Water Requirements for Southwestern Willow Flycatcher Habitat and Nesting at the Pueblo of Isleta

2006-2007 FINAL REPORT

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Introduction

SWFL Habitat: Vegetation and Surface Water

The southwestern willow flycatcher (SWFL, *Empidonax traillii extimus*) breeds in riparian habitats of the southwestern United States. In 1995, the southwestern subspecies of the willow flycatcher was listed by the U.S. Fish and Wildlife Service (USFWS) as federally endangered (USFWS 1995). A primary cause of the species' decline is habitat loss due to water diversion, impoundment, and channelization (USFWS 2002).

Throughout the southwest, SWFLs nest in dense riparian vegetation near lentic water; e.g., slow-moving streams, river backwaters, oxbows, or marshy areas (Sogge and Marshall 2000). These riparian habitats are created by hydrological events such as periodic flooding, sediment deposition, inundation, and groundwater recharge. SWFLs often place their nests in trees or shrubs that are rooted in or hanging over standing water (Whitfield and Enos 1996, Sferra et al. 1997). Surface water may be present early in the breeding season, but drying may leave soils damp or even dry later in the season. If traditional nesting areas become consistently dry due to drought or reservoirs receding, flycatchers may use the site for a breeding season or two, but over longer periods suitable riparian vegetation cannot be maintained, and dry sites are ultimately abandoned (Sogge and Marshall 2000).

Plant species composition and structure vary widely across the SWFL breeding range. Regardless of plant species composition or height, occupied breeding sites usually consist of dense vegetation in the patch interior or several dense patches interspersed with open water or sparser vegetation. The densest vegetation typically occurs in the first three to four meters above ground. Thickets of trees and shrubs used for nesting range in height from 2-30 m (6 to 98 ft, USFWS 2002).

Water could impact SWFL nesting in several ways. The plants that provide SWFL nest sites are riparian obligates – water is essential for development of required vegetation. If suitable SWFL habitat goes without water for several years, substrate plants die and habitat quality declines (USFWS 2002). It is therefore clear that water affects SWFLs through its effects on vegetation. Second, food availability for SWFLs may be "largely influenced by the density and species of vegetation, proximity to and presence of water, saturated soil levels, and microclimate features such as temperature and humidity" (USFWS 2004). Absence of water may therefore mean a reduced food supply for adults and nestlings.

Finally, flycatchers apparently choose nesting territories based on the presence of water. In particularly dry years, SWFLs at traditional nesting sites on the Middle Rio Grande nested in reduced numbers relative to wetter years (Smith and Johnson 2004, 2005) or failed to nest altogether (Johnson et al. 1999). In one New Mexico study, distance of nests from the main river channel was correlated with flow volumes (Brodhead and Finch 2005). In a study from Camp Pendleton, CA, 12 of 13 transient male territories were detected within 50 m of water, but only about half (9/17) of breeders were within 50 m. The rest were more than 150 m away (Kus 2000), which suggests that

SWFLs preferred territories not directly adjacent to flowing water. In New Mexico, stream flows (which indicate current and longer-term climatic conditions) have been reported to correlate with nest success during two narrow time windows, late June-early July, and late July (Brodhead and Finch 2005). Thus, the presence of adequate water appears to affect not only vegetation, but nesting decisions and even nesting success. However, previous studies have not clarified the importance of flowing water, saturated soil, or inundation to vegetation parameters, territory and nest site selection, or reproductive success. To manage SWFL habitat for recovery of the species, it is important to understand more precisely the species' water needs.

SWFLs at the Pueblo of Isleta

SWFLs have been known to nest at the Pueblo of Isleta since 1994, when the first systematic studies of the area were performed (Mund et al. 1994). SWFLs were also present in 1995 (Mehlman et al. 1995) and 1996 (B. Howe and J. Richardson 1996 data sheets). With assistance from Natural Heritage New Mexico (NHNM) and funding from the U.S. Army Corps of Engineers, the ESA Collaborative Program, the Pueblo of Isleta, and NHNM, the Pueblo conducted surveys in 2000; surveys and nest monitoring in 2003, 2004, 2005, 2006, and 2007; and habitat research in 2003-2007 (Johnson and Smith 2000; Smith and Johnson 2004, 2005, 2006, 2007).

In an effort to enhance SWFL breeding habitat, the Pueblo of Isleta began a project to introduce surface water to traditional SWFL nesting areas on the Pueblo. In 2004, the Pueblo installed a turnout gate to allow water movement from the Isleta Interior Drain into SWFL habitat at the Isleta Wasteway Channel site, where SWFLs nested in 2000, 2003, 2004, 2005, and 2006 (Johnson and Smith 2000; Smith and Johnson 2004, 2005, 2006, 2007). In 2004, the newly-installed turnout delivered water to the northern part of the study area, but no water reached the center of the study site where SWFLs have traditionally nested. In 2005, river flows were extremely high due to winter-spring precipitation and runoff, and the entire study area was inundated (Figure 1).

We know from previous studies (Johnson and Smith 2000; Smith and Johnson 2004, 2005, 2006, 2007) that in average years water tends to collect in some parts of the habitat and not others, such that some areas are consistently wet and some parts consistently dry. We observed an exceptionally wet year in 2005, when the entire habitat was inundated for much of the breeding season. Even in such an unusual year, higher areas dried before lower-lying spots. Thus, we can infer past water distribution in the habitat from present moisture distribution. Mapping wet versus dry areas of the study site and comparing vegetation between them provides information on the effects of varying saturation histories on current vegetation.

Finally, monitoring the effects of water management on SWFL territory establishment and nesting success provides insight into the effects of water on SWFL reproduction. Parasitism by brown-headed cowbirds (BHCO, *Molothrus ater*) and predation are important components of nesting success. Both could potentially be affected by water availability via its effects on vegetation. Water could also affect number of young fledged by influencing insect populations.

Figure 1. Isleta Return Channel 2004 (left) and 2005 (right), showing extreme fluctuations in water levels between average and excessively wet years. SWFL nesting area is left of road/investigators.

Relationship of Surface Water to Nesting Success at the Pueblo of Isleta

From 2000-2007, water levels in the traditional nesting area at the Pueblo have varied widely (Table 1). In 2000, the southern two-thirds of the study site was inundated or moist in the early part of the season. In 2003, all territories were completely dry. In 2004, the southern part of the site had saturated soil, and several territories were at least partially inundated at the beginning of the nesting season. After the extremely wet winter of 2005, the entire site was flooded at the beginning of the season, to a depth of over a meter in some places, and soil in all territories remained saturated throughout the nesting period. In 2006, the entire site was very dry early then wet after the breeding season was already underway, and in 2007 the south and parts of the north were inundated early in the season.

Predation, nest parasitism by brown-headed cowbirds, and nesting success at the Pueblo appeared to vary with water levels among years (Table 1). Predation and parasitism were highest and nesting success lowest in the driest year (2003), but nesting success was also relatively low in the wettest year (2005). Our data to date suggest that SWFLs do better in years of intermediate soil moisture.

The data in Table 1 suggest that a relationship may exist between the amount and timing of surface water at the Pueblo of Isleta and SWFL nesting success, mediated via parasitism and predation rates. In addition, this relationship is apparently not a simple matter of more water being better.

Table 1. SWFL nesting success, parasitism, and predation in dry, wet, and average years at Pueblo of Isleta.

Year	Soil Saturation	Number of Nests	Number of Successful Nests	% Nests Parasitized	% Nests Depredated	% Nests Failed (Other)	% Nest Success
2007	wet early, dry late	5	4	0	0	20	80
2006	dry early, wet late	9	3	11	33	22	33
2005	site flooded	7	3	14	14	43*	43
2004	partial early	10	5	0	0	50	50
2003	dry	6	2	33	50**	0	33

* One nest was both parasitized and abandoned

**One nest was both parasitized and depredated.

The goal of this project is to understand surface water requirements for territory establishment, nesting, and habitat development and maintenance at the Pueblo of Isleta. Specific objectives were to:

1. conduct breeding-season SWFL surveys at the study area,
2. conduct SWFL nest monitoring at the study area,
3. conduct vegetation measurements on nesting territories,
4. compare vegetation type and structure at nests and away from nests to determine desired vegetation parameters,
5. document and map saturated soils on 2007 SWFL territories,
6. investigate the relationship of soil saturation on the study site to territory selection and nesting success, and
7. investigate relationships of water availability to vegetation type and structure.

Methods

SWFL Surveys

In 2000, 2003, 2004, 2005, 2006, and 2007, we conducted protocol surveys at the Isleta Return Channel and the South of Isleta Marsh Expanded site. All maps showing locations of territorial males and nests were created in ESRI ArcGIS, version 9.2.

We followed survey protocols and habitat evaluation as outlined in the USFWS SWFL survey protocol (Sogge et al. 1997). No imminent project was planned within the survey areas; therefore, we followed a three-visit schedule, per the 2000 addendum to the protocol (USFWS 2000). Starting 16 May in 2006 and 15 May in 2007, we visited the Isleta Return Channel and South of Isleta Marsh sites within the recommended dates: survey 1,- 15-31 May; survey 2 - 1-21 June; survey 3 - 22 June-10 July. We conducted surveys between sunrise and 9:00 a.m. Both sites were accessible to thorough walking surveys within suitable habitat.

We determined status as migrant, territorial male, unpaired male, or pair (breeding/non-breeding) based on behavior. Any bird detected at a site in May that was not present in later surveys was considered to be a migrant. SWFLs were differentiated from other flycatchers by vocalizations, and we considered any birds detected between 15 June and 25 July to be of the southwestern subspecies (*E. t. extimus*, Rourke et al. 1999).

We determined breeding status based on activity of territorial birds. The observer sat or stood quietly in the habitat and watched for the presence of a female, listened for *whitt* and interaction calls between the pair mates, and looked for territorial defense, copulation, carrying of nesting material, carrying of food, incubation, or feeding of young.

All survey results were reported on standard SWFL survey and detection forms (Appendix 1, Sogge et al. 1997). In addition, as required by our USFWS permit, during the course of the study, we informed biologists at the USFWS New Mexico Ecological Service Office and New Mexico Game and Fish Department of detections of SWFLs and their nests.

Nest Monitoring

We monitored SWFL nests to determine success, brood parasitism, and number of fledglings. Nest monitoring followed standard SWFL nest monitoring protocol (see details in Rourke et al. 1999). We kept nest calendars to estimate transition times and allow accurate assessment of nest fate with minimum disturbance. To avoid triggering premature fledging, we did not visit nests during the last few days of the nestling period. Nests were checked every two or three days near hatching, or if the approximate hatch date was unknown. Otherwise, nests were checked every four to seven days. During nest checks, we entered the territory and determined adult activity, approached the nest from a different path each time, quickly checked the contents with a mirror pole, and left by a different path to avoid leaving a dead end scent path for predators. To determine whether a nest fledged young, we checked for fledglings being fed in the territory. All nest site coordinates were recorded with GPS units, taken in North American Datum (NAD) 27, for all years except 2007, when we switched to NAD 83, and plotted on digital USGS 7.5 minute quad maps. Territories in which nests failed were visited at least twice to check for re-nesting.

Vegetation Characteristics

In 2004-2007, we collected vegetation measurements at nests using methods developed by Dr. Peter Stacey of the University of New Mexico (P. Stacey, pers. comm. 2004, Kus 1998). This method differs from the method used before 2004 on the Pueblo but is the same as that used in other SWFL habitats in New Mexico in 2004 and earlier.

We recorded two types of vegetation measurements. First, we recorded nest-centered data similar to Rourke et al. (1999, p. 24), including data on nest height, substrate tree species and height, and distance to water. When distances could not be estimated on site they were measured using GIS on a digital aerial photo.

Second, we estimated vegetation cover in four 5 m diameter plots by noting the volume occupied by vegetation between the ground and 3 m, 3-6 m above the ground, and 6 m to the top of highest canopy over the plot (Kus 1998). One plot was centered at the nest tree, and three more plots were located 15 m from the nest tree at due north, 120º, and 240º compass headings. We recorded estimates as percent volume occupied by all plants and percent of the total plant cover volume contributed by the three most common species. Volume estimates were recorded in categories of 0, 1-10, 11-25, 26-50, 51-75, 76-90, and 90-100%.

We compared vegetation data for nests from 2004-2007 to a recent vegetation map of the area (Milford et al. 2005, revised by E. Milford in 2007). We compared the top three cover species and their rankings found at nests with the three dominant species as defined by the vegetation map.

Soil Moisture

In late April 2006, Pueblo of Isleta Water Resources Department personnel, under the direction of John Sorrel and Cody Walker, dug a shallow (about 20 cm) trench from the area near the new turnout (installed in 2004) from the Isleta Interior Drain to deliver water to the northern part of the site.

To track soil moisture changes throughout the site, we installed Tidbit temperature loggers (Onset Computer Corporation) at 50 m intervals on a predetermined grid covering the study area. We installed 40 loggers in 2006 and 42 in 2007. We did not install data loggers where the habitat was unsuitable for SWFLs, in a large section of gallery forest where we have never detected SWFLs. We installed the data loggers (Figure 2) in early and mid-May, before the breeding season, by digging a hole approximately 25 cm deep, filling it ¾ full with coarse silica sand, and burying the loggers in the sand. A piece of wire through a hole in the logger and attached to 1m rebar driven into the ground marked the spot and held the logger in place. We programmed the data loggers to collect temperature data every half hour. After the breeding season was over, we collected the loggers from the field and uploaded the data.

We compared daily temperature fluctuations at each logger with direct observations of soil moisture during the season, using notes and observations from 2006 and 2007. When the soil was muddy or flooded, the temperature difference between the daily maximum and minimum was usually 3° C or less. This transition point differs from the one we used for 2006. With two years of soil moisture and temperature data we were able to more accurately define the relationship between soil saturation and temperature fluctuation. We classified days at individual logger sites as dry if the 24-hour temperature fluctuation was 3° or more and wet if the difference was less than 3°. Based on the wet and dry logger classifications for both 2006 and 2007, we created soil moisture maps of the habitat on the first and fifteenth of each month throughout the breeding season.

