



Looking Downstream

2013 Update

**Physical and Ecological Responses to River Flow
Downstream of Hetch Hetchy Reservoir,
Yosemite National Park**



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Summary

The Looking Downstream project is an interdisciplinary study designed to better understand the physical processes and ecology of the mainstem Tuolumne River corridor between O'Shaughnessy Dam and the western boundary of Yosemite National Park. The project consists of hydrology, vegetation, and wildlife (bird, bat, and benthic macroinvertebrate) study components. An overarching goal of the Looking Downstream project is to provide information that water managers can use to manage environmental water releases from O'Shaughnessy Dam in ways that will more closely replicate natural physical processes and benefit dependent ecosystems downstream of the dam.

This status report details findings from the 2013 field season in Poopenaut Valley. The 2013 water year was dry, with 1 April and 1 May snow water equivalent measured at 61% and 31% of the 1 April average, respectively. 2013 also followed a dry year in 2012. Thus, hydrology studies in spring 2013 focused on monitoring low flow conditions; these low flows precluded filling the seasonal pond on the north side of Poopenaut Valley.

Analyses of our vegetation transect data show that sedge presence significantly decreased by 5% between 2008 and 2013 while both relative and total cover significantly increased. A significant increase in cover of forbs and ferns/allies was detected between 2008 and 2013. Monitoring indicates that although there is no significant change in wetland or upland plant frequency, there is a significant increase in both relative and total cover of wetland plants. While wetlands plants may not be spreading, already established plants appear to have more vigor and provide more cover. The majority of plant species present in frequency plots are native (between 73-82%) and no significant change in frequency between years was detected. However both relative and total cover of native species increased significantly between 2008 and 2013. This may indicate that while native plant presence as compared to non-natives is not increasing, those established native plants are increasing in cover and vigor. These changes could be due to the wide variation in water years between 2008 and 2013, modified river flows, or a combination of both. Continued monitoring should help resolve the effects that modified river flows have on vegetation in Poopenaut Valley.

In 2013, bird surveys resulted in surpassing the 100 mark (reaching 104) for the number of bird species documented in Poopenaut Valley during a standardized bird survey. One of these newly documented species, a Painted Redstart, was actually a new species for the park. Dry conditions in 2013 appeared to affect the way that birds in general used Poopenaut Valley, particularly on the north side where the seasonal pond remained dry. We found that in Search Area 1, adjacent to the pond, both species richness and relative abundance declined by 20% and 32% respectively compared to 2012, while both measures increased throughout the rest of the valley. Species richness and relative abundance increased most sharply (31% and 51%) in the montane riparian zone flanking the river that was in closest proximity to water throughout the season. The willows surrounding the ephemeral pond may provide desirable nesting and foraging habitat for Song Sparrows and Yellow Warblers when the pond is filled, but be unsuitable when dry. Nesting of birds with territories adjacent to the seasonal pond may hinge on the pond containing water, which would reinforce the importance of filling the ephemeral pond in May-June. Nest searching resulted in the discovery of 17 nests belonging to 11 species. None of these nests were threatened by flooding because river levels remained

relatively low throughout the spring and summer. By color-banding individual Yellow Warblers and Song Sparrows, we were able to create far more accurate territory maps for both species, and attribute nest success to specific, identifiable pairs. Continued monitoring, in particular color-banding and re-sighting color-banded birds will help us hone in on nesting chronology and identify the relationship between timing and magnitude of flow with nesting success of certain species.

Bat detection studies from 2011-2013 have identified an incredible biodiversity of bat species inhabiting Poopenaut Valley, with all 17 species of bats present in Yosemite National Park present in Poopenaut Valley. At least one species, the Mexican free-tailed bat, is present year-round. We documented five special status species, two of which were the first (spotted bat) and third (western mastiff bat) most frequently detected species during 2012. The considerable jump in spotted bat and western mastiff bat detections at the north site in summer 2012 requires further study; however, prey abundance in the seasonal pond and water level may be factors. Significantly lower detections of spotted bat and western mastiff bat during summer 2013 at both sites may also have been affected by the lack of water in the seasonal pond adjacent to the north site. Due to the absence of bat data during summer 2011 when the seasonal pond had the most water for the longest duration, we cannot conclude at this time that water alone was the main factor driving bat activity levels in Poopenaut Valley. The record setting increases for a majority of the bat species inhabiting Poopenaut Valley during the period in which the Rim Fire burned through the area was unexpected, and will continue to be investigated. Whether the increase in detection frequency for the majority of bat species at both sites during August-September 2013 can be attributed directly to the Rim Fire requires further investigation.

An important footnote to our 2013 update is the Rim Fire, which was ignited on 17 August 2013 and burned approximately 79,000 acres within Yosemite National Park, including Poopenaut Valley. The Rim Fire burned the north side of Poopenaut Valley on 23-34 August 2013 and the south side on 10-11 September 2013. The entire floor of the valley burned. Although overall the burn intensity in Poopenaut Valley was low, there were patches of high intensity burning in riparian areas adjacent to the river. Given that the Looking Downstream project is designed in part to monitor changes to the ecology in Poopenaut Valley due to current and possible future changes in water releases from O'Shaughnessy Dam, the Rim Fire has introduced a new response variable that will need to be carefully monitored and understood over subsequent years.

Chapter 1. Introduction

The primary goals of the Looking Downstream project are 1) to fill in first-order information gaps by collecting baseline information on the hydrology, vegetation, birds, bats, and benthic macroinvertebrates tied to releases of water from O'Shaughnessy Dam, 2) provide a general characterization of the river reach, and 3) assess its overall hydrological and ecological condition. An important overarching goal of these studies is to work collaboratively to produce science-based information and recommendations that the San Francisco Public Utilities Commission (SFPUC) can use to design environmental water releases that will be most beneficial to maintaining and enhancing ecosystems downstream of the dam.

Poopenaut Valley, a broad, low gradient valley located approximately 5.5 km (3.5 miles) downstream of O'Shaughnessy Dam, is one of the most ecologically diverse and productive areas in the river reach between the dam and the Yosemite National Park boundary. As a result, we consider Poopenaut Valley to be the location most sensitive to habitat disruption resulting from an altered hydrologic regime (National Park Service, 2009). For these reasons, we have focused our research efforts primarily in Poopenaut Valley, specifically on the meadow, wetland, and riparian ecosystems found there.

Our 2013 research in Poopenaut Valley consisted of five main subject areas: (1) surface and ground water hydrology, (2) upland, meadow, wetland, and riparian vegetation, (3) riparian-dependent bird species, (4) bats, and (5) benthic macroinvertebrate assemblages. Results from benthic macroinvertebrate research are reported separately by researcher Jeff Holmquist of the University of California White Mountain Research Station (Holmquist and Schmidt-Gengenbach, 2013). This report presents the other subjects in Chapters 2 through 5.

An important footnote to 2013 field work occurred in late summer with the Rim Fire, which burned approximately 79,000 acres in Yosemite National Park, including the Poopenaut Valley study area (Figure 1-1). The Rim Fire, which was ignited on 17 August, burned the north side of Poopenaut Valley on 23-34 August and the south side on 10-11 September (Figure 1-2). Although the fire burned at relatively low intensity (e.g., Figure 1-3), patches of riparian vegetation adjacent to the river and north side seasonal pond were intensely burned (Figure 1-4). Some of the data and results reported here were acquired prior to the Rim Fire (e.g., vegetation surveys), whereas others were acquired during and even after the fire (e.g., bat surveys). Given that NPS studies in Poopenaut Valley are, in part, designed to understand the effects of variable Tuolumne River flows on the ecology of the valley, the effects of the Rim Fire may prove somewhat confounding in the near term. We intend to continue detailed long-term monitoring of physical and ecological conditions in Poopenaut Valley to evaluate the effects of this fire within the broader scope of the overall study.

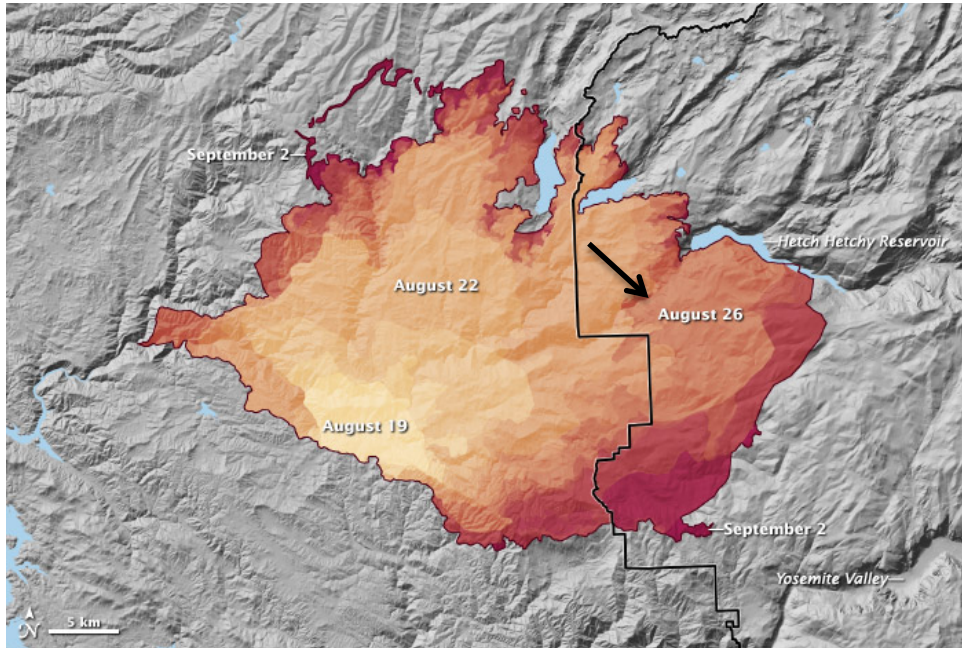


Figure 1-1. Progression of the Rim Fire perimeter from 19 August to 2 September 2013. Location of Poopenaut Valley marked by black arrow. Image courtesy NASA Earth Observatory.



Figure 1-2. Aerial image of Poopenaut Valley taken 10 September 2013 showing effects of the Rim Fire in Poopenaut Valley. View is to the southwest. Burned area on the north side of the Tuolumne River (right side) burned 23-24 August 2013. On 10-11 September 2013 the fire backed down the southern canyon wall (left side, showing active fire front) and subsequently burned the meadows on the south side of the valley.

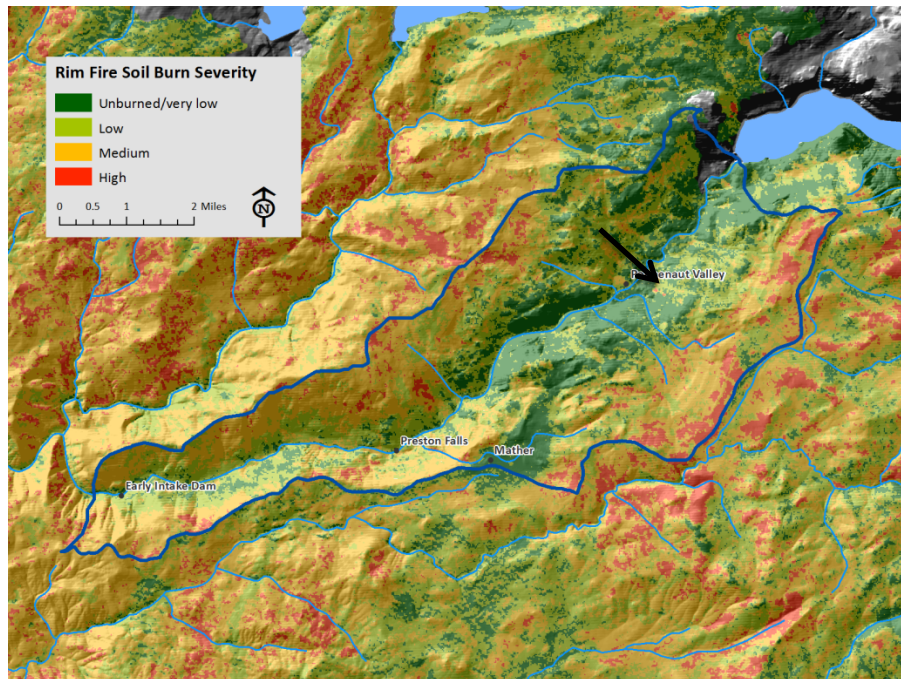


Figure 1-3. Rim Fire soil burn severity map for the Tuolumne River downstream of O’Shaughnessy Dam. Overall, Poopenaut Valley (marked by black arrow) burned at relatively low intensity, though there were isolated areas that burned hotter.



Figure 1-4. Photograph of former riparian vegetation adjacent to the river on the south side of Poopenaut Valley that experienced locally high burn intensity.

Chapter 2. 2013 Hydrology Studies in Poopenaut Valley

2.1 Introduction

Hydrology studies in 2013 primarily consisted of continued monitoring of water levels in the Tuolumne River, tributary streams, Poopenaut Valley seasonal pond, and groundwater within the meadows adjacent to the river. This report covers the period between the end of the 2012 flow experiment (June 13, 2012) and July 31, 2013. Due to low water conditions, there was no flow experiment in 2013.

2.2 Overview of the 2013 water year

The 2013 water year was dry, with 1 April and 1 May snow water equivalent measured at 61% and 31% of the 1 April average, respectively (Table 2-1). Precipitation at O'Shaughnessy Dam for WY2013 (California Data Exchange Center site HEM) was 61.7 cm (24.29 inches). A similar result for snowpack accumulation in the upper watershed is shown in Table 2-1. Data recorded at the US Geological Survey (USGS) gage in the Grand Canyon of the Tuolumne River upstream of Hetch Hetchy Reservoir (gage #11274790) indicated the onset of spring runoff was 12 March 2013, as determined using the maximum negative cumulative deviation from annual average flows. The peak spring runoff at the same gage occurred on 30 April 2013 at a level of 50 cubic meters per second (1,780 cubic feet per second). The seasonal pond in Poopenaut Valley was essentially dry during the reporting period.

Table 2-1. Summary snow water content for snow courses in the Tuolumne River watershed upstream of Hetch Hetchy Reservoir, 2013.

Snow Course	Course #	Elevation (m)	1 Apr Average (cm)	1 April 2013 (cm)	1 May 2013 (cm)
Dana	157	2987	79.0	45.0	31.8
Rafferty	158	2865	83.3	60.5	--
New Grace	368	2713	121.9	94.5	72.6
Tuolumne	161	2621	57.7	37.1	0.0
Wilma	163	2438	109.7	83.3	60.5
Paradise	167	2332	101.3	69.9	32.3
Vernon	169	2042	56.9	22.9	3.8
Beehive	171	1981	59.7	25.7	0.0
Lower Kibbie	173	2042	66.0	11.4	0.0
<i>Data source: NPS</i>			% 1 April Average	61%	31%

We maintained groundwater monitoring wells 1, 2, 3, 8, 10, 11, 13, 15, 16, and 19, as well as stream level recorders on three tributaries and at two locations along the Tuolumne River in Poopenaut Valley (Table 2-2, Figure 2-1). Figures 2-2 and 2-3 illustrate conditions along the downstream and upstream valley transects respectively. Compared to previous years, changes in water levels at all sites were muted and groundwater remained well below ground surface primarily reflecting minimal in-stream flows on the Tuolumne River. The peak flow on the Tuolumne River at the USGS gage downstream of Hetch Hetchy (gage #11276500) was 6.2 cms (218 cfs), which occurred on 5 April 2013. The total change in water level at all measured locations in Poopenaut Valley for the reporting period was generally less than 0.5 meters.

Table 2-2. Poopenaut Valley groundwater monitoring well depth and elevations.

Well Number	Elevation TOC* (m)	Stickup (m)	Ground Elevation (m)	Total well depth below ground surface (m)
1	1014.29	0.167	1014.124	3.730
2	1013.95	0.171	1013.783	3.960
3	1012.35	0.109	1012.241	3.540
8	1014.27	0.215	1014.057	2.720
10	1014.74	0.185	1014.554	3.770
11	1013.19	0.205	1012.985	3.650
13	1012.69	0.285	1012.399	3.099
15	1014.23	0.466	1013.768	4.863
16	1014.23	0.364	1013.859	4.898
19	1016.16	0.385	1015.780	5.789
Upstream recorder	1009.54	-	-	-
Downstream recorder	1009.60	-	-	-
Pond recorder	1012.48	-	-	-
SW Tributary	1013.46	-	-	-
SE Tributary	1012.99	-	-	-
North Tributary	1011.65	-	-	-

*TOC = Top of well casing

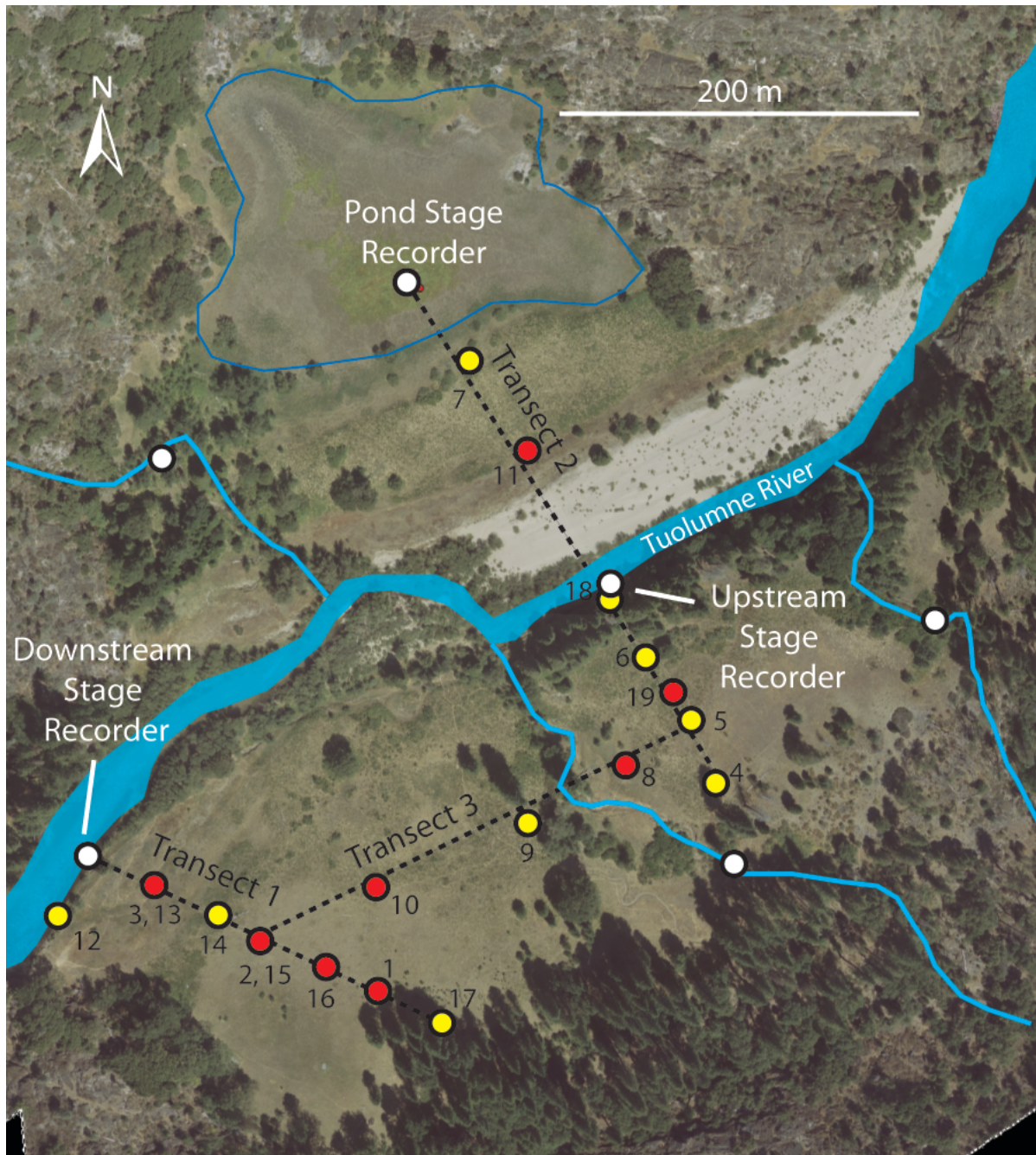


Figure 2-1. Poopenaut Valley water level monitoring locations. White dots indicate stage recorders in surface waters (Tuolumne River, tributaries, and seasonal pond). Red dots indicate existing groundwater monitoring wells. Yellow dots indicate former groundwater monitoring wells removed in October 2011.

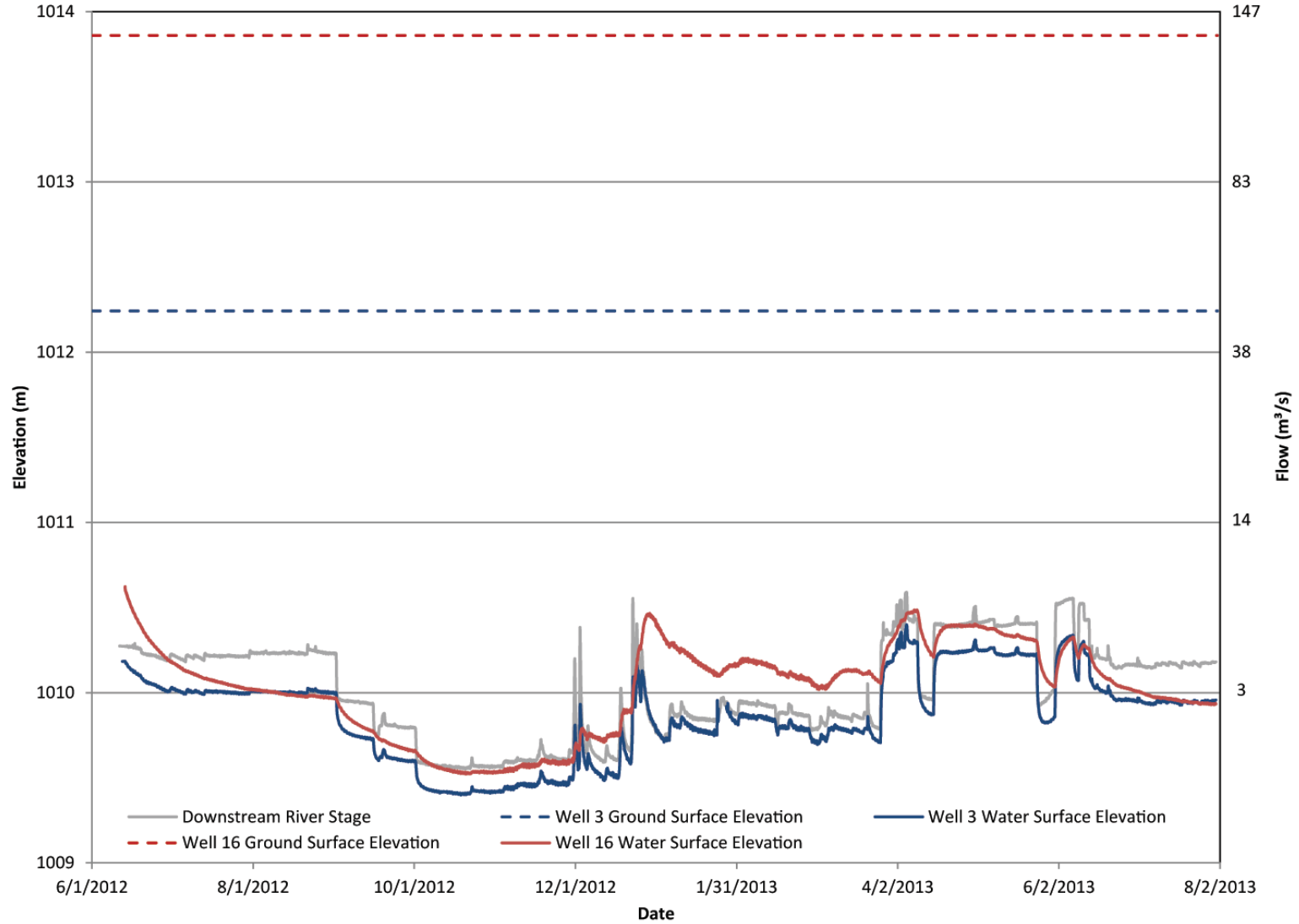


Figure 2-2. Poopenaut Valley groundwater monitoring well response to Tuolumne River flows along Transect 1 (downstream transect, see Figure 2-1), June 2012 – August 2013.

