

Results of 2011 Marbled Murrelet Surveys at Gazos Mountain Camp

by
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SUMMARY OF KEY FINDINGS
2011 GAZOS MOUNTAIN CAMP MURRELET SURVEYS

1. *Murrelet numbers at Gazos Mountain Camp have begun to show a slight, but statistically significant downward trend. However, murrelet numbers in general remain high relative to all other breeding areas.*
2. *For the first time ever there were no indications of breeding activity at Gazos Mountain Camp. The number of below canopy detections (1) and single silent bird below canopy detections (0) collapsed in 2011.*
3. *The non-linear trend of a two-year cycle in murrelet numbers (total detections) continued to be statistically significant in 2011, with "bad" years following "good" years. The environmental or biological cause for such a cycle, if it is real, is unknown.*
4. *An apparent increase in the year-to-year variability of below canopy detections is persisting.*

INTRODUCTION

Six audio-visual surveys have been conducted at Gazos Mountain Camp in July (or the immediately bordering days) from 1998 to the present. These surveys began as a component of the Apex Houston Gazos Creek Marbled Murrelet Monitoring Program, were a pro bono research effort from 2005 to 2010, and were partially funded by the Sempervirens Fund this year. Seven audio-visual (A-V) surveys (also known as ground surveys) were completed this year, one more than usual, by a team that included the author and Bryan Mori, an experienced inland murrelet observer.

METHODS

Surveys were conducted in the meadow at Gazos Mountain Camp, in Butano Redwoods State Park. The meadow is located 4.2 km from the ocean (see Figure 1). A complete description of the survey station can be found in the document, "Results of Marbled Murrelet Audio-Visual Surveys at Gazos Mountain Camp, 1998 – 2010; Final Report, Part II (Singer 2010).

Located just across the creek from the meadow is a 10 acre stand of old-growth forest containing suitable murrelet nest platforms. More murrelet nesting habitat can be found in four additional stands of old-growth forest or older second-growth forest found in the watershed within one mile of the survey station. These stands range in size from about seven to 75 acres and occupied behavior has been observed in the three larger stands (See Figure 3). An additional five stands of old-growth or older second-growth exist further upstream on either the North Fork or Main Stem of Gazos Creek.

Survey procedures follow the 1994 PSG Protocol for forest surveys (PSG Marbled Murrelet Technical Committee 1994), starting 45 minutes before sunrise and lasting for a minimum of 2 hours, or 15 minutes past the last detection. Occupied behavior consists of flights below one canopy tree height, or higher flights associated with circling over the meadow. Six surveys were conducted per season, over 11 seasons from 1998 to 2010 excluding 1999 and 2005. Seven surveys were done in 2011. All surveys were done in July or the days immediately preceding or following July.

Observations were recorded live into tape or digital recorders and later transcribed onto standard forest survey forms. The detection of other bird species was also noted. For species other than murrelets, the recorded information included time of first detection of the species, beginning time of the dawn songbird chorus, time and

direction of the first band-tailed pigeon flights, the time of all raven detections, the maximum number of ravens detected simultaneously, and the maximum number of jays detected simultaneously.

A consulting biostatistician was hired to look for any significant trends in the 1998 to 2011 data (Rominger 2011) and his findings will be discussed in the Results and Discussion section.

