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Long-Term Trend In Marbled Murrelets In Southeast Alaska Based On Christmas Bird Counts

Abstract

A significant proportion of marbled murrelets (*Brachyramphus marmoratus*) occur in Southeast Alaska. We examined long-term trends in marbled murrelet abundance in this region by analyzing published Christmas Bird Counts (CBC) for 7 sites from 1971 to 1993. We analyzed records of murrelet counts and counts standardized by effort. Murrelet counts were highly variable, in particular, most sites recorded one or a few unusually high counts during the time series. Our exploration of trend using a battery of statistical analyses failed to provide evidence for a decline in marbled murrelets across the region for the period 1971-1993. In general, there was high concordance among sites when counts occurred in the same year (e.g. Kendall's $W = 0.822$, $P = 0.0025$ among 5 sites) which supports our argument that trends in murrelet abundance should be examined for the region as a whole rather than focusing on individual sites. Although our analyses provide little evidence for a sustained decline in marbled murrelets in Southeast Alaska, we suggest that our failure to detect a decline does not indicate that a decline has not occurred, only that CBC data does not support such a conclusion.

Introduction

Marbled murrelets (*Brachyramphus marmoratus*) occur in coastal marine environments from central California to the Bering Sea and nest in coastal forests or on the ground in treeless regions. Compared to other seabirds in the region, the demography of this small cryptic seabird suggests that marbled murrelets may be particularly sensitive to environmental changes which influence adult survival (Ralph et al. 1995:13). Whereas some seabirds appear to rebound rapidly from natural (e.g. Harris and Wanless 1984) and anthropogenic catastrophes (e.g. Evans et al. 1993, Wiens et al. 1996, Day et al. 1997), other species, especially those with single egg clutches such as the marbled murrelet, may not have this capacity for rapid recovery (Ralph et al. 1995). Relatively small, long-term reductions in productivity and survival may jeopardize persistence of marbled murrelets to a greater extent than other alcids within its range (Ralph et al. 1995).

Recognized threats to marbled murrelet populations include natural reductions in prey fish due to long-term cyclic changes in sea water temperature, mortality from gill-net fishing, chronic marine oil pollution, large oil spills, and reduction in the geographic extent of coastal old-growth forests used for nesting (Piatt and Naslund 1995). Whereas marbled murrelets have endured natural fluctuations in the marine environment, the intensity of anthropogenic threats may be increasing (Carter et al. 1995, Carter and Kuletz 1995). In particular, the extent of old-growth forests used for nesting has declined significantly in Southeast Alaska during the past century (U.S.D.A. Forest Service 1991, Perry 1995). For instance, on the Tongass National Forest and surrounding forest lands in Southeast Alaska, approximately 384,000 ha, or about 17% of the "productive old forest" has been harvested since the early 1900's. Therefore, efforts to examine trends in regional populations of murrelets are becoming increasingly important in assessing the impact of human activities.

Concerns for the conservation status of marbled murrelets in coastal Washington, Oregon, and California led the U.S. Fish and Wildlife Service to list the species as threatened under the Endangered Species Act in September, 1992 (U.S. Fish and Wildlife Service 1992). The marbled murrelet population in North America was estimated to be on the order of 300,000 individuals with approximately 280,000 in Alaska (Ralph et al. 1995, Piatt and Naslund 1995). Recent comprehensive surveys place the estimate of all *Brachyramphus* near 687,000 in Southeast Alaska with a majority being marbled murrelets (Agler et al. 1998). An in-depth assessment of marbled murrelet conservation status in 1995 suggested that "available evidence indicates that the population of murrelets has declined over most of its range" (Ralph et al. 1995:17). More important, Piatt and Naslund (1995:294) stated that "populations in Alaska have apparently declined by more than 50 percent over the last 20 years." Their inference concerning trends in Alaska was based in part on examination of 20 years (1972-1991) of Christmas Bird Counts (CBC) from five of the 13 available CBC sites extending from the Northern Gulf of Alaska south to Sitka.

