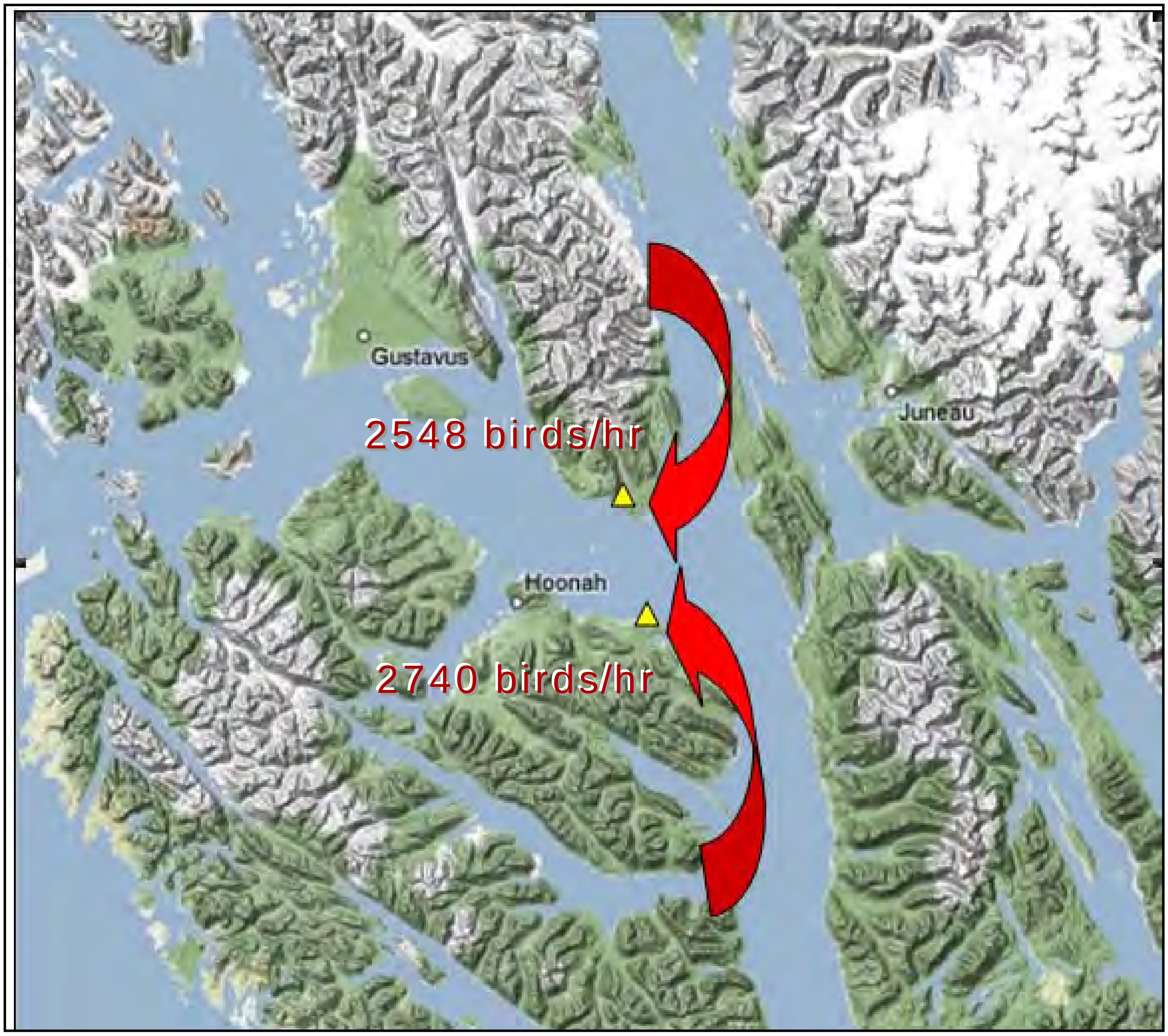
Murrelet Watch

Citizen-based monitoring of Marbled Murrelets and other seabirds in Southeast Alaska



2008 Progress Report

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Cover Graphic: Map showing the major flyway citizen-watch volunteers monitored and the numbers of birds per hour averaged during the peak of the breeding season in July 2008.

Table of Contents

List of Figures and Tables

Abstract

A citizen-based program for monitoring population trends of Marbled Murrelets (*Brachyramphus marmoratus*) was continued in 4 communities, and at 2 remote sites in Southeast Alaska in summer 2008. The community based flyway surveys were conducted 7–18 July, with observers gathering data in the early morning and/or late evening hours at 7 survey sites. The remote field camp surveys were conducted throughout the day from 20–27 July, from 2 survey sites in eastern Icy Strait. A total of 288 surveys were conducted from the communities, and 347 surveys were conducted from the remote field camps.

