Murrelet Watch – Citizen-based Monitoring of Marbled Murrelets and Other Seabirds in Southeast Alaska

2007 Progress Report

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Suggested citation:

Romanoff K, and M. Kirchhoff. 2007. Murrelet Watch—Citizen-based monitoring of Marbled Murrelets and other seabirds in southeast Alaska. Unpublished Report. Alaska Department of Fish and Game. Douglas, AK. State Wildlife Grant T-3, project 2.11. 24 pp.

Abstract

A citizen-based program for monitoring population trends of Marbled-Murrelets (*Brachyramphus marmoratus*) using land-based flyway surveys was initiated during summer, 2007. Volunteers in 5 communities completed 365 surveys, from 7 locations, over 52 individual survey days during the summer. Surveys were conducted mostly in the mornings, before 0900 hours. The average number of Marbled Murrelets counted per 15 minute survey was 9.7. Counts were higher in July than in June, and higher in early morning versus late morning and afternoon. Counts were significantly higher in the Juneau, Sitka and Ketchikan areas compared to the Funter Bay and Wrangell areas. To reduce noise in the data, we selected a subset of data for the trend analysis. We included surveys conducted between 0530 and 0830 hours during the month of July only. The Coefficient of Variation (CV) for this subset was 24% lower (CV = 1.3) than the CV for the entire data set. From these data we modeled the power to detect changes in the Marbled Murrelet population over time. The power was relatively low. Assuming 5 survey sites, 21 surveys per year per site, similar CV's to those measured in 2007, and a 10 year monitoring effort, we were 71% likely to detect a 5% per annum decline in the population. That likelihood could be increased by adding additional sites, conducting more surveys per site, extending the monitoring effort over more years, and/or selecting sites with higher flyway activity. We recommend this pilot program be continued, with the following changes: (1) conduct more intensive sampling in a narrower time frame (both daily and seasonally), and (2) add at least 2 high-activity sites elsewhere in the Archipelago. This will require locating volunteer crews in field camps for multi-day time periods as a compliment to the current road-based community approach.

Introduction

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small, diving seabird found in near-shore waters along the northwest coast of North America. The birds nest solitarily, often many kilometers inland on moss platforms in the canopy of tall old-growth trees. Their dispersed, secretive nesting behavior requires that population surveys be conducted when the birds are away from their nests, either sitting on, or flying over the water.

Surveys of birds on the water are typically conducted by boat or plane, with the observer either counting all of the birds within a fixed width strip (strip transects), or recording the distance of each bird from the transect centerline (line transects). A limitation of boat-based methods is the vessel requirement, and the time necessary to cover a representative area. Airplane surveys can cover large areas quickly, but reliable counts require flat calm ocean conditions, and those conditions are rare.

Birds flying to and from their nests at night, either to exchange incubation duties or to provision the young chick, can be counted using high-frequency radar (Burger 1997, 2001, Cooper et al. 2001). The radar system mounts on a boat or truck and is positioned near the mouth of an inlet or valley. Numbers of murrelets can be detected flying to and from the water and their nest site in the dark. This is believed a reliable index of population size (Burger et al. 2001).

Birds also fly during daylight hours as they move among productive foraging sites, or between foraging sites and their nests (VanVliet 1993, Whitworth et al. 2000). These birds fly low to the water, and can also be detected and counted using radar (ADF&G unpublished). During daylight hours, they can also be counted with a spotting scope trained across the water's surface. These flyway surveys require minimal training and equipment, and can be replicated widely in time and space by citizen volunteers. On some flyways, hundreds of Marbled Murrelets can be counted per survey for little cost (ADF&G unpublished data).

Flyway counts are most effective when terrain funnels large numbers of birds through waterways that are less than 3 km across. When waterways are very narrow (< 0.5 km), the field of view is small (vertically and horizontally). Birds flying above or below the field of view are missed, and birds flying through it pass quickly, which can make identification difficult. For waterways > 2 km, an unknown proportion of birds flying in the distant band are not detected. This percentage varies with viewing conditions (shimmer, rain, light, scope quality). Like radar surveys, flyway surveys provide an index of abundance (not a population estimate). The more abundant the population, the more birds will be detected during a standardized survey period.

This report analyzes data collected during the first year of a study using citizen volunteers to collect flyway count data. We examine variation in the counts within a day, within a season, and from site to site within the region. The study objectives are to determine the best times to conduct surveys (minimum variation), the number of survey replicates required, and the number of survey sites required to achieve acceptable power to detect population changes in the region.

Methods

Flyway Counts

Flyway counts were conducted from 7 locations in 5 communities in Southeast Alaska (Table 1). Potential volunteers were recruited from public talks given on Marbled Murrelets in each community. Interested persons attended a subsequent weekend training session where they were familiarized with the survey protocols, the survey equipment, and gained experience identifying flying birds.

Survey stations were typically set up on the beach, or adjoining roadway, with a variable zoom spotting scope trained across the water-body to the opposing shore. Distance to the opposing shore varied from site to site (Table 1, Appendix A). The eyepiece power was primarily set between 20 and 25 power, although observers were allowed to use other power settings if they felt it increased their ability to detect and identify birds. The scope was adjusted so the opposite shore line was in focus, and leveled so that the shoreline bisected the field of view.

Flyway Counts were generally conducted once per week, on weekends, usually in the morning. A survey consisted of 4 or more 15 minute “sample periods”. Pairs of observers alternated counting and recording duties on each 15 minute period. For each survey, we recorded date, time, weather, sea conditions, and tide information (Appendix 1).

Marbled Murrelets were counted flying either “in” or “out” based on flight direction through the field of view. These birds were tallied on a hand-held, double tally-counter. Other species counted included Loon spp., Common Murres, Pigeon Guillemots, Harlequin ducks, Scoter spp., “other” (e.g, Rhinocerous Auklets, or comorants), and “unidentified”. Counts of non-murrelet species were tallied by verbal communication between the observer and the recorder.

Focal Area Scans

Once per survey, the crews conducted a focal area scan, including number of birds seen, by species, sitting within their field of view on the water. These counts were done by unaided eye, except that binoculars and a spotting scope could be used to help identify individual birds to species, and to determine if birds were holding fish. In conjunction with each scan, the observers described weather, sea conditions, visibility, field of view or arc (degrees) and estimated maximum distance seaward that was surveyed. Counts were later converted to birds per km^2.

Results

From 28 May-30 July, crews conducted 365 flyway surveys, on 52 survey days, over 5 survey sites in southeast Alaska (Figure 1). Maps showing the scope locations and sight lines for each of the survey sites are included in Appendix A. In Juneau and Wrangell, different sightlines were surveyed by different crews. However, they were close enough in proximity to effectively sample the same population of birds. Thus, these sightlines were combined for reporting purposes.

Survey effort varied by site, with the largest number of surveys completed in Ketchikan (n = 131) and the fewest in Funter Bay (n = 32) (Figure 2). The number of surveys per day averaged 7.2 (SD = 4.6, range = 1-23).

On average, teams counted 9.7 Marbled Murrelets per 15 minute survey (SD=16.8, max = 108) (Table 1). Counts were highly variable among the 5 sites, with the higher numbers of birds in Sitka, Juneau and Ketchikan, and significantly lower numbers of birds in Wrangell and Funter Bay (Figure 3).

Most surveys were conducted in the mornings, with 69% of surveys occurring between 0530 and 0830 hours; however, some surveys were conducted as early as 0435 and as late as 2155 (Figure 4). There was a clear trend of higher counts on surveys conducted earlier in the day (Figure 5), and to a lesser degree, late in the day (Figure 6). These results are consistent with intensive flyway surveys conducted at Port Snettisham in 2005 and 2006 (ADF&G unpublished data), and reflect higher activity in early morning and late evening hours as birds apparently are flying to and from preferred foraging areas and nests (or resting sites).

In addition to variation within the day, there was also significant variation in counts throughout the summer. The number of birds increased over time, with significantly more birds counted after July 3rd, than before June 24th. The peak occurred in late July, consistent with patterns observed during intensive flyway surveys in Port Snettisham during 2005 and 2006 (ADF&G unpublished data). This overall pattern was largely determined by the survey results for Ketchikan and Sitka (Figure 8). The other communities showed weak or inconsistent patterns.

Other seabirds counted on the flyway surveys occurred in relatively small numbers compared to Marbled Murrelets (Appendix B). Of these, the most abundant species were scoters (in Juneau) and “Other species” (primarily Rhinocerous Auklets) in Sitka (Figure 9).