Based on this estimate of population decline and concern over loss of old-growth forest in Southeast Alaska, we sought to determine the long-term trend in murrelet populations for a more limited portion of Alaska but that portion supporting much of the species. We relied on Christmas Bird Counts as the most complete, long-term record of population trend. Since the early 1970's, volunteers recorded marbled murrelet numbers at seven locations in Southeast Alaska as part of the national Christmas Bird Count. These counts represent the longest time series available to examine potential changes in populations of this seabird in the region. Furthermore, a majority of the evidence leading to the inference by Piatt and Naslund (1995) that murrelets had declined by 50% in Alaska came from CBC data analyzed from a limited number of sites dispersed along the Alaska coast.

For a variety of reasons, counts from the CBC represent a very imperfect index to population trends (Bock and Root 1981). Some problems particular to marbled murrelets include the small marine area sampled relative to the distribution of the species, the clumped and variable distribution of murrelets during winter, and the relatively low number of sightings during counts relative to the total population. Winter distribution of marbled murrelets in Alaska is poorly understood (Piatt and Naslund 1995). In British Columbia, murrelets tend to occupy nearshore waters in protected areas during winter (Burger 1995) which would facilitate CBC trend counts. Christmas Bird Count data are an inappropriate substitute for, long-term, rigorously designed, local surveys (Bock and Root 1981) and must be regarded with skepticism compared to controlled censuses. However, as noted by Butcher (1990), other sources of bird population information frequently correlate with trends illustrated by CBC data.

As with any index, the degree to which survey conditions are controlled across years will strongly influence the performance of CBC in revealing true population patterns. Christmas Bird Counts are not as controlled as some scientific surveys (Bock and Root 1981, Butcher 1990). Therefore patterns observed from individual sites, if considered in isolation, are as likely to result from bias in the index as from pattern in bird population numbers. If regional effects are driving population trends, however, concordance among many sites from a region can provide evidence that bird population changes, rather than changes in the index, are responsible for observed patterns. Furthermore, because marbled murrelets in Southeast Alaska represent a regional breeding population (Piatt and Naslund 1995), combined counts from several sites throughout the region are most likely to reflect true population changes. Therefore, we examined murrelet population trend by focusing on all CBC data from Southeast Alaska. It should be emphasized that we focused on CBC counts because they represent the only long-term data for this population and the counts were used as the primary empirical basis for the estimate of a 50% decline in murrelets in Alaska.

Methods

We examined CBC data from 1971 to 1993 for seven sites in Southeast Alaska: Craig, Glacier Bay, Haines, Juneau, Ketchikan, Mitkof, and Sitka. These sites represent all the CBC sites from Southeast Alaska with records of marbled murrelets and overlaps with the group of CBC sites sampled by Piatt and Naslund (1995). Both Piatt and Naslund (1995) and we sampled Sitka, Juneau, and Glacier Bay, however we also examined the other 4 CBC sites from Southeast Alaska. Piatt and Naslund (1995) included Cordova and Kodiak Island, two sites far to the north, in their sample. For our analysis we focus on data published in *American Birds* as of the date we initiated this analysis (we include some analysis of counts from 1994-1996, however, to determine whether patterns observed through 1993 continued). The number of years surveyed, the first year surveyed, and the number of missing years after initiation varied among sites (Table 1). We examined both counts of murrelets and counts standardized by effort (murrelet count divided by total party-hours). Bock and Root (1981) suggest that effort is only

TABLE 1. Counts of marbled murrelets, and counts standardized by effort (party hours), from 1971-1996 for seven sites in

Site	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Murrelet counts													
Craig										0		0	
Glacier Bay	100	14		44	119	72		339		12	3	11	56
Haines						61	7		0	0	0	0	0
Juneau	102						35	148	19	5	5	53	24
Ketchikan					1								
Mitkof		0											
Sitka					1	2	141	339	8			25	31
Murrelet counts standardized by effort													
Craig										0		0	
Glacier Bay	3.57	0.41		1.38	2.64	2.12		7.88		1.09	0.13	0.32	2.33
Haines						3.05	0.23		0	0	0	0	0
Juneau	2.08						0.92	5.48	0.46	0.26	0.25	2.52	0.69
Ketchikan					0.03								
Mitkof		0											
Sitka					0.08	0.12	3.53	11.3	0.13			0.51	1.41

poorly related with numbers of birds counted for certain species because some species are easily observed. It is unknown whether CBC counts of murrelets depend strongly on effort (number of party hours). Therefore, we looked at both the raw counts and the standardized counts which we call count/effort data.

