Biological Effectiveness Monitoring for the Natomas Basin Habitat Conservation Plan Area 2006 Annual Survey Results






the NATOMAS BASIN conservancy

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Chapter 1
Introduction

1.1 Background

In November 1997, the Natomas Basin Habitat Conservation Plan (NBHCP) was submitted to the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (DFG) in support of an application for a federal permit under Section 10(a)(1)(B) of the Endangered Species Act (ESA) and a state permit under Section 2081 of the California Fish and Game Code. USFWS and DFG subsequently approved the plan and issued permits. A modified version of the NBHCP was approved in 2003 (City of Sacramento 2003).

The NBHCP (also referred to as the Plan) was designed to promote biological conservation while allowing economic development and the continuation of agriculture in the Natomas Basin (Basin). The Plan establishes a multi-species conservation program to minimize and mitigate the expected loss of habitat values and the incidental take of Covered Species that could result from urban development and certain activities associated with implementation of the conservation activities required as mitigation.

The overall goal of the NBHCP is to minimize incidental take of Covered Species in the permit area and to mitigate the impacts of covered activities on Covered Species and their habitats. Mitigation is accomplished primarily through the acquisition and management of reserve lands for the benefit of Covered Species. The primary biological goal of the NBHCP is to create a system of reserves, with both wetland and upland components, that will support viable populations of Swainson's hawk, giant garter snake, and other species covered under the Plan (hereinafter referred to as *Other Covered Species*).

The Natomas Basin Conservancy (TNBC) is the nonprofit entity responsible for administering and implementing the NBHCP and the Metro Airpark Habitat Conservation Plan (MAP HCP). The MAP HCP covers a 2,011-acre portion of the Basin, adjacent to Sacramento International Airport (SMF), that is part of the 17,500 acres of planned urban development considered in the NBHCP. TNBC serves as the plan operator on behalf of the City of Sacramento, Sutter County, and the MAP Property Owners Association. TNBC's actions are governed primarily by the terms of the NBHCP and the commitments set forth in the NBHCP Implementing Agreement. TNBC's primary function is the acquisition of habitat reserve lands and the development and implementation of Site-Specific

Management Plans (SSMPs) and Site-Specific Biological Effectiveness Monitoring Plans for each reserve within the Basin. A Technical Advisory Committee (TAC) provides technical assistance to TNBC.

To achieve the goals of the Plan, TNBC has retained Jones & Stokes to conduct the biological effectiveness monitoring required in the NBHCP. Biological effectiveness monitoring is conducted to verify the progress made toward meeting the biological goals and objectives of the NBHCP and to inform the adaptive management strategy. By the end of 2006, TNBC owned and operated 28 reserves totaling approximately 4,132 acres (1,672 hectares) in the Basin (Table 1-1). Two properties (Ayala and Brennan) were exchanged for larger, more desirable properties during 2006. The results of monitoring on these properties are documented in this annual report; however, they will not be monitored henceforth. Five properties (Bianchi West, Bolen West, Elsie, Frazer South, and Nestor) were recently acquired and were not monitored during 2006. Monitoring will begin on these properties in 2007.

Table 1-1. Mitigation Lands Acquired under the Natomas Basin Habitat Conservation Plan as of December 2006

Property	Date Acquired	Acres
Alleghany	11/7/02	50.3
Atkinson	6/12/03	205.4
Bennett North	5/17/99	226.7
Bennett South	5/17/99	132.5
Betts	4/5/99	139.0
Bianchi West*	11/7/06	110.2
Bolen North	4/29/05	113.6
Bolen South	4/29/05	102.4
Bolen West*	9/01/06	155.1
Cummings	11/7/02	66.8
Elsie*	11/7/06	158.0
Frazer	7/31/00	92.6
Frazer South*	11/7/06	110.4
Huffman East	9/30/03	135.7
Huffman West	9/30/03	181.0
Kismat	4/16/99	40.3
Lucich North	5/18/99	268.0
Lucich South	5/18/99	351.9
Natomas Farms	7/9/01	96.5
Nestor*	9/1/06	233.2
Rosa Central	3/23/05	106.3

Property	Date Acquired	Acres
Rosa East	3/23/05	100.0
Ruby Ranch	6/23/03	91.1
Sills	7/15/02	436.4
Silva	1/7/99	159.2
Souza	7/2/01	44.7
Tufts	9/29/04	148.0
Vestal	9/12/05	95.0
Total		**4150.3**
Ayala**	2/20/02	317.4
Brennan**	6/15/00	241.4

* Newly acquired in 2006. Monitoring will begin in 2007.

** Monitored in 2006 but exchanged for larger, more desirable properties in late 2006.

1.1.1 Location

The Natomas Basin is a low-lying area of the Sacramento Valley located in the northern portion of Sacramento County and the southern portion of Sutter County (Figure 1-1). The 53,537-acre (21,666-hectare) NBHCP Area (also referred to as the *permit area*) is bounded on the west by the Sacramento River, on the north by the Natomas Cross Canal, on the east by Steelhead Creek (formerly known as the Natomas East Main Drainage Canal), and on the south by Garden Highway (Figure 1-2).

The permit area contains incorporated and unincorporated areas under the jurisdictions of the City of Sacramento, Sacramento County, and Sutter County. The southern portion of the Basin is mostly urbanized, but most of the remainder is still agricultural.

1.1.2 Setting

The Natomas Basin is within the historical floodplain of the Sacramento and American Rivers. Prior to agricultural conversion, the Basin consisted of wetlands, narrow streams with associated riparian vegetation, shallow lakes, and grasslands on the higher terraces along the Basin's eastern edge. During the late 1800s and early 1900s, most of the Basin was converted to agriculture. Most native habitats were removed, and channelized water delivery systems replaced the natural stream corridors.

The central and northern portions are the lowest areas of the Basin. With deep clay soils, the flat and largely treeless terrain is characterized primarily by rice farming. Very few trees or other vegetation types are present, with the exception of areas along the Natomas Cross Canal on the Basin's northern boundary. This area supports a mature riparian forest and wetland complex throughout its length (Figure 1-3).

Situated primarily on alluvial soils, the southern and western portions of the Basin are characterized by a mixture of row, grain, and hay crops. Throughout this area, small remnant stands of valley oak woodland and remnant patches of riparian woodland, such as those along Fisherman's Lake, persist in an otherwise entirely agricultural area (Figure 1-4). The Sacramento River, on the Basin's western edge, supports mature cottonwood-dominated riparian forest (Figure 1-4). The southern portion of the Basin is rapidly being converted to urbanized uses, primarily residential development (Figure 1-5).

The eastern edge is on a terrace slightly higher than the rest of the Basin. This area, consisting primarily of loam and clay-loam soils and gently rolling topography, is characterized by annual grasslands and both dry and irrigated pastures (Figure 1-6). This area is bordered on the east by Steelhead Creek, a channelized drainage that supports an extensive wetland complex and sparse riparian vegetation along its length (Figure 1-6).

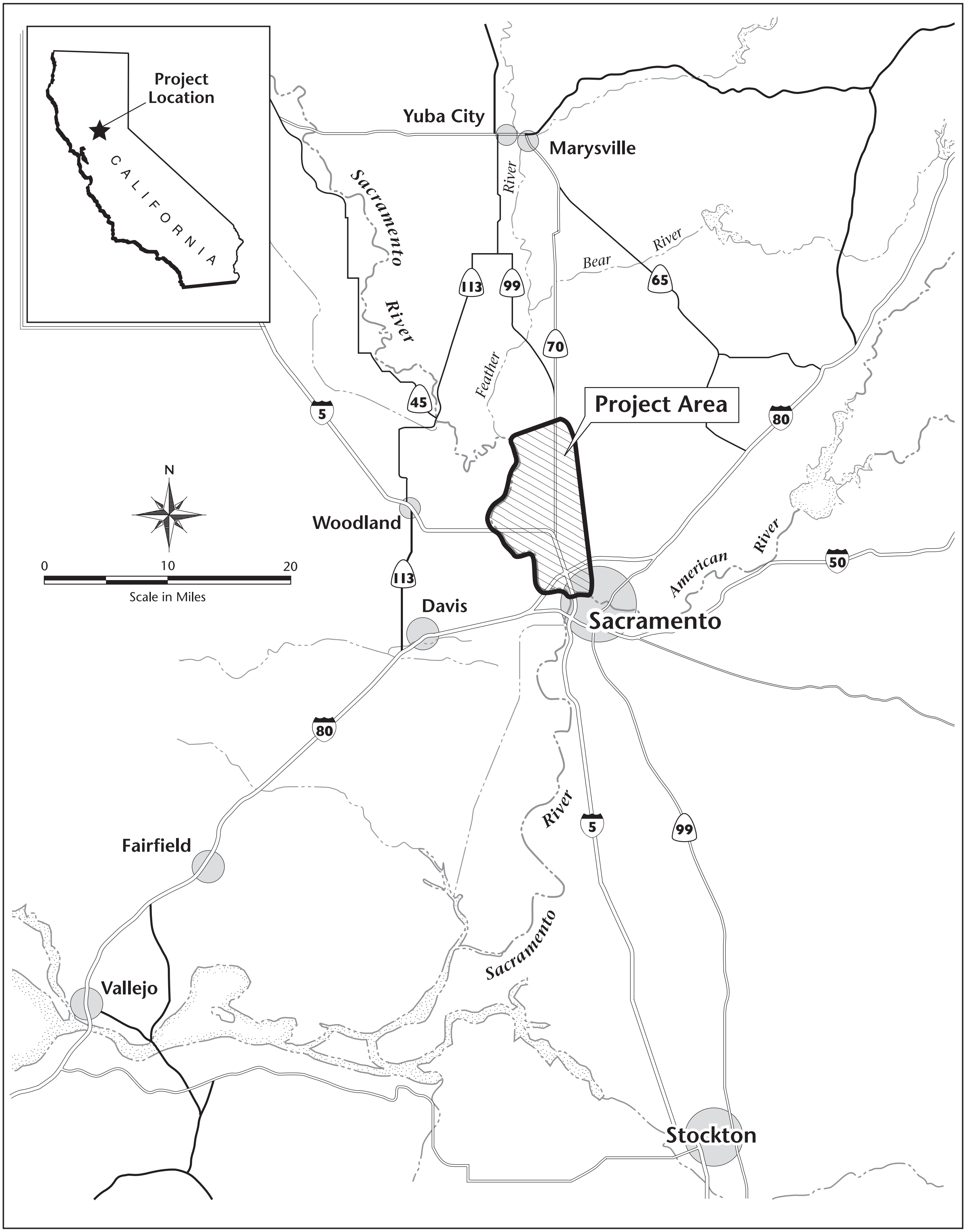
1.2 The Biological Effectiveness Monitoring Program

1.2.1 Goals and Objectives

The purpose of the Biological Effectiveness Monitoring Program is to evaluate the effectiveness of the NBHCP with respect to meeting its biological goals and objectives, and to inform the adaptive management strategy. In general, monitoring is designed to establish baseline conditions, track changes over time, and evaluate the effectiveness of management actions. Specific purposes of the Biological Effectiveness Monitoring Program are listed below.

- Track population trends of Covered Species within the permit area, both on and off reserve lands, in order to evaluate the effectiveness of the NBHCP in terms of sustaining populations of Covered Species in the Basin.
- Evaluate the effectiveness of the design and management of mitigation lands (reserves).
- Provide information that can be used to improve the design and management of reserves.

Monitoring must be conducted in accordance with the guidelines set forth in the NBHCP to achieve compliance with the provisions of the 10(a)(1)(B) permit.



Jones & Stokes

Figure 1-1
Natomas Basin Regional Location Map

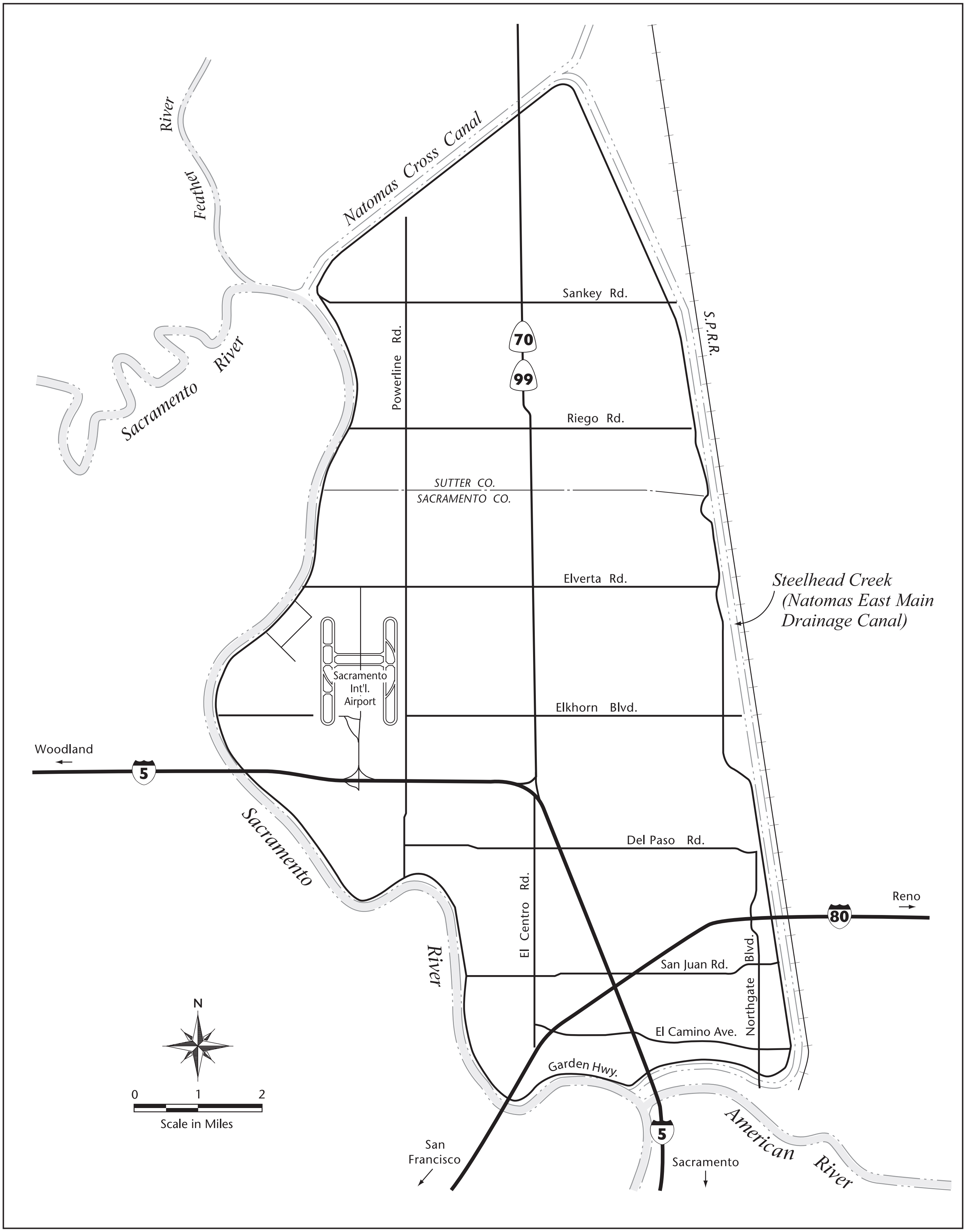


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Figure 1-2
Natomas Basin

Typical habitat of the central and northern Natomas Basin

Natomas Cross Canal

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Figure 1-3
Central and Northern Basin Habitats

Fisherman's Lake

Mature riparian forest along the Sacramento River

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Figure 1-4
Riparian Habitats in the Natomas Basin

Typical habitat of the west and south Natomas Basin

Residential development in the south Natomas Basin

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Figure 1-5
Southern and Western Basin Habitats

Typical habitat of the east Natomas Basin

Steelhead Creek (also known as the Natomas East Main Drain Canal)

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Jones & Stokes

Figure 1-6
Eastern Basin Habitats

1.2.2 Covered Species

The NBHCP covers a total of 22 species. These species are listed in Table 1-2.

Table 1-2. Species Covered under the Natomas Basin Habitat Conservation Plan

Common Name	Scientific Name
White-faced ibis	*Plegadis chihi*
Aleutian Canada goose	*Branta canadensis leucopareia*
Swainson's hawk	*Buteo swainsoni*
Burrowing owl	*Athene cunicularia*
Loggerhead shrike	*Lanius ludovicianus*
Bank swallow	*Riparia riparia*
Tricolored blackbird	*Agelaius tricolor*
Giant garter snake	*Thamnophis gigas*
Northwestern pond turtle	*Emys marmorata marmorata*
California tiger salamander	*Ambystoma californiense*
Western spadefoot	*Spea hammondii*
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*
Vernal pool fairy shrimp	*Branchinecta lynchi*
Midvalley fairy shrimp	*Branchinecta mesovallensis*
Vernal pool tadpole shrimp	*Lepidurus packardi*
Delta tule pea	*Lathyrus jepsonii* ssp. *jepsonii*
Sanford's arrowhead	*Sagittaria sanfordii*
Colusa grass	*Neostapfia colusana*
Boggs Lake hedge-hyssop	*Gratiaola heterosepala*
Sacramento Orcutt grass	*Orcuttia viscida*
Slender Orcutt grass	*Orcuttia tenuis*
Legenere	*Legenere limosa*

Two covered species—Swainson's hawk and giant garter snake—are currently listed under the state and/or federal ESAs and are widely distributed in the Basin; the preponderance of the monitoring effort is devoted to these two species. Accordingly, these species are addressed individually in Chapter 3, *Giant Garter Snake*, and Chapter 4, *Swainson's Hawk.* Covered plant species are addressed in Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring*. The remainder of the Covered Species are collectively referred to as *Other Covered Species* and are addressed in Chapter 5, *Other Covered Wildlife Species*.

1.2.3 Types of Monitoring

The NBHCP and its Implementing Agreement require that monitoring be conducted in accordance with conditions of the 10(a)(1)(B) permit. Accordingly, a comprehensive monitoring strategy has been developed to satisfy these conditions.

Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring

Comprehensive vegetation mapping began in 2004 and constitutes the baseline and foundation for all the monitoring efforts. Vegetation mapping is conducted both Basin-wide and on reserves. The mapping efforts on reserves are conducted at a higher resolution than the Basin-wide mapping efforts. These mapping exercises are building a comprehensive, chronological picture of changes in habitat type and extent that will continue through the permit term.

Floristic surveys were initiated in 2004. These surveys are conducted on reserves to monitor the vegetative composition of the reserves, to assess changes in vegetation over time, and to note any occurrence of covered plant species.

Noxious weed surveys were also initiated in 2004. These surveys are conducted on reserves to monitor the presence and extent of populations of such species. The presence of noxious weed populations can affect the ability of habitats to support covered species.

The methods and results of these surveys are described in Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring*.

Giant Garter Snake Monitoring

Monitoring efforts for giant garter snake have been conducted in the Basin since the late 1990s. A standardized sampling protocol and survey design was initiated in 2004. The methods and results of these surveys are described in Chapter 3, *Giant Garter Snake*.

Swainson's Hawk Monitoring

Systematic Swainson's hawk monitoring has been conducted under the auspices of the NBHCP since 1999. Because Swainson's hawks are far-ranging birds, this species is intensively monitored throughout the Basin. The methods and results of these surveys are described in Chapter 4, *Swainson's Hawk*.

Other Covered Wildlife Species Monitoring

Monitoring of populations of Other Covered Species was initiated in 2004. Surveys on reserve lands include surveys to evaluate the extent to which the NBHCP is meeting its objectives for Other Covered Species. Surveys for Other Covered Species on non-reserve lands are conducted to document changes in populations over time and to evaluate the extent to which reserve lands are meeting the objective of providing habitat for viable populations of Other Covered Species. The methodologies and results of these surveys are discussed in detail in Chapter 5, *Other Covered Wildlife Species*.

1.3 References

City of Sacramento. 2003. *Natomas Basin Habitat Conservation Plan; Sacramento and Sutter Counties, California*. Sacramento, CA.

Chapter 2

Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring

2.1 Introduction

2.1.1 Background

Biological effectiveness monitoring is designed to assess the progress of the NBHCP toward meeting the Plan's goals and objectives for Covered Species *and their habitats* [emphasis added]. One aspect of the biological effectiveness monitoring program that touches on all covered species is the mapping of vegetation and habitat types, and monitoring changes in those types over time. Two general types of vegetation and habitat monitoring were conducted to meet the goals and objectives of the HCP: monitoring on reserve lands and monitoring on non-reserve lands (Basin-wide monitoring).

Land cover and habitat monitoring on reserve lands was intensive, comprising vegetation and habitat mapping, complete floristic inventories on newly acquired reserves, surveys of suitable habitat for covered plant species, and noxious weed surveys. Basin-wide land cover and habitat type monitoring involved field checking each habitat polygon originally mapped in 2004 and documenting any changes in land cover types annually.

2.1.2 Goals and Objectives

Effective resource monitoring requires baseline information on the distribution and abundance of the resources of interest. The vegetation and habitat mapping component of the biological effectiveness monitoring effort established the baseline for the entire biological monitoring effort. The objectives of the Basin-wide vegetation and habitat monitoring component are listed below.

- Quantify the distribution and abundance of land cover and habitat types throughout the Basin.
- Provide the baseline against which changes in land cover and habitat types can be measured.

Provide spatially explicit information on the distribution and abundance of land cover and habitat types throughout the Basin to guide future reserve site acquisitions, to provide information on potential dispersal corridors between reserves, and to assess changes in the distribution and abundance of suitable habitats for covered species over time.

Floristic surveys on reserve lands are conducted annually. The objectives of floristic surveys on newly acquired TNBC reserve sites are listed below.

- Describe and thoroughly document the baseline vegetation and habitat conditions and develop a complete plant list.
- Document the location, numbers, and/or cover of invasive or noxious plant populations where they occur.

Determine if any covered plant species occur on the newly acquired reserves and, if so, document their location, numbers, and/or coverage.

The objectives of floristic surveys on existing reserves are listed below.

- Document changes in the distribution or condition of vegetation and habitat types.
- Document the location, numbers, and/or cover of invasive or noxious plant populations where they occur.

Conduct surveys for covered plant species in suitable habitat.

2.2 Methods

2.2.1 Land Cover Mapping

Baseline conditions were initially documented in 2004. To accomplish this, GIS specialists created a base map of the NBHCP Area using true-color digital ortho-rectified aerial photography of Sacramento and Sutter Counties purchased from AirPhotoUSA. The aerial photographs of Sacramento County were taken in April 2004 at a resolution of 1 foot (i.e., each cell represents an area on the ground approximately 1 foot square); the aerial photographs of Sutter County were taken in spring 2004 at a resolution of 2 feet (i.e., 4 square feet).

Botanists experienced with interpretation of aerial photographs and with the land cover and vegetation of the southern Sacramento Valley mapped land cover types on screen using ESRI's ArcGIS 9.0 software. Lines were drawn to delineate polygons following visible differences in color tone and texture on the photographs. Polygons were delineated at a scale of 1:2,500–1:5,000 (approximately 1 inch = 200–400 feet). Riparian areas and wetlands were in some cases digitized at larger scales. Minimum polygon size was generally 5 acres (2 hectares) for agricultural habitat types and developed areas, 0.25 acre

(0.1 hectare) for seasonal wetlands, and 0.5 acre (0.2 hectare) for other habitat types. Polygons were then field checked to ensure accuracy of the digitizing and photo-interpretation effort. Ditches were mapped as line features; consequently, the acreage of these features was not calculated. The 2005 baseline maps were revised when aerial photographs from that year became available.

Field verification of land cover polygons on reserve and non-reserve lands are conducted annually, primarily while conducting surveys for other purposes. Any remaining polygons are checked later in the season but before the harvest begins. A small proportion of polygons could not be checked because access to the private property on which they occur was not available.

Surveys were conducted in mid-summer, an appropriate time to map habitat polygons and document noxious/invasive plants. Each polygon on reserve lands was visited and verified, and the following data were collected.

- Dominant plant species (species constituting more than 20% of the vegetation cover).
- Land use impacts, such as the presence and extent of management or other human impacts (e.g., tree cutting, vegetation cutting, herbicide use, erosion).
- Other data (e.g., tree or vegetation height, number of trees, canopy cover) where relevant.
- Any changes in land cover or crop type, or in the distribution of suitable habitat for covered plant species.

2.2.2 Floristic Surveys

Floristic surveys to document baseline conditions, map habitat and vegetation types, record noxious weeds, and develop a plant list were conducted in mid-summer 2006 on the newly acquired Vestal Reserve. Vestal does not provide suitable habitat for early-blooming covered plant species, including vernal pool plants; consequently, the mid-summer timing was appropriate. Because Vestal consisted of a rice field and supports no natural vegetation other than the strip of valley oak woodland along the far side of the ditch on the western border, it was surveyed by driving the access roads and stopping occasionally to sample the vegetation and record plant species present.

On existing reserves, surveys were conducted to record any changes in vegetation, habitat, or crop type; detect any changes in the distribution and abundance of suitable habitat for covered species; and document noxious/invasive plant species. Additional plant species encountered were added to the cumulative list of species observed on each reserve.

Nomenclature follows *The Jepson Manual* (Hickman 1993) and online updates (Baldwin et al. 2006).

2.2.3 Noxious Weed Mapping

A complete list of noxious weeds known to occur in Sutter and Sacramento Counties was initially compiled from information in CalFlora (2004) and Jones & Stokes file data. The noxious weeds tracked during the field survey were those on Lists A, B, and Red Alert of the California Invasive Plant Council's (Cal-IPC's) Pest Plant List, a categorized list of pest plants of ecological concern in California (California Invasive Plant Council 1999, 2006). These lists comprise plants considered invasive to wildlands and natural vegetation, rather than weeds of agricultural importance that are found primarily in disturbed habitats.

Several non-listed plants that are potentially invasive in wetlands and may be of management concern on TNBC reserves were noted in the field surveys: joint grass, barnyardgrass, cattail, water primrose, and waterfern.

The list of weeds tracked on TNBC reserves is reviewed and updated annually on the basis of Cal-IPC updates and input from local land managers.

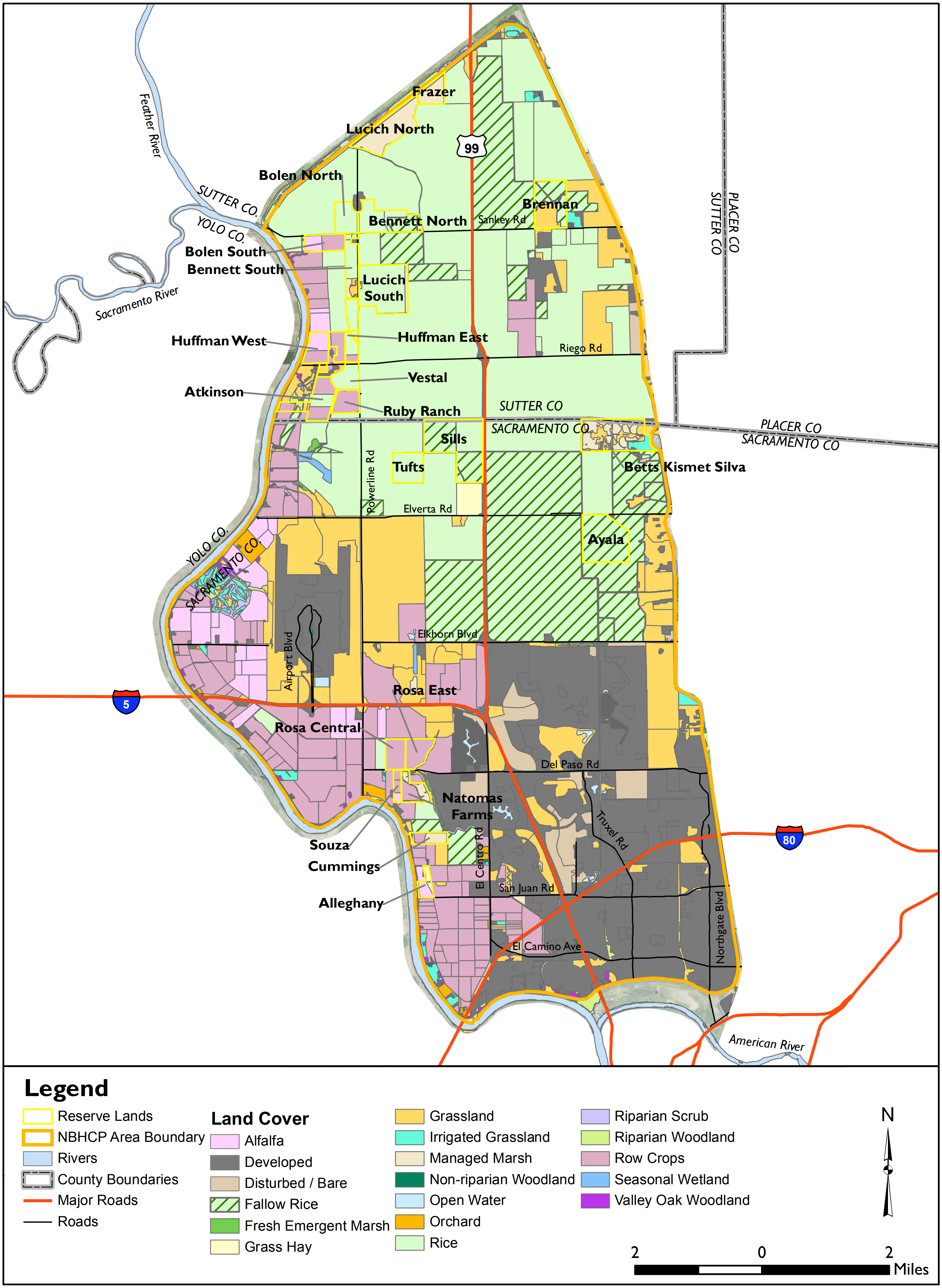
Each noxious weed occurrence observed during the field surveys was recorded; the level of infestation was recorded in five cover/distribution categories.

- T = Trace (rare): less than 1% cover.
- L = Low (occasional plants): 1–5% cover.
- M = Moderate (scattered plants): 5–25% cover.
- H = High (fairly dense): 25–75% cover.
- D = Dense (dominant): more than 75% cover.

2.3 Results

2.3.1 Land Cover Types Basin-Wide

The acreages of each land cover type mapped in the Basin from 2004 to 2006 are listed in Table 2-1. The distribution of these types is shown in Figure 2-1 (several land cover types have been combined in the figure for clearer representation). The major land cover types providing habitat for covered species in the basin, namely upland agricultural lands, ricelands, and wetlands, are shown in Table 2-2, along with the proportion of the Basin comprised by each type. Rice agriculture continues to dominate the landscape, accounting for 42% of the total area in the Basin, the same proportion as in 2005. The area of developed land increased: 25% of the Basin landscape is developed, compared with 23.7% that was developed in 2005, an increase of 667 acres (270 hectares). Fifteen percent of the Basin was in upland agriculture (alfalfa, row and grain



Jones & Stokes

Figure 2-1
Distribution of Vegetation Types in the Natomas Basin, 2006

crops, and other hay crops) in 2006, a similar proportion to that of 2005. Wetlands remain a small proportion of the Basin at 1.6% of the landscape.

Table 2-1. Basin-Wide Extent (acres) of Mapped Land Cover Types, 2004–2006

Land Cover Type	2004	2005	2006
Rice (not included in total)	*	*	14,782
Fallow Rice (not included in total)	*	*	7,998
Total Ricelands	23,337	22,653	23,165
Alfalfa	610	931	1,356
Irrigated Grassland	776	452	374
Grass Hay	158	178	153
Wheat	215	1,824	2,375
Milo	88	0	328
Tomatoes	93	50	145
Sunflower	0	709	572
Safflower	0	886	532
Other Row and Grain Crops	6,312	2,537	582
Fallow Row and Grain Crop	726	1,293	2,147
Orchard	173	184	184
Fresh Emergent Marsh (Created)	538	575	590
Fresh Emergent Marsh	138	138	154
Seasonal Wetland	105	105	105
Grassland (Created)	42	49	71
Nonnative Annual Grassland	7,475	7,389	6,786
Ruderal	330	329	406
Valley Oak Woodland	157	191	195
Riparian Woodland	331	348	346
Riparian Scrub	120	117	117
Non-riparian Woodland	98	52	50
Open Water	297	352	324
Developed – Low Density	1,383	1,565	1,639
Developed – High Density	9,234	9,859	10,764
Disturbed/Bare	1,470	1,440	1,127
Total	**54,206**	**54,206**	**54,203**

* Fallow and active rice fields were not distinguished in 2004 and 2005

Table 2-2. Basin-Wide Summary of Major Habitat Types, 2004–2006

	2004		2005		2006	
Habitat Type	Acres	Percent of Basin	Acres	Percent of Basin	Acres	Percent of Basin
Total Rice Lands	23,337	43.1	22,653	41.8	22,780	42.0
Wetlands	781	1.4	818	1.5	850	1.6
Upland Agriculture	8,819	16.3	8,681	16.0	8,412	15.5
Developed	12,087	22.3	12,864	23.7	13,531	25.0
Other	9,181	16.9	9,189	17.0	8,633	15.9
Total	**54,205**	**100.0**	**54,205**	**100.0**	**54,206**	**100.0**

Natural vegetation constitutes an extremely small proportion of the Basin and did not change significantly from 2005 to 2006. Tree- and shrub-dominated vegetation (valley oak woodland, riparian woodland, and riparian scrub) encompasses approximately 650 acres (263 hectares), slightly more than 1% of the land area in the Basin. The small area of terrace grassland on the eastern edge of the Basin was not differentiated from the nonnative annual grassland category, although this area includes some remnant valley floor grassland.

2.3.2 Land Cover Types on Reserves

The total acreages of each land cover type mapped on reserve lands from 2004 to 2006 are shown in Table 2-3; the major land cover types providing habitat for covered species on reserve lands—wetlands, upland agricultural lands, and ricelands—are shown in Table 2-4, along with the proportion of reserve lands comprised by each type. The total acreage differs from the 2005 total because of the acquisition of the Vestal Reserve, which added 95 acres (38 hectares) of riceland to the reserve lands total.

