USDA Forest Service, Alaska Region

DECISION NOTICE
FINDING OF NO SIGNIFICANT IMPACT
DESIGNATION ORDER
for the
Green Island Research Natural Area
on the
Chugach National Forest
Cordova Ranger District, Alaska

Background:

The Record of Decision for the Chugach National Forest Land and Resource Management Plan (Forest Plan), signed in 1984, recommended the establishment of the Green Island Research Natural Area (RNA) in eastern Prince William Sound. That recommendation was the result of an analysis of the factors listed in 36 CFR 219.25 and Forest Service Manual 4063.41. Results of that analysis are documented in the 1984 Chugach Forest Plan, the associated Final Environmental Impact Statement, and the Establishment Record for the Green Island RNA. The Forest Supervisor has reexamined information pertaining to the Green Island area. This analysis is documented in the Environmental Assessment for the Establlishment of the Green Island RNA (November 1996). All of these documents are available from the Chugach National Forest, 3301 "C" Street, Suite 300, Anchorage, AK 99503.

Designation:

Based on the analysis in the Environmental Assessment, it is my decision to adopt Alternative A, to establish the Green Island area as an RNA. Accordingly, under the authority delegated to me by the Chief of the Forest Service in Forest Service Manual 4063, and under regulations at 7 CFR 2.42, 36 CFR 251.23, and 36 CFR Part 219, I hereby establish the Green Island RNA. This RNA shall be comprised of 2,861 acres of land on Green Island, Little Green Island, and the Needle on the Cordova Ranger District of the Chugach National Forest, Alaska, as described in the Environmental Assessment and in the section of the Establishment Record entitled "Location."

The Chugach Forest Plan is hereby amended to change the allocation of the Green Island area from "Proposed" to Established RNA. This is a non-significant amendment of the Forest Plan (36 CFR 219.10(f)).

Reasons for the Decision:

Alternative A is selected because it provides opportunities for long-term research on a highly productive and naturally functioning marine-freshwater-terrestrial ecosystem. The Green Island RNA will be managed in compliance with all relevant laws, regulations and Forest Service Manual direction regarding RNAs, and in accordance with the management direction identified in the Chugach Forest Plan.

The other alternative considered was Alternative B, the "No Action" alternative, which would continue management of the Green Island area as a proposed RNA.

The proposed action (Alternative A) is consistent with the management direction and implements the land allocation for the Green Island area as recommended in the Forest Plan.

Public Involvement:

This proposed action was the subject of scoping during the preparation of the Environmental Assessment. No issues were identified. A public notice inviting comment on the Environmental Assessment was issued on November 5, 1996. In addition, the Environmental Assessment was mailed to 15 individuals and organizations who have expressed an interest in Chugach National Forest management. Only three comment letters were received, all of which supported RNA designation of this area.

Finding of No Significant Impact:

It has been determined through the Environmental Assessment that the proposed action is not a major Federal action that would significantly affect the quality of the human environment. Therefore, an environmental impact statement is not needed. This determination is based on the following factors (40 CFR 1508.27):

A. Context

Although this is an addition to the national system of RNA's, both short-term and long-term physical and biological effects are limited to the local area.

B. Intensity

1. There are no known effects on public health and safety.

2. There are no known effects on historic or cultural resources, actual or eligible National Register of Historic places, sites, park lands, prime farmlands, wetlands, or wild and scenic rivers. Effects on ecologically critical areas are minimal.

3. Effects on the human environment are not uncertain, do not involve unique or unknown risks, and are not likely to be highly controversial.

4. The action is not likely to establish a precedent for future actions with significant effects.

5. No significant direct, indirect or cumulative impacts to natural resources or other components of the human environment are anticipated.

6. The proposed action will not adversely affect any federally listed or proposed endangered or threatened species or associated critical habitat, nor will it affect any Regionally sensitive plant or animal species.

7. The proposed action is consistent with Federal, State, and local laws and requirements for the protection of the environment.

Notice and Implementation:

Legal notice of this decision will appear in the Juneau Empire and Anchorage Daily News. The Forest Supervisor of the Chugach National Forest shall notify the public of this decision and mail a copy of this Notice to all persons on the Chugach National Forest Plan mailing list. This decision and forest plan amendment will be effective 7 calendar days following publication of the legal notice of the decision in the Juneau Empire.

Appeal Rights:

This decision is subject to appeal pursuant to 36 CFR Part 217 by filing two (2) copies of the written notice of appeal within 45 days from the date the legal notice of this decision appears in the Juneau Empire. Any appeal must be filed with the Reviewing Officer:

USDA Forest Service
P.O. Box 96090, NFS, 3NW, Appeals Office
Washington, D.C. 20090-6090

Please also send a copy to:

Phil Janik, Regional Forester
USDA Forest Service
Alaska Region
P.O. Box 21628
Juneau, Alaska 99802

The notice of appeal must include sufficient narrative evidence and argument to show why this decision should be changed or reversed (36 CFR 219.7).

For further information, contact Robert DeVelice, Chugach National Forest, 3301 "C" Street, Suite 300, Anchorage, Alaska 99503, or by phone at (907) 271-2500.

/s/ Phil Janik _____ 7/25/97
Regional Forester Date

(2)AKNHP/GREEN

SIGNATURE PAGE

for

RESEARCH NATURAL AREA ESTABLISHMENT RECORD

Green Island Research Natural Area

Chugach National Forest

Alaska

The undersigned certify that all applicable land management planning and environmental analysis requirements have been met and that boundaries are clearly identified in accordance with FSM 4063.21, Mapping and Recordation and FSM 4063.41 5.e(3) in arriving at this recommendation.

Prepared by /s/ Glenn Patrick Juday Date 12/16/96

Glenn Patrick Juday, Associate Professor of Forest Ecology and Alaska Ecological Reserves Coordinator, University of Alaska Fairbanks, with contributions by Judy Sherburne, Alaska Natural Heritage Program, University of Alaska and Paul Alaback, University of Montana.

Recommended by /s/ Cal O. Baker Date 1/9/97

Calvin O. Baker, District Ranger, Cordova District

Recommended by /s/ Larry L. Hudson Date 2/10/97

Larry L. Hudson, Forest Supervisor, Chugach National Forest

Concurrence of /s/ George H. Maeller Date 3/3/97

for Thomas J. Mills, Station Director, Pacific Northwest Station

Establishment Record

for

Green Island Research Natural Area

within

Chugach National Forest, Alaska.

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RESEARCH NATURAL AREA ESTABLISHMENT RECORD
Green Island Research Natural Area

INTRODUCTION

The 2,861 acres (1,158 ha) Green Island Research Natural Area (RNA) is in the Chugach National Forest in southcentral Alaska (fig. 1). Green Island was named by Captain James Cook on May 18, 1778 during his voyage of discovery around the Pacific Ocean (Orth 1967). Little Green Island, a much smaller island directly southwest, derives its name from the larger island. Orth (1967) quotes Captain Cook's log, "...being entirely free from snow, and covered with wood and verdure, on this account they were called Green Islands." When approached from sea level, Green Island stands apart from the nearby late-lying snowfields and extensive tundra of Montague Island that reach nearly to tidewater (Photo 1). In reality Green Island has extensive treeless blanket bogs and appears forested mainly because trees cover the well drained slopes that are visible from the ocean surface (Photo 2). Although there are five officially named Green Islands in Alaska (Orth 1967) the Green Island Research Natural Area retains the name in recognition of its first use in Alaska here.

Land Management Planning

Green Island was nominated as an RNA during the land and resource planning process for the Chugach National Forest (USDA Forest Service 1984). Green Island was identified as an area inhabited by part of the remnant sea otter population that repopulated Prince William Sound after near-extinction of the species in the late 19th century, and a site containing:

(a) important haul-out sites for harbor seals and Steller sea lions, marine bird colonies, and several significant shorebird populations;

(b) beaches uplifted in the 1964 Great Alaska Earthquake;

(c) sites with some of the highest forest productivity and best-developed old-growth stands in the Chugach National Forest;

(d) shorelines that exhibit classic marine erosional features; and

(e) close linkages between terrestrial and highly productive marine ecosystems.

Green Island was initially identified by Chugach National Forest staff as an alternative to a proposed Coghill Lake RNA, which was judged to have too large an impact on timber, aquaculture, and recreation development options. Green Island was suggested instead as an area that contained pockets of productive forest sites with some of the largest trees in the Chugach National Forest. Green Island was proposed as one of nine RNAs in the draft Chugach Forest Management Plan. No major issues or conflicts specific to Green Island were identified during the public review and comment period for the draft plan. Green Island RNA was incorporated into the final Forest Plan (USDA Forest Service 1984).

OBJECTIVES

The objectives of establishing Green Island RNA are to:

1. Maintain an undisturbed upland around a marine intertidal and subtidal refugium from which sea otters repopulated Prince William Sound after their drastic population reduction during the Russian era in Alaska, and provide for the study and monitoring of recovery of the sea otter population after it was decimated in the Green Island area by the 1989 *Exxon Valdez* oil spill;

2. Monitor and document the structure of productive forests of outer Prince William Sound and maintain examples of these forest types in an unmanaged condition as a control for managed areas of Prince William Sound and the Chugach National Forest and as a major global change research installation;

3. Study and monitor the long-term effects of the 1989 *Exxon Valdez* oil spill and associated cleanup measures on beach fringe and upland ecosystems that are linked to marine study sites;

4. Protect seabird colonies and marine mammal haul out grounds, including a large colony of the federally Threatened Steller sea lions, and provide a site for monitoring their recovery from the 1989 *Exxon Valdez* oil spill;

5. Study and document ecological succession on beaches uplifted during the 1964 Great Alaska Earthquake;

6. Protect upland habitat adjacent to a rich shellfish and kelp forest marine area in order to cooperate with a potential state tidelands reserve and promote its recovery from oil damage;

7. Provide for study and monitoring of natural coastal erosion and associated rates of landform change and biodiversity on a medium-sized and a small island in Prince William Sound; and

8. Provide a well-documented site containing examples of the natural diversity features of outer Prince William Sound for educational and scientific use.

JUSTIFICATION STATEMENT FOR ESTABLISHMENT OF AREA

The elements of natural diversity that form the basis for selecting RNAs in Alaska are called type needs (Underwood and Juday 1979, Juday 1983). The type needs list for the Chugach National Forest is given in Appendix A of the Alaska Regional Guide (USDA Forest Service 1983). Type needs from the Alaska Region list that occur in Green Island RNA are shown in Table 1.

Table 1. Alaska Region Guide Research Natural Area type needs that occur in Green Island Research Natural Area.

ANIMAL SPECIES	
1.	Sea otter haul-out sites adjacent to important marine habitat (a species nearly extinct in the 1800s; population recovered strongly by mid-1980s, then was significantly reduced by 1989 *Exxon Valdez* oil spill).
2.	Steller sea lion haul-out and beach pupping site (Threatened species under Endangered Species Act).
3.	Bald eagle shoreline habitat with nest trees (special management under Bald Eagle Protection Act).
PLANT COMMUNITIES	
Closed Coniferous Forest	
4.	Sitka spruce (outer coastal fringe type)
5.	Western hemlock-Sitka spruce (oval-leaf blueberry type)
6.	Western hemlock-mountain hemlock (low elevation type)
Open Conifer Forest	
7.	Mountain hemlock (high elevation type)
Shrubland	
8.	Sitka alder
Herbaceous	
9.	Dunegrass (coastal gravel/boulder shores)
10.	Dunegrass-beach pea
11.	Halophytic herb (coastal)
Aquatic Vegetation	
12.	Marsh marigold
13.	Pondweed
GEOLOGIC FEATURES	
14.	Coastal Tectonic Uplift - An area where sub- or intertidal habitat was uplifted several meters in the 1964 earthquake. The area should be above high tide and undergoing plant colonization and geomorphic change.
15.	Small Islands and Rocks in Prince William Sound - Small islands and rocky islets illustrating differential rates of coastal erosion.

Green Island RNA contains some of the most significant marine mammal habitat in the National Forest system. Prince William Sound is one of the most intact areas of highly productive and naturally functioning marine-freshwater-terrestrial ecosystems in the world. The primary productivity (photosynthesis) of the marine ecosystem of southcentral Alaska is among the highest in the world (Kennish 1989). The abundant food resources and the largely intact and uninhabited upland, shoreline, and nearshore habitats provide for a notable number and diversity of large marine animals. Many of the animals in this system seek out small, predator free islands such as Green Island for resting, breeding, or other special needs.

The Prince William Sound area, including Green Island RNA, is one of the most northerly migratory bird overwintering areas in North America (Kessel and Gibson 1978). At least 40 species of birds have been seen within the RNA or immediately adjacent to it, and 23 other species are common in the region and almost certainly occur in the area. Many birds use the RNA and its surrounding waters for breeding or as a seasonally important staging habitat during migration. Sitka black-tailed deer from southeast Alaska were introduced into the Prince William Sound region in the early 20th century. Deer have colonized Green Island (Photo 3) but not Little Green Island; the browsed versus unbrowsed shrub understories of the two islands make an interesting contrast.

PRINCIPAL DISTINGUISHING FEATURES

The southwest Prince William Sound region was one of nine areas in the world where sea otters, *Enhydra lutris*, survived near-extinction in the early 20th century (Chanin 1985). Green Island and Little Green Island have provided important habitat for sea otters for many years, and numerous studies of sea otters have been conducted there (Kenyon 1969, Pitcher and Vania 1973, Garshelis 1983, Garshelis and Siniff 1983, Garshelis 1984, Garshelis and Garshelis 1984, Garshelis et al. 1984, Garshelis et al. 1986, Johnson 1987, VanBlaricom 1987, Irons et al. 1988). The islands are surrounded by shallow bedrock shelves that support highly productive and species-rich intertidal and subtidal kelp forest ecosystems (Photo 4). Kelp forest production is the basis for the food web that supports sea otters (Duggins et al. 1989). The RNA also provides isolated islands used as haul-out sites for the Steller sea lions, *Eumetopias jubatus*, a federally Threatened species, and pupping and resting sites for the harbor seal, a declining species (Pitcher 1989) of management concern. The islands are particularly attractive to marine mammals because they are exposed to few or no land predators yet have easy access to productive marine foraging habitat.

Green Island is covered with a mosaic of closed canopy Sitka spruce-western hemlock-mountain hemlock forest (Photo 5, 6), dwarf mountain hemlock forest and mountain hemlock woodland (Photo 6), and treeless muskeg or blanket bog (Photo 2, 7). Several other unclassified wetland types may exist on Green Island, but to date they have not been recognized in the type needs list. Society of American Foresters (SAF) cover types represented include western hemlock-Sitka spruce, Sitka spruce, *Picea sitchensis*, western hemlock, *Tsuga heterophylla*, and mountain hemlock, *Tsuga mertensiana*. Little Green Island supports some of the largest trees on the Chugach National Forest (Photo 8).

Old-growth forest indicator bird species such as the brown creeper, *Certhia familiaris*, inhabit both islands. Marbled murrelet are common on marine waters around Green Island and presumably nest in old-growth forest in the RNA. The marbled murrelet, *Brachyramphus marmoratus*, is a Threatened species in California, Oregon, and Washington and it's status in Alaska is C2. A few bald eagles, *Haliaeetus leucocephalus*, nest on Green Island in tall old-growth trees near the shoreline. Spruce and hemlock forests on Green Island experienced moderate to severe defoliation from 1988 through 1991 as the result of an outbreak of the western black-headed budworm.

Green Island RNA provides habitat for many marine and shorebird species (Isleib and Kessel 1973). Black oystercatchers, *Haematopus bachmani*, nest on open gravel beaches in the RNA. Black turnstones, *Arenaria melanocephala*, and surfbirds, *Aphriza virgata*, forage on the eggs (roe) of spawning Pacific herring, *Clupea harengus pallasi*, deposited in the early spring on offshore kelp and rocks (Norton et al. 1990). Nesting colonies of tufted puffin, *Lunda cirrhata*, and pigeon guillemots, *Cephhus columba*, occupy nearby Channel Rock (Sowls et al. 1978).

Green and Little Green Islands are underlain by vertically tilted sandstones and shales of the Orca Formation (Photo 9) (Dumoulin 1987) and exhibit several features of turbidite rocks including sole markings, rip-up, load casts, and conglomerates. Wave erosion of coastal bluffs on Green Island maintains bedrock exposures and illustrates particularly well the differential erosion resistance of the turbidite units. The islands were uplifted over six feet (two meters) by the 1964 Great Alaska Earthquake (Plafker 1969, 1990). A zone of forest and beach succession on the uplifted terrace parallels the shoreline (Eyerdam 1971, Juday 1987). The rocks, coastal erosion, and uplift features are particularly suitable for educational use because they are easily visible and readily accessible to visitors along the beach.

The marine environment surrounding Green and Little Green Islands is closely linked to the terrestrial upland ecosystems of the RNA through the movement of energy, nutrients, and plants and animals. Marine intertidal habitats along the southeast shore of Green Island and Little Green Island were investigated beginning in 1986 as part of RNA site documentation. Beach and intertidal habitats surrounding the RNA were highly productive and species-rich when first documented.

Effects of the *Exxon Valdez* Oil Spill

In late March of 1989 the waters, intertidal zone, and beaches around Green Island were oiled by the *Exxon Valdez* spill in Prince William Sound, the largest spill to date in North America. Many news reports and articles describing the effects of the *Exxon Valdez* oil spill include photographs or data taken from Green Island (Hodgson 1990).

An extensive program of damage assessments of the spill began late in the 1989 field season under provisions of the Comprehensive Environmental Response Compensation and Liability Act, including assessments of the Green Island area (*Exxon Valdez* Oil Spill Trustee Council 1993). After settlement of criminal action by Consent Decree in March 1991, results of damage assessments were released from confidentiality for litigation purposes. Results gradually have been

published since that time (e.g., U.S. Coast Guard et al. 1993). The principal author of this report analyzed the effects of the spill on RNA values independent of litigation related funding, so these results can be released to the public.