The results reveal a high level of noise in the data—that is, variation unrelated to the variable of interest- population size. The extraneous factors that influence the number of Marbled Murrelets counted include period of the day, period of the summer, and survey location. To control for those factors, we examined a subset of the data, looking for relatively high sample size, high means, and low variance. After examining multiple subsets of the data, the lowest coefficient of variation (CV) obtained was for surveys conducted in the early morning (between 0530 and 0730 hours) during the month of July (Table 2). The CV for this subset of data was 1.30, compared with a CV of 1.72 for the unfiltered dataset.

To compute power to detect change, we used the program Monitor (Gibbs and Arrelan 2007), and the parameters for the subset of data shown in Table 2. The run assumed an average of 21 surveys per site, on 5 sites. Surveys would be conducted during the month of July in the morning hours, between 0530 and 0830. The expected coefficients of variation (standard deviation / mean) would mimic those observed during the 2007 pilot study. For this prospective analysis, we weighted the CV from each survey site by its 2007 sample size. We assumed the sites would be monitored for 10 years, with no pre-supposition about the direction of population change. We assumed any observed change would be linear; and we accepted an alpha level of ≤ 0.10 (i.e., a < 10% chance of wrongly reporting an increase or decrease).

The results of the simulation indicate that this monitoring program over 10 years time could detect a 3% annual population increase with 66% likelihood. It would detect a 4% annual increase with 85% likelihood, and a 5% increase with 94% likelihood. The monitoring program is not as sensitive to population decreases. It could detect a 3% annual decrease with 45% likelihood, a 4% annual decrease with 56% likelihood, and a 5% annual decrease with 71% likelihood.

Discussion

The results show relatively high degree of variance, or noise, in the flyway count data, although not unlike that found in at-sea surveys conducted across similar daily and seasonal time intervals (ADF&G unpublished). Factors such as time of day, and date within the breeding season have a significant effect on the number of birds counted, quite apart from the size of the Marbled Murrelet population. Moreover, the covariates themselves are quite variable in their influence from area to area, and throughout the summer, which makes them difficult to model. Variation can be reduced by restricting the temporal window for surveys. We suggest morning hours, before 0830, during July, provide the optimal time for surveys. We recorded larger numbers of birds, and slightly lower variances, during these times.

The surveys can also be improved by selecting survey sites where relatively large numbers of Marbled Murrelets can be counted (increasing the mean), and/or by narrowing the sample frame temporally to reduce sample variance. It is also possible to increase the power of the surveys by increasing the number of survey sites, increasing the number of replicate surveys (within a site and year), and increasing the number of years surveyed.

Our goal is to have a > 90% likelihood of detecting a 3% annual decline in Marbled Murrelets over a 10 year period. We could reach that goal by doubling the number of sites surveyed to 10, by increasing the number of surveys on the existing 5 sites to 120, or by extending the monitoring period to 15 years. Rather than adopt any one of those changes in total, we recommend a combination of smaller changes and enhancements. Principle among these is a narrowing of the sampling time frame (both within the day and within the summer), increasing sample intensity (number of surveys per 10 days), and adding 2 or more high-activity sites to the sample frame. These changes should more than meet our monitoring objectives.

These power analyses assume there is no error in the counts themselves. That is, no birds are missed or misidentified during the counts. This is not likely true, which would mean the true power is probably lower than that reported here. There is also an issue of possible pseudo-replication in the current design. Because 15 minute surveys were conducted back to back at each site, they are likely auto-correlated. Future surveys can still be 15 minutes long to ensure alertness, but the results of 4 15-minute consecutive surveys might be summed, and reported as a tally for an 1 hour-long survey block. This will reduce the sample size by 75%, but should also stabilize the variance relative to the mean. The effect on the CV, and power, should not be dramatic.

Recommendations

We recommend continuing this exploratory project for one more year with the following recommended changes based on the results of work in 2007:

1) During the month of June, multiple sites should be scouted for marbled murrelet flyway activity. Only sites with > 3 MAMU detections per 15 minute survey should be considered as formal survey sites.
2) Add 2 or more survey sites from the following list of known or suspected high-activity areas:
    a. Port Snettisham (mainland)
    b. Strait Island (Sumner Strait)
    c. Sisters Island (Icy Strait)
    d. Point Adolphus (Icy Strait)
    e. Young Island, (Glacier Bay)
3) Conduct daily surveys during a 10-day time window, from 5-15 July.
4) Conduct surveys between 0530 and 0830 hours, and between 1930 and 2230 hours. Survey at least once in the morning, and once in the evening, each day.
5) Conduct all surveys in 4 consecutive 15 minute periods (alternating observers every 15 minutes) for a 1 hour "time block". If doing 2 or more time blocks in a morning/evening, separate the blocks by at least ½ hour.
6) When counting, record number of fish-holding birds flying in each direction separately from non-fish-holding birds. Fish-holding birds are likely breeders.
7) Maximize accuracy and precision by adhering to precise sight lines, using similar optics, and training/testing crews throughout the season.

Acknowledgements

We would like to thank the dedicated volunteers who generously contributed their time, talent, and energy to this study. They are: **Ketchikan:** Rosemarie Bengeron, Peter Dwyer, Cheryl Fultz, Debbie Gravel, Amanda Kiely, Drew Lindmer, Andy Piston, Jim Pomplun, Leslie Swada, **Sitka:** Kent Bovee, Erik Bahnsen, Kristina Calvin, Darlene Dehlin, Matt Goff, Kameron Perensovich, Joanne Kleis, John Kleis, Kitty Labounty, Natalie Sattler, Justin Schalon, **Juneau:,** Marge Hermans, Aleria Jensen, Laurie Lamm, Wayne Longacre, Beth Peluso, Pauline Strong, **Wrangell:** Bonnie Demerjian, David Rak, Paula Rak, and Carol Ross. We also thank Gus VanVliet for discussions and ideas that sparked this study, and for his assistance in identifying flyway monitoring areas.

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van Vliet G. 1993. Flyways and the Marbled Murrelet: observations and long-distance foraging flights by thousands of *Brachyramphus Mamoratun* during the chick-rearing period in the Icy Strait-Glacier Bay National Park region of northern Southeast Alaska. *Unpubl. Report*. On file. Alaska Department of Fish and Game, Douglas, AK. 9pp.

Whitworth, D. L., S. K. Nelson, S. H. Newman, G. B. van Vliet, and W. P. Smith. 2000. Foraging distances of radio-marked Marbled Murrelets from inland areas in Southeast Alaska. *The Condor* 102:452-456.

Table 1. Mean number of Marbled Murrelets counted per 15 minute survey period in each of the 5 survey areas, May 28-July 30, 2007. Overall CV = 1.72

Survey Area	Mean	Std. Deviation	N
Ketchikan	10.50	15.06	131
Wrangell	1.30	2.51	60
Sitka	14.56	24.50	88
Juneau	14.09	14.45	54
Funter Bay	2.09	3.49	32
Total	**9.76**	**16.81**	**365**

Table 2. Mean number of Marbled Murrelets counted per 15 minute survey period in each of the 5 survey areas during July, on surveys between 0530 and 0830 hours. Overall CV = 1.30

Survey Area	Mean	Std. Deviation	N
Ketchikan	11.21	11.62	39
Wrangell	1.33	2.15	12
Sitka	15.68	19.40	28
Juneau	15.0	19.28	23
Funter Bay	10.0	6.08	3
Total	**12.07**	**15.70**	**105**

Figures

Figure 1. Location of 5 sites in Southeast Alaska where Marbled Murrelets were surveyed with flyway counts in 2007.