RESULTS AND DISCUSSION

General Results

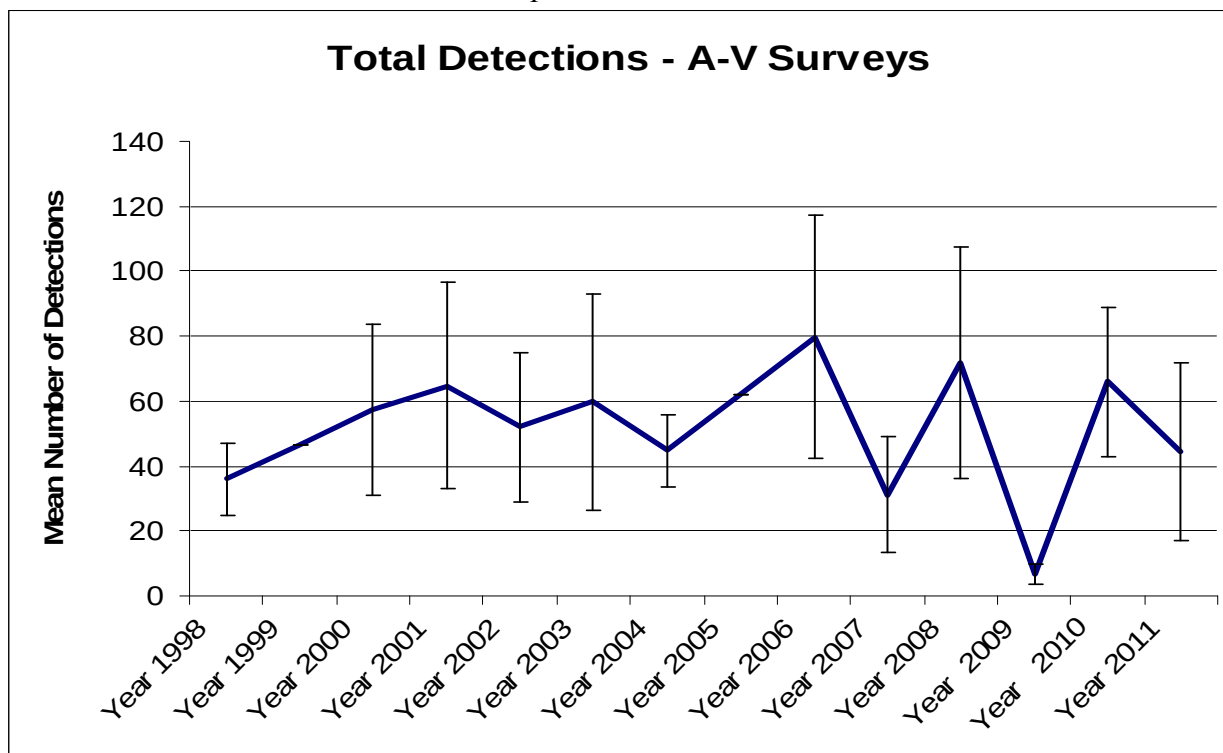
Seven A-V surveys were conducted in 2011 and the results are shown in Table 1 immediately below. Total detections for each year from 1998 to 2011 are shown in Graph 1, while Graph 2 shows annual values for heard-only detections, visual detections, and below 1 canopy detections. Graph 3 presents the values of Below Canopy and Single Silent Birds Below Canopy detections from 1998 to 2011.

Table 1. Year 2011 results of A-V (ground observer) surveys for murrelets at Gazos Mountain Camp. Values for the mean, standard deviation (s.d.) and coefficient of variation (C.V.) are given in the bottom rows.

