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ENVIRONMENTAL ASSESSMENT

McCarthy Creek Subsistence House Log Permit

United States Department of the Interior
National Park Service
Wrangell-St. Elias National Park and Preserve
December 2005

TABLE OF CONTENTS

Maps

Figures

Tables

1.0 PURPOSE AND NEED FOR ACTION

1.1 Purpose of Action

The National Park Service (NPS) is considering a request for subsistence house logs from a land owner in the upper McCarthy Creek area of Wrangell-St. Elias National Park and Preserve (WRST). In August 2005 the applicants' requested to harvest dead standing timber (120 logs) to construct a small private residence (about 280 square feet) on their private lands. The applicants' would harvest timber on National Preserve lands in the upper McCarthy valley during the winter season. Snowmachines would be used to transport logs to a tracked vehicle which would haul house logs harvested from upper McCarthy Creek valley to their private lands. With adequate snow conditions and during periods when the creek is frozen over or has ice build-up, up to 15 logs at a time would be transported on a sled behind the tracked vehicle. An estimated minimum of 8 round trips between the harvest area and the private lands would be necessary to transport 120 harvested logs to the applicants' private lands. The NPS is considering a special use permit to authorize this harvest. Map 1 shows the project area within WRST.

This environmental assessment (EA) has been prepared to evaluate potential impacts of the applicant's proposed and no action alternatives and mitigating measures to minimize adverse impacts to the park. The EA and the public comment will form the basis for a decision regarding issuance of a subsistence house log permit.

1.2 Need for Action

In 1980 the Alaska National Interest Lands Conservation Act (ANILCA) established WRST. The McCarthy Creek area and applicants' private lands are in the preserve portion of WRST. The preamble to Title 36 Code of Federal Regulations (CFR) Part 13 dated June 17, 1981, states the following in regard to subsistence use of timber and plant materials:

> *Section 13.49(a) relaxes the general public use regulations by allowing local rural residents in park areas where subsistence uses are allowed to obtain a permit to cut standing live timber of greater than three inches diameter at ground height for subsistence needs such as shelter or fuel. The Superintendent may permit cutting in accordance with the specifications of a permit if such cutting is determined to be compatible with the purposes for which the park area was established. Before issuing a permit, the Superintendent must determine that the proposed cutting is compatible with the purposes for which the park was established. Furthermore, the Superintendent will include in the permit any stipulations deemed necessary to project the resources of the park area…"*

The WRST Subsistence Log Policy (Appendix A) covers the non-commercial subsistence harvest of house logs that are greater than 3 inches diameter at ground height in accordance with ANILCA and Title 36 CFR 13.49. The policy provides for an allowable harvest not to exceed 120 trees (includes live and dead trees) for house logs. A spruce bark beetle infestation has killed a significant portion of the live spruce trees in McCarthy Creek Valley. Of primary concern to the NPS is the maintenance and protection of forest resources and other park values. Applicants for subsistence house log permits must meet the standard permit procedures and conditions provided in the policy.

1.3 Background

1.3.1 NPS Organic Act, Act Amendments, and NPS Management Policy

The 1916 Organic Act directed the Secretary of the Interior and the NPS to manage national parks and monuments to:

"…conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." (16 U.S.C. 1.)

The 1978 amendments to the 1916 Organic Act and 1970 General Authorities Act expressly articulated the role of the national park system in ecosystem protection. The amendments further reinforce the primary mandate of preservation by stating:

"The administration of activities shall be construed and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided for by Congress." (16 U.S.C. 1-a1.)

The NPS Organic Act and the General Authorities Act prohibit impairment of park resources and values. The 2001 NPS Management Policies use the terms "resources and values" to mean the full spectrum of tangible and intangible attributes for which the park is established and are 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 will allow the American people to have present and future opportunities to enjoy them.

The evaluation of whether impacts of a proposed action would lead to impairment of park resources and values is included in this environmental assessment. 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;
- Key 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 or other relevant NPS planning documents.

1.3.2 Park Purpose and Significance

In 1980 Congress passed and President Carter signed the Alaska National Interest Lands Conservation Act (ANILCA). Section 201(9) of ANILCA established Wrangell-St. Elias National Park and Preserve, containing over 13 millions of public lands to be managed for the following purposes, among others.

"To maintain unimpaired the scenic beauty and quality of high mountain peaks, foothills, glacial systems, lakes and streams, valleys, and coastal landscapes in their natural state; to protect habitat for, and populations of fish and wildlife including but not limited to caribou, brown/grizzly bears, Dall sheep, moose, wolves, trumpeter swans and other waterfowl, and marine mammals; and to provide continued opportunities, including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities. Subsistence uses by local residents shall be permitted in the park where such uses are traditional, in accordance with the provisions of title VIII.

WRST is to be administered subject to valid existing rights, pursuant to the NPS Organic Act of August 25, 1916, as amended and supplemented, which established the NPS and other applicable provisions of ANILCA.
WRST is the nation's largest national park unit (13.2 million acres) and designated wilderness (9.6 million acres). WRST extends over a region of vast proportions and diverse environments, representing some of the most outstanding examples of Alaskan natural and cultural resources. Extensive high mountain terrain, enormous glaciers and icefields, active thermal features, large canyons, extensive wildlife populations, and major historic mining features represent the significance of the park and preserve. WRST and Glacier Bay National Park and Preserve, Canada's Kluane National Park, and British Columbia's Tatshenshini-Alsek Park are, together, the world's largest designated World Heritage Site, an area encompassing 28 million acres.

1.3.3 Park Plans

General Management Plan (NPS 1986). The WRST general management plan states that one of the purposes of ANILCA is to provide the opportunity for local, rural residents engaged in subsistence activities consistent with management of subsistence resources, recognized scientific principles, and the purposes for which WRST was established. Subsistence management is covered in Appendix L of the general management plan, which includes a commitment by the NPS to prepare and maintain a park subsistence management plan.

WRST Subsistence Management Plan. The plan provides clarification in the management of subsistence uses by addressing major aspects of subsistence management topics such as timber cutting, shelters and cabins, trapping, resident zones, and traditional use areas. Chapter 8 of the park subsistence management plan states that non-commercial harvesting of standing timber for appropriate subsistence uses, such as house logs or firewood is allowed by permit. Permits may be obtained from park headquarters in Copper Center. The harvest of dead or downed wood for fires is allowed without a permit. In regard to house log permits, the logs may only be used for construction of a primary permanent residence and may not be used for commercial purposes. In regard to firewood permits, the harvest of firewood is limited to what is reasonably required for heating and cooking at the applicant's primary place of residence. NPS permitting of the harvest of timber for subsistence purposes (house logs or firewood) is addressed in the aforementioned WRST Subsistence Log Policy.

1.4 Issues and Impact Topics

Issues and impact topics identified during the internal scoping process for this EA are the basis for environmental analysis in this document. A brief rationale is provided for each issue and topic analyzed in the environmental consequences section of this environmental assessment. Issues and topics considered but not addressed in this document are also identified.

1.4.1 Effects on Forest Resources

Harvest of live standing timber for house logs could affect forest productivity and recruitment of forest resources that have recently been affected by a spruce beetle epidemic in the upper McCarthy Creek valley. Recent studies indicate that harvest of live standing timber is not sustainable for the foreseeable future. Slash generated may affect the spread of Spruce bark beetle, Ips beetle, or wildfire fuel levels within the project area.

1.4.2 Effects on Aquatic Resources and Fish

Use of a tracked vehicle and sled to transport harvested house logs between the applicants' inholding and Green Butte would require numerous stream fords of McCarthy Creek. Stream turbidity and fuel spills would diminish water quality, fish habitat and affect fish species. Harvest of trees may reduce potential large woody debris that is necessary for healthy fish habitat. Yarding or skidding may increase sediment transport to streams and affect bank stability.

1.4.3 Effects on Cultural Resources

Use of a tracked vehicle to transport harvested logs to the applicants' private lands could disturb or damage archaeological and historical resources in the area.

1.4.4 Effects on Safety

Avalanches, ice build-up along the access route, and ice ledges along McCarthy Creek could create safety hazards for the individuals marking, monitoring, harvesting and transporting harvesting logs to the applicants' private lands.

1.4.5 Issues Considered but Dismissed from Further Consideration

Effects on Soils

Use of a tracked vehicle and sled to transport harvested logs would occur in the winter season over frozen ground and snow cover. No soil impacts would be expected.

Effects on Wilderness

The access route does not traverse designed wilderness. The WRST Subsistence Log Policy does not permit the harvest of logs farther than 0.5 mile from the designated access route, and the wilderness boundary is greater than 1 mile from the access route.

Effects on Subsistence

No significant impact to subsistence fish and wildlife resources is anticipated as a result of issuing a permit for the harvest of subsistence house logs in the McCarthy Creek valley. The proposed subsistence house log harvest would reduce the ease of firewood harvesting close to the permit applicant's property. Due in part to its remote location, however, possible impacts to subsistence firewood and house-log resources from a subsistence house log permit are considered negligible. The impacts to subsistence of the proposed action as well as the no-action alternative are discussed more fully in the ANILCA Section 810 evaluation, which is included as Appendix B of this EA.

Effects on Visitor Use

Possible impacts on park visitors would be considered negligible because subsistence house log harvest and transport would occur outside of the peak summer visitation season.

Regional and Local Economy

Possible regional and local economic impacts would be considered negligible. Expenditures are local and regional business for the purposes of the house log permit would be negligible.

Threatened and Endangered Species

The American peregrine falcon has been delisted, and active nests are more than 2 miles from the project area. There are no other threatened or endangered species or critical habitat in the area.

Effects on Wildlife

Possible impacts on wildlife and wildlife habitat would be temporary and localized displacement of resident species during house log harvest and transport, and would be considered negligible.

Effects on Wetlands

Harvest and transport of house logs would occur in the winter season over frozen ground and snow cover. No wetland impacts would be expected.

Effects on Floodplains

None of the proposed actions associated with subsistence house log harvest and transport would adversely affect floodplain resources and functions, or increase the risk of flooding.

Effects on Visual Resources

Harvest and transport of house logs would occur in the winter season over frozen ground and snow cover. Logs would be harvested within 0.5 mile from either side of the designated route, but not within 300 feet of McCarthy Creek. Possible impacts on visual resources arising from the harvest of 120 dead standing trees in a 3188-acre study area affected by a spruce beetle epidemic would be considered negligible.

Effects on Minority and Low-Income Populations

The proposed action would not result in disproportionately high direct or indirect adverse impacts on any minority or low-income population or community.

1.5 Other Permits and Approvals Needed to Complete the Project

A Corps of Engineers Clean Water Act Section 404 permit may be needed for any part of the project that traverses the waters of the United States. The Alaska Department of Environmental Conservation may need to issue a Certificate of Reasonable Assurance pursuant to the Clean Water Act Section 401. The Alaska Department of Natural Resources may require a Fish Habitat Protection Permit for crossing streams bearing fish. Slash treatment may require a burn permit from the Alaska Department of Natural Resources.

Any permit issued by the NPS would be for actions affecting federally managed public land only. The applicants are responsible for obtaining permission to cross any non-federal lands.

2.0 ALTERNATIVES

2.1 Introduction

This chapter presents the alternatives by which the applicants would acquire house logs for construction of a permanent residential structure on their private lands in the McCarthy Creek valley. Authority enabling local rural residents in park units where subsistence uses are allowed permit the cutting of standing live timber for subsistence needs such as shelter or fuel [36 Code of Federal Regulations Section 13.49(a)]. The alternatives include a no action alternative and one action alternative. This chapter also includes the alternatives that will not be considered further and fully analyzed in this environmental assessment.

2.2 Alternative A – No Action

With the no action alternative, the applicants would be able to acquire house logs from sources external to park lands, and transport the logs to their property using snowmachines, aircraft, and non-motorized surface transportation methods; all of these surface transportation methods are allowed by ANILCA 1110(a) with no authorization from the NPS. The NPS would not issue a special use permit to the applicants for subsistence house logs, and the NPS would not authorize use of a tracked vehicle on park lands to transport house logs acquired from sources external to park lands to their property. The applicants' would not be subject to the Wrangell-St. Elias Subsistence Log Policy, and associated permit procedures and conditions.

External sources may be logs from state, private, or university lands, or transporting logs harvested outside of WRST. Another alternative source is a commercial log cabin package readily available at a cost of several thousand dollars in south central and interior Alaska. Logs from state, private, or university lands, or a log cabin package could be purchased by the applicants and transported to their property using the modes of transportation allowed by ANILCA 1110(a).

The allowable harvest under the Wrangell-St. Elias Subsistence Log Policy enables construction of a house that is about 280 square feet in size. Use of logs from external sources, such as a commercial log cabin package, would enable the applicants to construct a house larger than 280 square feet, if desired, without any authorization or approval by the NPS.

These aforementioned methods of access and material transport are allowed by ANILCA 1110(a), and do not require authorization by the NPS. The no action alternative represents existing conditions and provides the baseline for evaluating the impacts of the action alternatives.

2.3 Alternative B – Subsistence Use of Beetle-Kill House Logs (Applicants Proposal and NPS Preferred Alternative)

Under Alternative B, the NPS would issue the applicants a special use permit for the harvest of subsistence house logs in the upper McCarthy Creek valley. The applicants' harvest of subsistence house logs would be subject to the Wrangell-St. Elias Subsistence Log Policy, and associated permit procedures and conditions. The applicants would be allowed to harvest only dead standing timber in the winter. The NPS, in conjunction with the applicants, would physically mark 240 dead trees with flagging tape in the upper McCarthy Creek valley and collect GPS location data for marked trees. The applicants' allowable harvest would be the first 120 trees harvested that would be suitable for construction of a residence. The applicants would not be allowed to harvest subsistence house logs greater than 0.5 mile from the designated route; or within 300 feet of McCarthy Creek or any other water body. Suspension of the largest diameter end of the log will be required during all yarding or skidding activities.

Recent inventory of forest resources in the upper valley of McCarthy Creek indicates that about 50 percent of dead standing trees in a 3,063 acre study area have undergone deterioration by rot which renders them unsuitable for house construction. Consequently, the applicants would be authorized to use the first 120 trees harvested and found in a condition suitable for house construction. Harvested trees would be cut as close to the ground surface as feasible, and stumps must be less than 18 inches in height.

The applicants would use a tracked vehicle to transport house logs harvested from the upper McCarthy Creek valley to their property (Figure 1). The applicants indicated that they anticipated crossing McCarthy Creek at up to four locations. Hence they would need to cross McCarthy Creek at one or more locations depending upon the harvest area(s). It is unlikely that they would operate downstream of Nikolai Creek. Therefore, log harvest would require a minimum of 16 and potentially 50 to 100 crossings of McCarthy Creek during the winter at a time when McCarthy Creek is frozen over. Using a sled behind the tracked vehicle, the applicants would transport as many as 15 logs at one time to their property. Snowmachines would be used to bring logs to the tracked vehicle and sled. The allowable harvest would enable the applicants to construct a house of about 280 square feet.

The NPS would designate a route that corresponds to a segment of historic mining access along McCarthy Creek between the applicants' property at Marvelous Millsite downstream to the crossing below Green Butte and would potentially extend to Nikolai Creek if warranted. This route would be authorized by NPS for transport of harvested subsistence logs by tracked vehicle.

The applicant would be issues a special use permit (Form 10-114) completed in accordance with NPS-53, and issued under the auspices of the Wrangell-St. Elias subsistence green log policy. The subsistence house log permit would be subject to standard permit procedures and conditions, and other stipulations deemed necessary to protect the resources of WRST, including:

<u>House Log Harvesting</u>

- Logs may only be used for a primary place of residence, and not for commercial sale or in structures used for commercial purposes. Commercial purposes include sale of whole logs, sale of lumber milled from whole logs, or construction of a lodge or other commercial structure.

- Applicants are prohibited from harvesting live trees. Allowable harvest would be limited to dead standing timber only. The NPS would mark 240 dead trees; applicants' allowable harvest would be the first 120 trees marked and harvested and in a condition suitable for construction of a residence.
- Subsistence house logs may not be harvested farther than 0.5 mile from the designated transportation route.

- No trees, regardless of size, may be harvested within 300 feet of McCarthy Creek or any other water body.

- Permittee(s) will submit a slash treatment plan that is approved by both the NPS and Alaska DNR prior to beginning harvest.

- Slash treatment may include removal, piling and burning, scattering and cutting slash into pieces less than 5 feet in length and leaving both ends in contact with the ground, to a level that prevents the spread of Spruce bark beetles, Ips beetles and that prevents an increase in wildfire fuel loading. At a minimum all slash must be in contact with the ground surface

- Harvested trees would be cut as close to the ground surface as feasible and stumps must be less than 18 inches in height.

- Live trees will not be damaged during felling, yarding or skidding. Trees with any bark removed or girdled will be considered damaged and harvest/transport operations will cease until reviewed by the Superintendent or his designee.

- Suspension of the largest diameter end of the log will be required during all yarding or skidding activities.

- Yarding or skidding operations will cease if ground disturbance occurs.

- The applicant must be able to document that they qualify as a local rural resident and that their primary residence is located on their private lands on upper McCarthy Creek.

- An additional subsistence house log permit will not be issued to the landowner/family for a period of 10 years after this permit is issued. This condition applies to any land subdivided or transferred subsequent to the issuance of the original subsistence house log permit.

- An additional subsistence house log permit may be issued due to emergency or unusual and unforeseen circumstances such as fire or other damage.

<u>Tracked Vehicle</u>

- Travel with a tracked vehicle (D-5 Caterpillar or smaller) pursuant to this permit is authorized from the date of permit issuance until April 15 2006; and from October 20, 2006 until either April 15, 2007 or the expiration of the permit (whichever comes first). Travel during the above identified periods is further conditioned upon the ground being frozen to a minimum depth of 6 inches and the existence of snow cover sufficient to protect the resources (typically more than 6 inches of snow). Stream crossings will utilize ice or snow ramps. Open water crossings require advance approval by the Superintendent or designee.

- Before utilizing a tracked vehicle, the permittee will obtain all necessary State of Alaska permits and Department of Army permits. This permit does not authorize travel across private land. The applicant is responsible for securing permission to cross private land.

- The permittee shall notify the Superintendent 48 hours prior to the start of hauling of logs with a tracked vehicle. However, if after one or more trips are completed, and the site conditions still allow for use of a tracked vehicle to transport logs to proceed, this stipulation may be modified.

- The tracked vehicle may only be utilized on parklands on the designated transportation route. The designated transportation route for house logs with the tracked vehicle is the existing disturbed route from the applicants' private lands south to a location approximately 0.5 miles downstream of Green Butte where the trail begins to climb to uplands north of East Fork Creek. This route has 4 stream crossings of McCarthy Creek, and is about 3 miles in length.

- A maximum of 8 round trips with a tracked vehicle, is permitted on the designated transportation route. Additional trips require approval by the Superintendent.

- The Superintendent or his designees may accompany the permittee on any or all tracked vehicle trips to insure permit compliance.

- If the tracked vehicle utilized is a bulldozer, the bulldozer will travel with the blade up except as necessary to build snow bridges at sites approved by the Superintendent or his designee.

- No cut and fill of soil and/or gravel or blading causing ground disturbance is permitted.

- Placement of fill materials in the waters of the United States is prohibited.

- Tracked vehicle operators will not execute tight turns by locking one track without advance approval by the Superintendent or his designee.

- Debris, food and refuse generated by the permittee and/or his employees and coworkers will be removed from the preserve and disposed of in accordance with State and Federal law.

- Any tracked vehicle which breaks down or becomes stuck (i.e., cannot be extricated by means of immediately available resources), in support of transporting harvested logs will be reported as soon as possible to the Superintendent or his/her designees. Equipment must be removed or stabilized in consultation with the NPS.

- This permit does not affect applicant's use of snowmachines during periods of adequate snow cover.

Cultural Resources

- All cultural resources shall be avoided. The permittee shall not injure, alter, destroy, or collect any cultural resource site, structure, or object.

- Prior to building snow ramps, areas of concern for cultural resources would be located by park staff to ensure that cultural features are protected, such as historic bridge abutments not readily visible in snow and winter conditions.

- If a cultural resource is inadvertently impacted by the permitted activities, the permittee shall cease the activity, protect the resource, and notify the Superintendent immediately.

Water Resources

- A snow ramp must be constructed only of snow and ice, and must be substantially free of soil and organic debris.

- The permittee will avoid impeding the passage of fish, disrupt fish spawning, adversely affecting over-wintering or nursery areas identified by the Superintendent or his/her designees. The permittee shall not permanently block off or change the character or course of any stream.

Fuel

- No refueling of the tracked bulldozer is permitted on preserve lands.

- All spills of oil, petroleum products, and hazardous substances shall be reported to the Alaska Department of Environmental Conservation (ADEC) in accordance with Alaska law. Immediate actions will be taken to confine the spill to the smallest area. Discharge notification and reporting requirements from AS 46.03.755 and 18 AAC 75 Article 3 will be attached to the permit and are to be followed by the applicant.

- Violation of the terms and conditions of the permit may result in immediate revocation of the permit by the park superintendent.

2.4 Environmentally Preferred Alternative

The environmentally preferred alternative is defined as the alternative that will promote the national environmental policy as expressed in section 101 of the National Environmental Policy Act.

The environmentally preferred alternative is Alternative A – No Action. Alternative A most closely satisfies national environmental policy and goals. However, with the standard permit procedures and conditions, Alternate B would also contribute to meeting environmental goals.