Table 2-3. On-Reserve Extent (acres) of Mapped Land Cover Types, 2004–2006

Land Cover Type	2004	2005	2006
Rice (not included in total)	1,803	1,659	1,193
Fallow Rice (not included in total)	95	274	828
Total Rice Lands	1,898	1,933	2,021
Alfalfa	64	102	102
Irrigated Grassland	37	37	37
Grass Hay	129	19	19
Wheat	129	206	487
Milo	80	0	0
Tomatoes	53	0	0
Sunflower	0	0	0
Safflower	0	0	0
Other Row Crops	1	10	156
Fallow Row Crop	25	532	82
Fresh Emergent Marsh (Created)	519	556	556
Fresh Emergent Marsh	2	2	2
Seasonal Wetland	6	6	6
Grassland (Created)	39	45	67
Nonnative Annual Grassland	311	271	282
Ruderal	44	44	29
Valley Oak Woodland	5	6	7
Riparian Woodland	11	13	13
Riparian Scrub	3	3	5
Non-riparian Woodland	1	1	1
Open Water	0	0	1
Developed – Low Density	6	6	5
Developed – High Density	28	14	13
Disturbed/Bare	0	0	0
Total	**3,391**	**3,805**	**3,891**

Table 2-4. On-Reserve Summary of Major Habitat Types, 2004–2006

	2004		2005		2006	
Habitat Type	Acres	Percent of Reserve Lands	Acres	Percent of Reserve Lands	Acres	Percent of Reserve Lands
Total Rice Lands	1,898	56.0	1,933	50.8	2021	51.9
Wetlands	527	15.5	564	14.8	564	14.5
Upland Agriculture	389	11.5	886	23.3	863	22.2
Developed	34	1.0	19	0.5	19	0.5
Other	544	16.0	401	10.5	424	10.9
Total	**3,392**	**100.0**	**3805**	**100.0**	**3,902**	**100.0**

The total acreage of wetlands on reserve lands was the same as in 2005 because no new wetlands were constructed in 2006. The proportion of upland agriculture on reserve lands was similar to the 2005 figure, accounting for approximately 22% of reserve lands in 2006. The acreage in alfalfa on reserve lands did not change in 2006, remaining at 102 acres (41 hectares) or approximately 3% of reserve lands. In 2006, ricelands on reserves increased by 88 acres (36 hectares) as a result of acquisition of new reserve lands.

Table 2-5 provides a summary of the major habitat types on reserve lands as a proportion of those habitats in the entire Natomas Basin. The proportion of wetlands on reserves has remained relatively constant, with approximately two-thirds of the Basin's wetlands occurring on TNBC reserves. Rice on TNBC reserves accounts for 8.9% of the rice in the Basin, which is similar to the 2005 figure. The proportion of the Basin's upland agriculture on reserves remained at approximately 10% in 2006.

Table 2-5. On-Reserve Extent of Major Habitat Types as a Proportion of Each Habitat Type in the Basin, 2004–2006

	2004			2005			2006		
Habitat Type	Reserve Acres	Basin Acres	% of Habitat on Reserves	Reserve Acres	Basin Acres	% of Habitat on Reserves	Reserve Acres	Basin Acres	% of Habitat on Reserves
Total Rice Lands	1,898	23,337	8.1	1,933	22,653	8.5	2,021	22,780	8.9
Wetlands	527	781	67.5	564	818	68.9	564	850	66.4
Upland Agriculture	389	8,819	4.4	886	8,681	10.2	863	8,412	10.3
Developed	34	12,087	0.3	19	12,864	0.1	19	13,531	0.1
Other	544	9,181	5.9	401	9,189	4.4	424	8,633	4.9
Total	**3,392**	**54,205**	**6.3**	**3,803**	**54,205**	**7.0**	**3,891**	**54,206**	**7.2**

Baseline Surveys on New Reserves

Vestal

Land Cover Type Mapping

Three land cover types were mapped on the Vestal Reserve. These land cover types and associated acreages are shown below.

Rice	92.4
Valley Oak Woodland	1.1
Open Water	1.1
Total	94.6

The reserve consists primarily of one rice field, which was in cultivation in 2006. Small areas of other land cover types were mapped around the perimeter of the rice field.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve, and suitable habitat is not present for any covered plant species. Twenty-two plant species were recorded on the reserve, of which just over half are nonnative species.

Noxious Weed Surveys

A few yellow star-thistle plants were observed on the levee roads around the perimeter of the reserve. This plant was localized in extent, does not appear to be strongly invasive on the reserve, and is likely to be kept in check by ongoing cultivation.

Annual Monitoring on Existing Reserves

Land Cover Type Mapping

The acreages of each mapped land cover type on each reserve for 2004–2006 are listed in Table 2-6.

Table 2-6. Reserve Lands: Extent (Acres) of Each Land Cover Type, 2004–2006

Reserve/Habitat	2004	2005	2006
Alleghany			
Alfalfa	–	27.1	27.1
Grass hay	–	18.9	189
Wheat	46.0	–	–
Ruderal	1.9	1.9	1.9
Valley oak woodland	1.9	1.9	1.9
Developed/roads	0.5	0.5	0.5
Atkinson			
Rice	145.6	48.9	44.4
Grass hay	–	–	9.5
Grassland (created)	–	–	20.8
Wheat	–	21.4	–
Milo	21.3	–	–
Other row crops	–	9.7	52.3
Fallow row crop	21.0	108.0	70.3
Fresh emergent marsh	0.1	0.1	0.1
Seasonal wetland	0.1	0.1	0.1
Nonnative annual grassland	0.9	0.9	0.9
Ruderal	3.6	3.6	3.6
Valley oak woodland	1.1	1.1	1.1
Riparian woodland	9.6	9.6	9.6
Riparian scrub	2.1	2.1	2.1
Developed/roads	0.7	0.7	0.7
Ayala			
Rice	317.3	317.3	–
Fallow rice	–	–	317.3
Developed/roads	0.1	0.1	0.1
Bennett North			
Rice	213.4	213.4	146.5

Reserve/Habitat	2004	2005	2006
Fallow rice (to facilitate marsh construction)	–	–	67.0
Fresh emergent marsh (created)	7.1	7.1	7.0
Grassland (created)	1.6	1.6	1.5
Ruderal	3.3	3.3	3.3
Riparian scrub	Not mapped	Not mapped	0.2
Developed/roads	2.2	2.2	2.2
Bennett South			
Rice	82.9	–	82.9
Fallow rice (to allow field leveling)	–	82.9	–
Fresh emergent marsh (created)	17.0	17.0	16.8
Grassland (created)	20.6	21.1	21.1
Ruderal	1.6	0.8	0.8
Riparian scrub	Not mapped	0.6	0.6
Open water	0.2	0.2	0.2
Developed/roads	6.7	6.7	6.7
Betts Kismat Silva			
Irrigated grassland	37.1	37.1	37.1
Fresh emergent marsh (created)	140.3	140.3	140.3
Seasonal wetland	0.5	0.5	0.5
Nonnative annual grassland	151.8	151.8	150.3
Riparian woodland	0.1	1.1	1.1
Riparian scrub	0.6	0.6	0.6
Nonriparian woodland	0.9	0.9	0.9
Developed/roads	5.9	5.9	5.9
Bolen North			
Rice	–	–	105.7
Fallow rice (to allow field leveling)	–	105.7	–
Bolen South			
Fallow row and grain crops	–	103.1	–
Wheat	–	–	103.1
Valley oak woodland	–	0.7	0.7
Brennan			
Rice (organic)	69.7	75.8	–
Fallow rice (for weed control)	36.7	73.8	149.4
Fresh emergent marsh	1.6	1.6	1.6
Seasonal wetland	1.6	1.6	1.6
Nonnative annual grassland	128.2	85.2	87.1
Ruderal	2.0	2.0	–
Riparian woodland	0.7	0.7	0.7

Reserve/Habitat	2004	2005	2006
Developed/roads	0.7	0.7	0.7
Cummings			
Other row and grain crops	0.9	–	–
Fallow row and grain crop	62.2	17.8	–
Wheat (hay crop)	–	–	17.8
Fresh emergent marsh (created)	–	37.2	37.2
Grassland (created)	–	5.3	5.3
Nonnative annual grassland	1.92	4.7	4.7
Ruderal	0.6	0.6	0.3
Valley oak woodland	1.2	1.2	1.2
Riparian scrub	–	–	0.3
Frazer			
Fresh emergent marsh (created)	74.5	74.5	74.5
Grassland (created)	7.3	7.3	7.3
Nonnative annual grassland	–	–	10.6
Ruderal	10.6	10.6	–
Huffman East			
Rice	120.6	105.9	105.9
Fallow row and grain crops	–	14.8	–
Wheat	–	–	14.8
Huffman West			
Alfalfa	63.7	63.7	63.7
Milo	58.6	–	–
Tomatoes	53.5	–	–
Wheat	–	112.1	106.9
Developed/roads	0.6	0.6	–
Lucich North			
Fresh emergent marsh (created)[1]	223.8	223.8	223.8
Seasonal wetland	3.5	3.5	3.5
Nonnative annual grassland	23.7	23.7	23.7
Ruderal	10.7	10.7	10.7
Lucich South			
Rice	333.6	333.6	333.6
Fresh emergent marsh (created)	21.2	21.2	21.2
Seasonal wetland	0.2	0.2	0.2
Ruderal	3.3	3.3	3.3
Developed/road	0.2	0.2	0.2
Natomas Farms			
Wheat	43.6	43.6	44.0
Fresh emergent marsh (created)	35.2	35.2	35.2

Reserve/Habitat	2004	2005	2006
Grassland (created)	9.2	9.2	10.6
Nonnative annual grassland	4.4	4.4	4.1
Ruderal	3.0	3.0	1.5
Valley oak woodland	0.9	0.9	0.9
Developed/roads	0.2	0.2	0.2
Rosa Central			
Fallow row and grain crops	–	97.3	–
Wheat	–	–	97.3
Rosa East		–	–
Fallow row and grain crops	–	103.5	–
Wheat	–	–	103.5
Valley oak woodland	–	0.2	0.2
Riparian woodland	–	1.4	1.4
Ruby Ranch			
Rice	87.1	–	–
Other row and grain crops	–	87.1	87.1
Ruderal	3.5	3.5	3.5
Developed/roads	0.4	0.4	0.4
Sills			
Rice	432.4	419.3	136.7
Fallow rice (to allow field leveling)	–	11.9	294.5
Grass hay	128.9	–	–
Developed—high density	15.3	0.9	0.9
Souza			
Alfalfa	–	10.7	10.7
Wheat	39.0	28.4	–
Other row and grain crops	–	–	16.4
Fallow row and grain crops	–	–	12.0
Ruderal	0.2	0.2	0.2
Nonriparian woodland	0.3	0.3	0.3
Developed/roads	0.3	0.3	0.3
Tufts			
Rice	–	145.1	145.1
Vestal			
Rice	–	–	92.4
Valley oak woodland	–	–	1.1
Open water	–	–	1.1

[1] This total includes approximately 24 acres of upland habitat on berms in patches that were too small to map individually.

Few significant changes were noted in land cover types on reserves; the major changes from 2005 to 2006 were changes in the type of agriculture that resulted from the conversion of rice fields to upland agriculture and the rotation of upland agriculture crops. In addition, a large proportion of the rice on Sills was fallowed in 2006 for field leveling operations; a smaller area on Bennett North was also fallowed in 2006 to facilitate planned marsh construction. On Bolen North, the rice field that was fallowed in 2005 for field leveling operations was in production in 2006.

The managed marsh on Cummings continued to develop, with dense growth of tule and cattails covering much of the marsh area. On BKS and Bennett South, the planted riparian shrubs are maturing into relatively dense riparian scrub; this type was mapped as such in 2006.

Noxious Weeds Surveys

Noxious weed occurrences recorded from 2004 to 2006 are summarized in Table 2-7. No new noxious weed occurrences were noted in 2006. Generally there was little change in species or numbers of occurrences since 2005. In part this is because the noxious weed occurrences on many reserves are localized, do not appear to be strongly invasive, and are kept in check by ongoing cultivation. In some cases, active management is successfully controlling noxious plants. These management activities have targeted plant species that are known to or are very likely to become invasive and that are considered locally to be particularly invasive and/or difficult to control. Specific examples are giant reed on BKS, perennial pepperweed on BKS and Cummings, Himalayan blackberry on several reserves, and joint grass on BKS. The increased levels of grazing by both cattle and goats on the nonnative annual grasslands at BKS appear to be reducing the levels of yellow star-thistle, which had increased in density and abundance between 2004 and 2005. Chemical control activities conducted on the BKS reserve to control the spread of perennial pepperweed have not eliminated this species, but have likely prevented further spread.

Table 2-7. Noxious Weed Occurrences[1] on TNBC Reserve Lands

Reserve	Noxious Weed Species	2004	2005	2006
Bolen North	Perennial pepperweed	–	1, M	1,L
	Himalayan blackberry	–	1, T	1,T
Bolen South	Himalayan blackberry	–	5, L-H	5,l
Rosa	Himalayan blackberry	–	5, L-D	5, L-M
	Perennial pepperweed	–	3, T-M	3, T-L
	Sweet fennel	–	1, L	1,L
	Poison hemlock	–	1, H	1,M
Tufts	Yellow star-thistle	–	1, M	1,M
Alleghany	Sweet fennel	1, T	1, T	1, T

Reserve	Noxious Weed Species	2004	2005	2006
	Edible fig	1, T	1, T	1, T
	Himalayan blackberry	1, D	1, D	1, D
Atkinson	Edible fig	1, T	1, T	1, T
	Perennial pepperweed	3, M-H	3, M-H	3, M-H
	Himalayan blackberry	1, H	1, H	1, H
Bennett North	Yellow star-thistle	2, L	1, L	1, L
Bennett South	Bull thistle	1	none	none
	Yellow star-thistle	1, L-M	2, L-M	2, L-M
Betts-Kismat-Silva	Bull thistle	1	none	
	Yellow star-thistle	L-M	L-H	L-H
	Perennial pepperweed	T	T	T
	Giant reed	L	L	L
	Italian thistle	1, T	1, T	none
	Pennyroyal	L-M	L-M	L-M
	Catalpa	One tree	One tree	One tree
	Tree-of-heaven	1, M	1, M	1, M
	Himalayan blackberry	D	D	D
Brennan	Yellow star-thistle	3, L-D	8, L-D	Not surveyed
	Himalayan blackberry	D	D	
	Edible fig	1, T	1, T	
	Black locust	1, T	1, T	
Cummings	Himalayan blackberry	1, M	1, M	1, M
	Sweet fennel	1, T	1, T	1, T
	Perennial pepperweed	1, L-M	1, L-M	1, L
Frazer	Yellow star-thistle	1, H	1, H	2, L-H
Huffman East	Yellow star-thistle	1, L-H	7, L-H	7, L-M
	Himalayan blackberry	1,M	1, M	1, M
Huffman West	Yellow star-thistle	present	none	none
	Sweet fennel	none	2, T	2, T
Lucich North	Yellow star-thistle	present	10, L-H	10, L-H
	Perennial pepperweed	present	3, H	3, H
	Bull thistle	1, T	none	none
Lucich South	Yellow star-thistle	1	3, M	3, M
	Bull thistle	none	1, T	none
Natomas Farms	Sweet fennel	1, L	1, L	1, L
	Himalayan blackberry	1, M	1, M	1, L
Ruby Ranch	Yellow star-thistle	1, T	1, T	1, T

Reserve	Noxious Weed Species	2004	2005	2006
Sills	Yellow star-thistle	present	none	none
Souza	English ivy	1, D	1, D	1, M
Vestal	Yellow star-thistle	–	–	3,T

[1] Occurrences are listed by the number of occurrences on each reserve, followed by the level of infestation, as shown below:

T = Trace (rare): less than 1% cover.
L = Low (occasional plants): 1–5% cover.
M = Moderate (scattered plants): 5–25% cover.
H = High (fairly dense): 25–75% cover.
D = Dense (dominant): more than 75% cover.

Floristic Surveys

No covered plant species were recorded on TNBC reserves in 2006.

2.4 Discussion

2.4.1 Land Cover Types Basin-Wide

Changes in the distribution and abundance of vegetation and habitat types across the Basin from 2005 to 2006 were relatively minor. The total area of ricelands remained constant at 42% of the Basin; however, in 2006, 7,998 acres (3,237 hectares) of the ricelands, more than one-third of the total, were fallow, a significant change from 2005. The largest changes were the increase in developed acres (from 23.7% to 25.0% of the Basin) and the associated loss of nonnative annual grassland (Tables 2-1 and 2-2). Upland agriculture decreased by 269 acres (109 hectares) in 2006. The area of land planted in alfalfa, an important habitat type for Swainson's hawk, continued to increase, with an additional 426 acres (172 hectares) in 2006. The total extent of grasslands, wetlands, and native woodlands and scrub remained relatively unchanged from 2004 to 2005.

2.4.2 Land Cover Types on Reserves

Habitats on TNBC reserve lands are important components of the habitat landscape throughout the Basin. Created wetlands (managed marsh) on TNBC reserves provide important habitats for a number of covered species, account for approximately two-thirds of the wetlands in the entire Basin, and are consequently an extremely important component of the mosaic of Basin-wide habitats.

Rice and upland agriculture are the other two most important habitat types for Covered Species in the Basin. In 2006, ricelands on reserves increased by 88 acres (36 hectares) as a result of new reserve acquisition; ricelands on TNBC lands comprised 10.4% of the Basin-wide total, a similar proportion to 2005. Upland agriculture (grain and row crops, alfalfa, and other hay crops, and fallow upland fields) on reserve lands accounted for 10% of the upland agriculture in the Basin, a similar proportion to 2005.

Floristic Surveys

A cumulative total (2004–2006) of 381 plant species from 71 families have been recorded on reserve lands. Nonnative species account for more than half (55%) of this list. Approximately two-thirds of the species were dicotyledons and one-third were monocotyledons; the two groups included similar proportions of nonnative species. The five most common families have remained unchanged from 2005: the most common family was the grass family (Poaceae) with 77 species (20% of the total), followed by the sunflower family (Asteraceae) with 51 species (13%), the bean family (Fabaceae) with 22 species, and the mustard family (Brassicaceae) with 19 species. Three additional families are represented by more than 10 species each: the sedge family (Cyperaceae), the figwort family (Scrophulariaceae), and the dock family (Polygonaceae).

Species richness of the flora of each reserve was correlated with the size of the reserve and the diversity of habitat types. Large reserves with aquatic habitats (e.g., BKS and Lucich North) had the highest number of plant species, while smaller reserves with a high proportion of upland agriculture (e.g., Souza and Alleghany) generally had the lowest number of plant species.

Noxious Weeds

The majority of noxious weeds that occurred on reserves were widespread plants common in agricultural habitats in the Central Valley. Occurrences typically comprised small patches with low to moderate levels of infestations. No new noxious weed species were recorded in 2006 on reserves that had been surveyed in 2005.

For most of the noxious weed species occurrences recorded in 2005, no changes in extent or density were observed on reserves, a result of control in the course of agricultural activities; low invasiveness of some of the species; or active control methods successfully reducing or controlling infestations of some species, such as giant reed, Himalayan blackberry, and perennial pepperweed. The following discussion highlights the significant changes that were observed.

Perennial pepperweed is considered an aggressive invader of wetlands in California (Bossard et al. 2000; U.S. Geological Survey 2000; Renz undated). Once established—typically in moist habitats such as wetland perimeters and riparian areas—it forms dense monospecific stands that exclude other plants (U.S. Geological Survey 2000). Chemical control of perennial pepperweed was initiated in late 2004 on the BKS Reserve. Surveys conducted in 2006 indicate that small quantities of this plant are concentrated along the marsh/upland interface where control is especially difficult to achieve. However, this plant did not appear to increase significantly in 2006, suggesting that control efforts to date have been at least partially successful; complete eradication is very time consuming and difficult to achieve.

Yellow star-thistle displaces native plants, depletes soil moisture, and can interfere with livestock grazing (Bossard et al. 2000). Yellow star-thistle appeared to decrease in extent and vigor on BKS, where an increase had been noted in 2004–2005. This is likely due to increased grazing by cattle and goats throughout the upland portions of the reserve.

Himalayan blackberry, which is potentially invasive in riparian areas and sites with perennially moist soils, appears to be decreasing in response to management activities on the reserves where it occurs.

Jointgrass is of management concern locally and was targeted later in the 2005 growing season on the BKS Reserve. Further monitoring will be necessary to determine the effectiveness of this treatment.

Pacific bentgrass, a nonnative grass species that may have the potential to become invasive, was recorded for the first time in 2005 on several reserves in the northern and western portions of the Basin. This wetland grass has recently been documented as invasive in San Diego County (Zedler and Black 2004), where the initial invasion occurred in disturbed sites; however, once established, it appeared capable of invading undisturbed vernal pool systems. Surveys in 2006 indicated that this grass did not increase significantly during the 2006 growing season.

Management of aquatic weeds became a paramount issue in 2006, primarily because of the need to maintain open water habitat values for giant garter snake. The primary issues were the explosive growth of water primrose and the invasion by cattails of open water channels in managed marsh complexes. To a lesser degree, waterfern and hornwort, aquatic plants that can impede water flow, were also of management concern.

Water primrose is a perennial aquatic plant that roots along the shoreline and in shallow water and grows out across the water surface where it can form dense mats several inches deep. On some areas of marsh, it covered 100% of the water surface. Water primrose is of growing concern in central and northern California, and research is focusing on developing effective control methods. The taxonomy and identification of water primrose in California is unresolved at this time; further research is focusing on clarifying which species or subspecies are invasive because specific identity may be a factor in applying appropriate control methods as different taxa may respond differently to treatments (Grewell 2007). A preliminary trial to investigate potential treatments of severe water primrose infestations on the Frazer reserve began in 2006 and showed promising results.

Marsh maintenance activities required in the NBHCP, including dredging of open water channels, were conducted on the Natomas Farms, Bennett South, and Lucich North Reserves. Minor marsh enhancements, in the form of the addition of more steep-sided banks, were installed concurrently. Maintenance and enhancement activities will continue on the Bennett South and Lucich North Reserves in 2007.

On the Natomas Farms Reserve, an experiment was conducted to test the efficacy of two alternative management techniques to remove cattails that had invaded open water channels. In one cell, the channel was dredged, while herbicide control was used on another cell. Preliminary results indicate that the dredging technique was significantly more effective at removing cattails from the open water channel and creating and maintaining open water channels.

Monitoring of water primrose on managed marshes on TNBC lands and its responses to applied control methods should continue; the results achieved on TNBC lands will clearly be important for the future management of TNBC managed marshes and could have broader significance regionally.

2.5 Effectiveness

Biological effectiveness as it pertains to habitat management is measured on the basis of successful implementation of habitat management recommendations outlined in the NBHCP and developed by species and vegetation management experts to maintain and enhance habitats for covered species.

As discussed above, several management actions were initiated to control noxious weeds and invasive aquatic plants. Control of perennial pepperweed is an ongoing problem, but continuing chemical control efforts appear to be effectively preventing the continued expansion of this species. Cattle and goat grazing has been highly effective at controlling Himalayan blackberry and yellow star-thistle. Dredging to remove cattails invading open water habitats appears to be more effective than herbicide applications and was successfully implemented on the Natomas Farms reserve. As noted above, initial experimental trials to control water primrose and other aquatic weeds show significant promise. In all cases, monitoring should continue to document the effectiveness of management actions to control vegetation.

2.6 Recommendations

- Continue to monitor the distribution and abundance of noxious weeds on reserve sites, with a particular focus on aquatic weeds (e.g., water primrose, cattail, waterfern, and hornwort) where they may be compromising water and habitat management efforts for covered species.

- Institute a training program to ensure that all TNBC personnel, consultants, and contractors can identify perennial pepperweed and establish a rapid reporting system to ensure that new occurrences are reported immediately so that management action can be taken before the species becomes established.
- Institute a reporting and documentation program to track the timing and effectiveness of management actions to control noxious weeds and invasive aquatic plants.
- Document the methods used to treat noxious weed infestation on all reserves, and monitor their effectiveness over time to develop successful weed management protocols specific to TNBC reserves.
- Continue efforts to contain or eradicate perennial pepperweed on Atkinson, Cummings, and Lucich North and monitor the success of treatment at BKS.
- Continue to monitor the effectiveness of grazing to control yellow star-thistle.
- Continue to monitor the spread of jointgrass at Frazer and Lucich North and consider treatment; continue to monitor the eradication efforts at BKS to assess effectiveness of the methods used.

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Chapter 3
Giant Garter Snake

3.1 Introduction

3.1.1 Background

The NBHCP and its Implementing Agreement require that an annual survey of giant garter snake be conducted throughout the Basin (Chapter VI, Section E [2][a][2] of the 2003 NBHCP). An annual assessment of canals and ditches that provide connectivity between giant garter snake habitats is also required (Chapter VI, Section E [2][a][5]) of the 2003 NBHCP). In compliance with the conditions described in the NBHCP, this chapter documents the results of monitoring efforts for giant garter snake in the Basin.

Surveys conducted from 2001 to 2003 by the U.S. Geological Survey (USGS) emphasized the collection of distribution and demographic information needed to guide the conservation and management of giant garter snake under the NBHCP (Wylie and Casazza 2000, 2001; Wylie et al. 2000; Wylie and Martin 2002; Wylie et al. 2003; Wylie et al. 2004). Beginning in 2004, surveys have been conducted using a more standardized and comprehensive protocol (Jones & Stokes 2005a). The information collected by USGS has been incorporated into this report where appropriate (Wylie and Casazza 2000, 2001; Wylie et al. 2004).

3.1.2 Goals and Objectives

Monitoring efforts were conducted in accordance with protocols developed to meet the goals and objectives of the NBHCP. The main objectives of the giant garter snake monitoring effort as described in the NBHCP are listed below.

- To evaluate whether the conservation objectives of the NBHCP are being met.
- To detail the progress of NBHCP implementation with respect to giant garter snake and the wetland reserve system.
- To evaluate the habitat potential of mitigation lands proposed for acquisition.

- To aid in decision making for improving and adapting reserve design and management to better meet the needs of giant garter snake.

This monitoring effort employs a strategy for addressing giant garter snake presence and abundance, while simultaneously collecting the data necessary for more focused ecological studies in a standardized, repeatable fashion. Habitat characteristics are measured at each trap location to provide information necessary to improve habitat restoration efforts and facilitate adaptive management.

3.1.3 Life History

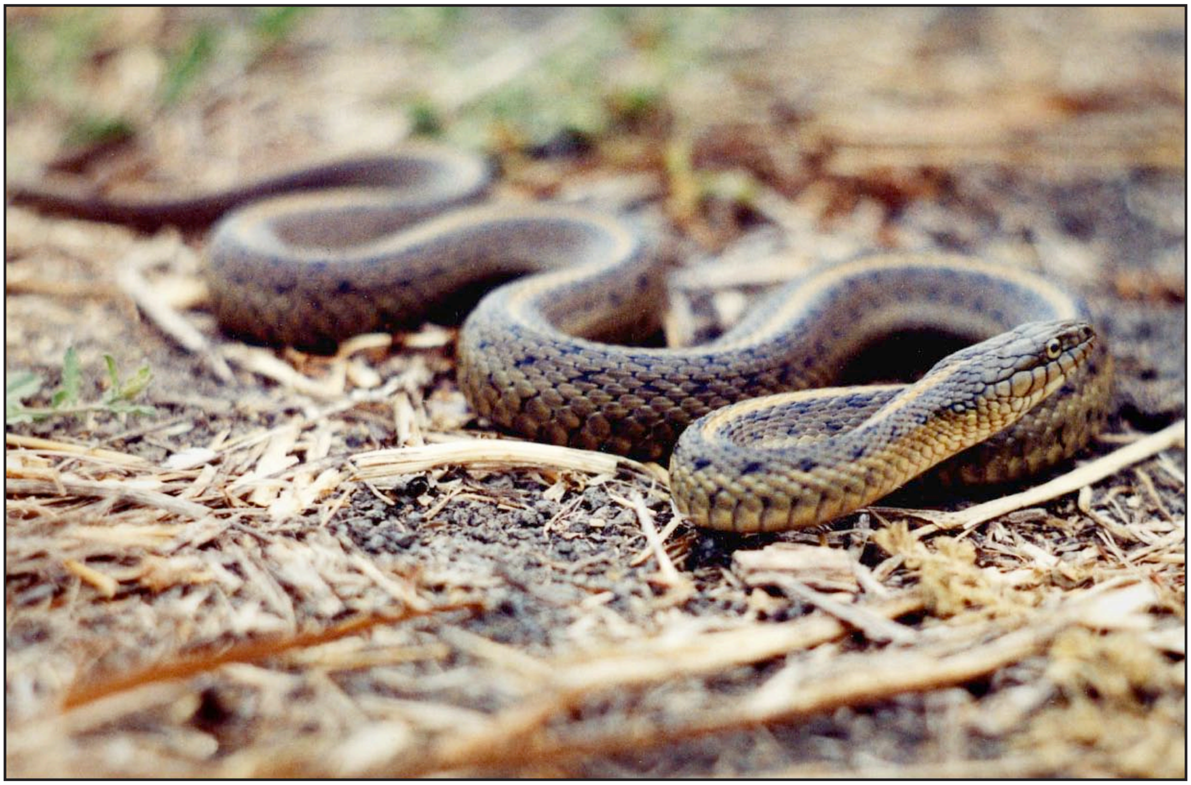
Giant garter snake is an aquatic species endemic to the Great Central Valley of California. Described as among California's most aquatic garter snakes (Fitch 1940), giant garter snakes are associated with low-gradient streams and valley floor wetlands and marshes, and have adapted successfully to rice agriculture. Giant garter snake is one of the largest species in the genus *Thamnophis*. A sexually dimorphic species, females can exceed lengths of 1 meter (39.37 inches) and weights of 0.9 kilogram (1.98 pounds), while proportionately smaller males are slightly shorter and seldom exceed 0.25 kilogram (0.55 pound).

Status and Range

Giant garter snake (Figure 3-1) was listed by DFG as threatened on June 27, 1971, under the California ESA and by USFWS on October 20, 1993, under the federal ESA (58 FR 54053). The species is considered vulnerable by the World Conservation Union (IUCN) (Baillie 1996).

The Natomas Basin supports one of the 13 extant giant garter snake subpopulations recognized by USFWS (U.S. Fish and Wildlife Service 1999). USFWS states that protection of the giant garter snake population in Natomas Basin is a *Priority 1* recovery task, defined as "an action, which must be taken to prevent extinction or to prevent a species from declining irreversibly" (U.S. Fish and Wildlife Service 1999). Documented occurrences of giant garter snakes in the Natomas Basin prior to 2004 have been collected from a variety of sources, including the California Natural Diversity Database (CNDDB), monitoring and project reports, and published and unpublished notes and reports. The distribution of these occurrences is shown in Figure 3-2.

Giant garter snake once ranged throughout the wetlands of California's Central Valley from Buena Vista Lake near Bakersfield in Kern County to the vicinity of Chico in Glenn and Colusa Counties (Hansen and Brode 1980). The species appears to have been extirpated from the San Joaquin Valley south of Mendota in Fresno County (Hansen and Brode 1980; Rossman and Stewart 1987; Stebbins 2003). The current known distribution is patchy, extending from near Chico in Butte County to Mendota Wildlife Area in Fresno County.



Giant Garter Snake

Figure 3-1
Giant Garter Snake

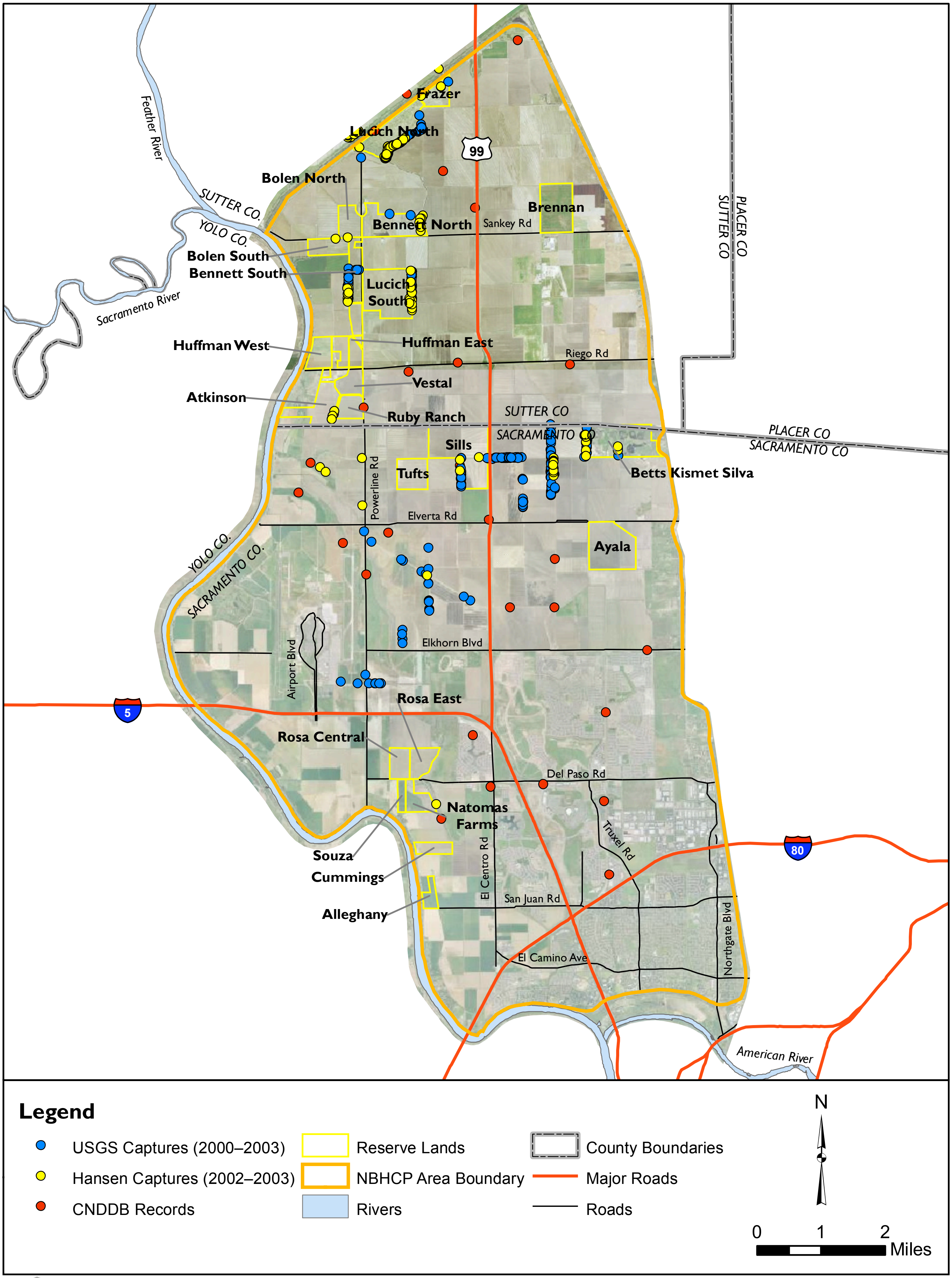


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Figure 3-2
Historical Occurrences of Giant Garter Snake in the Natomas Basin

Loss or degradation of aquatic habitat resulting from agricultural and urban development is the primary cause of the species' decline. Other contributing factors include predation of juvenile giant garter snakes by introduced predators, elimination of prey species by pesticides, road mortality, and maintenance and modification of agricultural water conveyance and reclamation infrastructure.

