RECLAMATION

Managing Water in the West

A Review of Vegetation and Hydrologic Parameters Associated with the Southwestern Willow Flycatcher – 2002 to 2008

Elephant Butte Reservoir Delta, NM

U.S. Department of the Interior
Bureau of Reclamation
Fisheries and Wildlife Resources
Denver, Colorado

February 2009

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A Review of Vegetation and Hydrologic Parameters Associated with the Southwestern Willow Flycatcher – 2002 to 2008

Elephant Butte Reservoir Delta, NM

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U.S. Department of the Interior
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INTRODUCTION

The current population of Southwestern Willow Flycatchers (*Empidonax traillii extimus* – hereafter referred to as SWFL or flycatcher) within Elephant Butte Reservoir was first detected in 1995, when a total of two territories were found. Historic records document SWFLs in the 1970's when several territories were found in the area then known as Elephant Butte Marsh (Hundertmark 1978, Hubbard 1987). The population of SWFLs within Elephant Butte Reservoir, NM has dramatically increased from 1995 to 2008 (Figure 1), when 229 territories were documented. Although studies have been conducted since 1995, the sample size prior to 2002 (1995-2001) was small, totaling 81 territories and 57 nests. Due to the small sample sizes prior to 2002, only the past seven years were assessed and evaluated. The population within Elephant Butte Reservoir is currently the largest population within the subspecies' range. This report summarizes the nesting parameters within Elephant Butte Reservoir and attempts to identify and discuss the nesting parameters that have resulted in the dramatic increase of this population.

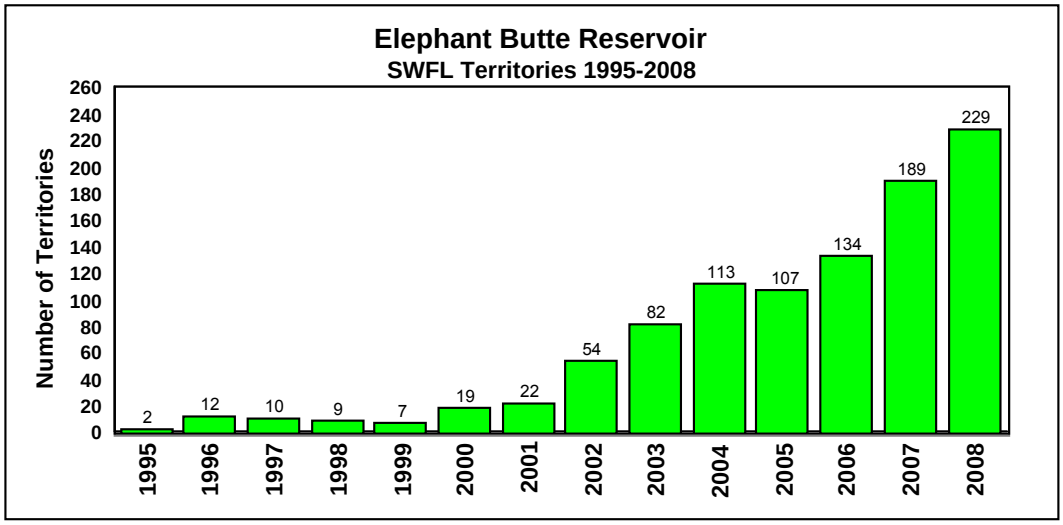

Figure 1. Annual detections of Southwestern Willow Flycatcher territories within the delta of Elephant Butte Reservoir since 1995.

This report summarizes data collected between 2002 and 2008 within the Elephant Butte Reservoir pool, since it comprised approximately 80 percent of all SWFL territories and 90 percent of all nest data during this period within the Middle Rio Grande (Figure 2). This is not to imply that Elephant Butte Reservoir provides the only suitable SWFL habitat within the Middle Rio Grande. Arguably, it possesses some of the highest quality breeding habitat, and certainly the most expansive and contiguous patches of suitable habitat. However, smaller suitable patches of occupied and unoccupied habitat do exist within the Middle Rio Grande.

Habitat availability has been a key component to the population increase. Habitat availability, as well as habitat characteristics, have been quantified and summarized in this report. In the fall of

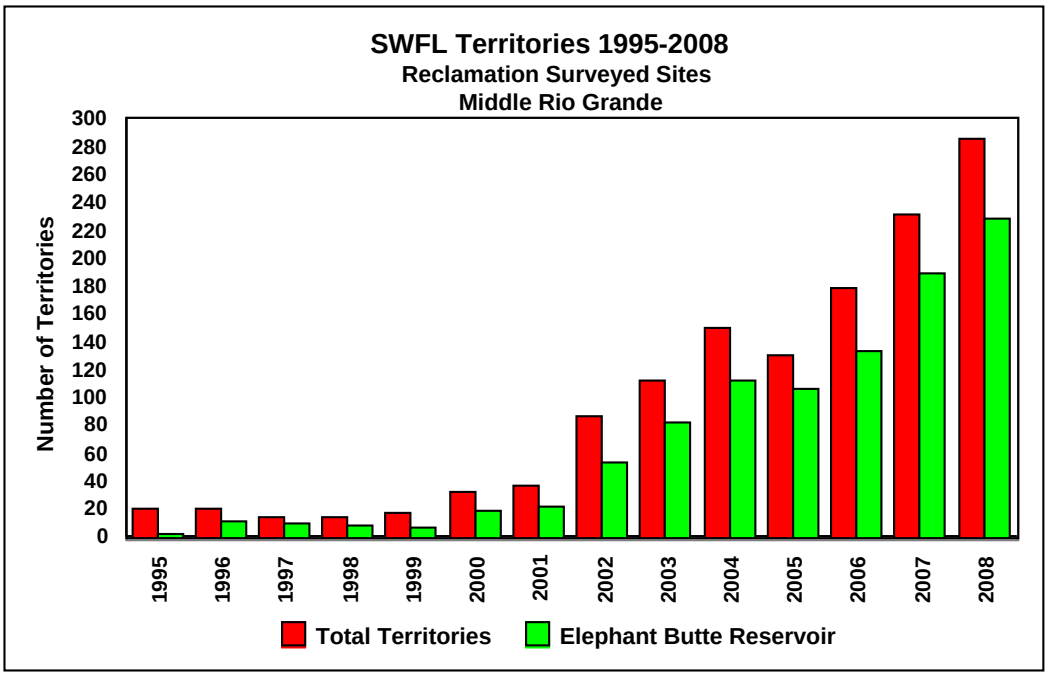

Figure 2. A majority of SWFL territories within all sites surveyed by Reclamation in the Middle Rio Grande during the past seven years have occurred within the pool of Elephant Butte Reservoir.

2007, aerial photography of Elephant Butte Reservoir was obtained. The extent of available occupied and unoccupied suitable habitat was modeled and quantified. Currently, there appears to be a relative abundance of suitable unoccupied habitat available to support a continued expansion of the Elephant Butte SWFL population. However, various factors including reservoir levels, natural succession, hydrologic changes, or other unforeseen events will ultimately determine the availability of suitable habitat in the future.

As with any riparian system, hydrology is the driving force. Hydrology has a greater effect on species composition, structure, and density than any other variable. Although sections of this report focus on the effects of surface hydrology on nesting variables, the role of hydrology in the establishment and maintenance of suitable habitat is also a key factor. However, the physical presence of surface water appears to be a determining factor of territory establishment for breeding SWFLs. Suitable habitat based solely on structure and density has not correlated with the spatial distribution of SWFLs within Elephant Butte Reservoir. It appears that SWFLs have a strong affinity for surface water when establishing territories.

Existing habitat, nesting, and distribution data gathered from the Elephant Butte SWFL population was utilized to determine the habitat characteristics responsible for the increasing population. Surface hydrologic conditions within the occupied habitat were evaluated to determine whether various hydrologic conditions affected nest success and productivity. The objective was to identify these variables and base future habitat restoration and enhancement efforts on the variables that SWFLs have identified as the most important.

ASSOCIATED REPORTS/STUDIES

Soils Study

In 2006 and 2007, soil samples were obtained from within patches of healthy, vigorous stands of suitable habitat, and compared to stands that once exhibited these same characteristics, but have since died back and are currently unsuitable, unoccupied stands. The objective of this study was to determine whether changes in soil chemistry were responsible for the die-off, rather than changes in hydrology. Data from 2006 were analyzed and no conclusive results were achieved. The analysis of data collected from the 2007 effort indicated salt concentrations were twice as high within healthy stands compared to the dying stands – contrary to the initial assumption that salt concentrations were responsible for the die-off. The salt concentrations within the healthy stands were still well within tolerable limits of the dominant vegetation (i.e. Goodding's willow – *Salix gooddingii*). Soil texture and nutrient composition varied greatly among healthy suitable stands, however all sites were either saturated or were established over a shallow water table. The dying stands of Goodding's willow all exhibited dry surface conditions and a lower water table – suggesting that hydrology, not soil chemistry, was the determining factor regarding the health of the various Goodding's willow stands within Elephant Butte Reservoir. The detailed results of this study can be found in Reed et al. (2008).

Nest Site Habitat Quantification

From 2004 to 2006, extensive microhabitat characteristics were measured from over 100 occupied nest sites, following the late-summer departure of the SWFLs. Data were collected from the nest site, as well as a randomly selected site between 50 and 100 meters from the nest. The methodology was developed in conjunction with the University of New Mexico and the New Mexico Natural Heritage Program. The objective of this study was to determine whether SWFLs select specific trees/territories to nest, or whether they select randomly from within suitable patches. Another objective of this study was to define the micro habitat characteristics of structure and density to aid in the development of restoration and enhancement projects, as well as to determine whether these restoration sites achieve the objective of creating suitable SWFL habitat. Results of this study can be found in Moore (2007).

Elephant Butte Photostations

In August 2005 a series of thirteen photo stations were established within the Elephant Butte Reservoir pool to visually document the development of woody vegetation. These photographs have been compiled in *Elephant Butte Reservoir Delta Photostations, 2005-2008* (Ahlers 2009).

2005 Review of SWFLs in Elephant Butte Reservoir

Status and Monitoring of Southwestern Willow Flycatchers within Elephant Butte Reservoir, New Mexico (Moore 2005) – This report provides an overview of Southwestern Willow Flycatchers and the role that Elephant Butte Reservoir and the Low Flow Conveyance Channel have played in the

recent establishment of flycatcher territories. The report also discusses the current hydrology, availability of habitat, and various factors that threaten the population.

Annual SWFL Surveys and Nest Monitoring Studies

Annual reports summarizing the findings of Reclamation SWFL surveys and nest monitoring have been prepared since 1995. The most recent results can be found in Moore and Ahlers (2009).

NESTING VARIABLES 2002-2008

Habitat Use

From 2002 to 2008, data on the nest substrate (i.e., what plant species the nest was physically constructed in) and dominant vegetation within the territory were collected at a total of 961 nests within Elephant Butte Reservoir (Table 1 and Figure 3).

Substrate

Nests that were physically placed in *Salix* spp., either Goodding's willow or coyote willow (*Salix exigua*), [hereafter referred to as willows, unless specifically identified] comprised 64.6 percent of the total, while 35.1 percent were constructed in saltcedar (*Tamarix* spp.); only 0.3 percent were found in cottonwood (*Populus* spp.).

Dominant Vegetation within Territory

SWFLs nested most frequently within native vegetation dominated territories (88.1 percent), while exotic dominated territories comprised less than 1 percent of the total. Territories comprised of both native and exotic vegetation (i.e., mixed) accounted for 11.1 percent of the total (Table 2 and Figure 4).

Discussion Points

Although exotic dominated territories comprised less than 1 percent of the total, 35.1 percent of all nests were physically placed in exotic saltcedar. Therefore, it is evident that SWFLs selectively utilize saltcedar as the nest substrate – likely due to the twig structure that saltcedar provides.

Native vegetation (dominated by Goodding's willow) is the primary component of most SWFL territories within Elephant Butte Reservoir. However, over the period of study there has been a gradual increase in the number of territories found in mixed stands of native and exotic, and a gradual increase in the number of nests placed in saltcedar substrate. In 2002, 29.2 percent of the nests were found in saltcedar, compared to 42.5 percent in 2008.

The trend towards an increased use of saltcedar as the nest substrate from 2002 to 2008 (Figure 5) is likely due to an increased abundance of saltcedar within the currently occupied sites. Several of the occupied stands in the upper pool elevations appear to be slowly transitioning from native to exotic, increasing the abundance of saltcedar. In 2002, 100 percent of all SWFL territories were found

within native dominated stands; in 2008, 75.0 percent were considered as native dominated (Table 2, Figure 6). This is likely due to changes in hydrology over the past seven years, and perhaps increased competition for the native dominated habitat.

The increased rate of saltcedar use by SWFLs and its dominance within occupied stands appears to correlate with a 2005 river channel degradation event. This resulted in a lowering of the water table, depriving some occupied, native-dominated stands of water and favoring the more drought-tolerant saltcedar.

Table 1. Nest substrate use by species.

	Number of Nests in Willows	Number of Nests in Saltcedar	Total Number of Nests	Percent Nests in Willows	Percent Nests in Saltcedar
2002	46	19	65	70.8%	29.2%
2003	69	27	96	71.9%	28.1%
2004	108	45	153	70.6%	29.4%
2005	89	38	127	70.1%	29.9%
2006	97	47	145	66.9%	32.4%
2007	120	93	215	55.8%	43.3%
2008	92	68	160	57.5%	42.5%
Nest Totals	621	337	961	64.6%	35.1%

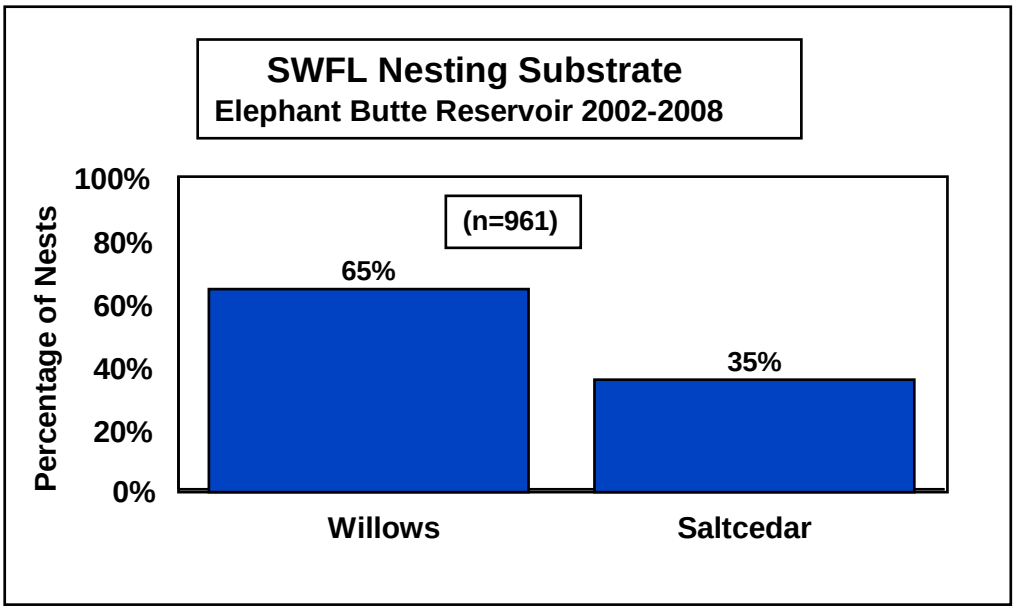

Figure 3. Percentage of SWFL nests in willow and saltcedar substrates, respectively.

