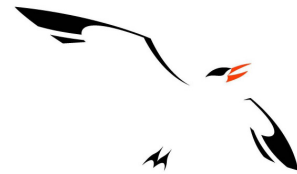


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Amargosa Canyon Songbird Project
2005-2009 Report to the Bureau of Land Management and Fish and Wildlife Service



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PRBO Contribution No. 1733

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SUMMARY

In 2009, the Amargosa River was re-colonized by 6 pairs of Bell's Vireos and 2 unmated males (Figures 2a and 2b). We located 8 nests for these pairs, three of which were abandoned prior to laying. The other five nests fledged 18 chicks. This was the first Bell's Vireo nesting observed in the Amargosa Canyon since 2006, and the first Bell's Vireo nesting ever observed on the Shoshone reach of the Amargosa River. While difficult to quantify, it is likely that *Tamarix* removal on the Shoshone reach opened up suitable habitat for Bell's Vireos, while cowbird trapping at several locations since 2007 produced enough potential recruits at China Ranch (which we found to host over 20 pairs in 2005) to then colonize Shoshone and the Amargosa Canyon.

From 2005-2008, PRBO Conservation Science surveyed approximately 120 hectares of native and *Tamarix*-dominated riparian habitat on the Amargosa River (Shoshone and Tecopa, CA) for Least Bell's Vireos and Southwestern Willow Flycatchers (Figures 1a - c). Over this period, we found one Bell's Vireo nesting territory on the Amargosa River, a pair that nested within 100m of the southern edge of the 2002 catastrophic burn. This pair was present in 2005 and in 2006, and all four nests were built in saltcedar (hence referred to as *Tamarix*, to represent a complex of *Tamarix ramocissima*, *Tamarix chinensis*, and *T. ramocissima* X *T. chinensis* found in the Southwestern United States), an exotic. We also found one unmated Bell's Vireo territory (in 2005) and one unmated Willow Flycatcher territory (in 2006), each in the burned area of the Amargosa Canyon.

Over the period of this study, we have located and monitored 465 nests for 32 species. With support from the Fish and Wildlife Service, we have maintained and ran seven to eight Brown-headed Cowbird traps at the Amargosa Canyon, Shoshone, and China Ranch since 2007. We have euthanized 203 female cowbirds over three years of cowbird trapping, and we have reduced cowbird parasitism from 40 percent before cowbird trapping to zero in 2009.

Similar to previous seasons, we detected Willow Flycatchers on the Amargosa River, but these individuals were migrants that did not remain for more than two or three days. From 2005-2009 we have not found Willow Flycatchers to breed on the Amargosa River.

INTRODUCTION

Riparian habitats cover only a small percentage of California (<0.5%), yet they may be the most important habitat for landbird species in California (Riparian Habitat Joint Venture 2004). Desert riparian habitats are by definition isolated and rare, and they face multiple threats. These threats include exotic plant invasions, increased fire frequency, domesticated and feral livestock over grazing, groundwater pumping, and outright loss to urbanization (Moore 2001). Only 2 – 15% of California's original desert riparian still exists, and much of remaining riparian habitats are fragmented and degraded (RHJV 2004).

In 2005, PRBO Conservation Science initiated the Amargosa Canyon Songbird Project (ACSP) in collaboration with the Bureau of Land Management Barstow Field Office and United States Fish and Wildlife Service Ventura Office. The ACSP began as an effort to locate breeding territories and nests of federally endangered Southwestern Willow Flycatchers and Least Bell's Vireos in advance of *Tamarix* removal on BLM, California Department of Fish and Game, and private landholdings on the Amargosa River and its tributary, Willow Creek (USFWS 2005). Much of the *Tamarix* removal project area lies within the Amargosa Canyon Area of Critical Environmental Concern, and is Wilderness. The entire project area also lies within the Shoshone-Tecopa Important Bird Area (IBA), one of only 148 Important Bird Areas designated by California Audubon within the state.

Partners In Flight (PIF) represents a cooperative approach to land bird conservation amongst federal, state, and local agencies, academia, non-profit organizations, industry, and philanthropic groups (<http://www.partnersinflight.org/description.cfm>). It has existed since 1990. As members of PIF and its California Partners In Flight (CalPIF) state chapter, PRBO Conservation Science, the BLM, and the FWS have sought to follow PIF's core objectives of helping species at risk, keeping common birds common, and developing voluntary partnerships for birds, habitats, and people by providing high-quality data collection and analyses to PIF contributors throughout the western United States. Thus PRBO has placed strong emphasis on all-species data monitoring and data collection, in order to contribute our findings on the entire avian community to land managers, to California Partners In Flight, and to inter-agency planning efforts such as the Riparian Joint Venture.

As such, surveying for Southwestern Willow Flycatchers (*Empidonax traillii extimus*) and Least Bell's Vireos (*Vireo bellii pusillus*) on the Amargosa River has presented PRBO a unique opportunity to stretch agency funds and gather territory and nest data on the Amargosa Canyon's entire avian community, in order to gauge the avian community's response to *Tamarix* removal and Brown-headed Cowbird (*Molothrus ater*) trapping.

The Amargosa River's riparian habitat is highly isolated due to its location near Death Valley in the central Mojave Desert, and it houses disjunct populations of several riparian bird species that are susceptible to local extirpation in the absence of sound management practices. Importantly, aside from Least Bell's Vireos and Southwestern Willow Flycatchers, several other species of concern are found to breed on the Amargosa River at Amargosa Canyon and Shoshone. Crissal Thrashers (*Toxostoma crissale*), Lucy's Warblers (*Vermivora luciae*), Yellow Warblers (*Dendroica petechia*), Yellow-breasted Chats (*Icteria virens*), and Loggerhead Shrikes (*Lanius ludovicianus*) are all California Species of Special Concern (Shuford and Gardali 2008) that we have found to breed at our study sites on the Amargosa. In addition, the Amargosa River represents the northwestern edge of the breeding ranges of several Mojave and Sonoran Desert species, such as Lucy's Warblers, Crissal Thrashers, Verdin (*Auriparus flaviceps*), Black-tailed Gnatcatchers (*Poliophtila melanura*), Brown-crested Flycatchers (*Myiarchus tyrannulus*), Ladder-backed Woodpeckers (*Picoides scalaris*), and a Sonoran Desert subspecies of Song Sparrow (*Melospiza melodia fallax*). Finally, we have noted an invasion by Indigo Buntings (*Passerina cyanea*) - over 20 territories detected in 2009 from one in 2008 - marking the westward edge of this species expansion.

To assign value of *Tamarix* eradication, we should consider value to the riparian avian community, weighing the effects of geography, landscape, and the likelihood that the restored riparian zone will provide high-quality native habitat (Sogge et al. 2006). However, while *Tamarix* removal from southwestern riparian habitats is an important objective for several federal and state agencies, these agencies lack pre- and post-treatment land bird data to apply adaptive management to *Tamarix* eradication projects (Sogge et al. 2006).

In the meantime, the current data that does exist on avian response to *Tamarix* eradication is mixed. Sogge et al. (2006) found that *Tamarix* habitats were not detrimental to Southwestern Willow Flycatcher physiology, immunology, site fidelity, productivity, and survivorship in Arizona (2005). Ellis (1995) found that bird species richness does not diminish in *Tamarix*-dominated habitats, but species composition changes - suggesting that maintenance of native riparian habitats will be necessary to conserve certain land bird breeding species in riparian zones of the Southwest. Sogge et al. (2005) found that the area and volume of *Tamarix* stands in the Grand Canyon were among the best positive predictors of bird species abundance, richness, and diversity. Sogge et al. (2008) noted that *Tamarix*'s value as habitat varies substantially by geography and bird species under consideration. At the Lower Colorado River, Van Riper et al. (2008) found that while *Tamarix* monocultures have lower breeding bird abundance, breeding bird abundance increases significantly if native vegetation reaches 20-40% of riparian cover.

Thus our all-species approach at the Amargosa Canyon will provide the BLM and USFWS with up-to-date information on Bell's Vireo and Willow Flycatcher territory location to assist restoration efforts, while simultaneously providing much-needed data on the entire riparian avian community's response to *Tamarix* removal and Brown-headed Cowbird management.

1.1 METHODS

1.1.1 Study Design

We initiated a 31.8 hectare plot near Shoshone (SHOS), a 32.7 ha plot at the north end of the Amargosa Canyon (AMNO), and a 34.5 ha plot in the southern Amargosa Canyon, at Modine Meadows (AMSO) (Figures 1a - c). Though the SHOS and AMNO plots each have contained significant amounts of *Tamarix*, they are generally now dominated by native vegetation. The AMSO plot is dominated by *Tamarix*.

