FINAL REPORT – PART II

RESULTS OF MARBLED MURRELET AUDIO-VISUAL SURVEYS AT GAZOS MOUNTAIN CAMP 1998 – 2010

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INTRODUCTION

Marbled Murrelets were discovered to be using Gazos Mountain Camp, then called Camp Villa Cathay, in 1996 (Singer, 1996). From 1998 to 2005 six audio-visual (A-V) surveys have been conducted there each year except for 1999 and 2005. The surveys were conducted in July (or the immediately bordering days) at the meadow which was formerly a ball field. These surveys, also referred to as "ground surveys", were originally part of the Apex Houston Gazos Creek Marbled Murrelet Monitoring Program, but have been a pro bono research effort since 2006. In 2010 the A-V surveys were conducted by the author, Portia Halbert of the State Parks Department, and Terris Kastner of the California Department of Fish and Game. In previous years some surveys were performed by Bill Webb, Bryan Mori, and Maria Ruth. A few surveys were done at other times of the year, but these surveys were not used in the analysis. A few incomplete surveys were also done over the years, including most notably, one survey in 2009 that included the observation of a murrelet carrying a fish. All monitoring efforts prior to 2010 were first reported in more detail in annual or biannual reports to the Apex Houston Trustee Council (see for example, Singer 2009, Singer and Hamer 2008, Singer 2007, etc).

Occupied Behavior is a type of murrelet behavior indicative of nesting nearby. It was originally defined to include flying below one canopy height and circling above one canopy height (PSG Marbled Murrelet Technical Committee 1994). As used here the term includes circling above canopy. In 2003 the definition was changed to exclude above-canopy flight (Evans et al. 2003). Occupied behaviors, by the current definition, are referred to as Below Canopy detections in this report.

METHODS

Surveys are conducted in the meadow at Gazos Mountain Camp, in Butano Redwoods State Park. The meadow is located 4.2 km from the ocean and 2.0 km upstream from the Double Low Gazos radar survey station (see Figures 1 and 2 at end of report). UTM coordinates (10S) of the meadow are X = 0562717, Y = 4117686. Located just across the creek from the meadow is a 10 acre stand of old-growth forest containing suitable murrelet nest platforms. Upstream on both the North and Middle Fork of Gazos Creek are older second-growth stand with residual trees. Upstream on the South Fork is the Bryan Grove – a 70 acre old-growth stand. Occupied behavior has been observed in all of these areas as well as in the Little Butano Creek Canyon bordering the Gazos Creek Canyon on the north side.

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. All surveys were done in July or the days immediately preceding or following July. A-V survey days at Gazos Mountain Camp only rarely coincided with radar survey days at Double Low Gazos.

Observations were recorded live into tape or digital recorders and later transcribed onto standard forest survey forms (see Appendix). The detection of other bird species was also noted. 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, all raven detections, the maximum number of ravens detected simultaneously, and the maximum number of jays detected simultaneously.

Weather conditions were also recorded including percent overcast, wind, temperature, precipitation, and visibility both horizontal and vertical. Since no weather conditions were encountered during surveys that interfered with the ability to detect murrelets, they will not be discussed in this report.

RESULTS AND DISCUSSION

Overall A-V Survey Results

Throughout the course of this project to date, there have been 66 surveys done (not counting the extra surveys) over 11 survey years. More than 132 hours were spent in the field conducting the surveys including 60 survey-hours of donated time for A-V surveys from 2005 on. These field surveys recorded a total of 3,419 detections (made by sight or sound), or an average of 51.8 detections per A-V survey. This detection level is higher than that from any other A-V survey station in the Santa Cruz Mountains (Suddjian, pers. comm., Evens, pers. comm.). The annual mean values for the A-V detections of all types over these 11 years ranged from 6.83 (2009) to 79.7 (2006), and are shown in Graph 1 below. The annual mean values for "Below Canopy" detections, considered to be Occupied Behavior according to the current survey protocol (Evans 2003), ranged from 0.67 (2009) to 19.33 (2008) and are shown in Graph 2 along with the mean tallies for "Visual" and "Heard-only" detections.

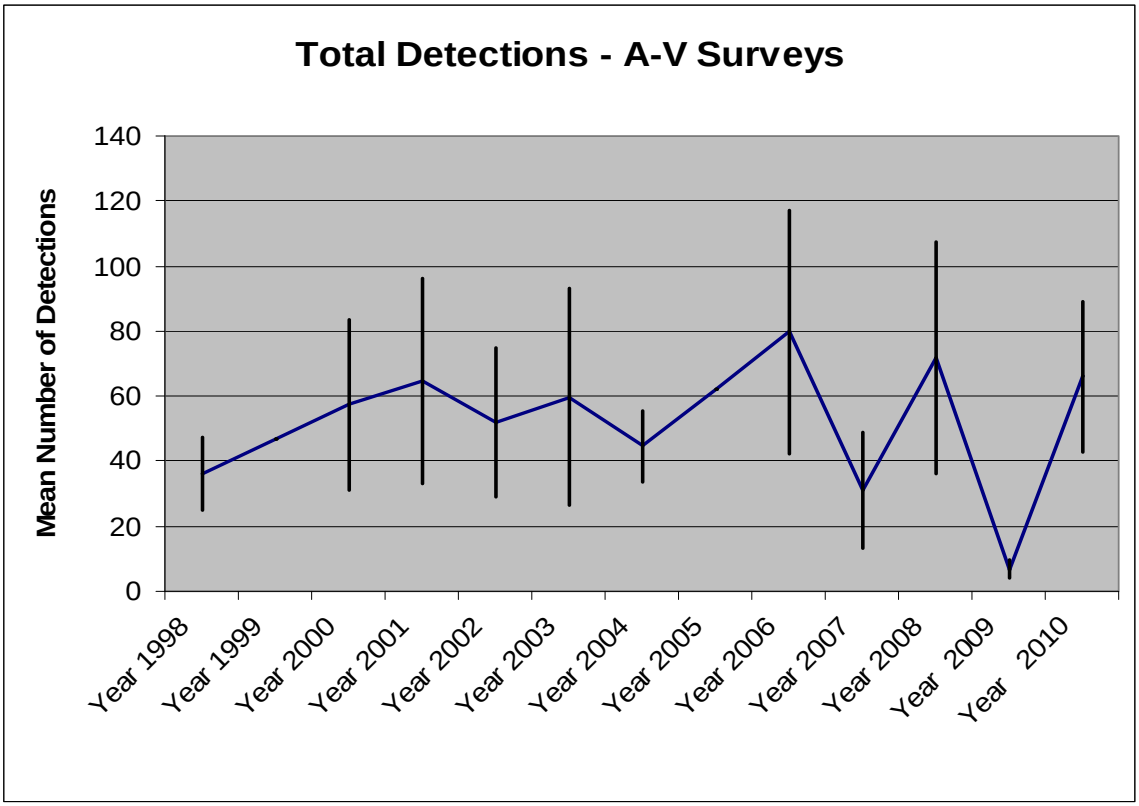
Most visual detections were of single murrelets or pairs. Groups of 3 – 5 birds were fairly common. Rarely seen were groups larger than 5 birds and the record group size was one group of 8 murrelets seen flying together on July 16, 2002.