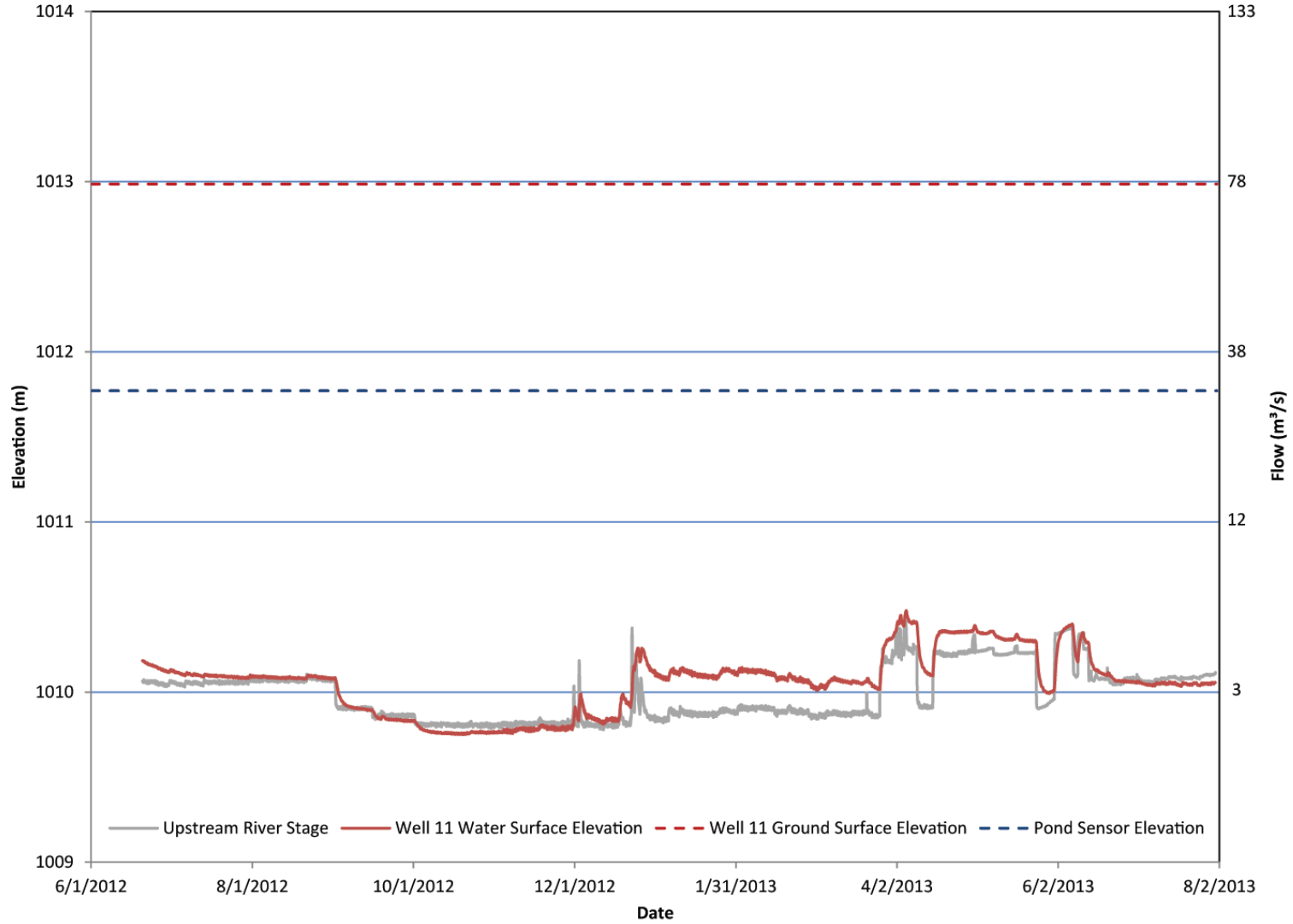


Figure 2-3. Poopenaut Valley groundwater monitoring well response to Tuolumne River flows along Transect 2 (upstream transect, see Figure 2-1), June 2012 – August 2013. The seasonal pond on the north side of Poopenaut Valley was dry for the reporting period.

2.3 Effects of the Rim Fire on hydrological installations

The Rim Fire essentially burned the entire floor of Poopenaut Valley between 23 August and 11 September 2013, though mostly at a very low intensity. The fire did damage some of the hydrological instrumentation, specifically some of the PVC groundwater monitoring well casings, the north side tributary stage recorder, and the seasonal pond stage recorder (Figure 2-4). Fortunately the pressure transducers in the wells were not damaged, and both the north side tributary and the pond were dry during the fire so no data were lost. These instruments were replaced in November 2013.



Figure 2-4. Fire-damaged stage recorder in the seasonal pond (dry) on the north side of Poopenaut Valley. This stage recorder was replaced in November 2013.

Chapter 3. 2013 Vegetation Studies in Poopenaut Valley

3. 1 Introduction

Herbaceous wetland and upland meadows intermixed with dense riparian trees and shrubs comprise the vegetation in Poopenaut Valley. The maintenance and enhancement of the ecological integrity of these communities requires flow magnitude, timing, frequency and duration sufficient to inundate wetlands and maintain the water table and soil moisture required for plants to establish and persist. The minimum hydrologic requirements for a jurisdictional wetland in the western mountain region is defined by the US Army Corps of Engineers to have soil saturation within 30 cm (12-inches) of the ground surface for a period of 14 consecutive days during the growing season 5 out of every 10 years (USACOE 2008). Through hydrologic assessments and modeling, we have recommended flow models and have a good sense of the physical response (e.g. soil saturation, water table level, soil moisture retention) to different flow magnitudes and durations. However, measuring the biological response requires a longer time period and is much more complicated. For example, Russo et al. (2012) suggests that surface soil inundation was the most effective method, in terms of minimizing the volume of flow releases, for saturating soils and supporting wetland hydrology but the effects on plants dependent on a high water table is unknown.

The wetland delineation and description of existing vegetation types in Poopenaut Valley, completed in 2007 (National Park Service, 2009) and refined in 2008 and 2009, provide a baseline of the composition and spatial distribution of plant communities and wetlands. Vegetation dominance, frequency, abundance and distribution vary widely between years due to fluctuations in annual temperature and precipitation. Therefore, detection of a plant community response to altered flows is likely to take many years of monitoring. In order to refine these assessments additional vegetation monitoring continued in the 2011 and 2013. In 2013, we continued to identify additional plant species occurring in Poopenaut Valley (bringing the total observed to 217).

3.2 Methods

To better assess changes in vegetation we established nine transects along and perpendicular to three established cross sections, recording 600 point-intercept data points and 50 nested frequency quadrats in 2008. Most transect ends used established rebar (for the cross sections) and vary in length depending on the location of those rebar. Cross Section 1 is broken up into 3 transects (to improve the repeatability in subsequent recording), Cross Section 2 has one transect and Cross Section 3 is broken up into 3 transects (1 on the south side of the river and 2 on the north side). We also installed one additional transect perpendicular to Cross Section 1 to better monitor Wetland 6 and a final transect north of the river at the west end (see Figure 3-1).

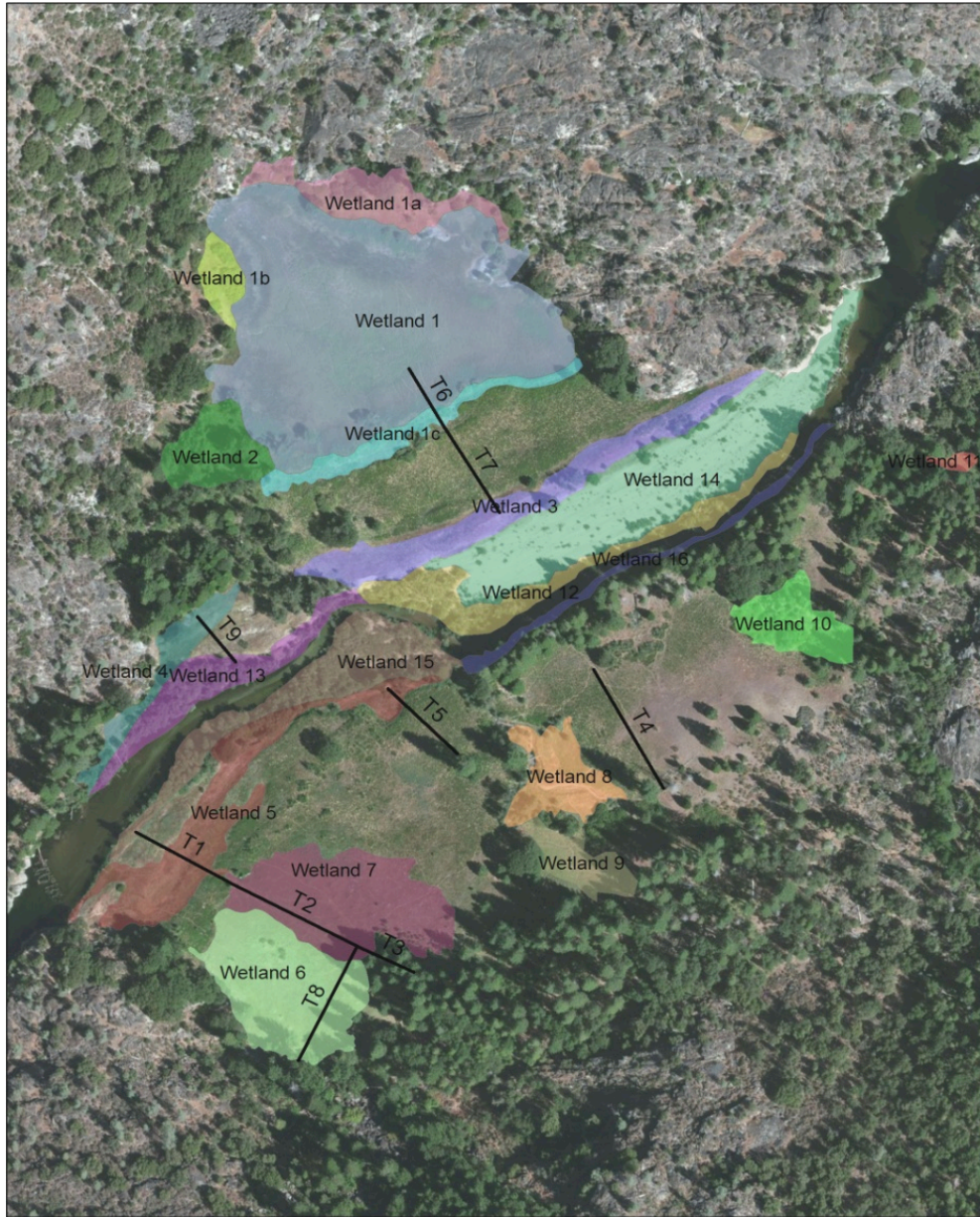


Figure 3-1. Vegetation monitoring transects and wetlands (2007) in Poopenaut Valley

Data collected on each transect includes a point-intercept reading every meter (on the whole number) and a varying number of nested frequency plots randomly placed along the transects.

For each point-intercept, we measured and recorded the height and species of the tallest plant intercepted and recorded any other plant species below. Each plant species is only counted once. Point intercept methodology gives us cover (often expressed as relative cover), frequency and composition (although less common species are often underrepresented). This method is simple and easy to use and is appropriate for large areas and monitoring dominant vegetation (Elzinga et al. 2006). Measurements are repeatable but observer error is high as the

tendency is to overestimate the number of “hits.” The same observer completed monitoring in all reads, lessening some of this inherent bias.

For nested frequency quadrats, the nest sizes include: 0.25 meters (read the corner closest to the beginning point). 0.5 meters (the half perpendicular to the transect) and the full meter. In 2011, an additional nest of 0.1 meters was added to better monitor very common species. Beginning in the smallest quadrat we recorded all species observed. Each species is recorded only once in the smallest nest in which it occurs.

Frequency is one of the easiest and fastest methods available for monitoring vegetation. It describes the abundance and distribution of species and is useful to detect changes in a plant community over time (Elzinga et al. 2006). However, because frequency data are non-absolute (presence/absence), they only indicate a change is occurring and which species are changing but the nature of those changes cannot be established. For example, a change in frequency does not necessarily relate directly to more concrete parameters such as density, cover, weight, height, volume or any criteria related to the amount of a species present at a location.

Good sensitivity to change is obtained for frequency values between 20 percent and 80 percent (Despain et al. 1991). Frequency values between 10 percent and 90 percent are still useful, but values outside this range only indicate species presence and do not detect change (Despain et al. 1991). Because frequency values are measured separately for each species, an optimum size quadrat for one species may be less than optimum or even inappropriate for another and this is partially resolved by using nested quadrats of different sizes.

3.3 Results

We installed transects in late July of 2008 and reread them in late April 2010, late July 2010, late July 2011, and mid-July 2013. Many analyses can be completed for the transect data including establishing the relationship between plant communities and water table utilizing hydrologic models along the cross sections, plant community level analyses, as well as comparative analyses between years. Following are preliminary comparative analyses between years of eight of the nine transects (due to errors on the 9th transect it was excluded). The large differences in conditions measured in April as compared to all other reads do not represent an actual change in ecological condition but rather are a factor of the time of year. Therefore, these comparisons are not represented as a change but as an indication of what species occur prior to any inundation or saturation from higher river flows. Most analyses focus on changes between 2008 and 2013.

3.3.1 Nested Frequency

Following are data summaries for general frequency by lifeform, native status and wetland indicator status in the largest quadrat (1 meter) across all transects in Poopenaut Valley. In 2008, 50 species were present in the plots, 44 in April of 2010, 62 in July of 2010, 55

in 2011, and 46 in 2013. Quadrats are treated as sampling units (n=50) and chi-square tests and McNemar's tests for paired samples were conducted. Basic statistics (chi-square and McNemar's) did not indicate significant change in frequency of specific plant species (e.g. Kentucky bluegrass or *Carex* spp.) between years. Further analysis is needed to test changes in frequency by differing nest sizes.

3.3.2 *Point-intercept*

Cover data from point-intercept measurements are summarized by percent relative cover (always equals 100%) and percent total cover (includes layered vegetation and can equal over 100%). Both relative and total cover includes substrate (litter, bare, water, rock etc.) as a proportion of the cover. In 2008, vegetation relative cover was 80%, 57% in April 2010, 94% in July of 2010, 93% in 2011, and 91% in 2013. Total vegetation cover was 106% in 2008, 47% in April 2010, 155% in July of 2010, 164% in 2011, and 146% in 2013. The increases in both relative and total vegetative cover is significant between 2008 and 2011 ($p=0.006$) and between 2008 and July 2010 ($p=0.001$) but not significant between July 2010 and 2011, July 2010 and 2013, or 2011 and 2013.

Using transects as the sampling unit (n=8) we applied paired *t* tests to detect change in cover by lifeform, native status and wetland indicator status between measurements. Paired *t* tests did not indicate significant change in cover of specific plant species (e.g. Kentucky bluegrass or *Carex* spp.) between years. Because transects sample less than 5% of the population, a finite population correction factor was not applied.

3.3.3 *Lifeform*

Lifeform of plants is based on physiological and morphological groupings and can provide a general picture of a plant community. For this analysis, plants are classified as a fern/ally, forb (herbaceous flowering plants), graminoid (grasses, sedges and rushes) and shrub. Grasses are further divided into annual vs. perennial, as there are large differences in functionality and cover between the two.

When comparing percent frequency of all plants by lifeform between 2008 and 2013, we see a slight decrease in annual grasses (not significant), little change in ferns/allies (not significant), an increase in forbs ($p=0.023$), varying presence of perennial grasses (not significant) and a slight decrease in sedges ($p=0.07$), (Figure 3-2). In April 2010, forbs and annual grasses were more frequent, likely because perennial grasses such as Kentucky bluegrass germinate early in the spring while sedges and ferns germinate later.

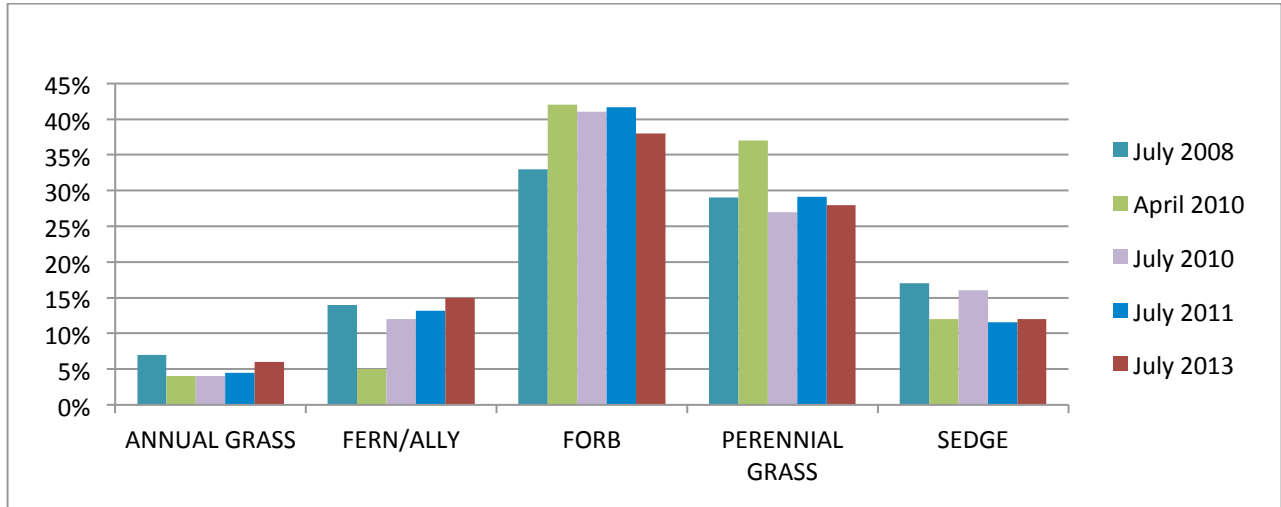


Figure 3-2. Frequency by lifeform

When we look at relative cover by lifeform, perennial grasses have the highest cover in all years (Figure 3-3). Changes in relative cover between 2008 and 2013 include none annual grass (not significant), none in fern/ally (not significant), an increase in forbs (not significant), an increase in perennial grass ($p= 0.01$), and an increase in sedges (not significant). As expected, relative plant cover was the lowest in April of 2010 due to the high cover of litter (substrate) and lower in 2008 when compared to July of 2010, 2011, and 2013.

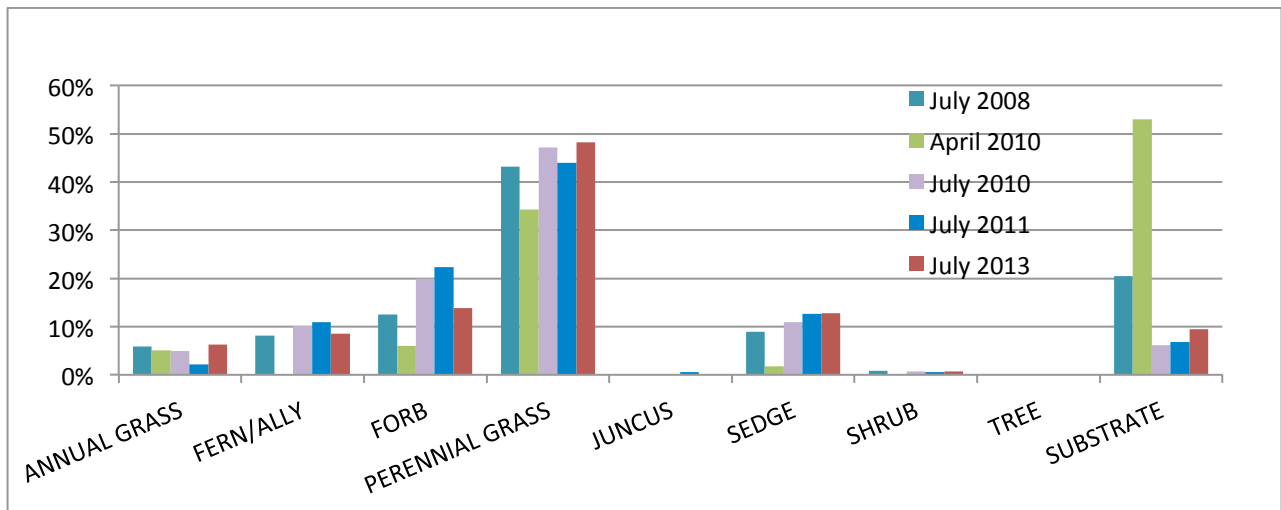


Figure 3-3. Relative cover by lifeform

Total cover shows a similar pattern to relative cover with perennial grasses dominating (Figure 3-4). Comparing 2008 and 2013, the increases in cover of annual grass ($p=0.4$), in fern/ally ($p=0.2$), and forbs ($p=0.1$) were not significant, while increases perennial grass ($p=0.01$) and sedges ($p=0.05$) were significant. Again, substrate cover was highest in April 2010 and slightly higher in 2008 as compared to 2010, 2011, and 2013. When compared to frequency data, although the presence of sedges decreased slightly in 2013, both relative and total cover increased.

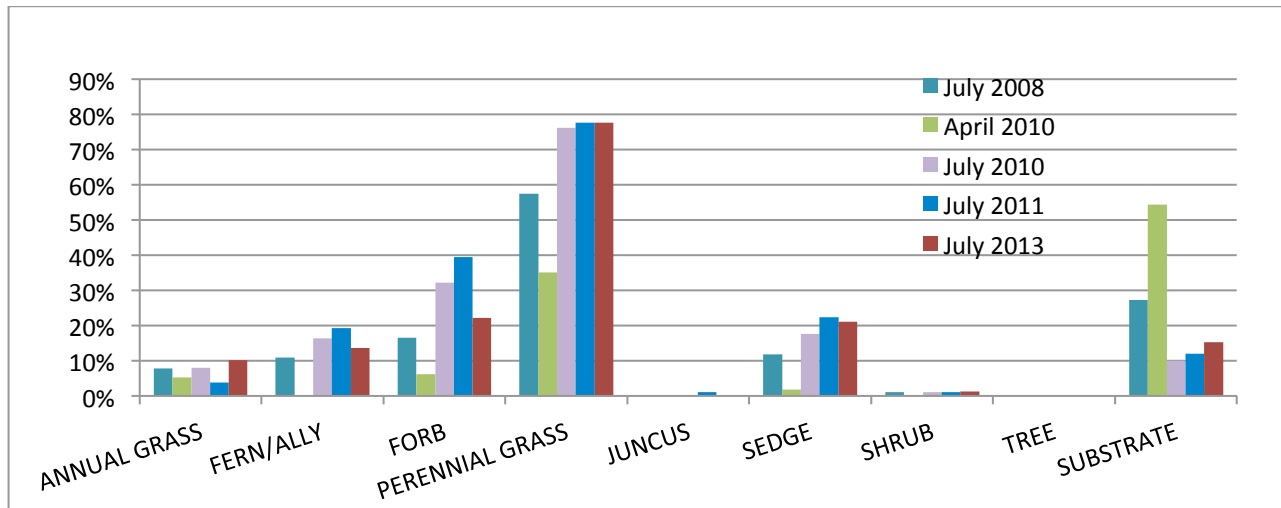


Figure 3-4. Total cover by lifeform

3.3.4 Wetland indicator

Considering the National Wetland Indicator (NWI) status of plant species helps determine the likelihood that a particular plant would or would not occur in a wetland (NRCS 2012). Not all species have ratings, particularly those that do not typically occur in wetlands, and in these cases, local knowledge of those plants was used to determine NWI status. Plants classified as upland (UPL) and facultative upland (FACU) occur in wetlands 0-33% of the time, facultative (FAC) plant species occur in wetlands 50% of the time and obligate (OBL) or facultative wet (FACW) occur 66-100% of the time in wetlands (NRCS 2012). To present the data, UPL and FACU plants are combined (Upland), and FACW and OBL (Wetland) are combined. When completing vegetation dominance tests for wetland delineations, FAC species are typically considered wetland but are kept separate for this data summary to demonstrate how the majority of species occurring in Poopenaut Valley can occur in both wetlands and uplands.

When looking at frequency by NWI rating, a slightly larger proportion of plants observed are classified as upland vs. wetland (Figure 3-5). The largest difference was observed in April and is likely due to the absence of inundation or high groundwater levels, conditions favored by

upland plant species. Statistical tests did not indicate significant change between measurements.

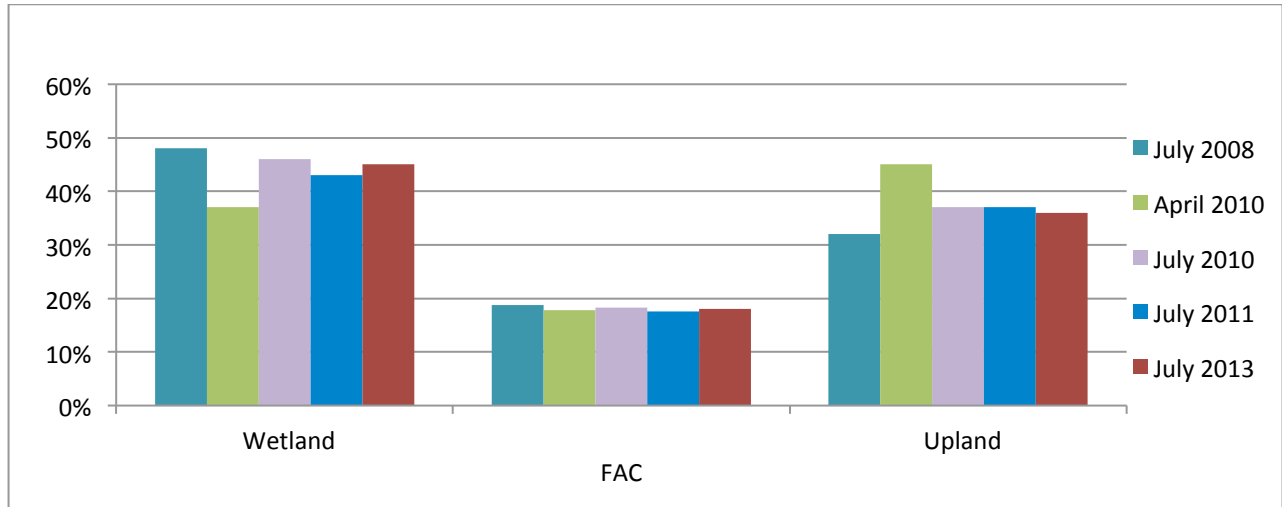


Figure 3-5. Frequency by wetland indicator

Relative cover of wetland plants increased (not significant) in July of 2010, 2011, and 2013 as compared to April 2010 and 2008 (Figure 3-6). Wetland plant relative cover increased (not significant) between July 2010 and 2011 and 2013. Again, April 2010 shows less total cover of vegetation and both wetland and upland species provide much less cover. FAC species relative cover remains generally the same for all reads.