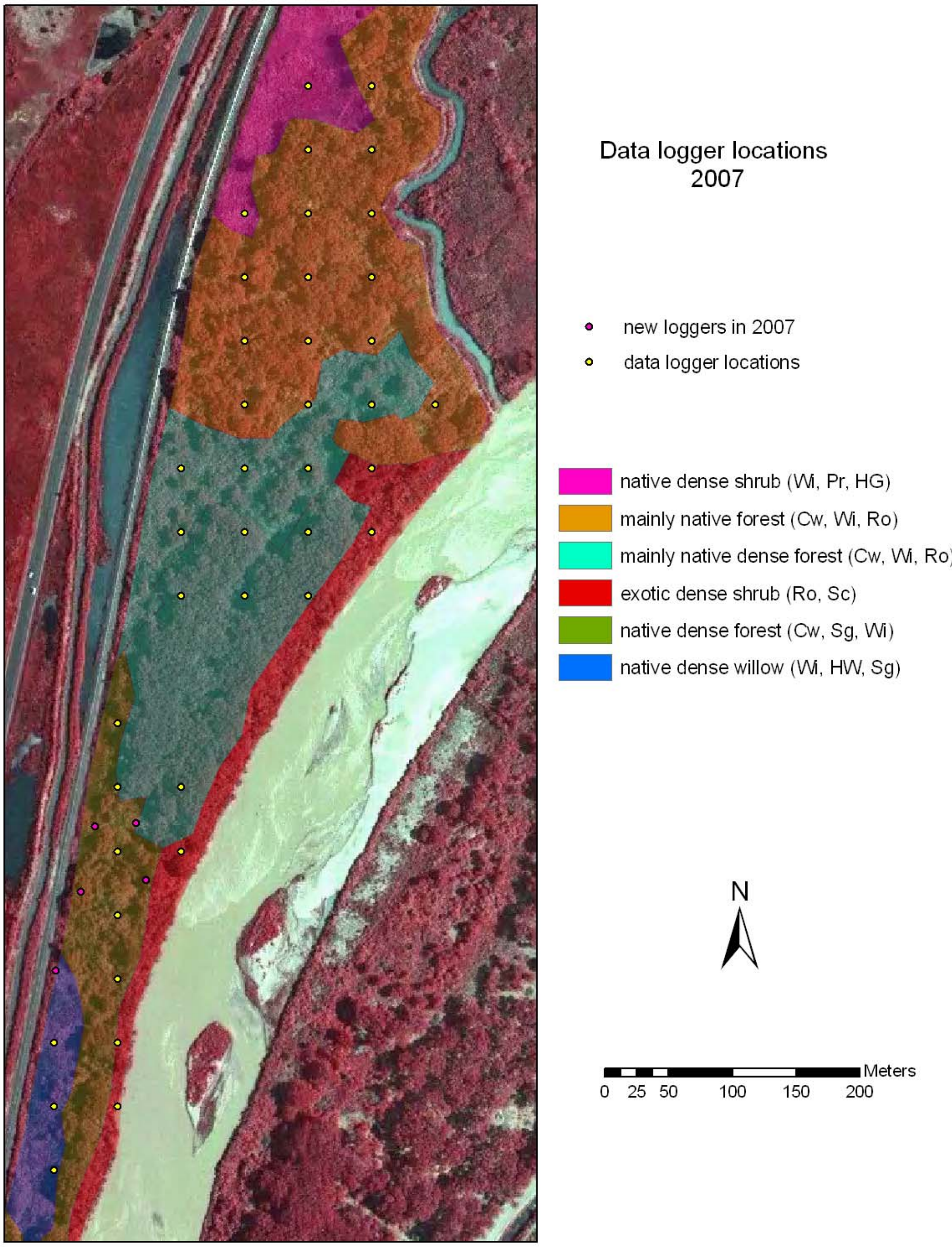

Figure 2. Data logger location, 2007.

Results

SWFL Surveys

In 2006, we spent about 30 hours mapping SWFL territories and completing surveys. We found nine nests and five SWFL pairs in nine territories (Table 2, Figure 3). There were more territories than pairs because males on two of nine territories were transient, and two territories (territories 1 and 3) moved or were abandoned early in the season. By the time the last nest had started (around 15 July), only 10 adults and five territories remained at the site (Table 3).

We spent about 36 hours in the habitat mapping SWFL territories in 2007, including the surveys. We found five nests and five SWFL pairs in eight territories (Table 2, Figure 3). On the remaining three territories we did not detect a female or a nest.

Table 2. Summary of survey dates and results.

Site	Year	Dates Visited	Adults	Pairs	Territories	Nests	Fledglings
Isleta Return Channel	2007	5/15, 5/22, 6/4, 6/19, 6/26	13	5	8	5	13
Isleta Return Channel	2006	5/16, 6/7, 6/29, 7/7	12	5	9	9	10
Isleta Return Channel	2005	5/16, 6/7, 6/30, 7/5	12	6	9	7	8
Isleta Return Channel	2004	5/18, 5/19, 6/18, 7/6, 7/19	14	7	7	10	13
Isleta Return Channel	2003	5/23, 6/13, 6/18, 6/19, 6/30	12	5	5	6	7
South of Isleta Marsh (expanded)	2007	5/29, 6/5, 7/6	1	0	1	0	0
South of Isleta Marsh (expanded)	2006	5/18, 6/1	0	0	0	0	0
South of Isleta Marsh (expanded)	2005	6/1, 6/14, 7/25	0	0	0	0	0
South of Isleta Marsh (expanded)	2004	5/25, 7/12	0	0	0	0	0
South of Isleta Marsh (expanded)	2003	5/23, 6/19, 6/27	0	0	0	0	0

Nest Monitoring

In 2006, one nest was parasitized by a BHCO. Three of nine nests (33%) were successful (fledged one or more SWFL young), and ten young fledged in 2006.

We found five nests in 2007, constructed by five SWFL pairs (Table 2). No nest was found to be parasitized. Four of the five (80%) nests were successful. Thirteen young successfully fledged this year. Only one nest failed; an adult flycatcher was found dead on that nest near the projected fledging date.

Of the five years, 2003 had the lowest nest and pair breeding success (Table 3). In 2004, we detected the highest number of breeding pairs, which had intermediate nest and pair breeding success. In 2006, birds had low nest success and intermediate pair success, and an average number of pairs bred. In 2007, an average number of pairs bred, but the nest and pair success were the highest we have recorded at this site (Table 3), and the number of fledglings equaled the high of 2004 (Table 2).

Over the four years we monitored nests, nests failed due to predation, abandonment, parasitism, starvation, and weather (Table 4). Four nests disappeared due to unknown causes. The most common causes of failure were abandonment (six nests) and predation (five nests). We suspect that at least some of the nests that disappeared for unknown reasons were depredated. Some could also have been destroyed by wind or rain storms. Success rates varied from 33% to 80%, with an average success rate of 46% for the four years (Table 4).

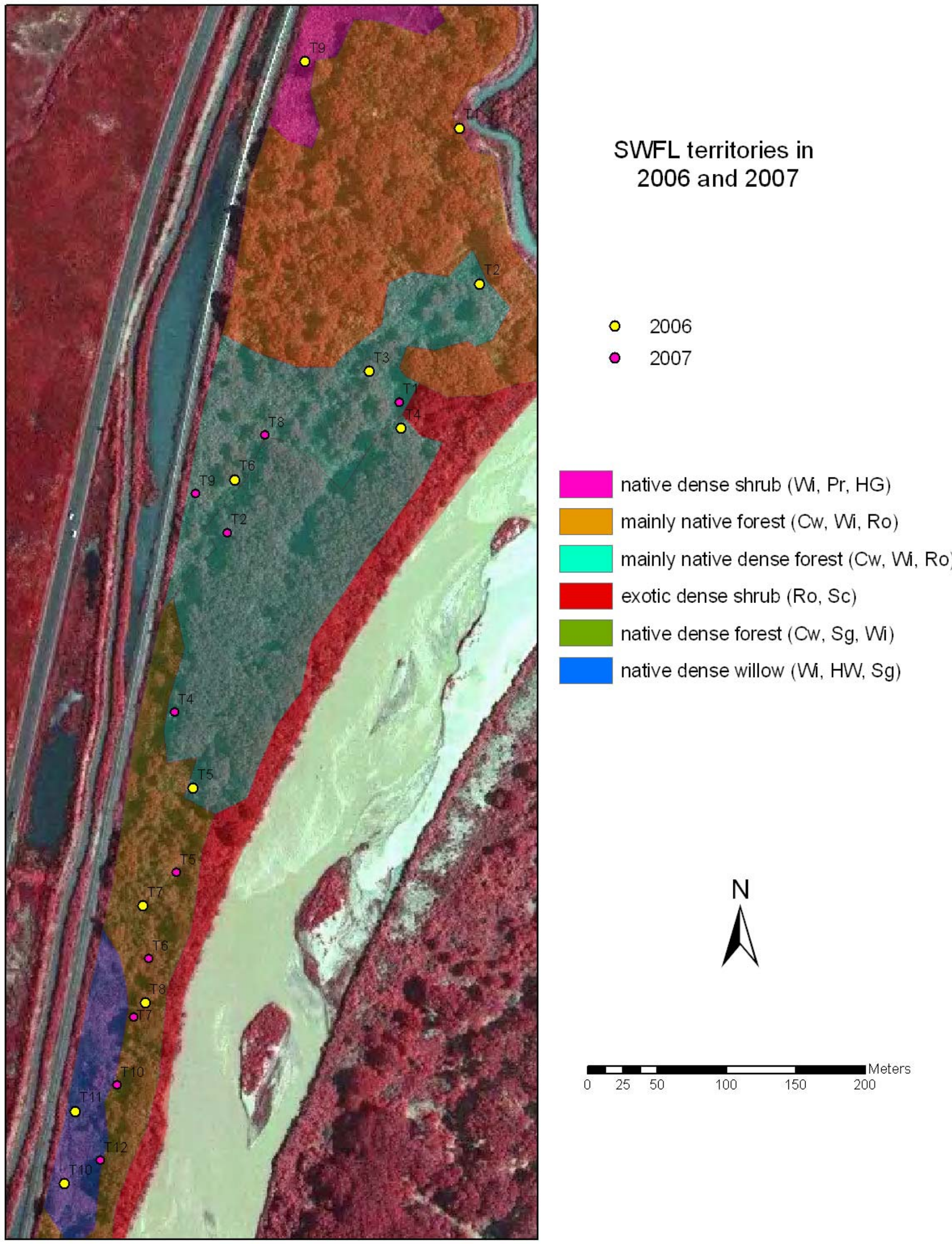

Figure 3. SWFL territories, 2006 and 2007.

Table 3. Nest and pair success rates and number of pairs breeding for five years at the Isleta Return Channel Site. Pair success exceeds nest success because some pairs successfully re-nested.

Year	Nest Success	Pair Success	N Pairs Breeding
2007	80%	80%	5
2006	33%	60%	5
2005	43%	50%	6
2004	50%	71%	7
2003	33%	40%	4

Table 4. Causes of nest failure, 2003-2007. Percent success for each year is shown in parentheses.

	Year					
	2003	2004	2005	2006	2007	Total
Reason for Failure						
Depredated	3		1	3		5
Abandoned		2	2	2		6
Parasitized	2		1	1		4
Starved/Died in Nest		1			1	2
Blew Down		1				1
Disappeared		1	1	0		4
Succeeded	2 (0.33)	5 (0.50)	3 (0.43)	3 (0.33)	4 (0.8)	17
TOTAL	6*	10	7**	9	5	37

* one nest was both parasitized and depredated

** one nest was both parasitized and abandoned

Vegetation Measures at Nest Plots

SWFL nests were placed in Russian olive (*Eleagnus angustifolia*), coyote willow (*Salix exigua*), and salt cedar (*Tamarix ramosissima*) in 2004, 2005, and 2007, but only Russian olive and coyote willow in 2003 and 2006 (Table 5). Nest centered measures for combined 2004-2007 fledged and failed nests are shown in Figure 4. None of the measures was significantly different between successful and unsuccessful nests.

Table 5. Species of substrate tree by nest.

Tree species	Nest 2003	Nest 2004	Nest 2005	Nest 2006	Nest 2007
Russian olive	1, 1b, 2, 3, 5	1, 1b, 1c (all the same tree), 4, 4b (two trees)	6	5, 7, 8b, 8c*	1
coyote willow	4	2,5,8	1, 10, 4	4, 10	5, 6
salt cedar		3, 7	4b, 7, 11		4, 7

*nest 8a disappeared before the species of the nest tree was recorded.

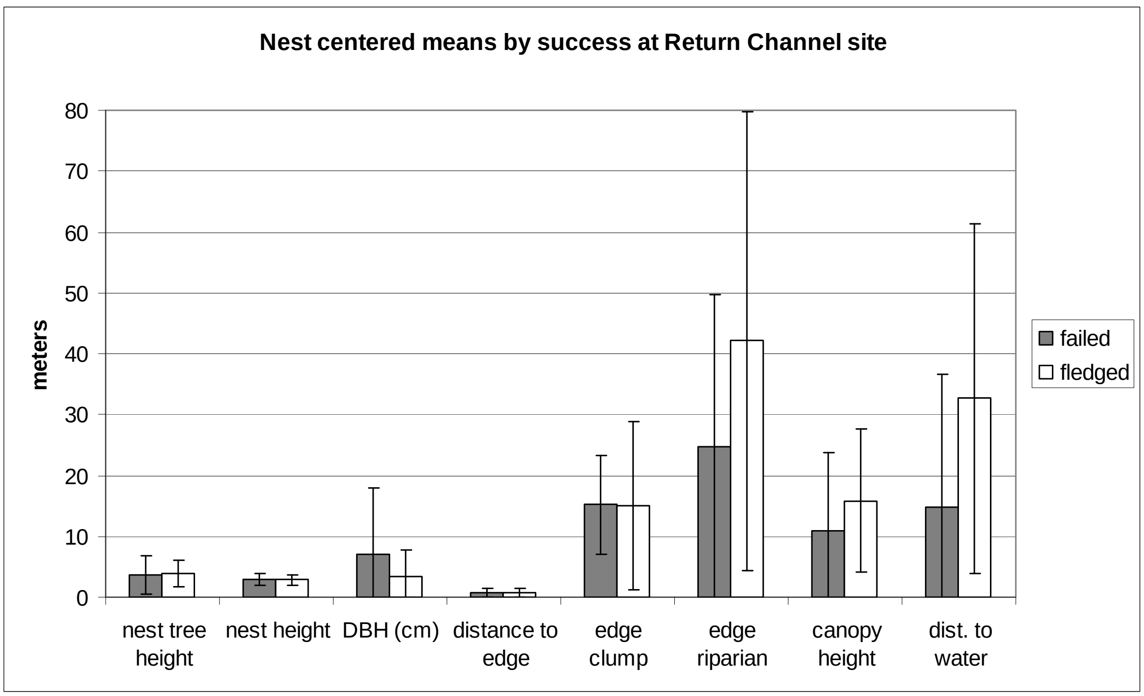

Figure 4. Nest-centered data at Isleta Return Channel site for 2003-2007 failed (N=11) and fledged (N=16) nests.