Habitat Use

Habitats occupied by giant garter snakes contain permanent or seasonal water, mud bottoms, and vegetated dirt banks (Fitch 1940; Hansen and Brode 1980). Prior to reclamation, these wetlands probably consisted of freshwater marshes and low-gradient streams. In some rice-growing areas, giant garter snakes have adapted well to vegetated, artificial waterways and the rice fields they supply (Hansen and Brode 1993).

Giant garter snakes are associated with aquatic habitats characterized by the following features.

- Sufficient water during the snake's active season (typically early spring through mid-fall) to supply cover and food such as small fish and amphibians.
- Emergent herbaceous wetland vegetation such as cattails and bulrushes accompanied by vegetated banks, which together provide basking, foraging, and escape cover during the active season.
- Upland habitat (e.g., bankside burrows, holes, and crevices) to provide short-term refuge areas during the active season.
- High ground or upland habitat above the annual high water mark to provide cover and refuge from flood waters during the dormant winter period (Hansen and Brode 1980; Hansen 1998).

The species appears to be absent from most permanent waters that support established populations of predatory game fishes; from streams and wetlands with sand, gravel, or rock substrates; and from riparian woodlands lacking suitable basking sites, prey populations, and cover vegetation (Hansen 1980; Rossman and Stewart 1987; Brode 1988; U.S. Fish and Wildlife Service 1999). The species also appears to be absent from natural or artificial waterways that undergo aggressive mechanical or chemical weed control or compaction of bank soils (Hansen 1988; Hansen and Brode 1993).

In the Central Valley, rice fields have become important habitat for giant garter snakes. Irrigation water typically enters the ricelands during April along canals and ditches. Giant garter snakes use these canals and their banks as permanent habitat both for spring and summer active behavior and for winter hibernation. Where these canals are not regularly maintained, lush aquatic, emergent, and streamside vegetation develops prior to the snakes' spring emergence. This vegetation, in combination with cracks and holes in the soil, provides much-needed cover during spring emergence and throughout the remainder of the summer active period.

Rice is planted during the spring after the winter fallow fields have been cultivated and flooded with several inches of standing water. In some cases, giant garter snakes move from the canals and ditches into these rice fields soon after the rice plants emerge above the water's surface, and continue to use the fields until the water is drained during late summer or fall (Hansen and Brode 1993). While in the rice fields, the snakes forage in the shallow warm water for small fish and the larvae of bullfrogs (*Rana catesbeiana*) and treefrogs (*Pseudacris regilla*). For shelter and basking sites, giant garter snakes utilize the rice plants; small, vegetated berms dividing the rice checks; and vegetated field margins. Gravid (pregnant) females may be observed in the rice fields during the summer; and at least some giant garter snakes are born there (Hansen and Brode 1993; Hansen 1998).

Movement

Giant garter snakes are strongly associated with aquatic habitats, typically overwintering in burrows and crevices near their active season foraging areas (Hansen 2004). Individuals have been noted using burrows as far as 50 meters (164 feet) from marsh edges during the active season, and retreating as far as 250 meters (820 feet) from the edge of wetland habitats while overwintering, presumably to reach hibernacula above the annual high water mark (Hansen 1986; Wylie et al. 1997; U.S. Fish and Wildlife Service 1999).

Ecological Relationships

Giant garter snakes are aquatic feeders that prey on small fishes, tadpoles, and small frogs (Hansen 1980; U.S. Fish and Wildlife Service 1999), specializing in ambushing prey underwater (Brode 1988). Historically, giant garter snakes probably preyed on native species such as thick-tailed chub (*Gila craisicauda*), Pacific treefrog, Sacramento blackfish (*Orthodon microlepidotus*), and California red-legged frog (*Rana aurora draytonii*) (which has been extirpated from the species' current range) (Cunningham 1959; Rossman et al. 1996; U.S. Fish and Wildlife Service 1999). Giant garter snakes now utilize introduced species such as small bullfrogs and their larvae, carp, and mosquitofish (*Gambusia affinis*); they are not known to consume larger terrestrial prey (e.g., small mammals or birds). Juveniles probably consume insects and other small invertebrates.

Predators of giant garter snakes include large vertebrates such as raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cinereoargenteus*), river otter (*Lontra canadensis*), opossum (*Didelphis virginiana*), Northern harrier (*Circus cyaneus*), hawks (*Buteo* sp.), herons, egrets, and American bittern (*Botaurus lentiginosus*) (U.S. Fish and Wildlife Service 1999). In areas near urban development, giant garter snakes may also fall prey to domestic or feral housecats (*Felis catus*) (Hansen pers. comm.).

3.2 Methods

3.2.1 Population Assessment

Surveys for giant garter snake were conducted throughout the Basin from the time of warming temperatures in mid-April until rice fields dried and temperatures decreased in late September. All canals, ditches, or drains within the Basin that were accessible because of either public ownership or specific right of entry were surveyed for both giant garter snake presence and habitat potential. Each year, survey effectiveness is limited to varying degrees by variable water and habitat conditions. In 2006, the areas where conditions constrained survey effectiveness were Bennett North, Bennett South, Lucich North, Natomas Farms, the Sacramento County Airport System (SCAS) Airport Operational Area (AOA), and the T Drain.

Study design combined the comprehensive visual survey and aquatic trapping methodologies applied by previous investigators, with more weight given to aquatic trapping surveys conducted in accordance with USGS methodology (Hansen and Brode 1980; Hansen 1988; Brode and Hansen 1992; Wylie et al. 2004). Sampling for giant garter snake in 2006 was conducted from April 13 to September 27.

Active Surveys

Active surveys are visual encounter surveys entailing walking or boating along linear ditches, drains, ponded areas, managed marshes, and adjacent uplands to search for basking, mating, and foraging snakes. Binoculars were used to detect wary snakes at a distance. When possible, snakes observed during these searches were captured by hand or with reptile snares to collect demographic and morphometric data. When capture was not possible, information regarding location, activity, ambient conditions, and environmental characteristics was recorded. Since 2005, active visual surveys have been conducted in three separate phases at predetermined locations and during all reconnaissance and trap-checking efforts.

Passive Surveys

Passive surveys entail the use of traps; these surveys were conducted in conjunction with active surveys. In 2006, a first set of 450 floating aquatic traps was divided into nine traplines of 50 traps each and deployed along a predetermined set of linear transects. Traps were placed at approximately 10-meter (33-foot) intervals along areas of linear aquatic habitat (canals, ditches, and drains) or the vegetation/open water interface of ponded or marshy habitat. Resulting traplines were approximately 500 meters (1,640 feet) long.

A second set of 100 traps was divided into two traplines deployed in conjunction with permeable silt fencing placed in managed marsh habitats on reserve lands. The purpose of these traplines was to test the hypothesis that drift fences would improve capture success by providing a foraging boundary similar to the boundary present in linear water conveyance features. These traplines were set in areas of open or densely vegetated shallow (≤ 1.5 meters [4.9 feet]) water without a naturally occurring foraging boundary that would direct snakes toward the traps. The resulting *drift fence* traplines were arranged with traps set on alternating sides of the fencing material at 5-meter (16.5-foot) intervals, resulting in traplines approximately 250 meters (820 feet) long.

GPS units were used to record the UTM coordinates of each trap location, and environmental characteristics, such as vegetation and substrate types, were noted for each point. Trap design and placement were modeled after methods refined by USGS (Casazza et al. 2000). Permanent reference and rotating trapping strategies were used.

The study design entailed the use of three reference traplines, six rotating traplines, and two drift fence traplines. Reference traplines are by definition left in place throughout the snakes' active season and provide critical information that rotating traplines cannot.

The Natomas Basin is subdivided by major highways into three regions: Area 1 is north of Interstate (I)-5 and west of State Route (SR)-99; Area 2 is south and west of I-5 and north of I-80; and Area 3 is east of I-5, east of SR-99, and north of I-80 (Figure 3-3). One permanent reference trapline was established in each area at sites most likely to remain viable as habitat during the term of the NBHCP permits, with emphasis placed on areas where capture and habitat history were previously documented by USGS (Figure 3-3). The Area 3 reference trapline in Snake Alley was in place for the duration of the sampling season. The Area 2 reference trapline in Fisherman's Lake was removed 1 week early following bankside mowing, which increased the vulnerability of the traps to theft or tampering. The Area 1 reference trapline in the T Drain was not set until mid-May when adequate water became available, and was moved to a nearby portion of the canal toward the end of the season due to the excessive growth of water primrose (*Ludwigia* spp.) at the original location, making the use of traps unfeasible.

The six rotating traplines were moved at set intervals across predetermined locations on both reserve and non-reserve lands throughout the Basin. When possible, locations were trapped twice to further account for seasonal variation in giant garter snake activity and movements. Emphasis was given to reserve over non-reserve lands by design and as a result of limited access to private properties throughout the Basin. Where canals or ditches were present next to managed marsh, traplines were placed in parallel (both ditch and marsh) to detect movement between these features.

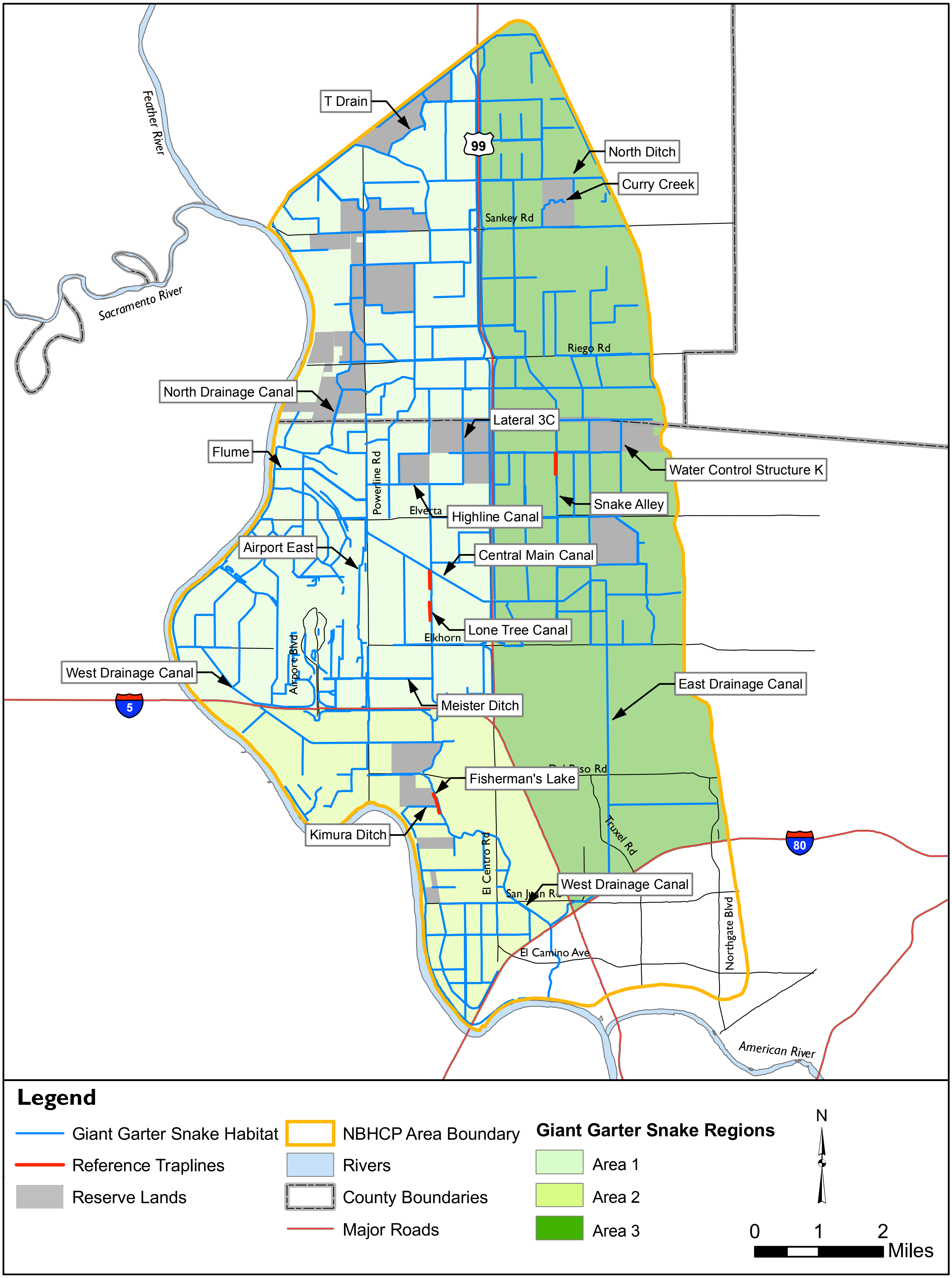

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Figure 3-3
Giant Garter Snake Habitat in the Natomas Basin, 2006

Traps used for drift fence traplines were constructed of eight-mesh hardware cloth (64 squares per square inch) rather than the standard four-mesh hardware cloth (16 squares per square inch) typically used. Little is known of newborn or juvenile giant garter snakes due to their low visual detectability and their ability to pass through coarser four-mesh traps. Newborn giant garter snakes may also die after becoming ensnared in the larger mesh (Wylie et al. 2004). Because newborn giant garter snakes cannot pass through the smaller eight-mesh cloth, this material was selected in an effort to sample for this smaller size class and to reduce the risks of mortality associated with four-mesh traps. Traps used for rotating and reference traplines were made of standard four-mesh hardware cloth for the durability needed to withstand extended periods in water, frequent transport, and resetting. All traps were checked daily.

Marking and Measuring

Weight, total length, snout-vent length (SVL), sex, scale counts and measurements on head and mid-body, and other physical features such as scars and tumors were noted for all snakes captured. Captured snakes were implanted with passive integrated transponder (PIT) tags for permanent identification. Tissue and/or blood was collected and archived for future genetic analyses. All snakes were released at their point of capture after recording the data.

Population Evaluation

Changes in the relative abundance of giant garter snakes in the Basin from year to year were evaluated on the basis of changes in the number of snakes caught, standardized by the amount of effort expended surveying for snakes (i.e., catch per unit effort). The software program CAPTURE (White et al. 1978; White et al. 1982) was used to estimate population size in discrete habitat segments on the basis of capture histories of marked individuals.

Survey Locations

Reserve Lands

Extensive sampling was conducted throughout TNBC reserves, with emphasis on managed marshes. Reserves were not sampled where aquatic habitat was not available, or where visual exposure or accessibility by the general public put traps at risk of theft or tampering that could result in unauthorized take of giant garter snakes. A rotating trapline was established in 2006 at the recently acquired Vestal Reserve. The Alleghany, Souza, Brennan, and Bolen South Reserves, and the managed marshes at Bennett South and Bennett North Reserves were not trapped, although visual surveys were conducted where aquatic habitat was present. Marsh maintenance and enhancement activities were being conducted on the Bennett South and Bennett North Reserves in 2006.

Non-Reserve Lands

Metro Air Park

Although the Metro Air Park (MAP) HCP area was sampled routinely by USGS from 2000 through 2003, all aquatic habitats within the MAP HCP area have been eliminated and the area has been fenced to prevent snakes from reentering it. However, the series of laterals and drainages collectively referred to as Lone Tree Canal (Figure 3-3) that remain outside the western edge of the MAP HCP area provide regional drainage and serve as a conduit for giant garter snakes dispersing from north to south. Accordingly, the rotating trapline previously established in Lone Tree Canal between Elkhorn Boulevard and Elverta Road was sampled again in 2006, along with the two previously established active survey transects (Figure 3-3).

Fisherman's Lake

Because Fisherman's Lake is adjacent to the Souza/Natomas Farms and Cummings Reserves and has historically supported giant garter snakes, the portion of the lake south of Del Paso Road was selected as the site for the permanent reference trapline in Area 2 (Brode and Hansen 1992; Wylie and Casazza 2000) (Figure 3-3). Traps were placed in a single trapline along the west edge of the waterway from April 22 to September 8, when they were removed due to vegetation control activities that increased exposure of the traps to the public.

Snake Alley

The ditch referred to as *Snake Alley* is situated in northern Sacramento County east of SR-99. This site has been sampled by USGS since 1998 (Wylie and Casazza 2000, 2001; Wylie et al. 2000; Wylie et al. 2004). The permanent reference trapline for Area 3 was established at this site (Figure 3-3).

Sacramento County Airport System

Access was again granted in 2006 by the SCAS to trap for giant garter snakes on all Sacramento International Airport (SMF) properties, including the fenced AOA and the SMF bufferlands outside the AOA perimeter. Outside the AOA, traps were divided into three 50-trap traplines, including a new trapline in Meister Ditch (Figure 3-3). Within the AOA, escorts were required at all times. In order to maximize geographic coverage under this constraint, traps were divided into two 25-trap traplines and one 50-trap trapline. All traplines remained in place for 14 days. As was the case in 2005, the customary second rotation could not be conducted within the AOA or in Meister Ditch due to the cessation of water deliveries through Meister Ditch and subsequent drydown of features within the AOA.

3.2.2 Habitat Assessment

Habitat Connectivity

Changing agricultural regimes, development, and other shifts in land use create an ever-changing mosaic of available habitat. In response to such changes, giant garter snakes move to find suitable sources of cover and prey. Connectivity between regions is consequently vital for maintaining access to available habitat and for genetic interchange. In an agricultural setting, giant garter snakes rely largely for such connectivity on the network of canals and ditches that provide irrigation and drainage. In addition to providing cover, foraging, and basking habitat, the canals and ditches in the study area serve an important role in giant garter snake movement, providing a critical linkage among reserves and other suitable habitats. The importance of these connective corridors was explicitly recognized in the NBHCP, which calls for an assessment of connective corridors throughout the Basin (Chapter VI, Section E [2][a][5] of the 2003 NBHCP).

The assessment of connective corridors was accomplished by evaluating the habitat suitability of the linear water conveyance structures that occur throughout the Basin. The assessment was conducted by driving along canals, ditches, or drains within the Basin that were accessible by either public ownership or specific right of entry. Potential connective corridors were identified by reference to aerial photographs and topographic and hydrographic maps. Potential corridors that could not be accessed directly were identified from adjacent roadways through binoculars and photographed using a digital camera with a telephoto lens. If a corridor could be viewed from one or both ends, but could not be viewed along its entirety, it was assumed that observed conditions were continuous throughout.

Segments were defined along all ditches and drains on the basis of habitat conditions. Each segment was scored using several habitat variables; the total scores were used to quantitatively assess habitat suitability according to a hierarchical classification of known giant garter snake habitat correlates. Minimum segment length was approximately 61 meters (200 feet). An exception to the minimum segment length was made where culverts or other features more than 6 meters long (approximately 20 feet) that could impede giant garter snake movement were identified; such areas were recorded as distinct segments. Habitat scoring criteria were drawn mainly from the *Draft Recovery Plan for the Giant Garter Snake* (U.S. Fish and Wildlife Service 1999) and adapted for use in GIS analysis. The location of each segment was digitized on screen to create a GIS layer, which was then attributed with the segment's habitat scores. The results of this analysis were used to identify potential dispersal corridors for giant garter snakes, and will be used as the foundation for more quantitative analyses of giant garter snake habitat suitability and connectivity in the future.

Preliminary classification values are based on factors discussed in both published and unpublished literature, as well as the personal experience of the biologists involved in the current effort (Hansen and Brode 1980; Brode 1988; Hansen 1988; U.S. Fish and Wildlife Service 1999; Hansen 2002, 2003; Wylie and

Casazza 2001). The preliminary habitat valuation categories are defined below. Point breaks between the valuation categories are based on generalized giant garter snake habitat and ecological requirements and are, consequently, somewhat arbitrary.

Suitable habitat is characterized by all the features necessary to support permanent populations of giant garter snakes, as listed below.

- Sufficient water during the active summer season to supply cover and food such as small fish and amphibians; emergent, herbaceous aquatic vegetation; and vegetated banks to provide basking and foraging habitat.
- Bankside burrows, holes, and crevices to provide short-term aestivation sites.
- High ground or upland habitat above the annual high water mark to provide cover and refugia from floodwaters during the dormant winter season. (Hansen and Brode 1980; Hansen 1988.)

Marginal habitat is characterized by any combination of those features listed above needed to support transient giant garter snakes on a temporary basis, or to act as connective corridors between areas of more stable or desirable habitat. This habitat need only possess the water, vegetation, and refugia required to provide minimal shelter for dispersing snakes. Marginal habitat is less likely to support permanent populations of giant garter snakes and is typically ephemeral, supporting lower concentrations of prey.

Unsuitable habitat is devoid of the water, vegetation, and/or refugia necessary to support giant garter snakes for any extended time. Such habitat is generally composed of small roadside ditches, gunite drains, or temporary swales that contain no water during the active spring and summer seasons. Unsuitable habitat corridors are no more likely to support giant garter snakes than any non-aquatic environment; if giant garter snakes are present in such habitats, it is only by chance.

The point range assigned to each valuation category is shown below.

Habitat Value	Point Range
Unsuitable	0–7
Marginal	8–12
Suitable	13–21

Habitat Use

In addition to the habitat classification outlined above, dominant terrestrial and aquatic vegetation, cover type and percentage, and hydrographic profile were documented within a 1-meter (3.3-foot) radius of all trap and capture locations to examine giant garter snake habitat use. Slope was classified into six categories of 15º each. Distance to terrestrial habitat (i.e., upland habitat with appropriate features such as vegetated banks and burrows or crevices) at each trap location was classified into six categories (<1, 1–5, 6–10, 11–15, 16–20, and >20 meters) to determine whether giant garter snake presence varies with proximity of upland refugia. Slope and distance were evaluated using a chi-squared test to determine if captures occurred more frequently than expected at trap locations with steep slopes or closer upland refuge habitat. Except in instances where traps had been tampered with or where an overabundance of crayfish necessitated the daily emptying of trap contents, prey composition and density in traps were documented for each trapline.

3.3 Results

3.3.1 Population Assessment

In total, 314 observations of giant garter snakes were recorded in 2006, comprising 245 captured individuals (including incidental hand captures), of which 136 were females and 107 were males; the sex of two captured neonates was undetermined. Thirty-seven individuals—16 males and 21 females—were captured multiple times. Twenty-three of the individuals captured had been marked in previous years: sixteen were marked in 2005, five were marked in 2004 (one of which was also recaptured in 2005), one was marked in 2003 by USGS, and one is presumed to have been marked by USGS prior to 2000. Giant garter snakes were observed in managed marsh habitats on six of the eight reserves with this habitat type, comprising 55 captures (including hand captures) of 52 individuals. The balance of recorded observations consisted of mortalities and incidental sightings or sightings during active surveys. Six individuals were found dead on or near roads.

For the second year in a row, more individuals were captured in the Basin than in any year since comprehensive monitoring efforts began in 2004 (Table 3-1), despite the fact that total trapping effort decreased slightly in 2006 due to variable water and habitat conditions (e.g., Bennett North, Bennett South, Natomas Farms, T Drain). Two hundred thirty-five individual giant garter snakes were trapped in 2006, up from 162 in 2005 and 82 in 2004 (Table 3-1).

Table 3-1. Seasonal Trap Success in the Natomas Basin, 2004–2006

Year	Individuals Captured	Total Trap Days	Success per Unit Effort (Individuals/Total Trap Days)
2004	82	49,127	0.0017
2005	162	65,836	0.0025
2006	235	63,400	0.0037

Similarly, capture success (calculated as the total number of individual snakes captured per trap day) increased from 0.0025 captures per trap day in 2005 to 0.0037 captures per trap day in 2006 (Table 3-1). This result could indicate an increase in the giant garter snake population in the Basin. Alternatively, it could be explained by new traplines being placed in highly productive areas that were not accessible during previous trapping efforts. Approximately 30% of the individuals trapped were captured in the Q Drain adjacent to the Bennett South, Huffman West, and Vestal Reserves.

As in 2005, rice fields were flooded later than usual, resulting in less habitat being available for snakes early in the season. This regime can lead to higher densities and greater capture success in the early spring months. In 2006, most captures occurred early in the season. The temporal distribution of captures from 2004 to 2006 is shown in Figure 3-4.

In total, relative abundance as measured by either local population size or capture success increased at 15 locations and decreased at eight locations where enough information was available to make the comparison. Trapping results from 2006 provided enough information to estimate population size for 13 locations, up from eight locations in 2005 and five locations in 2004 (Table 3-2). These results allowed for a direct comparison of population estimates from 2005 to 2006 at six locations.

Population estimates increased from 2005 at four locations.

- Silva west ditch at the BKS Reserve.
- Q Drain at the Huffman West Reserve.
- North Drainage Canal at Lucich South Reserve.
- Snake Alley.

Population estimates decreased from 2005 at two locations.

- T Drain at the Lucich North Reserve.
- Lateral 3A at the Tufts Reserve.

Where data were insufficient to estimate population size for both 2005 and 2006, capture success was used as a metric to evaluate changes in relative abundance. Capture success increased by two or more captures at the following seven locations.

- Q Drain at the Bennett South Reserve.
- Bennett Main Highline at Bolen North Reserve.
- Managed wetlands (west side) at Frazer Reserve.
- Managed wetlands (east side) at Frazer Reserve.
- Bennett Loop canal at Huffman East Reserve.

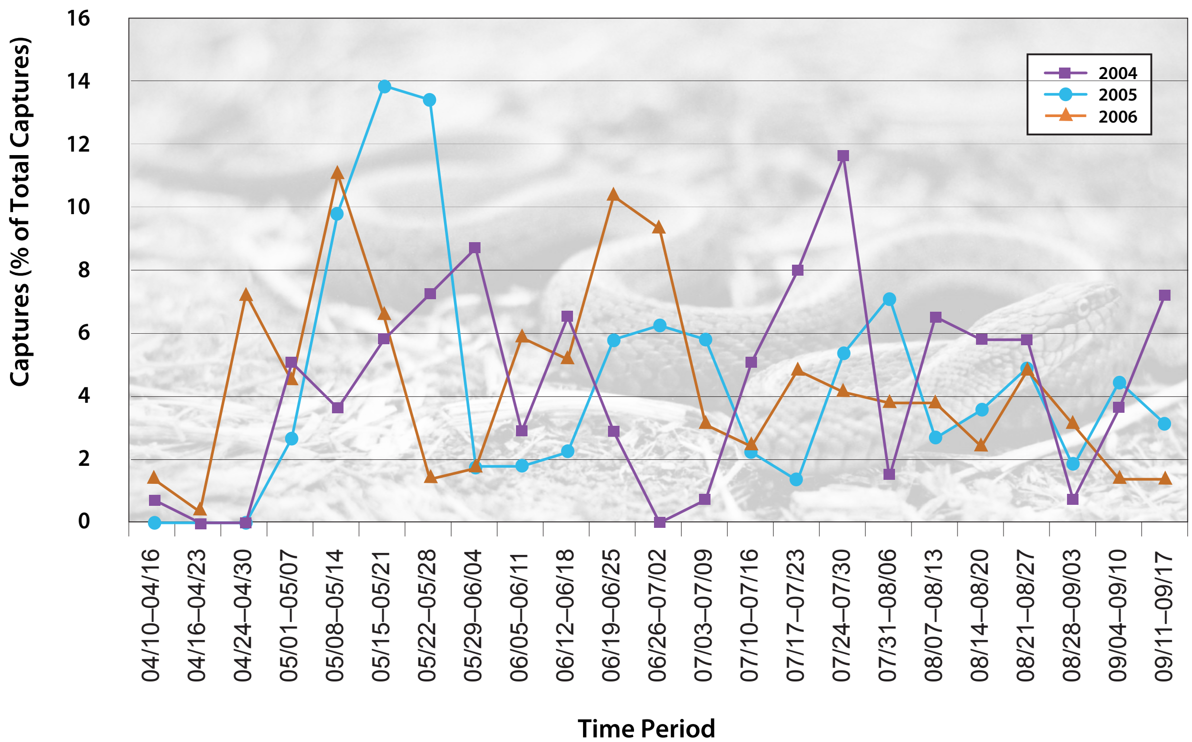

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Figure 3-4
Temporal Distribution of Giant Garter Snake Captures in the Natomas Basin, 2004–2006

Table 3-2. Selected Sampling Results and Population Estimates for Giant Garter Snakes, 2004–2006

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting	Total Individuals Captured	Traps	Trap Days	Capture Success (Individuals Trapped/ Trap Day)	Population Estimate
Reserve Sites									
Alleghany	—	—	—	—	—	—	—	—	—
Atkinson	Highline Ditch	2004	0	0	0	50	750	0	*
		2005	1/0	0	1	50	1,300	0.0008	*
		2006	0	0	0	50	1,400	0	*
	North Drainage Canal	2005	7/0	0	7	50	1,300	0.0054	*
		2006	7/0	0	7	50	1,400	0.0050	*
Ayala	"E" Drain	2004	0	0	0	50	750	0	*
		2005	0	0	0	50	700	0	*
	South Ditch	2004	0	0	0	50	750	0	*
		2005	5/2	0	3	50	1,350	0.0022	*
		2006	1/0	0	1	50	1,400	0.0007	*
Bennett North	North Ditch	2004	0	0	0	50	1,400	0	*
		2005	0	0	0	50	700	0	*
		2006	0	0	0	50	1,400	0	*
	W edge wetland	2004	9/4	0	5	50	1,400	0.0036	4 ± .82 (95% C.I. 4–4)
		2005	1/0	0	1	50	700	0.0014	*
	North Drainage Canal	2006	—	3/0	3	—	—	—	—
Bennett South	West Ditch (Q Drain)	2004	5/0	0	5	50	1,300	0.0038	*
		2005	1/0	0	1	50	1,350	0.0007	*
		2006	28/3	0/3	25	50	1,400	0.0179	47 ± 28.18 (95% C.I. 22–154)
	Marsh	2004	2/0	0	2	50	1,600	0.0012	*
		2005	2/0	0	2	50	1,400	0.0014	*
BKS	Central Ditch (Control Structure K)	2004	2/0	0	2	50	800	0.0025	*
		2005	6/1	0	5	50	1,400	0.0036	*
		2006	1/0	0	1	50	1,400	0.0007	*
	Silva West Ditch	2004	5/1	0	4	50	1,450	0.0028	6 ± 3.78 (95% C.I. 5–25)
		2005	10/2	1/6	9	50	1,700	0.0047	10 ± 4.50 (95% C.I. 7–29)
		2006	8/1	0	7	50	1,400	0.0050	16 ± 11.86 (95% C.I. 8–69)
	South Highline	2004	0	0	0	50	50	0	*

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting	Total Individuals Captured	Traps	Trap Days	Capture Success (Individuals Trapped/ Trap Day)	Population Estimate
	NW wetland	2004	0	0	0	50	650	0	*
	SW wetland (at Silva West Ditch)	2004	0	0	0	50	700	0	*
		2005	4/1	0	3	50	1,700	0.0018	*
		2006	3/0	1/1	4	50	1,400	0.0021	*
	NE wetland	2004	0	0	0	50	1,400	0	*
		2006	0	0	0	50	700	0	*
	N central wetland (at Control Structure K)	2004	0	0	0	50	550	0	*
		2005	0	0	0	50	1,400	0	*
	S central wetland (at Control Structure K)	2006	5/0	0	5	50	700	0.0071	*
	Silva south wetland drift fence	2005	2/0	0	2	50	1,750	0.0011	*
	Silva SW wetland drift fence	2006	15/2	0	13	50	2,900	0.0045	16 ± 11.86 (95% C.I. 8–69)
Bolen North	Bennett Main	2005	0	0	0	50	1,386	0	*
		2006	4/0	0/1	4	50	1,400	0.0029	*
Brennan	V Drain	2005	—	0/1	0	—	—	—	—
Cummings	Central wetland	2005	0	0	0	50	1,400	0	*
		2006	0	0	0	50	700	0	*
	East Wetland	2006	1/0	0	1	50	700	0.0014	*
Frazer	North Ditch	2004	0	0	0	50	700	0	*
	Highline Ditch	2005	0	0	0	50	1,450	0	*
		2006	1/0	0	1	50	1,400	0.0007	*
	W side wetland	2004	0	0	0	50	700	0	*
		2005	5/1	0	4	50	750	0.0053	7 ± 4.26 (95% C.I. 5–28)
		2006	11/0	0/1	11	50	700	0.0157	*
	E side wetland	2004	1/0	0	1	50	700	0.0014	*
		2005	1/0	0	1	50	650	0.0015	*
		2006	9/1	0	8	50	700	0.0114	26 ± 21.28 (95% C.I. 11–120)
	E side wetland drift fence	2006	1/0	0	1	50	800	0.0013	*