Heard-only murrelets were detected primarily by vocalizations but also, and uncommonly, by wing sounds or the "jet plane" sound. Over the course of the study wing sounds were heard on 9 days, with three days having two wing sounds each, for a total of 12. The "jet plane" sound was only heard once – on July 18, 1998. The "jet plane" sound is rarely made by murrelets and gets its name because it sounds like a jet plane is on a crash dive toward the observer from behind. For the observer, hearing a "jet plane" sound is both frightening and unforgettable.

Over the 1998 – 2010 period there was quite a range in recorded detection values, indicating a high degree of both intra-annual and inter-annual variability (Tables 3 and 4). Such high levels of variability are normally associated with A-V murrelet surveys (Jodice, and Collopy 2000). Another cause of high variability in the number of A-V detections are relatively low circling murrelets that leave sight just long enough to qualify as a separate detection. At Gazos Mountain Camp it is not uncommon to have what is almost certainly a single murrelet or a pair repeatedly makes passes over the meadow, usually just below or just above one

canopy. On mornings when this happens, one individual or one pair of birds can be the source of 5 – 10 detections.

Graph 1. Mean number of audio-visual detections at Gazos Mountain Camp, 1998 to 2010. 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 2010. No data exist for 1999 or 2005.

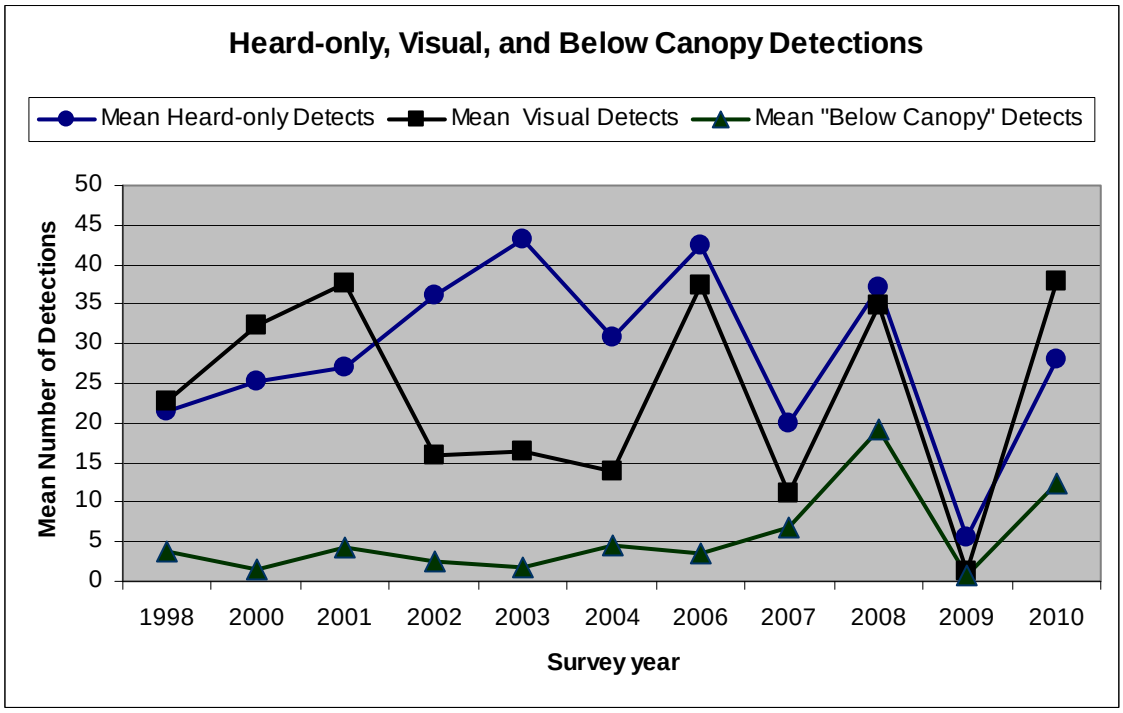


Table 1 below lists the mean values by year for each type of detection.

Table 1. Mean values of A-V survey results, 1998 – 2010. The sum of daily total detections for each year and the number of "Below Canopy" detections are also provided in parentheses in columns 1 and 2 respectively. Shaded values represent the highest value for each category of detection.

Year	Mean Total Detections and (Total Detections)	Mean Occ. Beh. Detections and (Below Canopy)	Mean Visual Detections	Mean Heard-only Detections	Mean Detections of Single Silent Birds Below 1 Canopy Ht.
1998	36.00 (216)	10.67 (3.83)	22.67	13.33	2.33
2000	57.33 (344)	15.00 (1.50)	32.17	25.17	1.00
2001	64.67 (388)	17.83 (4.33)	37.67	27.00	1.67
2002	52.00 (312)	9.17 (2.50)	15.83	36.17	1.50
2003	59.67 (358)	9.67 (1.67)	16.50	43.17	0.83
2004	44.70 (268)	9.50 (4.50)	13.80	30.80	2.20
2006	79.70 (478)	19.8 (3.50)	37.30	42.30	2.80
2007	31.17 (187)	9.17 (6.67)	11.17	20.00	3.33
2008	71.83 (431)	27.17 (19.33)	34.83	37.00	12.50
2009	6.83 (41)	0.83 (0.67)	1.33	5.50	0.67
2010	66.00 (396)	25.67 (12.50)	38.00	28.00	3.83

Table 2. Daily extremes of Total Detections by A-V surveys from 1998 – 2010, and annual means. Data are from six surveys in July of each year. Extreme high day and low day values are shaded.