2.5 Alternatives Considered but Eliminated from Further Consideration

The alternative of issuing a subsistence house log permit authorizing the applicants to harvest live standing trees was considered but rejected because it would not be compatible with the purposes for which WRST was established. NPS has conducted forest resource inventory and studies of the McCarthy Creek area. The 2005 McCarthy Creek Forest Resource Inventory Report (Michael G. Loso, Resource Report, NPS/AR/NRTR-2005-52, see Appendix A) concludes the following.

- White spruce forests in the upper McCarthy Creek valley have generally poor productivity and low recruitment.
- Forest productivity and recruitment are compounded by a spruce beetle epidemic that has caused high mortality of older white spruce forests, and additional forest losses are expected before the epidemic has run its course.
- Available data indicate that forest mortality currently exceeds the forest growth rate. Consequently, the harvest of live trees for the foreseeable future is unsustainable.
- Dead standing timber is abundant, and may provide a useful alternative to live trees for house logs and firewood.

2.6 Summary and Comparison of the Effects of the Alternatives

The effects of the no action and proposed action alternatives on forest resources, water quality and fish, cultural resources, and safety hazards are summarized below.

Impact Topic	**Alternative A** **No Action** **(Environmentally Preferred Alternative)**	**Alternative B** **Proposed Action** **Subsistence Use of Beetle-Kill House Logs**
Forest Resources	No effect. Moderate adverse cumulative effects.	Negligible effects. Moderate adverse cumulative effects.
Water Quality and Fish	Negligible effects. Moderate adverse cumulative effects.	Minor adverse effects. Moderate adverse cumulative effects.
Cultural Resources	Minor adverse effects. Moderate adverse cumulative effects.	Negligible effects. Moderate adverse cumulative effects.
Safety Hazards	No additional increased safety risks.	Minor to moderate increased safety risks.

3.0 AFFECTED ENVIRONMENT

This chapter describes the harvest corridor; transportation route; forest resources; water quality and fish; cultural resources; and safety within Wrangell-St. Elias National Park and Preserve that may be affected by the alternatives if implemented. The specific subjects covered in this chapter reflect the impact topics identified in the Purpose and Need for Action chapter of this environmental assessment.

The following documents contain additional descriptions of the aforementioned resource subjects within Wrangell-St. Elias National Park and Preserve, and are the source of the information presented in this environmental assessment.

- National Park Service, "Environmental Assessment, McCarthy Creek Temporary Access, Wrangell-St. Elias National Park and Preserve," 2004.

- National Park Service, "McCarthy Creek Forest Resource Inventory", Michael G. Loso, Resource Report NPS/AR/NRTR/2005-52, 2005.

3.1 Overview of McCarthy Creek Valley

The McCarthy Creek valley encompasses glaciers, moraines, forest, shrubland, and alpine tundra. The study area (Figure 1) encompasses 3188 acres, and represents the general extent of forested land in the valley considered accessible for subsistence use by rural residents. Forested land has or potentially supports > 10 % canopy cover by one or more of the five tree species found in the valley; about 2652 acres within the study area contain productive white spruce forest. According to the applicants, the feature known locally as 8 Mile Hill (Figure 1) is a major obstacle to house log transport. The feature is a steep hill situated along the route on the west side of McCarthy Creek upstream from the Nikolai Creek confluence. The hill constrains transport of heavy logs between lower McCarthy Creek and the applicants' Marvelous Millsite property to such an extent that such transport is impractical; and thus 8 Mile Hill defines the extent of the study area. A description of the physical character of the McCarthy Creek drainage is best provided by U.S. Geological Survey Water-Resources Investigation Report 93-4078 entitled: Hydrologic and Mass-Movement Hazards near McCarthy, Wrangell-St. Elias National Park and Preserve. That document is hereby incorporated by reference.

The harvest area is located within the McCarthy Creek drainage, an area located on the southern slope of the Wrangell Mountains with a watershed of approximately 77 square miles. The McCarthy Creek basin was formed by historic large-scale valley glaciation resulting in a classic "U" shaped valley cross-section. The McCarthy Creek Glacier, a remnant of that glacial system, provides feed waters for the watershed along with two major tributaries, East Fork and Nikolai Creek. In recent times McCarthy Creek has cut through bedrock in its upper reaches and glacial deposits along the valley floor to form an incised "V" shaped valley with a dynamic floodplain and a system of alluvial terraces. Steep valley side slopes, with associated talus, rock glaciers, landslides and avalanche areas, and more gently sloping fluvioglacial and glaciolacustrine features contribute additional elements to the area's landscape.

The ecosystem patterns of the McCarthy Creek valley are representative of the patterns of the greater Chitina valley. McCarthy Creek runs in a narrow barren floodplain, bordered by recent terraces with riparian forest and shrub types. Above the terraces are steep forested side slopes and uplands. The mountain sides support willow and alder thickets, rising to an alpine zone with tundra, bedrock and talus and small glaciers.

3.2 Forest Resources

3.2.1 Physiographic Units

Loso (2005) identified study area physiographic units based on readily discernible forest characteristics; the units are floodplains, flatwoods, and slopes. There are about 2652 acres of productive white spruce forest in the study area classified in one of these three physiographic units. Eighteen sites were selected for intensive field study; 4 in the floodplain unit, 9 in the flatwoods unit, and 5 in the slopes unit. Forest parameters such as species density, standing volume, population structure, and environmental characteristics were assessed at each of the 18 sites to document selected attributes for the three physiographic units (Table 1). **Floodplains** along McCarthy Creek include the active floodplain and recently formed terraces (Figure 2). Floodplains amount to about 156 acres in the study area. The active floodplain is scoured by floodwaters every year or two, and is predominately barren gravels and cobbles with scattered forbs and willow shoots (*Salix spp*). Terraces support white spruce and balsam poplar with a variable understory of soapberry.

Figure 2. Floodplains Physiographic Unit. Immediately left of McCarthy Creek stream channel is active floodplain. Further left is a sparsely vegetated terrace, with *Dryas* and willows. The forested terrace at extreme left is an older terrace with balsam poplar and white spruce.

TABLE 1. Selected attributes of three physiographic units in upper McCarthy Creek.

Physiographic Unit Parameters	**Flatwoods**	**Slopes**	**Floodplains**
Unit code*	21	23	25
Site numbers	3, 4, 9, 12, 13, 14, 15, 16, 17	1, 2, 6, 7, 11	5, 8, 10, 18
Total area (ha)	238	772	63
<1000 m from road (ha)	190	508	63
<500 m from road (ha)	126	359	63
<100 m from road (ha)	38	51	47
Elevation range (m)	760 - 850	670-1070	670-820
Slopes (□)	0-10	5-35	0-3
Parent Material	Lacustrine silts and clays, capped with 1-several meters diverse colluvium	Weathered colluvial dacite porphyry, limestone, and basalt	Fluvial sands and gravels
Soil drainage	Moderately to poorly drained	Moderately-well drained	Well drained
Depositional environment	Latest Pleistocene/early Holocene lake clays from the exposed floor of ice-dammed Lake Ahtna, and perhaps McCarthy Creek if ever impounded by the Kennicott Glacier.	Deeply weathered bedrock and minor glacial till periodically mobilized by debris flows, rockslides, avalanches, and fluvial incision. Some relatively stable interfluves and benches.	Deposited and periodically reworked by McCarthy Creek in the late Holocene. Most terraces are 1-several hundred years old.
Dominant canopy trees (% cover)	*Picea glauca* 30-50 *Picea mariana* 0-20	*Picea glauca* 35-45 *Betula papyrifera* 0-20	*Picea glauca* 20-45 *Populus balsamifera* 10-60
Dominant subcanopy shrubs (% cover)	*Salix* sp. 35-70 *Betula nana* 0-30	*Alnus crispa* 20-80 *Viburnum edule* 15-35	*Salix* sp. 15-70 *Sheperdia canadensis* 10-70
Dominant groundcover (% cover)	graminoids 10-70 *Cornus canadensis* 0-30	*Cornus canadensis* 15-40 *Equisetum arvense* 15-25	*Mertensia panicula* 10-30 graminoids 20-30
Stand age	128	144	139
Evidence of historic logging	Yes	Yes	Yes
Primary disturbance	Spruce beetle outbreak	Spruce beetle outbreak	Spruce beetle outbreak

*from *Field Instructions for the Annual Inventory of Coastal Alaska*

Flatwoods are characterized by black spruce, white spruce, and dense understory of willows and dwarf birch (Figure 3). Flatwoods amount to about 588 acres in the study area.

Figure 3. Flatwoods Physiographic Unit. The higher terrace in the right side of the figure is open spruce forest with tall shrub understory.

Slopes have mature, open stands of white spruce and scattered paper birch over a dense shrub layer of Sitka alder (Figure 4). Slopes amount to about 1908 acres in the study area.

Figure 4. Slopes Physiographic Unit. The floor of the "U" shaped glacial valley is evident across the middle of the figure, with the later incised valley of McCarthy Creek running from left to right below the rock glacier on photo right. The transportation alignment traverses from the stream up onto the upland unit through the lower center of the image. The slopes physiographic unit is the gently sloping forested area at photo center.

Study results and conclusions of the 2005 report by Loso follow; the complete resource report is in Appendix C.

The 18 study sites and primary physiographic units are shown in Figure 5. Slopes are the most extensive (1908 acres) followed by flatwoods (588 acres) and floodplains (156 acres). Buffer zones of 100 meters (300 feet), 500 meters (1500 feet) and 1000 meters (3000 feet) from the transportation route quantify the accessibility of standing timber in the different physiographic units. About 74 percent of floodplains are within the 300-foot buffer zone. About 7 percent and 16 percent, respectively, of slopes and flatwoods are within the 300-foot buffer zone.

3.2.2 Standing density and volume

White spruce densities are 344 stems/acre on slopes, 639 stems/acre on flatwoods, and 1432 stems/acre on floodplains. Seedlings are the most abundant size class in the study area. Seedlings constitute 65 percent of total density in flatwoods, 45 percent total density in slopes, and 84 percent total density in floodplains. The least abundant size class in the study area is house log-sized white spruce where densities are 49 stems/acre in flatwoods, 65 stems/acre in slopes, and 73 stems/acre in floodplains.

3.2.3 Spruce beetle mortality

Beetle mortality is highest in the oldest trees with disproportionate impacts on house log-sized trees. Less than 50 percent of house log-sized trees are in conditions suitable for house construction. Consequently, flatwoods average 20 useful houselogs per acre of which 13 are beetle-killed trees; slopes average 37 useful houselogs per acre of which 16 are beetle-killed trees; and floodplains average 40 useful houselogs per acre of which 36 are beetle-killed trees. Of the total standing volume of white spruce in the study area, 57 percent in slopes; 72 percent in flatwoods; and 90 percent in floodplains consist of dead timber. Because of the most recent and ongoing spruce beetle outbreak, dead trees now constitute 71 percent of total standing volume in upper McCarthy Creek; most of this volume is potentially useful for firewood. Likewise, 49 percent of house log-sized white spruce trees are dead; 47 percent of these dead trees are suitable for house construction. There are an estimated 40,000 usable house logs in the study area; 7,000 of these logs are within the 300-foot buffer zone along the transportation route while the remaining 33,000 are beyond the 300-foot buffer zone. In summary, selective harvest of live white spruce for house logs or firewood is not currently sustainable now or for the foreseeable future.

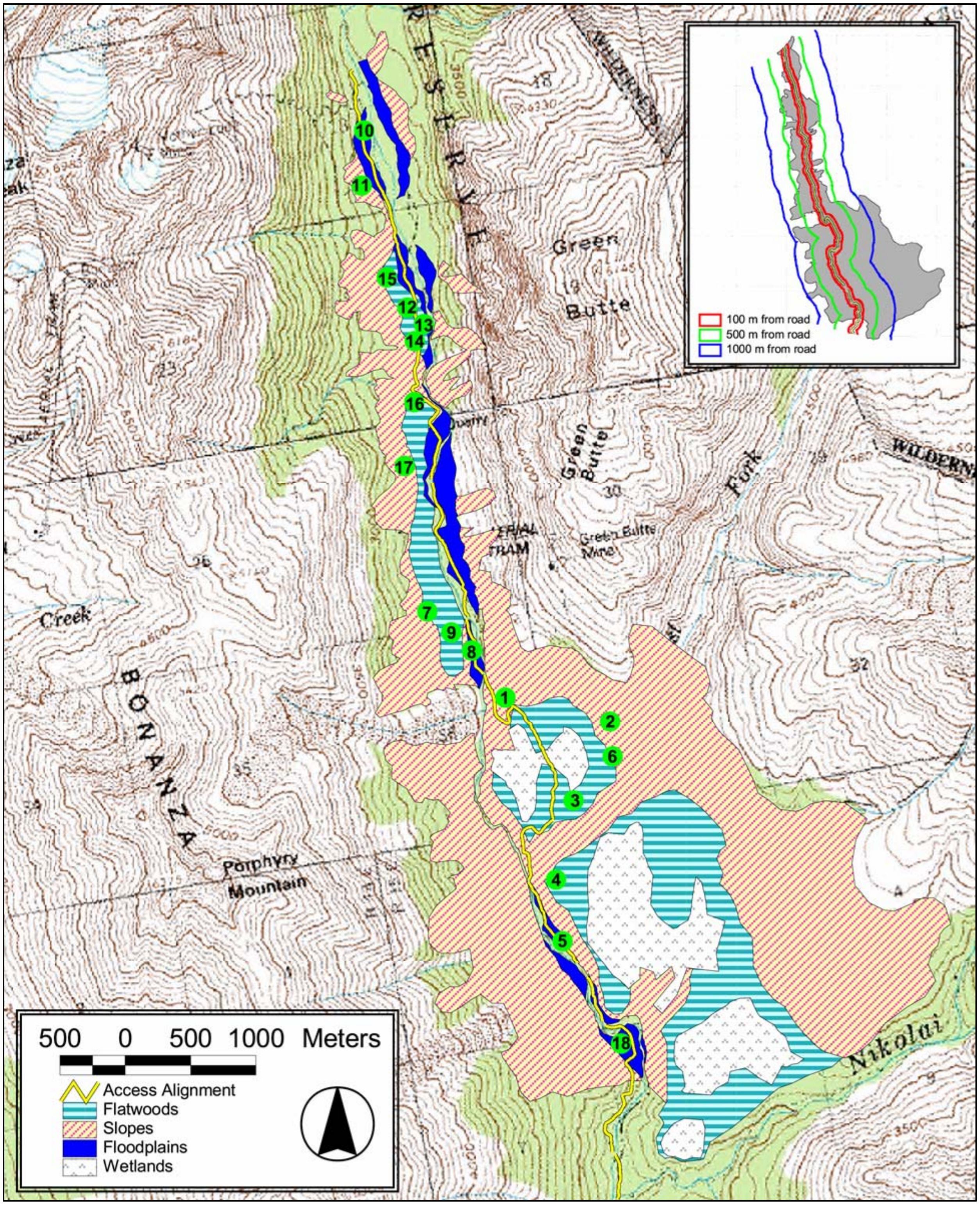
3.2.4 Productivity

The ongoing spruce beetle outbreak has severely affected net forest productivity in the study area. In each physiographic unit, there is no net gain in forest productivity; this indicates that white spruce forests are currently losing more volume to the spruce beetle outbreak than they are gaining through existing growth.

3.2.5 Population Dynamics

None of the sampled timber stands are even-aged, and none show evidence of fire or other such catastrophic disturbance. Existing information indicates that upper McCarthy Creek has not had a large catastrophic wildfire for the past few centuries. Instead, the forests in the study area have developed in response to windthrow, forest diseases, and prior selective harvest. Modeling suggest that forest recruitment in upper McCarthy Creek is currently to poor to maintain current densities of mature trees. Model predictions indicate that flatwoods and floodplains would have higher densities of mature trees than currently present; slopes would have slightly lower densities. These predictions further indicate that slopes have insufficient recruitment to maintain current tree densities, even without episodic mortality. In contrast, flatwoods and floodplains could sustain moderate episodic mortality and still maintain current mature tree densities. Regardless, episodic mortality occurs at high rates in each physiographic unit. In the past decade, spruce beetles and human activity have caused mortality of 48 percent,

Figure 5. Study sites 1-18 (numbered green circles) and physiographic units in upper McCarthy Creek. Inset shows buffers delineating forested land within 100 m (300 ft), 500 m (1500 ft), and 1000 m (3000 ft) from transportation alignment.



49 percent, and 80 percent of mature trees in slopes, flatwoods, and floodplains, respectively. Any increase in beetle mortality or human harvest would further decrease future densities of mature white spruce in the study area.

3.2.6 Human harvest

McCarthy Creek has substantial history of selective logging dating back to the mining era of 1911-1938 that is evident in the study area within 300 feet of the transportation route. In recent years, such as the winters of 2003-2004 and 2002-2003, the applicants have harvested much of their firewood from beetle-killed white spruce at a location west of McCarthy Creek on a bench less than 2 miles south of their Marvelous Millsite property. Sampling sites 12-15 are within the firewood harvest area locally known as the woodlot (Figure 6). Loso (2005) estimated that the applicants harvested 295 trees for a yield of 12 cords of firewood to heat two cabins during the aforementioned two winter seasons. Local knowledge indicates that annual firewood consumption ranges from 7-8 cords/cabin in Copper Basin; the applicants' firewood consumption is consistent with the rate of annual firewood consumption for the Copper Basin.

3.2.7 Conclusion

White spruce forests in the upper McCarthy Creek valley have generally poor productivity and low recruitment. Three physiographic units serve as habitat for the bulk of the white spruce in the valley: Flatwoods have a prominent black spruce component, with relatively low productivity and moderate recruitment; Slopes have an alder component, with moderate productivity and low recruitment; and Floodplains have a balsam poplar component, with higher productivity and higher recruitment. A spruce beetle epidemic has recently gained momentum in the valley, and high mortality of larger, older white spruce was most conspicuous in 2003. Further losses are expected before the epidemic has run its course. As a consequence of this outbreak, mortality currently exceeds growth when viewed from the perspectives of either wood volume or population demography. For the foreseeable future, the harvest of live trees is therefore unsustainable. Standing dead timber is abundant, and may provide a useful alternative to live trees for house logs and firewood.

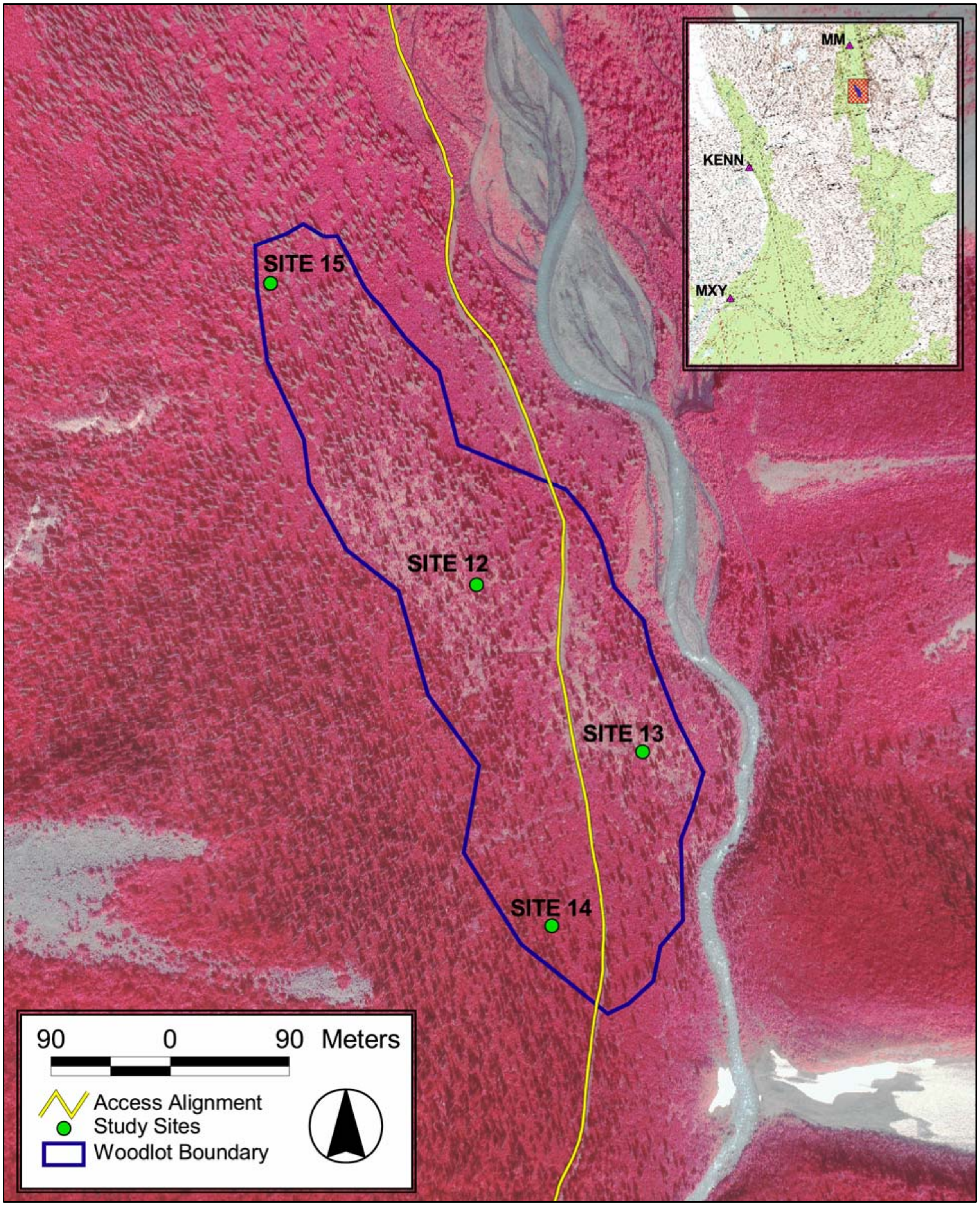
3.3 Water Quality and Fish

3.3.1 Watershed and Aquatic Habitat

McCarthy Creek originates from glaciers along the south slope of the Wrangell Mountains and runs naturally turbid during the summer months. Its waters tend to clear during non-summer months. Below it's origin along the base of the moraine of the McCarthy Creek glacier, the braided stream flows southward over a 300-600 foot wide flood plain and has an average gradient of 2.3 percent. Between stream miles 12.3 and 5, the stream flows through a series of bedrock canyons before turning west over an alluvial floodplain. Stream gradient, between stream miles 5 and the mouth, averages 1.9 percent. Peak flows range 2080 to 4500 cubic feet per second with average water velocities ranging from 7 to over 12 feet per second. Ridges enclosing the McCarthy creek watershed are from 6000 to 9000 feet in elevation. The mouth of McCarthy Creek is approximately 1360 feet in elevation. Glaciers and perennial snowfields presently cover about 4 percent of the McCarthy creek watershed (Jones and Glass, 1993).