Table 2. Dominant territory vegetation of SWFL territories within the Elephant Butte Reservoir pool between 2002 and 2008.

	Number of Nests in Native	Number of Nests in Exotic	Number of Nests in Mixed	Total Number of Nests	Percent Nests in Native	Percent Nests in Exotic	Percent Nests in Mixed
2002	65	0	0	65	100.0%	0.0%	0.0%
2003	93	0	3	96	96.9%	0.0%	3.1%
2004	150	0	3	153	98.0%	0.0%	2.0%
2005	123	0	4	127	96.9%	0.0%	3.1%
2006	122	0	23	145	84.1%	0.0%	15.9%
2007	174	3	38	215	80.9%	1.4%	17.7%
2008	120	4	36	160	75.0%	2.5%	22.5%
Nest Totals	847	7	107	961	88.1%	0.7%	11.1%

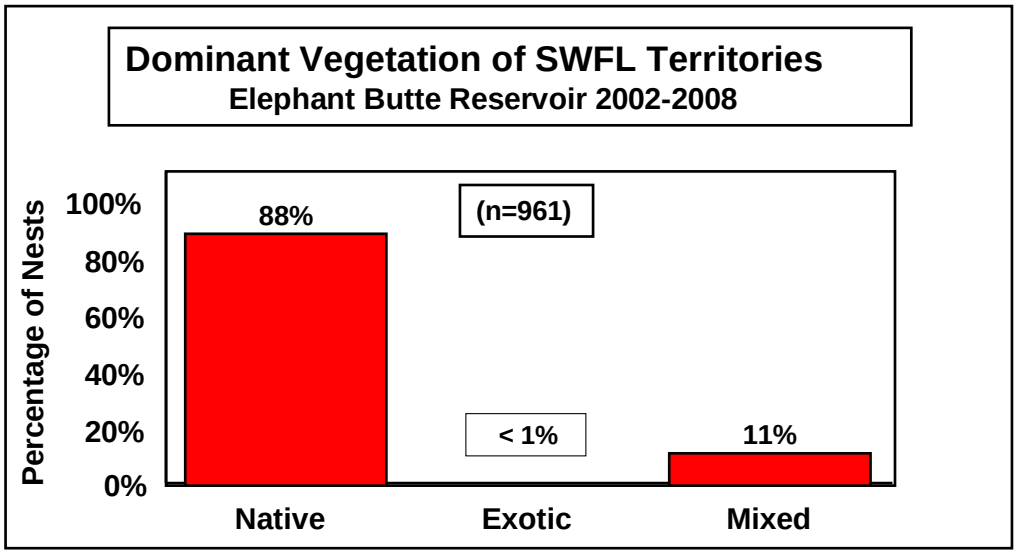

Figure 4. Dominant territory vegetation of SWFL territories within Elephant Butte Reservoir pool between 2002 and 2008.

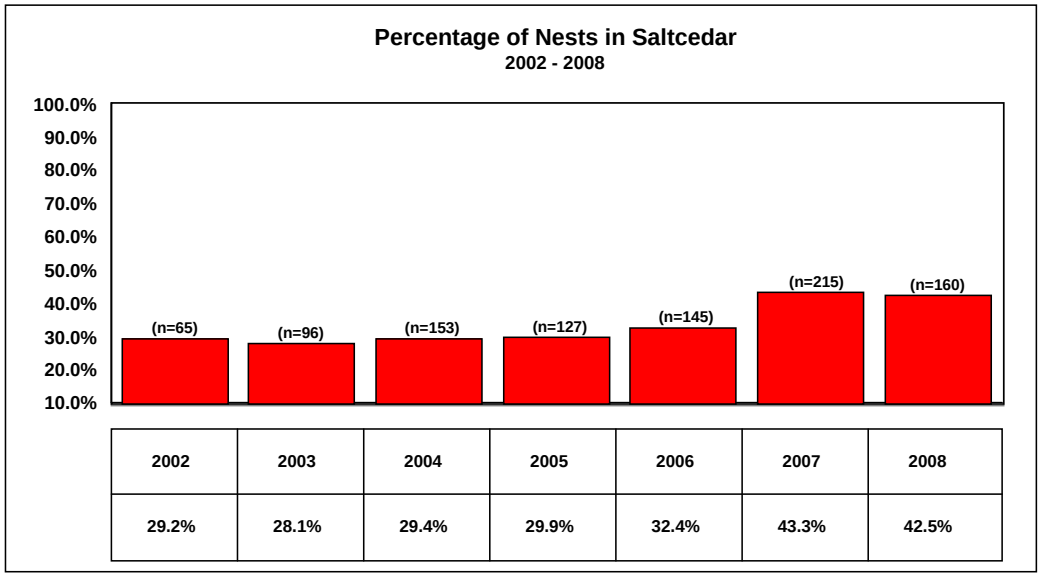

Figure 5. Percentage of SWFL nests placed in saltcedar substrate.

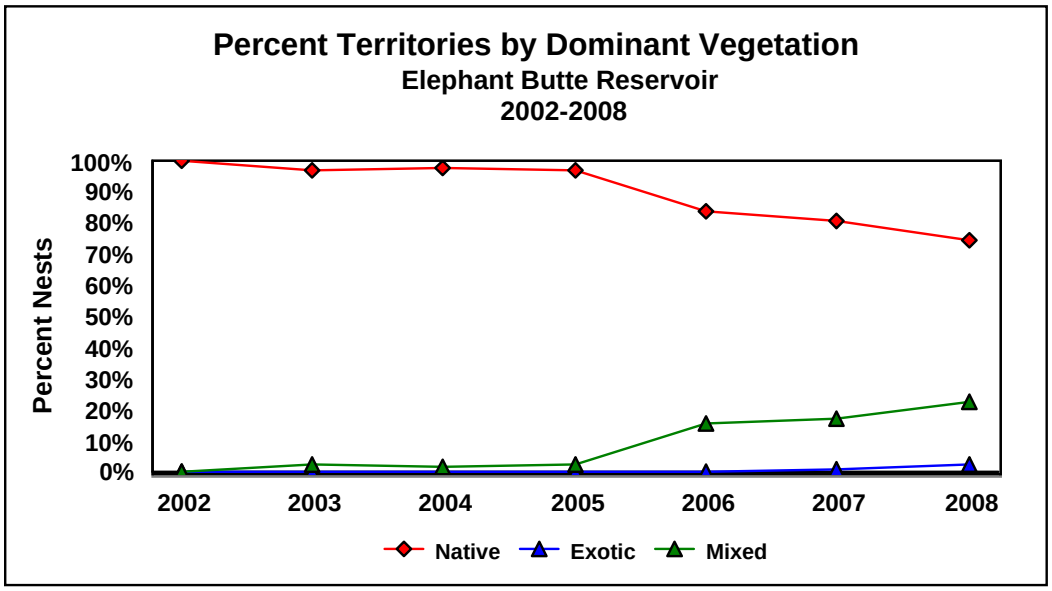

Figure 6. Dominant vegetation within Elephant Butte Reservoir SWFL territories.

Nest Success

Nest data were collected from a total of 934 nests with known outcomes during the period of 2002-2008. A successful nest is defined as a nest that successfully fledges at least one SWFL chick. Overall nest success was 53.9 percent during this period. Success rates ranged from a high of 58.2 percent in 2006 to a low of 47.7 percent in 2004 (Table 3).

Nest Success vs. Substrate

Nest success when the nest was physically placed in native willows was 55.1 percent (n=603). If the nest was placed in saltcedar, nest success was 51.7 percent (n=329) (Table 4 and Figure 7). Although nests placed in native vegetation did experience a slightly higher success rate than those found in saltcedar, the difference was not statistically significant (P=0.37, Df=1, χ^2=0.81).

Table 3. Summary of nest success.

Year	# Successful	Total	% Success
2002	35	65	53.8%
2003	48	94	51.1%
2004	71	149	47.7%
2005	68	120	56.7%
2006	82	141	58.2%
2007	113	205	55.1%
2008	86	160	53.8%
Total	503	934	53.9%

Table 4. Nest success compared among nest substrates.

	Number of Successful Nests in Willows	Number of Nests in Willows	Number of Successful Nests Saltcedar	Number of Nests in Saltcedar
2002	27	46	8	19
2003	34	67	14	27
2004	51	105	20	44
2005	49	83	19	37
2006	57	95	25	45
2007	66	115	46	89
2008	48	92	38	68
Nest Totals	332	603	170	329
% Nest Success	55.1%		51.7%	

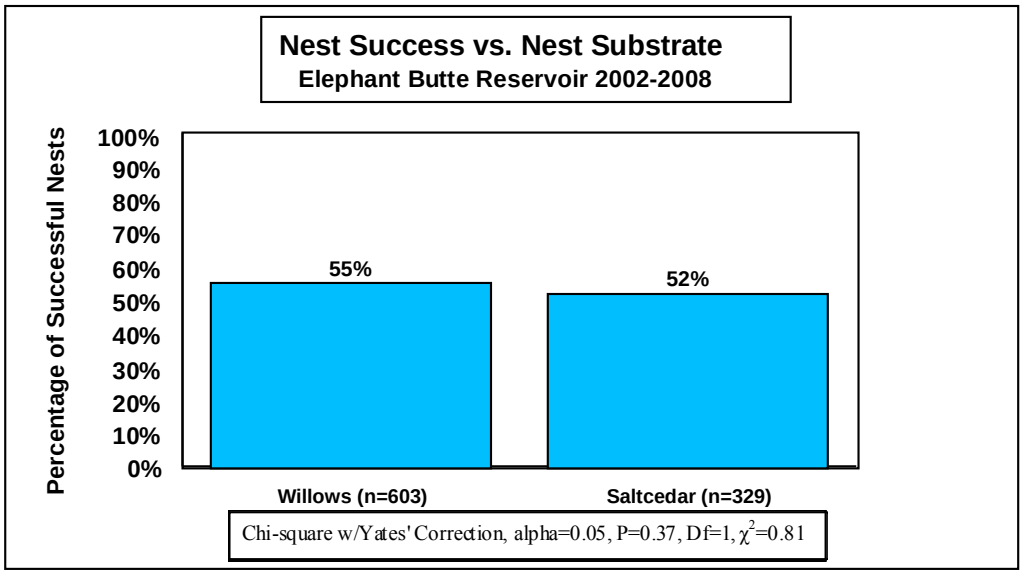

Figure 7. SWFL nest success by substrate.

Nest Success vs. Territory Dominance

Nest success within territories dominated by native vegetation equaled 54.8 percent (n=821), while those within exotic dominated territories was 42.9 percent (n=7), and those within mixed vegetation were 47.2 percent (n=106) (Table 5 and Figure 8). The sample size of nests from exotic dominated territories is obviously very small, and the percent nest success should not be considered as representative of the dominant vegetation. Data from nests found in exotic-dominated stands were not included in the statistical analysis. Although sample sizes between native (n=821) and mixed (n=106) vegetation are also somewhat skewed, a statistical analysis shows no significant difference between native and mixed stands (P=0.13, Df=1, χ^2=2.35).

Table 5. SWFL nest success by dominant vegetation within territory.

	Number of Successful Nests in Native	Number of Nests in Native	Number of Successful Nests in Exotic	Number of Nests in Exotic	Number of Successful Nests in Mixed	Number of Nests in Mixed
2002	35	65	0	0	0	0
2003	46	91	0	0	2	3
2004	70	146	0	0	1	3
2005	66	116	0	0	2	4
2006	72	118	0	0	10	23
2007	97	165	3	3	13	37
2008	64	120	0	4	22	36
Nest Totals	450	821	3	7	50	106
% Nest Success	54.8%		42.9%		47.2%	

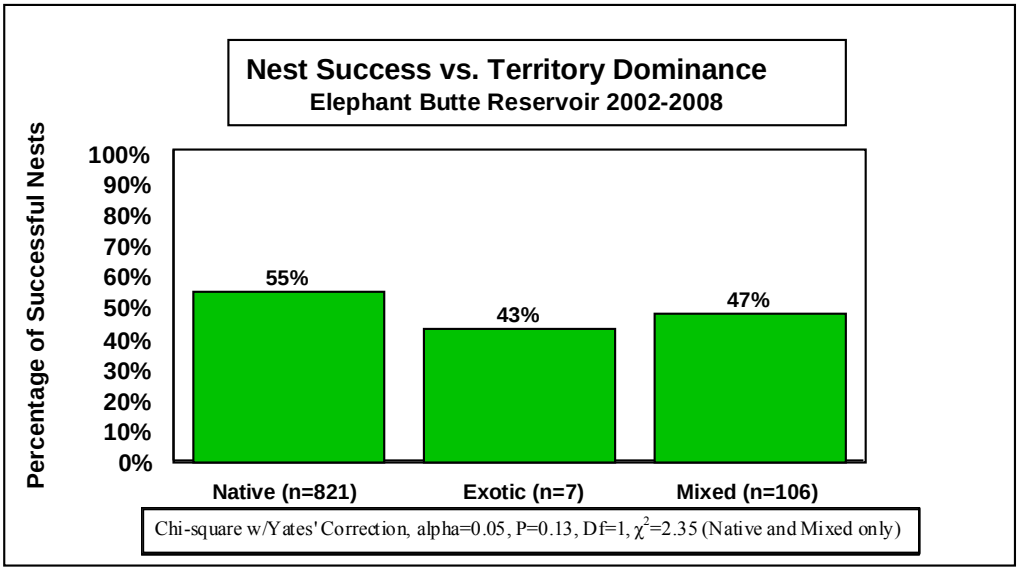

Figure 8. SWFL nest success and dominant territory vegetation.

Discussion Points

Nest success within stands of native-dominated vegetation is relatively higher than those of mixed stands. This is possibly due to the wetter hydrologic conditions that typically exist within the native stands that increase the structure/density of the vegetation, and subsequently the suitability of the site. It is likely that hydrology, which is a key factor in determining structure and density, plays a greater role than species composition in determining nest success. Also, the majority of occupied native dominated sites were flooded upon territory establishment. If the hypothesis is correct in assuming that SWFLs exhibit an affinity for surface water, this may also contribute to the greater abundance of SWFLs within the native dominated stands.

