



**MARbled MURRELET INLAND MONITORING PROGRAM
SANTA CRUZ MOUNTAINS REGION
2021 PROGRESS REPORT – POST CZU FIRE RESULTS**

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**2021 MARBLED MURRELET INLAND SURVEY RESULTS
SANTA CRUZ MOUNTAINS REGION**

OVERVIEW - KEY FINDINGS

- From a regional perspective (i.e., Big Basin, Butano and Gazos combined), total detections dropped from a record high in 2020, but was still greater than the long-term average, prior to the 2020.
- Regionally, occupied behaviors corresponded to the high recorded in 2020.
- Detections of single-silent birds below canopy (SSBBC) increased in 2021, equaling the peak recorded in 2017.
- At the station level, Gazos was recorded with the highest mean for total detections, occupied behavior and SSBBC per survey, while Butano was recorded with the lowest values for each category.
- Reversing a downward trend since 2019, total detections, occupied behavior and SSBBC at Big Basin were up, despite the severe fire damage at Big Basin State Park.
- The survey results at Big Basin North Escape Road (BBNER) survey station, new for 2021, paralleled those from the traditional Big Basin Redwood Meadow (BBRM) survey station, suggesting that detections at the two stations may have been comprised, at least in part, of the same birds.
- The long-term pattern of total detections between Big Basin versus Butano, Gazos and Portola combined, continued to move in opposing directions, possibly reflecting MAMU use of different stands over the years.
- Successful MAMU nesting was documented at Big Basin State Park, for the first time in 20 years, despite the severe reduction of habitat and clean-up activities related to the CZU Fire.

INTRODUCTION

This report presents the results of the 2021 marbled murrelet audio-visual (A-V) surveys from four breeding areas in the Santa Cruz Mountains (Figure 1). The four survey stations are: (1) Big Basin Redwood Meadow located in Big Basin State Park; (2) Gazos, also known as Gazos Mountain Camp, located inside Butano State Park, (3) Butano, which is also known as Butano Service Road or Little Butano, and is located in Butano State Park, and (4) Portola which is located at the Old Tree Parking Area in Portola State Park. All four stations are located in different watersheds. These sites have been surveyed for many years, although data from standardized survey methods only exist for 2014 and subsequent years.

The initial State Parks long-term monitoring program began in 2003 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) and Singer (2017). Other long-term murrelet A-V surveys in Zone 6 include the Gazos Mountain Camp study, which began in 1998 (Singer 2017; Singer 2013), and is merged into this study; surveys at Upper Pilarcitos Creek, on land belonging to the San Francisco Public Utilities Commission; surveys at Memorial County Park and Pescadero Creek County Park by the San Mateo County Parks Department; and surveys by the Midpeninsula Regional Open Space District on several of their preserves. A complete review of the history and extent of inland marbled murrelet monitoring efforts in the Santa Cruz Mountains through 2017 can be found in the Marbled Murrelet Management Plan for Zone 6 (Halbert and Singer 2017).

The 2020 CZU Lightning Fire

The 2021 MAMU inland monitoring program was presented with the unique opportunity to collect survey data the year following the tragic CZU Lightning Fire, which burned 86,500 acres and an estimated 62% of known nesting habitat in the Santa Cruz Mountains. A detailed account of the CZU Fire can be reviewed on the Santa Cruz Mountains Bioregional Council website: <http://www.scmbc.org/news>. Preceding the fire, record highs of MAMU total detections were recorded during the 2020 inland surveys (Bryan Mori Biological Consulting 2021).

Obvious questions stem from the aftermath of the devastating fire, regarding the region's marbled murrelet population - How will this impact the already vulnerable Santa Cruz Mountains marbled murrelet population? Will individuals remain in traditional stands, due to presumed strong site fidelity, or disperse from natal sites and attempt to occupy remaining pockets of habitat? If murrelets remain in natal stands, will they be subjected to higher levels of predation, due to fire-generated marginal conditions? How many years of recovery will be necessary to reestablish suitable murrelet nesting habitat? Fortunately, at-sea and inland monitoring programs have been in place for many years, establishing a pre-fire baseline from which continued monitoring hopefully can adequately address some of these questions.

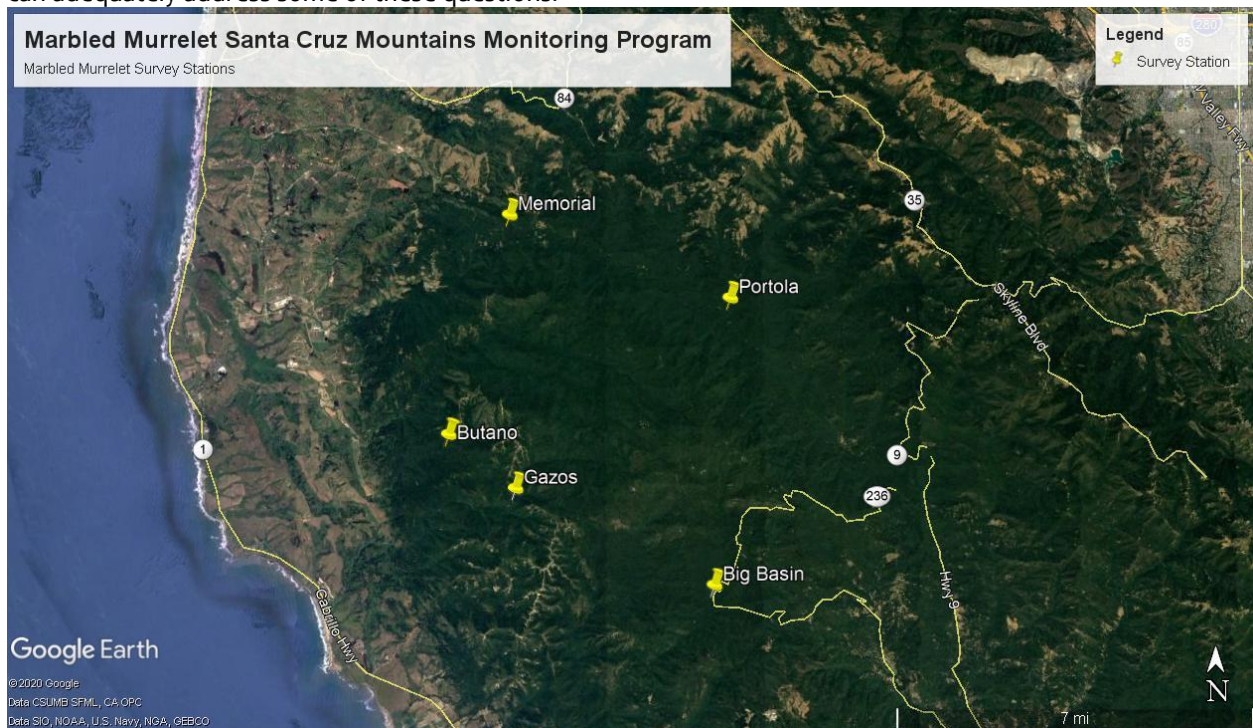


Figure 1. Traditional Marbled Murrelet survey stations discussed in this report.