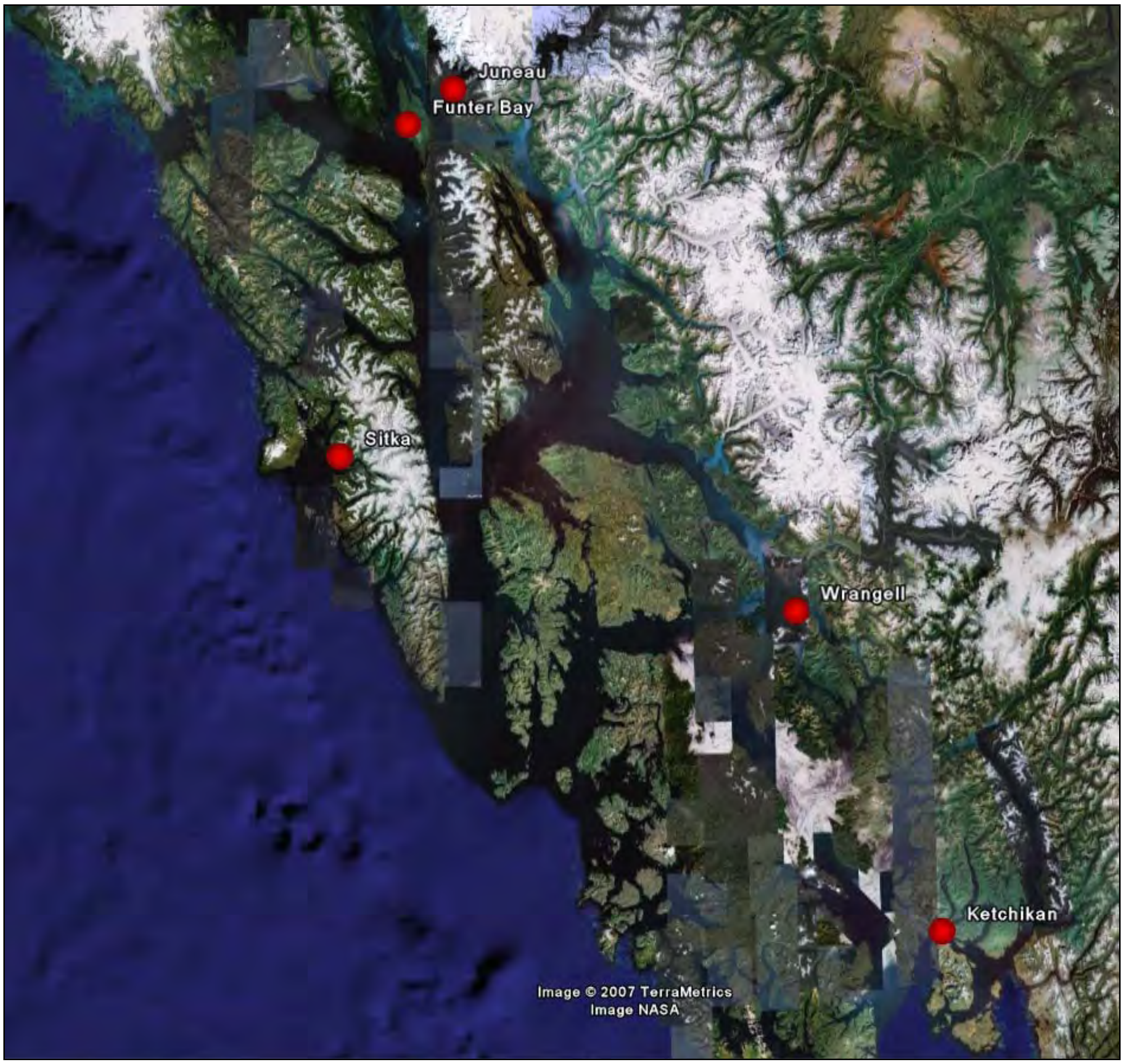

Figure 2. Relative survey effort by area (N surveys = 365)

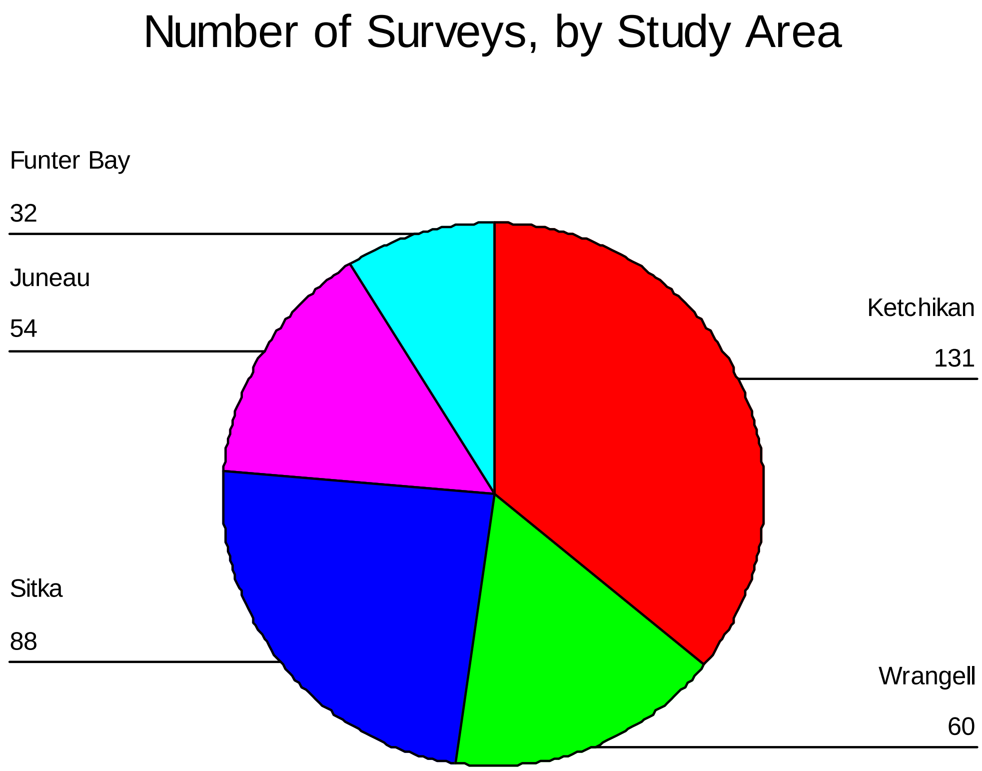

Figure 3. Mean Count of Marbled Murrelets per survey, by survey area. Counts reflect averages for the entire summer, over all times of day.

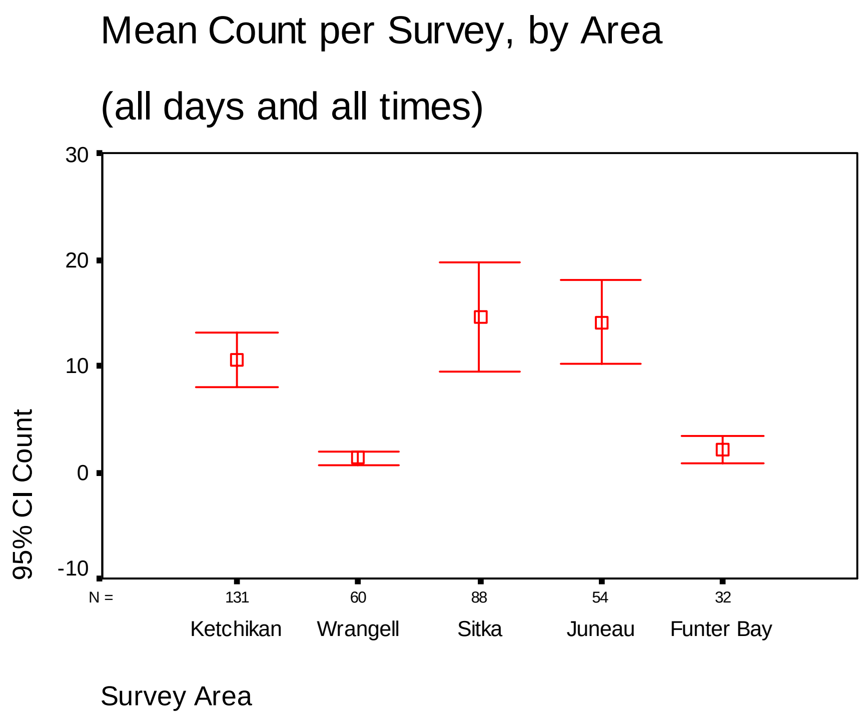

Figure 4. Sampling effort (percent of surveys) by hour of the day.

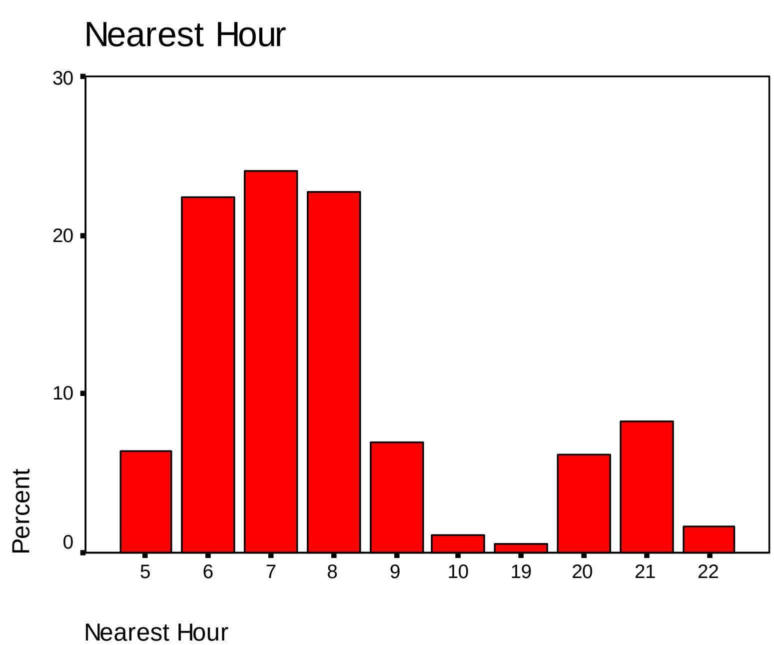

Figure 5. Mean number of Marbled Murrelets per 15 minute survey during the early morning hours.

