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Memorandum 27 September, 1991

TO: Stan Senner
Restoration Program Mgr.

FROM: Kathy Kuletz
Migratory Bird Management

SUBJECT: Report on 1990 Pilot Restoration Murrelet Study

Enclosed is the final report on Restoration Feasibility Study Number 4, Identification of Upland Habitats Used by Wildlife Affected by the EVOS: Marbled Murrelets. This fulfills the obligations of the cooperative agreement for FY 1991 funds for this project, to which ADF&G contributed $13,500.

Copies of this report can be made available on request. I have already provided copies to Paul Gertler (OOS) and Kent Wohl (MBM). Thank you again for your support and the review of the preliminary draft.

Kathy Kuletz

cc: Sandy Rabinowitch
Carol Gorbics

LITIGATION SENSITIVE

Study Title: Restoration Feasibility Study Number 4

Identification of Upland Habitats Used by Wildlife Affected by the EVOS: Marbled Murrelets

Lead Agency: U.S. Fish & Wildlife Service

Final Report

27 September, 1991

Kathy Kuletz
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I. STUDY TITLE

Identification of Upland Habitats Used by Wildlife Affected by the EVOS

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III. EXECUTIVE SUMMARY

The Restoration Planning Work Group identified protection of upland habitats as a potential way to assist the natural recovery of species which depend on upland habitats for some stage of their life. To fulfill this objective, planning agencies need specific information on habitat requirements of species affected by the Exxon Valdez Oil Spill (EVOS). Restoration Feasibility Study Number 4 was a pilot study to determine the potential for establishing the appropriate data base. This report presents results from the marbled murrelet (Brachyramphus marmoratus) portion of the project.

The marbled murrelet is a diving seabird that nests inland in trees and on the ground. Little is known about its nesting habitat requirements in Alaska. Naked Island, in central Prince William Sound, was the study site for the marbled murrelet pilot study. To monitor upland activity of murrelets the "dawn watch" method was attempted. The "intensive" dawn watch was found to be effective under remote Alaskan conditions. The observer recorded murrelets flying overhead or into trees at dawn, when birds fly inland to their nests. A total of 53 watches, including 6 at dusk, was conducted between 9 June and 18 August at 22 sites. A total of 2,250 "detections" (the visual or auditory observation of 1 or more murrelets) was made.

Murrelet activity patterns were similar to those reported in the southern portion of its range, with the majority of detections occurring 30 minutes before and after dawn. No activity was recorded during "dusk watches." There was variability within and among sites, but in general, detections peaked in late July and declined rapidly after 10 August. Behavioral observations were used as indicators to distinguish between an area's probable use as a nesting site as opposed to a flight corridor.

Seven sites were visited more than once to obtain information on variability and seasonal patterns and to try and locate nesting sites. Although no nests were found we were able to map several stands of trees with high activity levels, indicating a semi-colonial nesting distribution. In areas with high activity, multiple observers were used to focus on potential nest sites. This method narrowed down the search areas for several nests, and on two occasions murrelets were observed to land in trees. Now that these sites have been located, searches could begin during incubation in 1991 (late May to late June), with a high probability of success at finding active nests.

Habitat parameters were recorded in the field and taken from topographic maps and aerial photos. For nine stations, mainly in the South Cabin Bay drainage, fine-scale habitat classification was provided for three sample areas by the U.S. Forest Service. Among the five polygons in the main study area, murrelets flew most frequently into two areas with steep slopes facing west, and 70-80% cover of Hemlock old-growth. For all the watch stations combined, a cursory review of this small sample suggested greater murrelet use of inland areas at the heads of bays as opposed to the outer peninsulas. Slopes facing northwest, west or southwest may have greater use than slopes facing north, northeast or southeast on Naked Island. Open bog meadows, especially at the heads of bays, appeared to be used as flight corridors to upper wooded areas and as "display arenas" by birds using surrounding hillsides.

IV. INTRODUCTION

Marbled murrelets are diving seabirds that breed along the eastern Pacific from Northern California to Alaska. In 1990 the Canadian government listed them as a threatened species in British Columbia. They are currently being considered for threatened or endangered status along Washington, Oregon and California. An estimated 95% of the total population in U.S. waters occurs in Alaska, with Prince William Sound second only to Southeast Alaska in murrelet abundance (Mendenhall 1988). Murrelets were subject to direct mortality from the 1989 oil spill, and proportionally more were killed relative to their numbers at risk (Piatt et al. 1989). In Prince William Sound itself, marbled murrelets comprised 12% of all seabirds killed in the Exxon Valdez oil spill. Direct mortality probably affected the wintering population of marbled murrelets in the Sound (estimated at 25,000), which is only about 20% of the summer breeding population (between 80,0000-101,000) (K.Laing, pers. comm.). In contrast, murrelet numbers in Kodiak are higher in the winter than in summer (Zwieflelhofer and Forsell, 1989), and murrelets wintering there may also have been exposed to the spill.

Full analysis of boat survey data (NRDA Bird Study 2) is not available to date to determine if there has been significant injury on the population level. There is some indication, however, that in March surveys there was a greater decline in the oiled areas than in unoiled areas (K. Laing, pers. comm.). Summer surveys suggest that displacement from nearshore areas occurred in 1989, possibly from human disturbance (S.Klowsewski, pers.comm., Kuletz, unpubl. data). In addition there is evidence of petroleum hydrocarbon contamination of marbled murrelets collected in the oiled areas, whereas murrelets collected north of the spill zone had not been exposed (Kuletz 1991). The latter could have long-term consequences for marbled murrelets in the Sound.

Preservation of breeding habitat would assist the natural recovery of the murrelet population, and protect it from a second adverse impact. Unlike most other seabirds, it is not possible to locate conspicuous sites being used by large numbers of nesting birds within a region. Murrelets are secretive and widely scattered during the breeding season. At lower latitudes, the birds are known to nest in trees and have a strong preference for old-growth habitat: i.e., large trees with epiphytes and an open understory (Marshall 1988). However, in Alaska, it is not known whether these birds have the same requirements for nesting habitat. A tree nest was found in southeast Alaska in an old-growth stand of mountain hemlock (Quinlan and Hughes 1990). Anecdotal information indicates that marbled murrelets will nest in trees in southcentral Alaska, but the only documented nest sites found to date have been on the ground. The purpose of this study was to develop information which could be used to identify terrestrial sites critical to breeding marbled murrelets in southcentral Alaska.

The basic methods used in this study were developed in Oregon and California (Nelson 1989, Paton et al. 1990). These methods depend on an extensive road system, large numbers of observers and minimal logistical complications. A primary consideration in this study was testing and adapting the methodology under remote Alaskan conditions. Further, it had not been determined if murrelets at higher latitudes would have the same diel activity patterns evident in the southern portion of its range.

Ongoing damage assessment studies (NRDA Bird Study 6 and 9) on Naked Island provided a base from which to conduct a pilot study on monitoring marbled murrelet breeding activity. With funds from the NRDA restoration program, an extra field technician, equipment and supplies were added to assist in the project.

Study Site

The study site is part of the Chugach National Forest, in Prince William Sound, Alaska. Previous field studies on Naked, Storey and Peak Islands have indicated tht the estimated murrelet population is about 3,000 birds (Oakley & Kuletz 1979). Except for a few Kittlitz's murrelets (Brachyramphus brevirostris) sighted in early June, all identified murrelets were marbled murrelets. The island is relatively small (Fig. 1a) and isolated from the mainland and large islands. It was a common occurrence to hear murrelets flying over camp, suggesting upland nesting (Kuletz, unpubl. data). It was postulated that these factors would make Naked Island a good location to study marbled murrelet nesting activity in Prince William Sound.

Naked Island has four major bays which face north, south, southwest and west, and a channel to the north between it and two smaller islands, Storey and Peak. Since 1982, it has been the site of an active spring Pacific herring fishery. Except for a summer homestead on Peak Island, the islands are uninhabited. There are nine peaks or ridges over 165 m, with the highest at 405 m. There are small outcrops of shale but no dry alpine areas. Sitka spruce, western hemlock and mountain hemlock are the dominant overstory. The conifers range from shrub size in the meadows to about 24 m in the study areas used in 1990 (based on aerial analysis of sample trees at these sites). Alder and willow line the shoreline and are found in the patchwork of mixed conifer/bog meadows.

V. OBJECTIVES

A. Develop and test methods for establishing the presence of breeding birds.

B. Develop and test methods for locating nest sites.

C. Identify and characterize nest habitats and sites.

D Define the parameters of, and develop a proposal for, a full-scale upland habitat study for marbled murrelets.

E. Determine the costs of implementing a full-scale restoration project protecting upland habitats used by marbled murrelets.

VI. METHODS

Objective A: Develop and test methods for establishing the presence of breeding birds.

The Dawn Watch Method

The presence of murrelets inland has been documented in the southern portion of their range using the "dawn watch" (Nelson 1989, Paton et al. 1990). Murrelets visit their nests from May through August to exchange incubation duties and feed their one chick. They can be heard and seen flying inland at dawn, and to a lesser extent, sunset. Official dawn time for this study was obtained from the

Federal Aviation Administration Office at Kenai, Alaska, and originates from the Nautical Almanac Office, U.S. Naval Observatory, Washington D.C., in the table for Latitude 60° 34′ W, Longitude 151° 15′ W. From 9 June to 18 August, the duration of this study, official dawn ranged from 0334 to 0523 hours. Watches began at least 45 min before official dawn, and in some cases began 90 min before dawn. The starting time for the dawn watches ranged from 0238 to 0440 h. The watches were completed 75 min after official sunrise, plus 15 min past the last detection. During the watch, an observer described into a tape recorder murrelet numbers, flight directions, altitude and behavior.

Three watch types have been used in Oregon and California: 1) transects, whereby an observer travels along a line, (usually in a car), stopping 10 min at each "station" a given distance apart; 2) a grid system, whereby an observer rotates among 4 points on a grid, with each substation 50-100 m apart, staying at each substation about 20 min. This is best done in areas with open understory; 3) intensive surveys, whereby the observer remains at one station during the entire dawn watch. The first two methods were each tried twice and rejected for the Naked Island area. Traveling in rough terrain is slow and noisy and interferes with observations, and results are biased for the location the observer is monitoring at dawn. Thus, all the data reported here were derived from the 47 intensive (stationary) dawn watches.

Types of Detections

Observers spent two-four dawn watches with the principal investigator to become familiar with the recording protocol, murrelet calls and flight patterns. Following the dawn watch, the observer transcribed the tape recording onto a field data form (Appendix A). A "detection" is defined as the visual or auditory observation of one or more murrelets acting in a similar manner at a given point in time (Nelson 1990).

The types of detections fall into three basic categories: 1) audio, where only vocalizations are used to determine presence, directions, behavior and estimated number of birds; 2) visual, where the murrelet is seen but is silent. These observations provide a more exact description of flight behavior and number of birds; 3) both audio and visual, where an observed bird is vocalizing. Additional categories we eventually added were: 4) stationary calls, coming from the trees; 5) wing beats, made by birds landing but not usually seen; 6) "jet" sounds, a distinctive dive-bombing maneuver which is heard, but not seen. These latter three categories were also added, independently, by researchers in Oregon and California.

For comparison among sites, detections were also organized by behavior whenever possible. The range of behaviors are, in order of their degree of association with the immediate area: 1) landing in trees or making stationary calls; 2) circling below the canopy; 3) flying through the station below canopy; 4) circling above the canopy; 5) flying overhead high above canopy; 6) flying or heard at a distance >200 m from the station's center (i.e. the observer). The first three behaviors may be indicators of nearby nesting activity.

Site Selection

Seven sites were arbitrarily chosen within 2 km of camp (Fig. 1b), such that stations were at least 500 m apart and were laid out in a grid pattern to the north, south and east of camp in South Cabin Bay. At stations 2 and 8, 'substations' were established within 100 m from the original center. This was done to facilitate viewing and/or monitoring a suspected nest site. Station

Fig. 1a. Location of Naked Island in Prince William Sound, Alaska.

