairweather Range. Some private fixed-wing aircraft land on the Gulf of Alaska beaches. Visitors also view the park from scenic overflights offered by regionally-based charter aircraft. Some guided wilderness skiing activity based out of Haines, Alaska has been reported in the extreme northeastern corner of the park.

The Alsek River is a desirable river rafting destination that is internationally managed by permit. Rafting groups start their trips in Canada and leave the river in the National Preserve at Dry Bay. Dry Bay also serves as a portal for Fairweather Range mountaineering groups.

Public uses are distinctly different in the Dry Bay area of the National Preserve; they include commercial salmon fishing, guided sport hunting, fishing, fur trapping, subsistence hunting, personal use cabins, and three concession lodge operations. Dry Bay contains a network of designated vehicle trails, airstrips, and a commercial fish buying station as well as other developments. Cabins and commercial fishing uses are managed under special use permits.

3.6 Soundscape: The acoustic environment consists predominantly of natural sounds, including wind and rain. Over this natural background, human-made sounds of small motor vessels and cruise ships, high-altitude commercial aircraft, and low-level local fixed-wing aircraft are heard, primarily during the summer visitor season. Human voices may occasionally be heard; these are associated with short-duration recreational activity occurring on the water or shorelines. Helicopter trips to service the three NPS radio repeaters occur about once a year and a USCG helicopter patrol occurs about once a month depending on season. Table 3-1 provides examples of decibel levels of sounds that may be heard near climate stations.

Table 3-1. Decibel Levels of Ambient and Human-induced Sounds.
(Data derived from the following sources: Hamilton, 2003; LHH, no date; UCSC, no date).

Source	Decibels (dBA)
Rainfall	50
Normal Conversation	60
Wind	35-85
Shouting	90
Airplanes (overhead)	65-70
Helicopter (at site)	105
Helicopter (5 seconds away)	95
Helicopter (10 seconds away)	85
Helicopter (15 seconds away)	80

3.7 Cultural Resources: Glacier Bay National Park and Preserve is the traditional homeland of two Tlingit Tribes. The Huna Tlingit (represented by Hoonah Indian Association; HIA) claim Glacier Bay proper, Icy Strait, Cross Sound, and the outer coast north to Sea Otter Creek. The Gunaaxoo Kwáan (represented by Yakutat Tlingit Tribe; YTT) claim the Dry Bay Preserve and the outer coast south to Sea Otter Creek.

The Huna and Gunaaxoo Kwáan supported themselves on the lands and waters of the region for centuries. Although glacial advances within Glacier Bay during the Little Ice Age and tsunami events on the outer coast forced Tlingit clans to relocate to settlements outside the park and preserve, traditional peoples remain intimately tied to important resource gathering areas as well as sites associated with historic and mythological events throughout their territory. Many of these sites are eligible for listing as Traditional Cultural Properties (TCPs) in the National Register of Historic Places (NRHP).

The park and preserve also hosted European explorers, miners, fox farmers, the U.S. military, early settlers, the fish canning industry, and the commercial fishing industry. While historic structures are limited to a few severely deteriorated remains of camps, food caches, cabins, or

mine adits, NPS archeologists have documented more than 141 historic and archeological sites throughout the park and preserve.

Tlingit Homeland

The clans comprising the Huna Tlingit likely settled Icy Strait, Cross Sound, and Glacier Bay proper as early as 1200 AD when glacial retreat allowed habitation on the margins of a glacially-built outwash plain (Crowell and Howell 2013, Connor et al. 2009). Radiocarbon dates associated with a pre-Little Ice Age village site (*Xákwnoowu*) in Dundas Bay on Cross Sound suggest an inhabitation period beginning 700–750 years ago (circa 1200; Crowell and Howell 2013). Connor et al. (2009) propose a settlement period for Glacier Bay proper between 1250 and 1500 AD.

Oral history and scientific evidence indicate that the clans living in Glacier Bay proper, known as S'é Shuyee (*Area At The End Of The Glacial Silt*) were ultimately expelled during the glacial advance of the Little Ice Age (LIA) in the early 1700's (Connor et al. 2009, White 2009, Dauenhauer and Dauenhauer 1987). Clans living in Lituya Bay villages were also expelled at about that time by a tsunami event recounted in oral tradition (White 2009).

Following subsequent glacial retreat, the Huna Tlingit returned to their homeland, resettling areas in lower Glacier Bay and renewing their traditional hunting, gathering, and fishing activities in the area. While the Raven clans never resettled the outer coast, including Lituya Bay, it remained an important stopover location during extended hunting and fishing expeditions. Traditional harvest activities continued well into the twentieth century, although the establishment of Glacier Bay National Monument and associated federal regulations curtailed numerous traditional activities and precluded permanent settlement of the Huna Tlingit within Monument (and later Park) boundaries.

The Dry Bay area's rich resources attracted coastal Tlingit as well as people from "across the mountains", the Athabaskans. The Gunaaxoo Kwáan ("among the Athabaskans") have their roots along the Alsek and Akwe rivers, at the village of Gus'eix. Later, after tragedy left Gus'eix deserted, the clans rebuilt their houses in other parts of Dry Bay and eventually, people migrated in large part, to Yakutat. While the 1980 establishment of Glacier Bay National Preserve precluded Yakutat Tlingit resettlement in Dry Bay, the landscape is replete with Raven Creation stories that continue to anchor the Gunaaxoo Kwáan in place.

The NPS, HIA, and YTT have continued to explore mechanisms for maintaining the vital connection between the Huna Tlingit clans and the Gunaaxoo Kwáan clans and their respective homelands.

3.8 Station Site Descriptions

Dry Bay

The proposed Dry Bay climate station site (Photo 3-1) is within the developed portion of the National Preserve. The site is close to the Alsek River in a level, low elevation clearing

surrounded by mature alder woodland. The monitoring equipment would be mounted on an existing concrete pad.

Photo 3-1. Aerial photo showing proposed Dry Bay station site ("pad") near the Alsek River.

The Dry Bay area of the National Preserve originated as a braided glacial outwash plain more than 200 years ago. Today, the Alsek River still dominates the landscape with many streams and wetland habitats formed from earlier river tributaries. Ecological change in Dry Bay is rapid and dynamic; affected by large storms in the Gulf of Alaska, seasonal heavy rains, and rapid post glacial isostatic uplift of approximately 25 millimeters per year. Upland areas contain alder, cottonwood, and spruce forests, though areas closer to river channels and the coastal estuaries consist of a diverse array of sand dunes, mudflats, fresh and estuarine wetlands, grasslands, willow shrubland, and open coastal beach.

Dry Bay is lightly developed with scattered cabins, a network of maintained vehicle trails, temporary fishing camps, airstrips, and concession lodges. Brown bear, moose, gray wolf, lynx, and snowshoe hare all range throughout the Dry Bay area. Colonial nesting seabirds including gulls, terns, and jaegers nest on coastal sand dunes and estuary shorelines. The estuarine tidal flats attract thousands of migratory shorebirds, waterfowl, and seabirds in spring and fall. Many migratory songbirds forage in shrubby woodlands. Peregrine falcons and bald eagles are attracted to the migratory flocks.

Visitors to this part of the National Preserve during the summer season will hear and see frequent off-road vehicle (ORV) activity along designated trails as well as low-flying fixed-wing aircraft. Commercial fishing permittees transit from net sites, boat launches, and their cabin sites or temporary fishing camps throughout the summer. Subsistence and sport hunting and trapping, and sport angling are permitted in the National Preserve although harvests are usually modest. Three concession lodges provide guided hunting and fishing, lodging, and transportation from several airstrips. Small fixed-wing aircraft use several unmaintained airstrips scattered throughout Dry Bay. Larger cargo aircraft transport commercially harvested salmon in summer and early fall. River rafting groups arriving from the Alsek River typically pull out at Dry Bay

and may camp near the river overnight. Chartered aircraft use one primary airstrip to pick up rafting groups and equipment. Few pedestrians venture very far from the camping area on ORV trails.

Motor vehicle noise on trails is common throughout late spring, summer, and early fall. Human voices associated with commercial and sport fishing can occasionally be heard on the Alsek River and estuary boat launch and set net sites. Low-flying aircraft traffic is common in summer and fall. High-altitude commercial jet sound can be heard multiple times a day throughout the year. Visitors may also hear generators, power equipment, and motorboats depending on their location.

The Dry Bay area figures prominently in the pre-history and history of the Gunaaxoo Kwáan who lived at villages including Gusex. Although it is unclear when, and for how long, the Gunaaxoo Kwáan clans inhabited the area, de Laguna (1972) cites various informants who describe the importance of the village to numerous Yakutat clans including the L'uxnax.adi, the L'ux.ax.adi, the Koskedei, and their Eagle moiety spouses (Kaagwaantaan, Teqweidi). Numerous place names in the Dry Bay area memorialize Tlingit legends associated with Raven. Today, the Tlingit community in Yakutat continues to have strong associations with places within the National Preserve, invoking landmarks in clan songs, stories, and ceremonies; these landmarks are considered eligible for listing in the NRHP as TCPs. The Yakutat Tlingit community also harvests certain subsistence resources from the area.

Deception Hills

The proposed Deception Hills climate station site (Photo 3-2) is within the undeveloped portion of the National Preserve. It is located at approximately 2,200 foot elevation about ½ mile from the park's designated wilderness boundary.

Photo 3-2. Proposed Deception Hills station site showing USCG construction markers.

There are existing installations at this site including a USCG emergency communications array, NPS radio repeater, and a seismic sensor maintained by the University of Alaska Geophysical

Institute. The climate monitoring equipment and seismic sensor would be partially or completely integrated with the communications array, sharing the power source. Few if any visitors access this area of the park as the topography is steep, there are no established trails, and it is far from the marine coastline and floatplane-accessible lakes. The USCG communications array is faintly visible from a distance, particularly from vessels transiting the Gulf of Alaska close to shore.

The monitoring station site is located in a saddle on a steeply sloping ridge about 3 miles inland from the Gulf of Alaska. The site is above timberline containing low-growing alpine perennial and annual herbs, sedges, dwarf evergreen, and deciduous mat-forming plants. Mountain goats forage throughout the alpine areas of Deception Hills and have been observed in the immediate and surrounding area. The area is visited by wolverine, brown bear, black bear, wolf, raptors, and migratory passerine birds, although there is no obvious evidence of nesting, burrows, or dens. Wolverines occasionally damage the wooden seismic sensor instrument shelter.

During the site selection process for the USCG communications facility, no cultural artifacts or landscape indicators of either archeological or historical periods were detected. Likewise, in the scoping process for the USCG facility, no connection of spiritual significance to the Gunaaxoo Kwáan clans for this location was identified (USCG 2010).

Lituya Bay

The proposed Lituya Bay climate station site (Photo 3-3) is located inland of La Chaussee Spit on the north shore of Lituya Bay, in designated park wilderness.

Photo 3-3. Proposed Lituya Bay station site showing USCG range markers.

Climate monitoring instruments would be co-located with a pair of existing USCG navigational range markers. The flat, cobbled shoreline supports scattered perennial grasses, forbs, and low shrubby vegetation. A swath around and between the range markers is regularly cleared to maintain visibility for vessel navigation. The range markers are a recognized visual feature of the northwest shoreline of Lituya Bay, specifically visible to vessels approaching the mouth of the

bay. Wildlife found in this area includes gulls, migratory waterfowl, shorebirds, brown bears, wolves, and red foxes (Lewis pers.comm).

Lituya Bay (*Ltu.aa – Lake within the Point*) was an important settlement site for the L'uknax.adi and T'akdeintaan clans. Although it is unclear when the Tlingit first settled the bay, French explorer Rear Admiral Jean-Francois de Galaup, Compte de LaPérouse's "Plan of Port Des Francais" pinpoints four native villages in the Lituya Bay area in 1786 (LaPérouse 1799). These sites may have been seasonal fish camps; regardless, Lituya Bay was an important summer fishing and hunting location for centuries. A catastrophic giant wave, thought to have occurred in 1853, decimated the village (de Laguna 1972); oral history recounts this and the clan's resulting dispersal from Lituya Bay (White 2009). Because of the loss of lives from the wave event, Lituya Bay is considered *at.oowu* (an "owned thing") of the T'akdeintaan Clan. Although the area was never resettled permanently, individual Huna families continued to camp in Lituya Bay on fishing and hunting trips well into the twentieth century. Lituya Bay is considered eligible for listing in the NRHP as a TCP.

During LaPérouse's month-long stay in Lituya Bay, his crew established an observatory site on the northwest corner of Cenotaph Island where they buried bronze medals and a bottle staking the French claim to Cenotaph Island; they later buried a second bottle containing the names of crewmembers lost to drowning at the mouth of the bay. Several years later, in 1788, Russian explorers Ismailov and Bocharov aboard the *Three Saints* attempted to stake claim to Lituya Bay for Catherine II by burying a copper plate on the western shore of Lituya Bay a bit to the south of Cenotaph Island. This site is considered eligible for listing in the NRHP as the general location of the Russian claim event.

Despite Lituya Bay's long history as the site of Tlingit summer fishing villages, outposts for foreign exploration, full-scale mining operations, a homestead and fox farm, and a frequently sought refuge for vessels of all sorts traveling the outer coast, the bay today reveals little physical evidence of human use.

Queen Inlet

The proposed Queen Inlet climate station site (Photo 3-4) is located on a ridge separating lower Queen and Rendu Inlets, in designated park wilderness.

Photo 3-4. Proposed Queen Inlet station site.

Site vegetation is dominated by willow, soapberry, alder, and kinnikinnick. Brown bears are commonly observed travelling and foraging on lower slopes in Queen Inlet. Marmots, wolves and ptarmigan probably pass through the proposed station area. Sheltered areas in thicker brush may provide nest sites for passerine birds. Most visitors to the area are kayakers or private boaters traveling up Queen Inlet or camping on shore.

Although the Huna Tlingit likely used Queen Inlet as a camping area during seal hunting ventures, the area is not known to support sensitive cultural resources.

Photo 3-5. Seal hunting camp in Queen Inlet.
Edward S. Curtis, Alaska Harriman Expedition, 1899.

Lower West Arm Low-elevation

Two potential locations are being considered for this proposed climate station. Lone Island and Hugh Miller Island ((Photos 3-6, 3-7, and 3-8) have been preliminarily identified within the "Lower West Arm Low-elevation" area.

Lone Island

Photo 3-6. Lone Island.

Photo 3-7. Potential Lone Island station site.

Lone Island is within designated park wilderness and is a known bird nesting and marine mammal haul out site. The island is closed to foot traffic year round, and boaters may not approach closer than 100 yards. Harbor seals haul out on the shorelines most frequently in summer. Sea otters are frequently present in the waters near Lone Island and have also been observed hauled out on the island. Sea birds, primarily glaucous-winged gulls, along with smaller numbers of black-legged kittiwakes, black oystercatchers, and pigeon guillemots nest over much of the island each year. In 2014 over 400 seabirds exhibiting nesting behavior were recorded (T. Lewis pers. comm.). Humpback whales, murrelets, and pigeon guillemots forage offshore, and river otters, scoters, bald eagles, harlequin ducks, and mergansers forage along the shorelines. Terrestrial vegetation is dominated by elderberry, salmonberry, fireweed, cow parsnip, and grasses.

Because of its central and exposed location, Lone Island is visible to the majority of vessel-based visitors to Glacier Bay. Motor vessel and kayak traffic is common in late spring, summer, and early fall. Motor vessels range in size from large cruise ships to small skiffs.

For centuries the Huna Tlingit frequented Lone Island and other nearby islands during late spring and early summer to harvest the eggs of glaucous-winged gulls. This group of islands is known as K'wát' Aaní (*Seagull Egg Land*). Although egg harvest was curtailed in the mid-twentieth century, in 2010 the NPS determined that egg harvest could occur at various sites within Glacier Bay, including Lone Island, without impacting park resources and legislation authorizing harvest was passed in 2014. Pending regulations, gull egg harvest could occur again at this site.

Hugh Miller Island

Photo 3-8. Potential Hugh Miller Island station site.

Hugh Miller Island is within designated park wilderness on a rocky knob surrounded by dense alder brush. The knob is covered with moss and lichen. Wildlife potentially foraging along this shoreline includes black and brown bears, river otters, mink, moose, bald eagles, ravens, and gulls. Pigeon guillemots, murrelets, scoters, harlequin ducks, and mergansers may be found on or just offshore from this site. Passerine birds forage and likely nest in the adjacent brush border. Humpback whales forage near shore.

Blue Mouse Cove to the north and Sundew Cove to the south have been used as camper/kayaker drop-off points, and Blue Mouse Cove is also a popular motor vessel anchorage. Vessel traffic is common in late spring, summer, and early fall. Although the Huna Tlingit likely used this area, it is not known to support sensitive cultural resources.

Nunatak Lower

The proposed Nunatak Lower climate station site (Photo 3-9) is located on a level sparsely vegetated opening at the edge of a dry streambed in Nunatak Cove, in designated park wilderness.

Photo 3-9. Proposed Nunatak low-elevation station site.

Vegetative cover consists of grasses, sedges, herbs, and willow and alder seedlings.

Wildlife often observed travelling or foraging in this area includes black and brown bears, bald eagles, ravens, and gulls. Moose browse along the beach fringe and streambed willow brush. River otters, harbor seals, scoters, harlequin ducks, and mergansers may be found on or just off shore in Nunatak Cove. Passerine birds forage and likely nest in the adjacent brush border and shorebirds including black oystercatcher may nest on the shoreline. Humpback whales, murrelets, and pigeon guillemots may be found foraging just offshore.

Nunatak Cove is a popular camping area for kayakers; however the wide, shallow sloping beach at low tide makes the immediate installation site less popular. Although the Huna Tlingit likely used this area, it is not known to support sensitive cultural resources.

Nunatak Upper

The proposed Nunatak Upper climate station site (Photo 3-10) is located at approximately 1,000 ft elevation atop Nunatak Knob in designated park wilderness.

Photo 3-10. Proposed Nunatak high-elevation station site.

The site sits on an exposed bedrock outcrop surrounded by scattered Sitka spruce and thick alder. Brown and black bears, wolverines, marmot, and ptarmigan probably pass near the site. Passerine birds probably forage and nest throughout the area. Nunatak Cove is a popular camping area for kayakers.

A historic photopoint intended to document glacial recession and subsequent plant community development is located at the summit of Nunatak Knob. Although the Huna Tlingit likely used this area, it is not known to support sensitive cultural resources.

Beartrack

An existing NPS radio repeater (Photo 3-11) is located within designated wilderness on a shoulder of Beartrack Peak.

Photo 3-11. Beartrack radio repeater.

