Biological Effectiveness Monitoring for the Natomas Basin Habitat Conservation Plan Area 2005 Annual Survey Results

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Introduction

1.1 Background

In November 1997, the Natomas Basin Habitat Conservation Plan (NBHCP) (City of Sacramento 1997) 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.

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. 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, operation and maintenance of irrigation and drainage systems, 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*). More specific goals are listed below.

- Establishing and managing in perpetuity a biologically sound and interconnected habitat reserve system that mitigates impacts on Covered Species resulting from activities that are covered under the NBHCP, and that provides habitat for existing and new viable populations of Covered Species.
- Implementing an adaptive management program that responds to changing circumstances affecting covered species and their habitats.
- Providing open space that may benefit other wildlife and plant species.

- Ensuring that direct impacts of authorized development on Covered Species are avoided or minimized to the maximum extent practicable.

Achieving these goals requires the coordinated efforts of a multidisciplinary team. The Natomas Basin Conservancy (TNBC) is the nonprofit entity responsible for administering and implementing the NBHCP. As the Plan Operator, TNBC reports directly to the NBHCP permit holders (currently the City of Sacramento and Sutter County). 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 Natomas Basin (Basin). A Technical Advisory Committee (TAC) provides technical assistance to TNBC.

To achieve the goals of the Plan, TNBC has retained a reserve management team (Wildlands, Inc.) to carry out the design and certain management tasks associated with the habitat reserve system, and a biological effectiveness monitoring team (Jones & Stokes) to verify progress toward the biological goals and objectives and to inform the adaptive management strategy. These three entities—TNBC, Wildlands, and Jones & Stokes—operate as members of a team, with monthly meetings to ensure the seamless and timely interchange of vital information.

Acquisition of reserve lands has been carried out in accordance with the 0.5:1 acquisition-to-impact ratio required by the Plan; in other words, the rate of acquisition is tied to the extent of development, and TNBC has fulfilled its obligations to date in this regard. As of September 12, 2005, TNBC owned and operated 25 reserves, totaling approximately 3,942 acres (1,595 hectares), in the Basin (Table 1-1).

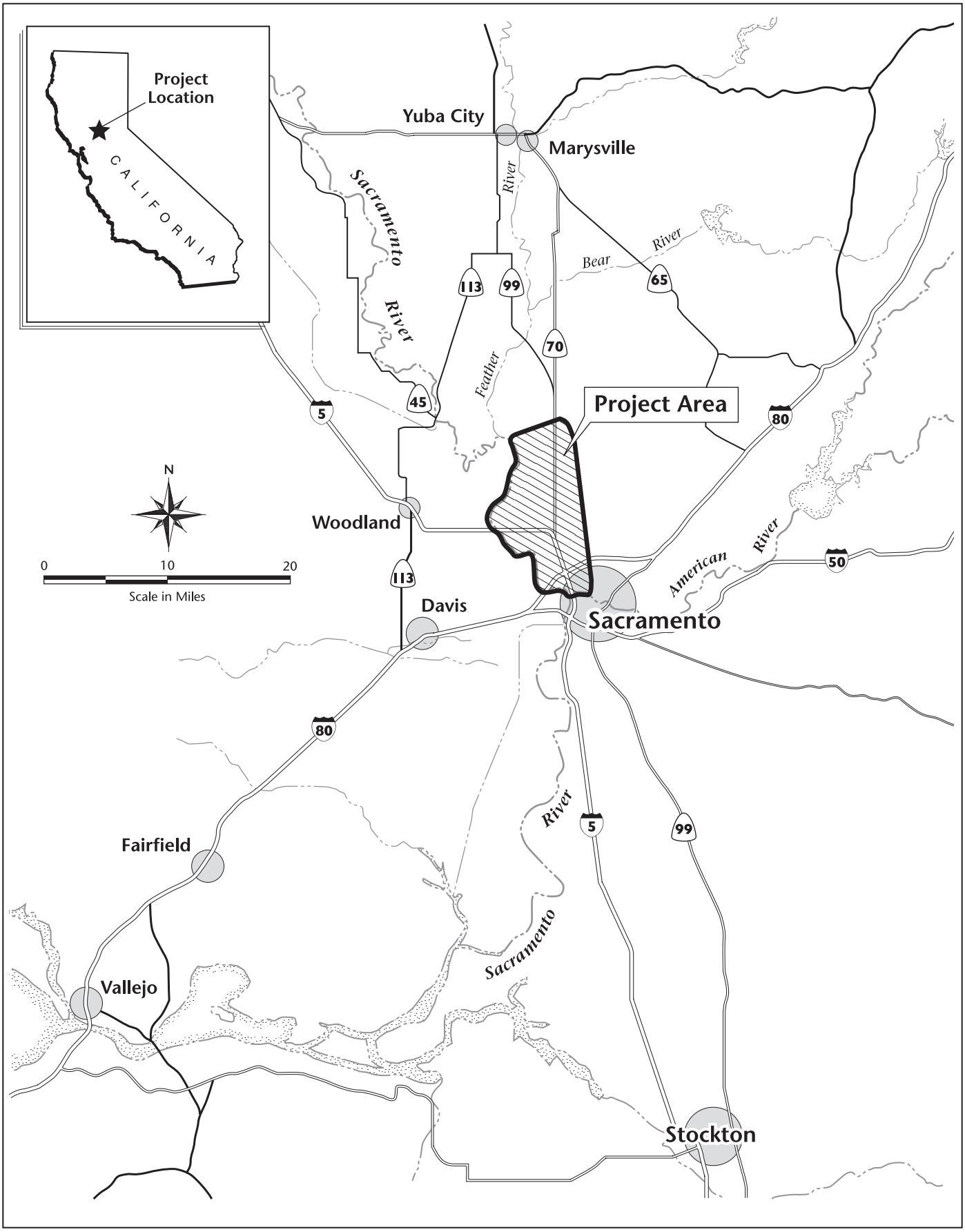
1.1.1 Location

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.

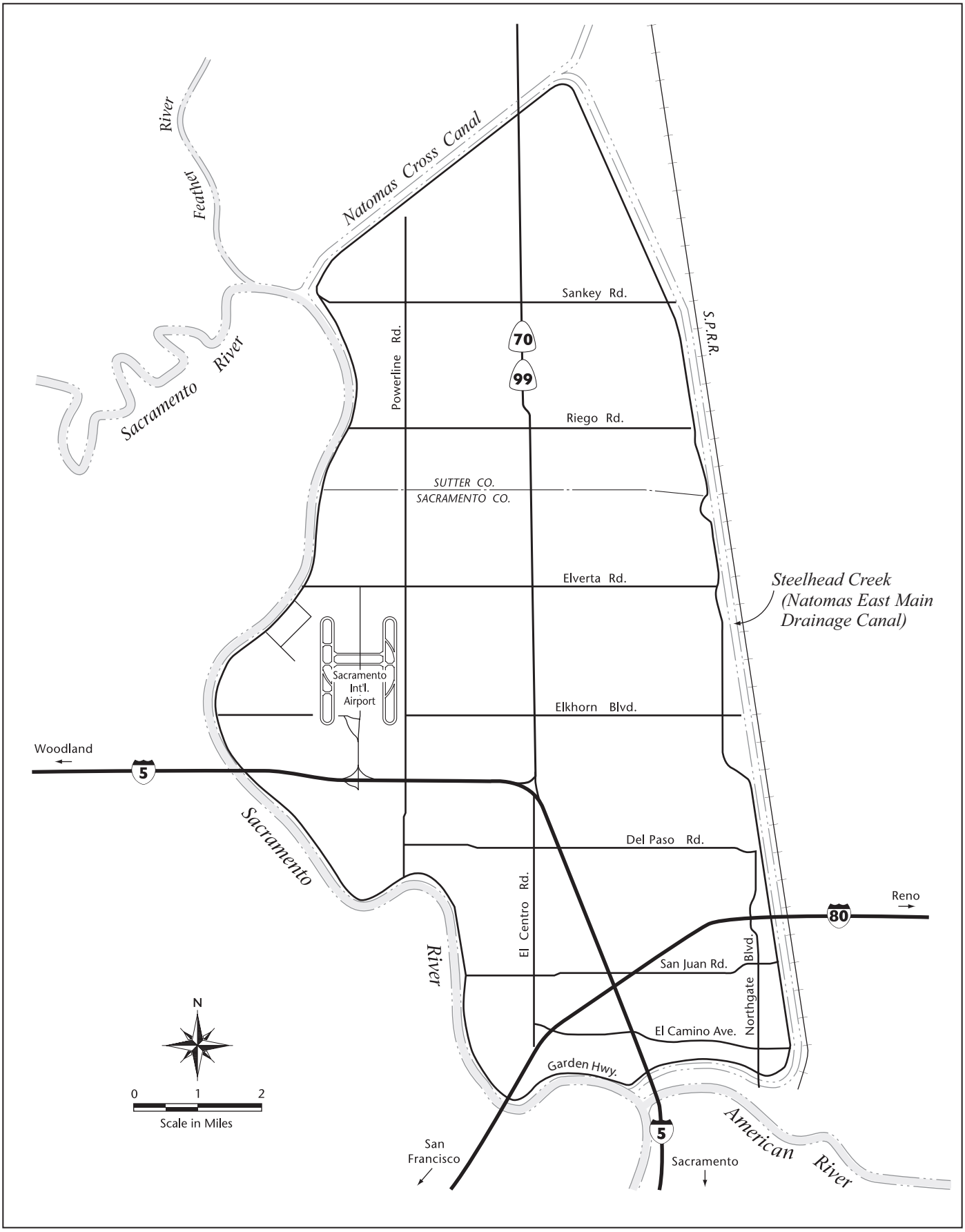
Table 1-1. Natomas Basin Habitat Conservation Plan Acquisition of Mitigation Lands as of September 2005

Property	Date Acquired	Acres
Alleghany 50	11/7/02	50.3
Atkinson	6/12/03	205.4
Ayala	2/20/02	317.4
Bennett North	5/17/99	226.7
Bennett South	5/17/99	132.5
Betts	4/5/99	139.0
Bolen North	4/29/05	113.6
Bolen South	4/29/05	102.4
Brennan	6/15/00	241.4
Cummings	11/7/02	66.8
Frazer	7/31/00	92.6
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
Rosa Central	3/23/05	106.3
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 South	9/12/05	95.0
Total		3,942.2



Jones & Stokes

Figure 1-1
Natomas Basin Regional Location Map



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Jones & Stokes

Figure 1-2
Natomas Basin

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 (Figure 1-3). 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.

1.2.2 Covered Species

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

Two covered species—Swainson's hawk and giant garter snake—are currently state- or federally listed 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.

Integrated Basin-Wide GIS Mapping and Habitat Monitoring

The foundations of the monitoring program are the creation of an integrated Basin-wide geographic information system (GIS) database and the development of monitoring protocols. Development of the integrated GIS database facilitates Basin-wide evaluations of baseline conditions and is the best tool available for tracking changes over time throughout the permit area. GIS technology is of critical importance in such a long-term assessment because it allows quantification of land cover and habitat types and provides the ability to track this quantification through time as conditions change.

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	*Clemmys marmorata marmorata*
California tiger salamander	*Ambystoma californiense*
Western spadefoot	*Scaphiopus 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*

Typical habitat of the central and northern Natomas Basin

Natomas Cross Canal

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Jones & Stokes

Figure 1-3
Central and Northern Basin Habitats

Fisherman's Lake

Mature riparian forest along the Sacramento River

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Jones & Stokes

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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Jones & Stokes

Figure 1-5
Southern and Western Basin Habitats

Typical habitat of the east Natomas Basin

Steelhead Creek (formerly the Natomas East Main Drain Canal)

04002.04

Jones & Stokes

Figure 1-6
Eastern Basin Habitats

Creation of the GIS database entailed extensive vegetation mapping. This mapping was undertaken by digitizing land-cover polygons on a mosaic of ortho-geo-rectified aerial photographs taken in spring 2004 at 1- and 2-foot resolutions. Botanists visited each polygon to field-verify the accuracy of the mapping. This process is described in detail in Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring.*

The integrated GIS database has been designed to support long-term monitoring both on and off reserves. On-reserve monitoring focuses on detailed efforts to monitor populations of covered species and habitat conditions. Off-reserve monitoring efforts focus primarily on documenting the presence or absence of Other Covered Species on non-reserve lands and tracking changes in habitats throughout the Basin over time. All monitoring results are documented in a systematized fashion and using standardized forms. Locational data are documented using global position system (GPS) units; monitoring results are then entered into the integrated GIS database to facilitate comprehensive analyses.

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 precise vegetative composition of the reserves, to assess the changes of this composition over time, and to note any occurrence of other covered plant species.

Noxious weed surveys were also initiated in 2004 and 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. Current efforts entail systematic surveys both on and off reserves in accordance with rigorous survey protocols. 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. These generalized surveys focus primarily on other covered bird species and are also used to obtain quantitative data on breeding and wintering bird populations using TNBC reserves. Surveys for northwestern pond turtles are conducted in conjunction with giant garter snake surveys.

Additionally, surveys for Other Covered Species are conducted on non-reserve lands 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 both types of surveys are discussed in detail in Chapter 5, *Other Covered Wildlife Species*.

1.3 References

City of Sacramento. 1997. *Natomas Basin Habitat Conservation Plan; Sacramento and Sutter Counties, California*. Sacramento, CA.

———. 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

Monitoring efforts for all Covered Species are designed to assess the progress of the NBHCP toward meeting the plans 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).

Vegetation 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 vegetation and habitat type monitoring involved field checking each habitat polygon in 2005 to the extent possible using the baseline map developed in 2004.

2.1.2 Goals and Objectives

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

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

- Provide spatially explicit information on the distribution and abundance of vegetation and habitat types throughout the Basin to guide future reserve site acquisitions and to provide information on potential dispersal corridors between reserves.

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

- Thoroughly describe and document vegetation and habitat conditions and develop a complete plant list.
- Determine if any covered plant species occur on the newly acquired reserves and, if so, document their location, numbers, and/or coverage.
- Document the location, numbers, and/or coverage of invasive or noxious plant populations where they occur.

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 coverage of invasive or noxious plant populations where they occur.
- Conduct surveys for covered plant species in suitable habitat.

2.2 Methods

2.2.1 Vegetation Mapping

To document baseline habitat conditions throughout the Basin in 2004, 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 (habitat types) on screen using ESRI's ArcGIS 9.0 software. Lines were drawn to delineate land-cover 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 equals 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. Isolated individual trees were mapped as point features.

Because ditches were mapped as line features, the acreage of these features was not calculated.

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

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. Notes were made on the presence or extent of management or other human impacts, such as tree cutting, vegetation cutting, herbicide use, and erosion.
- Other data where relevant (e.g., tree or vegetation height, number of trees, canopy cover).
- Any changes in vegetation, habitat or crop type, or the distribution and abundance of suitable habitat for covered plant species.

Most of these surveys were conducted in mid-summer, which was appropriate to map habitat polygons and document noxious/invasive plants.

2.2.2 Floristic Surveys

Floristic surveys to document baseline conditions were conducted in 2005 on five newly acquired reserves: Tufts, Bolen North, Bolen South, Rosa East, and Rosa Central (Rosa East and Central were combined for survey and reporting purposes and are referred to collectively as Rosa). Tufts, consisting of one rice field, was surveyed in mid-summer. Bolen North, Bolen South, and Rosa were acquired later in the year and were surveyed in September. These surveys were too late in the season to detect early blooming plants, but were appropriate to detect late-blooming plants, assess and document habitat conditions, and record and map noxious weed occurrences.

Survey intensity varied depending on habitat type and quality, species richness, and the probability of covered plant species occurring in a particular habitat type. The botanist walked meandering and intuitively controlled transects in areas of undisturbed vegetation. On agricultural portions of the reserves, surveys were less intensive, and entailed driving the access roads and stopping occasionally to sample the vegetation and record species present.

On existing reserve sites, 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 plant species (habitat polygons were mapped and documented as described above); document noxious/invasive plant species; and conduct surveys for covered plant species in appropriate habitat. Additional plant species encountered were added to the cumulative list of species observed on each reserve. Focused surveys for covered plant species were conducted as specified below.

- On the Betts-Kismat-Silva (BKS) Reserve, a survey for covered vernal pool plants was conducted in the constructed seasonal wetlands/vernal pools on May 7 as the pools were drying out; all plant species present in the pools were recorded.
- On the Atkinson Reserve, a survey for Sanford's arrowhead was conducted along the creek on September 19.

Nomenclature follows *The Jepson Manual* (Hickman 1993) and online updates (Baldwin et al. 2005). Common and scientific names of plants mentioned in the text are given in Appendix B.

2.2.3 Noxious Weed Mapping

A complete list of noxious weeds known to occur in Sutter and Sacramento Counties was compiled from information in CalFlora (2004) and Jones & Stokes file data. The noxious weeds mapped 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). These lists include plants considered invasive to wildlands and natural vegetation, rather than weeds of agricultural importance that are found primarily in disturbed habitats. The three categories are defined below.

- List A: Most Invasive Wildland Pest Plants. These species are documented as aggressive invaders that displace natives and disrupt natural habitats. List A comprises two sub-lists: List A-1 is widespread pests that are invasive in more than three Jepson regions (floristic regions of California; Hickman 1993); List A-2 is regional pests invasive in three or fewer Jepson regions.
- List B: Wildland Pest Plants of Lesser Invasiveness. These species are invasive pest plants that spread less rapidly and cause a lesser degree of habitat disruption; they may be widespread or regional.
- Red Alert: Pest plants with potential to spread explosively. These are species with infestations that are currently small or localized. If found, Cal-IPC, the County Agricultural Commissioner, or the California Department of Food and Agriculture (CDFA) should be alerted.

Invasive plants in the following Cal-IPC categories were not mapped, but were recorded on the floristic survey, with general notes on their abundance and distribution.

- Annual Grasses: a preliminary list of annual grasses, abundant and widespread in California, that pose significant threats to wildlands. Some of these species of annual grasses, particularly Italian ryegrass, slender wild oats, and ripgut brome, are widespread on TNBC reserves.
- Need More Information: plants for which current information does not adequately describe the nature of the threat to wildlands, distribution, or invasiveness. Examples from this list present on TNBC reserves include Russian thistle or tumbleweed and shortpod mustard.
- Considered but Not Listed: plants that, after review of status, do not appear to pose a significant threat to wildlands. An example from this list is milk thistle, a common plant on some TNBC reserves.

Cal-IPC's list does not include some species that are listed on CDFA's Noxious Weed List (2000).

- Plants found mainly or solely in disturbed areas, such as roadsides and agricultural fields.
- Plants that are established only sparingly, with minimal impact on natural habitats.

Plants found on TNBC reserves that are on CDFA's list but not listed by Cal-IPC include field bindweed, Bermuda grass, and puncture vine.

Several non-listed plants that are potentially invasive in wetlands and may be of management concern were noted in the field surveys; these species include joint grass, barnyardgrass, cattail, and waterfern.

Each noxious weed occurrence observed during the field survey was assigned a unique number, the species was identified, and the boundaries of the infestation were mapped. 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.

The list was reviewed before the 2005 field survey season, and no changes were made. Cal-IPC is conducting a statewide evaluation of invasive species (Cal-IPC 2003) that will result in a revised list of invasive plants grouped into new categories. In 2005, the reserves were surveyed for noxious weeds in mid-summer (June 7) when the weeds were evident and identifiable, with some follow-up surveys conducted in mid-September.

2.3 Results

2.3.1 Vegetation and Habitats Basin-Wide

In 2005, two new crop types—sunflower and safflower—were added to the list of habitat and vegetation types. The 27 recognized habitat types and the acreages of each in 2004 and 2005 are listed in Table 2-1. The distribution of these habitat types is shown in Figure 2-1. Several habitat types have been combined in the figure for clearer representation. Rice agriculture continues to dominate the landscape, accounting for 43% of the total area in the Basin, a decrease of less than 200 acres (81 hectares) since 2004. Twenty-one percent of the landscape is developed, compared with just under 20% that was developed in 2004, an increase of 764 acres (309 hectares). An additional 2.5% of the Basin's area has been graded for development; a similar extent was classified as graded in 2004. Fourteen percent of the Basin was in upland agriculture (alfalfa, row and grain crops, and other hay crops) in 2005, a decrease of 1% or approximately 550 acres (223 hectares), from 2004. Total grasslands in the Basin (including irrigated grasslands and ruderal areas) remained unchanged at 16% of the total.

Natural vegetation constitutes an extremely small proportion of the Basin and did not change from 2004 to 2005. Approximately 600 acres (243 hectares), slightly more than 1% of the land area in the Basin, remain covered by tree- and shrub-dominated vegetation (valley oak woodland and riparian woodland and scrub), unchanged since 2004. Slightly more than 800 acres (324 hectares) or 1.5% of the Basin, comprised wetlands in 2005, a slight increase (approximately 35 acres [14 hectares]) since 2004. 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 Vegetation and Habitats on Reserve Sites

The acreages of each habitat type mapped on reserve lands in 2005 are shown in Table 2-2[1] along with 2004 acreages for comparison. New acquisitions in 2005 added approximately 560 acres (227 hectares) of riceland to the reserve lands total; consequently, the proportion of the Basin's ricelands that are within TNBC reserves increased from 8.1% in 2004 to 10.6% in 2005. The conversion of a portion of Cummings Reserve to managed marsh has increased the total acreage of marsh on TNBC lands to 562 acres (227 hectares). The acreage of reserve lands in upland agriculture was lower in 2005 than in 2004; this decrease was due in large part to the trade of the upland field at the southern end of the Sills Reserve. The acreage in alfalfa on reserve lands increased by 38 acres (15

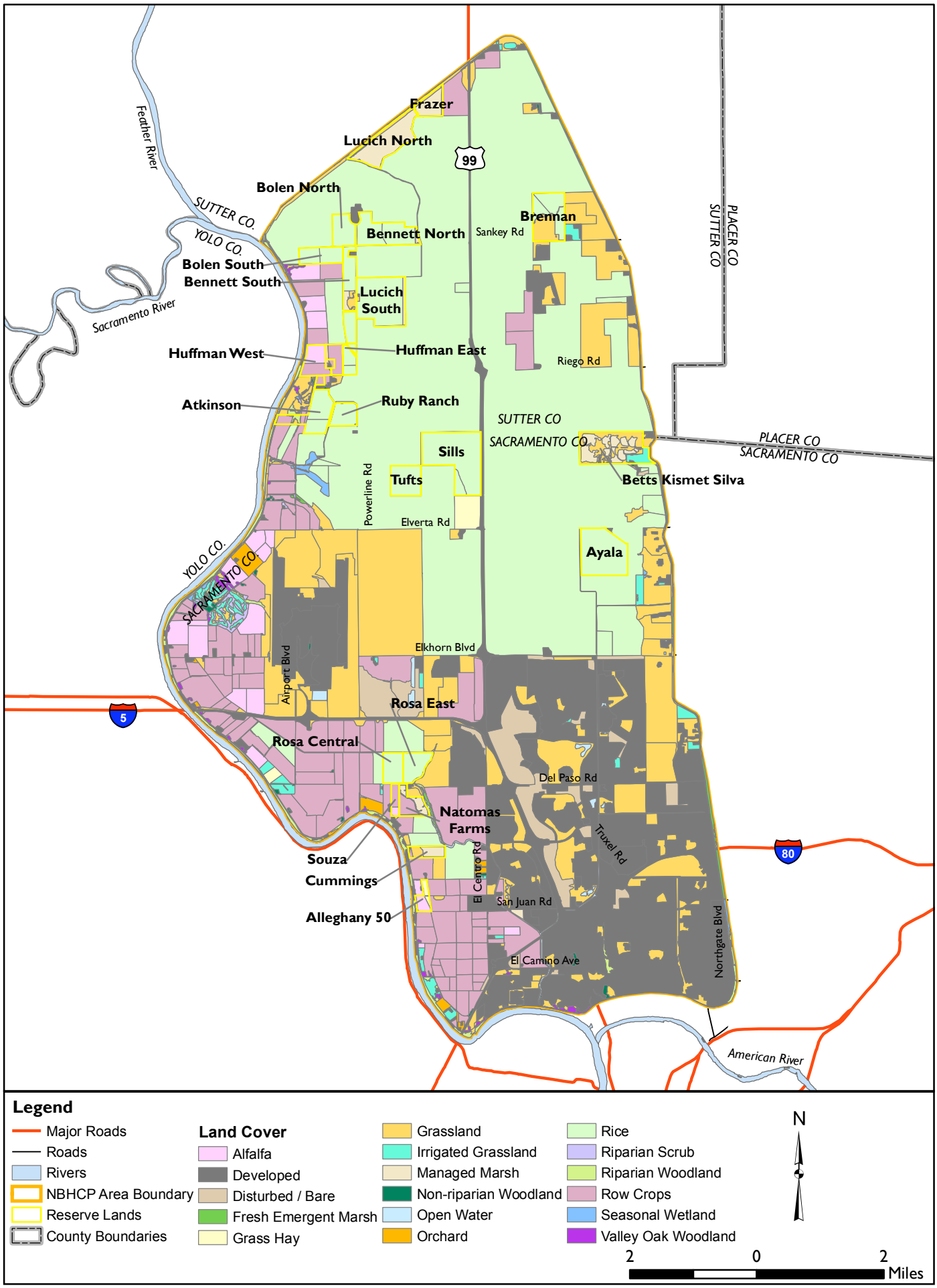
[1] Two factors contribute to the apparent discrepancy between the total acreages shown in Table 1-1 and Table 2-2. The total in Table 1-1 is the result of land surveys conducted in a method that did not produce data compatible with a GIS system; the total in Table 2-2 is the result of parcel boundaries drawn in a GIS environment. The second factor is the addition of the Vestal South Reserve in 2005; this reserve has not yet been mapped, and is accordingly not reflected in the total acreage shown in Table 2-2.