At all height intervals for 2004-2007, vegetation cover was significantly denser at the nest than at the three nearby subplots (subplots averaged, Student's t-test, 0-3m: $p<0.0001$, 3-6m: $p<0.001$, and > 6m: $p=0.05$). Exotic vegetation cover was also denser at the nest for 0-3 and 3-6m intervals ($p<0.001$ for both, Figure 5).

Although vegetation density at nest sites was higher than at the near-nest subplots, vegetation density was not significantly different between successful and unsuccessful nests (Figure 6). Parasitized nests (N=2, Figure 7) had the same dense understory as other nests (overall cover at 0-3m), but vegetation density above the nest (center 3-6 and >6m)

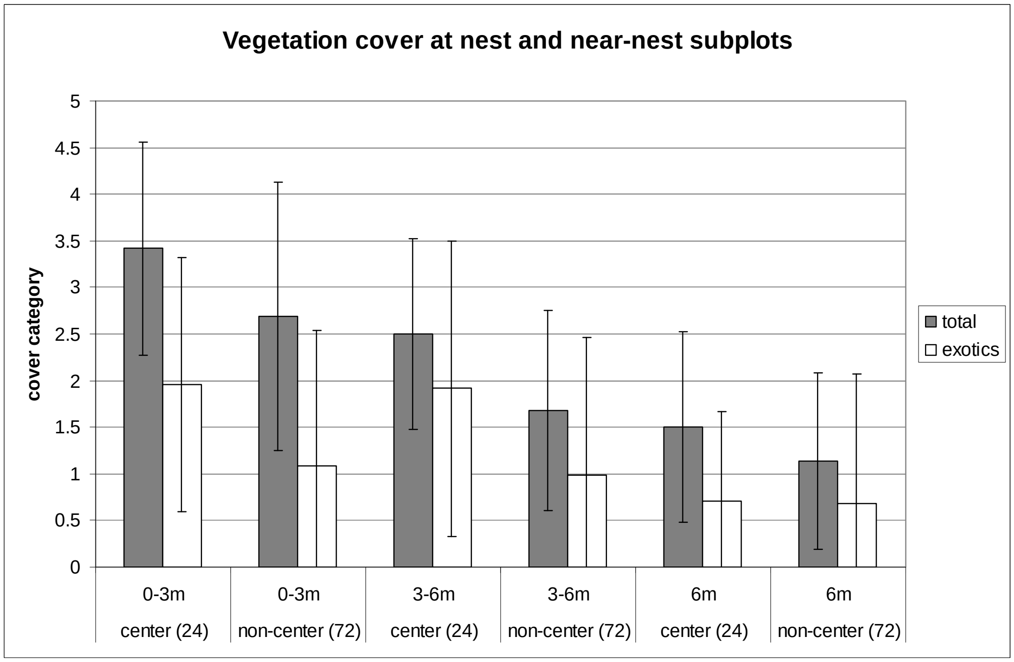

Figure 5. Vegetation cover averages for 2004-2007 at nest and near-nest subplots. Means with standard deviation bars; sample sizes in parentheses.

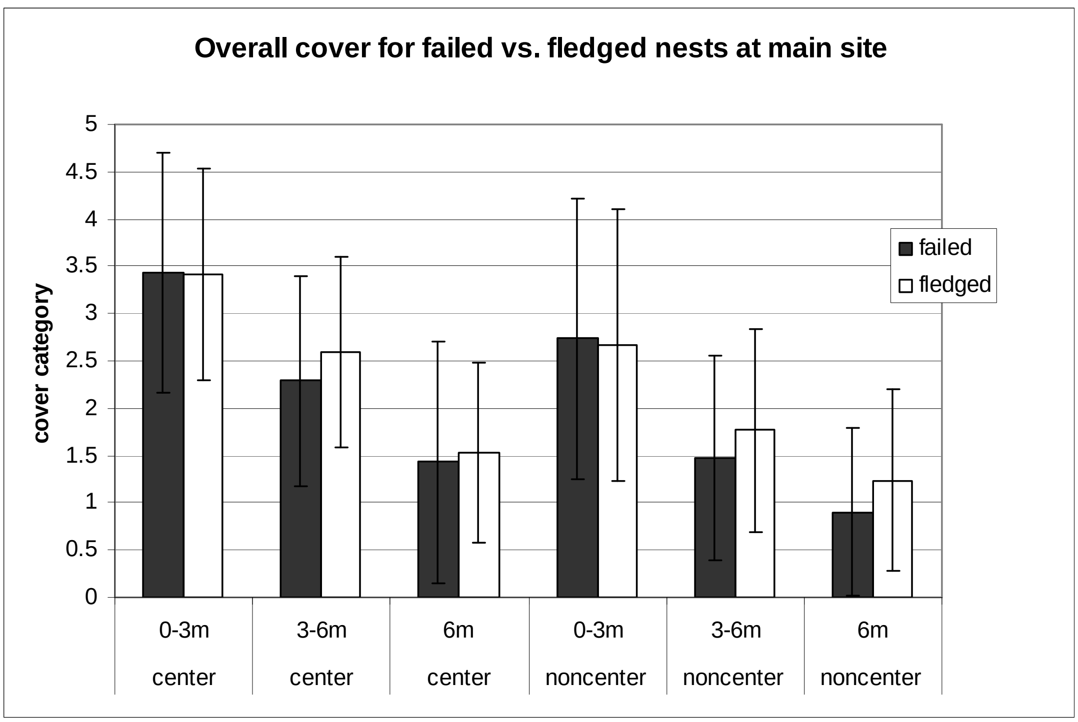

Figure 6. Overall vegetation cover at failed and fledged nests, averaged over 2004-2007. Means with standard deviation bars.

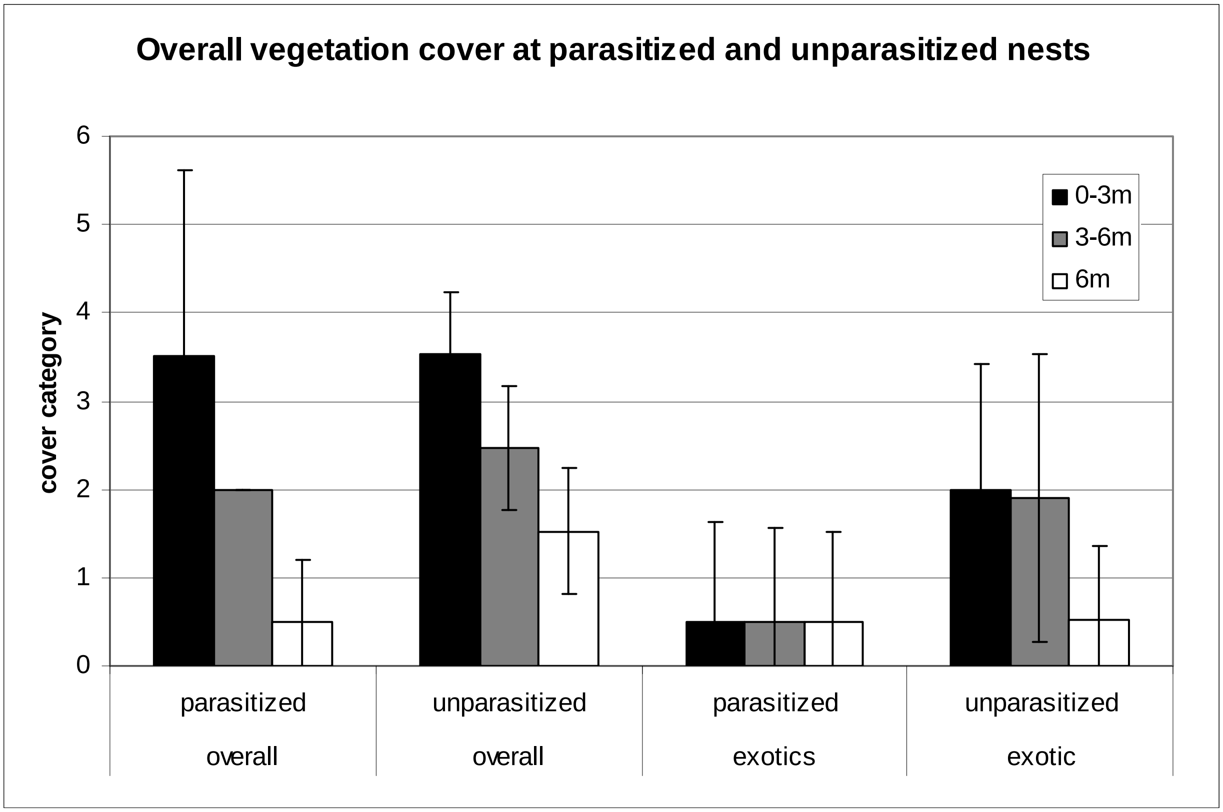

Figure 7. Overall vegetation cover at failed (N=7) and fledged (N=17) nests, averaged over 2004-2007. Means with standard deviation error bars. N=2 parasitized nests, N=19 unparasitized.

appeared to be somewhat lower at parasitized than non-parasitized nests. Exotic vegetation cover appeared much less dense at parasitized nests at 0-3m and 3-6m than at unparasitized nests. This suggests that unparasitized nests were surrounded by vegetation with a higher proportion of exotic species than parasitized nests. No statistical tests were performed because the sample of parasitized nests was too small to provide adequate power.

Soil Moisture and Vegetation

The revised vegetation map shows six main map units (MUs) covering the study site (Figures 8-20). The northernmost unit, Native Dense Shrub (pink on the map) contains coyote willow with common reed (*Phragmites australis*) and herbaceous grassy mesic vegetation. Also in the north is Mainly Native Forest (brown), containing cottonwood (*Populus deltoides*), coyote willow, and Russian olive in a gallery forest structure. Mainly Native Dense Forest (teal) contains mature cottonwood, with a dense coyote willow and Russian olive understory. Exotic Dense Shrub (red) is characterized by Russian olive and saltcedar. Native Dense Forest (green) contains cottonwood, Gooding's willow (*Salix goodingii*), and coyote willow. Native Dense Willow (blue) contains coyote willow, herbaceous wetland, and Gooding's willow with no large overstory trees. Table 6 shows the percentage of the study site covered by each vegetation type. All except two of the types, Exotic Dense Shrub and Native Dense Shrub, meet the definition of suitable SWFL habitat. Thus, roughly 110,000 m^2 (82%) of the study area is covered in suitable SWFL habitat (Table 6).

The MUs most often covered in water are Exotic Dense Shrub, Native Dense Forest and Mainly Native Dense Forest (Table 7). These three MUs, are situated in the lower elevation, southern half of the study area and have long habitat edges close to the river. All three are apparently influenced by groundwater flows coming from the river. Both native types comprise primarily native species of trees (cottonwood, Gooding’s willow) and shrubs (coyote willow), with some Russian olive understory in the Mainly Native Dense Forest MU. Exotic Dense Shrub is extremely dense Russian olive and saltcedar and, although often wet due to its proximity to the river, is rarely used by SWFLs for nesting. The Mainly Native Forest also regularly has had patches of wet soil. Native Dense Shrub has had small wet patches, and Native Dense Willow has been variably wet, with 59% wet soils in 2006 and dry soils at all three dates in 2007.

Table 6. Area and percent of study site covered in each vegetation type.

Vegetation Type	**Area (m^2)**	**% of area**
Mainly Native Forest (Cw, Wi, Ro)	44041	33%
Native Dense Forest (Cw, Sg, Wi)	15811	12%
Mainly Native Dense Forest (Cw, Wi, Ro)	43342	32%
Exotic Dense Shrub (Ro, Sc)	14698	11%
Native Dense Willow (Wi, HW, Sg)	6419	5%
Native Dense Shrub (Wi, Pr, HG)	9126	7%
Total	133438	

Table 7. Percent wet soil in each vegetation type at three sampling times, 2006 and 2007.