No. Of Total Detects	1998	2000	2001	2002	2003	2004	2006	2007	2008	2009	2010
Highest Day	49	100	105	75	127	59	125	59	128	11	103
Lowest Day	18	25	26	25	39	29	25	11	16	4	41
Annual Mean	**36.0**	**57.3**	**64.7**	**52.0**	**59. 7**	**44.7**	**79.7**	**31.2**	**71.8**	**6.8**	**66.0**

Long-term Trends by Detection Type

A simplified view of the various A-V detection categories can be made by dividing them into four main categories even though they overlap to some degree. These are: "Below Canopy" detections (which include low visual detections and the "Single Silent Bird Below Canopy (SSBBC)" category), Visual detections (which include all Below Canopy detections), "Heard-only" detections (which excludes all visuals, all Below Canopy, and all SSBBC detections), and "Total" detections which includes all of the above. These are plotted in Graph 2 above.

All types of detections, except Total Detections, had curves whose slopes tracked each other well from 2000 – 2001 and from 2008 to 2010. From 2001 to 2003, Heard-only detections increased while the other two types of detections either decreased or remained stable. From 2003 to 2004 and from 2006 to 2007, the number of Heard-only detections and Visual detections dropped while the number of Below Canopy detections increased. One possible explanation of why the slopes of these curves either track or don't track each other is given below.

If Below Canopy murrelet detections are indicators of nesting nearby, than we would expect them to track differently than Visual or Heard-only detection types, at least in those years when non-breeders are flying inland in good numbers. Peery et al. (2004) has shown that the number of murrelets flying inland from a radio-tagged population can vary by a factor of 3X or more from year to year depending on whether non-breeders fly inland or not. They go on to say that a small core of experienced breeders will attempt to breed almost every year.

Those experienced breeders in the Gazos Mountain Camp area would be detected as Below Canopy detections, which means that Below Canopy detections should show less year-to-year variability as non-breeders will not be flying below one canopy height. This seems to be the case at Gazos Mountain Camp as the Below Canopy detections remain fairly stable and don't track the movement of Visual or Heard-only detections. For example, from 2003 to 2004 and again from 2006 to 2007, the detections of both Heard-only and Visual birds dropped significantly while the number of Below Canopy detections did not and actually increased slightly. The pattern is not perfectly consistent, however, since in 2008 and 2009 Below Canopy detections closely tracked the other detections.

Lack of Correlation of Radar Surveys with A-V Surveys

When looking at both "high detection" years and "low detection" years we saw no correlation between results at the Gazos Mountain Camp A-V survey site and results at Double Low Gazos radar survey site located downstream. In fact the year of 2008 which had the second-highest number of A-V detections (431), had the second-lowest number of radar detections (207). This lack of correlation is likely explained by at least 4 reasons: (1) radar surveys and A-V surveys were not usually performed on the same day and there is much day-to-day variation, (2) repeated observations of a circling bird (in which the bird is out of sight for long enough to count as a separate detection) can skew A-V totals much higher, and (3) depending on their destination, murrelets can fly over one survey station and not the other since they are located 2 km. apart (see Figure 1). For example birds flying up the canyon may be going to other parts of the watershed and not Gazos Mountain Camp, or birds flying down the canyon might cross over a ridge before reaching the radar site. A few murrelets have been seen doing this at Gazos Mountain Camp, flying directly out to the west, and others may do so down the canyon before reaching the radar site. (4) As was observed in the 2009 radar study (Colclazier, Stumpf, and Singer 2010), and likely related to local topographic conditions, some murrelets fly too low to be picked up by radar.

2010 Rebound in Murrelet Numbers from 2009 Collapse

The number of murrelets detected in six July surveys in 2010 at Gazos Mountain Camp rebounded from a major decline that was experienced in the 2009 breeding season. As seen in Figure 1 at the end of the report, the 2009 mean was only 6.83 while the 2010 mean was 66.00 which is roughly similar to the mean of 71.83 in 2008.

The results from the 2010 surveys are presented in Table 3 below. In 2010, the mean number of total detections, visual detections, occupied behaviors and detections of single silent birds below canopy height (SSBBC) all rebounded to numbers that were generally comparable with 2008 and prior years. The single greatest high day and low day detection numbers for the 2009 – 2010 period are shown in Table 4 below. Additionally, on July 29, 2009, only a total of 4 detections were tallied which is the lowest number of detections ever recorded since surveys began in 1998. This contrasted dramatically with 2008 (7/16/08) when the record high number of one-day detections (128) was recorded. The highest number of one-day detections in 2009 was only 11, while in 2010 it was 103.

It will be interesting to know if 2009 was an aberration or if future years also show large oscillations in the number of total A-V detections. An increase in variability of detections may be an indicator of murrelet population changes.

Table 3. Year 2010 audio-visual surveys for murrelets at Gazos Mountain Camp. Values for the mean, standard deviation (STDV), and coefficient of variation (CV) are given in the bottom rows.

Date	Total Detects	Visual Detects	Heard-only Detects	Occ. Beh. Detects	Below Canopy Detects	Number of Single, Silent Birds Below 1 Canopy Ht. Detections (SSBBC)
7/12/10	58	30	28	16	9	3
7/13/10	82	45	37	42	22	6
7/14/10	41	35	6	18	15	4
7/19/10	48	12	36	18	7	0
7/23/10	103	81	22	35	9	2
7/28/10	64	25	39	25	13	8
MEAN	**66**	**38**	**28**	**25.67**	**12.5**	**3.83**
STDV	23.0	23.7	12.5	10.6	5.5	2.9
CV	0.35	0.62	0.5	0.41	0.4	0.75

Table 4. A comparison of the 2010 single day A-V values with the 2009 values for all types of detections. Values are ranked from highest to lowest. The 2009 values are given in parentheses after the 2010 values.

Total Detections	Visual Detections	Occ. Beh. Detections	Below Canopy Detections	Heard-only Detections	Number of Single, Silent Birds Below Canopy
103 (11)	81 (4)	42 (4)	22 (3)	39 (10)	8 (3)
82 (10)	45 (3)	35 (1)	15 (1)	37 (7)	6 (1)
64 (6)	35 (1)	25 (0)	13 (0)	36 (6)	4 (0)
58 (5)	30 (0)	18 (0)	9 (0)	28 (5)	3 (0)
48 (5)	25 (0)	18 (0)	9 (0)	22 (4)	2 (0)
41 (4)	12 (0)	16 (0)	7 (0)	6 (1)	0 (0)

Evidence of Nesting at Gazos Mountain Camp and Vicinity

One of the main purposes of the audio-visual surveys at Gazos Mountain Camp is to detect evidence of nesting – something that radar surveys cannot do.

