

**2015 FOREST SURVEY RESULTS
MARBLED MURRELETS IN THE SANTA CRUZ MOUNTAINS**

by

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ABSTRACT

Simultaneous A-V survey were conducted at the Butano, Gazos Camp, Portola, and Big Basin breeding areas on 5 days in 2015. Murrelet activity levels were generally high at Butano and Gazos Camp and low at Big Basin and Portola. All stations had some nesting-related behaviors (occupied behaviors) and Big Basin had a probable tree landing while Gazos Camp had a bird carrying a fish (see Appendix 2). Data were compared with prior year data, and the 2014 and 2015 data were subject to statistical analysis. The results showed no significant increases or decreases from last year, with the exception of Gazos Creek where the number of detections of single silent birds flying below one canopy (SSBBC) increased.

Note to the Reader

In order to simplify the report and promote better understanding of the broad scale distribution of murrelets across the landscape, A-V station names were abbreviated in this report. The list of station name equivalencies is given below.

<u>2014, 2015 Abbrev. Name</u>	<u>2011 Full Name</u>
Big Basin	Big Basin – Redwood Meadow
Butano	Butano – Little Butano Creek
Portola	Portola – Peters Creek Bridge
Gazos Camp	Gazos Mountain Camp

INTRODUCTION

This report discusses the results of 2015 Marbled Murrelet A-V surveys at four breeding areas in the Santa Cruz Mountains. A former fifth station, Memorial County Park, was eliminated this year. By doing so, we were able to increase the number of surveys at each remaining station from three to five. This effort is the continuation, on a reduced scale, of a long term inland murrelet monitoring program that was administered by the California State Parks Department and ended in 2011. That effort included 11 stations and 3 – 5 surveys at each station. Results of that effort can be found in Shaw (2011). Another long-term study is the Gazos Mountain Camp study which began in 1998, and, consisted of 7 surveys per year at one station (Singer 2013).

A good long-term murrelet monitoring program should strive to obtain information that will eventually provide answers to the following questions:

- (1) Which sites are the most important murrelet breeding areas and how does breeding effort (as indicated by nesting-associated-behaviors) vary from year to year?
- (2) What is the long-term trend for murrelet use at each site, and for the Santa Cruz Mountains as a whole?
- (3) How does murrelet use or murrelet breeding effort correlate to corvid control efforts or lack of same at each site?
- (4) Do murrelets in the Santa Cruz Mountains population divide themselves into subgroups that regularly use specific watersheds/flyways/breeding areas or do the non-breeders use all the watersheds, flying into different sites on different days?
- (5) Do murrelets in the Santa Cruz Mountains population visit more than one of our survey stations in the same morning?

Consequently, A-V surveys at breeding sites are an important component of any comprehensive Marbled Murrelet monitoring program.

METHODS

Audio-visual (A-V) Survey Methodology

Survey procedures followed the 1994 Pacific Seabird Group (PSG) protocol for forest surveys (Evans et al. 2003), starting 45 minutes before sunrise and lasting for a minimum of two hours, or 15 minutes from the last detection. Occupied behavior is defined as a flight below one-canopy or circling above one-canopy height but below two-canopy height. This definition is slightly different than that used in the protocol, in Shaw (2011), and in Singer (2013), but the resulting values are very similar and the raw data from Shaw were not available. Audible wing sounds from murrelets not seen were considered to be below-canopy flights by single birds.

As in 2014, A-V surveys at all four sites in 2015 were done simultaneously. Surveys were done at Big Basin, Butano, Gazos Camp, and Portola on these dates: July 1, July 7, July 10, July 24, and July 31.

In 2011 and prior years A-V surveys were not conducted simultaneously and the number of surveys per season (normally 3) was different at Portola and Gazos Camp. Portola had 5 surveys per season and Gazos Camp had 6 - 7 surveys per season. No surveys were done at Gazos Camp in 2005, and no surveys were done at any of the other sites in 2012 and 2013.

Observations were recorded live into tape or digital recorders and later transcribed onto standard forest survey forms. The maximum number of Common Ravens detected simultaneously and the maximum number of Steller's Jays detected simultaneously were also recorded. It should be noted that corvid detections can't be collected in the same manner as murrelet detections. This is because a single raven or jay, unlike a murrelet, can perch on a

branch nearby and make intermittent calls all morning long. Corvid sampling was more comprehensive in 2011 and prior years, and those findings can be found in Shaw (2011). In 2014 and 2015 the maximum number of murrelets seen in the sky at the same time was also recorded.

Relative viewing conditions at each station were determined by calculating the Index of Visibility and modifying it to obtain the Effective Visibility value. The Index of Visibility is the percentage of open sky that surrounds the site including the area behind the observer. Effective Visibility is the percentage of open sky visible to the observer when facing one direction only. Effective visibility values ranged from 50% at Gazos Camp to 20% at Butano. The value of these indices for each survey station are given in Table 1 in the Appendix. The procedure used to determine these values is available on the internet at www.williamwebbsite.com/Singer_Webpage.html.

RESULTS AND DISCUSSION

Total Detections

All four stations combined yielded a sum of 853 detections, with daily totals for the combined stations ranging from 108 to 263 per survey day (Table 3). The highest number of murrelet detections over the 5 days occurred at Butano (313) and at Gazos Camp (311) (Table 2). Together these two stations tallied 73% of all detections from all stations. In 2014, these stations tallied 76% of all detections. The total detections at Portola and Big Basin in 2015 were 139 and 90, respectively. Graph 1 compares means of total detections in 2015 with values from 2014 and 2011. Graph 3 compares values back to 2003 using data from Shaw (2011) and Singer (2010).