	Exotic Dense Shrub		**Mainly Native Dense Forest**		**Mainly Native Forest**		**Native Dense Forest**		**Native Dense Shrub**		**Native Dense Willow**	
Date	'06	'07	'06	'07	'06	'07	'06	'07	'06	'07	'06	'07
6/15		48.9		27.7		11.1		34.0		2.5		
7/1	19.9	45.6	5.1	9.9	10.5	15.1	74.5	4.7	14.1	2.1	58.9	
7/15	15.4	44.8	1.6	23.9		27.1	6.4	11.9		21.5		

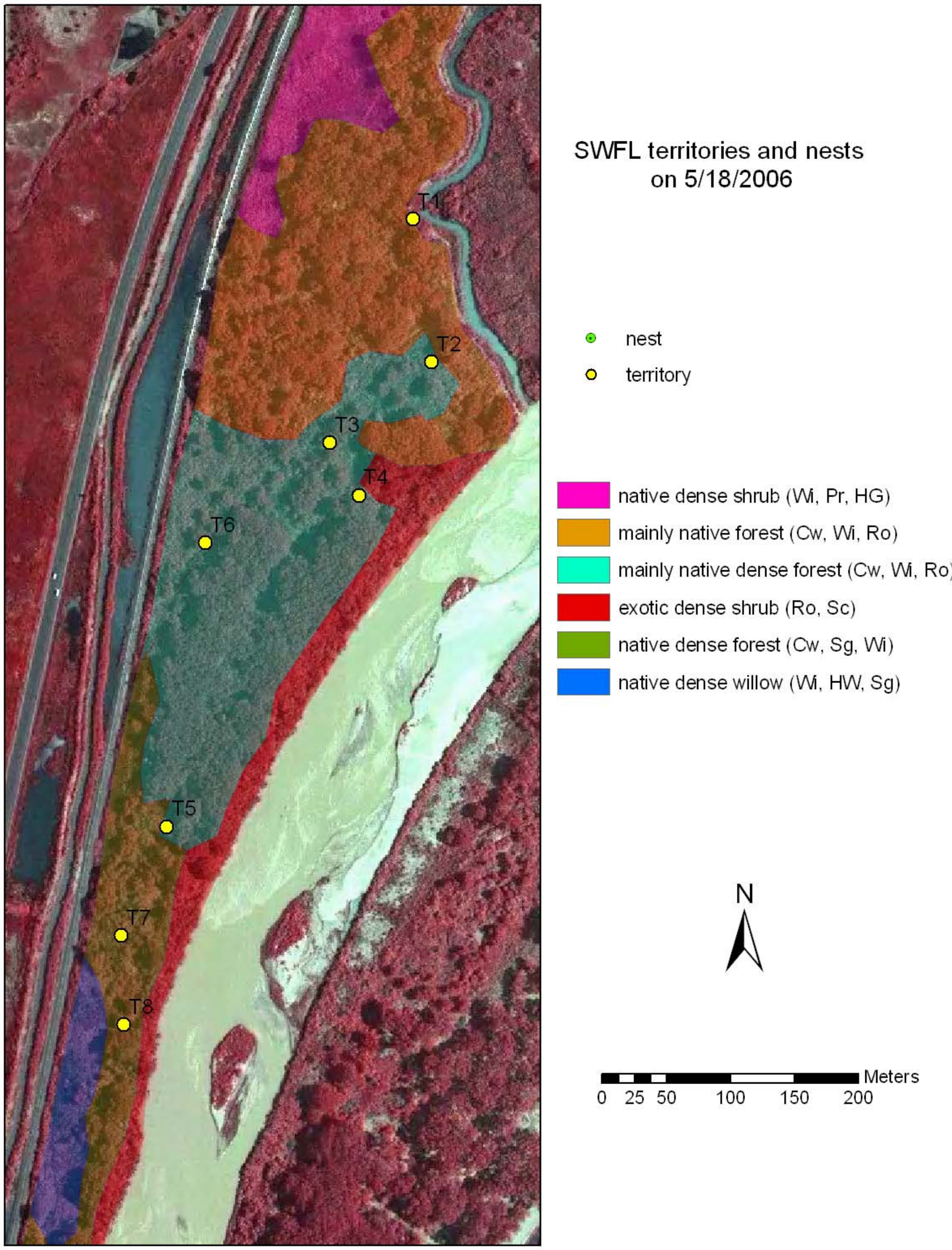

Figure 8. SWFL territories and nests on 5/18/2006.

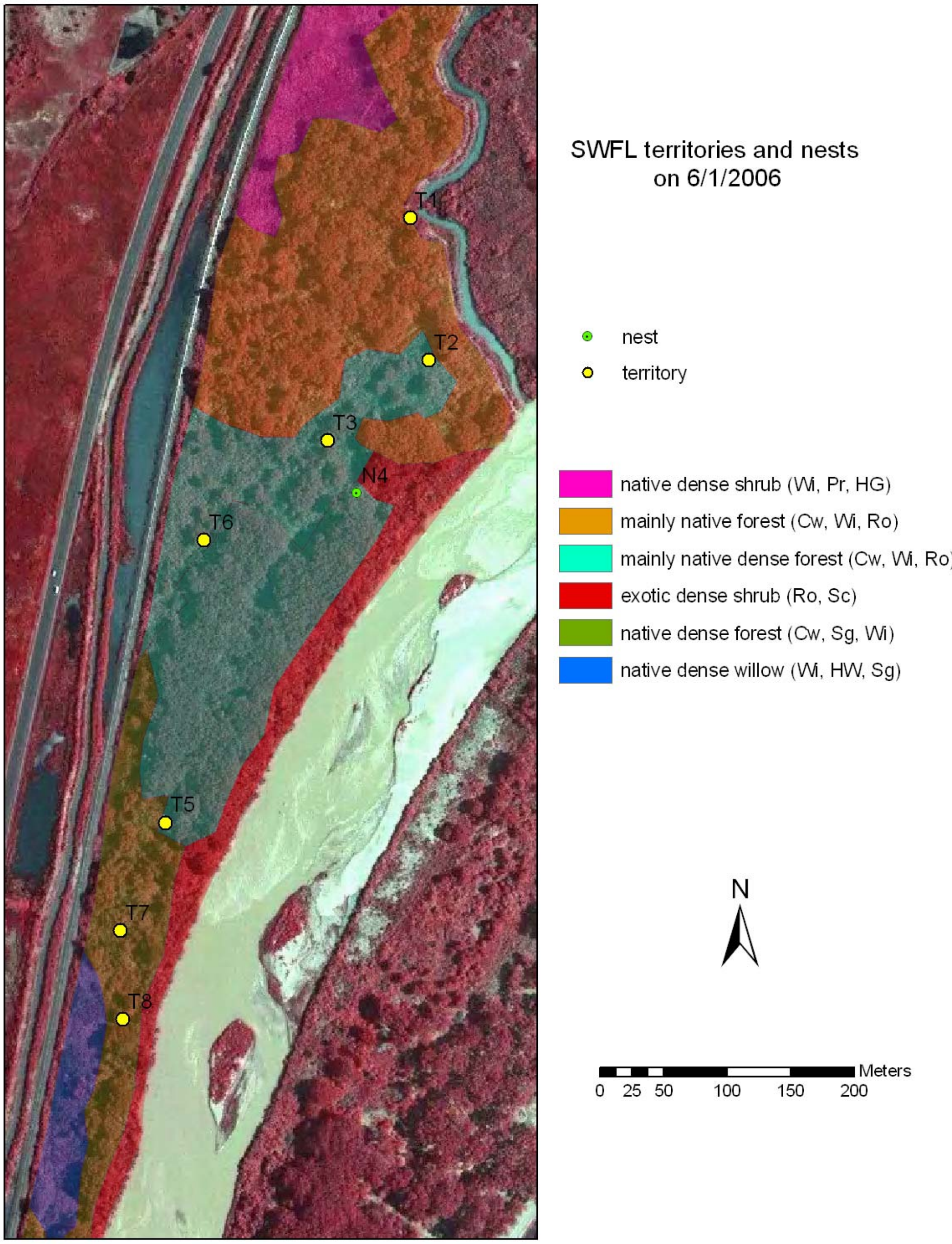

Figure 9. SWFL territories and nests on 6/1/2006.

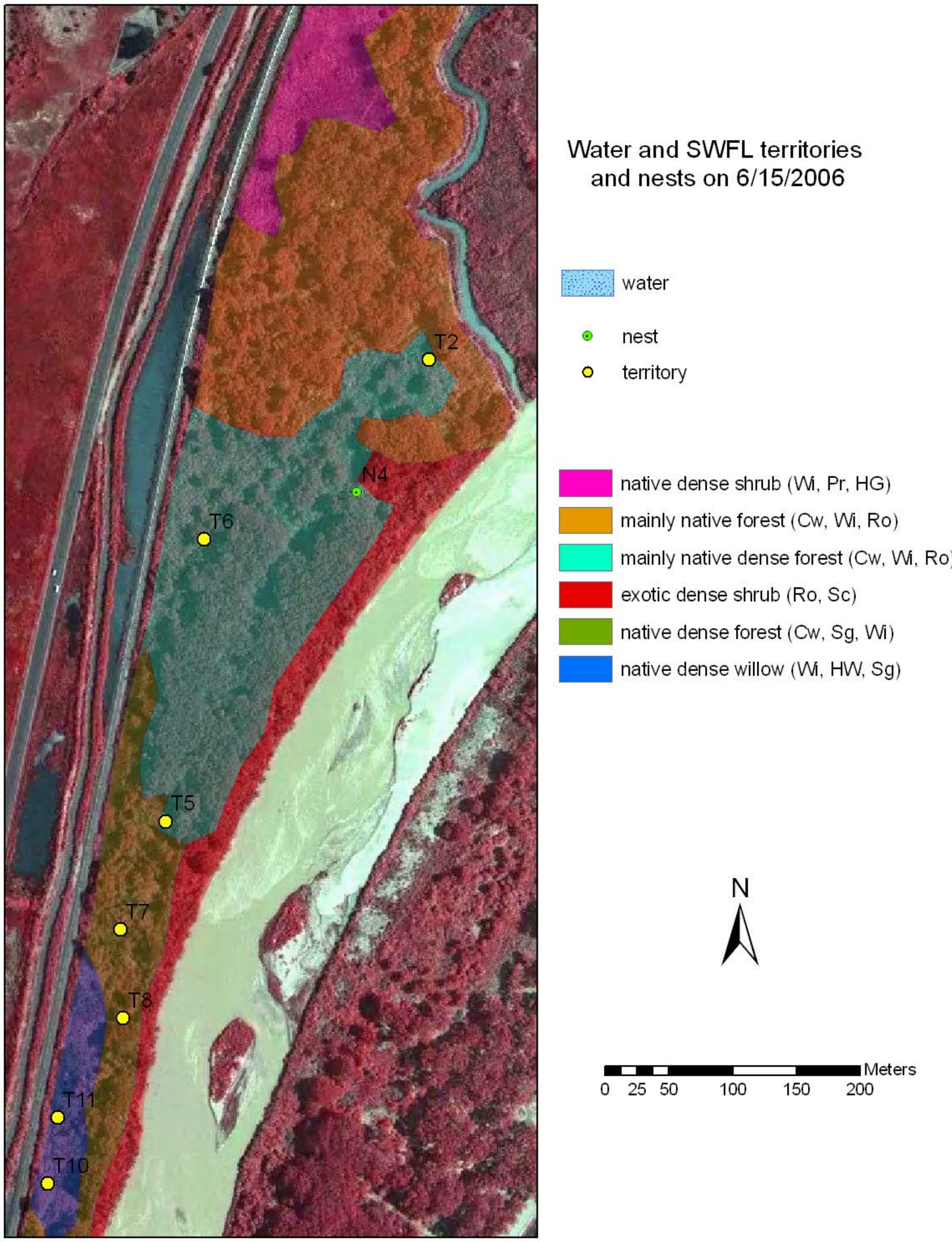

Figure 10. SWFL territories and nests on 6/15/2006.

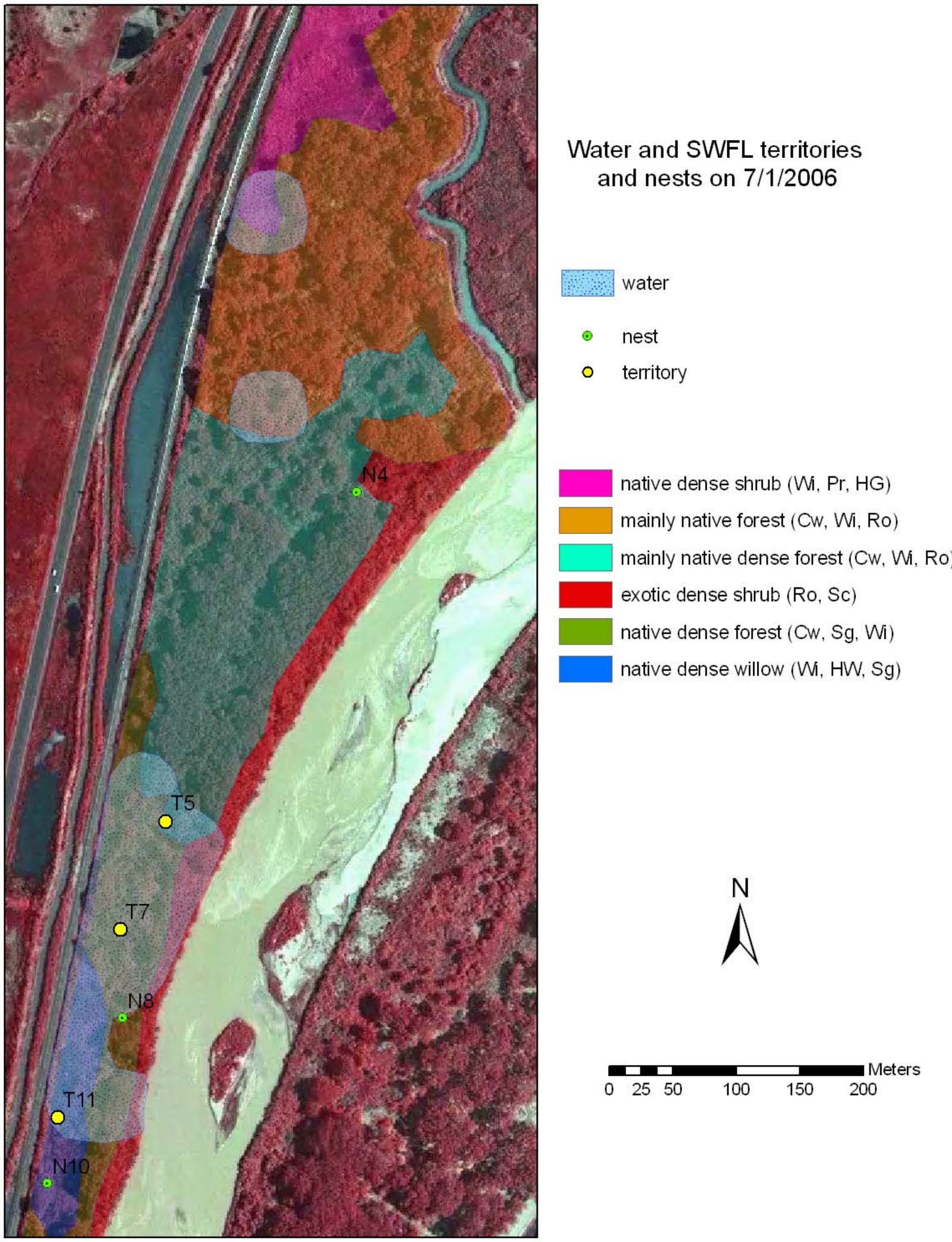

Figure 11. Water, SWFL territories, and nests on 7/1/2006.

