A Summary of Bird Monitoring Efforts and a Preliminary Evaluation of Restoration Efforts at Carman Valley.

Jim Steele
Sierra Nevada Field Campus
San Francisco State University
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jsteele@sfsu.edu

Summary

Three years of post restoration observation is too short a time period to account for lagging restoration effects such as increasing vegetative and insect populations which will impact bird populations. However we have still observed positive impacts from the restoration that are significantly beneficial to bird populations. As the summer drought progresses much of the suitable habitat in the Sierra Nevada begins to dry up and become unproductive. Before restoration the number of birds in August had steadily declined at Carman Valley. However in the post-restoration years we have witnessed an increased use of Carman Valley by both adults and hatch year birds during the post-breeding period. This increase has occurred despite a small overall decline in the number of breeding birds earlier in the same year.

Although the some species have continued to have smaller breeding populations than during the pre-restoration years, the more common species such as Western Tanagers, Song Sparrows, MacGillivray's Warblers, Yellow Warblers, American Robins, and Western Wood Peewees have increased their breeding numbers. Some of these increases have been supported by broader regional population increases that may be independent of any restoration benefits. Others such as the MacGillivray's Warblers have increased despite broad regional declines suggesting a strong site specific improvement. In addition we have witnessed species such as Canada Geese and Spotted Sandpipers, Sora and Tree Swallows nesting in this meadow for the first time since we began monitoring in 1992. If the initial indications of the restoration's benefits continue to hold, we would predict that the current breeding populations may become sources of increased abundance and become more independent of regional declines. We would further predict that these source populations would gradually generate an increased abundance such that post-restoration abundance will be significantly higher than our pre-restoration abundance.

Introduction

Evaluating the effects of restoration on bird populations in Carman Valley is not a simple task. Several other factors affect bird populations simultaneously. Climatic changes such as heavy spring snow pack can push breeding birds into lower elevations such as Carman Valley, while years with light snow pack can open up high elevation breeding areas and draw birds away from low elevation sites. Dry years can lower the abundance of foraging resources. And because most birds are migratory, changes that happen on the wintering grounds, and on migration can significantly change the abundance of birds that return each breeding season.

We have examined the changes in Carman Valley with 3 different contexts for both aggregate abundance as well as examining individual species. We can compare average abundance in pre-restoration years to the average abundance in post restoration years. However such a simple comparison does not account for the confounding factors mentioned above, so this simple comparison is not a reliable indicator by itself. A more informative approach compares those pre- and post-restoration years at Carman Valley to changes at 5 other sites in the local area over the same time period. And finally we can use data from the USGS's Breeding Bird Survey to define the long and short term trends in the Sierra Nevada of our common breeding species. Within the context of these abundance trends we can glean what species may have benefited the most from changes due to restoration.

We also look at changes in abundance during the breeding period which runs from late May though July and the post-breeding dispersal period which runs from July through August. We examine changes in abundance in June as an indication of changes in the breeding population. We look at the changes in August as indicators of changes in the post-breeding dispersal period. During this latter time birds are seeking out adequate foraging sites in which to complete their molt and store fat in preparation for migration. In fact it was the abrupt decline in bird abundance during the month of August that alerted us to the deteriorating hydrology and drying up of this Carman Valley meadow. We speculated that if the restoration had any immediate direct impact on the quality of bird habitat, it would first be visible as an increase in abundance of foraging birds during the month of August.

Methods

Carman Valley (CAVA) and 4 other mist net monitoring sites have been run since 1992. The other 4 sites are at higher elevation than the Carman Valley site and in some years were inaccessible due to snow during the first weeks of June. In anticipation of the restoration a 6th monitoring site was added in 1998 at Ramelli Ranch (RARA) in Sierra Valley at an elevation that is 100 feet lower than Carman Valley. Because RARA was at a similar elevation, had similar vegetation and was part of the same watershed, this site served as a control comparison to CAVA because it would experience similar impacts due to changes in snow pack and seasonal dryness. The data from the 4 higher elevations sites is presented as one average of all four sites.

Each site was ideally monitored 3 times each month from late May to end of August. Ten mist-nets were opened from sunrise and remained open for 6 hours for a total of 60 net-hours. Birds were captured, banded with unique USGS bands and species, age and condition data taken. Capture data is presented in captures per day where daily capture represents 60 net-hours. Only CAVA and RARA were accessible each year in late May so May captures are aggregated into the June statistics.