METHODS

Audio-visual (AV) Survey

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. For this study, an additional survey station was established in Big Basin State Park, near the intersection of North Escape Road and Gazos Creek Road, approximately 500 meters northwest of the traditional survey station (Redwood Meadows), to record MAMU activity at a MAMU nest site discovered earlier in the season (**Figure 2**). For the purposes of this study, the Big Basin survey stations will be referred to

as Big Basin Redwood Meadows (BBRM) and Big Basin North Escape Road (BBNER). Surveys were performed simultaneously at BBRM, BBNER, Butano and Portola on 1, 8, 15, 22, and 27 July. Gazos was surveyed on 2, 9, 16, 23 and 30, due to the necessary addition of the BBNER station and the lack of available surveyors. The surveys at Gazos were performed within one day of the standardized survey dates, except for the final survey, which occurred three days later. The surveyors for this study were Alex Rinkart, Bryan Mori, Inger-Marie Laursen, Mike Duffy and Portia Halbert, each surveying the same station, as in previous years. This standardized approach allows for long-term comparisons between stations and the pooling of station data to provide a snapshot of murrelet activity on a regional level, with less variability in observer bias. Survey data for 2021 also was obtained for Memorial County Park, for which survey data exist from as early as since 2003. For more detailed information on survey methods, please refer to the previous year's report (Bryan Mori Biological Consulting 2021).

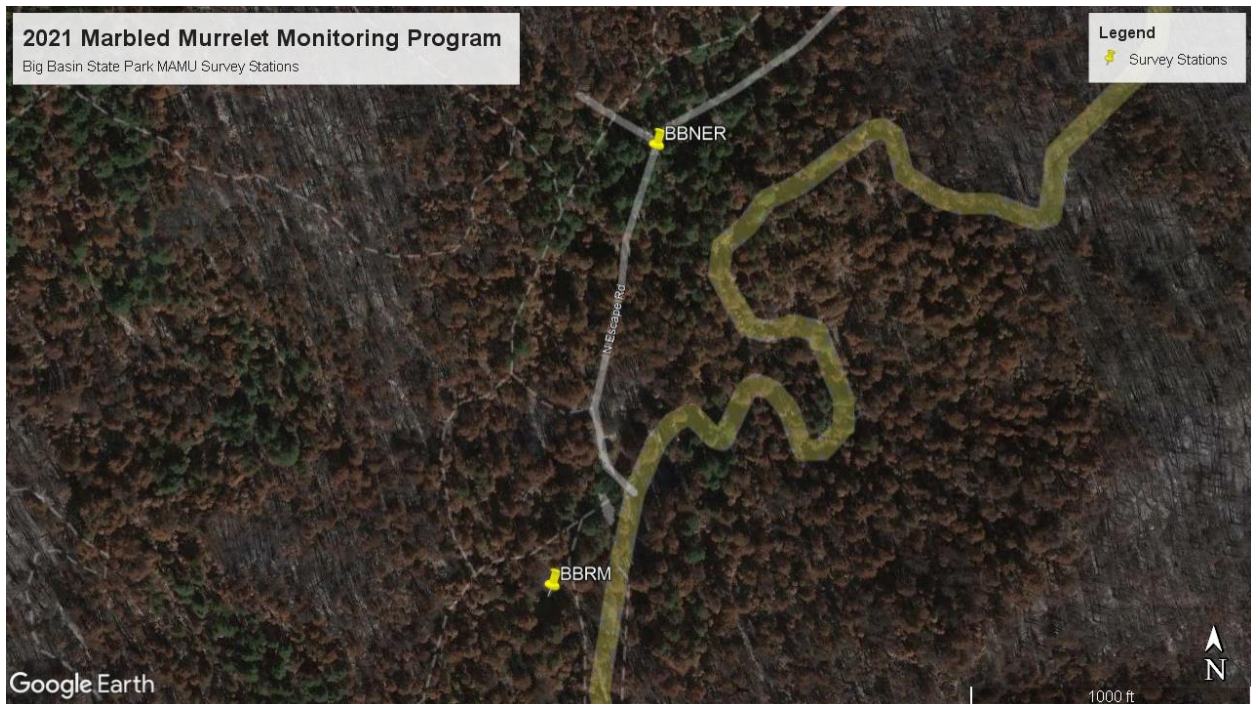


Figure 2. Map of the Big Basin State Park MAMU survey stations - BBRM (Big Basin Redwood Meadow) and BBNER (Big Basin North Escape Road). Note that BBNER is located within a patch of lightly burned forest. The Google Earth image depicts the severity of the CZU Fire near the headquarters region at Big Basin State Park.

Terminology

There are several detection categories used to analyze the survey results collected for this study and are consistent with previous reports. These categories are explained, below.

Total Detections

These consist of any detection of a murrelet by either sight or sound and can include detections of murrelet vocalizations that are more than 400 meters away from the observer.

Occupied Behaviors

For the purposes of this study, occupied behaviors are categorized as follows:

Circling Above Canopy. These observations are of murrelets seen circling overhead at a height between one canopy and two canopy (Singer 2019).

Below-canopy Detections. Observations of murrelets flying at or below canopy level. Studies have shown that below-canopy detections are made by birds with active nests or nests active earlier in the season, in the near vicinity (Plissner et al. 2015).

Single-Silent Birds Below Canopy (SSBBC). This subcategory of ‘below canopy detections’ is defined by observations of non-vocalizing, solitary murrelets flying at or below one canopy and is a strong indicator of nesting activity. Even stronger is the subcategory of ‘early single silent birds below canopy’, observations 8 minutes or more prior to sunrise. Although the cutoff time of 8 minutes is somewhat arbitrary, it does represent the approximate time limit for the earliest nest visits, as recorded during observations at active nests in California and Oregon (Nelson and Peck 1995, Singer et al. 1995). These individuals are most likely visiting the nest to make an incubation exchange or to provide the first feeding of the day to a nestling.

Wing Sound Detections. Wing sounds are non-vocal detections of murrelets usually of birds flying below canopy and often are of unseen birds. For this study, wing sound detections of birds not seen are presumed to be below-canopy detections and are believed to be strong indicators of nesting nearby. Thus, audible wing sounds from unseen murrelets were classified as ‘occupied behavior’.