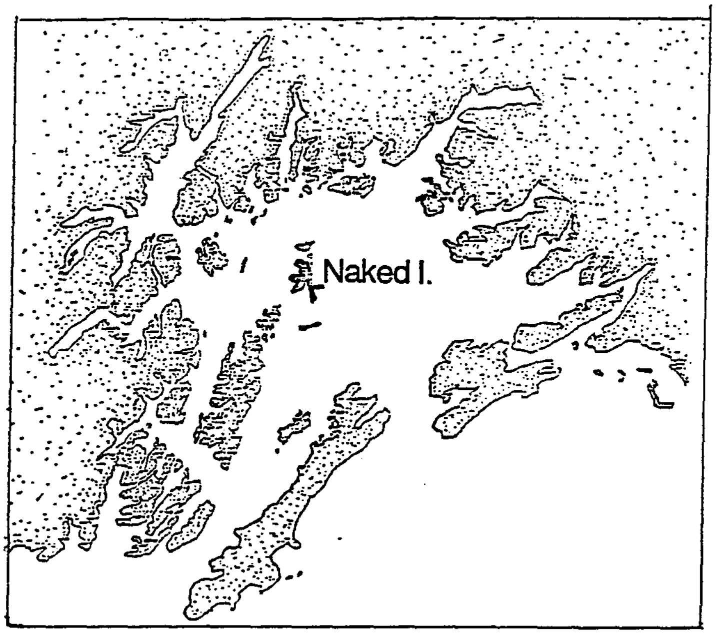
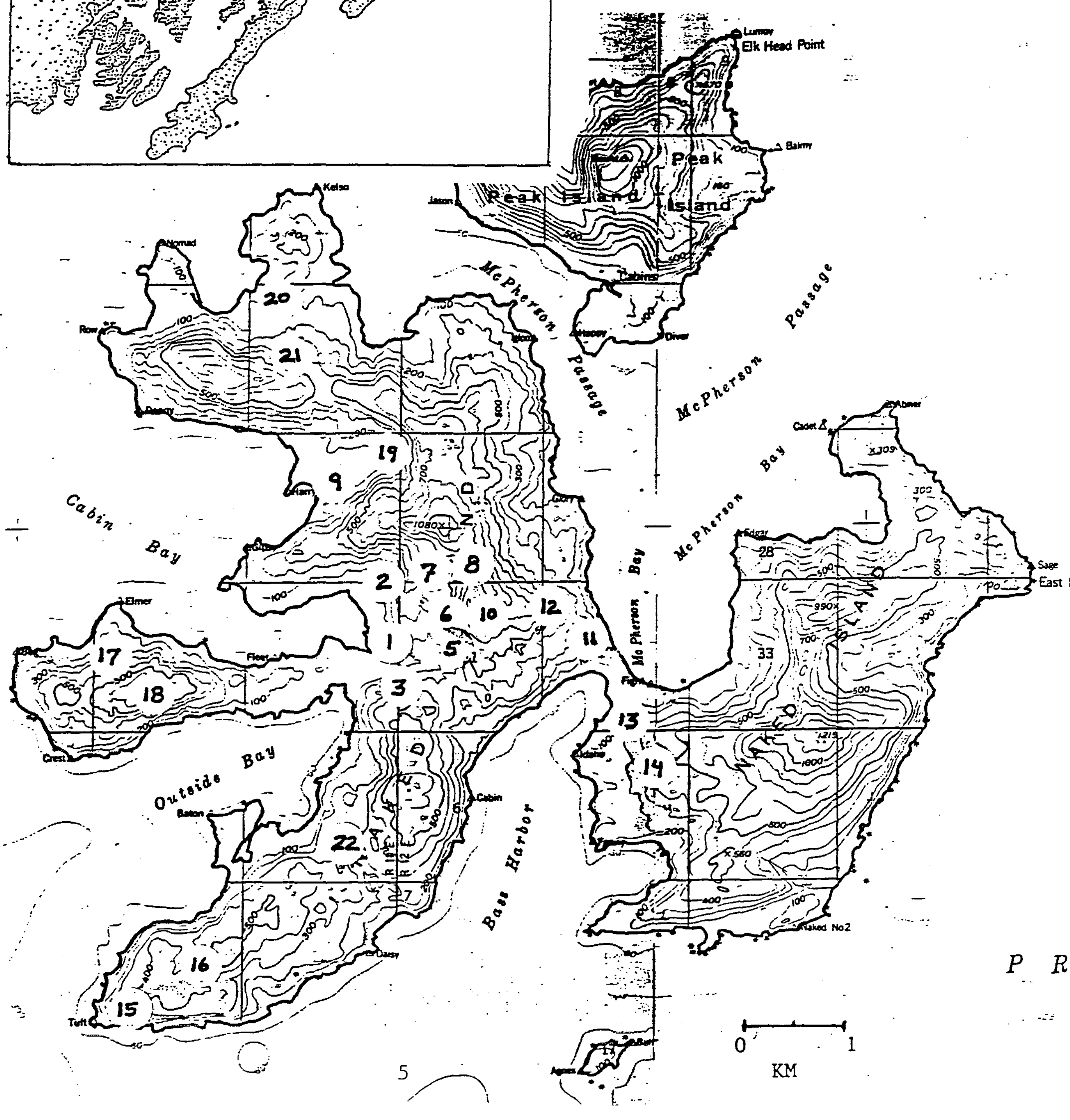


Fig. 1b. Location of dawn watch sites on Naked Island in 1990.



centers were located such that they had a minimum of 50% view (see Nelson 1989). Stations were field marked with flagging and metal tags during the day and marked on aerial photos. These stations were visited several times during the season (x = 4.3, range 2-9) to obtain variances and seasonal patterns within an area. Getting to the sites before dawn became more difficult under poor weather conditions and as the season progressed, when light levels were lower prior to dawn. Eventually, on-site camping was resorted to even for sites near camp.

Another set of stations was used to try methods which might apply to more temporary remote sites. We wanted to test the efficacy of a near-shoreline (coastal) station as an indicator of murrelet use further inland. These sites were scattered around the island, primarily the west side (Fig. 1b). They were visited once, and required on-site camping by an observer delivered to a beach by Zodiac. The observer spent two nights in the area. The first dawn, the observer established a station approximately 200 m from the shoreline. For the second dawn watch the observer moved inland, usually between 500-1000 m (flight distance) from the first site and at higher elevation. The data set thus consisted of seven paired sites, with South Cabin Bay represented by site 1 as coastal and site 6, inland (selected because site 6 was only visited once). To test for a correlation between coastal and adjacent inland sites, the seven paired sites were then ranked (by number of detections) and tested for significance with a Spearman's rank correlation.

Objective B: Develop and test methods for locating nest sites.

Once areas of murrelet activity were located, a more intensive "ground search" method was employed to narrow down potential nest sites within a slope or tree stand. These methods basically followed those outlined by Naslund et. al.(1990). Two or more observers worked together to "stake out" a clump of trees during a dawn watch to determine if birds flying into the trees were passing through en route to other stands or actually stopping in the immediate area. Eventually the multiple observers focused on individual trees. The next step would have been to focus on specific branches. The silent and fast approach of the birds going into a nest in low light necessitate this intensive approach (Nelson, pers. comm.). At Naked Island, a modified ground search technique was used on six occasions. Due to time constraints, a full scale effort could not be made, and only three of these stake-outs went beyond isolating a clump of trees.

Objective C: Identify and characterize nest habitats and sites.

Describing Habitat

Aerial photos of Naked Island, provided by the U.S. Forest Service (USFS), were used to assist in station location and in classifying habitat. Some features of the stations could be obtained from topographic maps: e.g., drainage system, slope degree and aspect, elevation and distance from the water. On-site field notes and photographs were also used to describe habitats, tree stands and individual trees of interest.

Aerial photos were also used to define habitat at selected sites where stations were located. The USFS Forestry Science Lab used an Analytical Plotter 190 (AP) to analyze 10 habitat-defined polygons in three study areas (Appendix B). The analysis provided perimeter and area of the polygon, dominate cover type, percent cover and average tree height in areas near nine stations, seven of which were in the South Cabin Bay drainage. Within these areas, 13 transects were used to determine slope incline (% grade) and aspect (Appendix D). In study area 2, which had five polygons analyzed by AP, I outlined an additional seven polygons from vegetation features evident on the aerial photographs. The main focus of our efforts were thus in Study area 2, (South Cabin Bay drainage) which was divided on an aerial photograph into 12 vegetation polygons, 5 of which had been analyzed by AP.

Determining Murrelet Use of Areas

The total number of detections includes both audio and visual detections, which were used to measure the level of murrelet activity in an area. The average number of detections per watch was calculated for each station (Table 1). Stations were then categorized for general orientation (Table 2) and location (Table 3), i.e., bay head or outer peninsula. The average number of detections within each category was derived from the station's averages.

Detections less than 200 m from the observer were considered "near" station (most of these were actually less than 100 m). Detections 200 meters or more from the observer were considered "far." Many of the detection records had flight directions. Where final flight direction was known, the estimated distance and location of the murrelet's last sighting was plotted on mylar sheets overlaid on aerial photos. An obvious problem with this method is that the birds could have been continuing on to another area. The data cannot be statistically tested, but were used as a relative measure of general activity into an area or habitat. For some compilations, detections with no recorded final direction were included if they had behaviors such as circling below canopy, stationary calling from trees, wing beats and jet sounds.

Locating Murrelet "Documented Use Sites"

Defining nesting habitat for murrelets requires a finer measure than general activity level in an area. The term "documented use site" is used to define a site where (1) evidence of a nest has been found, such as eggshells or a chick on the forest floor, or (2) specific types of sightings and murrelet behavior have been observed nearby. The latter relies primarily on visual sightings, with flight below canopy level indicating potential for nesting activity in the immediate vicinity. Other observations included in this category are wingbeats, jet sounds and stationary calling from trees. A data set consisting of these behaviors was pulled from the total detections to determine the potential for locating nesting sites at each station.

Objective D: Define the parameters of, and develop a proposal for, a full-scale upland habitat study for marbled murrelets.

Information obtained from this pilot study was used to develop a proposal for an upland habitat study for marbled murrelets (Appendix E). The proposal incorporated information gained in 1990 from researchers studying marbled murrelets in other regions as well.

Objective E: Determine the costs of implementing a full-scale restoration project protecting upland habitats used by marbled murrelets

An operating budget was developed for a one-year study in 1991 (Appendix E). However, a multi-year approach will be necessary to produce guidelines appropriate for management and/or acquisition of lands for restoration planning.

Table 1. Summary of dawn watch stations at Naked Island, Prince William Sound, 1990, with location, total and average number of detections per watch, percent of those detections near the station (% Near Site) and habitat information.

Station	Drainage	N of watches	Total Detections	Detections per watch	% Near Site	Slope Aspect	Meters From Water	Elevation (M)
001	S. CABIN BAY	5	232	46	5	270	300	30
002	S. CABIN BAY	11	786	71	34	225	300	46
003	INNER OUTSIDE BAY	3	113	38	60	225	350	30
005	S. CABIN BAY	4	160	40	40	270	750	61
006	S. CABIN BAY	1	24	24	50	225	900	152
007	S. CABIN BAY	4	192	48	14	225	600	122
008	S. CABIN BAY	3	183	61	37	225	1000	213
009	N. CABIN BAY	1	40	40	50	270	300	15
010	S. CABIN BAY	1	77	77	0	225	1000	189
011	BASS HARBOR	1	37	37	0	135	150	30
012	MCPHERSON BAY	1	2	2	0	135	450	137
013	MCPHERSON BAY	1	76	76	0	315	300	46
014	BASS HARBOR	1	112	112	45	225	600	91
015	TUFT PT. AREA	1	26	26	0	225	150	76
016	OUTSIDE BAY	1	4	4	0	315	300	137
017	S. CABIN BAY	1	21	21	0	315	300	76
018	S. CABIN BAY	1	1	1	0	360	500	168
019	N. CABIN BAY	1	61	61	33	225	800	30
020	BOB DAY BAY	1	64	64	1	315	300	46
021	LILJEGREN PASSAGE	1	34	34	2	45	900	91
022	OUTSIDE BAY	1	5	5	0	270	300	76

Table 2. Murrelet detections relative to orientation of dawn watch stations at Naked Island, Prince William Sound, Alaska, in 1990. The percent of Near visual detections is taken from visual detections at those stations, and does not include detections that were audio only.

Direction	Number of Stations	Ave.No.of Detections per Watch	Min No. of Detections	Max No. of Detections	% Near of Visual Detections
N	1	1	1	1	0
NE	1	34	34	34	0
E	.	.	.	.	.
SE	2	19	2	37	0
S	.	.	.	.	.
SW	9	58	24	112	30
W	4	38	5	46	23
NW	4	41	4	76	0

Table 3. Murrelet detections at dawn watch stations relative to bays and land forms on Naked Island.

Land Form	No. of Stations	No. of Watches	Ave. No. Detections	S.D.	% Near of Visuals
bay head	07	23	53	17	32
inland of bay head	10	18	46	33	32
outer peninsula	04	04	13	12	00

Budget estimates for a multi-year project will be made following the 1991 field season.

VII. RESULTS

Objective A: Develop and test methods for establishing the presence of breeding birds.

Time of day

Murrelet detections were made as early as 75 min prior to and as late as 90 min after dawn. The majority of birds were active inland from 30 min prior to and after official dawn (Fig. 2a). Numbers of birds peaked within 10 min of dawn and declined afterward. There was no obvious difference in distribution of murrelet activity between early-season and late-season watches (Fig 2b). During the six dusk watches, no murrelets were detected. On two extremely foggy evenings, however, murrelets were heard circling over camp for more than an hour. Similar behavior was noted over camp at about 0900 on June 30 and July 20, when heavy fog was at ground level. Thus, the most reliable time of day for conducting murrelet watches inland is at dawn, as is true in the southern portion of its range.

Types of Detections

Eighty-five percent of the total detections for the summer were audio only (Fig. 3). Visual detections accounted for 11%, with 4% of the total having both visual and audio components. These percentages are similar to those reported in Oregon and California (Nelson 1989). The percentage of visual detections of the total varied among stations (Table 4a), ranging from 0 to 33%

Total Detections and Seasonal Patterns

The mean total number of detections at stations visited more than once (N = 7 stations, 30 watches) ranged from 38-82 detections per watch. At stations visited once (N = 16) the total number of detections ranged from 1 to 112. The wide range of detections in the latter group is likely a reflection of the wider sampling throughout the island. The stations with multiple visits were concentrated in the south Cabin Bay drainage and, thus, might be expected to be more consistent.

There is some indication of seasonal changes in detection levels despite variability among stations (Fig. 4a). Overall, there seemed to be an increase after 10 July, with a peak in late July. Exceptions were relatively high detection levels on 12 and 20 June. After 1 August, there was a decline in detection levels, even at stations with previously high levels, such as those in south Cabin Bay. Very low numbers were recorded after 10 August.