Breeding bird survey data is taken from the USGS Breeding Bird Survey website using their trend analysis form (http://www.mbr-pwrc.usgs.gov/bbs/trend/tf03.html) Trends were taken from the data aggregated to represent the Sierra Nevada bioregion. The author of this paper also participates in 2 of those Breeding Birds Surveys.

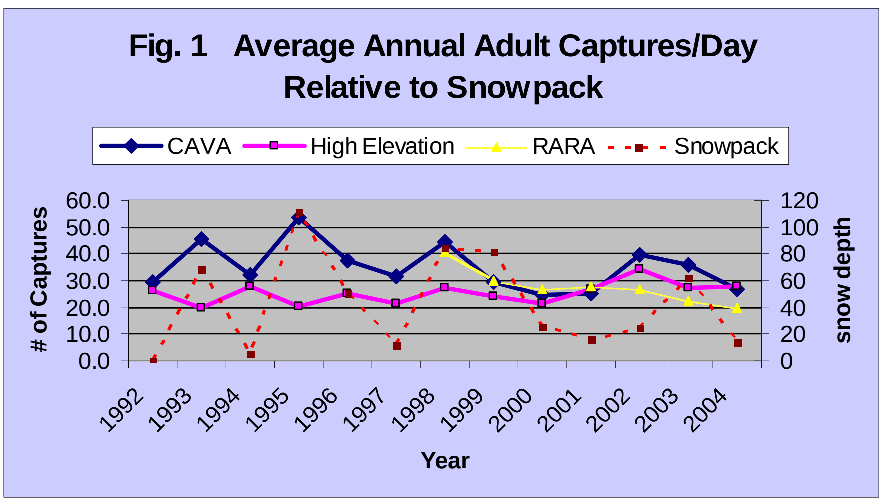
The Carman Valley site was also surveyed for breeding birds via song detection and sight on 5 different days. This provided information on presence of species not captured in the mist nets.

Results

Overall changes in abundance in the local region.

Examining the figure below (Fig.1), we can see the gross impact of changing snow pack on overall annual captures at Carman Valley, Ramelli Ranch and the 4 higher elevation sites. AS would be expected heavy snow pack that lasts into the breeding season pushes breeding birds from the high elevations into the low elevations. During the high snow years of 1992, 1995 and 1998 CAVA experienced the highest capture rates while abundance was depressed in higher elevations. This correlation is affected by timing of snow fall and temperatures. For example in 2003 almost all the snow fell in late seasons storms in April and May and melted very quickly. The effect was to have little impact on high elevation breeders. However low elevation birds who begin breeding during late April and May suffered a breeding collapse. This lowered the abundance of birds in the low elevation sites especially for species like the Orange-crown Warbler.

We see that there has been on average less snow pack in recent years and periods of higher snow-pack during the early 1990's. As a result of the lighter snow pack making more breeding habitat available, the average captures at high elevations has been "trending" higher while average captures at the lower elevation sites has been trending downwards. The RARA site exhibits a steep steady decline since its first year in 1998. The CAVA site demonstrates a similar decline in abundance as RARA and the numbers seem to follow in tandem until the post-restoration years. At CAVA the bird abundance rebounds in 2002 and 2003 and we suspect this rebound was, at least in part, due to the improved hydrology and its impact on the habitat. However in the dry year of 2004 we witnessed a lower abundance which suggests the overall climactic conditions and other factors had a strong effect on these aggregate numbers confounding any analysis of the restoration effects. However whereas in pre-restoration years we captured similar numbers in both CAVA and RARA, in contrast we captured about 50% more adults in CAVA the last 3 post-restoration years. This suggests a positive effect of restoration.



Seasonal Changes

This region of the Sierra Nevada experiences virtually zero rain from late May through August. The hydrological drying out of CAVA was most noticeable in August. With a depleted water table, the summer drought stressed the vegetation. Willows turned prematurely yellow and bird abundance plummeted. Fortunately CAVA's hydrology was restored by the fall of 2001 and the meadow was re-watered as evidenced by a rising water table, for the 2002-2004 seasons.

In the charts below for August, the positive effects of the restoration are quite noticeable. With the breeding habitats drying up as the summer drought progresses, adults are on the move and HY birds begin to dominate the riparian meadows searching for adequate food supplies. While there was little change in adult abundance at RARA during August, there was a large increase at CAVA and a smaller increase in the higher elevations. However these increases were not significant with $P<0.25$ for CAVA. However the increase at CAVA was significant for captures of HY birds. Again RARA showed no change but CAVA had 54% post-restoration increase that was significant at $P<.01$. For the higher elevations the number of HYs decreased. We feel these

August increases strongly point to the positive effects of restoration on the foraging value of CAVA. In the context of declining trends at CAVA and RARA and in the context of low snow pack years in which birds have typically moved into the higher elevations, the increases at CAVA suggest a strong site effect must be in play. And the only site effect appears to be the improved hydrology and higher water table that sustains the vegetation during the month of August.