Occupied Behavior Detections

All stations combined yielded a sum of 244 occupied behavior detections, which number represented 29% of all detections made (Table 2). The highest numbers of this type of detection were made at Butano (108) and Gazos Camp (102) (Table 2). These two stations in 2015 comprised 84% of all occupied behaviors at all sites. The corresponding value in 2014 was 91%. The total occupied behavior detections at Portola and Big Basin were 28 and 12, respectively. Graph 2 compares means of occupied behavior detections in 2015 with those from 2014 and 2011. Graph 4 takes the comparison back to 2003 using data from Shaw (2011) and Singer (2010).

SSBBC and Wing Sound Detections, and Other Evidence of Active Nesting

Certain murrelet behaviors seen and physical artifacts found are believed to be indicative of an active nest nearby. In order of decreasing strength of prediction, these are (1) grounded fledgling bird, (2) eggshell fragments, (3) branch landing heard or seen on a potentially suitable nest tree, (4) Jet plane sound, (5) SSBBC detections early during the survey period, (6) wing sounds, (7) other SSBBC detections, and (8) below canopy and other occupied behaviors. It

should be noted that only the first two finds are proof certain. A branch landing might be a nest or it might just be a murrelet practicing tree landings.

In 2015, all of our stations had indications of nesting nearby, and all had at least some SSBBC detections and wing sound detections (Table 4). With the exception of Butano, which had high numbers of SSBBC detections to begin with, all stations showed an increase from 2014 in the number of SSBBC detections and the number of wing sound detections (Table 5). At Gazos Camp, on July 31, a bird was seen carrying a fish, which is proof positive that there was a nest nearby. At Big Basin, also on July 31, a wing sound was detected followed by a branch landing sound. Unfortunately it was too dark to see where the landing occurred, but that too might have been a nest.

The number of wing sounds heard at all stations increased in 2015. In 2014, no wing sounds were heard at Big Basin or Portola but in 2015, 8 were heard at Big Basin, and 9 were heard at Portola (Table 5). In 2015 at Butano there were 52 wing sounds with a daily maximum of 20 heard on July 10. At Gazos Camp there was a total of 9 wing sound detections. Butano was the only station at which wing sounds were heard on every day.

Statistical Review of Year-to-Year Changes at the Same Station

A statistical analysis was performed on the data to look for significant detection differences between 2014 and 2015 at each station. Three types of detections tested are presented here - total detections, occupied behavior detections, and single-silent-birds-below-1-canopy detections (SSBBC). The analysis was performed by Emily Comfort who used a Welch-Satterthwaite Two Sample t-Test since the sample size varied from year to year.

The only station that showed a statistically significant difference between 2014 and 2015 was Gazos Camp, and only for SSBBC detections ($p = 0.026$). There were significantly more SSBBC detections in 2015 (mean of 8.4) than in 2014 (mean of 2.33). Of related interest is the fact that at Gazos in 2015, was a detection of a bird carrying a fish, the only such detection made thus far in this two-year study.

Statistical Analysis of Differences in Detections among the Four Stations

The data was analyzed using ANOVA to test for statistical differences in the mean number of each detection type among the four stations over the course of two years (Comfort 2015). Tukey's HSD test was used to compare the means across the four stations. The focus at each station was on three different types of detections - total detections, occupied behavior detections, and SSBBC detections. All analyses were performed using R statistical software (R Core Team, 2015) and RStudio (RStudio Team 2015). More detail about the methods used and software source can be found in Comfort (2015).

The findings are presented in Graph 5 – Boxplot of Total Detections by Site, Graph 6 - Boxplot of Occupied Behavior Detections by Site, and Graph 7 – Boxplot of SSBBC Detections by Site.

The findings were similar regardless of the type of detection analyzed and are summarized below:

- Butano had significantly more detections of each type than Big Basin or Portola
- There was no significant difference in detection totals between Butano and Gazos Camp.
- There was no significant difference in detection totals between Big Basin and Portola.

A simple way of stating the findings, is that our four survey stations consist of two high activity stations – Butano and Gazos Camp, and two low activity level stations – Big Basin and Portola.

Common Raven and Steller’s Jay Numbers

Although individual raven or jay detections were not recorded, the maximum number of ravens and jays detected at any one moment was recorded. The greatest simultaneous number of ravens was 3, which were detected at Big Basin on July 1. Ravens were detected at Big Basin and Portola on 4 out of 5 days. In contrast, Ravens were detected on only one day at Butano with a maximum of one bird.

The maximum number of jays detected simultaneously was 7 which was detected on two days at Portola. All stations had simultaneous detections of two or more jays on every day except for Butano which had zero detections on two days.

RECOMMENDATIONS

1. Continue to do site surveys simultaneously at all stations. This provides a clearer estimate of the relative levels of murrelet activity at each site.
2. Park managers should continue to manage the Butano survey site and the Gazos Camp survey site in such a manner as to maintain the relatively high levels of murrelet activity there and the low levels of raven and jay activity.

ACKNOWLEDGEMENTS

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analysis of the 2014 and 2015 data. Ramona Arechiga of the San Mateo County Parks Department was kind enough to provide the data from her 2015 A-V surveys which is mentioned in Appendix 2.