Table 2-1. Basin-Wide Extent of Mapped Habitat Types in 2004 and 2005

	2004		2005	
Habitat/Vegetation Type	Acres	Percent of Basin	Acres	Percent of Basin
Rice	23,336	43.1	23,145	42.7
Alfalfa	610	1.1	940	1.7
Irrigated Grassland	776	1.4	440	0.8
Grass Hay	158	0.3	178	0.3
Wheat	215	0.4	1,820	3.4
Milo	88	0.2	0	0.0
Tomatoes	93	0.2	50	0.1
Sunflower	0	0.0	709	1.3
Safflower	0	0.0	886	1.6
Other Row Crops	6,311	11.6	2,486	4.6
Fallow Row Crop	726	1.3	585	1.1
Orchard	173	0.3	182	0.3
Managed Marsh	538	1.0	573	1.1
Fresh Emergent Marsh	138	0.3	138	0.3
Seasonal Wetland	105	0.2	105	0.2
Grassland (created)	42	0.1	69	0.1
Nonnative Annual Grassland	7,475	13.8	7,841	14.5
Ruderal	330	0.6	329	0.6
Valley Oak Woodland	157	0.3	157	0.3
Riparian Woodland	331	0.6	333	0.6
Riparian Scrub	120	0.2	120	0.2
Non-riparian Woodland	98	0.2	98	0.2
Open Water	297	0.5	305	0.6
Developed—Low Density	1,383	2.6	1,382	2.6
Developed—High Density	9,234	17.0	9,998	18.4
Disturbed / Bare	1,470	2.7	1,334	2.5
Total	54,204	100.0	54,204	100.0
Summary				
Rice	23,336	43.1	23,145	42.7
Alfalfa	610	1.1	940	1.7
Upland Agriculture	7,590	14.0	6,712	12.4
Total Grasslands	8,622	15.9	8,679	16.0
Total Wetlands	781	1.4	817	1.5
Total native Woodlands/Scrub	608	1.1	610	1.1
Developed / Disturbed	12,087	22.3	12,714	23.5
Non-riparian Woodland	98	0.2	98	0.2
Open Water	297	0.5	305	0.6
Orchard	173	0.3	182	0.3
Total	54,204	100.0	54,204	100.0

Table 2-2. Extent of Mapped Habitat Types on Reserve Lands, 2004 and 2005

	2004		2005	
Habitat/Vegetation Type	Acres	Percent of Basin-Wide Habitat Occurring on Reserve Lands	Acres	Percent of Basin-Wide Habitat Occurring on Reserve Lands
Rice	1,898	8.1	2,444	10.6
Alfalfa	64	10.4	102	10.8
Irrigated Grassland	37	4.8	37	8.5
Grass Hay	129	81.6	19	10.6
Wheat	129	59.9	205	11.3
Milo	80	91.2	0	0.0
Tomatoes	53	57.3	0	0.0
Sunflower	0	0.0	0	0.0
Safflower	0	0.0	0	0.0
Other Row Crops	1	0.0	10	0.4
Fallow Row Crop	25	3.4	15	2.7
Managed Marsh	519	96.6	555	96.8
Fresh Emergent Marsh	2	1.2	2	1.2
Seasonal Wetland	6	5.6	6	5.6
Grassland (created)	39	91.8	65	94.0
Nonnative Annual Grassland	311	4.2	266	3.4
Ruderal	44	13.5	44	13.3
Valley Oak Woodland	5	3.1	6	3.8
Riparian Woodland	11	3.4	13	3.8
Riparian Scrub	3	2.2	3	2.5
Non-riparian Woodland	1	1.5	1	1.5
Open Water	0	0.1	0	0.1
Developed—Low Density	6	0.4	6	0.4
Developed—High Density	28	0.3	14	0.1
Disturbed / Bare	0	0.0	0	0.0
Total	3,391	6.3	3,812	7.0
Summary				
Rice	1,898	8.1	2,444	10.6
Alfalfa	64	10.4	102	10.8
Upland agriculture	417	5.5	249	3.7
Total Grasslands	432	5.0	412	4.7
Total Wetlands	527	67.5	562	68.9
Total native Woodlands/Scrub	19	3.1	22	3.5
Developed / Disturbed	34	0.3	19	0.2
Non-riparian Woodland	1	1.5	1	1.5
Open Water	0	0.1	0	0.1
Total	3,391	6.3	3,812	7.0



Jones & Stokes

Figure 2-1
Distribution of Vegetation Types in the Natomas Basin, 2005

hectares) in 2005, paralleling a Basin-wide increase; overall, alfalfa on reserve lands in 2005 constituted 10.8% of the Basin's total, up from 10.4% in 2004. A complete list of vascular plant species recorded on all reserves in 2004 and 2005 is provided in Appendix B.

Baseline Habitat Surveys on New Reserves

Bolen North

Vegetation Type Mapping

Two habitat types were mapped on the Bolen North Reserve. The habitat types and associated acreages are shown below. The distribution of these habitat types is shown in Appendix A.

■ Fallow Rice	106.34
■ Ditch	

The reserve consists of one rice field that was fallow in the 2005 crop season. Ditches occur around the edge of the field. A description of each habitat type follows.

Fallow Rice. The rice field was fallow in 2005, and at the date of the survey (September 9, 2005) had been recently disked and supported little vegetation.

Ditch. The surrounding ditches supported some aquatic vegetation, particularly the ditch at the north of the reserve, which was densely vegetated with species such as fringed willowherb, smartweeds, and annual water-aster.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Forty plant species were recorded on the reserve, of which 38% (15 species) are monocots (grasses, grass-like plants, orchids, and lilies) and 60% (24 species) are dicots (all other flowering plants). The flora comprises 19 families; the Poaceae (grass family) is the best represented family, with nine species (23% of the total list), followed by the Asteraceae (sunflower family) with six species (15%). Twenty-two (55%) of the species recorded are nonnative species.

Noxious Weed Surveys

Two occurrences of two noxious weed species were recorded on the reserve. These plants are listed below.

- Perennial pepperweed (Moderate): Scattered plants occur at the edge of the field just inside the southeast gate on Sankey Road.

- Himalayan blackberry (Trace): A single shrub is located at the water control structure at the southwest corner of the field. In addition, two patches were noted just outside the reserve along the west boundary.

These noxious weeds were localized in extent, do not appear to be strongly invasive on the reserve, and are likely to be kept in check by ongoing cultivation. Jointgrass was quite common, occurring in moderate to high-density patches along the sides of the berms on the west and south edges of the field, with a small patch on the east side just north of the gate.

Bolen South

Vegetation Type Mapping

Two habitat types were mapped on the Bolen South Reserve. The habitat types and associated acreages are shown below. The distribution of these habitat types is shown in Appendix A.

■ Fallow Rice*	110.42
■ Valley Oak Woodland	0.92

* Planted in wheat in late 2005.

The reserve consists of two rice fields that were fallow in the 2005 crop season, with a small area of valley oak woodland and some scattered valley oak trees along the southwest edge of the reserve. In addition, a single large Fremont cottonwood tree stands isolated in the cultivated portion of the west field near the valley oak woodland. A description of each habitat type follows.

Fallow Rice. The rice fields were fallow in 2005, and at the date of the survey (September 9, 2005) had been recently disked and supported little vegetation. These fields were planted in wheat in late fall 2005.

Valley Oak Woodland. One small polygon was mapped, consisting of a row of valley oaks along the south edge of the reserve. This patch is adjacent to a larger area of valley oak woodland southwest of the reserve. Valley oak is the dominant tree, and Himalayan blackberry the dominant component of the understory, together with nonnative annual grasses.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Forty-nine plant species were recorded on the reserve, of which 29% (14 species) are monocots (grasses, grass-like plants, orchids, and lilies) and 71% (35 species) are dicots (all other flowering plants). The flora comprises 21 families; the Poaceae (grass family) is the best represented family, with 12 species (24% of the total list), followed by the Asteraceae (sunflower family) with 10 species (20%). Twenty-nine (59%) of the species recorded are nonnative species.

Noxious Weed Surveys

Five occurrences of Himalayan blackberry were recorded on the reserve. These occurrences are described below.

- Himalayan blackberry (Low–High): Himalayan blackberry is concentrated in the southwest portion of the reserve, occurring below the valley oak trees and the single cottonwood tree. One additional patch at the southeast corner was mechanically removed.

Rosa

Vegetation Type Mapping

Four habitat types were mapped on the Rosa Reserves. The habitat types and associated acreages are shown below. The distribution of these habitat types is shown in Appendix A.

■ Fallow Rice*	200.81
■ Valley Oak Woodland	0.17
■ Riparian Woodland	1.38
■ Ditch	

* Planted in wheat in late 2005.

The reserve consists of two rice fields that were fallow in the 2005 crop season, and were planted in wheat in late fall 2005. There is a small area of riparian woodland bordering Fisherman's Lake in the southeast corner and a very small patch of valley oak woodland on the north edge. A description of each habitat type follows.

Fallow Rice. The rice fields were fallow in 2005. The majority of the fields had been recently disked at the date of the survey and supported little vegetation, except for a narrow strip along the west edge of Rosa Central that was undisked and supported a dense layer of regenerating wetland plants. Dominant species were barnyard grass, smartweed, prickly lettuce, and bearded sprangletop.

Riparian Woodland. A patch of remnant riparian woodland occurs along Fisherman's Lake in the southeast corner of the Rosa East Reserve. This patch was dominated by mature black willow and Fremont cottonwood trees, with a moderate to dense understory of Himalayan blackberry.

Valley Oak Woodland. One very small polygon was mapped, consisting of a row of a few valley oaks along road at the north edge of Rosa East. The understory consists of Himalayan blackberry and annual grasses. A few white mulberry seedlings and saplings were regenerating below the valley oaks.

Ditch. A ditch along the southern boundary of the reserve supported some aquatic vegetation.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Forty-nine plant species were recorded on the reserve, of which 41% (20 species) are monocots (grasses, grass-like plants, orchids, and lilies) and 59% (29 species) are dicots (all other flowering plants). The flora comprises 19 families; the Poaceae (grass family) is the best represented family, with 14 species (29% of the total list), followed by the Asteraceae (sunflower family) with seven species (14%). Thirty-one (63%) of the species recorded are nonnative species.

Noxious Weed Surveys

Ten occurrences of four noxious weed species were recorded on the reserve. These plants are listed below.

- Himalayan blackberry (Low–Dense): Five occurrences were mapped: two in the understory of woodland habitats, particularly in the riparian woodland where it formed dense patches, and three on the berms around the fields in the northwest and northeast corner. Most of these patches had been mechanically treated earlier in the season but were regenerating.

- Perennial pepperweed (Trace–Moderate): Three occurrences were mapped. Two were near the northeast corner at the edge of the field where they had been disked but were resprouting. The third patch, larger and denser than the other two, occurred along the road edge in the southeast corner and appeared to be undisturbed by disking this season.
- Sweet fennel (Low): Scattered plants were noted along the edge of the road in the northeast corner of Rosa East.
- Poison hemlock (High): One small patch was mapped in the northeast corner of the field on Rosa East.

The sweet fennel and poison hemlock were very localized in extent and do not appear to be strongly invasive on the reserve. They are likely to be kept in check by ongoing cultivation. The pepperweed and Himalayan blackberry have the potential to invade, and areas that had been disked or mechanically treated earlier in the season were showing signs of regenerating in mid-September 2005. One small area of jointgrass was noted in the northwest corner.

Tufts

Vegetation Type Mapping

Two habitat types were mapped on the Tufts Reserve. The habitat types and associated acreages are shown below. The distribution of these habitat types is shown in Appendix A.

■ Rice	145.1
■ Ditch	

Tufts consists of one rice field that was entirely in rice production in 2005.

Rice. The entire reserve was in rice in 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Twenty plant species were recorded on the reserve, of which 55% (11 species) are monocots (grasses, grass-like plants, orchids, and lilies) and 45% (nine species) are dicots (all other flowering plants). The flora comprises nine families; the Poaceae (grass family) is the best represented family with seven species (35% of the total list), followed by the Asteraceae (sunflower family) with four species (20%). Thirteen (65%) of the species recorded are nonnative species.

Noxious Weed Surveys

One occurrences of a noxious weed species was recorded on the reserve.

- Yellow star-thistle (Moderate): One small area was mapped along the edge of the road at the east side of the reserve.

Annual Habitat Monitoring on Existing Reserves

The acreages of each vegetation and habitat type in 2004 and 2005 are provided for existing reserves. Any new vegetation and habitat types recorded and any changes noted are described.

Alleghany 50

Vegetation Type Mapping

Six habitat types were mapped on the Alleghany 50 Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Wheat	45.96	0.00
■ Alfalfa	0.00	27.09
■ Grass Hay	0.00	18.87
■ Ruderal	1.88	1.88
■ Valley Oak Woodland	1.80	1.80
■ Developed /roads	0.50	0.50
■ Ditch		

In 2005, the upland agriculture fields were planted in alfalfa and hay crops. The valley oak woodland and ruderal habitats remained unchanged in 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 65%.

Noxious Weed Surveys

No new noxious weed occurrences were noted in 2005, and the following three occurrences of noxious weeds recorded in 2004 remained unchanged in 2005.

- Sweet fennel (Trace): One small area was located in a disturbed roadside site.
- Edible fig (Trace): A single shrub was located within roadside valley oak woodland.
- Himalayan blackberry (Dense): Patches were observed within roadside valley oak woodland.

These noxious weeds were still very localized in extent and showed no signs of invasiveness on the reserve.

Atkinson

Vegetation Type Mapping

Twelve habitat types were mapped on the Atkinson Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
Rice	145.56	48.89
Fallow Rice	0.00	96.56
Milo	21.40	0.00
Wheat	0.00	21.37
Fallow Row Crop	21.05	21.16
Seasonal Wetland	0.07	0.07
Nonnative Annual Grassland	0.87	0.87
Ruderal	3.60	3.60
Valley Oak Woodland	1.03	1.03
Riparian Woodland	9.57	9.57
Riparian scrub	2.06	2.06

■ Developed	0.69	0.69
■ Ditch		

In 2005, the upland agriculture field in the western portion of the reserve was planted in wheat. The smaller field west of the rice fields remained fallow. Approximately two-thirds of the rice-growing area was fallow in 2005. No changes in acreage were recorded in other vegetation and habitat types in 2005. The reserve continued to support a relatively high diversity of habitats, and no significant changes were noted in these habitats.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 55%.

Noxious Weed Surveys

No new noxious weed occurrences were noted in 2005, and the following occurrences of three noxious weed species recorded in 2004 remained relatively unchanged in 2005. The perennial pepperweed recorded in 2004 adjacent to the riparian woodland area was disked in 2005, and does not appear to have spread since 2004.

- Edible fig (Trace): Located in valley oak woodland, this occurrence is a single shrub that shows no signs on invasiveness on the reserve.
- Perennial pepperweed (Moderate–High): Three occurrences were noted, two of which are small and are likely constrained by agricultural operations. The third location, in the open area surrounded by riparian woodland and scrub, has the most potential to become invasive, although it appears that annual disking may be controlling its spread.
- Himalayan blackberry (High): Patches of Himalayan blackberry are scattered around the edges of the riparian woodland and could spread farther within this habitat. The native blackberry (California blackberry) is still common here, suggesting that the invasion of Himalayan blackberry may be relatively recent.

Bennett North

Vegetation Type Mapping

Six habitat types were mapped on the Bennett North Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice	213.44	213.44

■ Managed Marsh	7.06	7.06
■ Grassland (Created)	1.62	1.62
■ Ruderal	3.30	3.30
■ Developed	2.20	2.20
■ Ditch		

There was no change in the acreages of vegetation and habitat types on the Bennett North reserve from 2004 to 2005. No significant changes were noted in the managed marsh habitat. Water fern was abundant in 2005, covering an estimated 25% of the open water during the summer.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 58%.

Noxious Weed Surveys

No new occurrences of noxious weeds were observed in 2005, and only one of the two occurrences recorded in 2004 was still extant. The following occurrence of yellow star-thistle was recorded on the reserve in 2005.

- Yellow star-thistle (Low): One occurrence was identified in a disturbed site along roads in the rice-growing area of the reserve.

Bennett South

Vegetation Type Mapping

Seven habitat types were mapped on the Bennett South Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice	82.68	0.00
■ Fallow Rice	0.00	82.91
■ Managed Marsh	17.00	17.00
■ Grassland (Created)	20.63	21.08
■ Riparian Scrub	(not mapped)	0.32
■ Ruderal	1.57	1.57
■ Open Water	0.17	0.17
■ Developed	6.91	

The rice fields, which comprise roughly the northern half of the reserve, were fallow in 2005. In the managed marsh, cattails had become the dominant plant cover. Much of the created grasslands area was dominated by the native perennial blue ryegrass, with nonnative Italian ryegrass also abundant. A portion of the area that was mapped as ruderal in 2004 was categorized in 2005 as grassland (created); nonnative annual grasses and ruderal species had colonized and dominated the sown grassland area in 2004, but by summer of 2005 the sown perennial grasses, which included blue wildrye (the dominant species), and slender wheatgrass, purple needlegrass, creeping wildrye, and one-sided bluegrass, had established well and increased in cover. The planted riparian scrub was not mapped in 2004, but has increased in canopy cover and become well established and was accordingly mapped in 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 51%.

Noxious Weed Surveys

No new occurrences of noxious weed species were noted in 2005. Bull thistle, recorded in 2004, was not observed in 2005. The occurrence of yellow star-thistle recorded in 2004 around the entrance gate and staging area in the southeast corner of the reserve appeared to have increased in extent and density in 2005. It was not observed anywhere else in the managed marsh or grassland portion of the reserve, but one other small occurrence was recorded on a road between rice fields. The following new occurrence of yellow star-thistle was recorded on the reserve in 2005.

- Yellow star-thistle (Low–Moderate): Two patches were recorded in disturbed sites along roads and staging areas.

Betts-Kismat-Silva

Vegetation Type Mapping

Seven habitat types were mapped on the BKS Reserve in 2005. The habitat types and associated acreages for both and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Irrigated Grassland	37.26	37.26
■ Managed Marsh	140.49	140.49
■ Nonnative Annual Grassland	151.84	151.84
■ Seasonal Wetland	0.47	0.47
■ Riparian Woodland	1.55	1.55

■ Non-riparian Woodland	0.88	0.88
■ Developed	5.92	5.92

There was no change in the acreages of vegetation and habitat types from 2004 no 2005, and no significant changes were noted in any of these vegetation and habitat types in 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Almost 60 plant species were added to the reserve's flora in 2005. The proportion of nonnative plants was 60%, a slight reduction from the proportion recorded in 2004.

The intensive survey of the created seasonal wetlands added 13 plant species to the BKS list, of which nine species have not been recorded on any other reserve. Five of these species—smooth goldfields, elegant microseris, short woollyheads, slender woollyheads, and pinpoint clover—are native plants characteristic of season wetlands and vernal pools in the region.

The BKS plant list is much higher than any of the other reserves because it is one of the largest reserves and because it supports a variety of habitats, including residential areas with ornamental trees and nonnative plants associated with cultivation and landscaping.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. For several of the species recorded in 2004—pennyroyal, catalpa, and tree-of-heaven—there were no changes in density or extent since 2004. Bull thistle was not observed in 2005 and Italian thistle was rare. Giant reed continues to be controlled by cutting and is decreasing in vigor. Small patches of Himalayan blackberry around the residential area were removed in 2005. The larger patches of Himalayan blackberry that often provide nesting habitat for tricolored blackbirds were maintained at their 2004 extent by intensive grazing after the tricolored blackbird breeding season.

Perennial pepperweed has been the subject of focused eradication efforts since the end of 2003, and has declined greatly in both extent and density since 2004. During 2005, only scattered plants were noted at few locations at the margins of the marsh.

Yellow star-thistle has increased in extent and density since 2004. In 2004, the infestations were light to moderate and did not form dense stands. In 2005, yellow star-thistle was common in the pasture east of the milk barn and appeared to be increasing in the area around water control structure M, where it formed large, dense stands, especially along the road. Patches of yellow star-thistle were observed in several other upland grassland areas.

Jointgrass was subject to focused eradication efforts in 2005 using a combination of methods including water level management and mechanical treatment. The infestations were much reduced in extent and vigor toward the end of 2005.

Further monitoring will be necessary to determine the success of these treatments.

The occurrences of the eight species of noxious weeds recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Low–High): Patches of yellow star-thistle occurred in grassland areas and along roads and berms, especially in the western portion of the reserve. The infestations have increased in extent since 2004.
- Perennial pepperweed (Trace): Scattered plants were observed at a few locations along the margins of the managed marsh; this species is much reduced since 2004.
- Giant reed (Low): As a result of several years of control, the plants are small and reduced in vigor. The occurrence is monitored as part of the routine maintenance and controlled by a combination of cattle grazing, mowing, and hand cutting.
- Italian thistle (Trace): One occurrence was noted in annual grassland adjacent to the managed marsh.
- Pennyroyal (Low–Moderate): This plant occurs in two vegetation types: managed marsh and irrigated pasture. In the irrigated pasture, infestation is light and the plant is scattered in the moister areas. In the marsh, low levels of infestation occur along the edges. Pennyroyal is a plant of seasonally moist soils that is considered to be moderately invasive in wetlands (Cal-IPC 1999).
- Catalpa (Trace): A single mature tree grows near the milk barn, where it is monitored for invasiveness and currently shows no signs of spreading. This tree has been intentionally retained until successor trees planted nearby have matured, because it is regularly used by loggerhead shrikes, an Other Covered Species.
- Tree-of-heaven (Moderate): Several trees grow around one of the residences, where its potential invasiveness by suckering and seeding is kept in check by regular mowing and cattle grazing.
- Himalayan blackberry (Dense): Dense patches of Himalayan blackberry occur along fencelines and ditches in the eastern portion of the reserve. The blackberry has often provided nesting habitat for tricolored blackbird (an Other Covered Species) and is managed to provide the current extent of nesting habitat without spreading.

Brennan

Vegetation Type Mapping

Nine habitat types were mapped on the Brennan Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice (organic)	69.74	75.84
■ Fallow Rice	36.73	73.82
■ Nonnative Annual Grassland	128.24	85.06
■ Fresh Emergent Marsh	1.61	1.61
■ Seasonal Wetland	1.64	1.64
■ Ruderal	2.05	2.05
■ Riparian Woodland	0.67	0.67
■ Developed	0.67	0.67
■ Ditch		

Approximately two-thirds of the rice field north of Curry Creek was fallow in 2005; the remaining third of that area was in organic rice production in 2005. South of the creek, organic rice was grown on the eastern portion of the reserve, which was nonnative annual grassland in 2004. The remaining nonnative annual grassland was not grazed in 2005. No significant changes were noted in the remaining habitat types.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 56%.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. For three of the four noxious weed species recorded in 2004—Himalayan blackberry, edible fig, and black locust—no changes were noted since 2004.

The occurrences of the four species of noxious weeds recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Low–Dense): Eight occurrences of yellow star-thistle were mapped—five more than in 2004. Yellow star-thistle increased in extent and density in 2005, especially in the nonnative annual grasslands in the southern portion of the reserve. It was also common along roads around the reserve boundary. In the southern portion of the grassland field, yellow star-thistle occurred as scattered plants with several denser patches, and it was also common along the north edge of the grassland area south of Curry Creek at low to moderate density. It occurred along the edge of the roads around the edges of the reserve at one area on the west side, in the northeast corner, and along the entire east edge, also at low to moderate density.
- Himalayan blackberry (Dense): Dense Himalayan blackberry occurs along both banks of Curry Creek. The blackberry provides nesting habitat for black-crowned night-heron and snowy egret and is not currently controlled.

Because the creek corridor is surrounded by agriculture, the blackberry is unlikely to spread outside the corridor.

- Edible fig (Trace): A single shrub was noted along Curry Creek.
- Black locust (Trace): Three trees occur at the site of the former residence at the south end of the reserve. The trees are mature and do not appear to be spreading.

Cummings

Vegetation Type Mapping

Six habitat types were mapped on the Cummings Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Fallow Rice	58.23	0.00
■ Nonnative Annual Grassland	1.92	1.92
■ Managed Marsh	0.00	35.42
■ Grassland (Created)*	0.00	25.54
■ Ruderal	5.45	4.63
■ Valley Oak Woodland	1.16	1.16
■ Ditch		

* The acreage is approximate and may change when aerial photographs showing the created marsh area become available. This total includes approximately 10 acres (4 hectares) of upland habitat on berms that were too small to map individually.

Most of Cummings was converted to managed marsh and upland grassland at the end of 2004. By summer 2005, a diverse range of aquatic plants—native and nonnative, annual and perennial—had colonized the constructed marsh areas.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Twenty-five plant species were added to the reserve's flora, bringing the total cumulative list to 71 species. This increase is a result of the increase in aquatic and ruderal species that colonized the newly constructed marsh, berm, and sown grassland areas. The percentage of nonnative plant species increased from 52% to 58%, because most of the colonizing species were nonnative plants. However, the proportion of nonnative plants at Cummings is within the range recorded on most other reserves.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. For two of the three noxious weed species recorded in 2004—Himalayan blackberry and sweet

fennel—no changes were noted. The perennial pepperweed occurrence was disked in 2005, had not spread, and was reduced in vigor; further monitoring will be necessary to determine the success of this treatment.

Occurrences of the three species of noxious weeds recorded on the reserve in 2005 are summarized below.

- Sweet fennel (Trace): A single plant was recorded at an open, somewhat disturbed site in valley oak woodland.
- Himalayan blackberry (Moderate): Himalayan blackberry occurs at the edges and in the understory of valley oak woodland in the western portion of the reserve. In this location it has the potential to spread throughout the understory.
- Perennial pepperweed (Low–Moderate): Perennial pepperweed occurs in a patch of ruderal vegetation between the riparian woodland and grassland field; it was disked in 2005.

Frazer

Vegetation Type Mapping

Four habitat types were mapped on the Frazer Reserve in 2005. The habitat types and associated acreages for both 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Managed Marsh *	74.67	74.67
■ Grassland (Created)	7.29	7.29
■ Ruderal	10.60	10.60
■ Ditch		

* This total includes approximately 24 acres (9.7 hectares) of upland habitat on berms in patches that were too small to map individually.

There was no significant change in the acreages of vegetation and habitat types from 2004 to 2005. In 2005, cattails were the dominant plant cover over much of the managed marsh, and the annual aquatic plants that were common and widespread in 2004 were much less common in 2005. By late summer, most of the open water was covered by waterfern.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 56%.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. One occurrence of yellow star-thistle was recorded in 2005; the species had been more widespread in 2004.

The occurrence of yellow star-thistle recorded on the reserve in 2005 is summarized below.

- Yellow star-thistle (High): One occurrence of yellow star-thistle was recorded around the gate and access road in the northeast corner of the reserve.

Small patches of jointgrass were observed at several locations in the eastern portion of the reserve; most occurrences were along the edge of the marsh, but in some places the jointgrass was growing in shallow water away from the edges. Waterfern was more abundant than in 2004, and by mid-summer it had covered almost all the open water on the reserve.

Huffman East

Vegetation Type Mapping

Three habitat types were mapped on the Huffman East Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice	120.62	101.09
■ Fallow Rice*	0.00	19.53
■ Ditch		

* Planted in alfalfa in fall 2005.

Most of Huffman East continued in rice production in 2005, expect for a portion of the southeast rice field, which was fallow. This area was planted in wheat in fall 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 61%.