Fig. 2 August: Average Daily Adult Captures Before and After Restoration

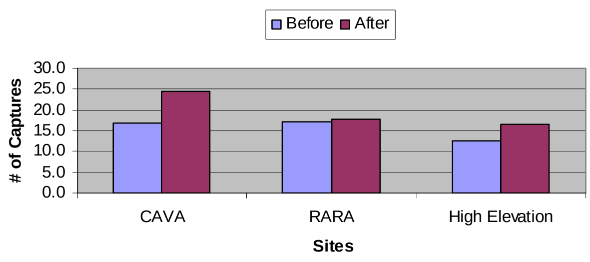
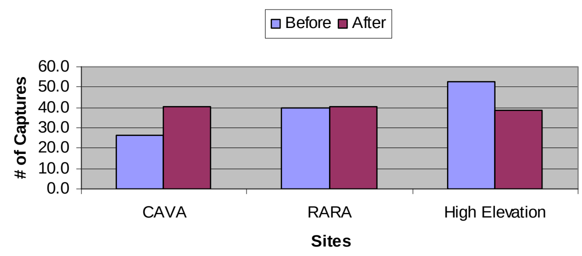


Fig. 3 August: Average Daily HY Captures Before and After Restoration



The data for the month of July is similarly supportive of the notion of a strong positive effect of restoration. In Fig. 4 we observe that the two low elevation sites experienced a drop in adult captures in contrast with an increase in captures at the high elevations. This is expected in drier years as more birds breed at higher elevations. And these adult captures reflect birds that bred on or near the monitoring site. However despite the lower adult captures in July at CAVA, we witnessed increased Hatch Year captures at Carman Valley and only at Carman Valley. It is not clear why the number of birds at high elevations has dropped over the past few years. It is tempting to think that there was a shift from the marginal habitat at higher elevations to richer resources elsewhere and Carman Valley received some of those dispersing birds. It is equally possible that there was greater productivity at the CAVA site and less breeding success at the higher elevations. It is impossible to tell from this study what factors are responsible for these differences. However these differences were not simply driven by changes in elevation as in contrast to CAVA's increasing HY's the numbers at RARA decreased. But despite our uncertainty to the exact cause, the data supports the notion that there was a positive site effect at CAVA.

Fig. 4 July:Average Daily Adult Captures Before and After Restoration

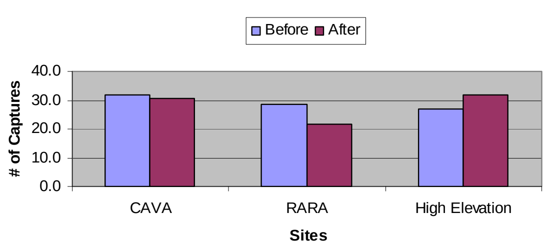
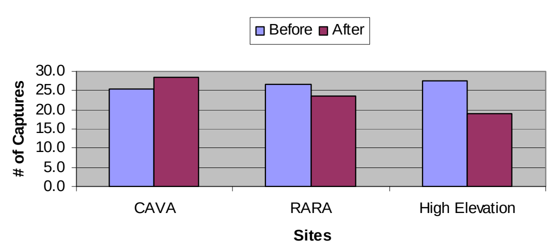
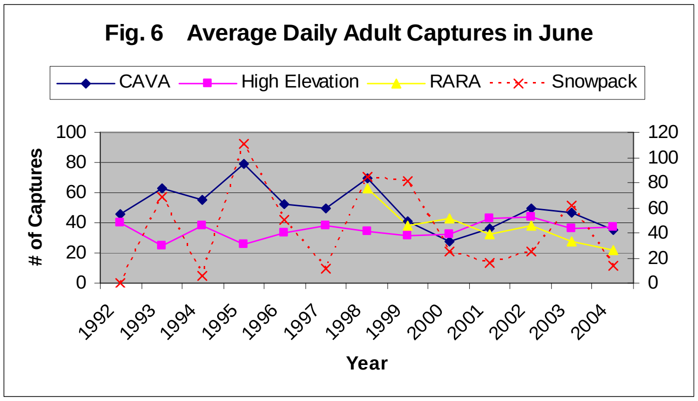