McCarthy Creek is a third order tributary stream that flows into the Kennicott River in the vicinity of the community of McCarthy. The Kennicott River is tributary to the Nizina River; the Nizina River is tributary to the Chitina River; tributary to the first order Copper River that flows into the marine waters of Prince William Sound. Flood plains along McCarthy Creek and it's tributaries are frequently flooded and are prone to rapid erosion and deposition during intense rainfall and periods of rapid snowmelt. The 1980 flood event covered or created nearly 850 acres

Figure 6. Permit applicants' firewood harvest area (woodlot) and study sites 12-15. Inset shows applicants' Marvelous Millsite (MM) homestead, Kennecott (KENN), and McCarthy (MXY) relative to harvest area location. Color infrared imagery dated July 9, 2003.



of floodplain. Sediments from continual mass wasting accumulate in stream channels and are mobilized during floods. Severe lateral erosion, scour and deposition occur during floods.

The Final EIS, Cumulative Impacts of Mining, Wrangell-St. Elias National Park and Preserve, Alaska states placer mining, drift mining and transportation routes have caused disturbance in the McCarthy Creek drainage. During the warm summer months, suspended sediments are in relatively high concentrations. Aquatic invertebrates and algae were observed in upper and lower McCarthy Creek in 1986. Large woody debris is present within the active channel (Figure 8). Suitable sized salmonid spawning gravels are present within McCarthy Creek.

Fish habitat in McCarthy Creek contains many low gradient riffles and scour pools (Overton and others, 1997) as well as many high gradient riffles. Numerous off-channel habitats such as side channels and beaver ponds are present at low flows. The beaver ponds near Green Butte appear to provide important rearing habitat. These beaver ponds are connected to the main channel of McCarthy Creek by a small stream flowing out of the ponds. Channel downcutting could result in a loss of connectivity to these ponds, substantially changing the quality and quantity of summer rearing habitat available to fish occupying McCarthy Creek.

Large woody debris appears to provide cover for fish in McCarthy Creek during a range of flows. Large woody debris is likely particularly important as it provides cover and low velocity areas during high flow periods. Large woody debris jams create off channel habitat , such as low velocity side channels that are extremely important to rearing, juvenile fish, particularly during high flow events. Large woody debris also aids in the development of deep pool habitat in the main channel which provides extremely important overwinter habitat. Large woody debris is also an important source of nutrients for macroinvertebrates. While large woody debris levels are unknown, a qualitative review from a helicopter suggests that large woody debris levels are currently high enough to positively affect fish habitat but that fish habitat would likely continue to improve if large woody debris levels increased. If large woody debris levels decreased measurably, a corresponding decrease in fish habitat quantity and quality would also be expected.

Plunge pools a meter or more in depth were observed during the October 2003 sampling efforts. These pools provide important overwintering habitat.

Many of the stream gravels in McCarthy Creek are large and may be difficult for fish exhibiting resident life histories to move while spawning, smaller gravels are present at some sites in large enough quantities to support spawning. Peak flows and velocities in McCarthy Creek are undoubtedly substantial enough to transport smaller spawning gravels. Interstitial spaces among large substrate particles provide important habitat for both fish and their prey, including many macroinvertebrate species.

High summer flows may limit the success of Spring spawning fish species by transporting stream channel substrate containing developing eggs. High levels of suspended sediments during summer flows may physically damage or cover developing eggs in relatively stable substrates. However, flows occurring in non-summer months are lower velocity, contain relatively little suspended sediment, and appear to provide an environment which supports spawning by Fall spawning species such as Dolly Varden.

Gravel substrate areas observed during the October 2003 fish sampling effort appear embedded with fine (< 2 mm diameter) sediment. Spawning Dolly Varden will clean these areas during the process of spawning, allowing for increased interstitial water flow to oxygenate the developing eggs. Spawning from September to early November (usually October) with alevins emerging from the gravels in late April to mid-May (Scott and Crossman, 1973), Dolly Varden are well adapted to surviving in streams with naturally occurring peak flows during summer months. A diverse range of life histories, including resident, fluvial, and anadromous forms, allow the species to persist even when their natal streams provide less than optimal rearing conditions during some years. However, human caused disturbances, such as the mobilization of fine sediments during low flow periods while eggs or alevins remain in the gravels, impact all life history forms and can affect the success of Dolly Varden populations. Nutrients, large woody debris, and substrate, including spawning gravels, are transported to the stream by landslides and debris torrents. Hydrologic and mass-movement hazards in the McCarthy Creek watershed are well documented by Jones and Glass (1993). Eroding stream banks, such as those found in the area referred to as Cutbank, also contribute nutrients, large woody debris, and substrate. Past actions, such as road and trail construction, have interrupted the transportation of these materials to stream channels. Prior to 2002, the dynamic nature of many of these landslides or debris torrent routes had covered the existing trail and restored the natural functions of these areas. However, renewed use, including the blading of many of these areas by tracked vehicle, has again interrupted the contribution of large woody debris and substrate materials to the stream channel. Left undisturbed these areas will likely recover in the next 10 to 100 years.

3.3.2 Aquatic Populations

Dolly Varden (*Salvelinus malma)* occur in the lower section of McCarthy Creek (ADFG Williams, pers. Comm.. 1982 in final environmental impact statement cumulative impacts of mining in WRST volume 1). The Creek has subsequently been surveyed twice by National Park Service personnel to determine the presence or absence of fish species. It was first surveyed in 2001. The 2001 sample site was located near the stream mouth. Juvenile Dolly Varden were captured during this survey. In October 2003, a second sampling event by National Park Service staff was conducted to determine the presence or absence of fish species in other areas of McCarthy Creek. Because of its short duration, this sampling event is not adequate to prove the absence of any fish species. However, this approach does document the presence of any fish species observed or captured. No additional fish species other than Dolly Varden are known to occur in McCarthy Creek. However, no known fish passage barriers exist between the Chitina River and McCarthy Creek in the vicinity of the Spokane Placer site. Additional fish species known to occur in the Chitina River drainage that could potentially inhabit McCarthy Creek include chinook and coho salmon, steelhead/rainbow trout, arctic grayling, and slimy sculpin. Existing fish presence data for McCarthy Creek is based upon brief sampling efforts at a few sites within the watershed.

Dolly Varden were also captured at all sample sites in 2003. Captured fish ranged from 30 to 432 mm in length with a mean of 95.8 mm (SE=51.3 mm). Length ranges for each site are summarized in Table 3. Length frequency analysis suggests that sampled fish lengths were well distributed around 55 mm and 115 mm (Figure 7). One large (432 mm) male was in spawning condition when captured. This is the largest Dolly Varden sampled in the Interior portion of the Park (excluding Yakutat District) to date. Dolly Varden appear to be present throughout McCarthy Creek and the lower portion of Nikolai Creek. Based upon aerial observations in 2003, the East Fork of McCarthy Creek appears to provide fish habitat similar to that in Nikolai Creek. Nominations received prior to July 2003 will not be considered by DNR until the 2005 regulatory cycle so regardless of any finding of anadromous fish in McCarthy Creek the stream will not be listed in State regulation as an anadromous stream prior to the 2005 regulatory cycle. At this time, due to the absence of any other known anadromous Dolly Varden populations within the McCarthy quadrangle, DNR has stated documentation of additional anadromous Dolly Varden within McCarthy Creek would be needed to support an anadromous determination for McCarthy Creek.

STREAM	SITE	GPS	Sample Year
McCarthy Creek	Green Butte	N 61.496 W142.785	2003
McCarthy Creek	Nikolai Confluence	N 61.442 W 142.776	2003
Nikolai Creek	Reach 1	N 61.444 W 142.773	2003
McCarthy Creek	Upstream NPS Boundary	N 61.414 W 142.874	2003
McCarthy Creek	Near mouth	N 61.431 W 142.924	2001

Table 2 Sample sites in McCarthy Creek, 2001 and 2003.

Length frequency data suggests 3 age classes of Dolly Varden within McCarthy Creek. Dolly Varden less than 90 mm in length appear to be age 0+; Dolly Varden over 90 mm but less than 160 mm; age 1+ fish (Figure 7). Eight fish were sampled that were over 160 mm in length, these fish are likely 2+ or older fish. Although spawning activity was not observed, the numerous small (less than 50 mm) individuals that were sampled strongly suggests that spawning is occurring within McCarthy Creek.

Sampling McCarthy Creek in October 2003 found that a Dolly Varden population is present. This corroborates prior sampling events. One Dolly Varden sampled is believed to be an anadromous specimen. The condition of both the large male sampled and the presence of numerous small individuals suggests Dolly Varden spawn and rear in McCarthy Creek. Fish habitat in McCarthy Creek does support a viable spawning population of Dolly Varden.

SITE	Sample Size	Minimum length (mm)	Average Length (mm)	SE	Maximum Length(mm)
Green Butte	63	66	114.8	16.8	149
Nikolai Confluence	39	35	68.2	67.4	432
Reach 1	14	30	122.9	79.1	250
Upstream NPS Boundary	27	40	70.7	34.9	157
Near mouth	8	84	117	34.8	180

Table 3 Fish sample size and length data by sample size

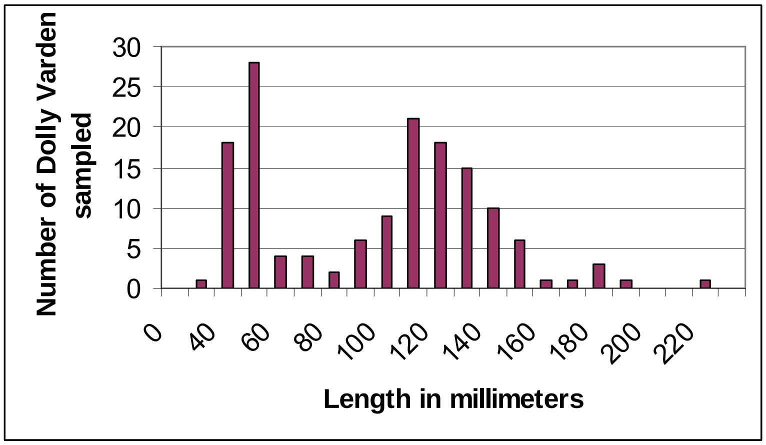


Figure 7. Length frequency of Dolly Varden in McCarthy Creek (all sample sites)

The viability of the Dolly Varden population in McCarthy Creek is unknown at this time. At this time, the only anadromous stream nomination ever submitted to the State of Alaska within the entire McCarthy Creek quadrangle based upon the presence of potentially anadromous Dolly Varden, is the nomination for McCarthy Creek based upon the 2003 sampling effort (personal communication, J. Johnson). This suggests that potentially anadromous or large fluvial Dolly Varden are extremely rare within the Chitina River watershed. We believe the potential for recolonization of this stream by other migratory populations of Dolly Varden is low because other populations are not known to occur in the vicinity of McCarthy Creek. Other streams within the Copper River Basin are known to contain extremely small populations of anadromous salmonids, such as Tanada Creek, where returning chinook salmon are estimated annually using a weir and returning adult populations range from 2 to 16 individuals. If spawning resident or fluvial Dolly Varden are present when ripe anadromous individuals return, individuals exhibiting different life histories can interbreed and the genetic contribution of the anadromous individuals likely enhances the viability of the resident or fluvial population.

If anadromous or fluvial Dolly Varden are truly rare in McCarthy Creek then the viability of the entire Dolly Varden population in McCarthy Creek is less than it would be if anadromous and fluvial individuals were strong components of the population. A tremendous level of work with bull trout (*Salvelinus confluentus*), a species that has only recently become taxonomically distinct from Dolly Varden, has shown that populations with only a resident component remaining, are at much higher risk of extinction than populations with migratory (fluvial or adfluvial) components. It is possible that past actions in McCarthy Creek, including mining, construction or maintenance of access routes, have impacted anadromous or fluvial populations and potentially reduced these populations to low levels. In addition, 2 large flood events in the past 20 years have undoubtedly resulted in short term impacts to the Dolly Varden population and their habitat.

Figure 8 Large woody debris along McCarthy Creek.

3.4 Cultural Resources

The McCarthy Creek valley contains 12 known historic sites related to lode mining and associated transportation. These are mostly comprised of mining camps, mines and mine features, road construction camps, isolated cabins, remains of bridge abutments, and tunnels. One site, the Green Butte Mining Camp Historic District (XMC-096), is eligible for listing on the National Register of Historic Places. Currently, in consultation with the Alaska State Historic Preservation Officer (SHPO), eleven other sites are being evaluated for their eligibility for inclusion into the register (XMC-042, XMC-043, XMC-044, XMC-045, XMC-046, XMC-049, XMC-050, XMC-051, XMC-064, XMC-102). Of the eleven, three have been determined eligible by the NPS. These include the McCarthy Creek Road (XMC-439), and two nearby cabins (XMC-044 and XMC-102). NPS is awaiting concurrence on its findings.

While no prehistoric sites have been identified within the area of potential effect of this project, sites found elsewhere in similar topographic settings within the park include lithic scatters, quarry sites, and village, hunting and fishing camps.

Additional information about cultural resources in the McCarthy Creek valley can be found in "Environmental Assessment, McCarthy Creek Temporary Access, Wrangell-St. Elias National Park and Preserve," issued by NPS in 2004 and hereby incorporated by reference.

3.5 Safety Hazards

3.5.1 Snow Avalanches

"Snow avalanching occurs during winter and spring on all slopes delineated as landslide prone, within all steep-walled canyons and along the cirque headwall of tributary streams, rock glaciers and glaciers" in the McCarthy watershed. (Jones, S., and Glass, R, 1993). The transportation route and house log harvest area upstream of Green Butte Millsite has landslide prone areas delineated along its entire length. During the winter of 2002 large avalanches crossed or threatened to cross the route upstream of Green Butte Millsite in at least 5 locations. During the winter of 2004 significant snow avalanches crossed McCarthy Creek in at least two areas. These include (1) immediately upstream of Dimond Creek with a run-out zone onto the Spokane Placer and (2) upstream of Big Ben Millsite with a run-out zone crossing the winter route to Marvelous Millsite.

A formal assessment of the risk has not be undertaken by an avalanche expert, but based upon the location of known and potential snow avalanche zones and our general knowledge of the valley there is a real and potentially significant safety concern for individuals harvesting house log and traveling along the route, especially in those areas listed above during periods of high avalanche danger.

3.5.2 Aufeis (icing)

"Aufeis is a mass of ice that forms by the overflow and subsequent freezing of sheets of surface water or emerging ground water" (Jones, S., and Glass, R., 1993). There are locations along the route where water issuing from seeps or flowing in small side drainages crosses the route and may result in aufeis development during winter months. Aufeis also forms in stream channels and may be present at any stream crossings. Extensive aufeis accumulations occur in McCarthy Creek basin during winter months (Jones, S., and Glass, R., 1993).

The ice surface and flows along side slopes or river bottoms may be hazardous because they are slippery or are too steep; these may pose challenges for traversing with a tracked vehicle and/or skidding plate.

3.5.3 Flooding

McCarthy Creek and side tributary flood magnitudes, frequency and potential causes are described in USGS WRI 93-4078 (Jones, S., and Glass, R., 1993). "Flooding may result from rainfall, snow melt or formation and subsequent failure of landslide dams, snow avalanche dams and sudden release of channel blockage by snow and ice" (Jones, S., and Glass, R., 1993). Rainfall and snow melt flood frequency determinations for McCarthy Creek near McCarthy indicate that the "fifty year" and "100 year" floods are approximately 3900 cfs and 4300 cfs. The 1980 flood was estimate at 4500 cfs.

The greatest safety concerns posed by flooding and high water would most likely be associated with periods of high rainfall and or rainfall on snow. There may be periods during the late spring, when high flows make stream channels crossings unsafe and/or unfeasible. Floods during winter months would most likely be associated with the release of channel blockage by snow and ice. These could be sudden and unpredictable. Monitoring of channel blockage and avoiding reaches down would reduce potential safety threats.

4.0 ENVIRONMENTAL CONSEQUENCES

The National Environmental Policy Act (NEPA) mandates that the environmental consequences of a proposed federal action be disclosed to the public. In this case, the proposed federal action is issuing a subsistence house log permit to the applicant who resides within Wrangell-St. Elias National Park and Preserve. This chapter of the EA presents the potential effects of the no-action and proposed action alternatives on forest resources; aquatic resources and fish; cultural resources; and safety. These effects provide a basis for comparing the advantages and disadvantages of the alternatives. The specific subjects covered in this chapter reflect the impact topics identified in Chapter 1 of this document, Purpose and Need for Action.

The environmental consequences to each impact topic are described in terms of direct, indirect, and cumulative with a conclusion. Impact thresholds are negligible, minor, moderate, and major.

For *natural resources impact topics:* negligible means that impacts would not be detectable, measurable, or observable. Minor means that impacts are detectable but not expected to have an overall effect on the resource. Moderate means that impacts are detectable with possible short-term effects, but would not threaten the continued existence of the resource. Major means that impacts are long-term or permanent, and possibly threatening to the continued existence of the resource.

For *cultural resources:* negligible means effects at the lowest level of detection that are neither adverse nor beneficial. The determination of effect for compliance purposes would be no adverse effect. Minor means that adverse alteration of a feature would not diminish the overall integrity of the resource, and the determination of effect would be no adverse effect. Minor also means beneficial stabilization or preservation of features according to the *Secretary of the Interior's Standards for the Treatment of Historic Properties;* the determination of effect would also be no effect. Moderate means that adverse modification of a feature would diminish the overall integrity of the resource, and the determination of effect would be adverse effect. A memorandum of agreement (MOA) is executed among NPS, state or tribal historic preservation officer, and Advisory Council on Historic Preservation (if necessary) in accordance with 36 CFR 800.6(b). Measures identified in the MOA to minimize or mitigate adverse impacts reduce the intensity of impact under NEPA from major to moderate. Minor also means beneficial rehabilitation of a structure in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*; the determination of effect would be no adverse effect. Major means alteration of a feature that would diminish the overall integrity of the resource, and the determination of effect would be adverse effect. Measures to minimize or mitigate adverse impacts cannot be agreed upon and NPS, state or tribal historic preservation officer, and/or Advisory Council on Historic Preservation are unable to negotiate and execute a MOA. Major also means beneficial restoration of a structure in accordance with the *Secretary of the Interior's Standards for the Treatment of Historic Properties*; the determination of effect would be no adverse effect.

For *safety:* negligible means that impacts would not be detectable, measurable, or observable. Minor means that impacts could be avoided or minimized through planning. Moderate means that safety concerns, resulting in increased accident rates, would exist regardless of efforts to minimize the hazard. Major means safety issues that would be long term and permanent.

4.1 Effects on Forest Resources

4.1.1 Alternative A – No Action Alternative

Direct and Indirect Impacts

Under this alternative, the applicants would acquire building logs or building materials from commercial sources or other sources external to park lands. The applicants would transport the materials to their private land using using horses, snowmachines, or airplanes; none of these modes of transport require NPS permitting. No live green trees or dead standing timber would be harvested from park lands for house construction; there would be no impacts on forest productivity and recruitment.

Cumulative Impacts

Historic mining activities in the McCarthy Creek valley have cleared routes and development sites. Selective logging dating back to the mining era has affected forest resources. In 2002, much of the access route from the applicants' private lands to McCarthy was cleared for mechanized travel by brushing, blading, and creation of sections of new alignment on undisturbed lands. Additional impacts to forest resources include an ongoing spruce beetle outbreak; forest mortality currently exceeds growth. Since 2002, the applicants have harvested about 150 dead standing trees each year for firewood; with an additional cabin to heat, the applicants would require about 225 dead standing trees each year for firewood. This alternative would have no impacts on forest resources; there would be moderate adverse cumulative impacts on forest resources.

Conclusion

Alternative A would have no adverse impacts on forest resources. The level of effects on forest resources with this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on forest resources.

4.1.2 Alternative B – Subsistence Use of Beetle-Kill House Logs (*Applicants Proposal and NPS Preferred*)

Direct and Indirect Impacts

Under this alternative, the NPS would issue a subsistence house log permit to the applicants. The permit would allow the harvest of dead standing timber only; the allowable harvest would be limited to the first 120 dead standing trees suitable for house construction. The applicants would transport the logs to their inholding using tracked vehicle and sled along an existing route. No logs would be harvested within 300 feet of McCarthy Creek. No live trees would be harvested from park lands; there would be negligible adverse impacts on forest productivity and recruitment. Slash would be treated to avoid increased spread of beetles or increased wildfire fuel loading. Harvest and transportation of house logs during the winter with adequate snow cover would have little effect on ground vegetation.