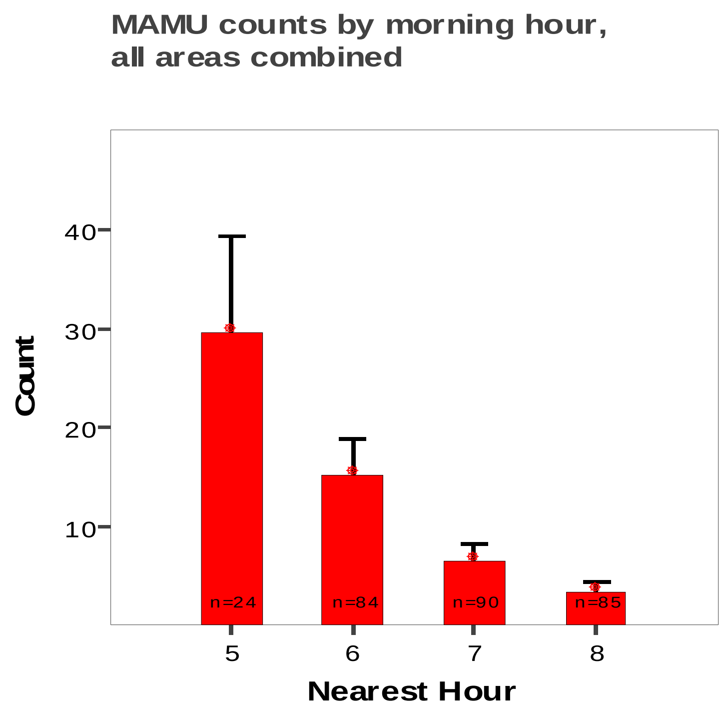

Figure 6. Mean number of Marbled Murrelets per 15 minute survey during the late evening hours.

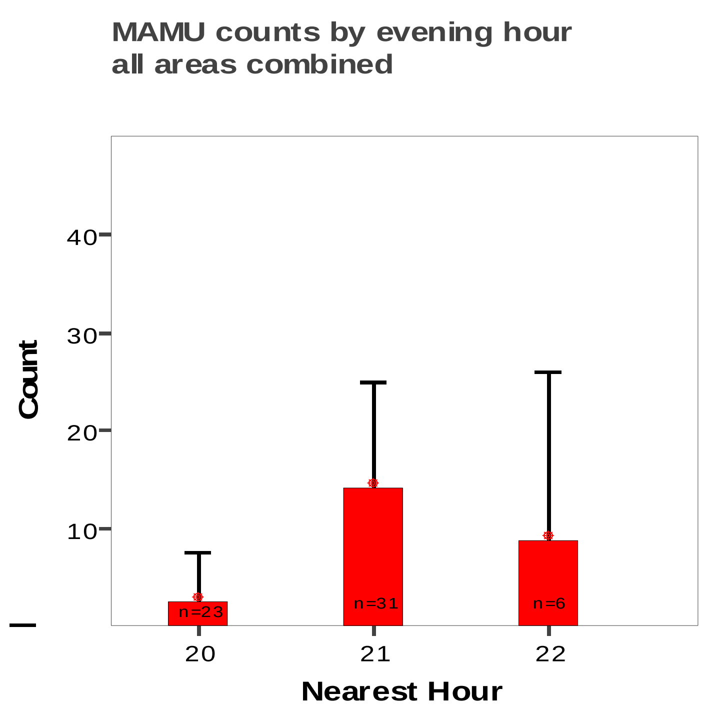

Figure 7. Number of Marbled Murrelets Counted per survey, between May 28 and July 30, 2007 (9-day intervals).

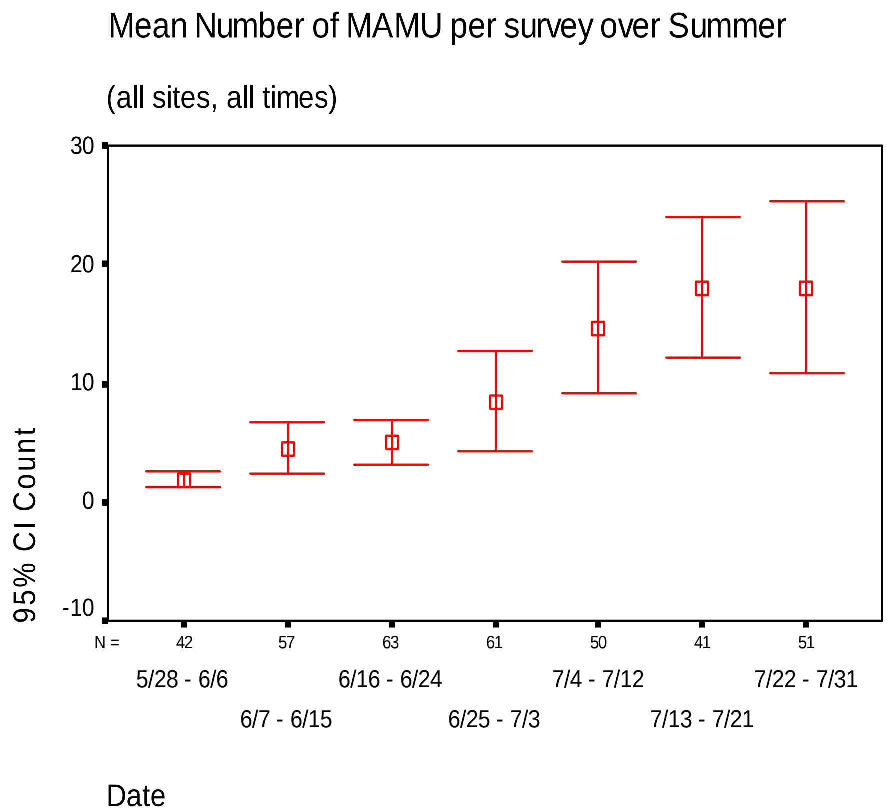

Figure 8. Number of Marbled Murrelets Counted per survey, between May 28 and July 30, 2007 (9-day intervals) at each study site

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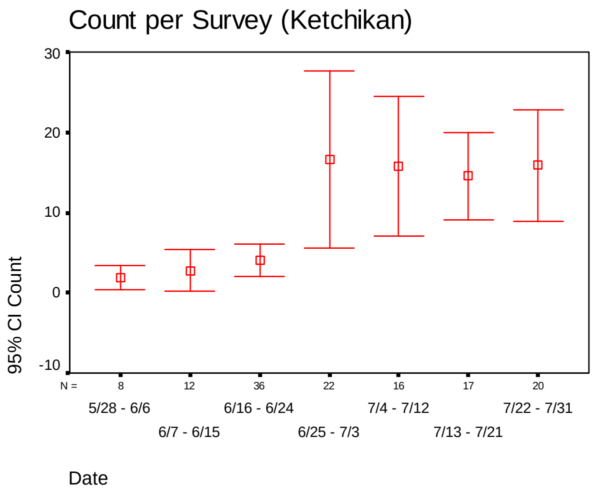
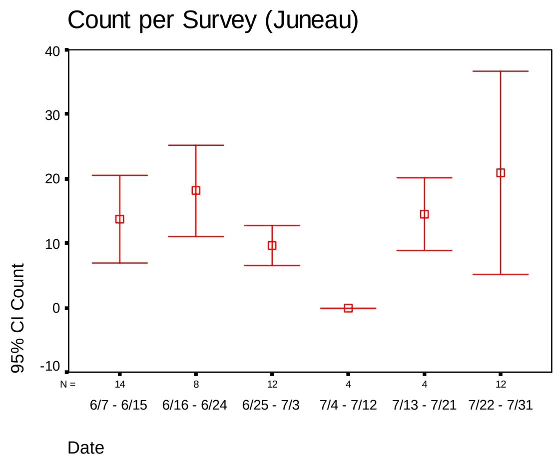
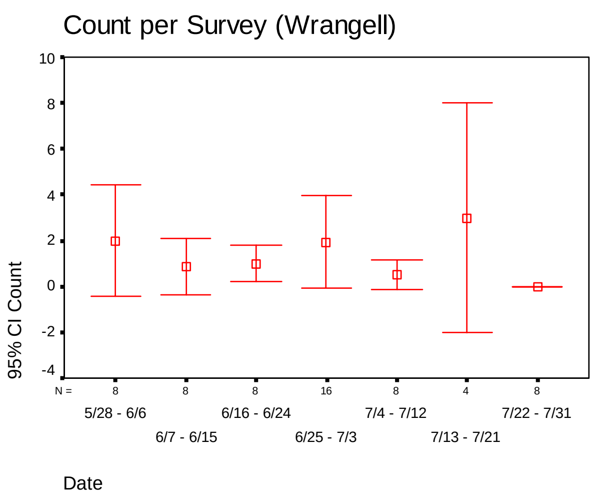
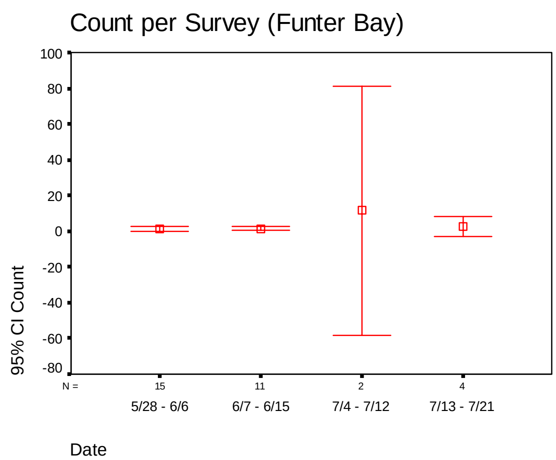