There are three different indicators of nesting that could potentially be observed during an audio-visual survey, other than finding a fledgling on the ground or finding a nest. These are listed below in order of stronger to weaker evidence:

1. Observation of a murrelet carrying a fish (certainty of nesting nearby)
2. Observation of a single silent murrelet flying below canopy height during the earliest incubation exchange or feeding time (usually no later than 8 minutes before sunrise) (very strong likelihood of nesting nearby – see Nelson and Peck 1995, Singer et al. 1995)
3. Observation of below-canopy flight (possible nesting nearby)
4. Audio detection of murrelet "jet plane" sound (believed to occur in nesting areas only)

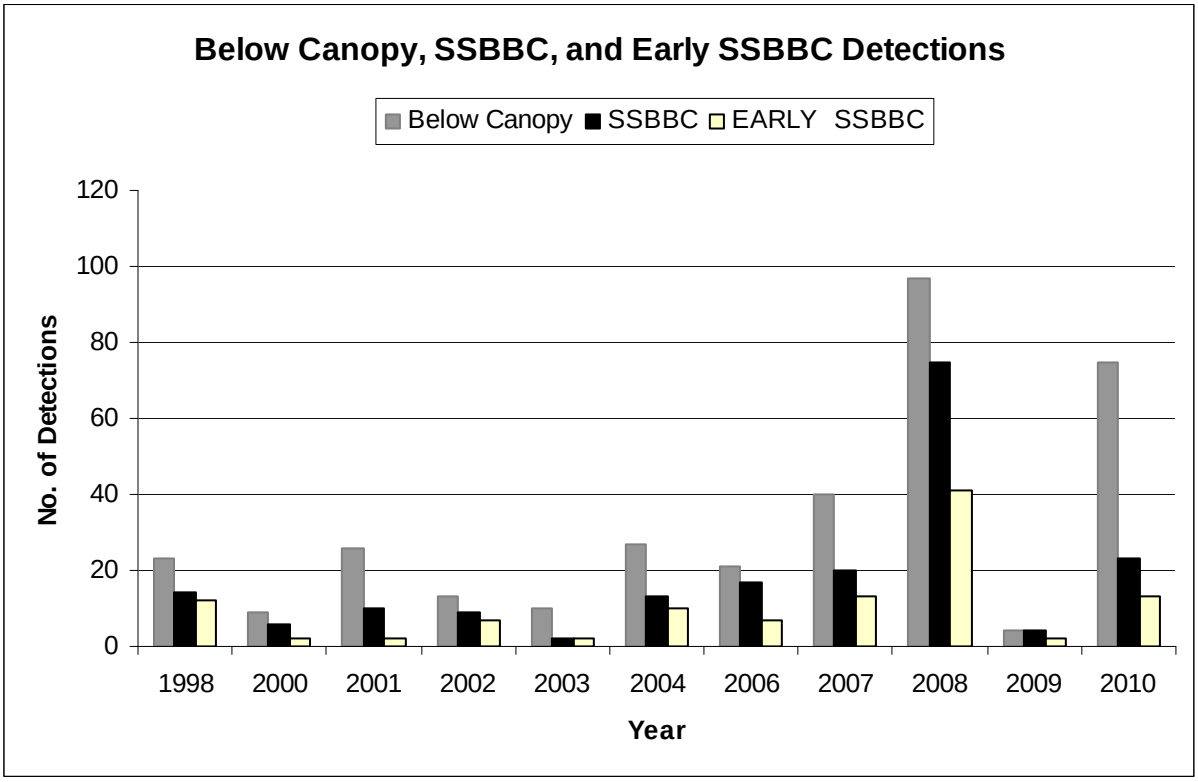
Observation of a Murrelet Carrying a Fish: This was seen only once at Gazos Mountain Camp on August 4, 2009. This occurred during an incomplete "extra" survey done after the six protocol surveys had been completed in July. The finding was notable for a number of reasons, not the least of which was that the 2009 survey season had been the lowest ever seen, with the combined total detections for all six surveys being only 41. This number is lower than the overall average detection number for a single survey day during the entire duration of the project (i.e., 1998 – 2010).

This survey was interesting for another reason. For a parent to be feeding a nestling, the nest must have been at least 30 days old. Yet for only 2 of the 6 prior surveys (June 28 to July 29) was there an observation of below canopy flight in the meadow. Nesting murrelets are known to repeatedly use the same approach route for nest visits (Nelson and Peck 1995, Singer et al. 1985), so the approach route to this nest must have not been over the meadow.

Observations of Single Silent Birds Below 1 Canopy Height Early in the Survey Period: During the egg stage, murrelets exchange places on the nest early during the survey period, typically at least 8 minutes before sunrise (Nelson and Peck 1995, Singer et al. 1995, Singer et al. 1991). Single silent birds below canopy (SSBBC) were detected on 41 out of the 66 survey days (62% of the time), but not all of these detections occurred early in the survey period (see Graph 3). Thirty surveys of the 41 survey days with SSBBC detections had at least one detection occurring earlier than 8 minutes before sunrise. Thus this particular type of nesting evidence occurred on 45% of the 66 survey days. In fact, no year had less than 2 survey mornings with this type of detection.

The high number of SSBBC detections at this site is unique for all Santa Cruz Mountain Survey stations and probably indicates that a consistent nesting effort is occurring at the Camp or the closely adjoining property almost every year.

Graph 3. Number of Below Canopy detections, Single Silent Birds Below Canopy (SSBBC) detections, and Early SSBBC detections, 1998 – 2010. Early SSBBC detections were of birds detected more than 8 minutes before sunrise. No data exist for 1999 or 2005.



Observations of Below Canopy Flights: These detections are what is defined as "Occupied Behavior" detections under the new survey protocol (Evans 2003). These are plotted in Graph3 above. Of the total 3,419 detections recorded during this survey, 346 (10%) were Below Canopy Detections, an average of 5.2 per survey morning. Of the 66 total survey mornings, 49 mornings (74%) had one or more Below Canopy detections. The year with the fewest number of days with Below Canopy detections was 2009 when only two days had Below Canopy detections. The years 1998, 2008, and 2010 had Below Canopy detections on every survey day. Below Canopy flights, now known as Occupied Behavior, are considered to indicate that nesting is occurring nearby (Evans 2003), so the frequency of Below Canopy flights would indicate that nesting is regularly occurring at or near Gazos Mountain Camp.

The increased annual variability in Below Canopy detections (2008 – 2010) might be an important new pattern if it persists. Total Detections have always shown high year-to-year variability as have radar detections (see Part I). At-sea counts of murrelets may also be showing an increase in variability, at least they did from 2008 to 2009 (Peery and Henry 2010). An increase in the size or frequency of year-to-year oscillations of murrelet detections, especially if it is simultaneously observed in radar counts, at-sea counts, and A-V detection numbers, could be indicative of more frequent changes in the prey availability status at sea. In years when ocean conditions limit prey availability, fewer murrelets will

nest, fewer will fly inland, and more may disperse away from their normal summer foraging areas at sea.