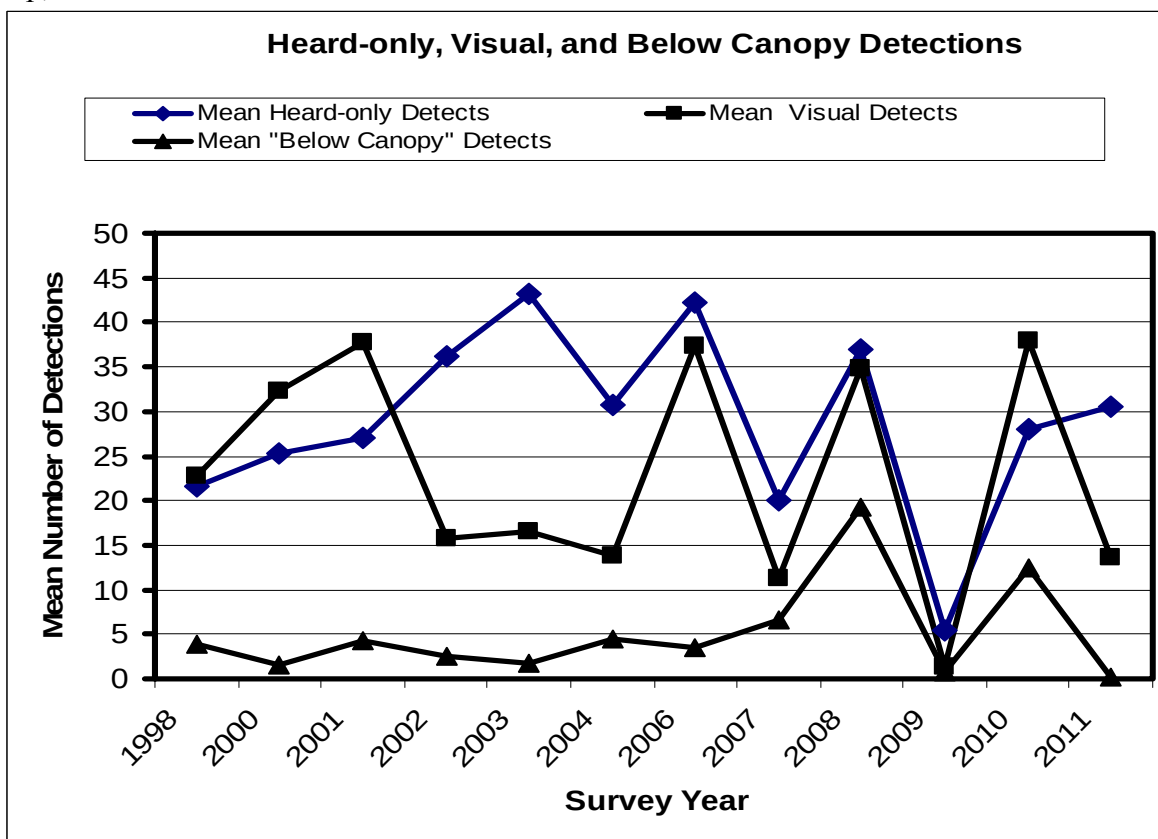
Date	% Overcast	Number of Detections	Number of Visual Detections	Number of Occupied Behaviors	Number of Below 1 Canopy Detections	Number of Single, Silent Birds Below Canopy (SSBBC)
6/30/2011	0	13	4	2	1	0
7/08/2011	100	7	0	0	0	0
7/12/2011	100	75	25	18	0	0
7/19/2011	0	41	8	7	0	0
7/23/2011	0 - 66	68	26	12	0	0
7/25/2011	100	38	12	5	0	0
7/28/2011	100	68	21	8	0	0
MEAN		44.29	13.71	7.43	0.14	0
s.d.		27.35	10.40	6.11	0.38	
C.V.		0.62	0.76	0.82	2.65	

Note: Occupied Behaviors include circling above canopy.

Graph 1. Mean number of audio-visual detections at Gazos Mountain Camp, 1998 to 2011. No data exist for 1999 or 2005. Error bars represent one standard deviation.



Graph 2. Mean number of heard-only, visual, and below canopy detections at Gazos Mountain Camp, 1998 to 2011. No data exist for 1999 or 2005.



Graph 1 shows that total detections in 2011 were in the typical range of 35 to 65, and that the recovery from the 2009 crash that was first noted in 2010 continues in 2011. Thus murrelet use of Gazos Mountain Camp continues to exceed the use of other known murrelet breeding areas in the Santa Cruz Mountains (Halbert, pers. comm., Evens, pers. comm.).

Although there are no large stands of old-growth forest near Gazos Mountain Camp, the potential murrelet nesting stands in the Gazos Creek Watershed have the advantage of being located in a wildland (i.e., undeveloped) area that lacks agricultural sites, recreational developments, and has very few residential areas. Consequently, the density of corvids, which are important murrelet nest predators, are likely to be low, and thus these areas are likely to experience lower nest predation rates than larger old-growth stands located at developed and heavily-used recreation sites, such as Big Basin Redwoods State Park, Portola State Park, Memorial County Park, etc. As many researchers have found and as Peery and Henry (2010) have noted, "Predation by corvids is high and appears to drive landscape-scale patterns in nest success in many regions."

If murrelets, like most alcids, exhibit a high degree of breeding site fidelity, then greater nest success rate in the Gazos Creek Watershed might be enough to sustain a fair-sized murrelet breeding population whereas at Big Basin State Park, where there has been a high degree of nest predation by corvids since the mid-1990s, murrelet detections have dropped to extremely low levels. When evaluating the quality of breeding habitat for murrelets, the density of corvids in the landscape may be a primary factor, equally important as nest tree physical parameters and stand characteristics (as were cited in Baker et al. 2006).