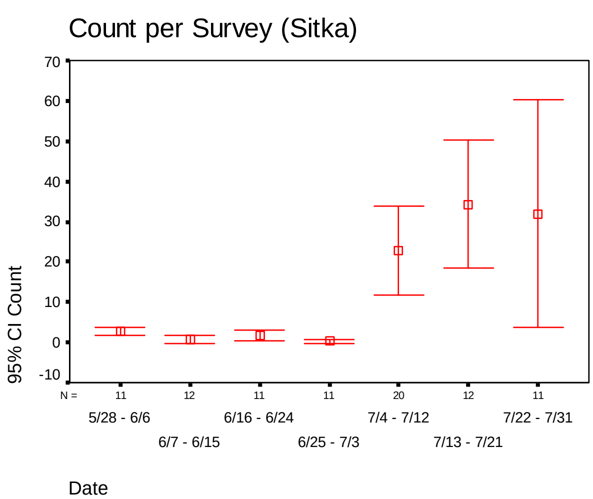
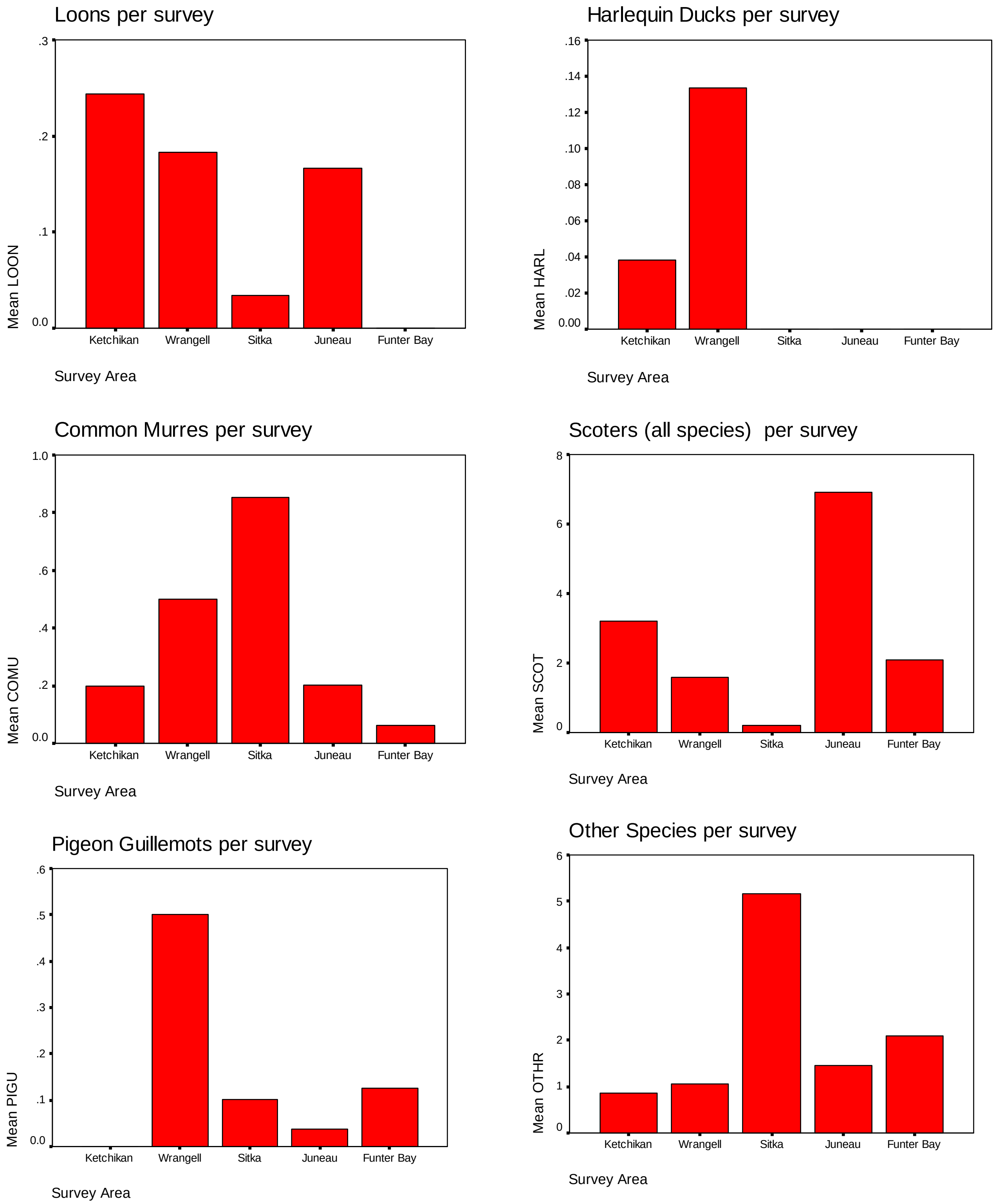


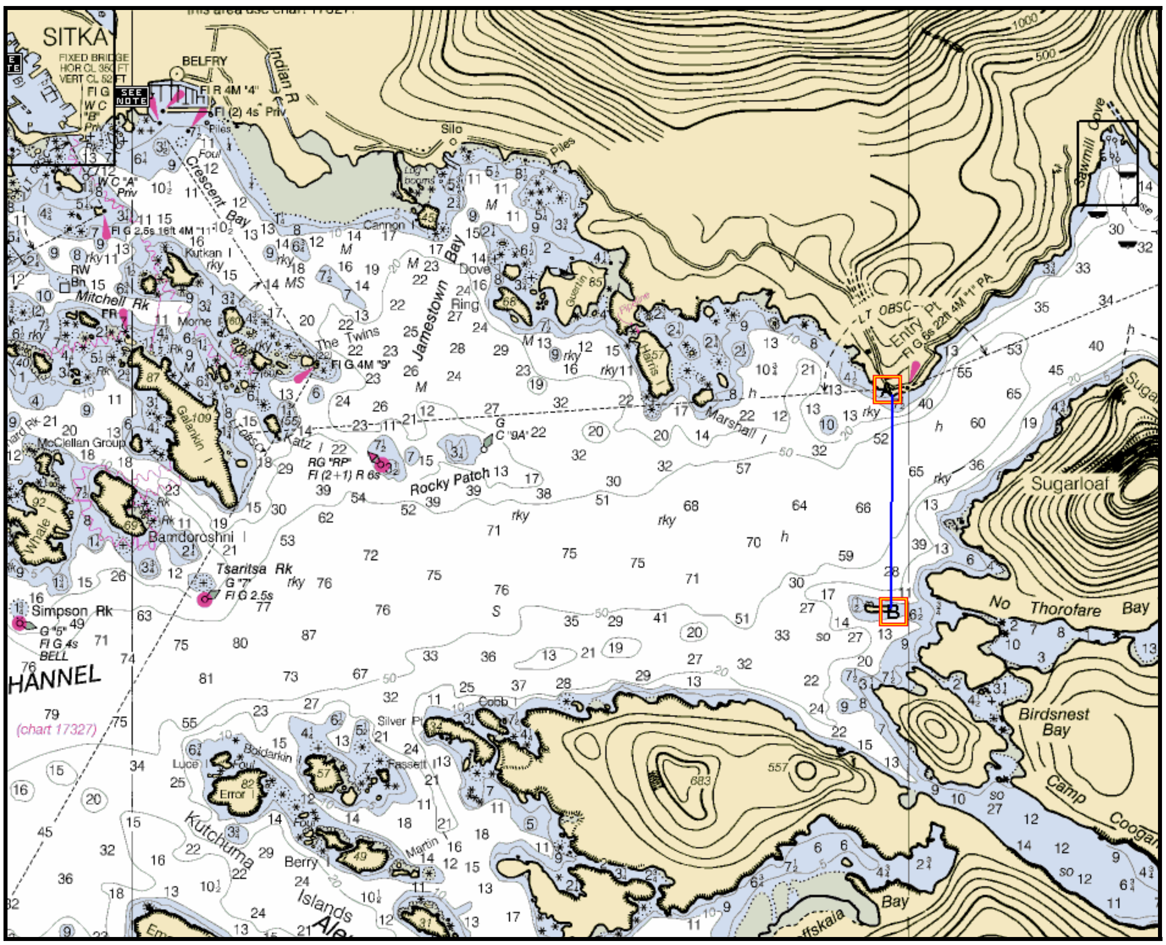
Figure 9.Numbers of other species counted per survey, by community