Community-based surveys showed a wide range in flyway activity, with the highest counts coming from the Sitka and Ketchikan sites, and very low counts from the Petersburg sites. Flyway activity at the community-based sites ranged into the low hundreds of birds per hour, whereas the flyway activity at the remote Icy Strait sites reached thousands of birds per hour during peak periods of the day. In Icy Strait, birds moved from east to west in the early morning hours, and returned in the opposite direction in the evening hours. The waters of western Icy Strait, from Point Adolphus to Lemesurier Island, are an important foraging area for Marbled Murrelets, drawing many birds from long distances.

The relatively low and variable counts associated with the community-based surveys translate into low power to detect population trends. Even with a sustained (10-year) annual monitoring program, the power to detect a 10% per annum decline is less than 20% (one-tailed t-test, P=0.10). In contrast, the peak morning and evening counts at 2 sites in Icy Strait had many birds, low variability, and acceptably high power to detect long-term trends (e.g., 98% power to detect a 4% per annum decline). While monitoring could be justified in Icy Strait using flyway counts, the method produces much lower, and more variable counts elsewhere in Southeast Alaska. For that reason, we recommend citizen-science-based monitoring for Marbled Murrelets be shifted from flyway counts to at-sea surveys, which have been shown to produce useful data for detecting population trends.

Introduction

The Marbled Murrelet (*Brachyramphus marmoratus*) is a small, diving seabird found in nearshore waters along the northwest coast of North America. The bird nests solitarily, often many kilometers inland, on moss platforms in the canopy of tall old-growth trees. Birds flying to and from their nests at night have been counted using high-frequency radar (Burger 1997, 2001; Cooper et al. 2001), which provides 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). During daylight hours, they can be counted with radar or with a spotting scope trained across the water's surface. Flyway counts are most effective when terrain funnels large numbers of birds through waterways that are less than 3 km across. For waterways > 3 km, an unknown proportion of birds flying in the distant band likely go undetected. As with radar surveys, flyway surveys provide an index of abundance (not a population estimate). Depending on how stable and uniform these surveys are over time (within day and within season), they can be useful for monitoring population trends in Marbled Murrelets.

The surveys in this study were conducted by volunteers under the supervision of Alaska Department of Fish and Game (ADF&G) staff. Some survey sites were accessed from community road systems, with volunteers conducting the surveys before or after work. In other cases, the surveys were conducted at remote sites, where volunteers established a field camp. At these latter sites, surveys were conducted throughout the day.

The purposes of this study are to (1) identify patterns of flyways activity in time and space, across a number of survey locations in Southeast Alaska (2) determine within- and between-day variability in flyway counts at these locations, (3) identify optimal times and locations for conducting these surveys, (4) model the statistical power of different surveys to detect Marbled Murrelet population trends over a 10-year time frame, and (5) make recommendations for citizen-based monitoring in the future.

Methods

Community-Based Surveys

Surveys were conducted at 7 sites along the road systems of 4 communities (Juneau, Petersburg, Sitka, and Ketchikan). Surveys were conducted for the first 2 hours before sunrise and the last 2 hours before sunset, alternating observers every fifteen minutes. These times were chosen because they encompass periods of maximum flyway activity by Marbled Murrelets as they move between nesting and feeding areas (Romanoff and Kirchhoff 2007). Surveys were conducted over a 10 day period, from 7–17 July, a time period which encompasses the likely peak of provisioning activity for breeding birds (Kirchhoff 2006, 2007).

Birds were counted using a waterproof, variable-zoom Barska® spotting scope with a 25–75 power eyepiece and an 80 mm objective lens. The scope was oriented so that the opposing shoreline bisected the field of view, and power was set to optimize detection. Observers tallied the number of murrelets flying in each direction on handheld counters. Birds on the water were not counted. Flying birds were reliably identified as murrelets by their size, shape, coloration, and distinctive flight characteristics (high speed, rapid wing beat, linear direction, and close to the water’s surface). Observers received thorough training on survey protocols and murrelet identification prior to conducting surveys. For each survey, observers also recorded information on weather and sea-state conditions, tidal stage, visibility, and other environmental variables.

Remote-site Surveys

Remote-site surveys were conducted by field crews stationed at the eastern end of Icy Strait, on Entrance Island near Point Couverden, and at Whitestone Harbor on Chichagof Island. These 2 sites were chosen because large numbers of murrelets had been previously documented flying westward in the early morning, and eastward in the late evening, through Icy Strait (Whitworth et al. 2000; Lindell, USFWS, unpublished). At each site, observers conducted flyway surveys using similar protocols described above, but with slightly different scheduling. Because the observers were on the site 24 hours a day, surveys were expanded to opportunistically sample all daylight hours, while still emphasizing the morning (0500–0900) and evening (1800–2200) “rush hours.” At these remote sites, 15-minute surveys were conducted on the hour and half-hour between 0500 and 2130, from 20–27 July. Surveys at remote sites were made using a Barska® scope with 25–75 zoom eyepiece and a 100 mm objective lens.