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APPENDIX 1 – Tables and Graphs

Table 1. Effective Visibility at Survey Stations

Station	Location	Index of Visibility (%)	Factors Modifying Index Value	Effective Visibility (%)
Big Basin	NE edge of Redwood Meadow – tall trees around perimeter	34.6	Minor head movement needed to see breadth of meadow.	30
Portola	Northeast edge of Old Tree Trail parking lot	25	None.	25
Butano	Butano Service Road on slope above Little Butano Creek – several small patches of open sky.	37.4	Must turn head to cover all gaps, so all cannot be covered simultaneously.	20
Gazos Camp	NE edge of meadow	55.5	One big gap, but requires some slight head movement to see all sky patches.	50

Table 2. 2015 Total Detections and (Occupied Behavior Detections)

Table 2 provides the number of total detections and occupied behavior detections (shown in parentheses) on every 2015 survey at all sites and provides the Coefficient of Variation (CV) for each site. CV values were high for all sites.

Date	Big Basin	Butano	Gazos Camp	Portola
July 1	8 (3)	43 (10)	67 (19)	7 (1)
July 7	19 (1)	125 (35)	41 (4)	78 (14)
July 10	59 (6)	82 (32)	58 (18)	30 (5)
July 24	3 (1)	26 (11)	57 (5)	22 (8)
July 31	1 (1)	37 (20)	88 (56)	2 (0)
TOTAL	90 (12)	313 (108)	311 (102)	139 (28)
MEAN	18 (2.4)	62.60 (21.60)	62.20 (20.40)	27.80 (5.60)
STDEV	23.96 (2.19)	40.77 (11.59)	17.20 (21.10)	30.24 (5.68)
CV	1.33 (0.91)	0.65 (0.54)	0.28 (1.03)	1.09 (1.01)

Table 3. Frequency of Detection Types in 2015 and 2014 – All Stations Combined*

Type of Detection	July 1, 2015	July 7, 2015	July 10, 2015	July 24, 2015	July 31, 2015	Total 2015-5 Surveys Per Station	Total 2014-3 Surveys Per Station*	Total 2014 Extrapolated to 5 Surveys Per Station*
Total Detects	125	263	229	108	128	853	453	755
Occupied behaviors	33	58	61	14	78	244	121	202
Single Silent Birds Below 1-Canopy	21	9	23	14	22	89	39	65
Wing Sounds	8	8	24	23	15	78	24	40

Notes: * Excludes values from Memorial.

Table 4. 2015 Single Silent Birds Below 1 Canopy (SSBBC) and Wing Sound (W) detections.

Wing sound detections are shown in parentheses. Note that SSBBC excludes vocalizing birds but includes single birds making a wing sound, but not a pair of birds making a wing sound. SSBBC and W detections are believed to have a strong predictive value of an active nest nearby, especially when detected on multiple days.

Date	Big Basin	Butano	Gazos Camp	Portola
July 1	1 (2)	7 (6)	12 (0)	1 (0)
July 7	0 (0)	4 (3)	3 (1)	2 (4)
July 10	1 (4)	13 (20)	8 (0)	1 (0)
July 24	1 (1)	0 (11)	7 (6)	6 (5)
July 31	1 (1)	9 (12)	12 (2)	0 (0)
TOTAL	4 (8)	33 (52)	42 (9)	10 (9)
MEAN	0.8 (1.6)	6.60 (10.4)	8.40 (1.80)	2.00 (1.80)
STDEV	0.45 (1.52)	4.93 (6.50)	3.78 (2.49)	2.35 (2.49)
CV	0.56 (0.95)	0.75 (0.63)	0.45 (1.38)	1.17 (1.38)

Note: CV stands for Coefficient of Variation

Table 5. 2014 – 2015 Changes in Means of SSBBC and Wing Sound (W) detections. Wing sound detections are shown in parentheses.

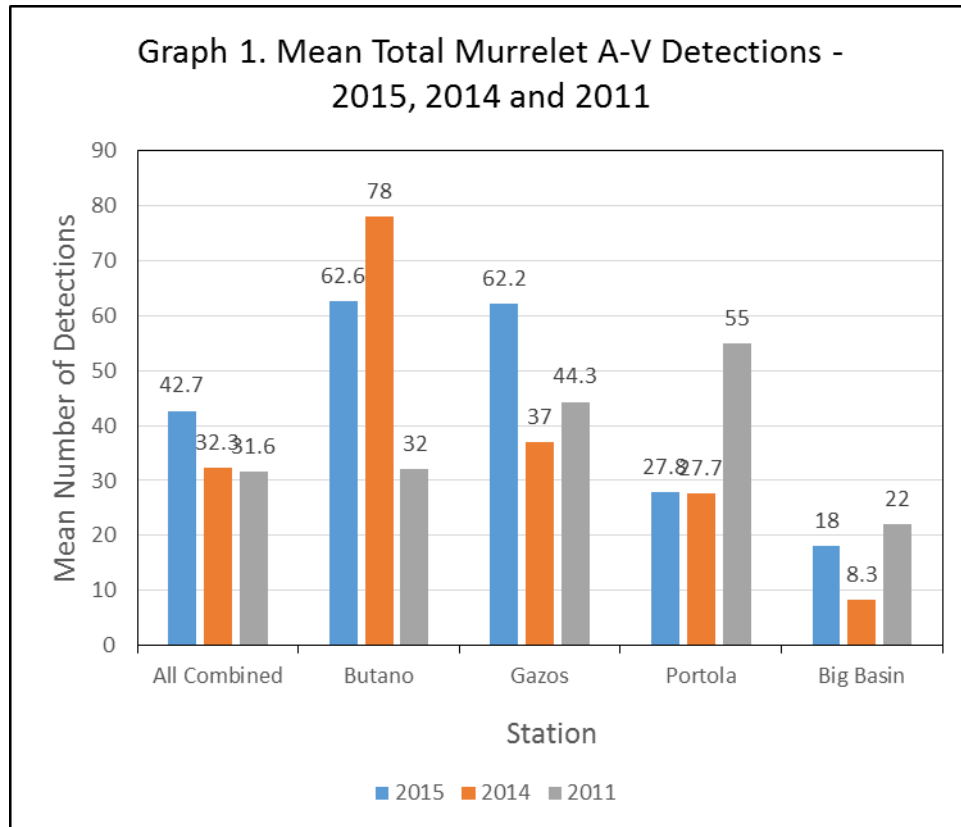
Year	Big Basin	Butano	Gazos Camp	Portola
2015	0.8 (1.6)	6.60 (10.40)	8.40 (1.8)	2.0 (1.8)
2014	0.33 (0)	9.67 (7.67)	2.33 (0.33)	0.67 (0)