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting	Total Individuals Captured	Traps	Trap Days	Capture Success (Individuals Trapped/ Trap Day)	Population Estimate
Huffman East	Bennett Loop	2005	3/0	0	3	50	1,350	0.0022	*
		2006	8/1	0	7	50	1,400	0.0050	15 ± 11.17 (95% C.I. 8–65)
Huffman West	Q Drain	2005	22/9	0	13	50	1,400	0.0093	16 ± 11.86 (95% C.I. 8–69)
		2006	34/6	0	28	50	1,400	0.0200	107 ± 55.27 (95% C.I. 50–297)
Lucich North	T-Drain	2004	79/42	3/1	38	50	7,150	0.0052	27 ± 12.35 (95% C.I. 16–73)
		2005	35/12	2/3	25	50	6,600	0.0035	27 ± 22.47 (95% C.I. 12–126)
		2006	20/1	1/0	20	50	6,350	0.0030	10 ± 7.32 (95% C.I. 6–44)
	NW wetland	2004	0	0	0	50	700	0	*
	SW wetland	2004	3/1	1/0	3	50	700	0.0029	*
	SE wetland	2005	24/3	0	21	50	1,700	0.0124	79 ± 49.25 (95% C.I. 34–262)
		2006	0	0	0	50	700	0	*
	Central Wetland	2006	3/0	0	3	50	700	0.0043	*
	North highline ditch	2005	—	0/1	0	—	—	—	—
		2006	—	1/0	1	—	—	—	—
Lucich South	North Drainage Canal	2004	11/1	2/0	12	50	1,850	0.0054	36 ± 30.94 (95% C.I. 14–170)
		2005	34/10	5/0	29	50	1,700	0.0141	35 ± 10.78 (95% C.I. 24–71)
		2006	19/1	0	18	50	1,400	0.0129	61 ± 53.71 (95% C.I. 21–291)
	Wetland edge	2004	2/0	1/1	3	50	1,800	0.0011	*
		2005	3/0	0	3	50	1,700	0.0018	*
		2006	4/0	0	4	50	1,400	0.0029	*
	Wetland drift fence	2005	5/0	0	5	50	2,800	0.0018	*
	Rice at center	2004	0	0	0	50	700	0	*
	Bennett Main highline ditch	2006	—	1/0	1	—	—	—	—
	Southern ditch	2006	—	1/0	1	—	—	—	—
Natomas Farms	NW wetland	2004	0	0	0	50	1,750	0	*
		2006	1/0	0/1	1	50	700	0.0014	*
	Center wetland	2004	0	0	0	50	1,000	0	*
		2005	3/2	0/1	1	50	1,700	0.0006	*
		2006	1/0	0	1	50	700	0.0014	*

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting	Total Individuals Captured	Traps	Trap Days	Capture Success (Individuals Trapped/ Trap Day)	Population Estimate
	E edge wetland	2004	0	0	0	50	700	0	*
	S edge wetland	2004	0	0	0	50	850	0	*
		2005	0	0	0	50	800	0	*
	S edge wetland drift fence	2005	0	0	0	50	1,700	0	*
	Kimura Ditch	2004	0	0	0	50	500	0	*
Rosa	West Drainage Canal	2005	2/0	0	2	50	1,450	0.0014	*
		2006	0	0	0	50	1,400	0	*
Ruby Ranch	(see Atkinson North Drainage Canal)	—	—	—	—	—	—	—	—
Sills Ranch	Highline Canal	2004	2/0	0	2	50	1,400	0.0014	*
		2005	3/0	0	3	50	1,500	0.0020	*
		2006	3/0	0	3	50	1,400	0.0021	*
	North Ditch (Drain 13)	2004	0	0	0	50	800	0	*
		2005	2/0	0/1	2	50	1,400	0.0014	*
		2006	4/0	0	4	50	1,400	0.0029	*
Souza	—	—	—	—	—	—	—	—	—
Tufts	Lateral 3A	2005	16/4	1/1	13	50	1,400	0.0086	16 ± 6.74 (95% C.I. 11–43)
		2006	6/1	0	5	50	1,400	0.0036	4 ± 1.71 (95% C.I. 4–14)
Vestal	West Ditch (Q Drain)	2006	26/9	0	17	50	1,400	0.0121	17 ± 3.93 (95% C.I. 14–31)
Off-Reserve Sites									
Fisherman's Lake	E side of channel	2004	1/0	0	1	50	1,950	0.0005	*
	W side of channel	2005	2/0	1/1	3	50	3,850	0.0005	*
		2006	5/1	1/1	5	50	6,950	0.0006	4 ± 1.71 (95% C.I. 4–14)
Metro Air Park	Lone Tree Canal (Central Section)	2004	0	0	0	50	602	0	*
		2005	1/0	1/0	2	50	1,500	0.0007	*
		2006	6/1	0	5	50	1,400	0.0036	11 ± 7.81 (95% C.I. 6–47)
Snake Alley		2004	16/7	0	9	50	5,600	0.0016	8 ± 1.34 (95% C.I. 8–15)
		2005	27/9	0/1	18	50	6,700	0.0027	14 ± 4.55 (95% C.I. 10–32)
		2006	45/13	2/0	33	50	7,200	0.0044	31 ± 17.93 (95% C.I. 16–101)

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting	Total Individuals Captured	Traps	Trap Days	Capture Success (Individuals Trapped/ Trap Day)	Population Estimate
SCAS Properties	SE AOA E Ditch	2004	0	0	0	25	725	0	*
		2005	0	0	0	25	350	0	*
		2006	0	0	0	50	700	0	*
	E AOA E Ditch	2004	0	0	0	25	350	0	*
		2005	0	0	0	25	350	0	*
	NE AOA E Ditch	2004	0	0	0	25	350	0	*
	S AOA S Ditch	2004	0	0	0	25	725	0	*
		2005	0	0	0	25	350	0	*
		2006	0	0	0	25	350	0	*
	W AOA W Ditch	2004	0	0	0	25	725	0	*
		2005	0	0	0	25	350	0	*
		2006	0	0	0	25	350	0	*
	West Drainage Canal	2004	0	0	0	50	350	0	*
	Flume Highline	2004	0	0	0	50	700	0	*
		2005	0	0	0	50	1,400	0	*
		2006	0	0	0	50	1,400	0	*
	Jacob’s Slough	2004	0	0	0	50	1,400	0	*
		2005	0	0	0	50	1,400	0	*
		2006	0	0	0	50	700	0	*
	Private ditch at SW AP property	2004	0	0	0	50	100	0	*
	Meister Ditch	2006	1/0	0	1	50	700	0.0014	*

- Drain 13 at Sills Reserve.
- Lone Tree Canal at Metro Air Park.

Conversely, capture success decreased by two or more captures at four locations.

- South ditch at the Ayala Reserve.
- Ditch extending north from water control structure K at BKS.
- Southeast managed marsh at Lucich North.
- West Drainage Canal at Rosa.

Capture results elsewhere were comparable to those of previous years (Table 3-2).

Reserve Lands

Alleghany, Cummings, Rosa Central, Rosa East, and Souza/Natomas Farms

Trapping was not conducted at Alleghany. Six visual encounter surveys totaling 2,907 meters (1.81 miles) were conducted. No giant garter snakes were observed during these surveys.

The trapping effort at the Cummings Reserve consisted of 1,400 trap days using standard traplines deployed within the managed marshes. One giant garter snake was captured in the eastern wetland; this is the only giant garter snake captured to date within the managed marsh at the Cummings Reserve (Jones & Stokes 2006). Seventeen valley garter snakes were also captured at Cummings.

Six visual encounter surveys totaling 3,095 meters (1.92 miles) were conducted along the Cummings wetland borders. No giant garter snakes were observed during these surveys.

The trapping effort at the Rosa Reserves consisted of 1,400 trap days using standard traplines deployed within the West Drainage Canal at the northern edge of the reserves. In contrast to 2005, when two giant garter snakes were captured, no giant garter snakes were captured in 2006. Four valley garter snakes were captured at Rosa.

Three visual encounter surveys totaling 1,506 meters (0.94 miles) were conducted along the West Drainage Canal. No giant garter snakes were observed during these surveys.

The trapping effort at the Souza/Natomas Farms Reserve consisted of 1,400 trap days. All trapping was conducted within managed marshes. A drift fence trapline was not deployed in 2006 due to dredging and re-sloping activities in the Natomas Farms wetlands. Two individual giant garter snakes were captured:

one in the western wetland unit prior to maintenance activities and one in the eastern wetland unit following the completion of maintenance activities. Six valley garter snakes were also captured at Souza/Natomas Farms.

Three visual encounter surveys totaling 1,502 meters (0.93 mile) were conducted along the Natomas Farms wetland borders, and three visual encounter surveys totaling 1,505 meters (0.94 mile) were conducted along the Kimura Ditch. No giant garter snakes were observed during these surveys.

In summary, three individual giant garter snakes were captured on or adjacent to reserve lands south of I-5: two within the Natomas Farms Reserve, and one within the Cummings Reserve. Five additional snakes were captured or observed south of I-5 on the permanent reference trapline at Fisherman's Lake (see *Non-Reserve Lands* below). The number of giant garter snakes observed south of I-5 was comparable to the number observed in 2005, which was a significant increase over the two giant garter snakes caught in 2004. However, capture success in this area is still low compared to elsewhere in the Basin.

Atkinson, Ruby Ranch, and Vestal

The trapping effort at the Atkinson and Ruby Ranch Reserves consisted of 2,800 trap days: 1,400 in the North Drainage Canal between the two reserves and 1,400 in the adjacent Highline Canal at the Atkinson Reserve. Seven individual giant garter snakes were captured in the North Drainage Canal; no giant garter snakes were captured in the Highline Canal. Two valley garter snakes were captured in the Highline Canal.

Six visual encounter surveys totaling 2,793 meters (1.74 miles) were conducted within and along the edges of the North Drainage Canal and along the ditch at the northern end of the Atkinson Reserve. No giant garter snakes were observed during these surveys.

Vestal was acquired in September 2005 and trapped for the first time in 2006. The trapping effort consisted of 1,400 trap days in the Q Drain on the western edge of the property. Seventeen individual giant garter snakes were captured; one of these snakes was originally captured 25 days earlier in the North Drain at Atkinson, one had been marked in 2005 from the Q Drain at Huffman West, and one was an unrecorded recapture presumably marked by USGS prior to 2000. Although formal visual encounter surveys were not conducted during 2006, surveyors always look for snakes while conducting trapping surveys. A neonate garter snake was observed on one occasion but could not be confirmed as a giant garter snake.

Three visual encounter surveys totaling 1,459 meters (0.91 mile) were conducted along ditches at Huffman West; no giant garter snakes were observed during these surveys.

Bennett South, and Lucich South

The trapping effort at Bennett South consisted of 1,400 trap days in the Q Drain at the western edge of the property. The managed marsh at Bennett South was not trapped in 2006 due to marsh maintenance and enhancement activities. Twenty-five individual giant garter snakes were captured in the Q Drain; one of these snakes was marked in 2004. Results were much higher than those of 2004 and 2005 (Table 3-2), and are comparable to the number of snakes captured in 2002 and 2003 (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2006). Two valley garter snakes were also captured in the Q Drain.

Twelve visual encounter surveys totaling 1,548 meters (0.96 mile) along wetland edges and 3,650 meters (2.27 miles) along ditches were conducted. A dead giant garter snake was found during one of these surveys at the eastern edge of the reserve near Powerline Road. Two neonate garter snakes were also observed, but eluded capture and could not be confirmed as giant garter snakes.

The trapping effort at Lucich South consisted of 2,800 trap days: 1,400 in the managed marsh and 1,400 in the North Drainage Canal on the eastern edge of the property. Three individual giant garter snakes were captured along the eastern edge of the managed marsh, and one was captured along the western edge of the managed marsh. Eighteen individual giant garter snakes were captured in the North Drainage Canal; one of these snakes was marked in 2004 and recaptured in 2005, and six others were marked in 2005. Capture success in the North Drainage Canal was lower than in 2005 (Table 3-2), but was comparable to previous years (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2006). One valley garter snake was captured in the North Drainage Canal.

Thirteen visual encounter surveys totaling 1,508 meters (0.94 mile) along the edges of the wetland and 5,149 meters (3.20 miles) along the edges of ditches and rice fields were conducted. Two giant garter snakes were captured by hand during these surveys: one along the Bennett Main highline ditch at the western edge of the reserve and one along the unnamed ditch at the southern edge of the reserve. One valley garter snake was captured by hand along the Bennett Main highline ditch.

Betts-Kismat-Silva

The trapping effort at BKS consisted of 8,500 trap days: 1,400 in the ditch along the western edge of the Silva parcel, 1,400 in the created wetland adjacent to the western ditch, 1,050 in the ditch extending north from water control structure K, 350 in the created wetland directly north of the structure K ditch, 700 in the created wetland directly east of the structure K ditch at the southern edge of the reserve, 700 in the created wetland at the northeastern corner of the reserve, and 2,900 in a drift fence array deployed along the western edge of the created wetland at the western edge of the Silva parcel.

Twenty-eight individual giant garter snakes were captured within or adjacent to the BKS Reserve. Seven were captured in the ditch along the west edge of the Silva parcel—one of which had been marked 5 days earlier in Snake Alley. Fifteen were captured in the wetland adjacent to the western ditch, including 12 from the drift fence array and one hand capture; one of these snakes was marked in 2005, one was originally captured in 2004 in the adjacent ditch to the west, and one was marked by USGS in 2003. Additionally, two individuals were recaptured in the Silva west wetland after originally being captured this year in the adjacent ditch to the west; one of these snakes was subsequently recaptured on the eastern edge of the wetland. One giant garter snake, a recapture from 2005, was trapped in the ditch extending north from water control structure K, and five individuals were captured in the created wetland directly east of the structure K ditch at the southern edge of the property. Capture success in the managed marshes was significantly higher than in 2005, which was the first year that giant garter snakes had been captured or observed within the managed marshes at BKS (Wylie and Casazza 2001; Wylie and Martin 2002; Wylie et al. 2004; Jones & Stokes 2006) (Table 3-2). Five valley garter snakes were captured at BKS: one in the structure K ditch and four in the wetland directly east of the ditch at the southern edge of the property.

Nine visual encounter surveys totaling 3,220 meters (2.00 miles) in and along the edges of the wetlands and 1,518 meters (0.94 mile) along the edges of ditches were conducted. No giant garter snakes were observed during these surveys.

Bolen North, Bolen South, and Bennett North

The trapping effort at Bolen North consisted of 1,400 trap days in the Highline Canal at the northwestern corner of the property. Four individual giant garter snakes were captured; these are the first giant garter snakes captured at the Bolen North Reserve (Jones & Stokes 2006). One valley garter snake was also captured at Bolen.

Three visual encounter surveys totaling 1,527 meters (0.95 mile) along ditches were conducted. One giant garter snake was observed in the small ditch interior to the Highline Canal at the northwestern corner of the property.

No trapping was conducted on the Bolen South parcel due to a lack of suitable aquatic habitat.

The trapping effort at Bennett North consisted of 1,400 trap days in the Spangler South Lateral canal at the northern edge of the Bennett North Reserve. The managed marsh at Bennett North was not trapped in 2006 due to diminished water levels throughout the season. No giant garter snakes were captured at Bennett North. Two valley garter snakes were captured in the Spangler South Lateral.

Twelve visual encounter surveys totaling 1,553 meters (0.96 mile) along wetland edges, 3,061 meters (1.90 miles) along ditches, and 1,485 meters (0.92 mile) along the edge of the rice field (which was fallow in 2006) directly west of the managed marsh were conducted. No giant garter snakes were observed during these surveys.

Frazer and Lucich North

The trapping effort at Frazer consisted of 3,600 trap days: 700 along the west and south edges of the western managed marsh, 700 along the vegetation–open water interface within the southeastern managed marsh, 1,400 in the Highline Ditch at the eastern edge of the reserve, and 800 in a drift fence trapline deployed at the northern edge of the southeastern managed marsh. Twenty individual giant garter snakes were captured within or adjacent to the Frazer Reserve: 11 in the western managed marsh, eight in the southeastern managed marsh, and one in the Highline Ditch at the eastern edge of the Reserve. One giant garter snake originally captured in the southeastern managed marsh was recaptured in the drift fence trapline. Capture success within the managed marshes at Frazer was significantly higher than in previous years (Jones & Stokes 2006) (Table 3-2). Eleven valley garter snakes were also captured in the southeastern wetland, including seven from the drift fence trapline.

Twelve visual encounter surveys totaling 4,623 meters (2.87 miles) in ditches and drains and 1,512 meters (0.94 mile) in the managed marshes were conducted at Frazer. No giant garter snakes were observed during these surveys; three valley garter snakes were observed.

The trapping effort at Lucich North consisted of 7,750 trap days: 1,400 in managed marshes and 6,350 in the T Drain, the permanent reference trapline for Area 1. Twenty-two individual giant garter snakes were captured: three in managed marshes and 19 in the T Drain; three of these snakes had been marked in 2005. Capture success was considerably lower than that of previous years (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2006) (Table 3-2). Eight valley garter snakes were also captured at Lucich North: four in the managed marshes and four in the T Drain.

Overgrowth of cattails, water primrose, and mosquito fern (*Azolla* spp.) throughout the managed marshes, along with maintenance and enhancement activities in the western marshes, limited the number of sites available for trapping at Lucich North in 2006. Furthermore, the T Drain did not have sufficient water for trapping until mid-May, and overgrowth of water primrose within the T Drain necessitated relocation of the trapline to an upstream portion of the canal in mid-August. These factors may have contributed to the decrease in capture success in 2006.

Fifteen visual encounter surveys totaling 4,551 meters (2.83 miles) along perimeter ditches and drains and 3,073 meters (1.91 miles) in managed marshes were conducted at Lucich North. Two giant garter snakes were captured by hand during these surveys: one along the T Drain at the eastern edge of the reserve and one along the T1 Drain on the northern edge of the reserve. Five valley garter snakes were also observed: two in ditches and drains and three in the managed marshes.

Huffman East and Huffman West

The trapping effort at Huffman East consisted of 1,400 trap days in the Bennett Loop canal at the western edge of the reserve. Seven individual giant garter snakes were captured. Capture success was higher than that of 2005 (Jones & Stokes 2006) (Table 3-2).

Three visual encounter surveys totaling 1,423 meters (0.88 mile) were conducted along ditches at Huffman East; no giant garter snakes were observed during these surveys.

The trapping effort at Huffman West consisted of 1,400 trap days in the Q-Drain between Huffman East and Huffman West. Twenty-eight individual giant garter snakes were captured; three of these snakes were marked in 2005, and one was marked in 2004. Capture success was significantly higher than that of 2005 (Jones & Stokes 2006) (Table 3-2).

Sills and Tufts

The trapping effort at Sills consisted of 2,800 trap days: 1,400 in the Lateral 3C canal running north to south, and 1,400 in the Drain 13 ditch running east to west, both in the northeast portion of the property. Three giant garter snakes were captured in the Lateral 3C canal, and four were trapped in Drain 13. Capture success was similar to that of previous years (Wylie et al. 2004; Jones & Stokes 2006) (Table 3-2).

Nine visual encounter surveys totaling 4,619 meters (2.87 miles) were conducted along perimeter ditches and drains at Sills. No giant garter snakes were observed during these surveys.

The trapping effort at Tufts consisted of 1,400 trap days in the Lateral 3A canal on the western edge of the property. Five individual giant garter snakes were captured there, one of which was marked in 2005. Capture success was considerably lower than that of 2005 (Jones & Stokes 2006) (Table 3-2). Six visual encounter surveys totaling 1,543 meters (0.96 mile) in Highline Ditch 3 and 1,542 meters (0.96 mile) in Lateral 3A were conducted at Tufts. No giant garter snakes were observed during these surveys.

Ayala and Brennan

The trapping effort at Ayala consisted of 1,400 trap days in the unnamed ditch at the southern end of the reserve. One giant garter snake was captured at Ayala along with two valley garter snakes.

Nine visual encounter surveys totaling 4,558 meters (2.83 miles) were conducted along the edges of ditches, drains, and rice fields. No giant garter snakes were observed during these surveys.

No trapping was conducted on the Brennan Reserve due to a lack of suitable aquatic habitat. Two visual encounter surveys totaling 1,019 meters (0.63 mile) were conducted along the V Drain at the northern edge of the reserve. No giant garter snakes were observed during these surveys.

The Ayala and Brennan properties were exchanged for more desirable mitigation lands in 2006. Consequently, these reserves will no longer be monitored in 2007.

Non-Reserve Lands

Metro Air Park (MAP)

The trapping effort at MAP consisted of 1,400 trap days in the Lone Tree Canal north of the Central Main Canal. Five individual giant garter snakes were captured. Capture success was considerably higher than that of recent years (Table 3-2) and was comparable to that of 2000 (Wylie et al. 2004; Jones & Stokes 2006).

Five visual encounter surveys totaling 2,525 meters (1.57 miles) were conducted along two transects in Lone Tree Canal between Elverta Road and I-5. No giant garter snakes were observed during these surveys.

Fisherman's Lake

The trapping effort at Fisherman's Lake consisted of 6,950 trap days on the permanent reference trapline for Area 2 along the west edge of the channel south of Del Paso Road. This trapline was removed 1 week early following mechanical treatment of bankside vegetation. Five individual giant garter snakes were captured, including one by hand, and one was observed. Five valley garter snakes were also captured.

Nine visual encounter surveys totaling 4,609 meters (2.86 miles) were conducted in and along the edges of the channel proper and adjoining features. No giant garter snakes were observed during these surveys; three valley garter snakes were observed.

Snake Alley

The trapping effort at Snake Alley consisted of 7,200 trap days along the permanent reference trapline for Area 3. Thirty-three individual giant garter snakes were captured, including two by hand. Capture success was considerably higher than that of previous years (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2006) (Table 3-2). Although USGS has captured and marked giant garter snakes in this location since 1998, no snakes previously marked by USGS were captured. One giant garter snake marked in 2004 was recaptured this year. Additionally, one valley garter snake was captured at Snake Alley.

No visual encounter transects were established at Snake Alley.

Sacramento County Airport System

The trapping effort on SCAS lands consisted of 1,400 trap days inside the fenced portion of the AOA and 2,800 trap days at locations on SCAS properties outside the AOA. One giant garter snake was captured in Meister Ditch directly south of the eastern part of the AOA. Three valley garter snakes were captured at the Flume Highline.

Nine visual encounter surveys totaling 4,440 meters (2.8 miles) were conducted at the following three locations outside the AOA: 1,528 meters (0.95 mile) along the West Drainage Canal west of Powerline Road, 1,407 meters (0.87 mile) at Lambert Ditch, and 1,505 meters (0.94 mile) along the North Drainage Canal at Prichard Lake. No giant garter snakes were observed during these surveys.

Movements

The increased trapping effort initiated in 2004 has resulted in several observations of relatively long-distance movement and movement between habitat types in 2006. A female captured in late April in Snake Alley was recaptured 5 days later approximately 917 meters (0.57 mile) to the northeast in the ditch along the west edge of the Silva parcel at BKS. Two other females captured in the west ditch were subsequently recaptured in the adjacent wetland at the Silva parcel; one of these snakes was recaptured on the eastern edge of the wetland approximately 283 meters (0.18 mile) northeast of its original capture location. A male trapped in the North Drainage Canal at Atkinson was recaptured 25 days later in the Q drain at Vestal approximately 935 meters (0.58 mile) to the northeast. A female trapped in the Q drain at Huffman West in September 2005 was recaptured in 2006 in the Q drain at Vestal approximately 765 meters (0.48 mile) to the southwest. Another male, first captured in 2004 in the Q Drain at Bennett South, was recaptured in 2006 approximately 1,400 meters (0.87 mile) to the south in the Q Drain at Huffman West. A female originally captured in the managed marsh at Lucich South in 2005 was recaptured in May 2006 in the adjacent North Drainage Canal.

General Observations

The use of drift fence traplines to increase capture probability in managed marshes produced mixed results in 2006. In the Silva west wetland at BKS, 13 individual giant garter snakes were captured in 15 capture events (0.0052 capture/trap day) using a drift fence trap line, compared with three individuals in three capture events (0.0021 capture/trap day) using standard trapping procedures. Alternatively, only one individual (a recapture from the standard trapline) was captured in the drift fence trapline (0.0012 capture/trap day) in the southeast wetland at Frazer, compared with eight individuals in nine capture events (0.013 capture/trap day) using standard trapping procedures. The difference in capture success between the two drift fence traplines is probably due to the different times of year in which they were deployed. The drift fence at BKS was deployed from mid June to mid-August, when the frequency of captures in the Basin was relatively high (Figure 3-4). In contrast, the drift fence at Frazer was deployed from mid-August to early September when the frequency of captures in the Basin was lower (Figure 3-4). More data are needed to adequately compare the relative capture success of drift fence and standard trap lines in wetland habitats.

The average size of male giant garter snakes captured in 2006 increased slightly for the second year in a row, averaging 563 millimeters (22.2 inches) (n = 128) SVL with an average mass of 103 grams (3.6 ounces) (n = 128) (Table 3-3). The average size of females captured in 2006 decreased slightly over the prior year, averaging 645 millimeters (25.4 inches) (n = 162) SVL with an average mass of 205 grams (7.2 ounces) (n = 162) (Table 3-3).

Table 3-3. Size Distribution of Natomas Basin Giant Garter Snakes, 2000–2006

Gender	Metric	2000	2001	2002	2003	2004	2005	2006
Male	Mass (g)	224 n=18	145 n=11	97 n=66	94 n=46	76 n=34	98 n=103	103 n=128
	SVL* (mm)	715 n=18	666 n=11	583 n=66	560 n=46	505 n=34	553 n=103	563 n=128
Female	Mass (g)	217 n=46	223 n=18	245 n=112	208 n=69	145 n=39	213 n=122	205 n=162
	SVL (mm)	709 n=46	718 n=18	721 n=112	669 n=69	592 n=39	670 n=122	645 n=162

* SVL = snout-vent length.

Prior to 2005, the average size (and thus, by inference, age) of male giant garter snakes captured in the Basin had decreased each year since 2000 (Figure 3-5). The average size of female giant garter snakes captured in the Basin exhibited a different pattern, with the decrease in size evident only in 2003 and 2004, and now again in 2006.

The overall size distribution of female giant garter snakes has shifted significantly to smaller size classes since 2004 ($\chi^2 = 64.85$, df = 26, $p \leq 0.001$). Conversely, the size distribution of male giant garter snakes has not shifted significantly in the same period ($\chi^2 = 4.17$, df = 8, $p \leq 1$).

Numerous valley garter snakes were captured throughout the season both in traps and by hand. California kingsnakes, western yellow-bellied racers, and Pacific gopher snakes were also observed. Captures of snakes other than garter snakes were incidental and are not discussed further in this document.

As in previous seasons, river otters were noted in most regions of the study area. River otters are known to kill giant garter snakes without consuming them (Wylie pers. comm.) and are suspected in several giant garter snake mortalities throughout the species' range, including two incidents in the Basin during 2004 (Jones & Stokes 2005b).

One dead giant garter snake found near the Flume Highline on SCAS property in 2006 appeared to have been bitten or chopped in half. Half of the snake was missing and abundant fresh otter scat was present, suggesting predation as a possible cause. On the other hand, the clean cut and the fact that the remaining half of the snake was located adjacent to a routinely maintained rice check box suggests the mortality may have been caused by a shovel. The exact cause of the mortality in this case is unknown.

3.3.2 Habitat Assessment

Habitat Connectivity

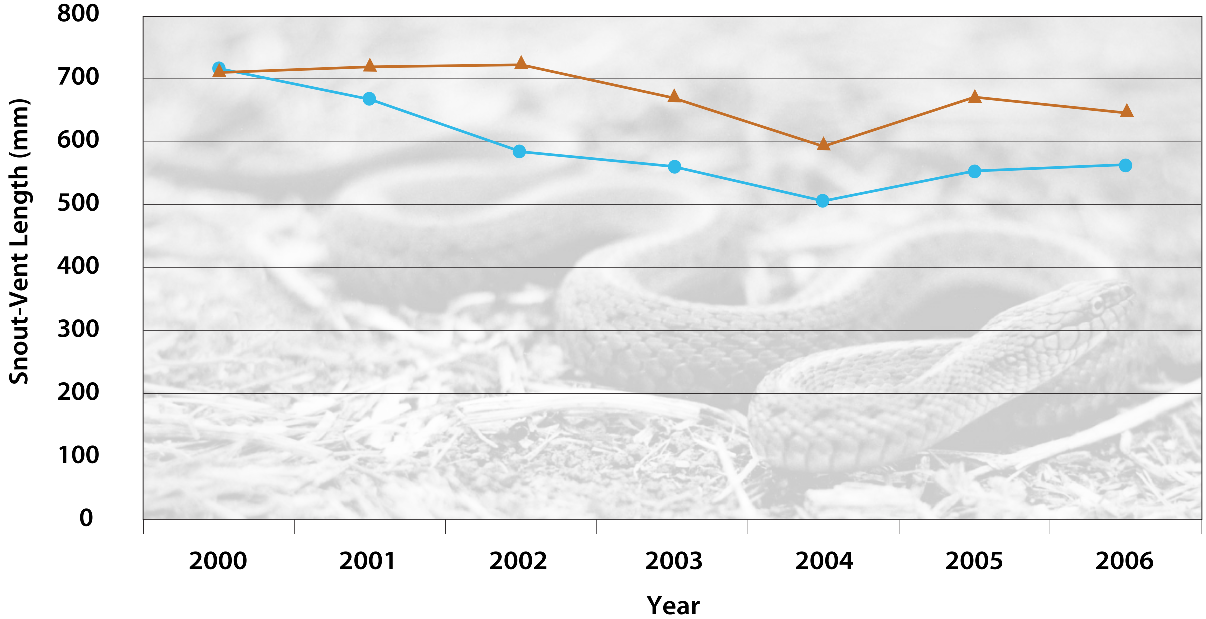
The habitat suitability of the water conveyance structures was documented and scored throughout the preponderance of the Basin. Figure 3-6 provides a graphical representation of the distribution of suitable habitats in the form of linear water conveyance structures that serve as connective corridors between habitats and the three regions of the basin. Features such as box or pipe culverts linking regions otherwise separated by major roadways or urban development are also depicted. Additional features depicted in the 2006 portion of Figure 3-6 reflect additional fieldwork conducted in 2006; they do not represent newly constructed aquatic features.

The most significant corridors spanning the Basin from north to south continue to be the primary drainages managed by Reclamation District 1000: the North Drainage Canal, East Drainage Canal, West Drainage Canal (including Fisherman's Lake), and Main Drainage Canal, all of which the NBHCP has identified as most likely to remain during the permit term (Figure 3-3).

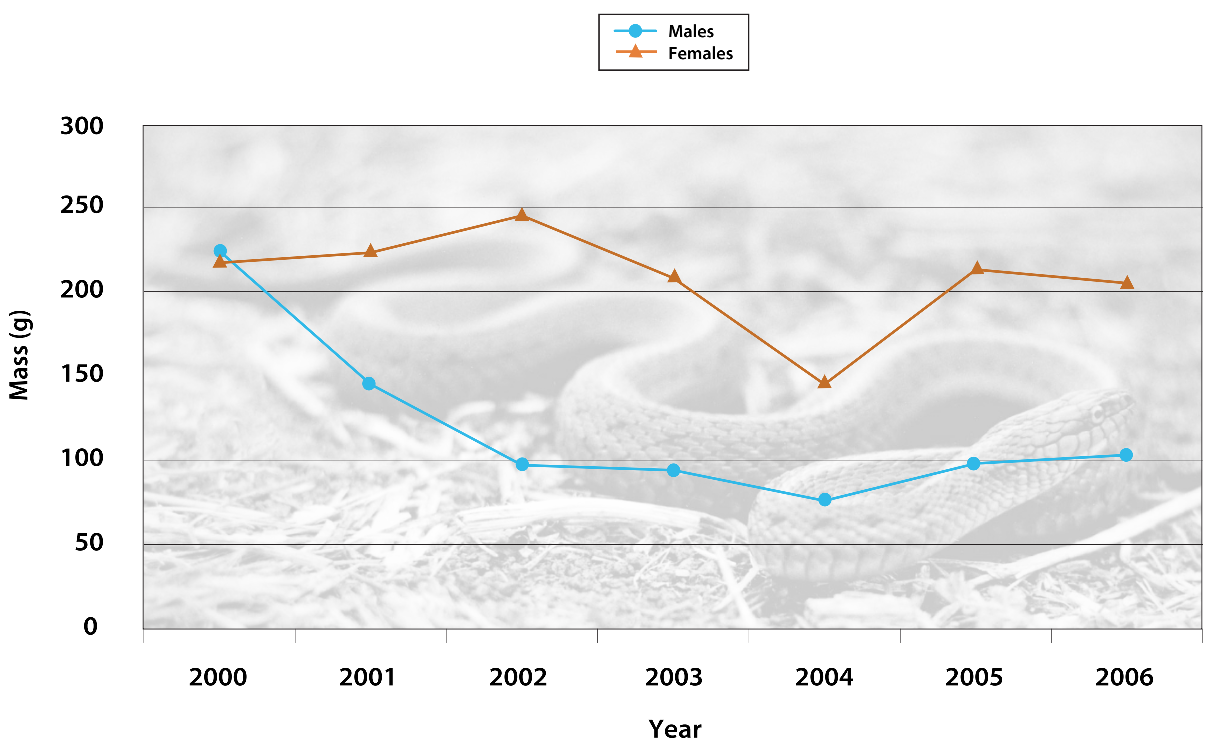
Area 1 and Area 2 are connected by the West Drainage Canal, the N Drain (parallel to Powerline Road), and Lone Tree Canal through culverts that pass under I-5.

The West Drainage Canal passes north under I-5 from the Fisherman's Lake area to the area west of SMF, where it lies disconnected from other hydrologic features.