It appears that SWFLs within Elephant Butte Reservoir have experienced nest success rates suitable for maintaining an expanding population. It is assumed that many of the young return to their natal site within Elephant Butte Reservoir. However, Paxton et al. 2007 states that <1 percent return to their natal patch. This may explain the continued expansion of the SWFLs further downstream and eastward within Elephant Butte Reservoir, as habitat develops. Surveys conducted annually since 2002 within a 125 mile reach of the Rio Grande from the Pueblo of Isleta to Elephant Butte Reservoir have not revealed similar increases anywhere within this reach that would compare to Elephant Butte Reservoir. This indicates that the returning young are establishing territories within Elephant Butte Reservoir, and are likely the largest contributing source of the expanding population.

Pair Success

Nest success is often the most common measure used for determining how effectively an avian population is reproducing. However, pair success should also be considered, and nest success alone does not reveal the full potential of a breeding population. The SWFL is a somewhat persistent species. SWFLs will often renest following a failed first nesting attempt, and at times attempt a third and even a fourth nesting attempt, primarily depending on when during the breeding season the nest

failures occurred. Although less frequently than renesting following a failed nest attempt, some pairs will also renest following a successful nesting attempt (Table 6), and some pairs are successful on multiple attempts (Table 7). These pairs contribute to the overall productivity of the population and may play a key role in population trends by "compensating" for unsuccessful pairs. A database was established to determine the success of breeding pairs within Elephant Butte Reservoir to determine what percent of individual pairs are ultimately successful at fledging at least one SWFL chick over the course of the breeding season. The database contains information only from those pairs where all nest outcomes during a particular season were known. From 2002-2008, data from a total of 588 pairs were analyzed and 70.9 percent of these pairs were ultimately successful at fledging young. Pair success ranged from a high of 79.1 percent in 2005 (n=67), to a low of 66.1 percent in 2003 (n=62) (Table 8). If successful nests from the pairs that fledged young from one or more nests are included in the totals and divided by the total number of pairs, pair nest success of 84.0 percent was achieved during the 2002-2008 period of study.

Table 6. Pairs that nest after successful 1st attempts (all pairs with nests).

	2002	2003	2004	2005	2006	2007	2008	2002-2008
Number of Pairs	45	64	90	74	93	131	138	635
Pairs nesting after successful 1st attempt	9	14	23	24	21	35	14	140
Percentage	20.0%	21.9%	25.6%	32.4%	22.6%	26.7%	10.1%	22.0%

Table 7. Pairs with two successful nests (all outcomes known).

	2002	2003	2004	2005	2006	2007	2008	2002-2008
Number of Pairs	45	62	86	67	89	121	118	588
Pairs with two successful nests	5	6	14	11	14	23	3	76
Percentage	11.1%	9.7%	16.3%	16.4%	15.7%	19.0%	2.5%	12.9%

Table 8. Summary of pair success.

	2002	2003	2004	2005	2006	2007	2008
Pair Success (Individually)	66.7%	66.1%	66.3%	79.1%	73.0%	71.1%	66.9%
Pair Success (Population)	77.8%	75.8%	81.4%	95.5%	89.9%	90.1%	70.3%

Total Pair Success (Individually) 2002-2008	70.9%
Total Pair Success (Population) 2002-2008	84.0%

Discussion Points

It appears that pair success rates observed over the past seven years have been sufficient to sustain the increasing population. In the event that suitable habitat becomes limited in the future, or the quality of suitable habitat diminishes, pair success rates may serve as an early indicator (along with nest success) of future population trends. Over the past seven years it is apparent that 2005 was an exceptionally productive year for SWFLs within Elephant Butte Reservoir. Nearly one-third of the

pairs monitored attempted to renest after a first successful attempt; nearly 80 percent of the individual pairs successfully fledged at least one chick; and when successful second attempts are factored into the total successful nests and divided by the number of pairs found within Elephant Butte Reservoir, over 95 percent of the pairs would have been successful. A 20 percent decrease from 2007 to 2008 in "pair success (population)" is of concern. Results from 2009 will determine whether this decrease is simply due to annual variability, or a possible trend.

Brood Parasitism

The Brown-headed Cowbird (*Molothrus ater*) is an obligate brood parasite known to parasitize over 200 avian species (Friedmann and Kiff 1985). Small open-cup nesting species such as the SWFL are particularly susceptible to cowbird parasitism. It is uncommon for SWFLs to successfully fledge their own young once they are parasitized, although a small percentage of SWFLs do fledge both their own young and a cowbird chick. For the purposes of this study, a SWFL nest was recorded as parasitized if a cowbird egg was found in the SWFL nest at any time during the respective nesting cycle, regardless of whether or not the cowbird egg had a reasonable chance of developing. Thus, parasitism rates may be exaggerated. With the exception of 2008, parasitism rates remained relatively constant ranging from 10.6 percent (n=141) to 18.1 percent (n=94); however, in 2008 the rate dropped to 3.1 percent (n=160). The reason for the relatively dramatic decline in parasitism is unknown. The overall parasitism rate from 2002 to 2008 was 12.3 percent (n=934) (Table 9).

Table 9. Summary of Brown-headed Cowbird parasitism.

	# Parasitized	Total Nests	% Parasitized
2002	8	65	12.3%
2003	17	94	18.1%
2004	25	149	16.8%
2005	16	120	13.3%
2006	15	141	10.6%
2007	29	205	14.1%
2008	5	160	3.1%
Total	115	934	12.3%

Nest Parasitism vs. Substrate

In an effort to determine whether SWFL nests that are placed in either willows or saltcedar substrate were more susceptible to parasitism, a total of 932 nests were evaluated. Parasitism rates when the nest was placed in willows were 11.1 percent (n=603), while those placed in saltcedar were 14.6 percent (n=329) (Table 10 and Figure 9). Although not statistically significant (P=0.08, Df=1, χ^2=3.07), overall parasitism was higher when the nest was placed in saltcedar substrate than in willow substrate.

Table 10. Parasitism based on nest substrate.

	Number of Parasitized Nests in Willows	Number of Nests in Willows (n)	Percent Parasitized Nests in Willows	Number of Parasitized Nests in SC	Number of Nests in Saltcedar	Percent Parasitized Nests in SC
2002	5	46	10.9%	3	19	15.8%
2003	11	67	16.4%	6	27	22.2%
2004	17	105	16.2%	8	44	18.2%
2005	11	83	13.3%	5	37	13.5%
2006	9	95	9.5%	6	45	13.3%
2007	11	115	9.6%	18	89	20.2%
2008	3	92	3.3%	2	68	2.9%
Nest Totals	67	603	11.1%	48	329	14.6%

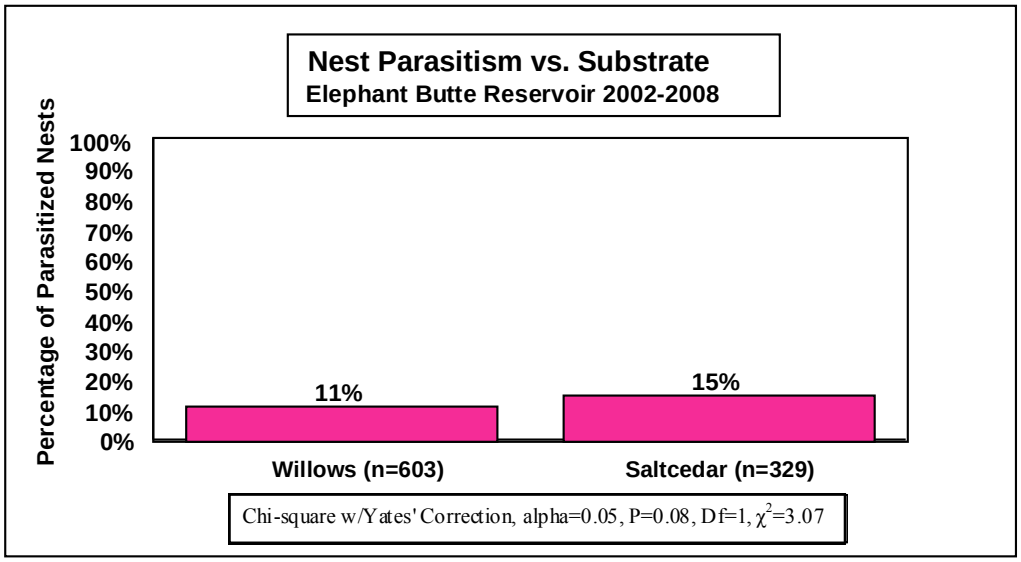

Figure 9. Brown-headed Cowbird parasitism rates for each nest substrate.

Nest Parasitism vs. Territory Dominance

Parasitism rates among stands dominated by native, exotic and mixed vegetation were also evaluated (a total of 932 nests). Parasitism rates between 2002 and 2008 were 12.2 percent (n=821) in native stands, 0 percent (n=7) in exotic stands, and 14.2 percent (n=106) in mixed stands. Due to the small sample size of nests found within saltcedar dominated territories, statistical analysis including saltcedar was not possible and results should not be considered as representative of the vegetation. Statistical analysis between native and mixed territories was conducted and no difference was detected (P=0.56, Df=1, χ^2=0.37). However, it appears that nests found within mixed stands do experience a slightly higher rate of brood parasitism than those found in native stands (Table 11 and Figure 10).

Table 11. Parasitism based on dominant vegetation within territory.

	Number of Parasitized Nests in Native	Number of Nests in Native	Number of Parasitized Nests in Exotic	Number of Nests in Exotic	Number of Parasitized Nests in Mixed	Number of Nests in Mixed
2002	8	65	0	0	0	0
2003	17	91	0	0	0	3
2004	25	146	0	0	0	3
2005	16	116	0	0	0	4
2006	10	118	0	0	5	23
2007	20	165	0	3	9	37
2008	4	120	0	4	1	36
Nest Totals	100	821	0	7	15	106
% Parasitism	12.2%		0.0%		14.2%	

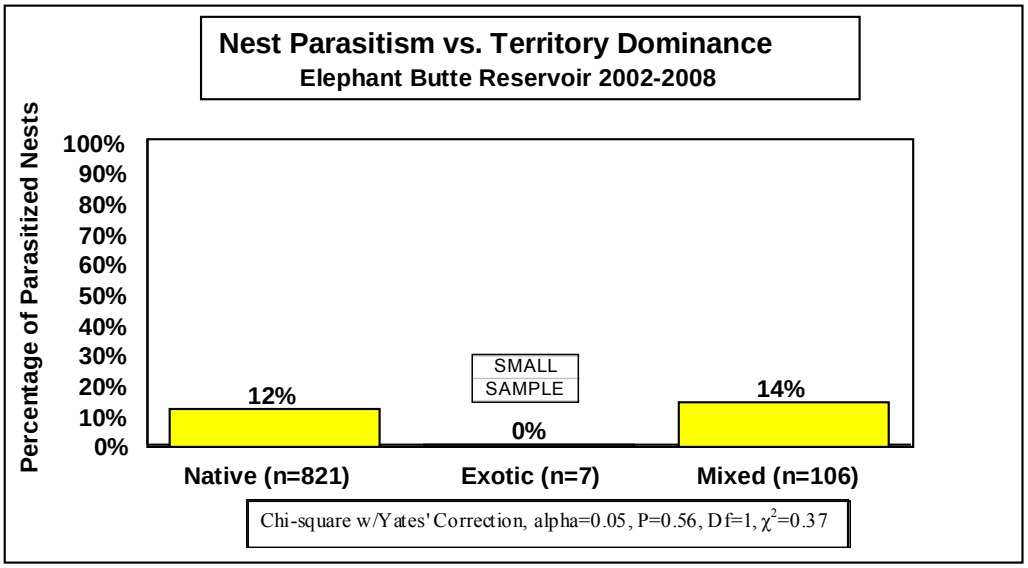

Figure 10. Brown-headed Cowbird parasitism rates within each dominant territory vegetation type.

Discussion Points

Brood parasitism is a contributing factor in nest failure. Cowbird trapping within the vicinity of Elephant Butte Reservoir was conducted from 1996 to 2001. Based on study results, trapping may have been effective at reducing overall parasitism, however no increase in nest success was documented (Siegle and Ahlers 2004). Compensatory factors such as habitat, predation, and nest abandonment appear to negate any positive benefit of decreased parasitism. The SWFL recovery plan (USFWS 2002) states that "cowbird control should be considered if parasitism exceeds 20-30 percent after collection of two or more years of baseline data". Parasitism rates over the period of study have consistently been below 20 percent (ranging from 3.1 percent to 18.1 percent), and the SWFL population has continued to expand.

Predation and Abandonment Rates

For this study, nest predation was defined as when the primary cause of nest failure was due to some form of avian, reptilian, or mammalian predation resulting in complete failure. Partial nest predation did occur in some instances, but was not classified as predation if the nest did not fail to produce at least one SWFL chick. Predation rates ranged from a low of 22.4 percent in 2007, to a high of 33.8 percent in 2008, with an overall rate of 29.6 percent (n=932) from 2002 to 2008 (Table 12). With the exception of 2007, predation rates remained relatively consistent ranging from 27.7 percent to 33.8 percent; however in 2007 the rate dropped to a low of 22.4 percent. The reason for this relatively dramatic decline in predation is unknown.

Abandonment is generally determined to be the cause of nest failure in the absence of either predation or parasitism. Abandonment rates from 2002 to 2008 ranged from 5.8 percent to 14.6 percent, with an overall rate of 9.7 percent (n=934) (Table 13). Similar to predation rates, abandonment was fairly consistent from 2002 to 2008, ranging from 5.8 percent to 10.6 percent. However, in 2007 abandonment rates increased to 14.6 percent. The reason for the increase in abandonment in 2007 is unknown.

Table 12. Summary of SWFL nest predation rates.

	# Depredated	Total	% Depredated
2002	19	65	29.2%
2003	26	94	27.7%
2004	47	149	31.5%
2005	38	120	31.7%
2006	46	141	32.6%
2007	46	205	22.4%
2008	54	160	33.8%
Total	276	934	29.6%

Table 13. Summary of SWFL nest abandonment rates.

	# Abandoned	Total	% Abandoned
2002	5	65	7.7%
2003	10	94	10.6%
2004	13	149	8.7%
2005	7	120	5.8%
2006	10	141	7.1%
2007	30	205	14.6%
2008	16	160	10.0%
Total	91	934	9.7%

Discussion Points

The primary cause of nest failure within Elephant Butte Reservoir continues to be predation. Approximately 30 percent of all nests fail due to predation, while nest abandonment accounts for about 10 percent of nest failures. Rates between years remain fairly consistent, and when both

predation and abandonment rates are combined, account for an average rate of nest failure of 39.3 percent.

Productivity of Successful Nests

A total of 502 monitored nests successfully fledged at least one chick during the period of 2002-2008 within Elephant Butte Reservoir (Table 14). An analysis was conducted to determine whether nest substrate or the dominant vegetation surrounding the nest influenced productivity. Annual productivity rates ranged from a low of 2.39 young/nest (n=86) in 2008, to a high of 2.90 (n=68) in 2005. Overall productivity of successful nests during this period was 2.62 (n=502) young/nest. The annual number of successful nests should not be misinterpreted as a direct indicator of the overall population or its trend. Not all nests were found, while others had unknown outcomes or failed.