RESULTS

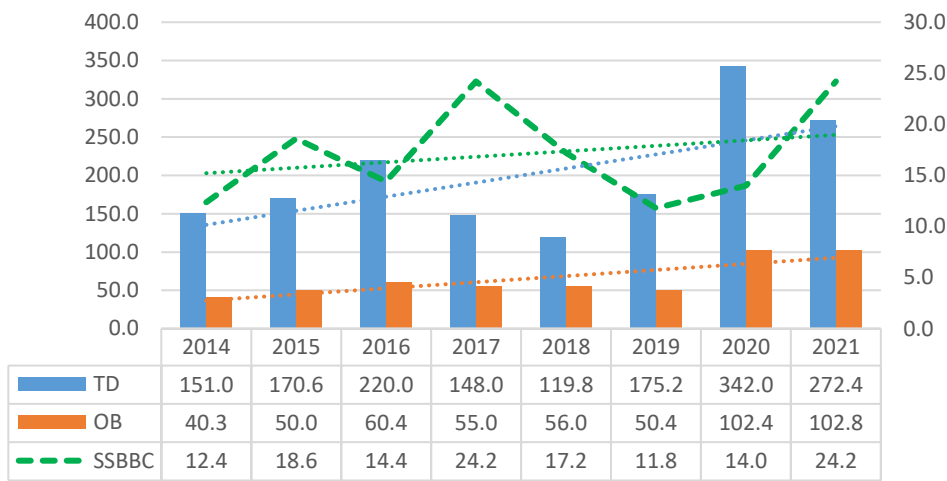
The results of the 2021 monitoring program are presented for the study region as a whole and for the individual survey stations. The survey stations are representative of the core of marbled murrelet breeding habitat in the Santa Cruz Mountains. Thus, combining the data provides a snapshot of their activity level, from a regional perspective. However, for this report, data from Portola were folded back into the regional analysis, since surveys at Portola have been conducted continuously over the past three years. In past reports (Singer 2019; Bryan Mori Biological Consulting 2021), the data only from Big Basin, Butano and Gazos were pooled, due to the absence of surveys at Portola in 2017 and 2018. As indicated earlier, the Gazos station was surveyed on different days.

Due to high day-to-day variability of detections inherent with AV surveys, and the small number of surveys performed at each station under the monitoring program, caution must be taken when evaluating trends of activity levels at any one station and comparing differences of murrelet activity levels between stations.

Regional Perspective - Survey Stations Combined

The mean number of total detections per day was 272.4, the mean occupied behavior detections was 102.8, and SSBBC observations averaged 14.2 per survey in 2021 (**Figure 3**). When compared to monitoring results from 2014-2020, the mean number of total detections dropped in 2021, but remained above the averages from 2014-2019 (**Figure 3**). Occupied behavior detections remained at the 2021 level, but observations of single-silent birds below canopy increased over 2020 values and equaled the high recorded in 2017 (**Figure 3**). All three categories appear to be trending upward since 2014.

Figure 3. Mean number of total detections (TD), occupied behavior (OB) and single-silent birds below canopy (SSBBC) for Big Basin, Butano, Gazos and Portola stations combined.



Individual Stations

The 2021 results for all survey stations (i.e., BBRM, BBNER, Butano, Gazos and Portola) are summarized on **Table 1** and **Figure 4**. Data from prior to 2014 also were evaluated for each station, however, as the data prior to 2014 were not collected in a standardized manner (e.g., consistent number of surveys at all stations and stations simultaneously surveyed), their presentations are meant to provide generalized long-term patterns, and should be interpreted with caution.

In 2021, Gazos was recorded with the highest mean total detections, occupied behavior and SSBBC of all the survey stations, with 96.2, 53.2 and 12.4 observations per survey, respectively. In contrast, Butano was recorded with the lowest means in each category, with 38.2, 8.0 and 0.4 observations per survey.

Figure 4. Mean number of total detections (TD), occupied behavior (OB) and single-silent birds below canopy (SSBBC) recorded at the survey stations. N = 5 for each station.

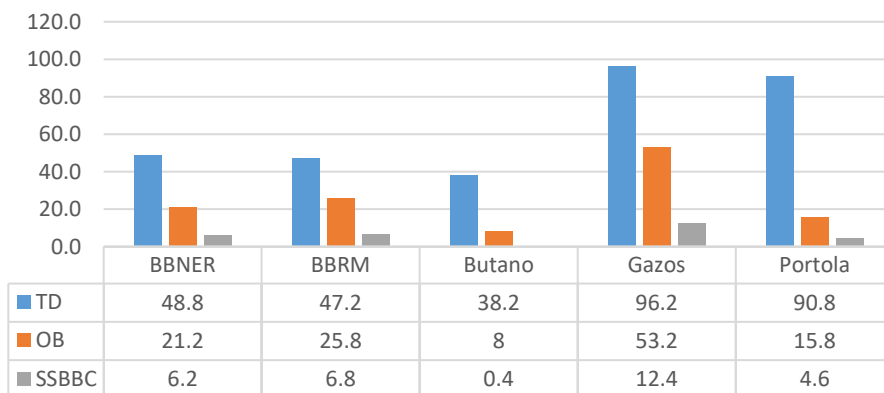
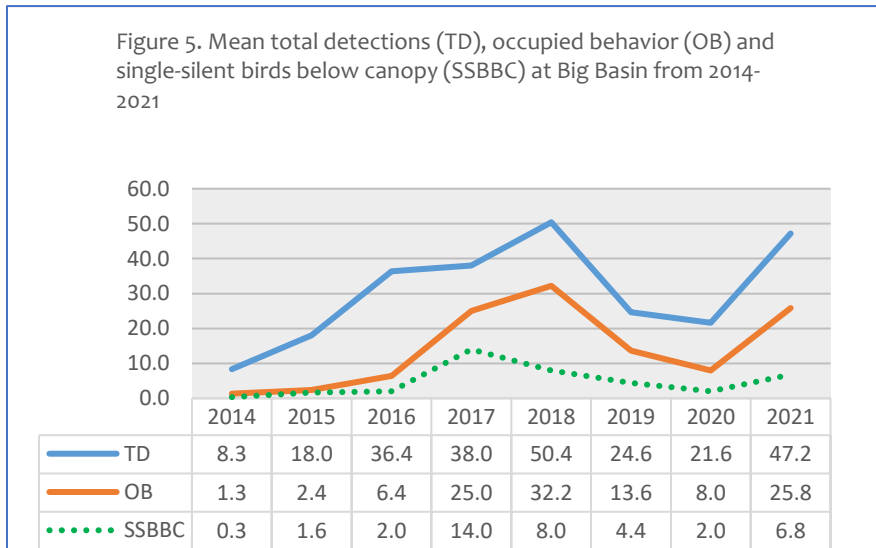