Noxious Weed Surveys

One new noxious weed species, Himalayan blackberry, was recorded in 2005. Yellow star-thistle has increased on the reserve since 2004, with seven occurrences noted, in contrast to one in 2004; the new occurrences are all small patches in disturbed areas along roads.

The noxious weed occurrences recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Low to High): Seven occurrences were identified along road edges.
- Himalayan blackberry (Moderate): A small patch of Himalayan blackberry was noted on the ditch bank.

Huffman West

Vegetation Type Mapping

Four habitat types were mapped on the Huffman West Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Alfalfa	63.65	63.65
■ Milo	58.62	0.00
■ Tomatoes	53.46	0.00
■ Wheat	0.00	112.08
■ Non-Riparian Woodland	0.29	0.29
■ Ditch		

Huffman West remained entirely in upland agricultural crops in 2005. The north field remained in alfalfa production, and wheat replaced milo and tomatoes in the south and east fields. A small area of native woodland has been planted in the southeast corner of the reserve.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 75%.

Noxious Weed Surveys

One new noxious weed species, sweet fennel, was recorded in 2005. Yellow star-thistle, which was observed on the reserve in 2004, was not recorded in 2005.

The noxious weed occurrences recorded on the reserve in 2005 are summarized below.

- Sweet fennel (Trace): Two small clumps were observed in the extreme northwest and southwest corners of the reserve.

Lucich North

Vegetation Type Mapping

Five habitat types were mapped on the Lucich North Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Managed Marsh*	223.78	223.78
■ Seasonal Wetland	3.54	3.54
■ Ruderal	10.74	10.74
■ Nonnative Annual Grassland	23.66	23.66
■ Ditch		

* This total includes approximately 50 acres (20.2 hectares) of upland habitat on berms in patches that were too small to map individually.

There was no change in the acreages of vegetation and habitat types from 2004 to 2005. Cattails became the dominant plant cover over much of the managed marsh, and the annual aquatic plants that were common and widespread in 2004 were much less common in 2005. By late summer, waterfern formed a complete layer on the open water in the northeastern portion of the reserve.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 57%.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. Two of the species recorded in 2004—yellow star-thistle and perennial pepperweed—were more abundant in 2005. The single occurrence of bull thistle recorded in 2004 was not observed in 2005.

Ten occurrences of yellow star-thistle and three of perennial pepperweed were observed in 2005. The noxious weed occurrences recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Low–High): Ten occurrences were recorded at locations throughout the reserve. Yellow star-thistle occurred extensively in the grassland between the Cross Canal levee and the major ditch on the north edge of the reserve; despite mowing, at the time of the September survey it was resprouting. Other occurrences were smaller in extent and scattered throughout the reserve along high and low berms. Yellow star-thistle also occurred at low to moderate cover on some of the islands in the south of the reserve.

- Perennial pepperweed (High): Three occurrences of perennial pepperweed were recorded in 2005; all were small patches near the water's edge on low berms, each near small groups of planted saplings.

Jointgrass appears to be increasing, particularly in the eastern portion of the reserve, where many patches were observed along the edges of the marsh at low berms. Waterfern was more widespread on the reserve than in 2004, and by late summer had formed a complete layer on the open water in the northeastern portion of the reserve.

Lucich South

Vegetation Type Mapping

Six habitat types were mapped on the Lucich South Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice	333.63	333.63
■ Managed Marsh	21.28	21.28
■ Seasonal Wetland	0.19	0.19
■ Ruderal	3.35	3.35
■ Developed/road	0.22	0.22
■ Ditch		

There was no change in the acreages of vegetation and habitat types from 2004 to 2005. In the managed marsh, cattail increased in cover and was dominant in 2005, together with barnyardgrass. Two species that were co-dominant with barnyardgrass in 2004, sprangletop and annual water-aster, were still very common in 2005. Waterfern was abundant in 2005, covering most of the open water surface.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 56%.

Noxious Weed Surveys

One new species of noxious weed—bull thistle—was recorded in 2005. The yellow star-thistle occurrence mapped in 2004 was no longer present in 2005, but three new occurrences were observed. The noxious weed occurrences recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Moderate): Three small infestations were recorded in disturbed areas along roads in the rice-growing portion near the northeast corner of the reserve.

- Bull thistle (Trace): A few plants were observed in a small area of disturbed ground along a road near the northeast corner of the reserve in the rice-growing portion.

In the managed marsh, waterfern was abundant in 2005, covering most of the open water surface by mid-summer. Small patches of jointgrass were observed along the eastern and western edges of the managed marsh.

Natomas Farms

Vegetation Type Mapping

Eight habitat types were mapped on the Natomas Farms Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Wheat	43.62	43.62
■ Managed Marsh	35.16	35.16
■ Grassland (created)	9.17	9.17
■ Nonnative Annual Grassland	4.44	4.44
■ Ruderal	3.00	3.00
■ Valley Oak Woodland	0.94	0.94
■ Developed/roads	0.25	0.25
■ Ditch		

There was no change in the acreages of vegetation and habitat types from 2004 to 2005. Wheat was again cultivated in the agricultural portion of the reserve. In the managed marsh, cattail had become the dominant aquatic plant by summer 2005, with umbrella sedge also common. Elderberry shrubs and associated riparian species were planted in and adjacent to the valley oak woodland area in late fall 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 58%.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005, and the occurrences of the two species recorded in 2004—sweet fennel and Himalayan blackberry—remained unchanged in 2005, as summarized below.

- Sweet fennel (Low): This plant occurs along the edge of a ditch, where it could spread in suitable soils, although it would be contained by agricultural activities.

- Himalayan blackberry (Moderate): A small patch of Himalayan blackberry occurs along the shallow ditch between Natomas Farms and Souza.

Ruby Ranch

Vegetation Type Mapping

Three habitat types were mapped on the Ruby Ranch Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Rice	87.11	0.00
■ Fallow Rice*	0.00	87.07
■ Ruderal	3.52	3.52
■ Developed/roads	0.44	0.44

* Planted in alfalfa in fall 2005.

The rice field on Ruby Ranch Reserve was fallow in 2005. This area was planted in alfalfa in fall 2005.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 57%.

Noxious Weed Surveys

No new noxious weed species were recorded in 2005. The occurrence of yellow star-thistle recorded in 2004 remained in 2005, and one additional yellow star-thistle occurrence was recorded. The noxious weed occurrences recorded on the reserve in 2005 are summarized below.

- Yellow star-thistle (Trace): Two occurrences were noted in roadside and ruderal areas along the north edge of the reserve.

Sills

Vegetation Type Mapping

Four habitat types were mapped on the Sills Reserve in 2005. The habitat types and associated acreages are shown below. The distribution of these habitat types is shown in Appendix A. In 2004, the southern field was removed from the reserve in a land exchange; 2004 acreages are given are for both the original and amended reserve areas.

	2004 (original boundary)	2004 (amended boundary)	2005
■ Rice	432.42	431.17	400.30
■ Fallow Rice	0.00	0.00	30.87
■ Grass Hay	128.89	0.00	0.00
■ Developed/roads	15.31	0.88	0.88
■ Ditch			

The majority of Sills was in rice production in 2005, except for a small fallow area in the southwest corner. The field used to grow grass hay in 2004 was removed from the system of reserve lands in a land exchange.

Floristic Surveys

No covered plant species or any other special-status plant species were observed on the reserve. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 67%.

Noxious Weed Surveys

No occurrences of noxious weed species were recorded in 2005. Yellow star-thistle, which was recorded in 2004, was not observed in 2005.

Souza

Vegetation Type Mapping

Five habitat types were mapped on the Souza Reserve in 2005. The habitat types and associated acreages for 2004 and 2005 are shown below. The distribution of these habitat types is shown in Appendix A.

	2004	2005
■ Wheat	39.04	28.34
■ Alfalfa	0.00	10.70
■ Ruderal	0.26	0.26
■ Non-riparian Woodland	0.25	0.25

■ Developed/roads	0.25	0.25

Alfalfa was cultivated on the southern third of Souza in 2005, while the rest of the area remained in wheat.

Floristic Surveys
No covered plant species or any other special-status plant species were observed on the reserve in 2005. Several plant species were added to the reserve's flora. The proportion of nonnative species remained stable at 71%.

Noxious Weed Surveys
No new occurrences of noxious weed species were noted, and the single occurrence of English ivy described below remained relatively unchanged in 2005.

- English ivy (Dense): Ivy occurs as a moderately dense layer under the trees in the southwest corner of the reserve, where it could spread and displace native understory species such as California blackberry.

2.4 Discussion

2.4.1 Basin-Wide Vegetation

Changes in the distribution and abundance of vegetation and habitat types across the Basin from 2004 to 2005 were relatively minor. The largest changes were a decrease in acreage of upland agriculture and the increase in developed acres (Table 2-1). Upland agriculture decreased by approximately 880 acres (356 hectares) (1.6% of the total Basin land area), and developed areas increased by approximately 630 acres (255 hectares) (1.2% of the Basin land area). The extent of land planted in alfalfa, an important habitat type for Swainson's hawk and Other Covered Species, increased by 330 acres (134 hectares) (0.5% of the Basin land area). The total acreage in rice lands, an important habitat type for giant garter snake, decreased by approximately 190 acres (77 hectares) (less than 0.4% of the Basin area). The total extent of grasslands, wetlands, and native woodlands and scrub remained relatively unchanged from 2004 to 2005.

Habitats on TNBC reserve lands are important components of the habitat landscape throughout the Basin. Created wetlands (managed marsh) on TNBC reserves account for slightly more than 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 two most important habitat types for Covered Species in the Basin. In 2005, rice on reserve lands comprised 11% of the total rice in the Basin, an increase from 8% in 2004. Conversely, upland agriculture (including row crops, hay, and alfalfa) on reserve lands accounted for 4.6% of the

upland agriculture in the Basin, down from approximately 5.9% in 2004; this reduction is largely a result of the removal of the southern field of Sills from reserve lands in 2005. Grasslands on TNBC reserves accounted for approximately 4.7% of the grasslands in the entire Basin in 2005, down from approximately 5.0% in 2004.

2.4.2 Floristic Surveys

A cumulative total (2004–2005) of 377 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 most common family was the grass family (Poaceae) with 75 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., Betts-Kismat-Silva 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) had the lowest number of plant species.

In the managed marshes on several of the reserves, cattails became the dominant plant cover in 2005, occurring over much of the shallow-water portions of the reserve, and in some areas, becoming established in the deeper water channels. Many of the ricefield weeds (Barrett and Seaman 1980) that had been abundant in 2004 were rare in 2005.

Four of the reserves acquired in 2005—Bolen North, Bolen South, Rosa East, and Rosa Central—were fallow and disked when they were surveyed late in the season. The lists of species occurring these reserves will undoubtedly increase substantially in 2006.

2.4.3 Noxious Weeds

The noxious weeds that occurred on reserves were widespread species common in agricultural habitats in the Central Valley. Generally, the rate of occurrence of these weeds was low, and occurrences typically comprised small patches with light to moderate levels of infestations. Thirteen weed species were detected over all the reserves in 2005, the same as in 2004. Yellow star-thistle was again the most commonly recorded species, occurring on 11 reserves, followed by Himalayan blackberry, recorded on 10 reserves. Perennial pepperweed and sweet fennel were recorded on five reserves. The other species each occurred on

three or fewer reserves. No new noxious weed species were recorded in 2005 on reserves that had been surveyed in 2004. Poison hemlock was recorded for the first time on TNBC reserves on Rosa East, one of the newly acquired reserves.

For most of the noxious weed species occurrences recorded in 2004, no changes were observed in extent or density on reserves. The following discussion highlights the significant changes observed.

Perennial pepperweed was aggressively targeted in late 2003 and 2004 for control and, if possible, eradication from BKS Reserve. Surveys conducted in mid- and late summer showed that these efforts had been largely successful: perennial pepperweed has declined greatly in both extent and density since 2004, and only a few scattered plants were noted in a few locations at the margins of the marsh in 2005. Monitoring should continue to assess the long-term effectiveness of the eradication efforts. On Atkinson and Cummings, the occurrences of perennial pepperweed recorded in 2004 were disked in 2005, and it does not appear to be spreading. New occurrences were noted at Lucich North, where the pattern of occurrence suggests that it is becoming established and may begin to spread. Currently, the infestations are very small in area, but they have a high potential to spread rapidly along the margins of the marshes. 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).

Yellow star-thistle increased in 2005 in extent and density on the Brennan, Lucich North, and especially the BKS Reserves. This species was recorded in small occurrences on these reserves in 2004. The increase in yellow star-thistle observed at Brennan may be a result of the cessation of grazing, while the increased levels of grazing planned at BKS is likely to provide effective control of the yellow star-thistle infestations there. Yellow star-thistle displaces native plants, depletes soil moisture, and can interfere with livestock grazing (Bossard et al. 2000).

Himalayan blackberry, which is potentially invasive in riparian areas and sites with perennially moist soils, appears to be stable on the reserves where it occurs. On the BKS Reserve, several occurrences were removed in 2005 and will continue to be monitored.

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

One nonnative grass species, Pacific bentgrass, that may have the potential to become invasive, was recorded for the first time on several reserves in the northern and western portions of the Basin. Pacific bentgrass is a wetland species that 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. This annual grass is also known as *blown grass* because the light and roughly egg-shaped panicle bearing seeds breaks off and is easily dispersed by the wind, like a tumbleweed. The managed marsh areas should be carefully monitored next year to see if this grass becomes invasive on Reserve lands in the Basin.

2.5 Effectiveness

As noted above, several small infestations of perennial pepperweed were documented on TNBC reserve lands during surveys in 2004. Because these infestations are small, immediate and aggressive action to eradicate these infestations before they become more dense and widespread is warranted and cost effective. After consultation with the biological effectiveness monitoring team and the reserve management team, TNBC took aggressive actions to control the infestations. This action has been effective in reducing the number and extent of infestations on BKS, and in 2005 only scattered perennial pepperweed plants remained. On Atkinson and Cummings, continued disking is preventing the spread of the pepperweed infestations and greatly reducing its vigor.

On BKS, the larger patches of Himalayan blackberry that provide nesting habitat for tricolored blackbirds were maintained at their 2004 extent by intensive grazing after the tricolored blackbird breeding season. Smaller patches that do not provide nesting habitat for tricolored blackbirds were removed in 2005 to prevent their spread.

Jointgrass was subject to focused eradication efforts in 2005 on BKS, where it had formed mono-dominant stands in seasonal wetland portions of the marsh. The infestations were much reduced in extent and vigor toward the end of 2005; further monitoring will be necessary to determine the success of these efforts.

2.6 Recommendations

- Continue to monitor the distribution and abundance of noxious weeds on reserve sites.
- 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.
- If grazing is not successful at controlling yellow star-thistle, consider mowing at an appropriate time of year to reduce seeding.

- Continue to monitor jointgrass spread at Frazer and Lucich North and consider treatment; continue to monitor the eradication efforts at BKS to assess effectiveness of the methods used.
- Implement management actions to remove cattails from the deep-water channels where they have become established and to limit the proliferation of potentially invasive floating aquatic weeds (e.g., waterfern, water primrose, hornwort) in open water areas.
- Continue to monitor aquatic weeds that are potentially invasive in wetlands and that are of local management concern (e.g., cattail, waterfern, water primrose, and hornwort).

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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 were conducted by the U.S. Geological Survey (USGS) and 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 by the TNBC Biological Effectiveness Monitoring Team using a more standardized and comprehensive protocol (Jones & Stokes 2005). The information collected by USGS, such as trap locations, length of deployment, and capture information, has been incorporated into this report where appropriate to allow for comparison of results across time (Wylie and Casazza 2000, 2001; Wylie et al. 2004).

3.1.2 Goals and Objectives

Monitoring efforts were conducted in accordance with protocols developed specifically 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 in the aforementioned habitat types, 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. Originally considered a subspecies of *Thamnophis ordinoides* (Fitch 1940), giant garter snake has undergone a lengthy series of taxonomic revisions and was finally accorded full species status in the late 1980s on the basis of morphological and distribution data (Rossman and Stewart 1987). This classification was subsequently supported by genetic analyses (Paquin 2001).

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 Endangered Species Act 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, monitoring and project

Giant Garter Snake

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Jones & Stokes

Figure 3-1
Giant Garter Snake

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). Giant garter snake 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 of the species is patchy, extending from near Chico in Butte County to Mendota Wildlife Area in Fresno County. Current locality records indicate that within this range, giant garter snakes are distributed in unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Brode and Hansen 1992; U.S. Fish and Wildlife Service 1997, 1999). These populations are isolated, lack protected dispersal corridors to other adjacent populations, and are threatened by land use practices and other human activities—particularly development of wetland and suitable agricultural habitats.

Loss or degradation of aquatic habitat resulting from agricultural and urban development is the primary cause of the species' declines. 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.

Selenium contamination and impaired water quality have also been identified as threats to giant garter snake, particularly in the southern portion of its range (U.S. Fish and Wildlife Service 1999). While limited data are available regarding the effects of specific contaminants, the bioaccumulative properties of selenium in the food web have been well documented in the Kesterson National Wildlife Refuge area (Saiki and Lowe 1987; Ohlendorf et al. 1988; Saiki and May 1988; Saiki et al. 1991; U.S. Fish and Wildlife Service 1999). Efforts to measure levels of selenium and mercury in giant garter snake populations in the Sacramento Valley are currently underway; these efforts include samples from the Natomas Basin subpopulation (Wack pers. comm.).

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). It appears that the majority of giant garter snakes move back into the canals and ditches as the rice fields are drained, although a few may overwinter in the fallow fields where they hibernate in burrows in the small berms separating the rice checks (Hansen 1998).

While in the rice fields, the snakes forage in the shallow warm water for small fish and larvae of bullfrogs and treefrogs. 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).

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

Water is drained from the fields during late summer or fall by a network of drainage ditches. These ditches are sometimes routed alongside irrigation canals, and are often separated from the irrigation canals by narrow vegetated berms that may provide additional shelter. Remnants of old sloughs may be present in rice-growing regions, where they serve as drains or irrigation canals. Giant garter snakes may use vegetated areas along any of these waterways as permanent habitat.

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, Pacific treefrog, Sacramento blackfish, and California red-legged frog (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; 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 (Hansen pers. comm.).

Nonnative bullfrogs are known to prey on juvenile giant garter snakes throughout their range (Treanor 1983; Dickert 2003; Wylie et al. 2003). While the extent of this predation and its potential effect on populations is poorly understood, preliminary data from a study at Colusa National Wildlife Refuge suggest that 22% of neonate giant garter snakes succumb to bullfrog predation (Wylie et al. 2003). Introduced predatory game fishes such as black basses, striped bass, catfishes, and sunfish probably prey on giant garter snakes and compete with them for smaller prey (Hansen 1988; U.S. Fish and Wildlife Service 1993).

Giant garter snakes coexist with valley garter snakes (*T. sirtalis fitchi*); in limited instances, both may be found with mountain garter snake (*T. elegans elegans*) where the latter species' range extends to the Central Valley floor. The extent of competition among these species is unknown, but it is likely that differences in habitat use and foraging behavior allow their coexistence (Brode 1988; U.S. Fish and Wildlife Service 1999).

3.2 Methods

3.2.1 Population Assessment

Surveys for giant garter snake were conducted throughout the Natomas Basin from the time of warming temperatures in March until rice fields dried and temperatures decreased in mid-October. All canals, ditches, or drains within the Natomas Basin that were accessible because of either public ownership or specific right of entry were surveyed for either giant garter snake presence or habitat potential. In some areas, survey effectiveness was limited by trap theft and tampering (e.g., Bennett North Marsh), or by variable water and habitat conditions (e.g., Fisherman's Lake).

Study design combined the comprehensive visual survey and aquatic trapping methodologies applied by previous investigators, with more weight given to passive surveys conducted in accordance with USGS methodology (Hansen and Brode 1980; Hansen 1988; Brode and Hansen 1992; Wylie et al. 2004). Active visual surveys were conducted in three separate phases at predetermined locations and during all reconnaissance and trap-checking efforts. Sampling for giant garter snake in 2005 was conducted from March 4 to October 18.

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 discovered 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. In 2005, active surveys were conducted three times each along predetermined transects. The general locations of all visual encounter surveys are shown in Figure 3-3.

Passive Surveys

Passive surveys involve the use of traps and were conducted in conjunction with active surveys. In 2005, 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. These 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 150 traps was divided into three 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 unique 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 locations of 2005 traplines are shown in Figure 3-3.

The study design entailed the use of three reference traplines, six rotating traplines, and three drift fence traplines. Reference traplines are by definition left in place throughout the snakes' active season, and are useful for several reasons. Permanent reference sites increase the probability of recapturing individuals through time, resulting in better estimates of survival and recruitment. Reference sites can also provide better information regarding species response to changing habitat conditions over time than do non-reference traplines, thereby developing information to inform the adaptive management process. Finally, reference sites provide information on seasonal variation in giant garter snake activity that short-term 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 3-4). One permanent reference trapline was established in each area; two remained in place until the end of the sampling season, and one was removed prematurely due to deteriorating habitat conditions. Reference sites were established in areas 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 (e.g., Snake Alley, T Drain, Fisherman's Lake) (Figure 3-4).

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 variability of giant garter snake activity. 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.

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 to vent length, sex, scale counts and measurements on head and midbody, 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 to examine mercury and selenium levels and for future genetic analyses. All snakes were released at their point of capture after recording the data.

Population and Density Estimates

The software program CAPTURE (White et al. 1978; White et al. 1982) was used to estimate population size on the basis of capture histories of marked individuals. Because most giant garter snake habitat exists in the form of linear water conveyance features, and most traplines were placed along these ditches and drains, population estimates were converted to a measure of linear density as the number of snakes present per kilometer (0.62 mile) of linear habitat. A linear index of density was chosen because the rotation of rice fields through active and fallow periods makes an areal index seasonally inconsistent and therefore impractical. Accordingly, methods for estimating densities are largely consistent with those applied by USGS in previous studies of giant garter snake within the Natomas Basin (Wylie and Casazza 2000, 2001; Wylie et al. 2004). Statistical models used to estimate density assume the population is closed, i.e., that no immigration or emigration occurs during the time period for which density is being estimated. Accordingly, estimates of density in 2005 were based on a 2-week sampling period.

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Figure 3-3
2005 Giant Garter Snakes Trap Locations and
Visual Encounter Surveys and Transects

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Figure 3-4
Giant Garter Snake Habitat in the Natomas Basin, 2005

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 snake. The Alleghany 50, Souza, Brennan, and Bolen South Reserves were not trapped, although visual surveys were conducted where aquatic habitat was present.

Non-Reserve Lands

Metro Air Park

Although the Metro Air Park (MAP) HCP area was sampled routinely by USGS from 2000 through 2003, construction activities and habitat modifications have precluded trapping within the MAP HCP area in subsequent seasons. However, the series of laterals and drainages collectively referred to as Lone Tree Canal (Figure 3-4) 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. The permanent reference trapline for Area 1 was established in Lone Tree Canal between Elkhorn Boulevard and Elverta Road (Figure 3-4).

Fisherman's Lake

Because Fisherman's Lake is adjacent to the Souza/Natomas Farms and Cummings Reserves and has historical significance as giant garter snake habitat, the portion of the lake south of Del Paso Road was selected as the site for the Area 2 reference line (Brode and Hansen 1992; Wylie and Casazza 2000) (Figure 3-4). Traps were placed in a single trapline along the edge of the waterway from May 6 to July 22, 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 3-4).

Sacramento County Airport System

Access was again granted in 2005 by the Sacramento County Airport System (SCAS) to trap for giant garter snakes on all Sacramento International Airport (SMF) properties: the fenced Airport Operational Area (AOA), and the SMF bufferlands outside the AOA perimeter. Outside the AOA, traps were divided into two 50-trap traplines, consistent with methods employed elsewhere in the Basin. Within the AOA, escorts were required at all times. In order to maximize geographic coverage under this constraint, traps were divided into four 25-trap traplines (Figure 3-4). All traplines remained in place for 14 days.

Unfortunately, the customary second rotation could not be conducted within the AOA due to the cessation of water deliveries through Meister Ditch. Meister Ditch supplied water to aquatic habitat and corresponding traplines in the eastern half of 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 habitat, 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 2001a, 2001b; 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 coverage for dispersing snakes. Marginal habitat is incapable of supporting permanent populations of giant garter snakes and is typically ephemeral, providing no permanent source 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 characterized 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 recorded to determine whether giant garter snake presence varies with proximity of upland refugia. 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

A total of 263 observations of giant garter snakes were recorded during 2005, comprising 182 individuals, of which 102 were females and 80 were males. Thirty-nine individuals—16 males and 23 females—were captured multiple times. Eleven of the individuals captured had been marked in previous years: eight were marked in 2004 and three were marked in previous years by USGS. Giant garter snakes were observed in the majority of constructed wetlands on reserve lands, comprising 51 observations of 45 individuals. The balance of recorded observations consisted of mortalities and sightings during active surveys. Three individuals were found dead on roads. The locations of captures for the 2005 surveys are shown in Figure 3-5.

Reserve Lands

Souza/Natomas Farms, Cummings, Rosa, and Alleghany 50

The trapping effort at the Souza/Natomas Farms Reserve consisted of 3,950 trap days: 2,550 trap days using standard traplines and 1,700 trap days using a drift fence trapline. Trapping took place between May 5 and September 9, 2005. All trapping was conducted within constructed wetlands. Fluctuating water levels in the Natomas Farms western wetland made trapping problematic because these fluctuations moved the water's edge significantly from day to day. One individual was captured in the eastern wetland unit.

Five visual encounter surveys totaling 5,788 meters (3.6 miles) were conducted along the Natomas Farms wetland borders, and three visual encounter surveys totaling 1,519 meters (0.94 miles) were conducted along the Kimura Ditch. One

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Figure 3-5
2005 Giant Garter Snake Capture Locations

giant garter snake was observed along the Natomas Farms wetland borders; no snakes were observed along the Kimura Ditch.

The trapping effort at the Cummings Reserve consisted of 1,400 trap days using standard traplines deployed within the constructed wetlands. No giant garter snakes were captured.

Six visual encounter surveys totaling 1,695 meters (1.1 miles) were conducted along 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. Two giant garter snakes were captured.

Three visual encounter surveys totaling 1,652 meters (1 mile) were conducted along the West Drainage Canal. No giant garter snakes were observed during these surveys.

Trapping was not conducted at Alleghany 50. Six visual encounter surveys totaling 2,695 meters (1.67 miles) were conducted. No giant garter snakes were observed during these surveys.