The AMNO plot was nearly entirely burned in a spring 2002 fire, and is in regeneration. The southern boundary of the AMNO plot matches the burn's southern extent. The AMNO plot is dominated by *Salix exigua* and isolated, recovering clones of *Salix gooddingii*. By 2009, these *S. gooddingii* had recovered to reach over 5 m in height on occasion. In addition, upland transition areas of the AMNO plot hold large patches of dense *Atriplex lentiformis*, *Pluchea sericea*, and *Phragmites australis*, with isolated pockets of *Prosopis glandulosa* and *Prosopis pubescens*. Some of these *Prosopis* patches are tucked into rocky areas that escaped the 2002 burn. Finally, the wettest reaches of the AMNO plot are becoming choked with *Typha* and *Schoenoplectus maritimus*. Both native and exotic vegetation have recovered rapidly after the fire, and BLM crews removed *Tamarix* re-growth across the southern half of the plot in the winter of 2006. We have monitored the AMNO plot for all species each season, beginning in 2005.

The AMSO plot did not suffer from the 2002 fire, and it contains mature stands of *Tamarix* that can exceed 7 m in height. These *Tamarix* stands form a closed canopy throughout much of the plot, though the *Tamarix* is occasionally broken by *S. maritimus* in wet areas and by isolated *P. glandulosa* and *P. pubescens* (even where the *Tamarix* is most dense). In addition, there are large swaths of *A. lentiformis* and *Suaeda moquinii* which are adjacent the Amargosa main stem's riparian and also adjacent spreading riparian channels within Modine Meadows. Finally, there is a semi-desiccated marsh in the northeastern section of Modine Meadows which holds *Typha*, *Schoenoplectus*, and sporadic, smaller *Tamarix*. The AMSO plot was assessed for all-species in 2005 and 2007, though we survey the AMSO plot for Least Bell's Vireos and Southwestern Willow Flycatchers every season.

The SHOS plot is approximately 20 miles upstream of Amargosa Canyon, on the Amargosa River near the town of Shoshone. The SHOS plot was initiated in 2006, prior to *Tamarix* removal. It is more xeric than the Amargosa Canyon plots, and prior to *Tamarix* eradication, the SHOS plot was dominated by *P. pubescens*, *P. glandulosa*, and *A. lentiformis*, with significant *Tamarix* cover as well. In addition, the SHOS plot also held isolated groves of *Tamarix aphylla* that reached approximately 10 m in height. Nearly all of this *Tamarix* cover was removed by the BLM prior to the 2007 field season, and the BLM has returned to the SHOS plot to control *Tamarix* regeneration after the 2007 field season as well. We have monitored the SHOS plot for all species since 2006. In addition, we surveyed approximately 25 hectares of the riparian zone south of Highway 178 in 2007-2009 for Least Bell's Vireos and Southwestern Willow Flycatchers in preparation for scheduled *Tamarix* eradication.

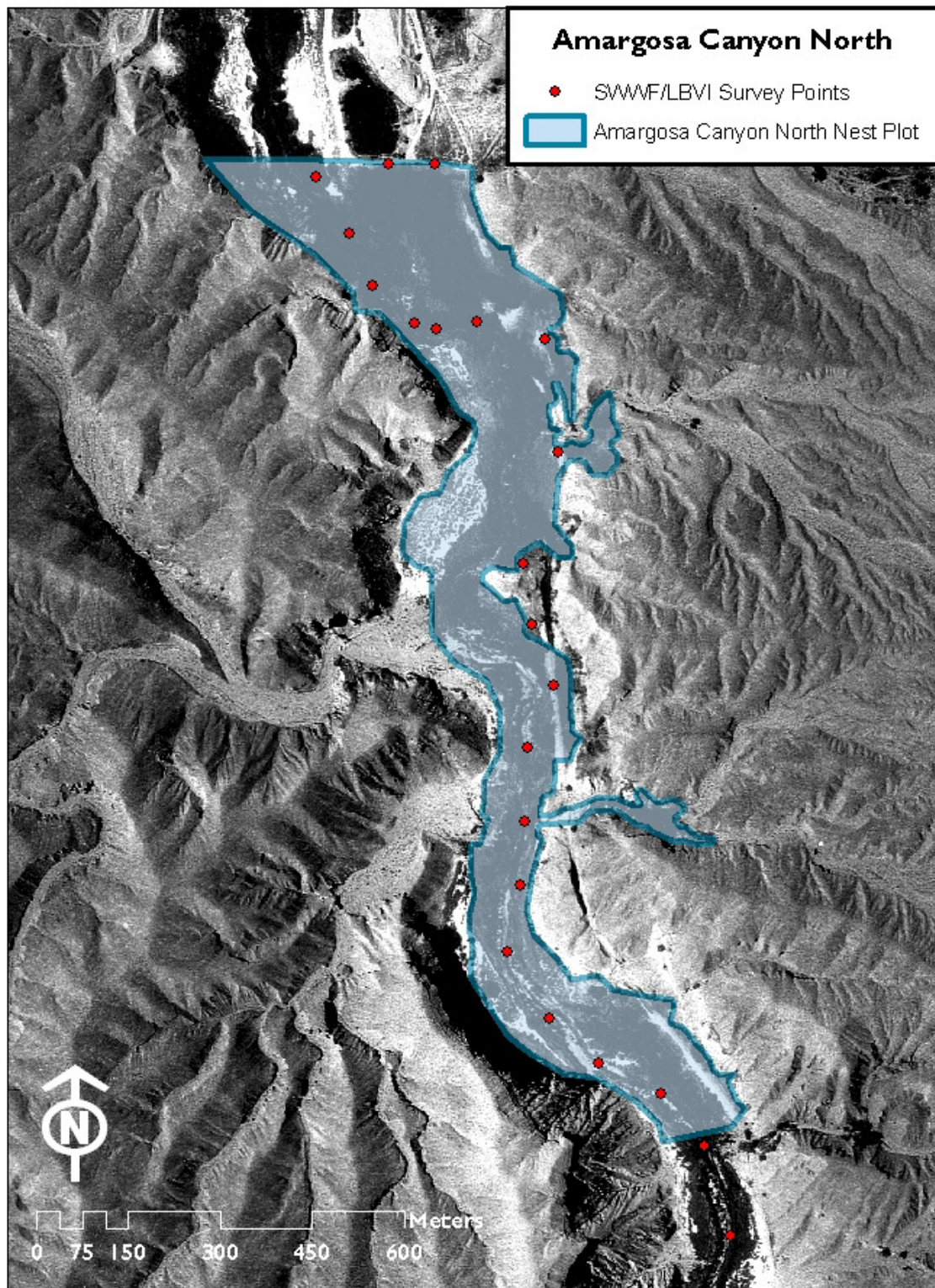


Figure 1a. Amargosa North (AMNO) nest plot, with Southwestern Willow Flycatcher and Least Bell's Vireo playback survey points. Monitored 2005-2009.