Table 6. Comparison of Total and Occupied Behaviors from 1995 to 2015 at all Survey Stations. Figures from 2011 and prior years are from Shaw (2011) or Singer (2010). The multiple park monitoring program began in 2003, but two stations had earlier data that is included here. Note that (1) only in 2014 and 2015 were park surveys conducted on the same day, and (2) raw data from 2011 and prior years only exists for Gazos Camp.

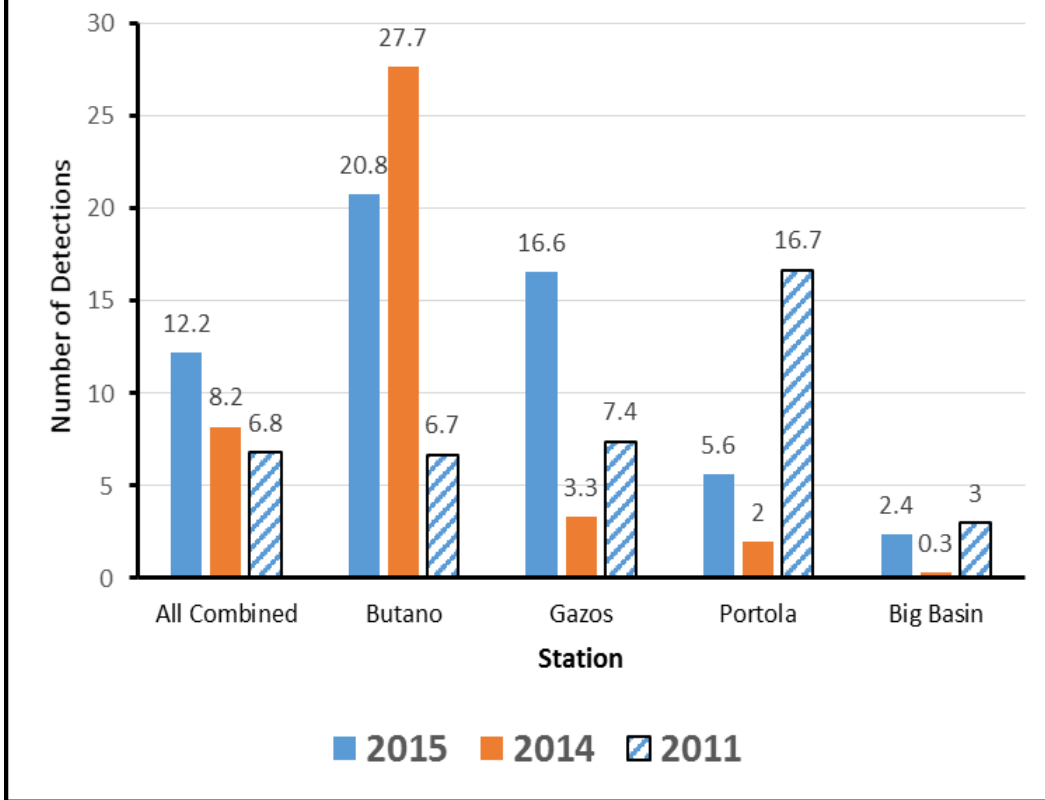
Station	Year	N	Average Total Detections	Average Occupied Beh. Detections
Big Basin – Redwood Meadow	1995	4	177.0	64.0
“ “	1996	4	97.0	27.5
“ “	1998	4	92.3	33.5
“ “	2001	3	86.3	8.0
“ “	2002	3	18.7	1.3
“ “	2003	3	16.3	1.3
“ “	2004	3	17.0	2.3
“ “	2005	3	14.0	1.3
“ “	2006	3	18.3	9.0
“ “	2007	3	16.3	2.7
“ “	2008	3	12.0	0.0
“ “	2009	3	1.7	0.0
“ “	2010	3	15.3	3.0
“ “	2011	3	22.0	3.0
“ “	2014	3	8.3	1.3
“ “	2015	5	18.0	2.4
Portola – Peters Creek Bridge	2003	5	33.2	6.0
“ “	2004	5	35.6	4.4
“ “	2005	5	18.0	0.2
“ “	2006	5	18.6	2.4
“ “	2007	5	30.6	0.8
“ “	2008	5	19.0	0.6
“ “	2009	5	5.4	0.0
“ “	2010	5	33.0	5.8
“ “	2011	5	55.0	16.7
“ “	2014	3	27.7	2.3
“ “ – near Peters Creek bridge	2015	5	27.8	5.6
Butano – Little Butano Creek	2003	3	34.0	6.0
“ “	2004	3	68.3	22.0