Cumulative Impacts

Historic mining activities in the McCarthy Creek valley have cleared access alignments and development sites. Selective logging dating back to the mining era has affected forest resources. In 2002, much of the access route from the applicants' private lands to McCarthy was cleared for mechanized travel by brushing, blading, and creation of sections of new alignment on undisturbed lands. Additional impacts to forest resources include an ongoing spruce beetle outbreak; forest mortality currently exceeds growth. Since 2002, the applicants have harvested about 150 dead standing trees each year for firewood. With an additional cabin to heat, the applicants would require about 225 dead standing trees each year for firewood; a total of 345 dead standing trees would be harvested in 2006 only for firewood and house logs. The additional contribution of negligible impacts from this alternative would result in moderate adverse cumulative impacts on forest resources.

Conclusion

Alternative B would have negligible adverse impacts on forest resources. The level of effects on forest resources with this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on forest resources.

4.2 Effects on Aquatic Resources and Fish

4.2.1 Alternative A – No Action Alternative

Direct and Indirect Impacts

Under this alternative, the slight increase in snowmachines and non-motorized surface transportation including horses would have negligible effects to fish habitat and fish population viability. The slight increase in snowmachine and non-motorized surface transportation would have little effect on fish habitat and fish population viability. Fish habitat would continue to recover from the effects of past actions at the current rate. The delivery of large woody debris to streams would return to natural levels and the function of large wood in stream channels would not be altered. Pool frequency and the quantity and quality of off-channel habitat would fluctuate within a range that more closely approximates the natural range. Fish population viability would likely increase as populations continue to recover from the effects of past actions.

Cumulative Impacts

Past actions that have affected fish and fish habitat within the analysis area include route construction and maintenance for the purposes of access to mining sites and more recently the 2002 blading of this route for residential use by the land owner. Delivery of large woody debris and substrate has likely been interrupted in the past by the route although prior to the 2002 blading of the route these disturbances had likely recovered to a functioning level. In addition, two approximately 100-year flood events have occurred within the watershed during the last 20 years (Jones and Glass, 1993). While these events are due to natural causes, the effects have likely had short term but potentially severe impacts to fish habitat and fish populations, including the viability of the Dolly Varden population in McCarthy Creek. Left undisturbed, fish habitat and populations are likely to recover from these events.

There are historic accounts of sport fishing in Nikolai Creek prior to the establishment of the park (National Park Service, 2001). Incidental harvest of migratory Dolly Varden occurs in subsistence fisheries in the Copper River. Additional discussions of subsistence and sport fisheries as well as other actions occurring within the Copper River Basin are presented in Christensen and others (2000).

Subsistence use and non-motorized use in the McCarthy Creek watershed has occurred in the past and is likely to continue in the future. ATVs and non-motorized uses may have a small effect on fish habitat including stream banks. Most subsistence use occurs either prior to Dolly Varden spawning or only during the early portion of the spawning period because moose hunting season ends September 20.

The above past, ongoing, and reasonably foreseeable future actions have caused moderate adverse impacts to fish habitat and fish populations. However, both have been and are expected to continue recovering in the future. The additional contribution of negligible impacts from the no action alternative would not change this; therefore, the overall cumulative impacts to aquatic habitat and fish would continue to be moderately adverse but recovering.

Conclusion

Alternative A would have negligible impacts on aquatic resources and fish. The level of effects to aquatic resources and fish would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on aquatic resources and fish.

4.2.2 Alternative B – Subsistence Use of Beetle-Kill House Logs (*Applicants Proposal and NPS Preferred)*

Direct and Indirect Impacts

Under this alternative the impact causing agents would include a tracked vehicle crossing streams; driving a tracked vehicle on an existing route; and possible fuel spills. Crossing when the water is generally frozen would partially mitigate the negative impacts to fish, fish eggs/embryos, and macroinvertebrates because driving over ice would prevent mobilization of fine sediments in the stream channel. In addition, crossing only where a Fisheries Biologist has determined that redds are not likely present will substantially reduce the potential for direct and indirect impacts to the Dolly Varden population because fine sediments that are mobilized during these crossings would be unlikely to reach Dolly Varden redds. The potential for fine sediments to be mobilized and deposited in redds would be extremely low with this alternative.

Travel over the route by a tracked vehicle has the potential to negatively alter fish habitat by altering the frequency and placement of large woody debris including debris jams present on the floodplain or in areas contributing large woody debris to the stream channel. The potential effects of reducing large woody debris levels in stream channels are reductions in cover, habitat complexity, off-channel habitat, pool depth, and nutrients for macroinvertebrates.

Alteration of large woody debris would be negligible with the proposed action. Permit conditions would not allow harvest of logs within 300 feet of McCarthy Creek or any other water body, and would require that large woody debris be circumvented by the tracked vehicle. Large woody debris would continue to contribute to the natural function of the stream.

Alternative B minimizes the risk of a fuel spill and its negative impacts to the aquatic ecosystem with permit conditions that require appropriate measures to prevent fuel spills and provide rapid containment of spilled fuel. The risk of spilled fuel entering the stream channel in quantities large enough to result in a significant impact to Dolly Varden populations is extremely low.

Cumulative Impacts

Past, ongoing, and reasonably foreseeable future actions have caused moderate adverse impacts to fish habitat and fish populations. However, both have been and are expected to continue recovering in the future. The additional contribution of minor impacts from the proposed action alternative would not change this; therefore, the overall cumulative impacts to aquatic habitat and fish would continue to be moderately adverse but recovering.

Conclusion

Alternative B would have minor adverse impacts on aquatic resources and fish. The level of effects to aquatic resources and fish would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on aquatic resources and fish.

4.3 Effects on Cultural Resources

4.3.1 Alternative A – No Action Alternative

Direct and Indirect Impacts

Under Alternative A, the applicants would acquire logs from commercial and other sources external to park lands, and transport the materials to their private lands by snowmachine, aircraft, and non-motorized methods. None of these modes of transport require a permit from NPS.

The valley's only airstrip is situated on the Spokane Placer claim, outside of the undertaking's area of potential effect. Use of the airstrip would have no effect on cultural resources. The use of snowmachines with adequate snow cover would not affect the historic fabric of the alignment. While horses can affect the alignment's historic fabric and damage artifacts, the effects of continuing this access at present levels would not diminish the overall integrity of the resource.

Cumulative Impacts

Historic mining actitivies in McCarthy Creek valley prior to 1940 established numerous residential and industrial sites and associated access alignments; such features are now historic. Some development in the valley has adversely affected the historic integrity of several properties potentially eligible for the National Register of Historic Properties. Weather extremes, periodic flooding of McCarthy Creek, and localized avalanches around Green Butte Mining Camp have also affected cultural resources. Much of the route connecting Spokane Placer with the town of McCarthy was reopened for mechanized travel by brushing and blading in 2002. Route construction in McCarthy Creek and attendant increases in visitation could lead to additional adverse effects on cultural resources arising from looting, vandalism, and inadvertent damage to sites. Past looting, vandalism, and inadvertent damage to sites has occurred in the past. The additional contribution of minor impacts with this alternative would result in moderate adverse cumulative impacts on cultural resources.

Conclusion

Alternative A would have minor impacts on cultural resources. The level of effects on cultural resources with this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on cultural resources.

4.3.2 Alternative B – Subsistence Use of Beetle-Kill House Logs (*Applicants Proposal and NPS Preferred)*

Direct and Indirect Impacts

Driving a tracked vehicle across McCarthy Creek with its blade up would have no effect on cultural resources. Improving a steam crossing by building snow bridges with the tracked vehicle would threaten cultural resources situated along the banks not readily visible under winter conditions, such as historic bridge abutments. The stipulation requiring identification of areas of concern by park staff to assure protection of these features would mitigate the adverse effects to these features, which contribute to a National Register-eligible road.
.
Assuming that this activity is conducted on frozen ground, adequate snow cover, and with blade of tracked vehicle up, driving the tracked vehicle on the existing route would have negligible effects on cultural resources; the historic fabric of the alignment would not be breached.

Driving the tracked vehicle on within the barren floodplain would have no effect on cultural resources.

Cumulative Impacts

Historic mining actitivies in McCarthy Creek valley prior to 1940 established numerous residential and industrial sites and associated access routes; such features are now historic. Development in the valley has adversely affected the historic integrity of several properties potentially eligible for the National Register of Historic Properties. Weather extremes, periodic flooding of McCarthy Creek, and localized avalanches around Green Butte Mining Camp have also affected cultural resources within the alignment corridor. Much of the route connecting Spokane Placer with the town of McCarthy was reopened for mechanized travel by brushing and blading in 2002. Improvements to the route and attendant increases in visitation could lead to additional adverse effects on cultural resources arising from looting, vandalism, and inadvertent damage to sites within the alignment corridor. Past looting, vandalism, and inadvertent damage to sites has occurred in the past. The additional contribution of minor impacts with this alternative would result in moderate adverse cumulative impacts on cultural resources.

Conclusion

Alternative B would have negligible impacts on cultural resources. The level of effects on cultural resources with this alternative would not result in an impairment of park resources that fulfill specific purposes identified in the park and preserve enabling legislation or that are key to the natural and cultural integrity of the park and preserve. There would be moderate adverse cumulative impacts on cultural resources.

4.4 Effects on Safety

4.4.1 Alternative A – No Action Alternative

Direct and Indirect Impacts

Snow Avalanches. Based upon the location of known and potential snow avalanche zones and general knowledge of the valley there is a real and potentially significant safety concern for individuals traveling along the route, especially in the following areas: proximal to and upstream of Big Ben Millsite, Eastside track opposite the cutbank, within one-half mile downstream of the Marvelous Millsite and upstream of the Dimond Creek. The applicants have spoken of "close calls" they experienced while traveling along their snow machine route. The decision to travel the route would be at the discretion of the traveler. An assessment of the avalanche risk has not been undertaken by an avalanche expert, but based upon the location of known and potential snow avalanches zones and general knowledge of the valley there is a minor safety concern for individuals traveling along the route and a major concern in those areas listed above during periods of high avalanche danger. There would be no increase in safety concerns posed by continued use of snow machines. All activities in a remote mountain setting have inherent risks.

Aufeis (icing). Areas of icing would be likely be encountered along the McCarthy Creek valley while traversing the route with snow machines in the winter. With adequate snow cover the traveler would be able to modify their route or schedule travel to avoid areas and periods of icing. The applicants have successfully utilized this route previously and therefore no significant safety concerns are anticipted.

Flooding. The greatest safety concerns posed by flooding and high water would most likely be associated with periods of high rainfall and or rainfall on snow. There may be periods during the late spring, summer and early fall months when high flows make stream channels crossings unsafe and/or unfeasible. These risks could be mitigated by avoiding passage during high water. Flooding during winter months would most likely be associated with the release of channel blockage by snow and ice. These could be sudden and unpredictable. Monitoring of channel blockage and avoiding reaches down stream would reduce potential safety threats.

Conclusion

Alternative A would not pose any additional increase to safety conditions beyond the existing conditions.

4.4.2 Alternative B – Subsistence Use of Beetle-Kill House Logs (*Applicants Proposal and NPS Preferred*)

Direct and Indirect Impacts

Snow Avalanches. Based upon the location of known and potential snow avalanche zones and our general knowledge of the valley there is a real and potentially significant safety concern for individuals harvesting house logs and traveling along the route, especially in those areas listed above. Travel along the transport route with tracked vehicle may be more likely to trigger a snow avalanche release. Decisions to undertake operations to mark trees, and harvest and transport house logs would be done in consultation with the NPS. Risk could be reduced by travel in the early morning before warm temperatures soften snow at higher elevations, by avoiding periods of high avalanche danger and by skirting around/avoiding areas with know and potential run-out zones.

Aufeis (icing). The ice surface and flows along side slopes or river bottoms may hazardous because they are slippery or are too steep; these may pose challenges for traversing with tracked vehicle and/or skid plate. There is a risk of the tracked vehicle sliding off the route and becoming stuck or turning over. Risk could be reduced to provide for safe and/or feasible passage along side slopes and over up or downhill gradients by avoiding unsafe icy slopes with the tracked vehicle and limiting operations to snow machine in those areas.

In addition, avoiding areas of unsafe or active aufeis formation in the floodplain and channel where feasible would eliminate or reduce potential hazards. During stream crossings operators should watch for hollow ice as the tracked vehicle could break through and may be unable to extract its self. Stream channel aufeis hazards could be reduced or eliminated by proper route reconnaissance and selection to avoid those reaches. For example one would anticipate that the operator would avoid areas of unsafe or active aufeis formation in the flood plain and channel where feasible.

Flooding. There may be periods during the late spring and early fall months when high flows make stream channels crossings unsafe and/or unfeasible. Flooding during winter months would most likely be associated with the release of channel blockage by snow and ice. These events could be sudden and unpredictable, but are rare. Monitoring of channel blockage and avoiding reaches down would reduce potential safety threats.

Conclusion

There is a minor to moderate increase in risks to safety under this alternative due to the window of operations from aufeis, flooding and snow avalanche. These would have only a minor additional adverse impact on safety conditions if proper reconnaissance, route selection and avoidance of dangerous reaches and period are integrated into operation while harvesting and transporting house logs within McCarthy Creek Valley.

5.0 CONSULTATION AND COORDINATION

The following National Park Service staff prepared sections of this EA:

Wrangell-St. Elias National Park and Preserve
Steve Hunt, Environmental Coordinator
Danny Rosenkrans, Geologist/Lands Specialist
Eric Veach, Acting Chief of Resources
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The following individual was consulted during preparation of this EA and prepared Appendix B:

Michael Gregg Loso, Ph.D., Associate Professor, Alaska Pacific University. Ph.D. Earth Sciences, University of California, Santa Cruz, 2004; MS Botany, University of Vermont, 1996; BS Environmental Studies, University of California, Santa Barbara, 1990.

The following National Park Service specialists were consulted during preparation of this EA:

Wrangell-St. Elias National Park and Preserve
Jed Davis, Superintendent
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6.0 Appendices

Appendix A

WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE SUBSISTENCE LOG POLICY

L30

January 1, 1989

Memorandum

To: Park Staff

From: Superintendent, Wrangell-St. Elias NP/P

Subject: Subsistence Green Log Policy

It is the policy of the Superintendent, Wrangell-St. Elias National Park and Preserve, to allow for the non-commercial cutting of green logs in accordance with the provisions of the Alaska National Interest Lands Conservation Act (ANILCA) and Title 36 CFR, Part 13.49, "... the Superintendent may permit cutting in accordance with the specifications of a permit if such cutting is determined to be compatible with the purposes for which the park area was established". This policy covers the non-commercial cutting of live standing timber (green logs) for appropriate subsistence uses, such as houselogs or firewood greater than 3" at ground height.
Of primary concern to the National Park Service is the maintenance and protection of forest resources and other park values. Subsistence green log permits will only be issued if it can be shown that harvest will not impair or otherwise degrade the viability of the forest resource and other park values.

Applicants for subsistence green log permits must meet the following conditions prior to issuance of a permit by the Park Superintendent.

STANDARD PERMIT PROCEDURES AND CONDITIONS:

For subsistence house log permits, the applicant must demonstrate a significant need for green logs, and may only be used for a primary place of residence.

Applicant, generally, must live within the park boundary and have demonstrated a customary and traditional use of park resources.

Applicant must provide evidence of exploring reasonable alternative sources for logs such as logs from state, private or university lands, or by transporting logs which are harvested outside the park, to the building site. The Superintendent will also consider the availability of suitable downed timber from both private and public lands in determining amount of green logs to be taken from park lands.

For subsistence house log permits, the applicant must submit a rough plan/sketch, dimensions and proposed method of construction to the Superintendent before permit is considered.

For subsistence house log permits, the allowable harvest shall not exceed 120 trees (includes both live and dead trees), the amount required for a cabin of 280 sq. ft. (determined on the basis of the average size of 237 cabins identified on park/preserve lands). This amount includes a 20% allowance for waste, unusable wood, tree size variability and miscellaneous needs.

For firewood permits, the applicant will be limited to what is reasonably needed for purposes of heating, cooking, etc. in the primary place of residence.

The Superintendent may further limit the amount of logs based on concerns for forest viability, limited annual production and potential impact on park values.

Subsistence house logs may only be used for a primary residence and may not be used for commercial purposes (sale of whole logs or sale of lumber cut from subsistence logs) or in structures used for commercial purposes (lodges, etc.).

Green logs granted for firewood use may be used only for that purpose and may not be used for house construction, saw timber or other uses unless specifically authorized on the permit.

All subsistence logs, must be marked and measured by NPS staff prior to harvest.

The Superintendent will designate access routes to be used for harvesting and skidding subsistence green logs.

Subsistence green logs may not be harvested farther than one half mile from a designated access route.

Timber felling and skidding will be limited by ground conditions and season to protect resource values and is generally limited to frozen ground with a minimum of 6-12" of snow cover.

An additional subsistence house log permit will not be issued to a landowner/family for a period of 10 years after the previous permit was issued. This condition applies to any land subdivided or transferred subsequent to the issuance of the original subsistence house log permit.

An additional subsistence house log permit may be issued due to emergency or unusual and unforseen circumstances (fire, other damage, etc.).

Subsistence firewood permits may be issued on a yearly basis.

Permits may not be issued in zones or areas where subsistence timber harvest would result in a threat to the viability of the forest resource or which would otherwise compromise the purposes for which the park was established.

Environmental, archeological, historical and subsistence compliance may be required prior to issuance of subsistence log permit.

The Special Use Permit (10-114) shall be the permitting instrument and shall be completed in accordance with NPS-53.

Violation of the terms and conditions of the permit may result in an immediate revocation of the permit by the Superintendent.

Subsistence green log permits may only be issued by the Superintendent or his designee.

Richard H. Martin
Superintendent

Appendix B

ANILCA SECTION 810(a) SUMMARY EVALUATION AND FINDINGS

ANILCA SECTION 810(a)

SUMMARY EVALUATION AND FINDINGS

VII. INTRODUCTION

This analysis was prepared to comply with Title VIII, Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA). It summarizes the evaluation of potential restrictions to subsistence uses that could result from the National Park Service (NPS) issuing a subsistence house log permit to allow the non-commercial cutting and removal of 120 dead standing trees from the McCarthy Creek valley within Wrangell-St. Elias National Park and Preserve.

VII. 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 effected 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 section 805;

(2) gives notice of, and holds, a hearing in the vicinity of the area involved; and

VII. 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 will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition, and (C) reasonable steps will be taken to minimize adverse impacts upon subsistence uses and resources resulting from such actions."

ANILCA created new units and additions to existing units of the national park system in Alaska. Wrangell-Saint Elias National Park, containing approximately eight million one hundred and forty-seven thousand acres of public lands, and Wrangell-Saint Elias National Preserve containing approximately four million one hundred and seventeen thousand acres of public lands, was created by ANILCA, section 201(9), for the following purposes:

> "To maintain unimpaired the scenic beauty and quality of high mountain peaks, foothills, glacial systems, lakes, and streams, valleys, and coastal landscapes in their natural state; to protect habitat for, and populations of, fish and wildlife including but not limited to caribou, brown/grizzly bears, Dall sheep, moose, wolves, trumpeter swans and other waterfowl, and marine mammals; and to provide continued opportunities including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities. Subsistence uses by local residents shall be permitted in the park, where such uses are traditional, in accordance with the provisions of Title VIII."

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."

VII. PROPOSED ACTION ON FEDERAL LANDS

The National Park Service proposes to issue a subsistence house log permit to allow the non-commercial cutting and removal of 120 dead standing trees in Wrangell-St. Elias National Park and Preserve in accordance with 36 Code of Federal Regulations Section 13.49(a), and provisions of the park's subsistence green log policy. A copy of the subsistence green log policy is in Appendix A of this environmental assessment. Alternative B, the proposed action alternative, is summarized below. A full discussion of the alternatives and their anticipated effects is presented in the environmental assessment.

Alternative A – No Action Alternative: The NPS would not approve the applicants' request for a permit to harvest subsistence house logs in the McCarthy Creek valley. The applicants would be able to acquire house logs or other building materials from sources external to park lands, and they could transport the logs to their inholdings using snowmachines, aircraft, and non-motorized surface transportation methods – all methods allowed under ANILCA section 1110(a) with no special authorization from the NPS required.

Alternative B – Subsistence Use of Beetle-Kill House Logs (Applicants' Proposal and NPS Preferred Alternative): The NPS would approve the applicants' request for a permit to harvest 120 subsistence house logs in the McCarthy Creek valley upstream of Nikolai Creek. White spruce (*Picea glauca*) is the tree species most commonly used for house logs as well as firewood in this area (Loso 2005). The logs would be harvested during the winter under conditions of snow cover and frozen ground. They would be transported from the harvest site to the designated access route by snowmachine and then along that access route to the applicants' inholding by tracked vehicle with sled. An estimated 50-100 crossings of McCarthy Creek would be necessary; however, creek crossings would occur when the creek is frozen over or has ice build-up. The harvest would be limited to trees killed as the result of a spruce beetle outbreak dating to 1990. No live trees (green logs) could be harvested. Due to the poor condition of some of the beetle-kill trees, NPS would mark 240 standing dead trees, and the applicants would be authorized to use the first 120 trees harvested and found in condition suitable for cabin construction. The harvested logs would be for the construction of a primary permanent residence only and could not be used for a structure used in commercial business or other commercial purposes. A number of terms and conditions would be applied to the permit to ensure protection of the preserve's resources and values. These are listed in the green log policy and the EA.

IV. AFFECTED ENVIRONMENT

A summary of the affected environment pertinent to subsistence use is presented here. The following documents contain additional descriptions of subsistence uses within Wrangell-St. Elias National Park and Preserve:

General Management Plan/Land Protection Plan, Wrangell-St. Elias National Park and Preserve, NPS Alaska Region, 1986.

