APPENDIX M

BERRYMAN ECOLOGICAL SURVEYS

DRAFT

Patterns of Winter Avian Abundance in Rice Fields and Urban Lakes in the Natomas Basin

Sacramento County, California

Prepared for: RWI Investments

Date: February, 2006

Prepared by: BERRYMAN Ecological

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 INTRODUCTION

1.1 Purpose

This study was designed to compare winter avian use of rice fields and urban lakes in the Natomas Basin of Sacramento County, California, and to assess the relative degree to which each of these habitat types may attract birds that pose a risk to aircraft.

1.2 Background

The Natomas Basin is located in California's Sacramento Valley, one of the most important wintering and migratory areas for waterfowl and other bird species in North America. Approximately 60 percent or more of the waterfowl population in the Pacific Flyway winter in or migrate through the Sacramento Valley (Ducks Unlimited 1995a). These waterfowl and other bird species pose a hazard to aircraft using the Sacramento International Airport, located at the heart of the Natomas Basin (**Figure 1**).

The location of the Sacramento International Airport along the Pacific Flyway poses a significant challenge to airport operators attempting to minimize the risk of aircraft bird strikes (Larson 2003). Aircraft bird strikes present a significant human safety risk and cost to the airline industry. The Federal Aviation Administration (FAA) estimates that wildlife strikes cost the U.S. civil avaition industry $500 million annually. Approximately 6,100 strikes were reported at civil airports in 2003 alone (Wildlife Services 2004). The level of bird aircraft strike risk at Sacramento International Airport has warranted full-time assistance from USDA to manage wildlife hazards (Wildlife Services 2004).

Changing land use patterns have altered the landscape of the Natomas Bain significantly, although a large proportion of this historic floodplain has continued to provide waterfowl habitat. The Natomas Basin is a low-lying area located along the east side of the Sacramento River, upstream of its confluence with the American River. Prior to 1914, this basin consisted of an alluvial plain with several large lakes and sloughs that provided surface drainage to the American River and habitat for an abundance of waterfowl (Hinds 1952, USFWS 2003; see **Appendix A**, 1908 Land Cover). After 1914, reclamation efforts such as construction of canals, levees, and pumping stations converted much of the Natomas Basin to agricultural production, primarily rice (USFWS 2003). As the natural wetlands were converted to ricelands, waterfowl wintering in the basin came to rely on winter flooded rice. Indeed, because of the limited amount of natural wetlands remaining, the large numbers of waterfowl wintering in California could not be supported without small-grain production such as commercial rice (Ducks Unlimited 1995b).

More recently, approximately 11% of the Natomas Basin has been converted from agricultural to urban uses (City of Sacramento, Sutter County, NBC 2002). Urban lakes have been constructed and are planned for construction in these urbanizing areas to provide surface storage for flood control purposes and conjunctive uses such as recreation and storm water pollution prevention.

The FAA discourages land uses that increase aircraft strike hazards by attracting birds into airport overflight zones. Urban lakes such as those constructed in the Natomas Basin may attract waterfowl including geese, gulls, and other species known to be involved in aircraft strikes. However, as described above, the Natomas Basin has historically supported waterfowl because of its low position in the watershed, itstendency to flood. In assessing the impacts of constructing urban lakes, one must make a comparison with pre-project conditions. This study was designed to compare the level of aircraft strike risk posed by these urban lakes as compared with pre-urbanization conditions (i.e., flooded agriculture).

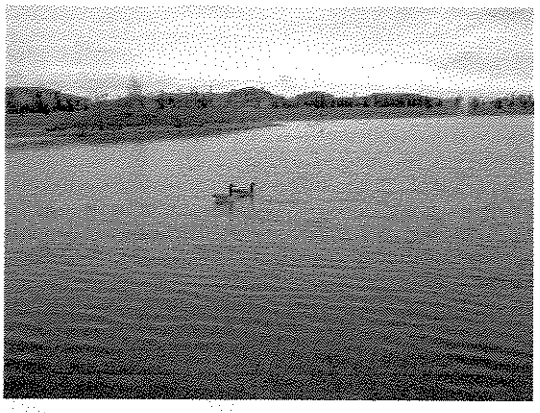
Figure 1: Study Area and Study Sites

2.0 METHODS

2.1 Study Area

The study area was the Natomas Basin, located in Sacramento County in the northern Sacramento Valley (**Figure 1**). Three man-made lakes were surveyed within the study area: these are described below and their locations in relation to the Natomas Basin are shown on **Figure 1**:

1. Northborough Lake is a large, L-shaped lake at the corner of Truxel Road and North Park Drive. It has gently sloping sides of approximately 25 degrees and consisted of round boulders of varying sizes. It has two islands that have similar sides as the periphery of the lake and small shrubs and willow trees.

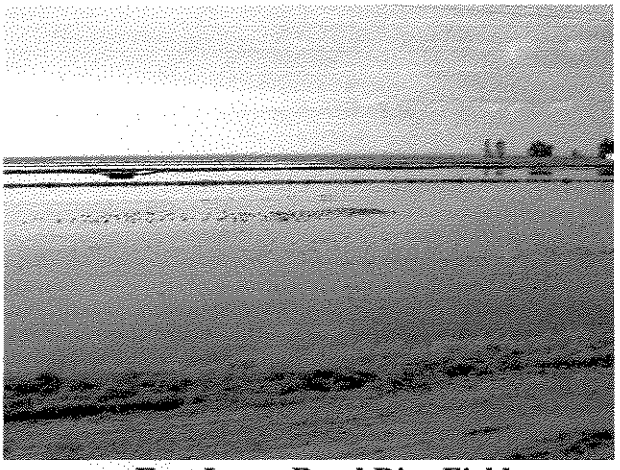


2. Alleghany Lake is just east of the corner of Truxel Road and Terracina Drive. Like Northborough Lake, it has gently sloping sides of approximately 25 degrees. It has one island that also has similar sides as the periphery of the lake and has small shrubs and willow trees.

3. Gateway North Lake is in the middle of Gateway North subdivision and is just east of El Centro Road and north of Arena Boulevard on the west side of Interstate 5 freeway. It has 90 degree rock sides and the lakeside homes abut the lakeshore.

Rice fields were surveyed along on a driving route that was chosen based on presence of flooded agriculture, lack of disturbance such as hunting pressure, and accessibility of the survey points. The survey route started at Sankey Road near Pacific Road, then east to east levee road, then south to west Elverta Road and to the Interstate 5 freeway (**Figure 1**).