Data Analysis

Because counts can be strongly influenced by viewing conditions, we excluded surveys from the analysis when visibility was rated fair, poor, or very poor. These included surveys with rain, drizzle, fog, wind, low light or poor contrast. Surveys with visibility rated good to excellent had ample light, high contrast (with the water), and minimal shimmer. Under these conditions, birds could be seen distinctly and details on the far shore (for viewing distances < 4 km) were visible. Because of the long distance between shores in Icy Strait, the counts at the Entrance Island and Whitestone Harbor locations miss an unknown (but presumably constant) proportion of more distant flying birds.

Flyway surveys are intended to detect trends in Marbled Murrelet populations over relatively long (5- to 10-year) periods of time. The power of these surveys to do that is a function of the variance in these surveys. We know Marbled Murrelets make more flights during the early morning and late evening hours when breeding birds are moving between foraging areas and their nests (Whitworth et al. 2000). We know further that the proportion of adult birds making flights on any given day within the breeding season will vary depending on the stage of the breeding cycle. These 2 sources of variance can be minimized by narrowing the temporal survey window. Thus, for our purposes, we define a survey data point as the mean number of birds seen per hour during either the morning or the evening "peak" periods for a given day.

Each survey is classified by the hour in which it was conducted. For remote site surveys, which were conducted on the hour and half hour, we averaged the counts for those two surveys and assigned the result to that same hour. Thus, a survey that was begun at 0530 and ended at 0545 was assigned to the 0500 hour. Because the community-based surveys started and stopped at irregular times throughout the hour, we assigned those surveys to the "nearest" whole hour. Thus, for example, any survey started between 0531 and 0629 was assigned to the nearest whole hour, or 0600.

The different survey schedules for the two types also meant differences in how the "peak" activity periods were defined. From previous work, we knew the peak flyway activity occurred in the post-dawn and pre-dusk hours (Romanoff and Kirchhoff 2007). For community based surveys, we planned surveys between 0500–0700 or 1900–2100 to capture presumed AM and PM "peak periods." In the case of remote surveys, crews were on site 24 hours a day and surveyed during all daylight hours. This allowed empirically-derived "peak periods" based on magnitude of the hourly counts. For remote-site surveys, this turned out to be 0500–0900 and 1800–2200 hours for the AM peak period and the PM peak period respectively.

Results

Community-based Flyway Counts

A total of 241 surveys with good or excellent visibility were conducted across 7 sites in Southeast Alaska over 11 days (7–18 July). The number of surveys conducted at each survey site is shown in Figure 1. The majority of surveys were conducted at Juneau's Fritz Cove site, Ketchikan's Mountain Point site, and Sitka's Whale Park site.