The area is a subalpine saddle surrounded by evergreen trees and shrubs that screen the equipment from visitors on the water below. Deciduous and evergreen alpine groundcover is present. Brown and black bears, moose, and wolverines probably pass through the site. Passerine birds probably forage and nest in the area. There is visible mountain goat trailing and an exposed mineral lick near the repeater. The repeater consists of a small equipment shelter, a 15-foot-tall tower with antennas, and a solar panel array. There is no evidence of permanent human trails or campsites in the area, although hikers occasionally climb the ridge and inadvertently discover the repeater facility.

Although the repeater lies within the Wooshkeetaan Clan territory, no culturally sensitive sites are known to exist in the immediate area.

Idaho Ridge

An existing NPS radio repeater (Photo 3-12) is located within designated wilderness high on Idaho Ridge.

Photo 3-12. Idaho Ridge radio repeater.

At 3,774 ft elevation, the radio repeater is at the highest elevation of all proposed monitoring sites, with little or no vascular vegetation present. Snow is present for much of the year. Wildlife use of the site is probably quite limited and transitory, most likely mountain goats, marmots, or ptarmigan. The repeater equipment is not visible to park visitors (except from the air), and very few if any hikers reach the area.

No known cultural sites exist in this area.

Brady Icefield

The proposed Brady Icefield station site would be located on an exposed rock nunatak within designated park wilderness (Photo 3-13).

Photo 3-13. Aerial view of the Brady Icefield.

The final specific location for this site would likely be one of three distinct rock outcrops (Figure 2.6), selected on the basis of minimizing environmental impact while achieving safe and reliable access. Little if any vegetation other than lichens is present, and wildlife is almost certainly transitory and limited to ptarmigan, marmots, migratory birds, and very rarely mountain goats and brown bears. The northeastern-most site would be within view of an access route across the icefield and/or to the high Fairweather Mountains used by hikers, skiers, and mountaineers. There are fixed-wing flightseeing tours over this portion of the Brady Icefield.

No known cultural sites exist in this area.

4.0 ENVIRONMENTAL CONSEQUENCES

This EA evaluates the effects of the proposed weather station installations on Glacier Bay National Park and Preserve. This chapter is organized by alternative and, where applicable, the environmental effects of each alternative are discussed. This information is based on readily available environmental information, information from NPS resource specialists, and field reconnaissance.

4.1 Methodology

For each issue selected for detailed analysis and for which the subject resources are described in Chapter 3, the direct, indirect, and cumulative effects are analyzed. The effects to the subject resources are analyzed on the basis of the duration, extent, and intensity of the impacts. Summary impact levels (characterized as negligible, minor, moderate, or major) are given for each issue topic in the analyses. Definitions of impact terms are provided below. Table 4-1 presents a summary of impact level thresholds.

Intensity of Impact:
Low – A change in resource condition is perceptible, but does not measurably alter the resource function in the park ecosystem, cultural context, or visitor opportunity.
Medium – A change in resource condition is measurable or observable, and an alteration is detectable to the resource function in the park ecosystem, cultural context, or visitor opportunity.
High – A change in resource condition is measurable or observable, and an alteration to the resource function in the park ecosystem, cultural context, or visitor opportunity is clearly and consistently observable.

Duration of Impact:
Temporary – Impacts last only a single visitor season or for the duration of the discreet activity, such as climate station installation or maintenance.
Long-term – Impacts extend for several years up to the life of the facility.
Permanent – Impacts are a permanent change to the resource that would last beyond the life of the facility even if the actions causing the impacts were to cease.

Context:
Common – The affected resource is widespread and is not identified in enabling legislation as important to the park, nor is it rare within or outside the park. The portion of the affected resource does not fill a unique role within the park or its region of the park.
Important – The affected resource is identified by enabling legislation or is rare either within or outside the park. The portion of the affected resource does not fill a unique role within the park or its region of the park.
Unique – The affected resource is identified by enabling legislation, and the portion of the affected resource uniquely fills a role within the park and its region of the park.

Table 4-1. Summary Impact Levels

Negligible	Minor	Moderate	Major	Impairment
Little or no impact to the resource would occur; any change that might occur may be perceptible but difficult to measure.	Change in the resource would occur. The change would be perceptible and measurable but would not alter resource condition.	Noticeable and measurable change in the resource would occur and would alter resource condition, but the integrity of the resource would remain.	Impact to the resource would occur that is easily defined, highly noticeable, and would measurably alter the integrity of the resource.	The resource no longer fulfills its specific purpose(s) in the enabling legislation, or it fails to fulfill its role in maintaining the park's natural integrity.

4.2 Cumulative Impact Assumptions

The cumulative effects analysis considers any actions which may occur within Glacier Bay National Park and Preserve. Effects are assessed by combining the potential environmental impacts of the alternatives with the impacts of human activities that have occurred since Glacier Bay National Monument was established in 1925, human activities that are currently occurring, and those that are proposed in the future.

4.3 ALTERNATIVE A: NO ACTION

4.3.1 Wilderness

Under Alternative A, no new weather stations would be installed. The effects of climate-forced change on the naturalness of GLBA's wilderness would continue to be extrapolated from data collected from existing low-elevation stations at Bartlett Cove, Gustavus, and Cape Spencer and those located outside the park and preserve. Because the park currently lacks a spatially appropriate weather/climate monitoring program, finer-scale information on the ecological effects of anthropogenic and natural climate change to wilderness character would be unavailable to managers. Understanding impacts to GLBA wilderness depends on identifying and distinguishing natural and anthropogenic ecosystem changes and their causes. Without these observations, NPS managers' ability to detect or interpret climate-related effects on wilderness resources and to respond with protective measures in the future would continue to be limited.

A detailed Minimum Requirements Analysis for this project is included in Appendix A.

Cumulative Impacts

Existing human developments are relatively small, and the cumulative effects on the resources and values of the park's designated wilderness are considered to be minor. Due to the inability to identify or monitor the effects of climate-forced change, there would be an adverse impact on the NPS ability to protect wilderness character.

The table below describes existing structures/installations within GLBA wilderness that have impacts to wilderness character similar to those in Alternative B. The lower three installations in

the table are shaded to distinguish them as managed by the U.S. Coast Guard. Unshaded installations are managed by the NPS.

Table 4-2. Existing installations in GLBA designated wilderness.

	Number of Installations	Number of locations	Purpose	Duration	Access	Maintenance interval	Authorization and management
Alsek River stage gage	1	1	Measures water level/flow	Move to non-wilderness location scheduled 2014-2015	Fixed-wing floatplane and/or boat	Annual	NPS Research Permit/MRA; USGS
Russell Island weather station (defunct)	1	1	Weather station	Defunct (slated for removal in 2015)	Motor vessel	None	Unknown/NPS
Blue Mouse Island cement pad	1	1	Air quality time-lapse camera platform	Defunct (slated for removal in 2015)	Motor vessel	None	NPS Research Permit
Continuous GPS stations	2 Queen Inlet and Hugh Miller Island	2	Crustal uplift (isostatic rebound) measurements	Permanent	Motor vessel	Annual	NPS Research Permit/MRA; NPS
DIDSON sonar	1	1	Anadromous fish enumeration	Installed in 2011; scheduled for removal in 2014	Foot and/or non-motorized vessel	Frequent during sockeye salmon run	Environmental Assessment/ MRA/NPS Research Permit; NPS
NPS radio repeaters	2	2	Supports internal park communication/ operations	Permanent	Helicopter	Annual	Unknown/NPS
Lituya Bay range markers	2 installations located within 100m proximity of one another	1	USCG aids to navigation	Permanent	Helicopter	Once every two years	ANILCA 1310a; USCG
Libby Island Light	1	1	USCG aid to navigation	Permanent	Helicopter	Once every two years	ANILCA 1310a; USCG
Cape Spencer structures and installations*	Cluster of multiple (7) installations	1	USCG aids to navigation, weather, communication, uplift (isostatic rebound), and aviation information	Permanent	Helicopter and motor vessel	Once every 3 months (4 times/year) (managed by USCG)	ANILCA 1310a and b; USCG
TOTALS	18	11					

**Cape Spencer Lighthouse (automated) remains operational and is an important aid to navigation for mariners. It is administered by the USCG and was placed on the NRHP (75002160) in 1975. Although the site (nearshore rock island) is owned by the NPS and is designated wilderness, the NPS does not actively manage the larger facilities.*

Conclusion: The No Action Alternative would result in minor negative impacts to designated wilderness areas.

4.3.2 Wildlife

Under Alternative A, no new weather stations would be installed. No direct impacts to wildlife would occur as a result of this alternative. However, the NPS' ability to predict or respond to climate-related effects on wildlife habitat within the park or preserve would continue to be limited. Climate change may affect food availability and quality, physical habitat structure and availability, and water and air quality; modify species behavior; trigger species range extension or restrictions; and facilitate the spread of non-native invasive organisms. Without finer-scale climate trend information, the NPS' ability to provide protection for wildlife within GLBA would be more difficult.

Cumulative Impacts

Wildlife habitat in the park outside Bartlett Cove and the Dry Bay area of the National Preserve has been largely unaffected by human development. Approximately 31 acres of nearshore and forest wildlife habitat has been converted to buildings, roads, trails, and parking lots in Bartlett Cove. Trails, cabins, campsites, airstrips, and concession lodges in the developed area of Dry Bay have reduced available wildlife habitat by about 180 acres. Besides the actual footprint of facilities, habitat in the immediate surrounding areas has been impacted by compaction and trampling from pedestrian and vehicle traffic. These actions have resulted in long- and short-term habitat loss, displacement of wildlife, and increased human-wildlife conflicts. Backcountry installations in the park, including radio communications, seismic sensors, and navigational aids impact very small areas of wildlife habitat. Park visitation in the backcountry, scientific research activities and administrative operations activities cause localized, temporary displacement of wildlife and disturbance of wildlife habitat. Most of this activity occurs in marine waters or the immediate shoreline of Glacier Bay proper. The area of wildlife habitat disturbed by human activity is minimal and limited to the area immediately surrounding facilities.

The cumulative impact on wildlife and habitat from human installations is minor. The No Action alternative would not contribute additional adverse impacts on wildlife and habitat in the park.

Conclusion: Because park managers would not have access to finer-scale weather and climate information from a range of habitats within the park and preserve, their ability to predict or respond to climate-related effects to the wildlife resource would continue to be limited. The No Action Alternative would have minor effects on wildlife and habitat.

4.3.3 Vegetation

Under the No Action Alternative, no new weather stations would be installed in the park or preserve. No direct impacts to vegetation would occur as a result of this alternative. However, park management's ability to predict or respond to climate-forced changes in important vegetation communities within the park and preserve would continue to be limited. Pre-Little Ice Age refugia plant communities that are identified in GLBA's enabling legislation may be impacted by climatic change, but without finer-scale climate information the NPS would be less able to protect these rare communities. Non-native invasive plant population expansions due to

climate change would continue to degrade GLBA's natural ecosystems, but without finer-scale climate information park managers would be less able to predict, or prepare for, or adapt to them.

Cumulative Impacts

Vegetation in parts of the park and preserve has been cleared for construction of buildings, roads, trails, and other facilities in Bartlett Cove. Facilities in the administrative area cover approximately 31 acres. Some vegetation is pruned, mowed, or removed periodically in the Dry Bay area of the national preserve. ORV trails, cabins, campsites, airstrips, fish processing facilities, and concession lodges have collectively removed approximately 187 acres of native vegetation. Outside Bartlett Cove and Dry Bay, other installations in the GLBA backcountry (Table 4-2) have affected very small areas of vegetation. Besides the actual footprint of facilities, plants in the immediate surrounding areas have been impacted by trampling from pedestrian and vehicle traffic. Dispersed vegetation impacts have also been caused by off-trail pedestrian traffic and camping along the Glacier Bay and the Alsek River shorelines. Concentrated areas of off-trail pedestrian traffic often take the form of unofficial social trails between campsites, and popular scenic destinations.

Backcountry installations in the park, including radio communications sites, navigational aids, and seismic stations impact very small areas of vegetation. The area of vegetation trampling from foot traffic during periodic maintenance is minimal and limited to the area immediately surrounding the installation. Maintenance activities at these existing facilities would continue to impact vegetation. The cumulative impact on vegetation from human installations is considered minor. This alternative would not contribute any adverse cumulative impacts on vegetation in the park.

Conclusion: The No Action Alternative would have minor negative effects on vegetation. Park managers' ability to predict or respond to climate-related expansion of invasive non-native species, increasing rate of exposure of de-glaciated soils, and changes in hydrological patterns and the responses by native plant communities would continue to be limited. No direct impacts from additional installations would occur.

4.3.4 Visitor Experience

Under Alternative A, no new climate monitoring stations would be installed, and there would be no direct impacts on visitor experience. However, without near-realtime weather observations or effective forecast models based on local climate data, park managers, pilots, vessel operators, and other visitors would be less able to predict and prepare for hazardous conditions.

Key interpretive messages for GLBA include how climate affects glacier activity and Southeast Alaska coastal and marine ecosystems, and how dynamic rates of change are demonstrated on the land. Because fine-scale climate and weather information would be unavailable, the NPS would be less able to educate the public about the influences of climate or to demonstrate tangible effects on the very resources for which the park is renowned.

Cumulative Impacts

Park visitors encountering existing navigational aids, radio repeaters, and other small installations in the backcountry, and exposed to noise from motor vessels or aircraft that provide access to maintain such equipment, may have a diminished visitor experience. Past and current projects and actions continue to cause minor adverse cumulative impacts to visitor experience. Few hikers and climbers see existing communications and seismic stations, which continue to have a minor impact on the pristine quality of the areas. During the summer months, passengers in low-flying aircraft may see those structures that are much less detectable from the water or from the ground. Standardized USCG navigational aids are routinely encountered by park boaters, and these types of installations are somewhat expected and accepted.

The No Action Alternative would not contribute any additional cumulative impacts to visitor experience.

Conclusion: The No Action Alternative would result in minor adverse effects on visitor experience. Due to the continuing lack of current local weather information, park managers' ability to educate the public about the effects of climate on park resources and values will continue to be limited.

4.3.5 Soundscape

Under Alternative A, no new climate monitoring stations would be installed, thus there would be no impact on the natural soundscapes of the park.

Cumulative Impacts

Cumulative effects to the natural soundscapes of the park backcountry include commercial jet aircraft, small aircraft lower-altitude flightseeing overflights, motorized tour and private boats, and large cruise ships. In the Bartlett Cove developed area, the sounds of vehicles, motor vessels, heavy equipment, generators, power tools, and human voices are common, especially in summer. In the Dry Bay area of the National Preserve ORV traffic, fixed-wing aircraft, motorized skiff, and small generator noise is frequent in summer and fall. Aircraft and boat noise disturbances are much more frequent during the summer months than other times of year. Helicopter use, though infrequent, is necessary at least once a year for access to one existing seismic station and three NPS radio repeaters in the backcountry. Human voices may be heard on the water and the shorelines of Glacier Bay proper, and near fishing cabins and campsites in Dry Bay.

Existing noise disturbance in the park has minor adverse cumulative impacts on soundscape. The No Action Alternative would not contribute any cumulative impacts on soundscape in the park.

Conclusion: The No Action Alternative would not create any additional impacts to the natural soundscape.

4.3.6 Cultural Resources

Under Alternative A, no new climate monitoring stations would be installed, and there would be no direct impacts on cultural resources.

Existing sites eligible to be listed on the NRHP, including those eligible for listing as TCPs, as well as historic and archeological sites, are subject to impacts from existing and future visitor use, scientific research activities, and select administrative uses. For example, human use of various kinds may impact TCPs viewed as sacred sites by Tlingit tribal members. Vessel traffic associated with visitor and administrative use and/or research activities can impact historic and archeological sites through increased wave action along shoreline sites. Aircraft landings in close proximity to sensitive historic and/or archeological sites can impact these sites through rotor- or propeller-generated air disturbance. Visitor use near known historic and archeological sites may encourage vandalism or theft of sensitive cultural resources. However, these known past and current projects and actions have resulted in only minor adverse effects on cultural resources. This alternative would not contribute any additional impacts on cultural resources since no new weather stations would be installed.

Cumulative Impacts

Past and current projects and actions have resulted in minor adverse cumulative impacts on cultural resources. This alternative would not contribute any additional cumulative impacts on cultural resources since no new weather stations would be installed.

Conclusion: Because park managers would not have access to finer-scale weather and climate information, their ability to predict, respond to, or adapt to climate-related effects to cultural resources would continue to be limited. No additional impacts to cultural resources would occur under the No Action Alternative.

4.4 ALTERNATIVE B: EXPAND CLIMATE MONITORING PROGRAM TO TEN SITES (Preferred Alternative).

4.4.1 Wilderness

Under Alternative B, ten new climate monitoring sites would be established in GLBA (Figure 2-2). The locations of RAWS proposed for Lituya Bay, Lower West Arm Low-elevation, Queen Inlet, Nunatak Lower, Nunatak Upper, and Brady Icefield are within designated wilderness. Also within wilderness are the two existing radio repeaters (Beartrack and Idaho Ridge) to which HOBO data-logging thermistors would be attached. Wilderness character values associated with naturalness, lack of development, and the opportunity for solitude would be impacted by these facilities which would remain indefinitely.

By providing information that allows managers to better detect and understand climate change, and make informed decisions, this alternative would help managers protect wilderness character. Expansion of the climate monitoring program to include the outer coast and high elevations where glaciers form, a robust maintenance schedule, and quality-controlled datasets would provide a considerably more complete and accurate record than that generated from previous

monitoring activities. Arendt et al. (2009) state that data from a high-elevation station such as Brady Icefield is very important to support predictions of future climate-forced change effects on land-terminating and tidewater glaciers, key resources for which GLBA was established.

This alternative would increase the number of administrative motor vessel visits through park waters adjacent to wilderness areas to install and maintain the station equipment. The number of helicopter landings occurring each year would increase due to the RAWS station at Brady Icefield. The data-logging thermistors at Beartrack and Idaho Ridge would be serviced only during regularly-scheduled radio repeater maintenance trips, resulting in no additional helicopter flights to those locations. None of the proposed stations requires motor vessel use through designated wilderness waters. Installation and maintenance trips to the two Nunatak station sites would require motor vessel use through eligible wilderness waters.

Additional aircraft reconnaissance flight(s) to the Brady Icefield would occur prior to the RAWS site being selected and installed. Due to extreme winter conditions, the Brady Icefield site may require more than one helicopter trip per year to repair or replace ice- and wind-damaged sensors.

Natural ecosystem processes would continue largely unaffected. A Lone Island installation would be sighted more frequently by vessel-based visitors than a station at Hugh Miller Island, although the probability of an individual vessel-based visitor seeing a station at either location is considered relatively low. Although vessel-based visitors are not physically within wilderness, they are nonetheless experiencing the terrestrial wilderness surrounding them.

A detailed Minimum Requirements Analysis for this project is included in Appendix A.