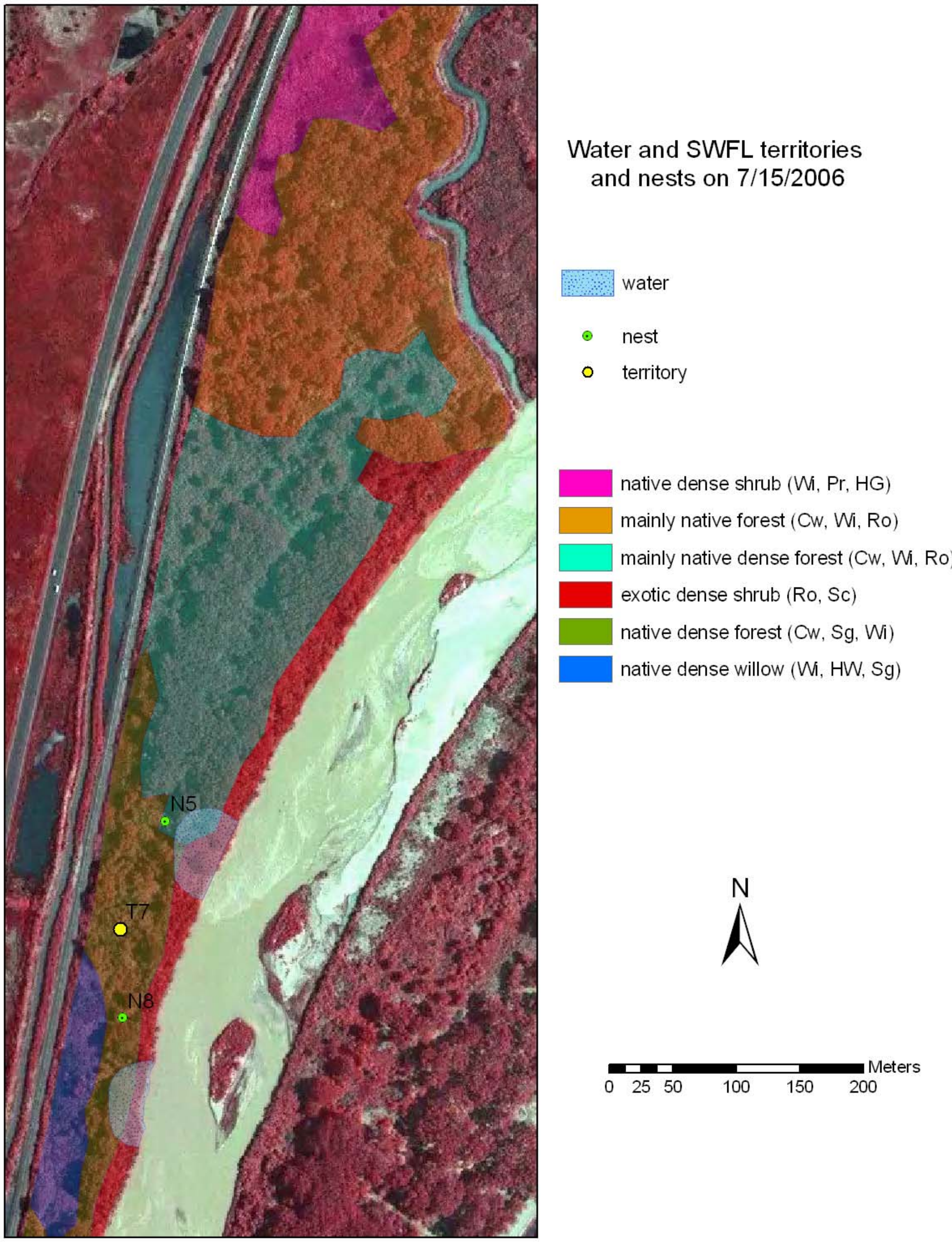

Figure 12. Water, SWFL territories, and nests on 7/15/2006.

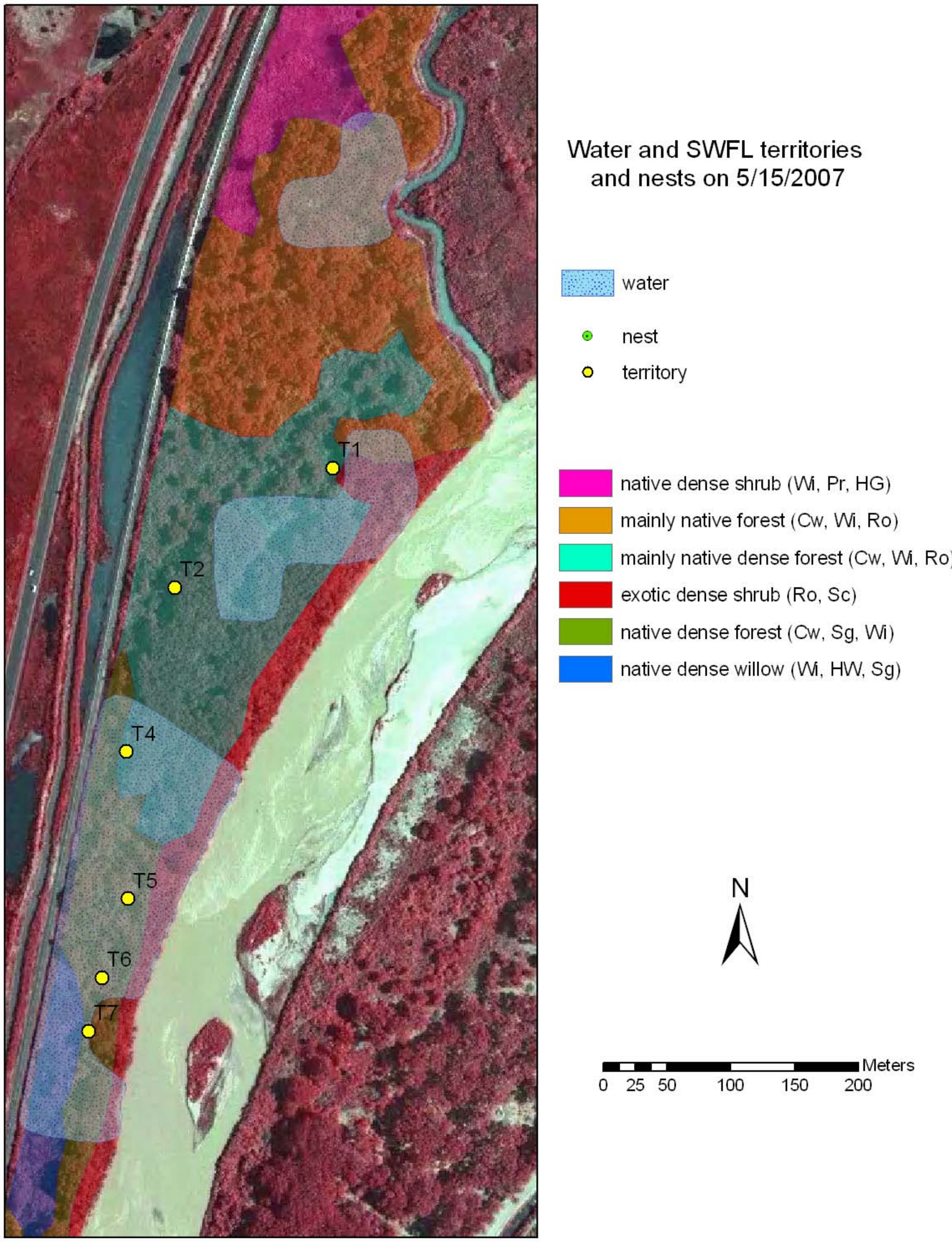

Figure 13. Water, SWFL territories, and nests on 5/15/2007.

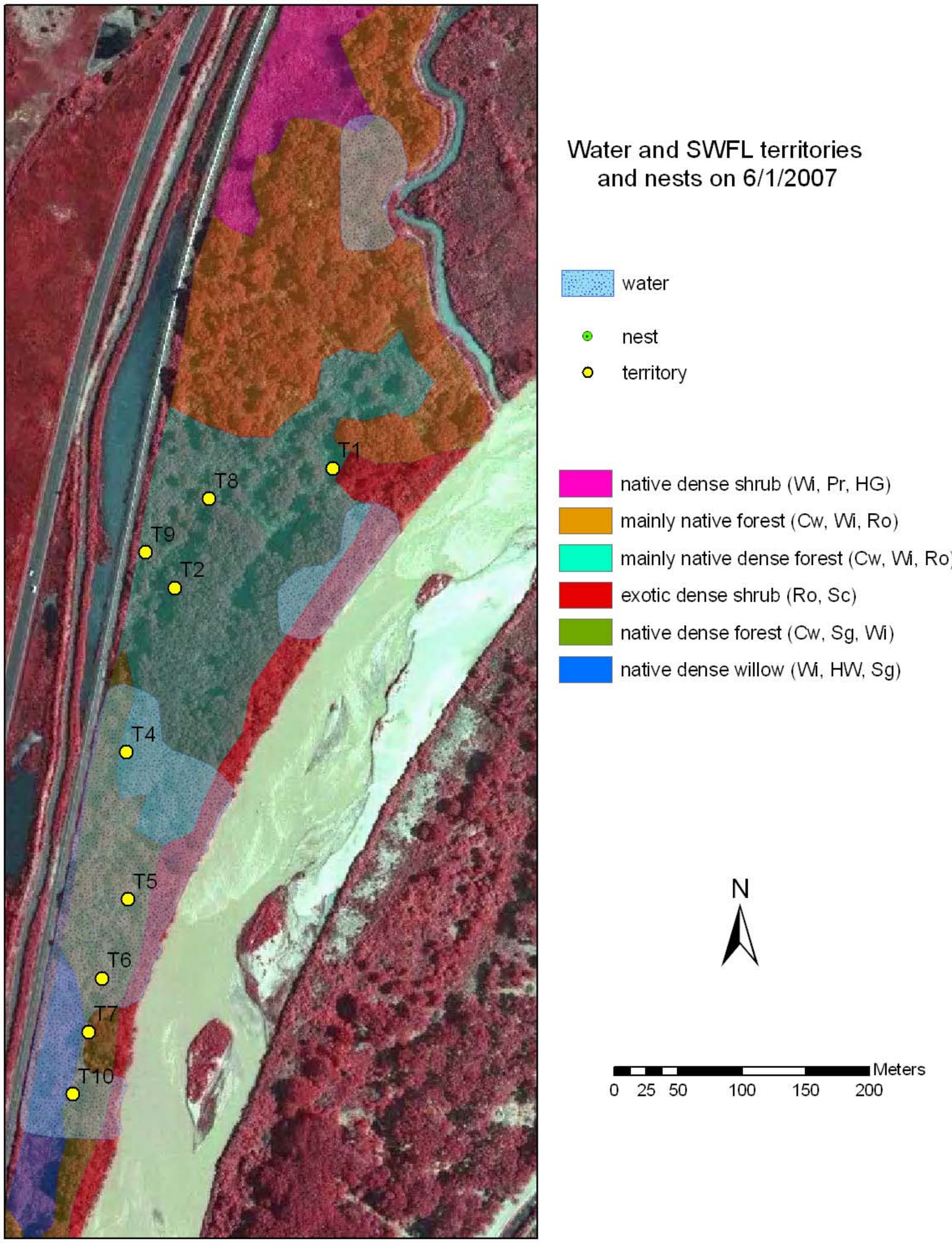

Figure 14. Water, SWFL territories, and nests on 6/1/2007.

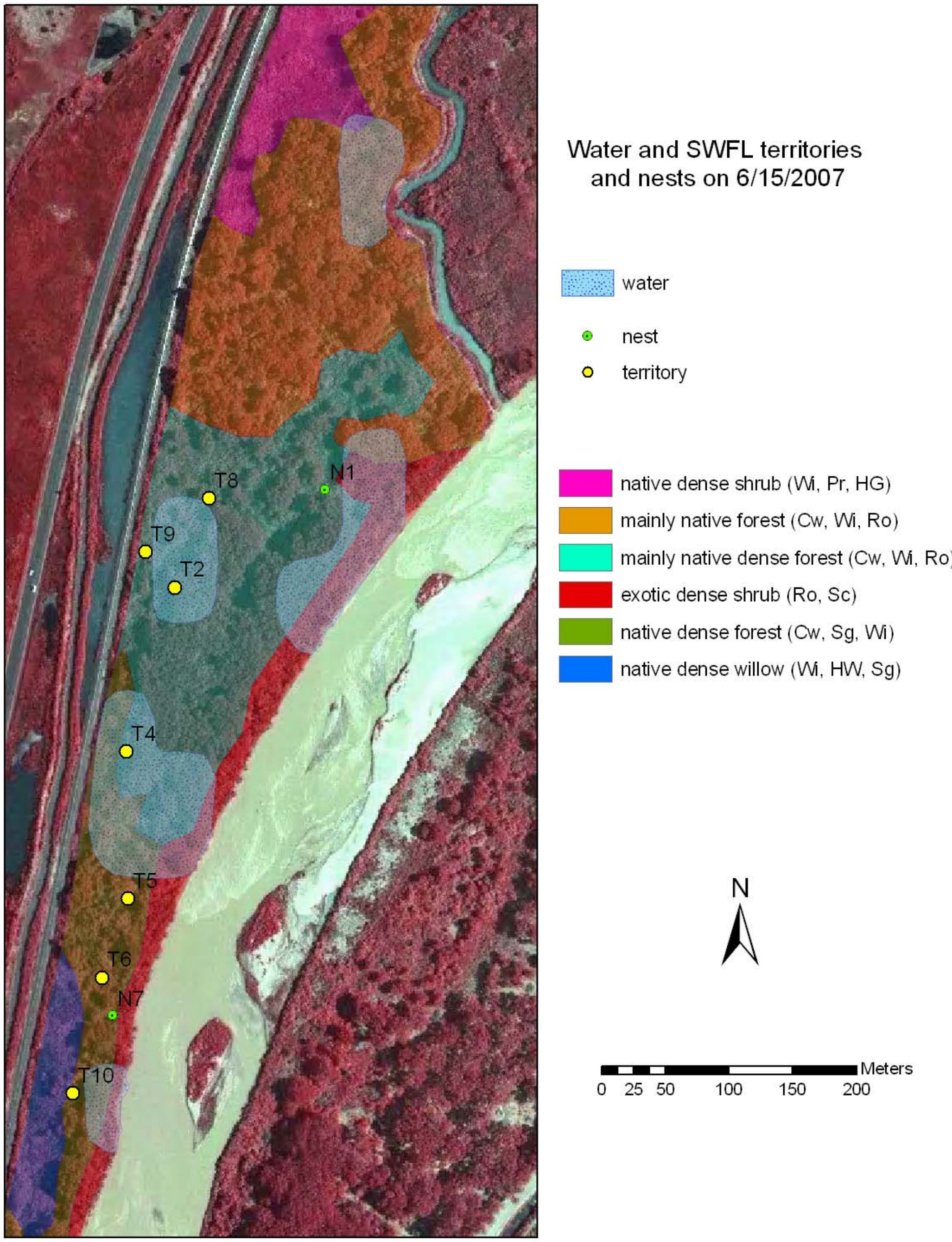

Figure 15. Water, SWFL territories, and nests on 6/15/2007.