Flock Sizes and Flight Patterns

Visual observations allow the observer to count the number of birds flying inland. Of the 318 visual detections where the number of birds was noted, 24% were of single birds and 65% were of pairs (Fig. 5a). The largest group was 5 birds, observed once. Thus, 72% of the 575 birds visually observed were in pairs (Fig. 5b). When circling, the pairs often split up and flew figure-eights or counter to each other. Often, one bird would disappear into the trees while the

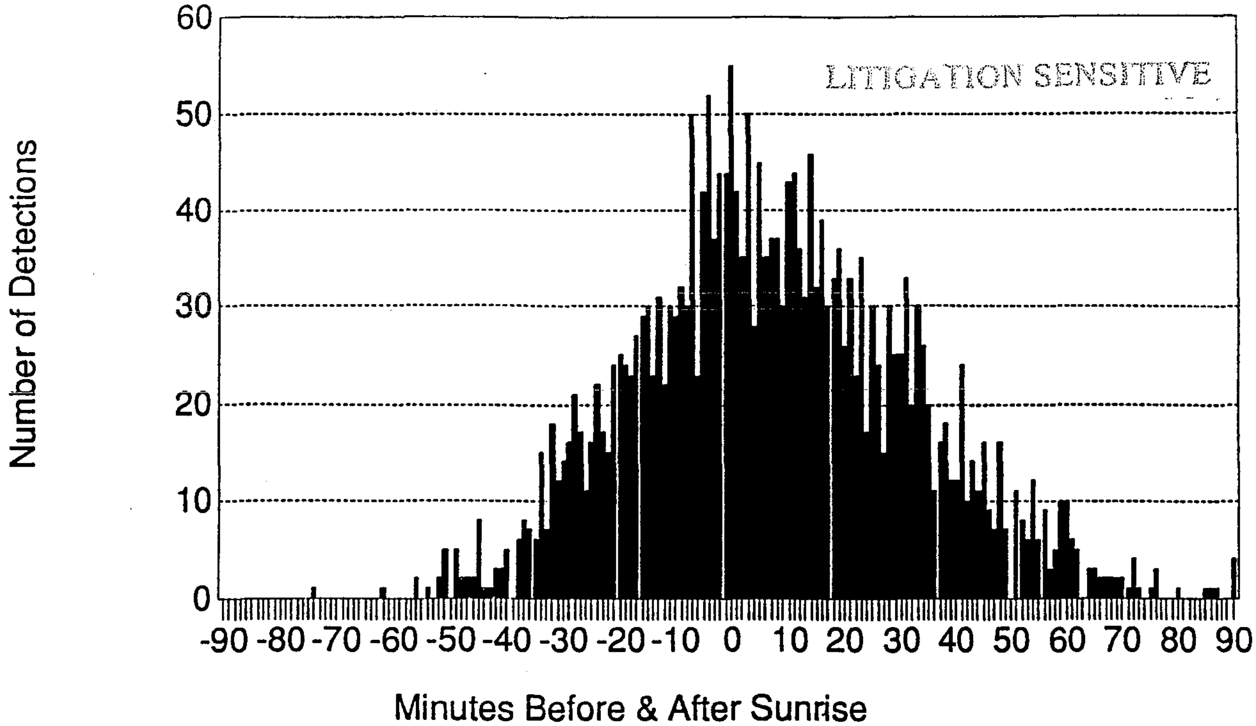


Fig. 2a. Marbled murrelet detections during dawn watches, relative to official sunrise. The data represent 2,428 detections recorded during 47 dawn watches at Naked Island, June, July and August, 1990.

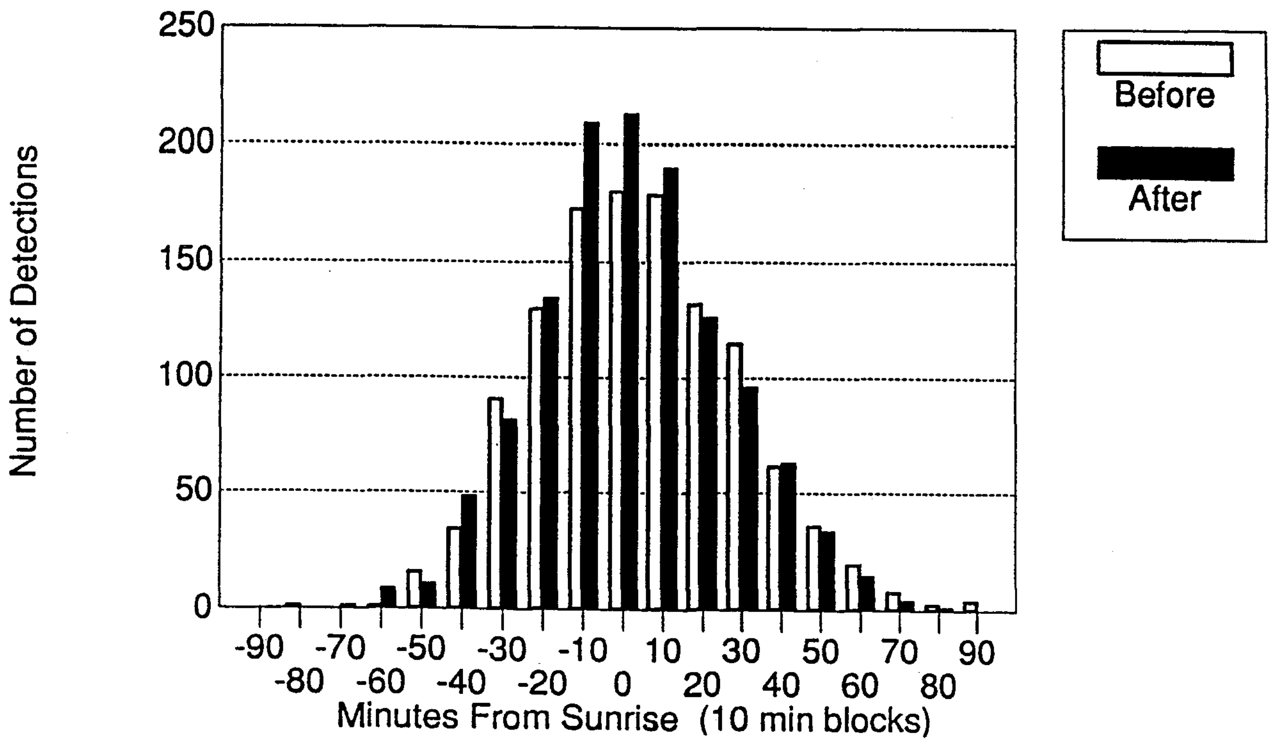


Fig. 2b. Marbled murrelet detections relative to official sunrise for early season dawn watches (before 12 July) and late season watches (after 13 July). Detections are grouped into 10-min blocks.

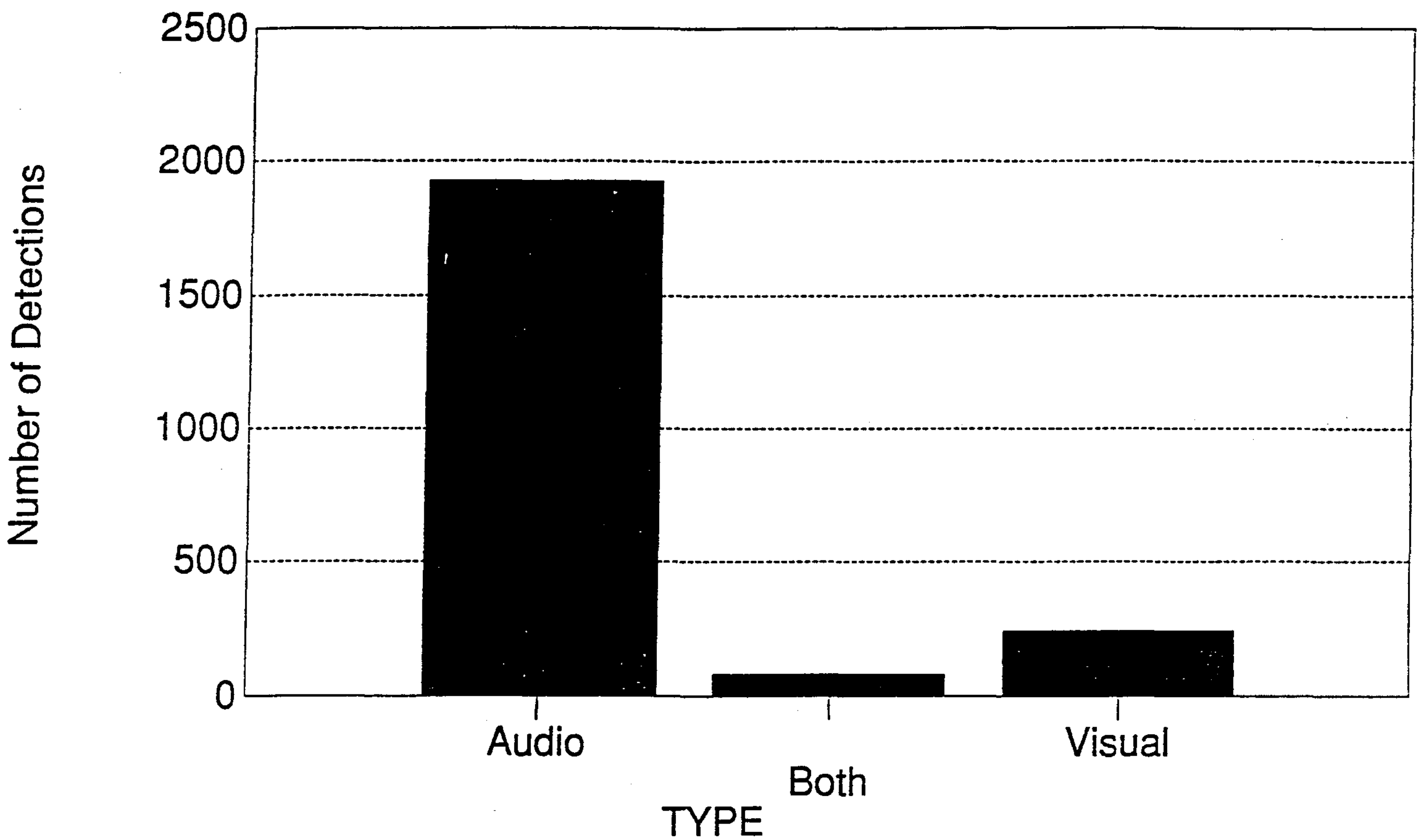


Fig. 3. Marbled murrelet detections divided into audio, visual or both audio and visual types of detections. Data are from all dawn watches done on Naked Island in 1990.

Table 4a. Summary of all murrelet detections, by station. Those stations with more than one dawn watch are presented with mean number of detections per watch, standard deviation, minimum and maximum number of detections and coefficient of variation.

STATION	N	Detection Types AUDIO	BOTH	VISUAL	TOTAL	MEAN/ WATCH	SD	MIN	MAX	CV
001	5	208	7	17	232	46.60	29.85	27	97	64.07
002	9	486	28	109	623	62.67	37.77	9	135	60.28
002A	2	132	8	23	163	81.50	6.36	77	86	7.81
003	3	108	3	2	113	37.67	27.68	12	67	73.49
005	4	124	14	22	160	40.75	27.18	19	80	66.71
006	1	16	2	6	24	24.00	.	24	24	.
007	4	184	4	4	192	48.00	16.41	32	70	34.19
008	3	105	9	10	124	41.34	10.60	30	51	25.64
008B	1	53	2	4	59	59.00	.	.	.	.
009	1	39	1	0	40	40.00	.	.	.	.
010	1	77	0	0	77	77.00	.	.	.	.
011	1	37	0	0	37	37.00	.	.	.	.
012	1	2	0	0	2	2.00	.	.	.	.
013	1	76	0	0	76	76.00	.	.	.	.
014	1	79	1	32	112	113.00	.	.	.	.
015	1	26	0	0	26	27.00	.	.	.	.
016	1	4	0	0	4	4.00	.	.	.	.
017	1	20	1	0	21	21.00	.	.	.	.
018	1	1	0	0	1	1.00	.	.	.	.
019	1	50	2	9	61	61.00	.	.	.	.
020	1	63	0	1	64	65.00	.	.	.	.
021	1	32	0	2	34	34.00	.	.	.	.
022	1	5	0	0	5	5.00	.	.	.	.

Table 4b. Summary of visual murrelet detections, by station, with a breakdown by behavior. Data are from all dawn watches done at Naked Island in 1990, using only detections that had behavior recorded. Near detections are those <200 m from the observer on station. For stations 002 and 002A, the detections were combined to derive the percent of near detections.

