ORIGINAL

AVIAN STUDIES AT BECHAROF LAKE
ALASKA PENINSULA/BECHAROF NATIONAL WILDLIFE REFUGE
KING SALMON, AK
JUNE-SEPTEMBER, 1997

BY:

COREY D. ADLER

Key Words: Alaska Peninsual, Becharof Lake, bird banding, landbirds migration, mist-nets, point counts, redpolls, sparrows, thrushes, warblers

U.S. Fish and Wildlife Service
Alaska Peninsula/Becharof National Wildlife Refuge Complex
P.O. Box 277
King Salmon, AK 99613

October 1997

TABLE OF CONTENTS

LIST OF TABLES, FIGURES AND APPENDICES

Tables

Figures

Appendices

ABSTRACT

Landbird inventories were conducted at Becharof Lake during June-September 1997. During June and July, point counts were combined with constant-effort mist netting at Gas Rocks on the southern shore of Becharof Lake. During August and September, constant-effort mist netting was conducted at Bible Camp on the northern coast of the main body of the lake. Mist netting yielded 2135 total birds banded of 20 species between both camps. The combination of mist netting, point counts and incidental observations allowed documentation of 75 species using the Becharof Lake area. The Bible Camp site is recommended for use as a long term fall migration banding station.

INTRODUCTION

Beginning in 1994, federal agencies were directed by Vice President Gore to adopt an "ecosystem approach" to wildlife and environmental management. The goal of the ecosystem approach is "to restore and maintain the health, sustainability, and biological diversity of ecosystems while supporting sustainable economies and communities" (Interagency Ecosystem Management Task Force 1995). This directive has broad implications for the U.S. Fish and Wildlife Service (Service). As a starting point separate funding was allocated to identify research needs and conduct relevant ecosystem field studies.

Fish and Wildlife Service managers divided the state of Alaska into 10 geographical units. Each unit focuses on a different water system-based ecosystem. The Bristol Bay/Kodiak unit team identified the Becharof Lake drainage as one of its focal areas, with plans to concentrate interagency efforts on baseline data collection. Alaska Peninsula/Becharof National Wildlife Refuge Complex biological staff then implemented landbird studies at Becharof Lake as part of the Ecosystem investigation.

Landbird studies serve as an essential indicator for ecosystem based management, because:

1) landbirds are typically short-lived, meaning that general population changes can be detected in only a few years;
2) multiple species and a relatively large number of individuals can be monitored with a single type of sampling;
3) avian species are important to a wide variety of habitats; and
4) biologists have the ability to study both residents and migrants simultaneously.

Since 1994 USFWS has conducted landbird survey on the Alaska Peninsula/Becharof National Wildlife Refuge Complex. From 1994 to present, the USFWS has run a constant effort mist netting project at Mother Goose Lake on the Alaska Peninsula Refuge. A landbird project has also been conducted on the Becharof Refuge, within the Becharof Lake drainage, since 1995. These two projects, along with other landbird surveys along the Peninsula, have collectively produced baseline avian data for the previously unsurveyed Alaska Peninsula (Dewhurst et al. 1995 and 1996).

In 1997, Ecosystem funding was again allocated for further baseline avian studies in the Becharof Lake area. Breeding survey inventory was conducted at Gas Rocks in June and July. The field staff and camp was moved in late July to Bible Camp because of the large numbers of birds that were encountered there during the fall migration of 1996.

Research objectives of avian studies at Becharof Lake are to:

1) determine relative abundance and breeding status of landbird species using the Becharof Lake Ecosystem (Gas Rocks);

2) document local habitat use by landbird species during both breeding and fall migration (Gas Rocks and Bible Camp);

3) collect baseline information on migration phenology of landbirds using the Becharof Lake area (Bible Camp); and

4) collect baseline data on presence and relative abundance of other migratory bird species using Becharof Lake from June through September (Gas Rocks and Bible Camp).

The broader goal of the Becharof Ecosystem studies is to provide an inventory of this large and diverse area. As a result of this of the inventory approach, the breeding survey site is moved annually. This movement contrasts with avian studies at Mother Goose Lake where the goal focuses on productivity and survivorship.

STUDY AREA

Becharof Lake is located within the Becharof National Wildlife Refuge on the Alaska Peninsula (Fig. 1). Centered at 57°55'N and 156°25'W, Becharof Lake is the second largest lake in Alaska encompassing approximately 117,000 ha. This immense lake is fed by Ruth Lake and Island Arm tributaries to the southeast, and Kejulik River to the east. The lake drains into the Egegik River and ultimately Bristol Bay to the northwest. The Bruin Bay Fault runs diagonally (SW/NE) across the main body of the lake creating its maximum documented depth at 182 m.

The southeastern arm of Becharof Lake is known as "Island Arm" for the numerous small, low-lying islands present. This portion of the lake was formed by glacial scouring, with the islands likely the results of moraines and till deposits. The surrounding western slopes of the Aleutian Mountain Range and associated lowlands are covered by volcanic ash with underlying layers of unconsolidated glacier till dating back to the Pleistocene (FWS 1985). On the south shore of the lake stands volcanic Mt. Peulik (1466 m), which last erupted in 1814. In 1977, a sequence of phreatic (water related) eruptions formed two maars ("Ukinrek Maars") just to the northwest of the volcano and just south of Gas Rocks (Kienle et al. 1980), which constitutes the most recent activity in the area.

Just to the northwest of Mt. Peulik lies the area called Gas Rocks. Gas Rocks is part of a volcanic plug that lies along the Bruin Bay fault (Symonds et al. 1996). The rocks themselves consist of three prominent peaks that rise about 700 ft. out of Becharof Lake and form a small peninsula. The area has been known as a site of vigorous carbon dioxide degassing since at least 1974, with a large, active carbon dioxide seep just offshore to the north of the Gas Rocks peninsula (Symonds et al. 1996).

The geography and therefore physical habitat of the Becharof Ecosystem varies from 1500 m mountains to virtual sea level. This variation makes it difficult to briefly summarize vegetation types. This study focused on lowland areas within 5-6 km of the lake. Kessel's classification is used to briefly describe the avian habitats near Gas Rocks and Bible Camp. The lake and its edges are

lacustrine waters and shorelines. Moving uphill away from the lake, tundra or dwarf shrub/grass meadows are interspersed with medium-tall shrub thickets of willows (*Salix spp.*) and alders (*Alnus crispa*). The local tundra vegetation is made up primarily of non-vascular flora (lichens and mosses) and crowberry (*Empetrum nigrum*), Labrador tea (*Ledum palustre*), and grasses (Gramineae). At Bible Camp, the brushy stands of alders become thicker as you head toward Bible Creek (approximately 1.5 km to the north).

Gas Rocks

Gas Rocks is located on the southern shore of Becharof Lake (Fig. 2). To the southeast of the Gas Rocks peninsula lies Mt. Peulik and to the south lie the Ukinrek Maars. The field camp was located on the west side of the peninsula close to the lake for the camp's water supply. The mist netting site (Fig. 3) was also located on the west side of the peninsula, along a west-southwest facing slope. The array was situated on a slightly elevated (100 m.) plateau, with consistent elevation throughout. The net array (Fig. 4) was set in a mosaic of willow and alder thickets and some small grassy meadows. Understory in and around the shrub thickets is dominated by grasses (family Graminae), fireweed (*Epilobium augustifolium*), marsh fern (*Thelypteris phegopteris*), horsetail (*Equisetum arvense*), and dwarf dogwood (*Cornus canadensis*). The site is bordered by ericaceous tundra to the west and east and more willow/alder shrub thickets to the north and south.

Bible Camp

Bible Camp is located in the Becharof National Wilderness Area along the northern coast of the main body of Becharof Lake. The field site consists of 8 plywood buildings built by the villagers of Egegik around 1965 as a summer bible camp. The site is located on a sharp peninsula jutting southerly into the lake. The Bible Camp mist-net array (Fig. 5) was located in the southern-most alder thicket of that peninsula. The peninsula slopes roughly to the north at the location of the net array. The thickets are located >500 m from the lakeshore, and are mostly homogenous alder (3 nets were partially bordered by a mosaic of alder and willow). The understory is composed of grasses and mosses. The site is bordered by bare gravel to the southeast, more alder thickets to the north, and ericaceous tundra in all other directions.

METHODS

Weather

Weather data was collected daily, usually around sunrise. At this time staff determined whether mist netting was feasible. Feasibility criteria followed guidelines established by Ralph et al.(1992). Current windspeed and precipitation were the two major factors that determined banding feasibility. When the wind was greater than 12-15 mph or if the rain was heavy or constant, banding was not started. Measurements of ceiling height, wind speed and direction, current precipitation, visibility, minimum and maximum temperature over the past 24 hours, and total rainfall over the last 24 hours were recorded.

Breeding Season Banding

Constant effort mist netting was conducted at Gas Rocks during June and early July. Mist netting and banding were conducted generally using the Monitoring Avian Productivity and Survivorship (MAPS) protocol established by DeSante and

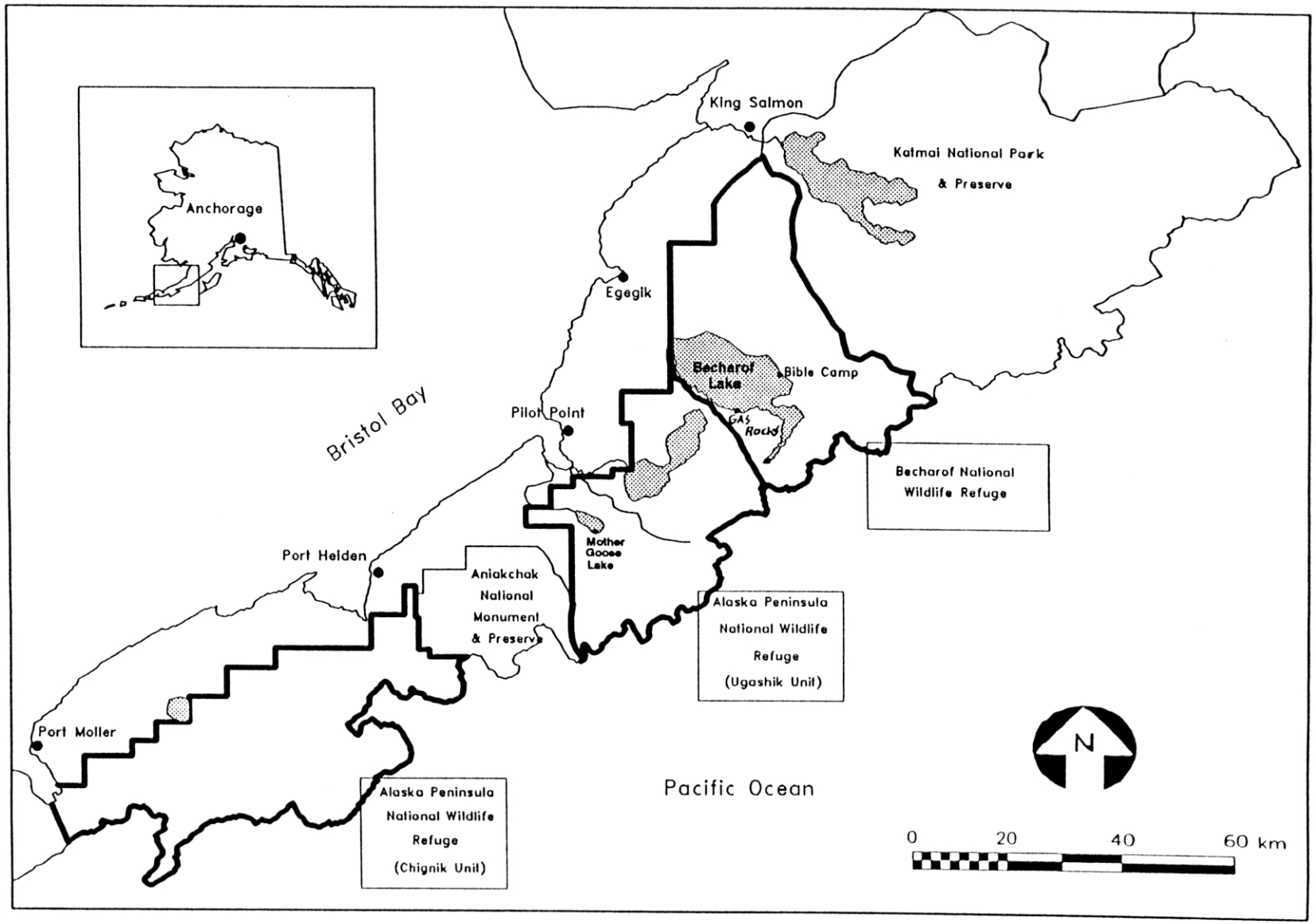

Figure 1. Gas Rocks and Bible Camp Study Areas on Becharof Lake in the Becharof National Wildlife Refuge.