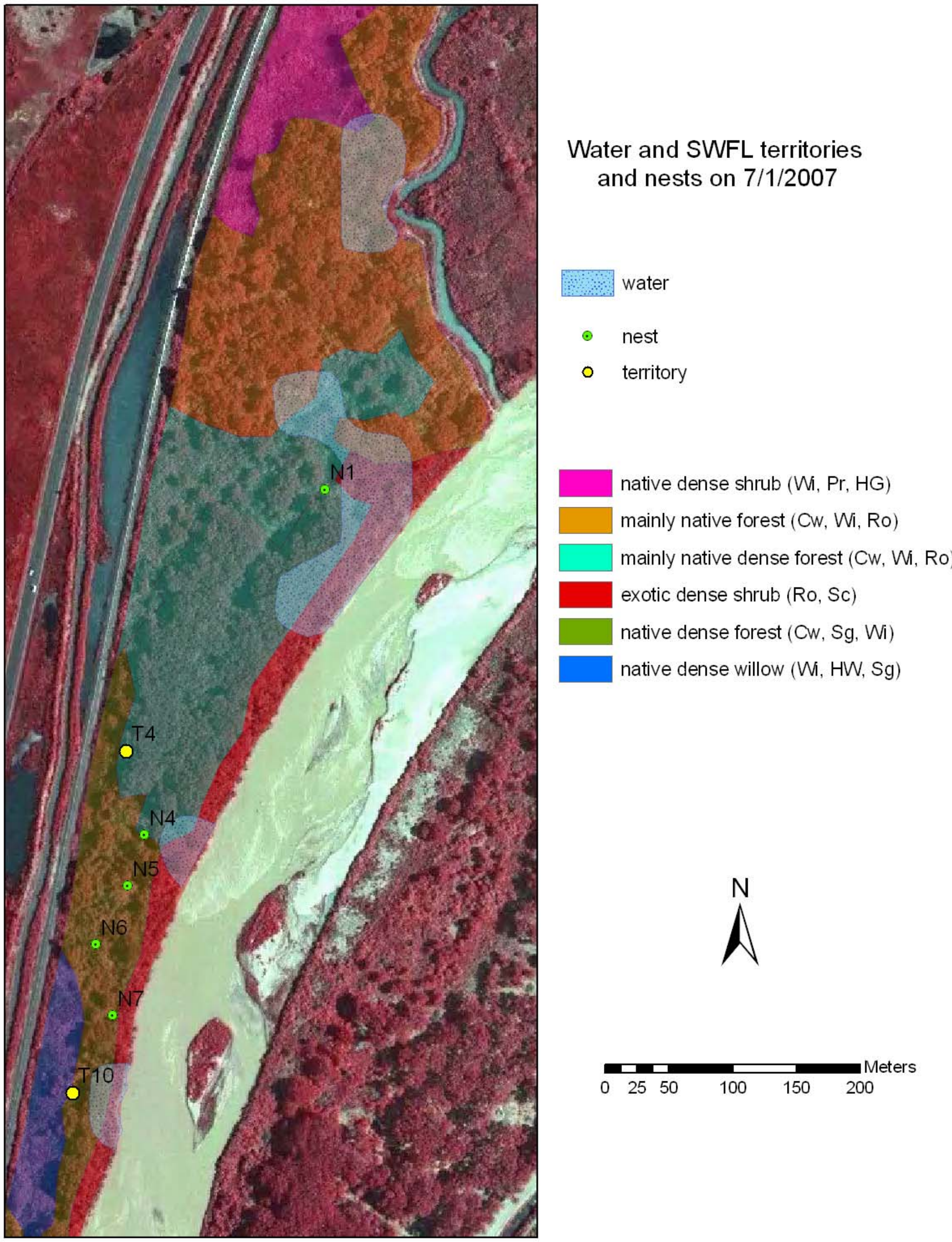

Figure 16. Water, SWFL territories, and nests on 7/1/2007.

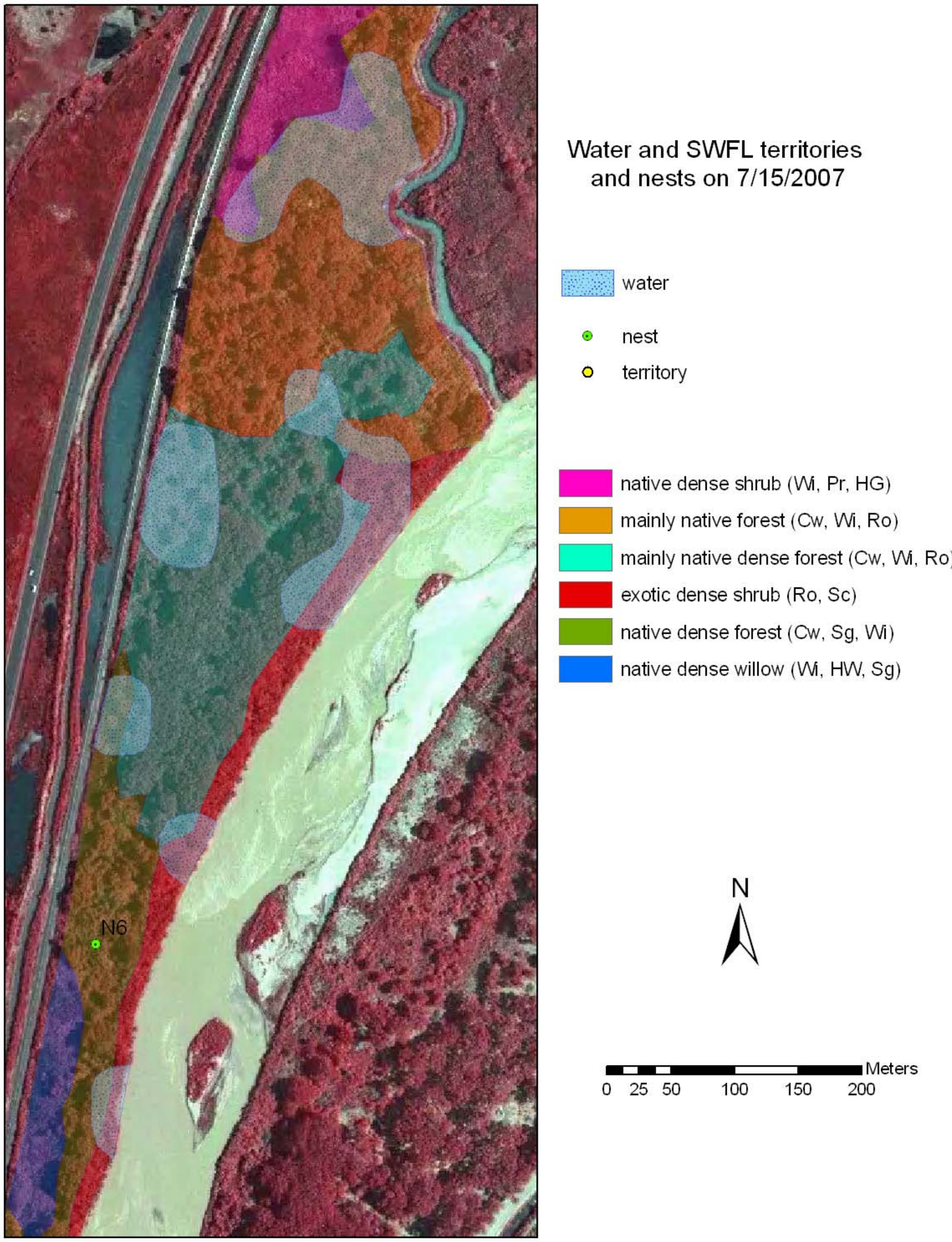

Figure 17. Water, SWFL territories, and nests on 7/15/2007.

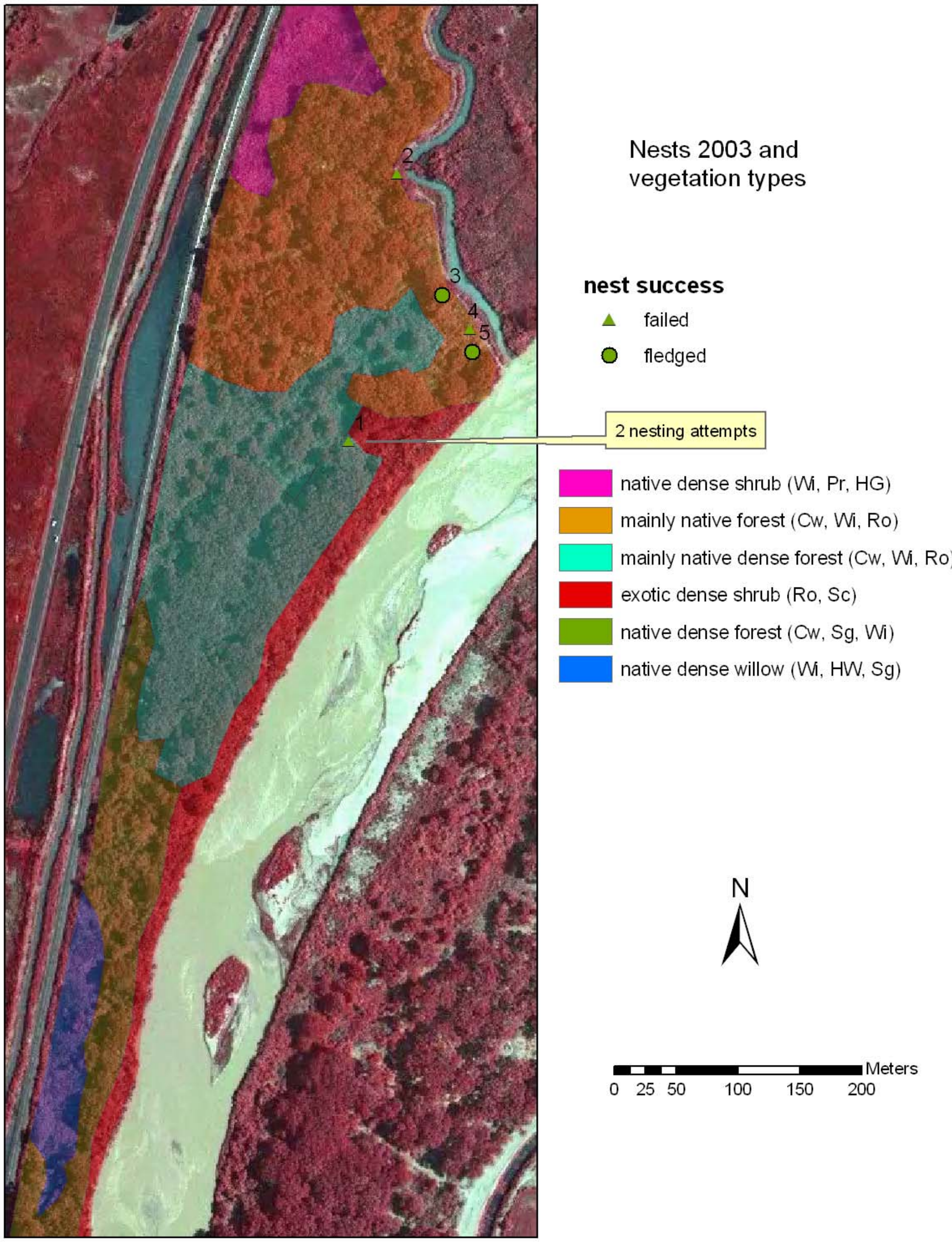

Figure 18. Nests 2003 and vegetation types.