		BEHAVIOR OBSERVATIONS									
STATION	N	LAND IN TREE	CIRCLE LOW	FLY THRU LOW	CIRCLE HIGH	FLY OVER HIGH	FLY BY DISTANT	TOTAL VISUALS	MEAN PER WATCH	SD	% OF NEAR DETECT.
001	5	0	0	1	11	6	3	21	4.80	5.07	5
002	9	1	22	20	66	16	9	134	12.89	12.71	34
002A	2	1	4	8	14	2	1	30	15.50	4.95	34
003	3	0	2	1	1	1	0	5	1.67	1.15	60
005	4	0	7	5	6	12	0	30	9.00	14.28	40
006	1	0	1	3	1	0	3	8	8.00	.	50
008	4	0	1	0	3	1	1	6	2.00	2.16	14
008B	3	0	5	2	8	3	1	19	6.34	6.03	37
009	1	0	3	0	2	0	1	6	6.00	.	50
010	1	0	0	0	0	1	0	1	1.00	.	0
011	1	0	0	0	0	0	0	0	0.00	.	0
012	1	0	0	0	0	0	0	0	0.00	.	0
013	1	0	0	0	0	0	0	0	0.00	.	0
014	1	0	4	10	0	0	17	31	31.00	.	45
015	1	0	0	0	0	0	0	0	0.00	.	0
016	1	0	0	0	0	0	0	0	0.00	.	0
017	1	0	0	0	1	0	0	1	1.00	.	0
018	1	0	0	0	0	0	0	0	0.00	.	0
019	1	0	2	1	6	0	0	9	9.00	.	33
020	1	0	0	1	0	0	0	1	1.00	.	100
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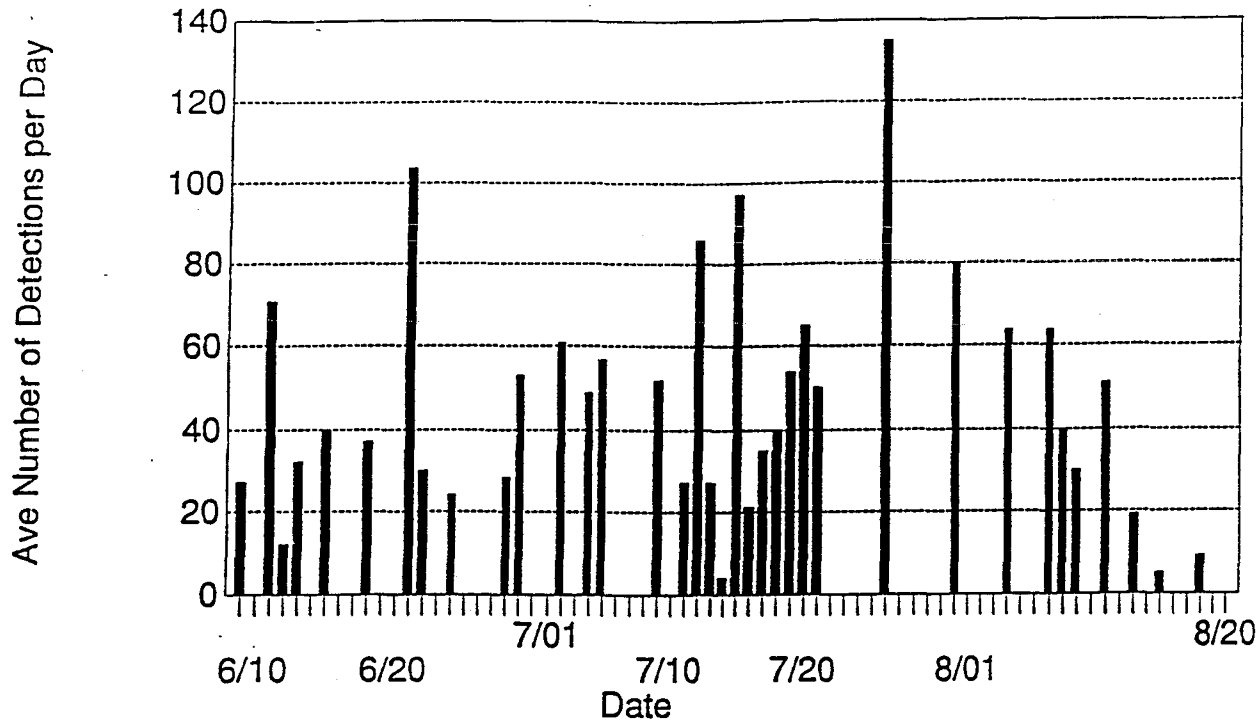

Fig. 4a. Average number of marbled murrelet detections per day, using data from all dawn watch stations on Naked Island in 1990.

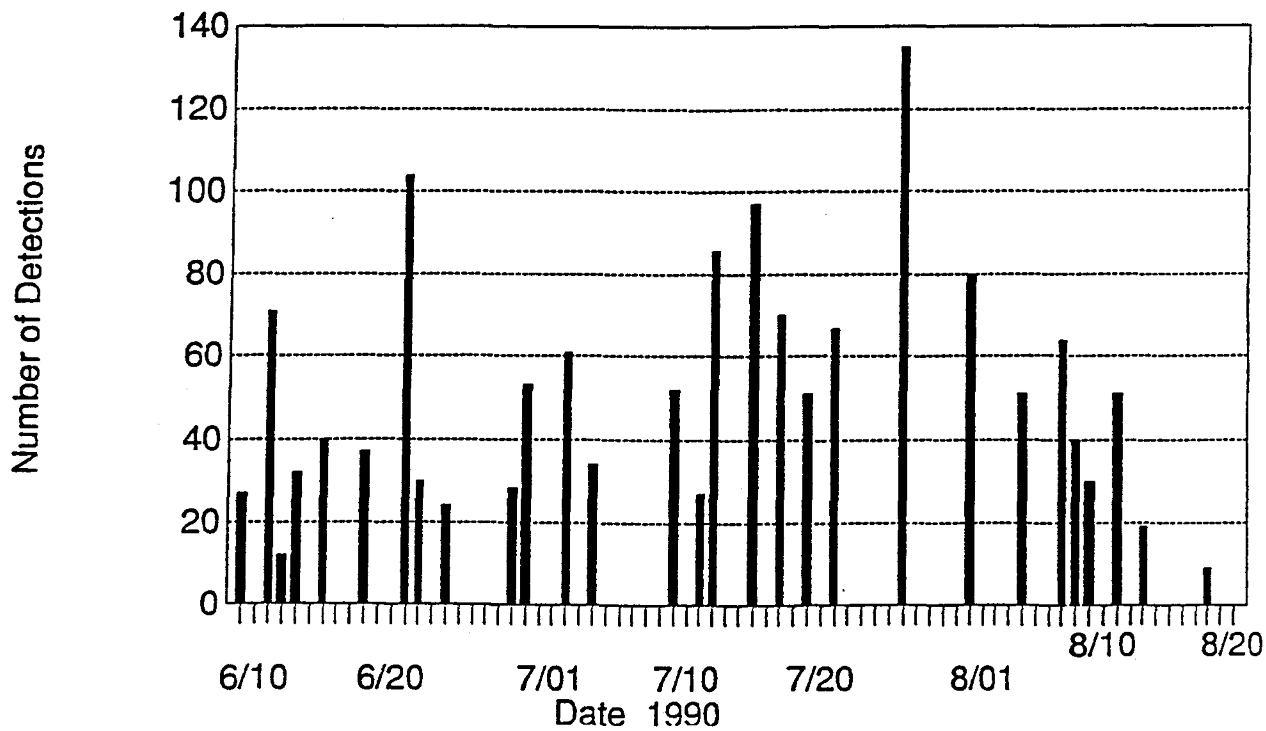

Fig. 4b. The number of murrelet detections, by date, for stations in the South Cabin Bay drainage system, Naked Island, 1990.

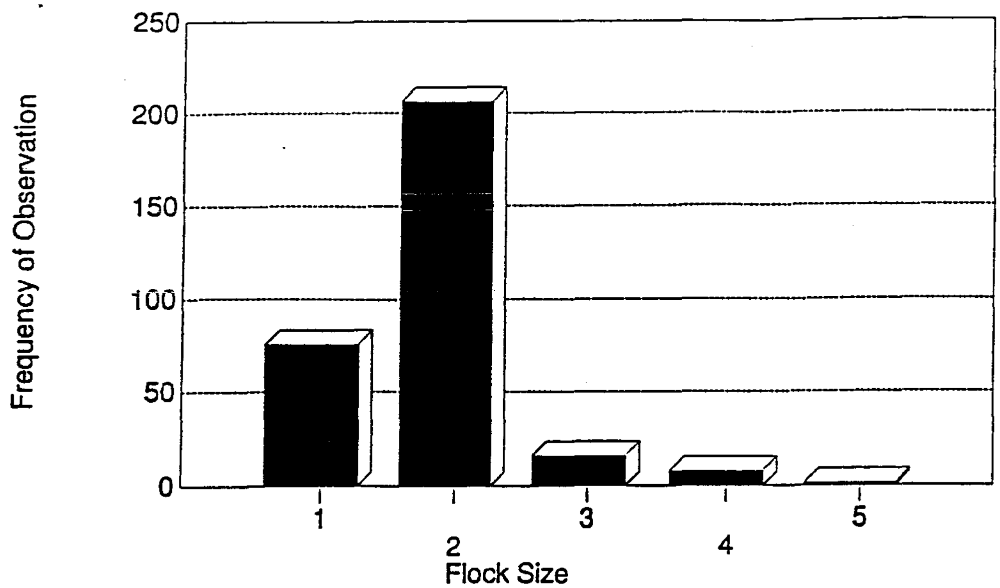

Fig. 5a. Frequency of marbled murrelet flock sizes observed during dawn watches at Naked Island in 1990. Data were taken from visual detections of murrelets only (N = 318 flocks).

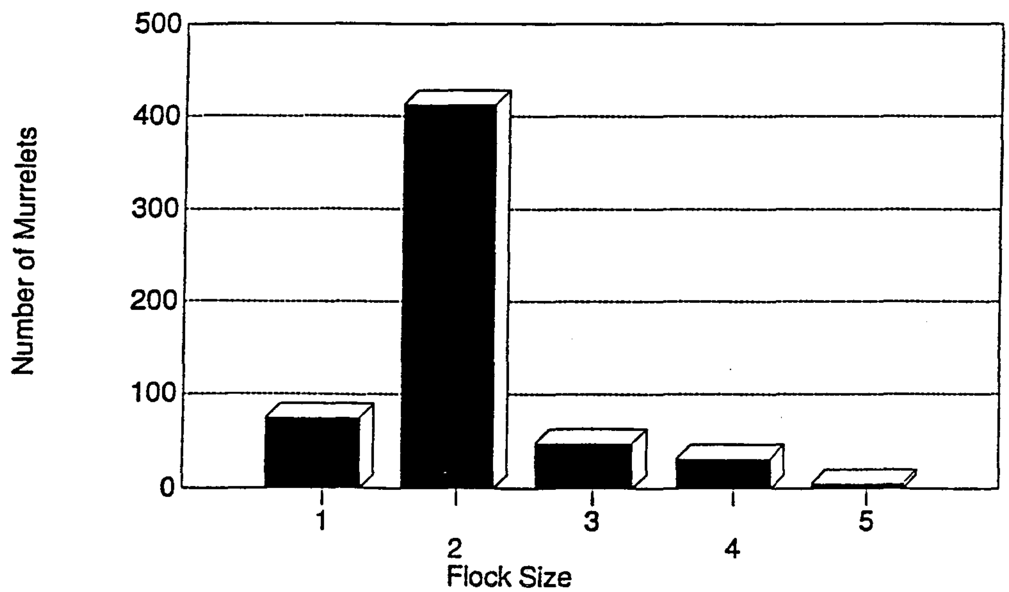

Fig. 5b. Number of marbled murrelets in each flock size observed during all dawn watches at Naked Island in 1990. Data were taken from visual detections of murrelets only (N = 575 birds).

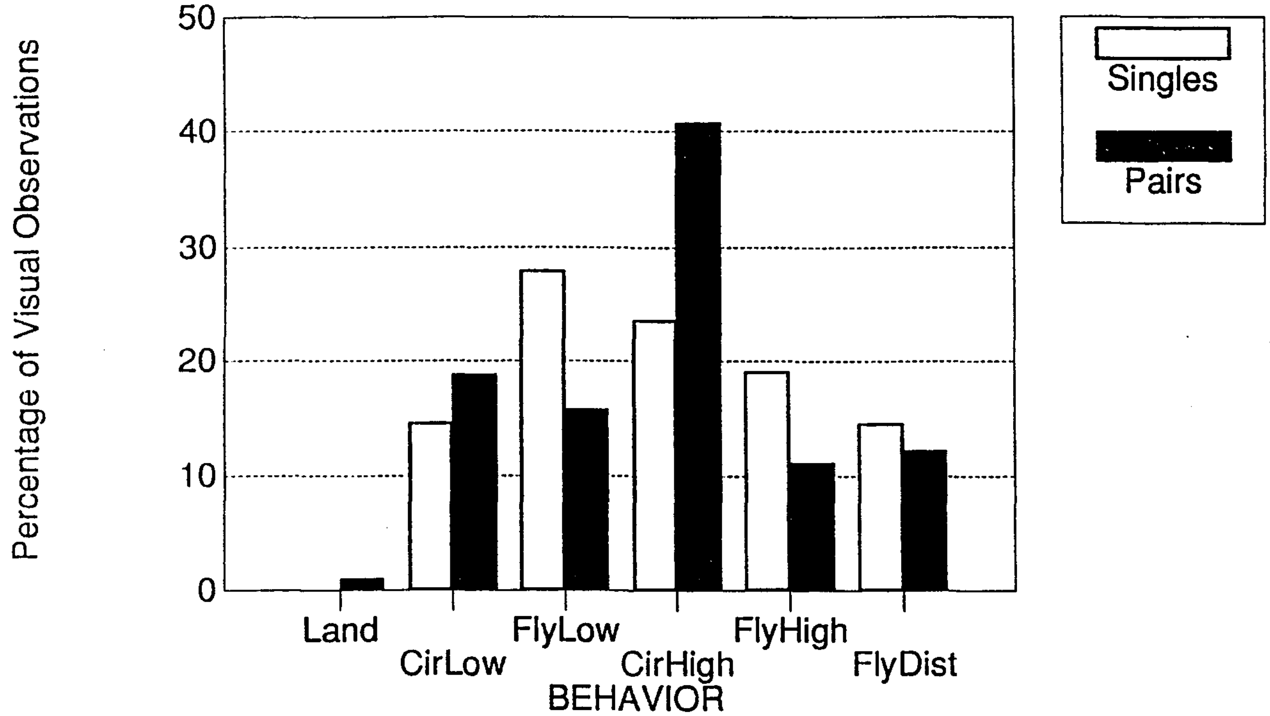

Fig. 6. Percentage of different behavioral observations for murrelets observed as singles or in pairs. Data were taken from visual detections of murrelets during dawn watches on Naked Island in 1990. Behaviors are: Land = land in tree, CirLow = circling below canopy, FlyLow = fly through station below canopy, CirHigh = circling above canopy, FlyHigh = fly over station above canopy, FlyDist = flying >200 m from observer.

other continued to circle or fly out to sea. Perhaps for this reason, single birds were more frequently seen flying low through the station, and pairs were more likely to be circling high above the canopy (Fig. 6; Chi Square = 11.86, df = 5, $P<0.05$). Alternatively, there is evidence that circling high and chasing behavior is not necessarily indicative of an established nesting pair. Some researchers speculate that these are prospecting birds or unmated birds in courtship displays. Video records of nests show that pairs exchanging incubation duties or feeding chicks are quiet and exchange greetings quickly (Nelson, pers. comm., Naslund, pers. comm.).