In summary, four giant garter snakes were observed on or adjacent to reserve lands south of I-5: two within the West Drainage Canal adjacent to the Rosa Central and Rosa East Reserves and two within the Natomas Farms eastern wetland unit. Four additional snakes were captured or observed south of I-5 on the permanent reference trapline at Fisherman's Lake (see *Non-Reserve Lands* section below). Although the number of giant garter snakes observed south of I-5 increased significantly over the 2004 captures, capture success is still very low compared to elsewhere in the Basin. Low capture success may be due in part to the fact that construction of the managed marshes on the Souza/Natomas Farms and the Cummings properties was only completed in 2003 and 2004, respectively. However, these results suggest that the population of snakes in the southwest portion of the Basin is very small; if this is true, then recolonization of newly constructed habitats would not be expected to occur rapidly.

Fifteen valley garter snakes were captured south of I-5: two in the West Drainage Canal at the Rosa Central and Rosa East Reserves, one on Powerline Road at the West Drainage Canal, 11 in the eastern wetland at Natomas Farms, and one in the wetland at Cummings.

Atkinson and Ruby Ranch

The trapping effort at the Atkinson and Ruby Ranch reserves consisted of 2,800 trap days: 1,400 in the North Drainage Canal and 1,400 in the adjacent Highline Canal. Eight giant garter snakes were observed: seven in the North Drainage Canal between the two reserves and one in the Highline Canal at the Atkinson Reserve.

Six visual encounter surveys totaling 2,728 meters (1.7 miles) were conducted within and along the edges of the Highline Canal and along the ditch at the northern end of the Atkinson Reserve. No giant garter snakes were observed during these surveys.

Ayala

The trapping effort at Ayala consisted of 2,200 trap days: 750 in the "E" Drain and 1,450 in the unnamed ditch at the southern end of the reserve. In consultation with TNBC, it was decided to discontinue transects on the E Drain after the first rotation in favor of sampling in constructed wetlands elsewhere in the Basin. Three giant garter snakes were trapped within or adjacent to the Ayala Reserve; these were the first such captures in this location.

Nine visual encounter surveys totaling 4,601 meters (2.89 miles) were conducted along the edges of ditches, drains, and rice fields. No giant garter snakes were observed during these surveys.

Bennett North, Bennett South, and Lucich South

The trapping effort at Bennett North consisted of 1,400 trap days: 700 in constructed wetlands and 700 in the linear ditches. Only one trapping session was conducted at Bennett North due to diminished water levels toward the end of the season. One individual giant garter snake was captured along the western edge of the constructed wetland; no giant garter snakes were captured in ditches. One Valley garter snake was captured in the ditch at the northern edge of the property.

Eleven visual encounter surveys totaling 1,902 meters (1.18 miles) along wetland edges, 3,008 meters (1.87 miles) along ditches, and 1,310 meters (0.81 mile) along rice field edges were conducted. No giant garter snakes were observed during these surveys.

The trapping effort at Bennett South consisted of 2,800 trap days: 1,400 in constructed wetlands and 1,400 in linear ditches. Two individual giant garter snakes were captured along the eastern edge of the constructed wetland, and one giant garter snake was captured in the ditch at the western edge of the property; these results are fewer than were captured in 2003 and 2004, respectively (Wylie et al. 2004; Jones & Stokes 2005) (Table 3-1). One Valley garter snake was captured in the ditch at the western edge of the property.

Six visual encounter surveys totaling 2,661 meters (1.65 miles) were conducted along the edges of ditches. No giant garter snakes were observed during these surveys.

The trapping effort at Lucich South consisted of 5,200 trap days: 1,750 in the constructed wetland, 6,350 in the North Drainage Canal, and 2,850 at a drift

Table 3-1. Selected Sampling Results and Population Estimates for Giant Garter Snakes, 1999-2005

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting Only	Traps	Trap Days	Capture Success (Captures/ Trap Day)	Population Estimate	Density (Snakes/km)
Reserve Sites									
Alleghany 50	—	—	—		—	—	—	—	—
Atkinson	Highline Ditch	2003	3/1			725	.0041	*	*
		2004	0/0			750	0	*	*
		2005	1/0	0	50	1,400	.00071	*	*
	North Drainage Canal	2003	0	0	25	406	0	*	*
		2005	7/0	0	50	1,400	0	*	*
Ayala	"E" Drain	2003	0	0	50	1,350	0	*	*
		2004	0	0	50	750	0	*	*
		2005	0	0	50	750	0	*	*
	E-W Drain	2003	0	0	50	700	0	*	*
		2004	0/0	0	50	750	0	*	*
		2005	5/2	0	50	1,450	.0034	*	*
Bennett North	North Ditch	2004	0		50	1,500	0	*	*
		2005	0	0	50	700	0	*	*
	W edge wetland	2004	9/3		50	1,450	.0062	4	9.76 ± 4 (95% C.I. 4–8)
		2005	1/0	0/0	50	700	0	*	*
Bennett South	West Ditch (Q Drain)	2000	15/5			1,800	.00083*	*	39 ± 10.04
		2001	2/0			912	.0022	*	*
		2002	28/8			1,770	.0158*	*	45 ± 9.98
		2003	26/7			840	.31	*	50 (95% C.I. 35–87)
		2004	5/0			1,350	.0037	*	*
		2005	1/0	0	50	1400	.00071	*	*
	Marsh	2003	0/0			700	0	*	*
		2004	2/0			1,650	.0012	*	*
		2005	2/0	0	50	1400	.0014	*	*

Table 3-1. Continued

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting Only	Traps	Trap Days	Capture Success (Captures/ Trap Day)	Population Estimate	Density (Snakes/km)
BKS	Central Ditch (Control Structure K)	2003	1/0			3,430	.0003	*	*
		2004	2/0			800	.0025	*	*
		2005	6/1	0	50	1400	.0043	*	*
	Silva West Ditch	2000	0/0			330	0	*	*
		2001	—		—	—	—	—	—
		2002	3/1			2,888	.0010	*	*
		2003	13/4			2,700	.0048	*	48 (95% C.I. 30–98)
		2004	5/1			1,500	.0033	*	11 ± 3.78 (95% C.I. 5–25)
		2005	10/2	1/6	50	1,750	.0057	10	18.7±4.51 (95% C.I. 7-29)
	South Highline	2004	0		50	50	0	*	*
	NW wetland	2004	0		50	700	0	*	*
	SW wetland (at Silva West Ditch)	2004	0		50	750	0	*	*
		2005	4/1	0	50	1,750	.0023	*	*
	NE wetland	2004	0		50	1,450	0	*	*
	N central wetland (at Control Structure K)	2004	0		50	600	0	*	*
		2005	0/0	0	50	1,400	0	*	*
	Silva south wetland drift fence	2005	2/0	0	50	1,750	.0011	*	*
Bolin North	Bennett Main	2005	0	0	50	1,386	0	*	*
Brennan	V Drain	2005	—	0/1	—	—	—	—	—
Cummings	Central wetland	2005	0/0	0	50	1,400	0	*	*
Frazer	North Ditch	2004	0		50	750	0	*	*
	Highline Ditch	2005	0	0	50	1,400	0	*	*
	W side wetland	2004	0		50	700	0	*	*
		2005	5/1	0	50	700	.0071	7	15.9±.4.26 (95% C.I. 5-28)
	E side wetland	2004	1/0		50	750	.0013	*	*
		2005	1/0	0	50	700	.0014	*	*
Huffman East	Bennett Loop	2005	3/0		50	1,400	.0021	*	*

Table 3-1. Continued

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting Only	Traps	Trap Days	Capture Success (Captures/ Trap Day)	Population Estimate	Density (Snakes/km)
Huffman West	Q Drain	2005	22/9		50	1,400	.016	7	16.3±.9 (95% C.I. 7-12)
Lucich North	T-Drain	2001	13/3			3,135	.0041	*	22 ± 7.17
		2002	51/14			2,852	.012*	*	32 ± 5.79
		2003	22/6			1,800	.012	*	40 (95% C.I. 27–68)
		2004	81/34	1/1	50	7,200	.011	27	54 ± 12.35 (95% C.I. 16–73)
		2005	37/12	2/3	50	6,650	.0056	27	42.39±24.47 (95% C.I. 12-126)
	NW wetland	2004	2/0		50	700	.0029	*	*
	SW wetland	2004	1/0		50	750	.0013	*	*
		2005	24/3	0	50	1750	.014	79	118.1±49.28 (95% C.I.34-262)
	North highline ditch	2005	N/A	0/1					
Lucich South	North Drainage Canal	2000	10/3			4,900	.035	*	63 ± 22.81
		2001	2/0			1,005	.0020	*	*
		2002	25/3			3,300	.0076	*	55 ± 12.5
		2003	16/4			1,900	.0084	*	39 (95% C.I. 28–73)
		2004	10/1			1,900	.0053	36	59 ± 30.94 (95% C.I. 14–170)
		2005	34/10	5/0	50	1,750	.019	35	55.3±3.99 (95% C.I.8-27)
	Wetland edge	2004	3/0		50	1,850	.0016	*	*
		2005	3/0	0	50	1,750	.0017	*	*
	Wetland drift fence	2005	5/0	0	50	2,850	.0018	*	*
	Rice at center	2004	0		50	750	0	*	*
Natomas Farms	NW wetland	2004	0		50	1,800	0	*	*
	Center wetland	2004	0		50	1,050	0	*	*
		2005	3/2	0/1	50	1,750	.06	*	*
	E edge wetland	2004	0		50	750	0	*	*
	S edge wetland	2004	0		50	900	0	*	*
		2005	0	0	50	800	0	*	*

Table 3-1. Continued

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting Only	Traps	Trap Days	Capture Success (Captures/ Trap Day)	Population Estimate	Density (Snakes/km)
	S edge wetland drift fence	2005	0	0	50	1,700	0	*	*
	Kimura Ditch	2004	0		50	500	0	*	*
Rosa	West Drainage Canal	2005	2/0	0	50	1,400	.0014	*	*
Ruby Ranch	(see Atkinson North Drainage Canal)	—	—		—	—	—	—	—
Sills Ranch	Highline Canal	2002	6/0			2,773	.0022	*	*
		2003	8/1			2,100	.0038	*	19 (95% C.I. 12–41)
		2004	2/0			1,450	.0014	*	*
		2005	3/0	0	50	1,500	.002	*	*
	North Ditch (Drain 13)	2004	0		50	700	0	*	*
		2005	2/0	0/1	50	1,400	.0014	*	*
Souza	—	—	—		—	—	—	—	—
Tufts	Lateral 3A	2005	16/4	1/1	50	1,400	.011	16	30±6.74 (95% C.I. 11-43)
Off-Reserve Sites									
Fisherman's Lake	E side of channel	2004	1/0		50	2,000	.0005	*	*
	W side of channel	2005	2/0	1/1	50	3,850	.00052	*	*
Metro Air Park	Lone Tree Canal (Central Section)	1999	?			?	?	*	8 (95% C.I. 6–12)
		2000	8/1			1,652	.0048	*	16 ± 6.09
		2001	1/0			1,606	.00062	*	*
		2002	—		—	—	—	—	—
		2003	0			700	0	*	*
		2004	0			602	0	*	*
		2005	2/0	0/1	50	1400	.0014	*	*
Snake Alley		1999	?			?	?	*	43 (95% C.I. 35–63)
		2000	9/1			3,168	.0028	*	19.5 ± 6.90
		2001	2/0			4,625	.00043	*	*
		2002	34/10			3,717	.0091*	*	20 ± 4.01
		2003	3/0			1,100	.0027	*	*
		2004	14/7			5,650	.0025	*	16.6 ± 1.34 (95% C.I. 8–15)

Table 3-1. Continued

Site	Location	Year	Total Trap Captures/ Recaptures	Hand Capture/ Sighting Only	Traps	Trap Days	Capture Success (Captures/ Trap Day)	Population Estimate	Density (Snakes/km)
		2005	27/9	0/1	50	6,750	.004	14	25.88±4.55 (95% C.I. 10-32)
SCAS Properties	SE AOA E Ditch	2004	0		25	750	0	*	*
		2005	0	0	25	350	0	*	*
	E AOA E Ditch	2004	0		25	300	0	*	*
		2005	0	0	25	350	0	*	*
	NE AOA E Ditch	2004	0		25	325	0	*	*
	S AOA S Ditch	2004	0		25	750	0	*	*
		2005		0	25	350	0	*	*
	W AOA W Ditch	2004	0		25	750	0	*	*
		2005		0	25	350	0	*	*
	West Drainage Canal	2004	0		50	350	0	*	*
	Flume Highline	2004	0		50	750	0	*	*
		2005	0	0	50		1,400	*	*
	Jacob's Slough	2004	0		50	1,450	0	*	*
		2005	0	0	50		1,400	*	*
	Private ditch at SW AP property	2004	0		50	100	0	*	*

Note:

* These values are recalculated on the basis of data provided and differ from values reported in the original literature.

fence transect deployed within the constructed wetland. Three individual giant garter snakes were captured along the eastern edge of the constructed wetland. Twenty-nine individual giant garter snakes were captured in the North Drainage Canal on the eastern edge of the property: 24 in traps and five by hand. Capture success in the North Drainage Canal was slightly higher than that of previous years (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2005) (Table 3-1).

Twelve visual encounter surveys totaling 1,784 meters (1.12 miles) in and along the edges of the wetland and 4,565 meters (2.84 miles) along the edges of ditches and rice fields were conducted. No giant garter snakes were observed during these surveys. One Valley garter snake was observed in the Highline Ditch at the northeastern corner of the property.

Betts-Kismat-Silva

The trapping effort at BKS consisted of 8,050 trap days: 1,750 in the ditch along the west edge of the Silva parcel, 1,705 in the created wetland adjacent to the western ditch, 1,400 in the ditch extending north from water control structure K, 1,400 in created wetlands adjacent to the ditch extending from water control structure K, and 1,750 in a single drift fence transect deployed within the southeastern corner of the created wetland at Silva. Nineteen individual giant garter snakes were captured within or adjacent to the BKS Reserve: eight in the ditch along the Silva parcel, three in the marsh adjacent to the western ditch, five in the ditch extending north from water control structure K, two in the southeast corner of the created wetland at the Silva parcel, and one in the driveway of the western residence by the locked access gate. This is the first time that giant garter snakes have been captured or observed within constructed wetlands at BKS (Wylie and Casazza 2001; Wylie and Martin 2002;Wylie et al. 2004; Jones & Stokes 2005). No giant garter snakes were captured in wetlands surrounding the ditch north of water control structure K.

Nine visual encounter surveys totaling 3,271 meters (2.03 miles) in and along the edges of the wetlands and 1,518 meters (0.94 miles) along the edges of ditches were conducted. Six giant garter snakes were observed during these surveys. Five Valley garter snakes were captured or observed: two in the ditch at the western edge of the Silva property, two in the wetlands north of water control structure K, and one along the earthen driveway at the southern edge of the Kismat parcel.

Bolen North and Bolen South

The trapping effort at Bolen North consisted of 1,386 trap days in the Highline Canal at the northwestern corner of the property. Although formal visual encounter surveys were not conducted during 2005, surveyors always look for snakes while conducting trapping surveys. However, no giant garter snakes were captured or observed at Bolen North. One Valley garter snake was captured during the second trap rotation.

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

Brennan

No trapping was conducted on the Brennan Reserve due to a lack of suitable aquatic habitat. Curry Creek dried entirely during the giant garter snake active season.

Three visual encounter surveys totaling 1,506 meters (0.94 miles) were conducted along the V Drain at the northern edge of the reserve. One giant garter snake was observed. This is the first documented observation of a giant garter snake at the Brennan Reserve or elsewhere in the Natomas Basin east of SR-99 between Riego and Howsley Roads.

Frazer and Lucich North

The trapping effort at Frazer consisted of 2,800 trap days: 1,400 in constructed wetlands and 1,400 in the Highline Ditch at the eastern edge of the reserve. Five individual giant garter snakes were captured within the constructed wetlands.

Twelve visual encounter surveys totaling 4,936 meters (3.07 miles) in ditches and drains and 1,635 meters (1.02 miles) in the constructed wetland were conducted at Frazer. No giant garter snakes were observed during these surveys.

The trapping effort at Lucich North consisted of 8,400 trap days: 1,750 in constructed wetland and 6,650 in the T Drain. Twenty-one individual giant garter snakes were captured in the constructed wetlands and 25 individual giant garter snakes were captured or observed in the T Drain; two of these snakes had been marked in 2004, and one was an unrecorded recapture presumably marked by USGS. Capture success was similar to but slightly lower than that of previous years (Wylie et al. 2003; Wylie et al. 2004; Jones & Stokes 2005) (Table 3-1).

Sixteen visual encounter surveys totaling 4,608 meters (2.86 miles) along perimeter ditches and drains and 1,371 meters (2.31 miles) in constructed wetlands were conducted at Lucich North. Four giant garter snakes were observed between the margins of the T Drain and the Lucich North wetland. One giant garter snake was observed along the highline ditch at the southern toe of the Natomas Cross Canal.

Six Valley garter snakes were captured or observed: five in ditches and drains and one in the Lucich North wetland.

Huffman East and Huffman West

The trapping effort at Huffman East and Huffman West consisted of 2,800 trap days in ditches and drains. Four giant garter snakes were captured in the Q-Drain between Huffman East and Huffman West and three were captured in the Bennett Loop at Huffman West.

Six visual encounter surveys totaling 2,987 meters (1.86 miles) were conducted at Huffman East and Huffman West. No giant garter snakes were observed during these surveys.

Sills and Tufts

The trapping effort at Sills consisted of 2,900 trap days in Lateral 3C at the western edge of the property and Drain 13 running from east to west in the northern half of the property. Three giant garter snakes were trapped in the Lateral 3C, and two were trapped in Drain 13. Capture success was similar to that of previous years (Wylie et al. 2004; Jones & Stokes 2005) (Table 3-1).

Nine visual encounter surveys totaling 4,781 meters (2.97 miles) were conducted at Sills. One giant garter snake observed during these surveys. One Valley garter snake was observed at the western property boundary.

The trapping effort at Tufts consisted of 1,400 trap days in Lateral 3A. Twelve individual giant garter snakes were captured there.

Eight visual encounter surveys totaling 2,037 meters (1.27 miles) in Highline Ditch 3 and 2,054 meters (1.28 miles) in Lateral 3A were conducted at Tufts. One giant garter snake was observed during these surveys.

Non-Reserve Lands

Metro Air Park

The trapping effort at MAP consisted of 1,400 trap days on the permanent reference trapline for Area 1 at Lone Tree Canal north and south of the Central Main Canal. Two giant garter snakes were trapped.

Five visual encounter surveys totaling 2,595 meters (1.6 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 3,850 trap days on the permanent reference trapline for Area 2 along the channel edge south of Del Paso

Road. This trapline was removed prematurely following mechanical and chemical management of bankside vegetation. Three giant garter snakes were captured and one was observed.

Nine visual encounter surveys totaling 4,714 meters (2.93 miles) were conducted in and along the edges of the channel proper and adjoining features. No giant garter snakes were observed during these surveys.

Snake Alley

The trapping effort at Snake Alley consisted of 6,750 trap days along the permanent reference trapline for Area 3. Eighteen individual giant garter snakes were captured, a capture rate similar to that of 2003 (Wylie et al. 2004). Although USGS has captured and marked giant garter snakes in this location since 1998, no snakes previously marked by USGS were captured. Two giant garter snakes marked in 2004 were recaptured.

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. No giant garter snakes were captured.

Nine visual encounter surveys totaling 1,565 meters (0.97 miles) along the West Drainage Canal west of Powerline Road, 1,539 meters (0.96 miles) at Lambert Ditch, and 1,588 meters (0.97 miles) along the North Drainage Canal at Prichard Lake were conducted outside the AOA. No giant garter snakes were observed during these surveys. Two Valley garter snakes were observed in the Flume and one was observed in Lambert Ditch.

Population and Density Estimates

Hansen and Brode (1993) estimated a local population size of 1,000 snakes per 2.6 square kilometers (1 square mile) of ricelands based on year-to-year mark-recapture rates (U.S. Fish and Wildlife Service 1999). USGS (Wylie and Casazza 2000, 2001; Wylie et al. 2000; Wylie and Martin 2002; Wylie et al. 2004) reported linear densities ranging from 8 (95% C.I. = 6–12) to 55 (95% C.I. not reported) giant garter snakes per linear kilometer from 1999 to 2003. In 2004, estimates ranged from 9.7 (95% C.I. = 4–8) to 55 giant garter snakes per linear kilometer (95% C.I. = 8–27). Results from 2005 range from 15.9 (95% C.I. = 5–28) to 118 giant garter snakes per linear kilometer (95% C.I. = 34-262). Estimates of linear density reported for 1999 through 2005 are summarized in Table 3-1.

Trapping results from 2005 provided enough information to estimate density for eight locations, up from five locations in 2004. The eight locations are the Silva West Ditch on the BKS Reserve, the Q Drain at Huffman West Reserve, the T drain at the Lucich North Reserve, the southwest managed marsh at the Lucich North Reserve, the managed marsh at the Frazer Reserve, the North Drainage Canal at the Lucich South Reserve, Lateral 3A at the Tufts Reserve, and Snake Alley.

Density estimates increased at the Silva west ditch on the BKS Reserve and the managed marsh at the Frazer Reserve.

Capture success (calculated as the number of captures per trap day, and used when sufficient recaptures are not available to estimate density) increased for the E-W Drain at Ayala, the ditch proceeding north from water control structure K at BKS, the managed marsh at the western edge of the Silva parcel at BKS, the managed marsh adjacent to the T Drain at Lucich North, and at Snake Alley (Table 3-1). Conversely, capture success at the western ditch at Lucich North (Q Drain) exhibited a continuing decline over that recorded prior to 2004. Capture results elsewhere were comparable to those from previous years.

Trapping and survey efforts increased substantially in 2005, resulting in the largest number of giant garter snakes captured since systematic trapping efforts began in the Basin in 2000. One hundred seventy individual giant garter snakes were trapped in 2005, up from 82 in 2004 (Table 3-2). Capture success increased from 0.0016 capture per trap day in 2004 to 0.0026 capture per trap day in 2005 (Table 3-2). Total captures (including hand captures) peaked in the early part of the season, with 89, or 48.9% of captures during 2005, occurring during the 28 days of between May 1 and May 28. Ninety-three, or 51.1% of captures, occurred during the 112 days between May 29 and September 17 (Figure 3-6).

The average size of giant garter snakes captured during 2005 was higher than that of 2004, with males in 2005 averaging 553 millimeters (21.8 inches) (n = 103) SVL with an average mass of 98 grams (3.5 ounces) (n = 103). Females captured in 2005 averaged 670 millimeters (26.4 inches) (n = 122) with an average mass of 213 grams (7.5 ounces) (n = 122).

Prior to 2005, the average size (and thus, by inference, age) of male giant garter snakes captured in the Natomas Basin had decreased each year since 2000 (Table 3-3). The average size of female giant garter snakes captured in the Natomas Basin exhibited a different pattern, with the decrease in size evident only during the last 2 years.

General Observations

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 entirely 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 Natomas Basin during 2004 (Jones & Stokes 2005). However, no giant garter snakes killed by river otters were observed in the Basin in 2005.

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 3-7 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 different regions of the basin. Features such as box or pipe culverts linking regions otherwise separated by major roadways or urban development for 2004 and 2005 are also depicted. Additional features depicted in the 2005 portion of Figure 3-7 reflect additional fieldwork conducted in 2005; they do not represent newly constructed aquatic features.

The most significant corridors spanning the Basin from north to south are the primary drainages managed by Reclamation District 1000; these include 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. Habitats east and west of SR-99 are at minimum linked through culverts by the V Drain, R Drain, H1 Drain, and Central Main Canal; each of these connects to a series of ditches, drains, and canals in their respective regions. Habitats north and south of I-5 are linked through culverts by the West Drainage Canal, the N Drain (parallel to Powerline Road), and the Lone Tree Canal. The West Drainage Canal passes north under I-5 from the Fisherman's Lake area to west of Sacramento International Airport (SMF), where it lies disconnected from other hydrologic features. The N Drain and Lone Tree Canal pass north under I-5 to the west and east of MAP, respectively, where each connects to a series of ditches, drains, and canals linked throughout the Basin. Several of these features are threatened by development.