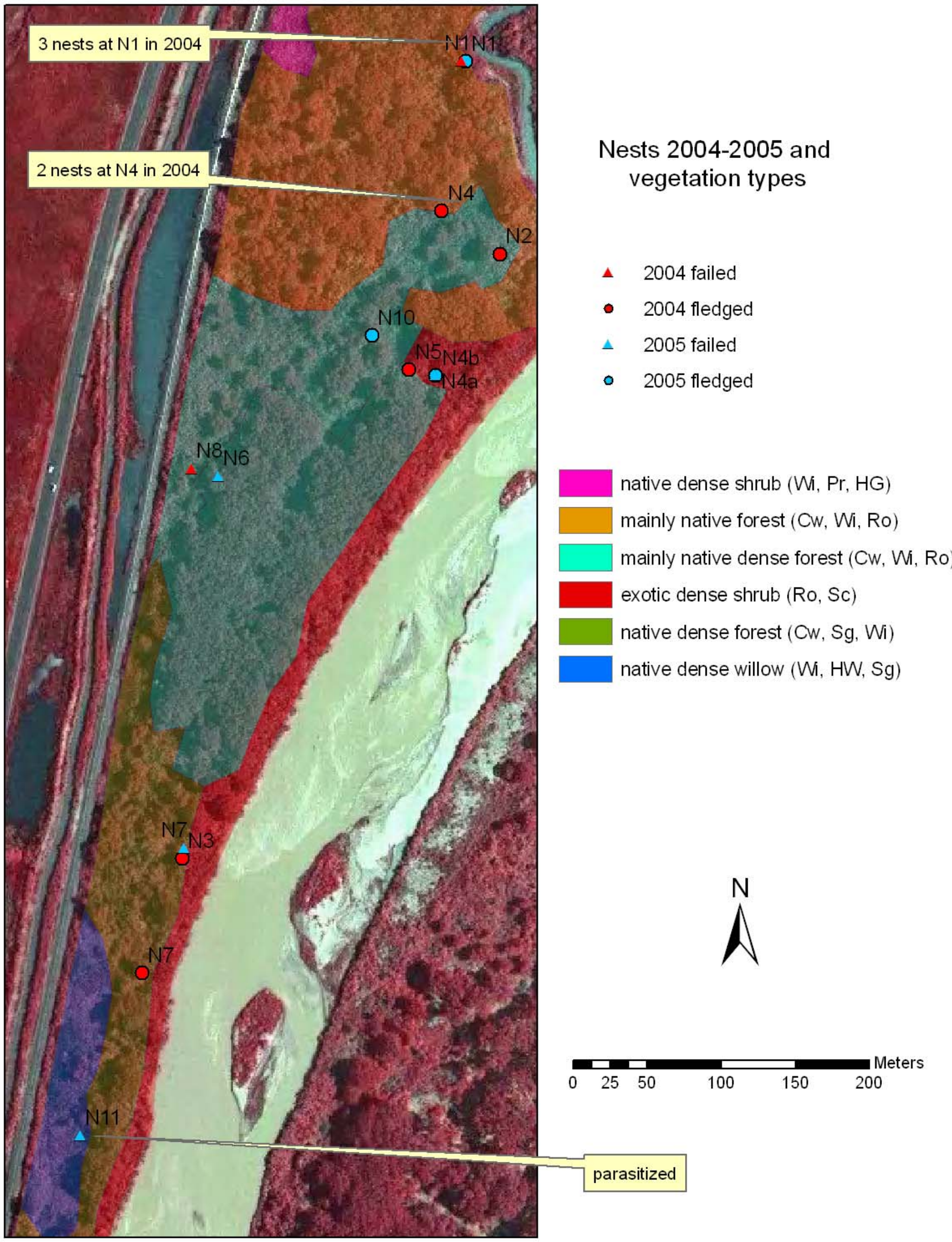

Figure 19. Nests 2004-2005 and vegetation types.

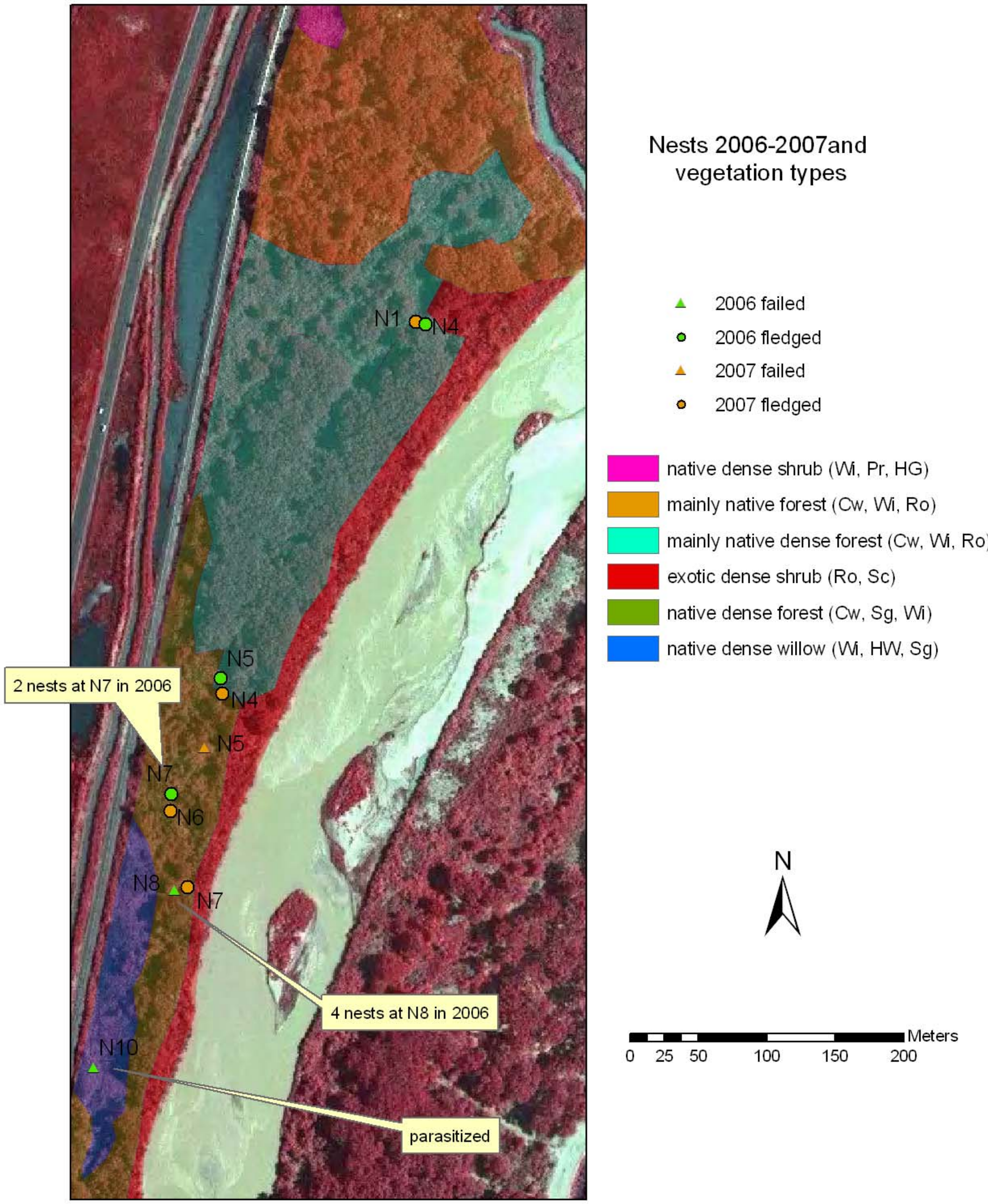

Figure 20. Nests 2006-2007 and vegetation types.

Soil Moisture and Nesting

Soil Moisture and Territory Establishment 2006

We mapped areas of moist and wet soil in the habitat, except for points where the loggers failed or were lost. Out of 40 loggers deployed in 2006 (Figure 2), 13 failed to collect data after the first day of deployment. In 2006 we were unable to find four loggers because they were still underwater when we collected loggers from the field. We recovered one of these in 2007 and never found the other three. In all, we collected data from 24 of the 40 loggers deployed in 2006.

In late May and early June 2006, when SWFLs were establishing territories, the entire site was dry, except for one small area near the river that was wet from groundwater (Figure 8). Five males established dry territories in the northern part of the study site, and three were settled in the southern part (Figure 8). The southern part is narrower, and territories are bounded by the river on the east and the Isleta Interior Drain on the west. By 3 June, the area was still dry (Figure 9).

Two unpaired males left their territories in the north by 13 June and apparently showed up on territories 10 and 11 in the south on 13 June (Figure 10). On 15 June, this left in the north the unpaired male on territory 2, the territory 6 unpaired male, and the territory 4 pair, which fledged young on 27 June (Figure 10). On 20 June, water releases from upstream reservoirs raised water levels in the Isleta Riverside Drain and the Rio Grande, saturating large parts of the study site. Soil at four of six active territories became saturated and rains on 27 and 29 June added more water to the habitat (Figure 11).

In early July, little rain fell, and by 15 July parts of the southern area had dried out (Figure 12). Nest 10 had failed and territory 11 had been abandoned, leaving only territories 5, 7, and 8 with active nests. The third nesting attempt by the pair in territory 8 was abandoned on 21 July. Rain began again the last few days of July, re-saturating the areas around the remaining nests 5 and 7, which went on to fledge young in early August.

In summary, in 2006 birds established territories throughout the habitat, but two pairs subsequently moved from dry parts of the habitat in the north to territories in the south. The southern territories were established near flowing water in the Isleta Riverside Drain. Although soils were mainly dry at the time the birds moved, our notes indicate mud on adjacent territory 8. The two new territories were under 6”-24” of water one week later on 20 June.

Soil Moisture and Territory Establishment 2007

In 2007 we re-deployed the 37 remaining loggers from 2006 plus five new loggers, for a total of 42 loggers (Figure 2). In 2007, we found all 42 loggers and uploaded data from them all.

On 15 May 2007, the southern part of the study site was covered in standing water, and large pools existed in the northern and middle sections (Figure 13). Six males had established territories in or near the wet areas. By 1 June, two new males had established territories in the middle section (T8 and T9), and another had settled in the south (T10). The areas near T1 and T2 had dried somewhat, but all the southern territories were still saturated (Figure 14).

By 15 June, soil in the southern area had begun to dry, leaving a wet patch near T10 and leaving T4 surrounded by water. Territories 5, 6, and 7 were drying, but the remaining northern territories were still wet or near water (Figure 15). By 1 July, territories 2, 8, and 9 had dried out and been abandoned, while nest 1, also in the central section, was underway (Figure 16). By 15 July, wet areas remained adjacent to the river, apparently influenced by groundwater flows from the Rio Grande, and along the Isleta Interior Drain on the west. Nests 4 and 7 in the south and nest 1 in the north had fledged and nest 5 had failed (Figure 17).

In summary, in 2007, birds avoided settling on the three northernmost 2006 territories and instead established territories in the wetter, southern area (Figures 8, 13). The southerly trend in territory establishment over the five years of the study is apparent on Figures 18-20.

Table 8. Success of nests over wet versus dry soil.

	Failed	Fledged
Wet	7	9
Dry	0	6

Soil Moisture and Nest Placement

Of 22 nests for which we have data on soil moisture near the nest, 16 (73%) were placed over water or saturated soil and six over dry soil (Table 8). Seven of the nests over water failed (44%), nine of the nests over water fledged (56%), and all six of the dry nests fledged (100%).

Vegetation Types Preferred for Nesting

We found general agreement between the vegetation map of the area (Milford et al. 2005, revised in 2007) and the plant species data at nests from 2004-2007. E. Milford visited the study site on 18 September 2007 and revised the map to increase accuracy.

Nest Vegetation 2006

In late May and early June 2006, we detected SWFLs singing on eight territories in three habitat types (MUs; brown, teal, and green on Figure 8). A ninth territory in an additional habitat is not shown on this map because the male was only present for a few days. By 13 June, however, two of the four northernmost territories were unoccupied (Figure 10). At the time the two males disappeared, two males appeared in the southernmost vegetation type, south of all existing territories. A third territory disappeared between 27 and 29 June. After this shift, all remaining territories were situated in three of the six vegetation types on the study area (from north to south): 1) Mainly Native Dense Forest (teal on the map, 2) Native Dense Forest (green), and 3) Native Dense Willow (blue, Figure 11).

In 2006, two of two nests (100%; Table 9, Figure 20) were successful in Mainly Native Dense Forest, one of six nests (17%) fledged in Native Dense Forest, and the only nest in Native Dense Willow was parasitized by BHCO and failed (0%).

Nest Vegetation 2007

In late May, we detected six territories in two habitat types (Figure 13). The northernmost territory has been occupied by a SWFL pair since this study began. The northern three territories were in Mainly Native Dense Forest, and the southern three territories were in Native Dense Forest.

In June (Figure 14), two additional territorial males (T8 and T9) showed up in Mainly Native Dense Forest, but we never detected females on those territories. Only the males at the north and south ends of this habitat type would pair with females and eventually nest. Their nests were situated at the edges of this habitat type. Also in June, one more territorial male appeared in Native Dense Forest, but we never detected a female or a nest on that territory (T10, Figure 14). The original three males in this habitat type went on to pair with females and nest.

In 2007, we did not detect SWFL territories in two other vegetation types used in past years: Mainly Native Forest (brown) and Native Dense Willow (blue, Figure 20). The one nest in Mainly Native Dense Forest was successful (100%; Table 9). Three of the four nests (75%) in Native Dense Forest were successful.

Nesting, Nest Success, and Vegetation Type 2003-2007

Over the five years of the study, SWFLs have nested preferentially in three of the six vegetation types: Mainly Native Forest, Mainly Native Dense Forest, and Native Dense Forest (Table 9). These are the only three MUs with a cottonwood overstory and a shrub understory. SWFLs have never nested in Native Dense Shrub (pink), which has no overstory and contains significant proportions of common reed and herbaceous grassy vegetation. They have built only two nests in Exotic Dense Shrub (Russian olive and saltcedar) and two nests in Native Dense Willow, which contains dense willow but has no overstory layer.

Success rates in the preferred types were 40%, 60%, and 46%, respectively (Table 9). The two MUs in which birds had the highest success rates were denser than the Mainly Native Forest, which had a success rate of 40%. One of two nests placed in Exotic Dense shrub was successful, but the sample size is too small to provide a reliable success rate. Both nests in Native Dense Willow were parasitized and failed.

Table 9. Nest success in each vegetation type, 2003-2007.

vegetation	2003	2004	2005	2006	2007	Total Nests	success rates
Native Dense Shrub						0	
Mainly Native Forest	2/4	1/5	1/1			10	40%
Mainly Native Dense Forest	0/2	2/3	1/2	2/2	1/1	10	60%
Exotic Dense Shrub			1/2			2	50%
Native Dense Forest		2/2	0/1	1/6	3/4	13	46%
Native Dense Willow			0/1*	0/1*		2	0%
% success	67%	50%	43%	33%	80%	37	

*these nests were parasitized by BHCO.