The undeveloped quality of wilderness would be diminished for an indefinite period of time by the addition of six new long-term installations. The actual footprints of the installations would be small, but the stations would affect the intrinsic value of large, undeveloped wilderness landscapes. Some sites would require routine brush removal so the somewhat larger physical footprint around each station's instrumentation would persist indefinitely. At one or more station sites a motorized rock drill may be necessary to install instrument anchor bolts. Of the eight stations proposed for designated wilderness, one (Lituya Bay) would be co-located with a pair of USCG navigational range markers that already have ground disturbance and visual impacts, as well as periodic disruptions from ongoing maintenance trips. NPS and USCG could coordinate site visits to minimize additional impacts. Two other stations would involve affixing small data-logging thermistors to existing NPS radio repeaters on Beartrack Mountain and Idaho Ridge; this would not involve any alteration of the existing installation footprints or visual profiles. The remaining five proposed RAWS in wilderness would be located on previously undisturbed sites.

The value of wilderness includes the opportunity for solitude or unconfined recreation. A wilderness experience is partly dependent on a wilderness setting without facilities or where *"the imprint of man's work (is) substantially unnoticeable"* (Wilderness Act Sec. 2(c) (1)). The presence of the stations and the yearly maintenance visits via motor vessels, fixed-wing aircraft, or helicopters would have site-specific effects on the opportunity for solitude, a sense of discovery, exploration, risk, and mystery. The knowledge that detailed weather information from

specific locations within wilderness is available, even if a person chooses not to view it, could diminish their sense of the area being unknown and unexplored.

Cumulative Impacts

Currently, signs of human development in GLBA's wilderness are very sparse. The cumulative effect on the resources and values of the vast area of wilderness and eligible wilderness is considered to be minor. This alternative would increase the number of similar installations by 44%. Alternative B would contribute adverse impacts from the installation of eight new stations in wilderness, five or six (depending on whether the Lituya Bay station could be physically mounted to an existing USGS range marker) with a physical footprint of approximately 144 square feet, and two with no additional physical footprint. Combined with known past, current, and future projects and actions (see Table 4-2), there would be minor adverse cumulative impacts on wilderness.

Conclusion: Alternative B would result in minor long term adverse impacts on wilderness from the installation and maintenance of eight new weather stations in designated wilderness.

4.4.2 Wildlife

Under Alternative B, installation of ten new climate monitoring stations would displace wildlife in the immediate vicinity during installation and maintenance. Disturbance would be temporary as installation would typically require part of one day at each site. For annual maintenance or repair, all but the Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield sites would be accessed by motorized boat, on foot, or by motor vehicle on an established trail in the National Preserve at Dry Bay. During maintenance trips, wildlife would be temporarily disturbed by vessels or a helicopter as well as by the presence and activities of people. Due to extreme environmental conditions, high elevation, and persistent snow and ice cover, wildlife use of the Brady Icefield RAWS site or the Idaho Ridge repeater site is likely negligible.

Wildlife startle responses to human-caused disturbance include increased locomotion costs, increased stress, reduction of foraging, and disruption of bedding (Cote 1996, Larkin 1996, Frid 2002). Mountain ungulates (sheep and goats) have been found to be disturbed at distances of up to 2 km (Cote 1996, Frid 2003, and Cote et al. 2013). These impacts can have increasingly severe affects during kidding periods (May 1 through June 15) and during high snow winters (November 15 through April 30) when food availability is minimal and locomotion costs increase drastically (Hurley, 2004). Disturbance from maintenance activities on wildlife would be considered minor as each site would be visited once or potentially twice each year, each time for a short period.

Brown and black bears, moose, mountain goats, wolves, coyotes, porcupines, river otters, martens, wolverines, marmots, red squirrels, ermine, voles, or shrews could be temporarily disturbed at specific sites. Based on the obvious trailing, browsed vegetation, and exposed mineral soil disturbance at the Beartrack radio repeater, mountain goats and other wildlife use the area on a regular basis.

Marine mammals including harbor seals, Steller sea lions, humpback and killer whales, Dall's and harbor porpoise, and northern sea otters may be disturbed during transit to and from sites around Glacier Bay and Lituya Bay. Harbor seals and sea otters have been observed hauled out on Lone Island during the summer months (May-August) since 2007. Seals often return to the water from haulouts in response to vessel activity at distances greater than 500 m (J. Womble, NPS data). Spring and fall (before May 1 and after September 30) patterns of harbor seal and sea otter use of Lone Island is unknown. By constraining installation and maintenance activities at Lone Island to periods when wildlife activity is reduced (before May 1 or after September 30), the likelihood of disturbance to wildlife would be minimized.

Bird species that could be disturbed during installation and maintenance activities at most of the station sites include nesting and foraging gulls and shorebirds, migratory waterfowl, passerine birds, raptors, and seabirds. Sensor towers that require guy wires could present a hazard for night-migrating birds. However, in most situations, unlighted towers less than 199 feet tall and located away from known bird concentration habitats pose lower risk (Woodlot 2003).

It is unlikely that any of the above species (mammals or birds) would be permanently displaced from any of the station sites.

Information collected under this alternative would help managers better understand climate and its effects on wildlife and habitats, thus providing for decision-making that would better protect them. Expansion of the climate monitoring program to additional habitats throughout GLBA, a robust maintenance schedule, and quality-controlled datasets would provide a considerably more complete and accurate record than that generated from previous monitoring activities. In particular, Arendt et al. (2009) state that data from high-elevation areas where glaciers form is very important to support predictions of future climate-forced change effects on the ecological communities within GLBA. The long-term influence of global and regional climate change is predicted to affect most if not all biological communities in Southeast Alaska.

A RAWS has a combined footprint (actual station base + supporting guy wires) of approximately 144 square feet depending on necessary tower anchoring. The HOBO thermistors (two sites, Beartrack and Idaho Ridge) would be mounted on existing structures causing no change in the site footprint. Although some sites consist of bare rock, rock rubble, and/or small pockets of soil supporting low-growing herbaceous vegetation, direct impacts to wildlife habitat would result from anchoring of equipment and from foot traffic. In addition to wildlife habitat impacts from anchoring techniques, small areas of habitat may require periodic brush clearing beneath and around the towers depending on the site. There would also be localized and temporary habitat disturbance from foot traffic during installation and maintenance; however, this would likely be short-lived, and limited to the area immediately surrounding the weather stations and the foot trail from the nearest shoreline access point. Already-scheduled once-a-year helicopter landings at Beartrack and Idaho Ridge for NPS radio repeater maintenance (during which thermistor maintenance would also occur) will continue to create transitory habitat impacts.

The total area of direct impact (ground footprint, including supporting guy wires) to wildlife habitat from the installation of the proposed new stations would be approximately 0.23 acre. The Deception Hills and Lituya Bay stations would be co-located with existing USCG installations

that already have some ongoing habitat modifications, and it is possible that all or portions of those stations could be mounted on existing structures, resulting in little or no additional ground disturbance from the installations themselves. To minimize impacts from maintenance visits to these sites, the NPS and USCG may coordinate their onsite activity.

Impacts on wildlife and habitat would be minor since human activity during installation and maintenance would be temporary and of short duration, and very little habitat would be disturbed when considering the extent of unaffected habitat in the surrounding area. However, if Lone Island were selected as the Lower West Arm Low-elevation RAWS site, the level of disturbance would be greater for nesting seabirds, as well as potentially for hauled-out harbor seals and sea otters, especially if installation and maintenance activities occurred during the summer season.

Cumulative Impacts

Approximately 31 acres of nearshore and forest wildlife habitat has been converted to buildings, roads, trails, and parking lots in Bartlett Cove. Trails, cabins, campsites, airstrips, and concession lodges in the developed area of Dry Bay have reduced available wildlife habitat by about 180 acres. Subsistence and sport hunting, commercial activities, and fishing contribute to cumulative effects to wildlife in the National Preserve. Besides the actual footprint of facilities, habitat in the immediate surrounding areas has been impacted by trampling from pedestrian and vehicle traffic and introductions of non-native plants. Human installations and public use have resulted in long and short-term habitat loss, displacement of wildlife, and increased human-wildlife conflicts. Backcountry installations including radio repeater sites, USCG navigation aids and seismic stations impact very small areas of wildlife habitat.

No additional radio repeater, navigational aids, or seismic sensors have been proposed for GLBA. Park visitation in the backcountry, and the presence of field crews maintaining monitoring stations, could cause localized, temporary displacement of wildlife and disturbance of wildlife habitat. Combined with known past, current and future projects and actions, there would be minor adverse cumulative impacts on wildlife. This alternative would contribute additional minor adverse cumulative impacts on wildlife and wildlife habitat.

Conclusion: Alternative B would result in minor temporary adverse impacts to wildlife and minor long-term adverse impacts to wildlife habitat from displacement of wildlife and disturbance of wildlife habitat during installation and periodic maintenance of weather stations.

4.4.3 Vegetation

Under Alternative B, ten new climate monitoring stations would be installed in the park and preserve. RAWSs have a combined footprint of about 144 square feet, depending on necessary tower anchoring. The new RAWS sites would impact approximately 0.23 acre depending on how the Lituya Bay station is constructed. Direct impacts on vegetation would result from foot traffic, anchoring of equipment, and maintaining clearances over time. In addition to vegetation being trampled or removed by anchoring techniques, small areas of vegetation could require clearing beneath and around the towers depending on the site. There would also be localized vegetation trampling from foot traffic during installation and maintenance; however, trampling would likely

be limited to the area immediately surrounding the weather stations, and its effects would likely be temporary and short-lived. Localized trailing from nearby landing beaches could also occur. Visits to each station would only occur once or twice annually, so trailing would probably not persist.

The Deception Hills site would require helicopter landings, but once the USCG completes the installation of their communications array a raised landing platform will minimize future impacts to vegetation. Vegetation is currently controlled at the Lituya Bay range marker site. Additional impacts from the climate station would be negligible. The data-logging thermistors for Beartrack and Idaho Ridge would not create additional impacts to vegetation.

Exotic plants or seeds could be transported to the sites on equipment, clothing, and footwear. New introductions could allow for exotic plants to establish and spread, especially in areas where the ground is disturbed by installation activities. However, mitigation to ensure that equipment, clothing, and footwear do not contain exotic plant material would be implemented (see Section 2.3).

Information collected under this alternative would help managers better understand climate and its effects on vegetation, thus providing for decision-making that leads to better protection. Expansion of the climate monitoring program to additional habitats throughout GLBA, a robust maintenance schedule, and quality-controlled datasets would provide a considerably more complete and accurate record than that generated from previous monitoring activities. In particular, Arendt et al. (2009) state that data from high-elevation areas where glaciers form is very important to support predictions of future climate-forced change effects on the ecological communities within GLBA. The long-term influence of global and regional climate change is predicted to affect most if not all plant communities in Southeast Alaska.

Impacts on vegetation, even if potentially long-term, would be minor in intensity and extent when compared to the extent of undisturbed vegetation in surrounding areas. Some installation sites naturally support little vegetation.

Cumulative Impacts

Vegetation in parts of the park and preserve has been cleared for construction of buildings, roads, trails, and other facilities in the developed areas of Bartlett Cove and Dry Bay. Facilities in the Bartlett Cove administrative area cover approximately 31 acres. Some vegetation is pruned, mowed, or removed periodically in the Dry Bay area of the national preserve where ORV trails, cabins, campsites, airstrips, fish processing facilities, and concession lodges have removed approximately 187 acres of native vegetation. Outside Bartlett Cove and Dry Bay, other installations in the GLBA backcountry (Table 4-2) have affected very small areas of vegetation. Besides the actual footprints of facilities, plants in the immediate surrounding areas have in some cases been impacted by trampling from pedestrian and vehicle traffic and introductions of non-native invasive plants. In undeveloped areas of the park, generally minor and dispersed vegetation impacts have been caused by the activities of backcountry campers, hikers, and anglers. A few areas of concentrated off-trail pedestrian traffic exist as unofficial social trails in

popular camping and scenic viewpoints along the shorelines of Glacier Bay, Dundas Bay, and the Alsek River.

Backcountry installations in the park, including radio communication sites, seismic stations, navigation aids, and RAWSs impact very small areas of vegetation. Maintenance activities at these existing facilities would continue to damage vegetation. The cumulative impact on vegetation from administrative buildings, cabins, roads, pedestrian and ORV trails, and other structures would continue to be minor. This alternative's installations and activities would contribute additional minor adverse cumulative impacts on vegetation in the park.

Conclusion: Alternative B would result in minor long-term adverse impacts to vegetation at most weather monitoring station sites; impacts would be limited to the effects of equipment anchoring and mostly temporary and short-lived trampling during installation and maintenance.

4.4.4 Visitor Experience

Under Alternative B, ten new climate monitoring sites would be established, some of which would have visual impacts to visitor experience. RAWS instrumentation requires clear exposure to the sky in order to effectively collect weather data and transmit it to satellites. Consequently, although visual impacts of installations could be mitigated via cryptic painting schemes, they could not be otherwise covered or obscured. Park visitors encountering RAWS equipment at close range, or subjected to administrative motor vessel or overhead aircraft noise during installation and maintenance, could have a diminished experience. Due to the remote location and inaccessibility of most of the installations, the silent operation of most of the instruments, and the limited time during which personnel would be actively working at each site, it is expected that a very small percentage of park visitors would be aware of them.

A Lower West Arm Low-elevation RAWS installation (particularly Lone Island) would provide real-time weather condition information for visitors travelling in Glacier Bay, improving safety and trip planning. Due to its central and relatively open location, climate monitoring instrumentation on Lone Island would be more visible to cruise ship, tour boat, charter, and private motor vessels traveling in the West Arm of Glacier Bay. To reduce the Lone Island station's visibility, instruments could be powered by methanol fuel cells to eliminate the solar panel and/or wind generator. The central tri-leg tower could be replaced by a guyed monopole. In addition, a solid-state ultrasonic anemometer could be substituted for the more standard spinning-cup anemometer, further reducing the installation's visual profile.

A Hugh Miller Island station could be observed by kayakers and concessioner boat tour passengers travelling close to shore. Two beaches in the area are used periodically as kayak camper drop-off points; one in Blue Mouse Cove to the north, and one in Sundew Cove to the southwest. Paddlers could travel along the shoreline where the equipment would be located. Private motor vessel passengers approaching the Blue Mouse Cove anchorage could also see the instrument tower briefly in passing.

Some stations could be visible to hikers and climbers on land if they are placed on exposed rock outcrops. Whether individual visitors detect an installation would vary greatly with distance,

viewing angle (from a boat on the water, while hiking, or from low-flying aircraft), and whether a structure was silhouetted against the sky or against a contrasting terrestrial background. The Lituya Bay station would be visible to vessels navigating by the associated USCG range markers inside the entrance to Lituya Bay. The Queen Inlet installation would be skylined if placed near the shoreward edge of the knob; it would also be directly visible from the water. An occasional hiker may encounter the station equipment as the station site is relatively easy to reach. Siting the equipment farther inland would reduce its visibility, especially if the solar panel could be deployed close to the ground (this might not be possible if the panel must be high enough to prevent burial by snow during the winter). As Nunatak Cove is a popular camping destination, the Nunatak Lower station could be encountered more frequently by backcountry visitors hiking along the beach, and could also be visible at a distance to boaters passing through Muir Inlet at high tide. During the summer months, passengers in low-flying aircrafts could spot any of the RAWS installations depending on weather and light conditions.

The Dry Bay RAWS could be sighted by ORV operators passing by on a designated trail.

The Deception Hills monitoring instruments would be incorporated into a USCG communications array co-located with a seismic sensor. Because the communications array is located approximately two miles from the shoreline at 2,214 foot elevation, it may be visible in certain light conditions to vessels transiting the Gulf of Alaska or to hikers traveling the Gulf of Alaska beach within the preserve. The climate station would not be distinguishable. Very few hikers travel inland to visit this part of the preserve.

All proposed station locations except Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield can be readily reached by transport methods and routes used by park visitors. Administrative visits involving small motorized boats landing on nearby beaches and hiking inland to stations would likely be indistinguishable from visitor recreational use. Stations at Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield would require the use of helicopters once or twice each year. These areas of the park are rarely visited. Because helicopter flights over the park are rare and are generally not viewed favorably as an element of a quality park visitor experience, such use constitutes an unwelcome disturbance. Helicopter-borne maintenance site visits to Deception Hills and Lituya Bay could be coordinated with the USCG to minimize the amount of disturbance. The NPS radio repeaters at Beartrack and Idaho Ridge receive a maintenance flight about once a year. The data-logging thermistors would be serviced during this flight.

The NPS is mandated to manage parks so they remain unimpaired for the enjoyment of future generations, and to promote understanding and appreciation of natural ecosystems. Real-time weather information collected and transmitted by the RAWSs would improve visitor safety and trip planning in the GLBA backcountry. Availability of educational and interpretive information about the park resources and values is important to a visitor's experience. Because the public values national parks, NPS interpretive messages about climate can influence societal actions.

The impact of Alternative B on visitor experience would be minor because the likelihood of visitors directly encountering the monitoring equipment would be relatively low, the installations themselves would be small or screened by topography, and it is unlikely that more than a few

visitors would be aware of activity during the periods when stations were being installed or maintained.

Cumulative Impacts

Park visitors encountering RAWSs, radio repeaters, navigational aids, or seismic equipment, and exposed to sights and sounds from motor vessels or aircraft associated with station installation and maintenance, could have a diminished experience. Existing radio repeaters and seismic sensors are located where little visitation occurs. Navigational aids are routinely encountered by vessels traveling through GLBA waters. Most existing installations have been present in their current locations for long periods of time.

Combined with known past, current, and future projects and actions, this alternative would result in minor adverse impacts to visitor experience because few visitors would be likely to encounter the installations directly, and access to four of the ten proposed stations generally requires the use of aircraft.

Conclusion: Alternative B would likely result in minor long term adverse impacts to visitor experience from direct encounters with the stations and temporary, short-lived noise and activity associated with station installation and periodic maintenance.

4.4.5 Soundscape

Under Alternative B, ten new weather stations would be installed, and activities associated with their installation and maintenance could have soundscape impacts. Climate monitoring station equipment itself is largely silent except for noise generated by wind generators or anemometers. Motor vessels would be used to access all proposed stations except Dry Bay, Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield. Noise from motorized transport would intrude upon the natural soundscape during daylight hours for 5-10 days during initial station installation, and approximately five days in each following year for scheduled maintenance. One additional day of motorized use could be necessary for a specific station if unscheduled repairs were necessary. The Dry Bay station would be accessed using an ORV from a designated general use trail.

Helicopters would be used for all visits to the Deception Hills, Beartrack, Idaho Ridge, and Brady Icefield stations, resulting in about six flights during the initial installation year and approximately three maintenance flights each year. One additional unscheduled flight to repair damaged instrument(s) at a station could be necessary each year. Depending on the destination and flightpath, a helicopter could be audible over GLBA for up to an hour during a flight to or from a monitoring station. Since helicopter-produced sound can be heard at long distances (see Table 3-1 for sound levels of helicopters at various distances), the natural soundscape would be diminished.