Remote Sites

For the seven paired dawn watches, there was a significant correlation between the number of detections made at the coastal site, and the number observed the second dawn further inland ($Rs = 0.85$, $0.01<P<0.05$). In five of the seven pairs, the second watch had fewer detections than the coastal site, suggesting that the birds were dispersing to different areas further inland. Although this is a small sample, the results suggest that the relative use of an upland area could be adequately determined by censusing a single coastal site. It would not be possible, however, to identify exactly what habitat types the birds are actually nesting in.

Objective B: Develop and test methods for locating nest sites.

Once potential nesting areas were identified by observing appropriate behavior during a dawn watch, the search area was narrowed using two - four people to simultaneously observe an area of high murrelet activity. This more focused effort is referred to as the ground search method, as it does not rely on radio telemetry. The stake out of an area is best done during the murrelet's incubation phase (mid May to late June in Prince William Sound). This takes advantage of highly predictable nest exchanges at dawn (Naslund, pers. comm., Nelson, pers. comm.). Our stake outs could not begin until July and were tried on six occasions until 3 August. Due to man-power constraints from other on-going projects, our efforts did not progress systematically from tree stand to tree clump to tree to branch. Even with a limited attempt, however, we were able to identify several suspected nesting trees. Although we observed pairs landing on specific branches on two occasions, the branches did not appear to be likely sites for nests. Since pairs, prospecting birds and possibly juveniles frequently land in nearby trees, especially after late July (Nelson, pers. comm.), these may not have been nest site branches.

A second, and potentially useful outcome of a stake out is the additional information gained on murrelet behavior and numbers within a defined area. Because birds appear to come and go from the trees during circling forays, the detections may be repetitive observations of the same birds, especially in areas where they appear to be nesting. An observer alone at a station with high activity would not be able to provide an estimate of the number of pairs in the area. This method might enable a field crew to make estimates of the number of pairs using a stand of trees. At station 2, where we used multiple observers, there were indications of at least four pairs using the wooded slope east of the station center, with possibly six pairs total.

Objective C: Identify and characterize nest habitats and sites.

It is beyond the scope of this pilot study to adequately test for correlations between habitat and murrelet activity. Results presented in this report are descriptive. Because of the low sample size and bias to survey areas near camp, results for these areas cannot be extrapolated to the entire island or other areas. They do, however, indicate features which may be focused on in future studies.

Because most of the stations were on the west side of Naked Island, the majority had a general southwest (N = 9), west (N = 4) or northwest (N = 4) orientation toward the water. Two stations were oriented southeast and one each faced north and northeast. Specific slopes analyzed by the AP faced west (N = 6), northwest (N = 4), north (1), south (1) and southwest (1). Station elevations ranged from 16-207 m, and flight distance from the water from 150-1000 m. Forest Service analysis of selected polygons identified seven vegetation types, consisting of different cover percentages of mixed conifer old-growth, hemlock old-growth and muskeg (Table 5). Sampled tree heights ranged from 4 to 24 m within these same polygons.

Total Detections as Indicators of Upland Use

At these dawn watch sites, it was possible to observe flight patterns at great distance. Murrelet directions indicated which areas might have high activity, even when the detection was distant (>200 m) from the station. In the south Cabin Bay drainage, when all stations were combined, bird traffic was heaviest going east and west, due to traffic between the bay head and westerly facing slopes (Fig. 7). More specifically, from station 2, near detections indicate that birds were heading primarily north and east, which were the steep heavily wooded slopes. The distant detections at station 2 were mainly to and from the west, which was the bay (Fig. 8). Birds moving in and out of the slopes east and northeast of station 2 appeared to use the meadows between the slopes and water for circling, aerial displays and chases. It appeared that birds nesting throughout the basin flew over the meadows at the head of the bay, resulting in the high number of distant detections for station 1.

The average number of total detections per watch was highest at the nine stations facing the water to the southwest (Table 2; $\bar{x}$ = 58 detections/watch, d/w), with slightly lower averages for stations facing west (N = 4, $\bar{x}$ = 41 d/w), northwest (N = 4, 38 detections) and northeast (N = 1, 34 detections). None of the stations had a general east or south orientation.

There was no significant difference in the average number of detections per watch among stations located at the heads of bays, inland of bay heads or on outer peninsulas (Table 3; ANOVA, N = 21 stations, F = 3.27, $0.05<P<0.10$). The F-value approaches significance, however, and suggests that this habitat feature merits further attention. Detections were highest at stations located at the heads of bays, <300 m from the water (N = 7, $\bar{x}$ = 53 d/w). These birds could have been traveling further inland. Stations further inland from the bay heads also had high numbers of detections (N = 10, $\bar{x}$ = 46 d/w). The lowest average detections per watch were recorded at stations located on the outer portions of the large peninsulas (N = 4, $\bar{x}$ = 13 d/w).

Within study area 2, murrelets were more frequently observed heading into relatively steep wooded slopes, i.e., polygons 2 and 3. However, high numbers also entered polygon 9, which had a lower percent cover of mixed conifers (Fig.

Table 5. Habitat analysis of polygons in South Cabin Bay, Naked Island and the number of murrelet detections observed headed into those polygons. Habitat data was taken from aerial photographs via analytical plotter by the U.S. Forest Service.

Polygon	Area (M2)	Habitat Type	Percent Cover	Ave.Tree Height	Percent Grade	Slope Aspect	Meters To Water	No.Detections Going To Area
1	90,340	MCO	75	19	low	250	025	12
2	185,504	HO	70	17	-46	271	300	45
3	201,396	HO	80	15	-66	271	850	32
4	170,100	HM	65	17	-40	190	450	5
5	210,187	MOC	30	14	-02	277	750	24

Key to Habitat Type MCO = Mixed Conifer old-growth
HO = Hemlock old-growth
HM = Hemlock mature
MOC = Muskeg/ open bog meadow/ mixed conifer

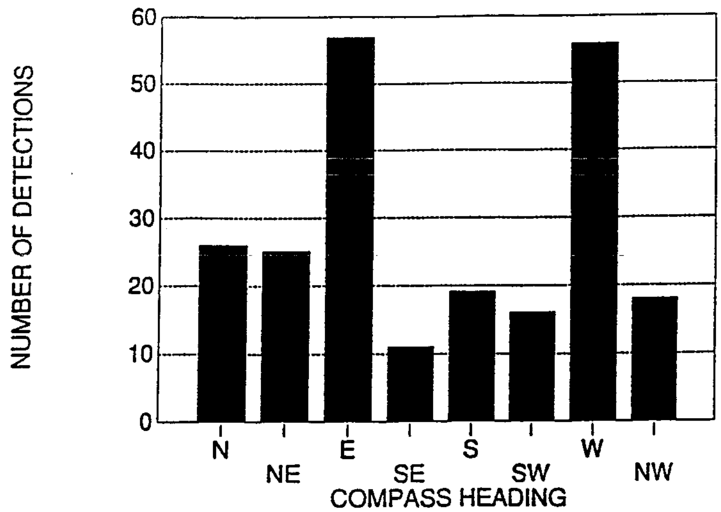

Fig. 7. The last recorded flight directions of murrelets during dawn watches in the South Cabin Bay drainage system. Data were taken from detections near station (<200 m from observer) where compass directions were obtained, at Naked Island in 1990 (N = 228 near detections).

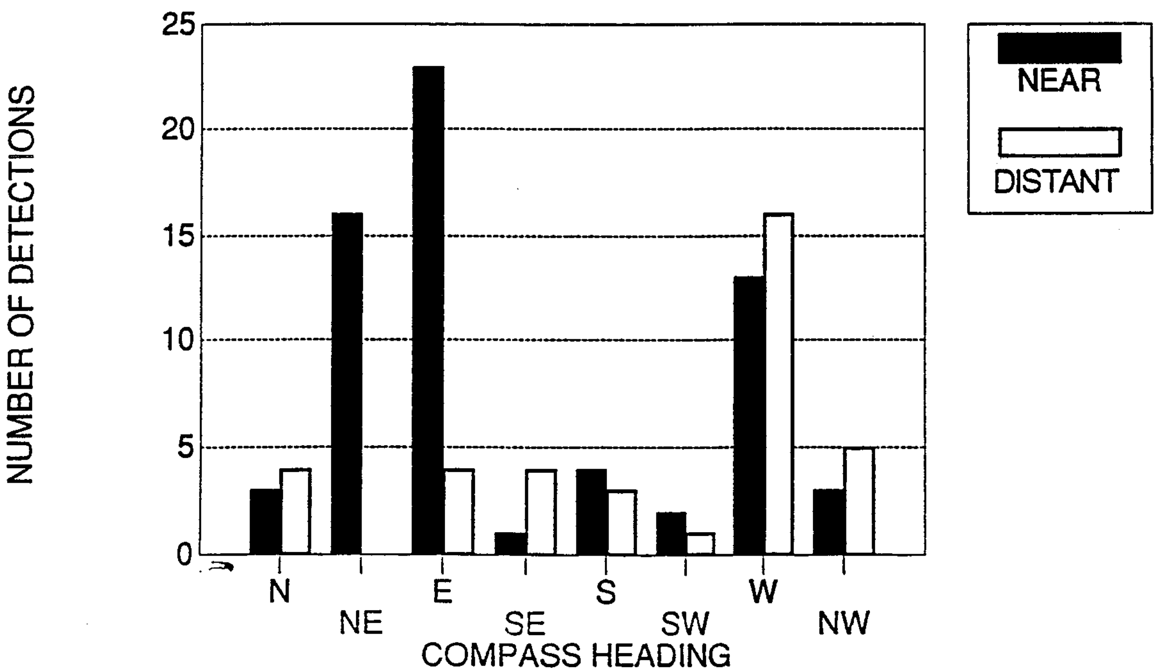

Fig. 8. The last recorded flight directions of murrelets during dawn watches at station 2, South Cabin Bay, Naked Island in 1990 (N = 102 detections). Detections are divided into Near (<200 m) and Distant (>200 m).

Fig. 9 . The number of murrelet detections plotted as heading into the polygons of Study Area 2, the South Cabin Basin. Black triangles mark the dawn watch stations.

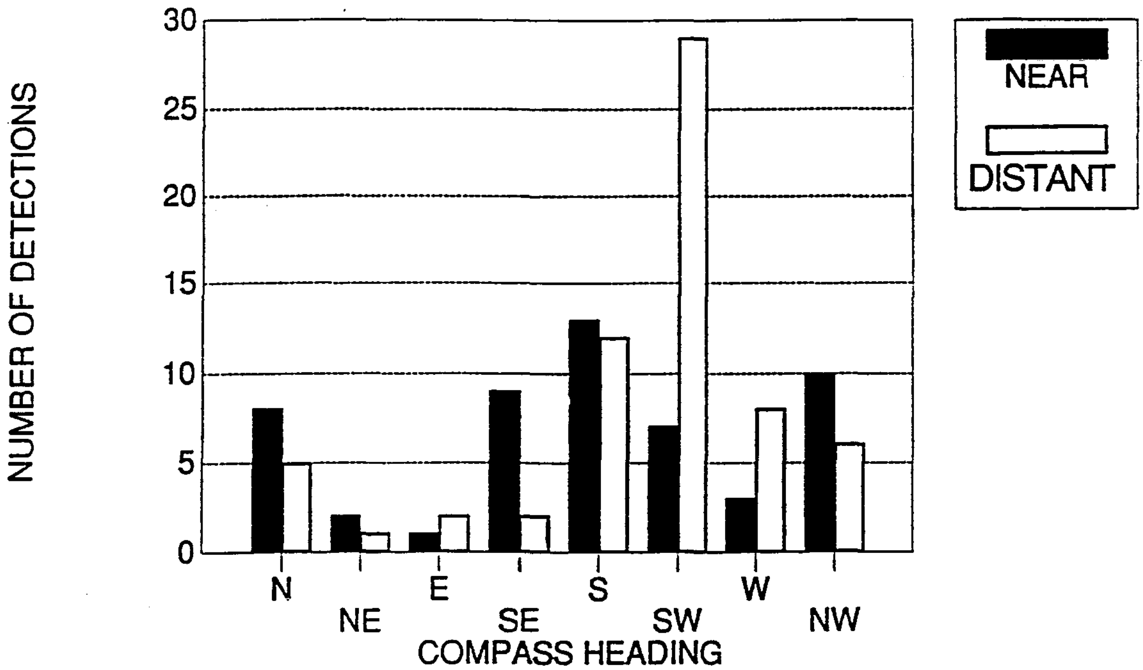

Fig. 10. The last recorded flight directions of murrelets during dawn watches at stations 20 and 21, in the northwest corner of Naked Island, in 1990 (N = 118 detections). Detections are divided into Near (<200 m) and Distant (>200 m).