Approach

We examined data by looking both at patterns of counts from individual CBC sites and combined the data from several sites. Our goal in the analysis centered not on determining population trend at particular CBC survey locales, but determining whether the CBC surveys for Southeast Alaska together suggest a trend in marbled murrelet population size in the region; we suggest that murrelets throughout Southeast Alaska represent the biological population of interest. Therefore, a variety of statistical approaches were employed to explore common patterns.

Because trend data can provide input to conservation programs for the marbled murrelet we paid particular attention to the consequences of Type II errors (failure to detect a downward trend). To increase the power of the test, in some analyses (Spearman rank correlation) we employed a one-tailed test explicitly examining hypotheses concerning downward trends. To further increase the chance of detecting a downward trend we employed a battery of statistical procedures, each with slightly different emphases and assumptions (Table 2). For all tests we paid particular attention to assumptions of the test prior to conducting any analysis. Here we concentrate on those tests least influenced by the extreme counts (nonparametric tests) although as indicated in Table 2, the results of all analyses lead to similar conclusions. The statistical details of the tests reported here are described below. Those who find statistical details tedious may wish to move directly to the results.

Individual Sites

Normal, least-squares regression is sensitive to extreme observations, especially at the ends of the gradient sampled for the independent variable (Belsey et al. 1980). A review of CBC data for the seven Southeast Alaska sites shows that at almost every site, the count for one year exceeded all others by a factor of two and up to 10 (Table 1). Given this and the potential sources of variation in CBC data due to observers and other conditions not related to murrelet abundance, we examined the pattern of yearly counts using a variety of nonparametric methods.

southeast Alaska.

1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
3		18			1	13	26	0	8	0	0	0
152		207	16	1		163			1478	474	1001	58
0	0	0	0	0	37	0	3	2	4	0	11	29
22	23	21	39	31	44	25	24	63	67	40	96	24
					38	56	56	693	48	42	105	31
				17	52	53	8	24	54	92	75	40
4	1	16	6	3	3	2	1	13	26	10	77	76
0.38		2			0.03	0.34	1.24	0	0.33	0	0	0
4.47		7.39	0.38	0.02		4.79			54.74	17.56	29.44	2.0
0	0	0	0	0	1.42	0	0.2	0.07	0.19	0	0.41	0.87
0.58	0.48	0.88	1.63	0.74	0.92	0.47	0.65	1.58	1.56	0.74	1.45	0.46
					1.19	0.97	1.06	12.4	1.0	0.73	2.10	0.76
				2.13	5.20	2.41	0.38	0.96	6.75	6.13	5.00	2.58
0.13	0.02	0.64	0.20	0.10	0.10	0.06	0.01	0.37	0.63	0.22	1.44	1.67

TABLE 2. Overview of analyses of marbled murrelet population trend as indicated by CBC counts at seven sites in Southeast Alaska. Each test was run for each of the seven sites or a combination of sites. Results summarize the broad pattern suggested by the group of analyses. Details are presented in methods and results.

Test	Why performed	Results
Runs tests	Search for evidence of a nonrandom pattern.	No evidence for patterns (Table 3)
Regression using rank transformed data	Search for downward trend w/ test not sensitive to extreme values.	Little evidence for downward trend (1 of 14 P-values < 0.10) (Table 4)
Spearman Rank Correlation	Search for downward trend w/ alternative test not sensitive to extreme values.	Little evidence for downward trend (2 of 14 P-values < 0.10) (Table 4)
Normal least-squares regression	Search for downward trend employing power of normal theory	No evidence for downward trend (Unpublished results)
Kendall's W	Examine degree of concordance among 7 CBC sites — do increases and decreases correspond across sites, within years.	Strong evidence for concordance among CBC sites (5 of 7 P-values < 0.01) (Table 5)
Tests on 'collapsed' data sets	Search for downward trend based on summed counts across all CBC sites using tests described above	No evidence for downward trend (Table 6 and unpublished results)

We first employed a series of runs tests (Daniel 1978) for evidence of a trend. Rejection of the null hypothesis—departures from the median over time are random—indicates a trend but does not suggest the particular nonrandom pattern.

We further examined the relationship between murrelet counts (and count/effort data) and year of census using Spearman rank correlation (Daniel 1978). A significant statistic would suggest murrelet numbers were falling during the period of surveys (one-tailed test).