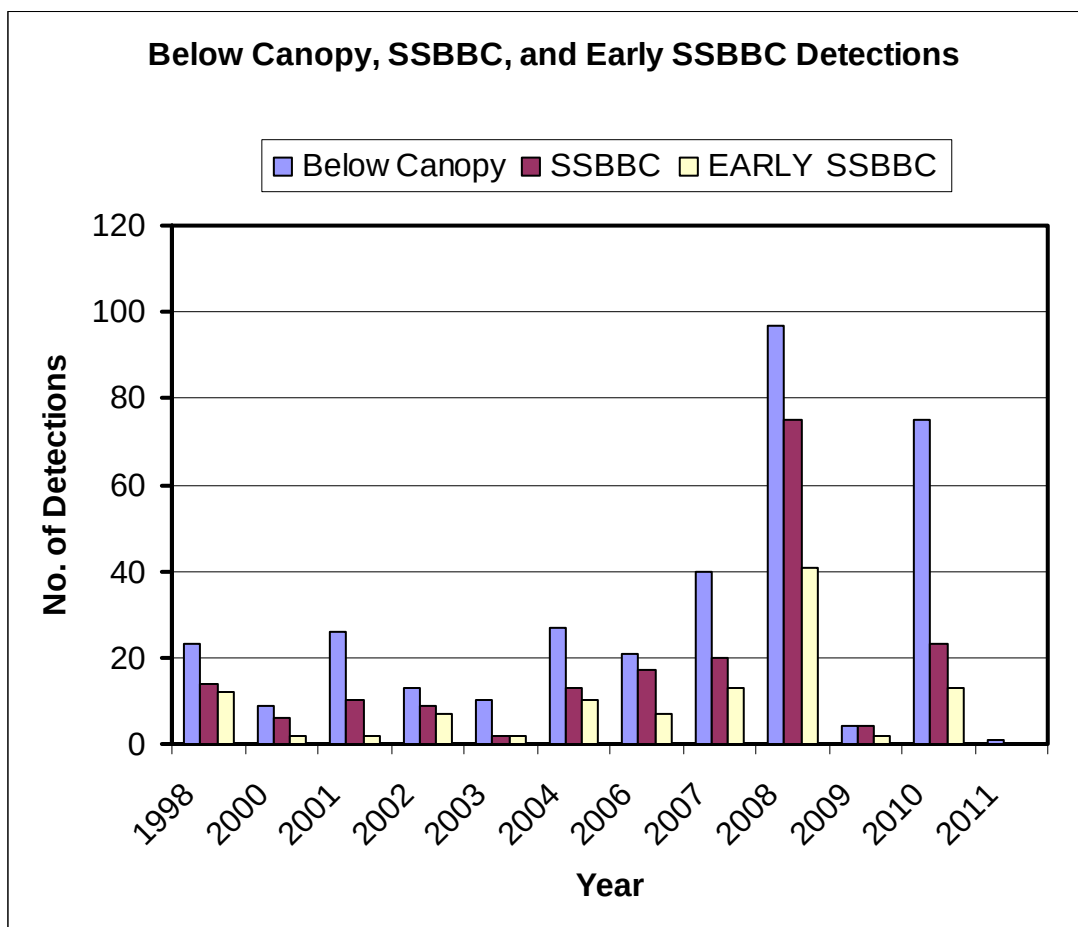
The number of common ravens (*Corvus corax*) detected on murrelet A-V surveys at Gazos Mountain Camp remains low. In 2011, ravens were detected on only two out of seven survey days (29% of the time), each time with a maximum of two birds. From 1998 to 2010, ravens were present on 21% of the survey days. In contrast raven detections in the meadow at Big Basin Redwoods State Park are likely to occur on every survey day, with many individuals seen.

Each year that the Gazos Mountain Camp A-V surveys are done provides both new insights and new questions about murrelet numbers and ecology in Zone 6. In 2011, for reasons unknown, the number of below canopy detections collapsed. Over the previous years of the study 74% of the survey days had below-canopy detections (Singer 2010) so the fact that only one day in 2011 had any is surprising. That detection was of a pair of birds, so there were no SSBBC

detections this year, and apparently no serious breeding attempts, at least none during the survey period.