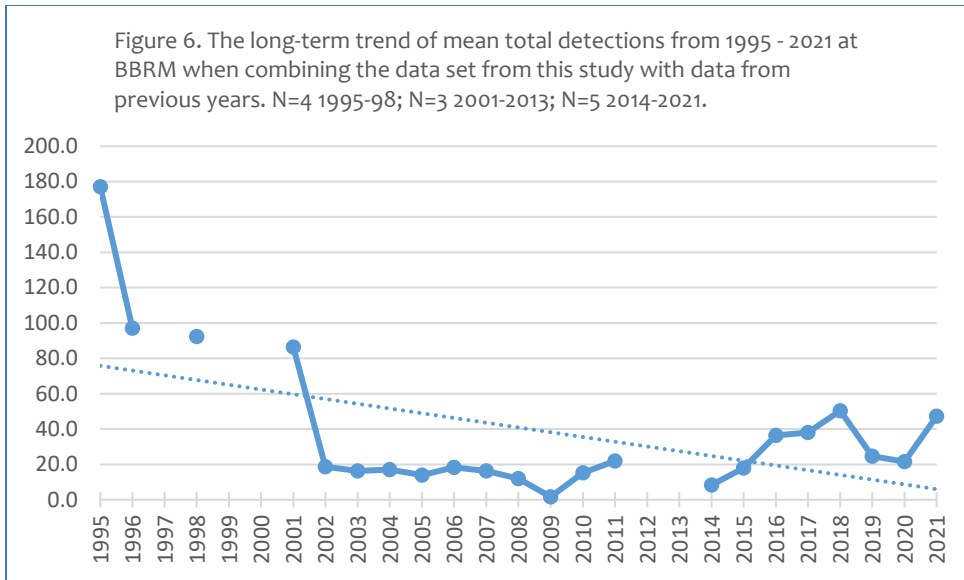
Table 1. Summary of daily MAMU observations from all survey stations – Big Basin Redwood Meadow (BBRM), Big Basin North Escape Road (BBNER), Butano (BU), Gazos (GA) and Portola (PO).

Date	Total Detections					Occupied Behavior					Single-Silent Birds Below Canopy				
	BBRM	BBNER	BU	GA*	PO	BBRM	BBNER	BU	GA*	PO	BBRM	BBNER	BU	GA*	PO
7/1/2021	37	53	30	77	112	16	32	11	56	10	5	14	0	20	4
7/8/2021	38	48	35	40	129	14	15	8	19	52	4	6	0	7	14
7/15/2021	124	106	41	175	79	77	43	5	94	15	23	11	0	15	2
7/22/2021	37	37	63	119	102	22	16	6	62	0	2	0	0	9	1
7/27/2021	0	0	22	70	32	0	0	10	35	2	0	0	2	11	2
\bar{x}	47.2	48.8	38.2	96.2	90.8	25.8	21.2	8.0	53.2	15.8	6.8	6.2	0.4	12.4	4.6
SD	45.88	38.11	15.51	52.30	37.52	29.74	16.63	2.55	28.51	21.12	9.26	6.34	0.89	5.18	5.37
CV	0.97	0.78	0.41	0.54	0.41	1.15	0.78	0.32	0.54	1.34	1.36	1.02	2.24	0.42	1.17
*Gazos survey dates 2, 9, 16, 23 and 30 July															

Big Basin Redwood Meadow (BBRM)

BBRM was recorded with a mean number of total detections at 47.2, a mean of 25.8 for occupied behaviors and a mean of 6.8 for SSBBC (Table 1). The numbers recorded for each category all peaked on July 15, and no detections were recorded on 27 July, the final survey date. The CV values indicate high daily variation for all detection categories (Table 1). The mean number of total detections, occupied behaviors and SSBBC in 2021 rose from the previous year, reversing the downward trend of SSBBC since 2017 and total detections and occupied behavior since 2018 (Figure 5). When including data from prior to 2014, the mean number of total detections have been trending downward since 1995 (Figure 6).





Butano

The mean number of total detections per day was 38.2, with detections ranging from a low of 22 on July 27 to a high of 63 on July 22 (**Table 1**). The mean occupied behavior per survey was 8.0, with a low of 5 observations on July 15 and a high of 11 on July 1. The lowest mean of SSBBC was recorded at Butano with 0.4 observations per survey, with an absence of SSBBC detections on four of the five surveys. The mean SSBBC was the lowest recorded between 2014 and 2021 (**Figure 7**). The CV values indicate moderate to very high variability per day for all detection categories (**Table 1**). Compared to 2020, the mean number of total detections dropped sharply to its lowest value, over the past 8 years (**Figure 7**). Occupied behaviors also decreased in 2021, but comparable to that observed 2019 (**Figure 7**). Looking at the long-term trend of mean total detections from 2003, the numbers of total detections seem to be trending upward, despite high annual variability (**Figure 8**).