The Deception Hills climate monitoring instrumentation would be incorporated into a USCG communications array, allowing USCG and NPS to combine trips to minimize helicopter activity over the park and preserve. Annual maintenance could be coordinated to occur at the same time as maintenance of the co-located USCG navigational aids (Lituya Bay) and NPS radio repeater

(Beartrack and Idaho Ridge) installations. Flight paths from a staging site outside the park or preserve would be designed to minimize the amount of time over park or preserve land and water.

Helicopter intrusions to natural soundscape would be minor because they would be temporary, of short duration, and would occur only on approximately four days each year once climate monitoring stations are installed.

Cumulative Impacts

Cumulative effects to the natural soundscapes of the park backcountry include motorized boats (cruise ships, tour, charter, and private vessels), small aircraft, passenger jets, and occasional human voices on or near shorelines. In the developed area of Bartlett Cove, sounds of generators, motor vehicles, heavy equipment, power tools, and building HVAC utilities are present year round. In spring, summer, and fall, human voices are frequent. In the Dry Bay area of the National Preserve, ORV noise is common during spring, summer, and fall. Helicopter flights over the park are infrequent; the USCG conducts coastal patrols along the outer coast and Cross Sound/Icy Strait approximately once a month depending on season, and there is at least one helicopter flight to the Deception Hills seismic station and the Beartrack, Deception Hills, and Idaho Ridge NPS radio repeaters annually.

Aircraft and motor vessel noise disturbances are much more frequent during the summer months than at other times of year. This alternative would result in at least four additional helicopter flights per year, one additional ORV trip in Dry Bay, and approximately four motorized vessel trips to the other climate stations around Glacier Bay proper each year. Noise intrusions would be temporary and of short duration, affecting different areas in GLBA. Human voices and other activity could occasionally be heard at each climate station site during a single day once or twice a year.

Combined with known past, current and future projects and actions, Alternative B would contribute minor additional adverse impacts on soundscape.

Conclusion: Alternative B would result in minor temporary adverse impacts on soundscape from noise intrusions during the installation and maintenance of the proposed climate monitoring stations.

4.4.6 Cultural Resources

Direct and Indirect Effects

Proposed climate station installations at Deception Hills, Queen Inlet, Lower West Arm Low-elevation, Nunatak Lower, Nunatak Upper, Beartrack, Idaho Ridge, and Brady Icefield are not located near known archeological or historic sites, or TCPs.

The Lituya Bay and Dry Bay sites reside within areas considered eligible for listing on the National Register as TCPs by the NPS. Numerous historic and archeological sites are known or suspected to occur in Lituya Bay and Dry Bay. However, the proposed climate station sites in

these areas would have negligible effects on the potential TCPs because the stations would occupy previously disturbed areas that have already undergone archeological review.

If any archeological or historical resources were discovered during installation at any of the new stations, installation activities would be halted immediately, and the park Superintendent and cultural resource managers would be notified. No further action would take place until the NPS provided clearance, which would occur only after consultation with the State Historic Preservation Officer and affected indigenous communities. It is expected that impacts on cultural resources would be negligible, and great care would be taken to prevent adverse effects at sites where they could occur.

Cumulative Impacts

This alternative would contribute negligible additional adverse cumulative impacts on cultural resources.

Conclusion: Alternative B would result in negligible adverse impacts to cultural resources from the installation of new climate monitoring stations.

5.0 CONSULTATION & COORDINATION

5.1 Public Involvement

The proposed climate monitoring program EA was announced to the public through local flyers; the National Park Service Planning, Environment, and Public Comment (PEPC) website; the park's public website; and electronic news releases to regional agencies, tribal governments, local businesses and private interest groups in June, 2013.

One sparsely attended public meeting was held on June 26, 2013 in Gustavus, AK. The 30-day issue scoping period ended on July 17, 2013. Written comments were received from the State of Alaska and the National Parks Conservation Association.

5.2 Tribal and Agency Consultation

NPS staff consulted with the Hoonah Indian Association on May 23, 2013 and October 29, 2013. The project and updates were presented to the Yakutat Tribe during government-to-government meetings on April 5, 2013 and April 22, 2014.

On July 2, 2014, the NPS initiated informal consultation with the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act. The NPS has determined that the proposed action is not likely to adversely affect the endangered humpback whale or the endangered distinct western population segment of Steller sea lion and has requested concurrence from NMFS.

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APPENDICES

APPENDIX A:

In March, 2013, the SEAN proposal was also evaluated using *A Framework to Evaluate Proposals for Scientific Activities in Wilderness* (Landres 2010). This framework provides a consistent and comprehensive approach for evaluating scientific activity proposed for wilderness. Since 2011, GLBA managers have used the framework to evaluate over 60 research proposals.

Every on-the-ground management action in wilderness compromises or diminishes some aspect of wilderness character, but some actions nevertheless are acceptable because the net potential benefits to wilderness outweigh the net potential impacts. Conducting scientific research in wilderness similarly creates both impacts and benefits. The decision to approve or deny a research permit application ultimately depends on whether the benefits justify the impacts.

The preliminary analysis of the proposal suggested a potential for the proposed project to result in both substantial benefits and substantial impacts, and indicated that a wilderness minimum requirements analysis was needed.

MINIMUM REQUIREMENTS DECISION GUIDE WORKSHEETS

". . . except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act..."

– the Wilderness Act, 1964

Monitoring Climate in Glacier Bay National Park and Preserve

Step 1: Determine if any administrative action is necessary.

Description: Briefly describe the situation that may prompt action.

Climate is a dominant factor driving the natural physical and ecological processes occurring within Glacier Bay National Park and Preserve (GLBA). Climate variations are responsible for short- and long-term changes in ecosystem fluxes of energy and matter and have profound effects on underlying geomorphic and biogeochemical processes. Two dominant drivers - wetness and disturbance - influence the major ecological communities in GLBA. Like other regions in Alaska, Southeast Alaska appears to be generally sensitive to changes in temperature. This is particularly due to the region's extensive glaciers, all of which are vulnerable to even slight warming. The long-term influence of humans on global and regional climate is expected to bring important changes to all of the ecosystem components in Southeast Alaska.

Documenting that change and understanding its impact on the holistic functioning and processes of ecosystems within GLBA would support the park mandate to manage its resources in a manner that protects those integral ecosystems that comprise the heart of the natural quality of GLBA's wilderness character. This documentation and understanding would come in the form of monitoring data that would be collected, analyzed, interpreted, and reported. At the most basic level, the NPS cannot evaluate appropriate ecosystem function when bounds of natural variability and/or reference conditions are not known.

Understanding sources and magnitude of change, especially with such a fundamental driver to the Glacier Bay ecosystem, is critical in understanding if the changes that are observed within GLBA are caused by some 'natural' or external force or whether they are caused by something that park has management control over. For example, if changes are observed in the distribution or abundance of certain wildlife species, it is critical to know if there is an administrative or visitor activity that is

causing this change or whether biological changes can be attributed to weather variability or trends in climate conditions. Having climate data and understanding the relationship between climate and glacial extent/volume will provide the means to tease apart the causes of the patterns that we see and make decisions about whether a change in resource management is warranted. In some cases, understanding patterns of natural change could decrease the likelihood of direct mitigation activities. In this manner, climate data would be one tool for protecting wilderness character.

The Southeast Alaska Inventory and Monitoring Network (SEAN) Weather and Climate Inventory report (Davey et al. 2007) identifies existing stations within and near GLBA that would be suitable for data harvest and describes the recommended approach for climate monitoring in Glacier Bay National Park and Preserve.

According to the report, based on climate change considerations alone, a recommended strategy would entail placement of stations in the pure coastal zone, in the pure interior zone, at higher elevations closer to the location of what is currently quasi-permanent ice, and in transition regions such as drainage divides. Additionally, the report states that climate inventory and monitoring activities should be based on a set of guiding fundamental principles. Any evaluation of a weather/ climate monitoring program begins with asking the following question: What is the purpose of weather and climate measurements?

Within the context of the climate monitoring proposed in GLBA, the following services constitute the main purposes of recording weather and climate observations (Davey et al. 2007):

- Consistently monitor climate over the long term to detect changes in environmental drivers affecting ecosystems, including both gradual and sudden events.
- Provide retrospective data to understand *a posteriori* changes in flora and fauna.
- Document for posterity the physical conditions in and near the park unit, including mean, extreme, and variable measurements (in time and space) for all applications.
- Provide measurements for real-time operational needs and early warnings of potential hazards (jokulhaups, landslides, mudflows, washouts, fallen trees, plowing activities, aircraft and watercraft conditions, rescue conditions, fog, restoration and remediation activities, etc.).
- Provide visitor education and aid interpretation of expected and actual conditions for visitors while they are in the park and for deciding whether and when to visit the park.

The report concludes that existing weather stations in the vicinity of GLBA do not provide adequate data for understanding climate change within the park. The reasons for this include coverage gaps that preclude the ability to assess weather and climate across a west-to-east coastal-to-interior gradient, a north-to-south fjord head-to-lower bay gradient, and an elevational gradient.

To eliminate these coverage gaps, the National Park Service (NPS) proposes to collect climate data within GLBA wilderness.

To determine if administrative action is necessary, answer the questions listed in A - F on the following pages.

A. Describe Options Outside of Wilderness

Is action necessary within wilderness?

Yes: ☒ **No:** ☐

Explain: Over 99% of the land within GLBA is either designated or eligible wilderness (Figure 1). Therefore, options for using non-wilderness lands are essentially restricted to lands in the Preserve (which is entirely non-wilderness) and near park headquarters, as well as lands outside of the park, or privately owned parcels within the park. As managers and scientists strive to understand climate change and its potential to impair park resources, access to local and down-scaled climate data is essential. Weather and climate data are a basic and vital link supporting nearly all internal and external research conducted in GLBA.

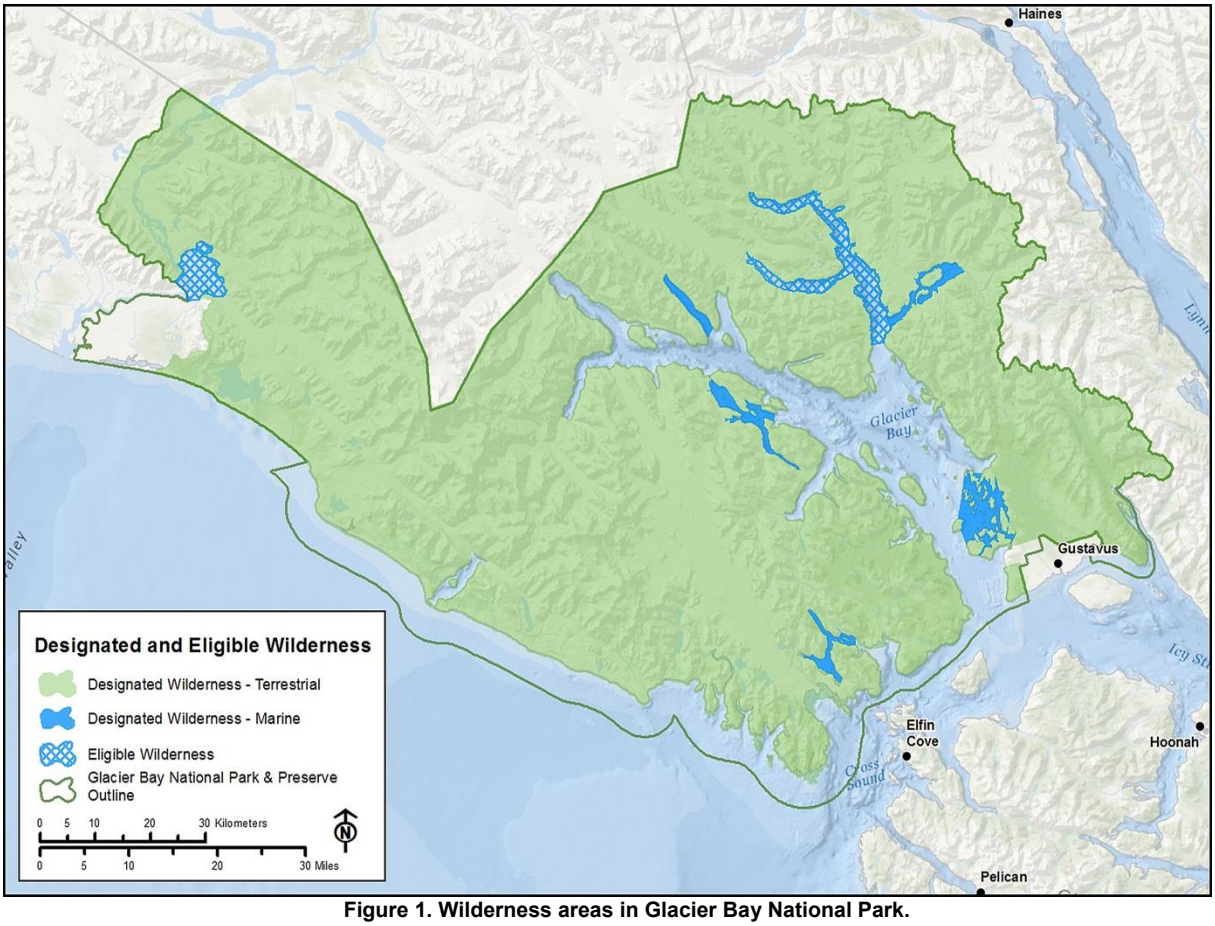

Figure 1. Wilderness areas in Glacier Bay National Park.

The SEAN climate inventory report (Davey et al. 2007) identifies existing stations suitable for data harvest and describes the recommended approach for climate monitoring in GLBA. The report concludes that the existing network of weather stations in the vicinity of GLBA does not adequately detect and document patterns of climate change within park boundaries.

B. Describe Valid Existing Rights or Special Provisions of Wilderness Legislation

Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that allows consideration of the Section 4(c) prohibited uses? Cite law and section.

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain: There is no provision in any wilderness legislation that requires the NPS to place these facilities for its own purposes.

C. Describe Requirements of Other Legislation

Is action necessary to meet the requirements of other laws?

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain: Monitoring climate is not required in any other legislation, but this type of research is strongly supported by the Proclamation initially establishing Glacier Bay National Monument (Coolidge 1925), which states that one purpose of the Monument is to provide:

> "… a unique opportunity for the scientific study of glacial behavior and of resulting movements and developments of flora and fauna and of certain valuable relics of interglacial forests."

In 1980 the Monument was re-designated a National Park by the Alaska National Interest Lands Conservation Act (ANILCA) which also designated 2.77 million acres as wilderness. The existing study area for this project is included within designated wilderness. One of the purposes of the wilderness designation is to

> "… maintain opportunities for scientific research in undisturbed ecosystems."

ANILCA Section 1310(b) authorizes the establishment, operation, and maintenance of facilities for weather, climate research and monitoring within conservation system units, but only after consultation with the Secretary and subject to terms and conditions to minimize the adverse effects of such activities (see section 1.2.2).

D. Describe Other Guidance

Is action necessary to conform to direction contained in agency policy, unit and wilderness management plans, species recovery plans, or agreements with tribal, state, and local governments or other federal agencies?

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: NPS Management Policies 2006 (NPS 2006) addresses the importance of and need for weather and climate monitoring efforts as well as scientific inquiry in wilderness in a number of sections:

Section 4.7.2 *Weather and Climate:* "Parks containing significant natural resources will gather and maintain baseline climatological data for perpetual reference".

Section 4.2 *Studies and collections: "*The Service will encourage appropriately reviewed natural resource studies whenever such studies are consistent with applicable laws and policies. These studies support the NPS mission by providing the Service, the scientific community, and the public with an understanding of park resources, processes, values, and uses that will be cumulative and constantly refined… Studies include projects conducted by researchers and scholars in universities, foundations and other institutions, tribal colleges and organizations, other federal and state agencies, and Service staff".

Section 2.3.1.5 *Science and Scholarship:* "The collection and analysis of information about park resources will be a continuous process that will help ensure that decisions are consistent with park purposes."

Section 6.3.6 *Scientific Activities in Wilderness:* "The statutory purposes of wilderness include scientific activities, and these activities are encouraged and permitted when consistent with the Service's responsibilities to preserve and manage wilderness".

Section 6.3.6.1 *General Policy:* "The National Park Service has a responsibility to support the appropriate scientific activities in wilderness and to use science to improve wilderness management. The Service recognizes that wilderness can and should serve as an important resource for long-term research into, and study, and observation of, ecological processes and the impacts of humans on these ecosystems. The National Park Service further recognizes that appropriate scientific activities may be critical to the long-term preservation of wilderness".

"Scientific activities are to be encouraged in wilderness. Even those scientific activities (including inventory, monitoring, and research) that involve a potential impact to wilderness resources or values (including access, ground disturbance, use of equipment, and animal welfare) should be allowed when the benefits of what can be learned outweigh the impacts on wilderness resources or values. However, all such activities must also be evaluated using the minimum requirement concept and include documented compliance that assesses impacts against benefits to wilderness. This process should ensure that the activity is appropriate and utilizes the minimum tool required to accomplish project objectives".

E. Wilderness Character

Is action necessary to preserve one or more of the qualities of wilderness character, including: untrammeled, undeveloped, natural, outstanding opportunities for solitude or a primitive and unconfined type of recreation, or unique components that reflect the character of this wilderness area?

Untrammeled: **Yes** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: The project is not necessary to preserve the untrammeled quality of GLBA wilderness.

Undeveloped: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: The project is not necessary to preserve the undeveloped quality of GLBA wilderness.

Natural: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: When using adaptive management strategies to support stewardship of parklands and wilderness, it is important to understand the pattern of climate change. Information collected by this project would help GLBA managers to plan strategies and make decisions that would promote naturalness and allow natural changes to occur.

Outstanding opportunities for solitude or a primitive and unconfined type of recreation:

Yes: ☐ **No:** ☒ **Not Applicable:** ☐

Explain: The project is not necessary to preserve the solitude or primitive/unconfined quality of GLBA wilderness.

Other unique components that reflect the character of this wilderness:

Yes: ☒ **No:** ☐ **Not Applicable:** ☐

Explain: Opportunities for scientific study is specifically mentioned in the Proclamation that established Glacier Bay National Monument. See Effects on the Scientific Purpose of Wilderness in Section F (below) for thorough discussion.

F. Describe Effects to the Public Purposes of Wilderness

Is action necessary to support one or more of the public purposes of wilderness (as stated in Section 4[b] of the Wilderness Act) for recreation, scenic, scientific, education, conservation, and historical uses?

Recreation: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: Action is not necessary to support the recreation purpose of GLBA wilderness.

Scenic: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: Action is not necessary to support the scenic purpose of GLBA wilderness.