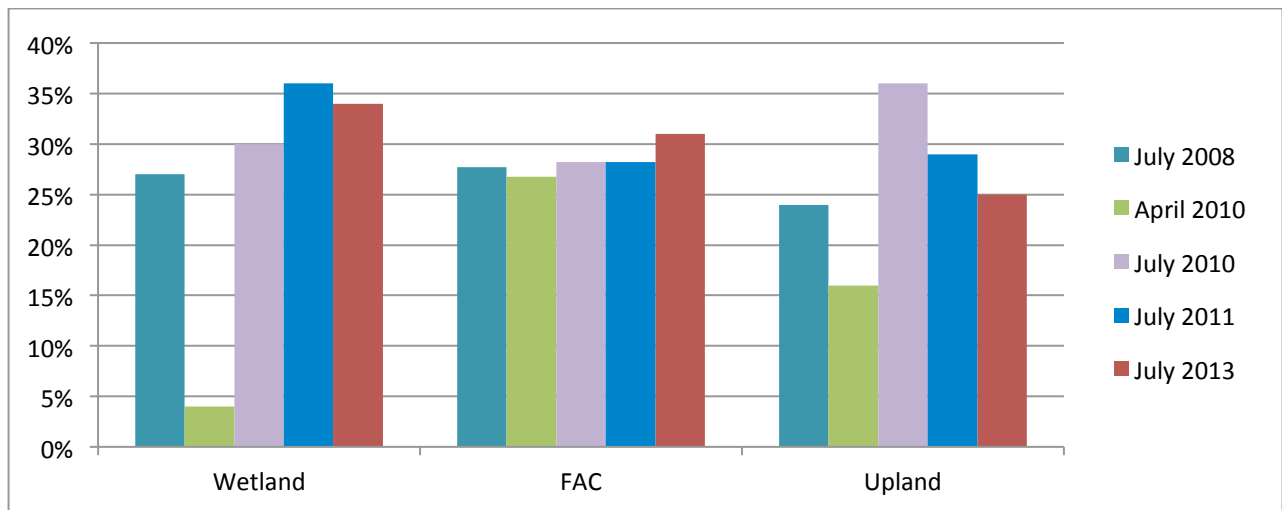


Figure 3-6. Relative cover by wetland indicator

Total cover follows a similar pattern; although cover of FAC species in April of 2010 is lower (Figure 3-7). This is likely due to the lower vegetation cover in general and the absence of several layers of vegetation that is present later in the season. The increase in frequency of wetland species between 2008 and 2013 is significant ($p=0.01$), as is the increase of FAC species ($p=0.03$), while the change in upland species is not.

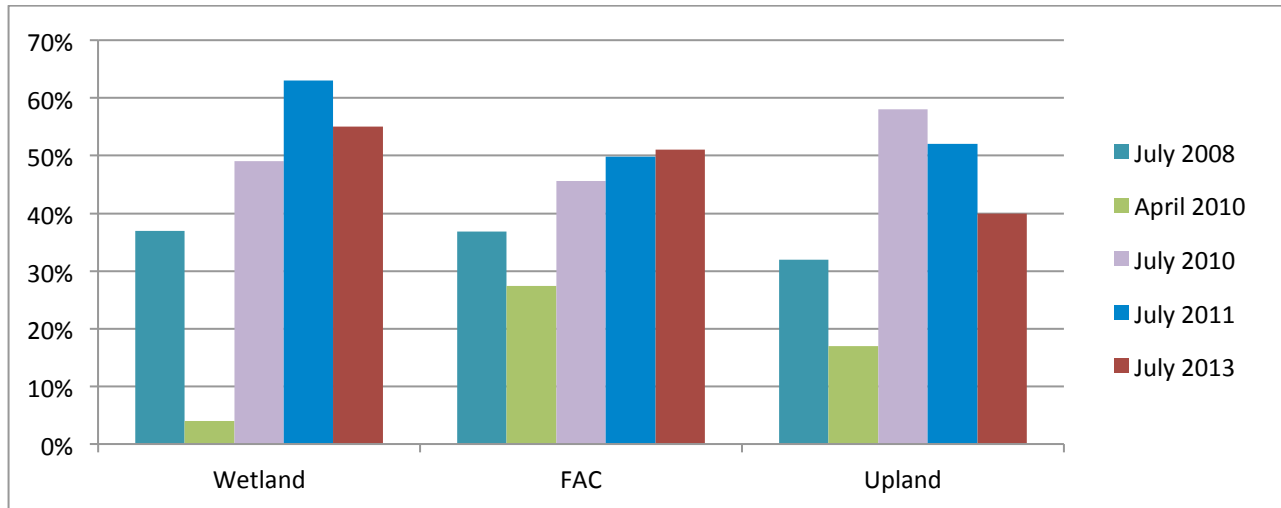


Figure 3-7. Total cover by wetland indicator

3.3.5 Native Status

The majority of plant species present in frequency plots are native (between 73-82%) and no significant change in frequency between years was detected (Figure 3-8). Non-native plant presence was higher as compared to other reads in April 2010 largely because Kentucky bluegrass and cheat grass germinate and begin growth earlier than many native species, particularly sedges.

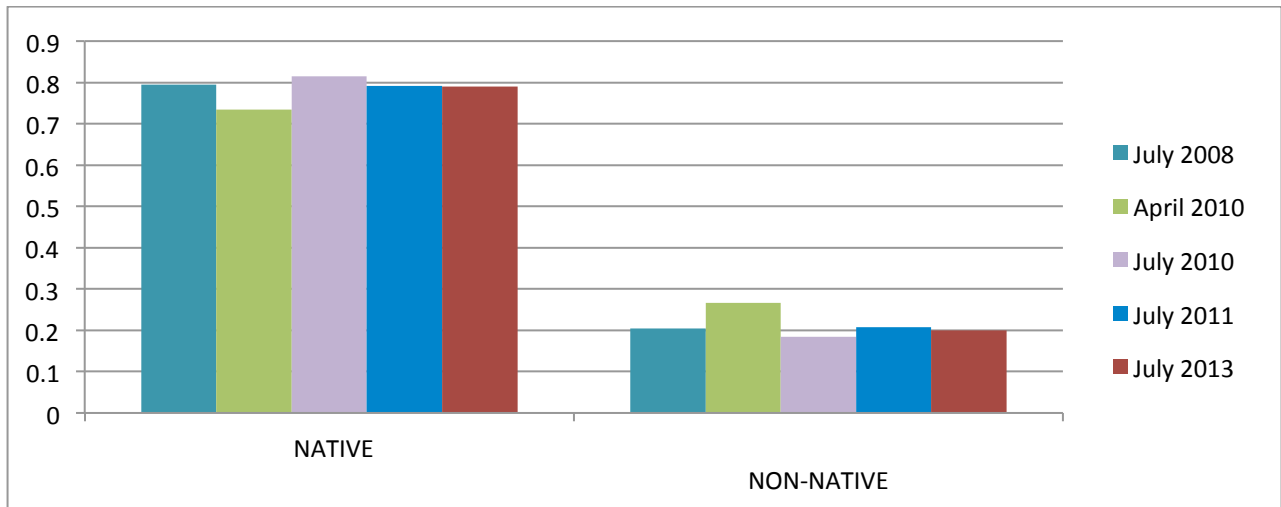


Figure 3-8. Frequency by native status

Relative and total cover of native species increased significantly ($p=0.004$) between 2008 and 2013 (Figures 3-9 and 3-10). Relative and total cover of non-native species also increased significantly ($p=0.02$) between 2008 and 2013. The large differences between April 2010 and other reads is likely due to the prevalence of Kentucky bluegrass and cheat grass early in the season.

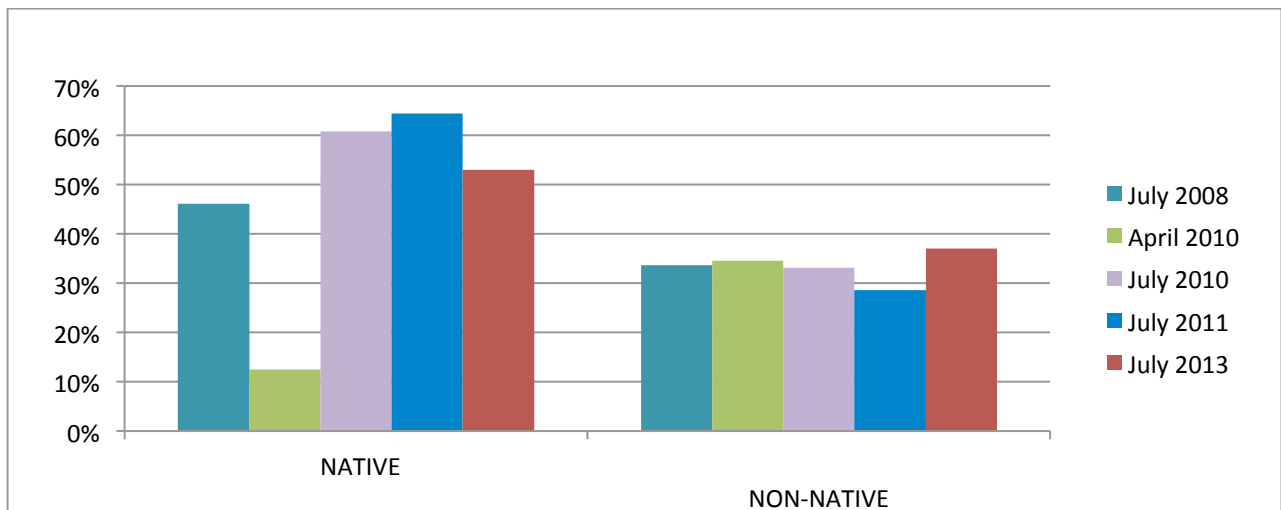


Figure 3-9. Relative cover by native status

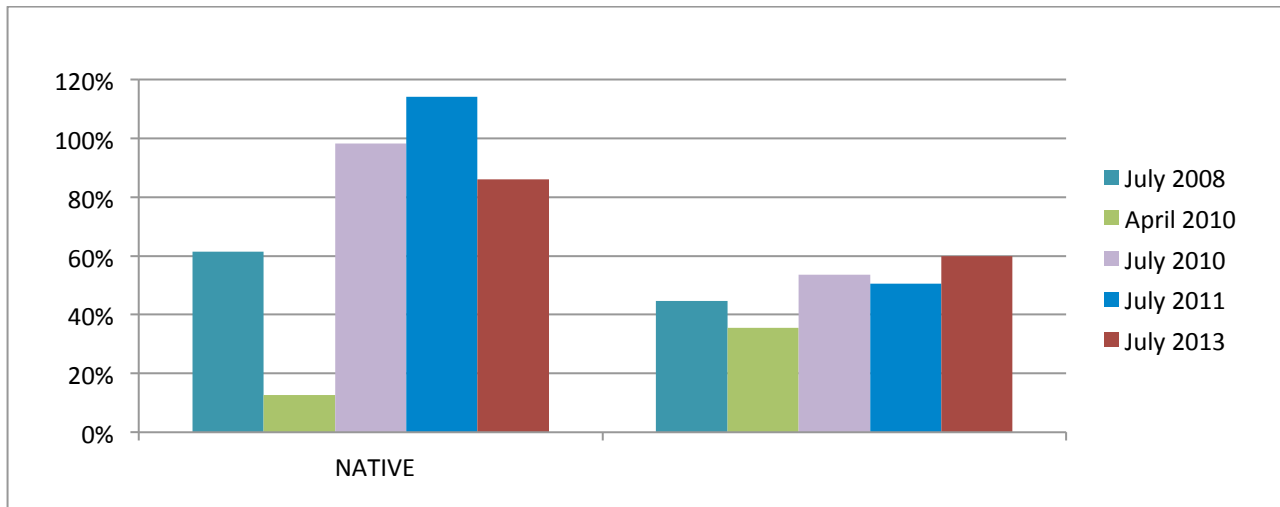


Figure 3-10. Total cover by native status

3.4 Discussion

The objective of vegetation monitoring is to measure changes in plant frequency and cover and to determine if modified flow regimes are influencing these parameters. From preliminary analyses, we do see measurable change but we must continue monitoring to see if these trends continue or are primarily due to inter-annual variation.

Measuring transects in April provided us with an idea of which plants are germinating when conditions are dry and moisture availability is completely dependent on precipitation. As expected, non-native species, annual species and C3 grasses (early germinators) such as Kentucky bluegrass dominate. In wetlands with natural hydrologic regimes, conditions are wet in late April when sedges and other native species may begin germination and this dry period prior to water release may give Kentucky bluegrass a competitive advantage.

Monitoring data indicates that both relative and total plant cover was significantly higher in 2010, 2011, and 2013 as compared to 2008. This may be due to the above average precipitation in the first two years. However, if future monitoring shows continued high or increased plant cover as compared to 2008 despite precipitation amounts, we may be more confident that it may be in part due to modified flows.

As water availability increases, we hypothesize that sedges will increase in both frequency and cover as compared to perennial grasses, namely Kentucky bluegrass. Studies of Kentucky bluegrass and associated groundwater levels indicate that prolonged inundation and saturation provides an opportunity for sedges to outcompete this non-native grass (Allen-Diaz 1991). Preliminary data summaries of our transect data show that sedge presence significantly decreased by 5% between 2008 and 2013 while both relative and total cover significantly increased. This may indicate that while some sedge species may be less frequent, others are increasing in vigor and cover. This change could be due to the wide variation in water years,

modified flows or more likely a combination of both. If continued monitoring shows a continuation of this trend, we may be more confident that modified flows are having a stronger influence.

A significant increase in cover of forbs and ferns/allies was detected between 2008 and 2013. Optimal moisture conditions may allow forbs to establish and compete with graminoids and increase fern vigor and cover. Again, this change could be due to the wide variation in water years, modified flows or more likely a combination of both. If continued monitoring shows a continuation of this trend, we may be more confident that modified flows are having a stronger influence.

Monitoring indicates that while there is no significant change in wetland or upland plant frequency, there is a significant increase in both relative and total cover of wetland plants. While wetlands plants may not be spreading, already established plants appear to have more vigor and provide more cover. This change could be due to the wide variation in water years, modified flows or more likely a combination of both. If continued monitoring shows a continuation of this trend, we may be more confident that modified flows are having a stronger influence.

The majority of plant species present in frequency plots are native (between 73-82%) and no significant change in frequency between years was detected. However both relative and total cover of native species increased significantly ($p=0.004$) between 2008 and 2013. This may indicate that while native plant presence as compared to non-natives is not increasing, those established native plants are increasing in cover and vigor. This change could be due to the wide variation in water years, modified flows or more likely a combination of both. It is unlikely that ongoing non-native plant treatment would have such an effect on native plant populations, as most treatment areas are relatively small and isolated. If continued monitoring shows a continuation of this trend, we may be more confident that modified flows are having a stronger influence.

No significant change in individual plant species was detected in our analyses. Further analyses, described below, may provide a more complete picture. Overall, our monitoring is detecting changes but we must continue this monitoring and identify indicator species to tease out the cause for these changes.

3.5 Future work

Transects will continue to be monitored every other year and utilizing our preliminary analyses as a guide, we will focus monitoring on key species that are most likely to respond to a modified flow regime. We will continue to measure a smaller nest added in 2011 to better monitor very common species. We will also investigate ways to correlate soil moisture gradients and plant community spatial distribution. Monitoring could also be expanded to look more closely at plant physiological response (root growth, vegetative growth, reproduction) in an environment where soils are very dry with low groundwater levels at the start of the growing season, are inundated or saturated during flooding, and return to drought conditions rather abruptly (as compared to an unimpaired hydrograph) again when flows decrease. By evaluating

plant response, we can identify those species that benefit from these conditions as well as those that decline and monitor these species as indicator species. For example, Goslee et al. (1997) found that plants can be used as indicators of water source, (e.g. primarily groundwater vs. surface water) and the associated water chemistry and hydro-period.

The difficulty of vegetation monitoring is to determine if any changes are ecologically important and are responding to a particular factor or a complex of environmental influences. Investigating relationships between wildlife and vegetation, groundwater levels and vegetation and individual plants physiological response will help to refine what influences plant cover and frequency and identify changes we expect to detect.

Chapter 4. 2013 Bird Studies in Poopenaut Valley

4.1 Introduction

The sensitivity of bird populations to changes in the ecosystem makes them an important indicator of overall habitat quality (Marzluff and Sallabanks, 1998). Long-term monitoring of birds, particularly during the breeding season, can be used to effectively assess habitat health (Ralph et al., 1993). Bird population dynamics have been used as scientifically viable surrogates for evaluation of ecosystem condition because (1) birds are conspicuous, easily observable, and monitoring and analysis are cost effective; (2) as secondary consumers (i.e. insectivores), birds are sensitive indicators of environmental change; and (3) knowledge of the natural history of many bird species has a rich basis in literature. In human-altered riparian areas, bird monitoring can be a valuable tool for assessing changes in habitat quality incurred from restoration efforts, river diversion and channelization projects, water impoundment, and flooding events.

One of the main objectives of bird studies in Poopenaut Valley is to gain a better understanding of how altered hydrology below O'Shaughnessy Dam affects breeding birds. We began investigations in 2007 by completing a California Wildlife Habitat Relationships (CWHR) model that predicts occurrence of vertebrate species (amphibians, reptiles, birds, and mammals) between O'Shaughnessy Dam and the park boundary and in Poopenaut Valley (National Park Service, 2007). Also in 2007, we began ground-truthing the model by conducting areas search surveys with the goal of characterizing the breeding bird community in Poopenaut Valley (National Park Service, 2007, 2008, 2009, 2010, 2012a, 2012b). Since 2007, we have continued to augment our survey methods in order to delve deeper into the breeding ecology of the bird community in Poopenaut Valley, with emphasis on five riparian focal species (RHJV, 2004). These focal species [Black-headed Grosbeak (*Pheucticus melanocephalus*), Song Sparrow (*Melospiza melodia*), Warbling Vireo (*Vireo gilvus*), and Yellow Warbler (*Setophaga petechia*)] play a central role in relating seasonal population trends of breeding birds in Poopenaut Valley to water availability.

After initiating bird studies in 2007 with search area surveys, beginning in 2008 we conducted point counts surveys; beginning in 2010 we conducted spot mapping surveys, nest searching, and territory mapping; beginning in 2012 we captured and banded birds; and beginning in 2013 we color-banded Song Sparrows and Yellow Warblers. We chose to more closely monitor these two species in particular because they both have special sensitivity to different aspects of the riparian system: Yellow Warblers are listed as a California Species of Special Concern, and Song Sparrows typically nest in the lowest vegetation strata, so their nests may be particularly prone to flooding in a managed hydrological regime.

Color-banding serves two primary functions in our survey efforts. First, it increases the accuracy of territory mapping because we are able to positively identify and track color-banded individuals. As our knowledge of territories becomes more accurate and reliable, this enables us to investigate potential correlations between territory size and other ecological attributes

associated with quality of available habitat. Second, color-banding provides an opportunity to measure multiple indices of avian population health, e.g., productivity, juvenile survival, adult survival, and recruitment. Color-banding can also reduce the amount of time and effort needed to locate an individual's nest and determine an individual's breeding status (Anders and Marshall 2005). Incorporating color-banding into the suite of avian survey techniques utilized in Poopenaut Valley results in a more thorough and comprehensive assessment of ways in which the altered flow regime might be influencing avian population dynamics. This information on breeding bird populations will feed into recommendations to the San Francisco Public Utilities Commission on timing water releases from O'Shaughnessy Dam in order to benefit breeding birds.

4.2 Methods

4.2.1 Bird Area Search and Point Count Surveys

We conducted the seventh year of standardized area search surveys (2007-2013) and the sixth year of point count surveys (2008-2013) to estimate bird community species abundance, composition, and habitat use in Poopenaut Valley wet meadow and montane riparian habitats. We conducted area searches in five distinct areas, each comprising approximately 0.03 km² (3 hectares) (Figure 4-1); see the 2007 Looking Downstream Report (National Park Service, 2009) for a thorough description of protocols and search areas.

In 2008 we established two point count locations, one on either side of the river in Poopenaut Valley at locations intersecting Areas 1 and 2; and Areas 3 and 4 (Figure 4-1). We used the standardized point count protocol for monitoring landbirds (Ralph et al., 1993, Nur et al., 1999), including the use of a standardized datasheet. Use of standardized survey methods allows data to be compared among years, as well as in areas outside of Poopenaut Valley. Each set of surveys were spaced at least 10 days apart and were completed by 10 am. Point counts were conducted for 5-minutes each, during each of the three visits, following the area searches. For both survey methods, the observer recorded observed species, method of detection (visual, song, or call), and indications of breeding status, such as copulation, courtship or territorial display, food carrying, and any observed fledglings. Data analysis of area searches and point counts included relative abundance, species richness, species diversity index, evenness, and dissimilarity (see 2007 Looking Downstream Report for description of data analysis methods and examples of standardized datasheets).



Figure 4-1. Bird search areas (same as spot map and nest search areas) and point count locations (PCL) in Poopenaut Valley.

4.2.2 Bird Spot Map Surveys

In 2010, we began conducting spot map surveys in the same avian search areas (Areas 1-5) as the area searches (Figure 4-1). We completed 4 visits in 2013. Because of comparatively low water flows in 2013, we did not encounter difficulty crossing the river, and were able to conduct a comprehensive survey of all five areas during each visit. During a single visit, we spent 40 to 90 minutes spot mapping each area, and finished by 12 pm. We adapted spot mapping methods from the standardized spot mapping protocol described by Bibby et al., (1992) and Ralph et al. (1993). The observer walked the area slowly, stopping for as long as necessary to mark every bird detected in its exact location on a map of the area. We recorded birds inside each area, and within 10 meters outside the area boundary, unless the boundary was the dividing line between areas. The observer distinguished males from females if possible, and marked their locations on the map using a different symbol. The observer also noted if males were singing (denoted by circling the male), recorded any and all territorial behavior including chasing or counter-singing (denoted by drawing dotted lines between individuals), and noted the direction of movement of individuals using arrows. During each visit, the observer recorded data on a new map.

At the end of the season, we prepared cumulative maps for the four focal species: Black-headed Grosbeak, Song Sparrow, Warbling Vireo, and Yellow Warbler in order to determine number of breeding pairs, territory sizes, and distribution. We digitized these maps and analyzed the detection data using geographic information system (ArcGIS) software. We mapped locations of individuals, pairs, and territorial behavior such as counter-singing and chasing. Measuring the size of bird territories has been done using various methods in the past (Hayne, 1949; Odun and Kuenzler, 1955; Suthers, 1960; Wiens et al., 1985). Traditionally, bird detections were marked on a map, and then clusters of detections were grouped into the smallest polygon in which no internal angle exceeded 180 degrees (Burgman and Fox, 2003). This method is known as minimum convex polygons (Mohr, 1947). Without the aid of computer analysis, minimum convex polygons remain the best choice because of their simplicity (Burgman and Fox, 2003). While this method provides useful insight into potential territories, it is susceptible to a lot of observer bias (Laver and Kelly, 2008; Nilsen et al., 2008; Worton, 1995). For each species, we plotted each pair's territory location and size using kernel density estimation which has been argued to be a more rigorous method of mapping home ranges (Borger et al., 2006; Naef-Daenzer, 1993; Seaman and Powell, 1996) than the minimum convex polygon method (Mohr, 1947; Silverman, 1986). The kernel density estimation produced a raster layer depicting detection densities. This layer estimated a probability density for the entire study area. To identify each territory belonging to a pair of birds, we used the kernel raster layer as a visual guide for creating a convex hull around groups of points. We used minimum registration number guidelines from I.B.C.C., (1970) to avoid selecting clusters with not enough detections. Each resulting convex hull represented an independent territory.

4.2.3 Bird Nest Search Surveys

Since 2010, we have conducted nest search surveys simultaneously with spot map surveys, and have used a standardized nest searching protocol (PRBO, 2001). Birds exhibiting probable or confirmed breeding activity such as foraging in pairs, carrying nesting material, or carrying food were followed as closely as possible in order to find nests, and their movements and behaviors were mapped onto the spot maps. For each nest, we recorded the nest location using a Global Positioning System (GPS) unit and recorded information about the status and location of the nest onto a nest card. During every subsequent site visit, we checked each nest and recorded the observed nest activity onto the nest card. At the end of the season, we transferred nest card information onto a nest record sheet and coded nest results.

4.2.4 Bird Mist-netting and Color-banding

Beginning in 2012, we captured birds using mist-nets, and in 2013 began color-banding captured Song Sparrows and Yellow Warblers. With few exceptions, we identified all captured birds to species, age, and sex; and banded them with USGS/BRD numbered aluminum bands. We collected the following data from all birds captured, including recaptures:

- capture code (newly banded, recaptured, band changed, unbanded)
- band number
- species
- age and how aged
- sex (if possible) and how sexed (if applicable)
- extent of skull pneumaticization
- breeding condition of adults (i.e., extent of cloacal protuberance or brood patch)
- extent of juvenal plumage in young birds
- extent of body and flight-feather molt
- extent of primary-feather wear
- presence of molt limits and plumage characteristics
- wing chord
- fat class and body mass
- date and time of capture
- station and net site where captured
- any pertinent notes

Our efforts were restricted to early morning hours, from local sunrise to approximately 0930. To capture the birds, we identified important movement corridors in each of the birds' territories and erected a 6-meter, 32 mm mesh mist net. Beneath the net, we hid an iPod equipped with a portable speaker and played a recording of the male song for up to approximately 20 minutes in order to attract the target species. We actively watched the mist-nets, and extracted any birds immediately after capture. We banded each individual with a USGS-issued silver aluminum band with a unique 9-digit identification number and a unique combination of color bands to allow individual identification during subsequent field observations. We also collected data following the Institute for Bird Populations' MAPS

(Monitoring Avian Productivity and Survivorship) protocol, including age, sex, breeding status, extent of body and flight feather molt, fat, wing chord length, and weight. Birds were released early with minimal data taken if they exhibited signs of stress.

In the event that birds other than Yellow Warblers or Song Sparrows flew into the net, we extracted and processed them as above, and banded them with a USGS silver aluminum band (if we had the proper size), but did not apply color-bands. All banding data were collected under permit no. 22423, administered by The Institute for Bird Populations (IBP). In accordance with the permitting requirements, IBP will send all electronically entered and proofed banding data to the USGS Bird Banding Laboratory at the Patuxent Wildlife Research Center, thereby contributing to a national long-term monitoring effort of birds.

4.3 Results

4.3.1 2013 Bird Area Searches

The seventh consecutive year of area search surveys in Poopenaut Valley took place during summer 2013 and comprised three separate visits (21 May, 31 May, and 12 June). Due to low water flow, all five search areas were accessible on each survey date. During the three visits, flow rates from the O'Shaughnessy Dam were 4.3, 2.8, and 4.4 cms (151, 99, and 157 cfs), respectively.