The RNA was not as heavily oiled as the remainder of the shoreline of Green Island. The beaches of the RNA were not mapped as oiled in the first oil damage surveys, but later were generally rated as lightly oiled; short segments of beaches within the RNA actually were more severely affected by oil.

The *Exxon Valdez* oil spill devastated several elements of the ecosystem at Green Island, especially the formerly abundant sea otters around the island and plants and animals in the upper intertidal zone. Sea otters were more severely affected by the oil in Prince William Sound than other areas of the spill (DeGange and Lensink 1990), and Green Island was one of two high density sea otter population areas affected in the Sound (DeGange et al. 1990). Oil triggered a major die-off of surfgrass, rockweed and other algae, and upper intertidal barnacles (Juday and Foster 1990).

Based on experience in other spills, the ecosystem should achieve a substantially normal condition within five to 10 years (Nelson-Smith 1973). However, continuing concerns about the effects of the spill include the potential for re-oiling from pockets of oil buried in beach gravels (Juday and Foster 1991), persistence of oil breakdown products, and lingering ecosystem-level effects because of the large scale of the *Exxon Valdez* oil spill.

Conclusion

Despite the oil spill the RNA retains exceptional value as one of a small number of places in outer Prince William Sound with a record of pre-spill intertidal life, as an area dedicated to monitoring the long-term recovery from the oil spill, and as a site suitable for detailed studies of the linkage between terrestrial and marine ecosystems on small islands.

LOCATION

Green Island RNA is in Prince William Sound in southcentral Alaska in the Cordova Ranger District of the Chugach National Forest. The center of Green Island is at 60° 16' N., 147° 23' W. The RNA extends for seven miles (11.2 km) on a northeast to southwest axis on Green Island from the watershed crest to the elongated southeast shore. It includes all of Little Green Island, which is 1.2 miles (2.1 km) southwest of the southwest tip of Green Island, and The Needle, an isolated small rock 6.5 miles (10.5 km) south southwest of Little Green Island (fig. 2).

Portions of Green Island, Little Green Island, and The Needle that are above mean higher high tide line are within the Chugach National Forest. The state of Alaska manages areas below mean high tide line and seaward 3.0 miles (4.8 km) as state public trust lands. Mean higher high tide line cannot always be physically located easily. In practice the seaward margin of upland ownership is usually recognized by the limit of well-established vascular plant communities, which mostly consists of dunegrass on Green Island. Southwestern Prince William Sound was uplifted by

the 1964 Great Alaska Earthquake, placing formerly submerged lands well above tidal range and significantly increasing the land area of Green and Little Green Islands. When formerly intertidal surfaces are uplifted they accrete to the upland (National Forest in this case) owner. These additions to the Chugach National Forest are not consistently depicted accurately in available maps, reports, or inventories, and care should be taken in distinguishing among pre- and post-earthquake sources.

Boundaries[1]

All bearings are given in true azimuth. Basis of elevations is mean sea level as depicted on the US Geologic Survey 1:63,360 scale topographic quadrangle maps for the Seward B-1 (1963), Seward B-2 (1964), and Seward A-2 (1963) quadrangles, Alaska. The boundary of the RNA (see fig. 2) is described as follows:

> Beginning at a point on Green Island, said point being the West 1/4 corner of Section 9, T. 2 N., R. 12 E., SM; thence East approx. 0.5 miles to the center of Section 9, t. 2 N., R. 12 E., SM; thence North approx. 0.5 miles to the North 1/4 corner of Section 9, T. 2 N., R. 12 E., SM; thence East approx. 0.3 miles to a small drainage at the 100 foot contour interval and designated "A" on the referenced map in Appendix; thence Northeasterly along aforesaid drainage (drainage flows southwesterly) to its headwaters in a muskeg and along a northeasterly flowing drainage to mean high tide in Section 3, T. 2 N., R. 12 E., SM, and designated "B" on the referenced map in Appendix; thence South and Southeasterly along mean high tide through Sections 3, 10, 15, 16, 21, 20, 19, and 30, T. 2 N., R. 12 E., and Sections 25, 26 and 35, T. 2 N., R. 11 E., SM to the watershed divide (dividing the southeasterly flowing drainage from the northwesterly flowing drainage) in Section 35, T. 2 N., R.11 E., SM and designated "C" on the referenced map in Appendix; thence Northeasterly along the aforesaid watershed divide through Sections 35, 26, 25 and 24, T. 2 N., R. 11 E., and Sections 19, 18 and 17, T. 2 N., R. 12 E., SM to the section line common to Sections 16 and 17, T. 2 N., R. 12 E., SM, and designated "D" on the referenced map in Appendix; thence North approx. 0.55 miles to the west 1/4 corner Section 9, T. 2 N., R. 12 E., SM and the Point of Beginning.
>
> The Research Natural Area Boundary also includes all of Little Green Island and The Needle above mean high tide.

Acreage and Elevations

Green Island RNA is 2,861 acres (1,158 ha) in size, including 46 acres (18.6 ha) on Little Green Island and 0.46 acre (0.19 ha) on The Needle. Elevations range from sea level to 520 feet (158 m).

[1] The surveyor certified boundary description and map is included in the Appendix.

Access (Figures 1, 2)

Access to Green Island is by boat or aircraft. Green Island is about 108 miles (174 km) southeast of Anchorage International Airport, 72 miles (116 km) southwest of Valdez harbor and airport, and 60 miles (97 km) west of Cordova (fig. 1). Boat charters are available in Whittier (accessible from Anchorage), Valdez, or Cordova. Floatplane charters are available in Anchorage and Cordova; helicopters can be chartered in Anchorage and Valdez. No roads exist on Green or Little Green Island.

Aircraft operations in Prince William Sound are regularly restricted by storms, heavy precipitation, high winds, and limited visibility because of fog and low clouds. During colder months supercooled water droplets in the atmosphere can cause dangerous wing icing conditions, and the short days of this high latitude location restrict daytime activities. Flights to Green Island are sometimes restricted by weather along the route, especially at Portage Pass between Anchorage and Whittier, even when conditions are operable at Green Island and the base of operations. Visitors arriving by aircraft cannot plan on adhering to a schedule and must be prepared to arrive or depart as circumstances dictate.

Boats provide the most reliable means of access to Green Island. Faster motor vessels can reach Green Island in about five hours from either Whittier of Valdez. Slower boats may require up to 12 hours, especially in adverse winds or sea state.

A narrow enclosed upper (northeast) arm of Gibbon Anchorage is an excellent small boat anchorage and float plane base. A public recreation cabin is at the upper end of the arm. Before the 1964 Great Alaska Earthquake the northeast arm was a channel between a small island and the main body of Green Island. Shoreline currents in the years following the earthquake uplift built a gravel spit between the two islands, enclosing the water (fig. 2). Shallow water in the arm limits the operation of deep-draft vessels, especially at extreme low tide stages.

AREA BY COVER TYPES

No comprehensive map of plant community types is available for Green Island RNA, but Figure 3 shows the location of closed canopy forests. The forests of the island do not exactly correspond to existing defined SAF forest cover types (Eyre 1980). Table 2 gives acreage figures for nearest equivalent SAF types and land cover features.

The closed canopy forest at Green Island most closely corresponds to SAF type 225 Western hemlock-Sitka spruce, except that it includes a minor component of mountain hemlock from sea level upward. Gravel beach terraces uplifted in the 1964 earthquake support early successional examples of SAF type 223 Sitka spruce, but only in locations such as Triangle Lake is this type more than about two or three tree crowns in width. Stable, excessively well drained sites are occupied by SAF type 224 Western hemlock, although this type is quite restricted in extent. Wave erosion of coastal bluffs produces most of the oversteepened, excessively well drained

topography on the island, but coastal erosion is so active on most bluffs that forests are not able to mature before a major slumping event strips all vegetation from the slope. SAF type 205 Mountain hemlock is defined as a high elevation forest type, but at Green Island it is the predominant forest cover at elevations near sea level on long bedrock ridges that parallel muskegs or blanket bogs. Above 400 feet (122 m) elevation a snowpack persists longer than elsewhere on the island and a more typical high elevation mountain hemlock type occurs.

Table 2. Extent of land cover features and estimated extent of forest types in Green Island Research Natural Area.

Cover Feature	Acres	Hectares	Percent
Total forest land	2,499	1,012	87
Muskeg	312	126	11
Ponds and lakes	51	20	2
Total	**2,861**	**1,158**	**100**
		Estimated Area	
Equivalent SAF Type	Estimated Portion of Total Forest	Acres	Hectares
225 Western hemlock-Sitka spruce	30%	750	303
223 Sitka spruce	1%	25	10
224 Western hemlock	9%	225	91
205 Mountain hemlock	60%	1499	607
Total	**100%**	**2,499**	**1,011**

Green Island, unlike larger islands in Prince William Sound, has few subalpine meadows or open rocky habitats. This is because the highest elevation is only 520 feet (158 m) and the bedrock is relatively soft, friable, and easily weathered. However, many muskeg types and limited areas of riparian habitat occur on the RNA. All of Little Green Island is covered with a productive western hemlock-Sitka spruce forest that is unusual for such a northerly location.

Permanent monitoring plots have been established on both Green and Little Green Island (fig. 2) to better document Prince William Sound forest types contained within the RNA. Both reference plots are within the western hemlock-Sitka spruce forest type, and represent relatively undisturbed highly productive examples of this type. Complete documentation of soils, understory vegetation, trees, stand structure, and age are available for the primary plot, Triangle Lake. Overstory structural data and soils information is available for the other plots. These data are available from the Alaska Ecological Reserves Coordinator at the University of Alaska Fairbanks and the Research Ecologist at the USDA Forest Service Forestry Sciences Laboratory in Juneau. These baseline data suggest Green Island contains outstanding examples of highly productive

old-growth forest in the Prince William Sound Region, meeting or exceeding criteria for meeting RNA cell type needs.

PHYSICAL AND CLIMATIC CONDITIONS

Tectonics

Green Island is located near the subducting margin of the Pacific and North American geologic plates - the zone where the Pacific plate dives under the North American Plate. This zone is one of the most active of its kind in the world. Strain that gradually accumulates on this system (about two inches or five centimeters of relative motion per year) is released suddenly through earthquakes about every 750 to 1,200 years. The Great Alaska Earthquake in late March of 1964 was the largest ever recorded in North America (Plafker 1969). The tectonic adjustment associated with the 1964 earthquake moved coastal southcentral Alaska about 33 feet (10 m) seaward and uplifted Green Island about eight to 10 feet (2.5 to 3.0 m) (Plafker 1990). A distinctive ring of uplifted beaches and rock shelves surrounds Green and Little Green Islands. The uplifted shore can be distinguished by post-1964 grasses, shrubs, and small trees invading these newly exposed sites.

Climate

Green Island RNA has a cold, maritime climate with high precipitation. The nearest representative weather station was operated at Cape Hinchinbrook Lighthouse 24 miles (38 km) due west of the RNA on the outer coast of the North Pacific (fig. 1) from 1944 to 1974 (Table 3). Two other stations that currently collect climatic records from outer Prince William Sound are not suitable for analysis because of short records, gaps in the records, or unrepresentative locations. The 1944-1974 time period was marked by a strong cooling trend in Alaska temperatures (Juday 1984), and the climate of Green Island and the Prince William Sound region is warmer today than indicated in Table 3.

The Green Island area experiences a highly maritime climate with a mean annual temperature of 41.5°F (5.3°C) and mean annual precipitation of 97 inches (245 cm). The annual range of temperature is relatively limited (ca. 20°F), and the mean annual temperature is much warmer than practically anywhere else at an equivalent latitude in North America because of oceanic influence. Farr and Hard (1987) classified coastal Alaska weather stations into climatic groups, and placed Cape Hinchinbrook in a group characterized by higher maximum and minimum fall temperatures and longer frost free period than nearby but more inland stations. Cape Hinchinbrook experienced an average of fewer than three days warmer than 70°F (21°C) per year, but a total of only about 10 days colder than 0°F (-18°C) during the entire 30-year interval. Temperatures are somewhat cyclic, with as few as 69 and as many as 157 days with temperatures below freezing recorded per year. Frequent, strong, well-developed low pressure storm systems sweep into the RNA from the south and east (Brower et al. 1988). Precipitation is abundant and frequent, amounting to about 30% of all weather observations (Brower et al. 1988). Precipitation at Cape Hinchinbrook is evenly distributed throughout the year, with a slight minimum in June and a slight maximum in September or October.

Table 3. Climatic Records (1944-1974[a]) for Cape Hinchinbrook (AEIDC 1989), Chugach National Forest, Alaska at 190 feet (58 m) elevation.

	Mean Temperature		(years in record)	Mean Precipitation		(years in record)
	°F	°C		Inches	cm	
January	30.1	-1.1	(29)	6.48	16.4	(30)
February	32.0	0.0	(29)	6.20	15.7	(30)
March	32.4	0.2	(29)	5.54	14.1	(28)
April	37.5	3.1	(28)	5.65	14.4	(29)
May	43.4	6.3	(29)	6.44	16.4	(28)
June	50.3	10.2	(29)	4.54	11.5	(30)
July	54.5	12.4	(28)	7.25	18.4	(31)
August	54.9	12.7	(27)	9.38	23.8	(31)
September	50.3	10.2	(29)	12.82	32.6	(30)
October	42.3	5.7	(28)	12.12	30.8	(29)
November	36.2	2.3	(29)	7.89	20.0	(30)
December	31.9	-0.1	(27)	8.39	21.3	(29)
Mean Annual	41.5	5.3	(24)	96.59	245.3	(25)
Mean May-September	50.7	10.4		40.43	102.7	
Mean October-April	34.6	1.5		52.27	132.8	
Maximum	81	27.2		127.45	323.7	
Date or year	June & July 1963			1947		
Minimum	-15	-26.1		45.49	115.5	
Date or year	March 1963			1950		

[a] Climatic records were not continuous throughout the interval; data presented in this table are based on the available number of years in the climatic record indicated in parentheses (station was discontinued after August 1974).

Spring phenological events often begin in late March, although snow cover at sea level can persist well into May in heavy snowfall years. Green Island is in the rain shadow of the highest elevations of Montague Island, which receives the full force of storms off the North Pacific. Visitors standing on the shore of the RNA can often observe rainfall persisting throughout the day on Montague Island a few miles away while the weather remains partly cloudy or sunny in the RNA.

DESCRIPTION OF VALUES

Flora

Taxonomic nomenclature in Table 4 and 5 follows Little (1979) for trees, Viereck and Little (1972) for shrubs, and generally follows Hulten (1968) for herbaceous vascular plants, except as noted. Table 4 is a list of 143 plant species that are known to occur in the Green Island RNA and Table 5 is a list of 161 species that probably occur in the RNA. Table 5 is based on Hulten (1968) distribution maps, plant collections from adjacent map quadrangle areas, or on species collected regionally within the same habitats. Consequently, Table 5 species are considered to have a good likelihood of occurring in the RNA. Based on the combined total of 304 species within the RNA. This represents approximately 20% of the flora of Alaska, which is high for such a small area. Fourteen species collected in the RNA represent the first record for outer Prince William Sound and 5 vascular plants (Table 6) were collected beyond their previously known distribution limits in Alaska (Hulten 1968). From this preliminary survey we conclude that the Green Island area has a good representation of low elevation forest and wetland types in the outer Prince William Sound area, and a wide range in forest productivity that is probably also typical of the area.

Green Island and nearby sites in outer Prince William Sound are particularly suitable locations for the study of island biogeography, especially the influence of island size and isolation on species colonization and diversity. The effects of islands on plant species diversity can be recognized in some cases by the absence of plant species. Interpretations based on the absence of plants require thorough species inventories in the area of analysis. Unfortunately, the flora of the Prince William Sound region has not been collected as intensively as other parts of Alaska.

We surveyed a variety of habitats and landforms to document the character of Green and Little Green Islands and to investigate how plant species were distributed along environmental gradients. Forested areas were surveyed more thoroughly than wetlands. Six distinct habitats were identified during the survey:

1) beach and open shoreline areas dominated by graminoids;
2) freshwater and adjacent aquatic habitat along lakeshores;
3) alder shrublands above the beach zone;
4) conifer forest;
5) riparian or wet streamside areas; and
6) muskeg-fen wetlands.

Table 4. Vascular plants collected[a] or observed[b] at Green Island Research Natural Area.