Productivity Based on Substrate

Of the 502 successful nests that were monitored during this period, 66.1 percent were constructed within willows and 33.9 percent were found in saltcedar (Table 14). From 2002 through 2008, successful nests in saltcedar substrate fledged an average of 2.60/nest (n=170). Productivity from nests found in saltcedar ranged from a high of 2.95/nest (n=20) in 2004, to a low of 2.26/nest (n=38) in 2008. During this same period, successful nests in willow substrate (n=332) fledged an average of 2.64/nest. Productivity from successful nests found in willows ranged from a high of 2.92/nest (n=49) in 2005, to a low of 2.48/nest (n=27) in 2002. A statistical analysis comparing productivity rates between willow and saltcedar substrates was conducted and no statistically significant difference was detected (t-test, *P*=0.65, t=0.46) (Figure 11).

Table 14. Productivity of successful nests based on nest substrate and dominant vegetation within the territory.

	Willow Substrate	(n)	Native Territory	(n)	Saltcedar Substrate	(n)	Exotic Territory	(n)	Mixed Territory	(n)	**TOTAL Annual**	**(n)**
2002	2.48	27	2.46	35	2.38	8	0.00	0	0.00	0	**2.46**	**35**
2003	2.56	34	2.59	46	2.71	14	0.00	0	3.00	2	**2.60**	**48**
2004	2.51	51	2.61	70	2.95	20	0.00	0	4.00	1	**2.63**	**71**
2005	2.92	49	2.88	66	2.84	19	0.00	0	3.50	2	**2.90**	**68**
2006	2.56	57	2.56	72	2.56	25	0.00	0	2.60	10	**2.56**	**82**
2007	2.79	66	2.71	97	2.65	46	2.33	3	2.92	13	**2.73**	**112**
2008	2.50	48	2.42	64	2.26	38	0.00	0	2.32	22	**2.39**	**86**
TOTALS	**2.64**	**332**	**2.62**	**450**	**2.60**	**170**	**2.33**	**3**	**2.64**	**50**	**2.62**	**502**

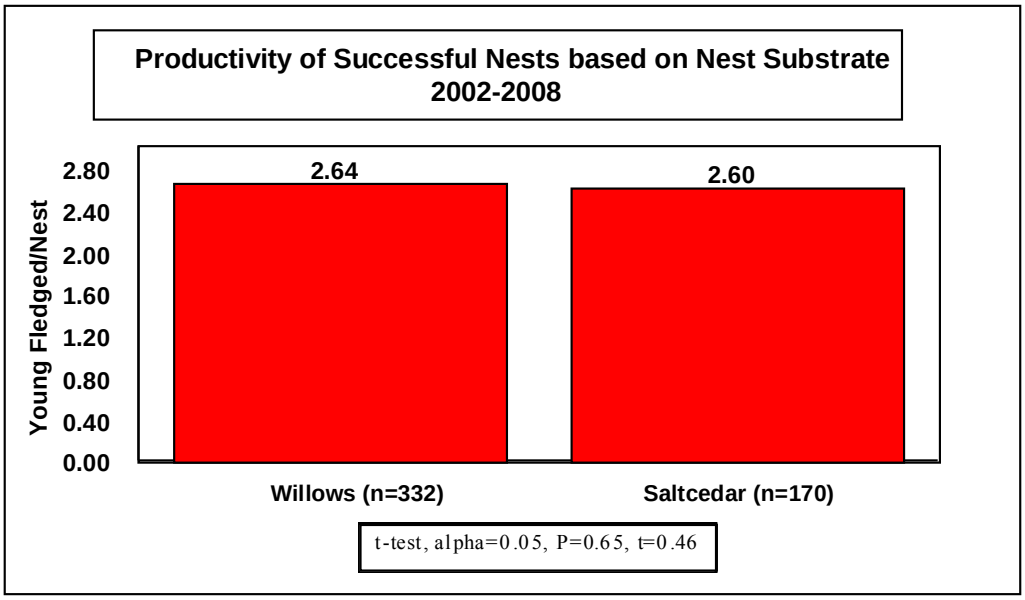

Figure 11. Productivity of successful nests based on nest substrate.

Productivity Based on Territory Dominance

Nearly 90 percent (n=502) of all successful nests that were monitored during this period were found within native vegetation dominated stands (Table 14). [Native dominated stands were defined as being comprised of greater than 75 percent willows within a 25 meter radius of the nest.] Less than 1 percent were found within exotic vegetation (i.e. saltcedar) dominated stands, and approximately 10 percent were found within mixed dominance stands.

The 450 successful nests within native dominated sites fledged an average of 2.62 young/nest. Productivity rates ranged from a high of 2.88/nest (n=66) in 2005, to a low of 2.42/nest (n=64) in 2008. Successful nests found in exotic dominated stands fledged an average of 2.33 young/nest (n=3). Fifty successful nests were found within mixed stands which fledged an average of 2.64 young/nest. Productivity rates within mixed stands ranged among years, from a high of 4.0 young/nest (n=1) in 2004, to a low of 2.32 young/nest (n=22) in 2008. Due to the small sample size of successful nests found in exotic dominated stands, statistical analysis was not possible. Although sample sizes were skewed, an analysis comparing native and mixed stands was conducted and no statistical difference was found (t-test, *P*=0.89, t=0.14) (Figure 12).

Discussion Points

Based on SWFL nest data from within Elephant Butte Reservoir from 2002-2008, nests found in saltcedar substrate are as productive as those found in native willows. However, a similar analysis of data which includes all successful nests from within the Middle Rio Grande from Highway 60 downstream to, and including Elephant Butte Reservoir (1999-2008) indicate that nests found in saltcedar (n=218) fledged an average of 2.50 young/nests, while those found in willows (n=375) fledged an average of 2.66 young/nest. Based on an analysis of this data set, successful nests found in saltcedar were significantly less productive than those found in willows (t-test, P=0.04, t=2.05). The difference in productivity between these two datasets is likely a function of overall habitat quality rather than the substrate species. SWFL habitat within Elephant Butte Reservoir is expansive, covering hundreds of acres, much of which is subject to flooding. Occupied SWFL

habitat found upstream within the Middle Rio Grande tends to be linear in shape, relatively small in size, and lacks frequent flooding. This does not imply that these sites are less critical to the flycatcher than those at Elephant Butte Reservoir.

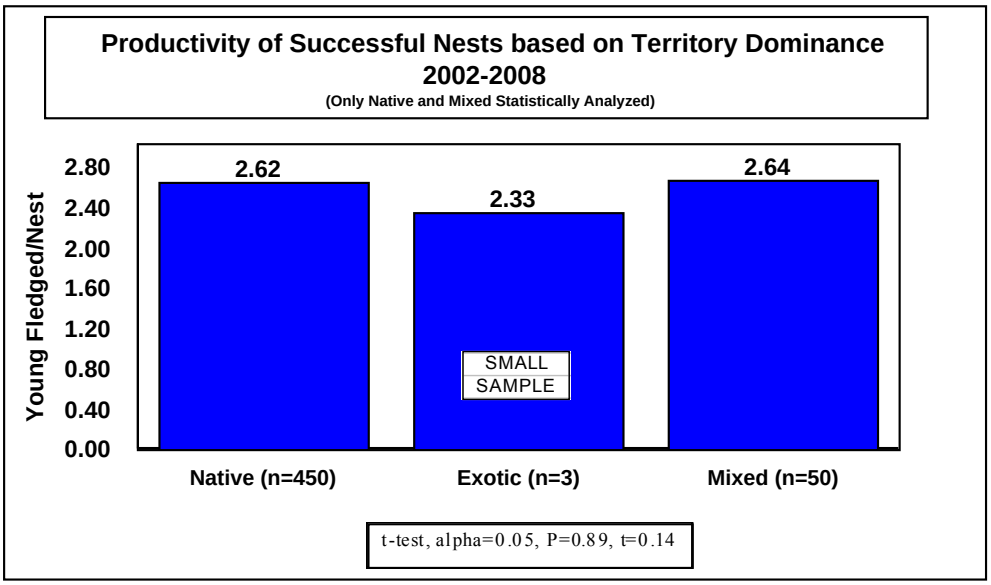

Figure 12. Productivity of successful nests based on dominant vegetation within territory.

EFFECTS OF HYDROLOGY ON NESTING PARAMETERS 2004-2008

Beginning in 2004, a detailed analysis of hydrologic conditions in the immediate and general vicinity of SWFL nests was initiated. The following section therefore is based on SWFL nests from 2004 through 2008. Data were recorded upon each nest monitoring visit, and were entered into a database for analysis. Hydrologic conditions are known to frequently change throughout the season, and even within individual nesting cycles. If multiple nesting attempts from individual pairs were documented, each nesting cycle was analyzed individually. The four hydrologic categories that were established are: Dry[(1)] all cycle; Saturated[(2)] /Flooded then Dry; Saturated/Flooded all cycle; and Flooded[(3)] all cycle. Flooded all cycle is a subset of Saturated/Flooded all cycle. This subset was established to determine whether the physical presence of water during the entire nest cycle affected the various nesting parameters.

[(1)] Dry is defined as soil conditions absent of saturation and appearing relatively dry within upper 12 inches of soil.
[(2)] Saturated is defined as when all voids between soil particles are temporarily filled with water to the soil surface (i.e. muddy).
[(3)] Flooded is defined as the physical presence of surface water of any depth.

It is likely that hydrologic conditions within the site and immediate proximity to the nest play several roles. Hydrologic conditions obviously will affect the density and structure of the vegetation and often the species composition of the site. It also will likely play a role in insect abundance (i.e. prey base) and diversity as well as micro-habitat characteristics (i.e. temperature and relative humidity). In addition, SWFLs appear to have a strong affinity for surface water, particularly upon territory establishment.

Analysis Based on Hydrologic Conditions Immediately Under Nest

An evaluation of nesting parameters and hydrologic conditions immediately beneath the nest was conducted. This study was initiated to determine whether an association between hydrologic conditions and nest success, predation, parasitism, or productivity exists (Table 15).

Nesting Success

Nest success was compared among the four hydrologic conditions found under the nest (Table 15 and Figure 13).

Dry All Cycle – From 2004 through 2008, a total of 170 nests were monitored where the nest was placed above dry soils during the entire nesting cycle. Of these, 50.0 percent were successful.

Saturated/Flooded then Dry – Only 12 nests during the period of study fell into this category. Under this category, the nest would have been initially constructed over saturated or flooded soils, but dried out during the nesting cycle. Of these 12 nests, 75.0 percent were successful. Due to the relatively small sample size, statistical analysis was not conducted and results should not be considered as representative of the conditions.

Saturated/Flooded All Cycle – The bulk of the nests were found under these conditions, which included either saturated soils and/or flooded conditions. A total of 593 nests were placed above saturated and/or flooded soils, and 55.3 percent were successful.

Flooded All Cycle – In an effort to determine whether flooded conditions effected the various nest parameters, nests that were placed above flooded conditions during each nesting cycle were also analyzed. This category is therefore a subset of the Saturated/Flooded All Cycle. A total of 413 nests fell into this category and 54.2 percent were successful.

Table 15. Summary of nest success, predation and parasitism rates based on hydrology under the nests.

NESTING SUCCESS	2004		2005		2006		2007		2008		**2004-2008**	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	**%**	**(n)**
Dry All Cycle	64.1%	39	54.5%	22	49.3%	75	30.0%	20	35.7%	14	**50.0%**	**170**
Saturated/Flooded then Dry	90.0%	10	0.0%	0	0.0%	0	0.0%	2	0.0%	0	**75.0%**	**12**
Saturated/Flooded all cycle	39.0%	100	57.1%	98	68.2%	66	58.5%	183	55.5%	146	**55.3%**	**593**
Flooded all cycle	33.3%	48	56.8%	88	64.3%	42	57.9%	114	53.7%	121	**54.2%**	**413**
Overall Success	49.0%	149	56.6%	120	58.1%	141	55.1%	205	53.8%	160	**54.4%**	**775**

PREDATION RATES	2004		2005		2006		2007		2008		**2004-2008**	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	**%**	**(n)**
Dry All Cycle	23.1%	39	40.9%	22	41.3%	75	25.0%	20	35.7%	14	**34.7%**	**170**
Saturated/Flooded then Dry	0.0%	10	0.0%	0	0.0%	0	50.0%	2	0.0%	0	**8.3%**	**12**
Saturated/Flooded all cycle	42.0%	100	29.6%	98	22.7%	66	21.9%	183	33.6%	146	**29.5%**	**593**
Flooded all cycle	45.8%	48	29.5%	88	21.4%	42	27.2%	114	33.9%	121	**31.2%**	**413**
Overall Predation	34.2%	149	31.7%	120	32.6%	141	22.5%	205	33.8%	160	**30.3%**	**775**

PARASITISM RATES	2004		2005		2006		2007		2008		**2004-2008**	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	**%**	**(n)**
Dry All Cycle	10.3%	39	4.5%	22	17.3%	75	35.0%	20	0.0%	14	**14.7%**	**170**
Saturated/Flooded then Dry	10.0%	10	0.0%	0	0.0%	0	50.0%	2	0.0%	0	**16.7%**	**12**
Saturated/Flooded all cycle	20.0%	100	15.3%	98	3.0%	66	11.5%	183	3.4%	146	**10.6%**	**593**
Flooded all cycle	25.0%	48	15.9%	88	4.8%	42	6.1%	114	3.3%	121	**9.4%**	**413**
Overall Parasitism	16.8%	149	13.3%	120	10.6%	141	14.2%	205	3.1%	160	**11.6%**	**775**

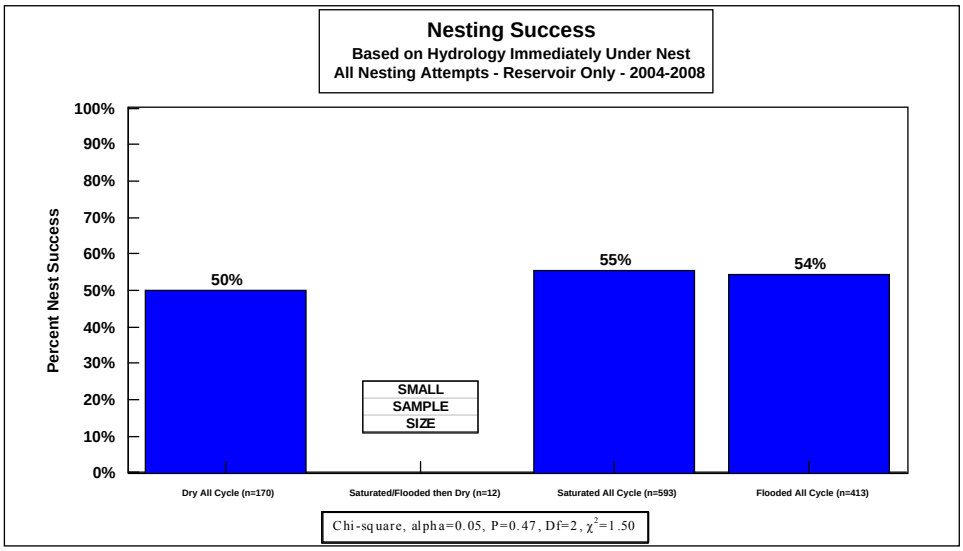

Figure 13. Summary of SWFL nesting success based on hydrology immediately under the nest.