Elverta Road Ricef Field



East Levee Road Rice Field

Sankey Road Rice Field

2.2 Survey Method

A standard 10-minute point count method was used, by which the observer recorded all birds seen and heard from a single point (survey point) during a 10 minute period (Howe et al. 1997, Ralph et al. 1993). The surveys for both urban lakes and rice fields started at ten minutes after sunrise, and ended no later than three hours after sunrise. The same observer surveys both the lakes and rice fields to avoid observer biases. At each point count, the observer recorded the number of birds observed for each species. For numbers between 100 and 200, the observer estimated to the nearest 10. For numbers between 200 and 1,000, the observer estimated to the nearest 50. For numbers greater than 1,000, the observer estimated to the nearest 100.

At the lake sites, survey points were spaced to maximize visibility of the entire lake without double-counting. Due to its L-shape, Northborough Lake had to be surveyed from two points to view the entire lake. The entirity of Alleghany Lake could be surveyed from one point. Due to the lakeshore homes of Gateway Lake, it could only be surveyed from two points, one point at the east side of the lake and one at the west side. Survey points at the rice fields were spaced 200 meters apart to maximize coverage and avoid double-counting. The observer would drive to each survey point and walk to the edge of the rice field for the point count.

2.3 Data Analysis

Assuming the number of birds per point count does not follow a Gaussian distribution, a nonparametric test was used to compare the total number of birds per point count in rice fields and urban lakes. A Mann-Whitney *U*-test was applied and significance was assessed at a 99% confidence interval. *P*-values ≤ 0.01 were considered statistically signficant. Data were also summarized by species observed at rice fields vs. urban lakes, and the range of numbers of individuals per species at rice fields vs. lakes. Species observed were lumped into various categories consistent with the categories used in the FAA National Wildlife Strike Database (e.g., ducks, geese, gulls . . .: FAA 2000) . Data was then summarized by the mean number of birds observed per survey site per species category.

3.0 RESULTS

3.1 Bird Abundance in Urban Lakes and Rice Fields

The number of birds observed per point count was significantly higher for rice fields than for urban lakes (**Table 1:** U = 224, P <0.0001). For rice fields, the total number of birds observed per point count ranged from 1 to 2,652, while for urban lakes, the total number ranged from 0 to 37. The mean number of birds per point count was 224.12 (*SD ± 428.69*) for rice fields and 12.12 (*SD ± 11.55*) for urban lakes.

Table 1: Median Number of Birds per Point Count

Location	n	Median	U
Rice Field	48	83	224
Urban Lakes	50	10	2176
Mann-Whitney U: 224			
99.0% CI: 44.000-113.000, **P:** <0.0001			

3.2 Species Observed

The diversity of bird species observed was higher at rice fields than at urban lakes: there were 18 species observed at rice fields and 10 at urban lakes (**Table 2**). Species observed at rice fields that were not observed at urban lakes were American widgeon, black-necked stilt, curlew, double-crested cormorant, green-winged teal, northern pintail, northern shoveller, phalarope, snow goose, snowy egret, sandpiper *sp.*, white-faced ibis, and western grebe. Species observed at urban lakes but not at rice fields included Canada goose, common merganser, green heron, and western grebe.

Table 2: Species Observed at Rice Fields and Urban Lakes

Species	Rice Fields	Urban Lakes	Group
American coot	0 – 1,000	0 - 6	Other
American widgeon	0 - 44	0	Ducks
Black-necked stilt	0 - 32	0	Shorebirds
Canada goose	0	0 - 23	Geese
Common grebe	0 - 2	0 - 3	Other
Common merganser	0	0 - 18	Ducks
Curlew	0 - 47	0	Shorebirds
Double-crested Cormorant	0 - 4	0	Other

Table 3: Species Observed at Rice Fields and Urban Lakes- Continued

Species	Rice Fields	Urban Lakes	Group
Great blue heron	0 - 2	0 - 1	Herons/egrets
Great egret	0 - 12	0 - 2	Herons/egrets
Greater yellowlegs	0 - 4	0	Shorebirds
Green heron	0	0 – 4	Herons/egrets
Green-winged teal	0 - 32	0	Ducks
Mallard	0 - 39	0 – 22	Ducks
Northern pintail	0 - 950	0	Ducks
Northern Shoveller	0 - 26	0	Ducks
Phalarope	0 - 19	0	Shorebirds
Snow goose	0 - 450	0	Geese
Snowy egret	0 - 22	0	Herons/egrets
Gull	0 - 130	0 – 9	Gulls
Sandpiper spp.	0 - 80	0	Shorebirds
White-faced ibis	0 - 33	0	Other
White fronted goose	0 - 750	0	Geese
Western grebe	0	0 – 1	Other
Total # Species present	**18**	**10**	

3.3 Number of Birds per Species Group

The mean number of birds per point count were higher at rice fields than at urban lakes for all groups (**Table 4**). Although Canada geese were present only at urban lakes, large flocks of snow geese and white fronted geese were observed at rice fields, so that birds in the geese group were much more abundant in rice fields than at the urban lakes.

Although the mean number of birds per point count per group were quite variable between sites, they were consistently higher at rice fields than urban lakes (**Figures 3,4**). Gateway Lake differed from the other two lakes in that it had no ducks or geese, but had a higher number of gulls than the other two lakes. Gateway Lake also had a moderate number of birds lumped as "other".

Table 4: Mean Number Birds per Group

Group	Habitat	Location	Total Birds	Mean Number*	Mean # when Observed* (dropping zeros)
Ducks	Rice	Elverta Rd.	3281	68.35	121.52
		Levee Rd.	730	15.2	91.25
		Sankey Rd.	345	7.18	38.33
	Lake	Alleghany lake	110	2.2	10
		Northborough lake	177	3.54	8.85
		Gateway Lake	0	0	null
Geese	Rice	Elverta Rd.	1180	24.58	393.33
		Levee Rd.	0	0	null
		Sankey Rd.	1050	21.88	350
	Lake	Alleghany lake	98	1.96	16.33
		Northborough lake	133	2.66	11.08
		Gateway Lake	0	0	null
Gulls	Rice	Elverta Rd.	562	11.71	40.14
		Levee Rd.	57	1.1875	57
		Sankey Rd.	110	2.3	27.5
	Lakes	Alleghany lake	0	0	null
		Northborough lake	8	0.16	8
		Gateway Lake	14	0.28	7
Herons/Egrets	Rice	Elverta Rd.	167	3.48	6.42
		Levee Rd.	10	0.21	3.33
		Sankey Rd.	10	0.21	5
	Lake	Alleghany lake	5	0.1	1
		Northborough lake	25	0.5	1.92
		Gateway Lake	0	0	0
Shorebirds	Rice	Elverta Rd.	447	9.3125	34.38
		Levee Rd.	50	1.04	50
		Sankey Rd.	71	1.48	17.75
	Lake	Alleghany lake	0	0	null
		Northborough lake	0	0	null
		Gateway Lake	0	0	null
Other	Rice	Elverta Rd.	1614	33.63	67.25
		Levee Rd.	1074	22.38	214.8
		Sankey Rd.	0	0	null
	Lake	Alleghany lake	9	0.18	1.29
		Northborough lake	23	0.46	2.09
		Gateway Lake	13	0.26	1.86