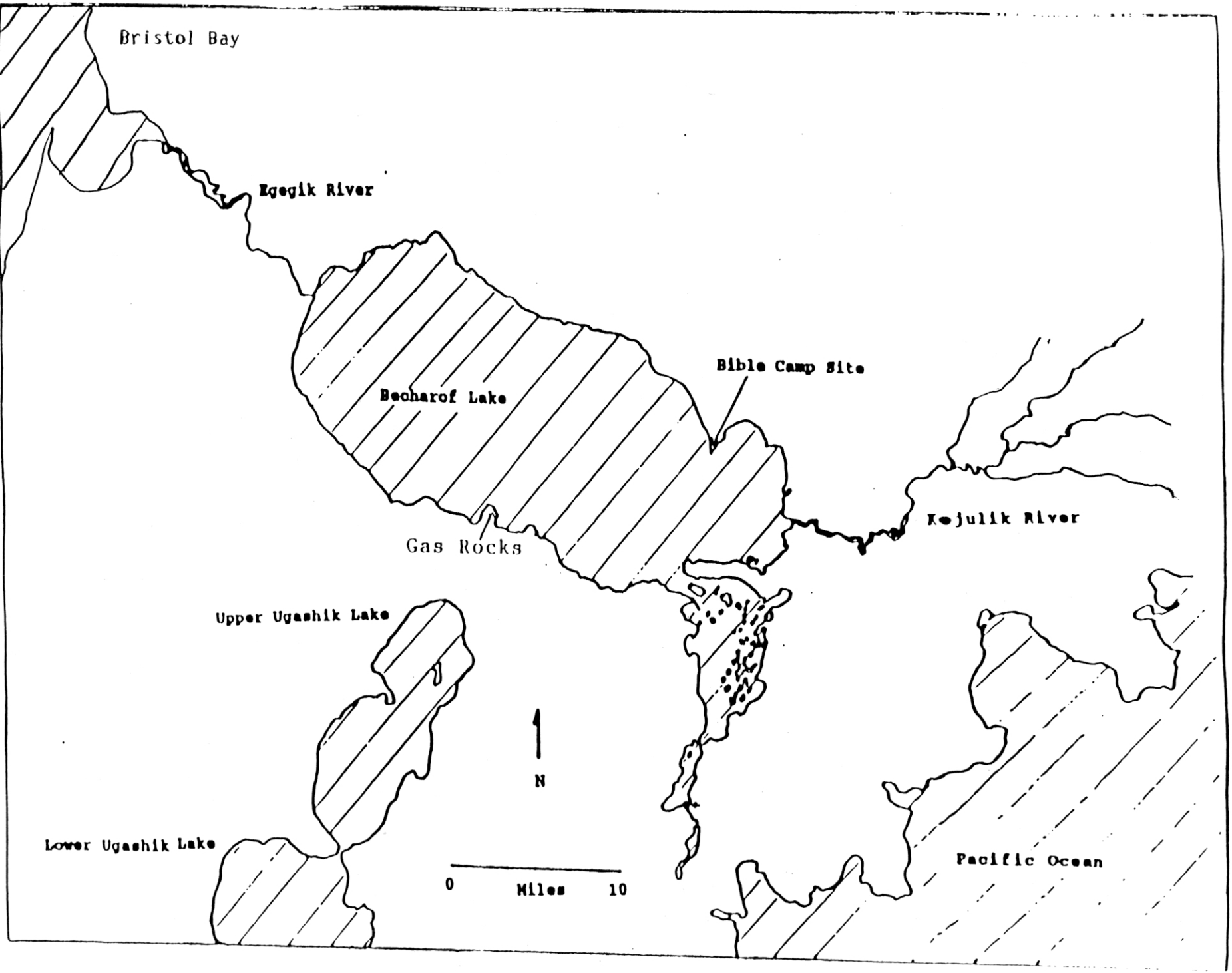

Figure 2 . Location of 1997 Becharof Lake study sites, Becharof National Wildlife Refuge.

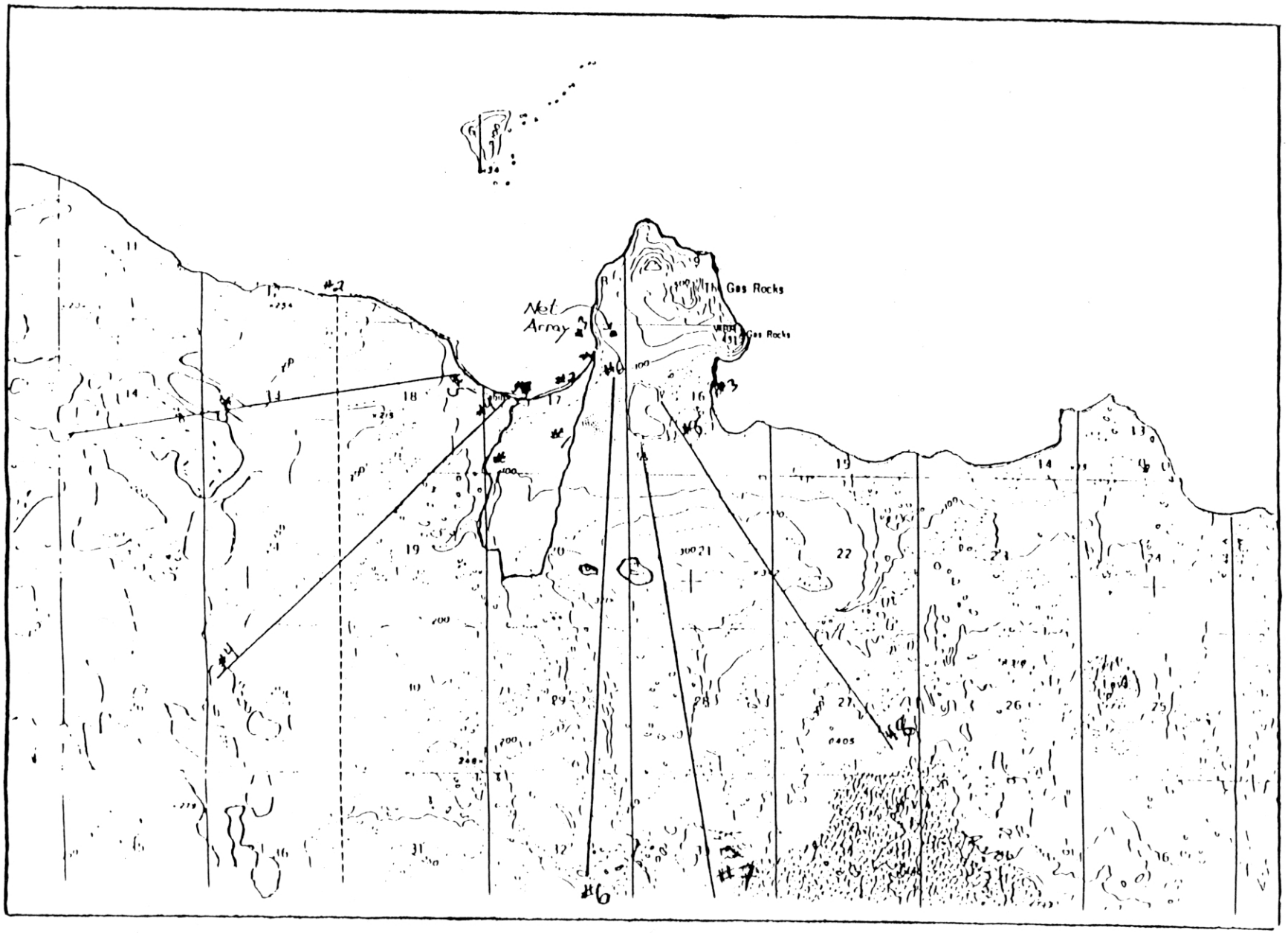

Figure 3 Location of the Gas Rocks mist net array and off-road point count routes at Gas Rocks, Becharof Lake, 1997

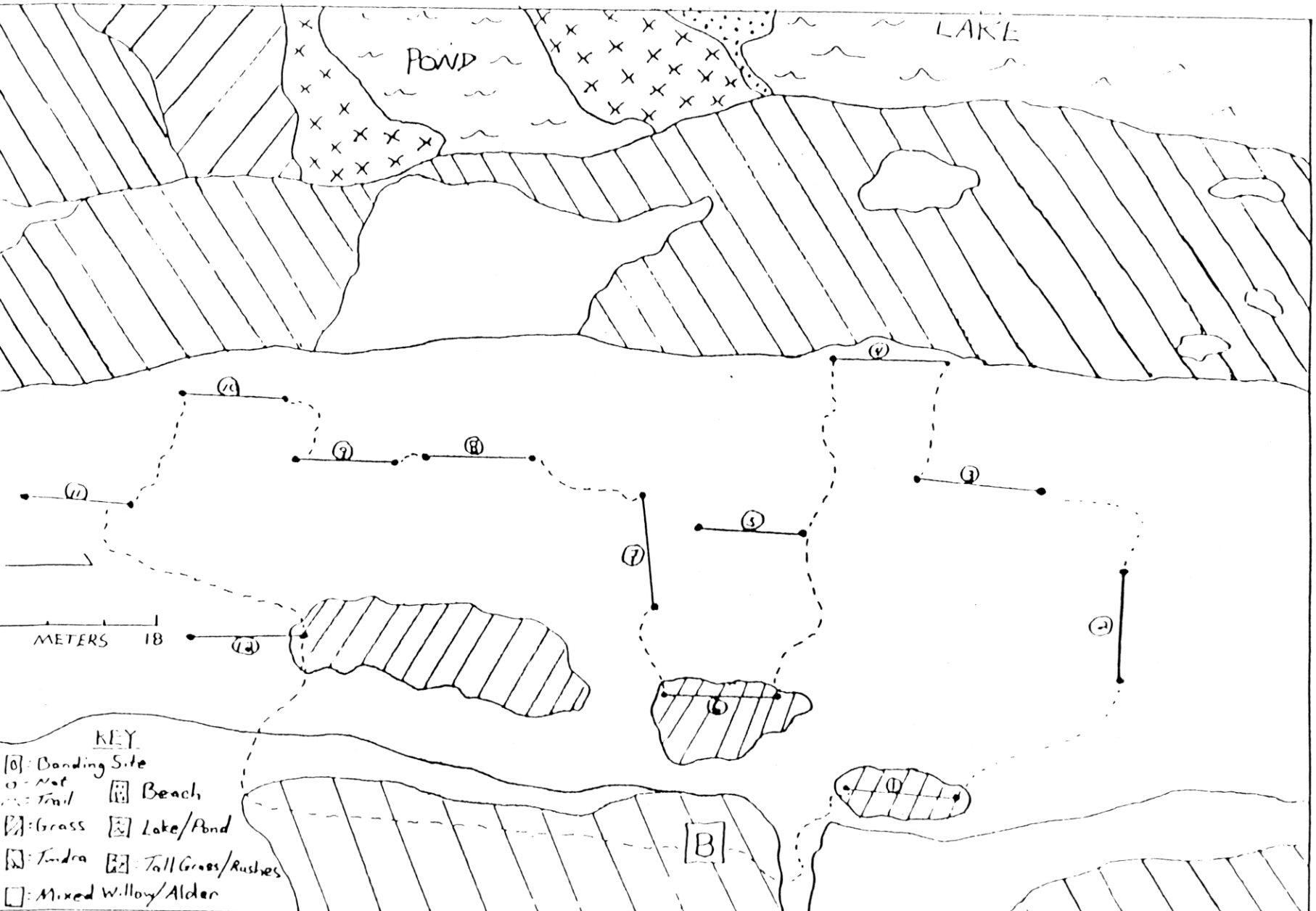

Figure 4. Sketch of Gas Rocks mist net site, Becharof National Wildlife Refuge, 1997