Appendix A

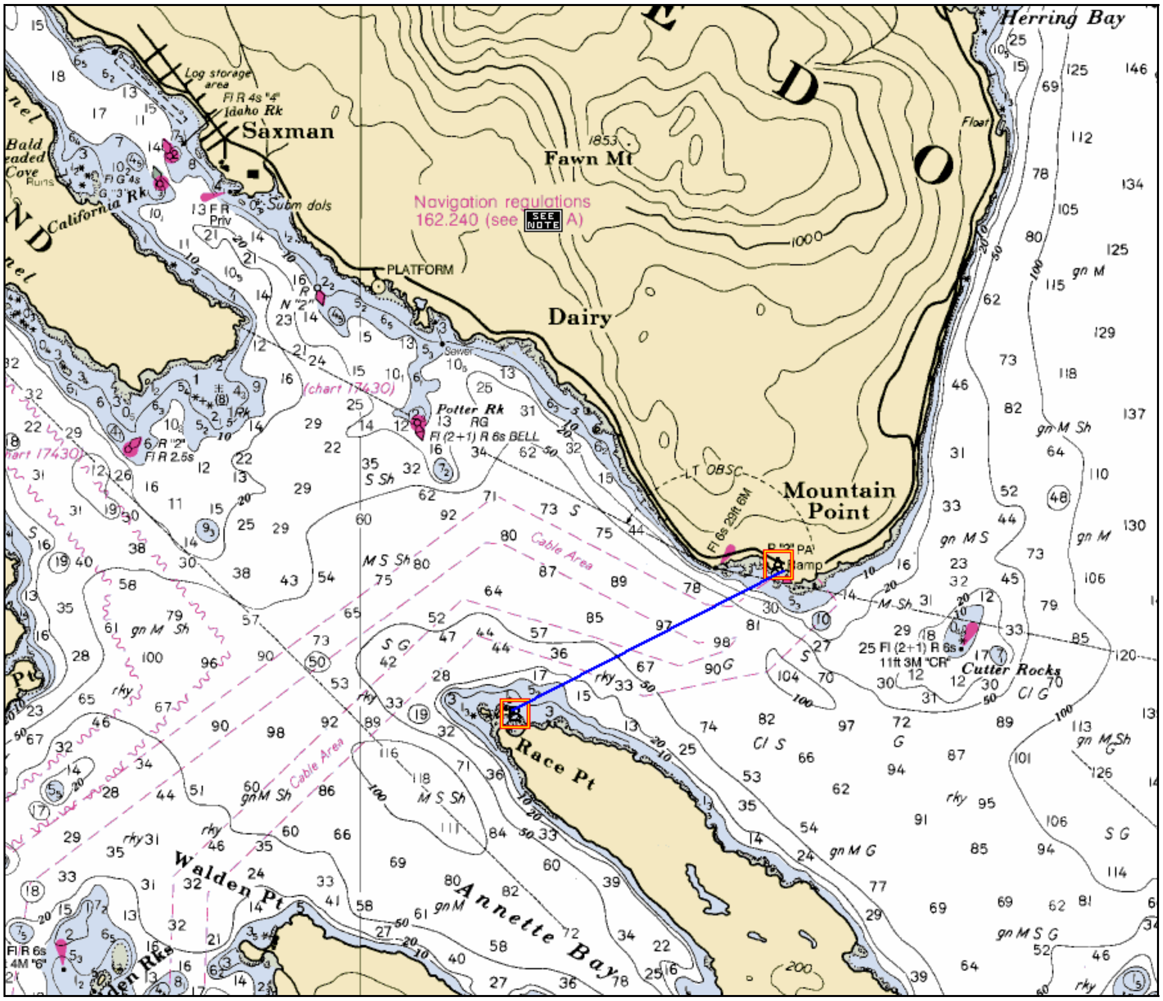
<u>Sitka -- Entrance Point</u>

Point A (scope)	57° 01.934’ N	135° 15.146’ W
Point B (terminus)	57° 01.217’ N	135° 15.153’ W
Distance 1.39 km		



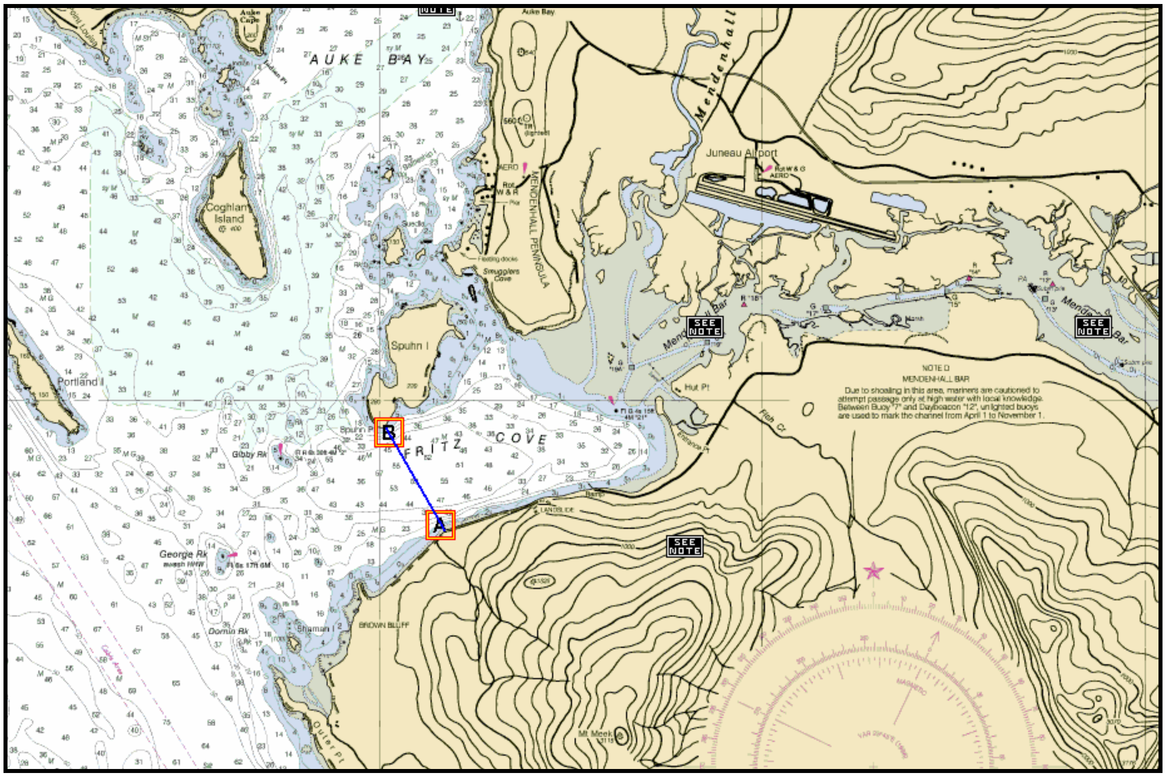
Ketchikan – Mountain Point

Point A (Scope)	55° 17.614’ N	131° 32.510’ W
Point B (Terminus)	55° 17.144’ N	131° 34.113’ W
Distance 1.90 km		