Final Environmental Impact Statement, Wilderness Recommendation, NPS Alaska Region, 1988.

Wrangell-St. Elias Subsistence Plan, NPS Alaska Region, 1998. (Updated approximately annually.)

Subsistence uses are allowed within Wrangell-St. Elias National Park and Preserve in accordance with Titles II and VIII of ANILCA. The national preserve is open to both federal subsistence uses and state-authorized general (sport) hunting, trapping and fishing activities. Qualified local rural residents who live in one of the park's 23 designated resident zone communities, live within the park, or have a special subsistence use permit issued by the park superintendent may engage in subsistence activities within the national park. State-regulated sport fishing is also allowed in the national park. The proposed action falls within the national preserve.

The landscape within Wrangell-St. Elias National Park and Preserve ranges from forests and tundra to the rock and ice of high mountains. The region's main subsistence resources are salmon, moose, caribou, Dall sheep, mountain goat, ptarmigan, grouse, snowshoe hare, furbearing animals, berries, mushrooms, and dead and green logs for construction and firewood. The McCarthy Creek valley has forests and shrubland at lower elevations, with alpine tundra, moraines and glaciers at higher elevations. It is an area where local rural residents could hunt for wildlife such as moose, brown bear, black bear, goat, Dall sheep, ptarmigan and grouse. Trapping for furbearers also occurs. Currently McCarthy Creek is not a significant area for subsistence fishing, however it does support some Dolly Varden and historic records indicate some fishing activity. Federally qualified subsistence users in the area have a positive customary and traditional use determination for freshwater fish in this creek. Vegetation within the area of the proposed harvest and access route ranges from floodplain terrances sparcely vegitated with dryas, forbs and low willow to terraces with young forests to wetlands with black spruce, low willow, moss, and forbs to high brush and open white spruce forest. The forest understory includes alder, willow, high-bush cranberry, soapberry and forbs. Except for the harvest of dead and downed trees for firewood and possibly berry picking, there is little to no subsistence use of vegetative material. Plant resources of potential interest to subsistence users include cloudberries and high-bush cranberries.

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 may vary considerable from previous years due to weather conditions, migration patterns, and natural population cycles.

VII. 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 as follows:

1. the potential to reduce important subsistence fish and wildlife populations by (a) reductions in numbers; (b) redistribution of subsistence resources; or (c) habitat losses;

2. the effect the action might have on subsistence fisher or hunter access;

VII. the potential for the action to increase competition for subsistence resources.

The potential to reduce populations:

Subsistence species of fish and wildlife and their habitats would be subject to some potential impacts and disturbances as a result of the proposed actions. The requested log harvest and transport may cause the temporary disturbance and displacement of wildlife and could result in minor habitat losses; however, this is not expected to result in long-term wildlife population declines. The log transport is not anticipated to have a direct impact on fish, as no harvest will occur directly adjacent to streams and stream crossings would occur over ice. Removal of trees from the local area for house logs in the short term and then for firewood to heat the new cabin on a more long-term basis will reduce the amount of large woody debris in local streams, thereby affecting the quality and quantity of fish habitat. The impact on fish populations is not anticipated to be significant, however, and subsistence harvest of fish in this valley is limited at best. Thus, the proposed alternatives are not expected to significantly alter fish or wildlife movements or reduce populations of important subsistence fish and wildlife resources.

Beyond this, NPS regulations and provisions of ANILCA provide the tools for adequate protection of fish and wildlife populations on federal public lands while ensuring a subsistence priority for local rural residents. NPS regulations allow the superintendent to enact closures, restrictions, or both if necessary to protect subsistence opportunities and ensure the continued viability of particular fish or wildlife populations.

The effect on subsistence access:

Rights of access for subsistence uses on NPS lands are granted by Section 811 of ANILCA. Allowed means of access by federally qualified subsistence users in Wrangell-St. Elias National Park and Preserve include motorboat, snowmachine (subject to frozen ground conditions and adequate snow cover), off-road vehicles (ORVs), and airplane (preserve only), along with non-motorized means such as foot, horses, and dog teams. The proposed action along with the no-action alternative would have no direct impact on allowed means of subsistence access, nor would they affect the areas open to subsistence users or the condition of the access routes to those areas. Thus, the proposed action as well as the other alternative discussed in this analysis should have no effect on subsistence hunter or fisher access.

The potential to increase competition:

Competition for subsistence wildlife or fish resources on federal public lands is not expected to significantly impact subsistence users as a result of either the requested log harvest or the no-action alternative. No substantive change in the condition of the access route – and thus ease of access to the area – is anticipated, nor are any of the alternatives discussed in this analysis expected to impact other factors, such as the number of people living in the area, that could affect competition for fish or wildlife.

The proposed action alternative could have an impact on the future ease of access to and thus competition for house logs and firewood in the upper McCarthy Creek valley. Under the action alternative, the applicants would harvest 120 standing dead trees under the conditions of their house log permit in the next year or two. Once the cabin is constructed, they would likely harvest approximately 75 trees each year to heat the new cabin (based on figures in Loso 2005: 19-20). (This harvest would be above and beyond the approx. 150 trees a year that are being harvested to heat the two existing cabins in the valley.) Loso (2005:22) writes that "from the perspective of white spruce productivity, even a substantial harvest of houselogs (*sic*) or firewood from this resource should have minimal negative impacts." Over time, however, the easily accessible trees would be depleted and subsistence users would have to travel further and perhaps onto more difficult terrain to harvest house logs and firewood. Nonetheless, possible impacts to subsistence firewood and house log resources from the requested house log permit are considered negligible due to its remote location.

VII. AVAILABILITY OF OTHER LANDS

As part of their application, the green log policy requires that the applicants demonstrate that they have looked into other reasonable alternatives, such as the harvest of house logs from state or private lands, before the NPS would issue a permit to harvest logs from park lands. Except for minor variations in where trees are marked and then harvested, no other NPS-managed lands would satisfy the request for the harvest of house logs in the upper McCarthy Creek valley. There are, however, other federal public lands within and outside of the park and preserve that are available for subsistence.

VII. ALTERNATIVES CONSIDERED

The EA and this evaluation have described and analyzed the proposed alternatives. The proposed actions are consistent with NPS mandates and the General Management Plan for Wrangell-St. Elias National Park and Preserve.

Allowing the applicants to harvest green logs in the McCarthy Creek valley was considered but rejected. A recent forest resource inventory of the valley indicates that such harvest is environmentally unsustainable and thus would adversely affect the forest resource (Loso 2005). No other alternatives that would reduce or eliminate the use of public lands needed for subsistence purposes were identified. It is possible for subsistence users to utilize other lands inside and outside the park and preserve. Subsistence users extend their activities to other areas as necessary.

VII. FINDINGS

This analysis concludes that the proposed action, including all proposed alternatives, will not result in a significant restriction of subsistence uses.

Reference:

Loso, Michael G. 2005. McCarthy Creek Forest Resource Inventory. Resource Report NPS/AR/NRTR-2005-52. United States Department of the Interior, National Park Service, Alaska Region.

Appendix C

McCARTHY CREEK FOREST RESOURCE INVENTORY RESOURCE REPORT

McCARTHY CREEK FOREST RESOURCE INVENTORY

Michael G. Loso

Resource Report, NPS/AR/NRTR-2005-52

McCARTHY CREEK FOREST RESOURCE INVENTORY

Michael G. Loso

Resource Report, NPS/AR/NRTR-2005-52

Cover photo: Wetlands on a forested bench east of McCarthy Creek, upstream from its confluence with the East Fork. Beetle-killed white spruce dominate the middle ground, and Green Butte is visible behind. Photograph by author Michael Loso, July 7, 2004.

United States Department of the Interior

National Park Service

Alaska Region

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SUMMARY

I conducted a forest resource inventory in the upper McCarthy Creek valley to assist with the management of subsistence timber harvest. Densities, standing volumes, productivity, site index, and demographic characteristics of white spruce were determined at 72 subplots in three mapped physiographic units: Flatwoods, Slopes, and Floodplains. Flatwoods (238 hectares in the study area) include black spruce and willows, have relatively low productivity, and show moderate recruitment. Slopes (772 ha) include birch and alder, have moderate productivity, and show low recruitment. Floodplains (63 ha) include balsam poplar and willows, have slightly higher productivity, and show the highest recruitment.

Relative to other parts of southcentral Alaska, all of the forests in upper McCarthy Creek have low potential productivity (site index = 56.0). Actual productivity is currently even lower because standing densities of white spruce are low, and because a major spruce beetle epidemic has killed much of the standing timber. Throughout the study area, measured gross productivity is low (0.22 m^3/ha/yr) and net productivity is negative. Because spruce beetle activity was quite high in the summers of both 2003 and 2004, and spruce beetles have a 1-2 year life cycle, substantial additional mortality is expected in the study area next summer and perhaps afterwards.

All of the sampled sites have mixed age distributions that suggest they developed in the absence of large fires. Using age-specific mortality rates inferred from similar forests in the adjacent Kennicott Valley, I used a demographic model to predict the equilibrium densities of mature trees. In the absence of major episodic mortality (like spruce beetle epidemics or selective human harvesting), recruitment is just sufficient to account for the densities of mature trees on Flatwoods and Floodplains, and recruitment is insufficient to account for current densities on Slopes. In the last decade, however, beetles have killed 49%, 48%, and 80% of the mature trees on Flatwoods, Slopes, and Floodplains respectively. Under these circumstances, the model shows that recruitment is clearly insufficient to replace the dying trees. There is no sustainable way to harvest live white spruce, whether for houselogs or for firewood, under the current conditions.

Beetle-killed spruce may offer an alternative source of houselogs and firewood for subsistence harvest. About half of the dead trees are rotten, but a viable resource remains: at present, ~32, 40, and 88 sound useful houselogs per hectare are found on Flatwoods, Slopes, and Floodplains. In the entire study area, then, there are over 40,000 usable houselogs. Beetle-kill also provides a potentially valuable firewood resource: by volume, 72% of the white spruce wood in upper McCarthy Creek's forests is currently supplied by dead trees.

The vast majority of these, however, would be very difficult to access. Slopes cover the largest portion of the study area, but are generally inaccessible due to steep slopes, thick brush, and distance from the road. Floodplains are rare, but they include the most accessible sites and the largest trees. As a consequence, even a narrow corridor of easily accessible land (100 m to either side of the primary access alignment) may contain over 7000 usable, beetle-killed houselogs. From the perspective of white spruce productivity, the use of some fraction of the beetle-killed white spruce for houselogs or firewood should have minimal negative impacts. Other impacts of such harvest, on wildlife habitat, visitor experience, and understory vegetation, for example, may be substantial but are beyond the scope of this work.

INTRODUCTION

Within the administrative boundaries of Wrangell-St. Elias National Park and Preserve, U.S.A. (WRST), the Alaska National Interest Lands Conservation Act (ANILCA) provides for the subsistence use of certain renewable resources by local residents. Specifically, Title 36 CFR Section 13.49(a) authorizes local rural residents in park areas where subsistence uses are allowed to obtain permits for the cutting of standing timber for subsistence needs. In accordance with this regulation, the National Park Service (NPS) has issued a Subsistence Green Log Policy (National Park Service, 1989) that provides guidelines for non-commercial cutting of live standing timber for a primary residence within the park, when other sources of house logs are not feasible. This policy states, in part:

> "Of primary concern to the National Park Service is the maintenance and protection of forest resources and other park values. Subsistence green log permits will only be issued if it can be shown that harvest will not impair or otherwise degrade the viability of the forest resource and other park values."

In February 2004, NPS staff received five applications for house log harvest permits from residents of the Marvelous Millsite property along upper McCarthy Creek in WRST. Because no systematic study of forest conditions had yet been conducted in the McCarthy Creek valley, NPS staff determined that a forest resource inventory was necessary to ensure that any permitted harvest would meet the stated goals of maintaining and protecting forest resources and other park values. This report is being prepared to address that need.

I focus here on white spruce [*Picea glauca* (Moench) Voss], the tree species favored and most commonly used by rural residents for both firewood and houselogs. Within the area that encompassed the upper McCarthy Creek Valley, the primary goals of this study were to: A) map the distribution of white spruce forest types; B) characterize the standing densities and volumes of all tree species; C) estimate the actual and potential productivity of white spruce, including characterization of the extent and intensity of an ongoing spruce beetle outbreak; D) model the population dynamics of white spruce; and E) relate these data to historic, current, and potential future impacts of human harvesting.

METHODS

Study Area

The McCarthy Creek Valley encompasses a mixture of glaciers, rocky moraines, forest, shrubland, and alpine tundra. The study area (61°29' N, 142°47' W; Figure 1) encompasses only the forested land deemed accessible for subsistence use by the permit applicants. Based on interviews with the applicants, the major obstacle to houselog transport is "Eight Mile Hill." This steep hill (on the primary access alignment along the west side of McCarthy Creek upstream from the confluence with Nikolai Creek, Figure 1) renders impractical the freighting of heavy logs between lower McCarthy Creek and the applicants' Marvelous Millsite property. The study area consequently encompasses only the forested land upstream of this location. Forested land is defined as having or potentially supporting >10% canopy cover by one or more of the Valley's five tree species (Viereck et al., 1992):

white spruce	*Picea glauca* (Moench) Voss
black spruce	*Picea mariana* (Mill.) B. S. P.

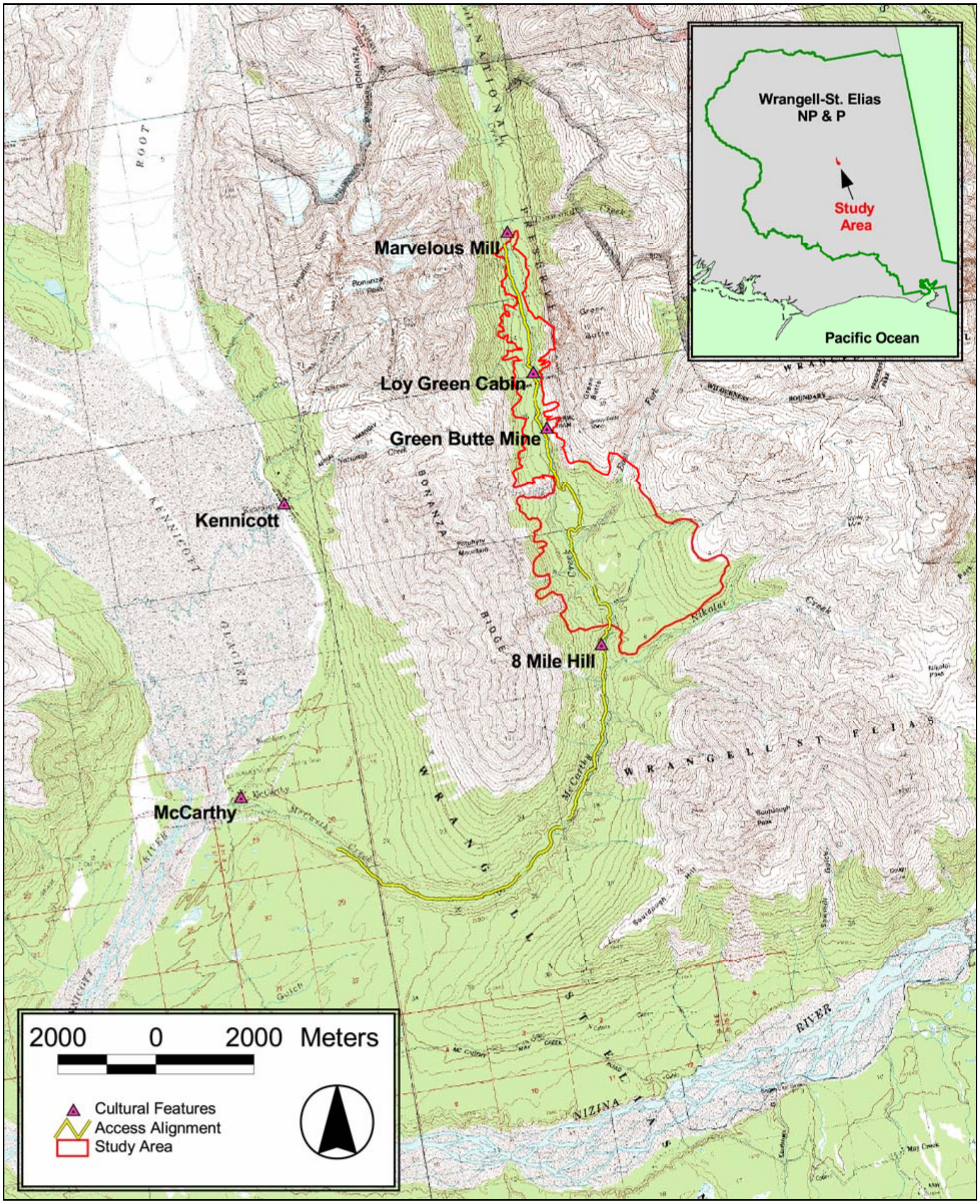

FIGURE 1. Location of the study area (red polygon) and select cultural features in McCarthy Creek and the adjacent Kennicott Valley. INSET: General location within Wrangell-St. Elias National Park and Preserve (green polygon), southcentral Alaska.

balsam poplar	*Populus balsamifera* L.
quaking aspen	*Populus tremuloides* Michx.
paper birch	*Betula papyrifera* Marsh. var. *humilis* (Reg.) Fern. & Raup

The general outline of forested land in the study area encompasses 1290 hectares (3188 acres), of which 1073 hectares (2652 acres) contain productive white spruce forest. In the study area, forest elevation ranges from 670 m (2200') at the McCarthy - Nikolai Creek confluence to 1066 m (3500') at highest timberline.

The McCarthy Creek Valley is part of the Wrangellia terrane, a block of crustal rock that originated in the tropical Pacific Ocean (Plafker et al., 1994). As the island-arc moved north during the Triassic and Jurassic, greenstones, limestones, and shales accumulated; they now underlie much of the study area. Wrangellia docked with mainland Alaska in the late Cretaceous, followed by the Chugach and Yakutat terranes. The latter event resulted in an intrusion of Tertiary dacite porphyry that underlies the southwestern portion of the study area, and gave rise to Quaternary and Tertiary volcanic rocks in the upper Valley that now mantle some of the study area as glacial deposits (MacKevett, 1978). Such deposits, from Pleistocene advances of the McCarthy Creek glacier, have mostly been extensively reworked by Holocene colluvial processes (on hillslopes) and fluvial processes (in floodplains and river terraces). Flat benches of poorly drained lacustrine sediments are conspicuous in the middle to lower reaches of the study area between 762 m (2500') and 945 m (3100'), and reflect late-Wisconsin glacial impoundment of McCarthy Creek (Hecht and Garb, unpublished) and/or the Copper River (Ferrians, 1989).

Sampling

The study area was stratified into physiographic units through analysis of existing aerial photos, field reconnaissance, and surficial geology maps (Jones and Glass, 1993). After excluding areas without a significant white spruce component (active river bars, rock glaciers, black spruce muskeg, and bogs), three physiographic units were identified using the criteria of the USFS Forest Inventory and Analysis Program in their 2004 Inventory of Coastal Alaska (Anonymous, 2004). General characteristics of these units are given in Table 1.

I found considerable geomorphic variation within each physiographic unit, yet each of the three units exhibited a particular vegetative character that was readily discernible both in the field and in aerial photos. **Flatwoods** (USFS unit 21) are characterized by a conspicuous black spruce (*Picea mariana*) component that, along with scattered white spruce and a typically dense subcanopy of willows (*Salix* sp.) and dwarf birch (*Betula nana*), distinguish them from other units. The steeper slopes and moderately well-drained soils of **Slopes** (USFS unit 23 – they call this unit "Moist Coves") contain mature, open stands of white spruce and scattered paper birch (*Betula papyrifera*) over a very dense shrub layer of Sitka alder (*Alnus crispa*). The younger and better-drained soils of **Floodplains** (unit 25) support white spruce and balsam poplar (*Populus balsamifera*) over a variably dense layer of soapberry (*Shepherdia canadensis*). Quaking aspen (*Populus tremuloides*) was not found in any of the study sites.

Eighteen sites were chosen for intensive study. The sites were initially chosen from aerial photos to maximize sampling efficiency, emphasize accessible forest, and represent relatively homogenous stands. Following this initially subjective site selection process, the exact location of each site center was randomized in the following manner: A) approximate latitude and longitude of the site was determined

TABLE 1. Selected attributes of three physiographic units in upper McCarthy Creek.