Southern Basin

A 1,871-acre (757-hectare) area situated directly east of the SMF from I-5 on the south to Elverta Road on the north that was formerly in rice production is currently in the process of conversion to an industrial and commercial project. This area provided both supporting habitat and one of the few connective corridors linking giant garter snake habitats north and south of I-5 prior to modifications that were completed in 2005. Except for the West Drainage Canal, all aquatic connective corridors originating in Area 2 south of I-5 passed through

Table 3-2. Seasonal Trap Success in the Natomas Basin, 2000–2005

Year	Individuals Captured	Total Trap Days	Success Per Unit Effort (Individuals/Total Trap Days)
2000	81	20,209	.0040
2001	31	18,687	.0017
2002	140	30,014	.0047
2003	101	39,782	.0025
2004	82	50,615	.0016
2005	170	65,535	.0026

Table 3-3. Size Distribution of Natomas Basin Giant Garter Snakes, 2000–2005

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

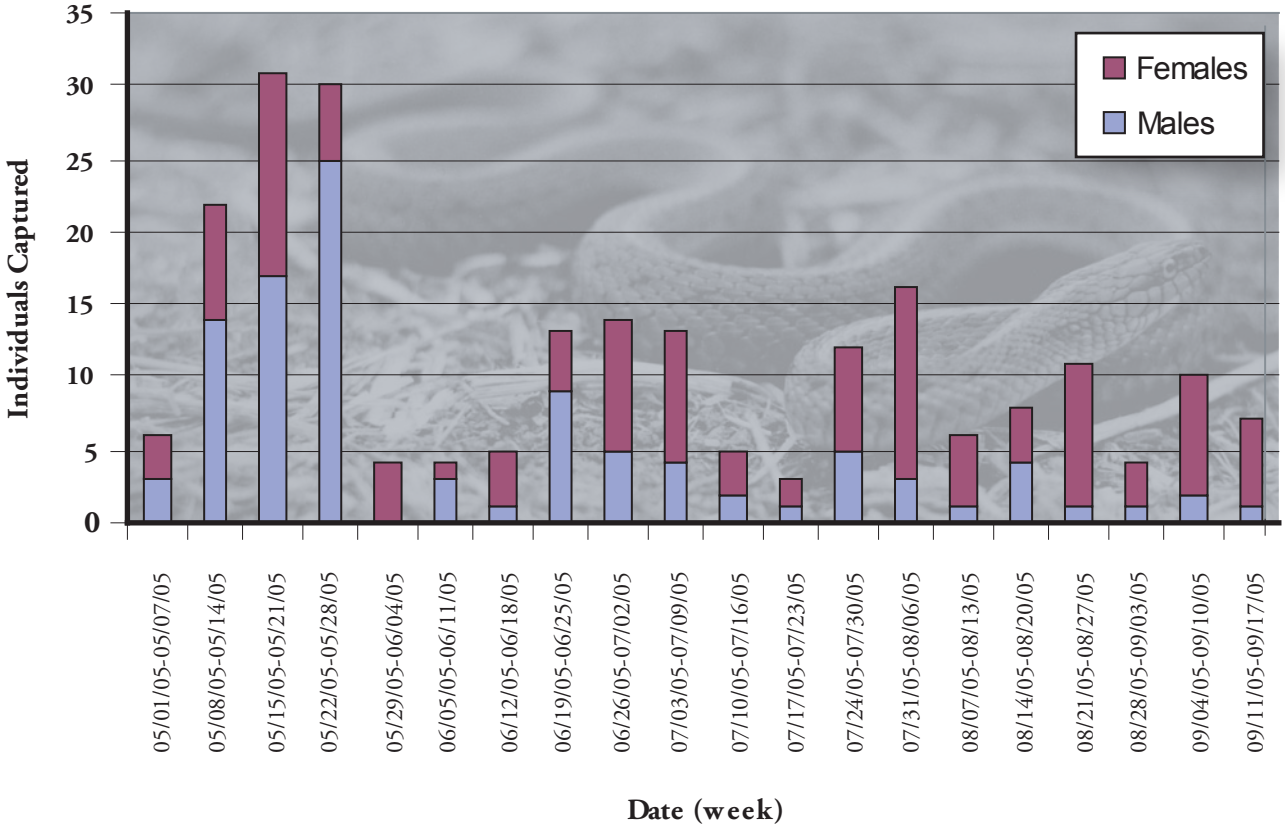

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Figure 3-6
Temporal Distribution of Giant Garter Snake Captures, 2005

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Figure 3-7
Change in Giant Garter Snake Habitat Connectivity, 2004 — 2005

this area before entering the AOA and the northern portions of Area 1. The Meister Ditch flowed into SMF at the southern edge of the AOA, where it connected via culvert to the Airport East Ditch (Figure 3-8). Both these ditches have historically supported giant garter snakes (Wylie et al. 2004; California Natural Diversity Database 2005; Hansen unpublished notes).

The No. 4 and 4a Ditches and the eastern segment of Meister Ditch were abandoned and filled, eliminating water sources to Meister Ditch west of Powerline Road and the Airport East Ditch, both of which dried to the extent that aquatic trapping transects were abandoned. Such drying will likely result in the loss of critical north-south connective corridors 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.

Two routes providing connection to habitats in the northern portion of the Basin come together at this single connective corridor between Areas 1 and 2 (Figure 3-8). The first, the series of laterals and drains collectively referred to as Lone Tree Canal, originates at the southeast corner of the Tufts Reserve and proceeds south along the eastern boundary of Metro Air Park to the double box culverts where it passes beneath I-5 to Fisherman's Lake (West Drainage Canal) via the L Drain (lower component of Lone Tree Canal). The second route originates at the southeast corner of the Sills Reserve and proceeds south through the I1 Drain along the western edge of SR-99 to the L2 Drain, which proceeds west to its intersection with Lone Tree Canal. The Central Main Canal and Lateral 5A connect these routes, which cross I-5 through the L Drain (Figure 3-8).

Both routes—and thus the connective corridor between Areas 1 and 2—are potentially threatened by the proposed development that is bounded by I-5, Lone Tree Canal, Elverta Road, and SR-99; the cessation of active farming on this property has already altered water deliveries to the GB Ditch immediately north of I-5.

The N Drain and West Drainage Canal also cross I-5 from Area 1 to Area 2. However, both canals terminate before reaching suitable snake habitat or reserves north of Elverta Road (Figure 3-8).

The East Drainage Canal provides the only connection between Areas 2 and 3 (Figure 3-7); 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 a critical linkage for reserves south of I-5 to other regions within the Basin.

Northern Basin

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 to the North Drainage Canal. 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, including 212 locations where giant garter snakes were captured. Most captures occurred in areas characterized by steep bank slopes. One hundred sixty-two (76.4 %) of the 212 capture locations were adjacent to banks with slopes exceeding 3:1. Giant garter snakes were captured at traps with steep-sided slopes significantly more frequently than expected ($\chi^2 = 33.1$, df = 5, $p < 0.000004$).

Distance to terrestrial refuge habitat was measured at most trap locations, including 183 locations where giant garter snakes were captured. Although more than 84% of captures occurred within 1 meter (3.3 feet) of terrestrial refuge habitat, and only 4.4% of captures occurred more than 15 meters (49.2 feet) from terrestrial refuge habitat, there was no apparent relationship between capture success and distance of the trap from the nearest upland refugia habitat. Even when distances were grouped into two categories (less than 10 meters and more than 10 meters from nearest upland refugia), giant garter snakes were not captured more frequently than expected closer to upland refugia habitat ($\chi^2 = 0.523$, df = 1, $p < 0.4696$). The lack of a statistically significant relationship may be due in part to the influence of drift fence traplines, where capture success was high and traps were farther from bankside habitats.

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

With the exception of the western ditch at Lucich North (Q Drain), all areas where density estimates were available for both 2004 and 2005 showed an increase in density. Similarly, overall capture success increased in 2005. While the increase in density estimates may reflect an actual increase in snake populations, the estimates should be interpreted with caution.

Table 3-4. Prey Densities at Natomas Basin Trap Locations, 2005

Transect ID	General Location	Trap Days	Tadpole	Density	Bullfrog	Density	Treefrog	Density	Fish	Density	Mosquitofish	Density	Crayfish	Density
DF1*	Natomas Farms – Drift Fence	1,700	1	.00059	31	.0182	0	0	55	.032	390	.23	112	.066
DF2*	BKS – Silva Drift Fence	1,750	3	.0017	9	.0051	0	0	5	.0029	2	.0011	29	.0166
DF3*	Lucich South Drift Fence	2,850	6	.0021	69	.024	0	0	2	.0007	134	.047	69	.024
RT1	Fisherman's Lake	3,850	1	.00026	13	.0034	0	0	19	.0049	7	.0018	65	.017
RT1b	Natomas Farms –SE Marsh	800	12	.015	29	.037	4	.005	29	.036	512	.64	75	.094
RT2	Snake Alley	2,800	0	0	1	.00036	0	0	4	.0014	1	.00036	275	.098
RT3	T Drain	3,050	4	.0013	36	.012	0	0	12	.0039	61	.02	190	.062
NP5	Atkinson – Highline Ditch	1,400	7	0.005	7	0.005	4	.0029	4	.0029	0	0	406	.29
NP6	Atkinson – North Drain	1,400	0	0	4	.0029	6	.0043	8	.0057	4	.0029	160	.11
NP10	Ayala – "E" Drain	750	1	.0013	0	0	0	0	15	.02	0	0	35	.047
NP11	Ayala – South Ditch	1,450	1	.00069	0	0	0	0	25	.017	6	.0041	151	.1
NP16	Bennett North – North Ditch	700	13	.019	2	.0029	0	0	8	.011	0	0	20	.029
NP17	Bennett North – Marsh	700	37	.053	37	.053	0	0	714	1.02	5	.0071	26	.037
NP22	Bennett South – Q Drain	1,400	23	.016	8	.0057	2	.0014	9	.0064	44	.031	205	.15
NP24	Bennett South – Marsh	1,400	12	.0086	7	.005	5	.0035	47	.034	3	.0021	54	.039
NP28	BKS – Silva West Ditch	1,750	6	.0034	7	.004	0	0	15	.0086	12	.0069	294	.17
NP29	BKS – Ditch N of Control Structure K	1,400	18	.013	35	.025	0	0	1	.00071	36	.026	430	.31
NP30	BKS – Silva West Marsh	1,750	3	.0018	9	.0051	0	0	483	.28	8	.0046	216	.12
NP31	BKS – Marsh at Control Structure K	1,400	65	.05	125	.089	0	0	296	.21	15	.01	116	.083
NP35	Cummings – Central Marsh	1,400	270	.19	8	.0057	0	0	12	.0086	46	.033	19	.014
NP40	Frazer – Highline Ditch	1,400	0	0	3	.0021	1	.00071	1	.00071	4	.0029	256	.18
NP41	Frazer – W Marsh	1,400	18	.013	12	.0086	0	0	43	.031	80	.057	590	.42
NP43	Huffman East – Bennett Loop	1,400	1	.00071	8	.00571	1	.00071	6	.0042	0	0	142	.1
NP45	Huffman West – Q Drain	1,400	1	.00071	13	.0093	1	.00071	12	.0086	93	.066	278	.2
NP51	Lucich North – Marsh	1,750	2	.0011	24	.014	5	.0029	35	.02	167	.095	200	.11
NP57	Lucich South – North Drain	700	22	.031	24	.034	0	0	13	.019	5	.0071	22	.031
NP58	Lucich South – Marsh	1,750	247	.14	52	.03	0	0	13	.0074	34	.019	191	.11
NP62	Sills – Highline Ditch	1,500	17	.011	6	.004	0	0	4	.0026	1	.00067	309	.21
NP63	Sills – Drain 13	1,400	1	.00071	11	.0079	0	0	13	.0093	15	.011	245	0.18

Table 3-4. Continued

Transect ID	General Location	Trap Days	Tadpole	Density	Bullfrog	Density	Treefrog	Density	Fish	Density	Mosquitofish	Density	Crayfish	Density
NP66	Natomas Farms	1,750	11	0.0063	14	0.008	1	.00057	119	.068	40	.023	97	.055
NP70	Tufts – Lateral 3A	1,400	3	.0021	1	.00071	0	0	11	.0079	60	.043	277	.2
NP86	Bolin North	1,386	2	.0014	14	.01	0	0	3	.0022	0	0	124	.089
NP88	Rosa – West Drain	1,400	7	.005	5	.0036	6	.0043	17	.012	5	.0036	164	.18
BP71	SCAS – AOA E Ditch	700	3	.0043	0	0	0	0	0	0	9	.013	172	.25
BP72	SCAS – AOA W Ditch	350	0	0	1	.0029	0	0	0	0	10	.029	72	.21
BP73	SCAS – AOA S Ditch	350	0	0	3	.0086	0	0	0	0	19	.054	63	.18
BP77	SCAS – Jacob Slough	1,400	7	.005	17	.012	1	.00071	20	.014	29	.021	84	.06
BP78	SCAS – Flume west of Powerline	1,400	6	.0043	1	.00071	0	0	1	.00071	4	.0029	422	.30
BP81	Lone Tree Canal – Central Section	1,400	20	.014	4	.0029	0	0	8	.0057	0	0	383	.27

Notes:

* 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;* Pacific treefrog = *Pseudacris regilla;* Fish = Sunfish (*Lepomis* spp.); Mosquitofish = *Gambusia affinis;* Crayfish (*Procambarus clarkii*); Black basses (*Micropterus* spp.); Carp (*Cyprinus carpio*); Crappie (*Pomoxis* spp.)

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Figure 3-8
Giant Garter Snake Habitat Connectivity, 2005

The statistical models used to estimate density 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.

The conversion of population estimates to densities on the basis of linear features is similarly problematic. Although the conversion to linear densities is a reasonable approach because traplines are established along linear ditches and channels, these linear features typically lie adjacent to rice fields, wetlands, uplands, or other habitats used by giant garter snakes. Thus, the choice of area is somewhat artificial because snakes clearly move between habitats and outside the boundaries of the linear segment defined by the trapline.

Finally, comparison of density 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 density 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 was46 (S.E. 3.8662; 95% C.I. = 42–58). This is likely due to seasonal variation in snake activity as well as variation in density 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 in the future. However, the modified sampling procedures initiated in 2004 require more caution when comparing estimates with those from previous years.

The increase in capture success in 2005 may reflect an actual increase in population size. However, other factors may also have caused or contributed to the increase in capture success. Weather patterns—and thus habitat conditions—were unusual in 2005: heavy rain continued into May, postponing rice field flooding until June. Consequently, the majority of water conveyance channels that provide aquatic habitat were charged for irrigation 4–8 weeks later than during a typical year, and aquatic habitat was therefore limited to managed marshes and a small subset of the drainages and laterals until June. Giant garter snakes may therefore have occurred in higher than average densities during the early spring months, resulting in the exceptional pulse of captures in May. The number of captures decreased notably once the irrigation system was charged and rice fields were flooded in June.

Captures in managed marsh also increased over those in 2004 (the first season in which giant garter snakes were observed in managed marsh in the Basin). Slightly more than 20% (n=51) of all captures occurred in managed marsh in 2005. However, it should be noted that most of the captures in managed marsh habitat occurred during the spring pulse described above, when the availability of other aquatic habitats (linear water conveyance features and flooded rice fields) was limited. The percentage of captures in managed marsh versus other aquatic habitats in 2005 was similar to that of 2004 (20% versus 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.

Although the average size of both male and female giant garter snakes captured in 2005 was larger than the sizes of snakes captured in 2004, the overall trend, especially for males, may indicate a shift in the size and age distribution of giant garter snakes in the Natomas Basin.

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 110 millimeters (4.3 inches) longer than males captured in 2005 (665 millimeters [26.2 inches] versus 553 mm [21.8 inches], respectively). The size of female giant garter snakes captured during the same period averaged more than 210 millimeters longer than those captured in 2005 (886 millimeters [34.9 inches] versus 670 millimeters [26.4 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 also appear to be smaller than giant garter snakes from other regions (Table 3-5). Male giant garter snakes captured in a semi-native perennial marsh in southern Sacramento County averaged 71 millimeters (2.8 inches) longer and 55 grams (1.9 ounces) heavier than those from the Natomas Basin, while females averaged 67 millimeters (2.6 inches) longer and 116 grams (4.1 ounces) heavier than those from the Natomas Basin (Hansen 2003). Similarly, male giant garter snakes captured in an area of rice agriculture immediately north of the Natomas Basin averaged 47 millimeters (1.8 inches) longer and 10 grams (0.35 ounces) heavier than those from the Natomas Basin, while females averaged 84 millimeters (3.3 inches) longer and 24 grams (0.85 ounces) heavier than those from the Natomas Basin (Hansen 2005). Sampling techniques in the three areas were identical.

Table 3-5. Size Distribution of Giant Garter Snakes Trapped in Different Regions and Habitat Types

Gender	Metric	Natomas Basin 2005 / Rice Agriculture	Middle American Basin 2004 / Rice Agriculture	Badger Creek 2002 / Perennial Marsh
Male	Mass (g)	98 n=103	108 n=48	153 n=30
	SVL (mm)	553 n=103	600 n=46	624 n=29
Female	Mass (g)	213 n=122	237 n=122	329 n=34
	SVL (mm)	670 n=122	754 n=70	737 n=32

Taken together, these results indicate that the size, and thus the age distribution, of giant garter snakes in the Natomas Basin may be 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 average size and age of female giant garter snakes would result in diminished recruitment, affecting the viability of the giant garter snake population in the Basin over time.

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. Figures 3-7 and 3-8 provide 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 potentially threatened by 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 variation 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 greater than 3:1. This may be due to the fact that in areas with steep sloped 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.

As noted above in *Habitat Use*, preliminary data collected in 2004 and 2005 are consistent with the hypothesis that giant garter snakes may respond positively in some situations to the placement of banks with slopes that exceed 3:1.

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. Portions of the BKS Reserve were also modified to provide additional steep-sloped banks.

Giant garter snakes were captured for the first time in 2005 in created marsh habitats in the Souza/Natomas Farms and BKS Reserves, and appear to be doing very well in constructed marshes on reserve lands. The created marshes provided critical aquatic habitat in 2005 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 bank- side habitats as appropriate on existing reserves.
- 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 2005.

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 monitoring, the study area was expanded 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.

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).

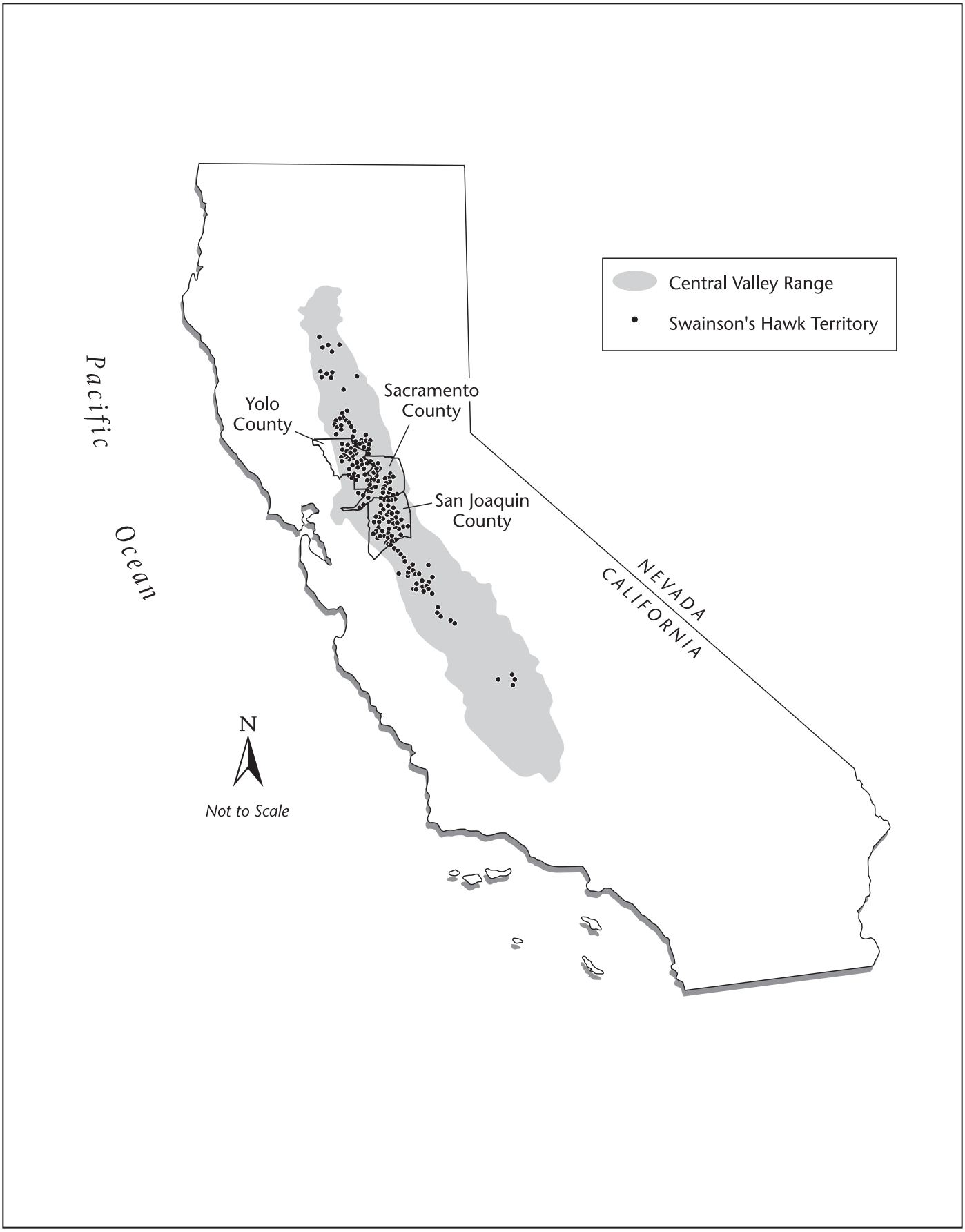
Despite the loss of native habitats in the Central Valley, Swainson's hawks appear to have adapted relatively well to certain types of agricultural patterns in areas where suitable nesting habitat remains (Figure 4-3). However, nesting habitat for Swainson's hawks continues to decline in the Central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

Light morph adult Swainson's Hawk

04002.04

Jones & Stokes

Figure 4-1
Adult Swainson's Hawk



Jones & Stokes

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

04002.04

Jones & Stokes

Figure 4-3
Swainson's Hawk Nesting Habitat

Habitat Use

Swainson's hawks usually nest in large native trees such as valley oak (*Quercus lobata*), cottonwood (*Populus fremontia*), walnut (*Juglans juglans*), and willow (*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, 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 2005 by a breeding 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, were mapped from aerial photographs in 2004 and updated in 2005 (see Chapter 2, *Vegetation Mapping, Floristic Inventory, and Noxious Weed Monitoring*). Cover types considered to be suitable Swainson's hawk foraging habitat were identified and the acreages were calculated. These data were then used to describe the types and distribution of

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

suitable Swainson's hawk foraging habitat on reserve lands and throughout the Basin.

4.3 Results

4.3.1 Population Assessment

Figure 4-5 illustrates the distribution of nesting Swainson's hawks in the Basin in 2005. Nest sites occur primarily in the southern portion and along the far western and northern edges of the Basin. These areas support both suitable nesting and foraging habitat. Crop patterns include a mixture of hay, row, and grain crops. Suitable nesting trees occur along roadsides, in remnant riparian and oak woodlands, and as isolated trees. Most of the Basin north of Elkhorn Boulevard and east of Powerline Road is unsuitable or only marginally suitable for nesting or foraging Swainson's hawks, and thus most of the area does not support nesting pairs. The agricultural land in this area is dominated by rice production, which provides limited foraging value to Swainson's hawks; moreover, very few trees exist in the region, limiting potential nesting sites.

A total of 92 Swainson's hawk nesting territories were monitored in 2005 (Table 4-1). Among these are one new territory in the interior of the Basin (NB-90), one new territory along the Cross Canal (NB-91), and one new territory along the Sacramento River (NB-92).

Of the 92 known nesting territories in the survey area, 45 were active (i.e., at least one adult was present on the nesting territory) and 47 were inactive (i.e., neither adult was observed on the nesting territory) in 2005. Of the 45 active sites, 31 were occupied by breeding pairs that successfully nested (i.e., reared young to fledging), producing a total of 49 fledglings (Table 4-2). Pairs that did not successfully reproduce occupied 12 of the remaining 14 active sites, and the reproductive outcome at two sites was undetermined. Eleven of the 12 unsuccessful pairs nested but failed to rear young to fledging; one territory was occupied, but the adult breeding pair did not attempt nesting.

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 in 2004 and 2005. Suitable habitat types include both cultivated and uncultivated lands. Suitable cultivated habitats include alfalfa and row, grain, and other hay crops (row, grain, and other hay crops have been combined because of seasonal and annual rotations). Suitable uncultivated habitats include irrigated pasture and other nonirrigated 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.

Table 4-1. Results of 2005 Swainson's Hawk Surveys, Natomas Basin Habitat Conservation Plan Area

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species
NB-1	A/S	2	Urban	Valley Oak
NB-2	A/S	1	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	Riparian along irrigation channel	Cottonwood
NB-10	A/S	1	Riparian	Cottonwood
NB-11	A/S	1	Riparian	Willow
NB-12	A/S	2	Riparian	Cottonwood
NB-13	A/S	1	Riparian	Cottonwood
NB-14	A/S	2	Ornamental	Eucalyptus
NB-15	NLE	0	Nesting habitat removed in 2002	None
NB-16	I	0	Remnant oak grove	Valley oak
NB-17	NLE	0	Lone tree, removed in 1998	None
NB-18	A/F	0	Lone tree	Cottonwood
NB-19	I	0	Tree along irrigation channel	Willow
NB-20	NLE	0	Nest tree removed in 2002	None
NB-21	A/S	1	Riparian	Cottonwood
NB-22	I	0	Tree along irrigation channel	Cottonwood
NB-23	A/S	2	Riparian	Willow
NB-24	A/S	1	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	I	0	Riparian	Cottonwood
NB-29	A/S	1	Riparian	Willow
NB-30	I	0	Riparian	Cottonwood
NB-31	A/S	2	Riparian	Cottonwood
NB-32	I	0	Riparian	Cottonwood

Table 4-1. Continued

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species
NB-33	I	0	Riparian	Cottonwood
NB-34	A/S	1	Riparian	Cottonwood
NB-35	I	0	Riparian	Cottonwood
NB-36	I	0	Riparian	Cottonwood
NB-37	I	0	Riparian	Cottonwood
NB-38	I	0	Riparian	Cottonwood
NB-39	A/S	2	Riparian	Cottonwood
NB-40	I	0	Riparian	Cottonwood
NB-41	I	0	Riparian	Cottonwood
NB-42	A/F	0	Riparian	Cottonwood
NB-43	I	0	Riparian	Cottonwood
NB-44	A/F	0	Riparian	Cottonwood
NB-45	A/S	1	Riparian	Sycamore
NB-46	A/U	U	Riparian	Cottonwood
NB-47	A/F	0	Riparian	Cottonwood
NB-48	I	0	Riparian	Valley oak
NB-49	A/U	U	Riparian	Cottonwood
NB-50	I	0	Riparian	Sycamore
NB-51	A/F	0	Riparian	Cottonwood
NB-52	A/S	1	Riparian	Cottonwood
NB-53	A/S	1	Riparian	Cottonwood
NB-54	I	0	Riparian	Cottonwood
NB-55	A/F	0	Riparian	Cottonwood
NB-56	I	0	Riparian	Cottonwood
NB-57	A/S	1	Riparian	Cottonwood
NB-58	I	0	Riparian	Cottonwood
NB-59	A/F	0	Riparian	Cottonwood
NB-60	I	0	Riparian	Cottonwood
NB-61	I	0	Riparian	Cottonwood
NB-62	A/F	0	Riparian	Cottonwood
NB-63	A/F	0	Isolated tree	Cottonwood
NB-64	A/S	2	Riparian	Cottonwood
NB-65	I	0	Riparian	Cottonwood
NB-66	A/F	0	Riparian	Cottonwood

Table 4-1. Continued

Nest site number	Status[1]	Number of young	Nesting Habitat	Nest Tree Species
NB-67	I	0	Riparian	Valley Oak
NB-68	I	0	Riparian	Cottonwood
NB-69	I	0	Freeway landscape tree	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 along driveway	Ornamental conifer
NB-74	I	0	Roadside tree	Willow
NB-75	I	0	Riparian	Cottonwood
NB-76	NLE	0	Trees removed in 2004	Cottonwood
NB-77	A/S	2	Riparian	Cottonwood
NB-78	A/S	1	Riparian	Cottonwood
NB-79	I	0	Riparian	Sycamore
NB-80	A/S	2	Riparian	Cottonwood
NB-81	A/X	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	I	0	Riparian	Cottonwood
NB-86	A/F	0	Riparian	Cottonwood
NB-87	A/S	1	Riparian	Cottonwood
NB-88	A/S	2	Riparian	Cottonwood
NB-89	I	0	Riparian	Cottonwood
NB-90	A/S	2	Riparian	Willow
NB-91	A/S	2	Riparian	Cottonwood
NB-92	A/S	2	Riparian	Cottonwood

Notes:

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

Table 4-2. Reproductive Data for Active Swainson's Hawk Territories in the Natomas Basin Habitat Conservation Plan Area, 1999–2005

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

Notes:

[a] Years 1999 and 2000 do not include the Sacramento River territories.