Fig. 5 July: Average Daily HY Captures Before and After Restoration



Breeding Adults



To understand the drop in July adults we must look at the changes in breeding adults and our June captures. In Fig. 6 we can see the relationship between total captures at different sites relative to snow pack. We have already discussed a partial explanation that the decreased numbers of breeding adults at lower elevations can be explained by differences in annual snow pack. Longer lasting snow packs drive breeding birds into lower elevation sites, while small snow packs open up higher elevation areas to more birds. We must also look at overall trends in the population of different species. Changes in the overall abundance will determine the size of the pool of birds that can take advantage of the fluctuating abundance and quality of breeding sites. Species that are declining in abundance may lack nearby source populations that can supply the recruits to take advantage of any improving habitat. And despite any habitat improvements on the breeding grounds, breeding populations may continue to decline if the reason for that decline rests in factors on the wintering grounds or migratory routes. For example despite restoration, we still capture 92% fewer Pine Siskins at CAVA (see Table 1). Yet the decline in Pine Siskins is not only significant at CAVA but significant to $P< 0.08$ in the Sierra Nevada aw well as showing a significant decline of -5.34 in the Western BBS region and a -12.24 decline in California and all significant at $P< 0.00000$. Clearly the decline of Pine Siskins involves factors beyond the scope of any one particular site.

However if a species has exhibited both negative short term and long term trends but in contrast the CAVA population is increasing, then we would suggest that the improved habitat conditions at CAVA may be positively and significantly responsible. For example MacGillivray's Warbler is demonstrating a negative but non-significant trend in the Sierra Nevada as well as a highly significant decline in the Western BBS region of -4.68 $P < 0.009$. Yet in Carman Valley MacGillivray's Warblers are showing a significant increase in the post restoration years ($P<0.10$). This suggests that improvements at CAVA are having a positive impact on MacGillivray's Warblers.

We are tempted to speculate that the increase of Song Sparrows, MacGillivray's Warblers, Yellow Warblers, American Robins, and Western Wood Peewees are all due to positive impacts of restoration. The highest abundance of captured Yellow Warblers, Song Sparrows and Western Wood Peewees occurred during the post restoration years. But these species are showing positive trends in the Sierra Nevada either in the long term or short term or both. There are too many confounding factors at play and only 3 years worth of post restoration data versus the 10 years of pre-restoration data. We suspect that it will take 10 years total of post restoration data before we can make more reliable determinations regarding the restorations impact on these species.

However we can confidently state that the restoration has created new breeding habitat for species that had been absent from that particular meadow since we began monitoring in 1992. Both Canada Geese and Spotted Sandpipers began breeding on each of the ponds that were created to fill the old channels. The populations of both those species has been either stable or non-significantly increasing since 1992 in the Sierra Nevada. Of greater interest is the first time nesting of 2 pairs of Sora beginning in 2004. Not only have

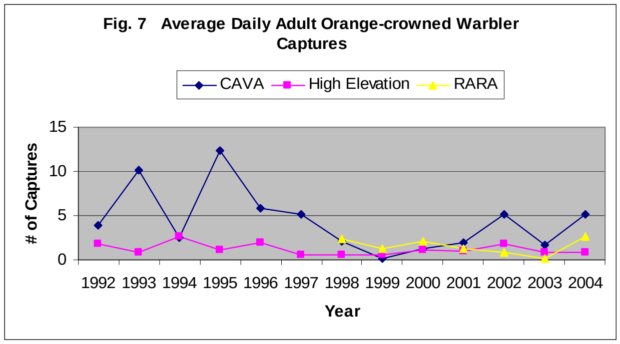
Sora been on a significant decline in the Sierra Nevada but have been declining at -7.93%/year (P <0.00000) since 1992 throughout the Western BBS region. Tree Swallows while declining in the Sierra Nevada the past 4 years began successfully breeding since 2002 in this meadow at CAVA for the first time since 1992. All of those species had source populations nearby so they could more respond more immediately to the improved habitat.

Table 1: Long and short term population trends in the Sierra Nevada. (Trend numbers for BBS data represent %/year change.)