Physiographic Unit Parameters	**Flatwoods**	**Slopes**	**Floodplains**
Unit code*	21	23	25
Site numbers	3, 4, 9, 12, 13, 14, 15, 16, 17	1, 2, 6, 7, 11	5, 8, 10, 18
Total area (ha)	238	772	63
<1000 m from road (ha)	190	508	63
<500 m from road (ha)	126	359	63
<100 m from road (ha)	38	51	47
Elevation range (m)	760 - 850	670-1070	670-820
Slopes (□)	0-10	5-35	0-3
Parent Material	Lacustrine silts and clays, capped with 1-several meters diverse colluvium	Weathered colluvial dacite porphyry, limestone, and basalt	Fluvial sands and gravels
Soil drainage	Moderately to poorly drained	Moderately-well drained	Well drained
Depositional environment	Latest Pleistocene/early Holocene lake clays from the exposed floor of ice-dammed Lake Ahtna, and perhaps McCarthy Creek if ever impounded by the Kennicott Glacier.	Deeply weathered bedrock and minor glacial till periodically mobilized by debris flows, rockslides, avalanches, and fluvial incision. Some relatively stable interfluves and benches.	Deposited and periodically reworked by McCarthy Creek in the late Holocene. Most terraces are 1-several hundred years old.
Dominant canopy trees (% cover)	*Picea glauca* 30-50 *Picea mariana* 0-20	*Picea glauca* 35-45 *Betula papyrifera* 0-20	*Picea glauca* 20-45 *Populus balsamifera* 10-60
Dominant subcanopy shrubs (% cover)	*Salix* sp. 35-70 *Betula nana* 0-30	*Alnus crispa* 20-80 *Viburnum edule* 15-35	*Salix* sp. 15-70 *Sheperdia canadensis* 10-70
Dominant groundcover (% cover)	graminoids 10-70 *Cornus canadensis* 0-30	*Cornus canadensis* 15-40 *Equisetum arvense* 15-25	*Mertensia panicula* 10-30 graminoids 20-30
Stand age	128	144	139
Evidence of historic logging	Yes	Yes	Yes
Primary disturbance	Spruce beetle outbreak	Spruce beetle outbreak	Spruce beetle outbreak

*from *Field Instructions for the Annual Inventory of Coastal Alaska* from the aerial photo; B) coordinates were entered into a handheld GPS; C) once in the field, a bearing to the site was selected from the nearest section of existing access alignment; D) GPS was used to follow the bearing in as straight a line as possible; and E) the site center was established at the first location <25 m (according to the GPS) from the chosen coordinates and meeting the following criteria: no saturated soil or standing water during the growing season; no exposure of bedrock; and a minimum of 10% canopy cover by trees >3 meters tall. No sites violated these criteria. At each site, sampling was performed in a manner consistent with the methods employed by the USFS Forest Inventory and Analysis Program in their 2004 inventory of Coastal Alaska (Anonymous, 2004). Each site consists of four subplots 7.3 m (24.0') in radius (0.017 ha, 0.042 acre) and four accompanying microplots 2.1 m (6.8') in radius (0.001 ha, .003 acre). As shown in Figure 2, each subplot/microplot pair was separated from the others by 36.6 m (120'). Except where otherwise noted, these subplots were treated as the basic sampling unit for subsequent analysis.

Standing stems were tallied to calculate density for white spruce, black spruce, balsam poplar, and paper birch in four size classes: seedlings [<2.54 cm (1") dbh], saplings [≥2.54 cm (1") dbh & <12.7 cm (5") dbh], poles [≥12.7 cm (5") dbh & <25.4 cm (10")], and houselogs [≥25.4 cm (10")]. Seedlings were measured in microplots only, while all other size classes were tallied in subplots. All stems were assigned to one of five damage classes: healthy live, damaged live (applied only to beetle-infested trees that still bore green needles), dead <3 years, dead ≥3 years and <15 years, or dead ≥15 years. Fifteen years is the approximate regional duration of the current spruce beetle outbreak (Loso, 1998), and the majority of spruce beetle mortality specifically located in McCarthy Creek occurred within the last three years (Wittwer, 2004; Zogas, 2004). For dead trees, cause of death was recorded as either spruce beetles or, in the few cases where there was no clear evidence of beetle attack, unknown.

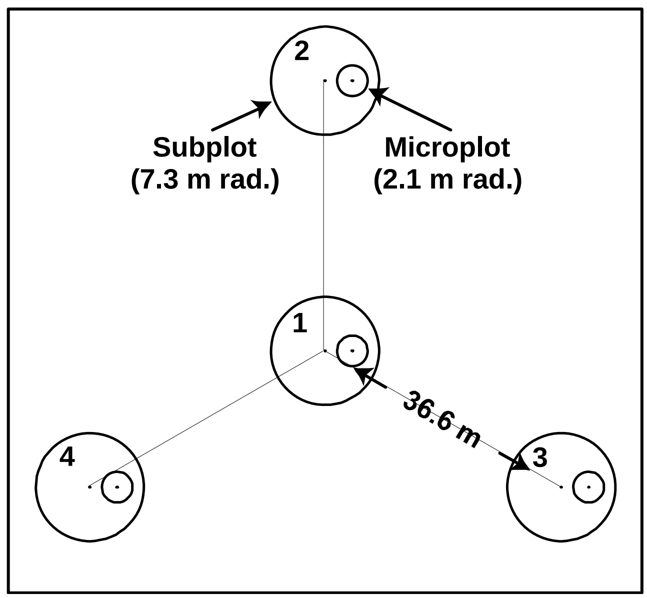

FIGURE 2. Configuration of subplots and microplots within each numbered study site. Follows USFS Forest Inventory and Analysis Program (Anonymous, 2004).

The height and dbh of saplings, poles, and logs of all species were recorded for subsequent calculations of standing volume. After 6 sites were sampled, I examined the correlation of height and dbh for each species, and determined that heights of stems <20 cm (7.9") dbh could subsequently be estimated by regressions of height on recorded dbh (shown in Figure 3). All of the height values for larger trees, including heights used later in calculations of white spruce site index, were measured directly. Height of all seedlings was recorded, and white spruce seedling substrate (mineral soil, duff, or rotten wood) was noted.

To document the population structure of white spruce, the ages of 449 stems (both alive and dead) were determined. I cored all white spruce stems ≥6 cm (2.4") dbh at breast-height with an increment borer,

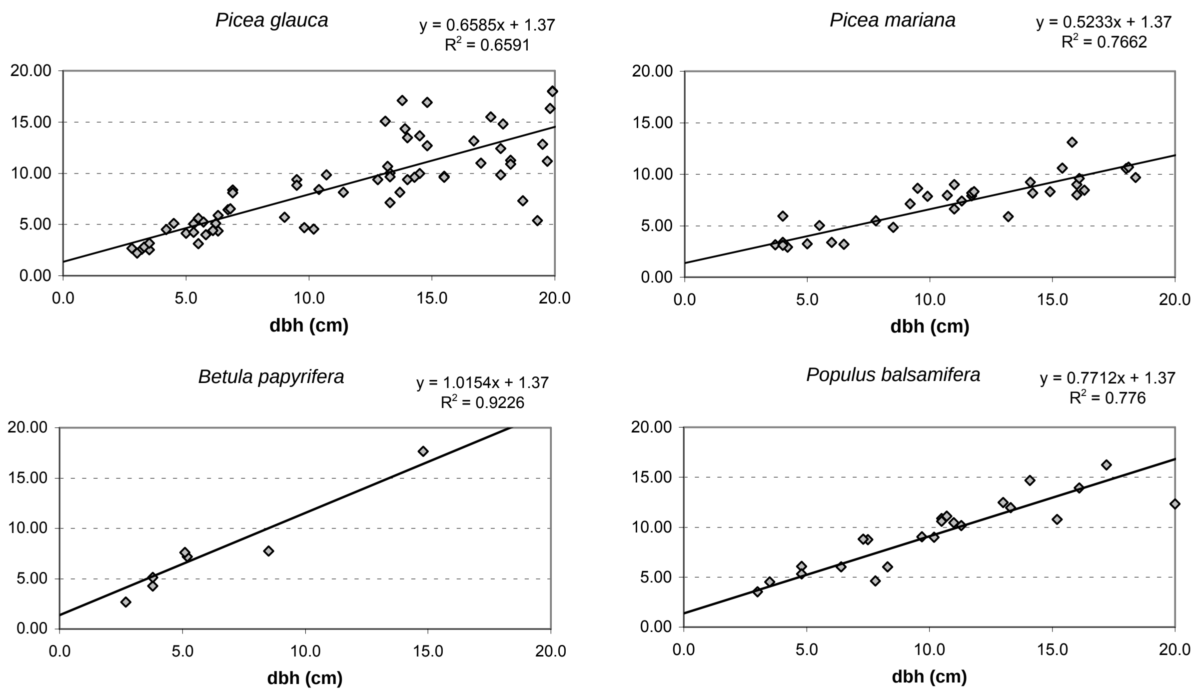

FIGURE 3. Relationship of height to diameter at breast height (dbh) for four different tree species in the upper McCarthy Creek valley. Regression equations are shown at upper right of each panel. These regressions were used to predict heights of additional trees smaller than 20 cm dbh; regressions are limited to trees with dbh < 20 cm to maximize variance reduction. Heights of trees with dbh ≥ 20 cm were always measured directly.

always to within 1 cm of the pith. Cores were shaved with a razor blade and examined under a dissecting microscope for number of annual rings and radial increment in the last 10 years. Counting errors are estimated to be less than ±5 years/100 years. On cores that missed the pith, number of missing rings was estimated based on an extrapolation of average ring width. To minimize destructive sampling of seedlings and saplings too small for an increment borer, ages of stems <6 cm dbh were estimated using a regression of age versus height developed in the adjacent Kennicott Valley (Loso, 1998).

Several environmental characteristics were recorded at each site. I noted the percentage cover of dominant vascular plant species in the canopy, subcanopy, and understory, and I examined shallow soil pits for soil drainage class, parent material type, and evidence of buried charcoal. Other indicators of disturbance history such as fire scars, tip-up mounds, age and number of cut stumps, beetle kills, down wood, cultural artifacts, and signs of geomorphic activity were noted. All fieldwork took place in July 2004.

Analysis

Physiographic units were initially hand drawn on 1:6000 scale aerial photographs. Delineated units were subsequently digitized using ArcView Geographical Information System (GIS) software. Rectified raster images of these and other aerial photographs were used as the base map while digitizing. The ArcView Geospatial Analyst was used to calculate total areas of mapped units, and also to generate buffer zones of varying widths along the primary access alignment. Areas of each physiographic unit contained within these buffer zones measure the relative accessibility of forest land from each unit.

The volumes of standing live and dead poles and houselogs (≥12.7 cm dbh) were calculated with Gregory and Haack's equations (for English units: 1964):

$$V_{\text{white spruce}} = -2.0555 + 0.2982D + 0.00181D^2H$$
$$V_{\text{balsam poplar}} = -3.2187 + 0.8281D - 0.05908D^2 - 0.01985H + 0.00199D^2H$$
$$V_{\text{paper birch}} = -2.5767 + 0.9524D - 0.10446D^2 - 0.03303H + 0.00282D^2H$$

where $V_{species}$ is tree volume (cubic feet) inside bark from a 0.3 m high stump to a 10.2 cm diameter top, H is tree height in feet, and D is diameter outside bark at breast-height. Cubic feet were converted to cubic meters ($m^3 = ft^3 \times 0.02832$). These equations were chosen as a best estimate for the amount of usable firewood in a given tree. Because no volume equation for black spruce was reported by Gregory and Haack, black spruce volume was calculated from the published white spruce equation and probably overestimated slightly due to the generally greater taper of black spruce (Vincent, 1965).

Actual productivity of white spruce for each landform unit (meters^3/hectare/year) was estimated by stand-table projection, a method considered most appropriate for uneven-aged, low-density stands such as those found in the Kennicott Valley (Avery and Burkhart, 1983). Live trees ≥12.7 cm dbh were grouped into 2.5 cm dbh size classes and annual increment determined using standard methodology (Beck, 1987). Production was computed as the sum of annual increment for each size class plus ingrowth. Two measures of actual productivity are presented: actual gross productivity, which measures the volume of wood added each year by living trees, and actual net productivity, which equals gross productivity minus the volume lost in mortality.

Site index is a commonly used means of estimating forest site quality, based upon the expected height of a given tree species at some arbitrary age (Hagglund, 1981). Site index was calculated for white spruce trees with Farr's equation (for English units: 1967a): $SI = H\ (0.49638 + 50.36166/A)$ where SI is site index, H is tree height in feet, and A is breast-height age in years. Site index was determined by applying this equation, in each study site, to the single tallest overstory tree that exhibited no sign of rot, subcanopy suppression, or physical damage. Farr's equation applies only to trees between 30 and 180 years old at breast-height; all trees used in this analysis fall within that age class. Grouped site index values for each physiographic unit are presented as means with standard errors of the mean, and are compared using one-way analysis of variance. Potential productivity was calculated by applying the average site index and stand age to standard yield tables (Farr, 1967b) which are based upon empirical data from well-stocked spruce stands in the Alaskan interior.

A demographic model was used to examine white spruce population dynamics, and specifically the relationship of white spruce recruitment to stand density. In this model, I distinguish between "typical" mortality patterns (defined here as the age-specific survivorship rates typical of mixed-age forest stands free of catastrophic exogenous disturbance) and "episodic" mortality (in this case, specifically including only human harvesting and spruce-beetle epidemics). Because forest stands in McCarthy Creek have been subjected to logging and possibly beetle attacks (Moffitt, 1922) repeatedly in the last century, I could not use age distributions of these stands to infer "typical" mortality patterns. Instead, I used age-specific survivorship rates derived from certain forest stands in the adjacent Kennicott Valley (~4-10 km from the study area) where there is no evidence of human harvest or historic spruce beetle outbreaks. Such stands reflect the long-term dynamics of forests where recruitment occurs in the understory and in small gaps created by individual tree mortality (Loso, 1998).

I used the same model structure as that used in the Kennicott Valley study, and further model details are available there (Loso, 1998). Recruitment age was defined as 40 years, and the lifespan of white spruce was defined as 299 years. Trees were considered mature at age 90, in this case meaning that they were generally old and large enough to be counted in volume estimates, harvested for firewood and/or houselogs, and attacked by spruce beetles. For any given tree that reaches recruitment age, then, the probability of reaching maturity is the cumulative product of the probabilities of surviving the five decades between 40 and 90. If the tree is then subject to episodic mortality, the probability of reaching each successive decade is the product of the probabilities of still being alive and of surviving both typical mortality (as defined by the Kennicott Valley dataset) and episodic mortality during the next decade. This yields:

$$N_m = \sum_{i=6}^{26} \left\lfloor R \left(\prod_{j=1}^{i-1} S_j \right) (1-E)^{i-6} \right\rfloor$$

where N_m is the total number of mature trees per hectare, R is the number of trees reaching recruitment age (40) per decade, S_i is the probability of a single tree surviving "typical" mortality factors through the ten-year age class i, E is the proportion of mature trees subjected to episodic mortality in each decade, and $i_{1\text{-}26}$ is tree ages 40-49, 50-59, 60-69 … 290-299. For each of the three physiographic units in upper McCarthy Creek, I substituted measured values of R and N_m into the model and solved for E.

RESULTS

Physiographic Units

Eighteen study sites and the three primary physiographic units are mapped in Figure 4. Slopes cover the most terrain (772 ha), followed by Flatwoods (238 ha) and Floodplains (63 ha). Also mapped are Wetlands – poorly drained sites with either no trees or with virtually pure stands of black spruce. These cover 152 ha within the study area.

Buffer zones of 100, 500, and 1000 m from the primary access alignment (inset, Figure 4) serve as a means to quantify the accessibility of stands in different physiographic units. When accessibility is taken into account the order of magnitude difference in coverage between Slopes and Floodplains is diminished. Floodplains are all located very close to the existing alignment, and Table 1 shows that even a narrow 100 m buffer includes 74% of the total unit. In contrast, only 7% of Slopes and 16% of Flatwoods are enclosed within that same narrow buffer. Even a broad buffer of 1000 m to either side of the alignment encloses only 66% of Slopes and 80% of Flatwoods. Distance to the access alignment is not a perfect measure of accessibility, but unquantified access impediments that include steep slopes, avalanche hazard, and thick brush are most significant on Slopes and least significant on Floodplains, further compromising the usefulness of some stands in the Slopes unit and, to a lesser extent, Flatwoods.

Standing Density and Volume

White spruce densities ranged from 850 stems/ha on Slopes to 3540 stems/ha on Floodplains, with Flatwoods intermediate at 1580 stems/ha (Figure 5). Seedlings were the most abundant size class on all

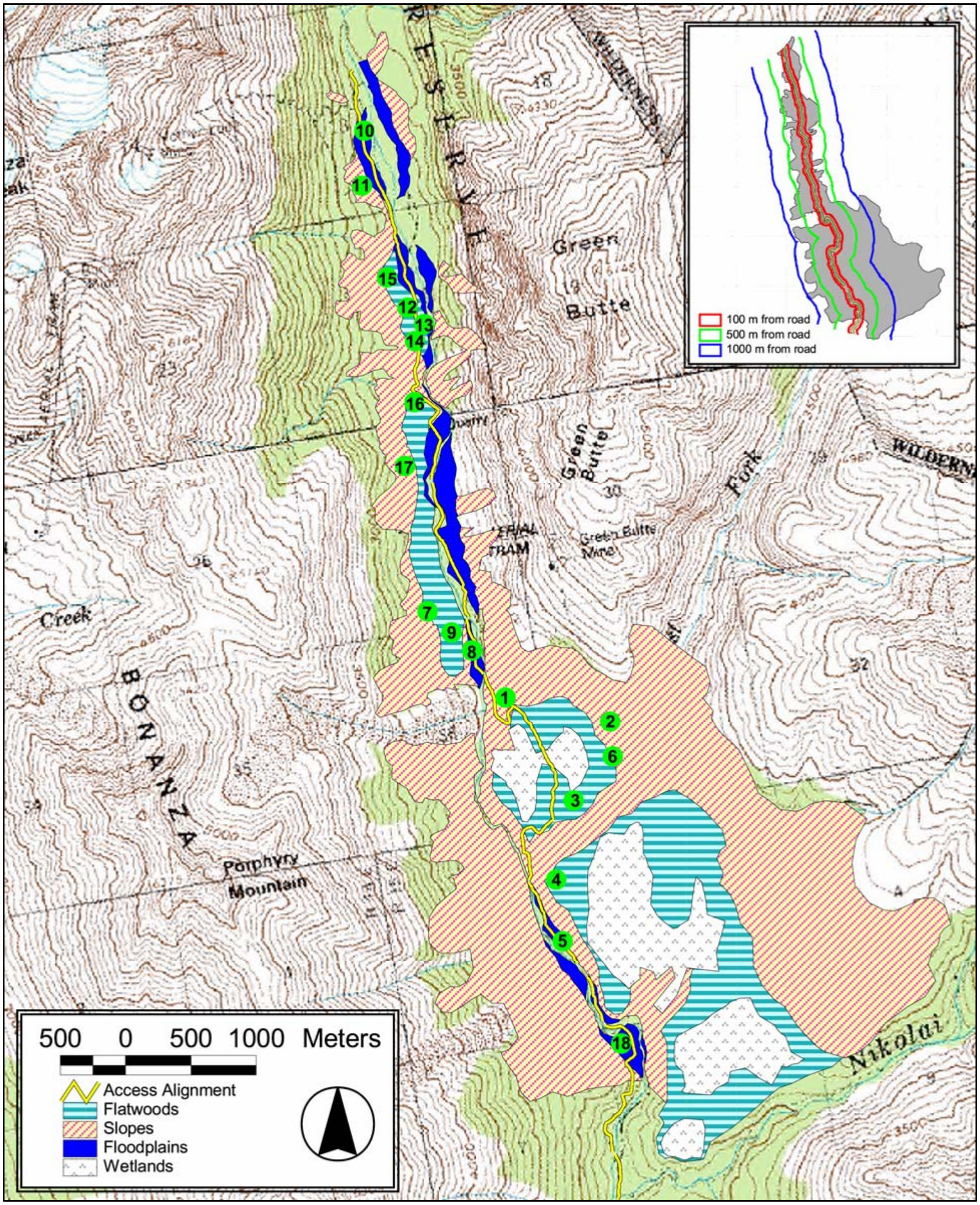

FIGURE 4. Study site locations (numbered green dots) and physiographic units in the upper McCarthy Creek Valley. INSET: Buffer corridors delineating forested portions of the study area (grey polygon) within 100, 500, and 1000 m of the primary access alignment.