9). For the 5 polygons in area 2 analyzed by AP, the two with the highest murrelet counts faced west and had 70-80% cover of hemlock old-growth (Table 5).

In the northwest corner of Naked Island, two remote stations faced north and northeast. Large numbers of birds flew over these stations, primarily south and southwest, above canopy and at a distance (Fig. 10), and appeared to be heading to a wooded slope in that direction. Aerial photo analysis described a polygon on this slope as 80% cover of mixed-conifer old-growth (Appendix C; polygon 1 of study area 3).

Visual Detections As Evidence of Nesting

Visual observations are most important in distinguishing a flight corridor from a potential nesting area (Nelson 1990). As an example, the types of behavior noted during visual detections at stations 1 and 2 show differences in the relative occurrence of site-specific activities and more distant observations (Fig. 11). Station 1 was centered in an open meadow at the head of South Cabin Bay, where birds were primarily observed circling or flying high or at great distance (>200 m from observer). Station 2, only 600 m away, was at the base of a slope of hemlock old-growth, where birds were observed circling and flying below canopy and on two occasions landing in trees. This would indicate that station 1 is a flight corridor, whereas station 2 is a probable nesting area.

Site 2 is an example of a "documented use site" as defined by Nelson (1990). For the 21 stations sampled in 1990 (combining substation 2B with 2), I made a rough estimate of documented use sites by considering the percentage of low, nearby visuals from the total number of visuals (Table 4b). At eight sites, the percentage of low visuals ranged from 32% to 60%, which may be evidence of local nesting activity. Because six of these nine sites were located in the South Cabin Bay drainage, where most of our effort was focused, it is unknown whether effort or fortuitous location of our camp is responsible for the high number of below canopy observations. Four sites had questionable or little evidence of local use. Finally, nine sites had no visuals or no below canopy visuals. Thus, of the sites we sampled, the most likely areas to focus on for intensive nest searches would be the wooded slopes: (1) E/NE of South Cabin Bay head (between stations 2 and 7), (2) SE or 1 km E of North Cabin Bay head (SE of station 9, plus station 19), and (3) 100-200 m up the NE slope of Bass Harbor bay head (station 14); (see Fig. 1b).

VII. DISCUSSION

Methodology: guides on applying the dawn watch

The Dawn Watch

The overall goal of this pilot study was to determine if methodologies used in California, Oregon and Washington could be applied to an Alaskan population of murrelets. This required investigating basic aspects of murrelet behavior such as the occurrence of a dawn activity period and outlining the seasonal nesting period. In addition, we wanted to substantiate the suspected nesting in trees of murrelets in southcentral Alaska.

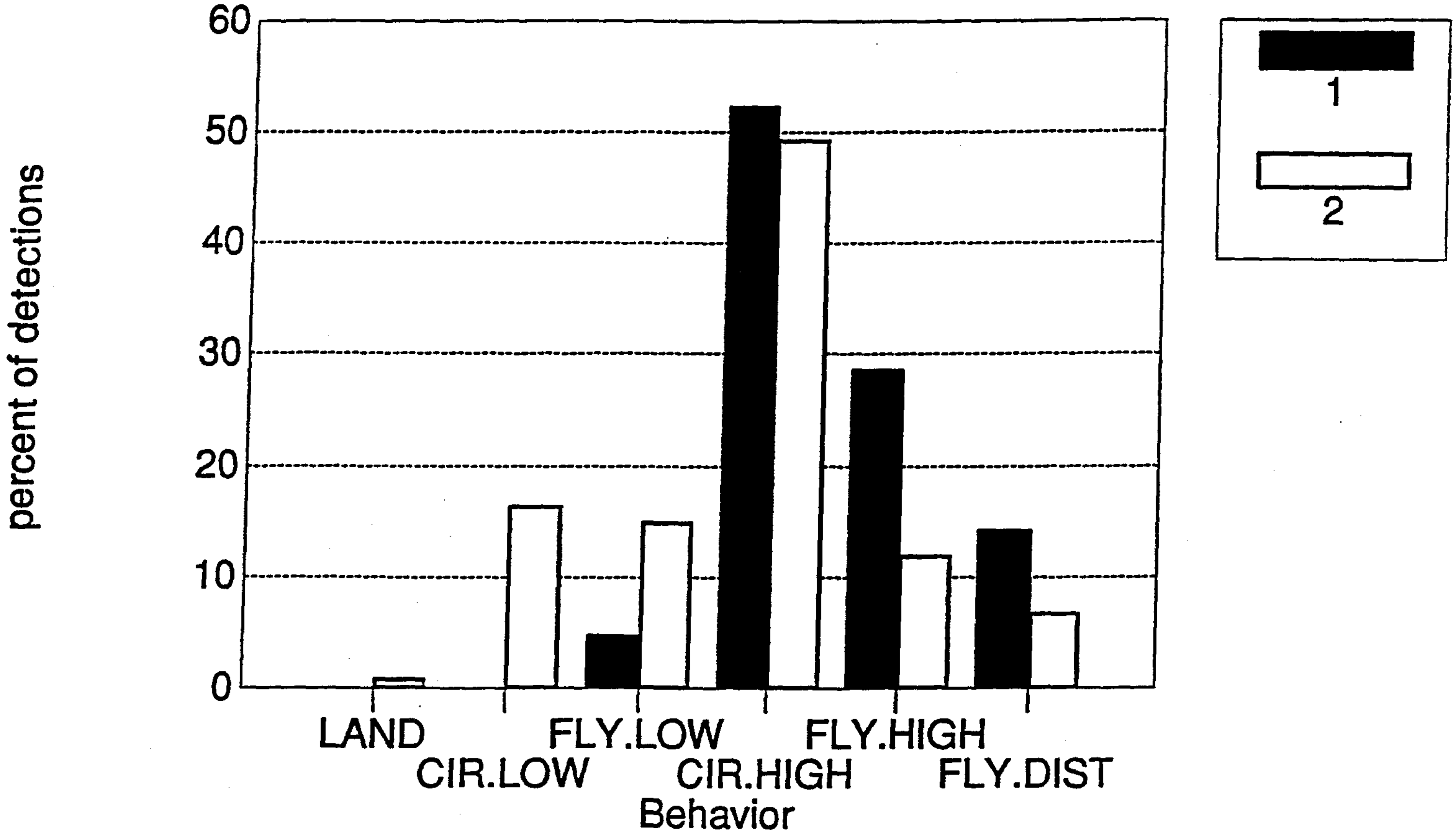

Fig. 11. Percentage of different behaviors for murrelets observed visually at stations 1 and 2 during dawn watches in South Cabin Bay, Naked Island in 1990. Behaviors are: Land = land in tree, CirLow = circling below canopy, FlyLow = fly through station below canopy, CirHigh = circling above canopy, FlyHigh = fly over station above canopy, FlyDist = flying high >200 m from observer.

This project demonstrated the applicability of the dawn watch to murrelets in Alaska. The intensive survey was found to be the most practical and useful for roadless areas. In areas with logging roads, the transect method could be attempted again. Similarly, high alpine tundra may be amendable to the grid method of dawn watches. In all cases, it is important that observers be well trained in distinguishing separate detections and describing behavioral observations. The low level of dusk activity (or its detectability) makes dusk watches inefficient. Once specific trees are located, however, an observer may be able to observe chick feeding at night using a night-vision scope (Nelson pers. comm.).

Coastal Sites

For censusing large, remote areas, the use of coastal dawn watch sites is logistically reasonable and has the potential for identifying areas of high murrelet activity. A more intensive effort than ours would be needed to truly test the correlation between coastal flight traffic and nesting activity further upland. However, the method employed in this pilot study could be applied when censusing large complex shorelines. This would serve a wider distributional study and locate the best areas for focusing more detailed work.

Seasonal patterns

The seasonal timing of surveys will depend on the goal of the study. Our results indicated that seasonal patterns of murrelet detection levels are similar to those noted in the southern portion of its range. Thus, to simply document murrelet presence, dawn watches could begin by mid May, based on estimated chronology (see below), and extend to mid August.

To obtain a measure of activity level for comparison purposes, more attention needs to be paid to time of year. Changes in detection levels will need to be anticipated when planning sampling schedules and analyzing data. In the southern portion of its range, murrelet detections increase mid to late May (Nelson, pers. comm.). This study supports the pattern observed later in the season in lower latitudes. Once incubation begins, detections drop slightly and level off. Beginning in mid July, detections increase again and reach a peak around late July. In August they decline, dropping dramatically after about 10 August.

Locating nests

If locating nests is an objective, studies should be more limited in scope and be most concentrated during the incubation phase. Because incubation changes are very predictable temporally, it is probably the best time to locate a nest (Nelson, pers. comm., Naslund, pers. comm.). At Naked Island, juveniles appear on the water after July 19 (Kuletz, unpubl. data), and peak around the last week of July and first week of August. Marbled murrelets have a 30-day incubation and 28-day fledging period. By backdating, peak egg laying occurs in late May and peak hatching in late June. Thus, the optimum time for finding nests may be late May to late June in Prince William Sound. Timing may vary locally; for instance, peak laying for Kachemak Bay murrelets, on the west side of the Kenai Peninsula, may be at least one week earlier and, overall, have a greater range of dates (Kuletz, unpubl. data).

Although no nests were found in 1990, this was partly due to the necessity of first locating high activity sites and the lack of time we were able to devote to this project. The limited number of stake-outs conducted in 1990 did yield good baseline information on clumps of trees to monitor in 1991. The only nonproductive stake-out was done 3 August, when birds in this previously busy site were no longer active. Where ground search techniques have worked in the "lower 48", several years of preliminary work were done prior to success. At a site like Naked Island, with a much higher density of murrelets, it should be possible to locate nests in the season following initial ground work. Efforts in 1991 could begin in late May at sites already located.

Study Design: Defining habitat and murrelet use

Defining Habitat

There is so little known about murrelet nesting in Alaska that it is difficult to define which habitat features include in a study. This is complicated further in Alaska by the occurrence of ground nesting and co-existence with Kittlitz's murrelets, which have only been found to nest on the ground. Eventually, a comprehensive study of marbled murrelet nesting habitats will have to consider the nesting activities and habitats of its congener, B. brevirostris.

Ground nesting could not be investigated on Naked Island because there are no dry ground or alpine areas on Naked Island. However, birds could potentially use forest ground cavities or the base of alders. Two murrelet nests (potentially Kittlitz's or marbled) have been found in Prince William Sound at the base of an alder clump (G. Balough, pers. comm. and J. Hughes, pers. comm.). At Naked Island, because birds were flying into the trees and circling forested areas, they were likely using the trees as nest sites.

The flight directions noted at the 1991 dawn watches indicated more birds were heading toward forested slopes, particularly those with large, dense hemlock or mixed hemlock-spruce as the primary cover. Based on this limited sample, the importance of timber stand volume (roughly similar to density) and stand class (tree size), may be basic habitat features on which to focus. Timber stand size may also be an important factor. In Oregon, Nelson (1990) found that more birds appeared to be using larger stands of timber. Other habitat features, such as orientation of a basin, slope aspect and location relative to bays and promontories, merit further attention as well. However, these factors might be extremely subject to local conditions or weather patterns. It would also be difficult to integrate all of these factors into a single study design. Finally, murrelets may prefer certain types of trees, although nests have been found in Douglas Fir, western hemlock, mountain hemlock and sitka spruce. The 1991 results may indicate if tree species is an important factor in Prince William Sound.

The scale of a habitat study will determine how fine or course-grained the habitat parameters should be defined. For a large distributional study, such categories as alpine, old-growth forests, secondary forests and mixed conifer/alder woodlands may be adequate. For a more detailed habitat study in a given area, gradations of forest volume, size class and tree species may be required.

Behavioral observations as indicators of "documented use sites"

In 1990, most of our stations were positioned with good views of surrounding hillsides. This gave us a good indication of what areas the birds flew toward, but the data were not specific enough for use with Geographic Information System (GIS) to integrate with habitat data. Using this method would require a greater percentage of detections with known directions and distances of birds entering the trees, which was difficult to do under low light conditions at a distance. One option would be to draw maps on-site and relate the hillsides to specific locations on topographic maps. Still, limitations of visibility would compromise the interpretation of results.

Specific types of behaviors can be indicators of a nest nearby. By focusing on below-canopy and near station detections, data can be more specific relative to habitat use. It is recommended that these types of observations be separated from the total detections and analyzed separately (Hamer and Cummins 1991, Nelson 1990). Keeping these observations well documented and separated will also be more compatible with a GIS system, since the area being observed is more restricted. In addition, the use of multiple observers during a stake out effort can provide an estimate of the number of pairs using a specific area. This will aid in determining relative use among habitats.