Scientific: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: The NPS recognizes that an understanding of ecosystem function is important to fulfill its legislative mandate to manage parks in a manner that leaves them unimpaired for the enjoyment of future generations. Identifying reference conditions and future sensitive resources, and providing information for management plans for species migration shifts are just two examples of how the data from this project could be used. In addition to the scientific public purpose, Glacier Bay National Monument's establishment was based in part on providing "… a unique opportunity for the scientific study of glacial behavior and of resulting movements and developments of flora and fauna…"

Numerous studies describe the effects of climate change on selected ecosystems, but it is important to quantitatively monitor meteorological conditions directly so that a reliable record of long-term change can be established. These data would be used by a myriad of researchers and park staff to understand other research and monitoring questions; it is the foundation data for understanding changes in Southeast Alaska ecosystems.

Education: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: National parks have a significant interpretive mission, and education and outreach are important components of wilderness stewardship. Climate has always been an important element of that interpretation, and climate change is rapidly being incorporated into that mission. The interpretative messages can address climate itself and its dynamic, causes of long-term changes, or the relation of climate to other ecological communities and physical processes in the park. Because the public values national parks, a message about climate change and its effects on parks has the ability to influence broad societal values and actions, and could garner more support for wilderness areas that protect natural ecosystems and processes. The NPS seeks to promote understanding of how science benefits park management decisions, including wilderness, and to actively share scientific findings in compelling and understandable ways.

Conservation: **Yes:** ☒ **No:** ☐ **Not Applicable:** ☐

Explain: If protection of natural resources and processes is to be achieved during the coming decades of climate change, managers need to use adaptive management strategies to deal with uncertain futures. Often there is a time lag between a climate shift and a change in species composition, and an understanding of changes in climate can help managers predict trends in flora and fauna, given different climate scenarios. Climate observations inform models designed to project future conditions across a complex topography. Improved understanding of climate change and its implications will better inform managers as they make decisions about broader preservation issues such as refugia for species and the need for additional wilderness areas, and will help managers be proactive, rather than reactive, in their management.

Historical use: **Yes:** ☐ **No:** ☒ **Not Applicable:** ☐

Explain: Action is not necessary to support the historic purpose of GLBA wilderness.

Step 1 Decision: Is any administrative action necessary in wilderness?

Administrative action necessary: **Yes:** ☒ **No:** ☐

Explain: Climate is a fundamental ecosystem driver across multiple scales. Understanding past climate patterns and future scenarios from predictive models is critical to determining natural variation in park resources, especially within the context of climate change, which has been mandated by NPS as an essential component of park management decisions. Climate change is expected to affect all components of park management ranging from predicting infrastructure damage due to greater storm intensity, to resource concerns such as potentially decreased fish productivity resulting from changes to habitat quality and timing of prey resource availability. As managers and scientists strive to understand climate change and its potential to impair park resources, access to local and down-scaled climate data is essential. Weather and climate data are a basic and vital link supporting nearly all internal and external research conducted within GLBA.

The SEAN climate inventory report (Davey et al. 2007) identifies existing stations suitable for data harvest and describes the recommended approach for climate monitoring in GLBA. The report concludes that the existing network of weather stations in the vicinity of GLBA does not adequately monitor patterns of climate change within park boundaries. Monitoring climate information within GLBA wilderness is necessary to understanding the impacts of anthropogenic change on the natural quality of GLBA's wilderness character as well as ensuring that the scientific purpose of wilderness and of GLBA is fulfilled.

If action is necessary, proceed to Step 2 to determine the minimum activity.

Step 2: Determine the minimum activity.

Given the complex topography and critical issues related to climate change, a scientifically defensible design for the minimum number of monitoring locations would consist of a sampling grid of approximately one station per 40 km (Fig. 2). The National Weather Service has strived for this as a minimum density grid for weather stations in the continental U.S, with the understanding that a higher density is desired for complex terrain such as that found within GLBA (Redmond and Simeral 2010).

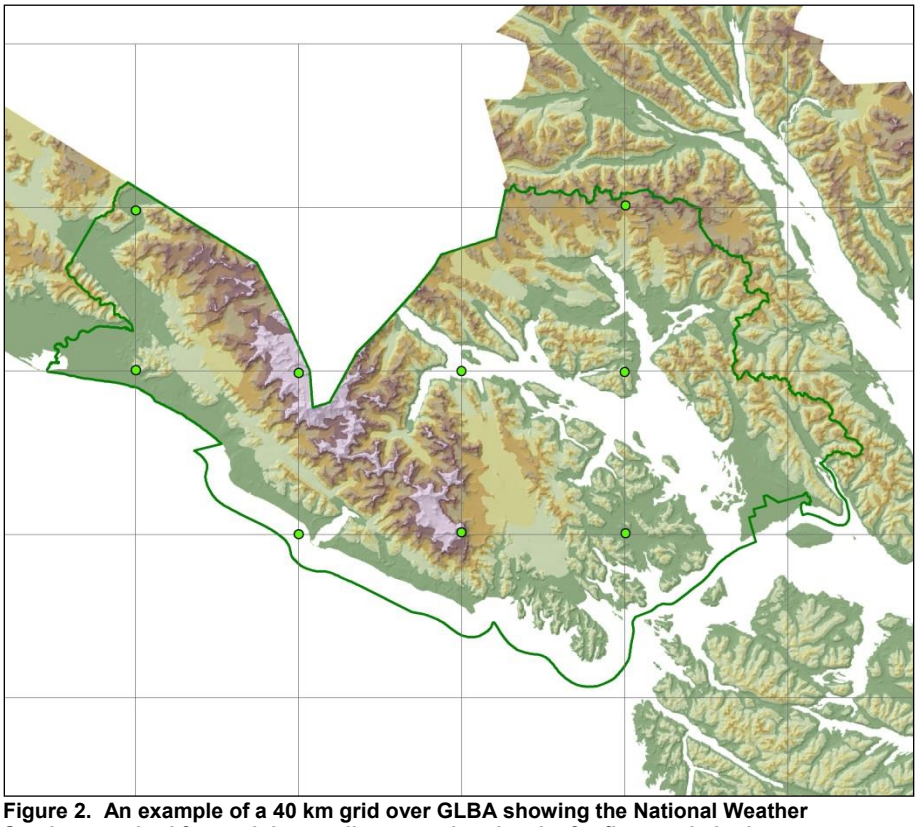

Figure 2. An example of a 40 km grid over GLBA showing the National Weather Service standard for a minimum climate station density for flat terrain in the continental U.S. Green dots represent climate station locations. Ideally, more stations (higher density) would be preferred given the park's elevationally complex terrain.

In order to minimize impacts to wilderness character, a number of options were considered for monitoring climate within GLBA. For each alternative below, we describe what methods and techniques would be used, when the activity would take place, where the activity would take place, what mitigation measures would be necessary, and the general effects to the wilderness resource and character.

ALTERNATIVE 1
No Action

Under this alternative no new climate monitoring stations would be installed in the GLBA wilderness. According to the SEAN climate inventory report (Davey et al. 2007), a climate or weather monitoring station need not necessarily be located within the unit boundaries to provide useful data and information regarding the park unit in question. An effective network could include some stations physically located within the administrative or political boundaries, and some stations located just outside (or even some distance away), but any "outside" stations would need to be *nearby* in behavior and representativeness. The report identifies three active stations within GLBA and at least 30 active stations within 60 km of the boundary, and concludes that existing weather stations in the vicinity of GLBA do not adequately address patterns of climate change within park boundaries. Figure 3 identifies principal stations in the general region of GLBA.

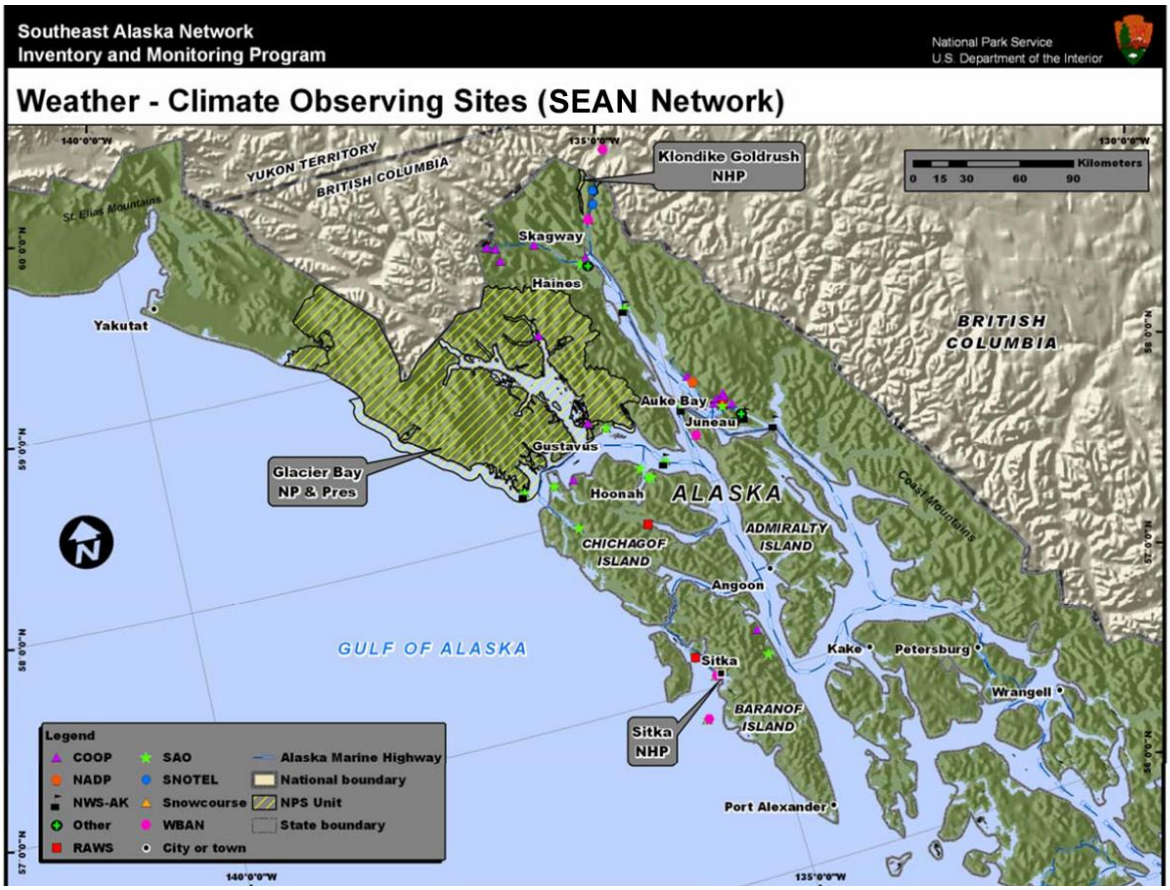

Figure 3. Existing climate and weather observing sites within and near (within 300 km of) GLBA (Davey et al. 2007). Note: since the creation of this figure, one new RAWS site has been added near the Gustavus airport.

Descriptions of Existing Weather Stations

- Five weather/climate stations have been identified within GLBA, three of which are currently active. Two are located at Cape Spencer within GLBA wilderness but within a developed footprint managed by the U.S. Coast Guard (USCG). These stations provide the longest data records in the park (1936-present). However, the National Weather Service Cooperative Observers Program (NWS COOP) station data from Cape Spencer have been unreliable since 1974. A station associated with NWS-AK is also located at Cape Spencer.

- The COOP station "Glacier Bay," located 10 km northwest of Gustavus at Bartlett Cove, has provided observations since1966. This station has scattered data gaps, particularly in the 1990s.
- The COOP station "Goose Cove" was active between 1970 and 1976 and was located on the east shore of the junction of Muir and Wachusett Inlets.
- Thirty-three COOP stations outside of GLBA that are within 30 km of the park unit have been identified. At least 23 of these COOP stations are active (Davey et al. 2007).
- At least ten NWS/FAA Surface Airways Observation (SAO) network sites are currently active within 60 km of GLBA. The closest SAO station is "Gustavus," located three km southeast of GLBA. Additional SAO stations are active at the Juneau, Haines, and Skagway airports. Many of the SAO stations include data records going back to the 1940s or earlier.
- The airport at Yakutat, northwest of GLBA, hosts both COOP and SAO stations that have collected several decades of reliable weather and climate data.
- One new RAWS site located on Nature Conservancy land near the Gustavus Airport.

Effects on Wilderness Character

Untrammeled - The ecological systems within the wilderness would not be further controlled or manipulated.

Undeveloped - The GLBA wilderness would remain largely undeveloped.

Natural - Additional information regarding the predicted ecological changes resulting from climate change and the potential effects of those changes to the naturalness of wilderness within the study area would be unavailable to managers for strategic planning and management decisions, and for improved/increased understanding regarding the current status and future of GLBA wilderness ecosystems. Understanding impacts to the natural quality of GLBA wilderness depends upon correctly identifying natural and anthropogenic ecosystem change and its causes. Perhaps the single most fundamental and important driver of ecosystem change is weather/climate. The park currently lacks a program of weather/climate monitoring at a spatial and temporal scale appropriate for interpreting effects on park ecosystems; without these observations, managers cannot begin to attribute ultimate and proximate causal factors to changes that may threaten the natural quality of GLBA wilderness.

Outstanding opportunities for solitude or primitive and unconfined recreation - Visitors to GLBA wilderness would continue to experience opportunities for solitude or primitive and unconfined recreation.

Effects on Other Wilderness Values

Cultural Heritage - Lands included in this wilderness are important spiritually and culturally to many local people and communities; the presence of modern human developments like climate stations could detract from the sense of place some cultures associate with lands encompassed by GLBA. For some people who may never visit this area, the "existence value" of wilderness is very important, and just knowing that these facilities exist would detract from its value.

Scientific Value - Glacier Bay National Monument's establishment was based in part on providing "… a unique opportunity for the scientific study of glacial behavior and of resulting movements and developments of flora and fauna…" By not effectively monitoring climate, park managers would not be able to establish reference conditions and evaluate appropriate ecosystem function.

ALTERNATIVE 2

Expand the climate monitoring program to ten locations within GLBA (eight within wilderness).

This alternative would expand the existing observational network to include eight additional RAWS instrument stations and two HOBO recording thermistors attached to existing radio repeaters (Fig. 4) within GLBA. Six of these new RAWS stations and the two HOBO thermistors would be located within wilderness.

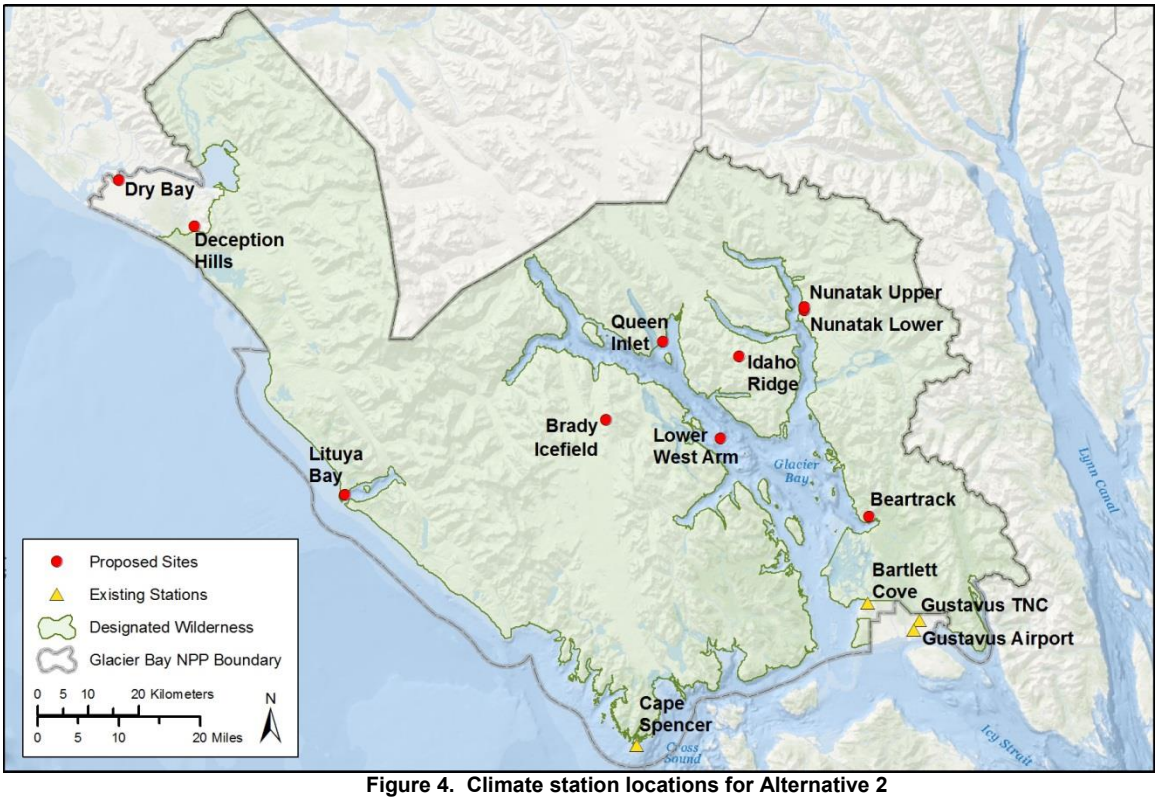

Figure 4. Climate station locations for Alternative 2

The proposed RAWS stations would collect a full suite of basic weather observations including air and soil temperature, precipitation, relative humidity, wind speed and direction, solar radiation and snow depth and transmit these observations hourly via satellite. These observations would be posted to the Western Regional Climate Center website or comparable data repository in near real-time.

All of these stations except Lituya Bay would consist of a ten-foot-tall tri-leg tower supporting all the sensors, antennae, a solar panel, and a data-logger/communications enclosure (Fig. 5). At Lituya Bay, instrumentation would be co-located with (preferably attached to) one of the existing USCG navigational range markers.

Figure 5. Typical climate station configuration.

Towers would be taped or painted dull/broken colors to blend in with surrounding vegetation and ground surface/rock. At each station, tower mounts would support sensors measuring air temperature, precipitation, relative humidity, solar radiation, wind speed and direction, and snow depth (and in some cases soil temperature), along with a GPS antenna and a Geosynchronous Operational Environmental Satellite (GOES) data transmission antenna. A steel enclosure attached to the tower would house electronic data storage and communications equipment. Power would be provided by a 33" x 21" x 2" solar panel mounted high on each tower, and at the base of each structure would be two battery boxes, each containing three 12-volt storage batteries (six batteries per station). An alternative power generation option could be a wind generator. The tower would typically be supported by three guy wires securely anchored to the ground. Tower components would be assembled on site using non-motorized equipment.

At sites where minimizing visibility (of the station to park visitors) is anticipated to be a special challenge, an ultrasonic wind speed sensor would be substituted for the conventional spinning-cup anemometer, and a small fuel cell located at the base of the tower would be substituted for the solar panel/wind generator. Some sites could require the use of anchor bolts in rock. For the stations located in wilderness, bolt holes would be drilled by hand. Should hand drilling prove to be unreasonably difficult as jointly determined by SEAN and GLBA staff, other installation options (including motorized rock drills) may be used to assure successful installation of the stations.