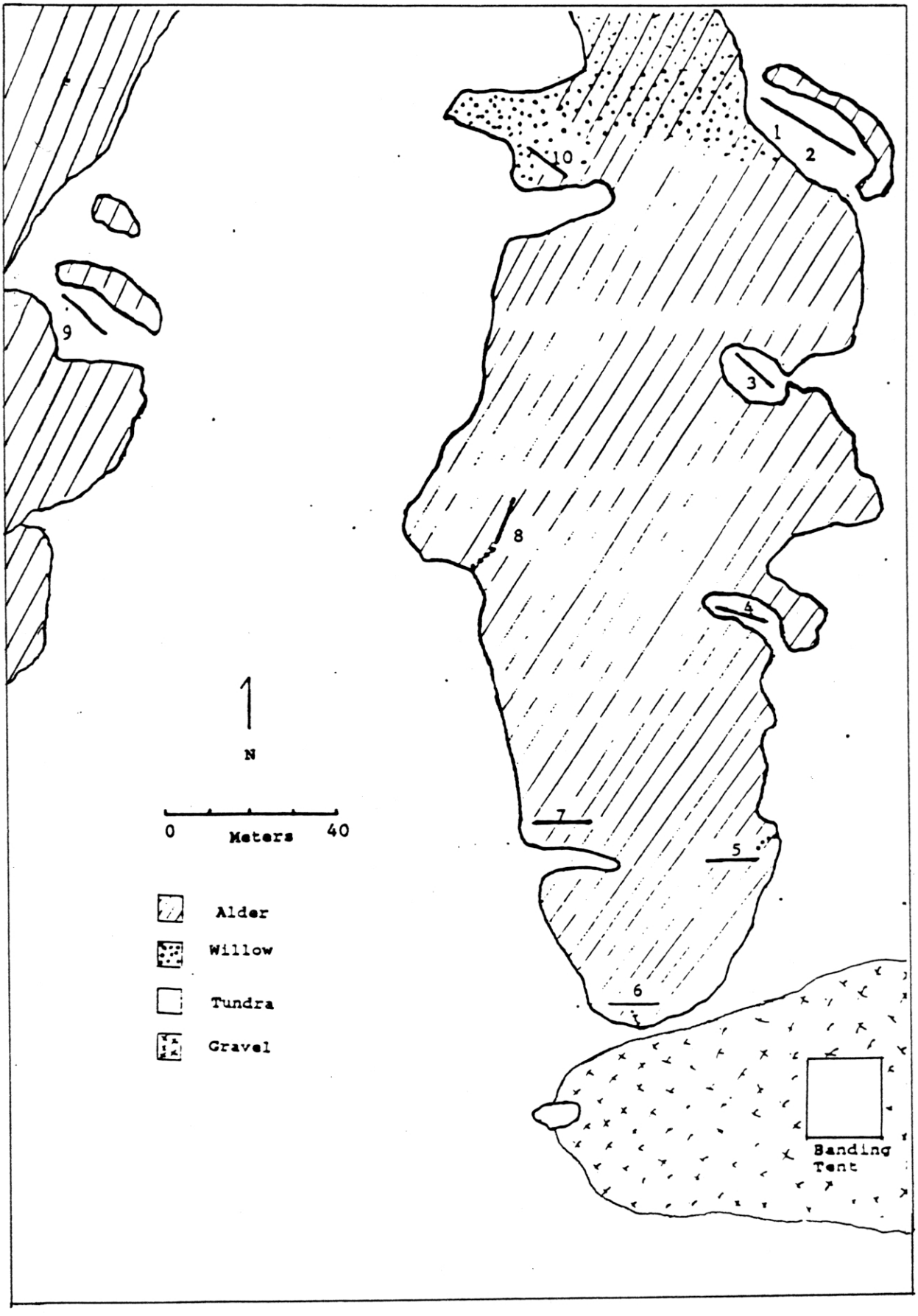

Figure 5. Sketch of Bible Camp mist net site, Becharof Lake, 1997.

Burton (1994). One notable exception was in frequency of banding, with a target of 2-3 times per week. Starting time was moved to 45 min after sunrise due to bear safety concerns (Dewhurst et al. 1995). All nets used were Association of Field Ornithologists (AFO) HTX mist nets [12 m (39.4 ft), 30 mm (1.2 in) mesh]. Rainy or windy conditions sometimes precluded the opening of all nets; at least half (6) had to be open or mist netting was not conducted.

All captured birds were brought back to the banding tent for processing. Captured birds were identified using standard field guides, aged using plumage attributes and/or skulling (Pyle et al. 1987), and sexed via plumage and presence/absence of a developed cloacal protuberance or brood patch. Captured birds were also weighed, measured, examined for amount of body fat, molt stage documented, and banded with a standard FWS/USGS metal leg band (DeSante and Burton 1994, Ralph et al. 1992). Local birds, or birds not yet capable of constant or sustained flight, were returned to the area of capture for release, while all others were released from the processing tent. Banding data were recorded on forms developed by Boreal Partners in Flight (BFIP) and later transferred to a Lotus Approach database. A schedule of the bird bands used was also sent to the Bird Banding Laboratory, Laurel, Md. Schedules were generated using the program Band_ops (ver 2.12, B.H. Powell 1995).

Consistent with previous years' banding methods, special measurements were taken on *Catharus* thrushes, alder flycatchers (*Empidonax alnorum*), Wilson's warblers (*Wilsonia pusilla*),and orange-crowned warblers (*Vermivora celata*) (Dewhurst et al. 1996). In 1996, BPIF developed regional bird banding forms, incorporating several new measurements of interest for the area. Additions included: color of eye rings, auriculars and rectrices; flight feather contrast in the coverts; and base color and wash or streaking in the body or undertail coverts. These new measurements are species specific with a detailed guide produced by BPIF (Colleen Handel, USGS, Anchorage, AK). BPIF also provided a guide with diagrams to help banders record more detailed descriptions of primary and rectrices feather shape for regional species. Age classifications [After Second Year (ASY) and Second Year (SY)] were sometimes made based on these plumage characteristics (Pyle et al. 1991).

Point Counts

Eight off-road point counts were conducted in and around the area surrounding Gas Rocks (Fig. 5). Each route consisted of 12 points, 400 to 500 m apart depending on the habitat (open areas required longer distances to avoid recounting birds). A 5 min census was conducted at each point. Vegetation descriptions were made at each stop by one person while another performed the count. All avian and habitat data was recorded on standardized forms and then sent into the USGS in Anchorage, AK were it was used in region wide analyses.

Gull Banding

An effort was made to travel to a nearby island and band glaucous-winged gull chicks. At least 6 different trips were made to the island to locate nests, count eggs, and to find bandable gull chicks. Many nests, eggs, and chicks were found; however, only one chick was found suitable for banding on 18 July. More chicks were not banded that day because of a thunderstorm that stopped banding efforts. No more trips were made to the island after 18 July because the camp was moved to a different location.

Vegetation Surveys

Vegetation data was collected at each mist net consistent with sampling methods used last year at Becharof Lake and Mother Goose camps. This year vegetation data was not done for Bible Camp since it had been collected in 1996. Four 1-m squares were described for each net, the centers being located

4 m from the ends of the net and 4 m perpendicular to the net lane. Estimates were made of the number of woody stems in the area, highest, lowest and average height of woody vegetation, estimated percentage of vascular and non-vascular ground cover, height of vascular cover, and all vascular species present in order of dominance. Habitat classifications were assigned to each net according to Kessel (1979).

Incidental vegetative observations also documented vascular plant species in the general camp areas. Specimens from both camps were pressed, mounted and ultimately stored in the USFWS herbarium in King Salmon. Blooming phenology was recorded weekly at Gas Rocks, based on daily observations.

Fall Migration Efforts

Field camp staff were moved from Gas Rocks to Bible Camp on 22 July to set up the migration banding station. Migration banding ran from 28 July to 13 September. Ten nets were operated daily as weather permitted. High bird numbers could force the closing of some nets, due to staffing constraints; however, additional volunteers and two crews of Earthwatch volunteers were brought to Bible camp, during the peak of migration, to reduce net closure. Methodology was consistent with fall migration protocols described by Dewhurst et al. (1995).

Birds recaptured within one hour of processing were not eliminated from the data as they may have been in the past. Birds were recorded as recaps, had at least their weight recorded, and then were marked as "Hourly Recaps" on the data sheet. This determination is consistent with methodology used at other migration stations operated by the Complex, but differs from breeding season protocol (where complete data on all captures is recorded).

For analytical purposes, landbird species described in this report were categorized by migration strategies following models established by national and western regional committees of Partners in Flight (Gauthreaux 1992, Carter and Barker 1993, Handel et al. 1995). The following migration strategy categories were used:

A = Neotropical migrant with majority of winter range south of U.S./ Mexico border
B = Neotropical migrant with majority of winter range north of U.S./ Mexico border
N = Nearctic migrant with entire or almost entire winter range in the U.S. and Canada
P = Palearctic or Paleotropical migrant with entire winter range in Asia
R = Resident species, non-migratory or very weakly migratory.

Avian Sightings

Daily records were kept of all birds sighted during the study period at the Gas Rocks and Bible Camp locations. Habitat type (Kessel 1979), behavior (Andres 1994) and observed breeding status were also recorded on customized forms (FWS files, King Salmon, AK)and then summarized into a database by species, first and last observation, number of days observed, peak count, and highest level of breeding activity observed. Observed breeding status includes only characteristics noted outside of mist netting activities.

Small Mammal Trapping

An effort was made to conduct small mammal trapping at Gas Rocks. This topic is report in a separate document which contains all the results of the trapping effort (Marcell 1997).

RESULTS

Weather

Gas Rocks.-- A total of 55.7 mm of precipitation was recorded at Gas Rocks from 08 June to 20 July 1997. Over half the total rainfall (29.6 mm) was recorded on 30 June and 06 July. Precipitation was recorded on 11 of the 43 days at Gas Rocks (26%). The 1995 Island Arm site recorded precipitation on 65% of their days, while Ruth River recorded precipitation on 57% of their days.

In past years the weather has been a considerable factor in the banding operations on the Becharof Lake area. The Island Arm area of Becharof Lake is known for its constant high winds and frequent storms. This year at Gas Rocks unseasonably warmer and more stable weather seemed to be the trend early in the summer. Wind and rain were not much of a factor for the banding and point counts, as they were in the past. Because of this years exceptional weather, we found that it was feasible to band on 33 of the 43 days (77%) at Gas Rocks, which is well above the 55% for Ruth River last year.

Bible Camp.-- A total of 123.85 mm of precipitation was recorded at Bible Camp from 24 July to 14 September. Precipitation was recorded on 25 of 53 (47%) days at Bible Camp. Total precipitation was about 50 mm less than the 1996 measurement, and days-of-measurable-precipitation was 47% this year compared to the 71% in 1996.