During area searches, we observed a cumulative total of 307 individual birds of 44 species in Poopenaut Valley in 2013. To account for the likelihood of duplicate observations of individual birds among visits, we estimated relative abundance to be 193 individual birds using the highest count from the three visits for each species (Table 4-1). The seven most frequently detected species, based on high counts, were Western Wood-Pewee (*Contopus sordidulus*) (15 individuals), Black-headed Grosbeak (14 individuals), Spotted Towhee (*Pipilo maculatus*) (14 individuals), Bullock's Oriole (*Icterus bullockii*) (11 individuals), Warbling Vireo, American Robin (*Turdus migratorius*), and Acorn Woodpecker (*Melanerpes formicivorus*) (10 individuals each). The five most frequently encountered species, based on gross totals, were Western Wood-Pewee (36 detections), Spotted Towhee, Black-headed Grosbeak (21 detections each), Warbling Vireo, and Yellow Warbler (20 detections each) (Table 4-1). Abundance totals are likely overestimates of actual numbers of individuals, as they do not control for bird movement between study areas throughout a survey morning and may reflect double-counted birds.

Table 4-1. Relative abundance of bird species detected by area searches in Poopenaut Valley, Yosemite National Park, in May – June 2013. Values reported are high counts for each species in each area across all three visits.

Species	Status	Search Area					Relative Abundance
		1	2	3	4	5	
Acorn Woodpecker		2		4	2	2	10
American Robin			3	2	3	2	10
Anna's Hummingbird			1	1	1	1	4
Belted Kingfisher				1		1	2
Blue-gray Gnatcatcher				1			1
Brown-headed Cowbird		1		1		1	3
Black-headed Grosbeak	RFS	1	3	3	3	4	14
Brown Creeper				2			2
Band-tailed Pigeon					1		1
Black-throated Gray Warbler			1	1	1		3
Bullock's Oriole			1	2	3	5	11
Bushtit			2		2		4
Canyon Wren				1			1
Cassin's Vireo		1	2	3	2		8
Common Merganser						2	2
Dark-eyed Junco				1	1		2
Dusky Flycatcher			1				1
Hairy Woodpecker						1	1
House Wren		1		2	1	1	5
Lazuli Bunting				4	2		6
Lesser Goldfinch			2			1	3
Mallard				2			2

MacGillivray's Warbler				1		1	
Mourning Dove		1	1			2	
Mountain Quail		1			2	3	
Nashville Warbler			1			1	
Northern Flicker		1	1	1	1	4	
Northern Rough-winged Swallow					2	2	
Pacific-slope Flycatcher			1			1	
Red-winged Blackbird		1				1	
Song Sparrow	RFS				4	4	
Spotted Sandpiper					1	1	
Spotted Towhee		1	4	1	6	2	14
Steller's Jay		1	1	1	4	1	8
Unidentified Woodpecker					1	1	2
Violet-green Swallow			1				1
Warbling Vireo	RFS			3	2	5	10
Western Kingbird					1		1
Western Scrub-Jay		2					2
Western Tanager			1	2	1	4	8
Western Wood-Pewee		2	1	4	3	5	15
Wrentit		1					1
White-throated Swift			6				6
Yellow Warbler	CSC, SSC, RFS		1	2	1	5	9
Relative Abundance		15	33	49	43	53	193

Bird indices from the wet meadow habitat in Search Area 3 had the highest species richness (27 species), diversity index ($H = 4.77$), and relatively high evenness ($J = 0.96$) (Table 4-2). The wet meadow areas averaged 35 detections (relative abundance) of 20 species, which is much less than the indices for the montane riparian area (Search Area 5) (53 detections of 22 species). This pattern is the opposite of last year's, in which the montane riparian zone averaged lower species richness and abundance than the wetland meadow areas. Of all five search areas, Search Area 5 had the most number of total detections (94 individual detections).

Table 4-2. Species richness, relative abundance, bird diversity, and evenness from area searches, by study area in Poopenaut Valley, Yosemite National Park, May - June 2013.

	Species Richness ⁺	Abundance Estimate*	Species Diversity Index*	Evenness*
Search Area 1 Wet Meadow	12	15	2.84	0.86
Search Area 2 Wet Meadow	18	33	3.38	0.89
Search Area 3 Wet Meadow	27	49	4.77	0.96
Search Area 4 Wet Meadow	22	43	4.36	0.97
Search Area 5 Montane Riparian	22	53	3.75	0.98

*For each species in a given area, the highest number of individuals for each species detected in the three visits is reported.

*For each area, the total number of species detected in all three area search visits is reported.

Analysis of area search survey data from Search Areas 1, 2, 3, 4, and 5 using the Bray-Curtis Dissimilarity Measure revealed that Areas 1 and 4 differed the most in community assemblage ($I_{BC} = 0.524$, Table 4-3), meaning they shared the least number of species in common. Areas 3 and 5 shared the highest degree of community similarity ($I_{BC} = 0.143$, Table 4-3), meaning they had similar species composition.

Table 4-3. Bray-Curtis Dissimilarity Matrix for bird assemblages by search area in Poopenaut Valley, Yosemite National Park, May - June 2013. Numbers enclosed in boxes indicate the least and most similar sites.

	Area 1	Area 2	Area 3	Area 4	Area 5
Area 1	0				
Area 2	0.429	0			
Area 3	0.286	0.333	0		
Area 4	0.524	0.280	0.360	0	
Area 5	0.412	0.333	0.143	0.357	0

4.3.2 2013 Bird Point Counts

The sixth year of point count surveys in Poopenaut Valley took place during 2013 and comprised three separate visits (21 May, 31 May, and 12 June). We were able to survey at both point count locations for all three visits due to low river flow. At North Poopenaut, we detected an average of 38.83 individuals of 24 total species; at South Poopenaut, we detected an average of 37.17 individuals of 24 species (Table 4-4). In total, 30 species were detected during point counts across all three visits.

Table 4-4. Raw abundance (total number of detections), relative abundance (mean individual detections), and species richness from point counts in Poopenaut Valley, Yosemite National Park, May-June 2013. Data include all detections, excluding flyovers.

Species	North Poopenaut		South Poopenaut	
	Total Individuals Detected	Relative Abundance	Total Individuals Detected	Relative Abundance
Acorn Woodpecker	5	1.67	4	2.00
American Robin	1	1.00	2	2.00
Brown-headed Cowbird	1	1.00	2	1.00
Black-headed Grosbeak	2	1.00	2	1.00
Brown Creeper			1	1.00
Bullock's Oriole			4	2.00
Canyon Wren	3	1.50		
Cassin's Vireo	2	1.00	4	2.00
Common Merganser	2	2.00		
Dusky Flycatcher	1	1.00	1	1.00
House Wren	1	1.00		
Lazuli Bunting	2	1.00	4	1.33
Lesser Goldfinch	3	3.00		
MacGillivray's Warbler			2	1.00
Mountain Quail	7	3.50	4	1.33
Northern Flicker	1	1.00	2	1.00
Northern Rough-winged Swallow	2	2.00	1	1.00
Red-breasted Nuthatch			1	1.00
Red-winged Blackbird	1	1.00		
Song Sparrow	2	1.00	2	2.00
Spotted Towhee	4	1.33	5	1.67
Steller's Jay	8	2.67	3	1.50
Unidentified Woodpecker			2	2.00
Warbling Vireo	5	2.50	5	1.67
Western Tanager	2	2.00	6	2.00
Western Wood-Pewee	8	2.67	9	3.00
White-headed Woodpecker			1	1.00
Wrentit	1	1.00		
White-throated Swift	1	1.00	2	2.00
Yellow Warbler	6	2.00	5	1.67
Abundance	71	38.83	74	37.17
Species Richness	24		24	

4.3.3 2013 Bird Spot Mapping

In 2013 we conducted the fourth consecutive year of spot mapping in Poopenaut Valley. We conducted four spot mapping visits: 26 April, 2 and 3 May, 9 and 10 May, and 16 and 17 May. Due to the observer's ability to cross the river and survey areas in both North and South Poopenaut, replicates of spot-mapping visits decreased by roughly half compared to 2012. A cumulative total of 411 birds of 51 species were detected in all five areas over all four visits. To account for possible duplicate observations among visits, we estimated relative abundance to be 229 individuals based on high counts for each species (Table 4-5).

Table 4-5. Species richness and relative abundance by search area using 2013 and 2012 spot-mapping data in Poopenaut Valley, Yosemite National Park. Data include all detections, excluding flyovers.

2013

	<i>Area 1</i>	<i>Area 2</i>	<i>Area 3</i>	<i>Area 4</i>	<i>Area 5</i>	<i>Total</i>
Number of visits	4	4	4	4	4	
Species Richness	25	28	23	22	29	51
Relative Abundance	43	45	43	35	63	229

2012

	<i>Area 1</i>	<i>Area 2</i>	<i>Area 3</i>	<i>Area 4</i>	<i>Area 5</i>	<i>Total</i>
Number of Visits	3	3	9	8	9	
Species Richness	24	24	30	33	33	51
Relative Abundance	34	45	92	84	72	327

In addition to species richness and relative abundance, spot mapping also yielded detailed results for the breeding biology of four riparian focal species: Black-headed Grosbeak, Song Sparrow, Warbling Vireo, and Yellow Warbler.

Black-headed Grosbeak. We detected Black-headed Grosbeaks in Poopenaut Valley during the first survey on 26 April 2013, during which time we observed a pair, as well as several males engaging in territorial behavior. Through spot-mapping, we identified 6 potential territories in Areas 3 and 5. It was difficult to confidently determine territory sizes because the birds often engaged in long flights across multiple survey areas. Individual detections throughout the breeding season averaged 5 individuals, but the highest daily count was 12 individuals on 21 May. Females were observed with nesting material as early as 2 May. Two Black-headed Grosbeak nests were found on 16 May and 21 May, respectively, both in the riparian corridor in Area 5. The fates of both nests are unknown, but it is likely that at least one fledged, because on 19 June, we observed a pair of adults feeding a fledgling. We also captured a juvenile Black-headed Grosbeak in a target net on 13 June in the dry creek bed area between Areas 3, 4, and 5C.

Song Sparrow. We detected three pairs of Song Sparrows during the first survey on 26 April 2013. All three pairs were observed along the riparian habitat of areas 5B and 5C, and were engaged in territorial behavior and counter-singing. One female was observed collecting nesting material from the bark of a tree. Also on that date, we observed a single male singing along a small willow stand on the far north side of Area 1, but no subsequent detections of Song Sparrows were made in that area. Three total territories were identified along the riparian corridor, each including observations of females carrying nesting material. We observed another female carrying nest material and located her nest on 2 May. Nest success was inconclusive, and no detections of juvenile birds were made until 30 July, when two juveniles were detected—possibly too late in the season to assume that hatch-year birds detected were local to the area (Figure 4-8 A).

Warbling Vireo. We first detected a total of 5 male Warbling Vireos during the first survey on 27 April 2013. Males were establishing territories by counter-singing. First detection of a female was made on 2 May. On 17 May, a female was observed making scolding begging calls to her mate, and this behavior was observed during surveys throughout the following month. On 26 June, we found a Warbling Vireo nest containing 2 nestlings.

Yellow Warbler. Yellow Warblers arrived later in Poopenaut Valley than the other focal species, consistent with observations from 2011 and 2012. We detected three males singing on 2 and 3 May, and more active counter-singing and territory establishment along the riparian corridor on 9 May. We encountered the first female on 9 May. On 17 May, we observed a female building a nest with willow or cottonwood down. On 18 June, we found two more nests, one with eggs and one with nestlings. Four total territories were confirmed. On 11 July, two separate pairs of Yellow Warblers were observed feeding fledglings.

We mapped breeding territories of Black-headed Grosbeak, Song Sparrow, Warbling Vireo, and Yellow Warbler using spot-mapping data (Figure 4-2). Most of the territories were located along meadow edges, especially where willows were present. We confirmed 4 Black-headed Grosbeak territories and postulated 2 more (Figure 4-3), confirmed 3 Song Sparrow territories (Figure 4-4), confirmed 3 and postulated 1 Warbling Vireo territories (Figure 4-5), and confirmed 4 Yellow Warbler territories (Figure 4-6). We used ArcGIS to map all detections of individual birds of each focal species and used a kernel density visualization to determine likely territory boundaries. However, this method of determining territory size and boundary is less informative given a low number of detections; therefore, we can only postulate territory existence and extent for certain individuals and those more poorly supported territories are denoted with hashed lines rather than solid lines.

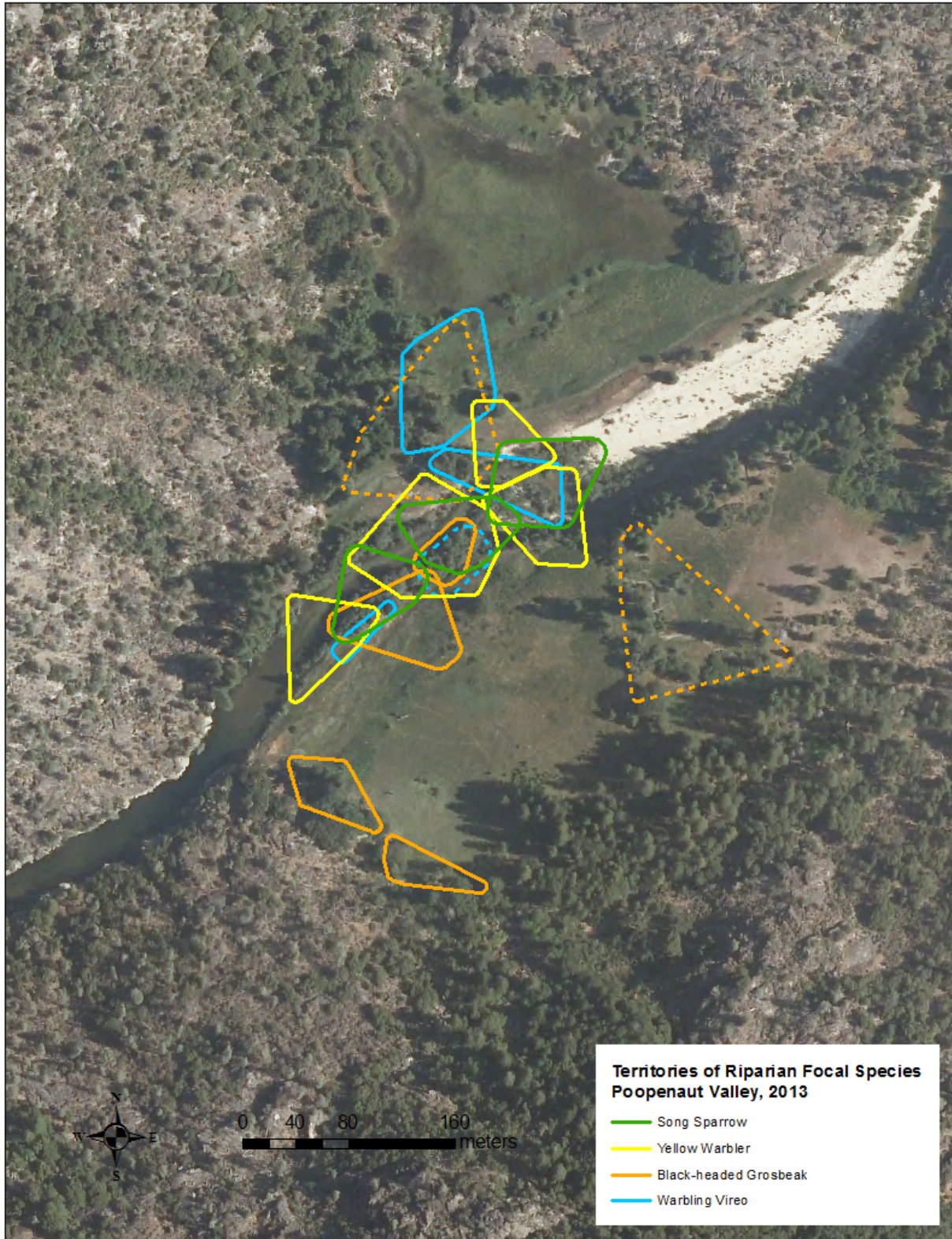


Figure 4-2. Yellow Warbler (YEWA), Black-headed Grosbeak (BHGR), Warbling Vireo (WAVI), and Song Sparrow (SOSP) breeding territories in Poopenaut Valley, 2013.

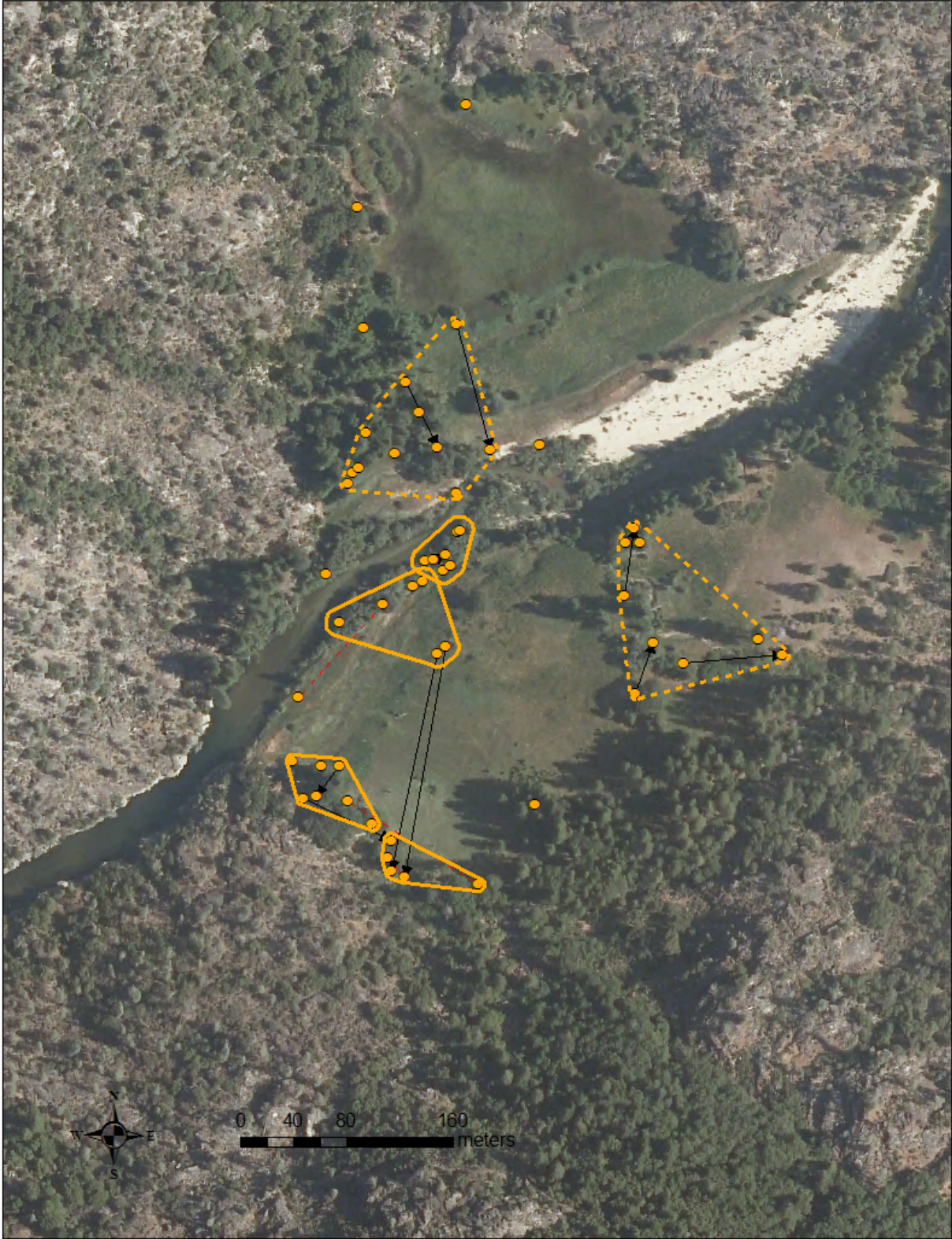


Figure 4-3. Black-headed Grosbeak territories in Poopenaut Valley, 2013. Black arrows signify individual movement; red dotted lines signify counter-singing events between two male birds.

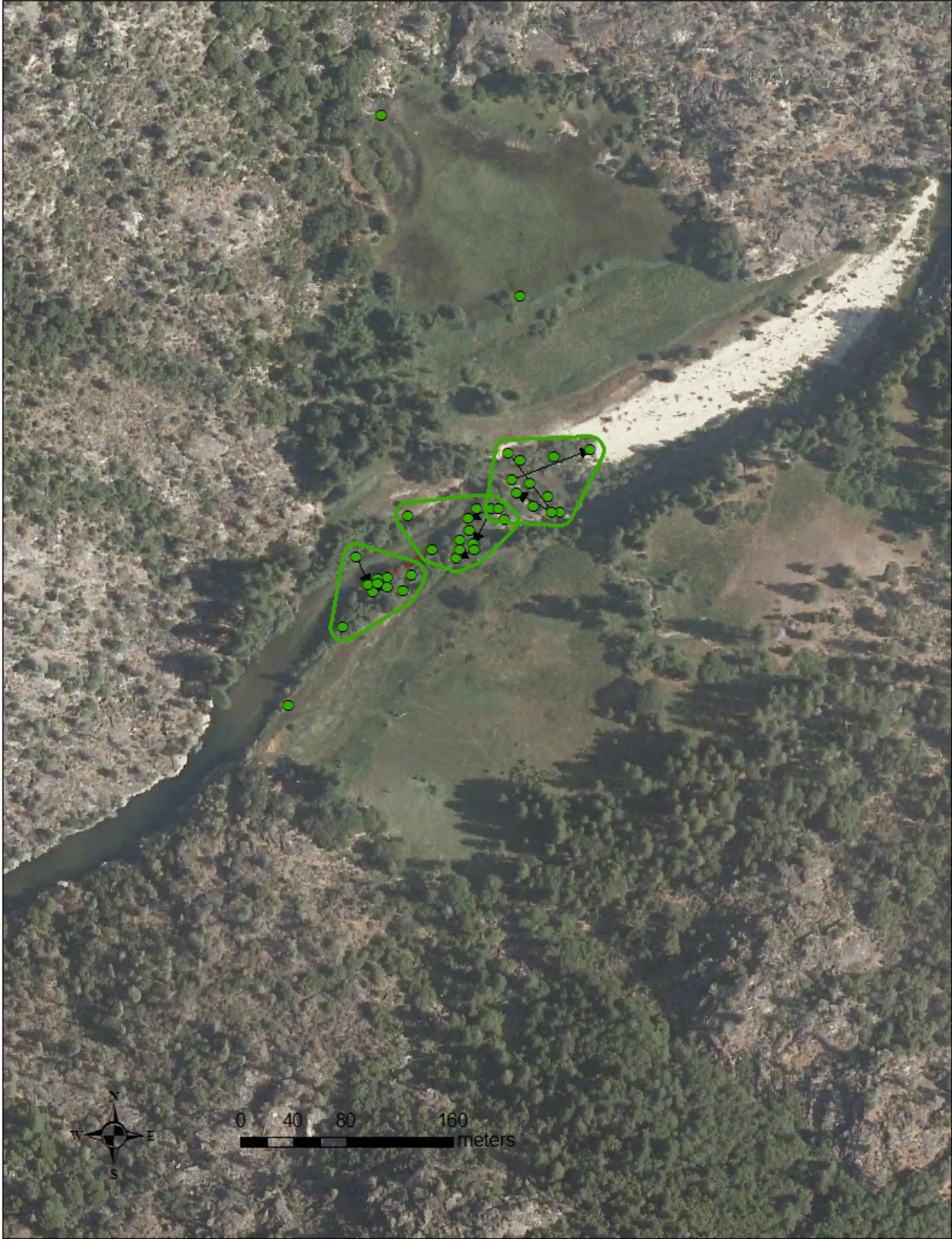


Figure 4-4. Song Sparrow territories in Poopenaut Valley, 2013. Black arrows signify individual movement; red dotted lines signify counter-singing events between two male birds.



Figure 4-5. Warbling Vireo territories in Poopenaut Valley, 2013. Black arrows signify individual movement; red dotted lines signify counter-singing events between two male birds.

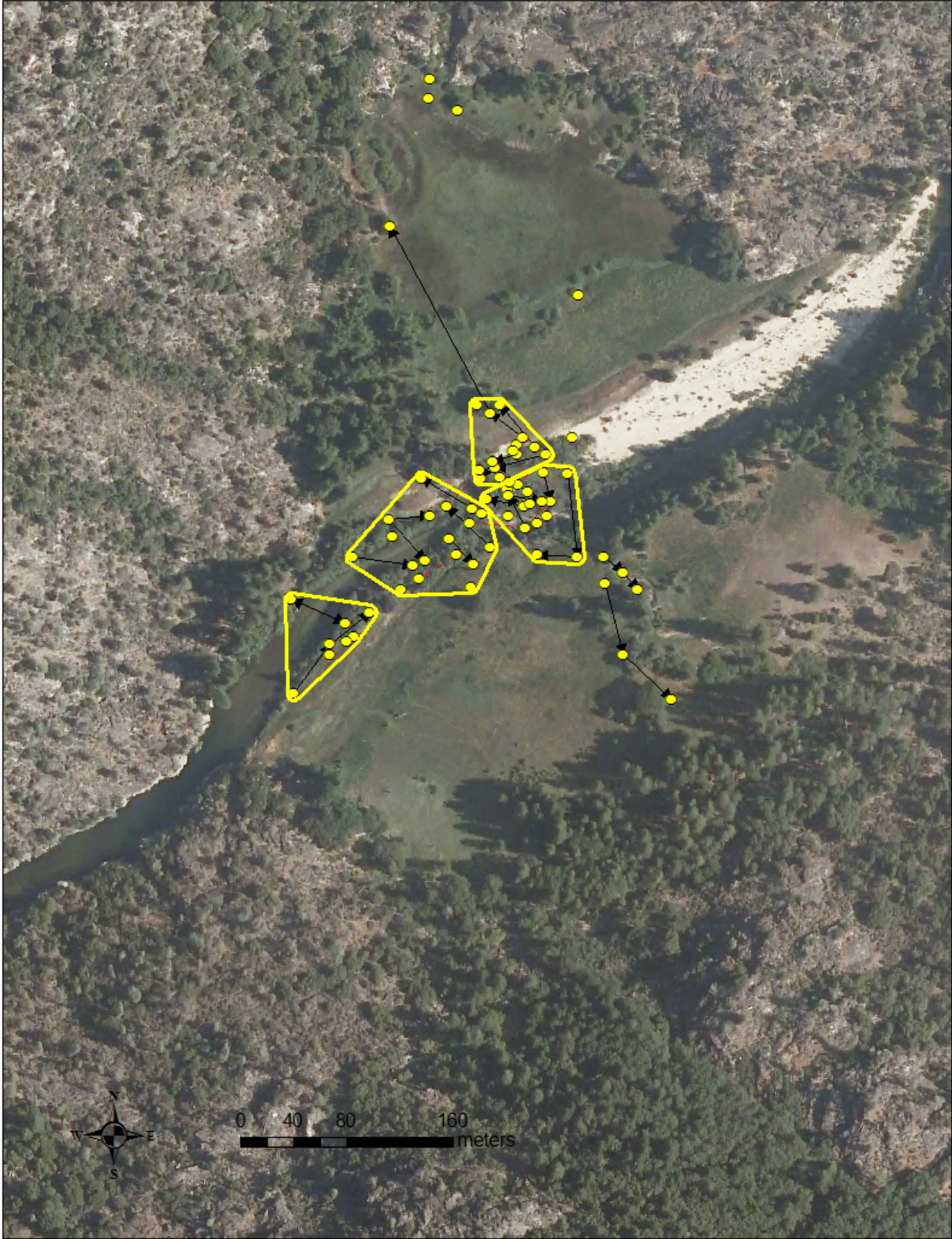


Figure 4-6. Yellow Warbler territories in Poopenaut Valley, 2013. Black arrows signify individual movement; red dotted lines signify counter-singing events between two male birds.