The N drain passes north under I-5 and connects to the Meister Ditch and the Airport East Ditch. However, the eastern segment of Meister Ditch and several supporting ditches were abandoned and filled in 2005, eliminating water sources to Meister Ditch west of Powerline Road and the Airport East Ditch. As a result, these areas dry to the extent that aquatic trapping transects have been abandoned. Such drying will likely result in the loss of one of the two functional north-south



Changes in Snout-Vent Length of Giant Garter Snakes in the Natomas Basin, 2000–2006

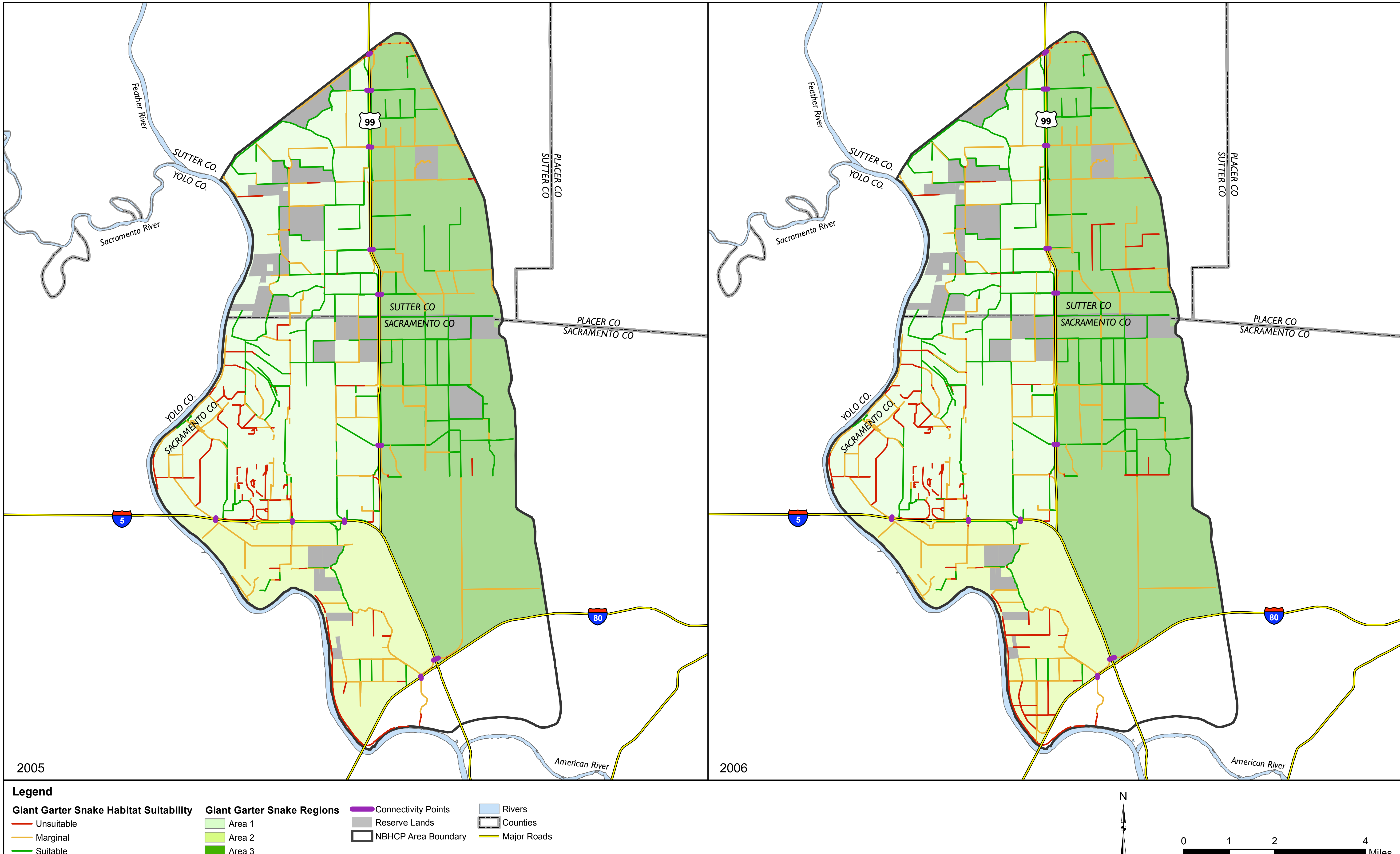


Changes in Mass of Giant Garter Snakes in the Natomas Basin, 2000–2006

04002.04 (03/07)

Jones & Stokes

Figure 3-5
Morphological Changes of Giant Garter Snakes in the Natomas Basin, 2004–2006



S:\GIS\PROJECTS\NBC\04002_04\ARCMAP\REPORT_2007\FIGURE3_5_GGS_CONNECTIVITY.MXD (02-15-07)

Jones & Stokes

Figure 3-6
Change in Giant Garter Snake Habitat Connectivity, 2005 — 2006

connective corridors between Area 1 and Area 2, and the degradation or loss of giant garter snake habitat (i.e., Meister Ditch and Airport East Ditch) within the SMF bufferlands.

The series of laterals emanating from the Lone Tree Canal culvert crossing at I-5 now provides the only functional connective corridor between Areas 1 and 2. However, even this connection is tenuous. The cessation of farming on the property that is bounded by I-5, Lone Tree Canal, Elverta Road, and SR-99 (the area is slated for development), in combination with the previously documented changes at the adjacent MAP property (Jones & Stokes 2006) has resulted in unpredictable and reduced water deliveries. With the exception of a pulse of water observed on September 7, the 1.9-kilometer (1.2-mile) section of Lone Tree Canal between Elkhorn Boulevard and the now partially piped Central Main Canal was completely dry, negating the connectivity of this corridor during 2006.

The East Drainage Canal provides the only connection between Areas 2 and 3 (Figure 3-5); although the NBHCP identified this feature as one that will remain in operation for the full term of the plan, this section constitutes 12 kilometers (7.6 miles) of disturbed channel surrounded by urban development. As such, this connection is largely unreliable; Lone Tree Canal, therefore, provides the only potentially viable connection between reserves south of I-5 and other regions within the Basin.

Areas 1 and 3 are connected by the V Drain, R Drain, H1 Drain, and the Central Main Canal through culverts passing under SR 99); each of these connects to a series of ditches, drains, and canals in their respective regions.

The footprint of proposed development under the South Sutter County Specific Plan at the boundary between Sacramento and Sutter Counties will span the Natomas Basin from Steelhead Creek on the eastern boundary of Area 3 to the North Drainage Canal in Area 1. These changes will affect the movement of giant garter snakes from habitats in the southern Basin to remaining habitats in Sutter County. While the development footprint will not cross the entire width of the Basin, it will interrupt all connective corridors between the North Drainage Canal and the eastern boundary of the study area.

Habitat Use

Slope was measured at most trap locations in 2005 and 2006, including 462 locations where giant garter snakes were captured during the 2 years combined. Most captures occurred in areas characterized by steep bank slopes. Giant garter snakes were captured at traps with steep-sided slopes significantly more frequently than expected (χ^2 = 19.95.1, df = 5, p < 0.001273).

Distance to terrestrial refuge habitat was measured at most trap locations in 2005 and 2006, including 445 locations where giant garter snakes were captured during the 2 years combined. Giant garter snakes were captured at traps placed closer to upland refugia habitat significantly more frequently than expected ($\chi^2 = 18.85$, df = 5, $p < 0.002049$).

An abundance of giant garter snake prey species was observed during trapping and survey efforts and in giant garter snake traps. Amphibian prey species included both larval and postmetamorphic bullfrogs and Pacific treefrogs. Fish prey species included a variety of bass, sunfish, common carp and other minnows, and mosquitofish. The numbers and densities of prey species observed at each trapline for which data were collected are summarized in Table 3-4.

3.4 Discussion

3.4.1 Population Assessment

The total numbers of individual giant garter snakes captured and overall capture success increased again in 2006. The increase in capture success in 2006 may reflect an actual increase in population size. However, other factors may also have caused or contributed to the increase in capture success. As noted above, approximately 30% of the individuals trapped in 2006 were captured in the Q Drain adjacent to the Bennett South, Huffman West, and Vestal Reserves. In contrast, only 14 individuals were trapped in the Q Drain during 2005, when the section of the drain adjacent to the Vestal Reserve was not available for trapping. The same unusual weather patterns—and thus habitat conditions—that were observed in 2005 occurred again in 2006: rain and cooler temperatures continued into late April, postponing rice field flooding until late May. Planted rice began emerging in the first 2 weeks of June and did not provide adequate cover until late June or early July. Giant garter snakes may therefore have occurred in higher than average densities in water conveyance channels and managed wetlands in April, May, and June, resulting in the higher frequency of captures in the first half of the season. Capture frequency decreased notably after the rice fields provided adequate cover in early July.

With the exception of the T Drain at Lucich North and Lateral 3A at Tufts, all areas where population estimates were available for both 2005 and 2006 showed an increase in population. While the increase in these estimates may reflect an actual increase in snake populations, the estimates should be interpreted with caution.

The statistical models used to estimate population size from mark recapture data assume the population being sampled is a *closed* population; that is, that neither immigration nor emigration occurs during the sampling period. Clearly, water conveyance features are highly interconnected, not only to one another but also to the rice fields they serve. Giant garter snakes are highly mobile, and vary significantly in their activity over time and between years. Accordingly, the closed population assumption is violated. The degree to which this violation of the assumption biases the estimates is unknown.

Table 3-4. Prey Densities at Natomas Basin Trap Locations, 2006

Transect ID	General Location	Trap Days	Tadpole	Density	Bullfrog	Density	Treefrog	Density	Fish	Density	Mosquitofish	Density	Crayfish	Density
DF2*	BKS – Silva Drift Fence	2,900	3	0.00103	0	0	0	0	5	0.00172	0	0	141	0.0486
DF3*	Frazer Wetland Drift Fence	800	10	0.0125	5	0.00625	0	0	17	0.0212	85	0.106	46	0.0575
RT1	Fisherman’s Lake	6,950	0	0	4	0.000576	0	0	32	0.00460	0	0	245	0.0353
RT2	Snake Alley	7,200	13	0.00181	4	0.000556	0	0	12	0.00167	4	0.000556	636	0.0883
RT3	T Drain (1)	4,750	85	0.0179	28	0.00590	0	0	19	0.00400	10	0.00211	175	0.0368
RT3b	T Drain (2)	1,600	11	0.00688	13	0.00812	0	0	0	0	0	0	132	0.0825
NP5	Atkinson – Highline Ditch	1,400	21	0.0150	1	0.000714	0	0	1	0.000714	0	0	307	0.219
NP6	Atkinson – North Drain	1,400	1	0.000714	1	0.000714	0	0	5	0.00357	0	0	162	0.116
NP11	Ayala – South Ditch	1,400	0	0	0	0	0	0	19	0.0136	6	0.00429	133	0.0950
NP16	Bennett North – North Ditch	1,400	0	0	0	0	0	0	25	0.0179	4	0.00286	354	0.253
NP22	Bennett South – Q Drain	1,400	56	0.0400	4	0.00286	0	0	11	0.00786	23	0.0164	210	0.150
NP28	BKS – Silva West Ditch	1,400	0	0	2	0.00143	0	0	26	0.0186	2	0.00143	267	0.191
NP29	BKS – Ditch N of Control Structure K	1,400	24	0.0171	97	0.0693	0	0	129	0.0921	43	0.0307	265	0.189
NP30	BKS – Silva West Marsh	1,400	0	0	5	0.00357	0	0	9	0.00643	5	0.00357	214	0.153
NP31	BKS – Marsh at Control Structure K	1,400	81	0.0579	64	0.0457	0	0	25	0.0179	6	0.00429	18	0.0129
NP35	Cummings – Wetland	1,400	15	0.0107	17	0.0121	0	0	18	0.0129	39	0.0279	104	0.0743
NP40	Frazer – Highline Ditch	1,400	3	0.00214	1	0.000714	0	0	4	0.00286	0	0	118	0.0843
NP41	Frazer – Marsh	1,400	27	0.0193	10	0.00714	1	0.000714	21	0.0150	24	0.0171	42	0.0300
NP43	Huffman East – Bennett Loop	1,400	3	0.00214	1	0.000714	2	0.00143	1	0.000714	0	0	143	0.102
NP45	Huffman West – Q Drain	1,400	3	0.00214	9	0.00643	0	0	3	0.00214	25	0.0179	126	0.0900
NP51	Lucich North – Marsh	1,400	351	0.251	3	0.00214	0	0	10	0.00714	34	0.0243	78	0.0557
NP57	Lucich South – North Drain	1,400	75	0.0536	1	0.000714	0	0	16	0.0114	1	0.000714	102	0.0729
NP58	Lucich South – Marsh	1,400	32	0.0229	13	0.00929	0	0	27	0.0193	18	0.0129	461	0.329
NP62	Sills – Highline Ditch	1,400	12	0.00857	0	0	1	0.000714	36	0.0257	0	0	363	0.259
NP63	Sills – Drain 13	1,400	4	0.00286	0	0	0	0	13	0.00929	27	0.0193	97	0.0693

Transect ID	General Location	Trap Days	Tadpole	Density	Bullfrog	Density	Treefrog	Density	Fish	Density	Mosquitofish	Density	Crayfish	Density
NP66	Natomas Farms	1,400	1	0.000714	2	0.00143	0	0	8	0.00571	21	0.0150	196	0.140
NP70	Tufts – Lateral 3A	1,400	21	0.0150	2	0.00143	0	0	7	0.00500	9	0.00643	141	0.101
NP86	Bolin North	1,400	5	0.00357	7	0.00500	1	0.000714	0	0	0	0	418	0.299
NP88	Rosa – West Drain	1,400	13	0.00929	1	0.000714	0	0	17	0.0121	0	0	163	0.116
NP90	Vestal – West Ditch (Q Drain)	1,400	1	0.000714	11	0.00786	0	0	13	0.00929	39	0.0279	127	0.0907
BP71	SCAS – AOA E Ditch	700	0	0	0	0	0	0	0	0	3	0.00429	178	0.254
BP72	SCAS – AOA W Ditch	350	0	0	0	0	0	0	0	0	0	0	241	0.689
BP73	SCAS – AOA S Ditch	350	0	0	0	0	0	0	0	0	10	0.0286	99	0.283
BP77	SCAS – Jacob Slough	700	0	0	4	0.00571	0	0	4	0.00571	12	0.0171	150	0.214
BP78	SCAS – Flume west of Powerline	1,400	18	0.0129	0	0	0	0	1	0.000714	2	0.00143	82	0.0586
BP81	Lone Tree Canal – Central Section	1,400	6	0.00429	3	0.00214	0	0	20	0.0143	0	0	670	0.479
BP89	SCAS – Meister Ditch	700	0	0	0	0	0	0	0	0	1	0.00143	213	0.304

* Signifies traps with 16 holes per inch of mesh compared to the standard 4 holes per inch; these traps capture larger number of small prey such as mosquitofish.

Key: Tadpole = *Rana catesbeiana* or *Hyla regilla;* Bullfrog = *Rana catesbeiana;* Treefrog = *Pseudacris regilla;* Fish = Sunfish (*Lepomis* spp.); Black basses (*Micropterus* spp0.); Carp (*Cyprinus carpio*); and Crappie (*Pomoxis* spp.); Mosquitofish = *Gambusia affinis;* Crayfish = *Procambarus clarkii*

Finally, comparison of population estimates across years must be undertaken with caution because population estimates are known to vary significantly depending on the timing and duration of the sampling period. For example, estimates of population size in 2004 for each month in the T Drain ranged from 27 (S.E. 12.3472; 95% C.I. = 14–95) to 8 (S.E. 0.8831; 95% C.I. = 8–11), while the population estimate using data pooled across the entire season was 46 (S.E. 3.8662; 95% C.I. = 42–58). This is likely due to seasonal variation in snake activity as well as variation in the relative abundance of snakes associated with changes in the distribution of suitable habitat through the season (e.g., as snakes move into rice fields as vegetation matures and becomes more suitable).

Beginning in 2004, sampling has been organized in 2-week periods to standardize sampling procedures such that estimates might be more comparable in future years. This approach reduces the bias associated with violation of the closed population assumption and makes comparisons of estimates across years more valid.

The number of individuals captured in managed wetlands in 2006 was comparable to that of 2005, despite the fact that the wetlands at Bennett South and Bennett North were not trapped this year. Of the 235 individuals trapped, 21.3% (n=50) were captured in managed wetlands. However, it should be noted that 60% (n=30) of the trap captures in managed wetland habitat occurred during the first half of the season when the amount of suitable rice habitat was limited. The percentage of captures in managed marsh versus other aquatic habitats in 2006 was similar to that of 2005 and 2004 (20% and 18%, respectively).

Regardless of the considerations discussed above, it is significant that while a larger proportion of captures continue to be recorded in linear drainage and irrigation features, giant garter snakes are utilizing managed marsh habitats within the Basin in notable numbers. The availability of managed marsh habitat at times when rice fields and other aquatic habitats are not available probably confers a significant advantage to giant garter snakes at an important time in the behavioral cycle—that is, when snakes emerge from winter dormancy and begin feeding, dispersing, and courting.

The average size of male giant garter snakes captured in 2006 increased slightly for the second year in a row, although the average size of females decreased slightly compared to those captured in 2005. Significant changes in the size distribution of giant garter snakes in the Natomas Basin are important because they could indicate a change in the age distribution and/or the health of the population.

The size of male giant garter snakes captured in the Basin by Hansen and Brode (1993) during the late 1980s and early 1990s averaged more than 100 millimeters (3.9 inches) longer than males captured in 2006 (665 millimeters [26.2 inches] versus 563 mm [22.2 inches], respectively). The size of female giant garter snakes captured during the same period averaged more than 240 millimeters (9.5 inches) longer than those captured in 2006 (886 millimeters [34.9 inches] versus 645 millimeters [25.4 inches], respectively) (U.S. Fish and Wildlife Service 1999).

However, this apparent trend could also be due to differences in sampling methodology. The hand-capture technique employed by Hansen and Brode (1993) likely selected for larger and more readily observable snakes, while the aquatic trapping techniques utilized since 2000 probably selects for smaller individuals (U.S. Fish and Wildlife Service 1999).

Giant garter snakes in the Natomas Basin and Middle American Basin, an area of rice agriculture immediately north of the Natomas Basin, appear to be smaller on average than giant garter snakes from other regions (Jones & Stokes 2006). Sampling techniques in all four areas were identical.

Taken together, these results indicate that the size, and thus the age distribution, of giant garter snakes in the Natomas Basin and Middle American Basin may be shifting to reflect a higher proportion of the smaller size classes. There are two possible explanations for this, each associated with different population trajectories. The first explanation is that the number of large female giant garter snakes is decreasing. Fecundity (the number of offspring produced) in this species is positively correlated with size; larger snakes produce more offspring (Hansen and Hansen 1990). Any decrease in the number of female giant garter snakes of larger size classes would result in diminished recruitment and a downward population trajectory, affecting the viability of the giant garter snake population in the Basin over time. The second explanation is that the number of small individuals is increasing. This would indicate increased recruitment and/or survivorship and a rising population trajectory.

Recent studies have demonstrated a higher survival rate for female than for male garter snakes (Lind et al. 2005). The shift in the size distribution of female giant garter snakes in the Basin and lack of a shift in males noted above are consistent with the hypothesis that the proportion of individuals in younger age classes have increased in the Natomas Basin population, suggesting a potential increase in survivorship and/or population recruitment.

3.4.2 Habitat Assessment

Habitat Connectivity

To achieve the goals and objectives of the NBHCP pertaining to giant garter snake, it is critical that areas of suitable habitat be interconnected. Figure 3-5 provides graphical representations of habitat suitability along linear water conveyance structures that can be used to identify those corridors most critical to maintaining connectivity between habitats known to be occupied by giant garter snakes.

Connective corridors linking habitats north and south of I-5 are seriously threatened by changes in land use and development; north-south corridors in the eastern half of the Basin are similarly threatened. If aquatic connectivity is lost, the system of reserve lands could become isolated patches of habitat containing small, discrete snake populations.

The negative impacts of small population size and isolation have been well documented; these include, among others, increased probability of extinction from random, catastrophic events and loss of genetic variation. Genetic divergence can potentially occur in a short time and may result from seemingly simple impacts, such as widened roads. Genetic research conducted by Melanie Paquin at California State University San Francisco in conjunction with USGS indicates that divergence of this kind may have already occurred to some extent in giant garter snakes in areas separated by the major highways that transect the Basin (Paquin 2001).

Habitat Use

Giant garter snakes require upland habitat with grassy banks for basking adjacent to aquatic habitat (U.S. Fish and Wildlife Service 1999). Studies have shown that giant garter snakes prefer aquatic habitat with banks riddled with cracks, rodent burrows, and crayfish burrows, and that they typically do not occupy areas devoid of these characteristics (Brode and Hansen 1992; Hansen and Brode 1993). Analysis of habitat characteristics at locations where giant garter snakes were captured support the hypothesis that giant garter snakes prefer areas with steep bankside slopes and aquatic habitats close to potential upland refuge habitats. This may be due to the fact that in areas with steeply sloping banks, upland habitats used for basking and refuge are closer to aquatic habitat used for foraging and escape cover.

3.5 Effectiveness

Biological effectiveness is measured on the basis of acquisition of reserve lands and land management activities designed to meet the goals and objectives outlined in the NBHCP for giant garter snake.

In 2006, TNBC exchanged the 242-acre Brennan tract for the Nestor and Bolen West tracts. These two properties comprise 388 acres and significantly contribute to achieving the reserve consolidation goals established in the NBHCP. In addition, monitoring results to date strongly indicate that overall trapping success in the Basin will be significantly enhanced as a result of this exchange, where two relatively unproductive properties (in terms of number of snakes captured) are being exchanged for two properties where capture success is likely to be quite high.

As noted above in *Habitat Use*, data collected over the last 3 years are consistent with the hypothesis that giant garter snakes may respond positively in some situations to the placement of banks with steep slopes and nearby potential upland refugia.

After consultation with the biological effectiveness monitoring team and in accordance with their recommendations, TNBC modified the design of the Cummings Reserve west of Fisherman's Lake in the southern portion of the

Natomas Basin to emphasize a greater proportion of steep slopes in bank construction. The Bennett South and Souza/Natomas Farms Reserves and portions of the BKS and Lucich North Reserves were also modified in 2006 to provide additional steeply sloping banks.

Giant garter snakes were captured for the first time in 2006 in created wetland habitat on the Cummings Reserve, and appear to be doing very well in the managed marshes on other reserve lands. The managed marshes provided critical aquatic habitat in 2006 at a time when aquatic habitats were limited by delays in rice planting in the Basin.

3.6 Recommendations

- Continue to incorporate steeper slopes or other design features that increase the proximity of bankside and aquatic habitats into future reserves, as allowed for in the SSMPs.
- Continue selective installation of steep-sided bankside habitats as appropriate on existing reserves.
- Continue efforts to reduce colonization of open water habitats by emergent vegetation and to control invasive aquatic weeds.
- Prioritize and give high consideration to the acquisition of reserves that protect movement corridors and promote further consolidation of reserve lands. The canals and ditches in the Basin serve an important role in giant garter snake movement, providing a critical linkage among reserves and other occupied habitats.

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Chapter 4
Swainson's Hawk

4.1 Introduction

4.1.1 Background

The NBHCP and its Implementing Agreement require that an annual survey of nesting Swainson's hawks be conducted throughout the Basin (Chapter VI, Section E [2][a][1] of the 2003 NBHCP). In compliance with the conditions described in the NBHCP, this chapter summarizes the results of surveys for Swainson's hawk in the Natomas Basin from 1999 to 2006.

It should be noted that the study area in the context of this species differs slightly from the study area used in all other surveys. For the purposes of conducting Swainson's hawk population monitoring, the study area was expanded in 2001 to include the far side of the peripheral water bodies (i.e., the Sacramento River, Steelhead Creek, and the Natomas Cross Canal) because these areas support nesting habitat for birds that forage within the Basin. Moreover, individual pairs may use alternate nest sites within given territories that span these water bodies. This expanded study area is referred to as the Basin in this chapter.

4.1.2 Goals and Objectives

Monitoring efforts for Swainson's hawk are designed to assess the progress of the NBHCP toward meeting the Plan's goals and objectives for Swanson's hawk populations and the habitats they use. The Swainson's hawk monitoring surveys are designed to achieve the following specific objectives.

- Document the numbers, distribution, density, and reproductive success of the Swainson's hawk population in the Basin.
- Conduct surveys in a systematic and repeatable manner that will ensure detection of all active Swainson's hawk nests in the Basin from year to year.
- Document changes in land use and availability of foraging habitats throughout the Basin over time.

4.1.3 Life History

Status and Range

Swainson's hawk (Figure 4-1) inhabits grassland plains and agricultural regions of western North America during the breeding season and winters in grassland and agricultural regions from Central Mexico to southern South America (England et al. 1997; Bradbury et al. in preparation). Early accounts described Swainson's hawk as one of the most common raptors in the state, occurring throughout much of lowland California (Sharp 1902). Since the mid-1800s, the native habitats that supported the species have undergone a gradual conversion to agricultural uses. Today, native grassland habitats are virtually nonexistent in the state, and only remnants of the once vast riparian forests and oak woodlands still exist (Katibah 1983). This habitat loss has caused a substantial reduction in the breeding range and in the size of the breeding population in California (Bloom 1980; England et al. 1997). Swainson's hawks are also sensitive to habitat fragmentation and avoid low-density development (e.g., parcels with improvements subdivided to less than 10 acres [4 hectares]) even though suitable prey conditions may exist (Estep and Teresa 1992). However, Swainson's hawks are also known to re-inhabit dense urban areas to nest if suitable nesting trees are present and suitable foraging habitat exists within 3.2 kilometers (2 miles) of the nest (England et al. 1995). The state currently supports between 700 and 1,000 Swainson's hawk breeding pairs (Swainson's Hawk Technical Advisory Committee file data), which is less than 10% of the historic population (Bloom 1980).

The Central Valley population (between 600 and 900 breeding pairs) extends from Tehama County south to Tulare and Kings Counties. The optimum foraging and nesting habitat conditions in portions of Yolo, Sacramento, and San Joaquin Counties support the bulk of this Central Valley population (Estep 1989, in preparation) (Figure 4-2). The Central Valley is surrounded by mountains—the Sierra Nevada on the east and the Cascade Range on the north—that geographically isolate it from the rest of the species' range. Extensive banding (Estep 1989, unpublished data; Anderson unpublished data; Bloom unpublished data; Woodbridge unpublished data) suggests that no movement occurs between the Central Valley breeding population and other populations. Results of satellite radiotelemetry studies of migratory patterns further indicate little to no interaction between the Central Valley population and other populations of Swainson's hawks (Bradbury et al. in preparation).

Despite the loss of native habitats in the Central Valley, Swainson's hawks appear to have adapted relatively well to certain types of agricultural patterns in areas where suitable nesting habitat remains (Figure 4-3). However, nesting habitat for Swainson's hawks continues to decline in the Central Valley because of flood control projects, agricultural practices, and urban expansion.

Light morph adult Swainson's Hawk

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Figure 4-1
Adult Swainson's Hawk

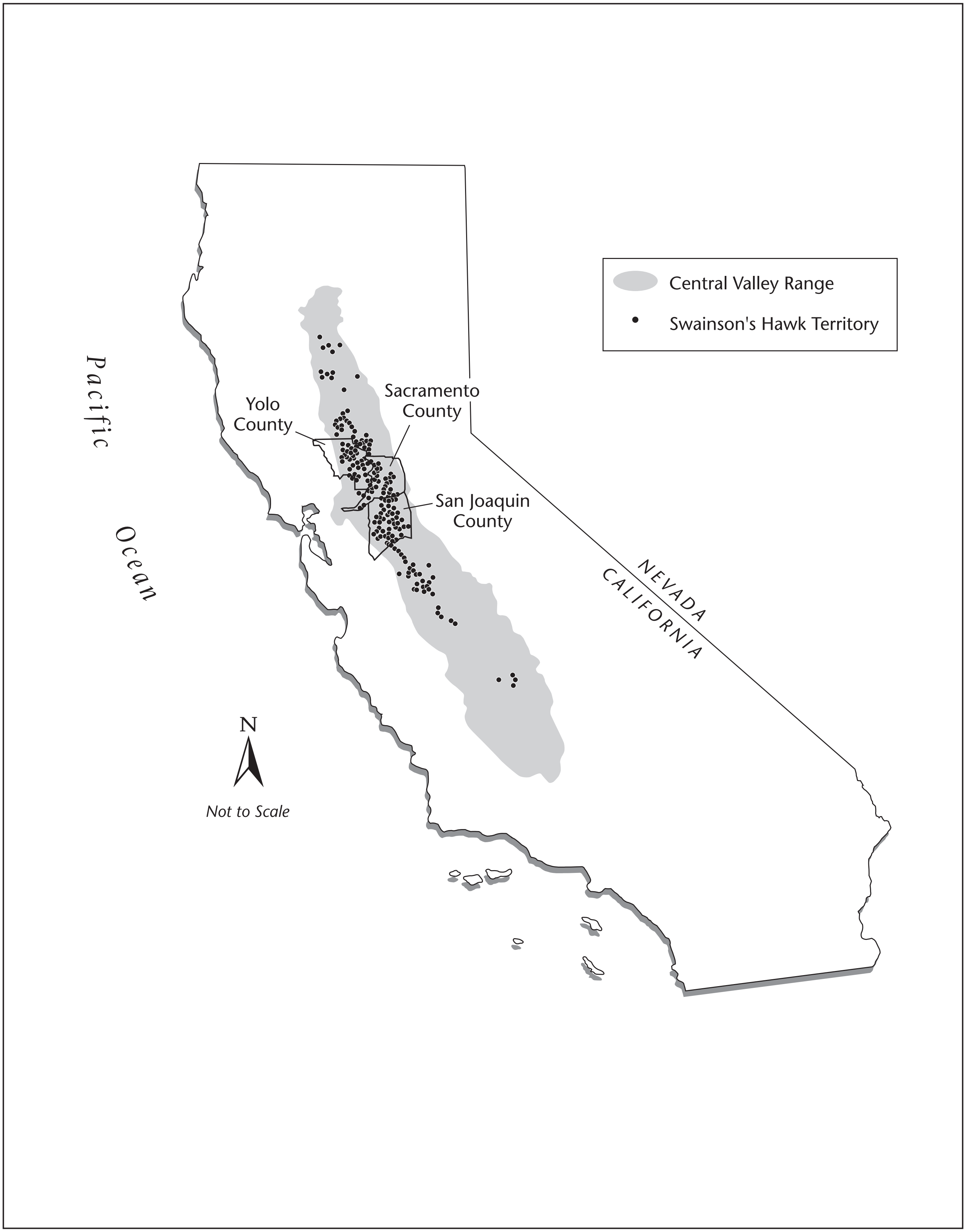

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Figure 4-2
Distribution of Swainson's Hawk in the Central Valley of California

Typical Swainson's hawk nesting and foraging habitat
in the Central Valley

Typical Swainson's hawk nest

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Figure 4-3
Swainson's Hawk Nesting Habitat

Swainson's hawk nest with eggs

Nestling Swainson's hawks

Nearly fledged Swainson's hawks

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Figure 4-4
Swainson's Hawks in the Nest

Habitat Use

Swainson's hawks usually nest in large native trees such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontii*), walnut (*Juglans* spp.), and willows (*Salix* spp.), and occasionally in nonnative trees, such as eucalyptus (*Eucalyptus* spp.). Nests occur in riparian woodlands, roadside trees, trees along field borders, isolated trees, small groves, and on the edges of remnant oak woodlands. Stringers of remnant riparian forest along drainages contain the majority of known nests in the Central Valley (Estep 1984; Schlorff and Bloom 1984; England et al. 1997). However, this is a function of nest tree availability rather than dependence on riparian forest. Nests are usually constructed as high as possible in the tree, providing protection to the nest as well as visibility from it (Figure 4-3).

Nesting pairs are highly traditional in their use of nesting territories and nesting trees. Many nest sites in the Central Valley have been occupied annually since 1979 (Estep unpublished data), and banding studies conducted since 1986 confirm a high degree of nest and mate fidelity (Estep in preparation).

In the Central Valley, Swainson's hawks feed primarily on small rodents, usually in large fields that support low vegetative cover (to provide access to the ground) and high densities of prey (Bechard 1982; Estep 1989). These habitats include hay fields, grain crops, certain row crops, and lightly grazed pasturelands. Fields lacking adequate prey populations (e.g., flooded rice fields) or those that are inaccessible to foraging birds (e.g., vineyards and orchards) are rarely used (Estep 1989; Babcock 1995). Urban expansion and conversion to unsuitable crop types (e.g., vineyards and orchards) are responsible for a continuing reduction of available Swainson's hawk foraging habitat in the Central Valley.

Breeding Season Phenology

Swainson's hawks arrive at the breeding grounds from early March to early April. Breeding pairs immediately begin constructing new nests or repairing old ones. Eggs are usually laid in mid- to late April, and incubation continues until mid-May when young begin to hatch. The brooding period typically continues through early to mid-July when young begin to fledge (England et al. 1997). Studies conducted in the Sacramento Valley indicate that one or two—and occasionally three—young typically fledge from successful nests, with an average of 1.4–1.8 young per successful nest (Estep in preparation) (Figure 4-4). After fledging, young remain near the nest and are dependent on the adults for about 4 weeks, after which they permanently leave the breeding territory (Anderson et al. in progress). By mid-August, breeding territories are no longer defended, and Swainson's hawks begin to form communal groups. These groups begin their fall migration from late August to mid-September. Unlike the rest of the species, which migrates to southern Argentina for the winter, the Central Valley population winters primarily in Central Mexico and, to a lesser extent, throughout portions of Central and South America (Bradbury et al. in preparation).

4.2 Methods

4.2.1 Population Assessment

Surveys were conducted by systematically driving all available roads within the NBHCP survey area. The survey area is defined as the NBHCP area and both sides of all peripheral drainages: the Sacramento River, Natomas Cross Canal, and Steelhead Creek. Where roads were not available to drive (e.g., the levee road along the Cross Canal), or where there were no roads to access potential nest trees, the surveys were conducted on foot. All potential nesting trees were searched for nests and adult Swainson's hawks using binoculars and/or a spotting scope.

Surveys were conducted in three phases. Phase one surveys were conducted early in the breeding season (late March to mid-April) to detect Swainson's hawk activity at previously known nest sites as well as in all other suitable nesting habitats, and to detect early nest failures that might otherwise be missed. All suitable nesting habitats were checked for the presence of adult Swainson's hawks and to note nesting activity and behavior (e.g., nest construction, courtship flights, defensive behavior). Activity was noted and mapped on field maps; locations of active nests were documented using a GPS unit.

Phase two surveys were conducted in mid-May through June to determine if potentially breeding pairs detected during phase one surveys were actively nesting, and to resurvey all previously unoccupied potential nesting habitat for late-nesting pairs.

Phase three surveys were conducted in July to determine nesting success and record the number of young fledged per nest.

An active territory is defined as a nest site that was occupied in 2006 by a pair of Swainson's hawks, regardless of the reproductive outcome. A successful nest is defined as a nest in which young were fledged. A failed nest is defined as one in which no young were fledged.

Incidental observations, such as foraging, roosting, and other sightings of adult Swainson's hawks, were also noted.