Wind was more of a factor affecting banding than rain. The nets at Bible Camp are fairly protected; however, unstable autumn weather patterns set up early around Bible Camp thus producing considerable wind to hamper banding activities. It was not uncommon to have a 3 to 4 day stretch were the wind was blowing 40+ kph all the time. Banding was only feasible on 27 of the 53 days (50%) at Bible Camp. The percentage of bandable days was well below the 69% for 1996 and also below the 62 to 73% recorded for all other fall migration stations previously operated by the Complex (Moore 1996).

Mist-netting and Banding

Breeding Season.-- Constant effort mist netting was conducted at Gas Rocks on 20 days between 09 June and 19 July. A total of 324 birds were captured in 1367.5 net hours (23.6 birds/100 net hrs), including recaptured, escaped and injured birds. Of those captures, 242 (15 species) were newly banded (Table 1). Individual net efficiencies varied from 15.9 to 49.1 birds/100 net hrs (Table 2). The most common species were Wilson's warbler (48 banded), yellow warbler (*Dendroica petechia*) (37 banded) and hermit thrush (*Catharus guttatus*) (33 banded). Five species were represented by 1-5 individuals.

Capture rates at Gas Rocks were quit low compared to 1995 Island Arm and 1996 Ruth River capture rates, and very low compared to Mother Goose capture rates. One theory to explain the low breeding density observed at Gas Rocks is that the area has been recently disturbed by volcanic activity, with the eruption of the Ukinrek Maars in 1977. This recent activity may have reduced the productivity of the Gas Rocks area and its recovery may be slower than expected.

Productivity, as measured by percentage of newly banded birds that were HY, was also low (26%) as compared to other sites on the Peninsula, and past Becharof Lake sites. The 1995 Island Arm site had 48% of their birds as HY, while Ruth River had 34% of their birds as HY. Sites at Mother Goose Lake generally have produced 60-80% HY birds (Dewhurst et al. 1995, Eskelin and

Table 1. Age composition of birds banded during mist netting operations a Gas Rocks (June-July) and Bible Camp (August-September), Becharof Lake, 1997.

Species	Gas Rocks				Bible Camp				Grand Total
	AHY*	HY	UNK	TOTAL	AHY*	HY	UNK	TOTAL	
Downy Woodpecker				0	4		1	5	5
Alder Flycatcher	1			1				0	1
Black-capped Chickadee	2	9	1	12	1	65	3	69	81
Ruby-crowned Kinglet				0		1		1	1
Gray-cheecked Thrush	2			2	3	8		11	13
Hermit Thrush	21	12		33	2	24		26	59
American Robin	3	2		5	1	15		16	21
American Pipit				0		3		3	3
Northern Shrike				0	2	6		8	8
Orange-crowned Warbler	22	4		26	15	148		163	189
Myrtle Warbler	1			1	2	1		3	4
Yellow Warbler	34	3		37	17	586		603	640
Northern Waterthrush				0		2		2	2
Wilson's Warbler	45	2	1	48	28	346	1	375	422
American Tree Sparrow	4	9		13	20	287	2	309	322
Savannah Sparrow	3	6		9	6	182		188	197
Fox Sparrow	11	4		15	4	18	1	23	38
Golden-crowned Sparrow	13	2		15	2	18		20	35
Gambel's White-crowned Sparrow	2			2	1	11	2	14	16
Common Redpoll	13	9	1	23	20	32	2	54	77
Total	176	62	3	242	128	1753	12	1893	2135

*AHY = After Hatch Year (All Adults)
HY = Hatching Year (Young of the year)
UNK = Unknown Age

Table 2. Summary of mist net efficiencies during banding operations at Gas Rocks (June-July) and Bible Camp (August-September), Becharof Lake, 1997. Capture rates are expressed as birds/100 net hours.

Gas Rocks													
Net #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Total**
Total Birds	20	57	19	18	18	20	26	19	26	28	50	21	322
Net Hours	116	116	113.5	106.5	113.5	116	116	110.5	11.5	116	116	116	1367.5
Capture Rate	17.2	49.1	16.7	16.9	15.9	17.2	22.4	17.2	23.3	24.1	43.1	18.1	23.6
Bible Camp													
Net #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**Total**
Total Birds	134	134	144	200	411	464	323	218	183	168			2379
Net Hours	125.5	125.5	120	123.5	127.5	143.25	137	137	113	132			1284.25
Capture Rate	106.8	106.8	120	161.9	322.4	323.9	235.8	159.1	161.9	127.3			185.2

Dewhurst 1996). Loss in productivity could be contributed to less days banding when young birds are around, a drier year were less food (mainly insects) was available or a less productive habitat caused by volcanic activity. Overall, the capture rates and productivity at Gas Rocks is lower compared to other places in the Becharof Lake drainage and to other places on the Alaska Peninsula.

Fall Migration.-- Mist netting was conducted at Bible Camp on 28 days between 28 July and 13 September. Capture efforts yielded 1893 banded birds of 19 species (Table 1), and 2383 total captures. Due to high bird volumes and staff limitations, on some days during August some nets were either shut early or not opened at all. Nets were open for 1284.25 total net hours, providing an overall capture rate of 185.2 birds/100 net hrs. Capture rates were highest on 06 August, (622.6 birds/100 net hrs) and steadily declined throughout the season (Fig. 6). Individual net efficiencies ranged from 106.8 to 323.9 birds/100 net hrs (Table 2). The most common species captured were yellow warblers (603 banded), Wilson's warbler (375 banded), and American tree sparrows (*Spizella arborea*) (309 banded), while only 5 species were represented by 1-5 individuals. Compared to the 1351 net hours and the overall capture rate of 182.8 birds/100 net hours for 1996, capture success at Bible Camp in 1997 was very similar.

Differences in individual species phenology (Table 3) were not as evident as at other Alaska Peninsula banding stations. In general, Type A migrants have displayed highest capture rates earlier in the season than Type B or Nearctic migrants (Moore 1996, Dewhurst et al. 1996). At Bible Camp, almost all species with substantial numbers had highest capture rates during the period 02-06 August. One exception to his was American tree sparrows who peaked during the period 28 July-01 August and then again from 01-05 September. Typically, Types A and B migrants departed earlier than Nearctic migrants or residents, which were still being captured during mid September.

Recaptures.-- Eleven species of birds were recaptured at Gas Rocks, accounting for 24.5% (78) of total captures (Table 4). Orange-crowned warblers (*Vermivora celata*) had the highest recapture rate (39.5%), with only 26 out of 43 captures being new birds. While gray-cheeked thrush (*Catharus minimus*) did exhibit a recapture rate of 71.4%, that number was discarded due to a sample size of only 2 individual birds. These birds lived near or in the net array and were constantly getting caught in the nets. For Bible Camp the overall recapture rate dropped to 18.3% (423), which is comparable to the 19.5% (482) encountered during the 1996 project. Once again hermit thrushes had the highest recapture rate at Bible Camp with 54.3% in 1997 and 57.1% in 1996. Only 26 out of the 57 hermit thrush captures were new birds.

This year the number of unique recaptures, birds recaptured just once, was compared to overall total recaptures. It was observed that of the 78 recaps at Gas Rocks, 40 (51.3%) were unique. At Bible Camp there were 423 total recaps and 352 (83.2%) were unique. This comparison was made to help show that many birds are captured and then recaptured usually once and then not again. This comparison also shows that some individuals are constantly recaptured and thus increasing the recapture rate. This analysis helps explain how local birds move or don't move during the breeding season, and how long migrants stay in a certain area during migration.

Four birds returned to Bible Camp this year from last year's banding effort. American tree sparrows #217171774, #217171780 and #217172997 were banded last fall as HY, sex unknown birds. This year the birds were aged as AHY with skulls of 6, but were not given a sex because of the lack of distinctive characteristics late in the season. Golden-crowned sparrow #808176689 was captured and banded last year at Bible Camp as a AHY, sex unknown bird. This year the bird was also aged as AHY, because of plumage etc., but was

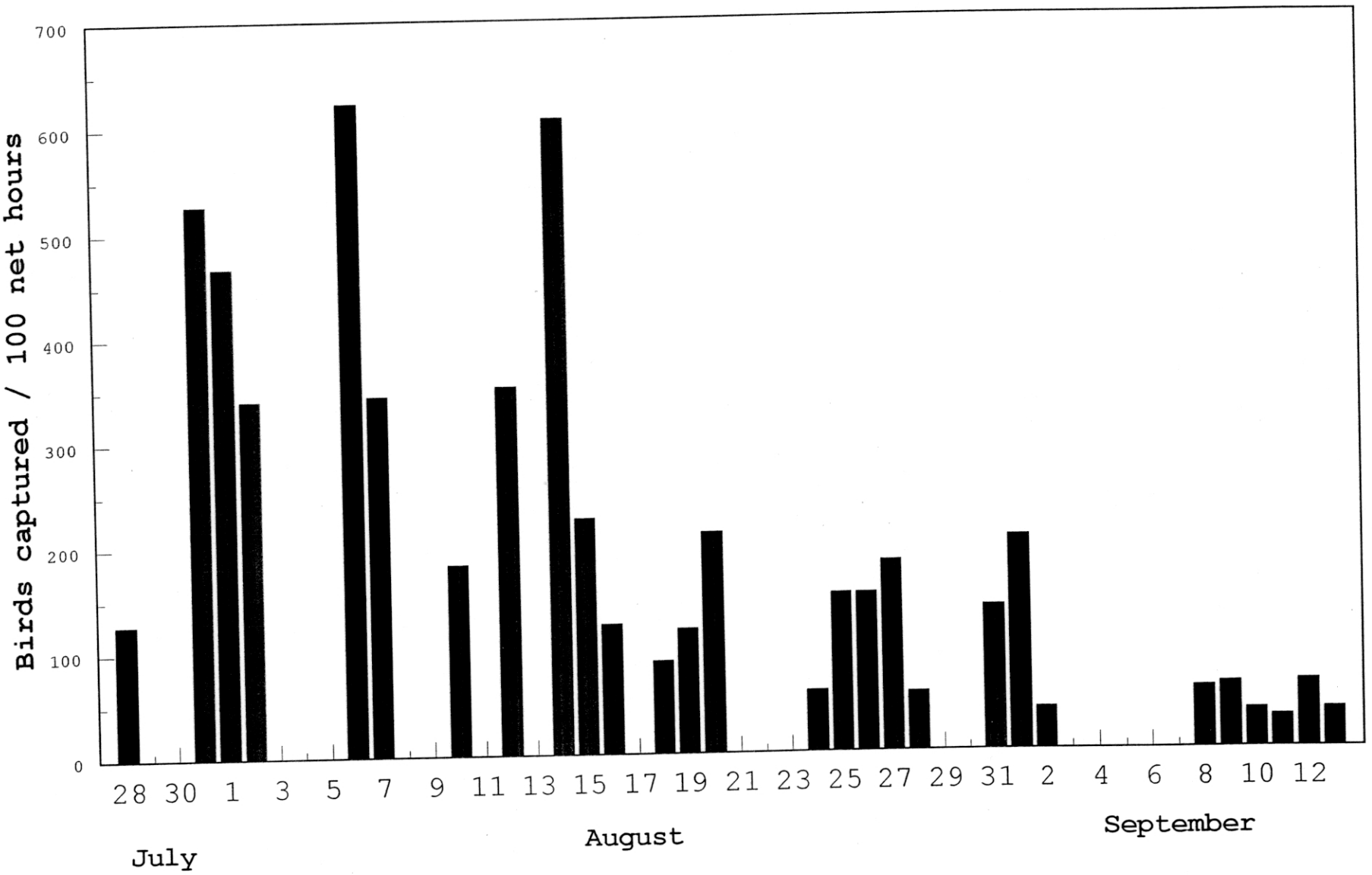

Figure 6. Capture rates of landbirds caught at Bible Camp, Becharof Lake, during July, August, and September 1997.