Species	Common name[c]	Basis for Listing
Achillea borealis Bong.	common yarrow	b
Actaea rubra (Ait.) Willd.	baneberry	b
Alnus sinuata (Regel) Rydb.	Sitka alder	b
Anemone narcissiflora L.	Narcissus-flowered anemone	b
Angelica genuflexa Nutt.	bentleaf angelica	a
Apargidium boreale (Bong.) Torr. & Gray	apargidium	a
Arabis hirsuta (L.) Scop.	hairy rockcress	a
Aruncus sylvester Kostel.	goatsbeard	b
Athyrium filix-femina (L.) Roth	ladyfern	b
Atriplex patula L	spearscale	b
Blechnum spicant (L.) Roth	deer fern	b
Boschniakia rossica (Cham. & Schlecht.) Fedtsch.	ground-cone	b
Calamagrostis canadensis (Michx.) Beauv.	bluejoint	a
Calamagrostis nutkaensis (Presl) Steud.	Pacific reedgrass	d
Caltha palustris L.	yellow marsh-marigold	b
Campanula rotundifolia L.	bluebells of Scotland	b
Cardamine umbellata Greene	little western bittercress	a
Carex anthoxanthea Presl	yellow-flowered sedge	a
Carex pauciflora Lightf.	few-flowered sedge	a
Carex sitchensis Prescott	Sitka sedge	d
Chrysanthemum arcticum L.	arctic daisy	a
Cicuta mackenzieana Raup	water hemlock (Hulten 1968)	a
Circaea alpina L.	enchanter's nightshade	b
Cladothamnus pyrolaeflorus Bong.	copper-bush	a
Claytonia sibirica L.	siberian spring-beauty	a
Cochlearia officinalis L.	scurvy-grass	b

Species	Common name[c]	Basis for Listing
Conioselinum chinense (L.) BSP.	western hemlock-parsley	b
Coptis aspleniifolia Salisb.	fern-leaf goldthread	b
Coptis trifolia (L.) Salisb.	three-leaved goldthread	a
Corallorrhiza trifida Chatelain	early coral-root	a
Cornus canadensis L.	bunchberry	b
Cornus suecica L.	Swedish dwarf cornel	a
Dodecatheon jeffrey Van Houtte	tall mountain shooting-star	a
Drosera rotundifolia L.	round-leaf sundew	b
Dryopteris austriaca = *D. dilatata* (Hoffm.) Gray	spiny shield-fern	b
Eleocharis palustris (L.) Roem. & Schult.	creeping spike-rush	a
Elymus arenarius L. ssp. *mollis* (Trin.) Hult.	beachgrass	b
Empetrum nigrum L.	black crowberry	b
Epilobium angustifolium L.	fireweed	b
Epilobium behringianum Haussk.	alpine willow-herb	a
Epilobium glandulosum Lehm.	glandular willow-herb	a
Epilobium hornemannii Rchb.	alpine willow-herb	a
Epilobium latifolium L.	river beauty	b
Epilobium sertulatum Haussk.	alpine willow-herb	a
Equisetum arvense L.	common horsetail	b
Equisetum variegatum Schleich.	variegated scouring-rush	a
Erigeron peregrinus (Pursh) Greene	wandering daisy	a
Eriophorum angustifolium Honck.	tall Alaska cotton-grass	a
Fauria crista-galli (Menzies) Makino	deer-cabbage	b
Fragaria chiloensis (L.) Duchesne	beach strawberry	b
Fritillaria camschatcensis (L.) Ker-Gawl.	chocolate lilly	b
Galium aparine L.	cleavers	a

Species	Common name[c]	Basis for Listing
Galium trifidum L.	small bedstraw	a
Galium triflorum Michx.	sweet-scented bedstraw	a
Gentiana douglasiana Bong.	swamp gentian	a
Geranium erianthum DC.	northern geranium	b
Geum calthifolium Menzies	caltha-leaf avens	b
Geum macrophyllum Willd.	large-leaf avens	b
Gymnocarpium dryopteris (L.) Newm.	oakfern	b
Heracleum lanatum Michx.	cow parsnip	b
Heuchera glabra Willd.	alpine heuchera	b
Hippuris vulgaris L.	common marestail	b
Honckenya peploides (L.) Ehrh.	beach greens	b
Hordeum brachyantherum Nevski	meadow barley	b
Iris setosa Pall.	wild flag	b
Juncus arcticus Willd.	arctic rush	a
Lathyrus maritimus L.	beach-pea	b
Lathyrus palustris L.	wild-pea	a
Ligusticum scoticum L.	beach lovage	b
Listera caurina Piper		d
Listera cordata (L.) R. Br.	heartleaf twayblade	a
Lupinus nootkatensis Donn	nootka lupine	b
Luzula parviflora (Ehrh.) Desv.	small-flowered woodrush	a
Luzula wahlenbergii Rupr.	Wahlenberg woodrush	a
Lycopodium annotinum L.	stiff clubmoss	a
Lycopodium clavatum L.	running clubmoss	a
Lycopodium selago L.	fir clubmoss	d
Lysichiton americanum Hult. & St. John	skunk cabbage	b

Species	Common name[c]	Basis for Listing
Maianthemum dilatatum (How.) Nels. & Macbr.	false lilly-of-the-valley	b
Malus fusca (Raf.) Schneid.	Oregon crab apple	b
Menyanthes trifoliata L.	buckbean	b
Menziesia ferruginea Sm.	rusty menziesia	b
Mertensia maritima (L.) S.F. Gray	oysterleaf	a
Mimulus guttatus DC.	yellow monkey-flower	b
Moneses uniflora (L.) Gray	single delight	b
Nuphar polysepalum Engelm.	yellow pond lilly	b
Oplopanax horridus (Sm.) Miq.	devils-club	b
Osmorhiza purpurea (Coult.& Rose) Suksd.	purple sweet-cicely	a
Oxycoccus microcarpus Turcz.	bog cranberry	a
Pedicularis parviflora J.E. Sm.	small-flowered lousewort	a
Phyllospadix serulatus cf.	surfgrass	b
Picea sitchensis (Bong.) Carr.	Sitka spruce	b
Plantago maritima L.	goose-toungue	b
Platanthera dilatata (Pursh) Lindl.	white bog-orchid	b
Platanthera saccata (Greene) Hult.	slender bog-orchid	a
Poa arctica R. Br.	arctic bluegrass	a
Poa eminens Presl	large-flower speargrass	a
Polygonum viviparum L.	alpine bistort	b
Polypodium vulgare L.	licorice fern	a
Polystichum braunii (Spenn.) Fee	prickly shield-fern	a
Potentilla egedii Wormsk.	common silverweed	b
Potentilla villosa Pall.	villous cinquefoil	b
Prenanthes alata (Hook.) Dietr.	rattlesnake root	b
Puccinellia nutkaenis (Presl) Fern. & Weath.	Pacific alkaligrass	a

Species	Common name[c]	Basis for Listing
Ranunculus bongardi Greene	stout buttercup	a
Ranunculus orthorhynchus Hook.	straight-beak buttercup	a
Rhinanthus minor L.	rattlebox	a
Ribes bracteosum Dougl.	stink currant	b
Ribes laxiflorum Pursh	trailing black currant	b
Rubus arcticus L.	nagoon berry	b
Rubus chamaemorus L.	cloudberry	b
Rubus pedatus Sm.	five-leaf bramble	b
Rubus spectabilis Pursh	salmonberry	b
Rumex crispus L.	dock (Hulten 1968)	a
Rumex fenestratus Greene = *Rumex occidentalis* Wats.	western dock	b
Rumex transitorius Rech. f.	beach dock	a
Sambucus calicarpa Greene	Pacific red elderberry	b
Sanguisorba stipulata Raf. = *Sanguisorba canadensis* L.	Sitka burnet	b
Scirpus cespitosus L.		d
Senecio pseudo-arnica Less.	false arnica	b
Senecio triangularis Hook.	arrow-leaf groundsel	b
Sorbus sitchensis Roem.	Sitka mountain ash	b
Sparganium angustifolium Michx. = *Sparganium emersum* Rehmann	narrow-leaved burreed	a
Stellaria calycantha (Ledeb.) Bong.	northern starwort	b
Stellaria crispa Cham. & Schlecht.	crisp starwort	a
Stellaria media (L.) Vill.	chickweed	b
Stellaria sitchana Steud.	northern starwort	a
Streptopus amplexifolius (L.) DC.	clasping twisted-stalk	b
Swertia perennis L.	swertia	a
Thelypteris phegopteris (L.) Slosson	northern beech-fern	b

Species	Common name[c]	Basis for Listing
Tiarella trifoliata L.	foamflower	b
Tofieldia glutinosa (Michx.) Pers.	sticky tofieldia	a
Trichophorum cf caespitosum (L.) Hartm. = *Scirpus caespitosus* L.	tufted clubrush	a
Trientalis europaea L. = *Trientalis europaea* L.	arctic starflower	b
Tsuga heterophylla (Raf.) Sarg.	western hemlock	b
Tsuga mertensiana (Bong.) Carr.	mountain hemlock	b
Vaccinium alaskensis How.	Alaska blueberry	b
Vaccinium caespitosum Michx.	bog blueberry	b
Vaccinium ovalifolium Sm.	early blueberry (also, ovalleaf blueberry)	b
Vaccinium uliginosum L.	dwarf alpine blueberry	b
Vaccinium vitis-idaea L. ssp. *minus* (Lodd.) Hult.	mountain cranberry	b
Vahlodea atropurpurea (Wahlenb.) E. Fries = *Deschampsia atropurpurea* (Wahl.) Scheele	mountain hairgrass	d
Veratrum viride Ait.	false hellebore	b
Veronica americana Schwein.	brooklime	b
Viburnum edule (Michx.) Raf.	highbush cranberry	b
Viola epipsila Ledeb. = *Viola palustris* L.	marsh violet	b
Viola glabella Nutt.	stream violet	b
Viola langsdorfii Fisch.	Alaska violet	b
Zostera marina L.	eel-grass	b

[a] Collections made by Paul Alaback, Glenn Juday, or Clara Jodwalis; voucher specimens in Forestry Sciences Laboratory Herbarium, Juneau, or University of Alaska Fairbanks Herbarium, Fairbanks.
[b] Field notes by Paul Alaback or Glenn Juday.
[c] Common names from Hall and Alaback (in press) for herbaceous plants, and Viereck and Little (1972) for shrubs.
[d] Collections made by Chugach National Forest vegetation field crews.

Table 5. Vascular plants that may occur[a] at Green Island Research Natural Area.

Species	Common name[b]
Aconitum delphinifolium DC.	monkshood
Adiantum pedatum L.	maidenhair fern
Agrostis alaskana Hult.	Alaska bentgrass
Agrostis borealis Hartm.	red bentgrass
Agrostis exarata Trin.	spike redtop
Agrostis scabra Wolld.	ticklegrass
Alopecurus aequalis Sobol.	shortawn foxtail
Andromeda polifolia L.	bog rosemary
Angelica lucida L.	seacoast angelica
Antennaria monocephala DC.	one-headed pussy-toes
Aquilegia formosa Fisch.	western columbine
Arabis lyrata L.	lyreleaved rockcress
Arctagrostis latifolia (R. Br.) Griseb.	polargrass
Barbarea orthoceras Ledeb.	wintercress
Botrychium boreale (E. Fries) Milde	northern grapefern
Botrychium lanceolatum (Gmel.) Angstr.	lance-leaved grapefern
Botrychium lunaria (L.) Sw.	moonwort
Bromus sitchensis Trin.	Alaska brome
Calamagrostis deschampsioides Trin.	hairy reed bent grass
Callitriche verna L. emend. Lonnr.	spring water-starwort
Carex aquatilis Wahlenb.	water sedge
Carex buxbaumii Wahlenb.	Buxbaum sedge
Carex canescens L.	gray sedge
Carex circinnata C.A.Mey.	coiled sedge
Carex disperma Dew.	two seed sedge
Carex enanderi Hult.	Enander sedge
Carex flava L.	yellow sedge

Species	Common name[b]
Carex gmelini Hook. & Arn.	Gmelin sedge
Carex kelloggii W. Boott	lenticulate sedge
Carex laeviculmis Meinsh.	smooth-stem sedge
Carex livida (Wahlenb.) Willd.	livid sedge
Carex lyngbyaei Hornem.	Lyngbye sedge
Carex macloviana d'Urv.	(no common name)
Carex macrocephala Willd.	large-head sedge
Carex macrochaeta C.A. Mey.	long-awn sedge
Carex mertensii Prescott	Mertens sedge
Carex nigricans C.A. Mey.	blackish sedge
Carex phyllomanica W. Boott	stellate sedge
Carex pluriflora Hult.	many-flower sedge
Carex pyrenaica Wahlenb.	Pyrenean sedge
Carex rostrata Stokes	beaked sedge
Carex saxatilis L.	russet sedge
Carex stylosa C.A. Mey.	variegated sedge
Cerastium beeringianum Cham. & Schlecht	Bering chickweed
Cerastium fischerianum Ser.	Fischer chickweed
Cinna latifolia (Trev.) Griseb.	woodreed
Claytonia chamissoi Esch.	toad-lilly
Cryptogramma crispa (L.) R. Br.	parsley fern
Cystopteris fragilis (L.) Bernh.	fragile-fern
Deschampsia beringensis Hult.	Bering hairgrass
Deschampsia caespitosa (L.) Beauv.	tufted hairgrass
Dodecatheon pulchellum (Raf.) Merr.	dark-throated shooting-star
Draba hyperborea (L.) Desv.	sub-boreal draba
Drosera anglica Huds.	long-leaf sundew
Epilobium anagallidifolium Lam.	alpine willow-herb

Species	Common name[b]
Epilobium leptocarpum Haussk.	(no common name)
Epilobium luteum Pursh	yellow willow-herb
Epilobium palustre L.	swamp willow-herb
Equisetum fluviatile L. ampl. Ehrh.	swamp horsetail
Equisetum silvaticum L.	horsetail
Eriophorum russeolum E. Fries	russett cotton-grass
Festuca brachyphylla Schult.	sheep fescue
Festuca rubra L.	red fescue
Gentiana amarella L.	northern gentian
Glaux maritima L.	sea milkwort
Glyceria pauciflora Presl	few-flowered mannagrass
Hierochloe alpina (Sw.) Roem. & Schult.	alpine holygrass
Hierochloe odorata (L.) Wahlenb.	vanilla grass
Hippuris tetraphylla L. f.	four-leaf marestail
Isoetes muricata Dur.	seaside quillwort
Isoetes truncata (A.A. Eat.) Clute	quillwort
Juncus alpinus Vill.	alpine rush
Juncus bufonius L.	toad rush
Juncus drummondii E. Mey.	Drummond rush
Juncus ensifolius Wikstr.	dagger-leaf rush
Juncus mertensianus Bong.	Mertens rush
Juncus oreganus S. Wats.	spreading rush
Juncus stygius L.	filiform rush
Ledum palustre L. ssp. *decumbens* (Ait.) Hult	narrow-leaf Labrador tea
Leptarrhena pyrolifolia (D. Don) Ser.	leatherleaf saxifrage
Loiseleuria procumbens (L.) Desv.	alpine-azalea
Luzula arcuata (Wahlenb.) Sw.	alpine woodrush

Species	Common name[b]
Luzula multiflora (Retz.) Lej.	field woodrush
Lycopodium alpinum L.	alpine clubmoss
Lycopodium sabinaefolium Willd.	Alaskan clubmoss
Mitella pentandra Hook.	alpine mitrewort
Moehringia lateriflora (L.) Fenzl	blunt-leaved sandwort
Montia fontana L.	water blinks
Myrica gale L.	sweet gale
Osmorhiza depauperata Phill.	blunt-fruit sweet-cicely
Parnassia fimbriata Konig	fringed grass-of-parnassus
Phleum commutatum Gandoger	alpine timothy
Pinguicula vulgaris L.	common butterwort
Plantago macrocarpa Cham.& Schlecht.	seashore plantain
Platanthera chorisiana (Cham.) Rchb.	chorus bog-orchid
Platanthera unalaschcensis (Spreng.) Kurtz (Spreng.) Kurtz	Alaska bog-orchid
Poa alpina L.	alpine bluegrass
Poa annua L.	annual bluegrass
Poa macrocalyx Trautv. & Mey.	large head bluegrass
Poa palustris L.	swamp bluegrass
Poa pratensis L.	Kentucky bluegrass
Poa stenantha Trin.	trinius bluegrass
Podagrostis aequivalis (Trin.) Scribn. & Merr.	northern bentgrass
Polemonium acutiflorum Willd.	blue jacobs-ladder
Polygonum amphibium L.	water smartweed
Polygonum aviculare L.	doorweed
Polygonum fowleri Robins.	fowler knotweed
Polygonum pennsylvanicum L.	Pennsylvania knotweed
Potamogeton alpinus Balb.	northern pondweed
Potamogeton berchtoldi Fieb.	Berchtold's pondweed

Species	Common name[b]
Potamogeton filiformis Pers.	thinleaf pondweed
Potamogeton gramineus L.	grass-leaved pondweed
Potamogeton natans L.	floating pondweed
Potamogeton vaginatus Turcz.	sheathed pondweed
Potentilla palustris (L.) Scop.	marsh cinquefoil
Primula cuneifolia Ledeb.	wedge-leaf primrose
Puccinellia grandis Swallen	shining alkaligrass
Puccinellia pumila (Vasey) Hitchc.	dwarf alkaligrass
Puccinellia triflora Swallen	three flowered alkaligrass
Ranunculus eschscholtzii Schlecht.	Eschscholtz buttercup
Ranunculus occidentalis Nutt.	western buttercup
Ranunculus repens L.	creeping buttercup
Ranunculus reptans L.	creeping spearwort
Ranunculus trichophyllus Chaix.	water crowfoot
Romanzoffia sitchensis Bong.	Sitka mist-maid
Rorippa islandica (Oeder) Borb.	marsh yellowcress
Rumex acetosella L.	sheep sorrel
Rumex obtusifolius L.	blunt-leaved dock
Ruppia spiralis L. = *Ruppia maritima* L.	ditch-grass
Sagina crassicaulis S. Wats.	beach pearlwort
Sagina intermedia Fenzl	snow pearlwort
Salix arctica Pall.	arctic willow
Salix commutata Bebb	undergreen willow
Salix reticulata L.	netleaf willow
Salix sitchensis Sanson ex Bong.	Sitka willow
Saxifraga ferruginea Graham	Alaska saxifrage
Saxifraga lyallii Engler	red-stem saxifrage

Species	Common name[b]
Saxifraga nivalis L.	snow saxifrage
Saxifraga punctata L.	cordate-leaved saxifrage
Selaginella selaginoides (L.) Link	low lesser-clubmoss
Senecio lugens Richards.	black-tipped butterweed
Sisyrinchium litorale Greene	blue-eyed grass
Sparganium hyperboreum Laest.	northern burreed
Spergularia canadensis (Pers.) G. Don	Canada sand-spurry
Spiraea beauverdiana Schneid.	Alaska spirea
Spiranthes romanzoffiana Cham.	hooded ladies-tresses
Stellaria humifusa Rottb.	low starwort
Suaeda depressa (Pursh) S. Wats. = *Suaeda maritima* (L.) Dumort	low sea-blite
Subularia aquatica L.	awlwort
Tellima grandiflora (Pursh) Dougl.	fringe-cups
Triglochin maritimum L.	maritime arrowgrass
Triglochin palustris L.	marsh arrowgrass
Trisetum cernuum Trin.	nodding oatgrass
Trisetum spicatum (L.) Richter	downy oatgrass
Urtica lyallii S. Wats.	stinging nettle
Valeriana sitchensis Bong.	Sitka valerian
Veronica serpyllifolia L.	tyme-leaf speedwell

[a] Nearby collection locality is depicted, or the species' general distribution in the RNA is indicated in Hulten (1968).