4.3.4 2013 Bird Nest Searching

In 2013, we conducted the fourth consecutive year of nest searching in Poopenaut Valley. We conducted nest searches opportunistically while focusing on other surveys on the following dates: 2 May, 3 May, 9 May, 16 May, 21 May, 30 May and 12 June. Concerted nest searching visits were made to Poopenaut Valley on 18 June, 19 June, 26 June, and 11 July. Most nest searching was conducted in the morning when bird activity was highest.

We located 17 nests of 11 species (Table 4-6) and plotted their locations using ArcGIS (Figure 4-7). We located seven nests belonging to focal species: one Warbling Vireo, two Black-headed Grosbeak, three Yellow Warbler, and one Song Sparrow nest. We also observed nesting behavior (nest-material carries, parental visits to fledglings) but did not confirm nest locations for the following species: Common Merganser (*Mergus merganser*), Cassin's Vireo (*Vireo cassinii*), Western Tanager (*Piranga ludoviciana*), Lesser Goldfinch (*Carduelis psaltria*), Red-winged Blackbird (*Agelaius phoeniceus*), and Belted Kingfisher (*Megaceryle alcyon*).

Table 4-6. Nests confirmed during 2013 nest searching in Poopenaut Valley, Yosemite National Park.

Species	Nest located	Nesting confirmed but not located
Acorn Woodpecker	1	
American Robin	1	
Black-headed Grosbeak ¹	2	
Bullock's Oriole	2	
Cassin's Vireo		1
Hairy Woodpecker	1	
House Wren	1	1
Mallard		1
Northern Flicker	1	1
Northern Rough-winged Swallow		1
Song Sparrow ¹	1	
Warbling Vireo ¹	1	
Western Tanager		1
Western Wood-pewee	3	
Yellow Warbler ¹	3	

¹Riparian Focal Species

In 2013, all seventeen nests were discovered between 2 May and 11 July, with the first three weeks in May being the most active nest-building period.

Acorn Woodpecker: Found 2 May in the afternoon by watching multiple individuals enter the same nest cavity in a large snag at the northernmost end of Area 1 about 40 feet high. No activity detected at nest site. **Fate unknown**—site was potentially a winter roost rather than a nest. UTM 11S 0252018 4200962.

American Robin: Found 16 May during nest building. We observed the female carrying lichen and bark to nest. Nest was located on an upper branch of a young Ponderosa Pine on the southernmost forested edge of Area 3. We observed incubation by the female on 31 May, but no activity or detection of the adult pair afterward. **Fate unknown**. UTM: 11S 0252090 4200361.

Black-headed Grosbeak:

Nest 1. Found 16 May during building stages by watching female use small twigs to construct a nest near the top of a willow on the riverbank in area 5C, roughly 8 meters high. On 30 May, the male was observed bringing food to the incubating female, possibly on eggs or nestlings. On 19 and 26 June, no activity was observed on the nest, but a male and female were bringing food to a fledgling near the nest area. **Fate: probable fledge**. UTM: 11S 0252039 4200609.

Nest 2. Found 21 May by observing the female visit the nest and stay, presumably to incubate eggs. Nest was built at the top of a willow tree about 9 meters high along the riparian corridor in Area 5C. No subsequent activity was observed during nest checks. **Fate: unknown**. UTM: 11S 0251977 4200561.

Bullock's Oriole:

Nest 1: Found 3 May during building stage. Female was building nest with long blades of grass and gossamer. Site was toward the top of a tall willow tree on the riverbank in Area 5C, about 8 meters high. No subsequent activity. **Fate: unknown**. UTM: 11S 0252069 4200644.

Nest 2: Found 3 May during building stage. Female and male were observed returning to the same clump of mistletoe in a large oak tree between Areas 3 and 4, presumably with nesting material. On 21 May, the male was observed visiting the nest repeatedly. On 31 May, both the male and female were observed bringing food items to the nest. We did not confirm nest success via observations of fledglings. **Fate: probable fledge**. UTM: 11S 0252182 4200494.

Hairy Woodpecker (Picoides villosus): Nest was found on 3 May in the initial stages of drilling, with both male and female drilling and calling at the cavity. The cavity was not yet large enough to accommodate a bird. Cavity is located in a dying branch of a large cottonwood tree approximately 10 meters from the north riverbank in Area 2. On 9 May, we observed the male call softly at the cavity before cautiously entering. The male and the female switched places after 10 minutes. On 31 May, no activity outside the nest was detected, but begging calls from inside the nest, presumably from the female, were heard. No subsequent activity. **Fate: unknown**. UTM: 11S 0252046 4200663.

House Wren (Troglodytes aedon): Nest found on 2 May by observing parental visits to the nest with building material. Nest was located in an established cavity in a short, stumpy snag about 1.2 meters from the ground, within the river plain in area 5C. On 9 May, both the male and female were observed nearby the nest, the male singing. On 9 and 16 May, the male was observed singing nearby, but saw no sign of the female. No subsequent activity was observed. **Fate: unknown; probable fail**. UTM: 11S 0251989 4200564.

Northern Flicker (Colaptes auratus): Nest was found on 10 May during building stage. We observed drumming from inside a cavity in a cottonwood tree at the edge of the sandy beach in Area 2, and the pair switching spots from within. Drumming was heard inside the cavity again on 16 May, and on 31 May, we observed the female look out from inside the cavity and then retreat inside again. After that, no more activity was detected. **Fate: unknown**. UTM: 11S 0252211 4200742.

Song Sparrow: Nest found on 2 May by female carrying nesting material to a willow on the south riverbank of Area 5C, in a well-hidden, vegetated portion of the tree about 8 meters high. On 3 May, the female was observed again carrying nest material with the male singing nearby. On 9 May and 16 May, both parents were observed nearby, foraging busily near the nest, with the male occasionally singing and the female occasionally visiting the nest tree. After that, no further activity was observed. **Fate: unknown**. UTM: 11S 02151983 4200568.

Warbling Vireo: Nest found on 26 June, via food carries by parents to large nestlings. Nest is located at the periphery of a large oak tree on the south riverbank in Area 5C, approximately 3 meters off the ground. On 11 July, we observed no sign of the fledglings or their parents. **Fate: probable fledge**. UTM: 11S 0251983 4200551.

Western Wood-Pewee:

Nest 1: Found 13 June during building stage. Parent was observed building with small grasses and twigs; nest was a neat cup built flush with a horizontal branch of a cottonwood tree, approximately 8 meters high. No subsequent activity was observed. **Fate: unknown**. UTM: 11S 0252171 4200564.

Nest 2: Found 18 June. Female was observed incubating the nest, which was a neat cup built in the crotch of two branches of a small willow tree in the river plain of Area 5C, just over 3 meters high. On 19 and 26 June, the female was incubating eggs, confirmed by video footage taken of the nest cup on 26 June. On 11 July, the nest was empty. **Fate: Fail**. UTM: 11S 0252075 4200607.

Nest 3: Found 11 July. Parent was observed feeding large nestling in nest. Nest was built on a horizontal branch of a willow overhanging the river, in Area 5C, just less than 3 meters off the ground. It is uncertain whether the nestling was a Western Wood-Pewee or a Brown-headed Cowbird (*Molothrus ater*). In late June, we observed a pair of Wood-Pewees in this area mobbing a Cowbird but did not locate the nest at that time. **Fate: unknown**. UTM: 11S 0252031 4200601.

Yellow Warbler:

Nest 1: Found 16 May. Female was building nest with willow down. Nest cup appeared almost complete, and was located about 7 meters high in the top of a willow tree on the south riverbank in Area 5C. On 31 May, we were unable to locate the nest in the tree, and remnants of what appeared to be a Yellow Warbler nest (soft cup made of willow down, hair, and tiny twigs) was on the beach below the nest tree. **Fate: fail**. UTM: 11S 0252072 4200643.

Nest 2: Found 18 June by observing two parental visits to feed two nestlings inside. Nest was located in a well-hidden, vegetated willow about 15 meters from the south riverbank in area 5C, about 6 meters off the ground. On 11 July, the color-banded male associated with that territory was observed feeding nestlings in the vicinity. **Fate: probable fledge.** UTM: 11S 0251967 4200544.

Nest 3: Found 18 June. Female was observed making visits to the nest to incubate. The nest was built between two crossed branches of a willow tree in the river plain of Area 5C, roughly 5 meters high (Figure 4-8 B). The female was wary to approach the nest during subsequent nest checks on 19 and 26 June. On 26 June, we took video footage of the nest to confirm activity. On 11 July, we observed the color-banded female associated with that nest feeding one fledgling. **Fate: fledge.** UTM: 11S 0252099 4200611.

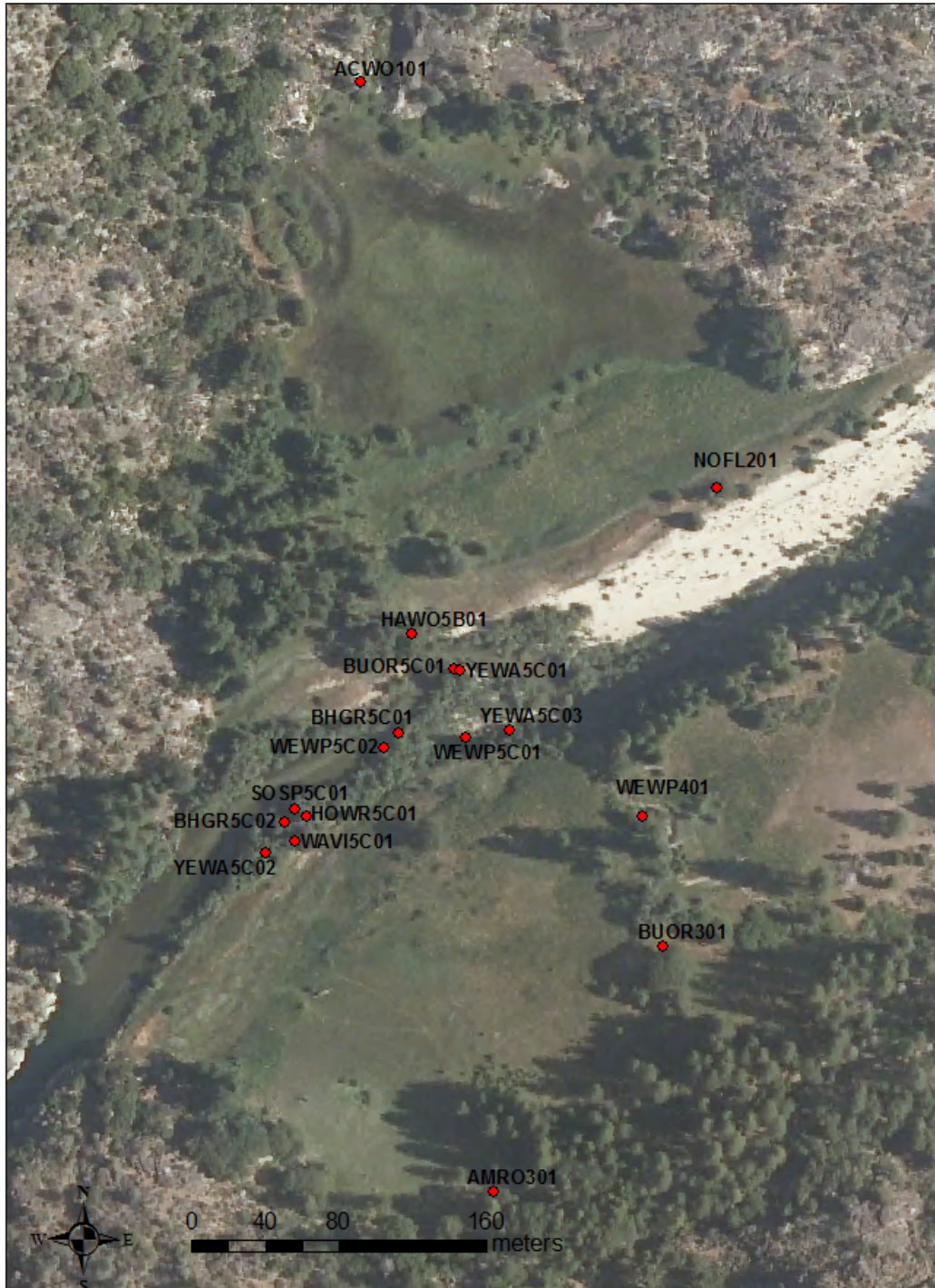


Figure 4-7. Locations of 17 bird nests in Poopenaut Valley, 2013. Each nest is marked with the species alpha code, followed by the numbered search area (1-5), followed by that species nest number. Alpha codes represent the following species common names: ACWO=Acorn Woodpecker, AMRO=American Robin, BHGR=Black-headed Grosbeak, BUOR=Bullock’s Oriole, HAWO=Hairy Woodpecker, HOWR=House Wren, NOFL=Northern Flicker, SOSP=Song Sparrow, WAWI=Warbling Vireo, WEWP=Western Wood-Pewee, and YEWA=Yellow Warbler.

4.3.5 2013 Riparian Focal Species (RFS) Color-banding

Soon after locating their respective territories in 2013, we began target-netting and color-banding individual Yellow Warblers and Song Sparrows. We set up nets opportunistically where we had observed pairs of Yellow Warblers and Song Sparrows frequenting the area (Figure 4-8 C, Table 4-7). Target-netting occurred during 5 total visits on 26 April, 2 May, 13 June, 18 June, and 19 June. In total, we color-banded 4 Song Sparrows and 4 Yellow Warblers of 3 males and 1 female of each species (Figure 4-9 A-C). Each of the individual birds exhibited active breeding condition, showing presence of a cloacal protuberance for males, and presence of a brood patch for females. Two of the Song Sparrows and two of the Yellow Warblers were recaptured from the banding effort in Poopenaut Valley in 2012, indicating breeding site fidelity in both year-round residents (Song Sparrows) and migrants (Yellow Warblers) in Poopenaut Valley. Each bird was observed in the field several times after banding, identified by its color band combination, and showed no sign of lasting stress. We were able to assign territories to each color-banded individual and track reproductive success or failure.

In addition to targeted species, we captured 4 Black-headed Grosbeaks (2 females, 1 male, and 1 juvenile) and 1 male Lazuli Bunting (*Passerina amoena*) on 13 June (Table 4-8). All adult birds were in active breeding condition.



Figure 4-8. (A) Juvenile Song Sparrow detected on 30 July, photo by Brian Whitehead; (B) Yellow Warbler nest discovered in willow shrub, photo by Brian Whitehead; (C) Mist-net set up adjacent to river, with audio-lure on ground beneath net.

Table 4-7. Target-netting locations in Poopenaut Valley.

NET #	UTM EASTING	UTM NORTHING	NET #	UTM EASTING	UTM NORTHING
1	252164	4200655	6	252041	4200606
2	252007	4200569	7	252155	4200563
3	251978	4200572	8	252172	4200550
4	252008	4200697	9	251946	4200520
5	252089	4200642			

Table 4-8. Banding summary of target-netting in Poopenaut Valley, 2012-2013.

DATE	CAPTURE TIME	NET	NEW/ RECAP	BAND NUMBER	SPECIES NAME	AGE	SEX	COLOR BANDS
					BLACK-THROATED GRAY			
7/10/2012	915	-	N	269082303	WARBLER	AHY	F	
7/10/2012	630	-	N	269082295	HOUSE WREN	AHY	U	
7/10/2012	550	-	N	255126272	SONG SPARROW	AHY	M	
7/10/2012	550	-	N	255126273	SONG SPARROW	AHY	M	
7/10/2012	630	-	N	255126274	SONG SPARROW	AHY	M	
7/10/2012	720	-	N	255126275	SONG SPARROW	AHY	M	
					WESTERN WOOD-			
7/10/2012	610	-	N	269082294	PEWEE	AHY	M	
					WESTERN WOOD-			
7/10/2012	730	-	N	269082300	PEWEE	AHY	U	
					WESTERN WOOD-			
7/10/2012	750	-	N	269082302	PEWEE	AHY	F	
7/10/2012	630	-	N	269082296	YELLOW WARBLER	SY	F	
7/10/2012	630	-	N	269082297	YELLOW WARBLER	ASY	M	
7/10/2012	700	-	N	269082298	YELLOW WARBLER	ASY	M	
7/10/2012	720	-	N	269082299	YELLOW WARBLER	SY	F	
7/10/2012	740	-	N	269082301	YELLOW WARBLER	AHY	M	
4/26/2013	820	1	R	255126275	SONG SPARROW	AHY	M	YY/SG
4/26/2013	950	2	R	255126274	SONG SPARROW	AHY	M	GG/YS
5/2/2013	710	3	N	225130775	SONG SPARROW	AHY	F	GR/TS
5/2/2013	710	3	N	225130776	SONG SPARROW	AHY	M	RY/ST
					BLACK-HEADED			
6/13/2013	920	7		UNBANDED	GROSBEAK	AHY	F	
6/13/2013	940	7	N	185128983	LAZULI BUNTING	ASY	M	
6/13/2013	630	5	N	263019801	YELLOW WARBLER	AHY	F	TT/YS
6/13/2013	820	6	R	269082298	YELLOW WARBLER	ASY	M	RR/GS
					BLACK-HEADED			
6/14/2013	940	7	N	UNBANDED	GROSBEAK	AHY	F	
					BLACK-HEADED			
6/15/2013	940	7	N	UNBANDED	GROSBEAK	ASY	M	
					BLACK-HEADED			
6/16/2013	940	7	N	UNBANDED	GROSBEAK	HY	U	
6/18/2013	640	8	R	269082301	YELLOW WARBLER	AHY	M	YY/GS
6/19/2013	710	9	N	263019802	YELLOW WARBLER	AHY	M	YT/YS

Age Code Key: HY=Hatching Year, AHY=After Hatching Year, SY=Second Year, ASY=After Second Year
 Color Band Key: G=Green, R=Red, S=Silver, T=Turquoise, Y=Yellow

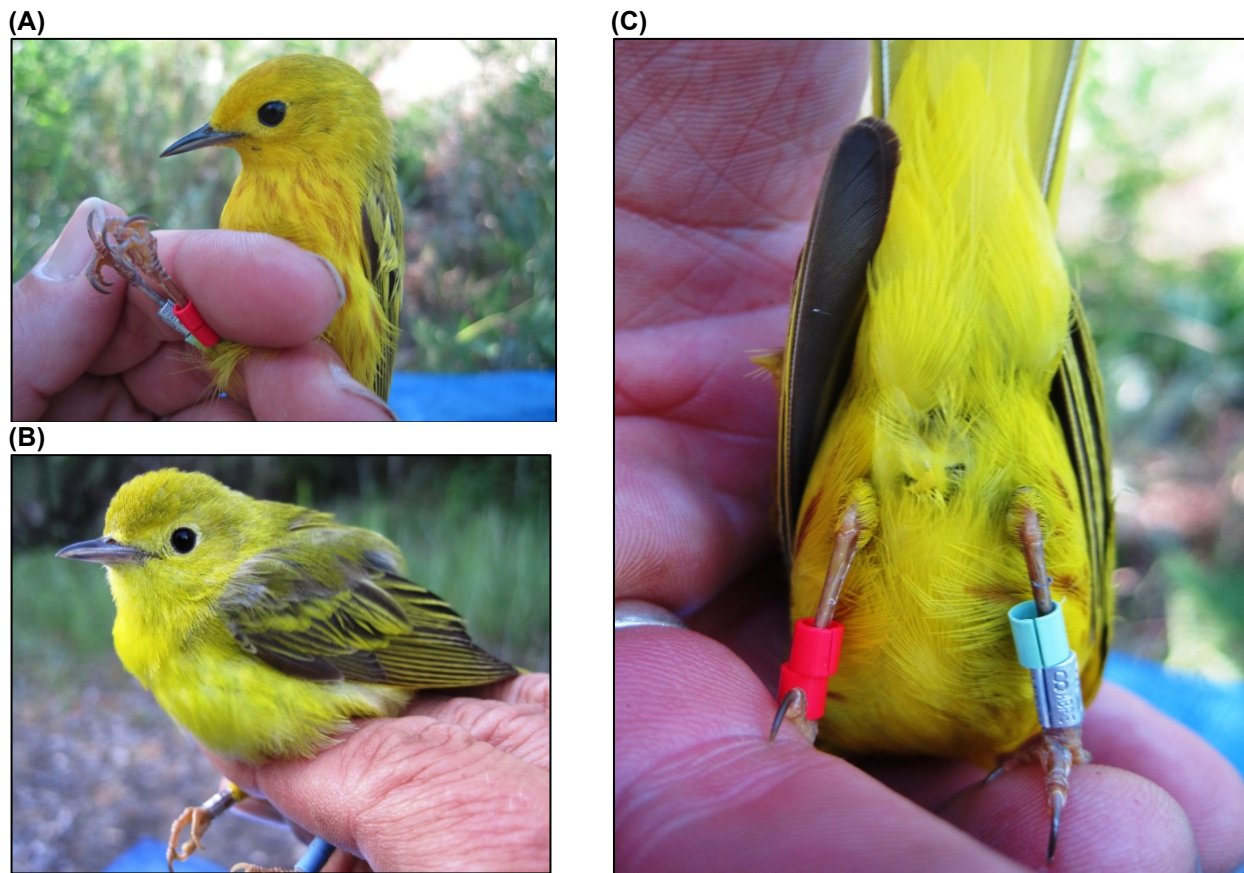


Figure 4-9. (A) Color-banded male Yellow Warbler and (B) color-banded female Yellow Warbler in Poopenaut Valley, 2013. (C) Bands are recorded top-to-bottom, left-to-right (e.g., Red Red / Turquoise Silver).

4.3.6 2013 Breeding Bird Summaries

Data collected during spot mapping and nest searching in 2011-2013 were used to calculate dates pertaining to arrival on the breeding ground, initiation of breeding, and fledging young for Riparian Focal Species (Table 4-9). These data showed that several species initiated breeding in late April or early May, when Tuolumne River levels were still artificially low. In 2013, detailed observations from 6 nests in particular contributed toward refining specific breeding chronology dates (Table 4-10).

Table 4-9. Preliminary life history breeding schedules for four Riparian Focal Species in Poopenaut Valley, Yosemite National Park, 2011-2013. Dates reflect earliest observed behavior pertaining to each activity, except where marked with an asterisk, indicating a hypothetical calculation based on known breeding observations and published life-history information.

YELLOW WARBLER			
Resident/Migratory	Migratory		
Site Fidelity	High		
Feeding type/food source	Insects and other arthropods; gleaning, sallying, hovering		
Nesting strata	Often contains heavy understory brush for nesting and tall trees for foraging and singing		
Nesting location	0.60 to 4.90 m above ground in shrub or deciduous sapling		
Capable of 2+ clutches?	One brood (3-6 eggs) normally reared; second brood rarely attempted		
	2011	2012	2013
Males arrive	2 May	3 May	2 May
Females arrive	5 May	12 May	9 May
Territory establishment	4 May	12 May	9 May
Females begin nesting	12 May ₁	-	17 May
Fledglings leave nest	3-10 June	-	12 June* to 11 July

₁Active nest 12 May 2011

SONG SPARROW			
Resident/Migratory	Resident		
Site fidelity	High		
Feeding type/food source	During breeding, primarily insects and other small invertebrates; some seeds and fruit		
Nesting strata	Nests commonly 0–4 m, mostly on ground under grass tuft or shrub; wet meadows and margins of ponds, lake and slow-moving streams		
Nesting location	Ground cover, low in grass and shrubs		
Capable of two clutches?	Yes		
	2011	2012	2013
Males arrive	28 April	27 April	26 April
Females arrive	28 April	27 April	26 April
Territory establishment	28 April	27 April	26 April
Females begin nesting	-	27 April ₁	26 April
Fledglings leave nest	-	20 May to 26 May	24 May*

₁Nest materials carried on 27 April 2012

BLACK-HEADED GROSBEAK			
Resident/Migratory	Migratory		
Site fidelity	Unknown		
Feeding type/food source	Gleans animal matter, primarily insects and spiders, and vegetable matter, including cultivated fruit and weed seeds. Most forage on foliage, twigs, branches, and in the air		
Nesting strata	In outer branches of deciduous trees, cottonwoods, willows, and other hardwoods that margin rivers and streams, also in oak-conifer forest. Occupies diverse habitats		
Nesting location	Shrub, canopy, favors meadows, clearings, and extensive edge		
Capable of two clutches?	No; clutch 2-5 eggs		
	2011	2012	2013
Males Arrive	28 April	27 April	26 April
Females Arrive	5 May	3 May	26 April
Males define territories	28 April	3 May	26 April
Females begin nesting	-	11 May ₁	2 May
Fledglings leave nest	-	4 June to 13 June	29 May* to 13 June

₁Active nest 11 May 2012

WARBLING VIREO			
Resident/Migratory	Migratory		
Site fidelity	Unknown		
Feeding type/food source	Highly plastic, primarily glean from twigs in broad leaf tree-tops for insects throughout the year, some fruit in winter		
Nesting strata	In forked lateral limbs of tree periphery, prefer cottonwood, alders, and aspens that line streams		
Nesting location	Canopy, tall, primarily coniferous trees, 7m or higher		
Capable of two clutches?	Yes, two considered normal; clutch 3-5 eggs		
	2011	2012	2013
Males Arrive	28 April	27 April	26 April
Females Arrive	28 April	27 April	2 May
Males define territories	28 April	27 April	26 April
Females begin nesting	-	11 May ₁	17 May ₂ , 25 May*
Fledglings leave nest	-	6 June to 18 June	30 June*

₁Active nest 11 May 2012, two more on 21 May 2012 ₂Female begging behavior to male observed on 17 May 2013, 25 May 2013 back-calculated as likely nest initiation date for Warbling Vireo nest that fledged on 30 June.