In the 2010 report (Singer 2010) I wrote, "increased annual variation in below canopy detections (2008 – 2010) might be an important new pattern if it persists." Since below canopy detections are associated with nesting and since the nesting effort will vary from year to year, based on prey availability at sea, this new pattern, which is persisting, is disturbing. A worst case scenario is that oceanographic and meteorological patterns are changing (perhaps due to global warming) such that the years with a deficiency of murrelet prey items during the breeding season are becoming more common. If so, there would be a decrease in the number of years in which murrelets initiate nesting activity. One way to test this theory would be to see if below canopy detections at other inland breeding sites are in sync with the Gazos Mountain Camp results. Unfortunately there may be only one or two other sites with enough below canopy detections occurring to allow for comparison, and those data weren't available at the time this report was written.

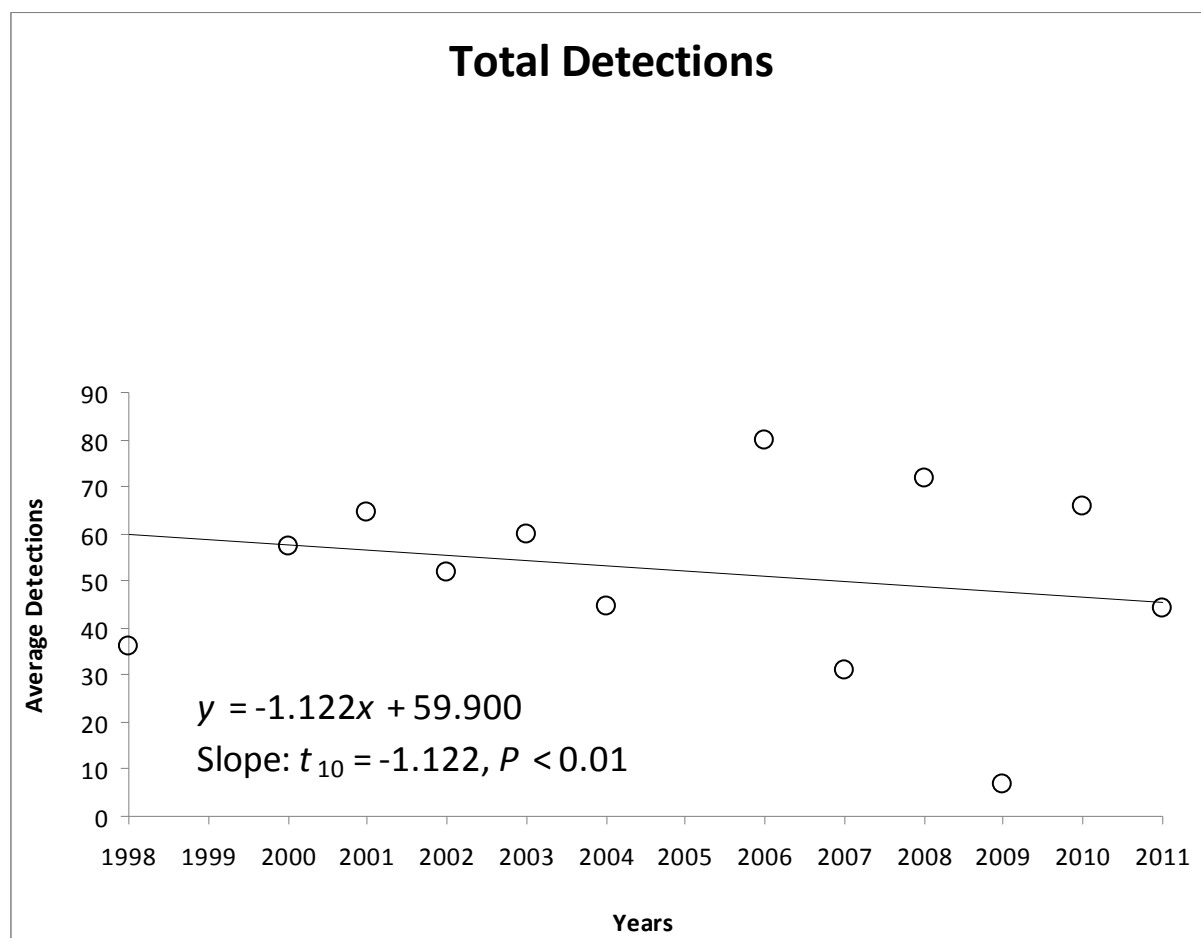
Graph 3. Number of Below Canopy detections, Single Silent Birds Below Canopy (SSBBC) detections, and Early SSBBC detections, 1998 – 2011. Early SSBBC detections were of birds detected more than 8 minutes before sunrise. No data exist for 1999 or 2005.