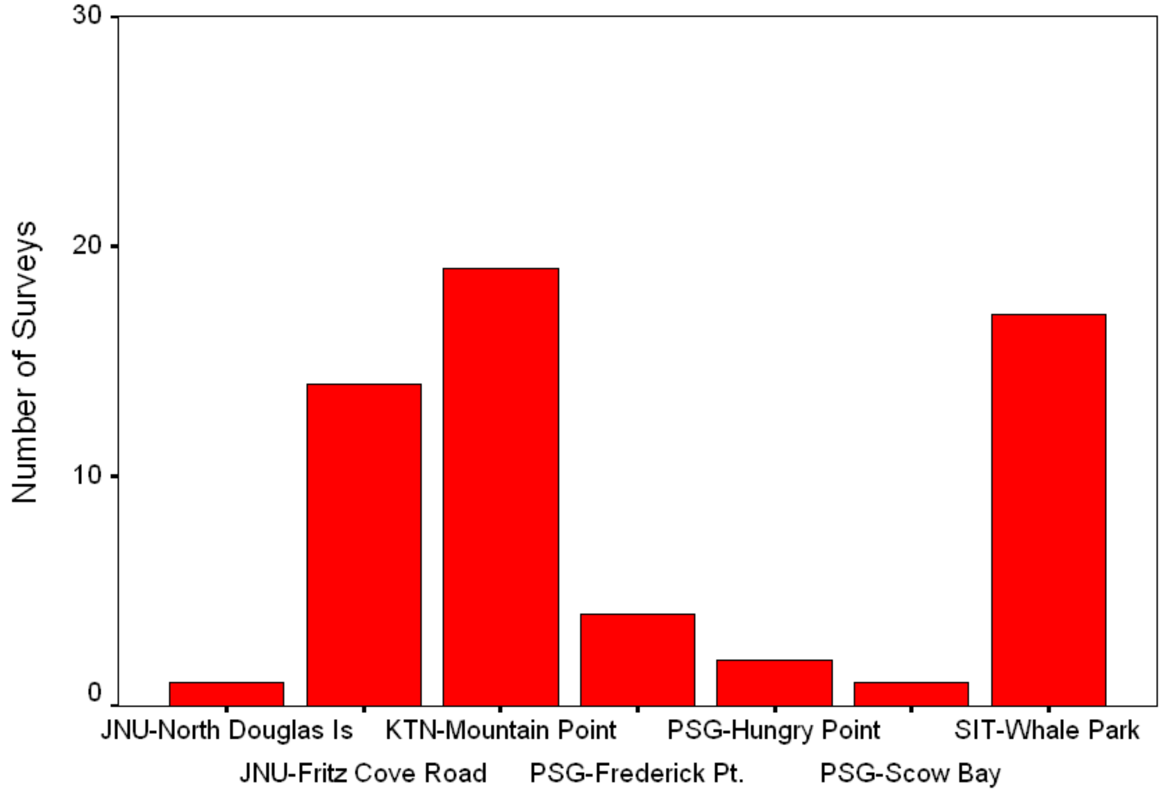

Figure 1. Survey frequency per site, 7–18 July 2008.

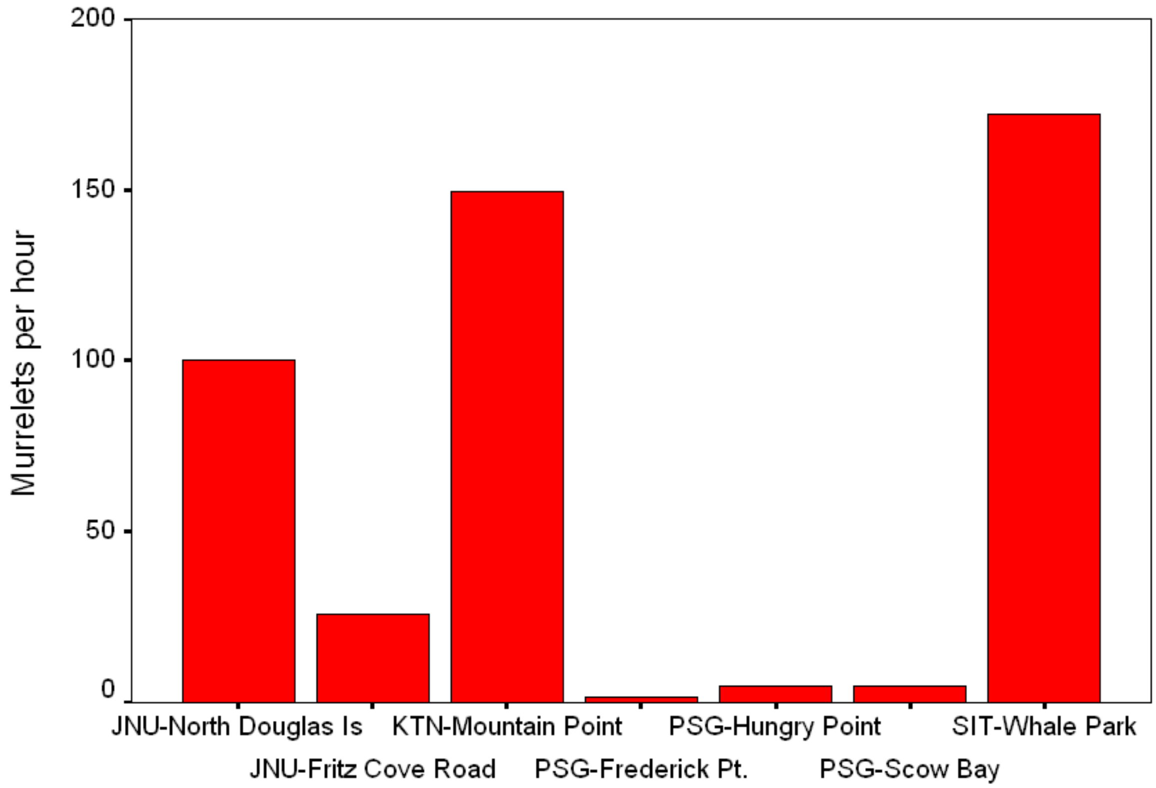

Figure 2. Flyway activity (murrelets per hour) at each of 7 survey sites, 7–18 July 2008.

The flyway activity (murrelets per hour) at each site is shown in Figure 2. Counts were very low in the Petersburg area, and effort was divided among 3 different survey sites there. For all subsequent analyses, we combined the survey results from the 3 Petersburg sites, and the 2 Juneau sites, and report results by community (Juneau, Petersburg, Ketchikan and Sitka).

Table 1. Mean number of murrelets per hour, by community, 7-18 July 2008

		Mean	Minimum	Maximum	Std Deviation	Count
Community	Juneau	31.27	.00	151.00	50.45	15
	Petersburg	2.86	.00	6.00	2.73	7
	Ketchikan	146.94	21.33	385.60	104.41	19
	Sitka	185.29	32.00	624.00	144.63	17

The flyway activity, by community, is summarized in Table 1. In this table, the "count" is the number of peak periods surveyed between 7 July and 18 July 2008. The mean number of murrelets per hour, by community, is represented graphically in Figure 3.