Discussion Points

No statistical difference in nest success was found between the three hydrologic conditions (P=0.47, Df=2, χ^2=1.50). However, in general, the sites that were saturated and/or flooded tended to have higher nesting success. These sites tend to support vegetation that is more dense and structurally suitable than drier sites (i.e. more suitable habitat). An analysis to determine whether there is a statistical difference of the vegetative characteristics within "dry" and "wet" [(1)] territories was conducted. Eleven nest site parameters were evaluated based on data collected from 11.35m radius center plots (Table 16). Evaluated parameters that showed a statistically significant difference included: shrub density/m^2, percent dead shrubs, nest height, and substrate height. The difference in shrub density and percent dead shrubs can easily be correlated with the drier conditions. The nest height and substrate height are likely a result of the reduced shrub layer, essentially forcing SWFLs to select trees and nest higher in an effort to increase concealment. In addition to the center plot, three additional plots (5m radius) were established at 15m centers from the nest tree. Nine nest site parameters were evaluated based on these data. Canopy and shrub data were collected from all four plots (Table 17). Evaluated parameters that showed a statistically significant difference included: percent canopy cover >6m, canopy height, and shrub density/hectare. Percent canopy >6m, and canopy height were greater at the dry sites primarily due to the lack of canopy >6m at the wetter sites. The greater shrub density at the wetter sites is indicative of greater water availability.

Based on the nest site quantification analysis it appears that the vegetative characteristics within each territory play a role in determining nest success. However, it is likely that the availability of water has a direct influence on the structure and density of vegetation. For a detailed analysis of all data associated with the Nest Site Quantification Study, see Moore 2007.

[(1)] Wet is defined as saturated soils or flooded.

Table 16. Nest site quantification data – center plot. Data were compared using a Chi-square test with an α of 0.05. **Boldface** indicated significant difference.

	Dry (n=31)	Saturated (n=52)	Statistical Analysis
Percent Trees (5cm-10cm dbh)	69.2%	67.0%	P=0.52
Percent Trees (10cm-20cm dbh)	30.6%	32.4%	P=0.58
Percent Trees (>20cm dbh)	17.3%	52.3%	P=0.20
Tree Density (number/ha)	2772.3	3050.7	P=0.32
Percent Dead Trees	4.1%	2.8%	P=0.37
Shrub Density/sq. meter	**2.3**	**3.7**	**P<0.01**
Percent Dead Shrubs	**45.8%**	**33.3%**	**P<0.01**
Percent Willow Shrubs	78.9%	83.1%	P=0.50
Percent Saltcedar Shrubs	18.8%	16.2%	P=0.68
Nest Height (m)	**3.27**	**2.49**	**P<0.01**
Substrate Height (m)	**6.6**	**4.78**	**P<0.01**

Table 17. Nest site quantification data – all plots. Data were compared using a Chi-square test with an α of 0.05. **Boldface** indicated significant difference.

	Dry (n=30)	Saturated (n=52)	Statistical Analysis
Percent Canopy Cover >6m	**26.7%**	**19.4%**	**P<0.01**
Percent Canopy Cover 3m - 6m	33.2%	31.7%	P=0.61
Percent Canopy Cover 0m - 3m	24.4%	26.1%	P=0.57
Canopy Height (m)	**8.5**	**7.7**	**P=0.03**
Shrub Crown Width (m)	1.0	1.0	P=0.91
Shrub Height (m)	3.0	2.8	P=0.12
Shrub Density/ha	**3292.8**	**8111.1**	**P<0.01**
Mid-canopy Crown Width (m)	2.7	2.9	P=0.27
Mid-canopy Height (m)	8.7	8.3	P=0.20

Nest Success vs. Nest Attempt vs. Hydrologic Conditions

Dry All Cycle – During the 2004 to 2008 period of study, a total of 112 first nesting attempts under Dry All Cycle were documented. Of these nests 51.8 percent were successful. During this same period, a total of 58 second/third nesting attempts were documented and 46.6 percent were successful (Figure 14). There is no statistical difference between first attempts and second/third attempts under the Dry All Cycle conditions (P=0.52, Df=1, χ^2=0.42).

Saturated/Flooded then Dry – The sample size of nests that fell within this category of Saturated/Flooded then Dry was small during the period of study and does not allow for statistical comparison. However, of the nine first nesting attempts documented under these hydrologic conditions 66.7 percent were successful. Of the three second/third nesting attempts, all were successful.

Saturated/Flooded All Cycle – Over 76 percent of all nesting attempts were found under Saturated/Flooded All Cycle conditions. Of the 377 first nesting attempts found under these conditions, 58.6 percent were successful. A total of 216 second/third nesting attempts were also

documented and 49.5 percent were successful. There is a statistical difference between first attempts and second/third attempts under the Saturated/Flooded All Cycle conditions (P=0.03, Df=1, χ^2=4.58).

Flooded All Cycle – This category of hydrologic conditions is a subset of Saturated/Flooded All Cycle. A total of 271 first nesting attempts were found over flooded conditions during the entire nest cycle; 59.4 percent were successful. Second/third nesting attempts accounted for an additional 142 nests, of which 44.4 percent were successful. There was a statistical difference between first attempts and second/third attempts under the Flooded All Cycle conditions (P<0.01, Df=1, χ^2=8.50).

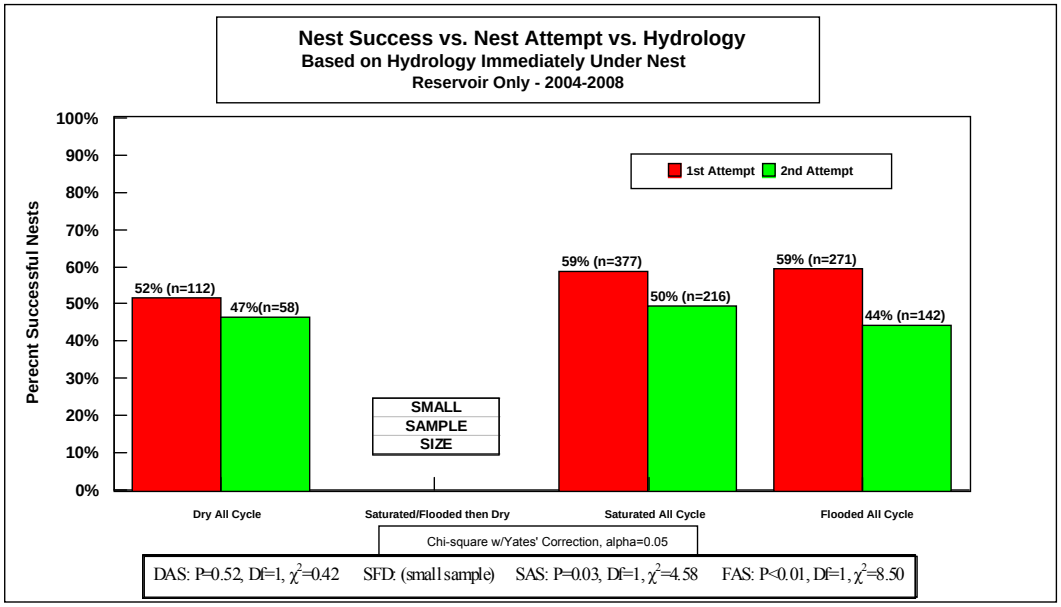

Figure 14. SWFL nest success based on nest attempt and hydrology immediately under the nest.

Discussion Points

Statistical differences between first nesting attempts and subsequent nesting attempts were found under both Saturated/Flooded All Cycle and Flooded All Cycle. However, under all hydrologic conditions first attempts did experience a higher success rate than second/third nesting attempts. Since renesting following a successful nesting attempt is less common than after a failed first attempt, second and third attempts generally followed a failed first attempt. The possible reason for a lower nest success on second/third attempts may be due to the pair's inability to select a nest site that is not as subject to predation or parasitism. This may also be related to the pair's age and experience. It is not likely that the lower nest success associated with subsequent attempts is associated with habitat quality or hydrologic conditions.

Predation Rates

Nest predation was also evaluated based on four hydrologic conditions found immediately under the SWFL nest. For this study, nest predation was defined as when the primary cause of nest failure was due to some form of avian, reptilian or mammalian predation resulting in complete failure (Figure 15 and Table 15).

Dry All Cycle – From 2004 through 2008, a total of 170 nests were monitored where the nest was placed above dry ground during the entire nesting cycle. Predation rates ranged from a high of 41.3 percent (n=75) to a low of 23.1 percent (n=39) over the period of study. Overall predation rate for Dry all Cycle from 2004-2008 was 34.7 percent (n=170).

Saturated/Flooded then Dry – Only 12 nests during the period of study fell into this category. Of these 12 nests, only 8.3 percent were predated. Due to the relatively small sample size, statistical analysis was not conducted.

Saturated/Flooded All Cycle – The bulk of the nests were found under these conditions, which included either saturated soils or flooded conditions. A total of 593 nests were placed above saturated and/or flooded soils and an average of 29.5 percent were predated. Predation rates ranged from a high of 42.0 percent (n=100) to a low of 21.9 percent (n=183).

Flooded All Cycle – In an effort to determine whether flooded conditions affected predation rates, the nests that were placed above flooded conditions during each nesting cycle were also analyzed. This category is therefore a subset of the Saturated/Flooded All Cycle. A total of 413 nests fell into this category. Predation rates ranged from a high of 45.8 percent (n=48) to a low of 21.4 percent (n=42), with an overall predation rate of 31.2 percent (n=413).

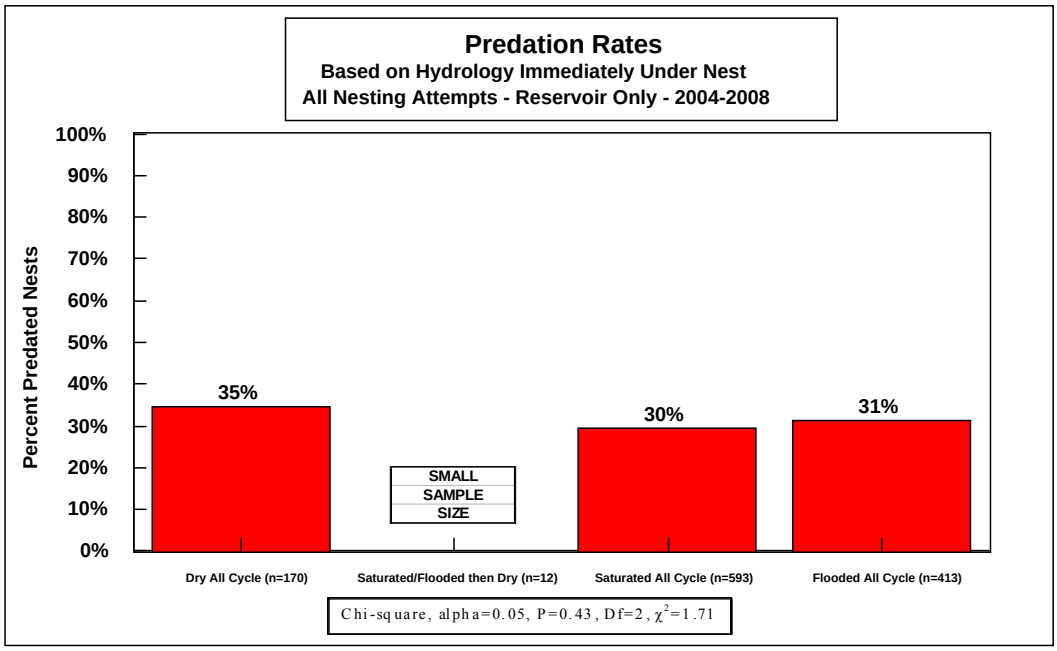

Figure 15. Predation rates based on hydrology immediately under the nest.

Discussion Points

Predation rates were variable between years of all hydrologic conditions, ranging from a high of 34.2 percent (n=149) in 2004 to a low of 22.5 percent (n=205) in 2007. Predation was more variable within years among the various hydrologic conditions. For example, in 2006 41.3 percent (n=75) of the Dry All Cycle nests were predated, while only 21.4 percent (n=42) were predated that were Flooded All Cycle. Although there was not a statistical difference among the three hydrologic

conditions of sufficient sample size (i.e. Dry all Cycle, Saturated/Flooded all Cycle, and Flooded All Cycle) (P=0.43 Df=2, $\chi 2$ =1.71), overall predation rates were slightly higher under the Dry All Cycle conditions.

Parasitism Rates

Parasitism was also evaluated based on the four hydrologic conditions found immediately under the SWFL nest (Table 15 and Figure 16).

Dry All Cycle – From 2004 through 2008, a total of 170 nests were monitored where the nests was placed above dry soils during the entire nesting cycle. Parasitism rates ranged from a high of 35.0 percent (n=20) to a low of 0.0 percent (n=14) over the period of study. Overall parasitism rate for Dry All Cycle from 2004 to 2008 was 14.7 percent.

Saturated/Flooded then Dry – Only 12 nests during the period of study fell into this category. Of these 12 nests, 16.7 percent were parasitized. Due to the relatively small sample size, statistical analysis was not conducted.

Saturated/Flooded All Cycle – A total of 593 nests were placed above saturated and/or flooded soils and 10.6 percent were parasitized. Parasitism rates ranged from a high of 20.0 percent (n=100) to a low of 3.0 percent (n=66).

Flooded All Cycle – In an effort to determine whether flooded conditions played a role in parasitism rates, the nests that were placed above flooded conditions during each nesting cycle were also analyzed. This category is therefore a subset of the Saturated/Flooded All Cycle. A total of 413 nests fell into this category. Parasitism rates ranged from a high of 25.0 percent (n=48) to a low of 3.3 percent (n=121), with an overall parasitism rate of 9.4 percent (n=413).

Discussion Points

Overall parasitism rates were fairly constant among years, except for 2008 when parasitism rates dramatically decreased under all hydrologic conditions. Parasitism ranged from a high of 16.8 percent (n=149) in 2004 to a low of 3.1 percent (n=160) in 2008. Parasitism was more variable within years among the various hydrologic conditions. For example, in 2007 35.0 percent (n=20) of the Dry All Cycle nests were parasitized, while only 6.1 percent (n=114) were parasitized that were Flooded All Cycle. Although there was not a statistical difference among the three hydrologic conditions of sufficient sample size (P=0.17 Df=2, $\chi 2$ =3.50), overall parasitism rates were highest under the Dry All Cycle conditions.