We also examined several least-squares regression models but here concentrate on models of rank transformed data (Conover and Iman 1981); an approach less influenced by outliers. We tested whether the slope of the function relating murrelet abundance to year was significantly different from zero.

Combining CBC Sites

We employed two basic approaches to examine the pattern in CBC counts across sites. First, regardless of whether or not CBC counts suggested a long-term decline in murrelet numbers throughout the region, we were interested in whether there was concordance among sites in murrelet abundance (i.e., did annual counts increase and decrease together across the region?). For this analysis we employed Kendall's W or Coefficient of Concordance (Daniel 1978). We examined Kendall's W for both murrelet counts and count/effort data. This test is analogous to Spearman rank correlation but tests for association among many sets of rankings, rather than just two.

Missing data within the time series for individual sites posed a problem (see Table 1). The time series examined using Kendall's W was determined by the number of years in which all sites had data: a missing value for any one site rendered a particular year missing for the analysis. Therefore we looked at 3 groupings of sites; 1) Glacier Bay, Juneau and Haines, n=10; 2) Glacier Bay, Juneau, Craig and Haines, n=6; 3) Glacier Bay, Juneau, Craig, Haines and Sitka, n=5. Only 2 years contain data on all seven sites (note that Table 1 includes data from 3 years beyond the years analyzed here).

To determine whether CBC sites, as a group, suggested a long-term decline in murrelet numbers, we combined the counts and count/effort across sites in two ways, using rank transformed data and using the untransformed data.

In order to combine sites it was necessary to either fill in years with missing data or eliminate years in which one of the sites being 'summed' lacked data. To maintain the benefits of a long, continuous time series we chose to fill in missing cells. We filled in missing cells only in cases lacking one or two years in succession for a site. If more than two cells where missing from a time series, the cells retained missing values. To fill in missing values, we applied the mean of the neighboring years to the missing year. When more than 2 years were missing from a time series, the CBC site could not be used to produce a summed score for the region based on those years. Relative to the number of years (time line), this procedure would have injected minimal dependence among years into the data. For instance nine of 68 cells were estimated for a 17-year trend examining combined data from four bays. The effect is also reduced because we used a ranking procedure to analyze the data.

After filling in missing cells, we calculated the rank score, within sites, for all CBC sites. We summed the rank scores within years for several combinations of sites. Our goal was a long time series that lumped as many sites as possible. We produced four groupings of sites: one grouping of four sites (Glacier Bay, Haines, Juneau, and Sitka) spanning 17 years; one grouping of three sites (Glacier Bay, Haines, and Sitka) spanning 18 years, and one grouping of two sites (Glacier Bay and Sitka) spanning 19 years.

We also summed the raw counts across these same groups of CBC sites. This produced collapsed data sets with similar structure as the collapsed, rank data but containing the actual counts (or count/effort data).

Results

Counts of murrelets showed high variability (Table 1). At most sites, counts in one or two years exceeded all other years by a factor of two. At Glacier Bay, the count in 1993, 1478 marbled murrelets, exceeded the next highest count (339 in 1978) by over a factor of four. At Haines, no marbled murrelets were reported in 11 of the 17 years but 61 and 37 murrelets were counted in 1976 and 1989. The most extreme variation occurred in the short time series reported for Ketchikan (n=6); volunteers counted 693 murrelets in 1992 while the next highest count was 56 in both 1990 and 1991.

No consistent trend in murrelet abundance was apparent at individual sites or across the region after examining data from multiple sites (Table 2). The pattern of no trend was robust across a battery of statistical tests. Below we describe the results in detail.

Individual Sites

The series of marbled murrelet counts at seven CBC sites showed no strong evidence for a non-random pattern over the period of record (Table 3). Runs tests tended to produce very high *P*-values suggesting no evidence for pattern in the time series.

Based on rank-transformed data (counts and count/effort), only a single linear regression model had a *P*-value less than 0.10 for the test of a slope different from zero (Table 4). All models with *P*-values less than 0.30 showed positive slopes suggesting, if anything, trends of increasing counts.

Spearman rank correlation (on counts and count/effort data) generally corroborated the patterns observed in the regression models examining rank transformed data (Table 4). Spearman rank correlation, however, suggested some relationship between counts and year. Ketchikan and Mitkof both had *P*-values less than 0.10; in both cases the relationship was positive but the counts only represent trends for the late 1980's and early 1990's (Table 1). Overall the results did not suggest a common trend for the region.