Relationship between at-sea and inland behaviors

Behavioral observations, besides indicating the proximity of nests, can serve as cues to phenological stages as well. Many of the inland observations coincided with observations made at-sea. For example, the percentage of birds observed in pairs inland is similar to the percentage of pairs on the water (Kuletz, unpubl. data). The increase in detections in late July reflects an increase in numbers of adults on the water. Similarly, as adults leave the Naked Island waters, their detections inland decline. By late August, the majority of murrelets on the water are juveniles, and most adults are absent (Oakley and Kuletz, 1979). Thus, at-sea counts of murrelets made in August are probably not a good indication of where to focus nest search efforts or murrelet habitat studies.

Murrelet nesting distribution relative to at-sea concentrations is currently unknown, and would be important information in formulating management guidelines. By combining at-sea surveys with upland surveys, it may be possible to gather data pertinent to this question. Islands such as Naked Island, which have high murrelet densities and are relatively isolated from the mainland, may provide the best opportunity for such a study.

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APPENDICES

Appendix A

MARBLED MURRELET INTENSIVE INVENTORY FORM

Observer's Name: ______________________ State/Province: ______________________

Starting Location: ______________________

Transect Description: ______________________

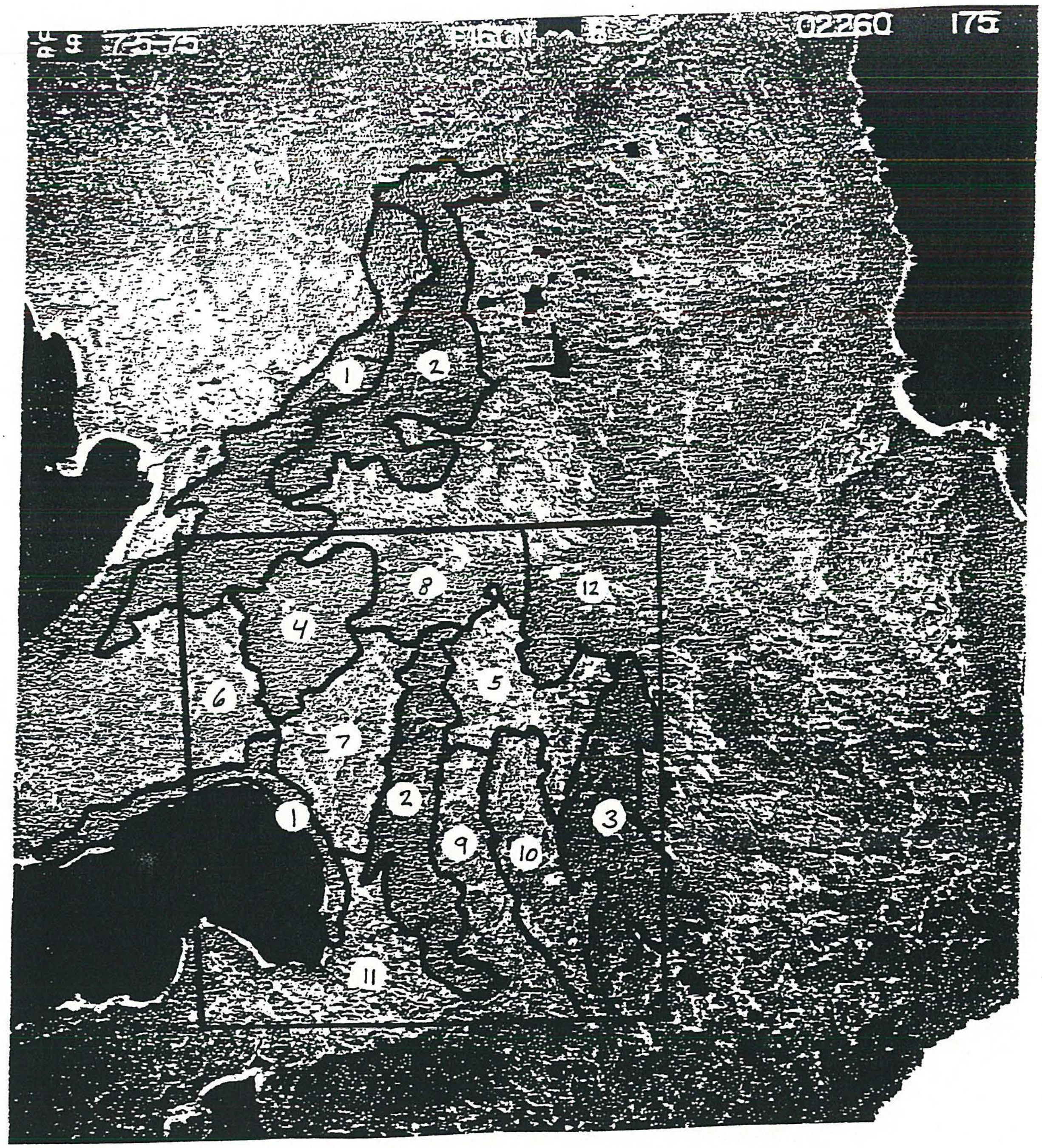
Distance to birds in: (Meters/Feet-circle one)

	Observer Initials	Mo.	Day	Year	St/Pv	Transect	Percent Cloud Cv	weather	Station Number	(MPH) WIND	°C TEMP	START TIME	END TIME
1													

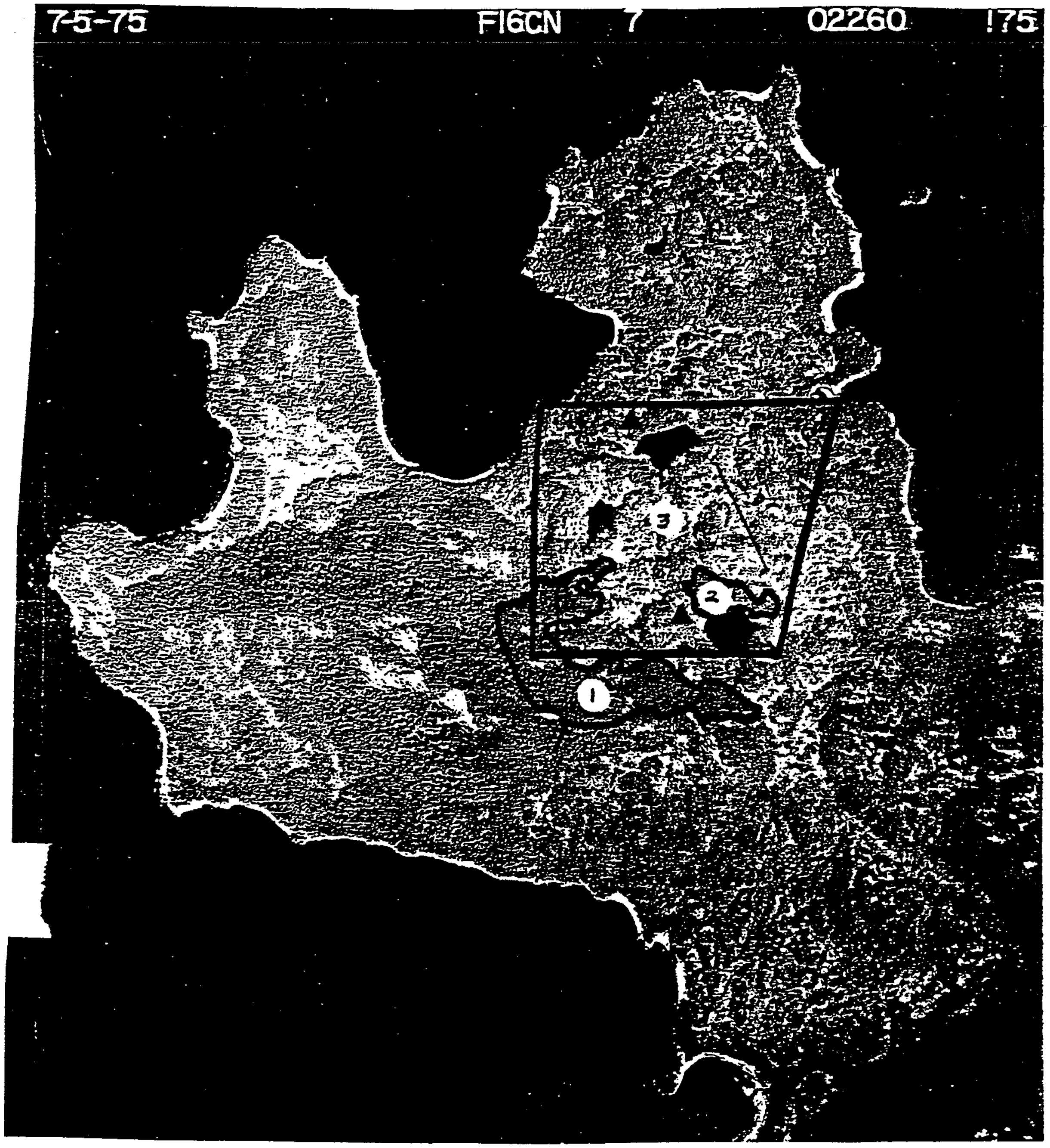
LUX (straight up)	Time of Observa.	Num. bird	Beh	Typ	Direct. Going	Call secs. (Audio)	Obs. secs. (Visual)	Distance to bird (m)(ft)	Direction From/or 1st	Height of Bird	NOTES

Beh. (Behavior): F=Fly over; C=Circle; B=Circle Below; T=Fly Through; L=Land. Typ. (Type): A=Audio; V=Visual; B=Both.
S = Fly Strait Past U=UNK

Notes: Place observations on the back of this sheet concerning special behavior, etc.
M=MULTIPLE CALLS, 1-9 = NUMBER OF VOCALIZATIONS HEARD.
HEIGHT OF BIRD (m)(FT) ABOVE GROUND
COMPASS BEARING FROM YOU TO BIRD (@ FIRST DETECTION)



Appendix B. Locations of polygons in Study Area 1 (North Cabin Bay, Naked Island, outside the square) and Study Area 2 (South Cabin Bay basin, inside square). In Study Area 2, only polygons 1 through 5 were analyzed by Analytical Plotter (USFS).



Appendix C. Locations of polygons in Study Area 3, the Northwest corner of Naked Island.. Polygon 3 includes all the area inside the "square" that is not part of polygon 1 or 2. Black triangles mark the dawn watch stations.

Appendix D. Habitat descriptions for study polygons on Naked Island, 1990. Measurements were taken from aerial photos using an analytical plotter (U.S. Forest Service).

Study Area	Polygon	Area (m2)	Perimeter (m)	Habitat Type	% Cover	Average Tree Height
1	1	6,844	359	MCO	80	14.6
1	2	3,972	262	MCO	60	13.4
2	1	90,340	3,480	MCO	75	18.5
2	2	185,504	3,689	HO	70	17.1
2	3	201,396	3,909	HO	80	15.2
2	4	170,100	2,383	HM	65	16.9
2	5	210,187	3,444	MOC	30	14.0
3	1	26,649	1,129	MCO	80	10.7
3	2	20,507	855	HO	50	8.7
3	3	625,536	4,941	MOC	20	5.6

Key to Habitats: MCO = Mixed conifer old-growth
HO = Hemlock old-growth
HM = Hemlock mature
MOC = Muskeg/ open bog meadow/ mixed conifer

Appendix D. Data for selected slopes within the polygons described above. Measurements were taken from aerial photographs using an analytical plotter.

STUDY AREA	POLYGON	TRANSECT	% GRADE	HORZ DIS	ASPECT
1	1	A1	-66	196	317
2		B1	-44	261	325
2	4	C1	-40	344	190
2		D1	-58	176	229
2	2	E1	-48	109	272
2	5	F1	-2	332	277
2	3	G1	-64	145	270
2	2	H1	-44	146	270
2		I1	-7	292	274
2	3	J1	-69	203	273
2		K1	-24	151	332
3	1	A2	-40	197	360
3	3	B2	-12	387	335

Appendix E

A Proposed Oil Spill Restoration Study

Identification of Upland Habitats Used by Marbled Murrelets in Prince William Sound

PROPOSED OIL SPILL RESTORATION STUDY

I. Cover

Title: Identification of Upland Habitats Used by Marbled Murrelets in Prince William Sound

Study Identification Number: To be Assigned
Name of Study Leaders: Kathy Kuletz

Lead Agency: U.S. Fish & Wildlife Service
Marine and Coastal Bird Project
Anchorage, Alaska

Cooperating Agency: U.S. Forest Service
Glacier Ranger District
Girdwood, Alaska

Cost of Proposal: $124,200

Inclusive Dates of Study Plan: March 1, 1991 - February 28, 1992

Signatures

Study Leader: ______________________________

Supervisor: ______________________________

Oil Spill Coordinator: ______________________________

Financial Officer: ______________________________

II. Introduction

The marbled murrelet (Brachyramphus marmoratus), a small nearshore alcid, is a species of concern from Alaska to California. They were listed as threatened in British Columbia in 1990 and are being considered for threatened or endangered status throughout its range in the United States. Loss of nesting habitat is postulated as the reason for their decline in B.C., Washington, Oregon and California. Population estimates for murrelets are not available for all of Alaska, but the area affected by the oil spill is believed to be a population center in Alaska (Mendenhall 1988). Marbled murrelets suffered direct mortality from the Exxon Valdez oil spill disproportionate to their numbers at risk in March (Piatt et al. 1990).

Further disruption of the Prince William Sound marbled murrelet population could be avoided by ensuring the availability of nesting habitat. The Restoration Planning Work Group, building on expert and public input, identified protection of upland nesting habitats as one way to assist the natural recovery of species which depend on upland habitats for some stage of their life cycle. To fulfill this objective, specific information is needed on habitat requirements of the marbled murrelet.