Station	Year	N	Average Total Detections	Average Occupied Beh. Detections
Butano – Little Butano Creek	2005	3	26.7	4.0
“ “	2006	3	48.0	4.3
“ “	2007	3	46.3	5.7
“ “	2008	3	20.7	3.0
“ “	2009	3	17.7	2.0
“ “	2010	3	62.0	19.7
“ “	2011	3	32.0	6.7
“ “	2014	3	78.0	28.7
“ “	2015	5	62.6	21.6
Memorial – Memorial	2003	3	4.3	0.0
“ “	2004	3	1.0	0.0
“ “	2005	3	1.3	0.0
“ “	2006	3	4.7	0.3
“ “	2007	3	0.7	0.0
“ “	2008	3	0.7	0.0
“ “	2009	3	0.7	0.0
“ “	2010	3	11.0	1.0
“ “	2011	3	4.7	0.3
“ “	2014	3	10.3	7.7
Gazos Camp – Gazos Mtn. Camp	1998	6	36.0	10.7
“ “	2000	6	57.3	15.0
“ “	2001	6	64.7	17.8
“ “	2002	6	52.0	9.2
“ “	2003	6	59.7	9.7
“ “	2004	6	44.7	9.5
“ “	2006	6	79.7	19.8
“ “	2007	6	31.2	9.2
“ “	2008	6	71.8	27.2
“ “	2009	6	6.8	0.8
“ “	2010	6	66.0	25.7
“ “	2011	7	44.3	7.4
“ “	2012	7	53.1	15.1
“ “	2013	7	28.1	2.1

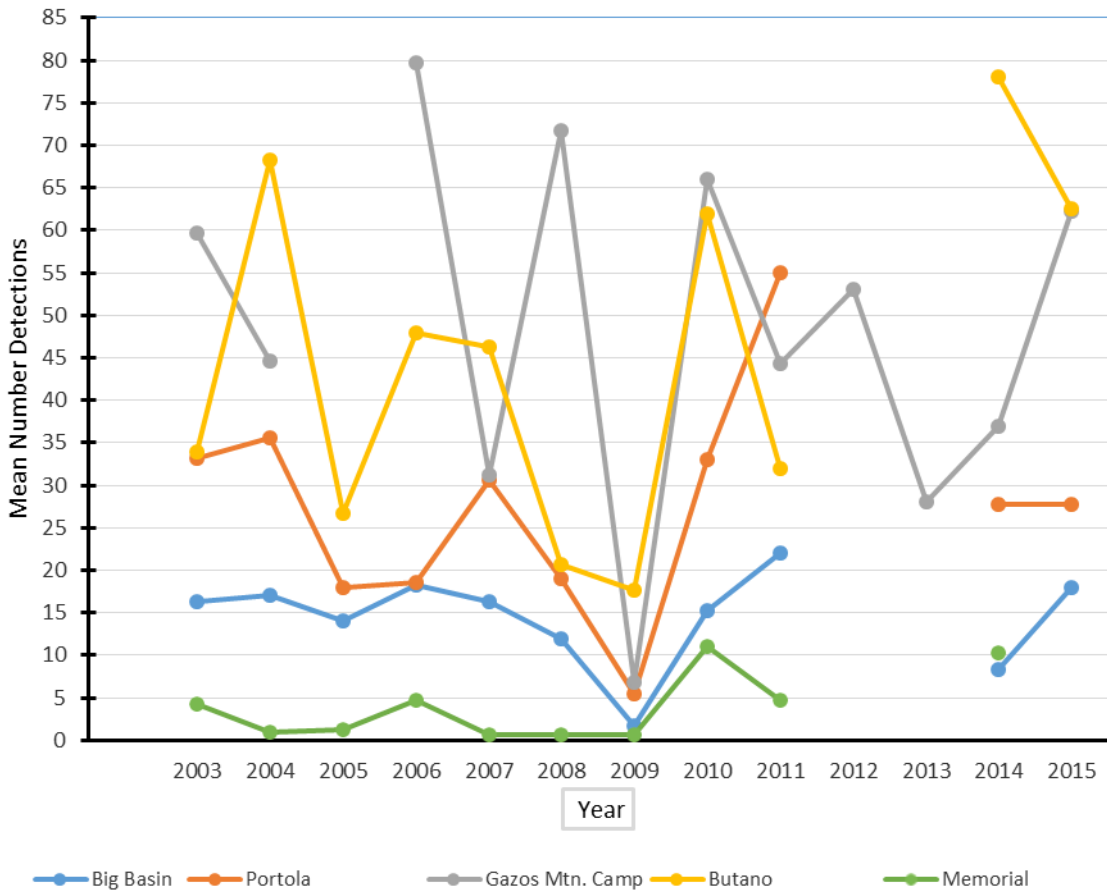
Station	Year	N	Average Total Detections	Average Occupied Beh. Detections
Gazos Camp – Gazos Mtn. Camp	2014	3	37.0	8.0
“ “	2015	5	62.2	20.4