4.2.2 Habitat Assessment

The distribution and abundance of vegetation and habitat types throughout the Basin, both on and off reserve lands, are documented annually (see Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring*). These data are used to document any changes in the distribution and abundance of suitable Swainson's hawk foraging habitat on reserve lands and throughout the Basin.

4.3 Results

4.3.1 Population Assessment

Swainson's hawks nested primarily in the southern portion and along the far western and northern edges of the Basin in 2006. These areas support both suitable nesting and foraging habitat: potential nesting trees are distributed along roadsides, in remnant riparian and oak woodlands, and as isolated trees; and foraging habitat is present in the upland row crops that dominate this part of the Basin. Conversely, most of the Basin north of Elkhorn Boulevard and east of Powerline Road is less suitable for nesting or foraging Swainson's hawks because it is dominated by rice production, which provides limited foraging value, and because there are relatively few potential nesting trees in this area.

A total of 94 Swainson's hawk nesting territories were monitored in 2006 (Table 4-1). Among these are two new territories along the Sacramento River (NB-93 and NB-94).

Table 4-1. Results of 2006 Swainson's Hawk Surveys, Natomas Basin Habitat Conservation Plan Area

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species[2]
NB-1	A-S	1	Urban	Valley Oak
NB-2	A-F	0	Ornamental	Cottonwood
NB-3	NLE	0	Nesting habitat removed in 2003	None
NB-4	I	0	Riparian	Cottonwood
NB-5	I	0	Riparian	Willow
NB-6	I	0	Ornamental	Eucalyptus
NB-7	NLE	0	Nest trees removed in 2002	None
NB-8	A-S	2	Field Border	Walnut
NB-9	I	0	Channelized riparian	Cottonwood
NB-10	I	0	Riparian	Cottonwood
NB-11	A-X	0	Riparian	Willow
NB-12	A-S	1	Riparian	Cottonwood
NB-13	I	0	Riparian	Cottonwood
NB-14	A-S	1	Ornamental	Eucalyptus
NB-15	NLE	0	Nesting habitat removed in 2002	None
NB-16	I	0	Oak grove	Valley oak
NB-17	NLE	0	Lone tree, removed in 1998	None
NB-18	I	0	Isolated tree	Cottonwood
NB-19	I	0	Tree along irrigation canal	Willow
NB-20	NLE	0	Nest tree removed in 2002	None
NB-21	A-F	0	Riparian	Cottonwood

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species[2]
NB-22	I	0	Tree along irrigation canal	Cottonwood
NB-23	A-S	1	Riparian	Willow
NB-24	A-S	2	Riparian	Valley Oak
NB-25	I	0	Riparian	Walnut
NB-26	NLE	0	Nesting habitat removed in 2002	None
NB-27	A-S	2	Riparian	Cottonwood
NB-28	A-S	2	Riparian	Cottonwood
NB-29	I	0	Riparian	Willow
NB-30	A-S	2	Riparian	Cottonwood
NB-31	A- F	0	Riparian	Cottonwood
NB-32	A- S	1	Riparian	Cottonwood
NB-33	A- S	1	Riparian	Cottonwood
NB-34	I	0	Riparian	Cottonwood
NB-35	I	0	Riparian	Cottonwood
NB-36	I	0	Riparian	Cottonwood
NB-37	I	0	Riparian	Cottonwood
NB-38	A- S	2	Riparian	Cottonwood
NB-39	A- F	0	Riparian	Cottonwood
NB-40	A- S	2	Riparian	Cottonwood
NB-41	I	0	Riparian	Cottonwood
NB-42	I	0	Riparian	Cottonwood
NB-43	I	0	Riparian	Cottonwood
NB-44	A- S	1	Riparian	Cottonwood
NB-45	A-X	0	Riparian	Sycamore
NB-46	I	0	Riparian	Cottonwood
NB-47	A-S	1	Riparian	Cottonwood
NB-48	I	0	Riparian	Valley oak
NB-49	A- F	0	Riparian	Cottonwood
NB-50	I	0	Riparian	Sycamore
NB-51	A-S	1	Riparian	Cottonwood
NB-52	A-S	2	Riparian	Cottonwood
NB-53	A-S	2	Riparian	Cottonwood
NB-54	I	0	Riparian	Cottonwood
NB-55	A-S	1	Riparian	Cottonwood
NB-56	I	0	Riparian	Cottonwood
NB-57	A-S	1	Riparian	Valley Oak
NB-58	I	0	Riparian	Cottonwood
NB-59	A-X	0	Riparian	Cottonwood
NB-60	I	0	Riparian	Cottonwood

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species[2]
NB-61	A-S	1	Riparian	Cottonwood
NB-62	I	0	Riparian	Cottonwood
NB-63	A-S	1	Isolated Tree	Willow
NB-64	A-S	1	Riparian	Cottonwood
NB-65	I	0	Riparian	Cottonwood
NB-66	A-S	2	Riparian	Cottonwood
NB-67	I	0	Riparian	Valley oak
NB-68	A-S	2	Riparian	Cottonwood
NB-69	I	0	Ornamental	Willow
NB-70	I	0	Riparian	Valley oak
NB-71	I	0	Riparian	Cottonwood
NB-72	I	0	Riparian	Cottonwood
NB-73	I	0	Tree row	Ornamental conifer
NB-74	I	0	Roadside tree	Willow
NB-75	A- S	1	Riparian	Cottonwood
NB-76	NLE	0	Trees removed in 2004	Cottonwood
NB-77	I	0	Riparian	Cottonwood
NB-78	I	0	Riparian	Cottonwood
NB-79	I	0	Riparian	Sycamore
NB-80	A-F	0	Riparian	Cottonwood
NB-81	I	0	Isolated tree	Cottonwood
NB-82	A-S	2	Riparian	Willow
NB-83	A-S	2	Riparian	Willow
NB-84	I	0	Riparian	Cottonwood
NB-85	A- S	2	Riparian	Cottonwood
NB-86	A- S	1	Riparian	Cottonwood
NB-87	A-X	0	Riparian	Cottonwood
NB-88	A-S	2	Riparian	Cottonwood
NB-89	I	0	Riparian	Cottonwood
NB-90	I	0	Riparian	Willow
NB-91	A-S	2	Riparian	Cottonwood
NB-92	A-F	0	Riparian	Cottonwood
NB-93	A-F	0	Riparian	Cottonwood
NB-94	A-F	0	Riparian	Cottonwood

[1] A = active; I = inactive; NLE = no longer extant; S = successful; F = failed; X = did not nest.

[2] For territories designated as I, NLE, or X in 2006, tree species shown reflect last active nest tree.

Of the 94 known nesting territories in the survey area, 45 were active and 49 were inactive (i.e., neither adult was observed on the nesting territory) in 2006. Of the 45 active sites, 32 were occupied by breeding pairs that successfully nested (i.e., reared young to fledging), producing a total of 48 fledglings (Table 4-2). Pairs that did not successfully reproduce included nine that nested but failed to rear young to fledging and four that occupied the territory but did not nest.

Table 4-2. Reproductive Data for Active Swainson's Hawk Territories in the Natomas Basin Habitat Conservation Plan Area, 1999–2006

Year	Number Active Territories	Number Successful Nests	Number Failed Nests	Number Active but not Nesting	Number Active with Unknown outcome	Number Young Reared to Fledging	Number Young per Active Territory[b]	Number Young per Occupied Nest[b]	Number Young per Successful Nest
1999[a]	15	14	1	0	0	25	1.67	1.67	1.79
2000[a]	18	10	4	4	0	20	1.11	1.43	2.00
2001	46	24	15	7	0	40	0.87	1.03	1.67
2002	43	24	11	7	1	38	0.90	1.09	1.58
2003	54	34	15	4	1	53	1.00	1.08	1.56
2004	59	39	12	4	4	54	0.98	1.05	1.38
2005	45	31	11	1	2	48	1.12	1.14	1.55
2006	45	32	9	4	0	48	1.07	1.17	1.50

[a] Years 1999 and 2000 do not include the Sacramento River territories.
[b] Excluding *Number Active with Unknown Outcome*.

Changes in the number of active Swainson's hawk nesting territories, the number of successful nests, and the number of young fledged from 2000 to 2006 are depicted in Figure 4-5. The number of active territories and the total number of young fledged showed no change from 2005 to 2006, while the number of successful nests increased by one.

Changes in the number of young fledged per active territory, per occupied territory, and per successful nest are depicted in Figure 4-6. There were no significant changes in reproductive performance from 2005 to 2006, and no significant trends have been observed since monitoring using the current protocols began in 2000.

A total of seven Swainson's hawk nest sites have been removed since the implementation of the NBHCP; however, no removal of historically active nesting sites was documented in 2006.

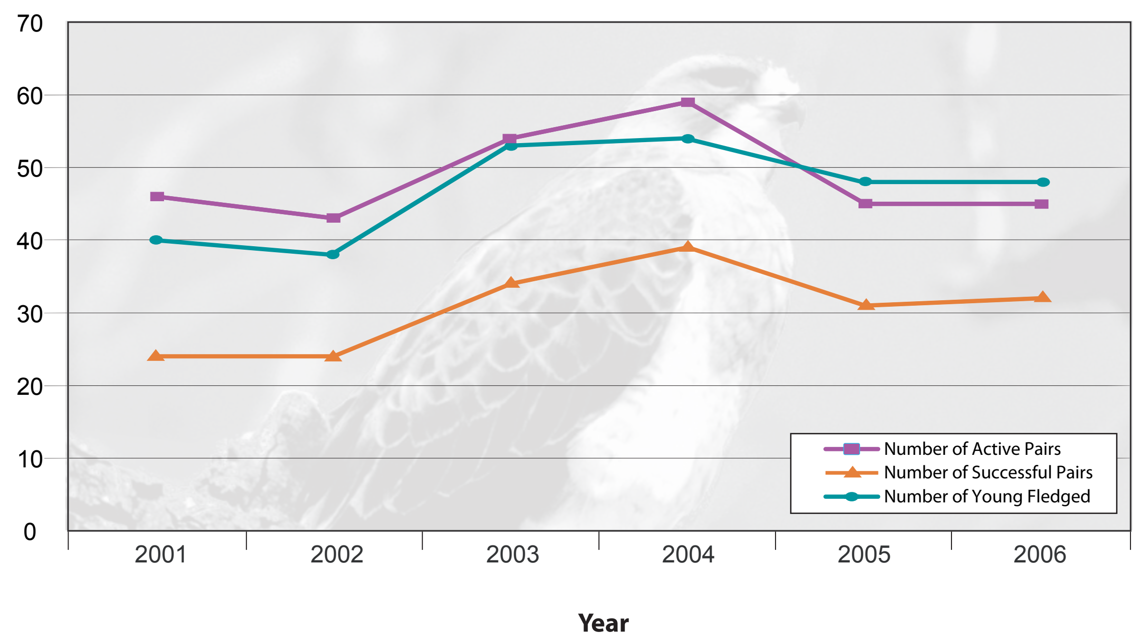

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Figure 4-5
Active Swainson's Hawk Territories 2001–2006

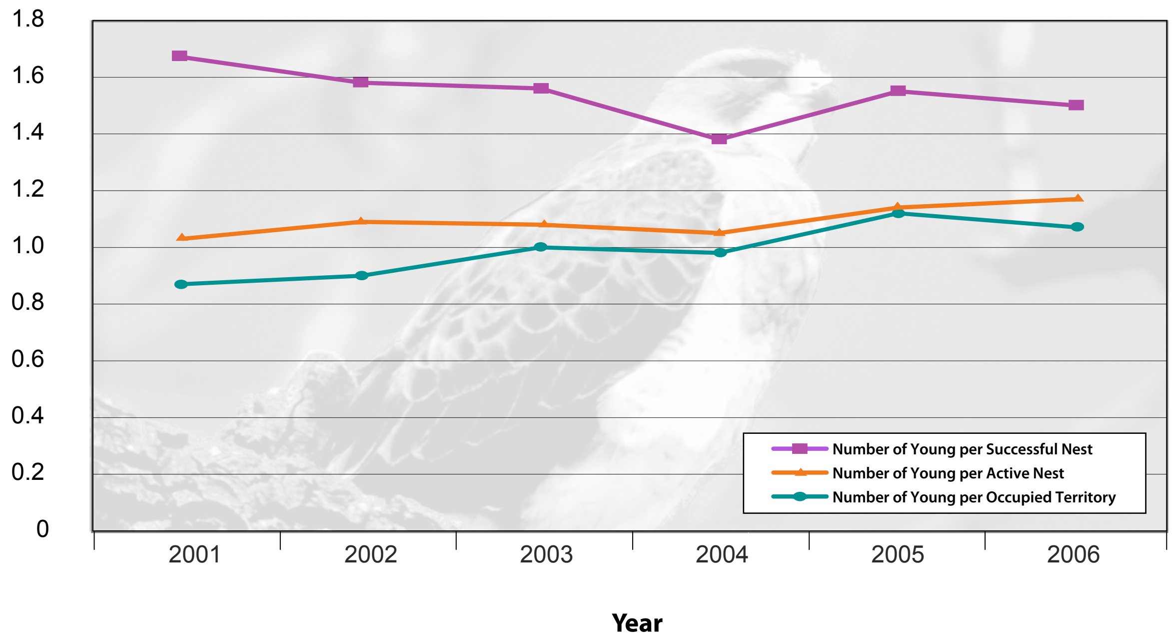

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Figure 4-6
Swainson's Hawk Reproductive Success 2001–2006

4.3.2 Habitat Assessment

Table 4-3 lists the habitat types in the Basin that provide suitable Swainson's hawk foraging habitat and their acreages from 2004 to 2006. Suitable habitat types include both cultivated and uncultivated lands. Suitable cultivated habitats comprise alfalfa and row, grain, and other hay crops. Suitable uncultivated habitats comprise irrigated pasture and other non-irrigated grasslands and pastures. The relative foraging value of the different types depends on prey density and availability, but all have foraging value; collectively, these habitat types provide an important diversity of foraging habitats in portions of the Basin. While other habitat types are occasionally used for foraging, their value is generally considered to be less than that of the habitat types listed above.

Table 4-3. Suitable Swainson's Hawk Foraging Habitat in the NBHCP Area 2004–2006 (acres)

Cover Type	2004	2005	2006
Alfalfa	610	931	1,356
Row, grain, and other hay crops[a]	7,591	7,477	6,834
Irrigated pasture	776	452	374
Grasslands	7,847	7767	7,263
Total	**16,824**	**16,627**	**15,827**

[a] Includes acres on reserve lands used to grow rice the previous year but are currently in transition to upland crops.

In 2006, approximately 15,827 acres (6,405 hectares), or 29% of the entire Basin, were in land cover types considered suitable Swainson's hawk foraging habitat, a decrease of about 800 acres (324 hectares) (4.8%) from 2005 (Table 4-3). This change was due primarily to the conversion of grasslands and upland agriculture to developed or disturbed (graded) habitats. As of 2006, the amount of suitable Swainson's hawk foraging habitat in the Basin has been reduced by approximately 27.8% (from a total of 21,908 acres reported in 2002) since implementation of the NBHCP (City of Sacramento 2003). The distribution of suitable foraging habitat in the Basin is depicted in Figure 4-7.

However, the extent of alfalfa, a cover type considered to be optimal foraging habitat for Swainson's hawk, increased by approximately 426 acres (172 hectares) in 2006. This increase resulted from crop rotation patterns—that is, more of the non-reserve lands in row and field crop production were rotated into alfalfa production than out of it.

Table 4-4 lists the habitat types on reserve lands that provide suitable Swainson's hawk foraging habitat and their acreages by reserve in 2006. The reserve system currently accounts for approximately 8% of the suitable Swainson's hawk foraging habitat in the Basin. Consequently, the extent to which TNBC-managed land will help sustain the Swainson's hawk population in the Basin is not yet determined.

Table 4-5 lists the extent and proportion of the various categories of suitable Swainson's hawk foraging habitat on reserve and non-reserve lands in 2006. The proportion of Swainson's hawk foraging habitat in higher-value crop types (i.e., alfalfa) on reserve lands is similar to the corresponding proportion on non-reserve lands (8% versus 9%).

Table 4-4. Extent (acres) of Swainson's Hawk Foraging Habitat on TNBC Reserves, 2006

Reserve	Alfalfa	Row, Grain, and Other Hay Crops*	Irrigated Pasture	Grasslands	Total
Alleghany	27	19	—	2	48
Atkinson	—	123	—	25	148
Ayala	—	—	—	—	0
Bennett North	—	—	—	5	5
Bennett South	—	—	—	22	22
Betts-Kismat-Silva	—	—	37	150	187
Bolen North	—	—	—	—	0
Bolen South	—	102	—	—	102
Brennan	—	—	—	87	87
Cummings	—	18	—	10	28
Frazer	—	—	—	18	18
Huffman East	—	15	—	—	15
Huffman West	64	107	—	—	171
Lucich North	—	—	—	34	34
Lucich South	—	—	—	3	3
Natomas Farms	—	44	—	16	60
Rosa Central	—	97	—	—	97
Rosa East	—	104	—	—	104
Ruby Ranch	—	87	—	4	91
Sills	—	—	—	—	0
Souza	11	29	—	—	40
Tufts	—	—	—	—	0
Vestal	—	—	—	—	0
Total	**102**	**745**	**37**	**376**	**1,260**

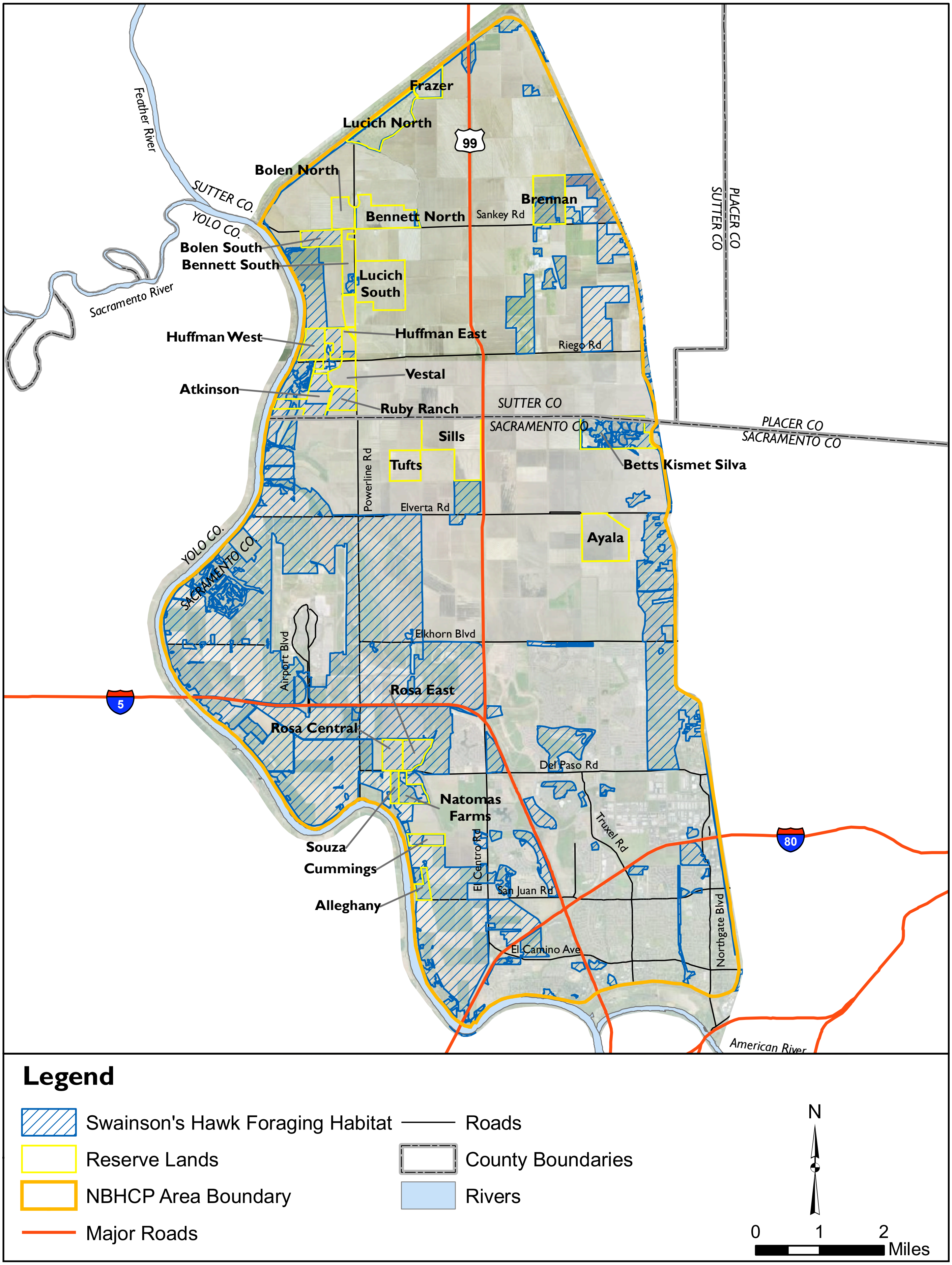

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Figure 4-7
Suitable Swainson's Hawk Foraging Habitat in the Natomas Basin, 2006

Reserve	Alfalfa	Row, Grain, and Other Hay Crops*	Irrigated Pasture	Grasslands	Total

* In 2006, the Row, Grain, and Other Hay Crops category consisted of grass hay, wheat, and fallow upland fields.

The proportion of habitats in row, grain, and other hay crops was higher on reserve lands than on non-reserve lands in 2006 (59% versus 42%) while the proportion of lands in grasslands habitats was much lower on reserve lands than non-reserve lands.

Table 4-5. Extent (acres) and Proportion (%) of Suitable Swainson's Hawk Foraging Habitat on and off TNBC Reserve Lands, 2006

	Alfalfa	Row, Grain, and Other Hay Crops	Irrigated Pasture	Grasslands	Total
On-reserve acreage	102	745	37	376	1,260
On-reserve percentage of cover type	8	59	3	30	100
Off-reserve acreage	1,254	6,089	337	6,887	14,567
Off-reserve percentage of cover type	9	42	2	47	100

4.4 Discussion

Based on the number of active territories and reproductive performance in 2006, there were no significant changes in the status of the Natomas Basin nesting population (Figures 4-5 and 4-6). However, the number of active territories in 2006 was similar to the number in 2005, which showed a relatively significant decrease compared with the previous 2 years (14 fewer than in 2004) (Table 4-2, Figure 4-5).

While the number of occupied territories decreased significantly in 2005 and remained at that reduced level in 2006, the magnitude of the overall change remains within the range of variation documented over the last 6 years, and no significant trends in population size have been noted (Table 4-2, Figure 4-5).

Overall reproductive performance (i.e., number of young fledged per occupied nest and number of young per successful nest) was also similar to that of 2005 and has remained relatively stable since 1999 (Table 4-2, Figure 4-6). Overall reproductive performance has remained relatively stable from 1999 to 2006, and is generally consistent with that of the Sacramento Valley population as a whole since the mid-1980s (Estep in preparation).

As in 2005, early spring storms and local flooding may have contributed to the continued low territory occupancy rate (compared with 2003 and 2004).

Swainson's hawk populations throughout much of the Central Valley appeared to be similarly affected.

The decrease evidenced in 2005 and 2006 may also be due in part to the abandonment of nesting territories in the south Basin, where the majority of urbanization in the City of Sacramento has occurred (Figure 4-7). Of the 23 territories in the interior of the Basin (i.e., not including sites along the perimeter channels) south of Elkhorn Road that were monitored from 1999 to 2006, five are considered no longer extant due to nest tree removal, and 13 were inactive. Of these 13, 11 have been inactive for 3 or more consecutive years. In other words, the bulk of the nesting population is becoming increasingly concentrated along the perimeter channels, while fewer active nests are found in the Basin interior—particularly in the south Basin—as development activities continue to remove habitat.

Nest tree removal has contributed to the reduction in nesting territories in the south Basin. As planned and proposed development continues, additional nesting pairs will likely be displaced, and foraging habitat will continue to be reduced in the Basin.

Continuing loss of trees limits future nesting opportunities and the ability of the Swainson's hawk population to respond to habitat changes throughout the Basin. Sacramento County has continued to allow residential development on the river side of the Sacramento River levee, accelerating tree loss as riparian vegetation is cleared for home sites. Several new home construction projects contributed to additional tree loss along the river in 2006. This loss of potential nesting trees and the increase in human disturbance along the river will likely result in additional territory abandonment and will limit opportunities for relocation of displaced nesting pairs and the establishment of new nesting sites.

In addition, the Sacramento County Airport System (SCAS) is proposing to remove trees on airport lands that are considered potential hazard trees due to bird use in keeping with standard FAA regulations (County of Sacramento 2006). While these actions may be warranted to meet FAA safety regulations, it could result in the removal of a substantial number of mature trees, including sites known to be used as nest sites.

4.5 Effectiveness

Biological effectiveness as it pertains to Swainson's hawk is measured on the basis of acquisition of reserve lands and management activities that meet the goals for Swainson's hawk habitat, as well as the population's response to these actions. It is also measured on the basis of successful implementation of management recommendations designed to further benefit Swainson's hawk through targeted acquisition or specific land management activities.

As discussed above, the status of the Swainson's hawk population in the Basin remains stable. While it is too early to reach conclusions regarding the overall effectiveness of the operating conservation program in conserving the population of Swainson's hawks that nest in the Basin, to date there have been no significant changes in the Basin-wide population beyond the expected loss of habitat and nesting pairs within development areas.

Swainson's hawk habitat goals continue to be met through establishment of suitable upland habitat on reserves. Site-specific management activities have been undertaken for purposes of maximizing habitat potential for Swainson's hawk. For example, grazing activities on the BKS Reserve are designed to maintain grass heights at optimal levels for foraging raptors, and reserves producing upland crops have long-term crop/fallow programs to maximize production of rodent prey (see the SSMPs for details).

As discussed in Section 4.4, reserve lands managed for Swainson's hawk foraging habitat continue to provide a high proportion of high-value cover types (i.e., alfalfa). In addition, TNBC has experimented with growing crop types with high value to Swainson's hawks on marginal soils to further enhance the value of upland habitat for Swainson's hawks and to broaden the repertoire of management options available for providing high quality foraging habitat.

Swainson's hawk habitat has been a key consideration in reserve land acquisition. Acquisitions have generally been consistent with recommendations that have been summarized in the Swainson's hawk annual report for the last several years, as well as in this report (see Section 4.6, *Recommendations*).

Acquiring reserve lands within 1.6 kilometers (1 mile) of the Sacramento River is desirable because a large segment of the nesting population occurs along the river and because the value of foraging habitat along the river is greater than that in the Basin interior. Several of the reserves are within this zone: Alleghany, Cummings, Souza, Natomas Farms, Rosa East, Rosa Central, Atkinson, Huffman West, Huffman East, Bennett South, and Bolen South. All these reserves (with the exceptions of Rosa East and Rosa Central, which were planted to wheat in fall 2006) include an upland component that provides suitable foraging habitat for Swainson's hawk.

Acquiring contiguous properties or properties with a high probability of being contiguous in the future is also desirable because greater contiguity enhances the suitability of Swainson's hawk foraging habitat. Contiguity has been and continues to be a key component in the decision-making process regarding reserve acquisition. The acquisition of the Rosa East and Rosa Central properties in 2005 successfully expanded and consolidated TNBC holdings in the southwestern portion of the Basin. In 2006, TNBC exchanged the 242-acre Brennan tract for the Nestor and Bolen West tracts. These two properties comprise 388 acres and significantly contribute to achieving the reserve consolidation goals established in the NBHCP.

4.6 Recommendations

- Continue to rely on survey results to strategize acquisition efforts with the goal of sustaining the existing Swainson's hawk population. Many of the pairs are in or near areas that will be affected by current or planned development; consequently, a net loss of suitable nesting and foraging habitat—and breeding pairs—is expected. To sustain the population in the Basin and to offset this loss, continued efforts should be made to create new nesting and foraging habitat in protected areas.
- Continue to focus acquisition efforts within 1.6 kilometers (1 mile) of the Sacramento River. This is the area that is currently most critical to sustaining the existing population because it provides the highest value nesting and foraging habitat and supports the majority of breeding pairs that use the Basin. Enhancement efforts (i.e., converting unsuitable habitat to suitable habitat) in this area will help to offset the loss described in item 1.
- Continue efforts to inform, educate, and share information with Sacramento County to raise awareness of the importance of native trees along the Sacramento River and on airport lands to provide current and future nesting habitat for Swainson's hawks and to emphasize how the continuing practice of tree removal on lands under the County's jurisdiction conflicts with the goals of the NBHCP.
- Focus acquisition and restoration efforts on upland habitats. While seasonal wetlands can provide some foraging value to Swainson's hawks, permanent uplands provide the highest value foraging habitat. Permanent uplands include non-rice agricultural fields, grasslands, and pastures.
- Continue to experiment with Swainson's hawk–friendly crops and crop rotations on marginal soils to further improve foraging opportunities.
- Carefully select and give preference to conservation sites that provide potential for additional acquisition of neighboring properties.
- Give preference to utilizing simple management techniques and existing farm resources for the Swainson's hawk components of the reserve lands. Efforts should be made to integrate surrounding farmlands with reserve lands.

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Chapter 5

Other Covered Wildlife Species and Avian Surveys

5.1 Introduction

5.1.1 Background

Other Covered Species are those species other than giant garter snake and Swainson's hawk that are addressed in the NBHCP and covered by its associated permits (Table 1-2). Monitoring efforts for Other Covered Species, like those for Swainson's hawk and giant garter snake, are designed to assess the progress of the NBHCP toward meeting the Plan's goals and objectives for Covered Species and their habitats. Two general types of monitoring were conducted to meet the goals and objectives of the HCP: monitoring on reserve lands and Basin-wide monitoring (i.e., on non-reserve lands).

5.1.2 Goals and Objectives

Monitoring populations of Other Covered Species was accomplished using a variety of techniques, including generalized avian surveys, to evaluate the extent to which the NBHCP is meeting its biological goals and objectives. The objectives of monitoring efforts on reserve lands are listed below.

- Document the presence/absence and use of reserve lands by Other Covered Species.
- Compare the relative success of Other Covered Species on reserve and non-reserve lands.
- Help determine the level to which TNBC reserves are supporting populations of Other Covered Species.
- Evaluate the extent to which the NBHCP is meeting its objectives to provide open space to benefit wildlife species.

Basin-wide monitoring was limited to surveys for Other Covered Species. The objectives of this monitoring effort are listed below.

- Document the presence/absence of Other Covered Species within the Basin.
- Compare the relative success of Other Covered Species on TNBC reserve and non-reserve lands.
- Help determine the level to which TNBC reserve lands are supporting populations of Other Covered Species by providing information on Basin-wide populations for comparison.

Secondary objectives of monitoring non-reserve lands include providing information to guide future reserve site acquisitions and providing information on Covered Species' use of, or presence within, corridors between reserves.

5.2 Methods

5.2.1 Reserve Lands Surveys

Surveys for Other Covered Species comprise surveys for covered avian species, northwestern pond turtle, covered vernal pool species, and other rarely occurring species.

Surveys for covered avian species were conducted using a generalized avian monitoring protocol that is a modified area search (Ralph et al. 1993). The survey technique consists of slowly driving roads and recording the numbers of each species (both covered and non-covered species) seen or heard on the reserve. Areas of dense vegetation, linear tree rows, and areas inaccessible by vehicle were surveyed on foot using the area search technique to ensure complete coverage. The exact route and the time allotted for the survey is specific to each reserve and is constrained to ensure consistency in effort and technique through time. The numbers of each bird species seen or heard during the search were recorded on a standardized data form. Species observed outside the reserve were not counted unless they were clearly associated with the reserve in some way (e.g., swallows flying overhead hawking insects or a raptor perched outside the reserve that is scanning the ground inside the reserve would be counted). Covered Species observed off the reserve during the survey or before or after the survey were recorded separately as incidental observations on standardized data forms. All reserves were surveyed on the same day to minimize bias associated with the movement of birds from one reserve to another and to off-reserve locations. The order in which the reserves were surveyed was rotated to avoid bias. Surveys on reserve sites were conducted monthly.

The specific routes taken and time allotted for each reserve are described in the *Natomas Basin Habitat Conservation Plan Area Biological Effectiveness Monitoring Program* (Jones & Stokes 2005).

Surveys for northwestern pond turtles were conducted during active visual surveys for giant garter snakes. Blue elderberry shrubs, the host plant for valley elderberry longhorn beetle, were documented during floristic inventory and noxious weed surveys (see Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Surveys*). All other observations of Other Covered Species were recorded as incidental observations and documented on data forms and using hand-held GPS units.

5.2.2 Basin-Wide Surveys

Surveys for Other Covered Species on non-reserve lands were specifically designed to obtain maximum geographic and temporal coverage of the Basin and to ensure repeatability and consistency. These surveys were conducted monthly.

The Basin was divided into three survey regions (Figure 5-1). The North Region covers the area between the Natomas Cross Canal and Elverta Road, the Central Region covers the area between Elverta Road and Del Paso Road, and the South Region covers the area between Del Paso Road and Garden Highway. A road transect was established in each region. Each road transect covers 48–51 kilometers (30–32 miles) and is surveyed in approximately 1.5 hours. Survey times were assigned to road segments within each transect to minimize variation in effort. In general, all surveys on non-reserve lands were concluded by 1200 hours, weather permitting. A single observer would drive slowly (when possible) and scan the area for Other Covered Species, occasionally stopping at pullouts or backtracking where appropriate. Stops occurred frequently to scan large fields for Other Covered Species, but the duration and number of stops was constrained by the time allotted for each segment and transect. See Jones & Stokes (2005) for a complete description of each survey route.

To ensure that the entire Basin was surveyed to the extent possible and that populations of Other Covered Species were not systematically missed, one survey region was selected for intensive coverage during each survey. The selected region was surveyed as completely as possible using all available roads, with no time constraints placed on the survey. A different region was selected for intensive coverage on each survey.

5.3 Results

5.3.1 Generalized Avian Surveys

Table 5-1 summarizes the number of individuals and number of species recorded from 2005 and 2006 on each reserve for selected taxonomic groups. The raptor group consists of hawks and owls, a group of predatory birds that are generally uncommon and serve as good indicators of ecosystem health. Although Swainson's hawk and burrowing owl are the only two covered species that are raptors, 17 other raptor species have been recorded during avian surveys in the Natomas Basin since 2004.