Table 3. Seasonal variation in capture rates* (birds/100 net hours) of ten migrant landbird species during fall migration banding at Bible Camp, Becharof Lake, 1997.

SPECIES**	July 28 - August 01	August 02 to 06	August 07 to 11	August 12 to 16	August 17 to 21	August 22 to 26	August 27 to 31	September 01 to 05	September 06 to 10	September 11 to 15	Cumulative
Neotropical Migrants Type A											
OCWA	49.2	49.4	31.6	34.9	16.1	7.5	5.3	1	0	0.68	17.8
YWAR	104.8	216.9	122.4	124.9	43.3	19.5	11.3	13.5	0.63	0	56.9
WIWA	42.9	103.6	97.4	63	22.2	35.6	6.7	2.1	0	0	32.7
Neotropical Migrants Type B											
HETH	4.8	2.4	2.6	9.7	2	4.6	4.7	7.3	3.8	1.4	4.6
SAVS	24.6	63.9	13.6	29.2	12.1	17.8	12	7.3	0.63	0	16.7
FOSP	4.8	4.8	2.6	0.57	2	2.9	0.67	4.2	0.63	0.68	2.1
GCSP	7.9	1.2	5.3	2.3	0	0	2.7	1	0.63	0	1.9
GWCS	0	4.8	9.2	2.3	0	1.7	0.67	0	0.63	0	1.5
Nearctic Migrants											
ATSP	70.6	43.4	15.8	26.9	7.1	20.1	58	69.8	16.5	0	31.6
CORE	1.6	20.5	0	2.3	7.1	1.1	3.3	11.5	12	2	5.5
Net Hours	126	83	76	174.5	99.25	174	150	96	158	147.5	1284.25

*Capture rates include all recaptures, releases, escapes and mortalities.

**OCWA - Orange-crowned Warbler
YWAR- Yellow Warbler
WIWA- Wilson's Warbler
HETH- Hermit Thrush
SAVS- Savannah Sparrow
FOSP- Fox Sparrow
GWCS- Gambel's White-crowned Sparrow
ATSP- American Tree Sparrow
CORE- Common Redpoll

Table 4. Recapture rates of species captured during mist netting operations at Gas Rocks (June-July) and Bible Camp (August-September), Becarof Lake, 1997.

Species	Gas Rocks					Bible Camp				
	Total*	All Recaps	% Recaps	Unique Recaps**	% Unique Recaps	Total*	All Recaps	% Recaps	Unique Recaps**	% Unique Recaps
Downy Woodpecker						5	0	0	0	
Alder Flycatcher	1	0	0	0	0					
Black-capped Chickadee	12	0	0	0	0	95	26	27.4	25	26.3
Ruby-crowned Kinglet						1	0	0	0	0
Gray-cheecked Thrush	7	5	71.4	2	28.6	19	8	42.1	6	31.6
Hermit Thrush	49	16	32.7	8	16.3	57	31	54.3	14	24.6
American Robin	6	1	16.7	1	16.7	20	4	20	4	20
American Pipit						3	0	0	0	0
Northern Shrike						9	1	11.1	1	11.1
Orange-crowned Warbler	43	17	39.5	7	16.3	226	63	27.9	51	22.6
Myrtle Warbler	1	0	0	0	0	3	0	0	0	0
Yellow Warbler	42	5	11.9	3	7.1	716	113	15.8	99	13.8
Northern Waterthrush						2	0	0	0	0
Wilson's Warbler	61	13	21.3	7	11.7	410	35	8.5	32	7.8
American Tree Sparrow	18	5	27.8	2	11.1	400	91	22.8	72	17.9
Savannah Sparrow	9	0	0	0	0	209	21	10	19	9.1
Fox Sparrow	20	5	25	3	15	27	4	14.8	4	14.8
Golden-crowned Sparrow	23	8	34.8	4	17.4	25	5	20	5	20
Gambel's White-crowned Sparrow	3	1	33.3	1	33.3	18	4	22.2	4	22.2
Common Redpoll	25	2	8	2	8	71	17	23.9	16	22.5
TOTAL	320	78	24.4	40	12.5	2316	423	18.3	352	15.2

*Total number of birds banded, recaptured, and recovered

** Unique Recaps are all birds that were recaptured at least one time. Repeat recaptures not included.

determined to be a male because of a cloacal protuberance of 3.

Unbanded Birds.-- Any bird which was unintentionally released after being touched by a staff member and prior to banding was classified as an escape. Four birds escaped at Gas Rocks (1.2% of captures) and 43 escaped at Bible Camp (1.8% of captures). We also had 2 birds released without bands, even though the bird was thought to have a band on it. No mortality was observed at Gas Rocks, while at Bible Camp 18 birds (0.76%) died due to predators in the area or handling injuries. Of those that died, at least 15 were killed by northern shrikes (*Lanius excubitor*), one was killed by a red fox (*Vulpes vulpes*), bear (*Ursus arctos*), or northern harrier (*Circus cyaneus*), and two appeared to die from strangulation in the net. Avian predators in the net array were always a constant problem at the net site.

Point Counts

Off-Road Point Counts.-- Eight off-road point counts (Fig. 3) were conducted in and around the Gas Rocks area, documenting a total of 36 avian species (Table 5). Overall species composition closely paralleled that of the mist net sites and incidental avian sightings of the Gas Rocks area. Only short-billed dowitcher (*Limnodromus griseus*) was added to the Gas Rocks species list as a result of the point counts.

Vegetation Surveys

Data collected on vegetation/habitat at the net lanes is presented in Tables 6 and 7. Willows and alders were often not keyed out to species. Habitat at Gas Rocks was rather uniform with mostly medium shrub thicket comprising the net array. The net array was set in a patch of mixed willow/alder surrounded by large areas of ericaceous dwarf shrub meadow and more medium shrub thicket. Habitat at Bible Camp was also very consistent. Nets were placed close to the edge of a large patch of medium shrub thicket which was surrounded by ericaceous dwarf shrub meadow and patchy bare cinder spots. Vegetation/habitat data was not collected in 1997 for the Bible Camp area. The data in Table 7 is the information that was collected in 1996 and can be used to compare the two study years. Changes in vegetation and habitat were not noticeable to one staff member that was at the camp in both '96 and '97. It is recommended that vegetation/habitat data be collected in 1998 or 1999 to document any changes in the area.

Appendix I is a list of 158 vascular plant species collected or observed at Becharof Lake during 1995, 1996, and 1997. During 1997, 23 new species were added to the inventory, including 2 new families (Athyriaceae and Thelypteridaceae). Also, 48 species observed or collected during 1996 were not found during 1997. Since plant collection was largely incidental during both years, species lists should only be classified as preliminary. Families missing at Gas Rocks, while all relatively common at Ruth River, were Aspidiaceae, Caprifoliaceae, Diapensiacea, Lentibulariaceae, Orchidaceae, Plumbaginaceae, Portulaceae, and Umbelliferae. Differences in vegetation composition may be related to the very sandy soil at Gas Rocks and also to the recent volcanic history and large amount of carbon dioxide in the area.

Incidental Avian Sightings

Seventy-one avian species were documented at or around Becharof Lake during 1997 (Appendix II). Observations were collected from a wide variety of habitats, from alpine tundra areas to dense shrubbery, to barren lake shores and dense stream edges. Based on these observations, 18 species were confirmed as breeding in the area, 28 were possible breeders and 25 showed no evidence of breeding.

Table 5. Frequency of species occurrence during Gas Rocks off-road point counts, June-July 1997. Frequency equals the number of points at which a species is detected divided by the number of points sampled.

Species	Route 1		Route 2		Route 3		Route 4		Route 5		Route 6		Route 7		Route 8	
	16 June	n*	18 June	n	20 June	n	22 June	n	04 July	n	25 June	n	28 June	n	03 July	n
Common Loon									0.08	1					0.08	1
Tundra Swan	0.08	1	0.08	1												
Green -winged Teal					0.08	1										
Greater Scaup			0.08	1												
Black Scoter			0.42	14												
Red-breasted Merganser	0.08	1														
Bald Eagle							0.08	1								
Rough-legged Hawk					0.17	2										
Unknown Falcon					0.08	1										
Willow Ptarmigan	0.17	2	0.42	9			0.08	1			0.17	2				
Sandhill Crane							0.17	3	0.08	1			0.08	1		
Semipalmated Plover	0.42	5			0.25	4	0.08	1	0.08	3	0.25	6	0.25	3	0.08	1
Greater Yellowlegs	0.08	1	0.33	4	0.08	2	0.33	7			0.17	2	0.33	7		
Red-necked Phalarope							0.08	1								
Least Sandpiper	0.17	4	0.17	4	0.17	4	0.17	3	0.17	3	0.08	1	0.75	13		
Short-billed Dowitcher							0.17	6								
Common Snipe	0.58	8	0.08	1	0.08	1			0.25	6	0.08	1			0.08	1
Mew Gull	0.33	6			0.08	5	0.17	3								
Glaucous-winged Gull	0.25	5	0.5	7	0.17	3	0.17	2	0.08	50	0.08	1			0.08	6

*n = number of individual birds encountered on the route.

Table 5 (cont.). Frequency of species occurrence during Gas Rocks off-road point counts, June-July 1997.
Frequency equals the number of points at which a species is detected divided by the number of points sampled.

Species	Route 1		Route 2		Route 3		Route 4		Route 5		Route 6		Route 7		Route 8	
	16 June	n*	18 June	n	20 June	n	22 June	n	04 July	n	25 June	n	28 June	n	03 July	n
Tree Swallow	0.08	1	0.33	13	0.25	14			0.08	2	0.17	4			0.08	2
Bank Swallow													0.33	5		
Common Raven	0.08	1			0.08	2									0.08	1
Gray-cheecked Thrush	0.08	1	0.17	2			0.08	1			0.42	5	0.25	3	0.08	2
Hermit Thrush	0.33	5	0.58	14	0.66	15	0.33	4	0.66	12	0.66	15			0.83	25
American Robin	0.33	4	0.08	1	0.08	1	0.25	4			0.33	5	0.25	3	0.25	4
American Pipit									0.08	2			0.33	4		
Northern Shrike			0.08	1											0.08	1
Orange-crowned Warbler	0.66	16	0.5	9	0.5	7	0.25	3	0.33	7	0.42	10	0.08	2	0.25	4
Yellow Warbler	0.75	19	0.42	12	0.17	2	0.25	3			0.17	2	0.5	7		
Wilson's Warbler	0.58	14	0.58	17	0.5	8	0.33	5	0.58	12	0.58	15	0.08	1	0.08	3
American Tree Sparrow	0.25	3	0.08	1			0.75	14	0.66	13	0.25	4	0.17	2	0.42	6
Savannah Sparrow	0.92	30	0.5	14	0.17	4	1	35	0.92	19	0.5	22	0.83	21	0.92	24
Fox Sparrow	0.5	13	0.42	6	0.33	4	0.08	1			0.5	7	0.58	8	0.25	5
Golden-crowned Sparrow	0.83	16	0.66	16	0.25	4	0.75	13	0.92	18	0.58	17	0.83	18	0.83	19
Gambel's White-crowned Sparrow	0.25	3	0.25	3			0.25	3	0.25	3					0.08	1
Lapland Longspur	0.66	21	0.42	9			0.33	7			0.42	13	0.17	2		
Common Redpoll	0.58	10	0.92	18	0.33	5	0.58	10	0.42	7	0.75	15	0.5	7	0.5	7
Unknown Bird											0.08	1				

*n = number of individual birds encountered on the route.

Table 6. Vegetation data collected during July 1997 from mist net sites at Gas Rocks, Becharof National Wildlife Refuge, Alaska
Values are expressed as means, while canopy density and woody vegetation height have the range
printed above the mean.