Statistical Analysis of Long-term Trends

As in 2010, an analysis was conducted by Andrew Rominger using the generalized least squares (GLS) method (Box et al. 1994) "to detect temporal trends in the data while accounting for autocorrelation (e.g. cyclicity) across census years" (Rominger 2011, which see for methods used). Four different types of detection were considered: Total Detections, Occupied Behavior Detections, Below Canopy Detections, and Heard-only Detections. Further analysis considered only the Total Detections category because it represents the greatest amount of information collected regarding potential murrelet presence, and it showed less variability between years, seeming to imply a more consistent measure of presence. The Student's t-test on the slope coefficient and a likelihood ratio test were performed to assess the statistical significance of temporal trend (see Rominger 2011 for full details on the tests used).

Graph 4. Statistical Analysis of A-V data, Total Detections (from Rominger 2010)



Statistical Significance of Apparent Trends

Total Detections (Graph 4) was found to have a statistically significant (P –value less than 0.05 for both the t-test and likelihood ratio test) downward trend. Prior to inclusion of 2011 data, the trend was only marginally significant. Below Canopy Detections were not significant using either test, and Heard-only Detections were not significant according to the likelihood ratio test. Strangely, Occupied Behavior detections (as defined here to include circling above canopy) now show a statistically significant slightly upward trend through time. This type of activity is not indicative of any one particular behavior such as birds flying to or beyond the survey station (total detections) or birds flying below canopy (indicative of nesting nearby). So it may not make biological sense to consider this category of detection.

Aberrant findings, like this one, are likely the result of too few data points and too much inter-annual variation – thus allowing the occasional large outlying data point, should it occur, to skew the data and create a false trend. The risk of statistically significant yet misleading results exists for all data categories. This risk is much reduced if statistical significance is consistently found for several years in a row. That is the target that we will be aiming for in this study. As Rominger (2011) has noted, "over time the effect of outliers should weaken and the trend and significance should be more consistent."

Linear vs. Non-linear Trends in Murrelet Numbers

As in 2010, autocorrelation analyses (Rominger 2010) found a cyclical pattern in Total Detections but not for Below Canopy Detections. Total Detections continue to show a two year cycle with "good" years tending to be immediately followed by "bad" years. The data through 2011 continue to show cyclicity as was first noted last year. The new data strengthens the case for this trend being real and not just an artifact of the current data set. The environmental or biological cause of this non-linear pattern is unknown, but may relate to prey conditions at sea that are known to promote or forestall breeding activity in seabirds in any given year (Cury et al. 2011). Continuation of this study will provide the additional surveys that will allow us to either accept or reject the occurrence of a cyclical trend in murrelet numbers.

SUMMARY AND RECOMMENDATIONS

Summary of Key Findings

1. Murrelet numbers at Gazos Mountain Camp have begun to show a slight, but statistically significant downward trend. However, murrelet numbers in general remain high relative to all other breeding areas.
2. For the first time ever there were no indications of breeding activity at Gazos Mountain Camp. The number of below canopy detections (1) and single silent bird below canopy detections (0) collapsed in 2011.
3. The non-linear trend of a two-year cycle in murrelet numbers (total detections) continued to be statistically significant in 2011, with "bad" years following "good" years. The environmental or biological cause for such a cycle, if it is real, is unknown.
4. An apparent increase in the year-to-year variability of below canopy detections is persisting.

Recommendations

1. Continue A-V surveys at all the major murrelet breeding areas in the Santa Cruz Mountains including Gazos Mountain Camp. Future surveys at Gazos Mountain Camp can be expected to answer such important questions as:

- will the newly revealed downward trend in murrelet numbers persist in 2012?
- will the collapse in breeding effort first observed in 2011 continue into 2012?
- will the cyclical pattern of "good" years following "bad" years persist into 2012? If so, this could be the first indicator of a new, but alarming, change in oceanographic patterns that affect murrelet breeding effort

Ideally, surveys at Gazos Mountain Camp would be expanded to include at least two surveys before July and two surveys after July in order to more fully cover the breeding season.