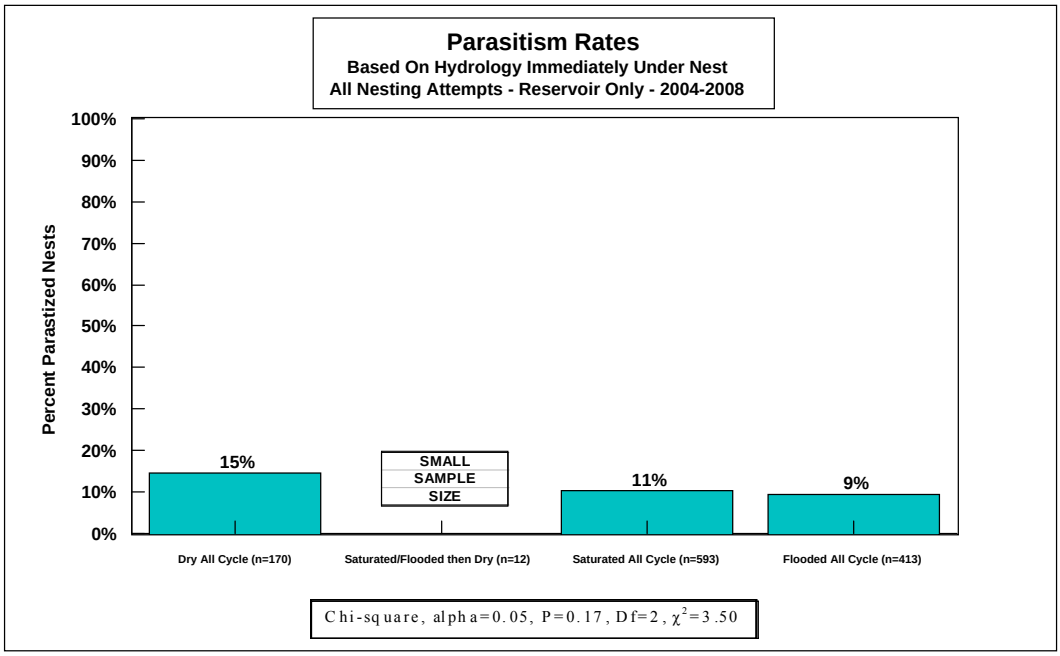

Figure 16. Parasitism rates based on hydrology immediately under the nest.

Productivity of Successful Nests

Productivity (i.e. young fledged/nest) of successful nests was analyzed among the various hydrologic conditions in an effort to determine whether these conditions may directly, or indirectly influence productivity (Figure 17 and Table 18).

Dry All Cycle – Overall productivity of successful nests from 2004 to 2008 under Dry All Cycle was 2.49 young/nest (n=85), ranging from a high of 2.83 young/nest (n=12) in 2005, to a low of 1.80 young/nest (n=5) in 2008.

Saturated/Flooded then Dry - Overall productivity of successful nests from 2004 to 2008 under Saturated/Flooded then Dry was 2.67 young/nest (n=9). Due to the small sample size within this category, no statistical analysis was conducted.

Saturated/Flooded All Cycle – A total of 328 successful nests were documented under these conditions from 2004 to 2008 and productivity was 2.67 young/nest. Productivity ranged from a high of 2.91 young/nest (n=56) in 2005 to a low of 2.43 young/nest (n=81) in 2008.

Flooded All Cycle – This subset of Saturated/Flooded All Cycle experienced the highest productivity of the various conditions, fledging 2.70 young/nest (n=224). Productivity of successful nests that were Flooded All Cycle ranged from a high of 2.94 young/nest (n=50) in 2005 to a low of 2.48 young/nest (n=65) in 2008.

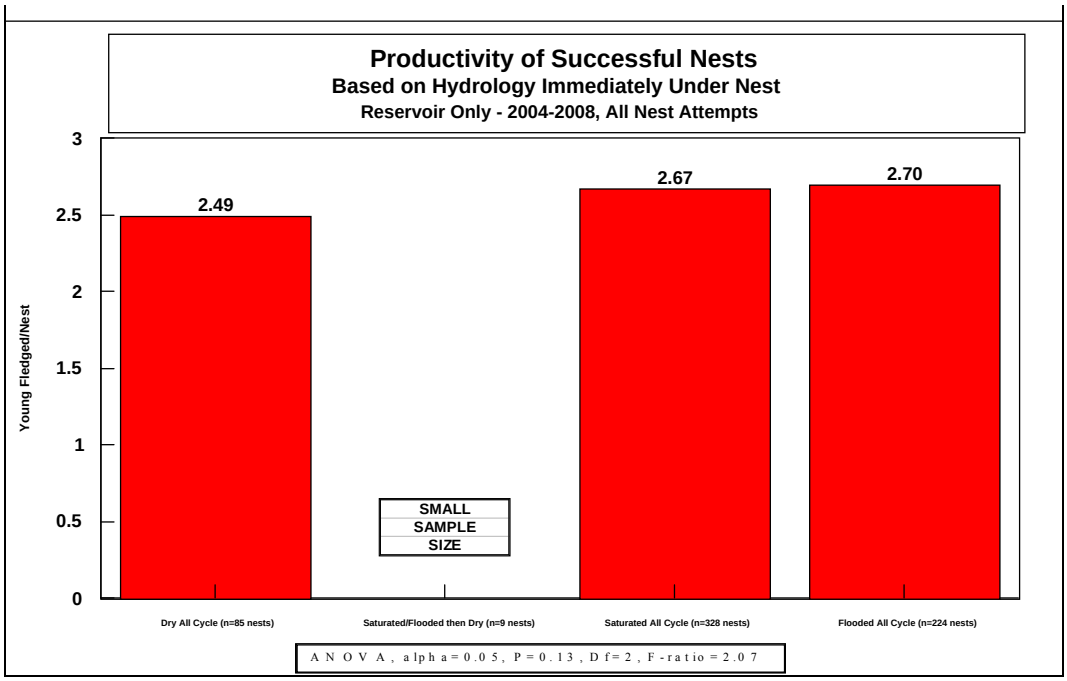

Figure 17. Productivity of successful nests based on hydrology immediately under the nest.

Table 18. Productivity of successful nests based on hydrology under nest (young/nest).

	2004		2005		2006		2007		2008		**2004-2008**	
	#	(n)	#	(n)	#	(n)	#	(n)	#	(n)	#	**(n)**
Dry All Cycle	2.28	25	2.83	12	2.62	37	2.50	6	1.80	5	**2.49**	**85**
Saturated/Flooded then Dry	2.67	9	N/A	0	N/A	0	N/A	0	N/A	0	**2.67**	**9**
Saturated/Flooded all cycle	2.79	39	2.91	56	2.51	45	2.74	107	2.43	81	**2.67**	**328**
Flooded all cycle	2.88	16	2.94	50	2.48	27	2.79	66	2.48	65	**2.70**	**224**
Overall Productivity	2.60	73	2.90	68	2.56	82	2.73	113	2.39	86	**2.63**	**422**

Discussion Points

Overall productivity of successful nests from 2004 to 2008 for all hydrologic conditions was 2.63 (n=422), ranging from a high of 2.90 young/nest (n=68) in 2005 to a low of 2.39 young/nest (n=86) in 2008. From 2004 to 2008, overall productivity ranged from 2.49 young/nest (n=85) under Dry All Cycle to 2.70 young/nest (n=224) under Flooded All Cycle. Although there was not a statistical difference among the three hydrologic conditions of sufficient sample size (i.e. Dry all Cycle, Saturated/Flooded all Cycle, and Flooded All Cycle) (P=0.13, Df=2, F-ratio =2.07), overall productivity was lowest under the Dry All Cycle conditions.

Analysis Based on Hydrologic Conditions in Vicinity of Nest

Distance to Water

The distance of nests to surface water was evaluated on a broad scale of <50m and <100m for all nests from 2004-2008. During this period, 92.9 percent of all nests (n=775) were found within 50 meters of surface water source, and 95.6 percent were within 100 meters of surface water, a difference of only 21 nests (Table 19). Only 34 nests, or 4.4 percent of the total, were found at distances greater than 100 meters of water. All nests found at distances greater than 100 meters were in 2006 – a year of reduced flows from the Low Flow Conveyance Channel (LFCC). Under normal LFCC flows, the territories in 2006 would have typically flooded.

Table 19. Distance of nests to surface water (i.e. Rio Grande, LFCC).

	2004		2005		2006		2007		2008		**2004 -2008**	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	**%**	**(n)**
Percent < 50m	99.3%	149	97.5%	120	66.0%	141	99.5%	205	98.8%	160	**92.9%**	**775**
Percent < 100m	100.0%	149	100.0%	120	75.9%	141	100.0%	205	100.0%	160	**95.6%**	**775**

The number of nests found <50m and <100m includes those that were constructed under flooded conditions (i.e. 0m). The extent that flooded conditions persisted throughout the breeding season was quantified regardless of nesting stage. Flooded conditions within the SWFL known breeding territories were evaluated early in the breeding season upon territory establishment (mid-May to early-June); during the peak nesting season of mid-June to early-July; and in the late breeding season of mid-July to early-August. In all years, with the exception of 2006, the percentage of flooded breeding territories declined throughout the breeding season (Table 20). The majority of breeding territories (65.8%, n=775) were flooded upon territory establishment from 2004-2008.
In 2004, early flooding was observed in 65.8% of the territories. However, by mid-June the number of flooded territories had declined to 36.9%. In contrast, flooding in early 2006 affected only 10.6% of the breeding territories; by late 2006, over 70% of the territories were flooded.

Table 20. Percentage of flooded breeding territories

	2004 (n=149)	2005 (n=120)	2006 (n=141)	2007 (n=205)	2008 (n=160)	2004-2008 (n=775)
Flooded mid-May to early-June	65.8%	81.7%	10.6%	77.1%	88.1%	65.8%
Flooded mid-June to early-July	36.9%	75.0%	39.7%	57.6%	77.5%	57.2%
Flooded mid-July to early-August	28.9%	70.0%	71.6%	52.2%	75.0%	58.7%

Nest Success

Nest success based on distance to permanent surface water for both >50m or <50m and >100m or <100m was evaluated (Figure 18 and Figure 19). It is important to note that there is little difference between the 50m and 100m analysis since 92.9 percent of the same nests are evaluated under both distances. No statistical difference in nest success was found at either the 50m or 100m distance to water (P=0.41, Df=1, χ^2 =0.69 and P=0.86, Df=1, χ^2 =0.03, respectively). It is also important to note

that, although statistical analysis was conducted, sample sizes within the 50m and 100m data sets are heavily skewed.

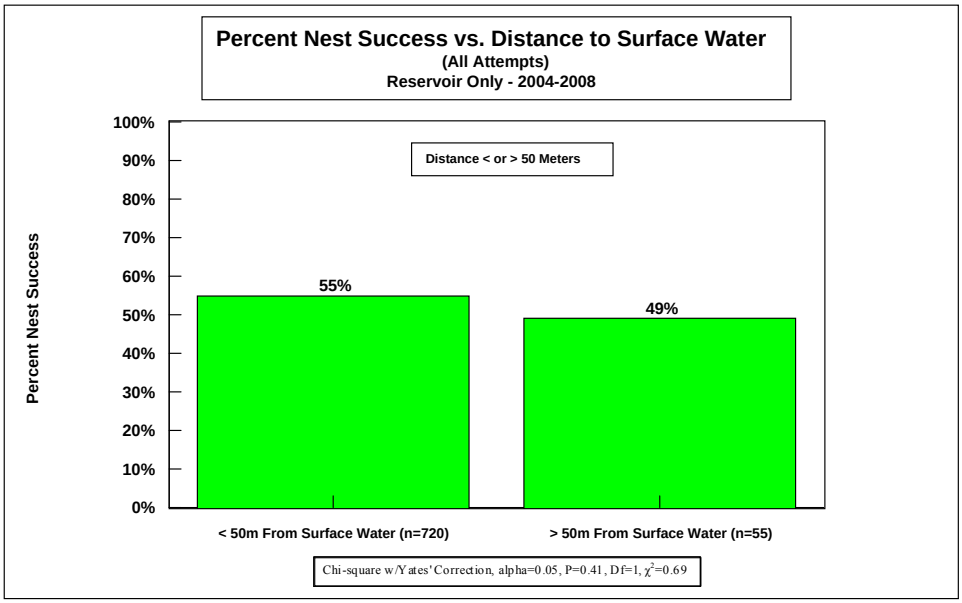

Figure 18. SWFL nest success in relation to distance to surface water (> or < 50 meters).

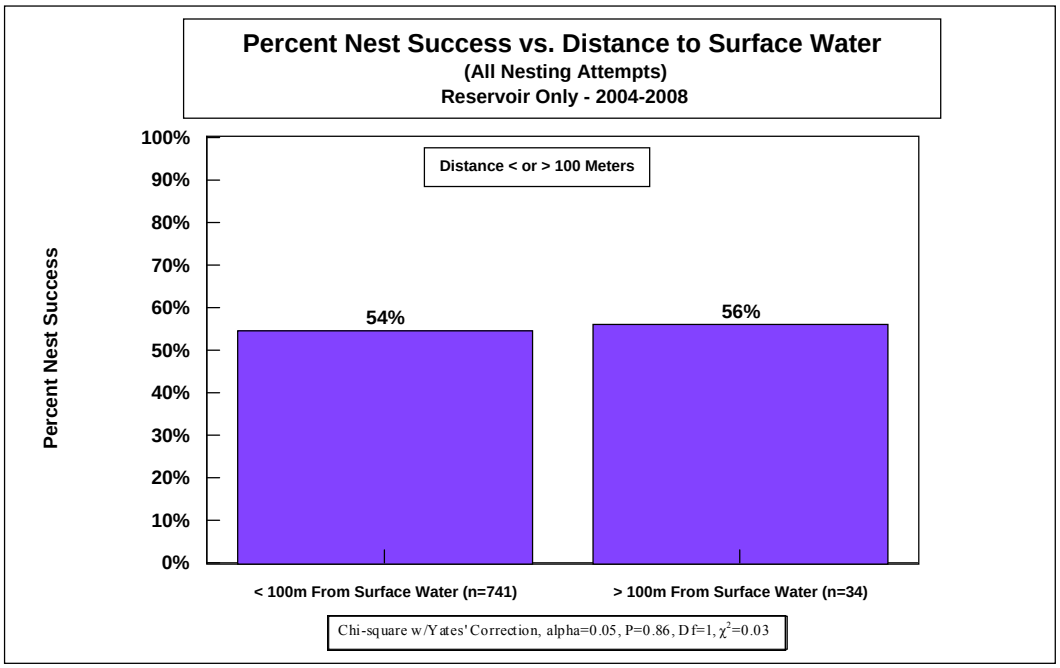

Figure 19. SWFL nest success in relation to distance to surface water (> or < 100 meters).