Net	No. Woody Stems	Woody Veg. Height	Vascular Cover Ht.	% Vascular Ground Cover	3 Dominant Vascular Taxa	Habitat Type [Kessel 1979]
1	2.3	1.5m to 2.5m 2.0m	0.5m	94	Graminae, Epilobium augustifolium, Equisetum arvense	Grass Meadow
2	2.5	1.0m to 2.0m 1.5m	0.5m	85	Graminae, Epilobium augustifolium, Equisetum arvense	Medium Shrub Thicket
3	6	1.0m to 2.0m 1.5m	0.5m	67.5	Graminae, Epilobium augustifolium, Equisetum arvense	Medium Shrub Thicket
4	2.5	1.25m to 1.5m 1.44m	0.33m	52.5	Epilobium augustifolium Empetrum nigrum, Achillea borealis	edge- Dwarf Shrub Meadow Medium Shrub Thicket
5	3.5	1.0m to 2.0m 1.5m	0.5m	68.8	Graminae, Cornus canadensis Epilobium augustifolium	Medium Shrub Thicket
6	1.3	0.0m to 2.0m 1.3m	0.75m	89.5	Graminae, Epilobium augustifolium Thelypteris phegopteris	Grass Meadow
7	3	0.5m to 3.0m 1.7m	0.38m	76.3	Graminae, Epilobium augustifolium Equisetum arvense	Medium Shrub Thicket
8	2.8	1.0m to 1.5m 1.25m	0.59m	62.5	Graminae, Thelypteris phegopteris Achillea borealis	Medium Shrub Thicket
9	7.8	1.0m to 2.0m 1.4m	0.5m	77.5	Graminae, Epilobium augustifolium Cornus canadensis	Medium Shrub Thicket
10	3.8	1.0m to 2.0m 1.8m	0.5m	70	Graminae, Thelypteris phegopteris Epilobium augustifolium	Medium Shrub Thicket
11	5	0.0m to 3.0m 1.6m	0.63m	96.3	Graminae, Epilobium augustifolium Thelypteris phegopteris	Medium Shrub Thicket
12	1	0.0m to 4.0m 2.5m	1.5m	95	Graminae, Thelypteris phegopteris Equisetum arvense	Tall Shrub Thicket
All Nets	3.5	0.0m to 4.0m 1.6m	0.59m	78.3	Graminae, Epilobium augustifolium Thelypteris phegopteris	

Table 7. Vegetation data collected during September 1996 from mist net sites at Bible Camp, Becharof National Wildlife Refuge, Alaska. Values are expressed as means, while woody vegetation height has the range printed above the mean.

Net	Canopy density	No. Woody Stems	Woody Veg. Height	Vascular Cover Ht.	3 dominant vascular taxa	Habitat type [Kessel 1979]
1	-	0.8	0.5 to 2.4 m 1.4 m	0.4 m	Graminae, Empetrum nigrum, Vaccinum uliginosum	Dwarf Shrub Meadow
2	-	1.5	0.5 to 1.8 m 0.5 m	0.6 m	Graminae, Achillea borealis, Empetrum nigrum	Dwarf Shrub Meadow
3	-	1.0	0.7 to 1.5 m 1.1 m	0.5 m	Empetrum nigrum, Graminae	Dwarf Shrub Meadow
4	-	2.0	0.1 to 2.0 m 1.3 m	0.6 m	Graminae, Empetrum nigrum	Dwarf Shrub Meadow
5	-	2.0	1.7 to 3.0 m 2.3 m	0.7 m	Graminae, Empetrum nigrum	Medium Shrub Thicket
6	-	4.0	1.3 to 2.3 m 1.9 m	0.4 m	Graminae	Medium Shrub Thicket
7	-	2.0	1.0 to 2.5 m 1.9 m	0.6 m	Graminae, Empetrum nigrum	Medium Shrub Thicket
8	-	0.3	2.4 m 2.4 m	0.6 m	Graminae	Medium Shrub Thicket
9	-	0.3	1.0 m 1.0 m	0.3 m	Graminae, Empetrum nigrum, Vaccinum vitis-idaea	Dwarf Shrub Meadow
10	-	1.5	0.8 to 2.3 2.0 m	0.5 m	Graminae	edge-Dwarf Shrub Meadow Medium Shrub Thicket
All Nets	-	1.5	0.1 to 3.0 m 1.6 m	0.5 m	Graminae, Empetrum nigrum	

A few noteworthy sightings were recorded at both Gas Rocks and Bible Camp. At Gas Rocks a gyrfalcon (*Falco rusticolus*) nest was observed with young as well as a rough-legged hawk (*Buteo lagopus*) and a bald eagle (*Haliaeetus leucocephalus*) nest with young. A female myrtle warbler (*Dendroica coronata*), with a brood patch, was caught in our mist nets even though there is no boreal forest for about 25 km. At Bible Camp six Emperor geese (*Chen canagica*) were observed on 12 September, while a gyrfalcon returned this year to visit us at least 13 times. Also observed at Bible Camp was a pair of myrtle warblers on 25 August and a rufous hummingbird (*Selasphorus rufus*), which flew into the banding tent and landed on the electric fence on 31 August.

DISCUSSION

Landbird Abundance and Breeding Status

Landbird abundance and breeding status was documented at Gas Rocks through the combined use of mist netting, point counts and incidental observations. Compared to the past two years of the study, 1997 proved to be a better year weather wise for breeding season banding. Without the constraints of bad weather days, balancing time between banding and point counts was not a problem.

This year point counts were given more of a priority then in years past. This year mist netting produced very low capture rates for the amount of time spent banding. Staff felt that more effort in point counts may produce a more representative sample of the surrounding area's avian fauna. The one constraint with points counts, because of our location on the lakeshore, was that we ran out of suitable area to conduct our counts. With the vast openness of the area there was a fear of sampling the same individual birds on neighboring transects. Transportation up and down the lakeshore to new areas was limited by weather. This limited our sample to eight point counts.

Mist netting and banding can provide estimates of relative abundance, for the local area, as well as allowing identification of in-hand breeding characteristics and documentation of less common species with confidence. However, these methods provide information about only a very small geographic area and are probably most useful for longer-term studies with the goal to inventory regional breeding range and habitat use. Inherent requirements of net placement may lead to greater similarity in mist net data between sites than will point count data. Because of the poor capture rate for mist netting, the success of the point counts, and because of the wider sample area of different habitats by point counts, this author continues to recommend that there be an emphasis put on point counts and less emphasis on breeding season banding. It is also recommended that more intensive nest searching be conducted to get a better feel of the breeding status of the local birds.

Habitat Use and Avian Species Composition

Vegetation survey methodology again allowed us to quantify habitat around each net lane. One problem with the system, that was noted at Bible Camp in 1996, was that many of the 1-m squares in the medium shrub thicket often had no woody stems originating in their area. Since canopy density was not collected at that site, habitat type was not immediately evident from the data sheets. Number of woody stems should probably include those crossing through the area as well as those originating within. This situation was not addressed during 1997, but it is felt that before the 1998 project, woody stem analysis should be reconsidered.

Using Kessel's (1979) avian habitat classification system allows broad comparisons with other sites on the peninsula, especially during the breeding season. The most obvious difference between Gas Rocks and the breeding sites in 1995 and 1996, was the overall decrease in bird numbers and species. Beside the low numbers of birds, it was also observed that Gas Rocks had a slightly different species composition then Ruth River and Island Arm. Most obvious was the increased number of hermit thrushes and black-capped chickadees (*Parus atricapillus*) caught at Gas Rocks. Larger areas of continuous medium shrub thicket at Gas Rocks compared to Ruth River and Island Arm is a probable cause of this difference.

Moving the site mid-summer prevented the ability to compare habitat use between the breeding season and fall migration. During migration, geographic features, like peninsulas and lakeshore point, may be more important than habitat for bird movements (Moore 1996, Dewhurst et al. 1996). However, the higher capture rates observed of tree sparrows and savannah sparrows at Bible Camp were somewhat predictable because of the large open areas.

Migration Phenology

Phenology during fall migration appeared relatively consistent with other banding sites on the Alaska Peninsula. Staff began banding on 28 July, nine days earlier than in 1996. We followed last year's suggestion to get to the migration station earlier. The earlier start did seem to affect our capture rates. According to BPIF (Fadley et al. 1995), the essential window for neotropical migrants is 1 August - 20 September, with an optimal seasonal period of 15 July-7 October. If breeding season efforts were focused on point counts, the conflict with migration banding would be eliminated. Point counts are generally not conducted after mid-July, which would allow adequate time to set up a banding operation for migration at a different site.

Staff saw that all the Type A migrants, and most of the Type B migrants had peak migration numbers during the period 02-06 August. This time period is well within our migration banding schedule. It was noticed that some of the Type B migrants and one of the Nearctic migrants (American tree sparrow) had peak migration numbers during the period 28 July to 01 August. This was the beginning of the migration banding season and actual peak numbers for these birds may have been missed. Because of this early peak it is suggested that the migration banding station start around mid July instead of late July. This earlier start will hopefully encompass any migration peaks that happen very early in the migration season. It is also suggested that the migration station be left in the field until at least 15 September. This ending date would hopefully encompass any late migration peaks that would occur, as was seen with a late season peak in American tree sparrows this year.

Another factor influencing efforts during the first half of migration banding was capture rates. Rates were so high, and staff was limited, that the complete net array could not be operated at times. Coverage of the entire net array was kept as consistent as possible; however, when all nets could not be opened we alternated which nets we opened on different days. Staff was increased as suggested from 1996; however, the increase in staff needs to be with previously trained and experienced banders so that it is possible to run the complete net array constantly and not just after the new staff is trained. This would eliminate running half nets and increase capture rates incredibly.

The BPIF Working Group (Fadley et al. 1995) recommended that new migration stations should be run for at least 2 years, and ideally would have a long term commitment of >10 years. Because of high bird numbers and low expense required to operate the station, Bible Camp particularly lends itself to long term study.

RECOMMENDATIONS

1. Bible Camp is recommended for use as a long term fall migration banding station. Fall migration banding would ideally begin by mid-July, with staff increased to at least 6 to 8 during August to allow all nets to be operated.

2. In view of plans to move the breeding season site annually, consideration should be given to de-emphasize banding during the breeding season and concentrating efforts on point counts. This would also allow the staff to move to Bible Camp by mid July.

3. Efforts should be made to key out alders, willows and grasses to species at all mist net sites and the habitat methodology needs to be reevaluated in regards to the woody stem issue.

4. A long term plan should be developed in 1998 for annual locations of the Becharof Lake Ecosystem study area. Targeted sites should take into account both logistical and biological considerations (Appendix III).

ACKNOWLEDGMENTS

Funding for this project was provided through the FWS Bristol Bay/Kodiak Ecosystem Team (Gary Wheeler - Team Leader), Refuge Complex Wildlife Inventory monies, and Earthwatch funds. Field work was conducted by a core team of Biological Technician Corey D. Adler and Refuge Interns Chris Alderete and Kristin Marcell. Assistance was provided by Wildlife Biologists Susan Savage, Subsistence Coordinator Ron Squibb, and Refuge Volunteers Janis Smoke, and Andrea Chatfield. Assistance was also provided by two Earthwatch teams of Beth Shields, Edith Buchon-Hanscom, James Hanscom, Ruth Games, and Erik Neuenschwander, that helped during the peak of migration at Bible Camp. Refuge Pilot Bill Smoke again provided numerous safe and smooth supply flights. Additional flights were provided by Branch River Air, Pen-Air, and C-Air. Many thanks are extended to Steve and Nina Fermen for permission to use the facilities at Bible Camp. No field project would be possible without the support of Refuge Manager Ronald E. Hood, secretarial staff Kim Montano and Cherl Amos, and of coarse, the entire Refuge Complex staff.