[b] Common names from Hall and Alaback (in press) for herbaceous plants, and Viereck and Little (1972) for shrubs.

It is noteable that 2 species the Truncate quillwort, *Isoetes truncata*, and the choris bog orchid, *Platanthera chorisiana*, are on the January Forest Service Region 10 Sensitive Species list. These species have been collected near the RNA or noted within the distribution maps of Hulten (1968) and may occur in the RNA.

Table 6. Vascular plant species collected in Green Island Research Natural Area beyond previously known distribution limits.

Species	Herbarium Accession Number and Date
Cicuta mackenzieana Raup	Alaback 1023; 19 July, 1986.
Corallorrhiza trifida Chatelain	Alaback 1019; 21 July, 1986.
Polystichum braunii (Spenn.) Fee	Alaback 1018; 20 July, 1986.
Ranunculus orthorhynchus Hook.	Alaback 1022; 22 July, 1986.
Rumex crispus L.	Alaback 1016; 21 July, 1986.

Plant communities

Large forest monitoring plots were established on Green Island at Triangle Lake (0.5ha) and on Little Green Island (0.1875 ha) (fig. 2). All trees larger than 2 cm were mapped and measured for diameter. The dominant vegetation cover was mapped throughout the monitoring plots. Large and productive forest is restricted to well drained slopes. The south-facing slope above Triangle Lake supports a particularly well developed old-growth western hemlock-Sitka spruce forest. Figure 4 shows a cross section view of the forest on the Triangle Lake slope.

Dense climax western hemlock stand of the ovalleaf blueberry, *Vaccinium ovalifolium*, understory type occupy steep headwalls at the top and bottom of the slope. A more open stand with a much higher dominance by Sitka spruce is found on a topographic bench in the middle of the slope between the two headwalls. The bench is largely made up of wet saturated ground based on the understory dominance of devil's club. This wet ground has a high incidence of trees blown over with intact rootwads, apparently producing a high light environment in the forest understory that allows greater reproduction of Sitka spruce than elsewhere on the slope.

Understory plant cover was sampled in 74 plots of 1.0 m^2 in the upper 0.25 ha of the Triangle Lake old-growth reference stand. Table 7 shows the composition, cover, and abundance of understory vegetation in the Triangle Lake old-growth reference stand, which is representative of most of the low elevation productive forest type on Green Island. In the shrub layer ovalleaf blueberry and Devil's club, *Oplopanax horridus*, are abundant but at relatively low frequencies over the entire sampling area, consistent with their concentrated occurrence in different habitats, the well drained slopes and wet seepage portions of the stand respectively. Salmonberry, *Rubus spectabilis*, is associated with Devil's club, but is less abundant in general. In the herb layer purple sweet-cicely,

Table 7. Forest understory cover summary for Triangle Lake plot, Green Island Research Natural Area, July 26, 1986.[a]

Growth form and species[b]	Percent Cover	Percent Frequency
Shrubs		
Menziesia ferruginea	7.80	8.1
Oplopanax horridus	24.63	39.2
Ribes bracteosum	0.68	1.4
Rubus spectabilis	7.90	20.3
Sambucus canadensis	0.05	1.4
Sorbus sitchensis	0.51	1.4
Vaccinium alaskaense	1.42	4.1
Vaccinium seedlings	0.41	27.0
Vaccinium ovalifolium	25.78	29.7
Herbs		
Actea rubra	1.76	14.9
Cornus canadensis	0.61	43.2
Heracleum lanatum	0.26	4.1
Listera caurina	0.12	9.5
Listera cordata	0.34	24.3
Lysichiton americanum	2.35	10.8
Maianthemum dilatatum	0.04	6.8
Moneses uniflora	0.01	1.4
Osmorhiza chiloensis	0.19	5.4
Osmorhiza purpurea	3.12	29.7
Ranunculus bongardi	0.08	4.1
Rubus pedatus	1.67	44.6
Streptopus amplexifolius	0.43	4.1
Stellarie crispa	0.08	4.1
Streptopus roseus	1.34	40.5

Growth form and species[b]	Percent Cover	Percent Frequency
Streptopus streptopoides	0.03	0.0
Tiarella trifoliata	1.23	50.0
Viola glabella	1.98	40.5
Grasses, Rushes and Sedges		
Graminae spp.	0.04	1.4
Luzula parviflora	0.07	2.7
Ferns and Other Vascular Cryptogams		
Athyrium filix-femina	5.11	17.6
Blechnum spicant	0.65	0.0
Dryopteris austriaca	0.19	1.4
Equisetum arvense	0.03	1.4
Gymnocarpium dryopteris	3.84	56.8
Lycopodium clavatum	0.16	5.4
Tree Seedlings		
Picea sitchensis	1.23	4.1
Tsuga heterophylla	0.61	6.8
Mosses		
Dicranum fuscescens	1.38	29.7
Hookeria lucens	0.09	8.1
Hylocomium splendens	41.28	83.8
Plagiomnium insigne	0.04	1.4
Pleuroziopsis rubescens	1.46	18.9
Pleurozium schreberi	4.34	10.8
Plagiothecium undulatum	0.30	28.4
Rhizomnium glabrescens	8.41	51.4
Rhytidiadelphus loreus	24.15	83.8
Sphagnum girgensonii	1.08	14.9

Growth form and species[b]	Percent Cover	Percent Frequency
Liverworts		
Jungermannia lanceolata	0.01	1.4
Marchantia polymorpha	0.01	1.4
Porella naviculare	0.07	1.4

[a] Data and summary by Paul Alaback. Number of plots = 74; size of plot = 1.0 m^2.

[b] Equivalent common names for vascular plants are given in Table 4. Nomenclature of mosses and liverworts follows Vitt et al. (1988).

Additional Reference:

Vitt, D.H.; Marsh, J.E.; Bovey, R.B. 1988. Mosses Lichens & Ferns of Northwest North America. Lone Pine Publishing, Edmonton, Alberta, and University of Washington Press, Seattle. 296 p.

Osmorhiza purpurea, ladyfern, *Athyrium filix-femina*, and oakfern, *Gymnocarpium dryopteris*, are the most abundant species, but foamflower, a small species with relatively low cover but high frequency is possibly a better ecological type indicator. Moss cover, especially of *Rhytidiadelphus loreus* and the feather moss, *Hylocomium splendens*,is abundant and widespread in all but areas of the densest shrub cover. Both Sitka spruce and western hemlock seedlings display relatively high frequency, although spruce has about twice the coverage of hemlock.

Table 8 is a summary of the biomass and annual primary production data from understory sampling in the Triangle Lake reference stand. Skunk cabbage, *Lysichiton americanum*, spiny shield-fern, *Dryopteris austriaca*, and ladyfern had the largest average size per individual. Ovalleaf blueberry occurred at the highest density, nearly 25,000 stem per ha, and supported by a large margin the greatest total biomass on the plot. The feathermoss *Hylocomium splendens* was projected to support the greatest annual production on the plot and the second highest standing biomass.

Fauna

Mammals and Amphibians

The greater Prince William Sound ecosystem is one of the most outstanding marine mammal habitat areas in the national forest system. Small islands in the Sound are free of large predators and within a large expanse of productive marine habitat. Nine marine mammals and one aquatic mammal are known to inhabit Green Island RNA and the adjacent marine waters. Green Island serves as an attractive haul out site for several marine mammals.

Table 9 is a list of 24 mammals and two amphibians that are known to occur or that may occur in the RNA and immediately adjacent marine waters. The mammalian fauna of Green Island RNA includes few native terrestrial mammals and a relatively large number of marine mammals. Only 14 terrestrial mammals appear to occur on Green Island, and two of those were introduced on nearby Montague Island and are assumed to have spread to Green Island. The low number of terrestrial mammals is due to island isolation effects.

Sea otter--The occurrence of the sea otter, *Lutra canadensis*, is one of the principal elements of biodiversity justifying the establishment of Green Island RNA. The Green Island area was known as an important region for sea otter pup rearing before the *Exxon Valdez* oil spill (DeGange et al. 1990). In the early 20th century the sea otter was nearly extinct because of overharvest. The 1911 Fur Seal Treaty protected both sea otters and fur seals. Chanin (1985) estimated that the worldwide sea otter population was reduced to between 500 and 1,000 by this time. Southwestern Prince William Sound was one of nine areas worldwide where a remnant population of otters survived (Kenyon 1969, Johnson 1987). The drastic reduction of sea otter numbers represents a population bottleneck that probably severely reduced the total genetic diversity of the species.

Table 8. Biomass and production summary for Triangle Lake plot, Green Island Research Natural Area, July 26, 1986.[a]

Species[b]	Mean Size	(SE)	N/ha	Mean Biomass	(SE)	Annual Production	(SE)	Percent Frequency
Actaea rubra	10.8	(2.3)	1622	9.60	(3.84)	9.60	(3.84)	14.9
Athyrium filix-femina	80.0	(15.6)	15811	1.41	(0.44)	1.41	(0.44)	17.6
Cornus canadensis	1.3	(0.1)	4595	3.15	(0.55)	3.15	(0.55)	43.2
Dicranum fuscescens	4.6	(0.9)	2973	14.87	(5.34)	3.72	(5.34)	29.7
Dryopteris austriaca	60.0	(60.0)	405	0.44	(0.44)	0.44	(0.44)	1.4
Equisetum arvense	2.0	(0.0)	135	0.10	(0.10)	0.10	(0.10)	1.4
grass	3.0	(0.0)	135	0.47	(0.47)	0.47	(0.47)	1.4
Gymnocarpium dryopteris	6.6	(1.1)	5811	3.76	(1.06)	3.76	(1.06)	56.8
Heracleum lanatum	4.8	(1.8)	541	0.51	(0.37)	0.51	(0.37)	4.1
Hookeria lucens	1.2	(0.2)	811	0.30	(0.16)	0.07	(0.16)	8.1
Hylocomium splendens	49.3	(2.7)	8378	948.69	(74.53)	237.17	(74.53)	83.8
Jungermannia lanceolata	1.0	(0.0)	135	0.00	(0.00)	0.00	(0.00)	1.4
Listera caurina	1.3	(0.2)	946	0.40	(0.15)	0.40	(0.15)	9.5
Listera cordata	1.4	(0.2)	2432	1.11	(0.30)	1.11	(0.30)	24.3
Luzula parviflora	1.7	(0.7)	405	0.78	(0.56)	0.78	(0.56)	2.7
Lysichiton americanum	69.2	(17.2)	9730	48.83	(18.10)	48.83	(18.10)	10.8
Lycopodium clavatum	3.0	(0.9)	541	0.82	(0.46)	0.82	(0.46)	5.4
Maianthemum dilatatum	0.6	(0.2)	676	0.13	(0.07)	0.13	(0.07)	6.8

Species[b]	Mean Size	(SE)	N/ha	Mean Biomass	(SE)	Annual Production	(SE)	Percent Frequency
Marchantia polymorpha	0.5	(0.5)	270	0.03	(0.03)	0.01	(0.03)	1.4
Menziesia ferruginea	12.9	(1.4)	4730	728.75	(383.17)	73.37	(37.98)	8.1
Mnium moss	3.0	(0.0)	135	1.34	(1.34)	0.34	(1.34)	1.4
Moneses uniflora	1.0	(0.0)	135	0.28	(0.28)	0.28	(0.28)	1.4
Oplopanax horrida	10.1	(0.9)	8784	370.13	(105.29)	88.88	(23.71)	39.2
Osmorhiza chiloensis	3.5	(0.6)	541	0.45	(0.22)	0.45	(0.22)	5.4
Osmorhiza purpurea	10.0	(1.6)	3108	15.98	(4.84)	15.98	(4.84)	29.7
Picea sitchensis	15.7	(11.8)	405	328.41	(325.97)	18.24	(18.00)	4.1
Pleuroziopsis rubescens	7.7	(2.0)	1892	36.82	(9.47)	36.82	(9.47)	18.9
Pleurozium schreberi	40.1	(7.7)	1081	71.53	(27.33)	17.88	(27.33)	10.8
Plagiothecium undulatum	1.0	(0.0)	2838	0.75	(0.18)	0.19	(0.18)	28.4
Plagiothecium undulatum	1.0	(0.0)	2838	0.75	(0.18)	0.19	(0.18)	28.4
Porella naviculare	5.0	(0.0)	135	0.00	(0.00)	0.00	(0.00)	1.4
Ranunculus bongardi	2.0	(0.6)	405	0.31	(0.18)	0.31	(0.18)	4.1
Rhizomnium glabrescens	16.4	(2.7)	5135	116.33	(18.74)	29.08	(18.74)	51.4
Rhytidiadelphus loreus	28.8	(2.4)	8378	395.90	(39.77)	98.97	(39.77)	83.8
Ribes bracteosum	13.0	(1.5)	541	112.92	(112.92)	20.36	(20.36)	1.4
Rubus pedatus	3.6	(0.8)	4595	1.30	(0.18)	1.30	(0.18)	44.6
Rubus spectabilis	7.7	(1.0)	4054	209.48	(96.26)	48.84	(19.78)	20.3

Species[b]	Mean Size	(SE)	N/ha	Mean Biomass	(SE)	Annual Production	(SE)	Percent Frequency
Sambucus canadensis	4.0	(0.0)	135	0.14	(0.14)	0.08	(0.08)	1.4
Sorbus sitchensis	10.0	(0.0)	135	7.69	(7.69)	2.20	(2.20)	1.4
Sphagnum girgensonii	7.3	(5.8)	1486	17.69	(14.57)	4.42	(14.57)	14.9
Streptopus amplexifolius	51.3	(4.3)	541	0.45	(0.26)	0.45	(0.26)	4.1
Stellarie crispa	2.0	(1.0)	405	0.11	(0.06)	0.11	(0.06)	4.1
Streptopus roseus	3.2	(0.4)	4189	0.74	(0.19)	0.74	(0.19)	40.5
Tiarella trifoliata	2.4	(0.3)	5135	4.27	(0.53)	4.27	(0.53)	50.0
Tsuga heterophylla	1.0	(0.4)	1216	0.07	(0.03)	0.02	(0.01)	6.8
Vaccinium alaskensis	7.0	(2.9)	405	20.74	(17.73)	2.38	(1.98)	4.1
Vaccinium spp. (immature)	1.3	(0.2)	3108	0.55	(0.13)	0.37	(0.09)	27.0
Vaccinium ovalifolium	7.0	(0.4)	24865	1300.09	(388.53)	144.17	(41.30)	29.7
Viola glabella	4.7	(0.8)	4189	6.05	(1.17)	6.05	(1.17)	40.5
Ferns				5.60	(2.50)			
Tree seedlings				328.48	(326.00)			
Mosses				1604.17	(191.46)			
Herbs				95.84	(32.30)			
Shrubs				2750.50	(1111.87)			
Vascular biomass				3180.42	(1472.67)			
Production				537.18				

[a] Data and summary by Paul Alaback. Number of plots = 74; size of plot = 1.0 m^2.
[b] Equivalent common names for vascular plants are given in Table 4. Nomenclature of mosses and liverworts follows Vitt et al. (1988).

Table 9. Amphibians and mammals[a] known to occur or that may occur in Green Island Research Natural Area.

Order and Common Name	Scientific Name	Comments
AMPHIBIANS		
Anura: Wood frog	*Rana sylvatica*	Possible, poorly documented[c]
Western toad	*Bufo boreas*	Seen in RNA, in muskeg on Green Island
MAMMALS		
Insectivora: Masked shrew	*Sorex cinereus*	[b]
Dusky shrew	*Sorex obscurus*	[b]
Chiroptera: Little brown Myotis	*Myotis lucifugus*	Possible, poorly documented
Rodentia: Red squirrel	*Tamiasciurus hudsonicus*	Seen on Green Island near Gibbon Anchorage
Northern flying squirrel	*Glaucomys sabrinus*	Possible, poorly documented
Northern red-backed vole	*Clethrionomys rutilus*	[b]
Tundra vole (Montague Island vole)	*Microtus oeconomus* *ssp. elymocetes*	[b] Possible, poorly documented
Brown lemming	*Lemmus sibiricus*	[b]
Northern bog lemming	*Synaptomys borealis*	[b]
Meadow jumping mouse	*Zapus hudsonius*	[b]
Cetacea: Killer whale (Orca)	*Orcinus orca*	Seen near RNA, on beach, nearshore waters
Dall's porpoise	*Phocoenoides dalli*	Seen near RNA, nearshore waters
Hump-backed whale	*Megaptera novaeangliae*	Seen in offshore waters
Harbor porpoise	*Phocoena phocoena*	Seen near RNA, nearshore waters[d]
Minke whale	*Balaenoptera acutorostrata*	Seen near RNA, nearshore waters[e]
Carnivora: Ermine	*Mustela erminea*	[b]
Least weasel	*Mustela nivalis*	Possible, poorly documented

Order and Common Name	Scientific Name	Comments
Mink	*Mustela vision*	[b], introduced to Montague Island
River otter	*Lutra canadensis*	Seen in RNA
Sea otter	*Enhydra lutris*	Seen in RNA, common before oil spill
Order pinnipedia: Harbor seal	*Phoca vitulina*	Seen in RNA
Northern fur seal	*Callorhinus ursinus*	Rare in region[e], mainly transient
Steller sea lion	*Eumetopias jubatus*	Seen in RNA
Order Artiodactyla: Sitka black-tailed deer	*Odocoileus hemionus*	Seen in RNA, introduced to Montague Island

[a] Nomenclature follows USDA Forest Service (1979)
[b] General distribution limits from Hall (1981) and/or Manville and Young (1965)
[c] General distribution limits from Behler and King (1979)
[d] Hall and Cornell (1985)
[e] Pitcher and Vania (1973)

Strictly speaking, sea otters are in Green Island RNA only when they are above mean higher high tide line. However, land use activity on shorelines such as Green Island has a decisive influence on the habitat suitability for sea otters of adjacent tidelands. Sea otters spend nearly all their lives in saltwater, but they come out of the water regularly (Kenyon 1969), often at known sites that are used repeatedly. Certain individuals come up on to the beach above the tide line more often than others. In the northern portion of their range and Alaska, sea otters may haul out in larger groups and haul out more often than in the southern part of their range (Riedman and Estes 1990). Haul-out behavior is known to occur throughout the year, but is more common in the winter. Sea otters sometimes come out of the water to avoid winter storms and they are known also to haul out for resting, often in groups.