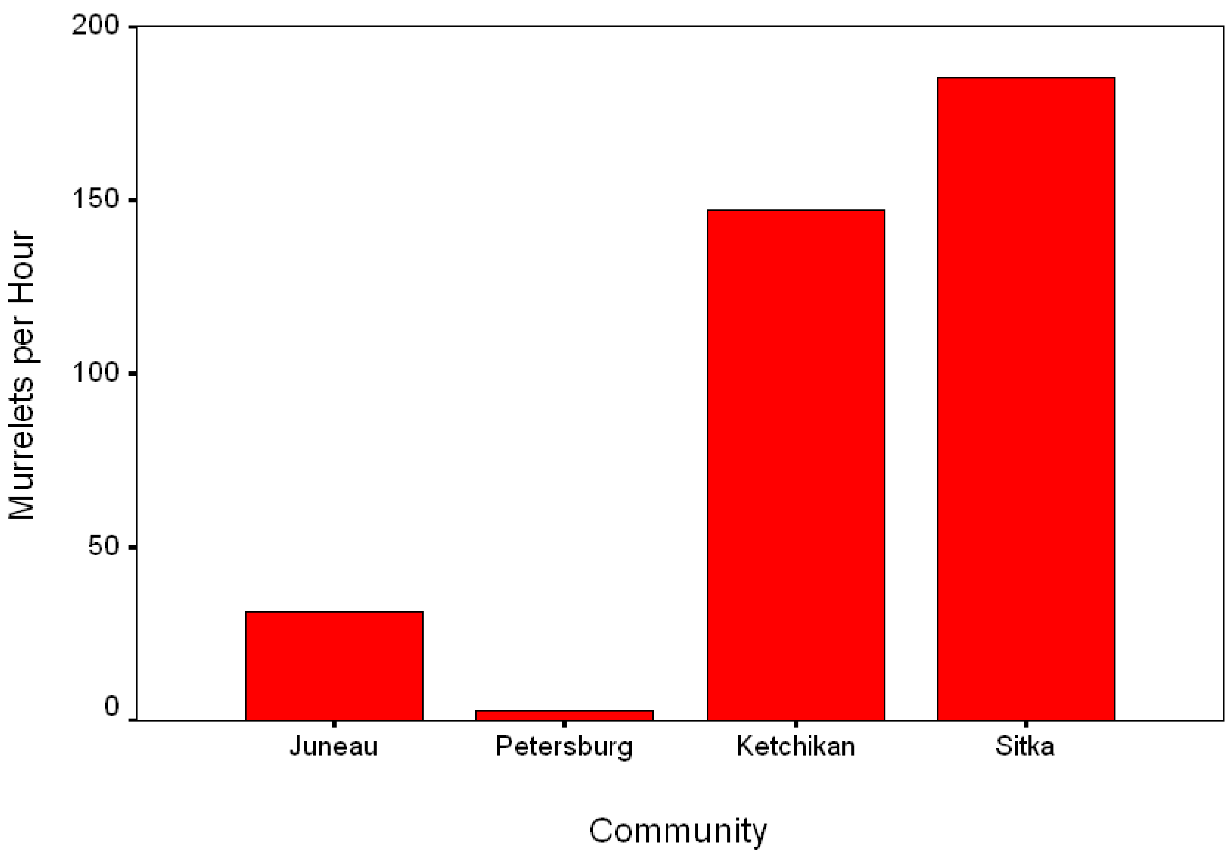

Figure 3. Flyway activity (murrelets per hour) at each of 4 communities in Southeast Alaska, 7–18 July 2008.

During each survey, observers recorded murrelets passing through the field of view as either going "in" or going "out," with the outbound direction being towards "bigger water." In most cases, this represented movement away from likely nesting areas, and towards likely feeding areas. The mean directional movement, by community, is shown in Figure 4. The number of birds outbound was, on average, 4 times greater than the number of birds inbound. This suggests that there is a distinct peak of outbound activity during the peak period in the morning (0500–0700 hours), but that birds are returning over a broader time window (and more likely later) than the 1900–2100 time period we surveyed in the evening.