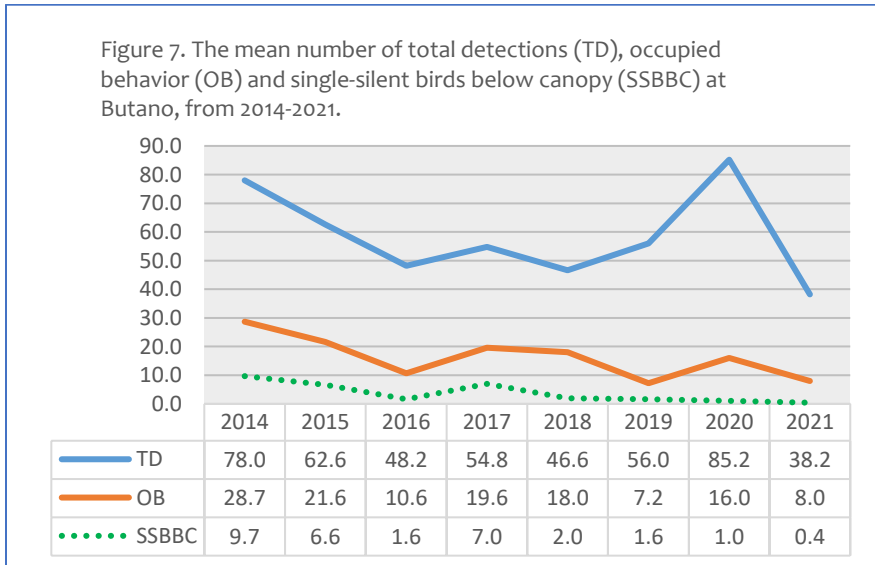
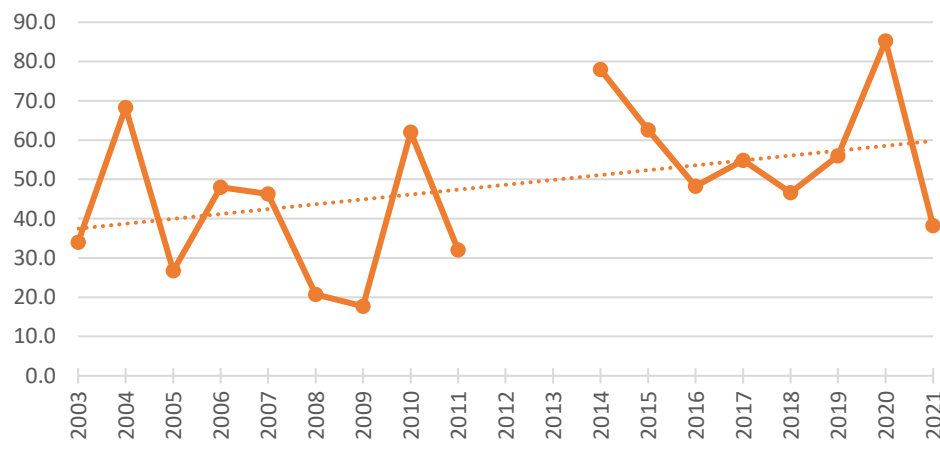


Figure 8. The long-term trend of mean total detections from 2003-2021 at Butano, when combining the data set from this study with data from previous years. N=3 2003-2011; N=5 2014-2021.



Gazos

Of all the survey stations, Gazos recorded the highest mean number of total detections, occupied behavior and SSBBC in 2021, with 96.2, 53.2 and 12.4, respectively. The total detections at 175 and occupied behaviors at 94 peaked on July 16, while a high of 20 SSBBC was recorded on 2 July. (**Table 1**). The CV values indicate a fairly high level of daily variation for all detection categories. When compared to the results from 2014-2020, the mean number of total detections was slightly lower than the high of 2020 but well above that recorded from 2014-19. Occupied behaviors showed a slight increase from 2020 and represent the highest value at Gazos over the past 8 years (**Figure 9**). Correspondingly, SSBBC observations in 2021 rose slightly to its highest value. Looking at the long-term trend since 1998, the mean total detections over the past two years are the highest recorded. Although highly variable, trend seems to be stable or slightly increasing since 1998 (**Figure 10**).

Figure 9. Gazos - Mean numbers of total detections (TD), occupied behavior (OB) and single-silent birds below canopy (SSBBC) from 2014-2021.

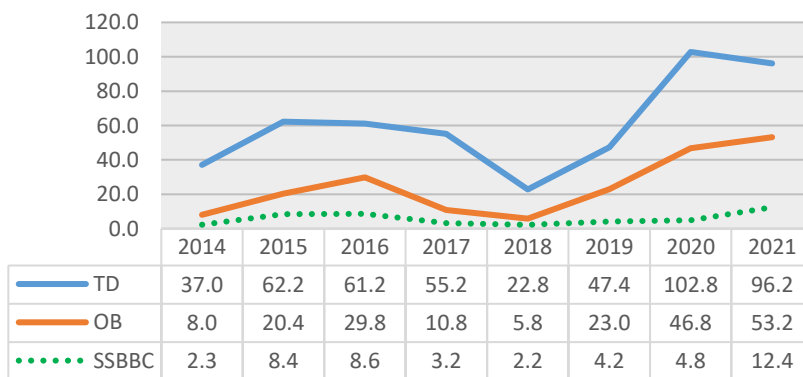
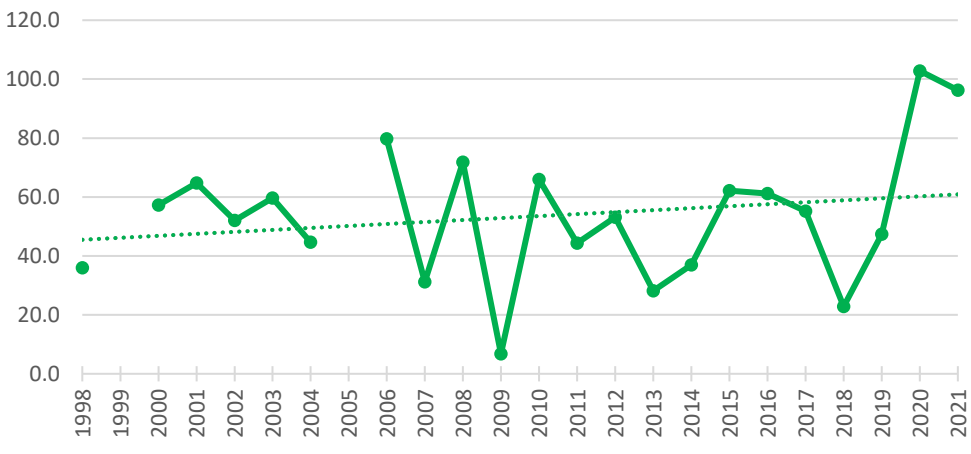


Figure 10. The long-term trend of mean total detections at Gazos from 1998 - 2021, when combining the data set from this study with data from previous years. N=6 1998-2010; N=7 2011-2013; N=4 2014-2021.



Portola

The Portola station was recorded with a mean number of total detections at 90.8, mean number of occupied behavior at 15.8, and mean SSBBC at 4.6 (**Table 1**). The 90.8 mean total detections was the second highest of all survey stations. All three categories were recorded with peak numbers on July 8. The CV values for all detection categories show moderate to very high daily variation (**Table 1**). Compared to the 2014-2020 results, all three categories were recorded with lower means than in 2020, but within the variability observed over the previous five surveys (**Figure 11**). Although the mean total detections in 2021 was lower than the previous year, it was the second highest value recorded since 2003, and the trend is upward, despite high annual variability (**Figure 12**).

Figure 11. **Portola** - Mean number of total detections (TD), occupied behavior (OB) and single-silent birds below canopy (SSBBC) from 2014-2021. Surveys were not conducted in 2017 and 2018.