Stations would be visited annually and could receive one additional maintenance visit per year in order to perform routine maintenance, replace failed sensors, and check for overall security of the installation, hardware, and cables. Access to most wilderness sites would be via motorized vessel and hiking. Access to the Lituya Bay station would include motorized vessel or floatplane; fixed-wing wheeled plane access is possible but unlikely due to landing conditions. Access to the Brady Icefield station would typically be via helicopter (possibly fixed-wing ski-plane as conditions allow). After initial installation, station maintenance visits would likely require three to four hours on site to trade out sensors, as necessary, and perform other routine maintenance and repairs.

HOBO data logging thermistors (Onset Model U23-400 equipped with radiation shields [Onset Model RS#], Fig. 6) would be fixed to existing NPS radio repeater towers at Idaho Ridge and Beartrack. This model is 4" x 1.5" in size and would fall within the footprint of the existing tower.

Figure 6. HOBO data logging thermistor.

HOBO data-loggers would be either downloaded or replaced in conjunction with radio repeater maintenance visits which are conducted via helicopter. No additional trips would be permitted.

Table 1. Non-wilderness locations are shown with grey text. Wilderness locations are shown in black text. Sites equipped with HOBO data logging thermistors only are shaded grey.

Site	Elevation	Location	Access	Land Status	Concurrent Land Uses
Dry Bay	Low elevation	N59.1676 W138.4841	Motor vehicle	Preserve (non-wilderness)	ORV trail system
Deception Hills	2,214'	N59.0924 W138.2165	Helicopter	Preserve (non-wilderness)	Seismic sensor, communication array
Beartrack	2,368'	N58.6129 W135.8668	Helicopter	Wilderness	Radio repeater
Idaho Ridge	3,774'	N58.894 W136.3216	Helicopter	Wilderness	Radio repeater
Queen Inlet	1,040'	N58.9173 W136.5844	Motor vessel and hiking	Wilderness	None
Lower West Arm Low-elevation	20-50' above sea level	See Fig. 3 & 6	Motor vessel and hiking	Wilderness	None
Nunatak Lower	< 20' above sea level	N58.9781 W136.1004	Motor vessel through eligible wilderness waters, and hiking	Wilderness	None
Nunatak Upper	1,000'	N58.9836 W136.1004	Motor vessel through eligible wilderness waters, and hiking	Wilderness	Historic photo site on summit
Brady Icefield	3,000' - 4,000'	See Fig. 7	Helicopter and/or fixed-wing on skis; hiking	Wilderness	None
Lituya Bay	< 20' above sea level	N58.6271 W137.6579	Motor vessel and/or fixed-wing floatplane; hiking	Wilderness	USCG aid to navigation

Lower West Arm Low-elevation

The exact location for this station has not been determined. There are two potential sites for this monitoring station: Lone Island and Hugh Miller Island (Figure 7). Both sites are less than 100' elevation above sea level along the West Arm of Glacier Bay proper. Lone Island's full exposure to West Arm weather conditions makes it an exceptional low-elevation monitoring site that could provide important safety information. The Hugh Miller Island site may provide similar quality data though how similar is unknown; it is expected that Lone Island observations would be ideal.

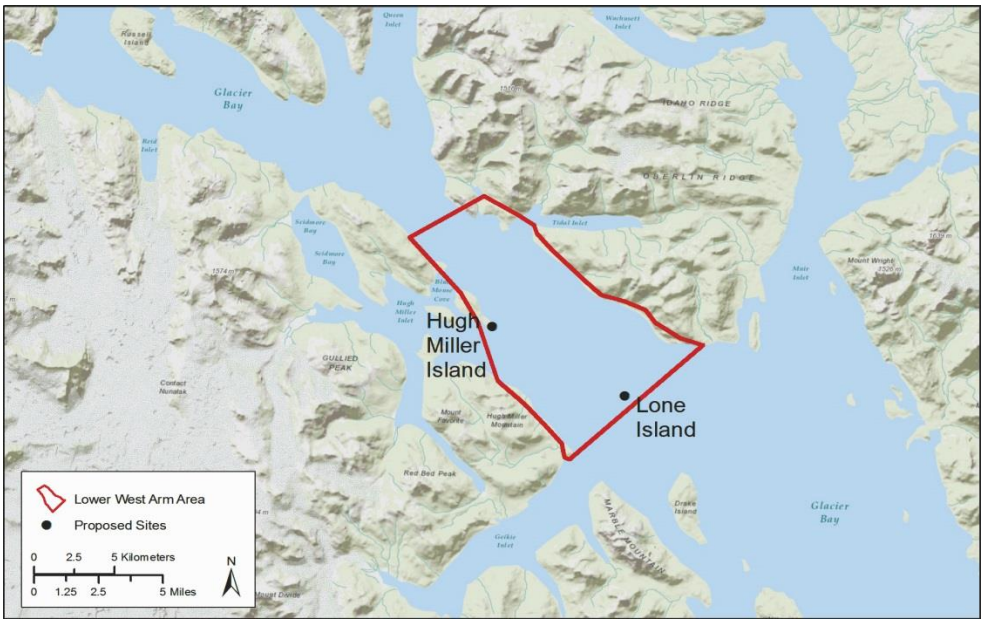

Figure 7. Potential sites for the Lower West Arm Low-elevation station.

Brady Icefield

The exact location for the RAWS installation has not been identified, but would be selected from several candidate sites 3,000-4,000 feet in elevation that offer bedrock outcrops expected to be relatively free of deep snow accumulation throughout the year (Fig. 8). A station on the Brady Icefield station would directly measure conditions on a large icefield that has a major influence on land-terminating and tidewater glaciers in GLBA (Davey et al. 2007). Observations from this station would serve as a direct measure of conditions at a large icefield that has a major influence on land-terminating and tidewater glaciers in GLBA (Arendt et al. 2009). The majority of the tidewater glaciers in GLBA form at high elevation on the Brady Icefield and this location also provides a direct link between the three directional and elevational gradients described by Davey, et al. (2007). It is believed that no other high-elevation location within GLBA can accomplish this objective. Lessons learned from maintaining a weather station at Chilkoot Pass (elevation 4,200') within Klondike Gold Rush National Historical Park would contribute to the sampling and maintenance schedule for the Brady Icefield station. Notably, access to the Brady Icefield site would typically be via helicopter (access via fixed-wing ski-plane could be possible if conditions allow).

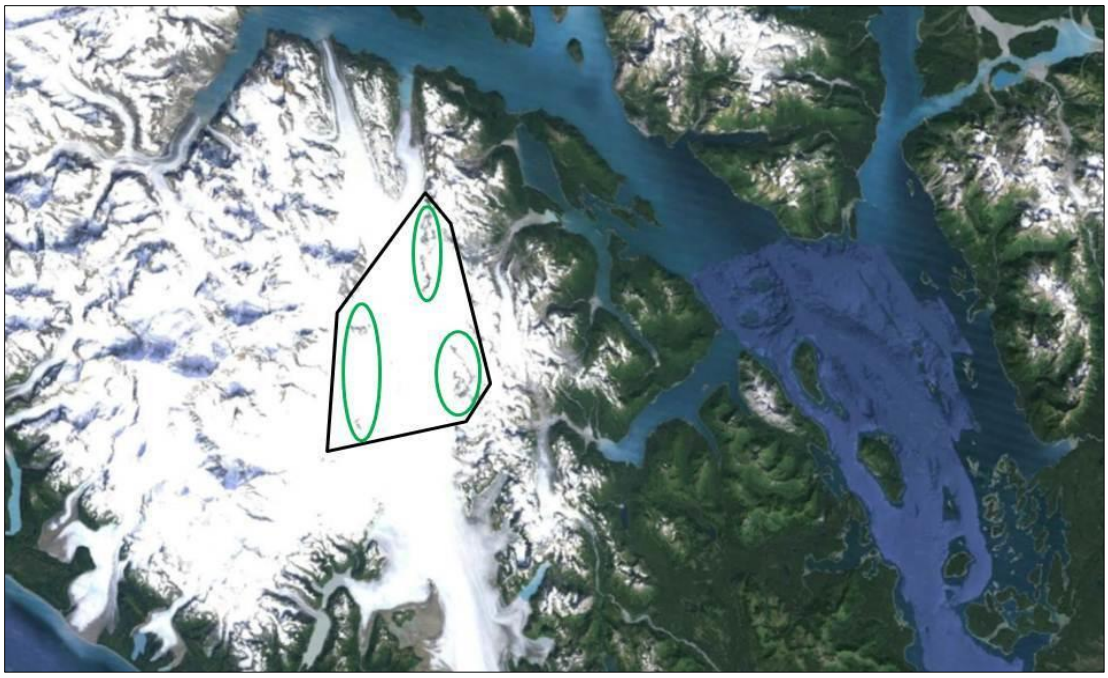

Figure 8. Potential Brady Icefield locations

Effects on Wilderness Character

Untrammeled - The proposed stations would likely not control or manipulate the ecological systems within GLBA wilderness.

Undeveloped - The GLBA wilderness would be impacted by the presence of six new RAWS installations and two data-loggers affixed to existing structures. Four of the wilderness equipment locations (excluding Lituya Bay, Beartrack, and Idaho Ridge) would be installed in areas that are currently undeveloped.

The climate stations would be placed primarily at undisturbed locations and would occupy a footprint of approximately 12' x 12' (144 sq. feet) depending on whether wildlife-resistant fencing becomes necessary. The HOBO thermistors would be attached to existing radio repeater towers and are 4" x 1.5" in size.

Every attempt will be made to drill anchor holes in rock by hand, but a motorized rock drill may be used if hand drilling is not feasible. It is unknown whether the motorized drill would be used, but if it were, it would impact the undeveloped quality of GLBA's wilderness.

Some minor vegetation clearing could be necessary to facilitate erecting and maintaining the tower structures, but no major site preparation would be necessary. Visual impact of the structures in areas otherwise devoid of the signs of human presence would be minimized to the extent possible but would nonetheless be long-term and would detract from the undeveloped wilderness character.

The amount of motor vessel traffic and possibly fixed-wing air traffic would increase due to the installation and maintenance of six new structures within GLBA wilderness. No additional air traffic would be permitted for maintenance of HOBO thermistors at the radio repeater sites. Exposed outer coast and higher-elevation sites (Lituya Bay, Queen Inlet, Nunatak Upper) may require

additional maintenance visits to repair damage from wind or winter conditions. Helicopter use would increase due to the installation and maintenance of the Brady Icefield station. It can be expected that this station will require additional helicopter flights to repair equipment damaged by high winds and severe conditions. These increases in motorized traffic would be long-term given the intent to maintain the stations for decades.

Natural - The natural conditions and biological diversity within GLBA wilderness would continue to be protected. Information collected by this project would help managers plan for and make decisions that would promote naturalness and allow natural changes to occur. Understanding impacts to the natural quality of wilderness depends upon correctly distinguishing natural from anthropogenic ecosystem changes and their causes.

Perhaps the single most fundamental and important driver of ecosystem change is weather/climate. With these observations, managers could begin to assign ultimate and proximate causal factors of changes that may threaten the natural quality of GLBA wilderness. Expansion of the network to include the outer coast and the Brady Icefield, a robust maintenance schedule, and quality-controlled data would provide a considerably more complete and accurate record than that generated by previous monitoring efforts. In particular, including a Brady Icefield site would provide a more robust network design leading to a stronger dataset that is more likely to achieve the project objectives. Data from a high-elevation icefield station is very important to supporting predictions of future climate change effects on land-terminating and tidewater glaciers (Arendt et al. 2009).

Lone Island is one of few locations in Glacier Bay considered important enough to wildlife that it is closed to foot traffic year round, and vessels are not allowed to approach closer than 100 yards. Ground-nesting seabirds and shorebirds breed on the island every year. Harbor seals and sea otters haul out on the shorelines. Humpback whales, harbor seals, Steller sea lions, sea otters, murrelets, pigeon guillemots, scoters, and harlequin ducks forage directly offshore.

Placing a RAWS on Lone Island would require motor vessel landings and foot traffic that could cause direct disturbance to birds and marine mammals during station installation and subsequent maintenance trips if those activities occurred during bird nesting season or while hauled-out marine mammals are present. Accessing the island without disturbing wildlife during these times could be difficult. Installation and maintenance of a climate monitoring station on Lone Island would also require consultation and permits from the National Marine Fisheries Service and the U. S. Fish and Wildlife Service.

The alternative RAWS site at Hugh Miller Island does not have the same level of wildlife use, is not closed to public entry, and would not require further interagency review or permitting.

Outstanding opportunities for solitude or primitive and unconfined recreation - Throughout the majority of GLBA wilderness, visitors would continue to experience opportunities for solitude or primitive and unconfined recreation. However, those opportunities could be impacted due to six new RAWS installations and increases in motorized vessel and aircraft traffic associated with installation and maintenance activities. Placement of monitoring stations in remote areas could impact visitor experience, especially if encountered by visitors on the ground.

The two potential Lower West Arm sites identified (Hugh Miller Island and Lone Island) are located in waters used by most vessels traveling the West Arm of Glacier Bay daily during the summer visitor

season; consequently, those stations could be sighted by wilderness visitors more frequently than stations at other locations. Lone Island is particularly visible to visitors aboard many of the vessels traveling up Glacier Bay each summer. The Hugh Miller Island site would be less visible to many park visitors. Vessels approaching the anchorage in Blue Mouse Cove could see the instrument tower, and kayakers paddling toward the camper pickup/drop-off sites at Sundew Cove and Blue Mouse Cove could pass close enough to notice the equipment. Potential mitigations at Lone Island, where minimizing visibility is anticipated to be a special challenge, include 1) substituting a monopole tower for the conventional tri-leg tower; 2) substituting an ultrasonic wind speed sensor for the conventional spinning-cup anemometer; and 3) substituting a small fuel cell located at the base of the tower for the usual solar panel/wind generator.

Although it is unlikely (due to the typically infrequent and short duration of station servicing), visitors could observe personnel and motorized vessels at or near the climate monitoring stations. Anthropogenic noise diminishes one's sense of solitude. In particular, the Brady Icefield region is relatively remote from the marine shoreline where the highest density of visitor use occurs, and it is known to be occasionally visited by mountaineers. It is believed that this visitor type may be especially sensitive to anthropogenic impacts to wilderness character. Noise from motorized vessels, fixed-wing aircraft, and helicopters, while usually of relatively short duration, could have impacts beyond the immediate vicinity of the climate stations because such noise can be heard over long distances.

The availability of the weather data itself could decrease the sense of self-reliance, adventure, and discovery of the wilderness. The knowledge that daily weather information is available, even if a person chooses not to view it, could diminish their sense of the area being unknown and unexplored. For some, the idea of a blank spot on the map has tremendous value; information collected by this project would add definition and consequently remove some of the mystery associated with those blank spots. In this sense, the project would diminish the positive sense of mystery, exploration, discovery, risk, and adventure associated with these wilderness areas.

Effects on Other Wilderness Feature of Value

Cultural Heritage - Lands included in the GLBA wilderness are important spiritually and culturally to many local people and communities; the presence of modern human developments like climate stations could detract from the sense of place some cultures associate with lands encompassed by GLBA. For some people who may never visit this area, the "existence value" of wilderness is very important, and just knowing that these facilities exist would detract from its value.

Scientific Value - Glacier Bay National Monument's establishment was based in part on providing "… a unique opportunity for the scientific study of glacial behavior and of resulting movements and developments of flora and fauna…" Data from these stations would enhance GLBA managers' understanding of climate, allowing them to establish reference conditions and evaluate appropriate ecosystem function. Observations from the Brady Icefield would serve as a direct measure of conditions at a large icefield that has a major influence on land-terminating and tidewater glaciers in GLBA (Arendt et al. 2009). This location is also a direct link between the three directional and elevational gradients deemed important to station network design by Davey, et al. (2007). In terms of monitoring the conditions that strongly affect the glaciers of GLBA, there is no surrogate for direct monitoring of climate on the Brady Icefield where many of the park's glaciers form. Without additional monitoring of climate at a centrally-located high-elevation icefield site where glaciers form, it would be difficult to accurately predict the effects of future climate change on the volumes

of glaciers within GLBA. It is believed that no other high-elevation location within GLBA can accomplish these purposes.

Alternatives considered but not formally analyzed

1. Preliminary SEAN Proposal (11 wilderness locations)

Between 1999 and 2011, weather instrument stations maintained by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Lab (CRREL) collected contemporary climate data (principally limited to temperature and precipitation) at 24 sites near sea level within GLBA wilderness (Figure 8). The initial SEAN proposal was to maintain all 24 CRREL stations as well as upgrade a subset of selected stations in that network to SEAN instrumentation standards. A field site evaluation involving climate experts from the National Weather Service Juneau office, a CRREL research physical scientist, the physical scientist and climate program manager serving the NPS Arctic Alaska and Central Alaska Inventory and Monitoring Networks, and the SEAN program coordinator, was conducted in September of 2008. Issues regarding existing CRREL sites, access to potential new sites, and a strategy to achieve the best possible representation of climate stations were discussed in detail. As SEAN and the GLBA continued to incorporate wilderness character concerns into the SEAN program site selection, the number of monitoring stations was reduced to include fewer "index stations" (among the network of 24 CRREL stations).

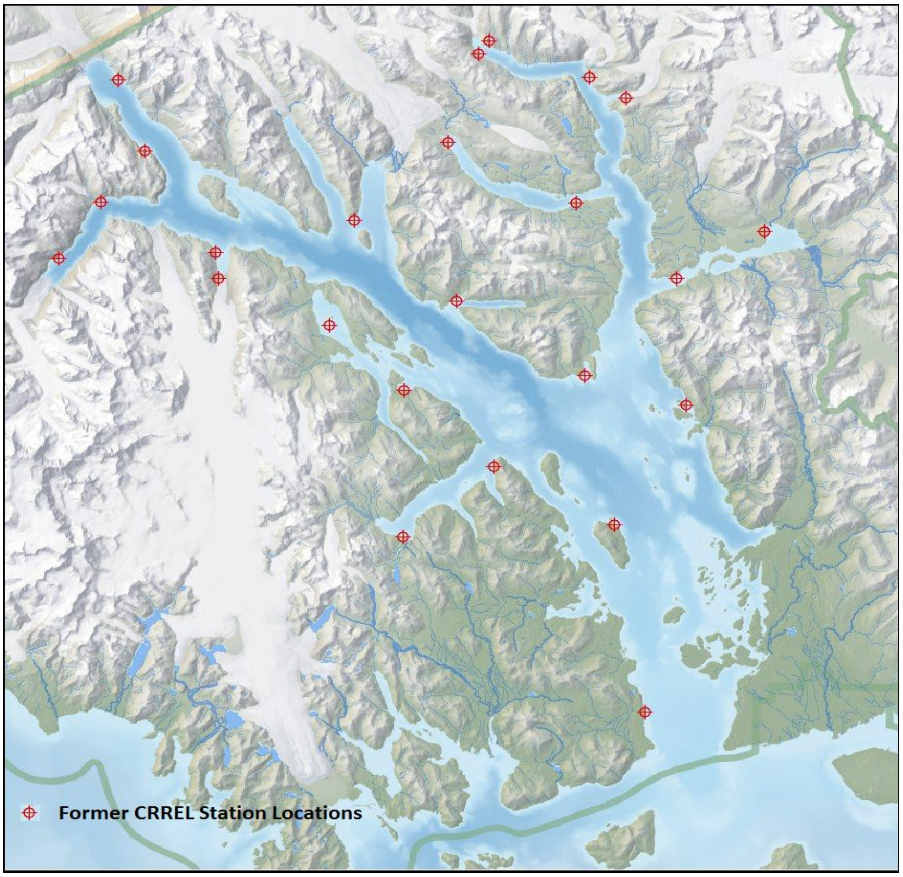

Figure 9 . Former CRREL Station locations.