Sea otters play a keystone role in subtidal ecosystems through their predation on shellfish (Estes and Palmisano 1974). Sea otters effectively control the numbers of shellfish that graze back kelps, the primary producers for the nearshore intertidal ecosystem. Green Island was the site of a definitive study that experimentally proved that sea otters restrict intertidal mussels to crevice refuges where otters are not able easily to pry them off their rocky attachment (VanBlaricom 1987). Without sea otters a less productive, shellfish-dominated, kelp-poor nearshore ecosystem develops (Duggins et al. 1989).

The *Exxon Valdez* oil spill caused an immediate and heavy mortality of sea otters (DeGange and Lensink 1990). At the time of the spill shallow waters near Green Island were recognized as important pup-rearing habitat (DeGange and Lensink 1990). Not only were many otters killed there, but pregnant and lactating females, the part of the population most important for reproduction, were disproportionately affected (DeGange and Lensink 1990).

Field notes of oil spill clean-up inspectors reported about 20 sea otters present in the summer of 1989 offshore from the RNA portion of Green Island. During site documentation of the RNA for this report, the first author saw fewer than 10 sea otters which appeared to be mostly young males (based on typical movement behavior of dispersing young males, lack of accompanying pups, sighting of individuals or small groups) that had begun to recolonize the area from nearby unoiled habitat. The amount of time that will be required for sea otter numbers to recover at Green Island is not known.

Steller sea lion--The Needle was one of five Steller sea lion, *Eumetopias jubatus*, rookeries and hauling grounds in the Prince William Sound-Kayak Island region in the early 1970's (Pitcher and Vania 1973), and the only one situated within the sheltered waters of the sound itself. The Needle is used year round by both sexes and all ages as a haul-out area; the only pupping that takes place is incidental (D. Calkins, Alaska Dept. of Fish and Game, pers. comm.). In southcentral Alaska Steller sea lions spend considerable periods of time on rocks and beaches well above mean higher high water but seldom more than about 62 feet (20 m) horizontally from the water's edge (Sandegren 1970). On smaller rocks and islands every available portion of the surface may be crowded with animals, and possession of territories on the limited spaces above the high tide line can be important for breeding success (Smith 1988).

Northern Montague Island and Green Island are the major concentration areas in Prince William Sound for spawning Pacific herring (Prince William Sound Environmentally Sensitive

Areas Spring, no date), an important prey species for Steller sea lions. A major seasonal movement of Steller sea lions into the waters surrounding the entire RNA occurs in the spring in response to the return of Pacific herring from the open ocean.

Pitcher and Vania (1973) reported counts of Steller sea lions on The Needle ranging from 195 to 236 in periodic surveys that began in 1957. More recent counts are 668 in 1989; 926 in 1990; and 430 in 1991 (D. Calkins, Alaska Dept. of Fish and Game, pers. comm.).

The Steller sea lion is a federally listed Threatened species under the Endangered Species Act. Reasons for the population decline are not entirely clear. Some studies have shown that the population is failing to reproduce because of poor nutrition and lack of food (e.g., Merrick et al. 1987). What is certain is that as numbers decline there are fewer reproducing females although pups that are born remain in good condition. In addition, juveniles (post-weaning until 4 to 5 years of age) are not being recruited into the population (pers. comm. Kathy Frost). Steller sea lions in Alaska primarily eat fish, especially capelin, sand lance, rockfishes, sculpins, Pacific herring, and flatfishes (Fiscus and Baines 1966). Stocks of these fish are heavily harvested by commercial fisheries. Restrictions on fishing in the immediate vicinity of sea lion colonies have been imposed under the Endangered Species Act.

Harbor seal--The RNA is a significant harbor seal, *Phoca vitulina*, haul-out and pupping area. Harbor seals regularly haul out onto land for resting, pupping, and some mating, and most population surveys are based on sightings on shorelines, rocks, or floating icebergs, although these counts systematically miss numerous animals under water. In 1973 Pitcher and Vania (1973) counted 170 harbor seals in the waters around or hauled out on the beach at Little Green Island, and an additional two around The Needle. They did not find harbor seals on the RNA portion of the shore of Green Island, but sighted a group of more than 100 on the beach and in the water at Channel Rock, 1.1 miles (1.7 km) south of Triangle Lake (fig. 2). The Channel Rock group undoubtedly uses the nearshore environment of the Green Island portion of the RNA and may haul out near Triangle Point occasionally. In 1990 the first author of this report saw at least three female seals with pups on the rocks along the northernmost shore of the Green Island portion of the RNA. In 1988, the year before the *Exxon Valdez* oil spill, Pitcher (1989) reported a maximum count of 66 harbor seals around Green Island and 95 around Little Green Island.

The harbor seal is a species of management concern because of a significant population decline. Pitcher (1989) reported a population decline of about 41% (pooled mean estimate) in Prince William Sound in 1988 compared to 1984. The oil spill reduced the population further (US Attorney Alaska 1991).

The diet of harbor seals overlaps to some degree with sea lions, but in addition includes significant amounts of cephalopods (octopus and squid). Harbor seals move into the RNA in early spring (March) following schools of Pacific herring that spawn in kelp beds around the RNA. Harbor seals fall prey to orcas (killer whales) where the ranges of the two species overlap (Mate 1981).

Whales--Killer whales, *Orcinus orca*, are common in the waters around the RNA where fish and especially marine mammal prey are abundant. Orcas kill and consume Dall's porpoise, harbor

porpoise, and harbor seal in Prince William Sound (Hall and Cornell 1985), and are known to kill minke whales (Mate 1981). The first author of this report observed an unsuccessful pursuit of a harbor seal by an orca in shallow water along the shore of the RNA near Triangle Lake (fig. 2), where the orca nearly beached itself. The availability of concentrations of seals, sea lions, and seabirds on the small islands of Prince William Sound offers a rich food source for orcas, and probably accounts for their abundance in the area.

Dall's porpoises, *Phocoenoides dalli*, and harbor porpoises, *Phocoena phocoena*, are common in the waters around the RNA and the first species often rides the bow wake of boats approaching the area. Minke whales are encountered regularly in waters around the RNA, and hump-backed whales are sighted often in the vicinity.

Montague Island Vole--The Montague Island vole, *Microtus oeconomus* ssp. *elymocetes*, a subspecies (Hall 1981) or possibly a distinct species of tundra vole, has been collected to date only on Montague Island, across Montague Strait from Green Island (fig. 2). Because of the shallow water between Green and Montague Islands it is possible that the vole inhabited both islands before they were separated by rising sea level about 11,800 to 10,000 years ago (Bloom 1983). Studies are underway to determine the degree of genetic difference between the tundra vole and the Montague Island vole. A survey should be conducted to establish whether the Montague Island vole is present on Green Island. The Montague Island vole is on the Alaska Region USFS Sensitive Species list (January 1994).

Birds

Table 10 is a list of 118 birds that are known to occur or that probably occur in Green Island RNA. Forty one species have been sighted in Green Island RNA or the immediately adjacent marine waters, and another 22 species are common in the region in habitats represented in the RNA and thus almost certainly present. The large number of bird species in the RNA is made up of a combination of shorebirds, marine birds, and terrestrial species which utilize diverse habitats including beaches and rocky shorelines, freshwater ponds, muskegs, and forest.

Prince William Sound, especially the outermost islands, is a major overwintering habitat for many mainland Alaska birds, and the northernmost in North America (Kessel and Gibson 1978). Large numbers of migrating birds also pass through the Sound. The following 4 bird species are of special note:

Yellow billed loon--The yellow-billed loon, *Gavia adamsii*, the largest member of the loon family, is primarily a Eurasian species with a relatively small population in North America (Terres 1980). The North American population winters in southcoastal Alaska, especially Prince William Sound, and in southeast Alaska and northern British Columbia. Much of the wintering population appears to concentrate in southcoastal Alaska, including Prince William Sound. The species has been seen in waters around the RNA. The local southcoastal Alaska population of the yellow-billed loon experienced relatively high losses from the *Exxon Valdez* oil spill (Piatt et al. 1990).

Table 10. Birds[a] known to occur or that may occur in Green Island Research Natural Area[b].

Common name	Scientific name	Comments
Common loon	*Gavia immer*	Overwintering species
Yellow-billed loon	*Gavia adamsii*	Significant overwintering population (Piatt 1990)
Arctic loon	*Gavia arctica*	Possible breeder on freshwater lakes
Red-throated loon	*Gavia stellata*	Probable breeder on shallow ponds
Red-necked grebe	*Podicepe grisegena*	Overwintering species
Horned grebe	*Podiceps auritus*	Migrant and winter visitant
Short-tailed albatross	*Diomedea albatrus*	Offshore, extremely rare, Endangered species
Black-footed albatross	*Diomedea nigripes*	Offshore, rare visitant
Sooty shearwater	*Puffinus griseus*	Seen near RNA (Islieb and Kessel 1973), offshore waters
Short-tailed shearwater	*Puffinus tenuirostris*	Seen near RNA, offshore waters
Fork-tailed storm-petrel	*Oceanodroma furcata*	Common near RNA, offshore waters
Double-crested cormorant	*Phalacrocorax auritus*	Seen in RNA, offshore waters and rocks
Pelagic cormorant	*Phalacrocorax pelagicus*	Abundant, local breeder
Red-faced cormorant	*Phalacrocorax urile*	Uncommon, local breeder
Great blue heron	*Ardea herodias*	Uncommon, resident
Canada goose	*Branta canadensis fulva*	Seen in RNA; breeder; ponds, lakes, meadows
Brant	*Branta bernicla*	Probable spring migrant
Mallard	*Anas platyrhynchos*	Feathers seen in RNA, ponds and lakes; overwintering
Gadwall	*Anas strepera*	Possible overwintering species

Common name	Scientific name	Comments
Pintail	*Anas acuta*	Abundant migrant, rare winter visitant
Green-winged teal	*Anas crecca*	Abundant migrant, rare winter visitant
Common goldeneye	*Bucephala clangula*	Migrant & winter visitant
Barrow's goldeneye	*Bucephala islandica*	Migrant & winter visitant
Bufflehead	*Bucephala albeola*	Migrant & winter visitant
Oldsquaw	*Clangula hyemalis*	Common migrant, rare local breeder
Harlequin duck	*Histrionicus histrionicus*	Breeding failure in oiled areas (*Exxon Valdez* Oil Spill Trustee Council 1993)
Steller's eider	*Polysticta stelleri*	Uncommon in area
King eider	*Somateria spectabilis*	Winter visitant
White-winged scoter	*Melanitta deglandi*	Common resident & migrant in region
Surf scoter	*Melanitta perspicillata*	Seen near RNA, offshore waters
Black scoter	*Melanitta nigra*	Overwinters but not a breeder in region
Hooded merganser	*Lophodytes cucullatus*	Uncommon in region
Common merganser	*Mergus merganser*	Common breeder, winter visitant
Red-brested merganser	*Mergus serrator*	Abundant migrant, common winter visitant
Goshawk	*Accipiter gentilis*	Feathers (oiled) seen in RNA
Rough-legged hawk	*Buteo lagopus*	Uncommon migrant in region
Bald eagle	*Haliaeetus leucocephalus*	Seen in RNA, minimum 3 breeding pairs in 1990
Gyrfalcon	*Falco rusticolus*	Rare in the region
Spruce grouse	*Canachites canadensis*	Fairly common resident
Black oystercatcher	*Haematopus bachmani*	Seen in RNA, breeder, nests on gravel beaches

Common name	Scientific name	Comments
Semipalmated plover	*Charadrius semipalmatus*	Common migrant, local breeder
American golden plover	*Pluvialis dominica*	Primarily migrant in region
Black-bellied plover	*Pluvialis squatarola*	Primarily migrant in region
Whimbrel	*Numenius phaeopus*	Seen near RNA
Greater yellowlegs	*Tringa melanoleuca*	Common breeder in region
Lesser yellowlegs	*Tringa flavipes*	Common migrant in region
Solitary sandpiper	*Tringa solitaria*	Common fall migrant in region
Spotted sandpiper	*Actitis macularia*	Common breeder in region
Wandering tattler	*Heteroscelus incanus*	Seen in RNA
Ruddy turnstone	*Arenaria interpres*	Seen in RNA, migrant in region
Black turnstone	*Arenaria melanocephala*	Seen in RNA, resident
Northern phalarope (also Red-necked phalarope)	*Lobipes lobatus*	Common breeder in region
Red phalarope	*Phalaropus fulicarius*	Probable migrant, seen at Hinchinbrook Entrance
Surfbird	*Aphriza virgata*	Seen in RNA
Sanderling	*Calidris alba*	Possible migrant or winter visitant, sandy beaches
Western sandpiper	*Calidris mauri*	Common migrant
Least sandpiper	*Calidris minutilla*	Abundant migrant, common breeder
Pectoral sandpiper	*Calidris melanotos*	Fairly common migrant
Rock sandpiper	*Calidris ptilocnemis*	Common migrant and winter visitant in region
Pomarine jaeger	*Stercorarius pomarinus*	Possible migrant
Parasitic jaeger	*Stercorarius parasiticus*	Seen in RNA
Glaucous-winged gull	*Larus glaucescens*	Seen in RNA, shores & intertidal, consumes barnacles

Common name	Scientific name	Comments
Herring gull	*Larus argentatus*	Common winter visitant in region
Mew gull	*Larus canus*	Abundant in region
Bonaparte's gull	*Larus philadelphia*	Common migrant, local breeder
Black-legged kittiwake	*Rissa tridactyla*	Seen in RNA, breeding colony on The Needle
Sabine's gull	*Xema sabini*	Seen near RNA
Arctic tern	*Sterna paradisaea*	Seen in RNA, along shore
Aleutian tern	*Sterna aleutica*	Seen in RNA
Common murre	*Uria aalge*	Abundant in winter, Montague Strait
Pigeon guillemot	*Cepphus columba*	Abundant resident, seen on offshore waters & rocks
Marbled murrelet	*Brachyramphus marmoratus*	Seen near RNA, near shore, abundant
Kittlitz's murrelet	*Brachyramphus brevirostris*	Seen near RNA
Parakeet auklet	*Cyclorrhynchus psittacula*	Seen at Montague Island
Rhinoceros auklet	*Cerorhinca monocerata*	Seen near RNA, nests on Channel Rock
Horned puffin	*Fratercula corniculata*	Common resident, offshore rocks and waters
Tufted puffin	*Lunda cirrhata*	Seen near RNA
Great horned owl	*Bubo virginianus*	Fairly common in northern PWS
Hawk owl	*Surnia ulula*	Possible overwintering
Short-eared owl	*Asio flammeus*	Probable in herbaceous beach habitat
Boreal owl	*Aegolius funereus*	Uncommon in region, possible in coniferous forest
Rufous hummingbird	*Selasphorus rufus*	Locally common migrant
Hairy woodpecker	*Picoides villosus*	Resident, uncommon in region

Common name	Scientific name	Comments
Downy woodpecker	*Picoides pubescens*	Resident, uncommon in region
Horned lark	*Eremophila alpestris*	Possible, migrant
Violet-green swallow	*Tachycineta thalassina*	Uncommon migrant, local breeder
Tree swallow	*Iridoprocne bicolor*	Uncommon migrant, local breeder
Steller's jay	*Cyanocitta stelleri*	Seen in RNA, Triangle Lake area, beach & forest edge
Black-billed magpie	*Pica pica*	Seen in RNA
Common raven	*Corvus corax*	Abundant resident and breeder
Northwestern crow	*Corvus caurinus*	Seen in RNA
Black-capped chickadee	*Parus atricapillus*	Seen in RNA
Chestnut-backed chickadee	*Parus refescens*	Common in forests of region
Brown creeper	*Certhia familiaris*	Seen in RNA, old-growth forest Near Nora's Point
Winter wren	*Troglodytes troglodytes*	Uncommon resident
American robin	*Turdus migratorius*	Fairly common migrant, rare winter visitant
Varied thrush	*Ixoreus naevius*	Seen in RNA
Hermit thrush	*Catharus guttatus*	Abundant in forest & shrub thickets of region
Golden-crowned kinglet	*Regulus satrapa*	Seen in RNA
Ruby-crowned kinglet	*Regulus calendula*	Seen in RNA
Water pipit	*Anthus spinoletta*	Possible migrant, beaches & tidal flats
Orange-crowned warbler	*Vermivora celata*	Most abundant breeder in region
Yellow warbler	*Dendroica petechia*	Seen in RNA
Yellow-rumped warbler	*Dendroica coronata*	Possible migrant

Common name	Scientific name	Comments
Townsend's warbler	*Dendroica townsendi*	Probable breeder in hemlock-spruce forests
Wilson's warlber	*Wilsonia pusilla*	Common migrant & breeder in region, shrub thickets
Pine grosbeak	*Pinicola enucleator*	Fairly common resident
Pine siskin	*Caruelis pinus*	Probable, hemlock-spruce forest
Red crossbill	*Loxia curvirostra*	Possible, hemlock-spruce forest
White-winged crossbill	*Loxia leucoptera*	Uncommon resident
Savannah sparrow	*Passerculus sandwichensis*	Probable in beachgrass shore
Tree sparrow	*Spizella arborea*	Possible migrant
White-crowned sparrow	*Zonotrichia leucophrys*	Possible migrant
Golden-crowned sparrow	*Zonotrichia atricapilla*	Possible migrant
Fox sparrow	*Passerella iliaca*	Seen in RNA, abundant, shrub thickets
Song sparrow	*Melospiza melodia*	Seen in RNA
Snow bunting	*Plextrophenax nivalis*	Possible migrant

[a] Nomenclature follows USDA Forest Service (1979), and American Ornithologists' Union (1957).