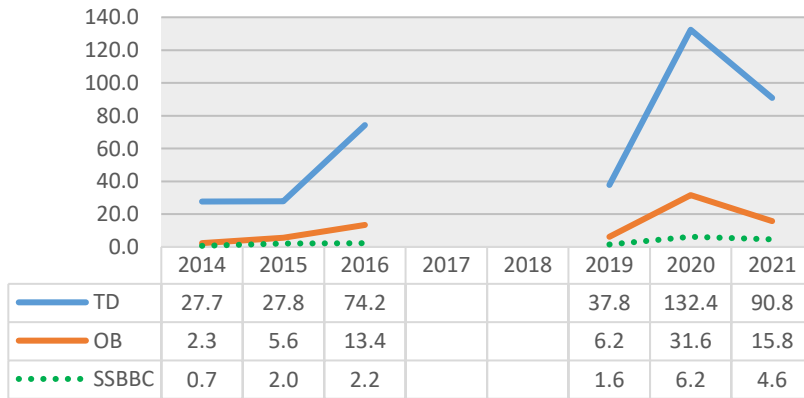
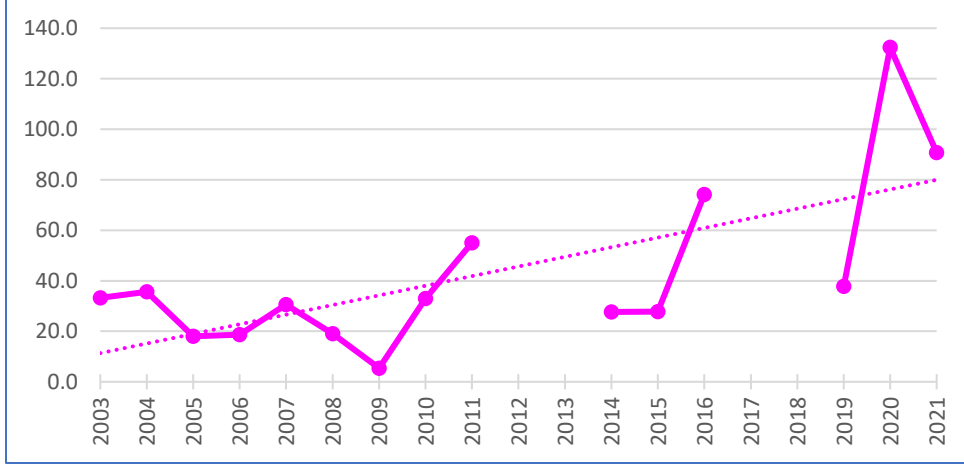


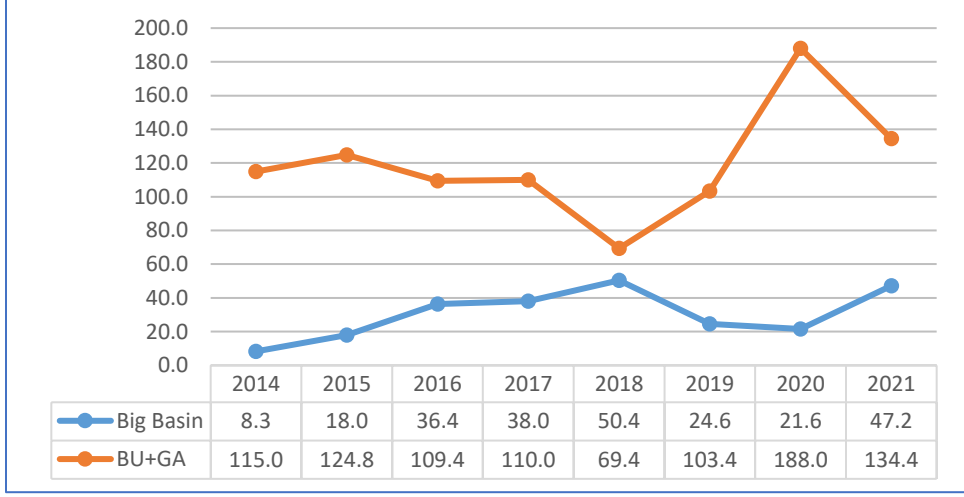
Figure 12. The long-term trend of mean total detections at Portola from 2003-2021, when combining the data set from this study with data from previous years.



A Closer Look at Big Basin, Butano and Portola

An interesting pattern was revealed in during the 2020 study, when comparing the mean total detections from 2014-2020. As the mean total detections for Big Basin increased from 2014 to 2018 and decreased from 2018 to 2020, the pattern generally moved in opposing directions for Butano and Gazos combined (Bryan Mori Biological Consulting 2021). This pattern continued in 2021 (**Figure 13**), perhaps reflecting interannual changes in stand use among the three state parks.

Figure 13. Comparison of mean total detections per year at BBRM versus Butano, Gazos and Portola combined from 2014-2021.

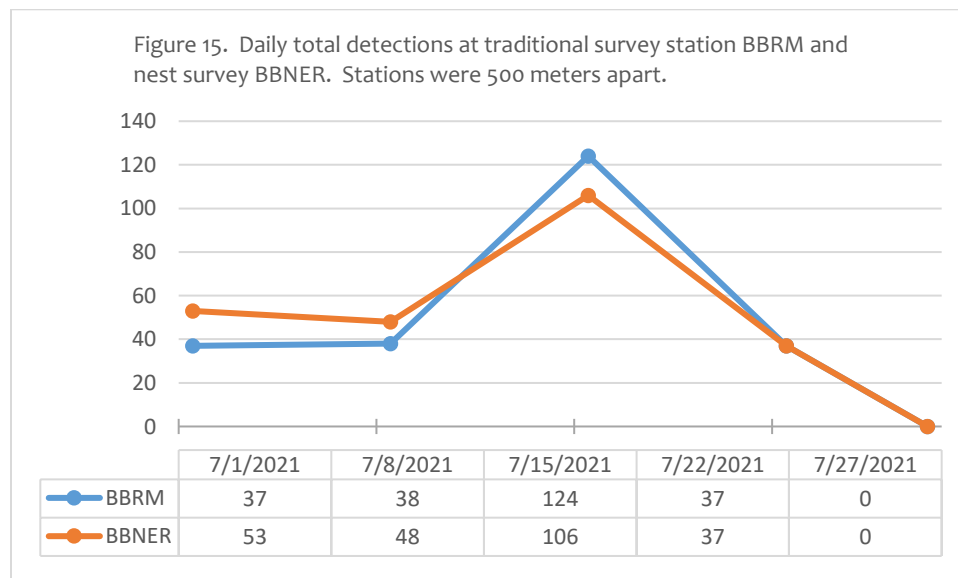
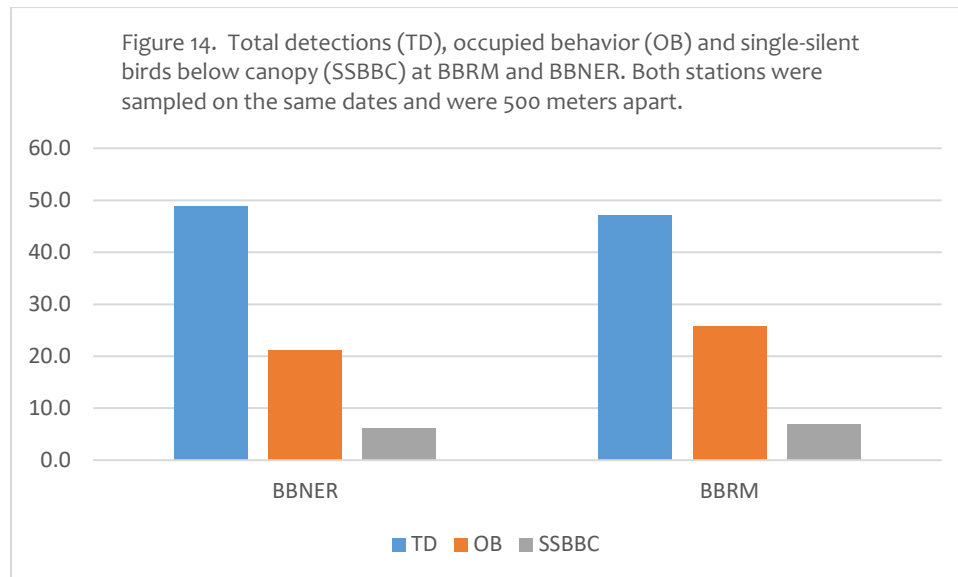