Table 4-10. Nest data for Riparian Focal Species in Poopenaut Valley, Yosemite National Park, 2013. Dates of building, egg-laying, and fledging are approximate, and marked with an asterisk (*) when they reflect front- or back-calculations rather than direct observations. Fledge date is hypothetical except for confirmed successful nests. Calculations are made from date of direct observation, and in the absence of multiple visits, the observation date is assumed to be the midpoint of the nest status.

NEST NAME	UTM EASTING	UTM NORTHING	ELEVATION (M)	CALCULATED NEST HEIGHT FROM GROUND (M)	DATE FOUND	DATE OF BUILDING	DATE OF EGG LAYING	DATE OF HATCHING	DATE OF FLEDGING	FATE
BHGR5C01	252039	4200609	1123	8	5/16	5/16	5/20*	5/30*	6/12*	fledge
BHGR5C02	251977	4200561	1114	11	5/21	5/12*	5/21	5/31*	6/13*	unknown
SOSP5C01	251983	4200568	1122	8	5/2	5/2	5/9*	5/28*	6/7*	unknown
YEWA5C01	252072	4200643	1122	15	5/16	5/16	5/18*	6/2*	6/13*	fail
YEWA5C02	251967	4200544	1119	7	6/18	6/4*	6/8*	6/12*	6/22*	fledge
YEWA5C03	252099	4200611	1113	12	6/18	6/6*	6/14	6/29*	7/9*	fledge

4.3.7 2007-2013 Cumulative Breeding Bird Summaries

Out of 104 species detected during 2007-2013 area searches, 2008-2013 point counts, 2010-2013 spot mapping, 2013 nest searching, and 2013 incidental observations, we confirmed 22 breeding species, detected 39 probable breeding species, 15 possible breeding species, and 28 unlikely breeding species in all study areas and points combined. Of these, 7 are riparian focal species (Black-headed Grosbeak, Song Sparrow, Spotted Sandpiper (*Actitis macularia*) Warbling Vireo, Wilson's Warbler, Yellow-breasted Chat (*Icteria virens*), and Yellow Warbler (RHJV, 2004); 2 are California Species of Concern (Yellow Warbler and Yellow-breasted Chat); 2 are nest predators [Steller's Jay (*Cyanocitta stelleri*) and Western Scrub-Jay (*Aphelocoma californica*)], and 1 is an invasive brood-parasite, Brown-headed Cowbird (Table 4-11).

Table 4-11. List of 104 bird species detected and their breeding status from area search (AS), point count (PC), spot map (SM), and nest searching (NS) surveys, or incidental observations (I), in Poopenaut Valley, Yosemite National Park, April – July, 2007 to 2013. New 2013 species additions indicated in bold print.

Species	Unlikely	Possible	Probable	Confirmed	Survey Type
Acorn Woodpecker				ON, T	SM, AS, PC
American Coot	X				SM
American Crow	X				SM
American Dipper			S		SM
American Robin				ON, T, CF, S, CN	SM, AS, PC
Anna's Hummingbird				CN, T	SM, AS, PC
Ash-throated Flycatcher		X			SM, AS
Bald Eagle	X				SM
Band-tailed Pigeon		X			SM, AS
Belted Kingfisher				CN	SM, AS
Bewick's Wren			S		SM, AS
Black Phoebe			S		SM, AS, PC
Black-headed Grosbeak				CF, P, T, CN, ON, F	SM, AS, PC
Black-throated Gray Warbler			S, P, T		SM, AS
Blue-gray Gnatcatcher			S		SM, AS
Brewer's Blackbird			S, P		SM, AS
Brown Creeper			S		SM, AS, PC
Brown-headed Cowbird			S		SM, AS, PC
Bullock's Oriole				ON, CN, S, P, F, CF	SM, AS, PC
Bushtit			P		SM, AS
California Towhee			S, P		SM, AS
Calliope Hummingbird			T, P		AS

Canada Goose			S, P	SM
Canyon Wren			S, P, T	SM, AS, PC
Cassin's Finch	X			SM
Cassin's Vireo			ON, T, S, P	SM, AS, PC
Cedar Waxwing	X			AS
Chipping Sparrow			S, CN, P, T	SM, AS, PC
Cliff Swallow	X			SM
Common Merganser			P	SM, AS, PC
Common Poorwill		S		I
Common Yellowthroat	X			SM
Dark-eyed Junco			S, P	SM, AS
Downy Woodpecker		X		SM, AS
Dusky Flycatcher			S, P	SM, AS, PC
Eared Grebe	X			
Evening Grosbeak	X			AS
Golden Eagle	X			
Golden-crowned Kinglet			S	SM
Gray Flycatcher	X			SM, AS, PC
Great Egret	X			SM
Great Horned Owl	X			I
Hairy Woodpecker			P, D	SM, AS, PC
Hammond's Flycatcher			S	SM
Hermit Warbler	X			SM
House Wren			ON, T, S, P	SM, AS, PC
Hutton's Vireo		X		AS
Indigo Bunting	X			NS
Lark Sparrow	X			SM

Lawrence's Goldfinch			P, F	NS, I
Lazuli Bunting			S, P, T	SM, AS, PC
Lesser Goldfinch			ON, S, P	SM, AS, PC
Lincoln's Sparrow			CN	PC, AS
MacGillivray's Warbler			S	SM, PC, AS
Mallard			F, ON, P	SM, AS, PC
Marsh Wren	X			SM
Mountain Chickadee			S	SM
Mountain Quail			S	SM, AS, PC
Mourning Dove			P	SM, AS
Nashville Warbler			S, P, T	SM, AS, PC
Northern Flicker			ON	SM, AS, PC
Northern Pygmy-Owl		X		NS
Northern Rough-winged Swallow			CN	SM, AS, PC
Northern Saw-whet Owl		X		I
Nuttall's Woodpecker			S, D	SM, AS
Oak Titmouse		X		SM, PC
Orange-crowned Warbler			S	SM, PC
Osprey		X		SM
Pacific-slope Flycatcher			S	SM, AS
Painted Redstart	X			I
Pine Siskin		X		SM, AS
Purple Finch			CN, S, P	SM, AS, PC
Red-breasted Nuthatch			S	SM, AS, PC
Red-tailed Hawk	X			I
Red-winged Blackbird			S, P, T,C	SM, AS, PC
Ruby-crowned Kinglet	X			SM

Savannah Sparrow	X			SM, AS
Song Sparrow			CN, CF, F, T, S, P, C, ON	SM, AS, PC
Spotted Owl			P, S	I
Spotted Sandpiper			P	SM, AS
Spotted Towhee			ON, S, P, CF, F	SM, AS, PC
Steller's Jay			P, F	SM, AS, PC
Townsend's Warbler	X			SM
Tree Swallow		X		SM
Vaux's Swift	X			I
Violet-green Swallow			F	SM, AS, PC
Virginia Rail		X		SM
Warbling Vireo			CF, T, S, P, CN, F, ON	SM, AS, PC
Western Bluebird		X		SM
Western Kingbird	X			SM
Western Meadowlark	X			I
Western Scrub-Jay			P	SM, AS, PC
Western Tanager			P, S, T	SM, AS, PC
Western Wood-Pewee			ON, S, P, CN	SM, AS, PC
White-breasted Nuthatch	X			PC
White-crowned Sparrow	X			AS
White-headed Woodpecker	X			PC
White-throated Swift			P, C	SM, AS, PC
Wilson's Warbler		X		SM, AS
Wood Duck			P	SM
Wrentit			S	SM, AS, PC
Yellow Warbler			ON, CN S, P,	SM, AS, PC

T, CF, C, F

Yellow-breasted Chat	S	SM, AS, PC
Yellow-rumped Warbler	S	SM, AS, PC

Breeding status for each species reported as unlikely, possible, probable, and confirmed (see National Park Service, 2007) at Poopenaut Valley, summers 2007-2013. Unlikely species represent those species considered transient in Poopenaut Valley. Codes indicating breeding status are: X = detected in study area during the breeding season; P = pair observed during the breeding season; S = more than one singing male in study area or male bird singing during at least 3 visits; D = drumming woodpecker heard; C = courtship behavior or copulation observed; T = Territorial behavior; CN = bird observed carrying nest material or nest building; CF = bird observed carrying food for young; F = recently fledged or downy young observed; ON = occupied nest observed.

4.4 Discussion

2013 was a markedly dry year, and the second consecutive summer when no substantial spring pulse was released from O'Shaughnessy Dam to fill the ephemeral pond on the north side of Poopenaut Valley. We found that in Search Area 1, adjacent to the pond, both species richness and relative abundance declined by 20% and 32% respectively compared to 2012, while both measures increased throughout the rest of the Valley. Species richness and relative abundance increased most sharply (31% and 51%) in Search Area 5, the montane riparian zone flanking the river that was in closest proximity to water throughout the season.

This year, the avian surveyor was able to cross the river to conduct spot-map, area search, and point count visits at all search areas in both North and South Poopenaut Valley throughout the entire season due to consistently low river flows. This increased access reflects a different survey effort from previous seasons: in 2011 and 2012, the number of replicates of each survey method was much fewer or non-existent depending on the observer's ability to reach the north side of Poopenaut Valley. As a result, survey effort was consistent across study areas this year, and allowed us to track bird movements in North Poopenaut over the course of the season.

Using the various monitoring efforts, we obtained valuable data about how two Riparian Focal Species (RFS) in particular used those areas—in early season, a male Song Sparrow and a male Yellow Warbler were both observed singing in Areas 1 and 2, adjacent to the seasonal pond (which remained dry all season). These observations are consistent with previous years. However, we did not detect either of these individuals or any females in those areas during subsequent visits, indicating that the habitat became unsuitable for nesting. In previous years, observers were unable to cross the river after their first one or two visits, so it is unknown whether the birds they detected at the beginning of the season persisted during those wetter years, or whether they followed the same pattern as 2013 of singing and later moving away. The willows surrounding the ephemeral pond may provide desirable nesting and foraging habitat for Song Sparrows and Yellow Warblers when the pond is filled, but be unsuitable when dry. Consistent monitoring in both North and South Poopenaut, combined with color-banding focal species early in the spring to track within-season movement, would further elucidate variations in breeding behavior that relate to the seasonal pond. Nesting of birds with territories adjacent to the seasonal pond may hinge on the pond containing water, which would reinforce the importance of filling the ephemeral pond in May-June.

Birds that nest in areas prone to flooding, such as riparian areas, may face risk of nest failure due to flooding. It follows that nest-site selection behavior to minimize this risk would be under positive selection. In a study of nest-site selection in saltmarsh sparrows, Gjerdrum et al. (2005) found that, depending on the species of bird, either microhabitat or timing of nesting relative to the tide could significantly influence nest success. Seaside Sparrows appeared to minimize the risk of nest flooding in a spatial context, tending to nest higher in vegetation, while the saltmarsh Sharp-tailed Sparrows appeared to use temporal cues to initiate nests between times of high tide. To our knowledge, the mechanism by which birds may “read” environmental cues to avoid nest flooding is unknown, but it may be possible that a ground-nesting riparian bird species such as the Song Sparrow may take into account flood risk when nest building, either temporally or spatially. The unpredictable nature of the regulated dam flow from O’Shaughnessy Dam has potential implications for the nesting success of Song Sparrows, and more study will be needed to determine how Song Sparrows select nest sites in years of both low and high flow.

Spot mapping surveys allowed us to more closely monitor the populations of Riparian Focal Species in Poopenaut Valley by allowing us to quantify the number of breeding pairs and nest locations with greater accuracy. Territory size has been linked to other aspects of the biotic and abiotic community, including avian body size, intraspecific competitive pressure, and resource availability (Peters, 1983; Schoener, 1968; Tompa, 1962; Hixon, 1980). It may be possible to use territory size to develop metrics to study these other variables as an evaluation of the health of bird communities and to gauge the relative habitat quality in Poopenaut Valley, but much more data on individual bird movement will need to be collected in order to make inferences about territory size.

Nest searching and monitoring continues to provide valuable information about both the birds’ use of habitat and their reproductive success in Poopenaut Valley. Due to low flows all season, no nests of the 17 we found were flooded. We found two Western Wood-Pewee nests in the direct floodplain of the Tuolumne River, one only 3 meters above the low water level. We had previously not considered Western Wood-Pewees as vulnerable to alterations in the hydrological regime, but these results suggest that we should monitor their nests more closely to determine if they, like Song Sparrows, are at risk of nest failure due to flooding. Continued monitoring of the nests of focal species is imperative to understanding the relationship between habitat quality and reproductive success in Poopenaut Valley.

Color-banding individual Yellow Warblers and Song Sparrows was extremely useful in determining territory size and tracking individuals throughout the field season. By color-banding birds, we were able to attribute nest success to a specific, identifiable pair in two cases in the Yellow Warbler, as well as create far more accurate territory maps for both of those species. In the future, color-banding all Riparian Focal Species would greatly contribute to our understanding of how birds use habitat in Poopenaut Valley (for example, we could determine the fates of early visitors to the north side of the Valley such as the aforementioned Yellow Warbler and Song Sparrow to see if they move within Poopenaut Valley to the riparian zone to compete for a territory along the river, or are excluded from the area entirely due to lack of available habitat). We could also track the instance of double-or triple brooding in Riparian Focal Species to determine their ability to re-nest in the event that their first clutch is flooded.

It appears that while flooding may pose a threat to some birds in Poopenaut Valley, the habitat structure and biotic community at large, as shaped by the hydrology, are the most important factors in bird species diversity and abundance. Heath and Ballard (2003) studied the relationship between bird communities and habitat characteristics of several riparian drainages in the Eastern Sierra, and found that riparian width was strongly positively correlated with the

probability of occurrence of Yellow Warblers and Song Sparrows. Based on our on-going observations, it remains our recommendation to mimic a natural hydrograph as closely as possible in order to fill the ephemeral pond, and maximize available nesting habitat and prey availability.

Chapter 5. 2013 Bat Studies in Poopenaut Valley

5.1 Introduction

Bats are essential in maintaining ecosystem health by controlling insect populations through nighttime foraging. Most bat species forage either directly over water or within the adjacent riparian zone, where plant and insect productivity is higher than in seasonally dry upslope areas. The riparian zone of Poopenaut Valley represents important foraging habitat for bat populations. There are 17 bat species known to occur within Yosemite National Park (Pierson et al., 2001), five of which are special status species that have experienced state-wide declines (Table 5-1). While population declines are based largely on issues that affect these species outside park boundaries, they serve to highlight the importance of park land as potential refugia, and signal a potentially heightened sensitivity of these species to management activities within the park.

Table 5-1. Common and scientific names of the seventeen bat species known to occur in Yosemite National Park. Species in bold indicate California species of special concern.

Common Name	<i>Genus species</i>
Pallid bat	<i>Antrozous pallidus</i>
	<i>Corynorhinus</i>
Townsend's big-eared bat	<i>townsendii</i>
Big brown bat	<i>Eptesicus fuscus</i>
Spotted bat	<i>Euderma maculatum</i>
Western mastiff bat	<i>Eumops perotis</i>
Western red bat	<i>Lasiurus blossevillii</i>
Hoary bat	<i>Lasiurus cinereus</i>
Silver-haired bat	<i>Lasionycteris noctivagans</i>
California myotis	<i>Myotis californicus</i>
Small-footed myotis	<i>Myotis ciliolabrum</i>
Long-eared myotis	<i>Myotis evotis</i>
Little brown bat	<i>Myotis lucifugus</i>
Fringed myotis	<i>Myotis thysanodes</i>
Long-legged myotis	<i>Myotis volans</i>
Yuma myotis	<i>Myotis yumanensis</i>
Canyon bat	<i>Parastrellus hesperus</i>
Mexican free-tailed bat	<i>Tadarida brasiliensis</i>

Bat populations in Poopenaut Valley may also serve as an ecological indicator of habitat health by providing information for further refining flow recommendations for the Tuolumne River, particularly the timing of when water should be released from O'Shaughnessy Dam. Past studies suggest that the highest bat species diversity, detection rates, and degree of foraging activity occur in the park's lower elevations (Pierson et al., 2001, Pierson et al., 2006, Pierson and Rainey 2009, Rainey et al., 2009). Most bat species in Yosemite forage for insects over ponds, rivers, meadows, and among riparian vegetation, which are all affected either directly or indirectly by stream flow. Bat species richness and foraging activity can be linked to prey availability which appears to respond to fluctuations in stream flow. This study aims to (1) determine seasonal patterns of bat species present in Poopenaut Valley, (2) quantify bat foraging activity in relation to stream flow, (3) aid in understanding the ecology of the seasonal pond as related to insect availability and stream flow, and most importantly (4) provide recommendations to SFPUC on timing water releases from O'Shaughnessy Dam in order to benefit focal bat species.

A fifth study objective has been added due to wildfire in the study area during August and September 2013. The Rim Fire began 17 August 2013 and burned over 257,000 acres in Stanislaus National Forest and Yosemite National Park, including Poopenaut Valley. The Rim Fire offers a unique opportunity to study the effects of wildfire on the bat assemblages inhabiting Poopenaut Valley, as described below.

5.2 Methods

We conducted acoustic bat surveys at two sites in Poopenaut Valley to determine species presence and activity level. We deployed one bat detector on the south side of the Tuolumne River and operated it on a year-round basis in order to determine seasonal bat patterns in relation to stream flow. We deployed a second bat detector on the north side of the Tuolumne River adjacent to the seasonal pond and, when accessible, operated it to determine the relationship between bat foraging activity and water levels and insect availability in the adjacent seasonal pond (Figure 5-1).

At each site, we secured one detector and external battery in a locked metal box at the base of a 20 foot tall metal pole (Figure 5-2). At the top of the metal pole, we mounted an external microphone in a weather-proof metal casing and positioned it horizontally to face the meadow opening (south site) and seasonal pond (north site) in order to increase the detection probability of foraging bats. We powered each detector with a 6-volt external battery, which was secured in the locked metal box. Each detector recorded sound in the high frequency range continuously during each night between 1900 and 0700 during the first month of survey. For the remaining time period, each detector recorded sound in the high frequency range each night at two different time periods: (1) 1900 - 2300 and (2) 0300 - 0700. Acoustic surveys at the south site occurred from 14 April 2011 to 11 September 2013. Acoustic surveys at the north site occurred from 19 April 2011 to 10 September 2013. Detectors were scheduled to be checked on a monthly basis.



Figure 5- 1. Acoustic monitoring sites targeting bat species in Poopenaut Valley, Yosemite National Park. Monitoring occurred between April 2011 and September 2013 at two sites: (A) north of the Tuolumne River adjacent to the seasonal pond and (B) south of the Tuolumne River.

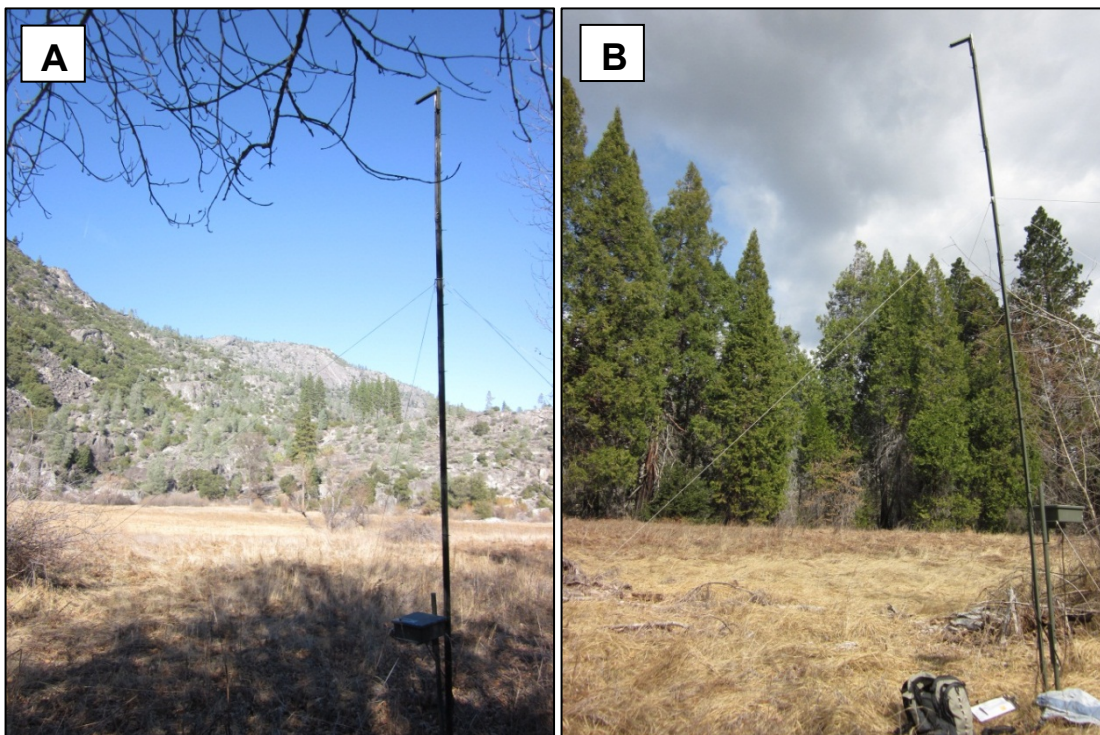


Figure 5-2. Acoustic bat detector set-ups in Poopenaut Valley (A) north of the Tuolumne River adjacent to the seasonal pond, and (B) south of the Tuolumne River.

We used Pettersson D500x ultrasound recording units coupled with SonoBat™ software for full-spectrum acoustic monitoring and bat echolocation call identification. The Pettersson D500x hardware is built specifically for long-term passive monitoring. SonoBat™ software provides a comprehensive tool for analyzing and comparing high-resolution full-spectrum sonograms of bat echolocation calls. SonoBat™ uses a decision engine based on the quantitative analysis of approximately 10,000 species-known recordings from across North America. The software automatically recognizes and sorts calls, then processes the calls to extract six dozen parameters that describe the time-frequency and time-amplitude trends of a call.

SonoBat's call trending algorithm recognizes the end of calls buried in echo and noise as well as establishes trends through noise and from low power signals. SonoBat™ generates high resolution continuous trends of time-frequency and time-amplitude content that enable robust parameter extraction. Inclusion of amplitude parameters increases classification performance above that achieved by using time-frequency parameters alone. We analyzed echolocation call data from each site using the batch process option in SonoBat™. The discriminant probability threshold for each echolocation call was set at 0.90 and the acceptable call quality was set at 0.80. Species were identified by consensus only.

Due to erratic equipment failure (both sites) and accessibility issues (north site only), continuous monitoring was not conducted during 2012, with a large data gap during the summer. Additionally, during December 2012, human error resulted in incorrect recording times at the north site, with the detector recording at a less than optimal time period (i.e. during daylight) for one of the daily monitoring sessions during that month. From 7-Dec-12 through 8-Jan-13, the detector at the north site recorded from: (1) 0700 – 1300 and (2) 1700 – 2200, effectively reducing detection probability by half. Although no species were detected at the south site during this same period, the detector appeared to be functioning. Total seasonal monitoring effort for each site is shown in Table 5-2.

The Rim Fire burned the north side of Poopenaut Valley 23-34 August 2013 and the south side 10-11 September 2013 (Figures 5-3, 5-4). Both bat detectors were in burned areas but continued to record when fire swept through the valley. The detector at the south site suffered minimal damage (burnt external microphone cable) whereas the detector at the north side remained undamaged.



Figure 5-3. Aerial image of Poopenaut Valley taken 10 September 2013 showing active burn front of the Rim Fire on the south side of the valley, and the area on the north side of the valley that burned on 23-24 August 2013. The northern area includes the seasonal pond and site of the north bat detector (A). The active burn front eventually reached the bat detector at the south site (B).



Figure 5-4. Poopenaut Valley post-Rim Fire on 23 September 2013. Bat detectors at the north site (A) and the south site (B) were in burned areas. Both detectors were recording during the Rim Fire.

5.3 Results

We documented a high diversity of bat species in Poopenaut Valley from spring 2011 through late summer 2013. Over this 2.5 year monitoring period, we detected all 17 bat species known to occur within Yosemite National Park (Pierson et al. 2001) in Poopenaut Valley; thus, Poopenaut Valley alone is as diverse as the rest of Yosemite National Park combined. Five of the 17 documented species are California species of special concern (pallid bat, spotted bat, western mastiff bat, Townsend's big-eared bat, and western red bat). Western red bat was recently detected for the first time at both the north and south sites in August - September 2013, during the period when the Rim Fire burned through the study area. Similarly, the fringed bat was detected for the first time at the south site during the Rim Fire. Although the pallid bat was detected at the south site in 2011 and at the north site in 2012, it was not detected at either site in 2013.