	BBS TREND DATA FOR SIERRA NEVADA				**CARMAN VALLEY MONITORING DATA**	
SPECIES	1992-2003	P-VALUE	2000-2003	P-VALUE	POST RESTORATION % CHANGE from Prerestoration Mean	P-VALUE
1. POSITIVE LONG TERM AND POSITIVE SHORT TERM BBS TRENDS						
Yellow Warbler	1.92	0.96	6.16	0.30	+ 42.3 %	0.06
Orange-crown Warbler	1.53	0.78	22.1	0.66	- 11.1 %	0.76
*Western Tanager	3.56	0.003	0.75	0.71	+ 50.0 %	0.61
2. NEGATIVE LONG TERM AND POSITIVE SHORT TERM BBS TRENDS						
*Dusky Flycatcher	-3.88	0.02	4.18	0.47	- 55.5 %	.05
*Warbling Vireo	-1.93	0.28	11.75	0.01	- 36.3 %	0.39
3. POSTIVITE LONG TERM AND NEGATIVE SHORT TERM BBS TRENDS						
*Oregon Junco	0.94	0.36	-7.68	0.01	- 41.1 %	0.03
*Song Sparrow	5.94	0.06	-3.75	0.53	+ 87.1 %	0.08
*Tree Swallow	8.89	0.42	-30.66	0.05	New Nesting Record	
Western Wood Pewee	0.76	0.58	-3.23	0.48	+ 120.0 %	0.14
4. NEGATIVE LONG TERM AND NEGATIVE SHORT TERM BBS TRENDS						
American Robin	-0.56	0.69	-2.09	0.69	+ 16.6 %	0.75
Chipping Sparrow	-2.09	0.56	-3.18	0.62	- 33.3 %	0.37
House Wren	-1.78	0.82	-2.17	0.84	- 40.0 %	0.78
MacGillivray's Warbler	-2.16	0.47	-7.61	0.23	+ 13.1 %	0.10
*Pine Siskin	-10.2	0.08	-36.3	0.08	- 92.7 %	0.01
**Sora	-7.90	0.000	-21.90	.001	New Nesting Record	

- * Designates significant trends in the Sierra Nevada with P<0.10.
- ** Designates significant trends in the Western BBS region with P<0.001

The percent decrease in Orange-crown Warblers seems troubling in light of the long and short term positive trends. Yet this may be mostly a statistical artifact depending on the chosen starting point for comparison. If we look at the BBS trend for Orange-crown Warblers from 1992 to only 2000 we find a negative non-significant trend of -3.87%/year with P< 0.65. Also due to the above average pre-restoration captures before 1998, the average post-restoration captures are still lower despite increased post-restoration captures relative to the 1998-2001 pre-restoration years. Also he breeding failure of 2003 due to the late April and May storms seems to an anomaly that offsets a more general post-restoration increase. In Fig. 7 we see that at CAVA Orange-crown Warblers declined from 1992 but seem to be rebounding in 2002 and 2004. Thus our data reflects a bias that will not rectified until we have a more equal time period to compare with perhaps similar heavy snow packs. Likewise there are several species that would show positive post-restoration increases relative to the 1999-2001 time frame of reference but negative changes relative to the 1992 to 2001 time period.



Summary

Three years of post restoration observation is too short a time period to account for lagging restoration effects that are increasing vegetative and insect populations. However we have still observed significant positive impacts from the restoration that are significantly beneficial to bird populations. As the summer drought progresses much of the suitable habitat in the Sierra Nevada begins to dry up and become unproductive. Before restoration the number of birds in August had steadily declined. However in the post-restoration years we have witnessed an increased use of Carman Valley by both adults and hatch year birds during the post-breeding period. This increase has occurred despite a small overall decline in the number of breeding birds earlier in the year.

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Appendix A

Table 1. Total Captures from 1992-2004.

(These numbers are not adjusted for annual changes in time of effort as are the numbers used to make the charts.)

Total captures for 6 sites in the Sierra Nevada													
SPEC	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AMDI											1		1