[b] Species listed as seen in RNA were sighted by the first author. Other species listed are presumed to be present on the basis of regional distribution in Prince William Sound and habitat use according to Armstrong (1983), Godfrey (1986), Isleib and Kessel (1973), and USDA Forest Service (1979).

Black-legged kittiwake--The Needle is one of 162 nesting colonies of black-legged kittiwakes, *Rissa tridactyla*, along the coast of southcentral Alaska; 263 nesting colonies occur statewide (Sowls et al. 1978). When inventoried in July of 1972, The Needle supported an estimated 760 black-legged kittiwakes. The kittiwake colony on The Needle experiences periodic complete reproductive failures. This is a characteristic of kittiwake colonies dependent on food webs in the Gulf of Alaska and North Pacific that experience dramatic ecosystem changes (Scott Hatch, US Fish and Wildlife Service, pers. comm.).

Marbled murrelet--The marbled murrelet, *Brachyramphus marmoratus*, is a robin-sized seabird that belongs to the alcid family. Under the Endangered Species Act, it has a C2 status in Alaska (listed Threatened in Oregon, Washington, and California). The C2 status implies the USFWS has information which may warrant listing, though more information on biological justification for vulnerability is needed.

The Prince William Sound population is resident (non-migratory), and was so abundant in a 1972 inventory that it was estimated to be the bird species with the greatest biomass in Prince William Sound (Isleib and Kessel 1973). Only a handful of marbled murrelet nests ever have been discovered, and the majority of these are on large upper canopy limbs of old-growth conifers (Quinlan and Hughes 1990). On the other hand marbled murrelet behavior consistent with nesting in alpine tundra or talus has been observed in Prince William Sound (Isleib and Kessel 1973) and ground-nesting by marbled murrelets is known elsewhere in Alaska (Simons 1980).

Marbled murrelets were abundant in saltwater around the RNA before the oil spill. They have been observed flying at dawn into the forest at Green Island, a characteristic nesting behavior, and may likely to be nesting within the RNA.

Black turnstone and surfbird--Norton et al. (1990) documented a spectacular concentration of migrating surfbirds, *Aphriza virgata*, and black turnstones, *Arenaria melanocephala*, in Prince William Sound. The birds were feeding on eggs (roe) deposited in the intertidal zone by spawning Pacific herring during their northward spring migration. At least 18,000 surfbirds and 10,000 black turnstones were observed in 1989, representing a significant portion of the species' total populations (Norton et al. 1990). The greatest concentration of birds was on northern Montague Island, just across from the RNA, but a few hundred were observed on Green Island as well (Norton et al. 1990). This area also has one the highest concentration of spring spawning herring in Prince William Sound (Prince William Sound Environmentally Sensitive Areas - Spring no date).

Insects

Western black-headed budworm--In 1989 and 1990 forests of the RNA experienced a major outbreak of the western black-headed budworm, *Acleris gloverana* (Walsingham), a defoliating moth of coastal Pacific forests. Both Sitka spruce and western hemlock are major hosts for the black-headed budworm. Budworm larvae consume only part of the host tree needle, which later dies (Furniss and Carolin 1977). Trees under attack at first appear brown or scorched, then drop their needles. Trees in later stages of attack appear skeletonized as only the new year's foliage is present on the tree. At the height of the black-headed budworm outbreak in the RNA in 1989 both young trees and old-growth displayed a completely brown canopy of dead needles. By 1990 and

1991 trees in the RNA had a thin canopy of single year's foliage, indicating that these trees were recovering.

Populations of the black-headed budworm are endemic but build up rapidly after one or two years of below average precipitation in July and August (Silver 1960). Prince William Sound experienced unusual intervals of clear, warm, dry weather in the early summer of 1988, 1989, and 1990 that appear to have triggered and sustained the black-headed budworm outbreak. The uninterrupted sequence of climatically favorable years appears to have contributed to the unusual severity of the black-headed budworm outbreak, which suggest a possible effect of global change in this system. Persistently cool and wet weather in the summer of 1991 appears to have significantly reduced the outbreak in Prince William Sound. Trees in the RNA that were already under stress were killed by the outbreak. Another year of heavy defoliation probably would have led to widespread tree mortality.

Geology

The RNA is part of the Prince William tectonostratigraphic terrane (Coney and Jones 1985), a structure that represents Late Cretaceous to Recent accretions of geologic fragments to North America. Green Island, Little Green Island, and The Needle are made up entirely of Paleocene turbidite or flysch (deep ocean sandstones and shales) deposits of the Orca Group (Tysdal and Case 1979). Typical Orca turbidite sequences include a conglomerate base, followed by a sandstone layer, and capped by a mudstone or shale. The beds are inclined at 76° to 80° (Photo 9) (Tysdal and Case 1979).

Green Island offers some of the best opportunities to observe, understand, and study the complete range of features associated with turbidites in the National Forest system. For example, Lethcoe (1990) used photographs from Green Island to illustrate middle fan deposits, conglomerates, ripple marks, convoluted flow, rip-up, groove casts, chevron marks, load casts, frondescent marks, and other features. Plant fossils, which are unusual in Prince William Sound, were discovered during RNA site documentation. The fossils are primarily leaf imprints and carbonaceous remains of wood and twigs.

Photo 2 shows that long narrow ridges of erosion resistant sandstone and conglomerate support well drained forest communities, which stand above poorly drained low sites that are softer shales or mudstone. Shallow caves are on the uplifted terrace (pre-earthquake shoreline) on the northern shore of the RNA. The caves were carved by wave action in softer sediments overlain by tilted erosion-resistant conglomerate and sandstone. Vertical turbidite beds accentuate the bench and headwall surfaces in the Triangle Lake forest plot (fig. 2). The bench may have been a wave-cut platform in softer rock with cobble beach fill from cliff-fall material.

Soils

Rieger et al. (1979) mapped the soils of the RNA as primarily Humic Cryorthods, with Terric Cryohemists, Terric Cryosaprists, and Terric Fragiaquods. In southcoastal Alaska humic

layers accumulate, and if they are not excessively well drained or incorporated into lower mineral layers by mass wasting processes, they become strongly acidic, persistently saturated, and promote Sphagnum moss development.

Soil churning and mixing on oversteepened slopes is common in the RNA. During RNA site documentation a buried, completely inverted soil profile was discovered over a void or cavity on an oversteepened slope. Sites occupied by Sphagnum are nearly always stable landforms, and they develop histic horizons under wetland conditions, which become muskegs (Photo 7).

Soil data for the Triangle Lake forest plot are available from the Research Ecologist at the USDA Forest Service Forestry Sciences Laboratory in Juneau.

Lands

The entire Green Island RNA is in National Forest ownership. No leases or easements affect the area. The bed of submerged lands below mean higher high water is trust land managed by the state of Alaska. Figure 5 shows the characteristics of the state submerged lands along the shore of Green and Little Green Islands. The proclaimed boundary of the Chugach National Forest extends offshore. Jurisdiction over the marine water column and animals in it are the responsibility of several state and federal agencies depending on the resource or activity.

Cultural

There are no Native inholdings or allotments on Green Island, but there are 3 sites which have cultural and/or historic significance. None of these sites are located within the RNA boundaries, but are worth mentioning for the record. One site is a Native fish camp, one is a Native commercial fishing anchorage and hunting camp site, and one is an archeological site and old hunting lookout. This latter site was not allowed for individual Native land selection, but that decision is appealable. In general, disturbance to any archeological site requires notification of the USFS Cordova District Ranger, Cal Baker, in Cordova.

Little information is available on the ancient native inhabitants of Green Island. Some evidence of native occupancy may have been destroyed in the periodic earthquake-induced shoreline rises and alternating periods of slow submergence. The portion of Green Island outside the RNA is more likely to have archeological sites because of the excellent sheltered water at Gibbon Anchorage. Gibbon Anchorage is on the western side of Green Island opposite the RNA and supports localized recreational activity (refer to Recreation section of this Establishment Record). Oil spill cleanup operations resulted in the discovery and, in some cases, the disturbance of archeological sites.

Lethcoe and Lethcoe (1985) provide a brief history of the Green Island area. In the early years of the 20th century James Hyden of Latouche Island started a fox farm and built several buildings in the Gibbon Anchorage area of Green Island. In 1907 he sold the farm to William Gibbon who operated the farm for many years. By 1916 there were several cabins, a blacksmith

shop, saltery, smokehouse, boathouse, and wharf. In the 1920's a Japanese syndicate had a role in the fox farm. No mailboat stop is listed for Green Island by the 1930's. After WW II the structures were used in a hunting guide operation. The Great Alaska earthquake in 1964 destroyed the wharf and structures. A cabin was constructed to support a long-term sea otter research project by the US Fish and Wildlife Service, and then turned over to the Forest Service to become part of the public recreation cabin system.

None of these sites is seen to present conflicts with use and protection within the Green Island RNA.

Other

Green Island is a significant scientific resource because of the numerous biological and geological studies mentioned previously. In addition, intensive, large-scale studies of a number of species and ecosystems damaged by the *Exxon Valdez* oil spill have amassed a huge data base that may be of value to continuing research, monitoring, and resource management.

IMPACTS AND POSSIBLE CONFLICTS

Mineral Resources

No historic mines or prospects occur on Green Island (Tysdal 1978). Modern mineral exploration and testing has revealed no mineral deposits (Tysdal 1978). Potentially economically important mineralized areas of copper, gold, and antimony in the Orca Group are associated with granitic intrusions, which are lacking in the RNA (Plafker and MacNeil 1966). The nature of the Orca Group as a thick accumulation of mineralogically unstable sandstone, mudstone, and conglomerate indicate poor potential for petroleum production or recovery, especially because potential source rock sandstones have low porosity and permeability (Winkler et al. 1976).

Grazing

No domestic livestock are on or near Green Island.

Timber

Green Island was allocated to non-timber production uses in the Chugach Forest Plan. There are currently no plans to harvest National Forest timber from this portion of Prince William Sound.

Cover Feature	Acres	Hectares	Percent of RNA
Commercial forest land	1,027	416	36
Non-commercial forest land	1,472	596	51

Watershed Values

Hydropower potential is very limited on Green Island because of a low elevation gradient, small total catchment area, narrow configuration of the island which produces short drainages, and the lack of high elevation snow-gathering area. Green Island is within the humid coastal zone of Alaska, but it occupies a minor rain shadow environment behind the continuous mountain crest of Montague Island.

Potable fresh water is very limited on Green Island. All of the lakes, ponds, and streams are suspect sources for drinking water because of potential contamination from birds and mammals. The Forest Service public recreation cabin at Gibbon Anchorage has a rain barrel cistern that collects water from the roof of the cabin. The cistern at the cabin is an important auxiliary source of freshwater for boaters and recreationists in this part of Prince William Sound.

Recreation Values

Green Island supports a variety of high-quality recreation resources. The scenery and wildlife viewing opportunities are exceptional. A diversity of marine mammals and birds can be seen from the island, including species of high public interest such as whales, seals, otters, eagles, and colonial nesting seabirds. The broad intertidal rock shelves around Green and Little Green Island display the high diversity of Prince William Sound intertidal life. Muskegs on the broad, level terraces of Green Island offer easy hiking terrain and excellent views of features such as the glaciers and tundra of Montague Island and scenic views of Prince William Sound. Old-growth forests with their large trees are features of high potential visitor interest.

A new public recreation cabin will be built at Gibbon Anchorage. The anchorage om the west side of the island, opposite the RNA, and the potential for human induced impacts within the RNA, especially given the island terrain, are minimal. The occasional person traveling on foot does not pose a disturbance problem.

Wildlife and Plant Values

Estimates of the pre- and post-spill populations or mortality of animals mentioned are taken from the summary of effects of the *Exxon Valdez* oil spill filed in federal court in April 1991 at the time of the Consent Decree (US Attorney Alaska 1991).

Steller sea lion--The Steller sea lion is listed as Threatened under the Endangered Species Act, and National Forest management must conform with species conservation measures.

Marbled murrelet--In June 1992 the Fish and Wildlife Service listed the marbled murrelet as Threatened in the lower 48 states. It's status in Alaska is C2 which implies the USFWS has information which may warrant listing, though greater information on the biological justification for vulnerability is needed.

Sea otter--The Alaska population of the sea otter is not classified as Threatened or Endangered, but the southern sea otter is listed as Threatened in California and Washington. The total Alaska sea otter population was estimated at 100,000 to 150,000 (Calkins and Schneider 1985) in 1985, with about 10,000 in Prince William Sound. The *Exxon Valdez* oil spill reduced the Alaska population by an estimated 3,500 to 5,500, almost exclusively in Prince William Sound and the Kenai Peninsula coast. Relatively rapid recovery is expected, but in areas of severe local depletion, such as Green Island, National Forest management should be compatible with sea otter recovery.

Harbor seal--The harbor seal was a declining species before the oil spill, in which an estimated 200 seals were killed. In response to the decline, the National Marine Fisheries has contracted for a harbor seal conservation plan to assist in management and to consider whether to designate the species as depleted under the Marine Mammal Protection Act or federally list it under the Endangered Species Act. Maintaining undisturbed conditions around terrestrial haul-out sites should be a high priority for National Forest management in and adjacent to the RNA.

Yellow billed loon--This species is reported to have experienced high losses relative to the size of the local population as a result of the oil spill (Piatt et al. 1990). Its North American breeding habitat is centered on the expanding oil fields of the arctic coastal plain. Management of the Green Island RNA adjacent to saltwater habitat should be designed to minimize unnecessary disturbance to the population.

Montague Island vole--If surveys locate the Montague Island vole on Green Island, the RNA should be part of the habitat management plan for this potentially endemic species. It is a USFS Region 10 Sensitive Species.

Killer Whale--About 182 killer whales in distinct families or "pods" inhabited Prince William Sound before the oil spill. The spill is a major suspected cause in the disappearance of 22 of these animals. National Forest habitat that supports or directly influences the orca's prey base of marine mammals and sea birds should be considered sensitive and managed to minimize disturbance.

Plants--Two plant species, the Truncate quillwort, *Isoetes truncata*, and the choris bog orchid, *Platanthera chorisiana*, are on the Forest Service Region 10 Sensitive Species list (January 1994). These species have been noted within the distribution maps of Hulten (1968) and may occur in the RNA. The Alaska Natural Heritage Program shows that three rare plants may occur on Green Island: redwood violet (*viola sempervirens*), Thurber bentgrass (*Agrostis thurberiana*), and goose-grass sedge (*Carex lenticularis* var. *dolia*) which has Category 2 status under the ESA. No proposed Threatened or Endangered plant species have been located in Green Island RNA. The five vascular species reported as range extensions in this Establishment Record should be given special consideration for management purposes until better information about their abundance is

available.

Special Management Area Values

No special management area designations apply to Green Island other than Research Natural Area. Plots in the area have been used in studies of the effects of the 1964 earthquake (National Academy of Science), the effects of the 1989 *Exxon Valdez* oil spill and clean up (Exxon and it's contractors, government natural resource damage and assessment teams), and the effects of bioremediation treatments after the spill (Department of Environmental Conservation and contractors). The location of forest (reference plots, fig. 2) and shoreline and intertidal monitoring plots (Juday and Foster 1990, 1991) used for evaluation of the RNA have been recorded for long-term relocation, study, and monitoring.

Transportation Plans

Access to Green Island is by boat or float plane. The island is not close to major air or water travel routes, although it was a heavily used staging area during cleanup and damage assessment operations after the *Exxon Valdez* oil spill. Gibbon Anchorage is strategically located as one of the only areas of sheltered water within a considerable area of marine surface and shoreline. The narrow channel in front of the Forest Service public recreation cabin is an outstanding stretch of water for float plane operations; it is sheltered, free of dangerous rocks, and has no surrounding topographic obstacles.

There are no plans for road construction on Green Island. The network of deer trails and open muskeg of low herbaceous and grass growth allow easy passage to most of Green Island. Most of the shoreline of the RNA provides good hiking, although a few portions of the beach are severely constricted during extreme high tide stages. Hiking is somewhat impeded on Little Green Island because of dense shrub growth that is not subject to deer browsing. However, Little Green Island is small and narrow and all locations can be reached with a short traverse from the beach.

MANAGEMENT PRESCRIPTION

Chugach National Forest LRMP Management Prescriptions for Analysis Area 17 - Timbered Sideslopes, Big Islands, Prince William Sound, which includes Green Island RNA are included as Appendix 1 of this Establishment Record.

Vegetation Management

Uplands

The terrestrial ecosystems of Green and Little Green Islands are isolated island ecosystems

that are self-sustaining to a high degree. The 1988-1990 outbreak of western black-headed budworm caused some tree mortality at Green Island. However, the outbreak should subside naturally without control measures in the RNA. No upland terrestrial vegetation manipulation is necessary for the foreseeable future.

Beaches

Plastic waste, derelict fishing gear, and a random sample of trash introduced into the waters of the North Pacific makes its way onto the beaches of the RNA. The highly energetic shoreline environment can incorporate these wastes into the accumulating gravel beaches of Green Island. Items such as steel cables and logs or posts with metal spikes or attached sheet metal have been partially buried by gravel at Green Island, forming obstacles that are hazardous to visitors or wildlife walking along beaches. It would be highly desirable to periodically schedule the removal of debris from the beaches of the RNA.

Cooperative Management

Management of the RNA should be placed in the context of a larger ecological unit that includes the marine environment. Many animals that feed on or in the sea rest or breed in the RNA. Water and nutrients moving off the RNA are vital habitat features for certain marine organisms. The configuration of the shoreline influences local oceanographic conditions. The Forest Service should work cooperatively with the state of Alaska and other federal agencies to achieve management of submerged lands and ocean resources in a manner that is compatible with the purposes of the RNA. This could involve state classification or designation of surrounding submerged lands and other actions by the several authorities that have jurisdiction of marine waters and living resources in them.