Successful MAMU Nesting at Big Basin State Park

A MAMU nest was discovered in the vicinity of station BBNER. The nest site is identified as Opal Creek #3. Evidence of potential MAMU nesting was discovered by Alex Rinkert, when he recorded below canopy detections during a point count, in late June, from a station near the intersection of North Escape Road and Gazos Creek Road as part of a separate, unrelated breeding bird survey. This observation led to the

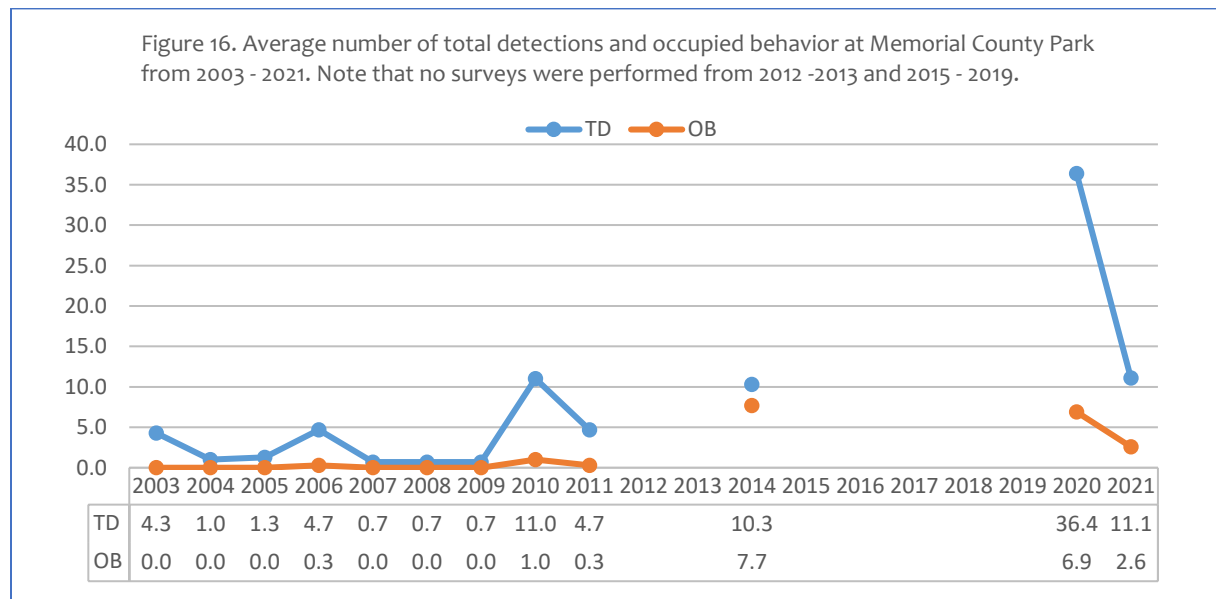
establishment of station BBNER for this study (**Figure 2**). The MAMU nest site was confirmed during the 1 July 2021 survey, when an adult carrying a fish was documented landing at the nest tree. In addition to the scheduled surveys for this study, the nest tree was closely monitored by a small group of researchers. Nine days after the nest was discovered, the fledgling flew from the nest on the eve of 9 July 2021. Twenty years had passed, since the last successful nesting was observed at Big Basin (Singer *et al* 1995). For more details on the nest discovery and monitoring, please visit: <https://santacruzbirdclub.org/wp-content/uploads/2021/10/66-2.pdf>.

BBRM vs BBNER. The BBNER nest site station was surveyed simultaneously with the traditional BBRM station, on the scheduled survey dates. The stations were located approximately 500 meters apart. When the survey data from both stations are compared, the values and dates of high and low detections correspond closely between the two stations (**Figures 14 and 15**), suggesting that the same birds may have been, at least in part, sampled at both stations.



Other Studies

Memorial County Park (MCP) was part of the original monitoring program from 2003 – 2014, but was discontinued following the 2014 survey season (Singer 2019). Murrelet surveys resumed at MCP, in 2020, independent of this study and continued in 2021 (E. Cole, pers. com.). The data from 2021 and previous years are presented here only to make generalized comparisons over the years. From 2003 – 2014, detection levels were relatively low, with a high mean of 11 total detections per survey recorded in 2010 (Figure 16). In 2020, the mean jumped sharply to 36.4 per survey, the highest level recorded at Memorial, since 2003, and corresponded to the overall increase in total detections observed elsewhere in 2020 (i.e., Butano, Gazos and Portola). In 2021, the average number of total detections fell sharply to 11.1 and occupied behaviors dropped to 2.6, values more consistent with years prior to 2020. Surveys also were performed at Pescadero Creek County Park, in 2021, where the mean total detections was 24.7, down sharply from 98.8 in 2020 and slightly below the range of means prior to 2021 (30 – 50 average number of detections; H. Ormshaw, pers. comm.). An interesting set of observations was recorded at Pescadero County Park on 8 July 2021, when a pair of murrelets was seen repeatedly approaching, landing briefly and taking off from the same limb of a large redwood (E. Cole, pers. comm.).