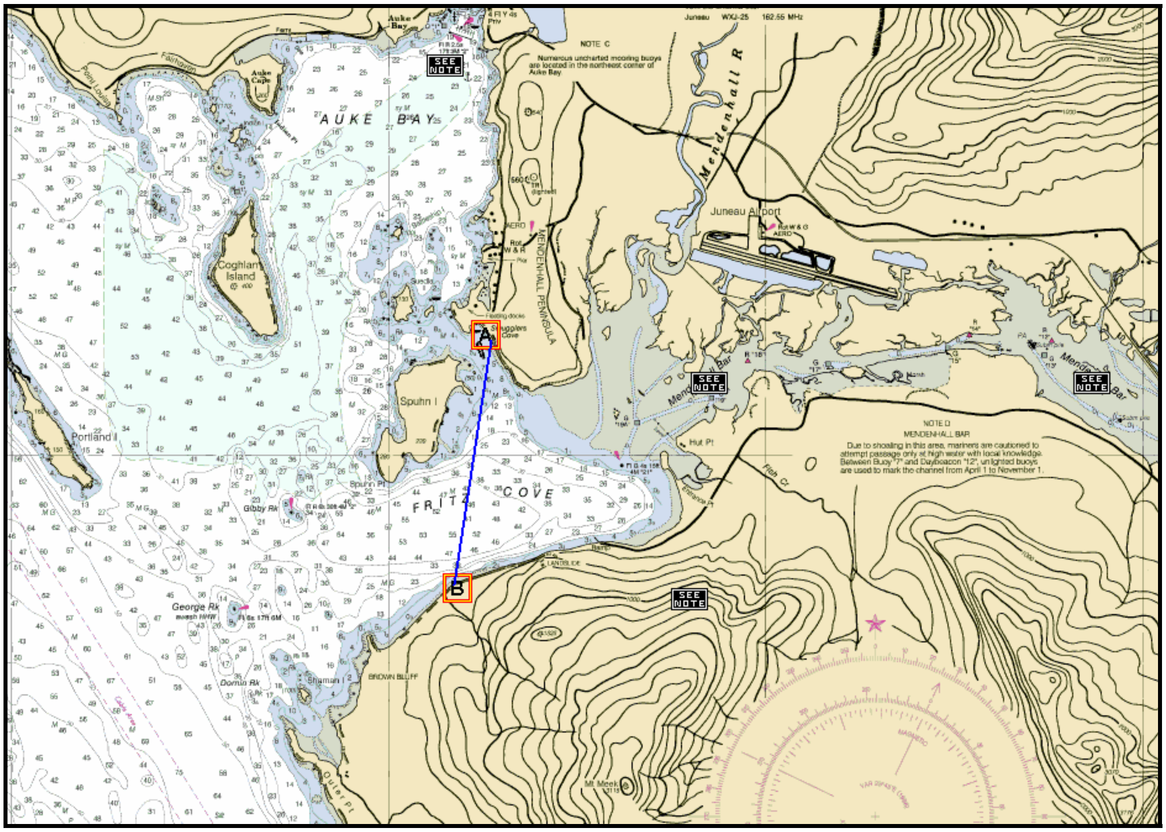
<u>Juneau – North Douglas</u>

Point A (scope)	58° 19.105' N	134° 39.143' W
Point B (target)	58° 19.811' N	134° 39.920' W
Distance 1.51 km		



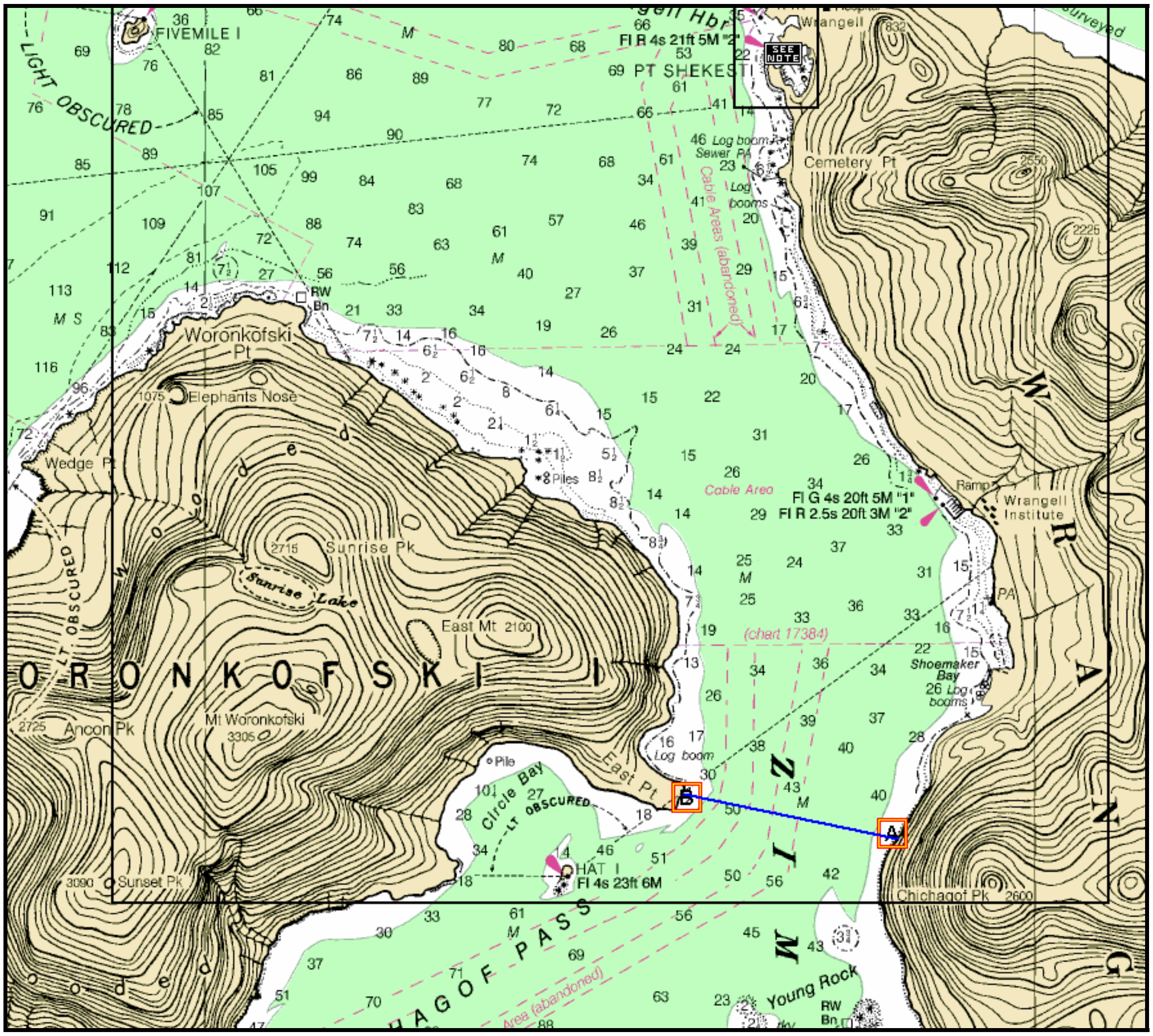
Juneau – Smugglers Cove

Point A (scope) 58 20.805’ N 134 38.635’ W
Point B (target) 58 19.101’ N 134 39.134’ W
Distance 3.19 km