Neotropical migrants are defined here as passerine (perching) birds such as flycatchers, swallows, and warblers that breed in North America in the summer and migrate in fall to the Neotropics (southern United States, Mexico, Central America, and South America) to spend the winter. Populations of neotropical migrants are generally declining, due in part to loss of habitats such as riparian woodlands on both their breeding and wintering ranges. The riparian woodlands on the western edge of the Natomas Basin are an important resource for breeding and migrating Neotropical migrants.

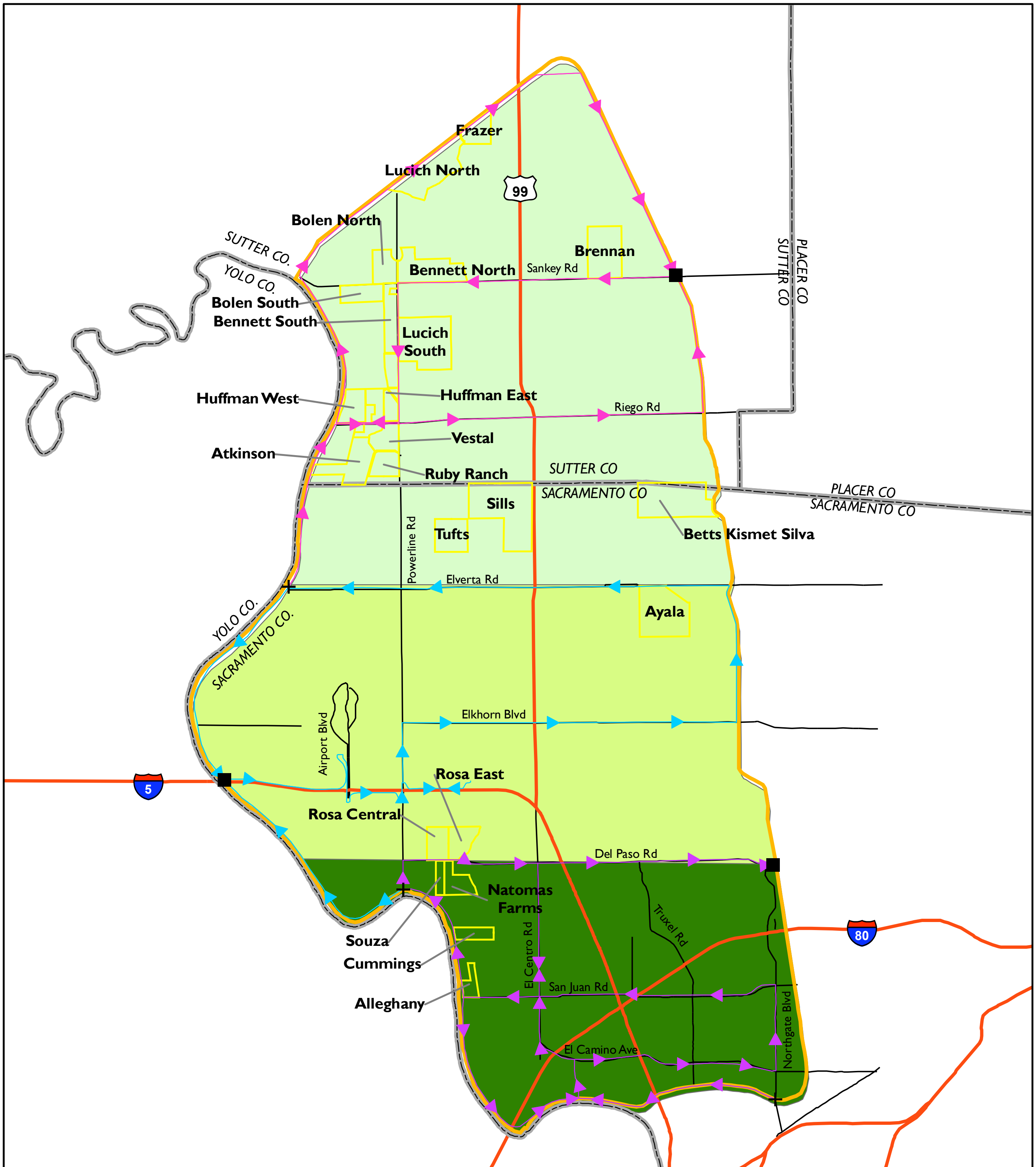
The waterfowl group consists of geese, swans, and ducks, and is an important aesthetic and sporting resource, as well as a group of species of high management concern.

The total number of individual raptors detected on reserve lands decreased from approximately 485 in 2005 to 455 in 2006, a relatively minor decrease. The number of raptors detected each month was more erratic in 2005, particularly during the winter months (Figure 5-2). The total number of raptor species detected on reserve lands decreased from 15 in 2005 to 12 in 2006. Ferruginous hawk, prairie falcon, and sharp-shinned hawk, species that are uncommon winter visitors in the Central Valley or are only present during migration, were not detected during reserve surveys in 2006.

The total number of individual waterfowl decreased from 14,200 in 2005 to 9,228 in 2006, a decrease of approximately 35%. The difference was due primarily to the large number of waterfowl detected on reserves during the February 2005 survey (Figure 5-3). Twenty-three species were detected in 2005 and 22 species in 2006.

Conversely, the total number of individual neotropical migrants detected increased from 590 in 2005 to 680 in 2006. The apparent increase is most likely attributable to the fact that no survey was conducted in July 2005. The large differences in the number of neotropical migrants detected each month (Figure 5-4) are primarily due to differences in the number of swallows detected (cliff, barn, northern rough-winged, and tree swallows); swallows account for approximately 74% of the individual neotropical migrants detected. However, only 11 species were detected in 2006, down from 17 species in 2005. The six species detected in 2005 that were not observed in 2006 were willow flycatcher, Pacific-slope flycatcher, black-throated gray warbler, Cassin's vireo, Wilson's warbler, and western tanager. All these species except western tanager were detected on the Atkinson Reserve.

The total number of shorebirds detected on reserve lands also increased, from 2,957 in 2005 to 3,511 in 2006, a modest increase of approximately 16%. The large spike in shorebird numbers in February 2005 was attributable to approximately 800 dunlins detected on the Lucich South Reserve (Figure 5-5). Likewise, the large number of individuals detected in December 2006 was



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Legend

Roads
Major Roads
County Boundaries
NBHCP Area Boundary
Reserve Lands

Survey Areas
North
Central
South

Survey Routes
North
Central
South

Survey Start and End Points
Start
End

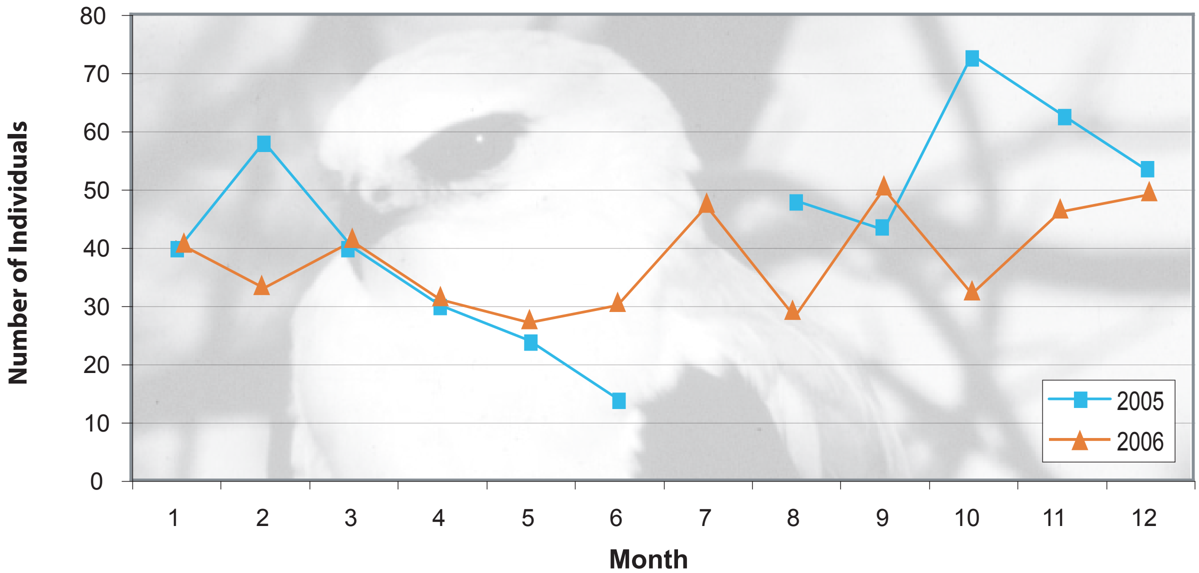
N

0 2.5 5 Miles

NBC Monitoring Program data sources: Jones & Stokes (2004)

Jones & Stokes

Figure 5-1
Monthly Basin-Wide Survey Routes on Non-Reserve Lands



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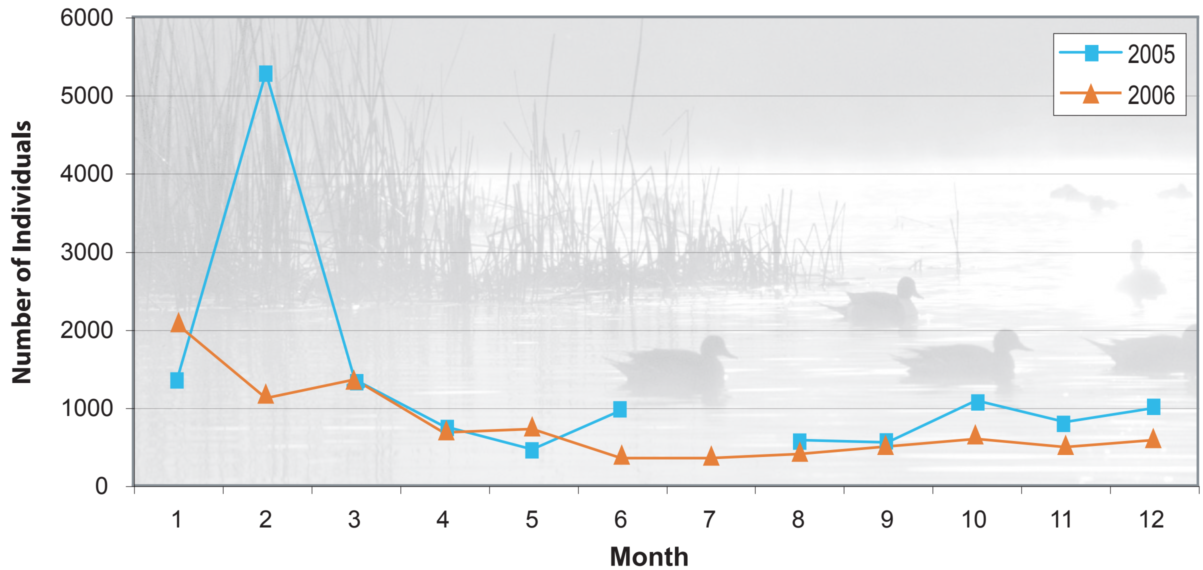
Jones & Stokes

Figure 5-2
Raptors Detected on Surveys in the Natomas Basin, 2005–2006



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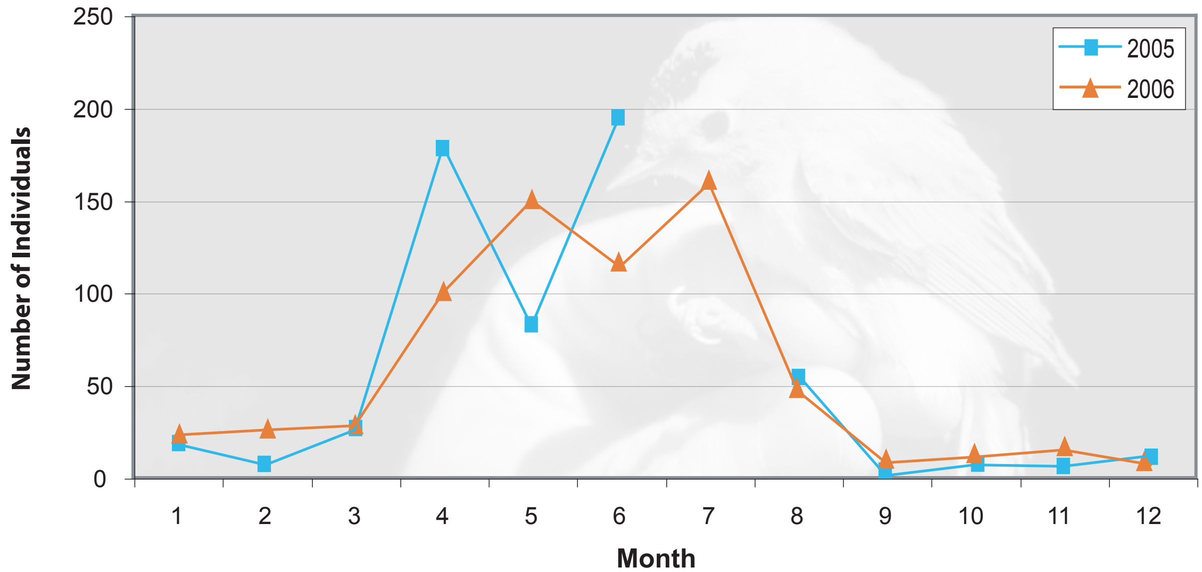
Jones & Stokes

Figure 5-3
Waterfowl Detected on Surveys in the Natomas Basin, 2005–2006



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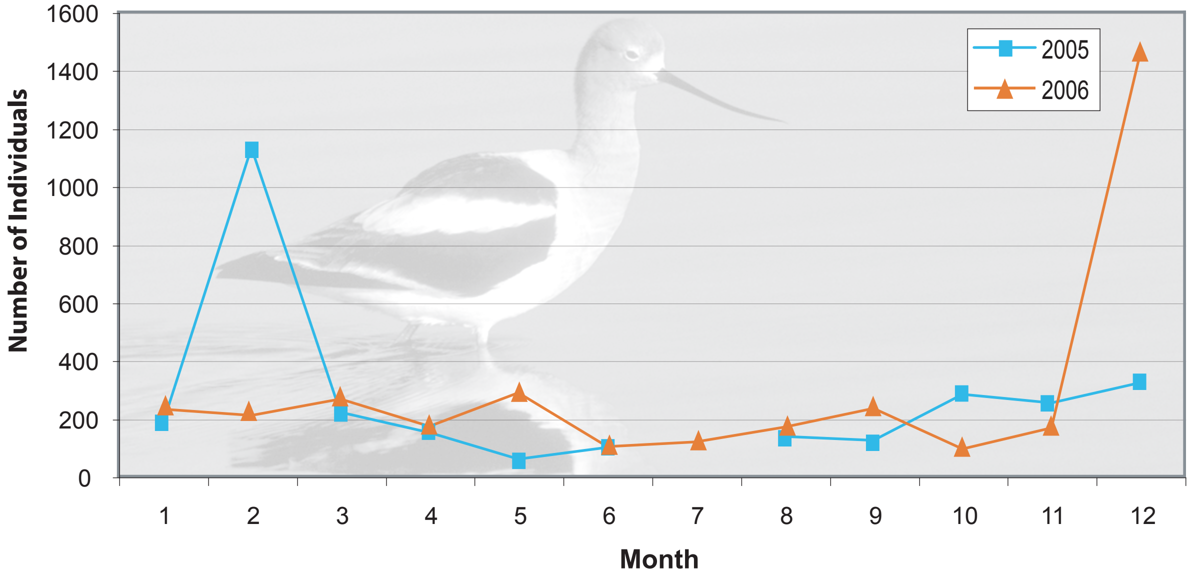
Jones & Stokes

Figure 5-4
Neotropical Migrants Detected on Surveys in the Natomas Basin, 2005–2006



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Jones & Stokes

Figure 5-5
Shorebirds Detected on Surveys in the Natomas Basin, 2005–2006

Table 5-1. Summary of Results of Monthly Surveys by Reserve[a], 2005–2006

	Waterfowl		Raptors		Neotropical Migrants		Shorebirds		All Bird Species	
Reserve	2005	2006	2005	2006	2005	2006	2005	2006	2005	2006
Allegheny		2 (1)	24 (5)	30 (8)	17 (5)	16 (5)	25 (1)	72 (3)	746 (47)	1,075 (54)
Atkinson	103 (8)	103 (5)	42 (8)	49 (7)	51 (13)	72 (8)	44 (4)	234 (7)	2,367 (87)	3,944 (78)
Bennett North	274 (10)	163 (9)	29 (5)	25 (5)	11 (2)	25 (4)	159 (4)	145 (4)	1,935 (53)	1,160 (52)
Bennett South	216 (8)	15 (3)	19 (3)	11 (4)	25 (4)	2 (2)	41 (3)	1,292 (4)	1,061 (47)	2,053 (40)
BKS	4,330 (20)	3,676 (19)	100 (10)	91 (9)	124 (6)	136 (7)	612 (9)	638 (9)	10,547 (92)	8,981 (94)
Bolen North	—	69 (5)	4 (3)	8 (2)	—	20 (4)	35 (1)	48 (2)	417 (22)	587 (36)
Bolen South	—	15 (1)	7 (4)	9 (3)	7 (2)	15 (3)	26 (1)	47 (3)	311 (35)	618 (39)
Cummings	515 (12)	418 (7)	27 (9)	19 (6)	72 (6)	62 (7)	116 (5)	106 (5)	1,666 (78)	2,883 (67)
Frazer	1,363 (16)	1,432 (16)	20 (4)	23 (4)	48 (3)	46 (4)	44 (4)	91 (3)	2,776 (53)	2,828 (58)
Huffman East	112 (7)	91 (3)	14 (4)	12 (4)	30 (2)	11 (2)	93 (2)	82 (1)	1,496 (46)	896 (38)
Huffman West	21 (3)	19 (3)	18 (5)	11 (3)	16 (3)	23 (4)	27 (1)	26 (1)	820 (44)	720 (35)
Lucich North	1,918 (17)	2,483 (17)	28 (5)	32 (4)	38 (4)	68 (5)	137 (5)	109 (5)	5,866 (61)	4,092 (70)
Lucich South	3,096 (13)	193 (6)	31 (7)	24 (4)	44 (3)	50 (4)	1,148 (9)	157 (5)	6,699 (65)	1,813 (49)
Natomas Farms	273 (8)	294 (10)	15 (6)	29 (8)	45 (4)	37 (5)	58 (2)	122 (4)	1,513 (58)	3,035 (73)
Rosas	—	74 (4)	6 (3)	21 (4)	4 (2)	27 (6)	15 (1)	10 (1)	446 (32)	759 (49)
Ruby Ranch	12 (2)	15 (2)	10 (4)	14 (4)	9 (2)	38 (5)	60 (2)	69 (4)	952 (35)	1,083 (38)
Sills	1,920 (11)	146 (5)	33 (5)	20 (4)	7 (1)	5 (2)	142 (4)	145 (5)	3,713 (52)	2,499 (52)
Souza	—	—	6 (3)	10 (3)	10 (1)	11 (5)	36 (1)	23 (1)	728 (26)	667 (35)
Tufts	31 (3)	16 (1)	6 (4)	9 (4)	2 (1)	8 (3)	74 (4)	43 (1)	576 (38)	525 (33)
Vestal	—	4 (2)	—	8 (5)	—	16 (3)	—	62 (4)	—	647 (40)

[a] Numbers reflect the total number of individuals of each group observed followed by the number of species observed (in parentheses).

attributable to approximately 800 long-billed dowitchers and 454 dunlins detected on the Bennett South Reserve.

Yellow-billed magpie—a species that has declined rapidly in the Central Valley, presumably due to mortality from the spread of West Nile virus—declined from 388 individual detections in 2005 to 236 individual detections in 2006.

A total of 117 avian species were detected on reserve lands in 2006, down from 130 species detected in 2005.

Rosa East and Central, Sills, Bolen North, Huffman East, Huffman West, Souza, Tufts, and Ruby Ranch

These reserves are devoted to rice production or upland row crops and contain little to no riparian, oak woodland, or managed marsh habitats. Consequently, fewer species and individuals are recorded on these reserves, although occasional concentrations of waterbirds are recorded. The Tufts Reserve had the fewest species (33), although a merlin was seen foraging over the reserve in January.

Thirty-six bird species were detected at Bolen North in 2006. Open country species typical of agricultural lands, such as American pipit, savannah sparrow, western meadowlark, and killdeer, were the most common species recorded.

Thirty-eight bird species were detected at Huffman East and 38 at Ruby Ranch. Several Cooper's hawk observations on the Huffman East reserve were noteworthy.

Fifty-two bird species were recorded at Sills in 2006. Large concentrations of ducks were recorded in February 2006, including more than 900 northern shovelers and 300 American wigeon.

The small patches of riparian and valley oak woodland on the Rosa East Reserve accounted for the relatively high number of species detected on the two Rosa reserves. A red-tailed hawk reared a brood of two young in the northeast corner of the reserve.

The Souza and Huffman West Reserves each had 35 species detected during surveys in 2006. However, Souza produced one of only two records for ash-throated flycatcher during the 2006 surveys, and a pair of lark sparrows observed there in December was one of only a few records for this species in the Basin in 2006.

Alleghany, Atkinson, Bolen South, and Vestal

These reserves have patches of riparian or oak woodland habitats in addition to the agricultural habitats and thus generally support a higher diversity of species than reserves with only agricultural habitats.

Fifty-four bird species were recorded on the Alleghany Reserve in 2006. A red-tailed hawk nested in a solitary valley oak at the western edge of the Alleghany Reserve. Forty-two long-billed curlew were observed on the reserve in February.

Seventy-eight bird species were detected on the Atkinson Reserve during 2006, down from 87 species in 2005. Species richness was high—second only to that of the BKS Reserve. The riparian forest on the Atkinson Reserve consists of a large patch of dense, mature riparian vegetation that is very uncommon in the Basin. The high species diversity observed on the reserve indicates that this vegetation type is an important resource for many resident and migratory wildlife species using the Basin. Several Neotropical migrants, including Wilson's warbler, orange-crowned warbler, Pacific slope flycatcher, and willow flycatcher, were observed in the riparian forest during migration. Atkinson also supports a high diversity of raptors, including red-tailed hawk, red-shouldered hawk, Swainson's hawk, Cooper's hawk, sharp-shinned hawk, American kestrel, northern harrier, and great horned owl. The Atkinson Reserve produced one of only two records for ash-throated flycatcher in the Basin during 2006 surveys.

Thirty-nine bird species were detected at Bolen South in 2006. Forty bird species were detected on Vestal in 2006. This number will serve as the baseline for subsequent monitoring years.

Bennett North, Bennett South, BKS, Cummings, Frazer, Lucich North, Lucich South, and Natomas Farms

These reserves all contain a managed marsh component on some part of the reserve. Frazer, Lucich North, and Natomas Farms are almost entirely composed of managed marsh, while the BKS Reserve contains a diverse mix of habitat types, including riparian habitats, willow thickets, and extensive grasslands. The Bennett North, Bennett South, and Lucich South Reserves are primarily rice Reserves with an associated managed marsh component, while the Cummings Reserve contains valley oak woodland and upland agricultural crops in addition to the managed marsh component.

Fifty-two bird species were recorded at Bennett North and 40 at Bennett South in 2006. An unusually large concentration of waterfowl at Bennett South on December 21, 2006, was a noteworthy observation. This concentration included snow goose (approximately 1,200), greater white-fronted goose (approximately 1,000), cackling goose (approximately 50), and tundra swan (approximately 80).

The BKS Reserve is one of the largest (approximately 640 acres) in the reserve system. The managed marsh and upland habitats are the oldest and most mature in the system, and BKS supports the highest diversity of aquatic habitats. The reserve provides important aquatic habitats for a large number of waterbirds, including American coot; common moorhen; and many species of ducks (American green-winged teal, American wigeon, bufflehead, cinnamon teal, gadwall, mallard, northern pintail, northern shoveler, ring-necked duck, and ruddy duck). The reserve provides important habitat for a large number of shorebirds (e.g., black-necked stilt, American avocet, greater yellowlegs, killdeer, least sandpiper, long-billed curlew, and long-billed dowitcher) during migration. Raptors observed using the site include Swainson's hawk, peregrine falcon, prairie falcon, white-tailed kite, northern harrier, red-tailed hawk, Cooper's hawk, American kestrel, burrowing owl, great horned owl, and barn owl.

Cummings moved into the top five reserves in terms of bird diversity, with a total of 67 species recorded in 2006. Fifty-eight bird species were detected at Frazer in 2006, up from 53 in 2005. Frazer is one of the few reserves where Virginia rail, a secretive water bird, is regularly detected.

Seventy bird species were detected at Lucich North in 2006. This reserve supports a high diversity of waterfowl, including American wigeon, mallard, cinnamon teal, northern shoveler, northern pintail, American green-winged teal, ring-necked duck, common goldeneye, bufflehead, ruddy duck, gadwall, wood duck, and the only hooded merganser recorded during reserve surveys.

Forty-nine bird species were recorded at Lucich South in 2006. Several species of shorebird were detected on this reserve in 2006: killdeer, long-billed curlew, least sandpiper, Wilson's snipe, and greater yellowlegs.

Seventy-three bird species were detected at Natomas Farms in 2006. The reserve continued to support a high sparrow diversity, with Lincoln's sparrow, fox sparrow, song sparrow, golden-crowned sparrow, white-crowned sparrow, savannah sparrow, and lark sparrows all recorded here in 2006.

5.3.2 Other Covered Species

Of the 20 species other than Swainson's hawk and giant garter snake covered by the NBHCP, five have been detected in the Basin. These species are white-faced ibis, loggerhead shrike, tricolored blackbird, burrowing owl, and northwestern pond turtle. Although suitable foraging habitat exists within the Basin for Aleutian Canada goose, this species has not been detected in the Basin since comprehensive monitoring began in 2004. Suitable nesting habitat for the bank swallow currently does not occur in the Basin. Suitable habitat for the vernal pool species—vernal pool fairy shrimp, mid-valley fairy shrimp, vernal pool tadpole shrimp, California tiger salamander, and western spadefoot—has not been reported in the Basin except for the 11 vernal pools (1 acre) created on the BKS reserve, although several wetlands are known to occur on private property along the extreme eastern edge of the Basin. To date, no evidence of occupancy of these 11 pools by any covered species has been observed. Several blue elderberry shrubs, the host plant for the valley elderberry longhorn beetle, have been documented in the Basin. None of the covered plant species have been detected in the Basin (see Chapter 2).

All of the five Other Covered Species known to occur in the Basin have been documented on TNBC reserve lands. The availability of suitable habitats for Other Covered Species by reserve is summarized in Table 5-2, along with the documented occurrences of each.

Three Other Covered Species have been documented breeding on reserve lands since comprehensive monitoring began in 2004. These breeding records are summarized in Table 5-3.

Table 5-3. Number of Pairs of Other Covered Species on TNBC Reserve Lands, 2004–2006

Species	2004	2005	2006
Western burrowing owl	1 (BKS)	1 (BKS)	1 (BKS, pair failed)
Loggerhead shrike	4 (3 BKS, 1 Brennan)	3 (2 BKS, 1 Brennan)	3 (1 BKS, 1 Alleghany, 1 Brennan)
Tricolored blackbird	0	~900 (BKS)	0

A total of 33 detections of Other Covered Species were recorded on 14 of the 20 reserves surveyed in 2006, compared with 40 detections on 11 of the 19 reserves surveyed in 2005. The total number of individual avian Other Covered Species recorded during reserve surveys are summarized in Table 5-4. The total number of individuals detected decreased from 2005 to 2006 for each species except Burrowing owl.

Table 5-4. Summary of Numbers of Observations of Other Covered Species Recorded during Monthly Avian Surveys on Reserve Lands, 2005–2006

Species	2005	2006
White-faced ibis	425	179
Burrowing owl	4	7
Loggerhead shrike	15	9
Tricolored blackbird	932	371

The numbers of avian Other Covered Species recorded in the Basin-Wide Surveys are summarized in Table 5-5.

Table 5-2. Summary of Observations of Other Covered Species (X) and Presence of their Habitats (shaded) on Reserves

Reserve	Valley Elderberry Longhorn Beetle	Northwestern Pond Turtle	White-faced Ibis	Burrowing Owl	Loggerhead Shrike	Tricolored Blackbird	Vernal Pool Invertebrates
Alleghany					X (breeding)		
Atkinson			X		X	X	
Bennet North		X	X		X	X	
Bennet South		X			X		
Betts-Kismat-Silva		X	X	X (breeding)	X (breeding)	X (breeding)	
Bolen North			X			X	
Bolen South							
Brennan			X		X (breeding)	X	
Cummings					X	X	
Frazer			X			X	
Huffman East			X			X	
Huffman West			X				
Lucich North			X		X	X	
Lucich South			X		X		
Natomas Farms					X		
Rosa East and West					X	X	
Ruby Ranch					X		
Sills			X		X		
Souza					X	X	
Tufts				X			
Vestal							

Table 5-5. Summary of Numbers of Observations of Other Covered Species Recorded on Monthly Basin-Wide Surveys, 2005–2006

Species	2005	2006
White-faced ibis	286	1,227
Burrowing owl	10	18
Loggerhead shrike	94	80
Tricolored blackbird	186	33

Loggerhead Shrike

A total of five shrike nests were located in the Basin in 2006, three of which occurred on reserve lands. One nest was located on the BKS Reserve, one fewer than recorded in 2005. For the third consecutive year, a nest was recorded on the Brennan Reserve in 2006. The third nest recorded on reserve lands in 2006, which successfully fledged young, was recorded on the Alleghany Reserve.

Of the two nests located on non-reserve lands, one was located just outside the Souza Reserve; the second nest was located near Elverta Road west of Powerline Road.

In 2006, loggerhead shrikes appeared to be less abundant than in 2005, especially during winter (Figure 5-6). The number of detections recorded during Basin-wide surveys decreased from 94 to 80. Similarly, the number of shrikes detected on reserve surveys decreased from 15 to nine. Twenty-three incidental detections were recorded in 2006, down from 27 in 2005 and 39 in 2004. As in 2005, loggerhead shrikes were detected throughout the Basin except for the northern interior and the developed portions in the southeastern portion of the Basin (Figure 5-7).

White-Faced Ibis

There have been no observations of white-faced ibis breeding in the Basin since comprehensive monitoring began in 2004. Although the number of ibis detected on reserve lands decreased from 425 in 2005 to 179 in 2006 (Table 5-4), the number of Basin-wide detections increased substantially (Table 5-5). However, ibis numbers are difficult to assess. They can forage singly or in large flocks, and often spend much of their time in rice fields where they are difficult to detect. Most observations of white-faced ibis are incidental sightings (not reported in the tables above) of large flocks moving from one location to another, or are reported by an observer inadvertently flushing them. For example, a single flock of approximately 1,500 individuals were observed incidentally on the BKS reserve in 2006, more than eight times the total number recorded during monthly reserve surveys. White-faced ibis were observed foraging and/or roosting on eight reserves: BKS, Atkinson, Bennett North, Bolen North, Frazier, Huffman West, Lucich North, and Lucich South.

In 2006, observations of white-faced ibis were scattered throughout the Basin north of I-5, with a concentration of observations in the north-central portion of the Basin (Figure 5-8). All but one observation were from the northern portion of the Basin north of Riego Road, and the majority of those were in rice fields west of SR-99.

In 2006, ibis began arriving in the Basin in June and generally increased in numbers through December. This pattern differs from that observed in 2005, when ibis increased from late May through October and apparently left the Basin by early November (Figure 5-9). Likewise, ibis numbers in 2004 peaked in June, and most had left the Basin by the end of August.

Tricolored Blackbird

The tricolored blackbird nesting colony on the BKS Reserve is the only known nesting colony in the Basin. Approximately 900 pairs nested there in 2005. The nesting colony was not active in 2004, and breeding did not occur there again in 2006. Up to 60 tricolored blackbirds were seen investigating the Himalayan blackberry patches at the historical colony location in early spring. Several flocks of up to 150 individuals were seen foraging in the pastures on the east side of the BKS Reserve in March. Tricolored blackbirds were detected foraging on five other reserves for foraging in 2006: Atkinson, Bennett North, Huffman East, Lucich North, and Souza.

The total number of tricolored blackbirds observed on reserve lands decreased from 932 in 2005 to 371 in 2006. Similarly, the numbers observed during Basin-wide surveys decreased from 186 in 2005 to 33 in 2006. The differences are primarily due to the lack of observations during the height of the breeding season in April, May, and June (Figure 5-10). Tricolored blackbirds are typically observed as a small component of the large blackbird flocks that winter in the central portion of the Basin. The distribution of Basin-wide detections of tricolored blackbirds was similar to that in 2005 (Figure 5-11).

Western Burrowing Owl

Burrowing owls are known to breed and winter at low density in the Basin, primarily along the eastern terrace and in the southeastern portion. A single pair has traditionally nested on the BKS reserve. This pair was observed intermittently on BKS through June, and may have initiated nesting. However, one of the adults was found decapitated near the burrow in early June, apparently by one of the resident great horned owls; this event likely led to nest failure. The remaining adult lingered for a few weeks, but has not been observed since.