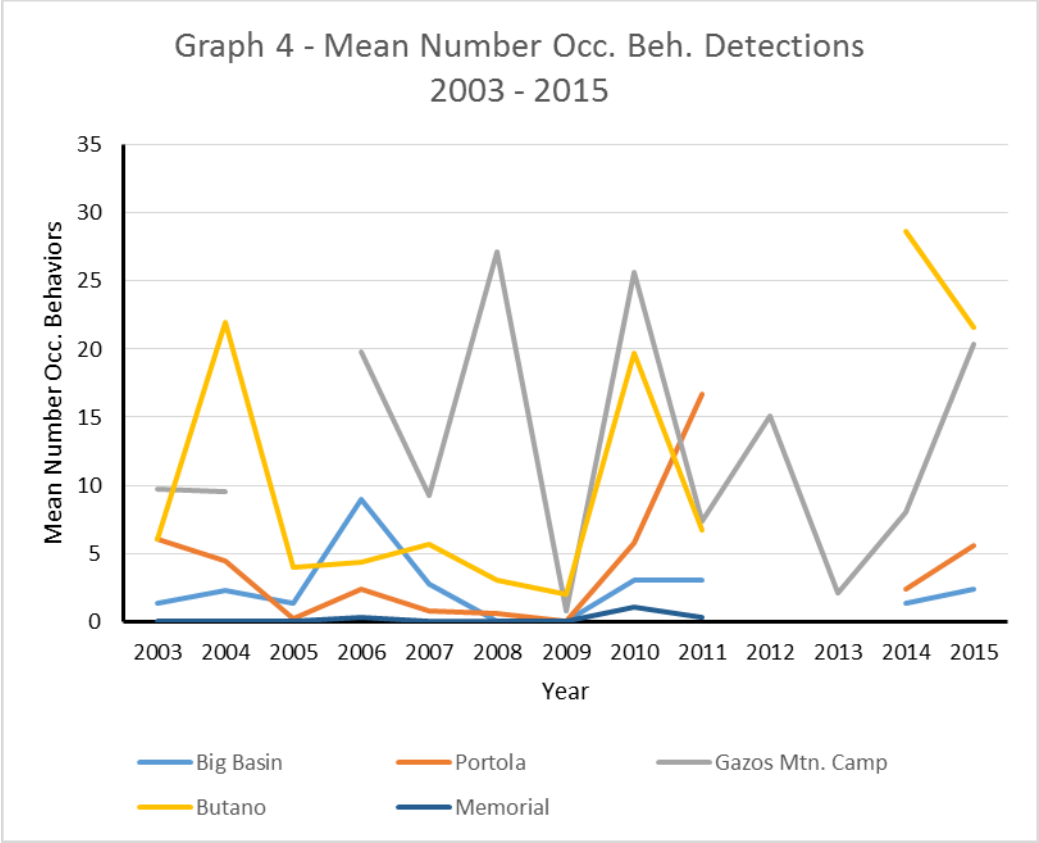


**Graph 2. Mean Occ. Beh. Murrelet A-V
Detections: 2015, 2014 and 2011**



Graph 3. Mean Number of Total Murrelet Detections
2003 - 2015





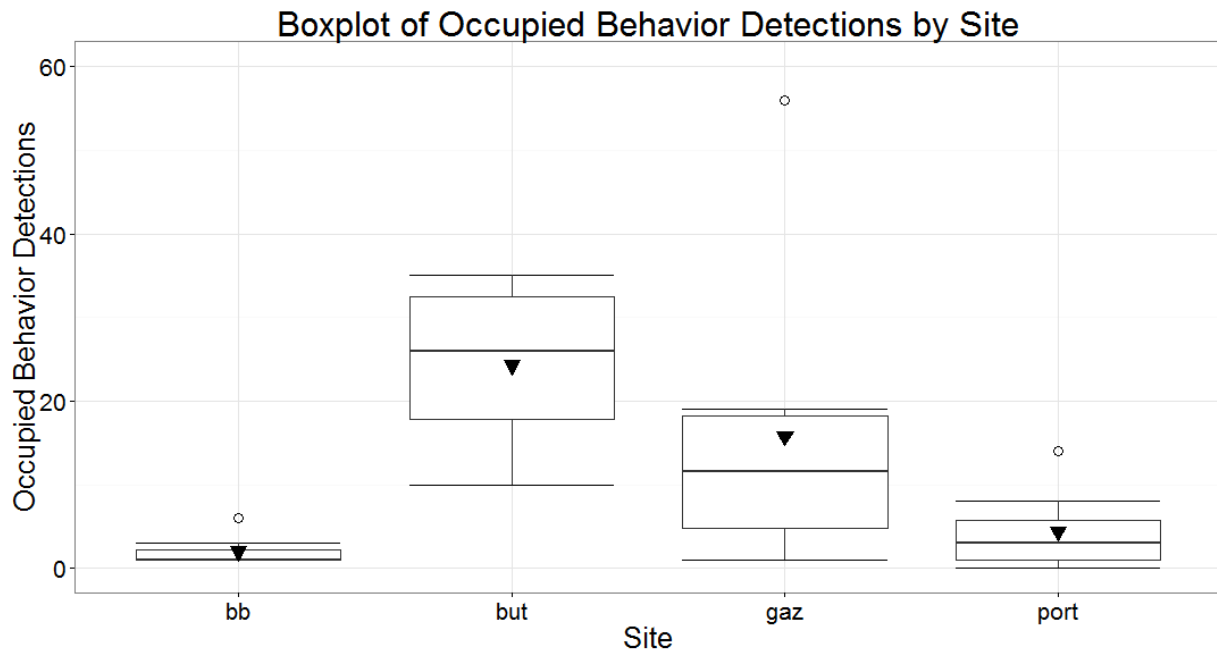
Explanation for Interpretation of Graphs 5, 6, and 7

The following boxplots show the mean value (black triangle), median (bold line), 1st and 3rd quartiles (box), the value of the largest observation that is less than or equal to the upper quartile plus 1.5 the length of the interquartile range (upper whisker), the value of the smallest observation that is greater than or equal to the lower quartile less 1.5 times the length of interquartile range (lower whiskers), and extreme values (circles) of detections by station. Stations are abbreviated as bb (= Big Basin), but (= Butano), gaz (= Gazos Camp), and port (= Portola).