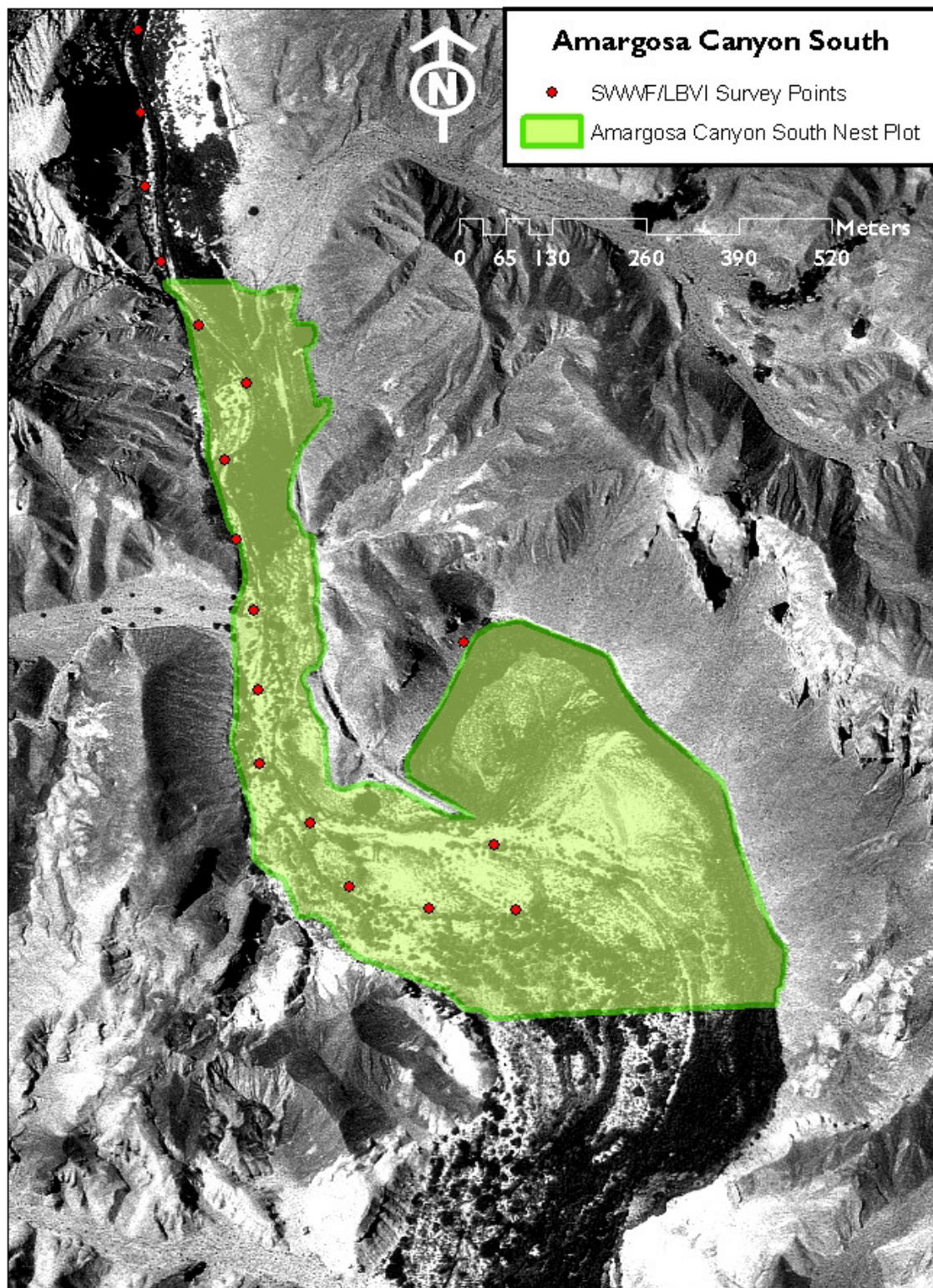


Figure 1b. Amargosa South (AMSO) nest plot, with Southwestern Willow Flycatcher and Least Bell's Vireo playback survey points. Monitored 2005 and 2007.

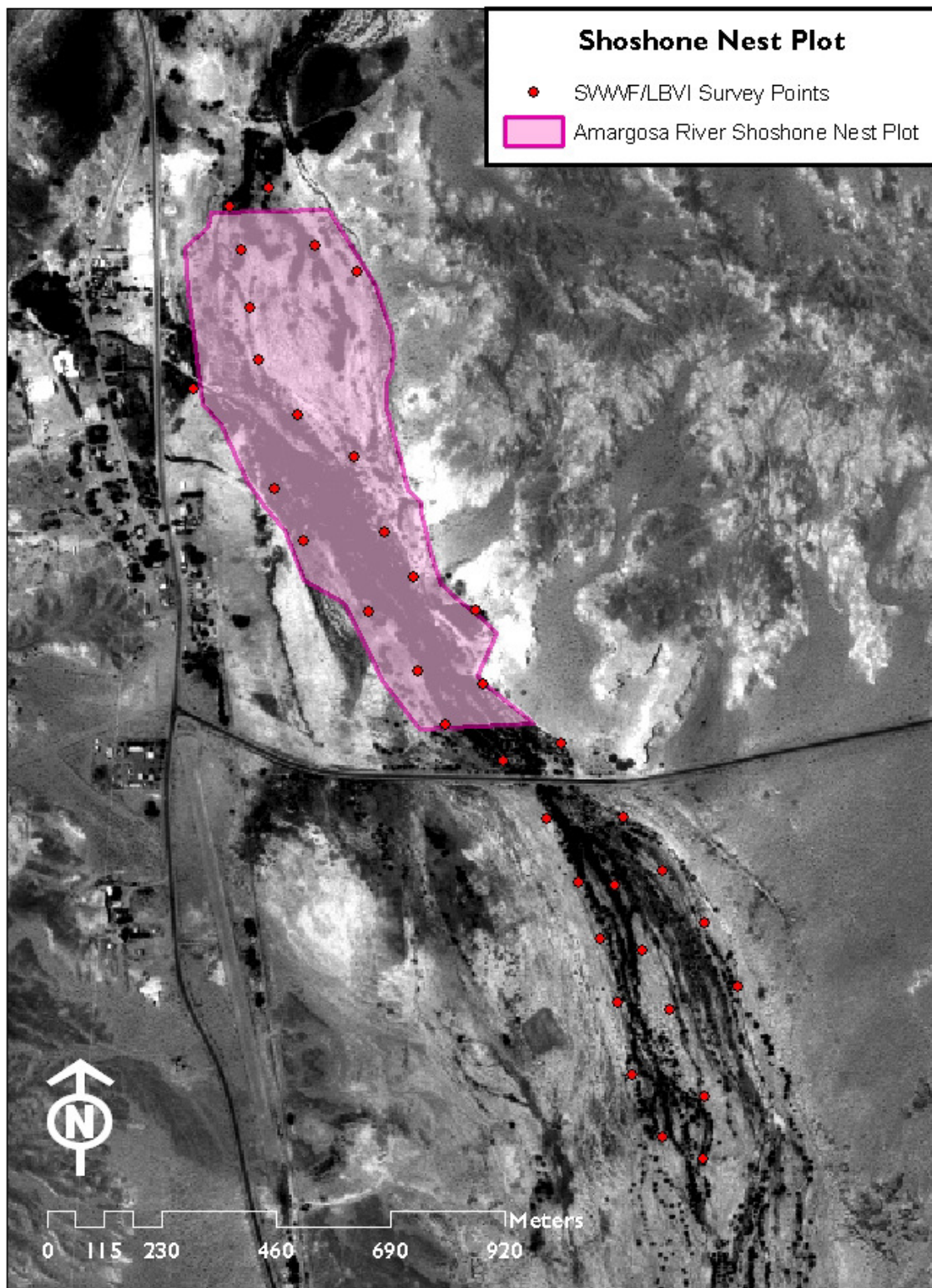


Figure 1c. Shoshone (SHOS) nest plot, with Southwestern Willow Flycatcher and Least Bell's Vireo playback survey points. Monitored 2006-2009.

1.1.2 Territory Mapping.

On UTM-gridded maps and using GPS Garmin V receivers, we mapped territorial behavior and nests for all species present on each plot three to four days per week, April 1 – July 31, 2005-2009. We followed guidelines suggested in International Bird Census Committee recommendations (IBCC 1970) and following Ralph et al. (1993). At the end of the season, daily spot maps were compiled to create territory maps of all breeding species. Territory numbers were summarized following Hall (1964). Non-territorial species (e.g. Mourning Doves, House Finches) were summarized by number of detected nesting females.

1.1.3 Nest Finding and Monitoring and Nest Vegetation Measurements

We located nests on each plot, which we then monitored at least once every four days, following protocols described in Martin and Geupel (1993), Martin et al. (1997), and Rourke (1999). On each visit to the nest, nest contents were recorded, and Brown-headed Cowbird parasitism noted. After nesting was complete, 5 m-radius and 11.3 m-radius vegetation assessments about each nest were conducted also following Martin et al. (1997). Using the same protocol, thirty non-nest vegetation assessments were conducted at randomly-generated locations on each plot for each season.

Nest and non-nest assessments included absolute cover estimates of shrub cover, non-woody cover, and groundcover. Groundcover was broken into “litter”, “bare ground”, and “rock”. Relative covers (by species) of absolute shrub and non-woody cover were estimated; relative species covers were then multiplied by absolute shrub and non-woody cover to give by-species absolute cover estimates for analysis. Numbers of “tree” stems (by species, stems over 8 cm in diameter at breast height (DBH)) were recorded by DBH size categories, in 11.3 m-radius plots around each nest and non-nest point. Canopy measurements included: “canopy height”, the maximum height of the canopy within 11.3 m of the nest, and “canopy cover”, the percent of the 11.3 m-radius plot covered by vegetation greater than 5 meters in height.

1.1.4 Brown-headed Cowbird Censuses

Tallies of Brown-headed Cowbirds were conducted daily on all plot visits from beginning of surveys until the end, in order to provide a per-hour index of cowbird abundance. Tallies are only indices of occurrence, not absolute counts.

1.1.5 Statistical Analyses

Nest survivorship calculations were limited to a pool of nests with known outcome and which were observed with at least one egg or young. Nest survivorship was calculated using two methods: Mayfield (1975, 1961) as recommended by Johnson (1979), and Proportion Successful (Martin 1992). The Mayfield method calculates the probability of nest success based on the daily survival rate of the given sample of nests. The method corrects for the fact that nests in any sample are likely to be found at various stages in the nest cycle. The recommended number of nests for use of the Mayfield method is 75 per species, however 20 nests is considered the absolute minimum sample size (Nur et al. 1999). We present Mayfield survival estimates for some species with sample sizes under 20, to provide a glimpse of this method’s capabilities once proper sample sizes are accrued over several seasons.