Audio Detection of Murrelet "Jet Plane" Sounds: During a steep dive, murrelets can make a loud sound with their wings that sounds similar to the jet engine of an airplance. This sound has only been observed in nesting areas (Nelson and Peck 1995). On July 18, 1998, a jet plane sound was heard during an A-V survey at Gazos Mountain Camp. This was the only jet plane sound heard during the entire project.

Statistical Analysis of Trends

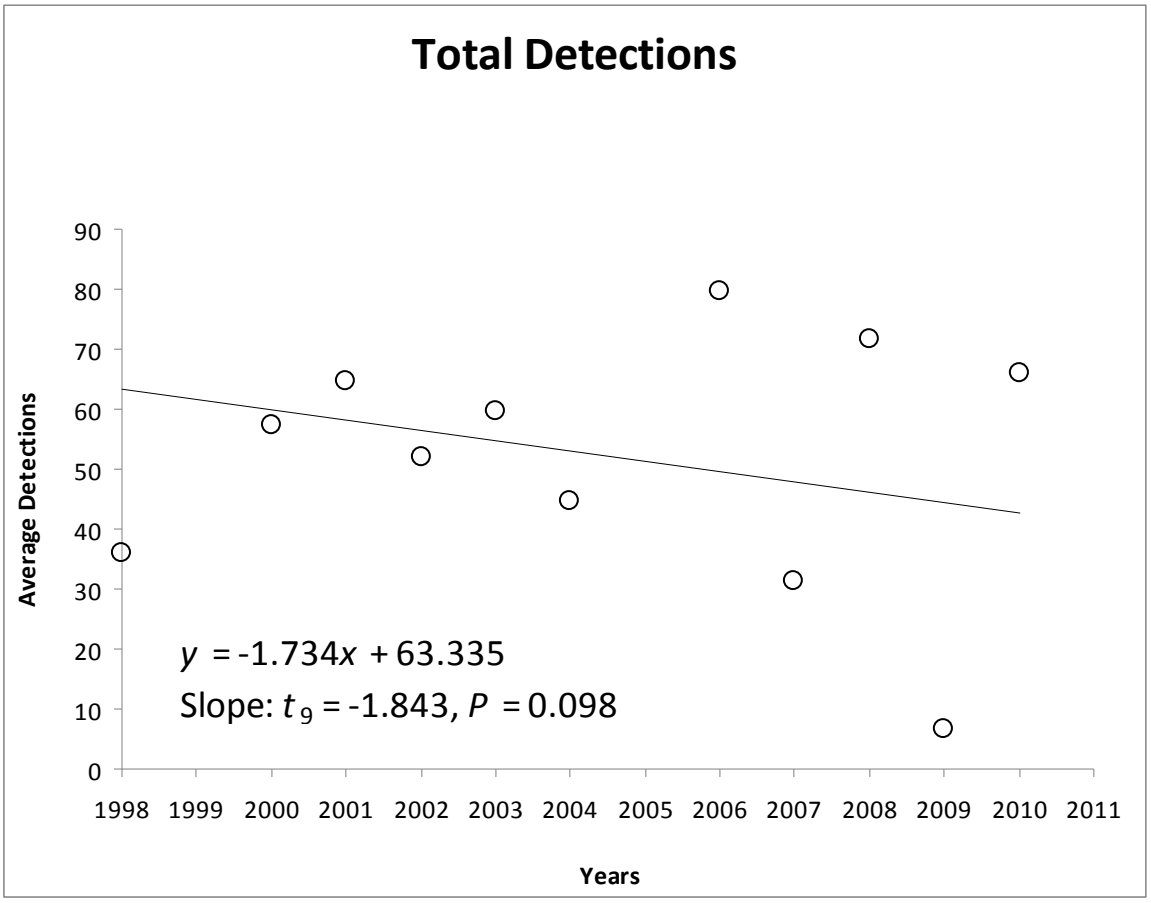
A biostatistical consultant was asked to review the data. He wrote up his findings (Rominger 2010) and the results are summarized here.

An analysis was conducted using the generalized least squares (GLS) method to determine if there has been a trend in murrelet A-V detections at Gazos Mountain Camp. Four different types of detection were considered: Total Detections, Occupied Behavior Detections, Below 1 Canopy Detections, and Heard-only Detections. Final analysis considers only Total Detections and Below 1 Canopy Detections for two reasons, the first being that Total Detections represents the greatest amount of information collected regarding potential murrelet presence, and the second being that Total Detections and Below 1 Canopy Detections show less variability between years, seeming to imply a more consistent measure of presence. The Student's t-test was used to evaluate the significance of the regression of detections through time, applying it to the slope coefficient using the residual degrees of freedom (df=9). Graphs 4 and 5 show the results of the analyses, showing the trend line computed by GLS and the result of the Student's t-test.

Total Detections (Graph 4) was found to have marginally significant downward trend (as the P-value is close to the significance cut-off of P = 0.05). Below Canopy Detections (Graph 5) showed no significant trend since 1998. Rominger notes that "In the case of Below Canopy Detections there is a substantial increase in variation for the last three years: these outliers likely confuse the pattern, drawing the trend line toward a more positive slope, and possibly violating the assumption of homogeneity of residuals in linear regression". In the analyses of Occupied Behavior detections and Heard-only Detections, the trend lines are much flatter and there was no significant trend.

Autocorrelation analyses (Rominger 2010) found that there is evidence of cyclicity in Total Detections but no evidence for cyclicity in Below Canopy Detections. Total Detections shows a cyclical pattern of "good" years tending to be immediately followed by "bad" years. This is an interesting finding, since evidence of cyclicity was also found in the 2010 radar data analysis (see Part 1 of this report). However, additional A-V survey years are needed to confirm that this non-linear pattern in A-V detections is not an artifact of the current data set.