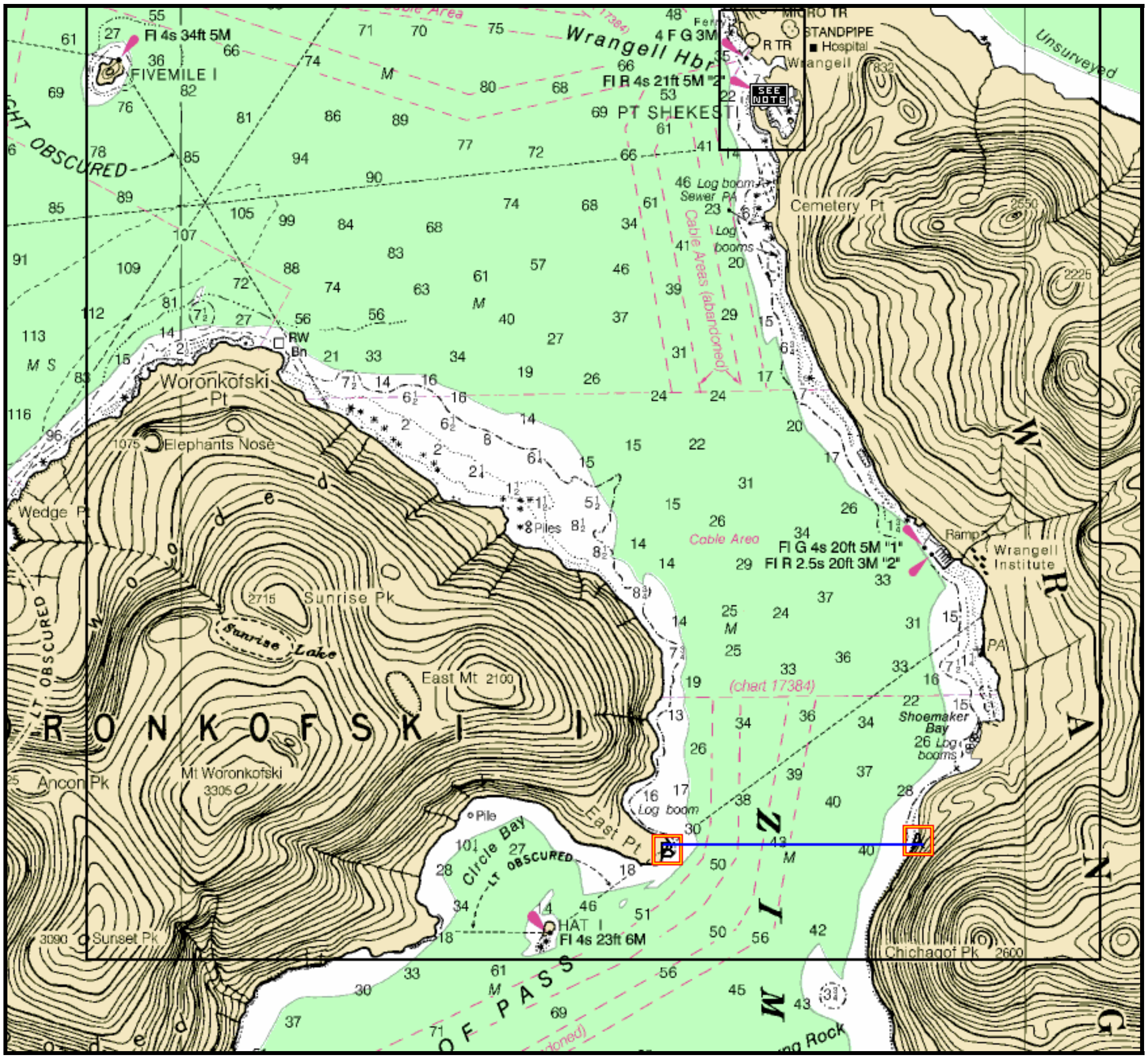
Wrangell – East Point

Point A (scope) 56° 22.765’ N 132° 21.646’ W
Point B (target) 56° 23.065’ N 132° 24.232’ W
Length – 2.71 km



Wrangell – 7.5 Mile Zimovia Highway

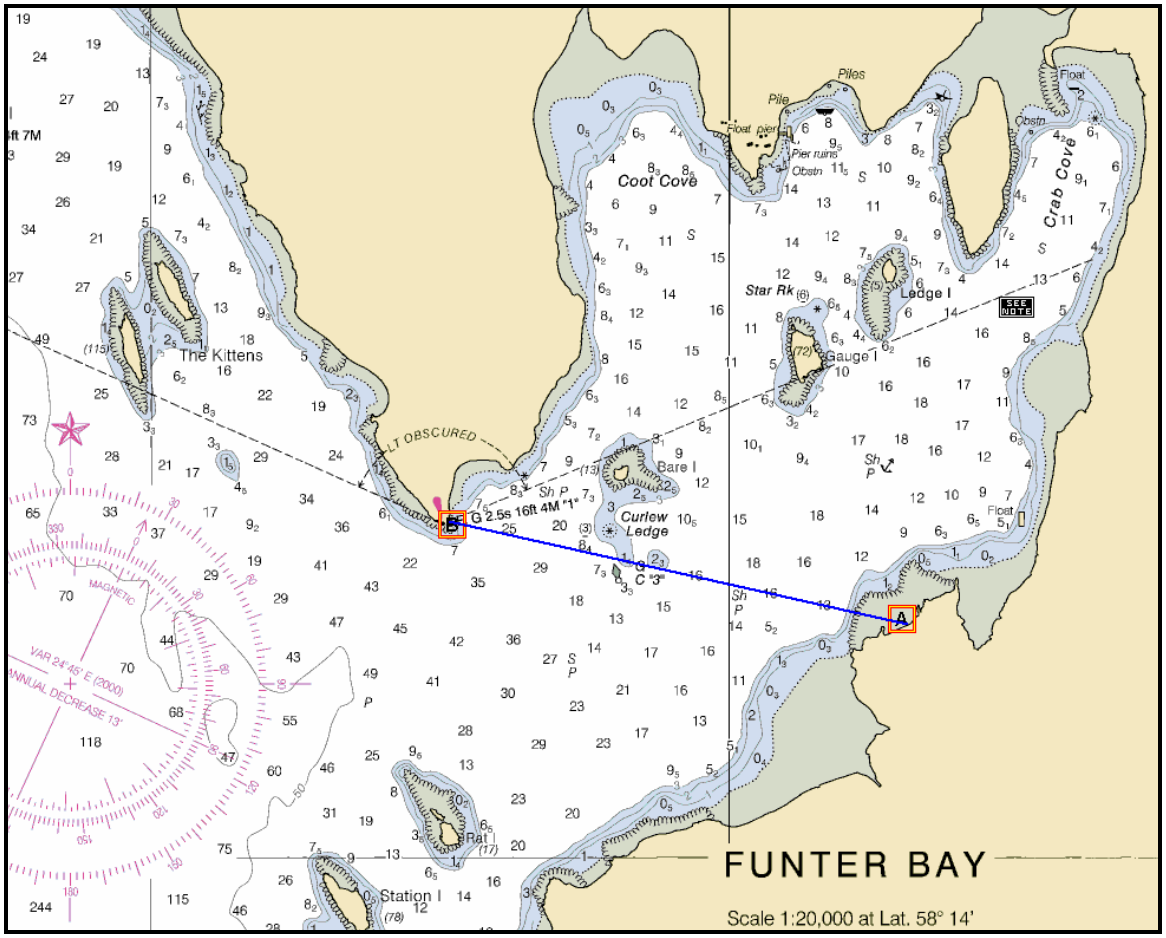
Point A (scope)	56° 23.107’ N	132° 21.203’ W
Point B (target)	56° 23.065’ N	132° 24.232’ W
Length 3.16 km		



Funter Bay – Clear Point

Point A (scope)	58° 14.424' N	134° 53.382' W
Point B (target)	58° 14.611' N	134° 54.968' W

Length 1.58 km



Appendix B

Counts of other species recorded during Flyway Surveys

Survey Area		LOON	COMU	PIGU	HARL	SCOT	OTHR	UNID
Ketchikan	Mean	.24	.20	.00	.04	3.21	.86	.71
	N	131	131	131	131	131	131	131
	Maximum	7	6	0	4	40	32	18
	Std. Error of Mean	.080	.070	.000	.031	.593	.281	.219
Wrangell	Mean	.18	.50	.50	.13	1.60	1.07	3.55
	N	60	60	60	60	60	60	60
	Maximum	3	16	4	6	38	39	75
	Std. Error of Mean	.077	.315	.131	.105	.707	.660	1.671
Sitka	Mean	.03	.85	.10	.00	.19	5.16	2.08
	N	88	88	88	88	88	88	88
	Maximum	2	9	2	0	7	119	40
	Std. Error of Mean	.025	.190	.043	.000	.099	1.741	.891
Juneau	Mean	.17	.20	.04	.00	6.91	1.46	.52
	N	54	54	54	54	54	54	54
	Maximum	4	7	2	0	43	18	8
	Std. Error of Mean	.091	.148	.037	.000	1.164	.584	.204
Funter Bay	Mean	.00	.06	.13	.00	2.09	2.09	1.03
	N	32	32	32	32	32	32	32
	Maximum	0	1	1	0	24	10	18
	Std. Error of Mean	.000	.043	.059	.000	.801	.524	.583
Total	Mean	.15	.39	.12	.04	2.67	2.13	1.51
	N	365	365	365	365	365	365	365
	Maximum	7	16	4	6	43	119	75
	Std. Error of Mean	.035	.078	.027	.021	.324	.463	.365