LITERATURE CITED

Dewhurst, D. A., T. D. Eskelin, and J. A. Melton. 1995. Passerine breeding and fall migration monitoring at Mother Goose Lake, Alaska Peninsula National Wildlife Refuge, Alaska June-September 1994. U.S. Fish and Wild. Serv., King Salmon, Alas., (Unpubl). 46pp.

_____, B.J. Johnson and N.S. Varner. 1996. A baseline ecosystem study: avian breeding and migration at the Island Arm portion of Becharof Lake, Becharof National Wildlife Refuge, Alaska, June-September 1995. U.S. Fish and Wild. Serv., King Salmon, Alas., (Unpubl). 34pp.

DeSante, D. F. and K. M. Burton. 1994. 1994 MAPS Manual: Instructions for the establishment and operation of stations as part of the Monitoring Avian Productivity and Survivorship Program. The Institute for Bird Populations, Point Reyes Station, CA., (Unpubl). 55 pp.

Eskelin, T. D. and D. A. Dewhurst. 1996. Landbird breeding and fall migration at Mother Goose Lake, Alaska Peninsula National Wildlife Refuge, Alaska, June-September 1995. U.S. Fish & Wildl. Serv., King Salmon, Alas., (Unpubl). 35pp.

Fadley, J., B. Andres, T. Pogson, K. Sowl, C. Sterne and A. Morkill. 1995. Boreal Partners in Flight working group - 1994 annual report. (Unpubl). 42pp.

Hagan, John III, T. L. Lloyd-Evans, J. L. Atwood, and S. Wood. 1989. Longterm changes in migratory landbirds in the northeastern United States: Evidence from migration capture data. Pages 115-130 in J. M. Hagan and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds.

Hulten, E. 1968. Flora of Alaska and neighboring territories - a manual of the vascular plants. Stanford Univ. Press, Stanford, Calif. 1007pp.

Interagency Ecosystem Management Task Force. 1995. The ecosystem approach: healthy ecosystems and sustainable economies. 137 pp.

Kessel, B. 1979. Avian habitat classification for Alaska. Murrelet 60:86-94.

Kienle, J., P.R. Kyle, S. Self, R. J. Motyka, and V. Lorenz. 1980. Ukinrek Maars, Alaska, I. April 1977 eruption sequence, petrology and tectonic setting. J. Volcanol. Geotherm. Res., 7:11-37.

Marcell, K.A. 1997. Small Mammal Mark/Recapture Baseline Surveys, at Gas Rocks-Becharof Lake, Alaska Peninsula/Becharof National Wildlife Refuge Complex, Alaska June-July 1997. U.S. Fish and Wildlife Service, King Salmon, AK, (Unpubl)., 9pp.

Moore, H. 1996. Avian fall migration at Yantarni Sound, Alaska Peninsula National Wildlife Refuge, Alaska, August-September 1995. U.S. Fish & Wildl. Serv., King Salmon, AK, (Unpubl)., 20pp.

Powell, B.H. 1995. The Banding Operations Database, version 2.12. NBS (currently USGS, BRD) Laurel, MD.

Pyle, P., S. N. G. Howell, R. P. Yunick, and D. F. DeSante. 1987. Identification Guide to North American passerines. Slate Creek Press, Bolins, Calif., 278pp.

Ralph, C. J., G. R. Guepel, T. E. Martin, and D. F. DeSante. 1992. Field Methods for monitoring landbirds. U.S. Forest Serv., Arcata, Calif., (Unpubl) 56pp.

Robbins, C. S., J. R. Sauer, R. Greenberg, and S. Droege. 1989. Population declines in North American birds that migrate to the Neotropics. Proceedings from the National Academy of Sciences 86: 7658-7662.

Sauer, J. R., and S. Droege. 1989. Geographic patterns in population trends of Neotropical migrants in North America. Pages 26-42 in J. M. Hagan and D. W. Johnston, eds. Ecology and conservation of Neotropical migrant landbirds.

U.S. Fish & Wildl. Serv. 1985. Becharof National Wildlife Refuge final comprehensive conservation plan, environmental impact statement and wilderness review. U.S. Fish & Wildl. Serv., Anchorage, Alas., 255pp.

APPENDICES

Appendix I. Vascular plants collected or observed at Becharof Lake, Alaska Peninsula, June-September 1995 and 1996. Identification and nomenclature is based on Hulten (1986). IA = Island Arm cabin, RR = Ruth River, BI6 = Bible Camp 1996, BI7 = Bible Camp 1997, GR = Gas Rocks.

ARALIACEAE

Echinopanax horridum, Devil's Club, --IA

ASPIDIACEAE

Gymnocarpium dryoppteris, Oak Fern, --RR

ATHYRIACEAE

Athyrium felix-femina, Lady Fern, --GR

BETULACEAE (Birch Family)

Alnus crispa, Sitka Alder, --IA,RR,BI6,GR
Betula nana, Dwarf Birch, --RR,GR

BORAGENACEAE

Eritrichium chamissonis, Arctic Forget-me-not, --IA,RR,BI6,GR
Myosotis alpestris subsp. asiatica, Alpine Forget-me-not, --GR

CAMPANULACEAE

Campanula lasiocarpa, Mountain Harebell, --IA,RR,BI6,GR

CAPRIFOLIACEAE

Sambucus racemosa, Elderberry, --IA,RR

CARYOPHYLLACEAE (Pink Family)

Cerastium arvense, Mouse-eared chickweed, --IA,RR
Cerastium beeringianum, Bering chickweed, --RR,GR
Minuartia artica, --IA
Minuartia macrocarpa, --RR
Moehringia lateriflora, Grove Sandwort, --RR,GR
Silene acaulis, Moss Campion/Cushion Pink, --IA,RR,BI6,GR
Stellaria laeta, --RR
Honckenya peploides subsp. major, --GR

COMPOSITAE (ASTERACEAE) (Composite Family)
Achillea borealis, Yarrow, --IA,RR,BI6,GR
Antennara monocephala, Pussytoes, --IA,RR,GR
Arnica frigida, Frigid Arnica, --RR
Arnica lessingii subsp. lessingii, --IA,GR
Artemisia arctica subsp. arctica, --RR,GR
Artemisia borealis, --GR
Artemisia globularia, Globular Wormwood, --IA
Artemisia Tilesii, Wormwood, --RR
Aster sibiricus --RR,GR
Chrysanthemum arcticum, --BI6
Chrysanthemum bipinnatum, --GR
Erigeron peregrinus, Coastal Fleabane, --IA,RR
Petasites frigidus, Arctic Sweet Coltsfoot, --IA,RR,BI6
Senecio congestus, Marsh Fleabane, --GR
Senecio pseudo-Arnica, Seabeach Senecio, --IA,RR,BI6,GR
Senecio resedefolius, Ragwort, --IA,RR,GR
Solidago multiradiata, Northern Goldenrod, --IA,GR

CORNACEAE (Dogwood Family)
Cornus canadensis, Bunchberry/Dwarf Dogwood, --IA,GR
Cornus suecica, Swedish Cornel/Dwarf Dogwood, --IA,RR

CRASSULACEAE (Stonecrop Family)
Sedum rosea subsp. integrifolium, Roseroot, --IA,RR,BI6,GR

CRUCIFERAE (Mustard Family)
Arabis lyrata subsp. kamchatica, --IA,GR
Arabis lyrata subsp. lyrata, --RR,GR
Barbarea orthoceras, Wintercress, --IA,RR
Cardamine pratensis, Cuckoo flower, --GR
Rorippa islandica, --GR

CYPERACEAE (Sedge Family)
Carex Lyngbyaei, Lyngby Sedge, --RR
Eriophorum angustifolium subsp. subarcticum, Tall Cottongrass, --IA,GR
Eriophorum Scheuchzeri, White Cottongrass --IA

DIAPENSIACEAE
Diapensia lapponica, Lapland Diapensia, --RR

EMPETRACEAE (Crowberry Family)
Empetrum nigrum, Crowberry, --IA,RR,BI6,GR

EQUISETACEAE (Horsetail Family)
Equisetum arvense, Coastal Horsetail, --IA,RR,GR

ERICACEAE (Heath Family)
Andromeda polifolia, Bog Rosemary, --IA,RR
Arctostaphylos alpina, Alpine Bearberry, --GR
Arctostaphylos uva-ursi, Bearberry, --IA
Cassiope lycopodioides, Alaska Cassiope, --IA
Ledum palustre subsp. decumbens, Labrador Tea, --IA,RR,BI6,GR
Loiseleuria procumbens, Alpine Azalea, --IA,GR
Oxycoccus microcarpus, Bog Cranberry, --IA
Rhododendron camtschaticum, Kamchatka Rhododendron, --IA,RR,GR
Vaccinium uliginosum subsp. microphyllum, Bog Blueberry, --IA,RR,
Vaccinium uliginosum subsp. alpinium, Alpine Blueberry, --GR
Vaccinium vitis-idaea, Lowbush Cranberry/Lingonberry, --IA,GR

GENTIANACEAE
Gentiana algida, --RR,BI6
Menyanthes trifoliata, Bog Bean, --IA
Swertia perennis, Star Gentian, --IA,RR,GR

GERANIACEAE (Geranium Family)
Geranium erianthum, Cranesbill, --IA,RR,GR

GRAMINEAE (Grass Family)
Alopecurus alpinus subsp. alpinus, Mountain Foxtail, --RR
Calamagrostis canadensis subsp. langsdorffi, Bluejoint, --IA
Elymus arenarius subsp. mollis, Lyme grass, --IA,GR
Festuca altaia, --IA
Festuca rubra, Red Fescue, --IA
Poa arctica, Arctic Bluegrass, --IA

HALORAGACEAE
Hippurus sp. Marestail, --RR

IRIDACEAE (Iris Family)
Iris setosa subsp. setosa, Wild Flag, --IA,GR

LEGUMINOSAE (Fabaceae) (Pea Family)
Lathyrus maritimus subsp. pubescens, Beach Pea, --IA,RR,GR
Lupinus nootkatensis, Nootka Lupine, --IA,RR,BI6,GR
Oxytropis campestris, Field Oxytrope, --IA
Oxytropis nigrescens, Purple Oxytrope/Blackish Oxytrope, --RR,GR
Oxytropis maydelliana, --GR

LENTIBULARIACEAE (Bladderwort Family)
Pinguicula vulgaris, Butterwort, --RR

LILIACEAE (Lily Family)
Fritillaria camschatcensis, Chocolate Lily, --IA,RR,GR
Lloydia serotina, Alp Lily, --RR
Streptopus amplexifolius, Wild Cucumber, --IA
Tofieldia coccinea, False Asphodel, --RR,GR
Allium schoenoprasum, Wild Chive, --GR

MYRICACEAE (Wax Myrtle Family)
Myrica gale, Sweet Gale, --IA

ONAGRACEAE (Evening Primrose Family)
Epilobium augustifolium, Fireweed, --IA,RR,BI6
Epilobium behringianum, Bering Willow-herb, --RR
Epilobium latifolium, Dwarf Fireweed/River Beauty, --IA,RR,BI6,GR
Epilobium glandulosum, --GR
Epilobium palustre, --GR
Epilobium sertulatun, --GR

ORCHIDACEAE (Orchid Family)
Coeloglossum viride subsp. bracteatum, --RR

PAPAVERACEAE (Poppy Family)
Papaver alaskanum, Alaska Poppy, --IA,RR
Papaver alboroseum, Corn Poppy, --IA,GR
Papaver lapponicum, Alpine Poppy, --GR

PLUMBAGINACEAE (Leadwort Family)
Armeria maritima subsp arctica,Thrift, --IA,RR,BI6

POLEMONIACEAE (Polemonium Family)
Polemonium acutiflorum, Tall Jacob's Ladder, --IA,RR,GR
Polemonium pulcherrimum, Pretty Jacob's Ladder, --IA,GR