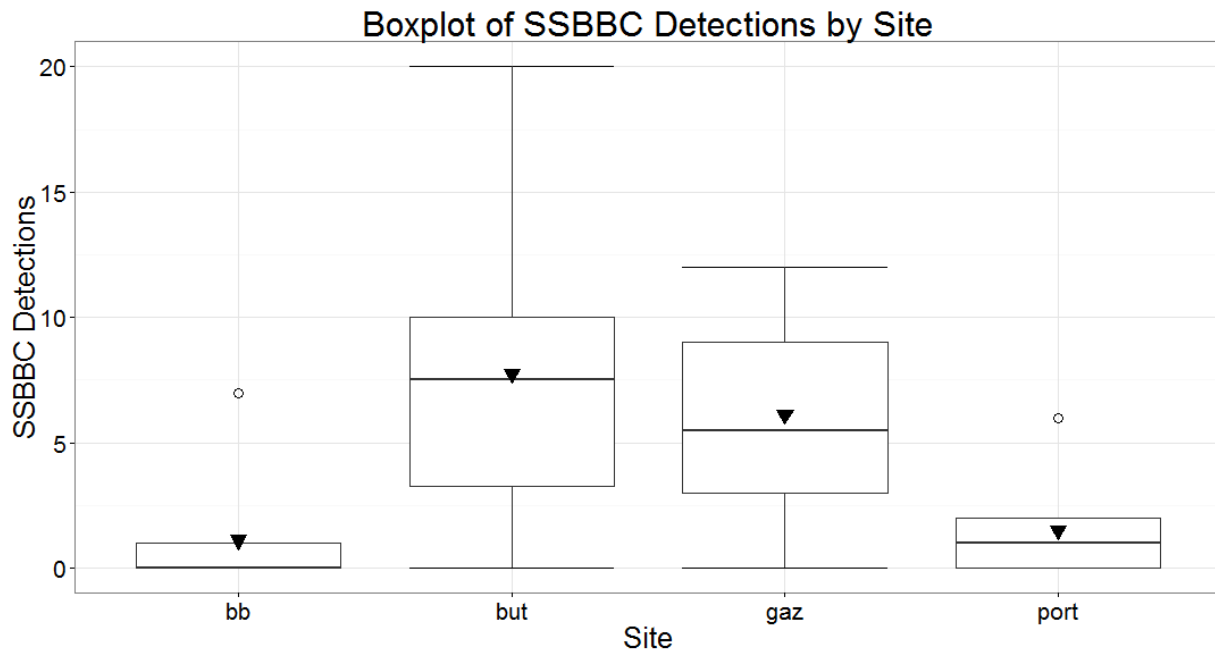
Graph 5 -



Graph 6 -



Graph 7 -



APPENDIX 2 - Interpretation of Observations Made at Different Stations in 2015

BUTANO: This station continued to have the highest activity level of all stations, but numbers for every category of detection except one were down a little from last year. The exception was wing sound detections which are most common at this site. The mean number per survey in 2015 (10.4) was up from the 2014 value of 7.67, and the single day maximum of 20 was close to last year's value of 22. The highest single value for any other station was 6 at Gazos Camp. Butano was the only site that had wing sounds detected on every single survey day. Daily values of total detections ranged from 26 to 125 with a mean of 62.6 and occupied behavior detections ranged from 10 to 35 each day with a mean of 21.6. Detections of single silent birds flying below one canopy height (SSBBC) ranged from 0 to 13, with a mean of 6.6.

GAZOS CAMP: Activity levels were up this year at this station, and the means for total detections, occupied behaviors, and visual detections were all very close to the Butano values. These two stations would appear to have the most murrelet activity of any place in the Santa Cruz Mountains. In 2015, the daily value of total detections ranged from 41 to 88 with a mean of 62.2 and occupied behavior detections ranged from 4 to 56 with a mean of 20.4. In 2014, the mean values for total detections and occupied behavior detections were 37 and 8, respectively.

A very noteworthy observation occurred during the July 31 survey, when a murrelet making a wing sound was also seen to have a fish in its bill. This was the first observation of a bird carrying a fish that we have had since the survey program was re-instituted in 2014, and it provided compelling evidence that an active nest was nearby. Observations like this are a reason why acoustic murrelet detectors can never replace human observers. Consistent with this observation were observations of single silent birds flying below one canopy (SSBBC) which occurred more frequently here than at any other station. The range of SSBBC detections at this site was 3 – 12. The mean was 8.4, higher than at any other station and higher than last year's value of 2.3. SSBBC detections are more strongly indicative of active nesting than are below-canopy flights in general.

PORTOLA: The Portola station is now located on the trailhead parking lot close to the Peters Creek bridge. The daily value for total detections ranged widely from 2 to 78 with a mean of 27.8 (note: in 2014 mean was 27.7). Occupied behavior detections ranged from 0 to 14 with a mean of 5.6 (note: in 2014, mean was 2.3). SSBBC detections ranged from 0 to 6 with a mean of 2. The number of wing sounds ranged from 0 to 5, with a mean of 1.8.