Figure 2: Bird Groups – Mean Numbers per Point Count, Rice vs. Lake

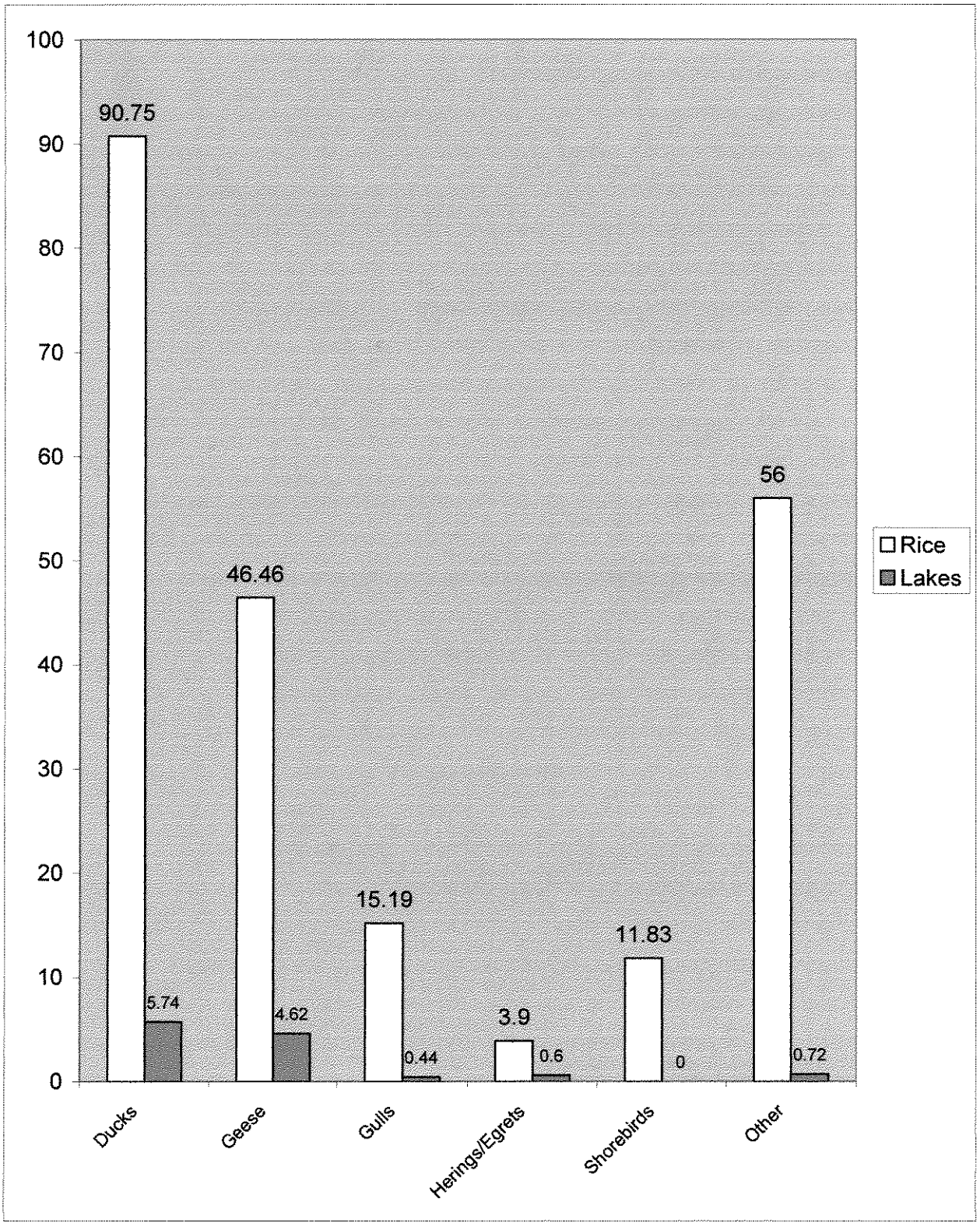


Figure 3: Urban Lakes – Mean Number per Point Count per Study Site

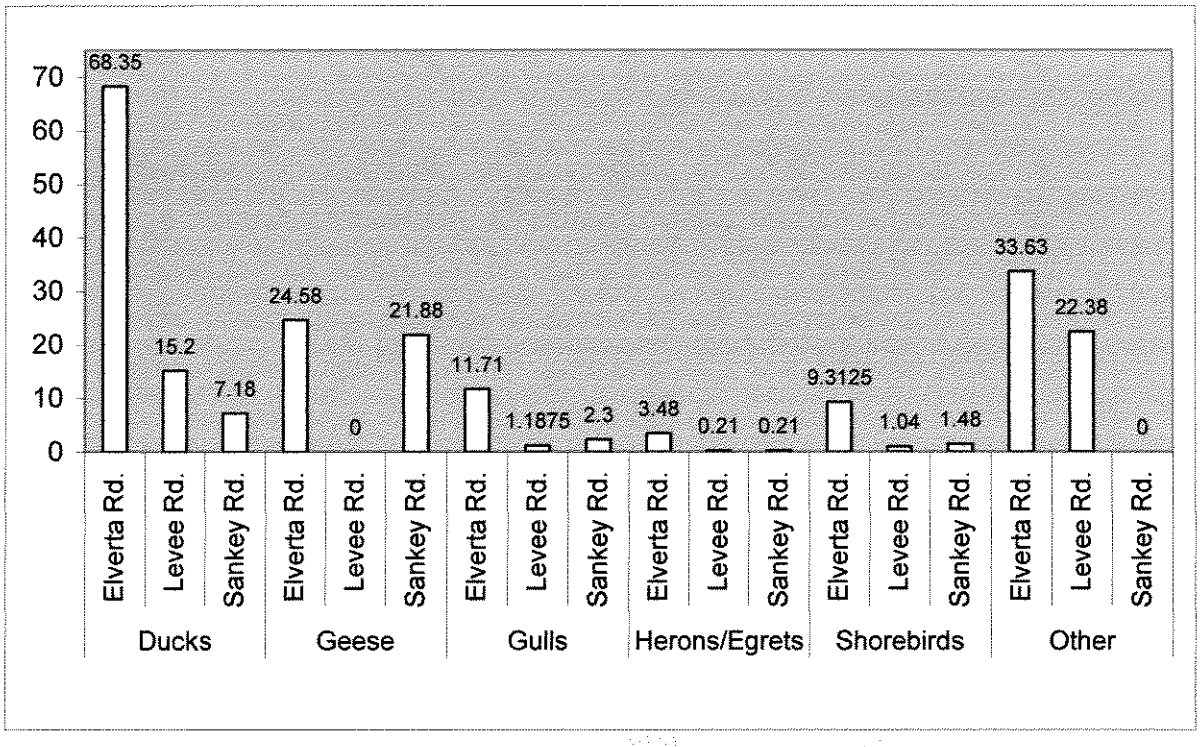
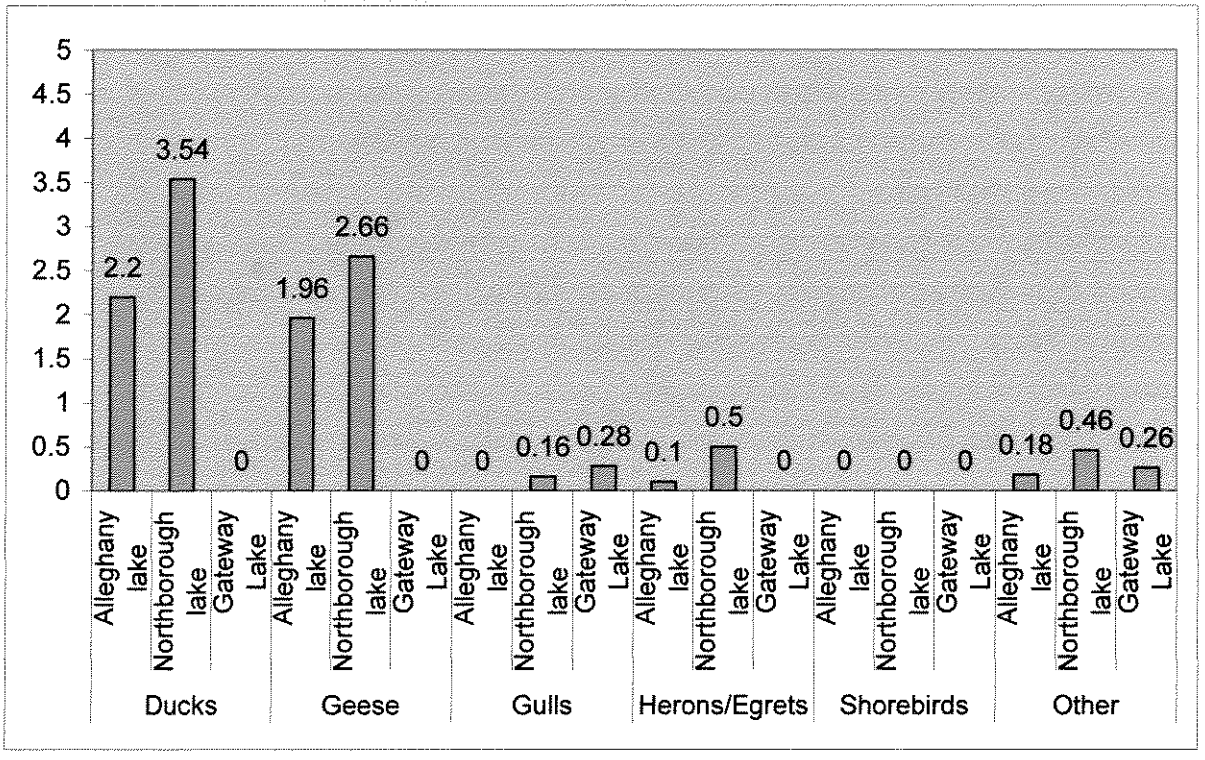


Figure 4: Rice Fields – Mean Number per Point Count per Study Site



Species grouped as "other" were those that did not fit into any of the categories in the FAA National Wildlife Strike Database. However, because of the large number of birds lumped into this category found in rice fields, and the relatively large proportion of lake birds designated as "other", this category was broken down further in assessing the relative proportions of different bird types present.

At both urban lakes and rice fields, ducks made up the highest proportion of total birds observed (**Figure 5**, **Figure 6**). Geese were the second most abundant group at urban lakes, while coots were the second most abundant group at rice fields, although geese also made up a large proportion of birds observed at rice fields. For both rice and urban lakes, the remaining categories made up less than 25% of total birds observed.