Unlike most other seabirds, there are no conspicuous sites used by large numbers of nesting murrelets. Murrelets are secretive and widely-scattered during their breeding season. In lower latitudes, the birds nest in coastal old-growth conifers (Marshall 1988, Nelson 1990, Quinlan and Hughes 1990). In Southcentral Alaska nesting requirements are unknown. There are qualitative accounts of tree nesting but no nests have actually been found. However, several ground nests have been found, some of which could have been the closely related Kittlitz's murrelet (B. breverostris).

In 1990, a restoration feasibility pilot study investigated methods of studying upland use by marbled murrelets on Naked Island. Using information obtained in 1990, this study will assist in the identification of murrelet nesting habitat and identify specific areas of nesting activity.

III. Objectives

A. Refine the censusing protocol for marbled murrelets at upland sites in Prince William Sound.

B. Document tree nesting of marbled murrelets in Prince William Sound.

C. Determine the presence and absence of marbled murrelet activity in selected upland habitat sites in Prince William Sound.

D. Describe habitat associations in documented use areas in Prince William Sound.

IV. Methods

Objective A: Refining censusing protocol for murrelets in Alaska

Through all aspects of this study, information will be collected that will help establish guidelines for conducting upland habitat surveys of nesting murrelets. The influence of weather, seasonal patterns and observational techniques will be considered. The standard survey is done by field personnel conducting a "dawn-watch survey." The "intensive" dawn-watch survey, whereby the observer remains in one location (Paton et al. 1990), proved most suitable for the remote, uneven terrain of Naked Island in 1990, and will be the basic field method of determining upland murrelet activity in 1991. The 1990 feasibility project at Naked Island (Kuletz 1990b) occurred from 9 June to 18 August. The 1991 season will begin in late May. To determine variability in detections and seasonal patterns, three of the stations which were surveyed at least three times in 1989 will be surveyed bi-monthly in 1991.

A dawn-watch survey is done at a pre-selected site during peak murrelet activity, when birds fly to their nests to exchange incubation duties or feed chicks. Since Naked Island birds displayed the same pattern as those at lower latitudes, each survey will be 45 minutes before to 75 minutes after official sunrise. Weather and lighting conditions (using a photography light meter) will be noted. Observers will use a tape recorder to note time of observation, type of detection (audio, visual or both), number of birds, number and types of vocalizations, direction and distance from the observer, and murrelet behavior (flight patterns, height of bird). Because birds may pass over an area without nesting there, certain behavioral activities and height of the bird will be used to classify the station as a "documented use area" (Nelson 1990). Birds flying silently through or circling below tree canopy, landing in trees or making stationary calls from trees indicate a documented use area.

All observers will be trained prior to the surveys, particularly in the classification of "detections" and in identification of murrelet calls and flight patterns. Field personnel will receive training via videos and audio tapes in the Regional Office, and in the field with the Study Leader.

A pilot study will be implemented to test the efficacy of tape recorders in determining murrelet activity in upland areas. If operable under Alaskan conditions, this system would enable greater coverage of areas where the number of field personnel are limited and access is difficult. A tape recorder will be set to record during the period of a dawn-watch survey in conjunction with a field observer. The number of audio detections recorded by the taperecorder will be compared to the number recorded by the observer. The number of visual detections missed by using the machine only will be noted as well, and compared between dense habitat (>50% sky covered) and open habitat (<50% sky covered).

Objective B: Documentation of tree nests in southcentral Alaska

In 1990, several sites with high murrelet activity were located on Naked Island. In some cases, potential nest sites were narrowed down to a few trees and birds were observed to land in trees.

Now that these areas are known, a focussed effort to locate nests will be made on Naked Island using the proven "intensive ground survey" method (Naslund 1990, Singer et al. in press). Multiple observers (2-3), connected by hand-held radios, will focus on specific clusters of trees, and eventually individual trees, to locate a potential nesting branch. Once a suspected nest branch is located, a tree climber will climb an adjoining tree to determine its existence. Data will be taken on nests following the Pacific Seabird Group's Nest Site Sampling Protocol (Varoujean and Carter 1989). Opportunistically, field personnel will search the ground below documented use sites for eggshell fragments in June or evidence of chicks in July.

The search for nests will be augmented by use of audio equipment which can detect the soft calls made at the nest by adults and juveniles, and the wing beats of birds landing in trees (Singer, pers. comm.; Nelson, pers. comm.). A stereo portable cassette tape recorder, equipped with headphones and remote microphones with parabolic reflectors will be used at documented use sites or suspected nest areas. If obtainable, a night vision scope will be used to aid visual observation of suspected nest trees during low-light hours. The number of hours spent on each methodology (ie., multiple observers, microphones, ground searching for eggshells) will be logged and presented along with their success rate.

Objective C: Determine presence and absence among habitat types

There is no adequate description of preferred nesting habitat for marbled murrelets in Alaska. Some features which may affect habitat choice are dominant cover type (tree species, age or absence of trees), stand volume (density of trees), stand size, slope aspect and incline, elevation, distance to water and topographic location (ie. outer peninsula vs inner bay head). For management considerations, the first three features, related to forest type, may be the most pertinent for large-scale application. The remaining features, while potentially influential, are difficult to isolate or control for in sampling. For Naked Island, habitat maps currently available through the U.S. Forest Service can provide information on stand size and volume, and to a lesser degree of accuracy, cover type. The original aerial photographs used to compose the maps will also be used to outline and evaluate forest stand information. Eventually, all lands within the Chugach National Forest will have plant association data available on a GIS system.

Using a timber type map available for Naked Island, dawn watch sample sites will be randomly selected for stand volume (high and low) and stand size (large and small). A minimum of 20 sites within the four possible combinations will be selected. Thus, 80 sites will be visited once during the summer. The presence and absence of marbled murrelets will be determined using intensive dawn-watch surveys at each site. Sampling effort will be rotated among habitat types throughout the summer to minimize seasonal effects, such as the increase in detections in late July. Other habitat features, such as slope aspect and incline, elevation and distance from water, will be included in the data base and used to post-stratify or use in a multiple regression on the number of murrelet detections.

Because Naked Island has no dry alpine area to test for murrelet use of this habitat, nearby Perry Island will be used as a secondary study site. No timber type map is available for Perry Island, but the island has clearly delineated alpine areas above the timbered zone. On Perry Island, a minimum of 10 paired comparisons will be made between a forested area and a nearby alpine area. Each pair (total of 20 dawn watches) will be done on the same morning by two observers stationed 500 -1000 meters apart.

Objective D: Describe habitat associations in documented use areas

Habitat data prepared by the U.S. Forest Service (USFS) will be used to evaluate detailed habitat features of documented murrelet use sites. The USFS has received $40,000 to conduct this aspect of the study. At documented use sites identified in 1990 on Naked Island, a plant ecology team from the U.S. Forest Service (USFS) will conduct ground surveys to provide detailed habitat data. In addition, the USFS will sample plots throughout Naked Island to compile plant-association data which will be entered into their GIS system and used to generate maps for all of Naked Island. Evidence of murrelet use (number of low visual sightings and nearby stationary calls) recorded for each of the 80 sites will be analyzed in conjunction with the GIS habitat data. If habitat\murrelet correlations are significant within this data set, results may be applicable throughout Prince William Sound, and could be tested in the future.

Once USFS study plots are completed on Naked Island, if time is available, they may assist with detailed habitat descriptions of newly discovered murrelet use sites on Naked Island. Additionally, for 5 days in late July, at least two USFWS biologists will accompany the USFS crew to Perry Island on their 30 ft. vessel. The purpose of this trip will be to classify habitat at selected dawn watch sites in that study area.

V. Data Analysis

A. Tests

The total number of detections (audio and visual) will be used as an indication of murrelet activity in the general area. Separate analyses will be done for those observations indicating documented use of the immediate habitat (ie., below canopy visual observations, wingbeats and calls from trees). In both cases, a two-way ANOVA will be used to test for significant differences in murrelet use among and between forest stands of variable volume and size. A multiple regression will also be performed on the number of detections per site, using cover types, slope aspect and incline, elevation and distance from water as independent variables. If a significant proportion of the variance is explained by one of these factors, it might be desirable to post-stratify the data, or will suggest future design changes.

For the Perry Island sites, a paired t-test will be used to test for differences between the forested and alpine areas done on the same day in the same general area. As with the Naked Island data, the total number of detections will be analyzed separately from the observations indicative of local nesting.

B. Products.

This study will provide maps, computerized data sets and a final report on marbled murrelet activity at all surveyed sites. Detailed data on habitat and timber types will be compiled for all documented use sites and nest sites, through the cooperation of the USFS. The presence and absence of murrelets will be correlated with habitat. The efficacy of different nest search methods will be presented. The use of tape recorders as replacements for field personnel will be examined and evaluated. These data can be used in subsequent phases of the study to test predictions of murrelet presence in the field. The usefulness of recording murrelet flight directions and distance to identify habitat use in GIS could also be investigated.

VI. Schedules and Planning

A. Report Submission Schedule:

March-May 1991	Prepare for field season/hire personnel
May-August 1991	Conduct field work
Sept.-Nov. 1991	Data input and analysis
December 1991	Draft report completed
February 1992	Final report completed

B. Sample and Data Archival

Original copies of field data will be archived in the USFWS oil spill file system. Copies of the data set will be archived with the USFWS marine and Coastal Bird Project and the USFS Glacier Ranger District.

C. Management Plan

Kathy Kuletz will serve as the Study Leader or principal investigator. Ms. Kuletz works under the direct supervision of the Project Leader, Marine and Coastal Bird Project, Division of Migratory Bird Management, Fish and Wildlife Service, Anchorage, Alaska. The Study Leader is responsible for coordinating the completion of field data collection (including the habitat association information, analysis of field data; and timely reporting of the information in draft and final reports. The Project Leader is responsible for achieving coordination with all other marine bird studies during the planning, implementing, and reporting phases of the study. The USFS investigators are responsible for completing the habitat association descriptions and timber typing as described in this proposal. The USFS investigators work under the general direction of the USFWS Study Leader, all of whom will cooperate toward the accomplishment of the study objectives.

D. Logistics

To complete this study will require the use of a 25-foot vessel, at least one 14 ft Achilles, and field camps in Cabin Bay on Naked Island and on Perry Island. Five USFWS field personnel will be required in June, and at least 4 in July and August. The USFS will have a crew of 3, which will use their own vessel for transport to the site. All camp facilities will be provided by USFWS.

VII. Budget

Salaries and Overtime

Study Leader GS-11 (1FTE)	-	$ 48,000
Biotech GS-7 (1FTE)	-	35,000
Biotech GS-5 (.4FTE)	-	9,100
Biotech GS-5 (.4FTE)	-	9,100
Total Salaries		$101,200

Travel/Per Diem	-	$ 7,000
Supplies	-	6,000
Equipment	-	10,000
Total		$124,200

IX. CITATIONS

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PROPOSED OIL SPILL RESTORATION STUDY

I. Cover

Title: Identification of Upland Habitats Used by Marbled Murrelets in Prince William Sound

Study Identification Number: 4

Name of Study Leaders: Kathy Kuletz

Lead Agency: U.S. Fish & Wildlife Service
Marine and Coastal Bird Project
Anchorage, Alaska

Cooperating Agency: U.S. Forest Service
Glacier Ranger District
Girdwood, Alaska

Cost of Proposal: $124,200

Inclusive Dates of Study Plan: March 1, 1991 - February 28, 1992

Signatures

Study Leader: ______________________

Supervisor: ______________________

Oil Spill Coordinator: Paul E Gertler 6/14/91

Financial Officer: [signature] 6/14/91

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Objective C: Determine presence and absence among habitat types

There is no adequate description of preferred nesting habitat for marbled murrelets in Alaska. Some features which may affect habitat choice are dominant cover type (tree species, age or absence of trees), density of trees, stand size, slope aspect and incline, elevation, distance to water and topographic location (ie. outer peninsula vs inner bay head). For management considerations, the first three features, related to forest type, may be the most pertinent for large-scale application. The remaining features, while potentially influential, are difficult to isolate or control for in sampling. For Naked Island, habitat maps currently available through the U.S. Forest Service can provide information on stand size, volume and size (age) classes and density, and to a lesser degree of accuracy, cover type. The original aerial photographs used to compose the maps will also be used to outline and evaluate forest stand information. Eventually, all lands within the Chugach National Forest will have plant association data available on a GIS system.

Using a timber type map available for Naked Island, dawn watch sample sites will be randomly selected for volume class (classes 1/2, 3 or 4) and stand class (1/2, 3/4). For volume classes 3 and 4, there are no stand classes of 1 or 2, so there are four possible habitat types. A minimum of 20 sites within the four habitats will be selected. Thus, 80 sites will be visited once during the summer. We will attempt to sample the habitat types equally throughout the summer (ie., early, mid and late summer), to minimize seasonal effects. The presence and probable absence of marbled murrelets will be determined using intensive dawn-watch surveys at each site. Other habitat features, such as dominant tree species, slope aspect and incline, elevation and distance from water, will be included in the data base and used to post-stratify or use in a multiple regression on the number of murrelet detections.

Because Naked Island has no dry alpine area to test for murrelet use of this habitat, nearby Perry Island will be used as a secondary study site. No timber type map is available for Perry Island, but the island has clearly delineated alpine areas above the timbered zone. On Perry Island, a minimum of 10 paired comparisons will be made between a forested area and a nearby alpine area. Each pair (total of 20 dawn watches) will be done on the same morning by two observers stationed 500 -1000 meters apart.

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