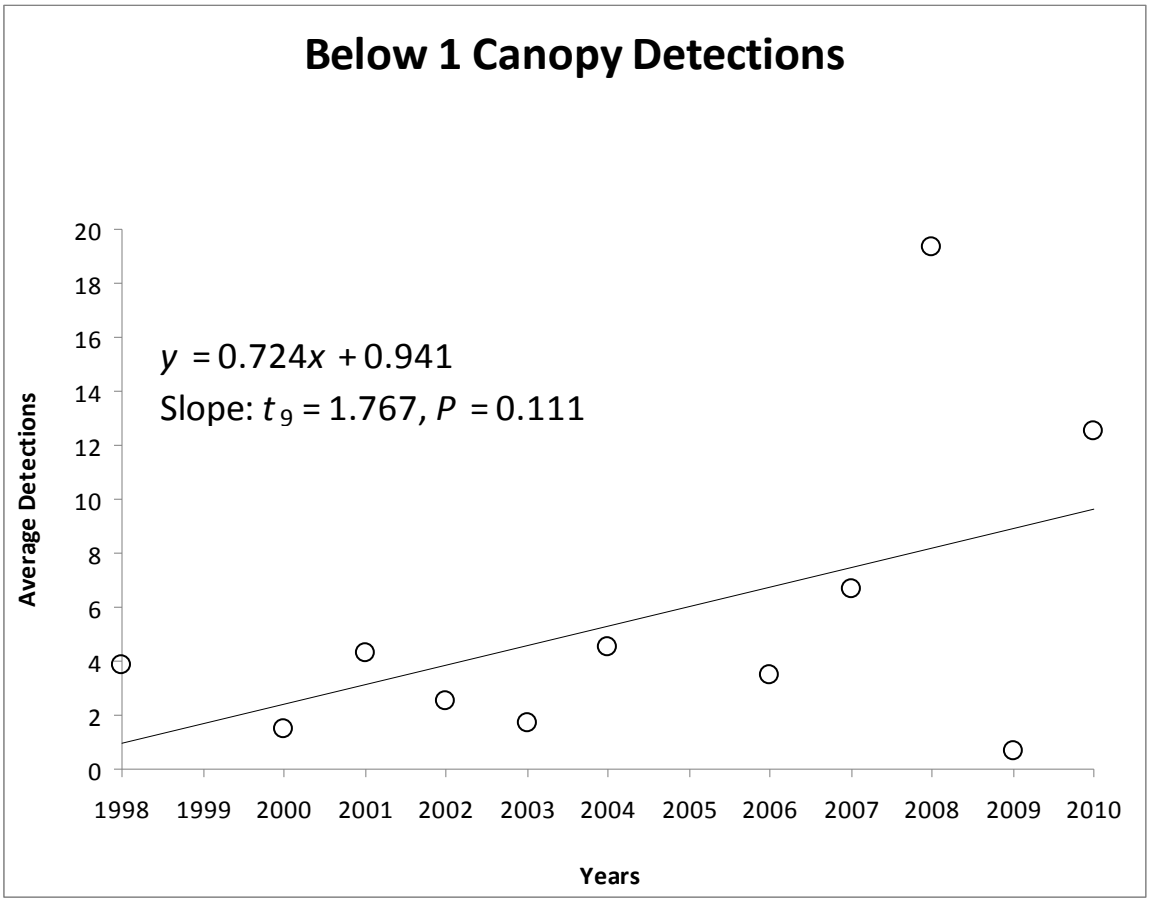
Graph 4. Statistical Analysis of A-V data, Total Detections (from Rominger 2010)



Other Birds Detected Including Murrelet Nest Predators

Other bird species detected on almost every survey included Pacific Slope Flycather (*Empidonax difficilis*) – which comprised the bulk of the dawn chorus every morning, American Robin (*Turdus migratorius*), Dark-eyed Junco (*Junco hyemalis*), Swainson's Thrush (*Catharus ustulatus*), Chestnut-backed Chickadee (*Poecile rufescens*), Band-tailed Pigeon (*Columba fasciata*), and Steller's Jay (*Cyanocitta stelleri*). Every survey detected from two to several jays, which are abundant throughout forested areas of the Santa Cruz Mountains. Jays are important predators of murrelet eggs and chicks (Nelson 1997, Singer et al. 1991), but they have always been present in the forests where murrelets nest. However the number of jays in a stand can be increased by human use (if the accompanying extra food source of garbage is not controlled), and in these cases they can exert an elevated predation pressure on murrelet nests. For this reason stringent food and garbage management rules are in place at Gazos Mountain Camp, and no human foods are available to corvids (pers. obs.).

Graph 5. Statistical Analysis of A-V Data, Below Canopy Detections (from Rominger 2010).



Common Ravens (*Corvus corax*) were much less common on murrelet dawn surveys, being detected on 14 survey-days (21% of the surveys), five of which were in 2002. They were detected on only one survey day in 2010 and one day in 2009. Each detection was only of one or two ravens. Common ravens prey on murrelet eggs, nestlings, and perhaps even adults (Nelson 1997, Singer et al. 1995, Singer et al. 1991). They have been known to force incubating or brooding adults off the nest to get at the egg or chick. Like jays, they are also attracted to areas where human habitation provides a supplemental food source. Unlike jays, they were not originally present in forested areas of the Santa Cruz Mountains. The first documented occurrence of a raven in Big Basin Redwoods State Park, an interior location, was in 1985, and their numbers have increased dramatically since then (Singer and Suddjian 1995).

Ravens represent a new and severe threat to the survival of murrelets in the Santa Cruz Mountains.

CONCLUSIONS

● Acquisition of the Gazos Mountain Camp property by the Sempervirens Fund with the assistance of oil spill restoration monies provided by the Apex Houston Trustee Council was an unqualified success. Audio-visual surveys at the Camp have shown a continued high level of murrelet detections in every year except 2009. Gazos Mountain Camp and environs is the most used of all the marbled murrelet breeding sites that are regularly monitored in the Santa Cruz Mountains.

● Flight behavior that is indicative of nesting nearby has been found at Gazos Mountain Camp in every survey year to date, including 2009. Since this property was purchased to protect murrelet nesting habitat and since nesting is continuing to occur, the use of oil spill restoration monies to help acquire this property was a sound decision.

● The collapse in A-V detections in 2009 at Gazos Mountain Camp did not persist in 2010 but instead was followed by a return to near normal numbers.

● Audio-visual survey numbers for Total Detections and radar survey numbers for Total Inbound and Outbound birds both suggest that the pattern of murrelet usage of the Gazos Creek Watershed over time may be a non-linear trend, and hence require a greatly extended sampling effort to determine their population trend to a statistical certainty.

● Annual variability of Below Canopy detections appears to be increasing. This new pattern could be important if it persists. Total Detections have always shown high year-to-year variability as have radar detections (see Part I). At-sea counts of murrelets may also be showing an increase in variability, at least they did from 2008 to 2009 (Peery and Henry 2010).

● The A-V monitoring program at Gazos Mountain Camp, even though unfunded for the last 5 years, has been successfully implemented each year and the results have been extremely valuable in documenting the amount and type of murrelet usage that is occurring at Gazos Mountain Camp.