Figure 5: Urban Lakes – Proportion of Each Group

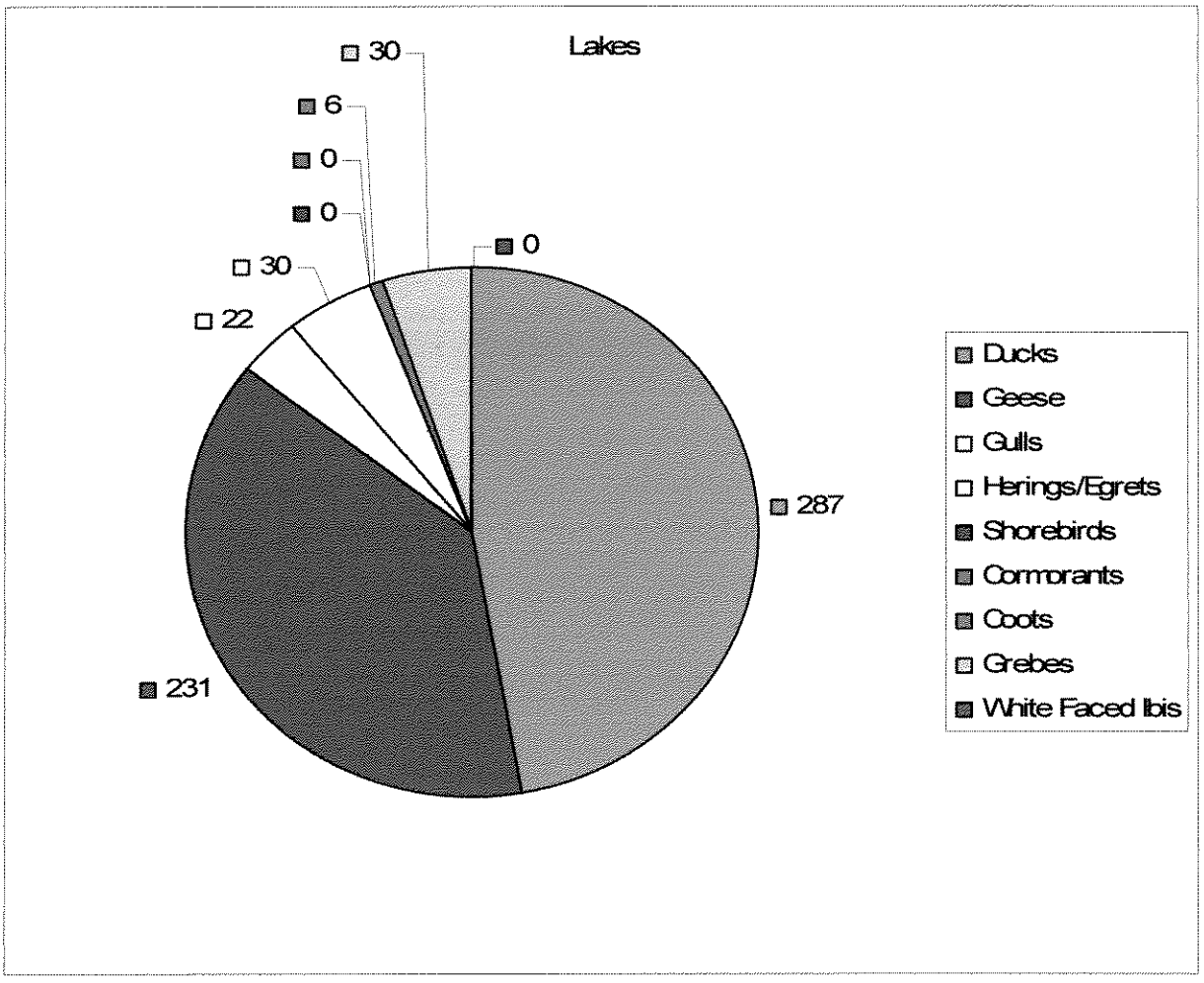
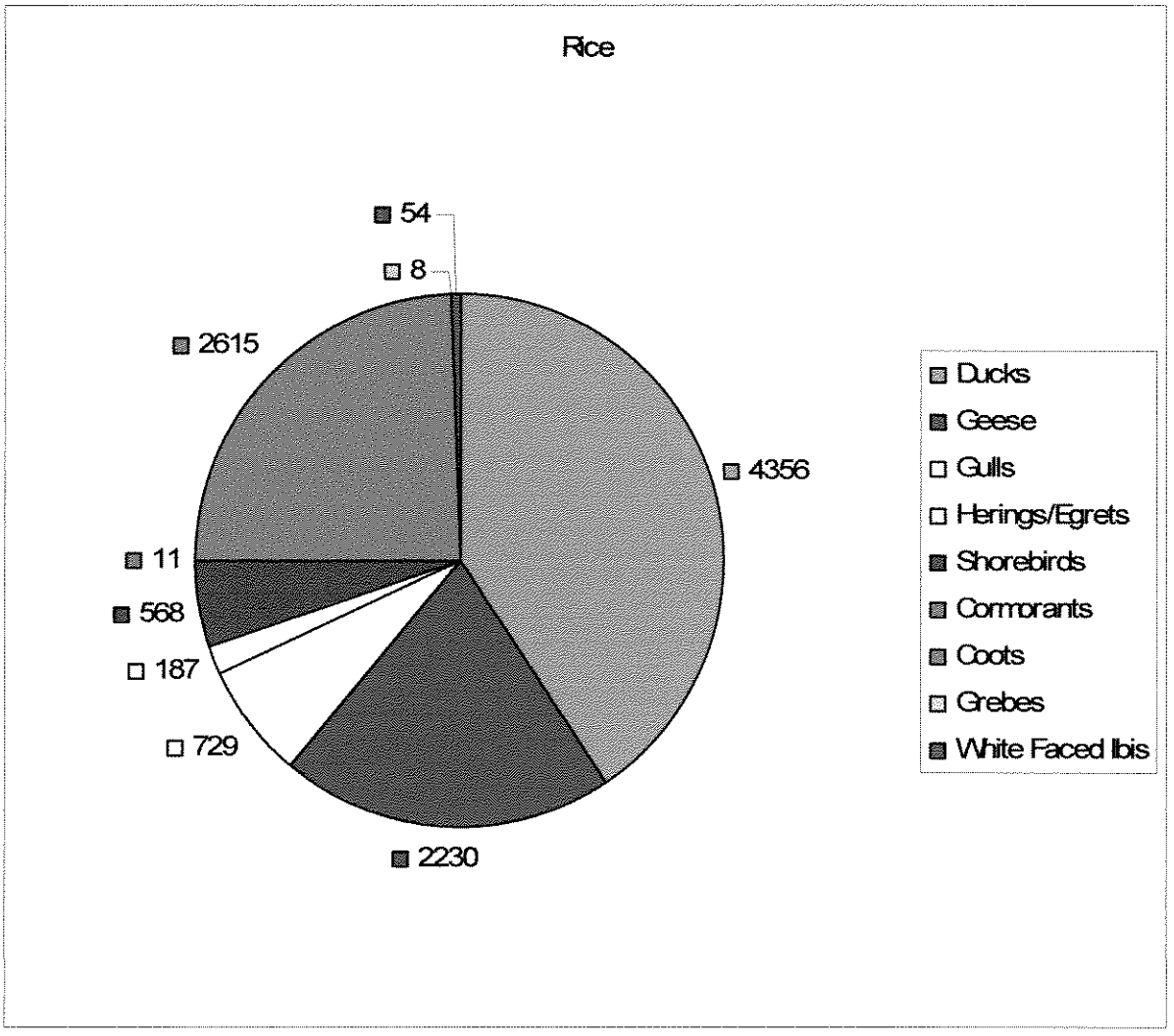


Figure 6: Rice Fields – Proportion of Each Group



3.4 Aircraft Hazard Levels

The FAA National Wildlife Strike Database (FAA) ranks various groups of birds in terms of relative hazard to aircraft as shown on Table 5.

Table 5: FAA Database – Wildlife Hazards to Aviation in the U.S.

Species	Relative hazard (1-100)	This study: lakes	This study: rice fields
Vultures	63	O	O
Geese	52	X	X
Cranes	48	O	O
Osprey	50	O	O
Pelicans	44	O	O
Ducks	37	X	X
Hawks	25	O	O
Eagles	1	O	O
Rock dove	24	O	O
Gulls	22	X	X
Herons	22	X	X
Mourning dove	17	O	O
Owls	16	O	O
American kestrel	14	O	O
Shorebirds	12	O	X
Crows/ravens	12	O	O
Blackbirds/starlings	9	O	O
Sparrows	4	O	O
Swallows	2	O	O

High risk species categories in **Table 4** and found at both urban lakes and rice fields are geese, ducks, gulls, and herons (grouped with egrets). Shorebirds, also idenfied as an aircraft hazard, were found only at rice fields and not urban lakes. As described in section 3.3, for all groups identified above as an airstrike hazard, greater numbers were found at rice fields than at urban lakes.