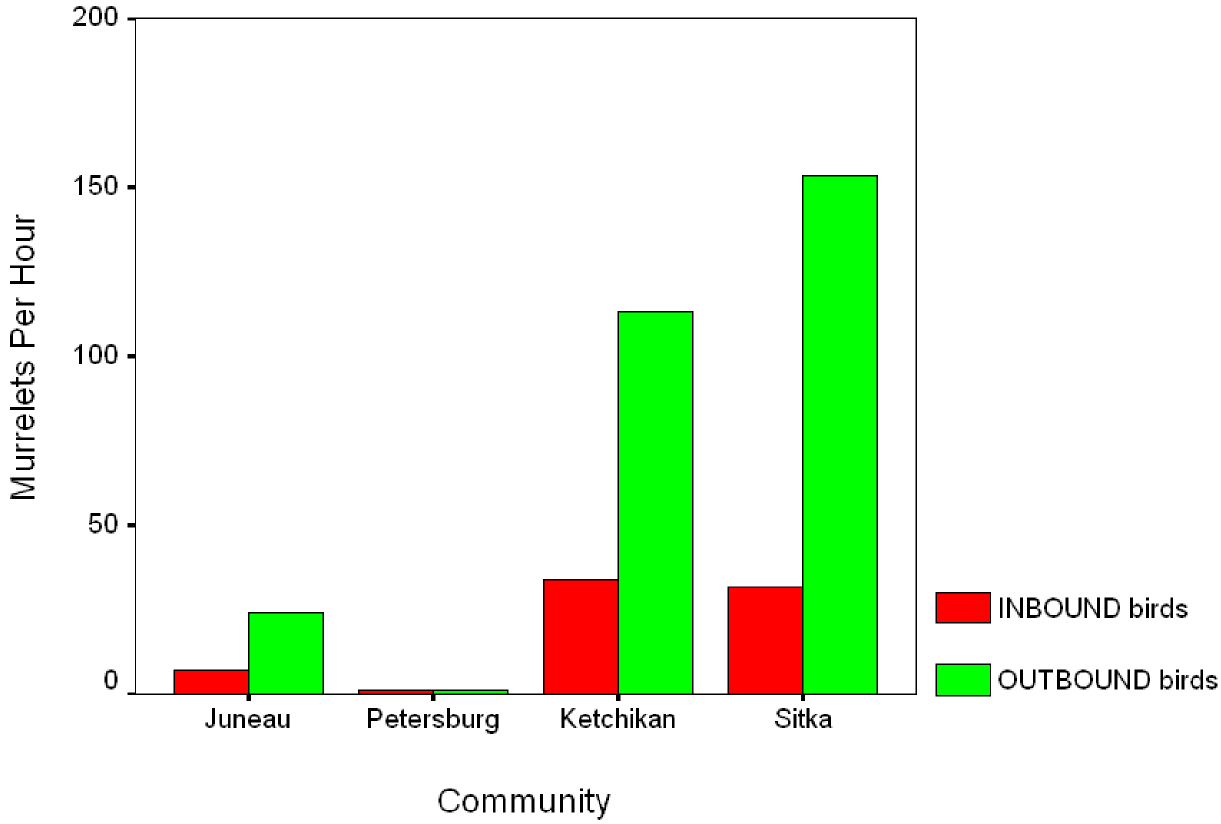

Figure 4. Inbound and outbound flyway activity at each of 4 communities in Southeast Alaska, 7-18 July, 2008.

The optimal time to survey murrelets for purposes of monitoring is when the Coefficient of Variation (CV = Standard Deviation divided by the Mean) is lowest. The CVs for murrelets counted during the early morning and late evening peak periods, by community, are shown in Table 2. There is high day-to-day variability in the numbers of birds counted, and that variability is similar for both the morning and evening peak activity periods.

Table 2. Coefficients of Variation (CV) for surveys of Marbled Murrelets (total) counted in the morning and evening peak periods, 7–18 July 2008.

Community	0500–0700 hours	1900–2100 Hours
Juneau	1.03	1.59
Petersburg	1.79	1.74
Ketchikan	0.76	1.02
Sitka	1.03	0.97

Program Monitor (Gibbs 1995) was used to calculate the power of these flyway surveys to detect change in the Marbled Murrelet population over time. For this exercise, we used the data from the morning surveys (0500–0700) from 3 communities (Juneau, Ketchikan, and Sitka), assumed a single time period (7–18 July) would be surveyed annually at these 3 sites for 10 years. We assumed the direction of population change was known (Piatt et al. 2007), and thus used at a one-tailed T test. The alpha level was set at 0.10 (i.e., 10% chance a true decline would go undetected).

The simulation results reveal that if the population were declining dramatically, at 10% every year, these surveys have a 19% chance of detecting that decline. If the population were declining at half that rate, 5% per year, these surveys would have a 12% chance of detecting the decline.

Minimally, we would want a monitoring program to be able to detect changes of 3–5% per annum with 80% or higher power. These results fail to meet that threshold by a large margin. Thus, we conclude that community-based counts similar to those gathered in 2008 would have very low power to detect trends, and are not suitable for population trend monitoring. This conclusion could change if alternative sites or times were identified that exhibited higher, less variable counts (i.e., lower CVs).

To evaluate that potential, we next examine the data from remote-site surveys which were selected for their known high flyway activity.