ADMINISTRATION RECORDS AND PROTECTION

Copies of the establishment record are filed with the Ranger District, the PNW Station, and the Alaska Ecological Reserves Coordinator at the University of Alaska Fairbanks.

Administration and protection of the physical area is the responsibility of:

District Ranger
Cordova Ranger District
P.O. Box 280
Cordova, Alaska 99574
tel: (907) 424-7661
DG: Mailroom: R10F04D02A

Herbarium specimens have been deposited in the University of Alaska Herbarium (ALA) located in the Museum at the University of Alaska Fairbanks. The UA Herbarium is the major repository for Alaskan plant collections.

Approval and coordination of observational and nonmanipulative research is the responsibility of the Cordova District Ranger and the PNW Research Station Program Manager most directly concerned. If issues relating to the handling, capture, marking, or harassment of wildlife are significant, approval of the Alaska Department of Fish and Game may be necessary. No special protection measures, other than protection of archeological resources as discovered, are required at Green Island RNA at present.

ARCHIVING

Maps accompanying this report were created as digital postscript documents (Adobe Illustrator for Macintosh ver 5.5 program) use as a map base the sources noted. The map files are archived with the archived with the Alaska Ecological Reserves Coordinator at the Agricultural and Forestry Experiment Station at the University of Alaska Fairbanks, the Alaska Region Ecology program, and the Forest Science Data Forest Science Data Bank, Corvallis, Oregon. An extensive documentary file of more than 300 color and black and white photographs, many at relocatable locations, was developed as part of RNA documentation. The photo file is archived with the Alaska Ecological Reserves Coordinator at the Agricultural and Forestry Experiment Station at the University of Alaska Fairbanks.

Terrestrial plant collections made on Green and Little Green Island are preserved in the Forest Service Herbarium in Juneau. Specimens of plants that represent range extension records are in the collections of the University of Alaska Herbarium in Fairbanks. Marine intertidal specimens collected in the area have been preserved at the University of Alaska Museum in Fairbanks. Stand maps and data from the permanent forest monitoring plots are archived in the files of the Alaska Ecological Reserves Coordinator at the Agricultural and Forestry Experiment Station at the University of Alaska Fairbanks and the PNW Research Station in Portland, Oregon. Understory vegetation plot data and light measurements are archived in the office of the Research Ecologist, USDA Forest Service, Juneau Forestry Sciences Laboratory and the PNW Research Station in Portland, Oregon.

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APPENDIX

Area Prescription

MANAGEMENT AREA 8

BIG ISLANDS, PRINCE WILLIAM SOUND PRESCRIPTION

370,000 Acres

EXPECTED AVERAGE ANNUAL OUTPUTS (1986-1990):

5	MRVD	Developed Recreation
25	MRVD	Dispersed Recreation
0	MAc	Wilderness
0	MRVD	Wilderness
2	MRVD	Wildlife
0	Ac	Wl. Hab. Imp.
1	MRVD	Sport Fisheries
6	MMLbs	Comm. Fisheries
2.1	MMBF	Timber (0.45 MMCF) (96 ac.)
0	Mining	Plans of Operations in Effect
370	MAc	Available for Mineral prospecting and development

MANAGEMENT DIRECTION:

Management for this area is directed by the activities, standards, and guidelines on the following pages for the three Analysis Areas within this Management Area. These are:

- Analysis Area 10 - Alpine — 120,000 acres
  Another 2,993,000 acres of the Alpine Analysis Area are within Management Areas 5, 6, 7, and 9. The Management Area 5 prescription contains the management direction (activities, standards, and guidelines) for the Alpine Analysis Area (AA-10).
- Analysis Area 17 - Timbered Sideslopes — 240,000 acres
- Analysis Area 18 - Depositional Valleys — 10,000 acres

ANALYSIS AREA 17 TIMBERED SIDESLOPES, BIG ISLANDS, PRINCE WILLIAM SOUND (240,000 acres)

PRIMARY MANAGEMENT GOALS:

-Increase developed and dispersed recreation opportunities
-Maintain landscape character
-Enhance marine oriented recreation opportunities
-Maintain wildlife habitat
-Improve fish habitat

PRIMARY MANAGEMENT PRACTICES:

-Develop marine recreation system
-Construct and maintain cabins and marine recreation facilities
-Harvest timber and reforest

RESOURCE	ACTIVITY	STANDARDS & GUIDELINES
RECREATION	A05 RECREATION AND VISITOR INFORMATION SERVICES SITE CONSTRUCTION	A. Construct two recreation cabins.
		B. Evaluate construction of one tent platform and/or anchor buoy (depending on site characteristics) by 1988.
	A06 RECREATION OR VISITOR INFORMATION SERVICES SITE REHABILITATION	A. Rehabilitate and/or relocate cabins when necessary to provide a safe recreational opportunity, protect existng investments, and prevent resource damage.
	A11 DEVELOPED RECREATION SITES - FULL SERVICE MANAGEMENT, PUBLIC SECTOR	A. Operate cabins at full service level with maintenance scheduled once a month during the summer season and as needed during the winter season.
	A14 DISPERSED RECREATION - FULL SERVICE MANAGEMENT	A. Emphasize Primitive I, Semi-primitive Non-motorized and Semi-primitive Motorized recreation opportunity spectrum classes.
		B. Evaluate the feasibility of establishing marine recreation system units including the following locations by 1995: 1. Constantine Harbor 2. Port Chalmers 3. Anderson Bay/Double Bay (Hinchinbrook Island) 4. Gibbon Anchorage
WILDLIFE AND FISH	C04 & C07 FISH HABITAT IMPROVEMENT	A. Complete 10 Federally funded projects by 1995 to improve fish habitat to produce 416,000 pounds of fish per year.
TIMBER	E05 TIMBER STAND IMPROVEMENT	A. Precommercial thin, on an annual average basis, a total of 180 acres within this Analysis Area and Analysis Area 18.
	E06 TIMBER SALE PREPARATION	A. Prepare and offer for sale an annual average of 1.90 MMBF (0.39 MMCF) of timber during the plan period.
	E04 REFORESTATION	A. Scarify the site or determine other means to reduce competition prior to planting.

MINERALS & GEOLOGY	G01 MINING LAW COMPLIANCE AND ADMINISTRATION	A. Based on no acres of wilderness proposed for this Analysis Area and subject to valid existing rights, approximately 240,000 acres (100%) of this Analysis Area are available for mineral prospecting and development. Prospecting and development will be governed by the General Mining Law of 1872 and other applicable laws and regulations.
FACILITIES	L23 TRAIL SYSTEM MANAGEMENT	A. Maintain trail at maintenance level 2.
RESEARCH	RESEARCH NATURAL AREA ESTABLISHMENT	A. Cooperate with Forest Service Research to evaluate the feasibility of establishing a Research Natural Area in the vicinity of Green Island and the Needles. (Approximately 2,500 acres all in this Analysis Area). B. Any proposed action within this potential Research Natural Area will be coordinated with Forest Service Research. Resource uses and activities will be compatible with the objectives for Research Natural Areas.

Boundary Description and Map

Research Natural Area Boundary Description

GREEN ISLAND RNA

An area within the Chugach National Forest, comprising portions of T. 2 N., R. 11-12 E., Seward Meridian on Green Island, comprising portions of T. 1 N., R. 11 E., Seward Meridian on Little Green Island and portions of T. 1 S., R. 11 E., Seward Meridian on The Needle, and as shown on the attached map entitled "Green Island RNA", said map being made herewith a part of this description, and said area being more particularly bounded and described as follows:

Beginning at a point on Green Island, said point being the West 1/4 corner of Section 9, T. 2 N., R. 12 E., SM; thence East approx. 0.5 miles to the center of Section 9, T. 2 N., R. 12 E., SM; thence North approx. 0.5 miles to the North 1/4 corner of Section 9, T. 2 N., R. 12 E., SM; thence East approx. 0.3 miles to a small drainage at the 100 foot contour interval and designated "A" on the referenced map; thence Northeasterly along aforesaid drainage (drainage flows southwesterly) to its headwaters in a muskeg and along a northeasterly flowing drainage to mean high tide in Section 3, T. 2 N., R. 12 E., SM, and designated "B" on the referenced map; thence South and Southwesterly along mean high tide through Sections 3, 10, 15, 16, 21, 20, 19 and 30, T. 2 N., R. 12 E., and Sections 25, 26 and 35, T.2 N., R. 11 E., SM to the watershed divide (dividing the southeasterly flowing drainage from the northwesterly flowing drainage) in Section 35, T. 2 N., R. 11 E., SM, and designated "C" on the referenced map; thence Northeasterly along the aforesaid watershed divide through Sections 35, 26, 25 and 24, T. 2 N., R. 11 E., and Sections 19, 18, and 17, T. 2 N., R. 12 E., SM to the section line common to Sections 16 and 17, T. 2 N., R. 12 E., SM, and designated "D" on the referenced map; thence North approx. 0.55 miles to the west 1/4 corner of Section 9, T. 2 N., R. 12 E., SM and the Point of Beginning.

The Research Natural Area Boundary also includes all of Little Green Island and The Needle above mean high tide.

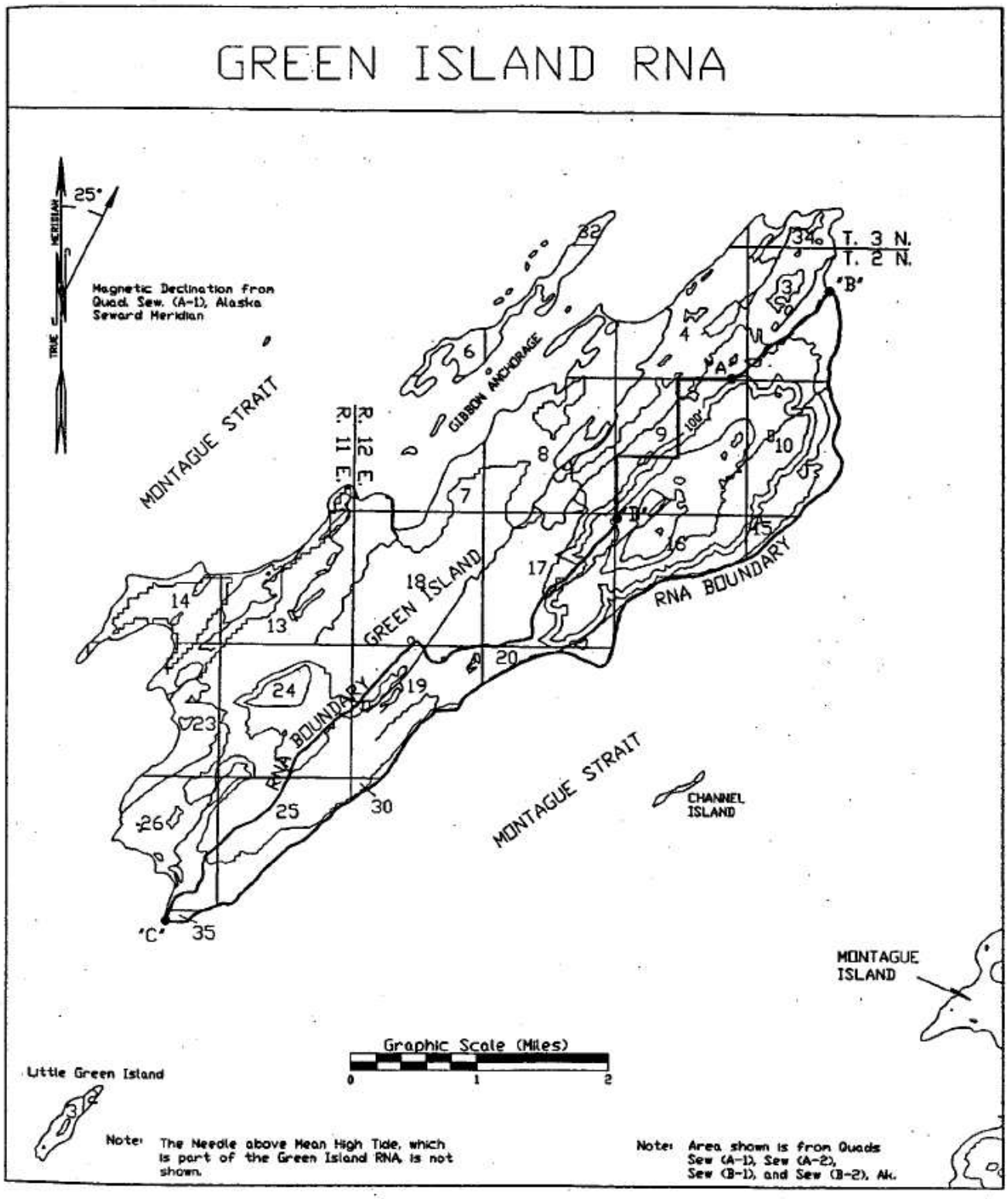
Informational distances and references to PLSS locations herein above were obtained by measurements and observations of the above referenced map.

End of Description

I certify that the above boundary description of the Green Island Research Natural Area was prepared by me or under my direct supervision.

Randy Schrank — **Forest Land Surveyor**

9-27-94 — **Date**


GREEN ISLAND RNA
25°
TRUE
MERIDIAN
Magnetic Declination from
Quad. Sew. (A-1), Alaska
Seward Meridian
MONTAGUE STRAIT
R. 11 E.
R. 12 E.
GIBBON ANCHORAGE
T. 3 N.
T. 2 N.
"B"
"A"
"B"
"C"
100'
GREEN ISLAND
RNA BOUNDARY
RNA BOUNDARY
MONTAGUE STRAIT
CHANNEL
ISLAND
MONTAGUE
ISLAND
Graphic Scale (Miles)
0
1
2
Little Green Island
Note: The Needle above Mean High Tide, which is part of the Green Island RNA, is not shown.
Note: Area shown is from Quads Sew (A-1), Sew (A-2), Sew (B-1), and Sew (B-2), Ak.

FIGURES

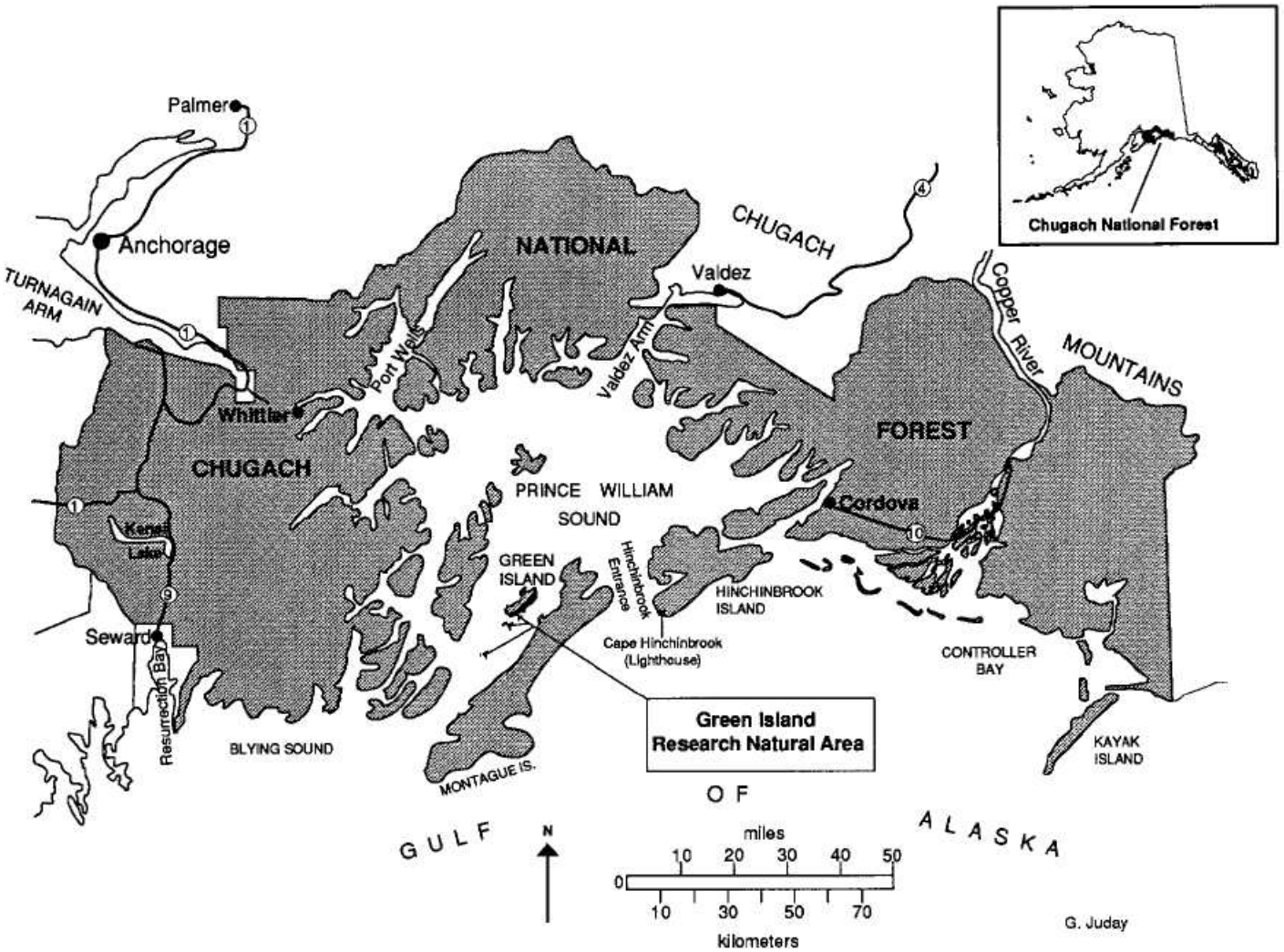


Figure 1 – CHUGACH NATIONAL FOREST ACCESS AND TRAVEL ROUTES: Green Island Research Natural Area.