Additionally, based on data compiled from 1990 to 1992 (Cleary et al. 2003), the top 20 bird species causing damage to civil aircraft in the United States were listed (**Table 6**). **Table 6** shows that four of the species identified in the top 20 were observed at urban lakes, while five of these species were observed at rice fields. Among these top 20 species, the number of birds observed per point count ranged higher at rice fields than at urban lakes. The species ranked highest in terms of aircraft hazard, Canada goose, was observed at urban lakes and not at rice fields.

Table 6: Data Comparison with Top 20 Bird Species Causing Damage to Aircraft

A. Rank	B. Species	C. Category of reported damage				D. Total	E. Urban Lakes[1]	F. Rice Fields
		Destroyed	Minor	Uncertain	Substantial			
1	Canada goose	1	163	64	111	339	0 - 23	0
2	Rock dove		49	16	54	119	0	0
3	Turkey vulture	1	42	18	32	93	0	0
4	Red-tailed hawk		33	14	24	71	0	0
5	Mallard		29	7	29	40	0 - 22	0 – 39
6	Mourning dove		15	15	20	50	0	0
7	European starling		24	8	15	47	0	0
8	Herring gull		7	4	29	40	0[2]	0
9	Snow goose		11	5	7	33	0	0 - 450
10	Ring-billed gull		7	5	12	24	0-9[3]	0 - 130
11	American crow		10	1	7	18	0	0
12	Great blue heron		11	4	3	18	0-1	0-2
13	Bald eagle		13	2	2	17	0	0
14	Osprey		8	1	7	16	0	0
15	Sandhill crane		10		6	16	0	0
16	Killdeer		7	6	2	15	0	0
17	Double-crested cormorant		4	2	5	11	0	0-4
18	Brown pelican	1	7	2	1	11	0	0
19	American kestral		1	3	6	10	0	0
20	Barn owl		2	1	7	10	0	0
	101 other species	O	92	26	111	229		

[1] Numbers in these E and F represent the range of total # of birds of a given species observed during a single point count.

[2] Although gull data was not recorded to species, herring gulls are not known to occur in the Sacramento area.

[3] Gull data was not recorded to species – these numbers are for all gull species observed.

4.0 DISCUSSION

4.1 Avian use of Rice Fields

Waterfowl arriving in the Central Valley require a diet rich in carbohydrates to replenish fat reserves lost during fall migration. Rice crops are eaten by many species of waterfowl because they are widespread, easily accessible, and provide high levels of carbohydrates. Historically, migratory waterfowl were viewed as major rice pests by farmers because of the amount of pre-harvest rice seed they consumed.

After harvest, up to 300 pounds of rice can remain on each acre of a rice field (Ducks Unlimited 1995b). This is a tremendous food resource for many forms of wildlife, especially when coupled with the variety of aquatic and terrestrial weeds found in rice fields. The seeds from all of these plants, along with the invertebrates commonly found there, provide a varied diet for a broad range of waterbirds. Waterfowl are among the most numerous of the species that are known to use rice fields. During fall and winter, after rice fields have been harvested, tens-of-thousands of ducks, geese, and swans can be seen resting and feeding in rice fields throughout the Sacramento Valley. Later, once grain and weed seeds are depleted, waterfowl and shorebirds still use fields to continue feeding on the insects and snails that occur on the decaying straw.

California has lost 90-95 percent of its original wetlands and the majority of these drained wetlands have been converted to rice fields (Ducks Unlimited 1995a). These rice fields are flooded in the spring and summer during the growing season and now have become surrogate wetlands for the locally breeding waterfowl like mallards. Ducklings need escape cover from predators and the rice stalks provide this needed habitat type. Moreover, the rice stalks provide a perfect substrate for invertebrates to cling to and feed on and the shallow water in rice fields provides a constant warm temperature for many invertebrate species.

All species of waterbirds have increased protein requirements during molt and egg laying. Agricultural fields flooded through late winter provide critical invertebrate food resources that provide the needed protein for molting and prelaying females (Ducks Unlimited, 1995b; Brouder, and Hill 1995). Rice fields provide about 250 pounds per acre of naturally occurring food sources such as small invertebrates, macroinvertebrates, tubers, edible shoots, and seeds. In addition, after harvest an average of 350 pounds per acre of rice is available to waterfowl. Rice fields managed as wetlands can provide as much as 600 pounds of food per acre, or 80 percent of the amount of food found in natural wetlands (Brouder and Hill, 1995). It is believed the reason for this is rice fields have a tremendous food base for waterbirds. Microinvertebrates are an important food base for waterfowl and shorebirds and are present in large numbers in rice fields.

Dabbling ducks are the most prevalent duck in the Central Valley. These include mallards, northern pintails, greenwing teal, northern shovelers, and American widgeon. When feeding in water, these birds as well as all the goose species, feed by tipping up in shallow

water. Therefore they only have access to food resources that are not deeper than their outstretched necks when tipping. Typically, 4-10 inches is the preferred feeding depth for dabbling ducks and this is the depth that rice fields are kept during spring and summer growing seasons and during the winter when farmers flood their rice fields for straw decomposition. Farmers need to dispose of the rice straw to make way for the next years crop. Burning traditionally was the preferred method but in 1991, the Legislature passed the Rice Straw Burning Reduction Act which gradually reduced the amount of acres that could use burning to dispose of the straw. Now, only 1/4 of the cropland can use the burn disposal method and only the farmer can prove that a disease is prevalent. Many farmers now flood their fields in the fall to help decompose the rice straw and they keep the water levels shallow for maximum oxygen and soil incorporation with the straw. This helps the straw rot and break down and also provides great habitat for shallow water loving species like waterfowl, shorebirds and wading birds.

The rice fields that were surveyed were also heavily used by shorebirds, including sandpipers, phalaropes, curlews, and dowitchers. These shorebirds also need shallow water to feed. Rice fields provide excellent habitat for invertebrates that are important for shorebirds and waterfowl (Wildlife Habitat Management Institute 2000). These invertebrate species include water boatman, backswimmers, water scorpions, giant water beetles, water beetles, dragonfly nymphs, and larva of mosquitoes, flies, midges, crane flies, soldier flies, dance flies, snipe flies, horse flies, and brineflies. Shorebirds prefer depths between 1-6 inches to forage for these prey invertebrate prey items.

Many wading birds such as egrets and herons were also observed in the rice fields. These wading birds also prefer shallow water for foraging and will feed in water up to 15 inches (Colwell and Taft 2000). These wading birds prefer larger macroinvertebrates like crayfish and vertebrates like rodents that frequent rice fields.

4.2 Avian Use of Urban Lakes

The man-made lakes that were surveyed are deeper than the water in the flooded rice fields and therefore these birds cannot feed efficiently in the lakes. Additionally, the water levels in the manmade lakes do not fluctuate for seed germination of emergent vegetation. The emergent vegetation seeds need exposed mud flats to germinate and grow, while the man-made lake levels are managed for a constant level.