Host eggs that disappeared in coincidence with the appearance of a new cowbird egg were assumed to be ejected by Brown-headed Cowbirds. Eggs that did not hatch in parasitized nests were presumed to not hatch due to cowbird parasitism. Nests were considered successful if at least one fledgling was observed, if parents were observed with repeated food carries to single locations, or

nestlings were seen within four days of the expected fledge date (and subsequent timing of re-nesting attempts did not point to nest failure of the original nest).

Statistical analyses were conducted with Stata Release 8.0 (STATA Corp. 2003) and Program R 2.6.2 (R Development Team 2008).

1.1.6 Endangered Species Surveys

In its *Biological Opinion for the Saltcedar Removal and Riparian Restoration Project within the Amargosa River Drainage* (2005), the USFWS asserted that the BLM should survey for federally-endangered Southwestern Willow Flycatchers (*Empidonax traillii extimus*) and Least Bell's Vireos (*Vireo bellii pusillus*), to minimize potential take during *Tamarix* eradication efforts (29).

We followed all Southwestern Willow Flycatcher and Least Bell's Vireo survey techniques and schedules outlined in Attachments A and B of the USFWS *Biological Opinion* (USFWS 2005), Sogge (2000 and 1997) and Rourke et al. (1999) in order to locate, map, find and monitor nests, and establish buffers for these species in advance of *Tamarix* eradication. In addition, our constant spot-mapping effort on the SHOS, AMNO, and AMSO plots enabled us to detect additional Bell's Vireos and Willow Flycatchers not detected during presence/absence surveys. Spot-mapping and nest-monitoring methodologies are found in Section 1.1.3 of this report.

Survey point locations are provided in Figures 1a-1c. All points in the Amargosa Canyon were surveyed in 2005, 2006, and 2007. Points near Shoshone were surveyed in 2006 and 2007 (north of Highway 178), and in 2007 (south of Highway 178).

1.1.7 Brown-headed Cowbird Trapping

The FWS secured funding in 2007-2009 to build and monitor eight Brown-headed Cowbird traps at select locations within the Saltcedar Removal and Riparian Restoration Project's area. With the help of several private land owners at Shoshone, Tecopa, and China Ranch, we set up seven of these traps in 2007, saving the eighth trap as a spare.

We conducted Brown-headed Cowbird trapping following methods described in McLeod et al. (2007). We used eight funnel-shaped Brown-headed Cowbird traps, also described in McLeod et al. (SWCA Consultants, which produced the McLeod et al. report, built the cowbird traps used on the Amargosa River).

Trap locations are depicted in Figures 2a-c. We placed two traps on the SHOS plot, and one trap on the AMNO plot. In addition, we placed two traps at nearby China Ranch, where the densest population of Bell's Vireos in the project area exists. We also placed one trap near the AMNO plot in Tecopa, near a horse corral where Brown-headed Cowbirds were seen gathering in 2005 and 2006. We also placed a cowbird trap at a private residence in Shoshone, again, where cowbirds were seen to congregate in 2005 and 2006.

We opened one trap each at Shoshone, China Ranch, and the Amargosa Canyon on April 19, approximately at the same time migrating female Brown-headed Cowbirds arrive at project sites. We opened second traps each at Shoshone, China Ranch, and the Amargosa Canyon on May 5, and our third Shoshone trap on June 10.

McLeod et al. (2007) noted that ideally, traps should be placed within 400 m of breeding areas. We strove to follow this suggestion; however, the AMSO plot is in Wilderness, and is a two-mile hike from the closest entrance point, preventing placement of a cowbird trap within 400 m of this plot.. If cowbirds

parasitize a higher percentage of nests on the AMSO plots than on SHOS or AMNO in the future, shooting may be the only potential control method for cowbirds breeding on the AMSO plot. However, with traps at AMNO, Tecopa, and at China Ranch, we have staked out the most likely entrance points for cowbirds commuting to the AMSO plot from their foraging grounds, and this may be enough to control them at this remote location.

Traps were checked at least once, and usually twice every 24 hours, and were replenished with water and seed regularly. Upon each trap check, we noted all new and existing cowbird captures, and recorded and released all non-target captures. At the direction of the FWS, only female cowbirds were euthanized. Juveniles were immediately released. Females and males' wings were clipped to prevent injury while being used as decoys, and males were cycled out of the traps if they had been used as a decoy for more than approximately seven to ten days.

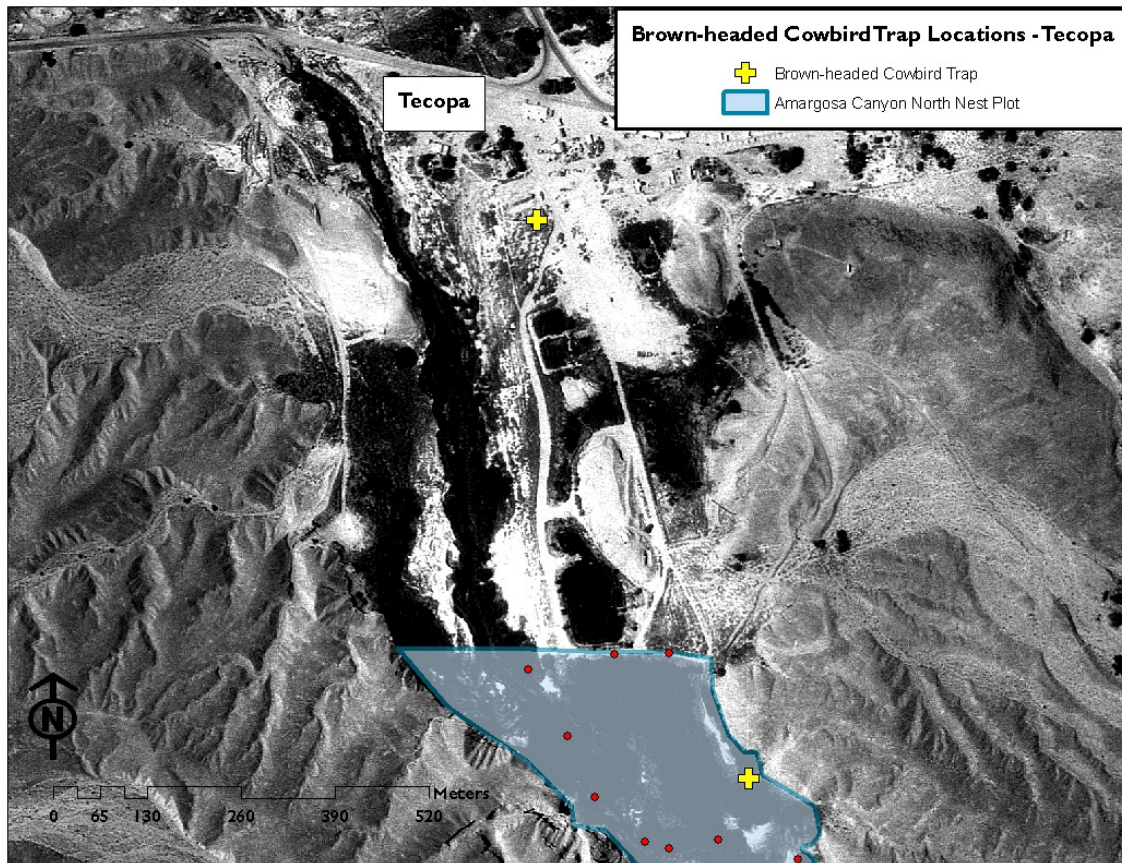


Figure 2a. Two Brown-headed Cowbird trap locations near the Amargosa River at Tecopa, CA. The Amargosa North (AMNO) nest plot is shaded blue.