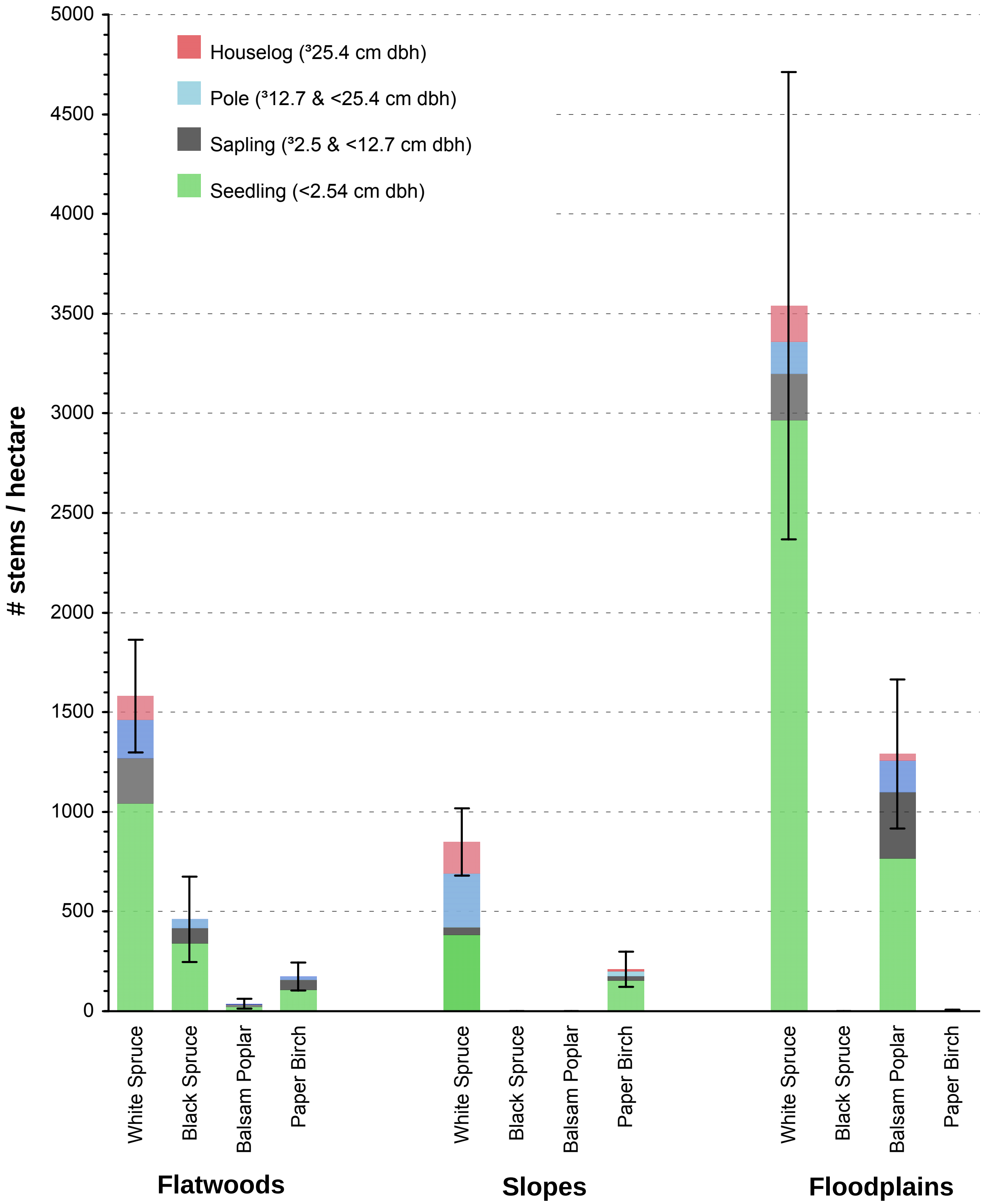

FIGURE 5. Stem density (combined live and dead standing stems/ha) of four tree species in upper McCarthy Creek, by physiographic unit. Error bars indicate standard error of the mean total density for all size classes. Relative contribution of each size class is shown by stacked colors.

physiographic units, contributing 65% of total density in Flatwoods, 45% on Slopes, and 84% on Floodplains. Overall variability of white spruce density was driven primarily by this variability in seedling density. The distinct vegetative character of each physiographic unit is reflected in the densities of other tree species (Figure 5). Flatwoods grow black spruce (460 stems/ha) and a minor component of paper birch (180 stems/ha), Slopes have only paper birch (210 stems/ha), and Floodplains are distinguished by high densities of balsam poplar (1290 stems/ha).

Houselog-sized white spruce always constitute a minority of the total stem density. Densities of stems in this size-class average 120, 160, and 180 per ha for Flatwoods, Slopes, and Floodplains respectively (Figure 5). Importantly, many (49%, 48%, and 80%, respectively) of these houselog-sized white spruce are dead, the vast majority due to an ongoing spruce beetle epidemic (Figure 6). When mortality is shown stratified by tree age class, it is clear that beetle mortality is highest in the oldest trees (Figure 7). The beetle epidemic has consequently had a disproportionate impact on houselog-sized trees, less than half of which remain sound and useful for cabin-building. After accounting for the remaining dead rotten trees, for the smaller numbers of damaged live trees (usually due to forkage or breakage of the main bole), and for losses to previous harvesting, the total number of useful houselogs per ha is significantly reduced from the total densities. Flatwoods average 49 useful houselogs per ha, Slopes 92/ha, and Floodplains 100/ha (Figure 6). Of these, 32, 40, and 88/ha, respectively, are beetle-killed trees; the remainder are currently green.

The standing volume of pole and houselog-sized white spruce (≥12.7 cm dbh) averaged 95 m^3/ha throughout the study area, with a minimum of 67 m^3/ha in Flatwoods and a maximum of 130 m^3/ha on Slopes (Table 2). The seemingly contradictory facts that Slopes have the lowest total density and the highest standing volume are a reflection of that unit's preponderance of larger trees, or—stated another way, the paucity of seedlings and saplings. Volumes of other tree species reflect the vegetative character described earlier. As with stem density, a majority of the standing volume of white spruce has been impacted by the ongoing spruce beetle epidemic. Of the total standing volume of white spruce on Flatwoods, Slopes, and Floodplains, 72%, 57%, and 90% respectively now consist of dead timber.

Productivity

Two different measures of actual current productivity were derived: gross productivity (volume growth in m^3/ha/yr) and net productivity (volume growth minus the volume lost to mortality, also in m^3/ha/yr). Throughout the study area, annual radial increment averaged 0.97 mm/yr and varied only slightly among physiographic units (Table 2). Consequently, most variability in gross productivity – which ranged from 0.09 to 0.43 m^3/ha/yr with a study area average of 0.22 m^3/ha/yr – was the result of differences among units in the densities of live poles and houselogs. Net productivity has been severely impacted by the ongoing spruce beetle outbreak. Based on the inferred mean annual mortality rate over the last decade (which probably underestimates mortality during the last 3 years), calculated net productivity is negative in all physiographic units. Because negative productivity is not technically possible, these values are presented as zero in Table 2. The important point is that white spruce forests throughout the study area are currently losing more volume to the spruce beetle epidemic than they are regaining through growth of the existing trees.

Site quality, as measured by the relationship of white spruce height growth to age, did not significantly differ among physiographic units. Site index for the three physiographic units ranged from 50.6 to 63.0,

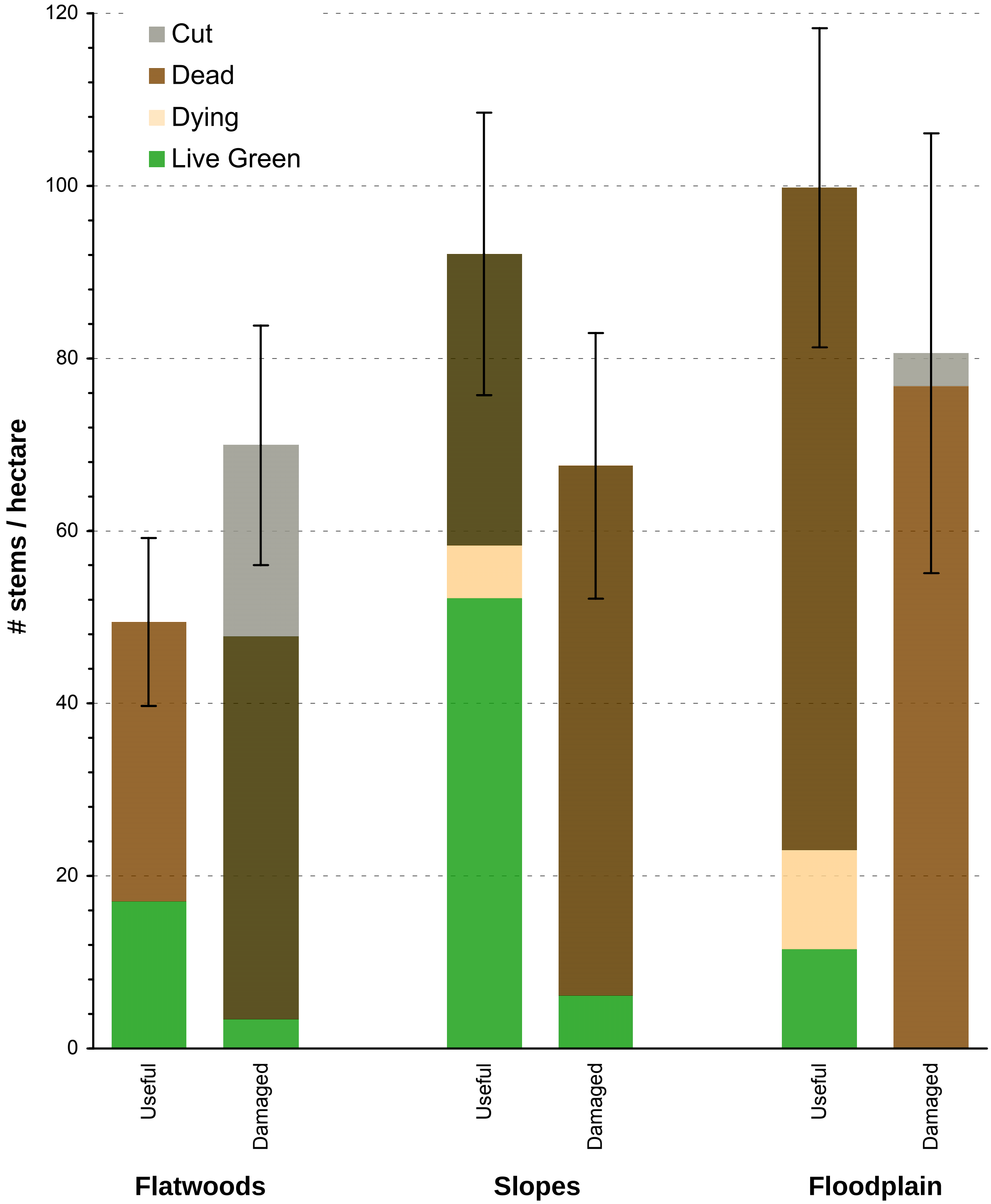

FIGURE 6. Densities of houselog-sized (dbh ≥ 25.4 cm) white spruce on three different physiographic units in upper McCarthy Creek. For each unit, stacked bars on left are trees considered useable for houselogs; trees on right are bent, broken, forked, or rotten. Each bar is broken down by tree damage class (live, dead, dying, or previously-harvested stump). Error bars are standard error of the mean for combined values.

TABLE 2. Productivity of white spruce, and standing volume of all tree species.

Physiographic unit	n =	Potential productivity (m^3/ha/yr)*	Mean radial increment (mm/yr)	Actual gross productivity (m^3/ha/yr)	Actual net productivity (m^3/ha/yr)**	Tree species	Mean live volume (m^3/ha)	Mean dead volume (m^3/ha)	Mean volume (total) ± 80% conf. int.
Flatwoods	36	0.35	0.89	0.17	0.00	White Spruce	18.40	48.21	66.61 ± 11.8
						Black Spruce	2.54	0.02	2.56 ± 1.6
						Balsam Poplar	0.21	0.00	0.21 ± 0.3
						Paper Birch	1.46	0.00	1.46 ± 1.9
Slopes	20	0.51	0.96	0.43	0.00	White Spruce	55.53	74.41	129.94 ± 18.5
						Black Spruce	0.00	0.00	0.00 ± 0.0
						Balsam Poplar	0.00	0.00	0.00 ± 0.0
						Paper Birch	6.77	0.10	6.87 ± 4.4
Floodplains	16	0.56	0.90	0.09	0.00	White Spruce	11.33	105.25	116.58 ± 26.0
						Black Spruce	0.00	0.00	0.00 ± 0.0
						Balsam Poplar	25.24	0.96	26.21 ± 10.5
						Paper Birch	0.00	0.00	0.00 ± 0.0
All	72	0.43	0.97	0.22	0.00	White Spruce	27.14	68.16	95.31 ± 10.4
						Black Spruce	1.27	0.01	1.28 ± 0.8
						Balsam Poplar	5.72	0.21	5.93 ± 2.8
						Paper Birch	2.61	0.03	2.64 ± 1.5

**from yield tables (Farr, 1967) based on site index and stand ages, assuming well stocked spruce forest*
*** mortality currently exceeds growth throughout the study area*

with the highest value on floodplains (Figure 8), but there was no significant difference among the site index values of the three units (ANOVA; $F = 1.65$; $p>F = 0.2210$). Overall, the average site index in McCarthy Creek (56.0) is only slightly lower than in the adjacent Kennicott Valley (59.13: Loso, 1998). The potential productivity of white spruce at current stand ages, derived from calculated site index and yield tables, ranged from 0.35 to 0.56 m^3/ha/yr (Table 2). On all physiographic units, these values are greater than calculated actual productivities.

Population Dynamics

I aged 449 white spruce in 18 study sites, and the oldest tree I cored had 330 rings at breast-height. Based on the predicted breast-height age of 34 years (Figure 4: Loso, 1998), this suggests an approximate true age of 364 years. An additional 79 trees were too rotten to be aged. These were largely older beetle-killed spruce, so age distributions from the 18 study sites (Figure 9) probably understate slightly the importance of older size classes. Most distributions show trees in a broad variety of age-classes, though some sites (notably #12-14) appear truncated at the older size classes, in part because of the bias just mentioned but primarily because of prior harvesting in those stands. In any case, none of the sampled stands are even-aged (Figure 9), nor show evidence of fire or other catastrophic stand-initiating disturbance. No charcoal or burned wood was found in any of the study sites, confirming that upper McCarthy Creek has remained free of large catastrophic fires for at least the last few centuries. Like forests in the adjacent Kennicott Valley, where Loso (1998) found no evidence of wildfire, forests in upper McCarthy Creek have developed in response to periodic creation of small gaps by windthrow,

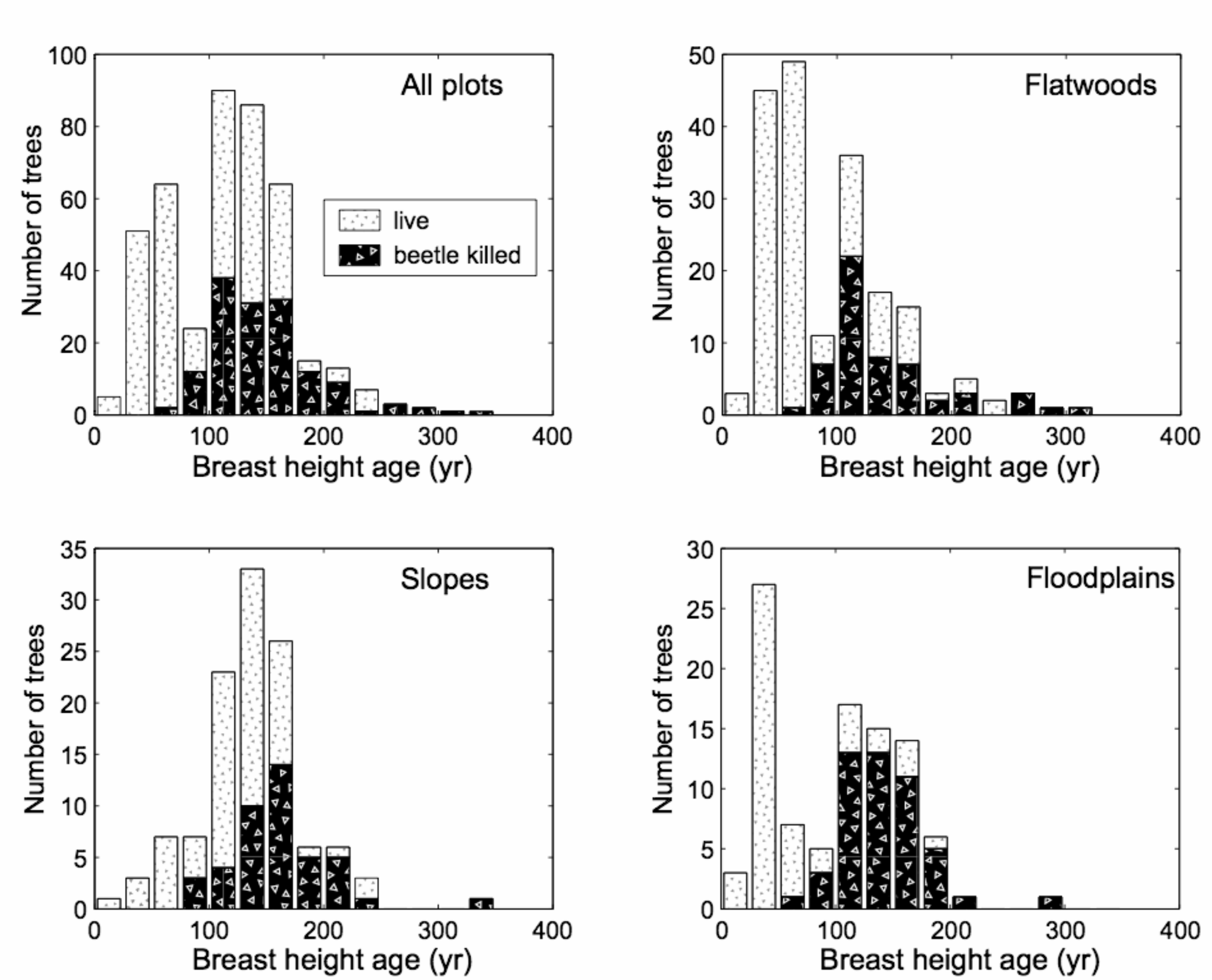

FIGURE 7. Breast-height ages (in 25-year bins) of white spruce in upper McCarthy Creek, shown divided into live and beetle-killed trees. Data from all dated trees (upper left panel) are shown stratified by physiographic region in the other three panels. Some larger trees with cores too rotten to date are also excluded: because larger beetle-killed trees are most commonly rotten, these plots slightly underestimate the proportion of beetle-killed trees in older age classes. Small trees (dbh<6.0 cm) were not cored and are excluded from this analysis. Average age at breast-height was 37 years in the adjacent Kennicott Valley (Figure 4: Loso, 1998), so these breast-height ages probably underestimate true tree age by a similar amount.

disease—including a possible spruce beetle epidemic in the 1920's (Moffitt, 1922), and prior selective harvest.

A demographic model suggests that recruitment in upper McCarthy Creek is currently too poor to maintain the current densities of mature trees (Table 3). Survival rates from the Kennicott Valley (Loso, 1998) were combined with current recruitment rates in upper McCarthy Creek to predict tree density in all three physiographic units. In a hypothetical case where there was no episodic mortality (neither spruce beetle epidemics nor human harvesting), the model predicts that Flatwoods and Floodplains would have higher densities of mature trees than are currently present, and Slopes would have slightly lower densities. In other words, forests on Slopes have a negative equilibrium episodic mortality rate, indicating that they (like similar forests in the Kennicott Valley) have insufficient recruitment to maintain current tree densities *even in the absence of episodic mortality*. Flatwoods and Floodplains, in contrast, could sustain moderate rates of episodic mortality (15% and 11% loss of mature trees/decade) and still maintain current mature tree densities.

This may reflect gradual diminishment of spruce recruitment rates over decades and centuries of accumulation of litter and moss while the forest has been free of major disturbance (especially fire), or alternatively implies that forest density is maintained by rare, episodic high-recruitment events. Either way, the important fact is that episodic mortality is occurring at a very high rate on all units: in the last ten years, the combined efforts of beetles and humans have killed 49%, 48%, and 80% of mature trees on Flatwoods, Slopes, and Floodplains respectively. Even allowing for the simplicity of the model and the difficulty of predicting "typical" mortality patterns for long-lived organisms like white spruce, current episodic mortality is clearly much higher than can be sustained by the forests of upper McCarthy Creek. Any increase in spruce beetle mortality or human harvest would further decrease future densities of mature white spruce on these stands.

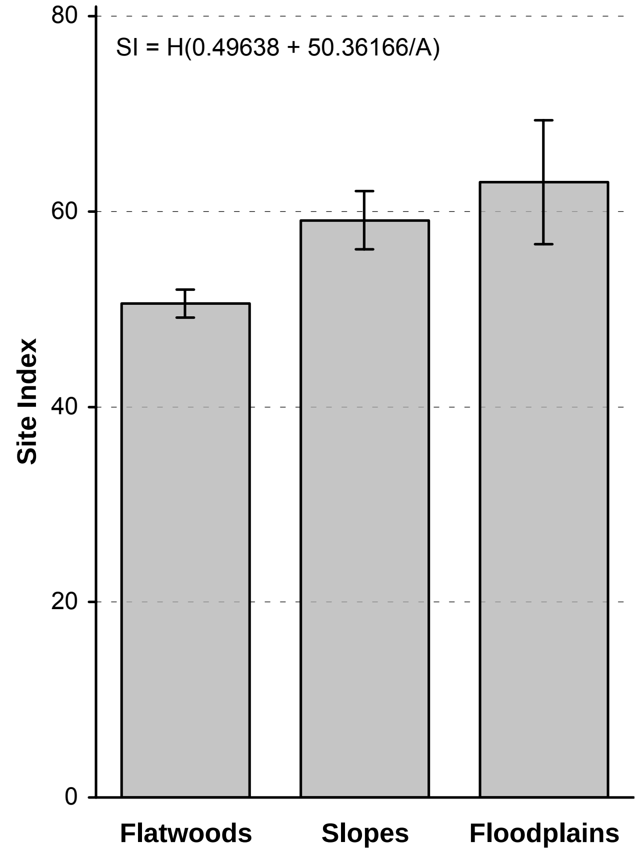

FIGURE 8. White spruce site index in three physiographic units of upper McCarthy Creek. Calculations are based on the equation shown at upper left, where H = tree height in feet and A = breast-height age in years (Farr 1967). Values are means ±SE based upon the single tallest canopy tree per study site.

Human Harvest

Compared with the more populous Kennicott Valley, where rail and subsequent road access allowed the importation of fuel and sawtimber that eased the demand for local white spruce (Loso, 1998), McCarthy Creek has a more substantial history of selective logging. Three broad categories of stump were found: mining era (~1911-1938), early park (~1970-1990), and Hale family (post-2000). The three categories were easily distinguished on the basis of appearance: mining era stumps are highly decomposed, early park era stumps are highly weathered and barkless but typically sound, and Hale family era stumps are fresh with logging slash still present (Figure 10).