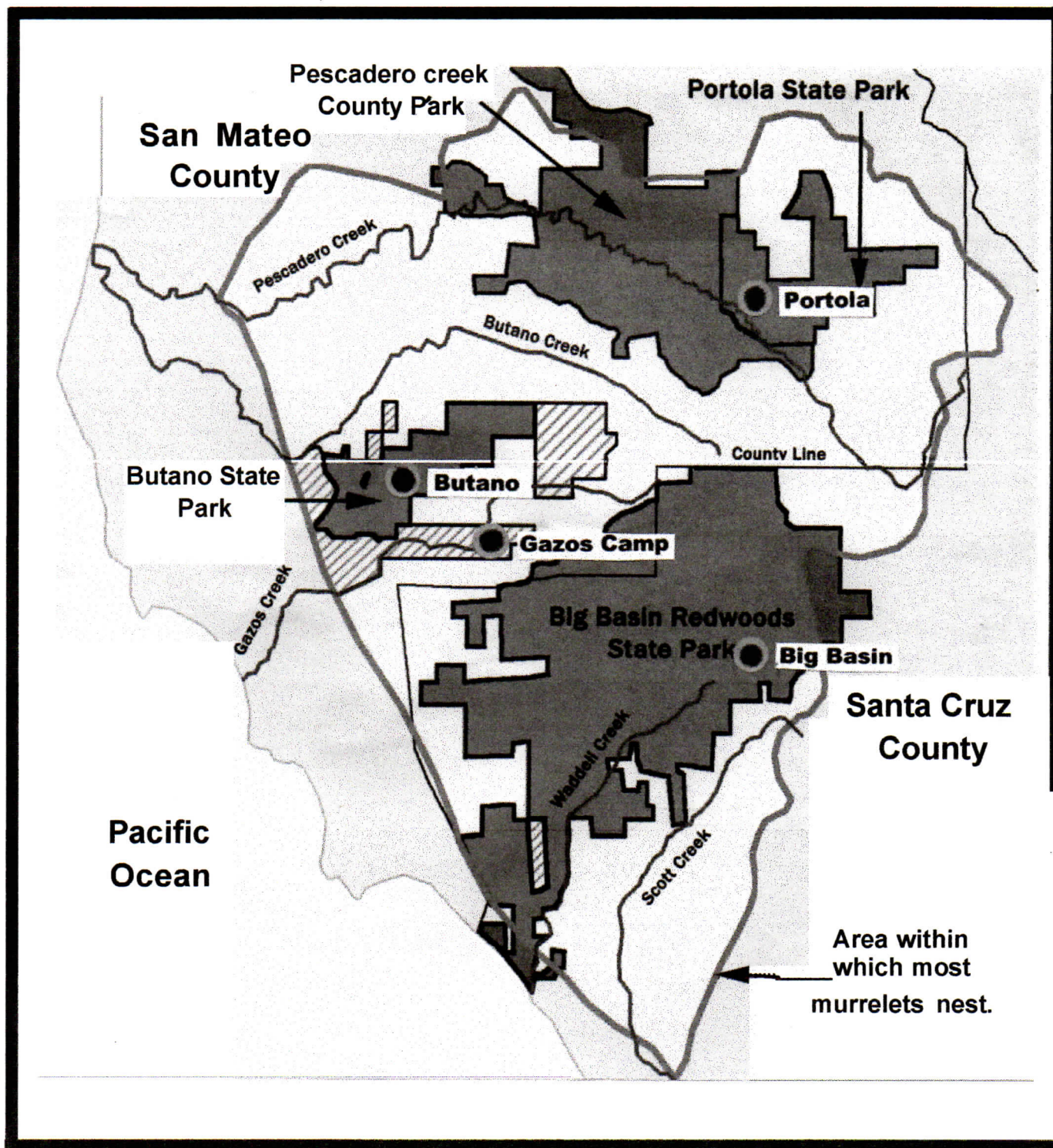
Adjoining Portola Redwoods State Park and just downstream is Pescadero Creek County Park. The San Mateo County Parks Department conducted many murrelet A-V surveys at several different stations there in 2015. It is interesting to compare our Portola station with their Dark Gulch station about 1.6 miles downstream (as the murrelet flies, about 2 minutes away). At Dark Gulch four protocol surveys were done between June 18 and July 16. Total detections at that site ranged from 5 to 85 with a mean of 28.8. Occupied behavior detections there ranged from 2 to 15 with a mean of 6.4 (Arechiga, pers. comm.). These values are very similar to our Portola values (total detects = 27.8; O.B. detects = 5.6).

BIG BASIN: The Big Basin station is located on the edge of Redwood Meadow near Park Headquarters. In 2015, the daily value for total detections ranged widely from 1 to 59, with a mean of 18. Occupied behavior detections ranged from 1 to 6 with a mean of 2.4. SSBBC detections ranged from 0 to 1 with a mean of 0.8. The number of wing sounds ranged from 0 to 4, with a mean of 1.6. This was an increase from 2014 when no wing sounds were detected at Big Basin.

The most notable detection occurred on July 31. The total number of detections that day was only one, but it was an extraordinary detection. At 5:54 AM, 19 minutes before sunrise, a wing sound was heard followed by the sound of a landing on a branch. Because it was still dark, it wasn't possible to see which tree the landing occurred in. Below-canopy detections (such as a wing sound) that occur 8 minutes or more before sunrise are considered to be more tightly tied to an active nest than other below-canopy detections. This observation shows that nesting may be occurring in sites that have very few detections. No vocalizations were recorded on this morning.

APPENDIX 3 – Station Location Map
(on following page)

Map 1. Location of Marbled Murrelet Audio-Visual Survey Stations



Map by L. Robinson, modified by S. Singer