TABLE 3. Examination of pattern in CBC counts for marbled murrelets in Southeast Alaska. Runs test examining hypothesis that pattern of counts over time displays a departure from the median or mean value which is random. A significant test suggests a nonrandom pattern. Tests here examine raw count data and employ the SPSS exact module to calculate the *P*-value.

Location	No. of of years	Runs test value	Exact *P*-value
Median			
Craig	9	3	0.762
Glacier Bay	16	64	0.429
Haines	17	could not be run because of # of zeros	
Juneau	18	28	0.218
Ketchikan	6	52	0.600
Mitkof	7	24	0.999
Sitka	17	6	0.129
Mean			
Craig	9	7.666	0.286
Glacier Bay	16	174.187	0.999
Haines	17	6.706	0.101
Juneau	18	41.666	0.999
Ketchikan	6	148.666	0.999
Mitkof	7	29.714	0.999
Sitka	17	36.588	0.125

TABLE 4. Trend in marbled murrelet abundance at seven CBC sites in Southeast Alaska. Analyses include regression based on ranks and Spearman Rank Correlation. For both models we examine rank counts and rank count/effort. Values reported are the number of years in time series, the regression coefficient (ß), significance of the regression model, Spearman rank correlation, and significance of the correlation.

Location	No. of years	Coef. for Year	*P*-value	Spearman Rank Corr.	*P*-value
Counts					
Craig	9	0.139	0.534	0.389	0.150
Glacier Bay	16	0.120	0.539	0.171	0.264
Haines	17	0.048	0.825	0.106	0.343
Juneau	18	-0.062	0.785	0.119	0.318
Ketchikan	6	0.179	0.171	0.637	0.087
Mitkof	7	0.183	0.145	0.607	0.074
Sitka	17	-0.205	0.361	-0.114	0.331
Count/effort					
Craig	9	0.343	0.099	0.186	0.315
Glacier Bay	16	-0.016	0.933	0.141	0.301
Haines	17	-0.218	0.381	0.100	0.351
Juneau	18	0.170	0.453	-0.009	0.485
Ketchikan	6	0.152	0.261	0.428	0.198
Mitkof	7	0.132	0.304	0.428	0.169
Sitka	17	0.284	0.197	-0.236	0.181

Trends After Combining CBC Sites

In general, murrelet counts (and count/effort data) throughout Southeast Alaska appear to vary in concordance with one another. We found strong evidence suggesting that CBC records for murrelets varied similarly throughout Southeast Alaska (Table 5).

Given the degree of concordance among CBC sites across Southeast Alaska, we examined the trend in CBC records for the region as a whole. Regression models based on sums of rank transformed count and count/effort data produced no evidence for a temporal trend in murrelet observations over the period of CBCs (Table 6). Spearman rank correlations examining data from all CBCs for Southeast Alaska also produced little evidence for long-term downward trend in counts or count/effort data (Table 6).

Discussion

The pattern of counts and counts standardized by effort (count/effort) from seven CBC sites in Southeast Alaska provide no evidence for a broad, sustained decline in marbled murrelets across the region for 1971-1993. Our failure to detect a decline does not indicate that a decline has not occurred. Power analyses are not available for the nonparametric tests examined here. By employing one-tailed tests, examining long time series, and using a battery of statistical analyses we sought to increase the power of our analyses to detect downward trends. Variability in counts, however, reduces power and these analyses examined data with high variability in year-to-year counts.

The most striking feature of the murrelet counts concerns the presence of one or a few unusually

TABLE 5. Concordance among CBC sites throughout Southeast Alaska as indicated by Kendall's W. Statistic indicates the degree to which values at several sites vary together: the degree to which they rise and fall as a unit. Number of years refers to the sample size for individual tests. Statistic tests the hypothesis that concordance = 0; rejection of the null hypothesis suggests evidence for concordance.