Discussion Points

With the exception of 2006 when 34 nests [24.1 percent of the 2006 total (n=141)] were found at distances greater than 100 meters from a permanent water source, 100 percent of all nests were less than 100 meters during 2004, 2005, 2007, and 2008 (Figure 19). The vast majority of all nests are found less than 50 meters from a permanent water source. The continued occupation of previously

established territories in 2006 demonstrates the relatively strong site fidelity associated with the species. Although SWFLs appear to exhibit a strong affinity for surface water it is not an absolute requirement. The primary role of hydrology continues to be the establishment, development, and maintenance of the riparian vegetation.

The extent of flooding that occurs early in the breeding season does not appear to directly affect overall nest success. For example: in 2004 the percentage of breeding territories that were flooded declined throughout the season (Table 20) and overall nesting success was 47.7% (Table 3). In 2006, the percentage of breeding territories that were flooded increased throughout the season and overall nesting success was 58.2%; and in 2008 more than 75.0% of the territories remained flooded throughout the breeding season and overall nest success was 53.8%. The difference in nest success between years is likely a function of annual variability in predation and parasitism rates, it is unlikely a function of whether the territory was flooded early or late, or remained flooded throughout the breeding season. However, as shown in Figure 15 nests that were constructed over saturated and/or flooded hydrologic conditions tend to be more successful, though not statistically greater.

CURRENT HABITAT AVAILABILITY AND SWFL DISTRIBUTION

Geographic Information Systems (GIS) habitat modeling of suitable SWFL habitat has been conducted since 1998. The GIS model has been developed based on the Hink and Ohmart (1984) vegetation classification system. Vegetation types where SWFLs have successfully reproduced have been documented and are included as suitable habitat types. The extent of these polygons is then quantified to determine the amount of available habitat based on structure and density. An additional GIS layer showing proximity of suitable habitat types within 100m of surface water is then applied. Areas that are both structurally suitable, and within 100m of surface water are considered to be suitable SWFL breeding habitat. Suitable SWFL habitat within Elephant Butte Reservoir was initially modeled in 2002 and again in 2005.

During the late-summer of 2007, true color and color infrared photography was again obtained from within Elephant Butte Reservoir. During the spring and summer of 2008, this photography was delineated and ground truthed. To evaluate recent trends, 2005 and 2008 model outputs were compared and the results are presented in Table 21. These results indicate a relative abundance of suitable occupied and unoccupied habitat, although the distribution of habitat has changed over the past few years. Habitat classifications of suitable habitat from 2005 and 2008 data likely exaggerate the true extent of suitable habitat. It is not possible [without extensive resources] to incorporate all microhabitat parameters at a level required to identify specific patch characteristics. Habitat patches are not homogenous in nature and although polygons are identified as suitable habitat, not all vegetation within the polygons is likely suitable.

Although the extent of suitable habitat may be somewhat exaggerated, relative data suggest that unoccupied suitable habitat remains relatively abundant. Suitable habitat trends from 2005 to 2008 are also relative and reflect overall changes in the extent of suitable habitat [Refinement of the 2008

classifications is currently being conducted to more accurately reflect suitable habitat conditions.] Suitable habitat by 5 ft contours was quantified between elevations 4345 ft and 4407 ft. There is currently no suitable SWFL habitat below 4345 ft within Elephant Butte Reservoir and 4407 ft is Elephant Butte Dam spillway elevation.

As shown in Table 21 the majority of suitable dry and flooded habitat exists above 4385 ft which corresponds to the current distribution of SWFLs shown in Figure 20 and Figure 21. In 2005 and 2008, approximately 618 acres and 986 acres of suitable habitat within 100m of water, respectively, existed above 4385 ft, representing an increase in nearly 368 acres. However, the most dramatic increase in available suitable habitat occurred below 4385 ft. In 2005, approximately 77 acres of suitable habitat within 100m of water existed below 4385 ft; by 2008 the extent of suitable habitat had increased to 785 acres.

Assuming an average territory size of 0.72 acres (Reclamation 2008a), the 229 territories within Elephant Butte Reservoir in 2008 occupied approximately 165 acres of available habitat – all within 100m of water. Based on the data presented in Table 21, over 1770 acres of suitable habitat within 100m of water is currently available. Although the entire remaining 1605 acres may not be homogenously suitable, it is only reasonable to assume that an abundance of suitable unoccupied habitat currently exists and is not a limiting factor for the SWFL population within Elephant Butte Reservoir. Habitat availability is believed to be the most significant contributing factor to the dramatic SWFL population increase observed over the past 14 years.

Table 21. Availability of suitable habitat (acres) by elevation range within Elephant Butte Reservoir.

	2005			2008		
ELEVATION	TOTAL SUITABLE DRY	TOTAL SUITABLE WITHIN 100m WATER	TOTAL SUITABLE	TOTAL SUITABLE DRY	TOTAL SUITABLE WITHIN 100m WATER	TOTAL SUITABLE
4345-4350	14.2	4.3	18.5	12.3	67.7	80.0
4350-4355	31.0	21.6	52.6	0.0	154.0	154.0
4355-4360	44.3	27.5	71.8	9.3	320.3	329.6
4360-4365	19.1	6.9	26.0	63.7	129.7	193.4
4365-4370	0.1	0.0	0.1	15.8	31.3	47.1
4370-4375	0.0	0.0	0.0	21.1	10.2	31.3
4375-4380	5.7	6.1	11.8	230.3	23.3	253.5
4380-4385	2.4	10.6	13.0	16.8	49.3	66.1
4385-4390	41.8	44.5	86.2	69.0	144.4	213.4
4390-4395	179.8	142.2	322.0	149.2	265.0	414.2
4395-4400	125.9	41.6	167.5	94.1	197.1	291.2
4400-4407	68.6	288.8	357.3	172.1	326.3	498.3
>4407	11.3	100.6	111.8	20.8	53.3	74.1
TOTALS	544.0	694.6	1238.6	874.4	1771.8	2646.2

The most obvious change in the extent of suitable habitat has been due to the reduced elevation of Elephant Butte Reservoir and the establishment of habitat in the exposed soils over the past 14 years. Habitat within the higher elevations is more mature than that found at the lower elevations, due to

the timing that the Reservoir receded. The majority of SWFLs continue to establish territories in the upper elevations of Elephant Butte Reservoir, presumably due to site fidelity and habitat availability. Suitable habitat at lower elevations within the pool will likely become occupied by SWFLs, barring any major changes in structure, density, or hydrology.

Changes in elevational distribution of SWFLs from 2005 to 2008 correspond to changes in habitat distribution. SWFL territories have slowly shifted eastward from the western edge of the pool, and southward from the upper end of the reservoir pool. As suitable patches developed, SWFLs began to expand downstream further into Elephant Butte Reservoir.

Significant sediment deposition has occurred over the past ten years within the upper portion of Elephant Butte Reservoir as a result of LFCC flows. Much of this area has aggraded to a point higher than the spillway at Elephant Butte Dam [i.e. 4407 ft (BOR Datum 43.3 ft below USGS)]. In 2007, 34 SWFL territories (18.0 percent of the total) were found in this area above spillway elevations (Figure 20) – essentially creating a refuge in the event of high reservoir elevations. An additional 111 territories were found above the 4400 ft elevation, within 7 ft of the spillway elevation. With the exception of 3 territories (1.6 percent of the total - two of which were likely late-migrants), all SWFLs were within the upper 22 ft (above 4385 ft elevation) of the reservoir pool. The distribution of SWFLs in 2008 was similar to those found in 2007; however a subtle shift of territories further into the conservation pool did occur. In 2008, 46 SWFL territories (20.1 percent of the total) were found in this area above spillway elevations (Figure 21). An additional 107 territories were found above the 4400 ft elevation. However, in contrast to the 2007 distribution, 19 territories (8.3 percent of the total) were established at elevations below 4385 ft.

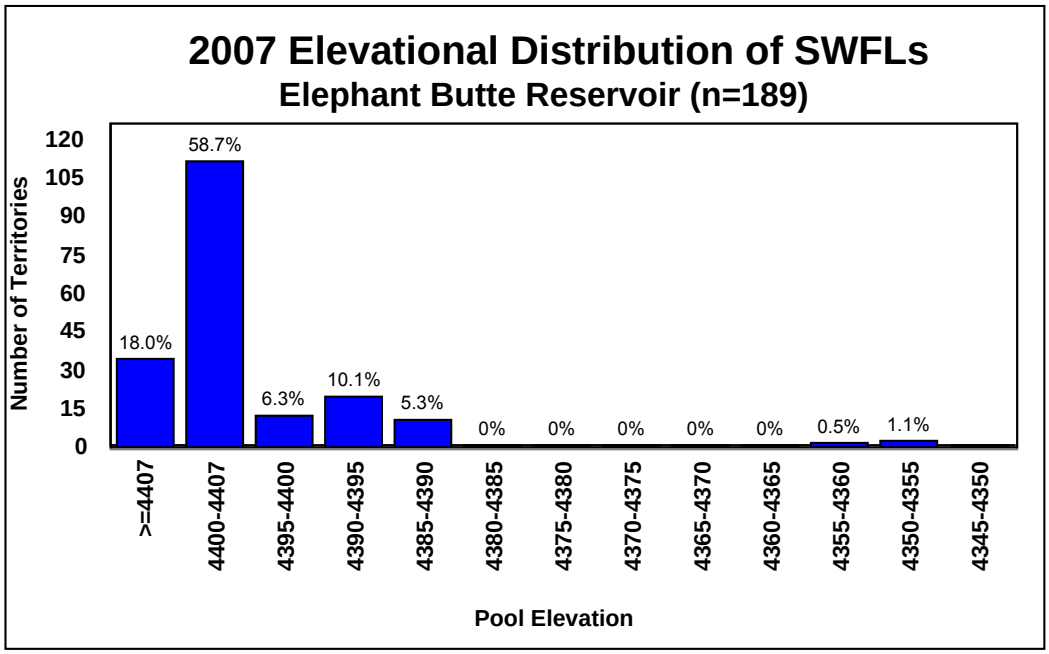

Figure 20. 2007 elevational distribution of SWFLs within the Elephant Butte Reservoir pool.

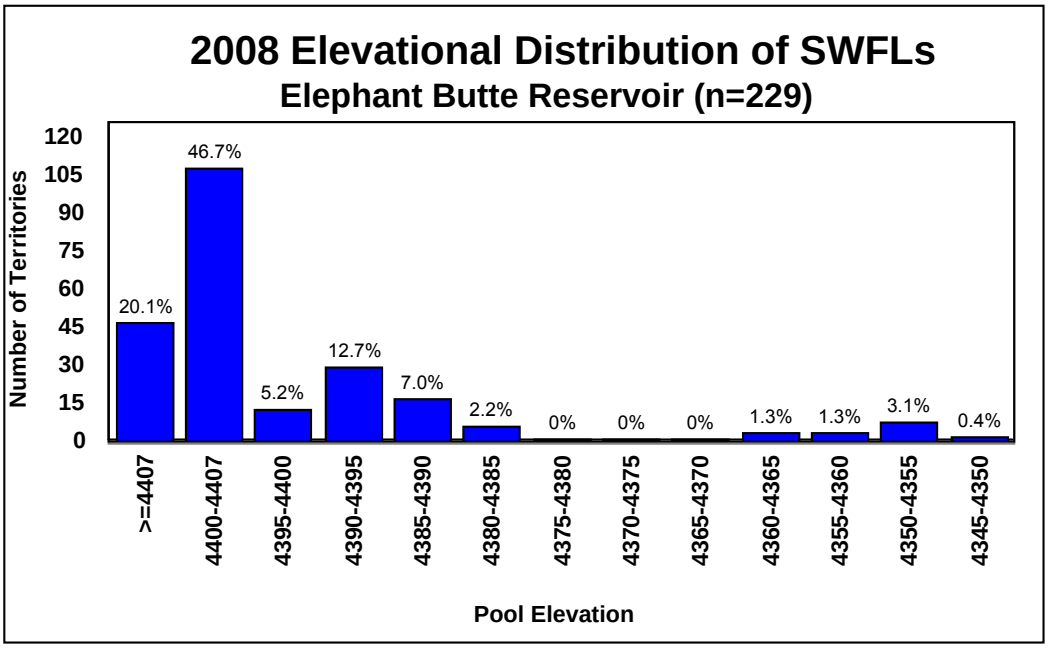

Figure 21. 2008 elevational distribution of SWFLs within the Elephant Butte Reservoir pool.

In addition to habitat changes as a result of reservoir levels, during the summer of 2005 high June flows significantly degraded the Rio Grande channel within Elephant Butte Reservoir from River Mile 58 to River Mile 60, 1.9 ft to 10.8 ft, respectively (Reclamation 2008). Channel degradation lowered the water table in the immediate vicinity of the river channel, reducing the structure, density and habitat suitability of the adjacent vegetation. In 2004, at sites DL-03 and DL-04, 18 territories with a nest success of 63.0 percent (n=27) were found in association with the Rio Grande; during the 2005 breeding season, 19 territories with a 54.5 percent (n=22) nest success were associated with the Rio Grande Channel. In 2006, the year following the 2005 flows, 12 territories with a 23.5 percent (n=17) nest success were found, and only 3 territories with 2 nests (both successful) were found in 2007. In 2008, 2 pairs with three nest attempts and an unpaired male territory were found at DL-03 and DL-04. One nest failed and the outcomes of the other two nests were unknown.

The number of SWFL territories directly associated with the Rio Grande channel has decreased since 2004. In 2004, 18 territories comprising 15.9 percent of the total 113 territories were found in association with the Rio Grande channel; in 2007 only three territories, comprising 1.5 percent of the total 194 territories were found in association with the Rio Grande channel; and in 2008 only three territories, comprising 1.3 percent of the total 229 territories were directly associated with the Rio Grande channel. Therefore, it is obvious that LFCC flows and groundwater seepage from the adjacent uplands play a far greater role in sustaining the current population of SWFLs than does the Rio Grande channel within Elephant Butte Reservoir.

Another important factor affecting the distribution of SWFLs within Elephant Butte Reservoir is the extent of flooding within structurally suitable habitat. As previously stated, the vast majority of territories are established within structurally suitable flooded habitat. [Flooding of the occupied sites is provided primarily by the outfall of the LFCC. Occupied sites further downstream within the pool are supported by high ground water levels and seeps from the adjacent uplands.] Ellis et al. (2008) also believe the presence of surface water can positively influence flycatcher recruitment and

occupancy. This positive relationship between SWFLs and surface water has also been observed within the Middle Rio Grande by Smith and Johnson (2008). Although a relative abundance (874 acres) of structurally suitable unflooded habitat exists within the pool, only on rare occasions do SWFLs establish territories within these sites. Flooded sites provide cooler and more moderate conditions than unflooded sites; flooded sites also provide for higher relative humidity and likely greater insect abundance. Although SWFLs could successfully nest in the unflooded sites, it is apparent that they prefer the flooded conditions. Since there is currently unoccupied, flooded suitable habitat available, it is likely that SWFLs will continue to expand and occupy these sites prior to occupying unflooded structurally suitable sites.