Discussion

Between-year Soil Moisture Patterns

In 2006 and 2007, the southern part of the habitat had deeper water, larger wet areas, and more wet days (Figures 11 and 13) than the northern part. In 2000 and 2004 also, standing water was present in the south early in the season. The exceptions to the pattern of standing water in the south occurred in 2003, when the entire site was completely dry, and 2005, when it was completely inundated. The southern part is lower in elevation - a contour line on the USGS topographical map passes between the north and south parts of the habitat. The southern section is apparently influenced by water levels in the river via lateral groundwater movement through a gravel substrate (John Sorrell pers. comm.). The northern section is not only higher but also wider and would therefore require greater groundwater movement to become saturated. The northern area is apparently influenced more by precipitation events than lateral groundwater movement, as suggested by the fact that the northern section had standing water mainly after precipitation events.

Water and Vegetation

Exotic Dense Shrub, Mainly Native Dense Forest, and Native Dense Forest had the highest percentages of saturated soils for the longest periods of time in 2006 and 2007 (Figures 11, 13, 14; Table 7). Native Dense Willow had large proportions of saturated soils but on fewer dates (Figures 11, 13, 14). Relatively small, low patches of Mainly Native Dense Forest in the center of the study site also became inundated when groundwater rose or rainfall was high (Table 7). Mainly Native Dense Forest and Native Dense Forest were the MUs in which nesting success was highest and in which birds chose to place the most nests. Mainly Native Forest, with slightly lower nest success, had the same number of nests as Mainly Native Dense Forest. Therefore, wetter native vegetation types were favored by birds for nesting, and nesting success in those MUs was highest. One exception was the Exotic Dense Shrub, which was extremely dense and consistently wet. Birds nonetheless avoided nesting in this type in favor of native types with a cottonwood overstory.

Nesting Vegetation Type

SWFLs nest in a variety of dense riparian vegetation types (Sogge and Marshall 2000). Native-dominated vegetation can vary from monotypic, single-stratum to multi-species, multi-layered types with canopy and sub-canopy structure. Exotic-dominated types typically contain a saltcedar understory in a cottonwood-willow gallery forest or tall, mature saltcedar (Sogge and Marshall 2000). At our study site, the Native Dense Willow type is mainly monotypic, single-stratum willow with no overstory, and the three native forest types have native cottonwood overstory with willow or willow/Russian olive understory. All four types fit the description of suitable habitat, above. Exotic Dense Shrub, the only exotic-dominated MU at the study site, contains dense Russian olive mixed with saltcedar but does not fit the above description of exotic vegetation types used by SWFLs because it lacks tall overstory trees. Native Dense Shrub, containing willow, grasses, and reeds, lacks the necessary shrub density.

Over the four years of the study, SWFLs have never nested in Native Dense Shrub and have nested only twice each (5.7% of 35 nests) in Exotic Dense Shrub and Native Dense Willow habitats. Of all nests, 89% have been constructed in (often on the edge of) one of three native forest vegetation types. All three types have a cottonwood overstory with shrub understory of either native willows or a mix of willow and Russian olive. Thus, although monotypic and multi-species single-stratum native vegetation types and dense exotic types occur on the study site, the SWFLs at the Pueblo of Isleta have more often nested in vegetation types with a cottonwood overstory and dense willow understory. Nesting success has been highest in the two native forest types with the densest shrub layers, Mainly Native Dense Forest and Native Dense Forest (60% and 46%, respectively). Preference for the denser forest types accords with our finding that vegetation at SWFL nests is denser than that in other parts of territories.

Of the three forest types, Mainly Native Forest is the northernmost and typically the driest, Native Dense Forest the southernmost and wettest, and Mainly Native Dense Forest intermediate in both latitude and soil moisture. The northern type is drier, it is classified on the map as less dense, and birds nesting there have a lower success rate. In 2006 only one and in 2007 no pair established a territory in the northern forest habitat. Thus, birds have barely used the Mainly Native Forest in the past two years. Although increased predation might be expected over the years in a drier habitat with sparser understory, six failed nests in Mainly Native Forest failed due to abandonment (3), parasitism (1), parasitism followed by predation (1), and either starvation or disease (1).

Nesting and Soil Moisture

From 2000 to 2007, the distribution of nests has shifted from north to south within the study site (Figures 18-20). In 2000, five nests were placed in the northern part, one in the center, and one in the south of the habitat. In 2003, all six nests were in the northern part of the habitat (Figure 18). In 2004 and 2005, birds constructed relatively more nests in the narrow, southern section, and territories were dispersed throughout the study site (Figure 19). In 2006, birds settled in the north but two moved south when northern territories remained dry (Figures 8, 9, and 20). In 2007, birds avoided the most northerly traditionally territories and settled early in the season, leaving territories packed into the narrow southern section (Figures 15, 16, and 20).

We suggest two likely explanations for the southerly shift. First, in 2006 and 2007, northern territories were drier than southern territories. Birds might have moved because they prefer moist soils and/or standing water. Second, the shrub layer in the south has steadily increased in height and density over the course of the study. These increases have likely been facilitated by seasonal availability of water in the south.

Increased vegetation density is apparently not the only reason for increased preference for southerly territories, because birds first settled, then moved out of northern territories (2006) and avoided them altogether (2007) when they were dry. We suggest that the improved structure at southern territories provided acceptable alternatives to the traditional northern part of the habitat when northern territories remained dry.

At the nest scale, 16 of 22 nests (73%) for which we have soil moisture data were constructed over standing water or wet soil. This finding is consistent with literature asserting a preference for nesting over saturated soil.

Soil Moisture and Nesting Success

Timing of standing water appears to be associated with nesting success at the site. In three of the six years we have been working at Isleta, the southern one-half to two-thirds of the site was covered in standing water at the time of territory establishment (2000, 2004, and 2007). This pattern has occurred most frequently and we consider it to be typical. Nest success was also highest in two of those three years (2004- 50%, 2007- 80%; Table 1). In 2000, we did not monitor nest contents for the entire nest cycle, but we did check nests from a distance well into the nesting period. It appeared that nest success would be high, with a possibility of up to 71% success. Thus, the typical pattern of standing water in the southern part of the study site during May and early June was associated with higher nesting success (“high,” 50%, and 80%). The lowest success rates occurred when the entire site was dry (2003) or was entirely dry early in the season (2006). Intermediate success occurred when the site was completely flooded for most of the season (2005). At the nest scale, about as many nests over wet soil as over dry soil fledged, but none of the dry nests failed. A possible explanation is that, other things being equal, SWFLs will choose wet over dry nest sites, but if dry nest sites have better vegetation structure than wet ones, the birds will choose structure over soil saturation.

Although soils were saturated in the southern part of the study area in the years with highest nesting success, several territories were established in the drier, northern section of the study site. Thus, the typical soil moisture pattern of early saturation may not benefit nesting SWFLs directly via wet territories. Standing water early in the nesting season may instead be associated with spring precipitation that results in greater insect abundance throughout the site.

Nest failure was most often due to abandonment or predation, with parasitism another significant cause. The exception was 2004, when four nests failed for other reasons (Table 4). Although water differences between years appear to be related to nesting success, the mechanism is not clear (Tables 1, 4). Predation may be correlated indirectly to water levels if adults forage further away from the nest in dry years and leave nests unattended for longer periods. Access of snakes or small mammals to nests is probably limited by deep standing water under nests, but this hypothesis does not explain the 20% predation rate in 2005, the year the entire site was completely inundated. Avian predators such as Cooper's hawks could account for some nest predation. Starvation and abandonment could also increase if lack of water reduced insect abundance and thereby required birds to be away from nests for longer periods.

If the lack of water in the north caused the birds to move south, then it may also have increased their risk of BHCO parasitism. In 2005 and 2006, the southernmost nest was parasitized. Both nests were in Native Dense Shrub with little or no overstory and may have been more visible to cowbirds. In addition to the lack of dense vegetation above the nest, spatial aspects of southern territories might place them at increased risk of parasitism. The southern part of the habitat is much narrower than the north and is bounded by open habitat, unlike the north. BHCO parasitism rates have been shown to increase with the amount of edge habitat (Sedgwick and Knopf 1988), open area nearby (Brittingham and Temple 1983), and proximity of foraging areas for BHCO (Tewksbury et al. 2006). In addition, several prominent snags provide perches for BHCO above southern SWFL territories. In 2003, the parasitized nest was in the drier north and was visible from the nearby road. It is possible that reduced insect abundance associated with dry soil, in combination with high visibility, increased BHCO access to that nest.

Water or Vegetation?

Five years of data suggest that SWFL territory choice and nest placement are based on multiple interacting factors. SWFLS appear to base territory choice on a combination of vegetation type and soil moisture. Most SWFLs in this study have established nesting territories in (often on the edge of) three main vegetation types, all of which include a cottonwood overstory and a willow understory. Birds will apparently abandon territories in otherwise acceptable habitat if territories remain dry and if acceptable alternatives are available. An exception was nest 4 in 2006. When two other territories shifted south, the territory 4 pair remained on a dry territory. Their nesting effort was ahead of the pairs that moved and they apparently chose not to abandon their investment. The distribution of territories has also shifted from north to south over several years, apparently in response to lack of water on the traditional territory sites in the north. With abundant water in the southerly territories, the shrub layer, particularly coyote willow, has grown taller since the beginning of the study, thus providing more suitable nesting habitat in southerly territories. We believe the south is becoming preferred both because of its higher soil moisture and its taller willow understory.

Our nest vegetation data indicate that once SWFLs choose a territory, they then tend to place nests at sites having denser vegetation around and above the nest. Nests are constructed in various shrub species; the shrub species appears less important than density of vegetation at and above the nest. In addition, nests are typically placed over standing water or wet soil.

Thus the answer to the question of which is more important, water or vegetation seems to be “both.” Water facilitates development of dense willow shrubs, but SWFLs at our study site also appeared to avoid territories in acceptable vegetation types when soil in those territories was very dry.

Management Recommendations

Native Dense Shrub (pink)

SWFLs have never nested in Native Dense Shrub (pink), which lacks an overstory layer and contains significant proportions of common reed and herbaceous grassy vegetation. Height and density of the willows in this MU, however, have increased over the years of the study. Although this area is not currently a high priority target for SWFL habitat management, if water could easily be supplied, this MU might develop into suitable habitat in time.

Mainly Native Forest (brown)

Our first management recommendation is for the Mainly Native Forest vegetation type, situated in the northern part of the study site. This habitat has the basic structure favored by SWFLs, cottonwood overstory and shrub understory, but in places the shrub layer is sparse. We suggest that annual inundation in the early part of the nesting season would encourage development of the willow shrub layer and create saturated soils favored by the birds. The Pueblo of Isleta has already laid the groundwork necessary to implement this recommendation. The turnout gate is in place and a trench has been dug from the turnout to an appropriate point in the Mainly Native Forest habitat. We recommend that the Pueblo either make the trench wider and deep enough that water would easily flow the length of the trench or install pvc pipe at the appropriate angle to transport water from the turnout to the target area.

Native Dense Willow (blue)

The potential for Native Dense Willow, in the south of the study site, to develop into good nesting habitat is inherently limited by the low elevation and narrow width of the site. This low-lying area is strongly influenced by groundwater, and soils are typically quite muddy. Cottonwood trees on the east edge should be left in place to provide marginal overstory, and any Gooding’s willow or cottonwood saplings at the site should be allowed to grow. We recommend that the tops of dead snags be cut off to eliminate BHCO perches.

Exotic Dense Shrub (red)

This extremely dense strip of Russian olive and saltcedar offers very little habitat potential in its present form, but restoration would be costly and difficult, given the lack of road access. We recommend monitoring this MU and minimizing its spread into the adjacent suitable habitats.

Mainly Native Dense Forest and Native Dense Forest (teal, green)

As long as Mainly Native Dense Forest and Native Dense Forest are partly or entirely inundated every year or two, this habitat will probably remain suitable for SWFL nesting. SWFLs have voted with their territory choices in favor of the current hands-off management practices in these habitats. However, if reduced precipitation and/or river volumes cause these MUs to stay dry all spring and summer, our recommendations would be similar to those for the Mainly Native forest: inundate most of both habitats at least every two years and preferably every year.

Future Work

To test our hypothesis that the typical soil moisture pattern is good for nesting success, we need more years of data on nesting success and soil saturation, particularly in atypical years. We have suggested that this relationship might be mediated through increased insect availability in years with high early spring precipitation or runoff. In 2008, we plan to begin monitoring insect prey availability to look for associations with soil saturation and nesting success. More data points should clarify the relationship between nest success and placement over wet versus dry soil. We will also continue to monitor vegetation and territory placement relative to soil moisture.

Conclusions

After five years of monitoring SWFL nesting, three years of studying habitat preferences, and two years of mapping water distribution and vegetation, it appears that SWFLs at the Pueblo of Isleta fit the typical SWFL habitat profile surprisingly well. SWFLs at our study site have more often established territories in three vegetation types, all of which contain a cottonwood overstory and dense coyote willow and/or Russian olive understory. These MUs are also consistently wetter than less preferred types. Within territories, SWFLs tend to nest on the edges of clumps, near open meadow habitat, and over wet soil. Nests are typically placed in vegetation that is denser than at other spots in the territory. Nests with low-density vegetation above the nest and nearby perches for BHCO appear to be at increased risk of nest parasitism.

Soil moisture patterns appear to be spatially associated with development of native shrub structure, as evidenced by the increasing height and density of willows in the wetter, southern MUs. Moisture thus affects territory establishment and nesting success via its effect on vegetation type and structure.

Nesting success appears to vary with the temporal and spatial distribution of standing water, and this effect occurs at time scales too short to be mediated through vegetation structure. Success has been higher in years having the typical pattern of soils that are wet during territory establishment and dry by mid-June. Nests fail primarily due to predation, abandonment, and parasitism. If insect abundance is higher during wet periods, birds may need to spend more time foraging and less time covering or guarding nests during dry spells. If so, any of the above factors could be expected to increase during dry periods.

More than twice as many nests were constructed over wet as over dry soil. We assume that birds occasionally nest over dry soil because they sometimes choose vegetation structure in lieu of soil saturation. The percent of successful nests was notably higher over dry soil. This difference in fledging success could be an effect of sample sizes and will be further investigated in future work.

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