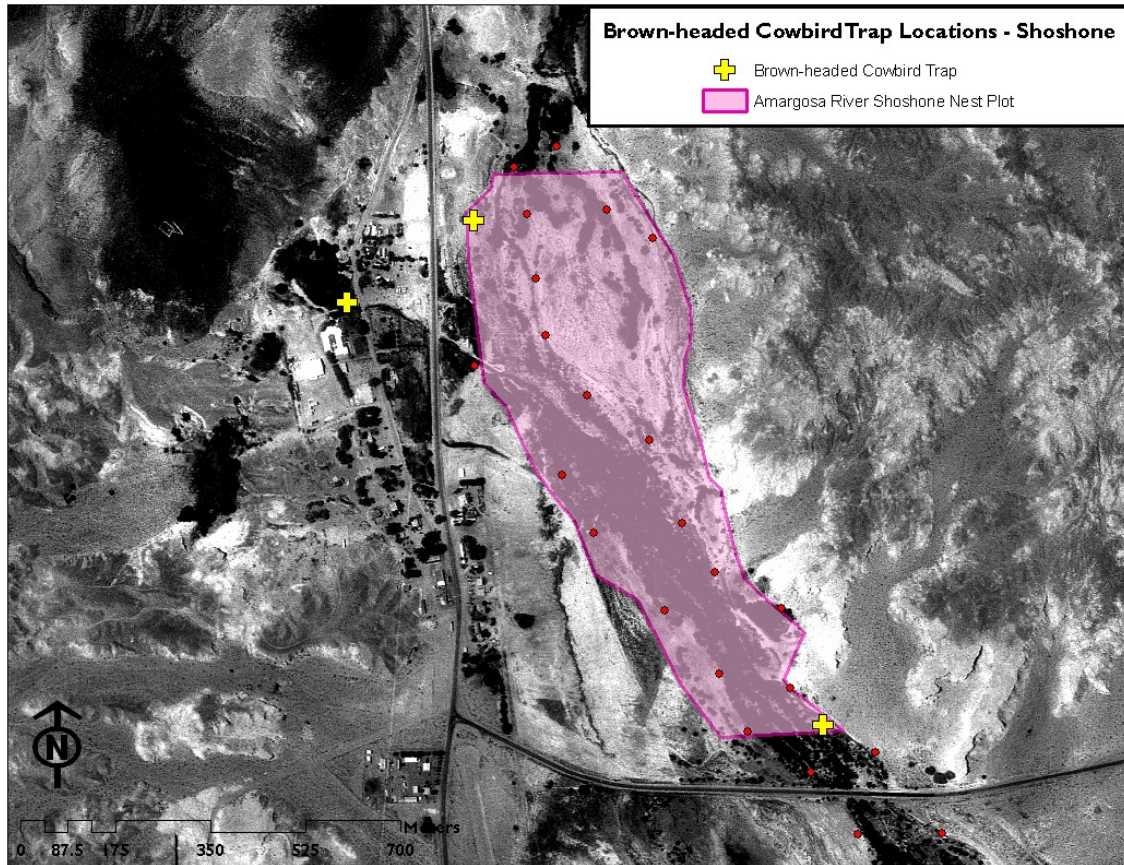


Figure 2b. Three Brown-headed Cowbird trap locations near the Amargosa River at Shoshone, CA. The Shoshone (SHOS) nest plot is shaded purple.

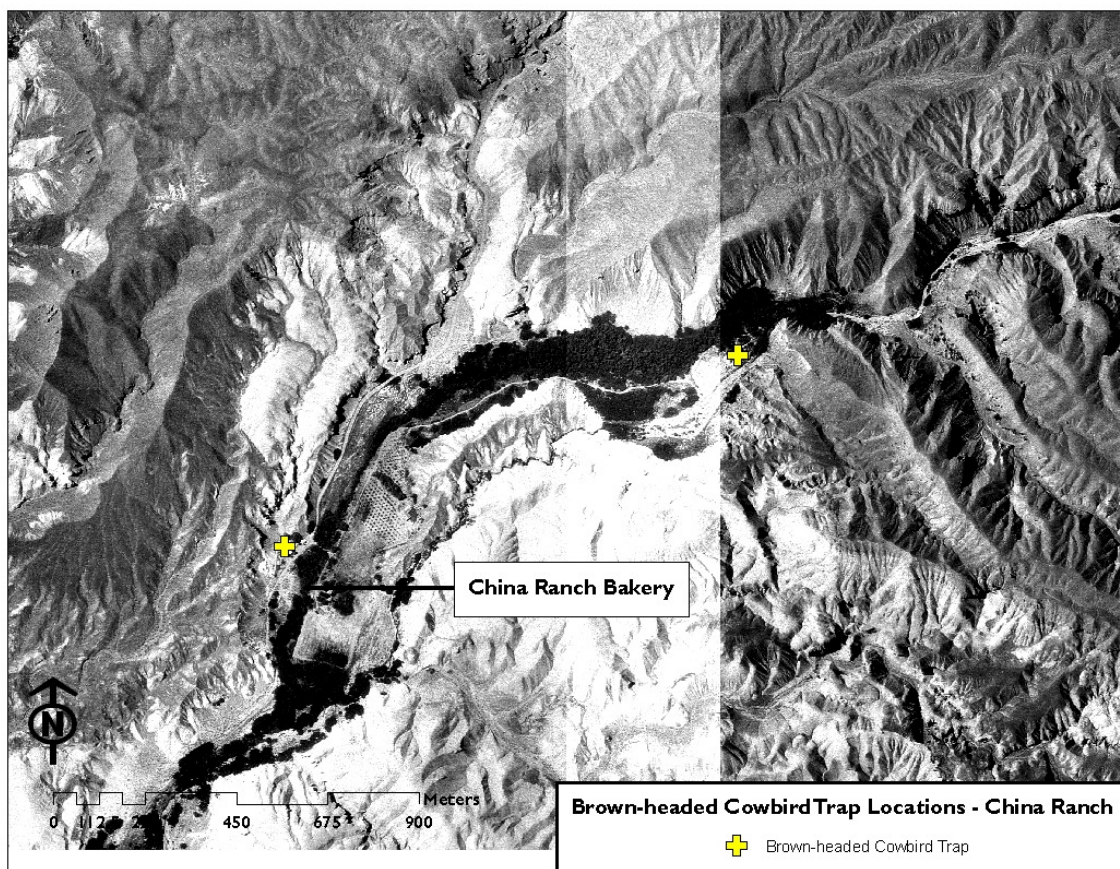


Figure 2c. Two Brown-headed Cowbird trap locations at China Ranch on Willow Creek, a tributary of the Amargosa River.

1.2. RESULTS AND DISCUSSION

1.2.1 Bell's Vireos

We detected six pairs of Bell's Vireos in 2009 (four pairs on the Shoshone plot and two on the Amargosa Canyon plot), as well as two unmated males (one on each plot). Figures 3a and 3b show territory and nest locations. We have not detected territorial Bell's vireos on the AMSO plot.

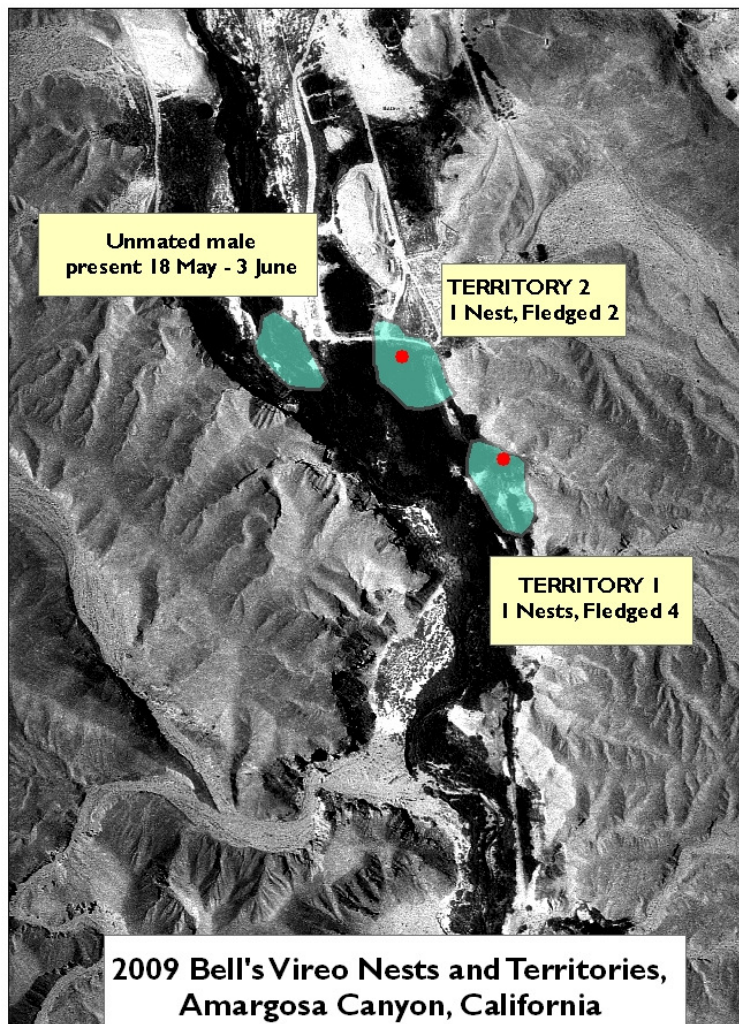


Figure 3a. Bell's Vireo territory locations and nests, Amargosa North plot (2009).