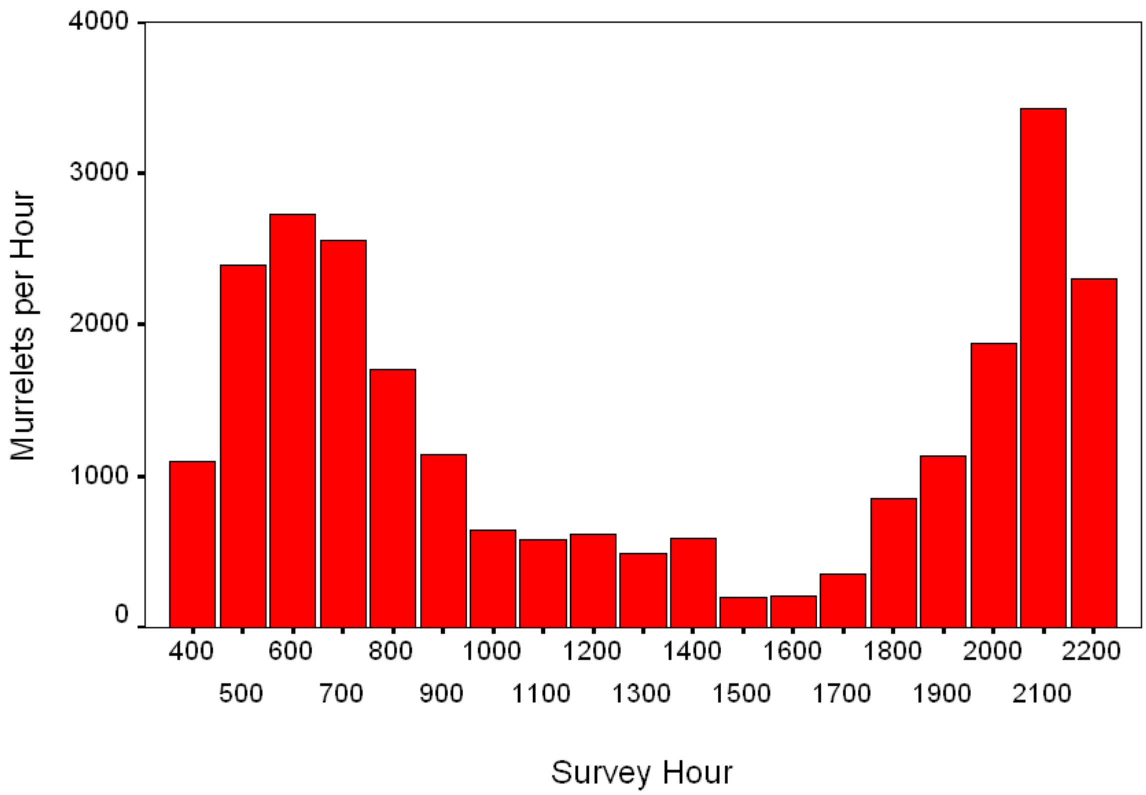

Figure 5. Flyway activity, by survey hour, measured at 2 remote sites in eastern Icy Strait, Southeast Alaska from 20–27 July 2008.

Remote-Site Flyway Surveys

A total of 347 surveys were conducted at either Entrance Island or Whitestone Harbor from 20–27 July 2008. Of these, 206 (59.5%) were rated as having excellent or good visibility, and these were the data used in subsequent analyses.

Flyway activity varied significantly throughout the day, with the peaks occurring in the early morning and late evening hours (Figure 5). On the basis of this figure, we defined the peak activity periods as 0500–0900 in the morning, and 1900–2300 in the evening (Note: For morning peak, this includes surveys started at 0500 and concluded before 0900. For evening peak, this includes surveys started at 1800 or later, and concluded before 2200. Due to darkness, only 1 survey was conducted after 2200 hours).

The morning peak was comprised primarily of birds flying west through Icy Strait, while the evening peak comprised primarily birds flying back to the east (Figure 6).

The mean number of birds per hour flying westbound in the morning at each survey location is shown in Table 3. The number of birds flying eastbound in the evening, at each location, is shown in Table 4. To provide a representative estimate for a given day, we required at least 4 valid surveys be conducted within each period, at each site. Survey periods/sites not meeting that threshold were dropped from further analysis.

Table 3. Westbound birds per hour counted during the morning peak, at Entrance Island and Whitestone Harbor, 20–26 July 2008.

				Survey Location					
				Entrance Island			Whitestone Harbor		
				Mean	Std Deviation	Count	Mean	Std Deviation	Count
July	20	AM	Westbound	1672	655	8	3887	2385	7
	21	AM	Westbound	2995	1432	8	2633	1297	8
	22	AM	Westbound	1480	407	2	2071	983	8
	23	AM	Westbound	.	.		2367	2243	6
	24	AM	Westbound	2978	1496	8	.	.	
	25	AM	Westbound	1357	271	3	.	.	
	26	AM	Westbound	1644	1030	2	632	587	6

Table 4. Eastbound birds counted during the evening peak, at Entrance Island and Whitestone Harbor, 20-26 July 2008.