Locations	No. of years	Kendall's W	*P*-value
Counts			
Glacier Bay, Haines, Juneau	10	0.760	0.0005
Glacier Bay, Haines, Juneau, Craig	6	0.919	0.0009
Glacier Bay, Haines, Juneau, Craig, Sitka	5	0.822	0.0025
Count/effort			
Glacier Bay, Haines, Juneau	10	0.760	0.0005
Glacier Bay, Haines, Juneau, Craig	6	0.839	0.0017
Glacier Bay, Haines, Juneau, Craig, Sitka	5	0.749	0.0047

TABLE 6. Trend in marbled murrelets from CBC counts throughout southeast Alaska based on linear regression models and Spearman rank correlation of *summed ranks*. Location refers to the group of CBC sites summed to form the dependent variable. Values reported include the number of years in the trend, regression coefficient (ß), significance of the regression model for ranks, Spearman rank correlation, and significance of the correlation.

Locations	No. of years	Regression Coef.	*P*-value	Spearman Rank Corr.	*P*-value
Counts					
Glacier Bay, Haines, Juneau, and Sitka	17	0.240	0.755	0.124	0.318
Glacier Bay, Haines, and Sitka	18	0.026	0.961	0.013	0.479
Glacier Bay and Sitka	19	0.138	0.732	0.096	0.348
Count/effort					
Glacier Bay, Haines, Juneau, and Sitka	17	0.035	0.944	0.094	0.359
Glacier Bay, Haines, and Sitka	18	-0.223	0.576	-0.126	0.309
Glacier Bay and Sitka	19	-0.059	0.843	0.017	0.473

high counts at each site; high counts are found in both the first and second half of the time series in almost equal proportions. High counts likely arise because CBC counts in Southeast Alaska sample a very small portion of the marine environment occupied by murrelets. The total count from all sites in any one year represented less than 1 percent of the estimated breeding population of the region. Murrelet numbers in small areas show variation with weather, tide, time of day, and local food availability (e.g. Carter and Sealy 1990).

The variability in counts at individual sites lead to difficulties examining murrelet trend for individual sites. However, we are most interested in using CBC data to uncover long-term trends on a regional basis as suggested by Butcher (1990). In this light, it seems reasonable to argue that the pattern exhibited by all seven CBC sites, taken as a unit, may represent an index to wintering murrelet abundance in the broad region of Southeast Alaska. Our analysis suggested concordance among sites. Concordance among sites supports an approach which examines the broad pattern of population change among the sites as a unit.

In general, our analysis of available CBC data provides little evidence for either increasing or decreasing trends in marbled murrelets for Southeast Alaska over the past couple decades. Our analysis is not alone in failing to detect the marked recent decline in murrelets noted by Piatt and Naslund (1995). Murphy et al. (1997: Table 1) examined counts of murrelets in selected portions of Prince William Sound comparing surveys in 1984/85 with 1989, 1990, and 1991. Their results suggest no change (1984 vs. 1989 and 1984 vs. 1990) or an increase in murrelet numbers (1984 vs. 1991). Murphy et al. (1997) did note the low power of their tests for the first two comparisons. These results are especially interesting given the documented mortality of murrelets in Prince William Sound as a result of the *Exxon Valdez* oil spill in March of 1989 (Piatt et al. 1990, Day et al. 1997). In contrast to the results of Murphy et al. (1997), Klosiewski and Laing (1994) report declining murrelet numbers in Prince William Sound between 1972 and 1991. Klosiewski and Laing (1994) and Murphy et al. (1997) used different methods and sampled different portions of Prince William Sound.

The mixed evidence for declining populations is interesting considering the negative trend in certain resources important to murrelets. In the Pacific Northwest, remaining murrelet populations appear to be closely associated with coastal waters adjacent to late-successional forest (Ralph et al. 1995). Harvest of productive virgin forest in Southeast Alaska has removed 182,250 ha of old forest (or about 8% of the commercially valuable timber land) on the Tongass National Forest since 1909 (U.S.D.A. Forest Service 1991); this land area does not include the significant harvest of old forest from non-federal land. In addition to the loss of potential nesting habitat, changes in the marine ecosystem in the Gulf of Alaska are purported to have reduced availability and biomass of important prey fish (Piatt and Anderson in press, as cited by Piatt and Naslund 1995). If marbled murrelet populations are not declining in response to these changes, the abundance of this seabird may currently be determined by other factors in Southeast Alaska.