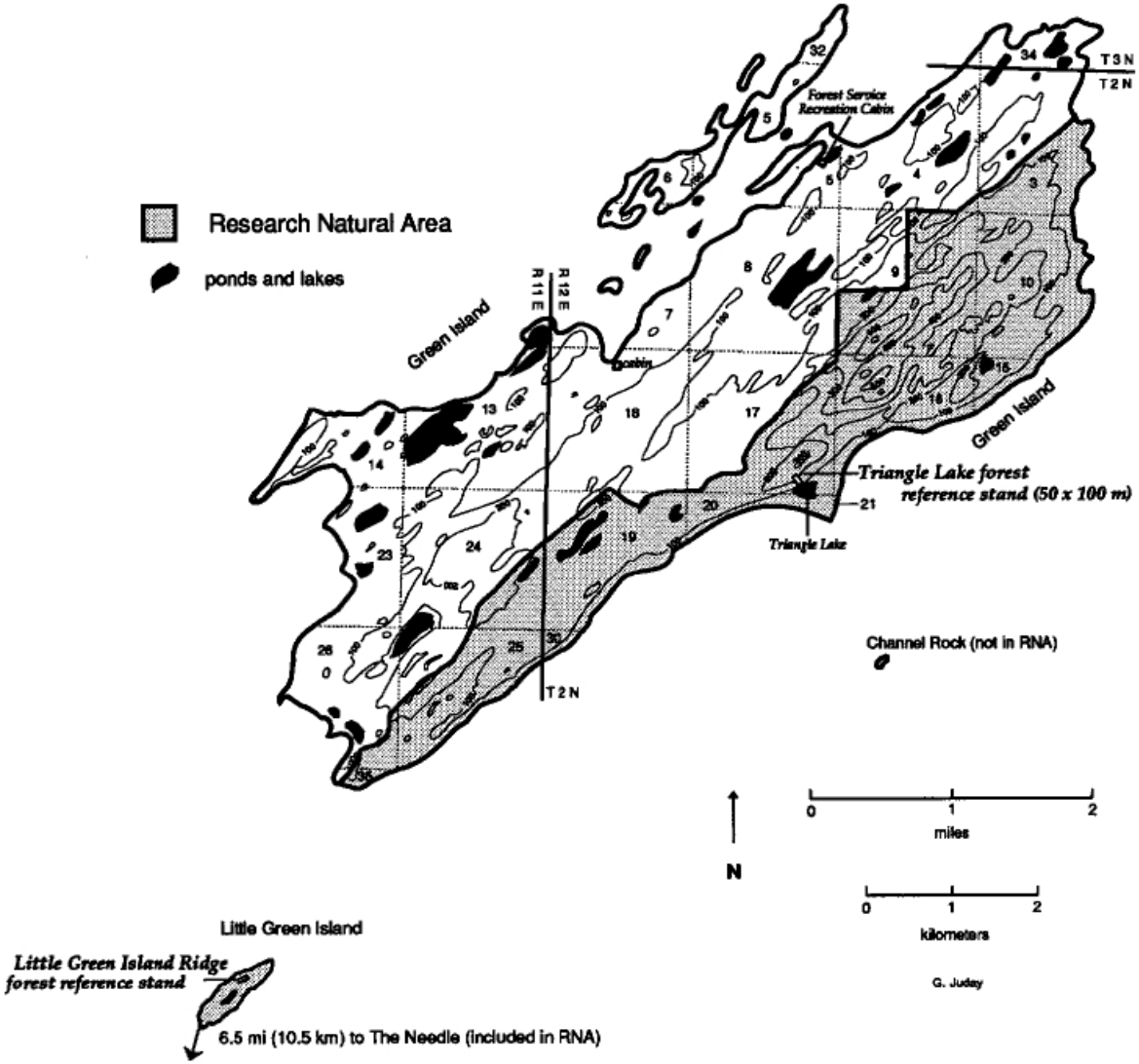


Figure 2 – GREEN ISLAND RESEARCH NATURAL AREA: Boundary and Elevation (excluding The Needle).

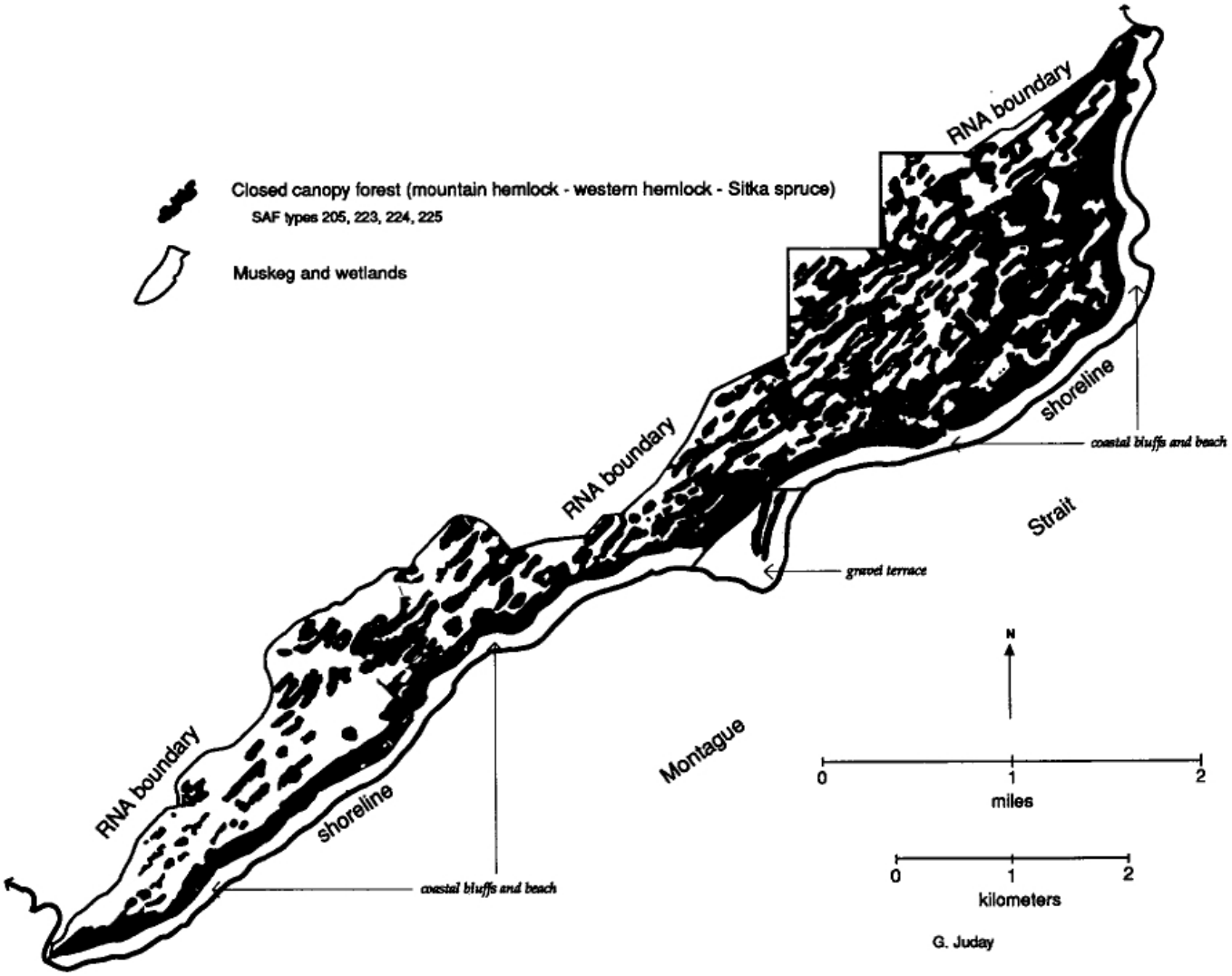


Figure 3 – DISTRIBUTION OF CLOSED CANOPY FOREST AND MUSKEG: Green Island Portion of Green Island Research Natural Area.

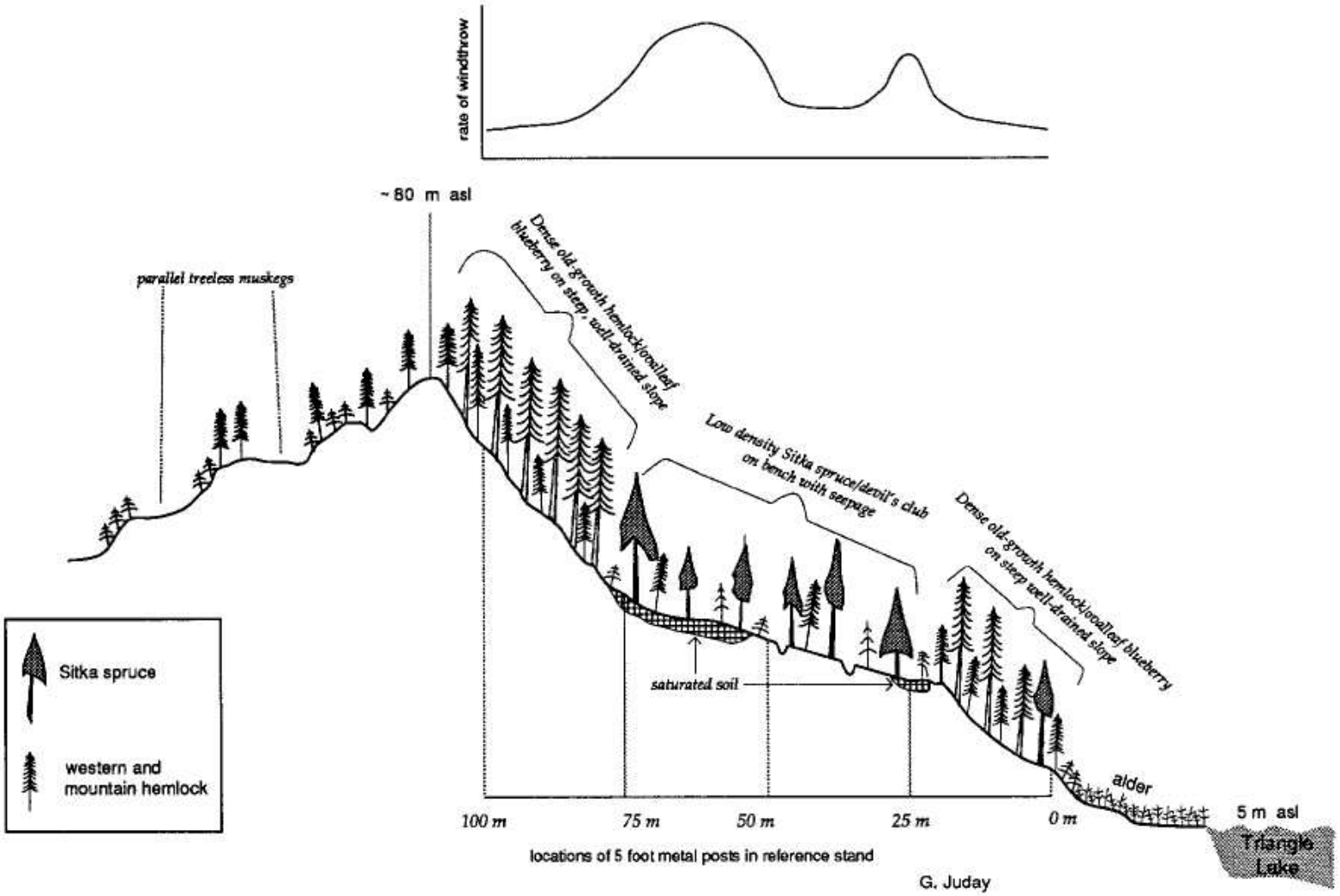


Figure 4 – VERTICAL ELEVATION PROFILE OF TRIANGLE LAKE FOREST REFERENCE PLOT (SCHEMATIC REPRESENTATION OF FOREST): Green Island Research Natural Area.

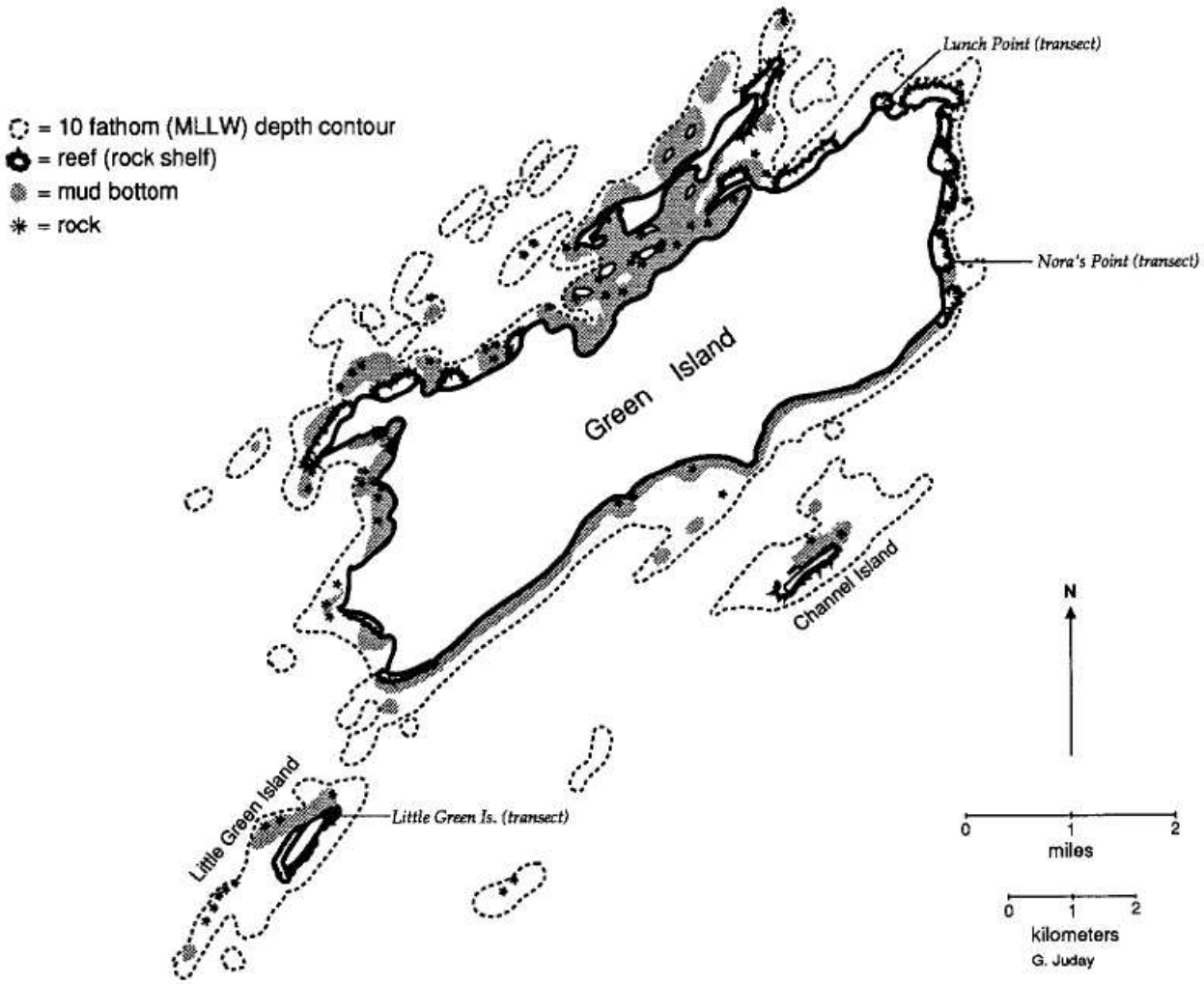


Figure 5 – OFFSHORE FEATURES OF GREEN ISLAND AND VICINITY: Green Island Research Natural Area.

PHOTOGRAPHS

Photo 1 – View of Green Island from sea level approach. The long, low island in the foreground (Green Island) appears thickly forested in contrast to the alpine snowfields of Montague Island (background).

Photo 2 – View of Green Island from the air (late March 1987). Note the extent of treeless blanket bogs or muskegs on level surfaces. Forests are limited to steep slopes between terraces. Late winter snow persists only at the higher elevations of the island.

Photo 3 – Tracks of Sitka black-tailed deer in mud of Green Island RNA. Deer were introduced to nearby Montague Island in 1916 and have spread to Green Island by swimming about 6 miles across Montague Strait. Deer browsing has significantly affected the structure of old-growth forests of Green Island, but not Little Green Island.

Photo 4 – Rocky beach and intertidal habitat at Green Island RNA, July 1986, before the *Exxon Valdez* oil spill. A diverse and productive intertidal community with abundant macroalgae (kelp) developed on this rock shelf since March 1964 when the area was uplifted about 2.5 meters in the Great Alaska Earthquake, the largest recorded in North America.

Photo 5 – Triangle Point at Green Island Research Natural Area (March 1987). Triangle Lake old-growth forest reference stand is located on the steep south-facing slope behind the lake. The lake was a brackish lagoon before the 1964 earthquake uplift. The beach is now a steep-profile, high energy, coarse gravel shingle beach. Parallel rows of Sitka spruce trees of different ages have developed on the different gravel beach ridges.

Photo 6 – Forest, beach, and lake at little Green Island (March 1987). Some of the largest trees in the Chugach National Forest occur on a low ridge on the far side of the lake to the immediate right of this view. A broad intertidal shelf resulting from earthquake uplift can be seen around the island.

Photo 7 – Close-up of a slightly sloping muskeg with saturated soil and mountain hemlock forest in the background on slope. Note the prominent standing snags in the forest, a sign of old-growth condition.

Photo 8 – Large old-growth western hemlock (126 cm d.b.h.) on Little Green Island. Understory plants collected for this report represent major extensions of known distribution and indicate the relatively mile, maritime nature of the climate here. Dense shrub cover of *Vaccinium ovalifolium* (ovalleaf blueberry) indicates that this site is not browsed by deer.

Photo 9 – Vertical upturned layers of sandstone and siltstone-shale at Little Green Island. The entire RNA is made up of this turbidite sequence of the Orca Formation. Erosion-resistant steep slopes are well-drained and support forest. Softer rock that forms terraces between ridges is covered with muskeg.