POLYGONACEAE (Buckwheat Family)
Polygonum caurianum, --RR
Polygonum pennsylvanicum, --RR
Polygonum vivparum, Alpine Meadow Bistort, --IA,GR
Rumex arcticus, Arctic Dock, --IA,RR,BI6,GR

PORTULACACEAE (Purslane Family)
Claytonia chamissoi, Toad Hilly--RR
Claytonia sarmentosa, Spring Beauty--RR

PRIMULACEAE (Primrose Family)
Androsace chamaejasme subsp. Lehmanniana, Rock Jasmine, --IA,RR,GR
Primula cuneifolia subsp. saxifragifolia, Pixie eyes, --RR
Trientalis europaea subsp. arctica, Starflower, --IA,RR,GR

PYROLACEAE (Wintergreen Family)
Pyrola asarifolia, Pink Pyrola/Wintergreen, --IA,RR,GR

RANUNCULACEAE (Crowfoot Family)
Aconitum delphinifolium subsp. chamissonianum, Monkshood, --IA
Aconitum delphinifolium subsp. delphinifolium, Monkshood, --RR,GR
Caltha palustris, Marsh Marigold, --IA,GR
Ranunculus confervoides, --GR
Ranunculus reptans, --RR
Thalictrum sparsiflorum, Few Flower Meadowrue, --IA

ROSACEAE (Rose Family)
Dryas octopetala subsp. octopetala, Mountain Avens, --IA,RR,GR
Geum macrophyllum, subsp. macrophyllum, Large-leaf Avens, --RR
Geum Rossii, Yellow Avens, --IA,RR
Luetkea pectinata, Alpine sperea, --RR
Potentilla Egedii subsp. Egedii, --IA
Potentilla norvegica, Norwegian Cinquefoil, --GR
Potentilla palustris, Marsh Fivefingers, --IA,RR,GR
Potentilla uniflora, One-Flowered Cinquefoil, --GR
Rubus arcticus subsp. stellatus, Nagoonberry, --IA,RR,BI6,GR
Rubus chamaemorus, Cloudberry, --IA,RR
Sanguisorba stipulata, Burnet, --IA,RR
Spirea Beauverdiana, Alaska Spiraea, --IA,RR,GR

RUBIACEAE (Madder Family)
Galium boreale, Northern Bedstraw, Alaskan Baby's Breath, --IA

SALICACEAE (Willow Family)
Salix arctica subsp. crassijulis, Arctic Willow, --RR
Salix glauca subsp. acutifolia, Grayleaf Willow, --IA
Salix phlebophylla, --RR

SAXIFRAGACEAE (Saxifrage Family)
Chrysoplenium Wrightii, Northern Water Carpet, --IA,GR
Heuchera glabra, Alpine Heuchera, --IA,RR
Parnassia palustris subsp. neogaea, Northern Grass-of-Parnassus, --IA,GR
Saxifraga bronchialis subsp. Funstonii, Spotted Saxifrage, --IA,RR,GR
Saxifraga hirculus, Bog Saxifrage, --IA,RR,BI7
Saxifraga nivalis, Snow Saxifrage, --RR
Saxifraga oppositifolia subsp. oppositifolia,
Purple Mountain Saxifrage, --RR
Saxifraga punctata, subsp. Nelsoniana, Cordate-leaved Saxifrage, --RR
Saxifraga serpyllifolia, Thyme-leafed Saxifrage, --IA,RR
Saxifraga unalaschcensis, Unalaska Saxifrage, --RR

SCROPHULARIACEAE (Figwort Family)
Lagotis glauca subsp. glauca, Weasel Snout, --IA,RR
Limosella aquatica, Mudwort, --GR
Mimulus guttatus, Yellow Monkey Flower, --IA,RR,GR
Pedicularis capitata, Capitate Lousewort, --IA,RR,GR
Pedicularis Kanei, Kane Lousewort, Wooly Lousewort --IA,GR
Pedicularis labradorica, Labrador Lousewort, --IA
Pedicularis langsdorffii, Langsdorf Lousewort, --RR
Pedicularis parviflora, --IA
Pedicularis verticillata, Bumble bee Flower, --IA,RR,GR
Rhinanthus minor subsp borealis, Rattlebox, --IA,RR
Veronica america, Brooklime, --GR

THELYPTERIDACEAE (Marsh Fern Family)
Thelypteris phegapteris, Marsh Fern, --GR

UMBELLIFERAE (APIACEAE) (Parsley Family)

Angelica lucida, Wild Celery, --IA,RR,BI6
Bupleurum triradiatum subsp. arcticum, Thoroughwax, --BI7
Cicuta mackenzieana, Mackenzie (Poison) Water Hemlock, --IA
Heracleum lanatum, Cow parsnip, --IA,RR,BI6
Ligusticum scoticum, Beach Lovage, --IA

VALERIANACEAE (Valerian Family)

Valeriana capitata, Capitate Valerian, --IA,GR

VIOLACEAE (Violet Family)

Viola epipsila, Marsh Violet, --GR
Viola Langsdorffii, Alaskan Violet, --IA,RR

Appendix II. Summary of avian observations at Becharof Lake, June-September 1997. Observations prior to 07/21/97 were at or around Gas Rocks; later observations were made at or around Bible Camp.

Species	Date First Observed	Date Last Observed	No. Days Observed	Peak Count and Dates	Breeding Status*
Red-throated Loon	01-Jul	31-Aug	23	8 on 03 August	O
Common Loon	24-Jun	10-Sep	37	10 on 10 September	X
Horned Grebe	13-Aug	24-Aug	7	5 on 20 August	O
Red-necked Grebe	16-Aug	12-Sep	9	2 on 08 August; 09,10 September	O
Double-crested Cormorant	09-Jun	12-Sep	46	200+ on 10 September	X
Pelagic Cormorant	21-Aug	30-Aug	3	3 on 30 August	O
Tundra Swan	10-Jun	10-Sep	13	4 on 8,23,31 August; 8,10 September	CR
White-fronted Goose	30-Jul	17-Aug	5	50 on 10,17 August	O
Emperor Goose	12-Sep	12-Sep	1	6 on 12 September	O
Green-winged Teal	10-Jun	13-Sep	6	12 on 12 September	O
Mallard	16-Jun	29-Jun	3	4 on 16 June	X
Northern Pintail	07-Jun	17-Jul	13	7 on 27 June	CR
American Wigeon	12-Jun	17-Jul	6	2 on 12, 13 June	O
Greater Scaup	07-Jun	23-Aug	23	50 on 16,17 June	CE
Harlequin Duck	28-Jun	03-Sep	3	6 on 03 September	CR
Black Scoter	06-Jun	14-Aug	25	30 on 06 June	PO
White-winged Scoter	17-Jun	28-Jun	2	25 on 28 June	PO
Red-breasted Merganser	06-Jun	13-Sep	49	30 on 12 September	CR
Common Merganser	08-Jun	01-Aug	4	5 on 17 June	PO
Bald Eagle	06-Jun	14-Aug	37	5 on 28 June	CR
Northern Harrier	11-Jun	10-Sep	13	2 on 21 August	X
Rough-legged Hawk	19-Jun	11-Sep	14	2 on 20,25,28 June	CY
Merlin	13-Aug	19-Aug	5	1 on 13,14,15,16,17,18,19 August	O
Gyrfalcon	21-Jun	10-Sep	13	3 on 14 July	X
Willow Ptarmigan	06-Jun	13-Sep	35	55 on 31 August	CR
Sandhill Crane	22-Jun	08-Sep	16	2 on 05 August	PO
Black-bellied Plover	22-Jul	22-Aug	13	15 on 04,22 August	O
Lesser Golden Plover	24-Aug	13-Sep	8	6 on 11 September	O
Semipalmated Plover	06-Jun	05-Sep	40	15 on 01 August	CR
Greater Yellow Legs	06-Jun	08-Sep	42	10 on 06 June and 10 July	PA
Spotted sandpiper	03-Aug	10-Aug	4	3 on 03 August	O
Whimbrel	01-Aug	13-Sep	12	25 on 22 August	O
Black Turnstone	21-Jul	13-Sep	13	20 on 08 August	O
Surfbird	21-Aug	21-Aug	1	1 on 21 August	O
Sanderling	06-Sep	06-Sep	1	1 on 06 September	O
Least Sandpiper	11-Jun	14-Aug	20	17 on 28 June	CE
Rock Sandpiper	03-Aug	03-Aug	1	18 on 03 August	O
Short-billed Dowitcher	01-Aug	01-Aug	1	30 on 01 August	O
Common Snipe	09-Jun	17-Jul	21	6 on 04 July	PO
Red-necked Phalarope	13-Jun	27-Jun	3	2 on 13 June	PO
Parasitic Jaeger	25-Jun	29-Aug	7	2 on 27 June and 08 August	O
Mew Gull	13-Jun	13-Sep	38	10 on 06,07,17 July	X
Glaucous-winged Gull	07-Jun	13-Sep	84	500+ on 09,18 July	CY
Black-legged Kittiwake	02-Aug	08-Aug	3	2 on 08 August	O
Arctic Tern	28-Jul	13-Aug	6	50 on 08 August	O
Short-eared Owl	03-Aug	03-Aug	1	1 on 03 August	X

Appendix II (cont.). Summary of avian observations at Becharof Lake, June-September 1997.

Species	Date First Observed	Date Last Observed	No. Days Observed	Peak Count and Dates	Breeding Status
Rufous Hummingbird	03-Aug	31-Aug	1	1 on 31 August	O
Belted Kingfisher	01-Aug	05-Aug	2	1 on 01,02,03,04,05 August	O
Tree Swallow	06-Jun	02-Jul	27	50+ on 08,09,10 June	X
Bank Swallow	10-Jun	30-Jul	8	100 on 10 June	CO
Black-billed Magpie	06-Jun	09-Sep	17	2 o 06,10 June and 01 July	X
Common Raven	10-Jun	13-Sep	29	8 on 12 September	PO
Black-capped Chickadee	11-Jun	13-Sep	26	12 on 13 September	X
Ruby-crowned Kinglet	11-Sep	11-Sep	1	1 on 11 September	O
Gray-cheecked Thrush	07-Jun	28-Aug	11	5 on 31 July	PT
Hermit Thrush	06-Jun	28-Jul	37	25 on 03 July	PT
American Robin	07-Jun	11-Sep	41	20 on 01 September	CN
American Pipit	21-Jun	12-Sep	37	40 on 17,20 August	X
Northern Shrike	10-Jun	12-Sep	27	8 on 06 August	PO
Orang-crowned Warbler	07-Jun	06-Jul	19	14 on 16 June	PT
Yellow Warbler	07-Jun	10-Aug	22	15 on 16 June	CR
Wilson's Warbler	10-Jun	16-Aug	21	12 on 04 July	CR
Northern Waterthrush	12-Aug	20-Aug	2	1 on 12,20 August	O
Myrtle Warbler	28-Jun	25-Aug	2	2 on 25 August	X
American Tree Sparrow	13-Jun	09-Sep	19	15 on 22 June	CR
Savannah Sparrow	10-Jun	30-Aug	39	35 on 22,29 June	X
Fox Sparrow	07-Jun	08-Aug	23	10 on 16,28 June	CY
Golden-crowned Sparrow	02-Jul	18-Jul	15	19 on 03 July	PT
Gambel's White-crowned Sparrow	15-Jun	27-Aug	9	5 on 20,25 June	X
Lapland Longspur	10-Jun	14-Aug	17	12 on 16 June	CY
Common Redpoll	09-Jun	13-Sep	46	30 on 01 September	X

* Key to Breeding Status:

O = Observed/ non-breeding
X = Possibler Breeder
PO = Pair Observed
PC = Courtship
PT = Permanent Territory
CR = Recently Fledged Young
CO = Occupied Nest
CE = Nest w/ Eggs
CY = Nest w/ Young
PA = Agitated Behavior
CN = Carrying Nesting Materials