Analyses of CBC data should be viewed as a preliminary examination of population patterns when more rigorous survey information is lacking. Our analysis does not assess potential bias associated with these data resulting from changes in methods, survey protocol, or the geographic relationship between CBC sites and murrelet concentrations in Southeast Alaska. Sites chosen for CBCs may or may not survey geographic areas important to murrelet trends in Southeast Alaska. Furthermore, there may be a substantial lag between decline in reproduction and numbers of adult birds observed during winter surveys. Therefore, strong conclusions concerning murrelet trend in Southeast Alaska cannot be established based on these data. Marbled murrelet populations may indeed be in peril within Southeast Alaska, but no such trend can be detected with the only available, long-term data using a variety of analyses.

Decisions regarding conservation of murrelets in Southeast Alaska require some indication of population trends in the region. Our conclusion (absence of strong evidence for a sustained decline in marbled murrelets), drawn from seven sites in Southeast Alaska differ from those of Piatt and Naslund (1995) who examined five sites extending from the Northern Gulf of Alaska south to Sitka. Reasons for these differences are not clear but may be related to differences in geographic areas examined, problems in data analysis and interpretation, or unrecognized aspects of murrelet biology and movements. The disparity between our conclusions and those reached by Piatt and Naslund (1995) invites explanation.

Piatt and Naslund (1995) examined CBC data from five of the 13 available CBC sites throughout coastal Alaska. Sites they examined include Cordova and Kodiak Island; coastal areas which represent two relatively independent breeding areas hundreds of kilometers north of the breeding unit in the Alexander Archipelago sampled by their other three sites (Piatt and Naslund 1995:286). Therefore, their choice of sites has a high probability of mixing counts from populations or subpopulations that may be influenced by very different factors. We chose to examine all available sites from one region, Southeast Alaska, to avoid this potential problem. Furthermore, their sample also included only the northern subset of CBC sites from Southeast Alaska. The limited sample Piatt and Naslund (1995) examined from Southeast Alaska could lead to different observed patterns in abundance than those we detected in our analysis. Our analysis more adequately sampled the geographic extent of the population in Southeast Alaska and avoided the potential problems of mixing samples from two, geographically distinct groups of murrelets.

Piatt and Naslund's (1995:293) conclusions are further compromised by problems in data analysis and interpretation. Among other problems, they interpreted trends after they "smoothed [*summed counts*] by taking 5-year running averages of the annual data" (italic ours). Trend analysis assumes independent observations and employing a moving average explicitly creates dependence among observations (Kendall 1973). Interannual variation in murrelet abundance is removed by this approach, and high or low counts from a single year become part of the apparent pattern for four more years. Based on their report, Piatt and Naslund reached their conclusion regarding a "steady decline in abundance of about 50 percent" based on visual inspection of a plot of the smoothed data (see Figure 7 in Piatt and Naslund 1995:294). However, visual inspection of the plot shows that plotted values from 1974 to 1979 changed little. In the next year, though, the plotted value dropped by almost 50 percent and then remained about the same for the next 10 years. This step change in the plotted values between 1979 and 1980 is the most striking feature of their analysis, rather than a "steady decline in abundance."

An examination of potential environmental explanations for the differing conclusions of our studies may be unwarranted given the potential problems with the analysis presented by Piatt and Naslund (1995). Further examination of the demography of marbled murrelets will be necessary to determine trends for this species in Southeast Alaska. Finally, informed conservation decisions in the future will depend on a strong, long-term monitoring program, not linked to CBC counts, to assess trend in murrelet abundance.

Epilogue

Our analysis was conducted prior to formal publication of the results reported by Piatt and Naslund (1995); when we began, data was available through 1993. Through our analysis, we sought to compare trends for murrelets in the Alexander Archipelago with conclusions reached in the murrelet assessment (Ralph et al. 1995). Because of the variety of statistical approach we used to examine the data, our analyses included over 100 statistical tests. Therefore, we have not run our full analyses with counts that now exist in reports for 1994-1996. We have examined the recent data, however, to determine whether the new information would likely change the conclusions reached from our analysis.

Counts from all 7 bays in 1994, 1995 and 1996 (see Table 1) are either within the 95 percent bound on the mean from all former years or fall *above* the bound. The zero counts for Craig are the lowest in relation to earlier counts. Even these values fall within rounding of the 95 percent bound on the mean for Craig. Furthermore, these zero counts mirror zero counts in the earliest CBC records for this bay.

Counts in the past few years, then, corroborate the pattern observed in the years we analyzed most thoroughly. Christmas Bird Counts continue to provide little evidence for a broad, sustained decline in marbled murrelets in Southeast Alaska.

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