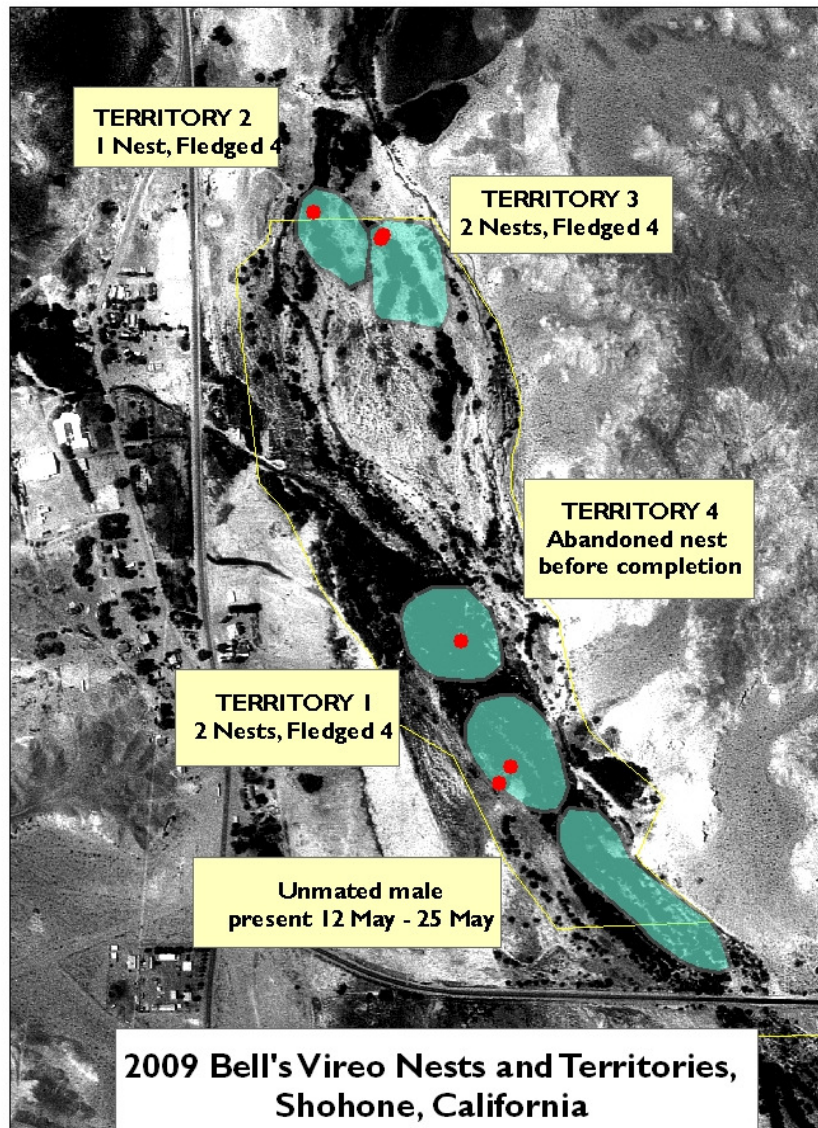


Figure 3b. Bell's Vireo territory locations and nests, Shoshone plot (2009).

Table 1. Bell's Vireo nest locations and outcomes, 2009. Coordinates in NAD83 Zone 11.

Pair	Date found	Substrate	utme	utmn	Outcome
Amargosa1	20-May	Honey Mesquite	570203	3966416	fledged 4
Amargosa2	22-May	Narrowleaf Willow	570023	3966625	fledged 2
Shoshone1	12-May	Honey Mesquite	566189	3981345	abandoned
Shoshone1	29-May	Honey Mesquite	566212	3981367	fledged 4
Shoshone2	21-May	Screwbean Mesquite	565918	3982180	fledged 4
Shoshone3	23-May	Screwbean Mesquite	566025	3982150	abandoned
Shoshone3	6-Jun	Screwbean Mesquite	566022	3982144	fledged 4
Shoshone4	4-Jun	Screwbean Mesquite	566137	3981549	abandoned

1.2.2 Willow Flycatchers

We again failed to locate paired Willow Flycatchers on the Amargosa River. Table 2 lists detections and coordinates in 2009, as well as behavior. Daily follow-up visits to these locations did not yield flycatchers. We have not found paired Willow Flycatchers at this location since the project's inception, only migrants generally found at roughly the same locations in the canyon each season, as they pass through on migration.

Table 2. 2009 Willow Flycatcher detections, with UTM coordinates in Nad83 Zone 11.

Date	utme	utmn	Behavior
22-May	569907	3966587	one fitzbew, foraging
25-May	569895	3966630	silent, around all morning
3-Jun	570000	3966600	10 fitzbews, but never seen after 6/3
3-Jun	569960	3966445	2 birds, 2 fitzbews some interaction but never seen again
15-Jun	570215	3966204	one fitzbew, foraging
15-Jun	570200	3965788	heard one fitzbew, nothing further

1.2.3 Nesting Species

We have monitored 465 nests for 32 species, documenting a return to the Amargosa Canyon by Bell's Vireos, Inyo County's first Green Heron nesting record, and an invasion by over 20 Indigo Bunting territories in 2009 as highlights.

Table 3. All nests located and monitored 2005-2009 at the Amargosa River, Inyo County, CA.

Species	Nest Type	Mgmt Status	Nests
American Kestrel	cavity		2
Ash-throated Flycatcher	cavity		5
Bell's Vireo	cup	State and Federally Endangered	13
Bewick's Wren	cavity		11
Black-tailed Gnatcatcher	cup		14
Blue-gray Gnatcatcher	cup		7
Blue Grosbeak	cup		20
Brown-crested Flycatcher	cavity		3
Common Raven	cup		6
Common Yellowthroat	cup		3
Costa's Hummingbird	cup		1
Crissal Thrasher	cup	California Species of Special Concern	24
Gambel's Quail	cup		1
Green Heron	cup		1
House Finch	cup		3
Indigo Bunting	cup		4
Ladder-backed Woodpecker	cavity		2
Lesser Goldfinch	cup		3
Lucy's Warbler	cavity	California Species of Special Concern	20
Mourning Dove	cup		23
Northern Rough-winged Swallow	cavity		1
Phainopepla	cup		22
Rock Wren	cavity		1
Red-tailed Hawk	cup		3
Red-winged Blackbird	cup		1
Say's Phoebe	cup		6
Song Sparrow	cup		41
Verdin	dome		114
Virginia Rail	cup		1
Western Kingbird	cup		4
Yellow-breasted Chat	cup	California Species of Special Concern	51
Yellow Warbler	cup	California Species of Special Concern	54

1.2.4 Brown-headed Cowbird Trapping

We have captured and euthanized 203 female cowbirds in three years of trapping (Table 4). We have reduced cowbird parasitism to zero in 2009 and have not caught a juvenile cowbird since 2007, suggesting that few parasitized nests in 2008 fledged cowbird young. Figure 4 illustrates by-year percent parasitism for all potential cowbird hosts combined. Potential host productivity has doubled to tripled since cowbird trapping began in 2007.

Table 4. Total brown-headed Cowbird captures, Amargosa River, Inyo County CA. All females were euthanized. Male and juvenile captures may represent duplicates as excess male and juvenile captures were periodically released and recaptured.