Total captures for 6 sites in the Sierra Nevada

SPEC	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AMKE												1	
AMRE	1												
AMRO	54	22	46	24	31	29	42	45	27	58	78	48	46
AUWA	186	37	444	53	97	314	122	104	213	164	180	87	117
BBMA										2			
BBWO						1					1		1
BEKI												1	
BEWR							1	2		3			9
BGGN		1											
BHCO	6	3		1	5	5	7	15	4	4	7	18	7
BHGR	5	3	8	1	8	15	32	28	19	12	15	25	19
BLPH													1
BRBL	3	3	2			1	1	2				2	4
BRCR	18	9	24	20	18	17	22	11	29	47	28	24	17
BRSP	12	4	8	2	11		12	9	9	18	28	12	5
BTSP											1		
BTYW	4	2	5			2	2			3	1	2	3
BUOR			3										
BUSH			1		1				2	13	2	4	
CAFI	50	20	50	21	14	15	12	14	9	10	17	29	28
CAVI	41	21	30	22	22	21	21	20	22	17	18	32	15
CCSP								1					
CEDW					1		2						
CHSP	31	19	35	19	13	10	30	11	13	14	31	26	46
CLSW									2	2	1		
COYE						1		1	2	2			1
CSWA													1
DOWO			1	3	3	2	5	3	9	3	5	1	1
DUFL	55	47	69	41	51	46	67	41	46	70	96	75	57
EUST				1									
EVGR	9	7	7	4	4	19	7	7	6	4	11	18	9
FOSP	36	18	16	15	24	21	58	47	34	45	47	23	15
GCKI	21	10	37	10	13	27	20	16	24	29	15	18	3
GRFL	34	13	24	16	12	20	2	13	21	34	14	24	24
GRSP													1
GTTO	23	14	15	26	22	17	83	54	32	48	42	28	22
HAFL	33	30	50	5	56	26	25	24	39	32	29	29	26
HAWO	5	2	2	2	2	2	4	3	4	3	6	6	2
HETH	13	6	4	1		7	7	4	4	15	17	8	16
HEWA	31	17	130	15	29	40	24	22	38	19	39	15	26
HOFI									3		12	2	6
HOWR	29	18	30	16	26	12	7	10	12	19	26	5	18
INBU					2								

Total captures for 6 sites in the Sierra Nevada

SPEC	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
LAZB	11	10	5	2	9	14	4	3	5	14	21	15	12
LEGO	3		2	1			9	11	6	24	12	15	18
LISP	90	81	77	98	154	144	157	104	132	170	91	93	96
MAWA							1						
MGWA	89	111	158	129	170	109	160	89	107	99	162	162	156
MOBL			3										
MOCH	78	35	55	44	34	30	37	60	115	59	124	81	87
MWCS	106	54	72	68	58	50	102	81	73	79	86	64	48
NAWA	173	61	419	66	57	56	29	31	47	27	65	21	54
NOWA										1			
NRWS					1			2	2	1	5		
OCWA	612	294	1530	306	452	269	197	156	360	182	414	158	396
OJRU													4
ORJU	462	188	377	158	274	283	267	279	329	426	435	296	278
OSFL	1		1		1			1	2	1			1
PIGR	1	2		3	4	3	11	2	12	2	19	8	9
PISI	63	35	126	51	42	30	57	17	24	16	10	8	5
PSFL	1	1	3		1	1	1	1		2			1
PUFI	24	22	22	4	15	9	27	7	10	31	56	30	27
PYNU					1				1			1	1
RBNU	22	4	23	19	26	4	12	10	52	4	26	6	33
RBSA	50	33	26	11	24	14	32	17	35	49	58	46	46
RCKI										2			
RECR								2		2			
RSFL	1	1			4	1	2	1			4	2	2
RWBL		1				2	1		2		1	2	2
SAVS	12	2	4	8	11	22	10	12	10	16	13	14	34
SOSP	94	76	79	79	122	142	320	211	193	142	211	202	185
SPSA		1						5	1		1		
SPTO	12	4	8	6		3	23	13	11	10	15	13	7
SPTT													1
SSHA	1												
STJA		2					3	2	2		2	1	
SWTH	6	5	3	1		3	5	10	21	12	15	12	18
TOSO	1		1		1				3	2	3	2	1
TOWA			2	2	1	1						1	
TRES												1	
VESP	11	5	7	3	5	5	19	8	10	12	7	4	3
WAVI	88	93	125	85	79	63	90	72	53	104	104	76	53
WBNU		1			3		1	1	1	1	3		2
WEBL	6		6				1	1			1		2
WEFL									3	1	1	4	1
WESJ		1											

Total captures for 6 sites in the Sierra Nevada													
SPEC	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
WETA	12	4	49	13	18	33	18	35	31	43	44	44	49
WEWP	25	16	29	13	20	30	28	15	34	45	58	46	54
WHWO			2	1	1	3	1	3	1		6	6	2
WIFL	18	18	15	9	12	13	9	9	7	19	19	10	16
WISA	1	2	2		5	4	3	7	3	1	2	1	
WIWA	212	200	237	181	208	175	217	173	156	173	171	170	174
WIWR						3		2	1		1	1	
YWAR	74	74	73	69	80	103	128	93	128	120	142	158	185