DISCUSSION

Post-CZU Fire Regional Murrelet Activity

The CZU Fire although tragic, offered the rare opportunity to record MAMU inland activity following severe destruction to MAMU habitat in the Santa Cruz Mountains. Based on Google Earth post-fire images, the CZU Fire severely burned most of Big Basin Redwoods State Park and parts of Butano State Park/Gazos, significantly reducing the extent of MAMU nesting habitat. Within this burned area, pockets of moderately burned forests remained throughout the parks. Fires of less severity also burned through the watersheds of South Fork Butano, North Fork Butano and the southern flanks of Pescadero Creek. Spared were forests adjoining the northern slopes of the Pescadero Creek watershed, including Portola Redwoods State Park, the northern section of Pescadero Creek County Park and Memorial County Park.

Given the burn pattern and locations of our survey stations, possible outcomes were considered, including no noticeable change in detection levels, a sharp increase of detections, or a sharp decrease in detections at regional (i.e., survey stations combined) and individual survey station levels. At a minimum, a sharp drop in detections at sites located in high to extreme severity burned forests (e.g., BBRM and Gazos) was reasonable to expect, with a possible increase at survey stations located in unburned (e.g., Portola) or low to moderately burned forests (e.g., Butano), presuming that birds from severely burned forests might seek unburned pockets of mature forests in search of suitable nesting habitat.

The results, however, were contrary to these expectations. For instance, at the regional level, although there was a drop in mean total detections, the drop was not remarkable when compared to past years. Additionally, occupied behavior detections remained the same as the 2020 seven-year high, while SSBBC detections slightly rose from 2020 and matched the high in 2017 (see **Figure 3**).

The 2021 results also were contrary to expectations at 3 out of 4 survey stations. First, BBRM total detections and occupied behavior rose sharply to near 2018 highs, while SSBBC detections also were up, but less markedly (see **Figure 5**). The 2021 BBRM results were surprising, given the severity of burn at Big Basin and the downward trend in these categories since 2018; an important factor to consider, however, is the close proximity of the newly established BBNER and how MAMU activity levels observed there likely influenced the results at BBRM (see further discussion, below). Second, while there was a decrease of mean total detections at Gazos, the difference from the 2020 peak year was slight (102.8 v 96.2), while both occupied behaviors and SSBBC rose from 2020 (see **Figure 9**). Finally, all three observation categories were down at Portola (see **Figure 11**), inconsistent with the idea that detections might increase in unburned stands, due to MAMU inhabiting severely burned stands seeking suitable habitat elsewhere. Only at Butano (low to moderate burn severity) were the results consistent with expectations following the CZU Fire. There, the mean total detections dropped sharply to an eight year low. Occupied behavior and SSBBC also were down, although less abruptly (see **Figure 7**).

Looking at the 2021 results, overall, one would not suspect a severe fire had burned through the core of MAMU habitat in 2020. Despite poor habitat conditions, strong site fidelity may have influenced the year-1, post-fire survey results by moderating the response of MAMU to the effects of the CZU Fire. A decrease in inland activity might be seen in the succeeding years, if MAMU productivity decreases on a regional basis, in reaction to the widespread loss of habitat. Nevertheless, the 2021 results highlight the challenges of interpreting results from inland surveys relative to changes in forest habitat, even drastic changes from severe fires.

Patterns of Regional Distribution and Occurrence

When the data for BBRM are compared to Butano, Gazos and Portola combined, mean total detections continued to move in opposing directions in 2021 (**Figure 13**). While this pattern may simply be a coincidental artifact of sampling, it could reflect changes in stand usage over time. Whether it continues in subsequent years, in the aftermath of the CZU Fire, remains to be seen.

Memorial County Park and Pescadero County Park

The drop in overall detections at Memorial and Pescadero County Parks in 2021 did not support the idea that detection levels would be similar to or higher in these two parks than in 2020, given the extensive fire damage to MAMU habitat in the Santa Cruz Mountains, south of Pescadero Creek. MAMU detections in the northern section of Region 6 still may increase in subsequent years, presuming that strong site fidelity will influence stand occupancy initially, but may wane as MAMU explore areas outside of natal home ranges, in search of suitable nesting habitat. As mentioned, above, the 2021 results highlight the challenges of interpreting results from inland surveys relative to changes in forest habitat conditions.

MAMU Nesting at Big Basin State Park

The successful MAMU nesting at Big Basin State Park reflects the impressive level of site-tenacity and resilience of this species, and is a hopeful sign. Not only did the MAMU nesting pair cope with the loss of habitat due to the CZU Fire, but also the emergency post-fire clean-up activities that were taking place in the surrounding forest during the nesting period, outside of a protection buffer that was established by State Parks following the nest discovery. These activities included the felling of hazardous trees, use of heavy machinery, staging of vehicles and wood chipping. Despite the odds, the nest site was successful, which is truly remarkable.

Another interesting outcome resulted from the establishment of the BBNER survey station. BBNER was simultaneously surveyed with the traditional BBRM station, and their results matched closely with regards to total detections, occupied behavior, SSBBC and the dates corresponding to the highs, lows and absence of daily detections (**Figures 14 and 15**). Also, the stations are 500 meters apart and near enough to one another for birds to travel between the stations in several seconds. Given these factors, it appears safe to assume the same birds were being sampled at both stations. This conclusion, however, generates a fundamental question regarding the sampling scheme, moving forward. Assuming that BBNER becomes a permanent station for monitoring nesting success in upcoming years, should surveys continue at BBRM, despite the apparent redundancy? Why maintain both survey stations, if the data are thought to represent the same birds? On the other hand, an argument for retaining BBRM would be its longevity – survey data for this station reach back to the early 1990s, and continuity into the future is desirable in creating a robust data set. The matter of whether to retain BBRM necessitates careful consideration. Ideally, both stations would be operative moving forward, if available resources allow.

RECOMMENDATIONS

See Singer 2019 and Bryan Mori Biological Consulting 2021 for additional recommendations.

- In light of the CZU Fire, continuation of the murrelet monitoring program is crucial, in order to detect possible changes in activity levels on a regional and/or station level, stand or watershed occupancy (presence/absence), and nesting behaviors.
- Continue surveying at BBNER to monitor nest site fidelity and to compare the results with traditional station BBRM to assess the relationship between the two stations.
- Consider revisiting a tracking study of at-seas birds, using GPS/satellite tags to collect fine scale inland flight behavior, to help shed light on the breadth of habitat use, identify areas of concentrated use, and help to clarify the relationship between inland detections and numbers of birds.

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