Evidence of selective logging was found in all three physiographic units, generally within one to three hundred meters of the primary access alignment. Many of the stumps I encountered fell outside of established study sites, though a few were tallied formally and included in density calculations (Figure 5). Stumps were often found on the flattest, most accessible terrain, but occasionally stumps were

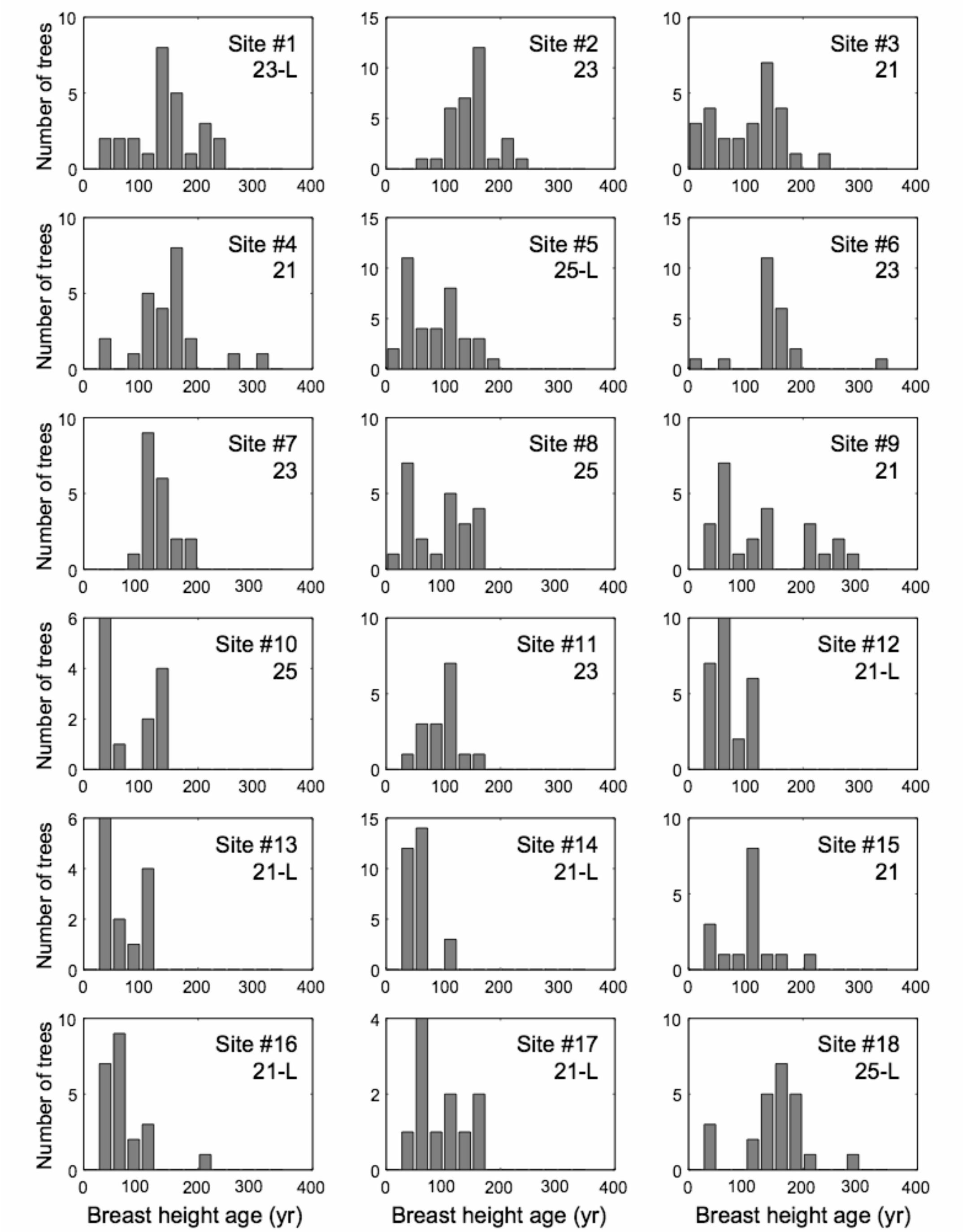

FIGURE 9. Breast-height ages (in 25-year bins) of all datable white spruce on 18 study sites in upper McCarthy Creek. Numerals below site numbers refer to physiographic unit: 21 = Flatwoods, 23 = Slopes, 25 = Floodplains; 'L' indicates that there was evidence of historic logging in the plot. Small trees (dbh < 6 cm) were not cored and are excluded from this analysis. Some larger trees with cores too rotten to date are also excluded. Average age at breast-height was 37 years in the adjacent Kennicott Valley (Figure 4: Loso 1998), so these breast-height ages probably underestimate true tree age by a similar amount.

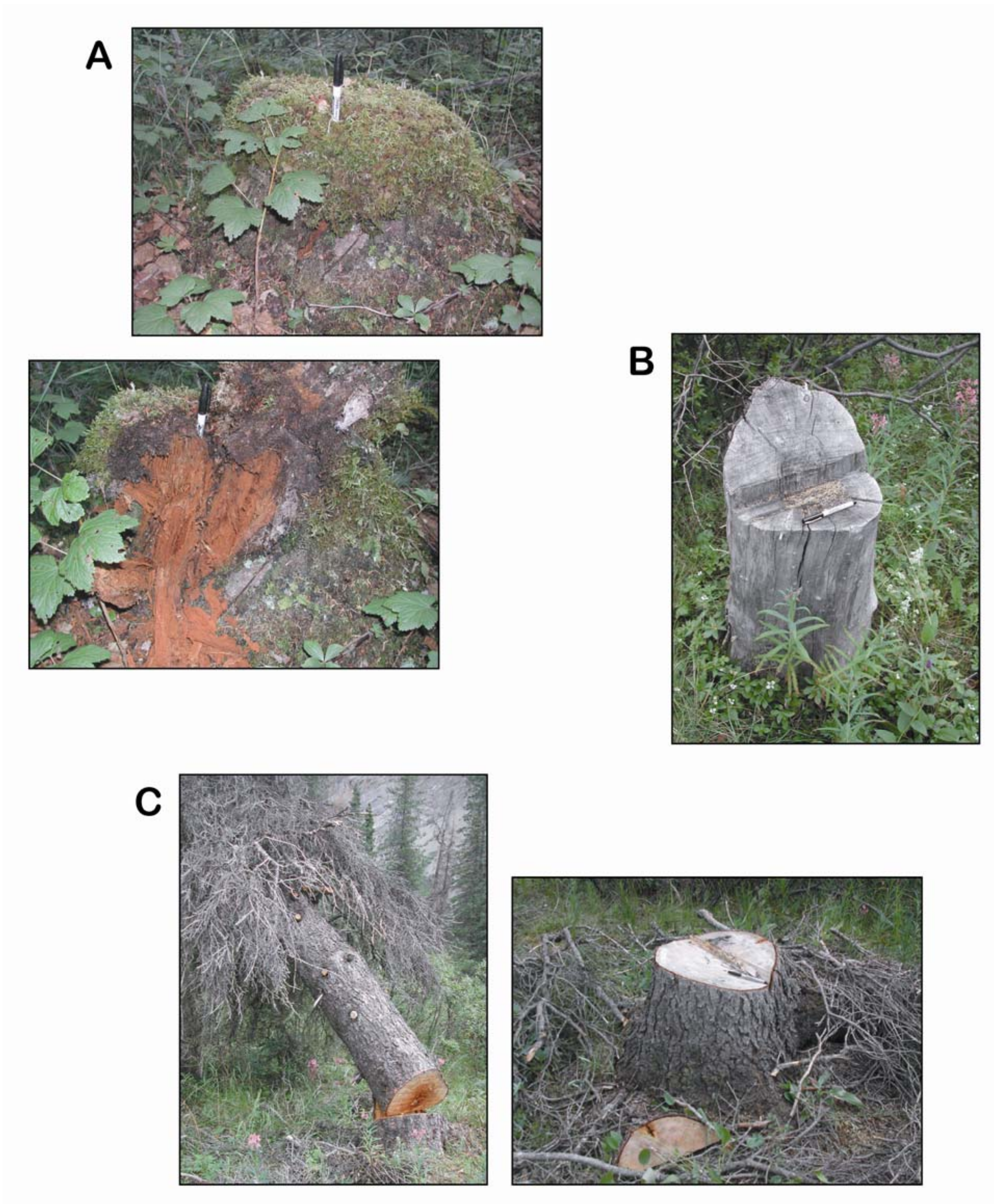

FIGURE 10. Photographs of logged stumps from McCarthy Creek, depicting three generations of selective logging: **A.** mining era stumps (~1911 - 1938) are decomposed and easily crumble; **B**. early park era stumps (~1970 - 1990) are weathered and barkless but typically sound; and **C**. Hale family era stumps (post - 2000) are fresh with logging slash (and sometimes the whole tree) still present.

TABLE 3. Model results comparing white spruce recruitment to mature tree density.

variable	unit	**Flatwoods**	**Slopes**	**Floodplains**	**Kennicott**[¤]
Current recruitment rate	# recruits/ha/decade	91	36	60	30
Current tree density	# mature/ha	425	421	329	354
Modeled tree density without episodic mortality*	# mature/ha	888	351	584	287
Modeled equilibrium episodic mortality rate	% mature/decade	15%	-3%	11%	-3%
Current episodic mortality rate	% mature/decade	49%	48%	80%	34%

* Episodic mortality includes human harvest and spruce beetle attack

Percentage of mature trees that could be lost to episodic mortality each decade and still maintain current densities. Negative numbers indicate recruitment cannot maintain current densities.

[¤] Data collected in the adjacent Kennicott Valley in 1996; model results from Loso 1998.

encountered in surprisingly steep and densely vegetated stands. Mining era stumps were most common within a few kilometers of the Green Butte Mine, and early park era stumps were found almost exclusively in the woods near the Loy Green cabin (Figure 1). A more systematic effort was made to map the occurrence of cut stumps from the Hale family era.

In recent years, especially including winters of 2002-03 and 2003-04, the Hale family has obtained much of their firewood from beetle-killed white spruce in an area informally known as "the woodlot," located west of McCarthy Creek on a bench just north of the Green Butte mining operation (Figure 11). The woodlot is very accessible; it is mostly flat, it has a relatively brush-free understory, and it is close to both the existing road and the Hale family residence at the Marvelous Millsite. Sites 12-15 lay wholly or partly within the woodlot and numerous fresh stumps were encountered in the course of sampling these locations. In total, 13 subplots were randomly located within the mapped boundaries of the woodlot (Figure 11). In addition to the normal sampling conducted at each of these sites, cut stumps were counted at each site in expanded subplots of 14.6 m radius. The mean number of Hale family era stumps in each expanded subplot averaged 2.38 with an 80% confidence interval of 0.75. This yields a cumulative harvest intensity of 35.6 trees per hectare, suggesting a total modern harvest of 295 trees in the 8.3 ha woodlot.

To evaluate the plausibility of this estimate, it can be used to estimate the fireweed consumption of a 2-cabin family over the course of 2 winters. The average diameter of cut stumps in the woodlot was 31.2 cm, and throughout the study area white spruce of that size (with diameters ranging from 28 to 34 cm) had an average volume of 0.40 m^3. If a family used 12 cords (30 m^3) of firewood per cabin per year, they would have had to harvest approximately 297 trees in 2002-03 and 2003-04 to meet the needs of two cabins – very nearly the total harvest estimated in the field. Based on interviews with local residents of the nearby Kennicott Valley, Loso (1998) estimated that the average annual firewood consumption was 8 cords/cabin. Welbourn (1982) interviewed foresters and researchers from around the state, and estimated that the average annual firewood consumption was 7-8 cords in the Copper Basin, and as high as 10-15 cords in the Delta area. The point is not that the Hale family consumed exactly 12 cords per year in two different cabins, but rather that the estimated harvest of 295 trees can be plausibly explained solely in terms of the family's firewood needs.

DISCUSSION

White spruce stands in upper McCarthy Creek exhibit the general characteristics of old-growth forest (Oliver, 1981): loss of overstory integrity, complicated forest structure with numerous height classes including understory advance regeneration, and mixed-age distributions. These characteristics are apparently uncommon in southcentral and interior Alaska, where recurrent fires favor even-aged populations. In the Kennicott Valley, Loso (1998) described old-growth white spruce growing on hillsides with a dense alder understory, but old-growth stands in upper McCarthy Creek occur in a wide variety of settings that include Flatwoods, Slopes, and Floodplains. Low recruitment is a conspicuous feature of old-growth stands in the Kennicott Valley, and is apparent in the McCarthy Creek forests also. Along McCarthy Creek, recruitment is lowest on the physiographic unit which is most directly analogous to the Kennicott Valley old-growth stands (Slopes), but I used a simple demographic model to test the sufficiency of recruitment on each unit independently.

In the hypothetical absence of episodic disturbance (beetle epidemic or human harvest), the model suggests that recruitment rates on Floodplains and Flatwoods would be sufficient to maintain current densities of mature trees. On Slopes, where recruitment rates are lower and more comparable to those in old-growth stands of the Kennicott Valley, recruitment would be just below the level necessary to maintain current densities. Given potential errors in the model (described more fully in Loso, 1998), these results equivocate on a question of ecological interest: does a sustainable climax state exist for old-growth white spruce forests? On a more practical issue, however, the model is clear: in the last decade the beetle epidemic has exceeded the forest's ability to generate new seedlings by a very wide margin. Trees are being killed much more rapidly than they are being recruited into the population in all three physiographic units.

For those trees that remain green and healthy, site quality in the upper McCarthy Creek valley is relatively poor. Values observed throughout the study area (46-86, mean 56) were widely dispersed, but are overall lower than the adjacent Kennicott Valley (53-72, mean 59: Loso, 1998) and slightly lower than sites elsewhere in the southern Copper River Basin (50-64, mean 58: Farr, 1967b). In the Alaskan interior, where summers are longer and warmer, site index is generally much higher (70-90). Only on the Porcupine River, north of the Arctic Circle, did Farr (1967b) find an average site index (55) lower than that found in McCarthy Creek. The reasons for poor productivity in McCarthy Creek include elevation (much of the study area is near the altitudinal limit for white spruce), limited insolation (the valley is too narrow and deep for any given tree to receive a full day's direct sunlight), and poor drainage on some sites (particularly Flatwoods).

Potential productivity estimates derived from these low site index values are nonetheless exaggerated. There are two reasons for this. First, the yield tables used to estimate potential productivity (Farr, 1967b) are based upon *well-stocked* spruce forests in interior Alaska. The densities of pole and houselog-sized trees in McCarthy Creek are lower than those used to generate the yield tables. Second, and more importantly, actual productivity has been dramatically diminished by spruce beetle mortality. Gross

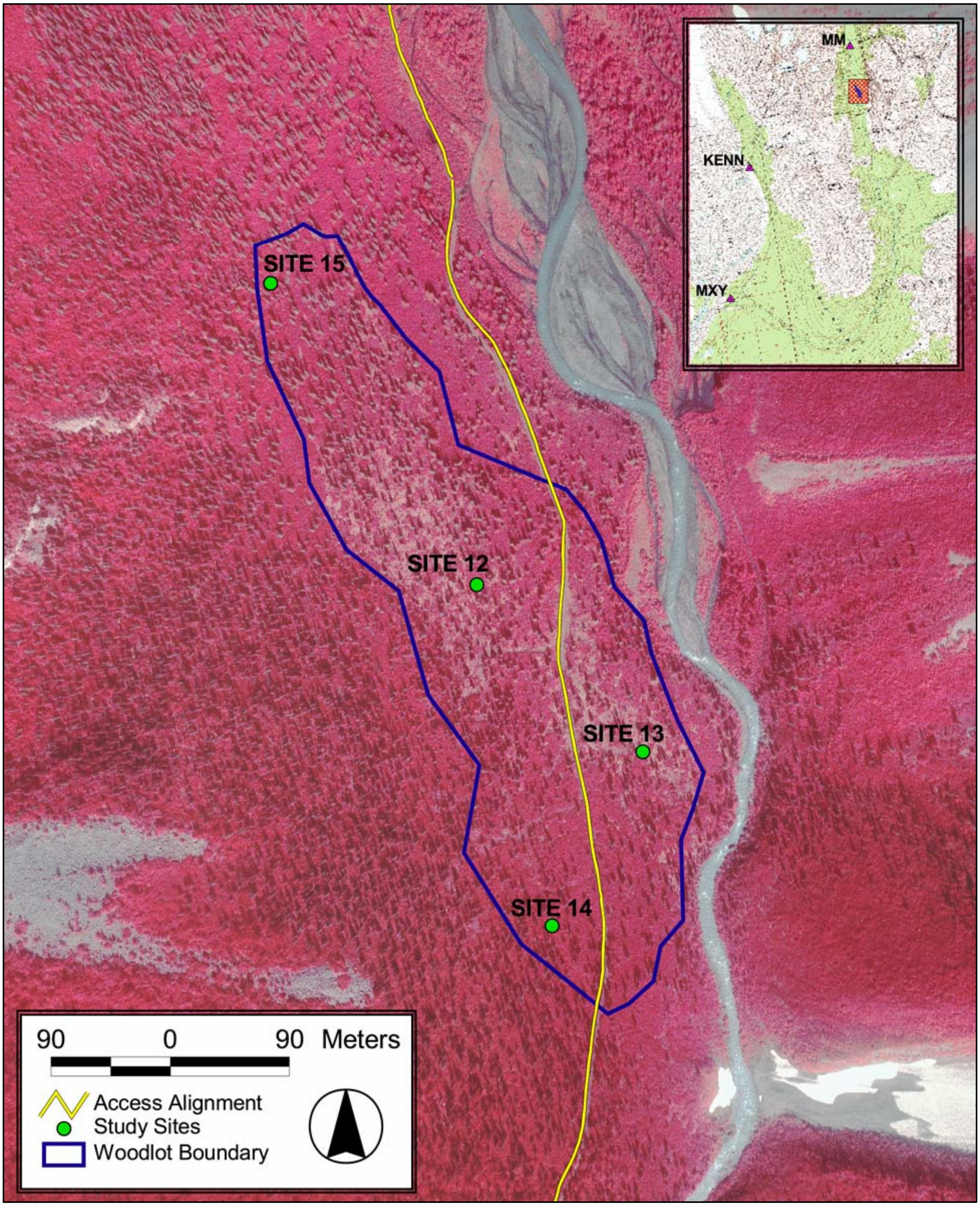

FIGURE 11. Approximate boundaries of "the woodlot," an area of recent intensive beetle-kill harvest by the permit applicants. Base map: 1:6000 scale color infra-red taken July 9, 2003. INSET: General location of the aerial photo and woodlot, showing locations of McCarthy (MXY), Kennicott (KENN), and Marvelous Millsite (MM) – the permit applicants' homestead.

productivity is diminished because fewer live trees remain to grow and add wood volume to the forest. Net productivity, which subtracts from gross productivity the volume of dying trees, is actually negative, indicating that the volume of live spruce in upper McCarthy Creek is growing smaller each year.

Mortality associated with the ongoing spruce beetle outbreak clearly overwhelms other, more subtle trends in forest dynamics. It is difficult to make quantitative predictions about the future of the outbreak, but the regional spruce beetle outbreak that began around 1990 was slow to reach McCarthy Creek, and is likely to worsen. Beetle-induced mortality was fairly low in the McCarthy Creek drainage until 2003, the year when a large fraction of the now-dead spruce was killed (Zogas, 2004). There are three reasons to suspect that these forests will suffer significant additional mortality in the next year and perhaps beyond: 1) spruce beetle outbreaks in other parts of the state have generally lasted longer than one or two years in any given stand; 2) spruce beetles populations react favorably to warm summers, and this summer (2004) was extremely warm and dry; and 3) spruce beetles typically have either one or two-year life cycles, implying that beetles which attacked and killed McCarthy Creek timber in 2003 or 2004 (or both) will launch their offspring in 2005. Forest productivity and live tree density are thus expected to be further diminished by this ongoing disturbance. In terms of firewood production, these effects should be mitigated somewhat by the opening or thinning of canopy gaps that release surviving trees from above and below-ground competition, stimulating increased volume growth. Neither beetle-kill nor selective human harvest, however, are likely to increase spruce recruitment, which is dependent primarily upon disturbance of the forest floor (Zasada and Gregory, 1969). In summary, the selective harvest of live white spruce for houselogs or firewood is currently unsustainable, and will remain that way for the foreseeable future.

On the other hand, the current beetle epidemic has created a bonanza of standing dead spruce. Dead trees now account for 71% of the total standing volume in upper McCarthy Creek. Most of this volume is potentially useful for firewood. Likewise, 49% of the houselog-sized white spruce likewise are dead, and 47% of those dead trees are sound and straight enough to be used for building. In the entire study area, that suggests there are over 40,000 usable houselogs. Even within a narrow corridor of easily accessible land (for example, 100 m [328 ft] to either side of the primary access alignment), there are probably over 7000 usable, beetle-killed houselogs. From the perspective of white spruce productivity, even a substantial harvest of houselogs or firewood from this resource should have minimal negative impacts. Other impacts of such harvest, on wildlife habitat, visitor experience, and understory vegetation, for example, may be substantial but are beyond the scope of this work.

CONCLUSIONS

White spruce forests in the upper McCarthy Creek valley have generally poor productivity and low recruitment. Three physiographic units serve as habitat for the bulk of the white spruce in the valley: Flatwoods have a prominent black spruce component, with relatively low productivity and moderate recruitment; Slopes have an alder component, with moderate productivity and low recruitment; and Floodplains have a balsam poplar component, with higher productivity and higher recruitment. A spruce beetle epidemic has recently gained momentum in the valley, and high mortality of larger, older white spruce was most conspicuous in 2003. Further losses are expected before the epidemic has run its course. As a consequence of this outbreak, mortality currently exceeds growth when viewed from the perspectives of either wood volume or population demography. For the foreseeable future, the harvest of green trees is therefore unsustainable. Standing dead timber is abundant, and may provide a useful alternative to live green trees for houselogs and firewood.

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