				Survey Location					
				Entrance Island			Whitestone Harbor		
				Mean	Std Deviation	Count	Mean	Std Deviation	Count
July	20	PM	Eastbound	1726	2068	8	2076	2020	6
	21	PM	Eastbound	1519	1050	5	865	980	6
	22	PM	Eastbound	1462	641	5	1859	1178	8
	23	PM	Eastbound	1689	687	6	.	.	
	24	PM	Eastbound	1539	625	6	3516	.	1
	25	PM	Eastbound	2187	844	6	.	.	
	26	PM	Eastbound	3255	3464	3	.	.	

The flyway activity (birds per hour) for each study area, and each peak period, is summarized in Table 5. The CV's at Entrance Island were approximately half those recorded at Whitestone Harbor, and evening surveys exhibited slightly lower CVs than morning surveys.

Table 5. Mean flyway activity (birds per hour in either direction) during the morning and evening peak periods at Entrance Island and Whitestone Harbor between 20–26 July 2008. A peak period in any given day must have 4 or more surveys with good-excellent visibility to be included.

Mean, SD and N (peak periods) from which CV is computed

		Mean	SD	N	CV
Entrance Island	AM	2580.5	758.6	3	.29
	PM	1727.2	252.8	6	.15
Whitestone Harbor	AM	2338.1	1172.6	5	.50
	PM	1619.1	648.6	3	.40

Program Monitor (Gibbs 1995) was used to calculate the power of these flyway surveys to detect change in the Marbled Murrelet population over time. We assumed 4 independent location/time combinations (Table 5) would be surveyed in a single time period (20–27 July) annually for 10 years. We assumed the population was currently declining (Piatt et al. 2007), and thus used a one-tailed T test. The alpha level was set at 0.10 (i.e., 10% chance a true decline would go undetected).

The simulation results reveal relatively high power to detect declines in the population (Table 6). We could detect a very steep (10%) annual decline 89 percent of the time, and a moderately steep (5%) annual decline 68 percent of the time.

Table 6. Power to detect a change in population (increase or decrease) assuming the direction of change is know (one-tailed T test) with p= 0.10. The model projects power for 4 plots (Entrance AM, Entrance PM, Whitestone AM, Whitestone PM) surveyed annually in late July, for 10 consecutive years.

Change in Population (per Year)	Power to Detect a Decrease	Power to Detect an Increase
10	89	100
9	88	100
8	87	100
7	81	100
6	79	97
5	68	87
4	58	77
3	47	58
2	32	40
1	22	21

Conclusions and Recommendations

Flyway counts are suitable for monitoring population trends if replicate surveys, or samples, yield low Coefficients of Variation (e.g., < 0.30). In this study, we were able to accomplish that at 2 stations in eastern Icy Strait sites where thousands of Marbled Murrelets an hour are flying into and out of the strait on a daily basis. The roadside counts conducted out of each community are somewhat less promising, owing to the inherent variability in those counts. Based on the pilot data collected to date (2 summers), we cannot recommend continuation of the roadside counts for monitoring purposes.

We have been highly impressed with the dedication, enthusiasm, and quality of data collected by a large cadre of volunteers in communities around Southeast Alaska. Assuming we want to continue to tap into the enthusiasm for purposes of monitoring murrelets, we believe their efforts could be better utilized doing standard at-sea surveys. At-sea surveys represent the most accepted and widely used monitoring tool for Marbled Murrelets throughout their range, and research in Southeast Alaska on monitoring methods (Kirchhoff 2007, 2008) confirms their power here.

For the final year of this study, we recommend that the efforts of volunteers be shifted to doing at-sea surveys near each community, specifically to survey routes established by the USFS in 1991 and 1992. (USFS unpublished data; maps on file ADFG, Douglas). These survey routes typically included 2 shoreline tracks (100 and 500 m offshore) and periodic transects perpendicular to the shore (1500 m long). Based on our knowledge of the distribution of murrelets in Southeast Alaska, and the difficulties replicating meandering shoreline transects year to year (Kirchhoff 2007), we recommend our focus be on replicating the perpendicular to shore transects from these surveys. Transect routes nearest to the local communities should receive the highest priority for monitoring.

These transects are line transects (not strip transects), and as such, have relatively high power to detect trends (Kirchhoff 2007). Volunteers would most likely work on weekends, from boats owned and operated by ADF&G (e.g., 24–32 ft aluminum vessels based in area offices). Assuming those logistical requirements can be met, doing at-sea line transects would provide a dataset that has value not only as a point of comparison with population levels in the early 1990s, but also as one that allows us to compute power to detect trends and recommend an effective monitoring protocol for the long-term in Southeast Alaska.

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