● Corvid counts on murrelet A-V surveys at Gazos Mountain Camp have not shown any increase in the number of corvids at Gazos Mountain Camp.

RECOMMENDATIONS

1. Acquire the remaining privately-held murrelet breeding stands, giving a priority to stands in remote areas away from youth camps, public campgrounds, small farms, or rural housing that might provide a source of human food for corvids. Such undeveloped sites are more likely to support successful murrelet nesting.

2. Continue A-V surveys at all the major murrelet breeding areas in the Santa Cruz Mountains including Gazos Mountain Camp. Surveys at Gazos Mountain Camp should be expanded to include at least two surveys before July and two surveys after July in order to

more fully cover the breeding season. It should be noted that one year of A-V surveys is about half as expensive as one year of radar surveys.

3. Instigate and provide support for a local coordinating committee of wildlife professionals to guide and promote murrelet research/management efforts and to encourage cooperation between individual researchers, resource agency staff, land conservancy staff, and land managers who are committed to maintaining the Santa Cruz Mountains murrelet population. Important purposes of the committee would be to identify the most important local needs, find funding sources for high priority projects, and promote coordination and cooperation among research and management efforts that are being funded.

4. Continue to implement public education efforts in and around murrelet breeding areas that are located in or near developed settings, whether those developments are for residential, agricultural, or recreational purposes. These would include youth camps, small farms, public campgrounds, and rural home areas. Expand the successful food control measures that have been used at Gazos Mountain Camp to other areas where needed and as appropriate.

5. If acoustic murrelet detectors prove to be accurate in the discrimination of murrelet vocalizations, their use should be restricted to the limited situations where information about murrelet flight behaviors is not needed. They should not be used as a monitoring tool in the existing A-V murrelet survey sites where nesting is or was formerly known to be occurring. At Gazos Mountain Camp the heard-only detections represented from as little as 37% of the total detections and never more than 72% of the total detections. Heard-only detections also showed more annual variation than the Below Canopy (Occupied Behavior) detections that are all visual.

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Figure 1. Location Map - Gazos Creek

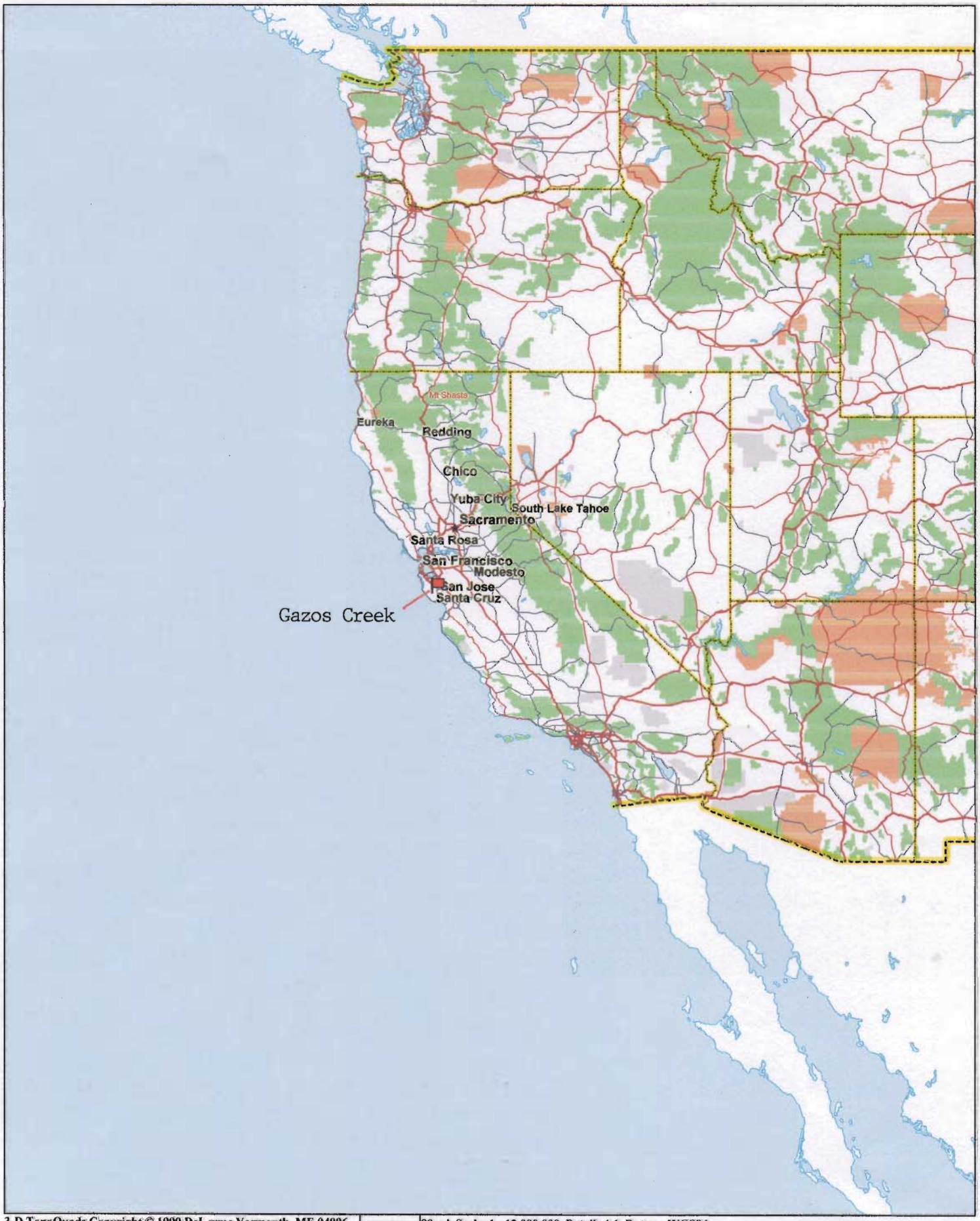


Fig. 2. Gazos Mtn. Camp & Survey Sites
Ground survey sta.
Gazos Mtn. Camp
Radar survey sta.
Pomeroid Ranch
Deer Park Ridge
Rodgers Gulch
The Potato Patch
Big Dipper Ranch
Horseshoe Ranch
Burns Ranch
Mt. Ellen
Tahana Gulch
Chandler Gulch
Shaw Gulch
Little Chicken Hollow
Goat Hill
Lane Hill
Memorial Park
Worley Flat
Indian Point
China Flat
Martin Ridge
Loma Mar
Dark Gulch
Round Hill
Roy Gulch
Windmill Gulch
Newell Gulch
Dearborn Park
Pescadero
Coyote Ridge Trail
Pomponio Trail
Summit Trail
Portola State Park
Butano Ridge
Butano Park
Butano State Park
The Mesa
Yankee Jim Gulch
Guard Station
Ocean View Summit
Big Basin Redwoods State Park
Pigeon Point Light Station
Big Basin
Chalk Mountain
Pine Mountain
Little Basin
Franklin Point
Eagle Rock
Locatelli Ranch
Point Ano Nuevo
Point Ano Nuevo
Ano Nuevo Island State Park
Ano Nuevo Island
Ano Nuevo Bay
Wilson Gulch
Deadman Gulch
Las Trancas
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APPENDIX