Preliminary results show that bat assemblages in Poopenaut Valley varied by year, site (Figures 5-5 to 5-7), and season (Figures 5-8, 5-9). Whereas the majority of species tended to arrive in late spring/early summer, peak in detection frequency during late summer, and depart sometime during the fall, three species stood out with considerably higher detection frequencies, one of which remained year-round (Figures 5-8, 5-9). The biggest difference in detection frequency occurred at the north site during summer 2012; the spotted bat had three times as many detections as the next most frequently detected species, the western mastiff bat. During summer 2013, there were significantly less detections of spotted bat and western mastiff bat at both the north and south sites, although they remained the third and second most frequently detected species, respectively (Figures 5-10, 5-11). Rounding out the top three, the Mexican free-tailed bat had a similar detection rate over the 2.5 year study period, exhibiting an increase in detection frequency each year during summer and fall, and the highest detection frequency recorded for this species at the north site during August-September 2013 when the Rim Fire swept through the area (Figures 5-10, 5-11). Habitat requirements and arrival/departure dates of the eight most frequently detected bat species in Poopenaut Valley are described in Table 5-3.

Seasonal bat use of Poopenaut Valley varied between species, with Mexican free-tailed bat being the only species that was detected year-round at both sites over the duration of the study period (Figures 5-8, 5-9). At the north site, the western mastiff bat was detected continuously since May 2012, remaining over-winter in 2012/2013 (Figure 5-10). Other species detected during winter 2011/2012 at both sites include silver-haired bat, California myotis, hoary bat, and Yuma myotis (Figures 5-12, 5-13). With the exception of Mexican free-tailed bat and western mastiff bat, only one other species was detected during winter 2012/2013, the silver-haired bat (Figures 5-12, 5-13).

Interestingly, detection frequency increased for the majority of bat species at both sites during the Rim Fire in late summer 2013, with 10 species setting new records for detection frequency in Poopenaut Valley (Figures 5-8, 5-9). This increase was especially pronounced at the north site, with every species that was detected increasing in frequency during the period in which the fire was present. At the south site, all species detected increased in frequency during

August-September 2013 with one exception; the small-footed myotis remained stable during the Rim Fire and did not increase in detection frequency. During the Rim Fire, the Mexican free-tailed bat had the highest detection frequency at the north site, followed closely by California myotis, and to a lesser extent, canyon bat, hoary bat, and Yuma myotis. Like the Mexican free-tailed bat, the California myotis had the highest detection frequency ever recorded for this species at the north site during the Rim Fire. At the south site, there were noticeable increases in detection frequencies of the Mexican free-tailed bat, silver-haired bat, California myotis, big brown bat, Yuma myotis, and long-legged myotis during the Rim Fire. In past years at both sites during this time period, in the absence of fire, the majority of species detection frequencies decreased or remained stable.

Accessibility issues at the north site and equipment failure at both sites prevented continuous monitoring over the 2.5 year survey period, which had negative effects on the detection probability of each species. For example, at the north site during summer 2011, the detector operated only five days during June, July, and August (Table 5-2). As a result, seasonal comparisons between years and sites will become more meaningful when additional data are collected over the coming years.

Table 5-2. Total seasonal monitoring effort from acoustic bat detectors at two sites in Poopenaut Valley, Yosemite National Park from 14 April 2011 to 11 September 2013. For each season and site, the first number indicates total number of days that the detector was operated; the second number in parentheses indicates the percentage that the detector was operated.

	Spring 2011 (Mar-May)	Summer 2011 (Jun-Aug)	Fall 2011 (Sep-Nov)	Winter 2011/2012 (Dec-Feb)	Spring 2012 (Mar-May)	Summer 2012 (Jun-Aug)	Fall 2012 (Sep-Nov)	Winter 2012/2013 (Dec-Feb)	Spring 2013 (Mar-May)	Summer 2013 (Jun-Aug)
North	42 (46%)	5 (5%)	48 (53%)	70 (78%)	92 (100%)	88 (96%)	74 (81%)	57 (63%)	92 (100%)	92 (100%)
South	14 (15%)	18 (20%)	82 (90%)	90 (100%)	90 (98%)	92 (100%)	88 (97%)	87 (95%)	90 (98%)	91 (99%)

Table 5-3. Occurrence, habitat requirements, and arrival/departure dates of the eight most frequently detected bat species in Poopenaut Valley from 14 April 2011 to 11 September 2013. Arrival/departure dates represent when each species was first/last detected each year. Some species were present year-round. Note*Acoustic bat detectors were not operating continuously during the entire monitoring period. Refer to Table 5-2 for total seasonal monitoring effort.

SPOTTED BAT		
Occurrence/habitat	Widely distributed throughout Sierra Nevada, with records > 3000 m. Occurs in habitats ranging from desert scrub to montane coniferous forests	
Feeding type/food source	Forages in a wide variety of habitats, 5-15 m off the ground, primarily for moths	
Roosting structure	Uses crevices in rock faces for roosting and reproduction	
Seasonal movements	Makes local movements in some areas, from high elevations in summer to lower elevations in fall. Little is known about the California populations; may be yearlong residents, or migratory.	
	NORTH	SOUTH
2011		
Arrival	19-Apr-11	15-Apr-11
Departure	18-Sep-11	16-Sep-11
2012		
Arrival	21-May-12	27-May-12
Departure	8-Nov-12	15-Aug-12
2013		
Arrival	18-May-13	28-Jul-13
Departure	2-Sep13	24-Aug-13

WESTERN MASTIFF BAT		
Occurrence/habitat	Found in a variety of habitats to > 3000 m in elevation. From desert scrub to chaparral to oak woodland and into the ponderosa pine belt.	
Feeding type/food source	Detected most often over meadows and other open areas, but will also feed above forest canopy; sometimes to high altitudes (1,000 feet)	
Roosting structure	Roosts primarily in crevices in cliff faces and occasionally trees	
Seasonal movements	Unknown	
	NORTH	SOUTH
2011		
Arrival	19-Apr-11	14-Apr-11
Departure	4-Oct-11	17-Oct-11
2012		
Arrival	1-Jan-12	30-Apr-12
Departure	11-Dec-12	30-Sep-12
2013		
Arrival	16-Jan-13	5-May-13
Departure	10-Sep-13	9-Sep-13

MEXICAN FREE-TAILED BAT		
Occurrence/habitat	Uncommon in high Sierra Nevada but found throughout California. Found in all habitats including mixed conifer forest, but open habitats such as woodlands, shrublands, and grasslands preferred.	
Feeding type/food source	Forages high, 100 ft above ground.	
Roosting structure	Roosts in caves, mine tunnels, crevices, and buildings.	
Seasonal movements	In California, makes local movements to and from hibernacula or short migrations attitudinally.	
	NORTH	SOUTH
2011		
Arrival	21-Apr-11	14-Apr-11
Departure	31Dec-11	31-Dec-11
2012		
Arrival	2-Jan-12	1-Jan-12
Departure	11-Dec-12	26-Nov-12
2013		
Arrival	8-Jan-13	9-Jan-13
Departure	10-Sep-13	11-Sep-13

CANYON BAT		
Occurrence/habitat	Wide range including desert, grassland, woodland, and mixed conifer forests. Yearlong resident in California	
Feeding type/food source	Feeds at low to moderate heights over water, rocky canyons, and along cliff faces.	
Roosting structure	Roosts in rock crevices, mines, caves, and buildings.	
Seasonal movements	Yearlong resident in California. May make local movements.	
	NORTH	SOUTH
2011		
Arrival	19-Apr-11	15-Apr-11
Departure	2-Oct-11	2-Oct-11
2012		
Arrival	5-Mar-12	23-Apr-12
Departure	2-Nov-12	5-Oct-12
2013		
Arrival	31-Jan-13	15-May-13
Departure	10-Sep-13	10-Sep-13

CALIFORNIA MYOTIS		
Occurrence/habitat	Broad distribution over western North America, most abundant at mid-elevations. Found in almost every habitat.	
Feeding type/food source	Forages in canopy and along riparian corridors on insects and moths.	
Roosting structure	Uses crevices in wide variety of natural and anthropogenic structures.	
Seasonal movements	Individuals can be active in winter, even in below freezing temperatures.	
	NORTH	SOUTH
2011		
Arrival	19-Apr-11	15-Apr-11
Departure	18-Oct-11	14-Nov-11
2012		
Arrival	13-Jan-12	31-Jan-12
Departure	7-Nov-12	5-Nov-12
2013		
Arrival	2-Mar-13	28-Apr-13
Departure	10-Sep-13	11-Sep-13

SILVER-HAIRED BAT		
Occurrence/habitat	Broad distribution concentrated in northern part of CA.	
Feeding type/food source	Forages above canopy, in forest clearings, and in riparian zone along water courses for wide variety of insects and moths	
Roosting structure	Roosts in trees	
Seasonal movements	Migratory	
	NORTH	SOUTH
2011		
Arrival	2-May-11	15-Apr-11
Departure	27-Dec-11	24-Dec-11
2012		
Arrival	19-Jan-12	1-Jan-12
Departure	21-Dec-12	12-Aug-12
2013		
Arrival	8-Jan-13	3-Feb-13
Departure	10-Sep-13	10-Sep-13

HOARY BAT		
Occurrence/habitat	The hoary bat is the most widespread North American bat. Habitats include cottonwood riparian habitat, forested areas, and woodlands.	
Feeding type/food source	Feeds primarily on moths.	
Roosting structure	Roosts in dense foliage of medium to large-size trees	
Seasonal movements	Migrates between summer and winter ranges, probably over long distances. During spring and fall, large groups are encountered, occasionally in unusual locations. Females precede males in the northward spring migration, which occurs from Feb - May. Fall migration occurs Sep - Nov.	
	NORTH	SOUTH
2011		
Arrival	21-Apr-11	16-Apr-11
Departure	18-Oct-11	14-Nov-11
2012		
Arrival	17-Feb-12	24-Apr-12
Departure	15-Oct-12	14-Oct-12
2013		
Arrival	23-Apr-13	19-Jan-13
Departure	9-Sep-13	11-Sep-13

YUMA MYOTIS		
Occurrence/habitat	Usually occurs below 8,000 feet in elevation. Optimal habitats are open forests and woodlands with sources of water over which to feed. More highly associated with water than any other species.	
Feeding type/food source	Forages over open, still, or slow-moving water and above low vegetation in meadows for emergent insects (midges, mayflies, caddis flies) and moths.	
Roosting structure	Roosts in buildings, caves, or crevices.	
Seasonal movements	Probably makes local or short migrations to suitable hibernacula. Individuals that spend summer at high elevations probably move downslope.	
	NORTH	SOUTH
2011		
Arrival	21-Apr-11	14-Apr-11
Departure	18-Oct-11	27-Dec-11
2012		
Arrival	25-Feb-12	3-May-12
Departure	7-Nov-12	8-Nov-12
2013		
Arrival	18-Feb-13	27-Apr-13
Departure	10-Sep-13	11-Sep-13

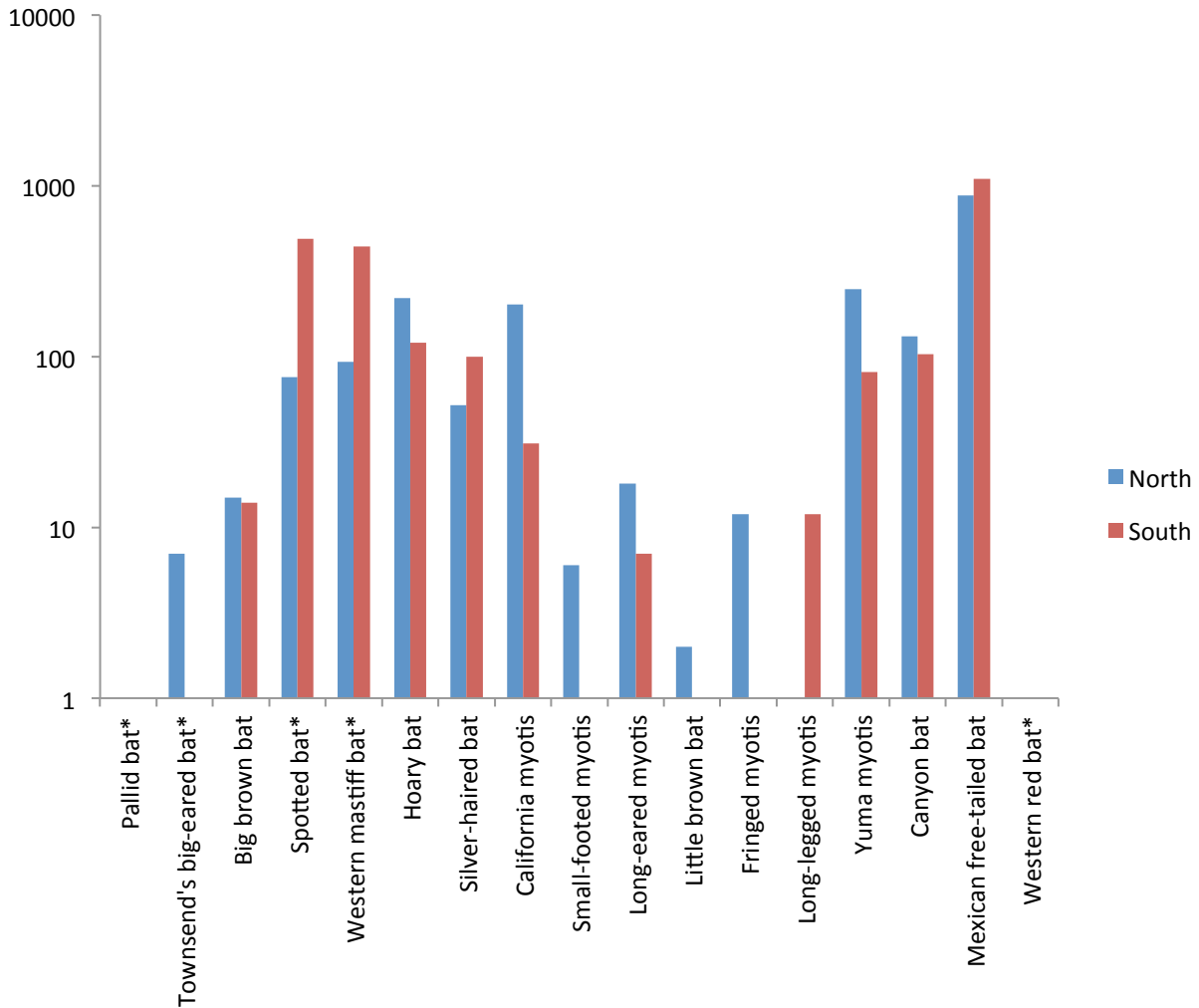


Figure 5-5. Total bat detections on a logarithmic scale (base 10) in Poopenaut Valley by site between 14 April 2011 and 31 December 2011 (Year 1). Note that total bat detections does not necessarily indicate abundance, as a single bat may produce many detections. A total of 16 bat species were detected. * indicates California species of special concern.

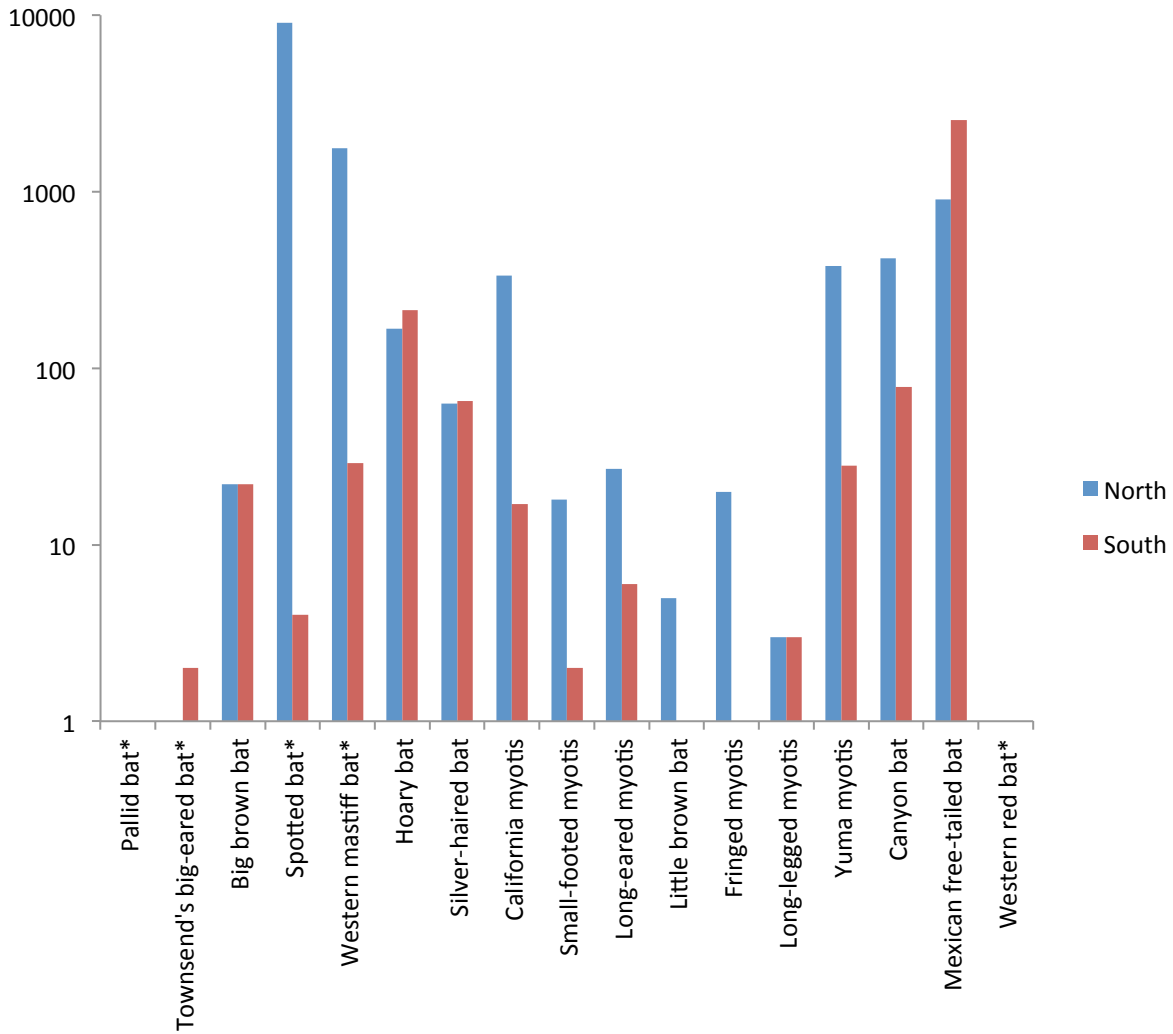


Figure 5-6. Total bat detections on a logarithmic scale (base 10) in Poopenaut Valley by site between 1 January 12 and 31 Dec 2012 (Year 2). Note that total bat detections does not necessarily indicate abundance, as a single bat may produce many detections. A total of 16 bat species were detected. * indicates California species of special concern.

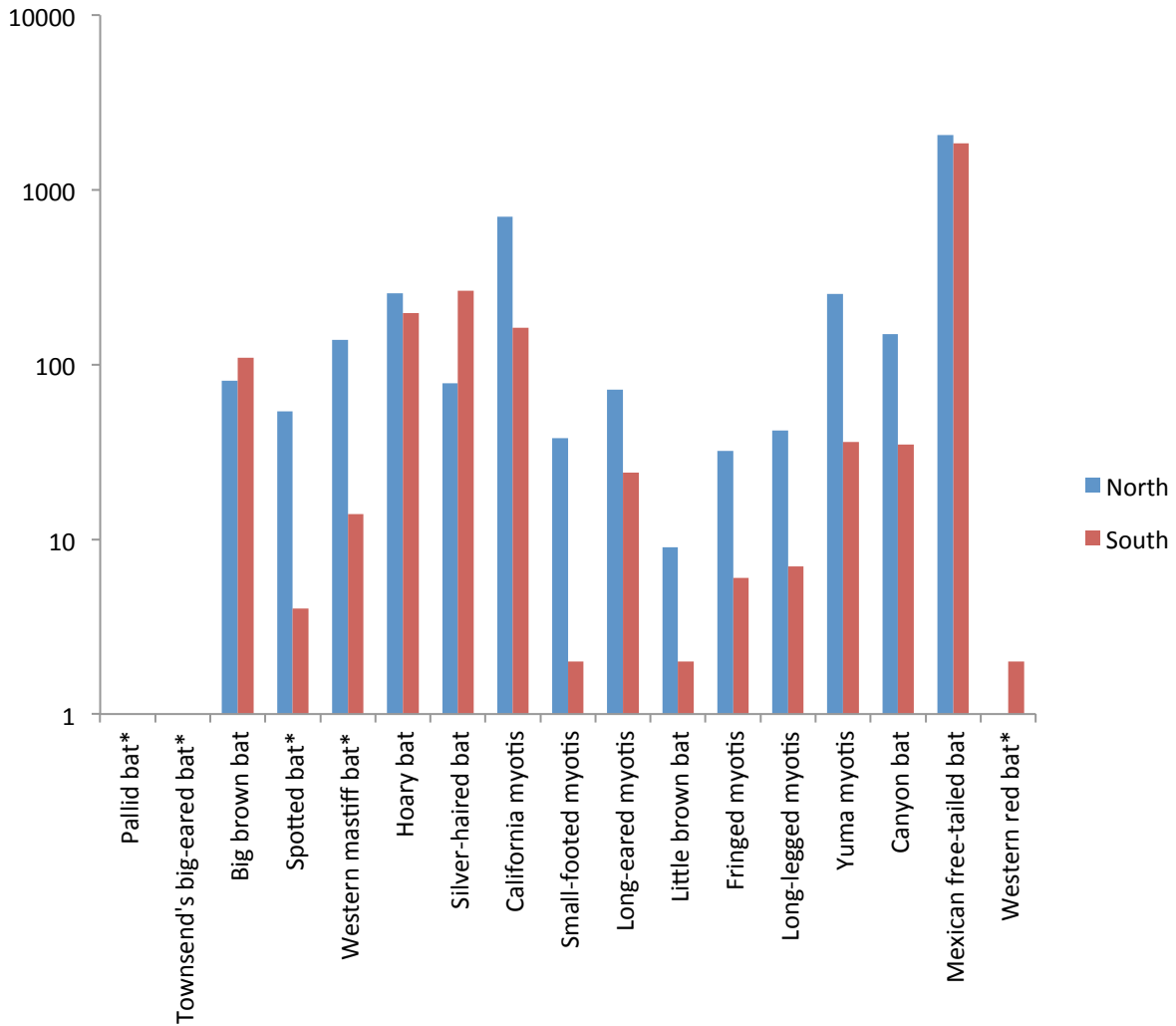


Figure 5-7. Total bat detections on a logarithmic scale (base 10) in Poopenaut Valley by site between 1 January 2013 and 11 September 2013 (Year 3). Note that total bat detections does not necessarily indicate abundance, as a single bat may produce many detections. A total of 16 bat species were detected. * indicates California species of special concern.

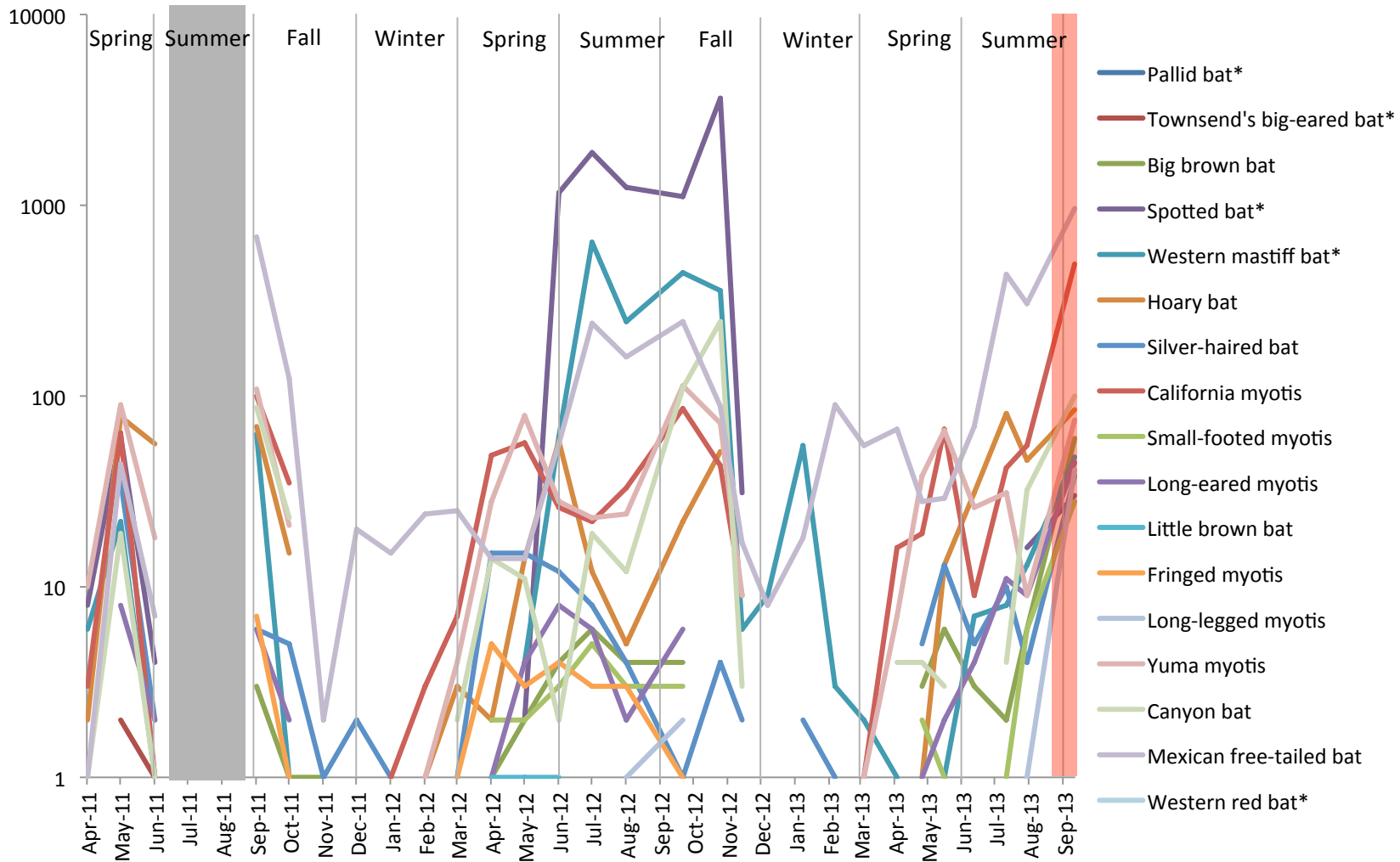


Figure 5-8. Total detections of 17 bat species on a logarithmic scale (base 10) north of the Tuolumne River in Poopenaut Valley on a monthly basis from 14 April 2011 to 10 September 2013. No data were collected between July and August 2011 (gray bar). The Rim Fire burned through the area 23-24 August 2013 (red bar). * indicates California species of special concern.