[b] Excluding Number Active with Unknown Outcome

Table 4-3. Suitable Swainson's Hawk Foraging Habitat in the NBHCP Area 2004–2005

Cover Type	2004 Acres	2005 Acres
Alfalfa	610	940
Row, grain, and other hay crops	7,590	6,712
Irrigated pasture	776	440
Grasslands	7,847	8,239
Total	16,823	16,331

In 2005, approximately 16,331 acres (7,420 hectares), or 30% of the entire Basin, was in cover types considered suitable Swainson's hawk foraging habitat, a decrease of about 492 acres (199 hectares) (Table 4-3). However, the number of acres in alfalfa, a cover type considered to be optimal foraging habitat for Swainson's hawk, increased by approximately 330 acres (134 hectares) in 2005, due primarily to the establishment of this cover type on reserves.

The distribution of suitable foraging habitat in the Basin is depicted in Figure 4-6. The majority of these cover types occurs in the Basin's southwest corner and on its western edge along the Sacramento River. While there are pockets of suitable habitat in other areas, the majority of the northern and central Basin is traditionally under rice production, a crop type that is considered generally unsuitable for Swainson's hawk foraging. Most of the southeast corner of the Basin has been or is currently being developed and is largely unsuitable for Swainson's hawk foraging.

Table 4-4 lists the habitat types on reserve lands that provide suitable Swainson's hawk foraging habitat and their acreages in 2005 by reserve. The reserve system currently accounts for approximately 5% 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. However, the proportion of Swainson's hawk foraging habitat in higher-value crop types (i.e., alfalfa) on reserve lands is greater than the corresponding proportion on non-reserve lands (13% versus 5%, respectively), while the proportion of habitats in lower-value crop types (i.e., row, grain, and other hay crops) is lower on reserve lands than on non-reserve lands (33% versus 41%, respectively) (Table 4-5).

Table 4-4. Extent of Swainson's Hawk Foraging Habitat on the TNBC Reserves, 2005 (acres)

Reserve	Alfalfa	Row, Grain, and Other Hay Crops*	Irrigated Pasture	Grasslands
Alleghany 50	27	19	—	2
Atkinson	—	43	—	4
Ayala	—	—	—	—
Bennett North	—	—	—	5
Bennett South	—	—	—	22
Bolen North	—	—	—	—
Bolen South	—	—	—	—
Betts-Kismat-Silva	—	—	37	152
Brennan	—	—	—	87
Cummings	—	4	—	26
Frazer	—	—	—	18
Huffman East	—	—	—	—
Huffman West	64	112	—	—
Lucich North	—	—	—	34
Lucich South	—	—	—	3
Natomas Farms	—	43	—	17
Rosa Central	—	—	—	—
Rosa East	—	—	—	—
Ruby Ranch	—	—	—	4
Sills	—	—	—	—
Souza	11	28	—	—
Tufts	—	—	—	—
Total	102	249	37	374

Note:
* In 2005, the Row, Grain, and Other Hay Crops category consisted of grass hay and wheat.

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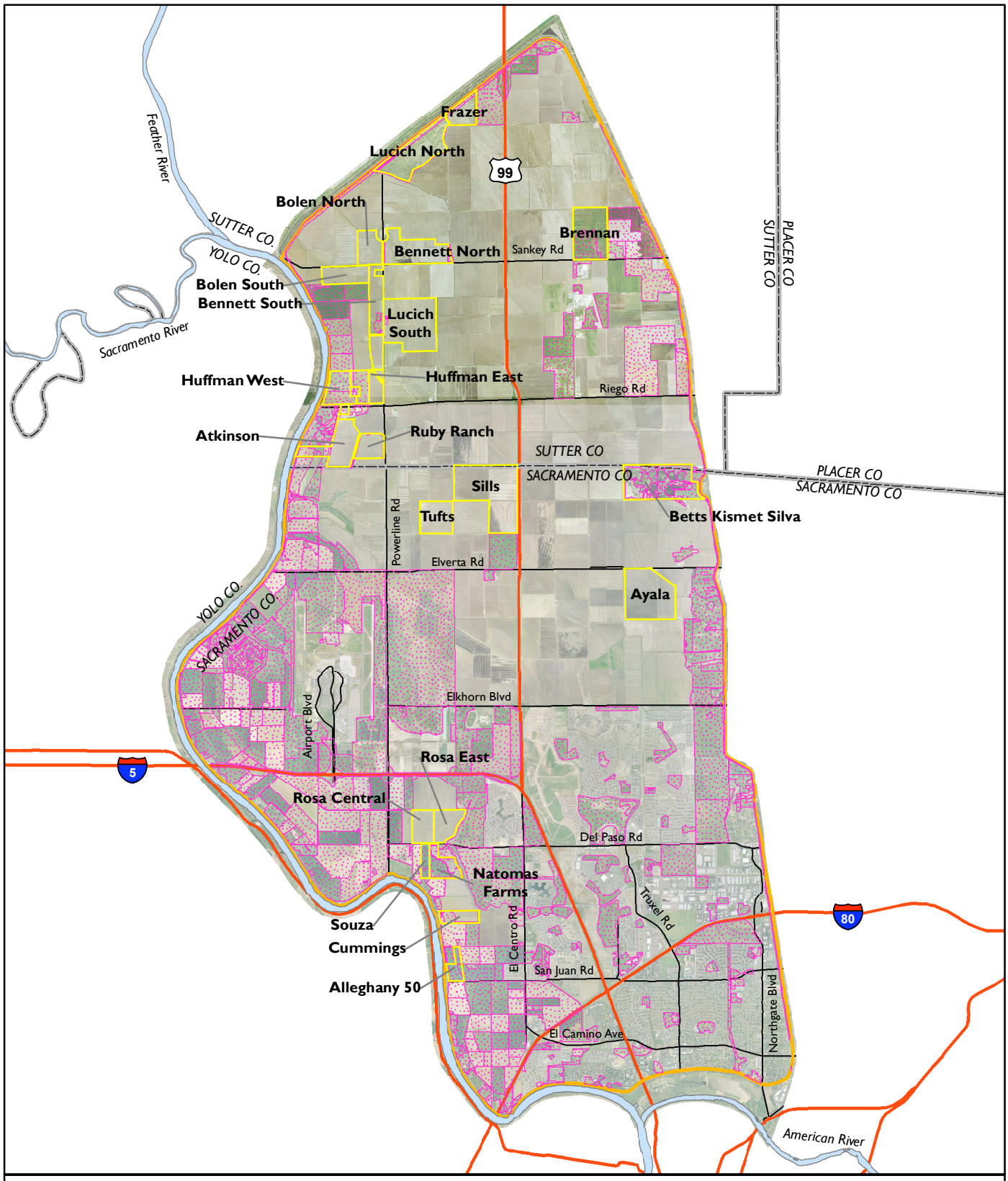
Figure 4-5
Locations of Swainson's Hawk
Nest Sites in the Natomas Basin, 2005



Legend

- Roads
- Major Roads
- Rivers
- Swainson's Hawk Foraging Habitat
- County Boundaries
- NBHCP Area Boundary
- Reserve Lands

N

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Figure 4-6
Suitable Swainson's Hawk Foraging Habitat in the Natomas Basin, 2005

Table 4-5. Extent (acres) and Proportion of Suitable Swainson's Hawk Foraging Habitat on and off TNBC Reserve Lands, 2005

	Alfalfa	Row, Grain, and Other Hay Crops	Irrigated Pasture	Grasslands	Total
On-reserve acreage	102	249	37	374	762
On-reserve percentage of cover type	13	33	5	49	
Off-reserve acreage	838	6,463	403	7,865	15,569
Off-reserve percentage of cover type	5	41	3	51	

4.4 Discussion

Based on the number of active territories and reproductive performance, the nesting population in the Basin continues to remain generally healthy (Table 4-2). However, in 2005 there was a relatively significant decrease in the number of active territories (14 fewer than in 2004) and the number of successful nests (eight fewer than in 2004). While the decrease in the number of active territories could be attributed to a decrease in the size of the breeding population, it may also be due to early nest failures that went undetected. Spring storms may have prevented breeding or caused early nest abandonment, particularly north of the I-5 bridge along the Sacramento River.

While the total number of active territories in the study area decreased in 2005 for the first time in 4 years, the magnitude of the decrease is within the range of variation documented over the last 5 years, and no significant trends in population size have been noted (Table 4-2).

Only three new territories were identified in 2005: one in the interior of the basin, one along the Cross Canal, and one along the Sacramento River. This is fewer than the number documented in previous years; the decrease may suggest the possibility of known breeding pairs using alternate nest sites, as well as the local movement of displaced pairs (e.g., breeding pairs whose nest trees were removed). Because very few individuals in this population have been marked (i.e., color banded), local movements of individuals or nesting pairs cannot usually be confirmed; accordingly, newly discovered nest sites are often considered new territories.

In 2004, the first nesting Swainson's hawk pair to nest on reserve lands was observed. The pair nested on the BKS Reserve (NB-81) and successfully fledged one young. A pair was observed early in 2005 at the 2004 nest site; however, it abruptly abandoned the site early in the spring and was not detected subsequently. The cause of this abandonment is unclear. The pair in 2004 were both dark-morph birds, while the pair in 2005 consisted of one light- and one dark-morph bird, indicating that at least one of adults was new on this territory in

2005. The BKS Reserve continues to provide nesting and foraging habitat for Swainson's hawk and other raptors.

Overall reproductive performance (i.e., number of young per occupied nest and number of young per successful nest) has remained relatively stable (Table 4-2). While the overall number of young fledged was lower than the 2004 number (as a result of fewer breeding pairs), the number of young fledged per occupied nest and per successful nest was higher than in 2004. Overall reproductive performance has remained relatively stable between 1999 and 2005, and is generally consistent with the Sacramento Valley population as a whole since the mid-1980s (Estep in preparation).

While several nesting sites have been removed as a result of ongoing development or other activities, this has not yet resulted in a detectable decline in the overall population; however, removal of nest trees and loss of foraging habitat has contributed to a reduction in the number of active territories in the southern interior portion of the Basin. As planned development continues, additional nesting pairs will likely be displaced, and foraging habitat will continue to be reduced in the Basin.

A total of seven Swainson's hawk nest sites have been removed since the implementation of the NBHCP (Figure 4-5). Three of these, NB-3, NB-17, and NB-76, were removed as a result of development permitted under the NBHCP. One site, NB-7, was permitted for removal under the Metro Airpark Habitat Conservation Plan (MAP HCP). Three sites, NB-15, NB-26, and NB-20, were removed during maintenance activities by the Sacramento County Airport Systems (SCAS) staff; these sites were not permitted for removal. In each of these cases all available nesting trees were removed, and thus all three nesting territories are considered no longer extant. Another site, NB-63b, was removed in 2005 along with all surrounding trees and understory vegetation. This unauthorized tree removal was conducted during the breeding season and likely resulted in the loss of eggs or young. The alternate nest site for this pair, NB-63a, remains intact; consequently, there is still potential for this pair to occupy the nesting territory in subsequent years.

The majority of the new sites that have been identified in the last several years, with few exceptions, are along the peripheral drainages (e.g., the Sacramento River) or the edges of the Basin. As expected, active nest sites in the southern interior portion of the Basin have declined as a result of nest site removal and development activities.

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. 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. As noted above, trees continue to be removed by SCAS. Continuing tree removal on Sacramento International

Airport lands could substantially reduce available nesting habitat in the Basin. Conservation efforts (e.g., maintaining and creating new upland foraging habitat and nesting habitat on reserves) can help to offset losses and counter probable future population declines.

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 in Section 4.5.1, 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 acquisitions and reserve management with respect to population stability, 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. As suggested in Section 4.6, the decline in the number of active nesting territories in 2005 may be a result of nest abandonment caused by spring storms.

To date, TNBC has acquired sufficient habitat in the Basin, relative to lands permitted for development, to meet the overall compensation goals of the NBHCP. Swainson's hawk habitat goals also 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 4.5.2, reserve lands that support Swainsons's hawk foraging habitat provide a higher proportion of high-value cover types (i.e., alfalfa) than non-reserve lands.

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 4.7, *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: Bolen South,

Alleghany 50, Cummings, Souza, Natomas Farms, Atkinson, Huffman West, Huffman East, Rosa East, Rosa Central, and Bennett South. All these reserves, with the exceptions of Rosa East and Rosa Central, 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. In addition, TNBC has been strategizing opportunities to trade properties (e.g., Ayala) for other properties that are either currently contiguous or have a high likelihood of becoming contiguous through additional acquisitions. 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.

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.
- 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) within this area will help to offset the loss described in item 1.
- Coordinate 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

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 the monitoring efforts 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 (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 objective to provide open space to benefit other wildlife species, in addition to objectives specifically related to Other Covered Species. The objectives of these 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 the sampling effort in 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, and vernal pool 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. Non-covered 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 for repeatability to ensure consistency, as well as in a manner to obtain maximum geographic and temporal coverage of the Basin. 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 Reserve Lands

TNBC reserves provide a variety of habitats for Other Covered Species. The availability of suitable habitats for Other Covered Species by reserve are summarized in Table 5-1, along with the documented occurrences of each.

Alleghany

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, burrowing owl, loggerhead shrike, and tricolored blackbird.

One loggerhead shrike was detected on the Alleghany Reserve during basin-wide surveys.

Forty-seven bird species were detected during 2005, up from 44 species in 2004. Red-winged blackbirds, savannah sparrow, and western meadowlark were the most common species detected. Several species of raptors were detected on this reserve, including American kestrel, great horned owl, red-shouldered hawk, red-tailed hawk, and northern harrier. Ten sandhill cranes were observed flying over the reserve.

Atkinson

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: valley elderberry longhorn beetle, northwestern pond turtle, white-faced ibis, Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

The seasonal wetland located on the reserve is small and shallow, and generally would not pond for long enough to support vernal pool invertebrates, California tiger salamander, western spadefoot, or any of the covered vernal pool plant species.

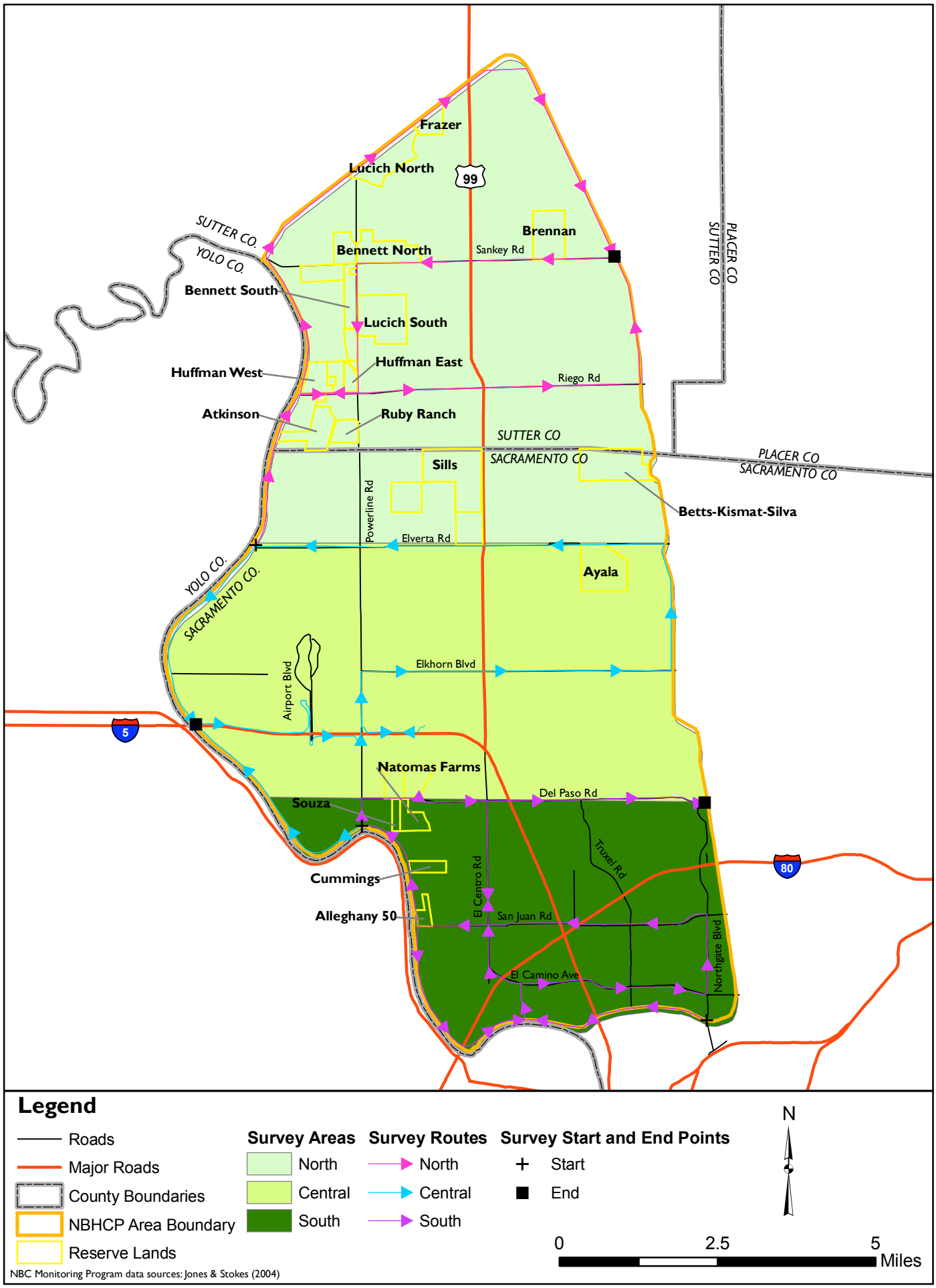
One Swainson's hawk was observed on the reserve in 2005, and six tricolored blackbirds were observed foraging on the site in June. The pair of loggerhead shrikes observed breeding just outside the reserve in 2004 was not present in 2005. Three blue elderberry shrubs, the host plant for valley elderberry longhorn beetle, are present in the riparian woodland on the reserve.

Eighty-six bird species were detected during 2005, up from 71 species in 2004. Species richness was high—second only to that of the BKS Reserve. Red-winged blackbird, Brewer's blackbird, American crow, and savannah sparrow were the most common species detected. The riparian forest attracted several neotropical migrant birds during migration, including Wilson's warbler, orange-crowned warbler, Pacific slope flycatcher, and willow flycatcher. The high diversity of raptors noted in 2004 increased in 2005: red-tailed hawk, red-shouldered hawk, Swainson's hawk, Cooper's hawk, sharp-shinned hawk, American kestrel, northern harrier, and great horned owl were all recorded.

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 community this is an important resource for many resident and migratory wildlife species using the Basin.

Table 5-1. Summary of 2005 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		
Atkinson					X	X	
Bennet North		X			X	X	
Bennet South		X			X		
Betts-Kismat-Silva		X	X	X	X(breeding)	X(breeding)	
Bolen North and South						X	
Brennan			X		X (breeding)	X	
Cummings					X		
Frazer			X			X	
Huffman East						X	
Huffman West							
Lucich North			X		X	X	
Lucich South					X		
Natomas Farms					X		
Rosa East and West							
Ruby Ranch					X		
Sills			X				
Souza							
Tufts				X			



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Jones & Stokes

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

Bennett North

The vegetation types and land uses present on the reserve provide suitable habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

White-faced ibis were observed using the marsh in July, August, and September. Three tricolored blackbirds were observed in a large mixed-species flock of blackbirds in March, and 65 were observed foraging on the reserve in May. One loggerhead shrike was observed on the reserve in May during a Basin-wide survey.

Fifty-three bird species were detected on this reserve in 2005, up from 38 species in 2004. Red-winged blackbird was the most common species detected, followed by mallard. Brewer's blackbird, killdeer, and savannah sparrows were also abundant.

Bennett South

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

Although white-faced ibis were observed using the reserve in 2004, no white-faced ibis were observed on this reserve in 2005. One loggerhead shrike was recorded on the reserve in June.

Forty-eight bird species were detected on this reserve in 2005, up from 24 in 2004. Red-winged blackbirds and mallards were again the most common species detected. Of note were a yellow-headed blackbird detected in June and a least bittern that was observed in the managed marsh portion of the reserve in September.

Betts-Kismat-Silva

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: California tiger salamander, western spadefoot, northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, tricolored blackbird, and vernal pool invertebrates.

The Swainson's hawk pair that nested on the site in 2004 did not return to breed on the site in 2004. Two of the three loggerhead shrike nests recorded in 2004 were active in 2005, but only one was confirmed to produce young. The

tricolored blackbird nesting colony on the BKS reserve was active in 2005, with an estimated 900 breeding pairs.

The burrowing owls north of the milk barn were detected during surveys in April, May, and June, but apparently did not breed successfully. No burrowing owls were detected after June during surveys on this reserve until well after the breeding season.

White-faced ibis were observed roosting in the managed marsh habitats during surveys in August, September, and October.

Vernal pool habitats on the reserve were checked regularly during the wet season. Although an unidentified species of clam shrimp was detected in the pools, there was no evidence of occupancy by covered vernal pool invertebrates or amphibians.

Ninety-two bird species were detected on this reserve in 2005, up from 80 in 2004. The diversity of wildlife on BKS is higher than that on any other reserve. BKS supports large numbers of waterbirds, including American coots; 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). Red-winged blackbirds were abundant. Significant numbers of shorebirds (black-necked stilt, American avocet, greater yellowlegs, killdeer, least sandpiper, long-billed curlew, and long-billed dowitcher, among others) also use the site. Raptors observed using the site include prairie flacon, white-tailed kite, northern harrier, red-tailed hawk, and American kestrel.

Bolen North and Bolen South

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

Six tricolored blackbirds were observed in a large mixed-species blackbird flock on Bolen North in September.

These reserves were acquired in April 2005, and avian surveys commenced in August 2005. Twenty-two and 35 bird species were recorded on Bolen North and Bolen South, respectively. The greater species diversity on Bolen South is due to the presence of a small amount of valley oak woodland on the site. On Bolen North, savannah sparrow, western meadowlark, and killdeer were the most common species recorded, which is consistent with habitat conditions on the site in 2005 (graded and disked fallow rice field). The small patch of valley oak woodland on Bolen South attracted a few additional species, such as western bluebird, orange-crowned warbler, spotted towhee, and California towhee, among others.

Brennan

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

The seasonal wetlands located on the reserve are too small and the duration of ponding is too short to support vernal pool invertebrates, California tiger salamander, or western spadefoot.

Two white-faced ibis and 37 tricolored blackbirds were recorded using the reserve during monthly surveys. One pair of loggerhead shrikes nested on the reserve in the same tree as in 2004.

Fifty-four bird species were detected on this reserve in 2005, up from 38 in 2004. Red-winged blackbird, Brewer's blackbird, western meadowlark, and savannah sparrow were among the most common species recorded on the reserve.

The black-crowned night-heron and snowy egret nesting colony in Curry Creek was again active in 2005, and had increased since 2004. Approximately 1,500 black-crowned night-herons and 600 snowy egrets were observed at the peak of the breeding season in the colony. Nests were built in Himalayan blackberry and in the small patch of riparian trees.

Cummings

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: valley elderberry longhorn beetle, northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

In 2005, Swainson's hawks were observed on three occasions flying over the reserve, and one observation of loggerhead shrike was recorded during monthly reserve surveys. Several loggerhead shrikes were recorded incidentally on the edge of the reserve; on one occasion a group of four individuals, two of which were juveniles, were observed, indicating that a pair probably nested nearby.

Seventy-eight bird species were detected on this reserve in 2005, up from 30 in 2004. The large increase in diversity may have been related to habitat changes as the created marsh habitats, constructed in late 2004, matured and vegetation cover increased. Red-winged blackbirds and mallards were the most common species on the reserve in 2005; moreover, the diversity of duck species was much higher and included mallard, gadwall, cinnamon teal, wood duck, American wigeon, northern shoveler, northern pintail, and ring-necked duck.

Frazer

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

Approximately 150 white-faced ibis were recorded using the created marsh habitats on the reserve in October, and three tricolored blackbirds were recorded in a small flock of red-winged blackbirds in March.

Fifty-three bird species were detected on this reserve in 2005, up from 34 species in 2004. Large numbers of red-winged blackbird, common moorhen, American coot, and mallard were commonly observed. Smaller numbers of shorebirds were also recorded.

Huffman East

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

One white-faced ibis was observed flying over the reserve in 2005, and a flock of 75 tricolored blackbirds was observed using the reserve in June and December.

Forty-six bird species were detected on this reserve in 2005, up from 31 in 2004. Red-winged blackbird, savannah sparrow, and killdeer were among the most abundant species observed in 2005.

Huffman West

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, burrowing owl, loggerhead shrike, and tricolored blackbird.

No detections of Other Covered Species were recorded on this reserve in 2005.

Forty-four bird species were detected on this reserve in 2005, up from 33 in 2004. Brewer's blackbird was the most common species recorded. Overall bird diversity was low.

Lucich North

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, Swainson's hawk, burrowing owl, loggerhead shrike, and tricolored blackbird.

Small flocks of white-faced ibis (14–25 birds) were recorded using the reserve during monthly reserve surveys in August and November. Loggerhead shrikes were observed foraging over the marsh on the reserve in February, June, and October. Three tricolored blackbirds were recorded in a large mixed-species flock of blackbirds foraging on the reserve in October.

Sixty-one bird species were detected on this reserve in 2005, up from 54 in 2004. Large numbers of red-winged blackbirds were recorded in 2005, and mallard, American coot, American green-winged teal, savannah sparrow, and American pipit were among the most common species observed. The numbers and diversity of duck and shorebird species recorded in 2005 was generally greater than that observed in 2004; duck and shorebird species observed in 2005 include killdeer, American avocet, greater yellowlegs, black-necked stilt, long-billed dowitcher, American wigeon, mallard, cinnamon teal, northern shoveler, northern pintail, American green-winged teal, ring-necked duck, bufflehead, ruddy duck, gadwall, and wood duck.

Lucich South

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

One Swainson's hawk was observed during monthly reserve surveys in February, and one loggerhead shrike was observed using the reserve in August.