Waterfowl use the man-made lakes primarily for loafing, and they are not found in large numbers in this habitat type. Gradually sloped sides like those of Allegheny and Northborough lakes in our survey appear to be more attractive to waterfowl because this allows the birds to climb out of the water to rest and preen. This behavior was observed in our surveys. The lakes that had sloping sides had more birds and the birds observed on these waters were frequently seen resting out of the water. Gateway North Lake, which has 90 degree sides that prevent waterfowl from exiting to rest and preen had virtually no waterfowl during our surveys.

4.3 Aircraft Strike Hazard: Urban Lakes versus Rice Fields

The results of this study indicate that not only are total numbers of birds higher at rice fields than at urban lakes, but numbers of birds belonging to species known to pose a hazard to aircraft are also higher in rice fields. Indeed, numbers were higher at rice fields than urban lakes for all species groups.

4.4 Canada Geese

Canada goose, the species identified in **Table 6** as the greatest hazard to aircraft, was observed only at urban lakes and not at rice fields. While the numbers of Canada geese observed at urban lakes were low (0 to 23 per point count) compared with other geese such as snow geese (0-450) at rice fields, the increasing numbers of Canda geese in the United States is a concern to the USDA in their efforts to minimize wildlife strikes hazards (pers. comm. Scott Beckerman, USDA, January 13, 2005).

The number of Canada geese that nest and/or reside predominantly within the conterminous United States has increased dramatically in the past 20 years. The total number of Canada geese counted during winter in North America has increased from 980,000 in 1960 to 3,734,500 in 2000 (Mid-winter Survey unpublished reports), and Canada geese are now thought to be more abundant in the United States than at any time in history (USFWS 2005). Recent surveys suggest that the Nation's resident breeding population now exceeds 1 million birds in both the Atlantic and the Mississippi Flyways and is continuing to increase. In the Mississippi Flyway alone, the 1998 spring Canada goose population estimate exceeded 1.1 million birds, an increase of 21 percent from 1997. Data collected on California populations of Canada geese between 1970 and 1999, however, indicate that populations have not been increasing along the Pacific Flyway as dramatically as along the Atlantic and Mississippi Flyways (USFWS 2005).

The increase in resident Canada goose populations in the United States is partially attributed to increasing urban and suburban development which has resulted in the creation of ideal goose habitat; that is, parklike open areas with short grass adjacent to small bodies of water. Urban lakes may therefore pose a risk to aircraft by attracting Canada geese, and if population levels grow along the Pacific Flyway as they have been along the Atlantic and Mississippi Flyways, the risk may increase over time. However, a number of design and management measures can be implemented to minimize attraction of Canada geese to urban lakes. The following are among a variety of measures frequently used to make property less attractive to geese:

- Post signs prohibiting feeding of geese.
- Do not plant grass along the lakeshore, leave a 20-30 foot barrier strip of tall grass (6 inches or more) adjacent to lakeshore, or place fencing or other barriers between the lakeshore and surrounding grasslands.
- Plant dense hedges or erect fencing near lakeshore areas to reduce access to your lawn

- Check property frequently for nest building activity in the spring, and remove any nesting materials found

5.0 CONCLUSION

In conclusion, the results of this study indicate that winter rice fields in the Natomas Basin attract a greater number of birds that pose a risk to aircraft than do urban lakes in the Natomas Basin. Although the urban lakes observed supported a greater quantity of Canada geese (a high-risk species for aircraft strikes) than rice fields, the low numbers of these geese found at urban lakes indicate that the overall degree of hazard presented by urban lakes is lower than rice fields. While Canada goose populations are believed to be increasing in the coterminous United States and therefore could pose a greater future risk, a number of design and management measures can be implemented at urban lakes to minimize attractants. The data suggests that replacement of flooded agriculture in the Natomas Basin with urban lakes is expected to reduce risk of aircraft strikes at the Sacramento International Airport.

6.0 LITERATURE REFERENCED

Brouder, S. M. and J. E. Hill. 1995. Winter Flooding of Ricelands Provides Waterfowl Habitat. California Agriculture, 49, pp. 58.

City of Sacramento, Sutter County, and Natomas Basin Conservancy. 2002. Draft Natomas Basin Habitat Conservation Plan. Prepared in association with Reclamation District 1000 and Natomas Central Mutual Water Company. Prepared for US Fish and Wildlife Service and California Department of Fish and Game. July 2002.

Cleary, E.C., R.A. Dolbeer, and S.E. Wright. 2003. Federal Aviation Administration National Wildlife Strike Database Serial Report Number 9.

Colwell, MA; Taft, OW. 2000. Waterbird Communities in Managed Wetlands of Varying Water Depth. Waterbirds. Vol. 23, no. 1, pp. 45-55.

Ducks Unlimited, Inc. 1995a. Wildlife Resources of the Central Valley, California Birds - Part II: Winter Residents and Transients.

Ducks Unlimited, Inc. 1995b. Enhancing Agricultural Fields for Waterfowl.

Federal Aviation Administration. 2000. Airport Wildlife Management: Most Hazardous Species. Airport Wildlife Management Bulletin #26 – Spring, 2000

Hinds, N.E.A. 1952. Evolution of the California Landscape. California Division of Mines Bulletin No. 158. 240 pp.

Howe et al. (Howe, R.W., G.J. Niemi, S.J. Lewis, and D.A. Welsh. 1997. A standard method for monitoring songbird populations in the Great Lakes Region. Passenger Pigeon 59(3):183-194.).

Larson, M. 2003. "Airport's aim: Say 'bye-bye' to the birdies." Sacramento Business Journal. August 15.

Ralph, C.J., G.R. Geupel, P. Pyle, P.T. Martin, and D.F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41pp.