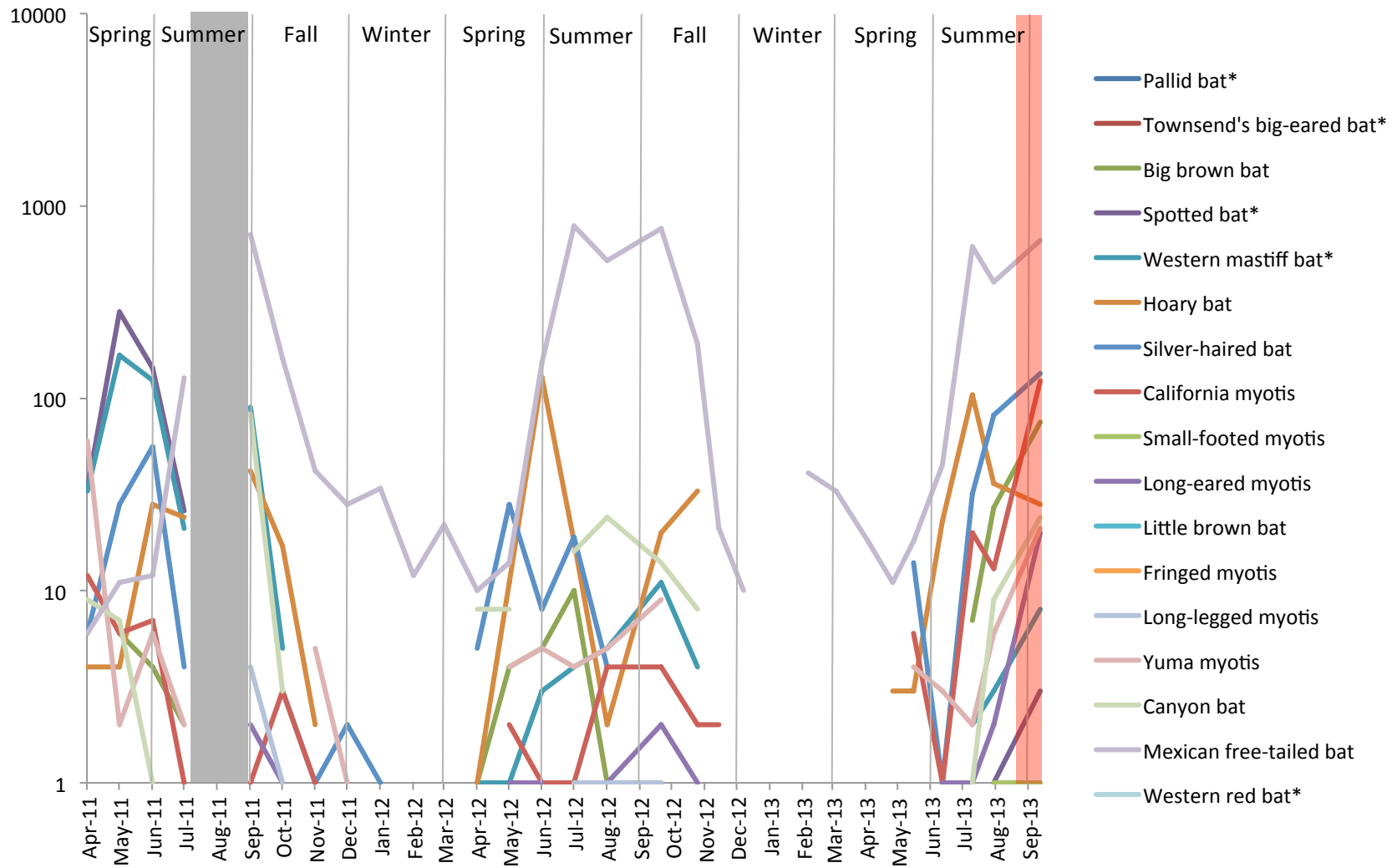


Figure 5-9. Total detections of 17 bat species on a logarithmic scale (base 10) south of the Tuolumne River in Poopenaut Valley, on a monthly basis from 14 April 2011 to 11 September 2013. No data were collected in August 2011 (gray bar). The Rim Fire burned through the area 10-11 September 2013 (red bar). * indicates California species of special concern.

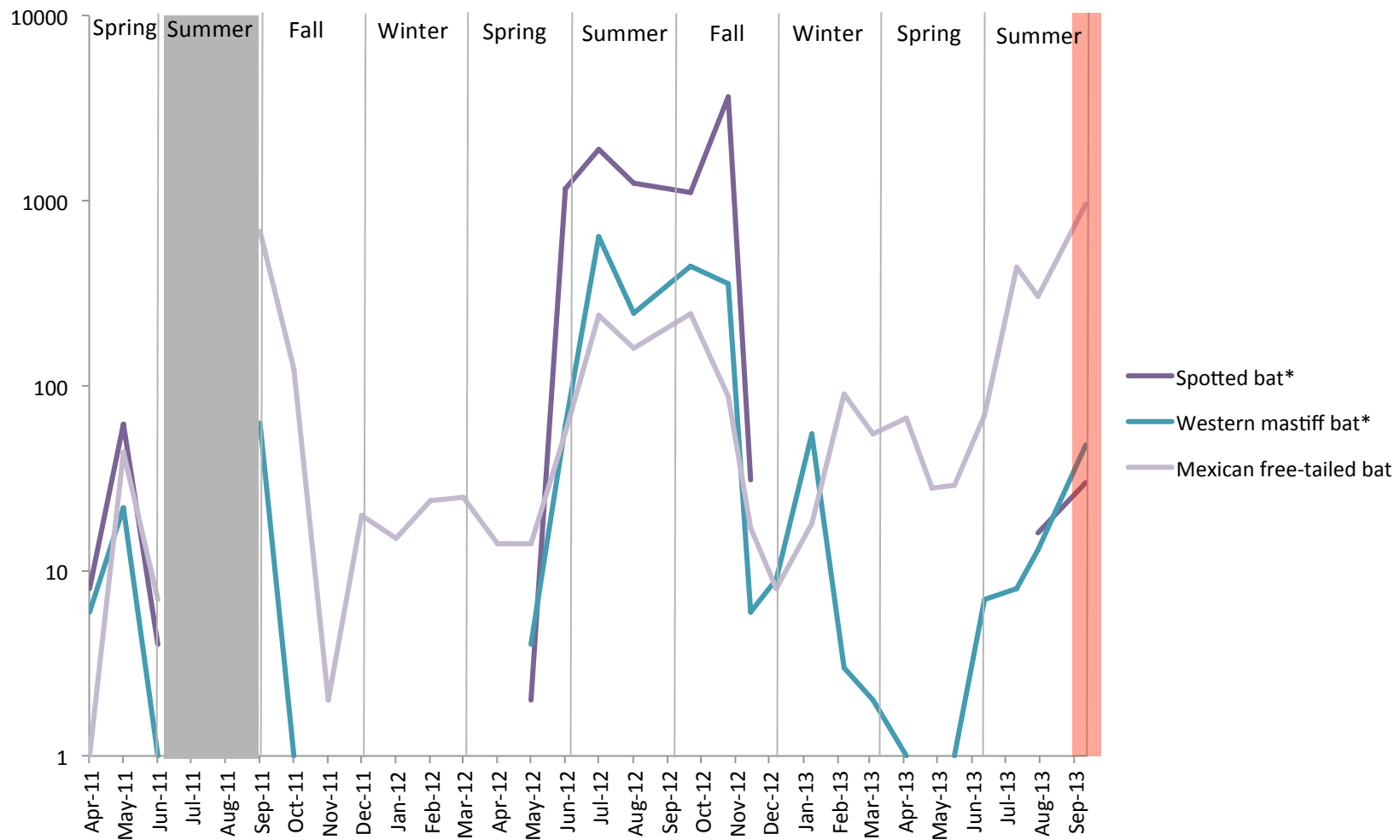


Figure 5-10. Total detections of the three most frequently detected bat species (spotted bat, western mastiff bat, and Mexican free-tailed bat) on a logarithmic scale (base 10) north of the Tuolumne River in Poopenaut Valley, on a monthly basis from 14 April 2011 to 10 September 2013. No data were collected between July and August 2011 (gray bar). The Rim Fire burned through the area 23-24 August 2013 (red bar). * indicates California species of special concern.

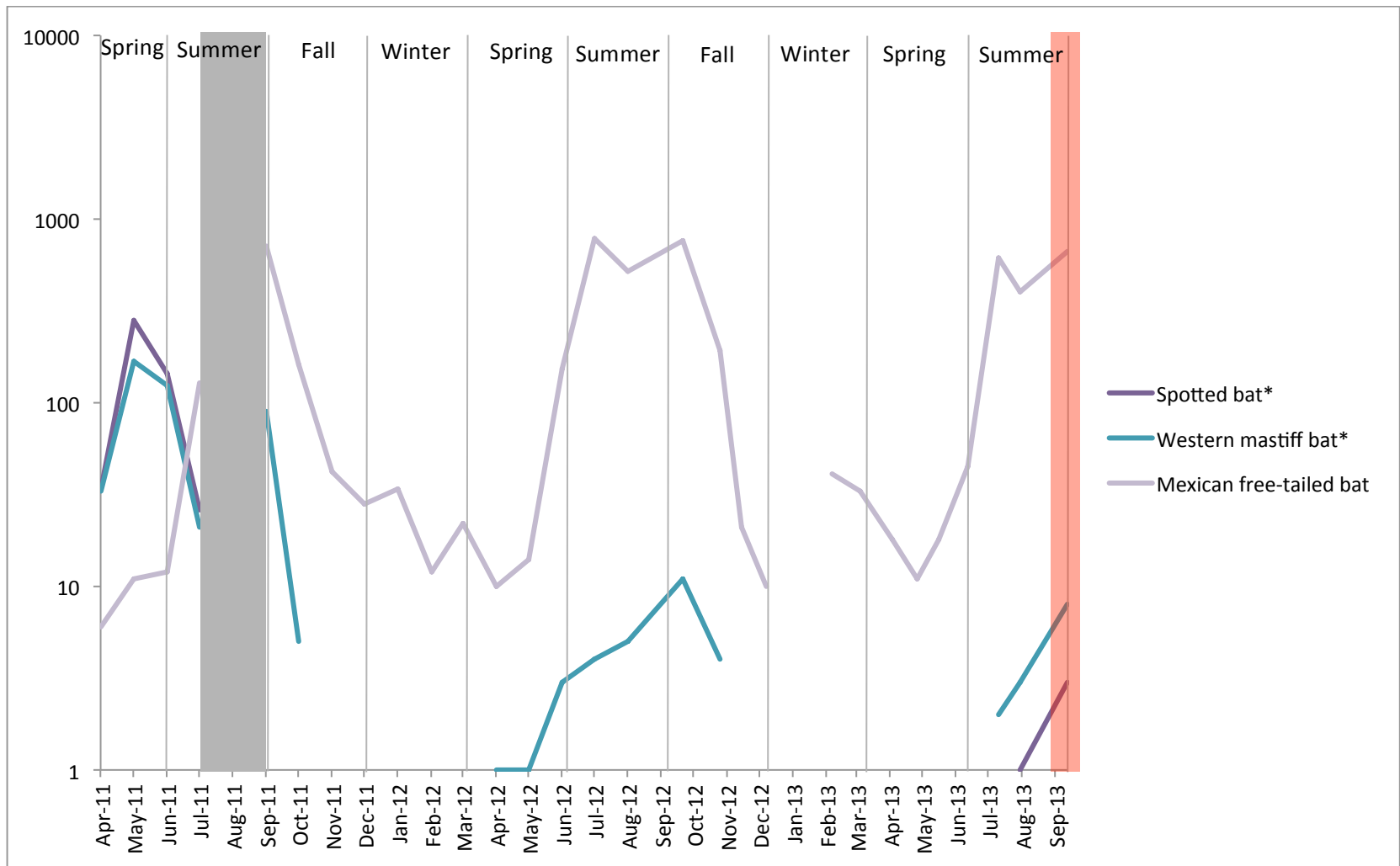


Figure 5-11. Total detections of the three most frequently detected bat species (spotted bat, western mastiff bat, and Mexican free-tailed bat) on logarithmic scale (base 10) south of the Tuolumne River in Poopenaut Valley, on a monthly basis from 14 April 2011 to 11 September 2013. No data were collected in August 2011 (gray bar). The Rim Fire burned through the area 10-11 September 2013 (red bar). * indicates California species of special concern.

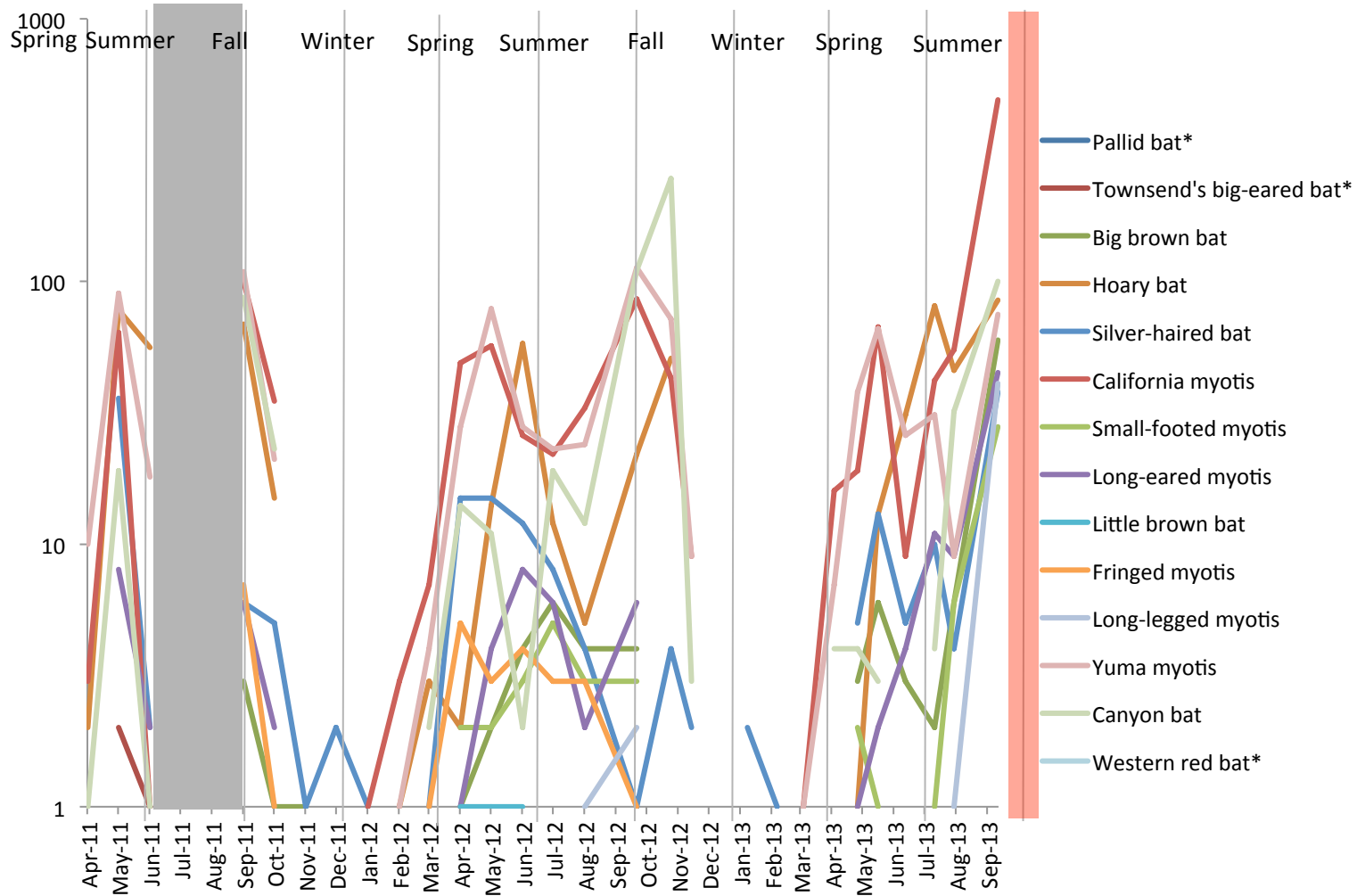


Figure 5-12. Total detections of 14 bat species on a logarithmic scale (base 10) north of the Tuolumne River in Poopenaut Valley, on a monthly basis from 14 April 2011 to 10 September 2013. No data were collected between July and August 2011 (gray bar). The Rim Fire burned through the area on 23-24 August (red bar). * indicates California species of special concern.

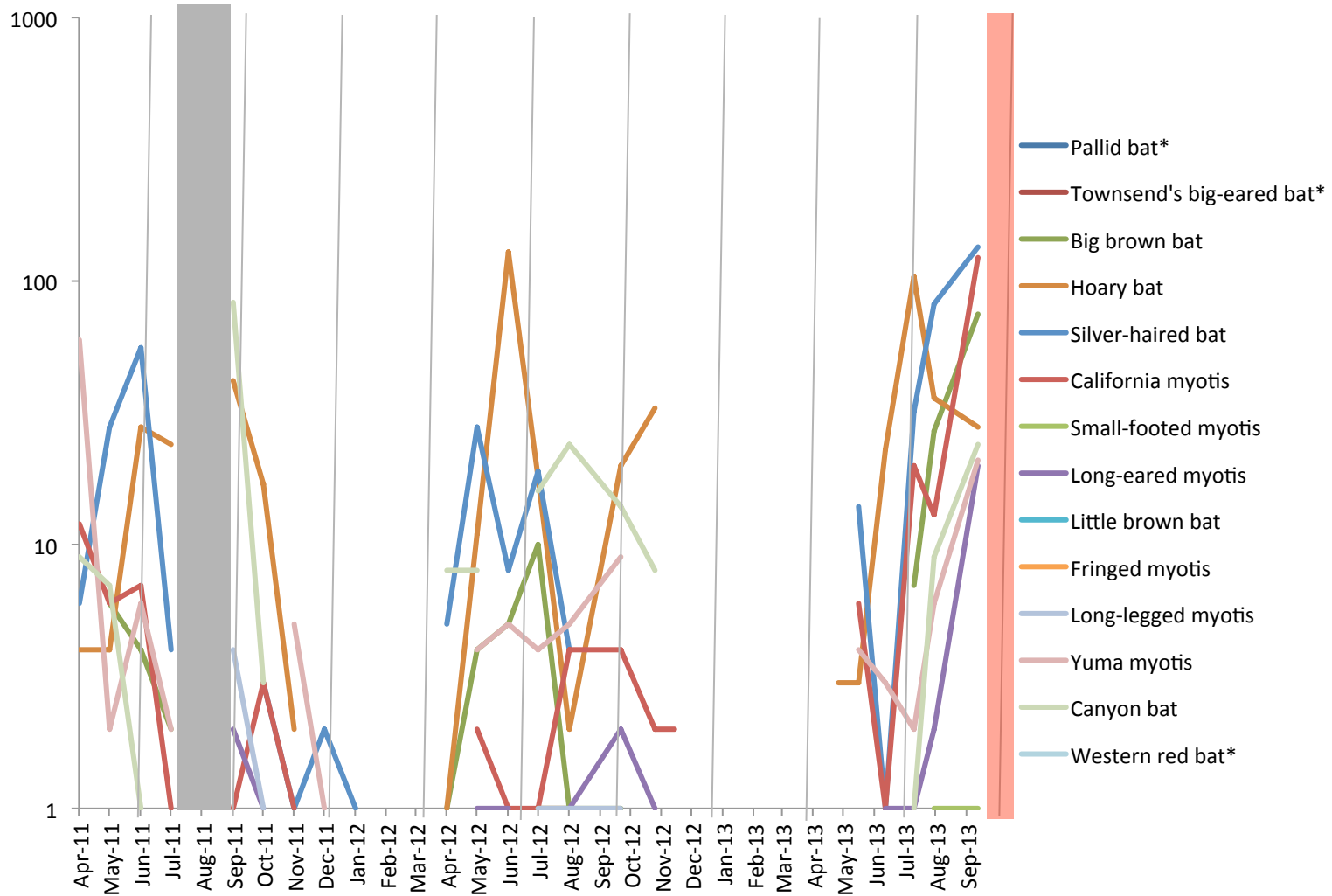


Figure 5-13. Total detections of 14 bat species on a logarithmic scale (base 10) south of the Tuolumne River in Poopenaut Valley, on a monthly basis from 14 April 2011 to 11 September 2013. No data were collected in August 2011 (gray bar). The Rim Fire burned through the area 10-11 September 2013 (red bar) * indicates California species of special concern.

5.4 Discussion

Preliminary results of this study have identified an incredible biodiversity of bat species inhabiting Poopenaut Valley, with at least one species, the Mexican free-tailed bat, present year-round. We documented five special status species, two of which were the first (spotted bat) and third (western mastiff bat) most frequently detected species during 2012. The considerable jump in spotted bat and western mastiff bat detections at the north site in summer 2012 requires further study; however, prey abundance in the seasonal pond and water level may be factors.

Holmquist and Schmidt-Gengenbach (2012) found that benthic macro-invertebrate fauna in the seasonal pond north of the Tuolumne River adds considerably to the total biodiversity of the Poopenaut Valley ecosystem. The seasonal pond contributed an additional six orders and 28 families to those identified from the Tuolumne River benthic macro-invertebrates during 2007-2009; two orders and eight families were detected in 2011-12 (Holmquist and Schmidt-Gengenbach 2012). Winter 2011/2012 was also a much drier winter than the previous year; so perhaps the controlled water level in the seasonal pond attracted spotted bats to this area during summer 2012, when other areas across the Sierra Nevada were already dry.

Significantly lower detections of spotted bat and western mastiff bat during summer 2013 at both sites may also have been affected by the lack of water in the seasonal pond adjacent to the north site. Spring runoff peaks upstream of Hetch Hetchy reservoir occurred on 23 June 2011 and 23 April 2012. The seasonal pond in Poopenaut Valley filled in winter and spring in both years containing at least some water at the time of the controlled floods each year. However, low water conditions in 2012 limited high flows necessary to spill water into the seasonal pond. Thus, the seasonal pond had less considerably less water in it and remained filled for a shorter duration in 2012 compared to the previous year. In 2013, the spring runoff peak on the Tuolumne River immediately upstream of Hetch Hetchy reservoir occurred on 30 April 2013. The seasonal pond in Poopenaut Valley was dry during the reporting period in 2013, and there were no experimental flows that would have filled the pond.

Due to the absence of bat data during summer 2011 when the seasonal pond had the most water for the longest duration, we cannot conclude at this time that water alone was the main factor driving bat activity levels in Poopenaut Valley. An experimental flow that would result in the filling of the seasonal pond during summer 2014 would help address this discrepancy in the data, and help confirm if higher water levels for longer durations in the seasonal pond attract the impressive number of spotted bats that were detected in significantly higher frequency during summer 2012 when the pond had water.

Interacting with water availability, prey abundance also affected bat assemblages in Poopenaut Valley in 2013. During 2013 sampling, Holmquist and Schmidt-Gengenbach (2013) found that a number of pond-associated benthic macro-invertebrate taxa were uncommon or absent in samples, including damselflies, mosquitos, water beetles, and some midges. The low diversity and abundance in pond riparian habitat were likely in part a result of lack of pond filling in 2013 (Holmquist and Schmidt-Gengenbach, 2013). The lack of invertebrate prey due to the pond remaining dry likely had a negative effect on the bat assemblages in Poopenaut Valley

during spring and summer 2013, with spotted bat, western mastiff bat, and to a lesser extent, canyon bat, detected in significantly lower frequency.

The record setting increases for a majority of the bat species inhabiting Poopenaut Valley during the period in which the Rim Fire burned through the area was unexpected, and will continue to be investigated. Whether the increase in detection frequency for the majority of bat species at both sites during August-September 2013 can be attributed directly to the Rim Fire requires further investigation. It is likely that multiple factors are interacting to affect bat activity.

The Rim Fire will also likely have affected the invertebrate assemblage in Poopenaut Valley, directly through mortality of plant-associated taxa, indirectly via habitat loss, and via emigration of mobile organisms from the area (Holmquist and Schmidt-Gengenbach, 2013). Adults, juveniles, and eggs that were already in overwintering stages in surface soils are likely to have suffered some mortality (Holmquist and Schmidt-Gengenbach, 2013). A reduction in invertebrate prey, whether from wildfire or lack of filling of the seasonal pond, may have direct consequences for bat assemblages that inhabit Poopenaut Valley. However, wildfire on the landscape can also have a positive effect on bat species. In their study of the 2002 McNally Fire in the Sierra Nevada, Buchalski et al. (2013) suggest that bats may exhibit some resiliency to landscape scale fire in mixed-conifer forests of California, and that some species preferentially select burned areas for foraging, perhaps facilitated by reduced clutter and increased post-fire availability of prey and roosts. This may explain the increase in detection frequency for the majority of bat species inhabiting Poopenaut Valley during the Rim Fire. Post-fire monitoring will help determine what effects the Rim Fire had on bat assemblages inhabiting Poopenaut Valley.

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