2. Pool A-V survey data from Butano State Park (one of the few inland sites with a sufficient number of detections) with the Gazos Mountain Camp A-V data and use statistical tests to look for significant long-term trends in murrelet numbers.

ACKNOWLEDGMENTS

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Figure 1. Location Map - Gazos Creek

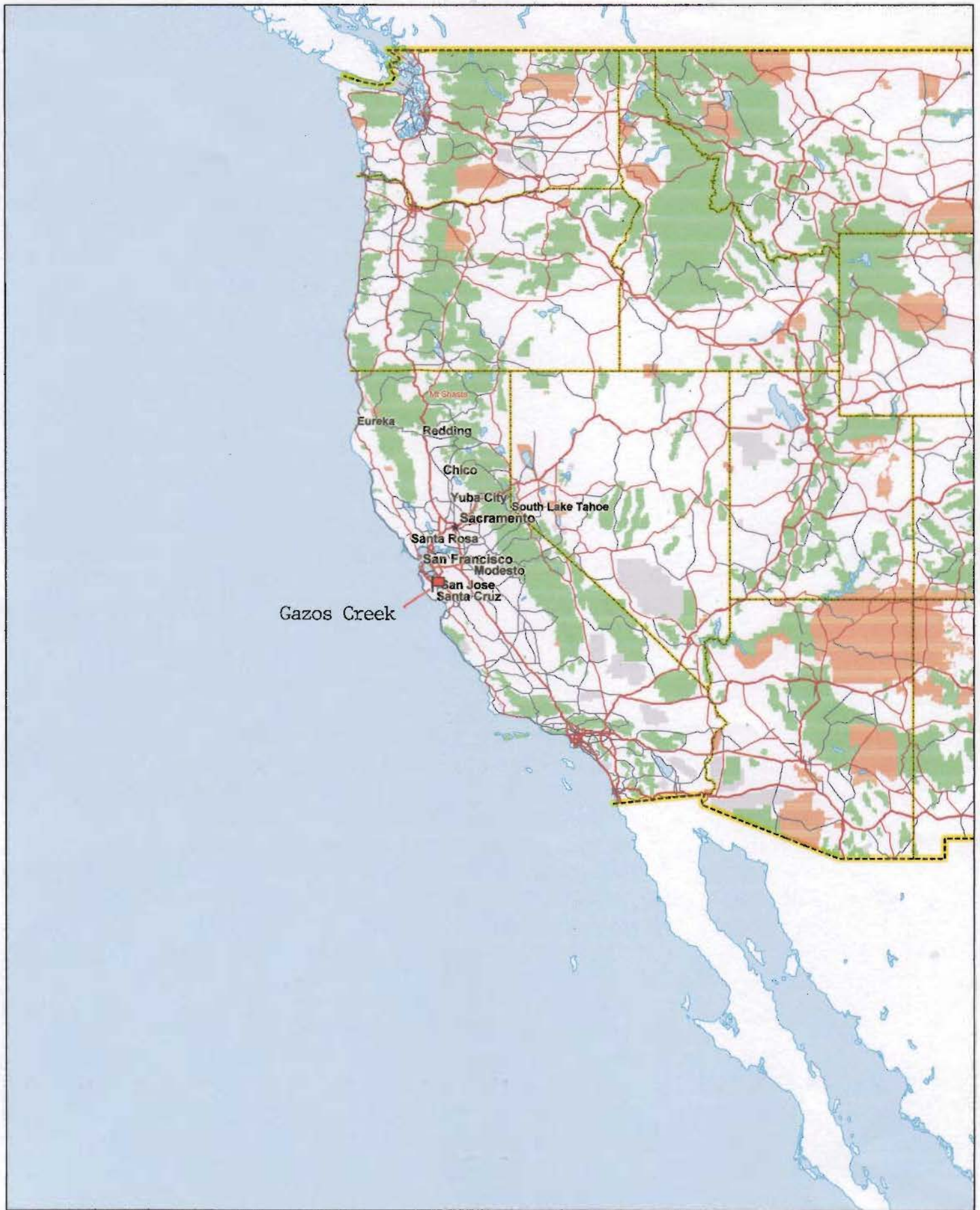
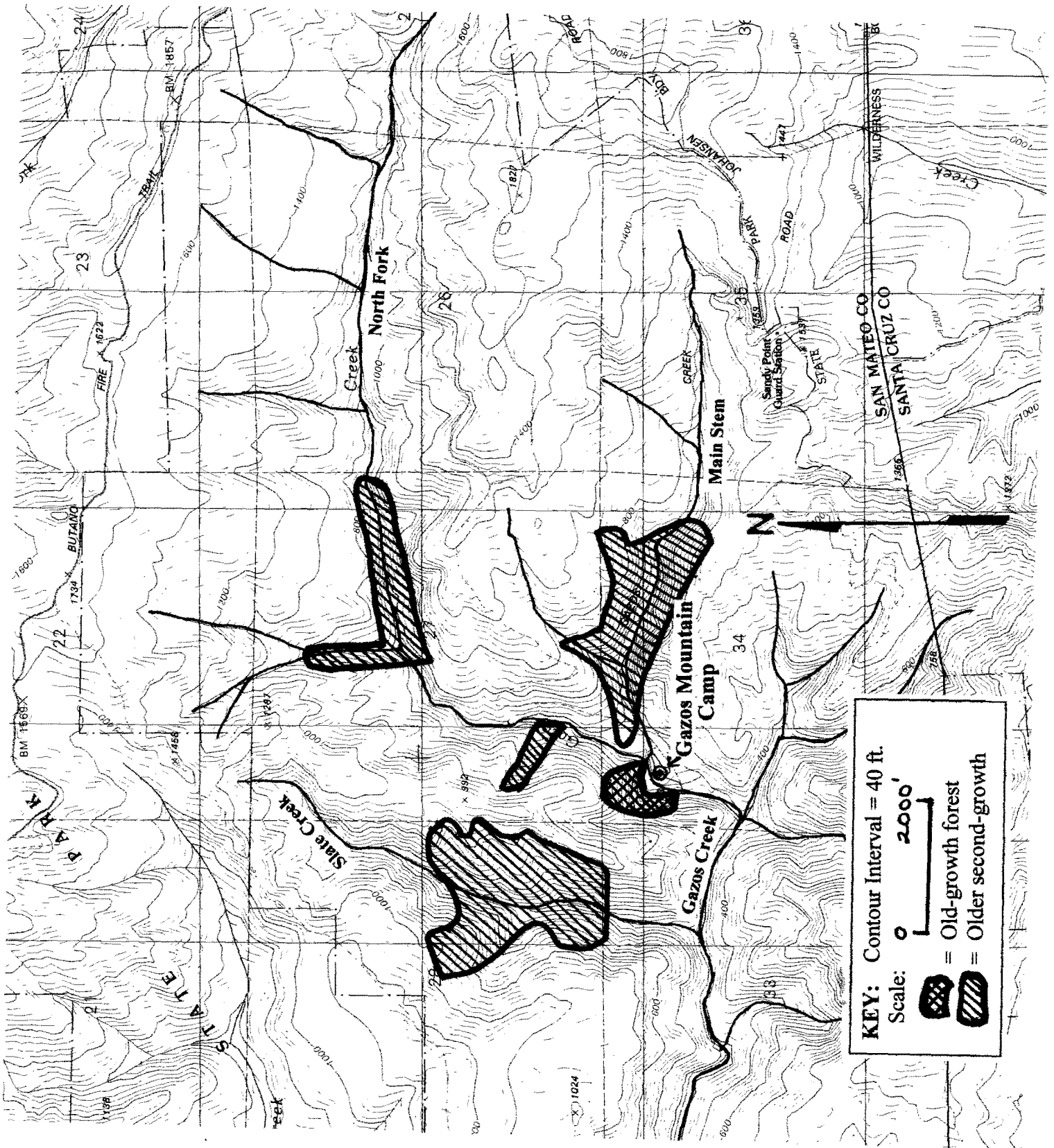




Figure 3. Old-growth and Older Second-growth Stands
Within One Mile of Gazos Mountain Camp



Note: All stands have shown occupied behavior except the small stand on the North Fork.