Index stations: New fully-instrumented climate stations that would provide hourly information on basic meteorological parameters including air temperature, precipitation, wind speed and direction, relative humidity, solar radiation, and snow depth.

- Gloomy Knob (with alternates including Jaw Point or Tarr Inlet at 1000' elevation)
- North Muir Inlet
- Brady Icefield
- Lone Island
- Lituya Bay
- Dry Bay (not in wilderness)

Other stations: CRREL stations included "as-is" or with minor upgrades to complement the fully-instrumented index sites and with an emphasis on minimizing their visibility to park visitors.

- South Muir Inlet
- Tidal Inlet
- Queen Inlet
- Johns Hopkins Inlet
- Willoughby Island
- East Adams Inlet

Additional climate information could be obtained by adding temperature sensors to two existing NPS radio repeater sites and evaluating which CRREL sites would best contribute to achieving the SEAN climate monitoring objectives, with the potential for eliminating redundant sites.

Once it was determined that the CRREL stations did not deliver reliable or useful data, the station design considerations changed significantly enough to abandon this alternative in favor of fewer, more reliably instrumented and maintained installations.

2. Expand the climate monitoring program to nine new locations within GLBA (seven within wilderness, no station on Brady Icefield).

This alternative would involve establishing climate stations at the locations identified in Alternative 2, with the exception of Brady Icefield. Expansion of the network to the outer coast, a robust maintenance schedule, and quality-controlled data would provide a more complete record than previous monitoring efforts. Without an icefield location however, it would be difficult to accurately predict the effects of future climate change on the volume of glaciers. The majority of the tidewater glaciers in GLBA form at high elevation on the Brady Icefield. Given variation in local and regional climate, employing data from another site to assess or predict changes in glacial volume or mass within GLBA runs the risk of resulting in spurious conclusions.

For example, while other sites in proximity to quasi-permanent ice within GLBA such as Reid Inlet knob and locations on Grand Pacific Glacier were considered, they are at much lower elevation, likely below the zone of glacier formation and would, therefore, be of limited value in predicting changes in glacial volume loss or gain (see Arendt et al. 2009). Without additional monitoring of climate at a high-elevation site where icefields form, it would be difficult to accurately predict the

effects of future climate change on the volume of glaciers within GLBA. It is believed that no other high-elevation location within or outside of GLBA can accomplish these purposes.

Safety of Visitors, NPS Personnel, and Contractors

The use of fixed-wing aircraft, motorized vessels and helicopters all raise safety issues that are addressed under NPS safety policies. Safety will always be the highest priority in any alternative implemented.

Alternative 2 includes a climate station on either Lone Island or Hugh Miller Island, centrally located in the lower West Arm of Glacier Bay. Providing near-real time information on weather conditions in remote areas, as well as strengthening forecast models using network observations, would enhance the safety of aircraft and marine vessels transiting the area. Pilots and vessel operators would be able to make better-informed go/no go and routing decisions. Lone Island's full exposure to West Arm weather conditions makes it an exceptional low-elevation monitoring site.

Comparison of Alternatives

What is the effect of each component activity on the qualities of wilderness character?

Table 2. The comparison table is intended to help guide the selection of the alternative best representing the Minimum Activity. Note, however, that no attempt has been made to scale or weight the "rankings" (e.g., numbers of pluses and minuses) to reflect the relative importance of the various effects. In the table immediately below, a "+" (plus) indicates a net positive effect, and a "-" (minus) indicates a net negative effect.

IMPACTS TO WILDERNESS CHARACTER	Alternative 1 No action	Alternative 2 Expand to eight wilderness locations (six RAWS, 2 thermistors)
Untrammelled		
	No effect	No effect
Undeveloped		
Number of installations	No effect	8 -
Installation footprint	No effect	RAWS
Access method ***(note that these scores represent the impacts associated with only a single calendar year of access)***	No effect	Motor vessel, fixed-wing, foot, and helicopter (--)
Motorized equipment*	No effect	?
Vegetation clearing	No effect	-
Natural		
Increased understanding of natural quality	-	Expansion to outer coast and icefield (++)
Ecologically Sensitive Area	NA	-
Solitude or Primitive/Unconfined Recreation		
Waivers for wilderness waters	No effect	No effect
Visibility (Lone Island or Hugh Miller Island)	NA	-
Sense of discovery	No effect	-
Helicopter impacts	NA	-
Cultural Quality	No effect	-
Scientific Value	-	+++
NEGATIVE EFFECTS	2 -	16 -
POSITIVE EFFECTS	0	5 +

* A motorized rock drill may be used if hand drilling is not feasible. Should a motorized drill be used, it would have a negative impact on the undeveloped quality of GLBA's wilderness.

Cumulative Impacts

The table below describes existing structures/installations within GLBA wilderness that have impacts to wilderness character similar to those in Alternative 2. The lower three installations in the table are shaded to distinguish them (managed by the U.S. Coast Guard [USCG]) from the other installations that are managed by the NPS.

	Number of Installations	Number of locations	Purpose	Duration	Access	Maintenance interval	Authorization and management
Alsek River stage gage	1	1	Measures water level/flow	Move to non-wilderness location scheduled for 2014	Fixed-wing floatplane and/or boat	Annual	NPS Research Permit/MRA; USGS
Russell Island weather station (defunct)	1	1	Weather station	Defunct (slated for removal in 2015)	Motor vessel	None	Unknown/NPS
Blue Mouse Island cement pad	1	1	Air quality time-lapse camera platform	Defunct (slated for removal in 2015)	Motor vessel	None	NPS Research Permit
Continuous GPS stations	2 Queen Inlet and Hugh Miller Island	2	Crustal uplift (isostatic rebound) measurements	Permanent	Motor vessel	Annual	NPS Research Permit/MRA; NPS
DIDSON sonar	1	1	Anadromous fish enumeration	Installed in 2011; scheduled for removal in 2014	Foot and/or non-motorized vessel	Frequent during sockeye salmon run	Environmental Assessment/ MRA/NPS Research Permit; NPS
NPS radio repeaters	2	2	Supports internal park communication/ operations	Permanent	Helicopter	Annual	Unknown/NPS
Lituya Bay range markers	2 installations located within 100m proximity of one another	1	USCG aids to navigation	Permanent	Helicopter	Once every two years	ANILCA 1310a; USCG
Libby Island Light	1	1	USCG aid to navigation	Permanent	Helicopter	Once every two years	ANILCA 1310a; USCG
Cape Spencer structures and installations*	Cluster of multiple (7) installations	1	USCG aids to navigation, weather, communication, uplift (isostatic rebound), and aviation information	Permanent	Helicopter and motor vessel	Once every 3 months (4 times/year) (managed by USCG)	ANILCA 1310a and b; USCG
TOTALS	18	11					

*Cape Spencer Lighthouse (automated) remains operational and is an important aid to navigation for mariners. It is administered by the USCG and was placed on the National Register of Historic Places (75002160) in 1975. Although the site (nearshore rock island) is owned by the NPS and is designated wilderness, the NPS does not actively manage the larger facilities. The site's research installations are managed by the NPS under the NPS permit system.

The table below estimates the amount of cumulative change (installations and helicopter landings) that each alternative would contribute to current conditions of wilderness in GLBA.

Change in number of similar installations and number of discrete installation locations (some would be co-located) in wilderness for each alternative.					Change in annual number of routine annual helicopter landings in wilderness for park operations and research (excluding those at the Cape Spencer Lighthouse, and the USCG Libby Island and Lituya Bay aids to navigation which are not managed by the NPS).		
	Total # installations	% increase	# discrete locations	% increase		Total # landings	% increase
Alternative 1	18	0%	11	0%	**Alternative 1**	2	0%
Alternative 2	26	47%	16	50%	**Alternative 2**	4	100%

Mitigation Requirements

The SEAN's major work plan priority for 2014 is to complete a Weather and Climate long-term monitoring protocol for GLBA and Klondike Gold Rush National Historical Park. The document will include detailed field installation and maintenance plans, data management routines, future cost projections, and schedules for data analysis and reporting. This detailed operations plan will be approved by the park prior to station installation. Schedules for revisiting the program's sampling design, such as discontinuing a given station, will be included as standard operating procedures for analysis and reporting.

The SEAN will periodically conduct formal reviews of the effectiveness of its long-term climate monitoring program, as incoming data indicate is necessary. The first of these reviews is likely to occur three to seven years following initial station deployment. Reviews can confirm the efficacy of the current network, identify information gaps that could recommend additional stations, or identify redundant/incomplete data that could recommend removal of station(s). Primary reasons to consider removal of a station will include cost of maintenance or, given a sufficiently long time series to enable robust analyses, strong correlation with another station either inside or outside the park. Additionally, if an installation or access to it is causing unacceptable impacts to park resources, it will be removed. This will be determined by coordination with other research and monitoring programs in the region and with GLBA staff. When less wilderness-intrusive technological methods (e.g., wireless instruments, portable instruments, remote sensing) that can duplicate or improve upon existing data collection methods and results become available, they will replace the existing instrumentation. GLBA has a successful history of removing outdated or underutilized equipment and facilities from wilderness and park management will monitor and ensure that this review takes place.

Adverse impacts to the wilderness resource would be mitigated by minimizing the number and duration of field activities, minimizing ground disturbance to the smallest practicable footprint, and installing each climate station in such a manner as to minimize the impact on social elements of wilderness character.

When stations are installed and maintained, every attempt will be made to use only non-motorized hand tools. Some sites may require the use of anchor bolts in rock, in which case bolt holes would be drilled by hand. Should hand drilling prove to be unreasonably ineffective as jointly determined by SEAN and GLBA staff, other installation options (including motorized rock drills) may be used to ensure effective installation of the stations. In order to ensure that a station can be fully deployed and tested in a single day, thereby avoiding additional wilderness impacts associated with a multi-day

effort, individual anchor bolt holes will need to be successfully drilled in 60 minutes. It is expected that most and perhaps all holes can be hand-drilled in this timeframe under average conditions. If hand-drilling requires more than 60 minutes, motorized rock drills will be employed.

Stations would be painted to maximally blend in with their natural surroundings, though a single color scheme must suffice all year. The usual choice includes mottled greenish and/or tan colors of vegetative/ground surface camouflage with overlapping patterns of color and contrast to break up visual shape patterns (thermometer housings must remain as white as possible for accurate air temperature measurements).

Project managers would consult with park staff to determine the most appropriate timing for maintenance trips based on local knowledge of visitor and wildlife activities.

Step 2 Decision: What is the Minimum Activity?

Selected alternative: Alternative 2: Expand the climate monitoring program to ten locations within GLBA (eight within wilderness).

Rationale for selecting this alternative (including documentation of safety criterion, if appropriate):

Twenty-four climate monitoring stations existed within park wilderness at the start of planning for this project. After numerous discussions, refinements, and iterations that included guidance from park management, the existing 24 sites were removed, and the SEAN proposed placement of climate stations in ten index locations within GLBA (eight within wilderness). The proposal of ten new stations represents the culmination of a multi-year process optimizing monitoring program feasibility and minimizing impact to natural, cultural, and wilderness resources while still achieving the technical objectives of the SEAN climate monitoring program. GLBA and SEAN staff conducted site evaluations and analysis of potential sites based on siting criteria, wilderness mitigation efforts, and management concerns.

The Minimum Activity (Alternative 2) would contribute eight additional installations in GLBA wilderness, increasing the number of similar installations from 18 to 26. The number of discrete installation locations would increase from 11 to 16. Within Glacier Bay proper a total of approximately five motor vessel visits to discrete climate station sites would be added annually (none in designated wilderness waters, one in eligible wilderness waters), although every attempt would be made to logistically combine maintenance trips to multiple stations whenever possible, and/or with trips for other park management purposes. The number of routine annual helicopter landings in wilderness for NPS administrative purposes (only) would double, from two to four. There would be an increase of one additional fixed-wing floatplane landing annually (in non-wilderness waters) in Lituya Bay.

This Minimum Requirements Analysis contends with three activities that are prohibited in wilderness unless deemed the minimum necessary to manage the area for the purposes of the Wilderness Act: installations, helicopter landings, and motorized equipment . The justification and mitigations for allowing each of the prohibited activities are detailed below.

Installations

Weather observations and long-term monitoring are important to understanding how climate variability and change relates to the complex dynamics within Southeast Alaska ecosystems. There are no direct actions the park can take to eliminate anthropogenic climate change, but long-term monitoring can contribute to knowledge of the impacts of climate change on park resources. Maintaining climate stations in key locations throughout GLBA is the recommended way to collect this data over the long term and across diverse ecosystems and topography. The benefits of understanding more about the natural quality of Glacier Bay's wilderness and of fulfilling some of its scientific purpose outweigh the impacts associated with the presence of long-term structures in designated wilderness. Indeed, we believe that the presence of a well-designed and maintained network of climate stations would help preserve the wilderness character of GLBA over the long term. The network described in Alternative 2 represents the minimum in terms of number of stations and station locations that would achieve the project objectives while minimizing impacts.

The net benefits of a robust network of installations are further enhanced by additional mitigations intended to diminish potential impacts. Both potential sites for the Lower West Arm Low-elevation station (Lone Island and Hugh Miller Island) would be visible to many park visitors travelling the West Arm of Glacier Bay. While Lone Island offers an ideal location for weather and climate monitoring, a station located there would be highly visible to park visitors (reducing opportunities for solitude and primitive and unconfined recreation) and is an ecologically sensitive area with high wildlife use. The alternate location at Hugh Miller Island would provide similar climate and weather data but mitigates visibility and wildlife disturbance concerns.

Importantly, the network described in Alternative 2 includes a station on the Brady Icefield. As described above, an effective climate station network for GLBA depends on the ability to assess weather and climate across a west-to-east coastal-to-interior gradient, a north-to-south fjord head-to-lower bay gradient, and an elevational gradient (Davey et al. 2007). Moreover, data from high-elevation climate stations near icefields are very important to support predictions of future climate change effects on ecosystems, including effects on land-terminating and tidewater glaciers (Arendt et al. 2009). Observations from the Brady Icefield would serve as a direct measure of conditions at a large icefield that has a major influence on land-terminating and tidewater glaciers in GLBA (Arendt et al. 2009). The majority of the tidewater glaciers in GLBA form at high elevation on the Brady Icefield. This location is a direct link between the three directional and elevational gradients deemed important to station network design by Davey et al. (2007). Without climate monitoring at a high-elevation icefield site where glaciers form, it would be difficult to accurately predict the effects of future climate change on the volumes of glaciers within GLBA. It is believed that no other high-elevation location within GLBA can accomplish these purposes.

Aircraft Landings

As described above, the selected Minimum Activity (Alternative 2) includes a station on the Brady Icefield. This alternative also provides for helicopter access for station installation and maintenance. It is estimated that the station would be accessed once or twice annually (as necessary) via fixed-wing ski-plane or helicopter for the duration of the project, which is currently projected to last in perpetuity or until improvements in technology allow for station reduction or removal. The Wilderness Act is very specific that landing of aircraft in wilderness is prohibited unless allowed by law, to satisfy an existing private right, or is the minimum necessary to administer and protect the wilderness.

However, the impacts on wilderness character of the limited helicopter use described in Alternative 2 are the minimum necessary to successfully install and maintain a Brady Icefield station. A Brady Icefield station is essential to fully achieving the project objectives, and a successful project is necessary for effectively administering and protecting the wilderness.

Alternative access methods would fail to achieve the project objective of reliably and consistently maintaining a Brady Icefield station. Due to safety concerns, logistical issues, and long-term sustainability of the monitoring program, mountaineering trips by foot are not a feasible and reliable option for accessing a Brady Icefield location. This is due to the heavy weight and bulkiness of maintenance gear (extra sensors, deep-cycle batteries, tools, etc.), necessary technical expedition expertise and required mountaineering equipment, weather dependence, and the multi-day/person time commitment required for such trips. It is believed that these would be severe impediments to adequately and safely maintaining that station in a long-term, sustainable manner that ensures high-quality and continuous data collection required to fully achieve the monitoring objectives. The principal issues are reliability, a continuous data stream, and practical sustainability of the program over the long term (presuming perpetuity).

Local air charter companies with the ability to offer fixed-wing access to the Brady Icefield (such as Mountain Flying Service in Haines) have stated that February-May are the months they are willing and able to safely attempt icefield landings. After May (subsequent to exposure by melting snow), crevasses and other ice features create unacceptable landing hazards. Based on maintenance experience of the Chilkoot Pass station in Klondike Gold Rush National Historical Park, it has been determined that the pre-June time period is much too early to reliably service a high-elevation climate station; typically the Chilkoot Pass station is not ice-free and devoid of snow and ready to access until late June or July. Operational uncertainties surrounded fixed-wing ski access to the Brady Icefield would be severe impediments to reliably and safely maintaining that station in a manner that achieves the monitoring objectives over the long term. Consequently, limited helicopter access (to the minimum extent necessary to successfully install and maintain a Brady Icefield climate station) is an essential element of the Minimum Activity (Alternative 2). Nevertheless, every attempt will be made to find a location for the Brady Icefield station that could potentially be accessed by fixed-wing ski-plane in the spring. Scouting trips would be made to attempt to find a location to mount the instrumentation that would be snow-free during the spring period when fixed-wing plane access might be more feasible. For sustained maintenance, every attempt would be made to first use a fixed-wing plane for accessing the station before considering the use of a helicopter. Each year the Superintendent would make an annual decision about which access method would be authorized for the Brady Icefield station.

The data-loggers installed at the two radio repeater locations would be maintained via helicopter, but only when the communication towers are being maintained. No additional helicopter access would be authorized.