Sixty-one bird species were detected on this reserve in 2005, up from 37 species in 2004. Large number of ducks and shorebirds were recorded on the Lucich South Reserve in 2005. Particularly high concentrations of dunlin (800) and greater white-fronted geese (1,200) were recorded in February. Three river otters were observed in the managed marsh portion of the reserve in October.

Natomas Farms

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

One loggerhead shrike was recorded in 2005 during monthly reserve surveys in November.

Fifty-eight bird species were detected on this reserve in 2005, up from 51 species in 2004. Red-winged blackbird, savannah sparrow, and mallard were the species most commonly observed. Sparrow diversity was high on this reserve; Lincoln's sparrow, fox sparrow, song sparrow, golden-crowned sparrow, white-crowned sparrow, savannah sparrow, and lark sparrows were all recorded on the reserve in 2005.

Rosa East and Rosa Central

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

No detections of Other Covered Species were recorded on these reserves in 2005.

These reserves were acquired in April 2005, and monthly avian surveys commenced in August 2005. Thirty-two species were recorded on the reserves during monthly reserve surveys. Red-winged blackbird, Brewer's blackbird, and savannah sparrow were the most abundant species recorded. The small patches of riparian and valley oak woodland on the reserves attracted a few additional species, such as Bewick's wren, house wren, ruby-crowned kinglet, and yellow-rumped warbler.

Ruby Ranch

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

No observations of Other Covered Species were recorded during the monthly reserve surveys in 2005. However, a loggerhead shrike was observed on the reserve in both March and September during Basin-wide surveys, and three tricolored blackbirds were observed in a mixed-species blackbird flock in September.

Thirty-five bird species were detected on this reserve in 2005, up from 20 in 2004. As in 2004, red-winged blackbird was the most abundant species recorded on the reserve. Killdeer, American pipit, savannah sparrow, American crow, and yellow-billed magpie were also among the most commonly observed species.

Sills

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, burrowing owl, loggerhead shrike, and tricolored blackbird.

Eight white-faced ibis were observed using the reserve in August of 2005. A single Swainson's hawk was observed flying over the reserve in October—a time when most hawks had already migrated out of the area.

Fifty-two bird species were detected on this reserve in 2005, up from 40 in 2004. Large numbers of red-winged blackbirds and savannah sparrows were recorded in 2005. Large concentrations of ducks were recorded on the reserve in February 2005, including more than 900 northern shovelers and 300 American wigeons.

Souza

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

No detections of Other Covered Species were recorded in 2005.

Twenty-six bird species were detected on this reserve in 2005, up from 16 in 2004. Species diversity was the lowest of all the reserves. (Bolen North had fewer species recorded in 2005, but was only surveyed from August through December.) Red-winged blackbird, American crow, savannah sparrow, and mourning dove were among the species most commonly observed during 2005.

Tufts

The vegetation types and land uses present on the reserve provide habitat for the following Other Covered Species: northwestern pond turtle, white-faced ibis, Aleutian Canada goose, loggerhead shrike, and tricolored blackbird.

No detections of Other Covered Species were recorded during surveys in 2005. An incidental observation of a burrowing owl was recorded in September.

This reserve was acquired in 2004, and monitoring began in January 2005. Thirty-eight bird species were recorded on the reserve. Red-winged blackbird was the most commonly observed species, followed by American pipit and killdeer. Four species of shorebird and three heron species were recorded using the reserve.

5.3.2 Basin-Wide

The distribution and abundance of Other Covered Species throughout the Basin, both on and off reserve sites, was recorded using a variety of techniques: generalized surveys conducted monthly on reserve lands, basin-wide surveys conducted monthly on non-reserve lands, and incidental observations made during other surveys and activities (e.g., floristic surveys and surveys for giant garter snake and Swainson's hawk).

This section describes the results of all these surveys as they pertain to Other Covered Species. Many Covered Species have not been detected in the Basin since comprehensive surveys for all covered species began in 2004. The following Covered Species were detected in the Basin and are discussed below: northwestern pond turtle, burrowing owl, white-faced ibis, tricolored blackbird, and loggerhead shrike. Several blue elderberry shrubs, the host plant for valley elderberry longhorn beetle, were also documented.

Valley Elderberry Longhorn Beetle

Several blue elderberry shrubs, the host plant for valley elderberry longhorn beetle, were found in the riparian habitats near Elkhorn Pump Station, along the Sacramento River, and near the Prichard Lake Pump Station in 2005. Two shrubs near the entrance gate of the Cummings Reserve, and several shrubs in riparian habitat near Elkhorn Pumping Station northwest of Sacramento International Airport were documented in 2004 (Figure 5-2).

Northwestern Pond Turtle

Northwestern pond turtles were observed in several of the same locations where they were detected in 2004, including Fisherman's Lake, near the Prichard Lake Pump Station, and near the Elkhorn Pump Station. A pair of northwestern pond turtles was also observed in the North Drainage Canal adjacent to the Ruby Ranch Reserve. No northwestern pond turtles were observed in the Airport East or Airport West Ditches where they were observed in 2004 (Figure 5-3).

Burrowing Owl

Four pairs of burrowing owls and several single birds were observed in the Basin in 2005 (Figure 5-4). The pair on the BKS Reserve that fledged at least four young in 2004 was observed in April, May, and June, but apparently did not breed. A pair fledged at least three young from a nest on the east side of the levee Road along Steelhead Creek. A third pair, observed near the Sysco plant on Pacific Avenue, exhibited breeding behavior, but breeding was never confirmed. A single bird observed just north of this pair in April and another single bird observed on the Tufts Reserve along lateral 3a in September were likely migrating birds, and were not seen again.

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Figure 5-2
Occurrences of Blue Elderberry Shrubs, 2005

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Figure 5-3
Occurrences of Northwestern Pond Turtle, 2005

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Figure 5-4
Occurrences of Western Burrowing Owl, 2005

There were several additional reports in 2005 of burrowing owls in the developed portion of the Basin. These include a report of pair of burrowing owls adjacent to a shopping center (Quick pers. comm.), four owls in July near the Truxel Avenue I-80 onramp (Marr pers. comm.), and two pairs of owls near Arena Boulevard. The latter two pairs were subsequently relocated prior to construction activities.

The single birds documented along the eastern edge of the Basin and in the center of the Basin in 2004 were not observed in 2005 (Figure 5-4).

White-Faced Ibis

In 2005, 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 5-5). Ibis were observed foraging and/or roosting on the Bennett North, BKS, Brennan, Frazier, Lucich North, and Sills Reserves.

White-faced ibis began arriving in the Basin in 2005 in May and increased in numbers through October before leaving the Basin completely by the end of November. This contrasts sharply with the pattern observed in 2004, in which ibis numbers peaked in June and most ibis had left the basin by the end of August (Figure 5-6). Large numbers of ibis were documented foraging and roosting on reserve properties. The largest concentration of ibis detected in the Basin in 2005 was approximately 750 birds recorded incidentally on the BKS Reserve early in October. In fact, four of the six largest concentrations of Ibis recorded in 2005 were on reserve lands.

Tricolored Blackbird

The tricolored blackbird nesting colony at the BKS Reserve was active in 2005. An estimated 900 pairs nested in the Himalayan blackberry patches in the riparian scrub just east of the row of cottonwood trees along the border between fields 2 and 6. Smaller groups of birds nested in each of the smaller patches of blackberry to the east of the main patch and in another distinct patch approximately 427 meters (1,400 feet) northwest of the main colony. The distribution of detections of tricolored blackbirds was similar to that in 2004 (Figure 5-7). In 2005, tricolored blackbirds were observed on the Atkinson, Bennett North, Bolen North, Brennan, BKS, Frazier, Huffman East, and Ruby Ranch Reserves.

Loggerhead Shrike

In 2005, loggerhead shrikes appeared to be less abundant than in 2004, especially during winter. Although the number of detections recorded during Basin-wide surveys increased from 33 to 91, this was due primarily to increased survey effort (significantly more Basin-wide surveys were conducted in 2005). Twenty-seven

incidental detections were recorded in 2005, down from 39 in 2004. As in 2004, loggerhead shrikes were detected throughout the Basin except for the northern interior and the developed portions in the southeastern portion of the Basin (Figure 5-8).

Five loggerhead shrike nests were detected in 2005, down from seven in 2004. Two nests were located on the BKS Reserve, one fewer than recorded in 2004. Only one nest was recorded on the Brennan Reserve in 2005, down from two nests in 2004. The fourth nest was located near the Atkinson Reserve, and the fifth nest was just south of Sacramento International Airport. The pairs that nested in 2004 near the Natomas Farms Reserve and the Atkinson Reserve did not nest in 2005.

5.4 Discussion

The TNBC reserves provide important habitats for birds in the Central Valley. One hundred thirty species were recorded on reserve lands in 2005, down from 148 in 2004. Most species recorded are typical of the Central Valley, and are associated with open agricultural 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. Diversity is highest on the BKS Reserve, a large reserve where managed marsh, nonnative annual grassland, and riparian and non-riparian woodlands occur in close association.

Large numbers of white-faced ibis were again observed throughout the Basin during 2005. 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 November. The significant change in temporal dynamics between 2004 and 2005 of the white-faced ibis population that inhabits the Basin may be related to the following two factors. In 2005, white-faced ibis began nesting locally in April in the Yolo Bypass, but the first breeding attempt was flooded out in late May. At least some of the birds re-nested in June, delaying the normal breeding cycle for this portion of the population by approximately 2 months, resulting in delayed postbreeding movements. Moreover, the rice fields in the Basin were flooded approximately 2 months later in 2005 than in 2004 (Hansen pers. comm.), delaying the availability of the major source of foraging habitat for ibis in the Basin. It seems likely that ibis will begin nesting in the Basin at some point in the future.

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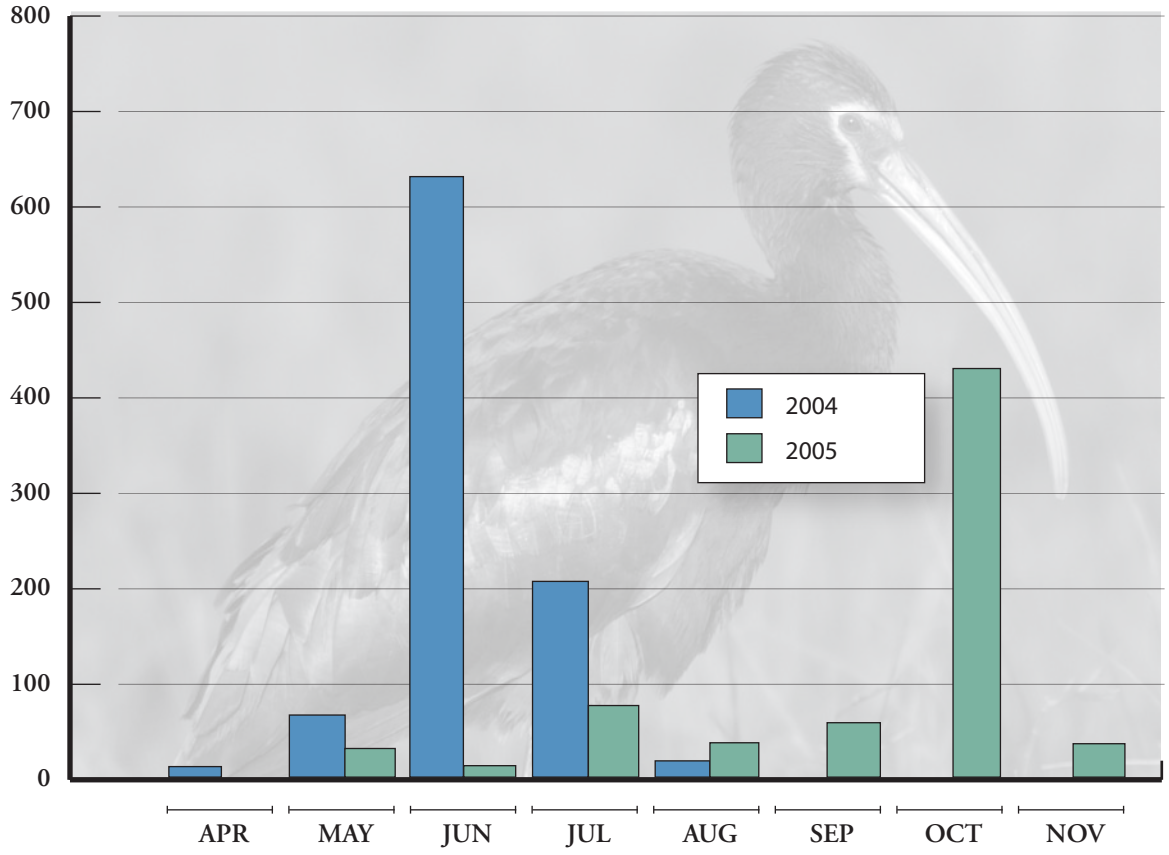
Figure 5-5
Occurrences of White-Faced Ibis, 2005



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Jones & Stokes

Figure 5-6
White-Faced Ibis Numbers Detected on Surveys in the Natomas Basin, 2004–2005

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Figure 5-7
Occurrences of Tricolored Blackbird, 2005

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Figure 5-8
Occurrences of Loggerhead Shrike, 2005

Few burrowing owls were observed in the Basin in 2004, and although the number increased in 2005, this was mainly due to incidentally reported observations primarily in developed areas of the southeast portion of the Basin. The distribution and abundance of burrowing owls in the Basin and elsewhere in rapidly developing areas suggests that some owls may select small infill habitats with light fixtures that provide tall perch sites and that attract easily detected and available insect prey. Unfortunately, these habitats are generally unstable and become unsuitable as development in the area continues and California ground squirrels, the main source of burrows, are eradicated.

Other suitable habitats for burrowing owls are limited in the Basin, primarily due to a lack of suitable rodent burrows for shelter and breeding sites; this lack of burrows is in turn related to non-friable clay soils and generally high water tables. Rice-growing areas are generally unsuitable for burrowing owls, although individuals will occasionally utilize burrows in rice checks and levees during the winter. Accordingly, habitat for burrowing owls is generally limited to the outer edges of the Basin and, as noted above, areas undergoing rapid development.

A significant breeding population of tricolored blackbirds occurs in the Basin; the single known breeding site is located on the BKS Reserve. Despite the failure to breed in 2004, breeding pairs appeared to saturate most of the available habitat on the BKS Reserve in 2005 and breeding was successful. Smaller numbers of tricolored blackbirds were again regularly observed in other areas of the Basin, and several reserves provide foraging habitat. While ample foraging habitat appears to be available, suitable breeding sites may be limited.

Very few northwestern pond turtles were observed in 2004 or 2005. 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 slider (*Trachemys scripta*) may be negatively affecting populations of northwestern pond turtle. 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).

A few previously undocumented blue elderberry shrubs were recorded in the Basin in 2005, although this species is clearly not abundant. Suitable riparian habitats are generally limited to the north, west, and south Basin margins along the Sacramento and American Rivers 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 also generally lacking in the Basin. In most cases, suitable upland habitats adjacent to aquatic breeding sites are lacking.

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 species populations to these 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 a cattle and goat grazing regime on the BKS reserve. Habitat conditions for burrowing owls and foraging raptors appear to have improved as a result of these vegetation management practices.

Management efforts to control the spread of Himalayan blackberry, a non-native species considered invasive in many habitats in California, was successfully conducted without any adverse impacts to nesting tricolored blackbirds in 2005.

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 non-tilled land on upland agricultural fields to provide potential burrowing owl nesting habitat, and consider the provision of artificial burrowing owl nest boxes in these areas.
- Increase strategic cattle grazing, mow, or take other actions to reduce vegetation height in nonnative annual grasslands on the eastern end of the BKS Reserve.

The tricolored blackbird colony at BKS is the only known breeding site for this species in the Basin. Tricolored blackbirds are itinerant breeders that often change nesting locations from year to year (Beedy and Hamilton 1999). Heavy predation by black-crowned night-herons was noted in previous years, and tricolored blackbirds failed to breed in 2004 on the BKS reserve. Although the tricolored blackbird colony at BKS was active in 2005 and breeding was successful, TNBC should consider the following actions to provide additional security for the nesting tricolored blackbird population in the Basin.

- Continue to manage 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.

5.7 References

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5.8 Personal Communications

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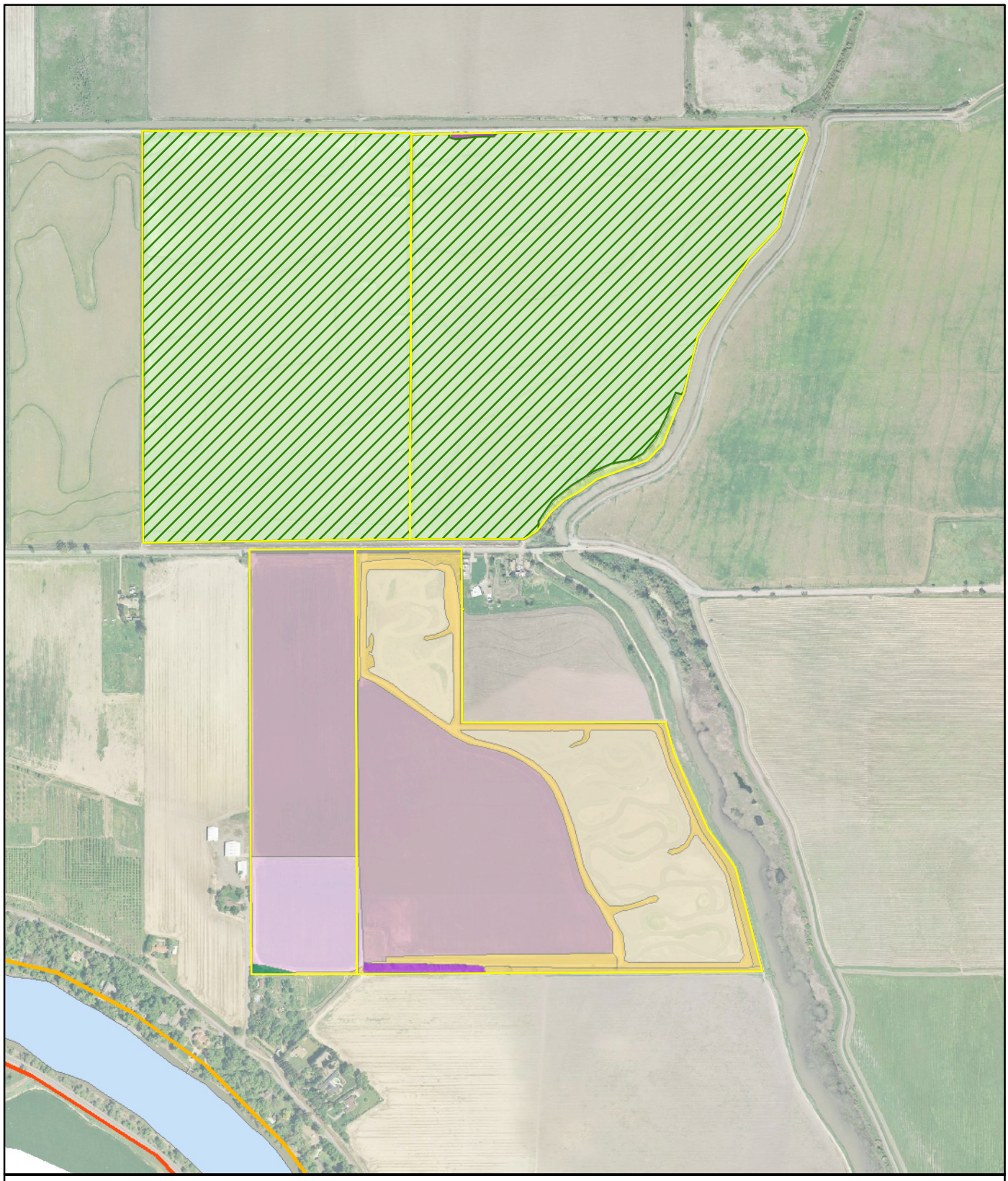
Appendix A

NBHCP Reserve Vegetation Maps

Jones & Stokes

Figure A-1
Cummings and Alleghany 50 Land Cover, 2005



Legend

- Major Roads
- Rivers
- NBC Project Boundary
- Reserve Lands

Land Cover

- Alfalfa
- Developed
- Grassland
- Managed Marsh
- Non-riparian Woodland
- Open Water
- Rice
- Rice, Fallow
- Riparian Woodland
- Row Crops
- Valley Oak Woodland

N

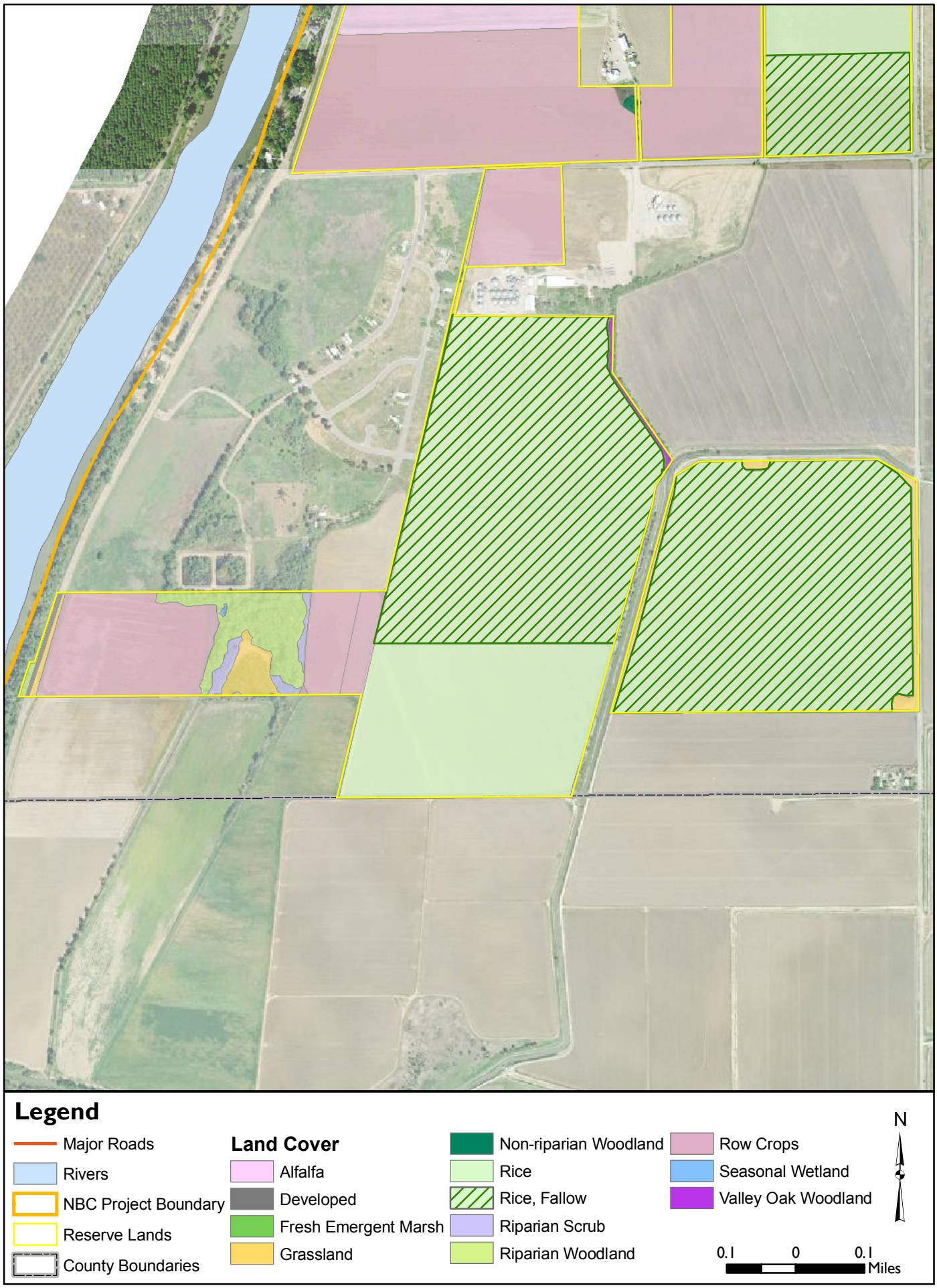
0.1 0 0.1 Miles

Jones & Stokes

Figure A-2
Rosa Central, Rosa East, Souza, and Natomas Farms Land Cover, 2005

Jones & Stokes

Figure A-3
Tufts and Sills Land Cover, 2005



Jones & Stokes

Figure A-4
Atkinson and Ruby Ranch Land Cover, 2005

Jones & Stokes

Figure A-5
Huffman East and Huffman West Land Cover, 2005

Jones & Stokes

Figure A-6
Bennett North, Bennett South, and Lucich South Land Cover, 2005

Legend

Reserve Lands

Land Cover

- Alfalfa
- Developed
- Grassland
- Managed Marsh
- Open Water
- Rice
- Rice, Fallow
- Riparian Scrub
- Seasonal Wetland
- Valley Oak Woodland

N

0.25 0 0.25 Miles

Jones & Stokes

Figure A-7
Bolen North and Bolen South Land Cover, 2005

Legend

NBC Project Boundary

Reserve Lands

Land Cover

Grassland

Managed Marsh

Row Crops

Seasonal Wetland

N

0.25 0 0.25 Miles

Jones & Stokes

Figure A-8
Frazer and Lucich North Land Cover, 2005

Legend

Reserve Lands

Land Cover

- Developed
- Fresh Emergent Marsh
- Grassland
- Irrigated Grassland
- Rice
- Rice, Fallow
- Riparian Woodland
- Seasonal Wetland