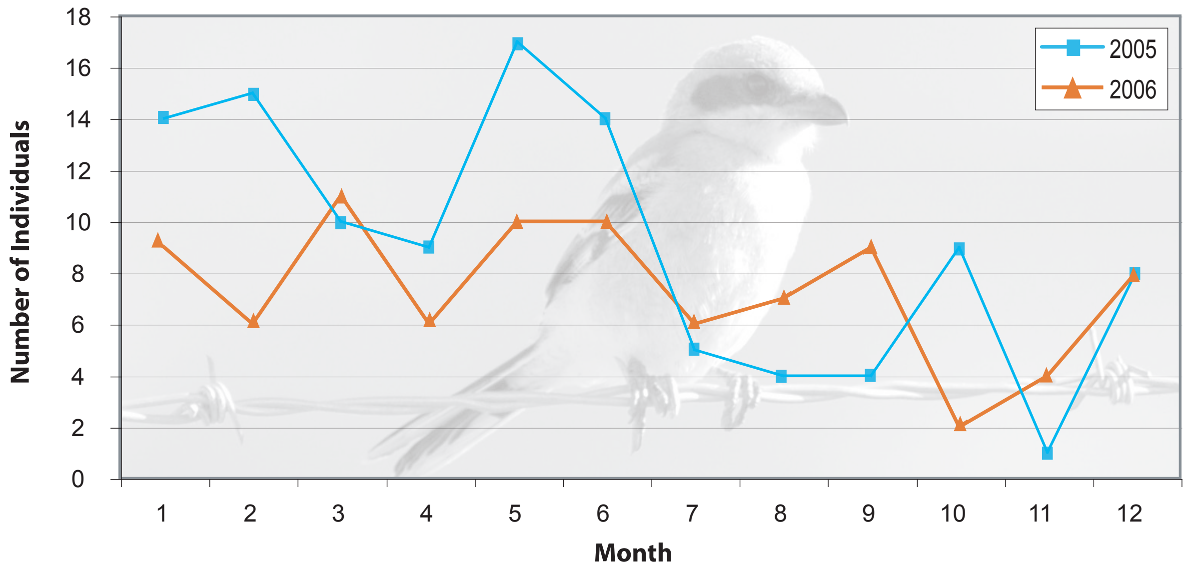

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Figure 5-6
Loggerhead Shrike Detected on Surveys in the Natomas Basin, 2005–2006

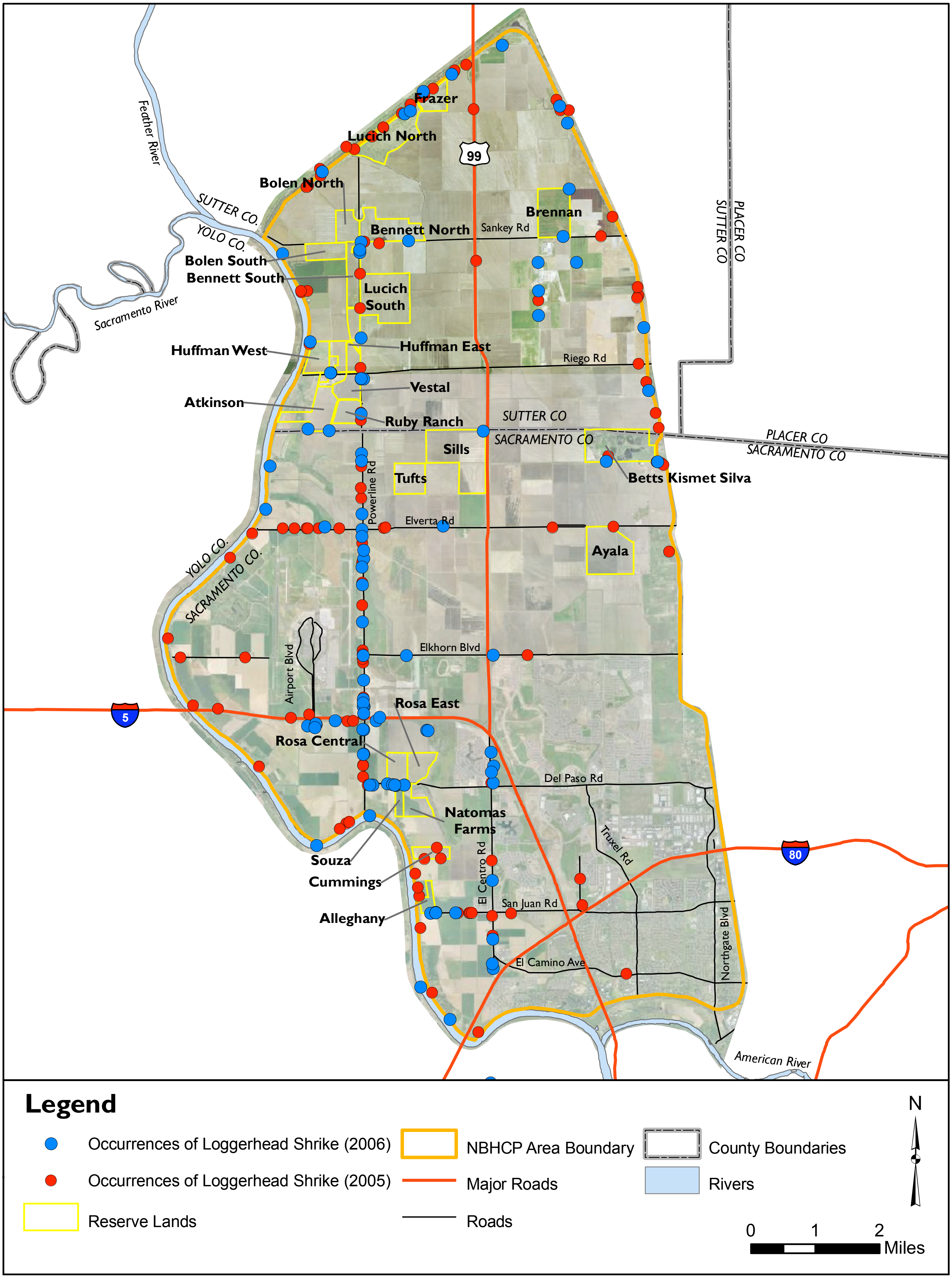

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Figure 5-7
Occurrences of Loggerhead Shrike

Legend

- Occurrences of White-Faced Ibis (2006)
- Occurrences of White-Faced Ibis (2005)
- Reserve Lands
- NBHCP Area Boundary
- Major Roads
- Roads
- County Boundaries
- Rivers

N

0 1 2 Miles

Jones & Stokes

Figure 5-8
Occurrences of White-Faced Ibis

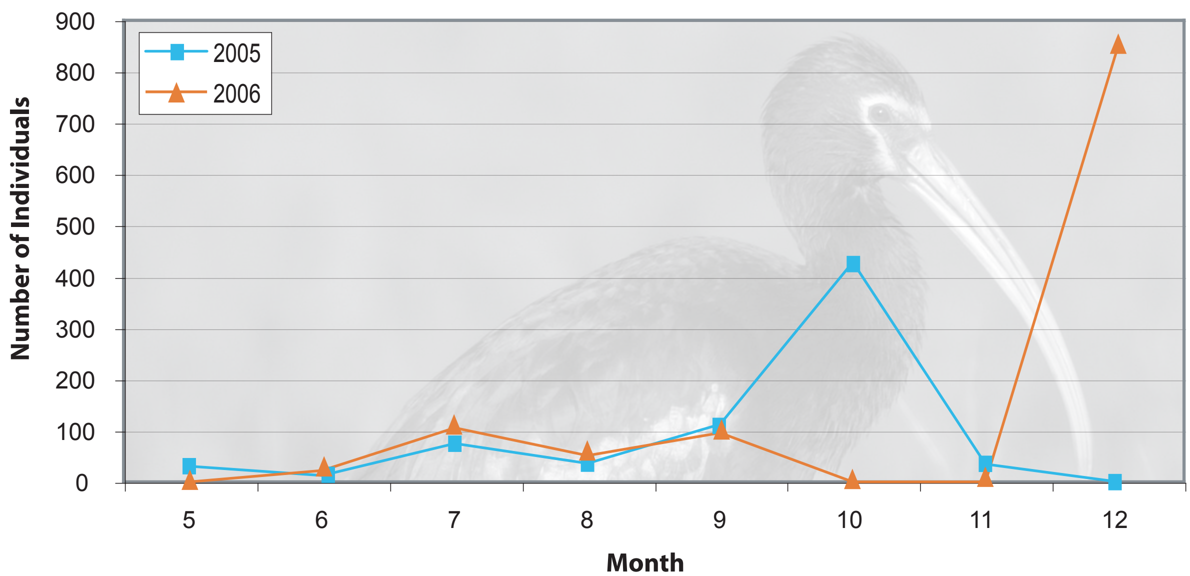

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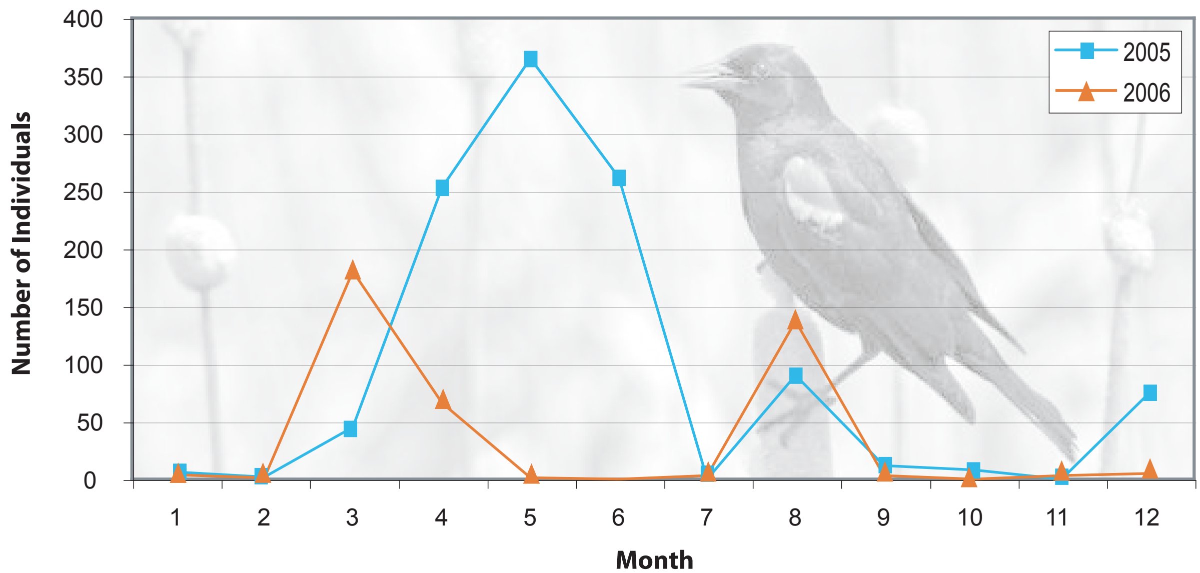
Figure 5-9
White-faced Ibis Detected on Surveys in the Natomas Basin, 2005–2006



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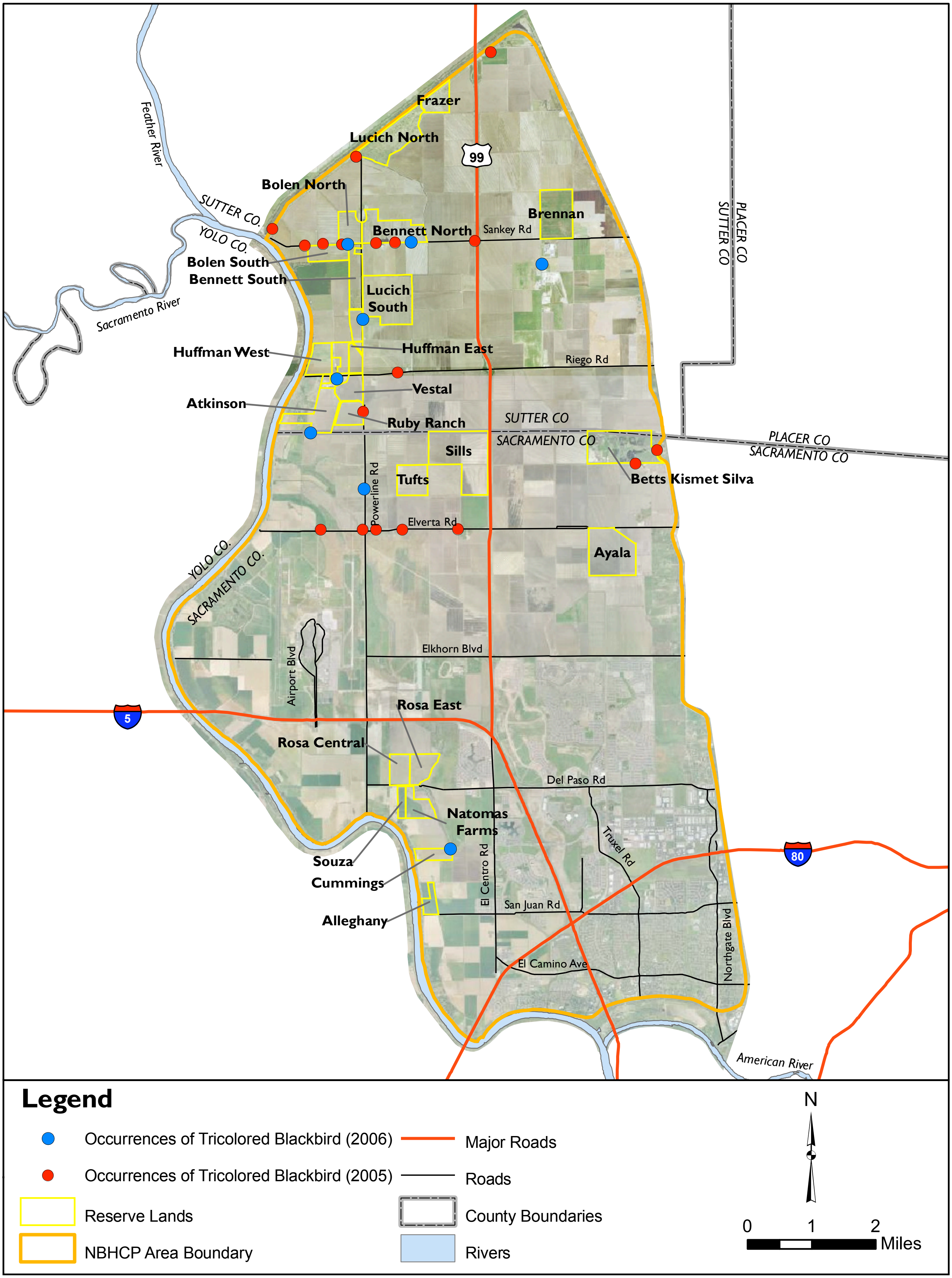
Jones & Stokes

Figure 5-10
Tricolored Blackbirds Detected in Surveys in the Natomas Basin, 2005–2006



Jones & Stokes

Figure 5-11
Occurrences of Tricolored Blackbird

Despite the presence of California ground squirrels on the Atkinson, Bennett North, Cummings, Huffman West, Lucich South, Natomas Farms, Ruby Ranch, Sills, and Souza Reserves, no burrowing owls were observed there in 2006.

Three additional pairs of burrowing owls and several single birds were observed during surveys on non-reserve lands in 2006 (Figure 5-12). The pair on the east side of the levee Road near Sankey Road apparently did not breed. The pair near the Sysco plant on Pacific Avenue exhibited breeding behavior, but breeding was never confirmed. Breeding also could not be confirmed for the pair on eastern Elkhorn Boulevard.

Several additional burrowing owls were reported from the developed areas in the southeastern portion of the Basin in 2006. A total of 10 burrowing owls, comprising three pairs and one brood, were observed in various locations on the Arco Arena property in early October, and an additional pair and two additional individual owls were observed in other developed areas outside the Arco Arena property.

Valley Elderberry Longhorn Beetle

The have been no sightings of valley elderberry longhorn beetle in the Basin since comprehensive monitoring began in 2006. However, several blue elderberry shrubs, the host plant for this species, have been documented in the Basin on both reserve and non-reserve lands (Figure 5-13). In addition, blue elderberry shrubs have been planted on the Natomas Farms and Cummings Reserves. One previously undocumented blue elderberry shrub was recorded in 2006 at the northeast corner of the Rosa Reserve.

Northwestern Pond Turtle

Northwestern pond turtles are known to occur in several areas of the Basin, including Fisherman's Lake and near the Prichard Lake and Elkhorn pumping stations. The naturalized but non-native red-eared slider (*Trachemys scripta elegans*), which superficially resembles western pond turtle, is also established in the Basin. The presence of red-eared sliders makes accurate detection of western pond turtles difficult because it is often difficult to distinguish the two species in field situations. Consequently, incidental sightings can rarely be ascribed to either species with certainty. The distribution of northwestern pond turtle sightings for 2004 to 2006 are shown in Figure 5-14.

5.4 Discussion

The TNBC reserves provide important habitats for birds in the Central Valley. A total of 117 species were recorded on reserve lands in 2006, down from 130 in 2005. All avian species recorded are typical of the Central Valley and are associated with open agricultural habitats, aquatic habitats, and oak woodlands. Diversity is lowest on small reserves dedicated to rice or upland agriculture, increasing on reserves in row crops where remnant patches of riparian scrub or valley oak woodland occur. Higher diversity is found on reserves with a managed marsh component and on reserves with a diversity of habitat types. Diversity is highest on the BKS Reserve, a large reserve where managed marsh, nonnative annual grassland, and riparian scrub occur in close association. The top five reserves in terms of avian diversity were BKS (94 bird species), Atkinson (78), Natomas Farms (73), Lucich North (70), and Cummings (67). Clearly, TNBC reserve lands are meeting the objective articulated in the NBHCP to provide open space to benefit wildlife species.

Fewer loggerhead shrikes were detected in 2006 in the Basin than in 2005 on both reserve and non-reserve lands. Shrikes are typically abundant in winter along Powerline Road where a barb-wired fence surrounds SMF lands. Reasons for the decline in shrike detections are unknown; the level of variability observed may be within the normal range of variation for this species.

Large numbers of white-faced ibis were again observed throughout the Basin during 2006. White-faced ibis populations have been increasing steadily in the Basin over the last decade. This species is known to nest in only a few scattered locations in the Central Valley (Ryder and Manry 1994), in habitats similar to those that now occur on the BKS Reserve. Breeding white-faced ibis often move nomadically in response to changing environmental conditions (Ryder and Manry 1994). In 2004, the population of white-faced ibis in the Basin peaked in June and decreased thereafter, with no ibis detected after surveys conducted in August. In 2005, the population of white-faced ibis peaked much later—in October—and ibis were still being detected in the Basin in November. In 2006, ibis were observed consistently from May through the end of December. The peak number observed at BKS in early fall, a flock of 1,500, is a significant number on the state level and is similar to the numbers supported on Sacramento National Wildlife Refuge.

A significant breeding population of tricolored blackbirds occurs in the Basin; the single known breeding site is on the BKS Reserve. Although the breeding colony was not active in 2004 or 2006, breeding was highly successful in 2005. Small numbers of tricolored blackbirds are regularly observed in other areas of the Basin, and several reserves provide important foraging habitats. While ample foraging habitat appears to be available, suitable breeding sites may be limited. Tricolored blackbirds are itinerant breeders that often change nesting locations from year to year (Beedy and Hamilton 1999).

As in previous years, few burrowing owls were detected in the undeveloped portions of the Basin in 2006. The distribution and abundance of burrowing owls in the undeveloped portions of the Basin are indicative of the general lack of suitable habitat for burrowing owls in the interior portion of the Basin. Rice-growing areas are generally unsuitable for burrowing owls, although individuals occasionally utilize burrows in levees during the winter. Alternatively, the presence of a relatively large number of burrowing owls (up to 10) in the Arco

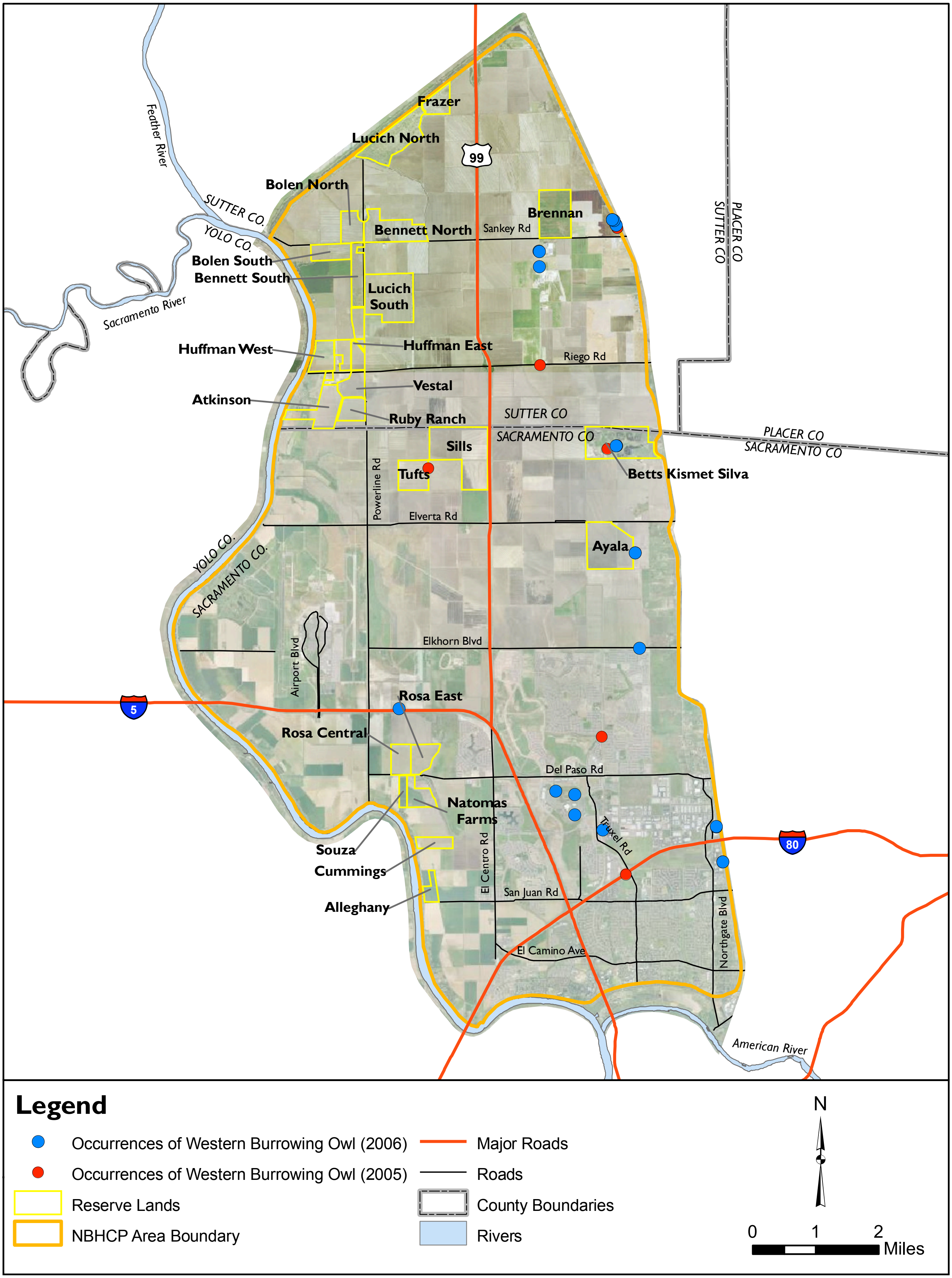


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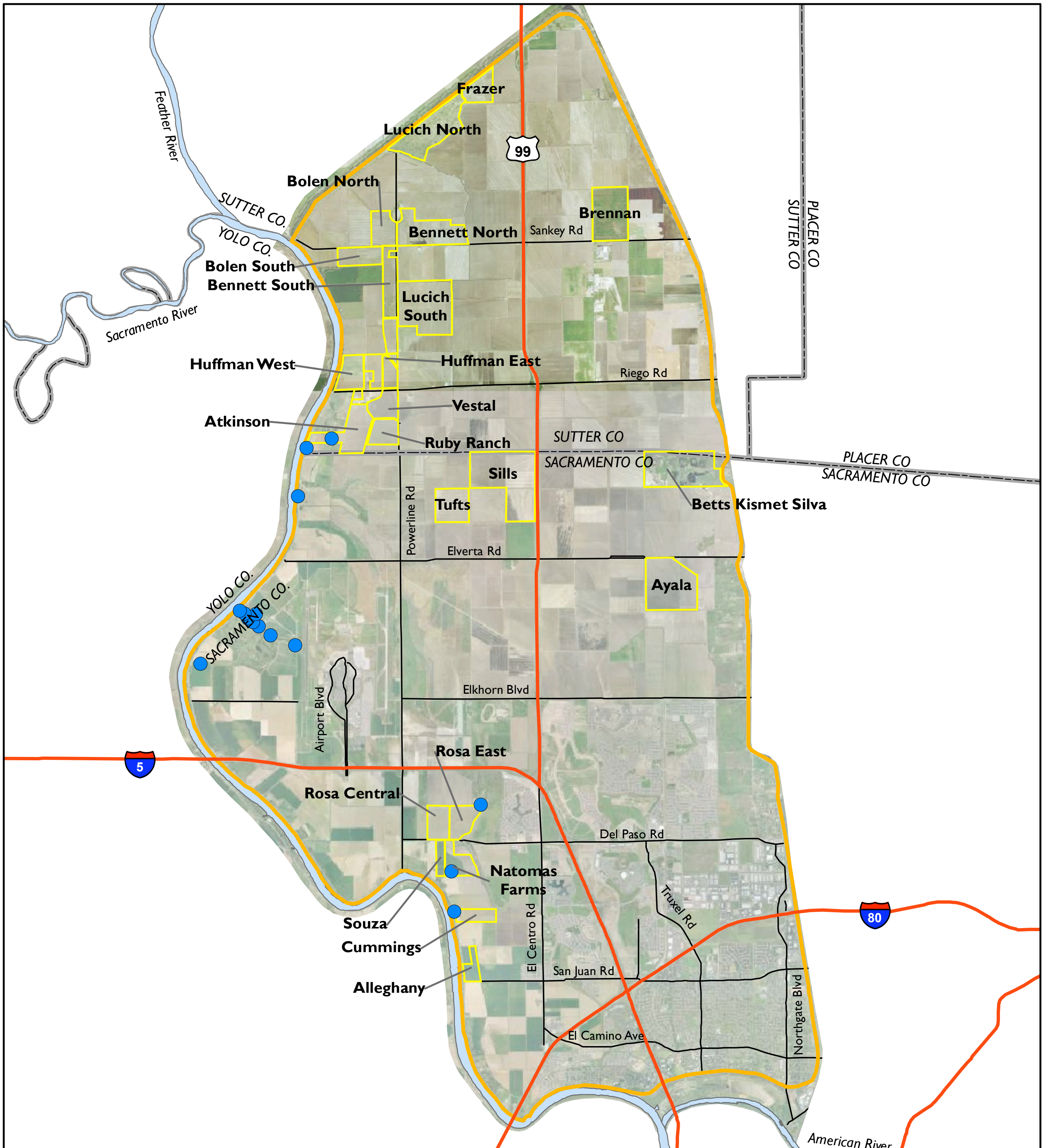
Figure 5-12
Occurrences of Western Burrowing Owl



Legend

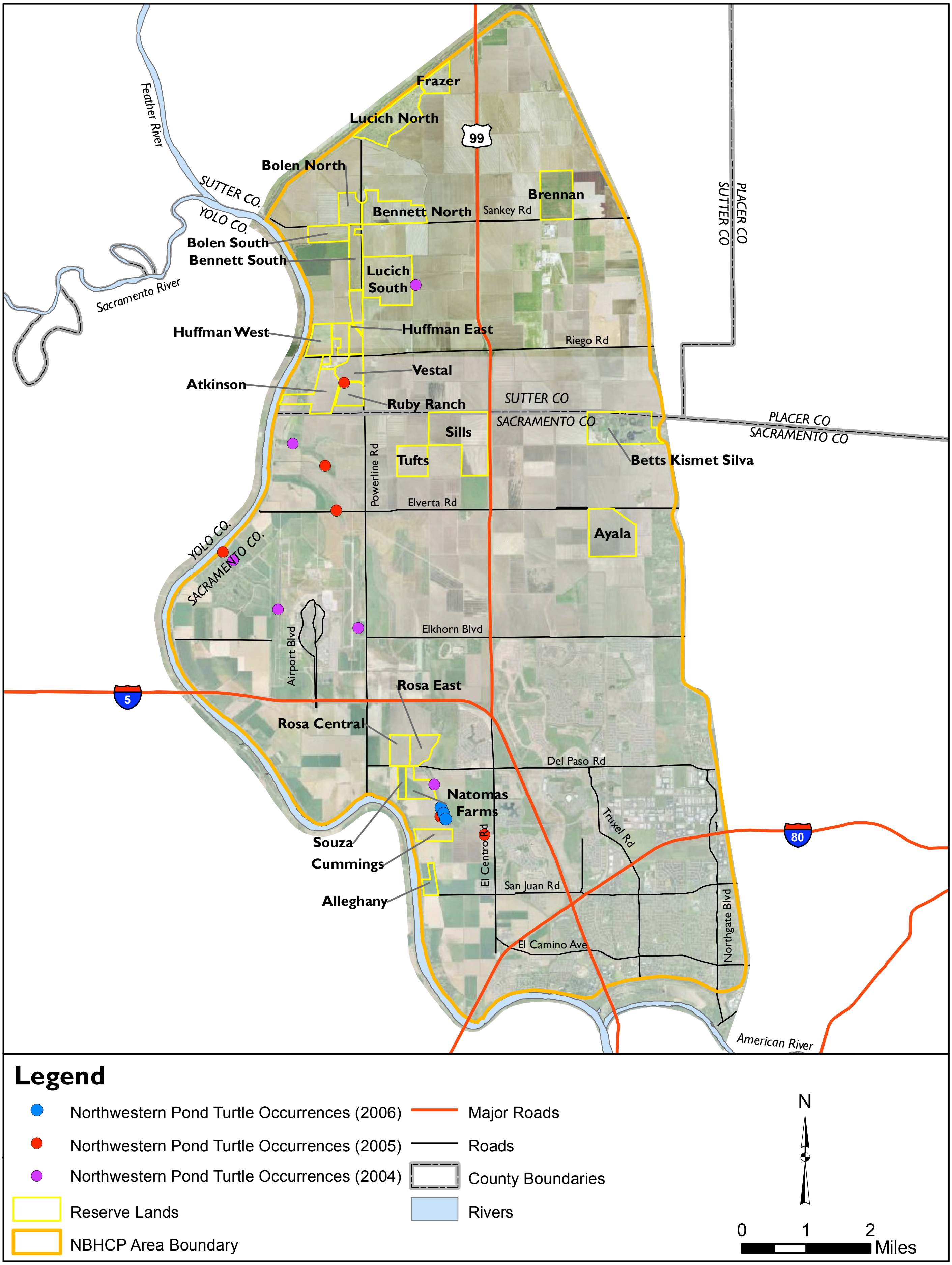
- Occurrences of Blue Elderberry Shrubs
- Reserve Lands
- NBHCP Area Boundary
- Major Roads
- Roads
- County Boundaries
- Rivers

N

0 1 2 Miles

Jones & Stokes

Figure 5-13
Occurrences of Blue Elderberry Shrubs, 2006



Jones & Stokes

Figure 5-14
Occurrences of Northwestern Pond Turtle

Arena parking area and other developed areas in the southeast portion of the Basin suggests that some owls may be selecting small infill habitats with light fixtures that provide tall perch sites and that attract insect prey. As development in the area continues, insect prey may become less abundant and the viability of developed areas as burrowing owl habitat may be compromised.

The historic and continued eradication of California ground squirrels, the main source of burrows, is likely a significant factor in the reduction of burrowing owl populations, and protection of burrowing mammal populations has been proposed as a management strategy for the success of this species (Haug et al. 1993). The presence of California ground squirrels on 10 TNBC properties highlights the importance that TNBC reserves are likely to play in the future success of this species in the Basin.

Northwestern pond turtles have been detected in very low numbers in the Basin since comprehensive monitoring began in 2004. Lack of a standardized technique for conducting surveys and a corresponding lack of comparative data make an assessment of pond turtle populations difficult. The expansion of the nonnative red-eared slider may be adversely affecting populations of northwestern pond turtle (Patterson pers. comm.). In addition, aggressive management of water conveyance features and other factors that degrade upland nesting habitat—the same factors identified as potentially affecting giant garter snake—may be contributing to small numbers of pond turtles in the Basin (U.S. Fish and Wildlife Service 1999; Hansen pers. comm.).

One previously undocumented blue elderberry shrub was recorded in the Basin in 2006. Suitable riparian habitats are generally limited to the north, west, and south Basin margins along the Sacramento River and the Natomas Cross Canal.

Habitats for Other Covered Species associated with vernal pools, such as vernal pool invertebrates, western spadefoot, and California tiger salamander, are generally lacking in the Basin. None of these species have been detected and no habitat(s) capable of supporting them have been reported since implementation of the NBHCP.

5.5 Effectiveness

Biological effectiveness as it pertains to Other Covered Species is measured primarily on the basis of land management activities that promote the development and enhancement of habitats for these species and the response of populations to these management actions.

In late 2004 and 2005, TNBC and the biological effectiveness monitoring team discussed the desirability of reducing vegetation height in grassland areas on some reserves, particularly the BKS Reserve, to improve foraging habitat for burrowing owl and Swainson's hawk. TNBC instituted an intensive cattle and goat grazing regime on the BKS Reserve and introduced grazing on the Natomas

Farms and Cummings Reserves. Habitat conditions for burrowing owls and foraging raptors appear to have improved as a result of these vegetation management practices. In addition, more upland habitats are being incorporated into the design of managed marsh habitats, which should provide additional nesting habitat for northwestern pond turtles.

5.6 Recommendations

Burrowing owl populations in the Basin have likely always been small. Efforts to protect crops and levee roads in agricultural areas have typically included intensive ground squirrel control, further reducing potential habitat for this species. TNBC should consider the following actions to augment burrowing owl populations on reserve lands.

- Continue to allow natural colonization of new habitats by California ground squirrels and/or provide burrowing owl nest boxes in suitable upland habitats on selected reserves.
- Consider maintaining an unplowed (but mowed as necessary) strip of land on upland agricultural fields to provide potential burrowing owl nesting habitat.
- Consider allowing development projects where burrowing owls occur to actively relocate their burrowing owls onto TNBC reserves.

The tricolored blackbird colony at BKS is the only known breeding site for this species in the Basin. Although the tricolored blackbird colony at BKS was active in 2005 and breeding was successful, no breeding activity was recorded in 2006. TNBC should consider the following actions to provide additional security for the nesting tricolored blackbird population in the Basin.

- Continue to manage some created marsh habitats to further promote the development of dense tule stands. This action will also benefit white-faced ibis.
- If current created marsh habitats are not utilized by tricolored blackbirds for nesting and the currently occupied nesting habitat is abandoned, consider creating additional nesting habitat for this species at BKS or other reserves.

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