CALIFORNIA MARBLED MURRELET FOREST SURVEY FORM

Survey Visit to Protocol (Y or N, initials): ☐☐ Page 1 of ____
Total Detections: _____
Species of Concern (circle one, details on last pg.): **Y** or **N**
Month _____ Day _____ Year _____

Area Name: _____ Site Name / Number: _____ Station Number: _____

Sta. Location - UTM zone: ____ E (x) coordinate: _____ N (y) coordinate: _____ Source: _____ Datum: _____ FOM: ____

Observer (s) Name: _____ Initials: _____ Affiliation: _____ Phone: (___) _____

Station Elevation: _____ **Ft / M** Position on Slope (circle one): **Bottom/plain, Lower 1/3, Mid 1/3, Upper 1/3, Ridgetop**

Station Placement (circle one): **Inside, Outside**

Distance from Survey Site Boundary: _____ Units of Measure for **ALL** Horizontal Distances: _____

Station Canopy Cover (circle one): **1** = 0 to 25%, **2** = 26 to 50%, **3** = 51 to 75%, **4** = 76 to 100% Canopy Height _____

ENVIRONMENTAL CONDITIONS:

Official **Sunrise** Time: _____ **Source**: _____ **Begin Survey** Time: _____ **End Survey** Time: _____

Temperature at Sunrise: _____ Temperature at End of Survey: _____ (circle one) **C** or **F** revised: 2 / 2000

TIME	VERTICAL VIEWING			HORIZ. VIS. TO 100 M	AUDIBILITY TO 200 M	PRECIPITATION			WIND	NOISE	NOTES
	CEILING	CLOUD COVER	VISIBILITY TO 2 CANOPY			RAIN	FOG	OTHER			

Ceiling: **UL** = Unlimited (clear), **HI** = >2.0 canopy height, **MID** = >1.25 to ≤ 2.0 canopy height, **LO** = ≤1.25 canopy height, **U** = Unknown.
Cloud Cover: **0** = 0%, **1** = 33%, **2** = 66%, **3** = 100%.
Vertical Visibility: **N** = Impaired (detections may be missed due to conditions), **Y** = Unimpaired (conditions allow for reliable detection), **U** = Unknown.
Horizontal Visibility: **N** = Impaired (detections may be missed due to conditions), **Y** = Unimpaired (conditions allow for reliable detection), **U** = Unknown.
Audibility: **N** = Impaired (detections may be missed due to conditions), **Y** = Unimpaired (conditions allow for reliable detection).
Precipitation - Rain & Fog: **N** = None, **L** = Light, **M** = Moderate, **H** = Heavy. **Other:** **H** = Hail, **S** = Snow. (Indicate intensity using same codes for rain & fog).
Wind: **0** = <1 mph (calm), **1** = 1-3 mph (leaves barely move), **2** = 4-7 mph (leaves rustle, sm. twigs move), **3** = 8-12 mph (leaves & sm. twigs in constant motion), **4** = 13-18 mph (sm. branches move), **5** = 19-24 mph (lg. branches & sm. trees start to sway), **6** = 25-31 mph (lg. branches in constant motion), **7** = 32-38 mph (whole trees move), **8** = 39-46 mph (twigs & sm. branches break).
Noise: **N** = None, **A** = Aircraft, **B** = Bird song/calls, **C** = Creek/water drainage, **M** = Machinery, **P** = Rain/hail, **T** = Tree drip, **V** = Vehicle, **W** = Wind, **O** = Other (explain in Notes).

Occurrence No. _____ Data Point No. _____ Sequence No. _____ Reference No. _____
Quad. Code _____ Photo Code _____ General Location _____
Data Entry Initials _____ Data Entry Date _____ Data QC Initials _____ Data QC Date _____
Protocol Review Initials _____ Review Date _____ Highest Biological Status _____
CDFG DATABASE USE ONLY

CALIFORNIA MARBLED MURRELET FOREST SURVEY FORM

Detections - This Side Page Total: _____ Pg. ____of____

Area Name: _____

Observer (s) Initials: _____ Month _____ Day _____ Year _____ Site Name / No: _____

Data Recorder's Name: _____ Units of Measure (circle one): **U.S.** / **Metric** Station Number: _____

SURVEY ACYIVITY: **Note Significant Weather Changes on Page 1** revised: 2 / 2000

STATUS - I / O	DETECTION #	DETECTON TIME	INITIAL DETECTION DIRECTION	TYPE	AUDITORY					# BIRDS SEEN	BEHAVIOR	INITIAL FLIGHT DIRECTION	BIRD HEIGHT SEEN Canopy= 1.0	CLOSEST DIST. TO BIRDS SEEN ( ) units	DEPART FLIGHT DIRECTION	FINAL DETECTION DIRECTION	NOTES Heard Only Dist. To Birds (L= Loud, M= Moderate, F= Faint)
					VOCAL SERIES				OTHER								
					Start	End	#	OL	W / J								

TYPE: **H** = Heard Only (no visual), **S** = Seen Only (silent), **B** = Both Seen and Heard.

AUDITORY - Vocal Series (Vocalizations): **K** = KEER calls, **G** = Groan (alternate) calls, **O** = Whistle or Soft Que calls, **U** = Unknown, --- = None or N/A. Indicate the vocal type heard at both the start and end if calls grade between different types during the detection. Indicate the number heard **1-5** or **M** = Multiple. **OL** = Overlapping Vocalizations (**Y** or **N**).

AUDITORY - Other (Non-Vocal Sounds): **W** = Wing Sound, **J** = Jet Sound, --- = None or N/A. If both are heard write W / J.

BEHAVIOR: **F** = Flight Over Canopy, **C** = Circle Over Canopy, **T** = Fly-Through At or Below Canopy (≤ 1.0), **B** = Circle At or Below Canopy (≤ 1.0), **L** = Seen Landing in or Departing From a Tree, **S** = Stationary Calling (fixed-point multiple calls <100 m), **U** = Unknown.

(Check Reverse Side When Using 2-Sided Forms)