N

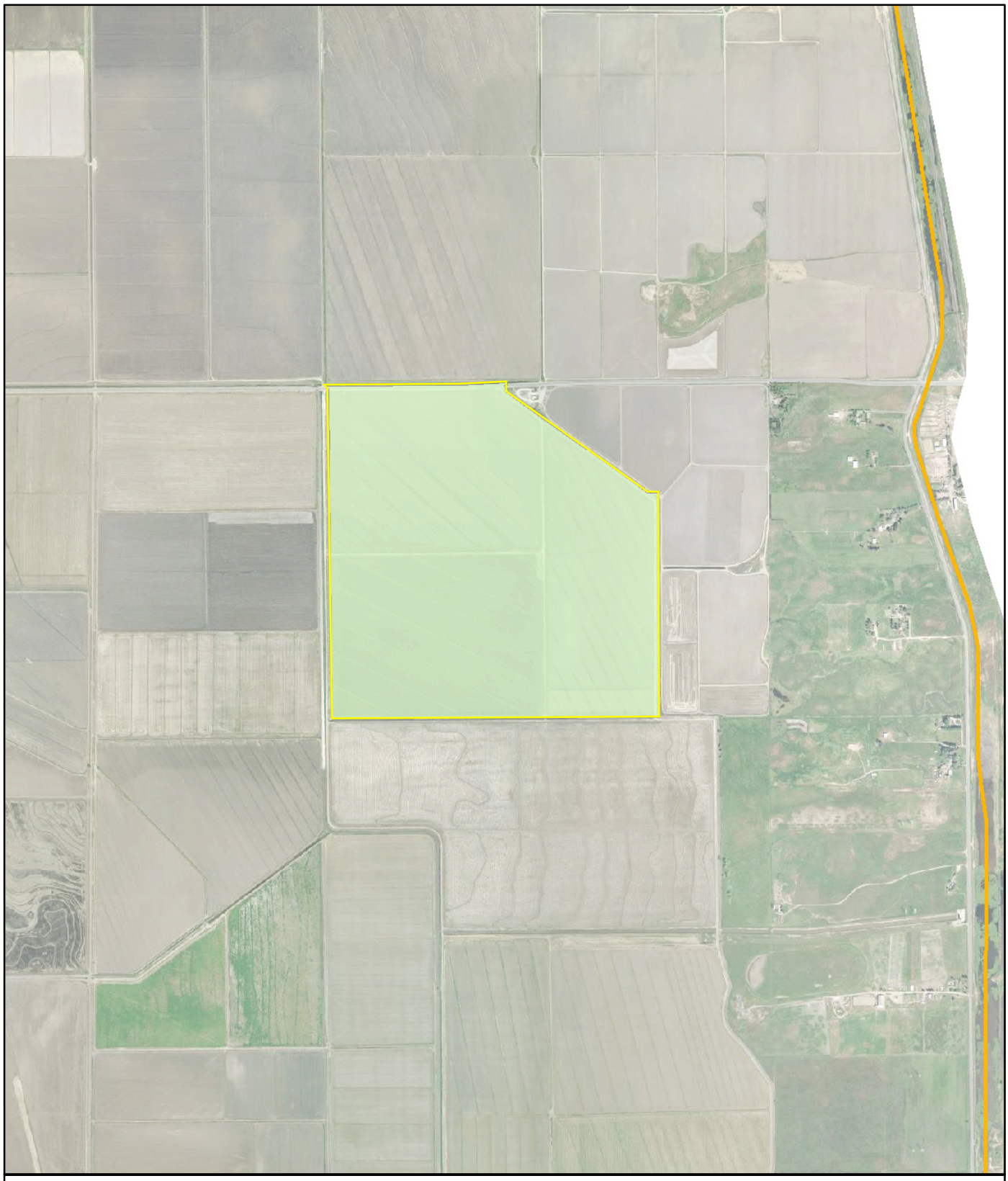
0.1 0 0.1 Miles

Jones & Stokes

Figure A-9
Brennan Land Cover, 2005

Jones & Stokes

Figure A-10
Betts-Kismet-Silva Land Cover, 2005



Legend

NBC Project Boundary

Reserve Lands

Land Cover

Rice

N

0.25 0 0.25 Miles

Jones & Stokes

Figure A-11
Ayala Land Cover, 2005

Appendix B

Floristic Survey Results

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
Ferns and Fern Allies																					
Azollaceae	**Mosquito Fern Family**																				
Azolla filiculoides	Waterfern			X	X	X	X			X	X	X	X	X	X				X		
Equisetaceae	**Horsetail Family**																				
Equisetum telmateia ssp. *braunii*	Giant horsetail		X																		
Marsileaceae	**Marsilea Family**																				
Marsilea vestita ssp. *vestita*	Hairy waterclover				X									X		X					
Monocotyledons																					
Alismataceae	**Water-Plantain Family**																				
*Alisma lanceolatum**	Lance-leaved water-plantain		X		X		X		X	X	X	X	X	X	X	X			X		X
Alisma plantago-aquatica	Common water-plantain															X					
Echinodorus berteroi	Burhead		X								X	X		X	X			X			
Sagittaria longiloba	Gregg arrowhead											X		X		X					
Sagittaria montevidensis ssp. *calycina*	California arrowhead		X	X	X				X	X	X	X		X	X	X		X			
Sagittaria sp.	Arrowhead										X	X						X			
Cyperaceae	**Sedge Family**																				
Cyperus cf. *esculentus*	Nutsedge		X	X	X		X		X		X			X			X	X			
*Cyperus difformis**	Variable flatsedge				X	X			X		X			X	X	X	X	X			
Cyperus eragrostis	Umbrella sedge	X	X	X	X	X	X		X		X	X		X	X	X	X	X	X		X
Cyperus odoratus	Fragrant flatsedge										X			X							
Eleocharis acicularis	Needle spikerush		X																		
Eleocharis macrostachya	Creeping spikerush					X					X			X		X					
Eleocharis obtusa var. *engelmannii*	Blunt spikerush / Engelmann's spikerush				X						X			X		X					
Scirpus acutus var. *occidentalis*	Common tule	X	X	X	X	X			X	X	X			X	X	X	X	X	X		

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
Scirpus maritimus	Prairie bulrush				X						X			X							
*Scirpus mucronatus**	Ricefield bulrush				X	X	X		X		X	X		X	X	X					
Hydrocharitaceae	**Waterweed Family**																				
Elodea canadensis	Canadian pondweed											X									
Juncaceae	**Rush Family**																				
Juncus balticus	Baltic rush	X			X	X															
Juncus bufonius	Toad rush		X		X	X		X	X		X			X	X	X	X	X	X	X	
Juncus effusus	Soft rush		X		X	X	X														
Lemnaceae	**Duckweed Family**																				
Lemna sp.	Duckweed		X	X	X	X				X	X	X	X	X	X	X					
Poaceae	**Grass Family**																				
*Agrostis avenacea**	Pacific bentgrass		X	X	X						X			X	X	X					
Alopecurus carolinianus	Tufted foxtail									X	X			X							
Alopecurus saccatus	Foxtail		X	X	X										X			X	X		
*Arundo donax**	Giant reed					X															
*Avena barbata**	Slender wild oats		X		X	X			X		X	X	X	X	X		X	X		X	X
*Avena fatua**	Common wild oats	X		X						X	X			X		X			X	X	
*Briza minor**	Little quaking grass		X			X															
*Bromus catharticus**	Rescue brome		X	X			X			X				X							
*Bromus diandrus**	Ripgut brome	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
*Bromus hordeaceus**	Soft chess	X	X	X	X	X		X	X	X	X			X	X	X			X		
Bromus madritensis ssp. *rubens**	Foxtail chess										X										
Crypsis schoenoides *	Swamp grass										X			X							

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
*Cynodon dactylon**	Bermuda grass		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X
Deschampsia danthonioides	Annual hairgrass		X	X		X			X					X	X	X					
*Digitaria sanguinalis**	Hairy crabgrass		X		X	X		X					X		X						
Distichlis spicata	Saltgrass					X		X		X	X			X							X
*Echinochloa crus-galli**	Barnyardgrass		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			
*Eleusine tristachya**	Threespike goosegrass					X															
Elymus glaucus	Blue wildrye			X	X						X			X	X						
Eragrostis pectinacea var. *pectinacea*	Tufted lovegrass					X															
Eragrostis sp.*	Lovegrass					X															
*Festuca arundinacea**	Reed fescue		X																		
Glyceria occidentalis	Sweet flotegrass				X	X					X			X	X		X	X	X		
Hordeum brachyantherum	Meadow barley			X		X				X	X			X	X	X					
Hordeum marinum ssp. *gussoneanum**	Mediterranean barley								X		X			X		X			X		
Hordeum murinum *	Foxtail barley	X	X	X	X	X			X	X	X		X	X	X	X	X	X	X	X	
Leersia oryzoides	Rice cutgrass										X			X							
Leptochloa fascicularis	Bearded sprangletop		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			
Leymus triticoides	Creeping wildrye							X													
*Lolium multiflorum**	Italian ryegrass	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
Muhlenbergia rigens	Deergrass					X															
Nassella pulchra	Purple needlegrass			X		X															
*Oryza sativa**	Rice		X	X	X				X			X			X		X	X	X		X
*Paspalum dilatatum**	Dallisgrass	X	X	X	X	X	X		X		X	X		X	X		X	X			X
Paspalum distichum	Jointgrass		X	X	X	X	X		X					X	X		X	X			
*Phalaris aquatica**	Harding grass																			X	

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
*Phalaris minor**	Littleseed canarygrass		X	X						X	X	X	X	X		X	X		X	X	
*Phalaris paradoxa**	Paradox canarygrass	X			X	X								X	X	X					
*Poa annua**	Annual bluegrass	X		X		X			X	X	X		X	X	X	X		X	X		
*Polypogon interruptus**	Ditch beard grass		X	X				X		X	X			X		X					
*Polypogon monspeliensis**	Rabbit's-foot grass		X	X	X	X	X	X		X	X	X	X	X	X	X	X		X		
*Setaria pumila**	Yellow bristle grass			X		X							X		X	X					
*Sorghum bicolor**	Milo		X										X								
*Sorghum halepense**	Johnsongrass	X	X	X	X		X	X	X	X	X	X		X		X	X	X	X		
*Triticum aestivum**	Wheat	X																		X	
*Vulpia bromoides**	Foxtail fescue				X	X			X	X		X									
Vulpia microstachys	Small fescue			X						X	X			X	X	X					
*Vulpia myuros**	Rattail fescue			X		X					X										
Pontederiaceae	**Mud Plantain Family**																				
*Heteranthera limosa**	Ducksalad										X			X				X			
Typhaceae	**Cattail Family**																				
Typha angustifolia	Narrow-leaved cattail				X							X							X		
Typha domingensis	Southern cattail			X			X	X	X		X				X	X	X			X	X
Typha latifolia	Broadleaf cattail			X	X	X			X		X	X		X	X	X		X	X		X
Dicotyledons																					
Aceraceae	**Maple Family**																				
Acer negundo	Box-elder							X		X						X					
Amaranthaceae	**Amaranth Family**																				
*Amaranthus albus**	Pigweed amaranth					X															
Amaranthus sp.	Amaranth						X	X		X			X								

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
Anacardiaceae	**Sumac Family**																				
Toxicodendron diversilobum	Poison-oak		X					X													
Apiaceae	**Carrot Family**																				
*Ammi visnaga**	Bisnaga			X				X			X			X							
*Conium maculatum**	Poison hemlock																X				
*Daucus carota**	Wild carrot											X									
*Foeniculum vulgare**	Fennel	X								X							X				
*Torilis arvensis**	Hedge parsley	X	X																		
Araliaceae	**Ginseng Family**																				
*Hedera helix**	English ivy																			X	
Asclepiadaceae	**Milkweed Family**																				
Asclepias fascicularis	Narrow-leaf milkweed					X			X												
Asteraceae	**Sunflower Family**																				
Achyrachaena mollis	Blow-wives				X	X			X						X	X			X		
Ambrosia sp.	Ragweed							X			X			X							
*Anthemis cotula**	Mayweed										X			X							
Aster subulatus var. *ligulatus*	Annual water-aster		X	X	X	X	X	X	X	X	X			X	X	X	X	X			
Baccharis pilularis	Coyote brush			X		X				X					X						
Baccharis salicifolius	Mulefat					X			X												
*Carduus pycnocephalus**	Italian thistle					X															
*Centaurea solstitialis**	yellow starthistle		X	X	X	X			X		X	X		X	X			X	X		X
Centromadia fitchii	Fitch's spikeweed				X	X		X													
*Chamomila suaveolens**	Pineapple weed			X		X			X						X						
*Cichorium intybus**	Chicory	X			X	X			X			X	X		X	X					

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
*Cirsium vulgare**	Bull thistle		X	X	X	X		X						X		X					
*Conyza canadensis**	Horseweed		X		X	X	X	X		X	X	X		X	X		X				
Eclipta prostrata	False daisy						X				X			X	X		X				
*Filago gallica**	Narrow-leaved filago					X															
*Gnaphalium luteo-album**	Cudweed everlasting		X	X	X	X	X	X	X		X	X	X	X	X	X		X			X
Helianthus annuus	Annual sunflower		X																		
Heterotheca grandiflora	Telegraphweed				X	X															
Holocarpha virgata ssp. *virgata*	Common tarweed		X			X															
*Hypochaeris glabra**	Soft cat's-ear					X			X												
*Lactuca saligna**	Willow lettuce													X		X					
*Lactuca serriola**	Prickly lettuce	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
*Lactuca virosa**	Bitter lettuce		X			X			X	X	X	X	X	X	X	X			X		
Lasthenia glaberrima	Smooth goldfields					X															
*Leontodon taraxacoides**	Hairy hawkbit														X						
Microseris elegans	Elegant microseris					X															
*Picris echioides**	Bristly ox-tongue	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Psilocarphus brevissimus var. brevissimus	Woollyheads					X															
Psilocarphus tenellus var. tenellus	Slender woollyheads					X															
*Salsola tragus**	Russian thistle, tumbleweed					X															
*Senecio vulgaris**	Common groundsel	X		X	X	X					X		X	X	X			X	X	X	
*Silybum marianum**	Milk thistle	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	
Soliva sessilis *	Lawn burweed					X															
Sonchus asper ssp. *asper**	Prickly sow thistle	X		X	X	X				X	X			X				X	X		
*Sonchus oleraceus**	Common sow-thistle	X	X		X	X		X	X	X		X			X	X	X		X	X	

Scientific Name	Common Name	Alleghany	Atkinson	Bennet North	Bennet South	BKS	Bolen North‡	Bolen South‡	Brennan	Cummings	Frazer	Huffman East	Huffman West	Lucich North	Lucich South	Natomas Farms	Rosa East & Central‡	Ruby Ranch	Sills	Souza	Tufts‡
Taraxacum officinale	Dandelion					X															
*Tragopogon porrifolius**	Salsify		X																		
Xanthium spinosum	Spiny coccklebur					X															
Bignoniaceae	**Bignonia Family**																				
Catalpa bignonioides *	Catalpa					X															
Boraginaceae	**Borage Family**																				
Amsinckia menziesii var. *intermedia*	Common fiddleneck	X	X		X	X			X		X	X	X	X	X			X			
Heliotropium curassavicum	Heliotrope		X													X					
Plagiobothrys stipitatus var. micrantha	Stipitate popcornflower					X			X												
Brassicaceae	**Mustard Family**																				
*Brassica nigra**	Black mustard	X	X	X						X			X		X	X					
*Brassica rapa**	Field mustard				X	X				X		X		X			X				
*Capsella bursa-pastoris**	Shepherd's-purse	X				X			X	X	X	X	X		X	X		X	X	X	
Cardamine oligosperma	Idaho bittercress					X															
*Cornopus didymus**	Lesser swinecress		X	X		X				X	X		X	X	X	X				X	
*Hirschfeldia incana**	Shortpod mustard			X									X	X	X						
Lepidium dictyotum	Alkali pepperweed								X												
*Lepidium latifolium**	Broadleaved pepperweed		X			X	X			X				X			X				
*Raphanus sativus**	Wild radish	X	X	X	X	X		X	X			X		X	X	X	X			X	
Rorippa curvisiliqua	Westwen yellowcress		X	X							X			X	X				X		
Sibara virginica	Common rockcress					X				X											
*Sinapis arvensis**	Charlock mustard			X				X						X		X			X		
*Sisymbrium officinale**	Hedge mustard						X	X													

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Callitrichaceae	**Water-Starwort Family**																				
Callitriche marginata	Water-starwort				X				X												
Caprifoliaceae	**Honeysuckle Family**																				
Sambucus mexicana	Blue elderberry		X							X											
Caryophyllaceae	**Pink Family**																				
*Cerastium glomeratum**	Mouse-ear chickweed				X																
*Spergularia rubra**	Red sandspurry				X	X									X						
*Stellaria media**	Common chickweed					X				X	X					X		X	X		
Celastraceae	**Staff-Tree Family**																				
Ceratophyllum demersum	Coontail, hornwort									X		X		X	X						
Chenopodiaceae	**Goosefoot Family**																				
*Chenopodium album**	White goosefoot													X							
Chenopodium sp.	Goosefoot					X	X	X		X									X	X	
Convolvulaceae	**Morning Glory Family**																				
*Convolvulus arvensis**	Field bindweed	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Cressa truxillensis	Alkali weed	X				X										X		X			
Crassulaceae	**Stonecrop Family**																				
Crassula aquatica/solieri	Water pygmy-weed								X					X	X						
*Crassula tillaea**	Moss pygmy-stonecrop												X								
Elatinaceae	**Waterwort Family**																				
*Elatine ambigua**	Asian waterweed					X				X	X			X							
Elatine brachysperma/rubella	Waterweed										X			X							
Euphorbiaceae	**Spurge Family**																				
*Chamaesyce maculata**	Spotted spurge					X											X				

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Chamaesyce serpyllifolia ssp. *serpyllifolia*	Thyme-leaved spurge										X			X							
Eremocarpus setigerus	Doveweed					X										X					
Fabaceae	**Legume Family**																				
Glycyrrhiza lepidota	Wild licorice	X														X					
*Lotus corniculatus**	Bird's-foot trefoil		X	X	X	X										X					
Lotus purshianus	Spanish lotus				X																
Lupinus bicolor	Miniature lupine				X	X			X		X		X	X	X						
*Medicago polymorpha**	Bur-clover	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	
*Medicago sativa**	Alfalfa											X	X					X		X	
*Melilotus alba**	White sweetclover		X	X	X						X		X	X		X					
*Melilotus indica**	Indian sweetclover			X							X			X		X					
*Robinia pseudoacacia**	Black locust								X												
*Trifolium campestre**	Hop clover				X	X				X											
*Trifolium dubium**	Suckling clover				X	X			X				X			X					
*Trifolium fragiferum**	Strawberry clover					X															
*Trifolium glomeratum**	Clustered clover					X															
Trifolium gracilentum var. *gracilentum*	Pinpoint clover					X															
*Trifolium hirtum**	Rose clover												X			X					
*Trifolium pratense**	Red clover					X															
*Trifolium repens**	White clover					X				X											
*Trifolium subterraneum**	Subterranean clover					X															
*Vicia sativa**	Common vetch				X	X			X				X					X	X		
*Vicia villosa**	Hairy vetch			X		X			X	X	X		X	X	X	X					

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Fagaceae	**Oak Family**																				
Quercus lobata	Valley oak	X	X		X	X		X							X	X	X	X		X	
Gentianaceae	**Gentian Family**																				
Centaurium muehlenbergii	Monterey centaury				X					X	X	X		X							
Geraniaceae	**Geranium Family**																				
*Erodium botrys**	Big stork's-bill			X	X	X			X			X			X						
*Erodium cicutarium**	Red-stemmed filaree			X		X					X	X	X	X	X	X					
*Erodium moschatum**	White-stemmed filaree	X	X	X		X			X		X	X	X	X				X	X		
*Geranium dissectum**	Cut-leaf geranium	X	X	X	X	X			X	X	X	X	X	X		X		X	X		
*Geranium molle**	Dove's-foot geranium					X								X							
Haloragaceae	**Water-Milfoil Family**																				
Myriophyllum sp.	Water milfoil										X	X									
Juglandaceae	**Walnut family**																				
Juglans californica var. *hindsii*	California black walnut	X				X			X	X						X				X	
Lamiaceae	**Mint Family**																				
*Lamium amplexicaule**	Henbit deadnettle												X		X				X		
Lycopus americanus	American bugleweed										X										
*Mentha pulegium**	Pennyroyal					X															
Stachys ajugoides/albens	Hedge nettle		X																		
Trichostema lanceolatum	Vinegarweed				X	X															
Lythraceae	**Loosestrife Family**																				
Ammannia coccinea/robusta	Redstem		X		X	X			X	X	X			X	X	X	X				
*Lythrum hyssopifolium**	Hyssop loosestrife		X	X	X	X	X	X	X	X	X	X	X	X	X	X			X		

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Malvaceae	**Mallow Family**																				
*Abutilon theophrasti**	Velvet-leaf		X					X	X	X	X		X	X	X	X	X			X	
*Malva neglecta**	Common mallow			X							X										
*Malva nicaeensis**	Bull mallow		X	X	X	X		X		X	X	X		X	X	X	X	X	X		
Malvella leprosa	Alkali mallow	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X		X
*Modiola caroliniana**	Carolina bristle-mallow					X															
Moraceae	**Mulberry Family**																				
*Ficus carica**	Edible fig	X	X			X			X												
*Morus alba**	White mulberry		X			X											X				
Myrtaceae	**Myrtle Family**																				
*Eucalyptus camulduensis**	River red gum					X															
*Eucalyptus globulus**	Blue gum					X															
*Eucalyptus polyanthemos**	Silver dollar gum					X															
Oleaceae	**Olive Family**																				
Fraxinus latifolia	Oregon ash	X							X											X	
Onagraceae	**Evening-Primrose Family**																				
Epilobium brachycarpum	Panicled willow-herb						X	X									X				
Epilobium ciliatum	Fringed willowherb	X	X	X	X	X	X	X			X			X	X	X			X	X	
Epilobium pygmaeum	Smooth spike-primrose					X															
Ludwigia peploides	Floating water-primrose						X		X										X		X
Ludwigia peploides ssp. *montevidensis**	Floating water-primrose			X	X	X					X			X	X				X		
Ludwigia peploides ssp. *peploides*	Floating water-primrose					X								X		X					
Oenothera elata	Evening primrose		X								X										

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Oxalidaceae	**Oxalis Family**																				
*Oxalis corniculata**	Yellow sorrel					X															
Oxalis sp.*	Sorrel	X																			
Plantaginaceae	**Plantain Family**																				
*Plantago coronopus**	Buckhorn plantain					X															
*Plantago lanceolata**	English plantain					X					X			X					X		
*Plantago major**	Common plantain					X															
Platanaceae	**Plane Family**																				
Platanus racemosa	Western sycamore			X		X				X					X						
Polygonaceae	**Buckwheat Family**																				
Polygonum amphibium	Water smartweed						X	X													
*Polygonum arenastrum**	Common knotweed	X	X		X	X	X	X	X	X	X		X	X	X	X		X	X	X	
*Polygonum hydropiper**	Common smartweed, marsh pepper			X	X				X		X	X	X	X		X					
Polygonum lapathifolium	Willow smartweed		X	X		X	X	X	X			X	X	X	X		X				
*Rumex dentatus**	Toothed dock										X			X							
*Rumex conglomeratus**	Clustered dock					X															
*Rumex crispus**	Curly dock	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	X		X
*Rumex pulcher**	Fiddle dock		X			X					X					X					
Portulacaceae	**Purslane Family**																				
Calandrinia ciliata	Red maids			X	X					X	X	X	X	X	X	X		X	X		
Claytonia perfoliata	Miner's lettuce				X	X										X		X			
*Portulaca oleracea**	Common purslane					X									X						
Primulaceae	**Primrose Family**																				
*Anagallis arvensis**	Scarlet pimpernel		X		X	X	X	X			X	X	X	X	X	X				X	

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Ranunculaceae	**Buttercup Family**																				
Myosurus minimus	Common mousetail			X											X				X		
Ranunculus bonariensis var. *trisepalus*	Carter's buttercup				X	X			X						X			X			
*Ranunculus muricatus**	Prickle-fruited buttercup		X			X				X	X			X		X					
Ranunculus sp.	Buttercup								X		X										
Rosaceae	**Rose Family**																				
*Pyracantha angustifolia**	Firethorn					X															
Rosa californica	California wild rose	X	X	X	X	X															
*Rubus discolor**	Himalayan blackberry	X	X		X	X	X	X	X	X						X	X				
Rubus ursinus	California blackberry	X	X	X		X				X					X	X				X	
Cephalanthus occidentalis var. *californicus*	Buttonwillow	X		X	X					X	X			X	X						
Rubiaceae	**Madder Family**																				
Galium aparine	Bedstraw	X	X		X					X		X								X	
Salicaceae	**Willow Family**																				
Populus fremontii	Fremont cottonwood	X	X		X	X		X		X	X	X	X	X		X		X			
Salix exigua	Narrow-leaved willow		X	X	X				X												
Salix gooddingii	Black willow		X		X	X			X	X	X	X		X	X	X	X				
Salix lasiolepis	Arroyo willow		X		X					X					X		X				
Scrophulariaceae	**Figwort Family**																				
Bacopa eisenmanii	Eisen water-hyssop		X	X	X				X		X	X		X	X	X					
Castilleja attenuata	Valley tassels								X						X						
Dopatrium junceum *	horsefly's eye				X																
*Kickxia elatine**	Sharp-leaved fluellin										X										
Limosella acaulis	Broad-leaved mudwort										X			X							

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Lindernia dubia	Yellowseed false pimpernel				X																
Mimulus guttatus	Seep-spring monkeyflower		X			X															
Triphysaria eriantha	Johnny-tuck					X															
Triphysaria pusilla	Dwarf owl's clover					X															
*Veronica anagallis-aquatica**	Water speedwell									X		X		X					X		
*Veronica arvensis**	Corn speedwell					X															
Veronica peregrina ssp. *xalapensis*	Purslane speedwell	X	X	X	X	X			X		X	X	X	X	X	X		X	X		
*Veronica persica**	Persian speedwell					X															
Simaroubaceae	**Quassia Family**																				
*Ailanthus altissima**	Tree-of-heaven					X															
Solanaceae	**Nightshade Family**																				
*Datura stramonium**	Jimson weed		X							X											
*Lycopersicon esculentum**	Tomato											X									
*Physalis lancifolia**	Narrowleaf tomatillo		X	X		X			X								X				
*Physalis philadelphica**	Tomatillo					X					X			X							
Solanum americanum	Common nightshade					X	X	X						X			X	X			
Urticaceae	**Nettle Family**																				
*Urtica urens**	Dwarf nettle									X											
Verbenaceae	**Vervain Family**																				
Phyla nodiflora var. *nodiflora*	Turkey tangle fogfruit					X								X							
*Verbena bonariensis**	Purpletop vervain						X	X			X			X	X						
Viscaceae	**Mistletoe Family**																				
Phoradendron villosum	Oak mistletoe		X																		

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Vitaceae	**Grape Family**																				
Vitis californica	California wild grape		X							X						X					
Zygophyllaceae	**Caltrop Family**																				
*Tribulus terrestris**	Puncture vine											X			X						
Total plant taxa for reserve		48	96	80	95	164	40	49	78	71	109	64	53	117	93	92	49	53	54	31	20

‡ Reserves acquired in 2005

* Nonnative species