Motorized Equipment

Some sites could require the use of anchor bolts in rock to reliably support the climate tower. For all the stations located in wilderness, bolt holes would be drilled by hand. Should hand drilling prove to be unreasonably difficult as jointly determined by SEAN and GLBA staff, other installation options (including motorized rock drills) may be used to assure successful installation of the stations. In order to ensure that a station can be fully deployed and tested in a single day, thereby avoiding additional wilderness impacts associated with a multi-day effort, individual anchor bolt holes will

need to be successfully drilled in 60 minutes. It is expected that most and perhaps all holes can be hand-drilled in this timeframe under average conditions. If hand-drilling requires more than 60 minutes, motorized rock drills will be employed.

Recommendation

This recommendation comes down to balancing impacts and benefits to very important qualities of Glacier Bay's wilderness character and one of its very important and relatively unique values; we must balance its superlative undeveloped quality and opportunities for solitude while attempting to understand more about the natural quality of wilderness character and fulfilling the park's scientific purpose.

It is acknowledged that the current suite of proposed sites in the SEAN proposal represents the culmination of a multi-year process optimizing monitoring program effectiveness and feasibility while minimizing impacts to wilderness character. It is also acknowledged that removing select stations from the SEAN proposal significantly compromises the value of the data collected within GLBA in terms of the overall project objective. The recommended minimum activity for monitoring weather and climate in GLBA is Alternative 2: Expand the climate monitoring program in ten new locations within GLBA (eight within wilderness) (Alternative B in the Environmental Assessment).

Check any Wilderness Act Section 4(c) uses approved in this alternative:

- ☐ mechanical transport
- ☒ motorized equipment
- ☐ motor vehicles
- ☐ motorboats
- ☒ landing of aircraft
- ☐ temporary road
- ☒ structure or installation

Record and report any authorizations of Wilderness Act Section 4(c) uses according to agency procedures.

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Appendix B

ANILCA Section 810(a) Subsistence Summary Evaluation and Findings

I. Introduction

This section was prepared to comply with Title VIII, §810 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. It summarizes the evaluation of potential restrictions to subsistence activities that could result from expansion of the climate and weather monitoring program in Glacier Bay National Park and Preserve (park).

II. The Evaluation Process

Section 810(a) of ANILCA states:

"In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands . . . the head of the federal agency . . . over such lands . . . shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands which would significantly restrict subsistence uses shall be affected until the head of such Federal agency:
(1) gives notice to the appropriate State agency and the appropriate local committees and regional councils established pursuant to §805;
(2) gives notice of, and holds, a hearing in the vicinity of the area involved; and
(3) determines that (A) such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands, (B) the proposed activity would involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition, and (C) reasonable steps would be taken to minimize adverse impacts upon subsistence uses and resources resulting from such actions."

Presidential proclamations in 1925 and 1939 established and expanded Glacier Bay National Monument. In 1980, Title II of ANILCA created new units and additions to existing units of the National Park System in Alaska. More specifically, Section 202 of ANILCA expanded Glacier Bay National Monument by the addition of an area containing approximately 523,000 acres. ANILCA re-designated the monument was as Glacier Bay National Park. Along the south bank of the Alsek River at Dry Bay, Alaska, approximately 57,000 acres was designated as Glacier Bay National Preserve.

ANILCA Section 202(1), created the park for the following purposes:

"To protect a segment of the Alsek River, fish and wildlife habitats and migration routes and a portion of the Fairweather Range including the northwest slope of Mount Fairweather. Lands,

waters, and interests therein within the boundary of the park and preserve which were within the boundary of any national forest are hereby excluded from such national forest and the boundary of such national forest is hereby revised accordingly."

Federal law and regulations prohibit ANILCA Title VIII subsistence uses on federal public lands in Glacier Bay National Park only. However, ANILCA (Sections 1313) and Title 36 Code of Federal Regulations (CFR) (Section 13.41) authorize subsistence uses on federal lands in Glacier Bay National Preserve.

ANILCA 816 (a) states:

"All national parks and park monuments in Alaska shall be closed to the taking of wildlife except for subsistence uses to the extent specifically permitted by this Act. Subsistence uses and sport fishing shall be authorized in such areas by the Secretary and carried out in accordance with the requirements of this title and other applicable laws of the United States and the State of Alaska."

With regards to Glacier Bay National Preserve, Section 1313 of ANILCA states:

"A National Preserve in Alaska shall be administered and managed as a unit of the National Park System in the same manner as a national park except as otherwise provided in this Act and except that the taking of fish and wildlife for sport purposes and subsistence uses, and trapping shall be allowed in a national preserve under applicable State and Federal law and regulation. Consistent with the provisions of Section 816, within national preserves the Secretary may designate zones where and periods when no hunting, fishing, trapping, or entry may be permitted for reasons of public safety, administration, floral and faunal protection, or public use and enjoyment. Except in emergencies, any regulations prescribing such restrictions relating to hunting, fishing, or trapping shall be put into effect only after consultation with the appropriate State agency having responsibility over hunting, fishing, and trapping activities."

ANILCA Sections 1314 (c) states:

"The taking of fish and wildlife in all conservation system units; and in national conservation areas, national recreation areas, and national forests, shall be carried out in accordance with the provisions of this Act and other applicable State and Federal law. Those areas designated as national parks or national park system monuments in the State shall be closed to the taking of fish and wildlife, except that:
(1) notwithstanding any other provision of this Act, the Secretary shall administer those units of the National Park System and those additions to existing units, established by this Act and which permit subsistence uses, to provide an opportunity for the continuance of such uses by local rural residents; and
(2) fishing shall be permitted by the Secretary in accordance with the provisions of this Act and other applicable State and Federal law."

The potential for significant restriction must be evaluated for the proposed action's effect upon:

". . . subsistence uses and needs, the availability of other lands for the purposes sought to be achieved and other alternatives which would reduce or eliminate the use. . . ." (ANILCA §810(a))

III. Proposed Action on Federal Lands

Alternatives A and B are described in detail in the environmental assessment (EA). Customary and traditional subsistence use on National Park Service (NPS) lands would continue as authorized by federal law under all alternatives. The NPS proposes to install up to eight Remote Automated Weather Stations (RAWS) and two data logging thermistor instruments within the park and preserve as part of the NPS Southeast Alaska Inventory and Monitoring Network Vital Signs plan. Two of the proposed stations would be located within the National Preserve.

IV. Affected Environment

Subsistence uses, as defined by ANILCA Section 803, means:

"The customary and traditional use by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade."

Subsistence activities include hunting, fishing, trapping, and collecting berries, edible plants, and wood or other materials. Other important subsistence use areas within the region include Icy Strait, Excursion Inlet, Cross Sound, Port Frederick, and Tongass National Forest. Most of the rural communities of southeastern Alaska rely on renewable natural resources for at least a portion of their subsistence needs. About one-third of the rural communities of the region take at least half of their meat and fish by hunting and fishing (ADF&G 2002).

Residents of such communities as Gustavus (population of 460), Hoonah (753), Elfin Cove (18), Pelican (83), Excursion Inlet (14), Sitka (8,985) and Yakutat (656) engage in subsistence uses near the boundaries of Glacier Bay National Park (ADCCED 2012). Community subsistence resource activities include hunting, fishing, and gathering gull eggs, shellfish, firewood, wild plants, and berries. Historical resource utilization patterns, such as gull egg gathering, fish camps or communal marine mammal and deer hunts, are linked to traditional social and subsistence use patterns. Sharing of resource occurs between communities, as well as within communities throughout the region.

ANILCA and NPS regulations authorize subsistence use of resources in all Alaska national parks, monuments and preserves with the exception of Glacier Bay National Park, Katmai National Park, Kenai Fjords National Park, Klondike Gold Rush National Historical Park, the pre-1980 Mount McKinley National Park, and Sitka National Historical Park. ANILCA provides a preference for local rural residents over other consumptive users should a shortage of

subsistence resources occur and allocation of harvest becomes necessary. The main subsistence species, by edible weight, are salmon, deer, non-salmon fish, marine invertebrates, bears (black and brown) and seals. Local people use a variety of salmon (chum, coho, pink, and sockeye), while halibut, herring, smelt, cod, greenling, lingcod, char, and Dolly Varden are also used for subsistence purposes (ADF&G 2012).

ANILCA and NPS regulations authorize subsistence use of resources in Glacier Bay National Preserve and prohibit subsistence uses in Glacier Bay National Park (Codified in 36 CFR, part 13). Current U.S. Fish and Wildlife Service regulations allow residents of Hoonah and Yakutat to gather glaucous-winged gull eggs on National Forest lands in Icy Strait and Cross Sound, including Middle Pass Rock near the Inian Islands, Table Rock in Cross Sound, and other traditional locations on Yakobi Island between May 15 and June 30. The land and waters of Glacier Bay National Park remain closed to all subsistence harvesting. The NPS recognizes that patterns of subsistence use vary from time to time and from place to place depending on the availability of wildlife and other renewable natural resources. A subsistence harvest in a given year many vary considerably from previous years because of such factors as weather, migration patterns, and natural population cycles. However, the pattern is assumed to be generally applicable to harvests in recent years with variations of reasonable magnitude.

V. Subsistence Uses and Needs Evaluation

To determine the potential impact on existing subsistence activities, three evaluation criteria were analyzed relative to existing subsistence resources that could be impacted.

The evaluation criteria are: the potential to reduce important subsistence fish and wildlife populations by (a) reductions in numbers; (b) redistribution of subsistence resources; or (c) habitat losses; the affect the action might have on subsistence fishing or hunting access; and the potential to increase fishing or hunting competition for subsistence resources.

The Potential to Reduce Populations: Installation of climate monitoring stations would have a long-term but small impact on wildlife habitat and populations. The alternatives considered would not adversely affect the distribution or migration patterns of subsistence resources. Therefore, no change in the availability of subsistence resources is anticipated as a result of the implementation of this proposed action.

Restriction of Access: The proposed action would not restrict current Title VIII subsistence use patterns on federal public lands within the region. Glacier Bay National Park is closed to ANILCA Title VIII subsistence uses.

Increase in Competition: Continued implementation of provisions of ANILCA should mitigate increased competition, however significant, from resource users other than subsistence users. Therefore, the proposed action would not significantly restrict or increase competition for ANILCA Title VIII subsistence resources on federal public lands within the region.

VI. Availability of Other Lands

Choosing a different alternative would not decrease the impacts to park resources for subsistence. The preferred alternative is consistent with the mandates of ANILCA, including Title VIII, and the NPS Organic Act.

VII. Alternatives Considered

The EA and this evaluation have described and analyzed the proposed alternatives. The proposed actions are consistent with NPS mandates, ANILCA, and the GMP for the park and preserve. No other alternatives that would reduce or eliminate the use of public lands needed for subsistence purposes were identified.

VIII. Findings

This analysis concludes that the preferred alternative would not result in a significant restriction of subsistence uses.

REFERENCES:

Alaska Department of Commerce, Community and Economic Development (ADCCED). 2012.

Alaska Community Database Community Information Summaries (CIS). Accessed April 2012 at http://www.commerce.state.ak.us/dca/commdb/CF_CIS.htm.

Alaska Department of Fish and Game (ADF&G). 2012. Community Subsistence Information System – All Years. Accessed April 2012 at www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.resourceRegionData.

APPENDIX C

Potential Climate Station Site Evaluations

Glacier Bay National Park and Preserve
Climate/Weather Monitoring Installation Site Evaluations

Protocol:
Set GPS coordinates, set survey pole in likely location at correct height (same height as proposed CSI stations with GOES Links), take pictures from land and water (25m, 50m, 100m, 150m).

Equipment Needs:
2 Cameras (5-10 photos of each site from land and boat), Survey Pole for visibility testing, measure tape, gps.

Date: 10/27/2010 Evaluators: Barb Bruno, Brendan Moynihan, Justin Smith

1.Site Name: Queen 2
2.Coordinates: N 58. 91730 W136.58440
3.Elevation/Aspect: ~1000 feet
4.South Exposure (solar): excellent
5.Southeast Exposure (GOES): excellent
6.Description: 1000’ knob on SE shoulder of ridge between Queen and Rendu
7.Access: steep hike up south ridge
8.Use patterns (camping, hiking, kayaking, etc.): drive by
9.Visibility: If sited close to edge the installation would be skylined and visible from water. Siting tower further back from the edge would mitigate some of these visibility issues. Solar panel would have to be sited close to the ground.
10.Flat and anchorable ground: adequate
11.Pad size (minimum 11-20 feet): adequate if brush is cut back
12.Vegetation and soil type: kinik kinik, soapberry, willow, some alder BRUSHY site
13.Known precipitation and temperature trends (CRREL data): Na
14.Reliability of Existing Equipment (from CRREL): na

15.Notes (incl. gaps in knowledge, Wilderness concerns, Wilderness waters, wildlife patterns and potential for damage, wind scour, etc):
Existing brush will have to be cut now and ongoingly to site tower away from edge to reduce visibility concerns. Tower can be painted. Solar panels should be kept very low to reduce visibility concerns.
Good site.

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Glacier Bay National Park and Preserve
Climate/Weather Monitoring Installation Site Evaluations

Protocol:
Set GPS coordinates, set survey pole in likely location at correct height (same height as proposed CSI stations with GOES Links), take pictures from land and water (25m, 50m, 100m, 150m).

Equipment Needs:
2 Cameras (5-10 photos of each site from land and boat), Survey Pole for visibility testing, measure tape, gps.

Date: 10/27/2010 Evaluators: Barb Bruno, Justin Smith, Brendan Moynihan

1.Site Name: Nunatak 4
2.Coordinates: N 58.97810 W136.10039
3.Elevation/Aspect: S/SW sea level
4.South Exposure (solar): excellent
5.Southeast Exposure (GOES): excellent
6.Description: old creek bed in Nunatak Cove
7.Access: short hike on north side of Nunatak Cove
8.Use patterns (camping, hiking, kayaking, etc.): Nunatak Cove is a popular camping spot, it is unlikely that people will camp at this location due to shallow waters and long haul for kayaks at low tide.
9.Visibility: slightly visible from Nunatak Cove at high tide
10.Flat and anchorable ground: plenty
11.Pad size (minimum 11-20 feet): plenty
12.Vegetation and soil type: grasses, willow, some small alder
13.Known precipitation and temperature trends (CRREL data): Na
14.Reliability of Existing Equipment (from CRREL): na

15.Notes (incl. gaps in knowledge, Wilderness concerns, Wilderness waters, wildlife patterns and potential for damage, wind scour, etc):
Good low elevation site. Some visibility issues from Nunatak Cove.

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Glacier Bay National Park and Preserve
Climate/Weather Monitoring Installation Site Evaluations

Protocol:
Set GPS coordinates, set survey pole in likely location at correct height (same height as proposed CSI stations with GOES Links), take pictures from land and water (25m, 50m, 100m, 150m).

Equipment Needs:
2 Cameras (5-10 photos of each site from land and boat), Survey Pole for visibility testing, measure tape, gps.

Date: 10/26/2010 Evaluators: Barb Bruno, Brendan Moynihan, Justin Smith

1.Site Name: Nunatak 3
2.Coordinates: N 58.98368 W136.10039
3.Elevation/Aspect: ~1000 feet
4.South Exposure (solar): excellent
5.Southeast Exposure (GOES): excellent
6.Description: bedrock outcropping on south shoulder of Nunatak
7.Access: steep brushy hike up south shoulder
8.Use patterns (camping, hiking, kayaking, etc.): Nunatak Cove is used for camping. This site would not be visible except to the rare Nunatak hiker
9.Visibility: potentially less skylining than Nunatak 2
10.Flat and anchorable ground: adequate
11.Pad size (minimum 11-20 feet): adequate
12.Vegetation and soil type: alder, vegetation manipulation will be required.
13.Known precipitation and temperature trends (CRREL data): Na
14.Reliability of Existing Equipment (from CRREL): na

15.Notes (incl. gaps in knowledge, Wilderness concerns, Wilderness waters, wildlife patterns and potential for damage, wind scour, etc):
Good site preferred by SEAN. Larger bedrock area than Nunatak 2 so it can be placed away from the edge to avoid skylining. Less vegetation manipulation than Nunatak 2.

Good site.

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Climate Station Site Evaluation Checklist

Date/Time: 04 September 2013

Area/Transect: Blue Mouse Cove, Option 3

Site Location/Description: South tip of peninsula south of Blue Mouse Cove

Latitude: N58.76168° Datum:

Longitude: W-136.43895°

Elevation: Approximately 20 ft

Flat and anchorable ground? Yes. Small knob provides suitable site

Pad size? (min 11' x 20') Yes

Clearing size? (distance to trees/cliffs) Approximately 15 ft by 15 ft

South exposure (solar)? Partial, SE orientation

South-east exposure (GOES)? Yes

Soil type:

Vegetation type: Mostly moss/lichen with shrubs surrounding knob

Recommended instrumentation:

Access: Easy beaching with boat; there would be some difficulty carrying gear to top of knob; batteries may need to be installed below knob.

Photos: Labeled *Blue Mouse Cove Option 3 (1) - Blue Mouse Cove Option 3 (7)*

Notes:

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Glacier Bay National Park and Preserve
Climate/Weather Monitoring Installation Site Evaluations

Protocol:
Set GPS coordinates, set survey pole in likely location at correct height (same height as proposed CSI stations with GOES Links), take pictures from land and water (25m, 50m, 100m, 150m).

Equipment Needs:
2 Cameras (5-10 photos of each site from land and boat), Survey Pole for visibility testing, measure tape, gps.

Date: 10/21/2010 Evaluators: Barb Bruno, Craig Murdoch, Todd Bruno

1.Site Name: Lone Island 2
2.Coordinates: N 58.72192 W136.29498
3.Elevation/Aspect: ~50feet
4.South Exposure (solar): good – some brush screening
5.Southeast Exposure (GOES): good- some brush screening
6.Description: site is approximately 40' south of Lone Island 1, behind elderberry bush and surrounded by salmonberry.
7.Access: south side through brush, north side up grassy swale. Waiver required for access year round.
8.Use patterns (camping, hiking, kayaking, etc.): Every boat accessing West Arm drives by this island.
9.Visibility: Behind elderberry bush so as to be screened by brush to south and higher knoll to north. Still visible but less so than Lone Island 1.
10.Flat and anchorable ground: not flat, may require concrete pad
11.Pad size (minimum 11-20 feet): brush will need to be cut to clear area for tower installation
12.Vegetation and soil type: large brush is elderberry, salmonberry
13.Known precipitation and temperature trends (CRREL data): Na
14.Reliability of Existing Equipment (from CRREL): na

15.Notes (incl. gaps in knowledge, Wilderness concerns, Wilderness waters, wildlife patterns and potential for damage, wind scour, etc):
This site is representative of using the existing brush on Lone Island to screen the proposed structure. Photo taken demonstrates height of brush compared to survey pole. Site elevation is approximately 2-4 feet higher at base than that brush.
Small animal trails?, nests etc. abound.
Wind data could be compromised at this site.
Still very visible from southwest.
Gull nesting and egg collection.
Bird concerns? Would they roost on the tower? Would guy wires be a problem.
Path forming to tower?
Access only during certain weather conditions.

Lots of birds during site visit and sea lions.

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