	Begin Date	Females	Males	Juveniles
2007	2 June	26	111	20
2008	8 May	84	164	0
2009	23 April	93	82	0

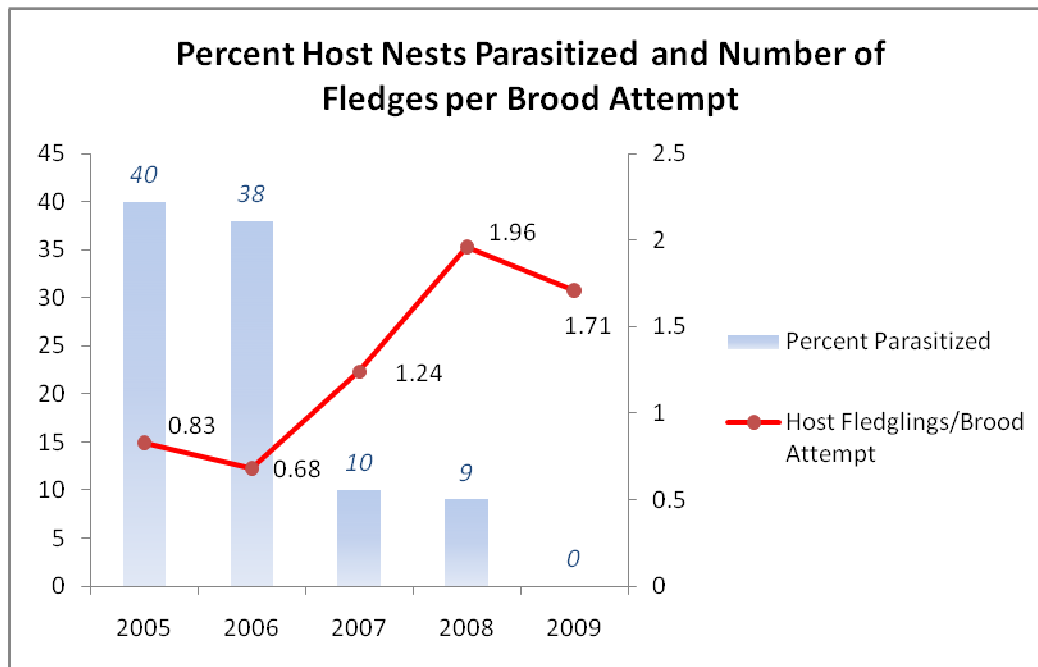


Figure 4. Percent potential cowbird host nest attempts actually parasitized, and number of host fledglings per brood attempt for Bell's Vireos, Black-tailed Gnatcatchers, Blue Grosbeaks, Song Sparrows, Yellow Warblers, and Yellow Warblers at the Amargosa Canyon and Shoshone, Inyo County, CA. Brown-headed Cowbird trapping began in 2007.

1.2.5 Territory Density

We found highest territories for all species at the *Tamarix* – dominated AMSO plot. Essentially, AMSO contains fewer species than the native-dominated plots, but the species that *Tamarix* supports are supported in great numbers. They include Lucy’s Warblers, Yellow-breasted Chats, and Crissal Thrashers (California Species of Special Concern) and Song Sparrows and Blue Grosbeaks (California Partners In Flight Riparian Focal Species).

Table 5. Breeding species richness and territory density per hectare at Amargosa Canyon (North and South) and Shoshone, Amargosa River, Inyo County CA.

	Breeding Species Richness	Territories per Hectare
AMNO	21.7	2.4
AMSO	12	2.8
SHOS	16	2.7

Figure 5a illustrates an example of our spot-mapping efforts, showcasing territory density and locations for Song Sparrows on the Amargosa Canyon South (AMSO) plot in 2005. Figure 5b depicts Song Sparrow territories on the Amargosa Canyon North (AMNO) plot during the same year.

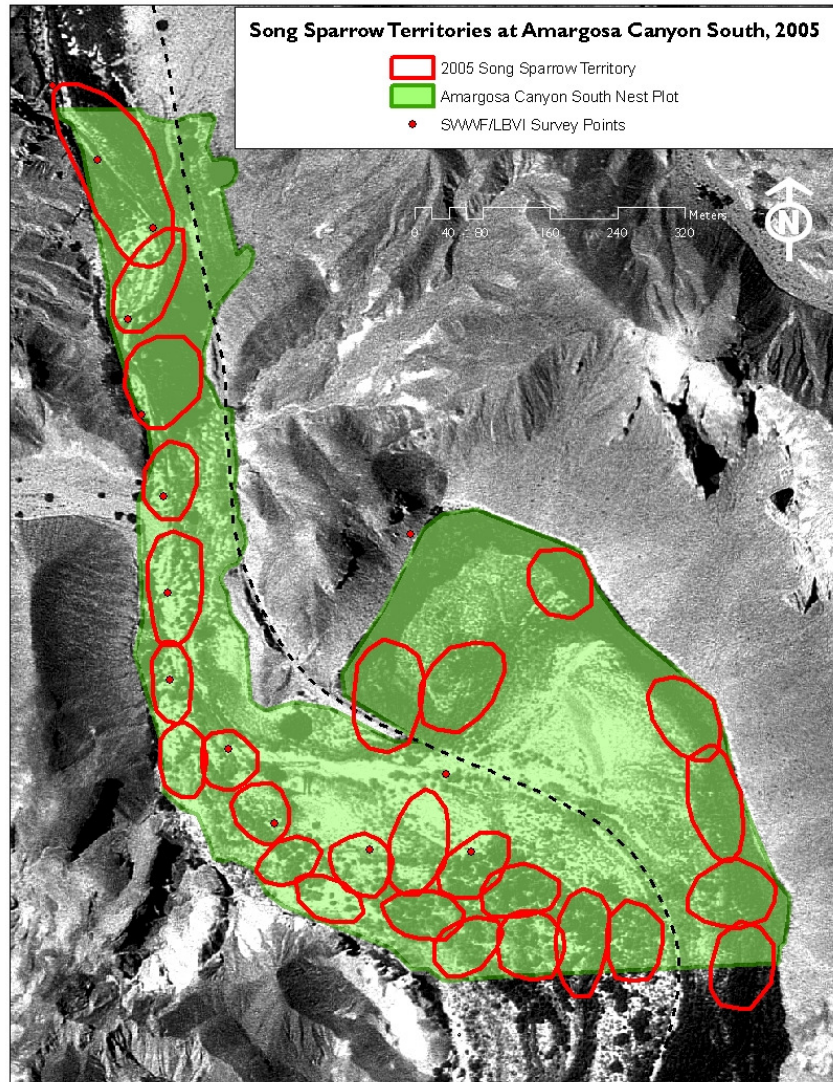


Figure 5a. Song Sparrow (*Melospiza melodia*) territories on the AMSO nest plot, 2005.

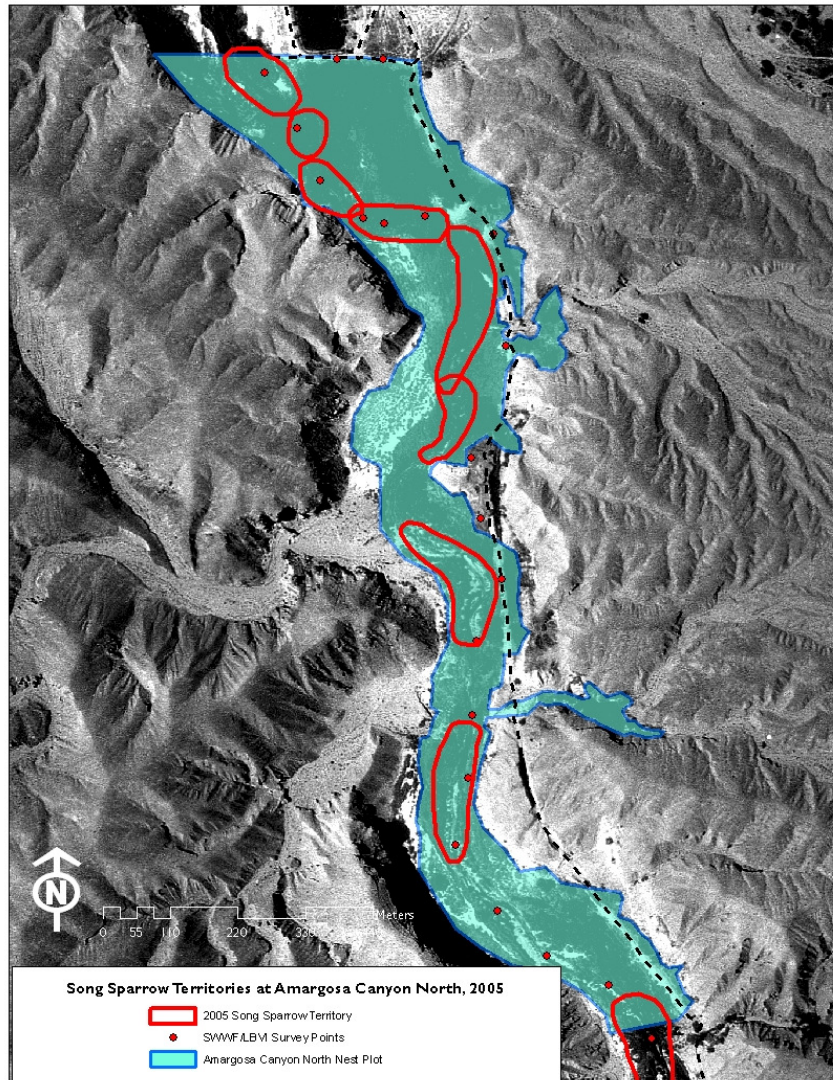


Figure 5b. Song Sparrow (*Melospiza melodia*) territories on the AMNO nest plot, 2005.