Figures 22 and 23 illustrate the distribution of territories within the upper-pool of Elephant Butte Reservoir in relationship to structurally suitable habitat and flooding. Areas shown as flooded in Figures 22 and 23, may not have been flooded during the entire breeding season, but were flooded for at least a portion of the season. As clearly shown, suitable unflooded habitat existed in both 2005 and 2008, however the vast majority of territories were established within suitable flooded habitat. In 2005, 107 territories were established within the upper-pool; 82% were within flooded habitat. In 2008, 210 territories were established within the upper-pool; 97% were within flooded habitat. These data illustrate a strong correlation between occupied habitat and flooded conditions.

DISCUSSION

The population increase of SWFLs within Elephant Butte Reservoir over the past 14 years has been dramatic; from two territories in 1995 to 229 territories in 2008. Habitat and hydrologic conditions have been favorable for the continued expansion of the population. This population is currently the largest with the SWFL's range. Upon evaluation of the existing data, it appears evident that the wetter the hydrologic conditions, the more favorable the habitat is for breeding SWFLs - but only to a certain degree. When evaluating the nest parameters based on hydrology under the nest, and excluding the Saturated/Flooded then Dry category which had small sample sizes, the Dry All Cycle experienced the lowest nest success, the highest predation rates, the highest parasitism rates, and the lowest productivity of all hydrologic categories. This is likely due to a combination of factors including: reduced structure, density, foliage height diversity, prey abundance, greater fluctuation in daily temperatures, and lower relative humidity. Much of the habitat in the upper pool that is supported by flows from the LFCC has been flooded for several years. The prolonged flooding has allowed portions to mature, but has limited the establishment of younger age classes in the understory since exposed soils were not present. Also, stands of predominately Goodding's willow are beginning to show signs of stress, presumably due to prolonged flooding. Some stands of previously occupied habitat within the upper pool are no longer supporting breeding flycatchers due to reduced structure and density. Fortunately, there is currently a relative abundance of suitable habitat remaining to support the increasing population. The question of greatest concern to resource managers remains – How much water is needed, and when is it needed to sustain and increase the current population?

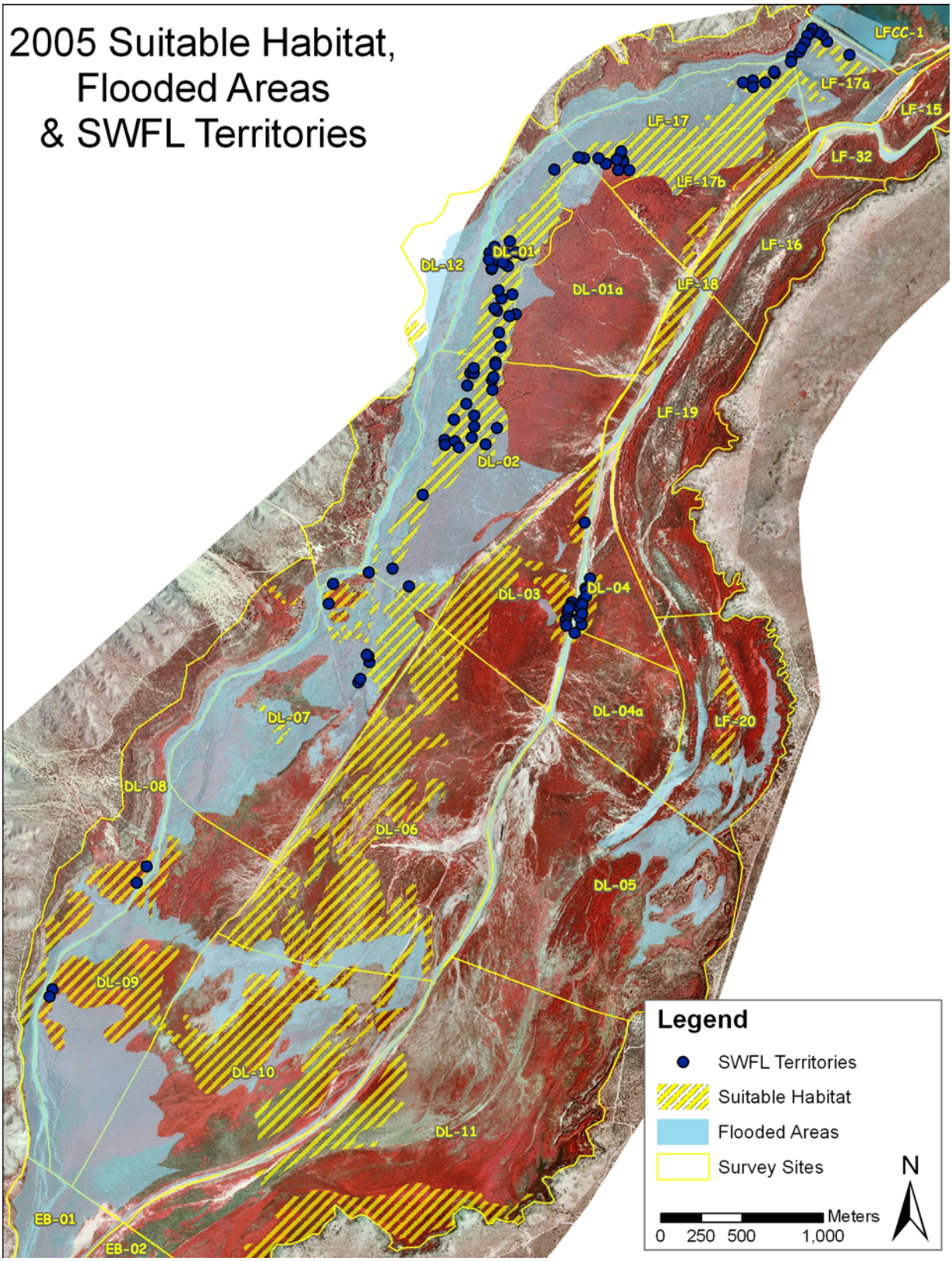

Figure 22. 2005 territory distribution within the upper-pool of Elephant Butte Reservoir.

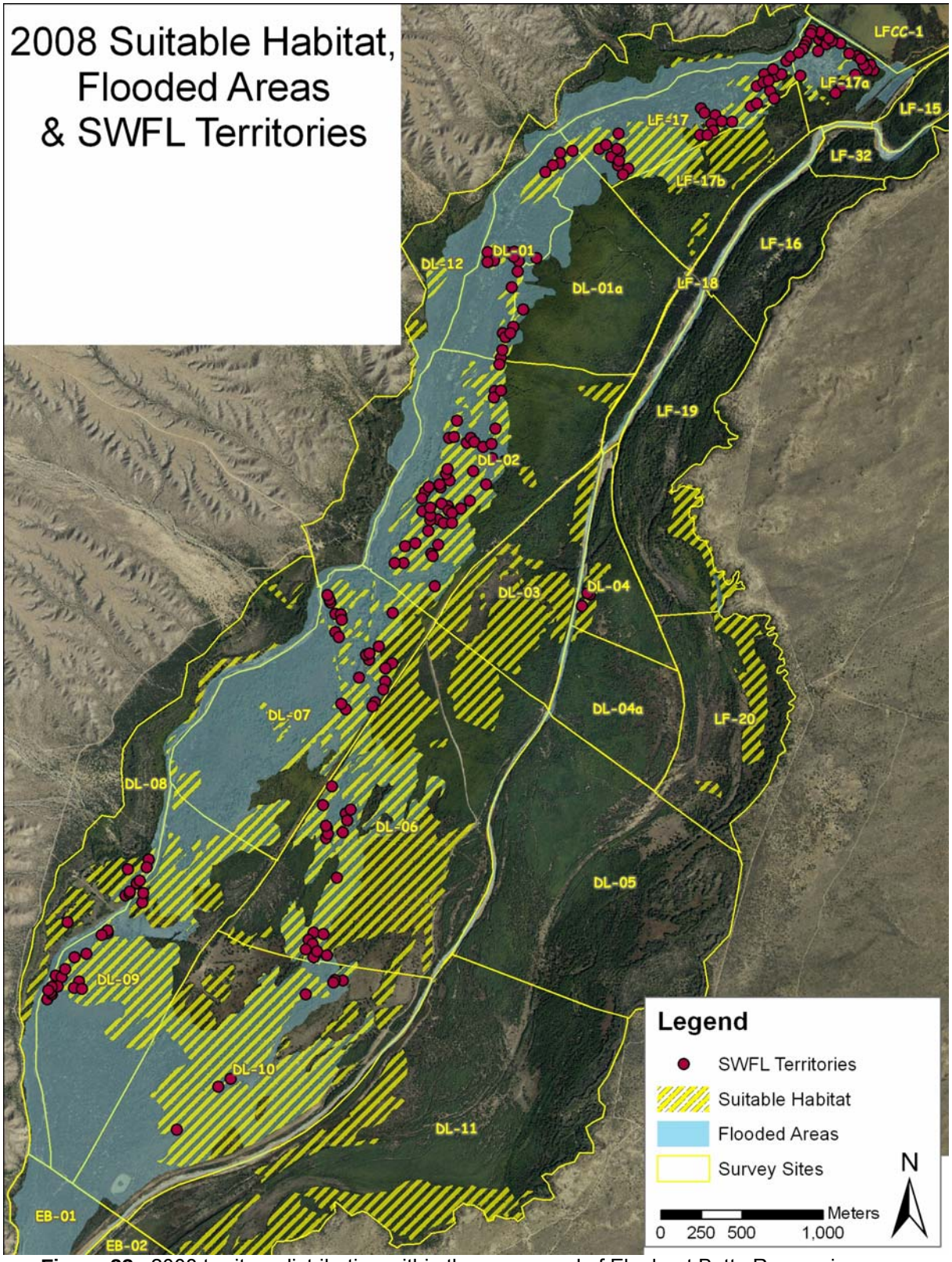

Figure 23. 2008 territory distribution within the upper-pool of Elephant Butte Reservoir.

How Much Water Is Needed?

First and foremost, the amount of water needed for SWFL habitat should be sufficient for the establishment, development and maintenance of the vegetation - the actual cubic feet per second (cfs) of flow or acre feet needed to accomplish this is very site-specific. Whether flooding is achieved by overbank flows from the primary watercourse or requires pumping to flood the site is also site specific. There should be enough flows to allow periodic flooding early in the spring prior to seed dispersal of willows. Soils should then be exposed to allow for germination of native vegetation, and be timed to minimize the establishment of exotic vegetation. Scouring flows following successful germination should be avoided.

Secondly, based on the SWFL's apparent affinity for surface water, the presence of surface water during territory establishment is very desirable. Although SWFLs prefer to establish territories within flooded habitat, site fidelity will result in the returning of SWFLs to unflooded sites in the absence of surface water, as demonstrated in 2006. It is possible that both these conditions can be achieved if the structurally suitable habitat can be flooded early in the breeding season (mid-May to early June). Surface water would be physically present upon territory establishment and subsequently continue to help maintain the vegetation even after the surface water has seeped away. A high water table should be maintained – draining and channel degradation should be avoided whenever possible.

For the majority of SWFL territories within Elephant Butte, the cfs needed to flood the occupied sites has been quantified. As previously discussed, nearly all current SWFL territories are associated with the vegetation supported and maintained by flows from the LFCC, not the Rio Grande. As a component of the ongoing SWFL studies, 19 "hydro" gauges were established in 2004 within occupied SWFL habitat supported by flows from the LFCC. The objective of this study was to determine the cfs needed to flood the occupied habitat. In 2008, a minimum of approximately 250 cfs from the LFCC was needed to flood all occupied areas where gauges were established. Thirteen of the 19 gauges had surface water present when flows were at least 100cfs. The gauges that were the first to dry were those located the furthest upstream in the reservoir pool. The upper pool has continued to aggrade and requires greater flows annually to achieve flooded conditions.

As previously discussed, statistically significant differences in vegetative characteristics do exist between dry and wet sites. Saturated or flooded soil conditions likely contribute to higher habitat suitability along with several other factors: wet conditions likely increase prey abundance, increase foliage height diversity, reduce the daily variation in both temperature and humidity (i.e. cooler and damper), limit access by predators reducing predation, and also reduce parasitism by requiring cowbirds to travel greater distances to forage and by increasing the abundance of other suitable hosts, thereby reducing parasitism rates on the SWFL.

Impacts of Reservoir Elevations

It is not possible at this time to accurately determine the effect that rising reservoir elevations may have on SWFLs. Depending on the depth and duration of the flooding associated with rising

reservoir levels, impacts could be either positive or negative, short term or long term. Rising reservoir levels will likely enhance the habitat suitability in some areas by depositing rich sediments, flushing salts, and irrigating the existing vegetation. If reservoir levels rise and are sustained for extended periods, patches of suitable habitat would be lost. Declining reservoir levels will expose new soils and allow for the establishment of younger age class vegetation, which can provide new habitat for the SWFL.

If reservoir elevations remain low, portions of the upper pool will continue to dry and some patches of suitable habitat will likely diminish in suitability. Other patches of suitable habitat with high groundwater will continue to mature past a point of suitability. Regeneration of younger age classes will diminish in the absence of saturated soils and catastrophic fires may become more likely. Habitat suitability within the upper portions of the pool will likely decline, while habitat at lower elevations will continue to develop. SWFLs will likely respond to these changes, moving further into the pool in pursuit of suitable habitat. Territories established in closer proximity to the current reservoir levels are more likely to be lost when the reservoir elevations increase.

An Elephant Butte Reservoir impact assessment model was developed to assess the potential impacts to SWFLs as a result of projected reservoir levels over the next five years (2009-2013). The model includes projected reservoir levels under three inflow scenarios, the availability of suitable habitat, future population estimates, and the potential beneficial and adverse impacts associated with a rising reservoir. The output from this model based on the projected reservoir levels from 2009 to 2013 predicts a possible displacement and loss of several SWFL territories, as well as the enhancement of several patches of habitat. Detailed results of this model can be found in "Five-Year Operation Plan for Elephant Butte Reservoir – Biological Assessment" (Reclamation 2008a).

Future

Based on available data regarding the abundance and distribution of suitable habitat and foreseeable hydrologic conditions, the population of SWFLs within Elephant Butte Reservoir is expected to continue increasing over the next several years – short-term. However, even under ideal conditions, natural succession will occur and sites are likely to become unsuitable breeding habitat in the long-term. If the reservoir remains at relatively low levels and the water table within some suitable areas continues to decline, a gradual replacement of native vegetation with saltcedar would be expected. Habitat restoration in close proximity to the Elephant Butte Reservoir SWFL population should be pursued.

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