CONCLUSIONS

From 2005 through 2009, we completed five years of endangered species surveys and all-species spot-mapping and nest-monitoring on the Amargosa, as well as three seasons of Brown-headed Cowbird trapping. Our cowbird trapping has appeared to have increased Bell's Vireo nest success at a source population at nearby China Ranch (we do not monitor nests there but do cowbird trap) to the point that surplus recruits have re-colonized the Amargosa River. *Tamarix* removal at Shoshone in particular may have increased the Shoshone reach's viability as Bell's Vireo nesting habitat, as Bell's Vireos have not been detected to breed during surveys on the *Tamarix* – dominated AMSO plot. Though we still need more data to address passerine response to *Tamarix* and its eradication, we are able to put forward some conclusions from our work in order to provide information and recommendations to the Bureau of Land Management, United States Fish and Wildlife Service, the Nature Conservancy, and private land owners with property on the Amargosa River and its tributary Willow Creek.

Our most important recommendation is ***increased future monitoring***. The USGS and other authors have repeatedly highlighted that despite the millions of dollars spent on *Tamarix* removal in the southwestern United States, very little data exists on the effect *Tamarix* eradication has on most of the bird species that rely on the habitats that we are ostensibly working to improve.

1. **Brown-headed Cowbird trapping has increased nesting success, more than doubling productivity and likely hastening Bell's Vireo reoccupation of the northern Amargosa Canyon and Shoshone reach.**

The keys to the revival of the Amargosa Bell's Vireo population are 1) close proximity to a source population (China Ranch on Willow Creek), 2) cowbird trapping to increase productivity to produce recruits, 3) removal of *Tamarix*, as Bell's Vireos are less likely to occupy *Tamarix* monocultures. Productivity for all potential host species has dramatically increased since 2007, when cowbird trapping began. Three consecutive years of Brown-headed Cowbird trapping were required before Bell's Vireos returned to the Amargosa River. Though suitable habitat existed on the Amargosa North plot prior to cowbird trapping, only one territory was detected on Amargosa North before cowbird trapping.

2. **Though our nesting pair of Bell's Vireos occupied *Tamarix*-dominated habitat, for the most part, Willow Flycatcher and Bell's Vireo detection in *Tamarix* were rare, and much less-common than in the native-dominated, mesic northern section of the Amargosa Canyon.**

Studies in Arizona and on the Lower Colorado River have shown that *Tamarix* of certain age and structure can support breeding Willow Flycatcher territories (Sogge et al. 2006). However, this has not occurred at the Amargosa Canyon. The age of the southern Amargosa Canyon's *Tamarix* stands is unknown, and it is unknown whether these stands could grow to necessary height and density to support Willow Flycatchers in the future.

3. **Though more data is required to address this issue fully, preliminary data showed that open cup nest success was roughly equal between native and *Tamarix* substrates. Overall nesting success for all species was higher in *Tamarix* substrates, due in large part for a tendency for cavity and dome-nesting species (which have higher nest success than open cup-nesting species) to nest in native plants.**

4. *Tamarix* appears to have a mixed effect on passerine abundance and diversity on the Amargosa River.

a. The mesic, willow-dominated northern Amargosa Canyon held significantly higher breeding species diversity and species richness than the *Tamarix*-dominated southern Amargosa Canyon, and held close to significantly higher breeding species diversity and richness than the more xeric mesquite-dominated Shoshone reach of the Amargosa River. Mesquite-dominated habitat held higher (though not significantly so) breeding species diversity and species richness than the *Tamarix*-dominated southern Amargosa Canyon.

b. Though differences were not significant, the *Tamarix*-dominated southern Amargosa Canyon held higher territory abundance (for all species combined) than native-dominated habitats in the northern Amargosa Canyon and at Shoshone.

Sogge et al. (2008), Hunter (1988), and Ellis (1995) have pointed out that *Tamarix* invasion can have mixed effects on avian abundance and diversity. These effects depend on geography, climate, and the bird species that compose the community. Thus while *Tamarix* invasion in New Mexico (Ellis 1995, Hunter 1988) and the Grand Canyon (Sogge et al. 2008) may have increased riparian passerine diversity, *Tamarix* monocultures in the southern Lower Colorado River Valley appear to have decreased passerine diversity and abundance and density (Van Riper et al. 2008, Rosenberg et al. 1991).

At the Amargosa Canyon, the species that successfully nest in *Tamarix* habitat (Song Sparrows, Lucy's Warblers, Bewick's Wrens, Yellow-breasted Chats, Verdin, and Crissal Thrashers) have built up high densities in these *Tamarix* stands. However, many other species exist only in small numbers in *Tamarix* habitat (Yellow Warblers, Blue Grosbeaks, Common Yellowthroats, Black-tailed Gnatcatchers, Blue-gray Gnatcatchers, Phainopeplas) and several do not exist in *Tamarix* habitat at all (Ladder-backed Woodpeckers, Ash-throated Flycatchers, Brown-crested Flycatchers, Green Herons).

5. Prior to eradication of *Tamarix* in the southern Amargosa Canyon, the BLM and USWFS should consider its effect on breeding birds using these habitats.

Currently, the southern Amargosa Canyon is supporting dense populations of breeding Lucy's Warblers, Bewick's Wrens, Yellow-breasted Chats, Song Sparrows, and Crissal Thrashers. Each of these species' populations may be significantly and negatively impacted by *Tamarix* eradication in and around Modine Meadows. Lucy's Warblers, Yellow-breasted Chats, and Crissal Thrashers are all California Bird Species of Special Concern, and each of these species has limited nesting opportunities outside of the Amargosa Canyon, due to the Mojave Desert geography and climate.

Van Riper et al. (2008), Shafroth et al. (2008), and Sogge et al. (2008) expressed concern that complete *Tamarix* eradication, without clear re-vegetation goals and knowledge of the site's capability to support high-quality native habitat, can have negative impacts on the riparian bird community. This concern is particularly relevant if there is an absence of native vegetation to assist in passive restoration.

Important questions (all from Shafroth et al. 2008) should continue to be asked such as 1) how quickly can the southern Amargosa Canyon regenerate quality riparian habitat after eradication? 2) does the southern Amargosa Canyon have high enough water availability, flooding frequency, adequate flood timing, and slow flood recession to support significant stands of willow? 3) does

the southern Amargosa Canyon have sufficient dry season flow to support willow seedlings? 4) is the southern Amargosa Canyon's soil salinity high enough to support regenerating willow or mesquite? 5) do the soils of the southern Amargosa Canyon still hold sufficient soil microbes/mycorrhizal fungi to support willow or mesquite? 6) did the southern Amargosa Canyon support quality native vegetation (complex vegetation structure with significant willow and/or mesquite) prior to *Tamarix* invasion?

If the southern Amargosa Canyon cannot support dense willow stands of proper vegetative structure, the site will never hold breeding Willow Flycatchers. If the site cannot be quickly restored to high-quality mesquite stands, it will also be unlikely to hold breeding Bell's Vireo territories. If restoration of the southern Amargosa Canyon can reach the amount of mesquite cover we have found at Shoshone, this will take several years – at the expense of the habitat which currently holds the highest densities of Lucy's Warblers, Bewick's Wrens, Song Sparrows, Yellow-breasted Chats and Crissal Thrashers in our study area.

If the BLM is unable to successfully regenerate high-quality mesquite habitat in the southern Amargosa Canyon (which may be easier to achieve than regenerating high-quality willow habitat), the two most likely post-eradication outcomes will be either *Tamarix* and/or *Atriplex lentiformis* re-sprouting (Shafroth et al. 2008). Each scenario would only set back the clock for the Amargosa Canyon's riparian bird community.

As an alternative, Van Riper et al. (2008) found that on the Lower Colorado River, a native component of only 40-60% of riparian cover produced the highest avian abundances. It may be more cost effective, and more beneficiary to the Amargosa River avian community for the BLM, TNC, and USFWS to explore an alternative directed toward *increasing* mesquite and willow cover, rather than *eradicating* *Tamrix* cover in the southern Amargosa Canyon.

6. Due to high aridity, slash piles of *Tamarix* persist for several years, creating a fire hazard and preventing regeneration of the riparian corridor.

Several slash piles from recent *Tamarix* eradication still exist on the Sorrell property at Shoshone, in the northern Amargosa Canyon south of Cowboy Canyon, and just south of the Bell's Vireo territory in the southern Amargosa Canyon. This slash is a virtual dead zone, with little to no riparian vegetation emerging through it – a condition that has now existed for over three years at Shoshone and north of Modine Meadows.

It is of note that we have discovered slash piles from previous eradication attempts during our spot-mapping of Modine Meadows, along the old Tonopah-to-Tidewater causeway and in the heart of Modine Meadows. It is undetermined exactly how old these brush piles are, but they are several years old. Nothing has regenerated under them, and our biologists use them as paths to navigate the otherwise densely-vegetated Meadows.

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