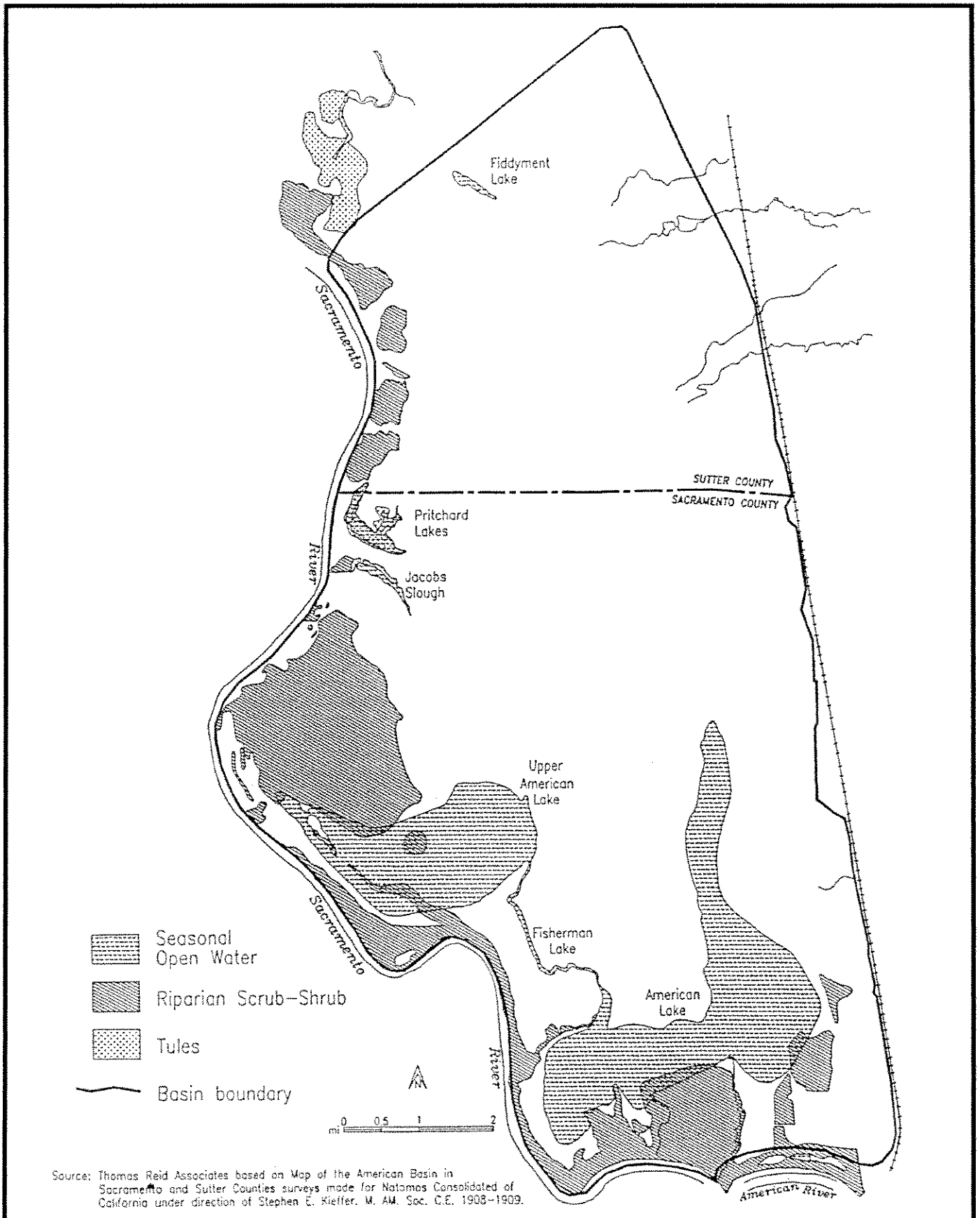
USFWS 2005. Final Environmental Impact Statement, Resident Canada Goose Management. USFWS Division of Migratory Bird Management.

US Fish and Wildlife Service. 2003 Intra-Service Biological and Conference Opinion on Issuance of a Section 10(a)(1)(B) Incidental Take Permit to the City of Sacramento and Sutter County for Urban Development in the Natomas Basin, Sacramento and Sutter Counties, California. June 24. #1-1-03-F-0225.

Wildlife Services 2004. FY 2003 Accomplishments under the Government Performance and Results Act. USDA

Wildlife Habitat Management Institute. 2000, July. Fish and Wildlife Habitat Leaflet, Number 17, Shorebirds.

Appendix A – 1908 Land Cover



Source: Thomas Reid Associates based on Map of the American Basin in Sacramento and Sutter Counties surveys made for Natomas Consolidated of California under direction of Stephen E. Kieffer, M. AM. Soc. C.E. 1908–1909.

FIGURE 5
1908 LAND COVER
REVISED NATOMAS BASIN HCP

Appendix B – Data Sets

Natomas Man-made Waterbird Survey Point Counts					
Survey #	Date	Survey Point	Species Detected	Number	Total per Point Count
1	2-Jan	East side of Northborough lake	Mallard	8	21
			Canada Goose	9	
			Green Heron	4	
2	2-Jan	West side of Northborough lake	Mallard	12	26
			Canada Goose	12	
			Common Grebe	2	
3	2-Jan	West side of Gateway lake			0
4	2-Jan	East side of Gateway lake			0
5	2-Jan	Alleghany lake	Canada Goose	23	37
			Mallard	13	
			Western Grebe	1	
6	4-Jan	East side of Northborough lake	Mallard	8	32
			Canada Goose	16	
			American Coot	6	
			Green Heron	2	
7	4-Jan	West side of Northborough lake	Mallard	5	8
			Common Grebe	2	
			Common Merganser	1	
8	4-Jan	West side of Gateway lake	Common Grebe	1	1
9	4-Jan	East side of Gateway lake			0
10	4-Jan	Alleghany lake	Mallard	11	29
			Canada Goose	15	
			Great Blue Heron	1	
			Common Merganser	1	
			Green Heron	1	
11	7-Jan	East side of Northborough lake	Mallard	9	17
			Canada Goose	8	
12	7-Jan	West side of Northborough lake	Mallard	8	10
			Canada Goose	2	
13	7-Jan	West side of Gateway lake	Common Grebe	1	1
14	7-Jan	East side of Gateway lake			0
15	7-Jan	Alleghany lake	Mallard	16	33
			Canada Goose	16	
			Western Grebe	1	
16	8-Jan	East side of Northborough lake	Mallard	7	10
			Great Blue Heron	1	
			Green Heron	2	
17	8-Jan	West side of Northborough lake	Mallard	11	20
			Unknown Gull Species	8	
			Western Grebe	1	

18	8-Jan	West side of Gateway lake			0
19	8-Jan	East side of Gateway lake			0
20	8-Jan	Alleghany lake	Mallard Canada Goose Common Grebe	8 12 2	22
21	10-Jan	East side of Northborough lake	Mallard Common Grebe	22 1	23
22	10-Jan	West side of Northborough lake	Mallard Common Grebe Western Grebe Great Egret	4 3 1 2	10
23	10-Jan	West side of Gateway lake	Unknown Gull Species Common Grebe	5 1	6
24	10-Jan	East side of Gateway lake			0
25	10-Jan	Alleghany lake	Mallard Common Merganser Common Grebe	9 18 1	28
26	11-Jan	East side of Northborough lake	Mallard Great Blue Heron Common Merganser Green Heron	6 1 2 4	13
27	11-Jan	West side of Northborough lake	Mallard Canada Goose	12 14	26
28	11-Jan	West side of Gateway lake			0
29	11-Jan	East side of Gateway lake			0
30	11-Jan	Alleghany lake	Green Heron Common Grebe	1 1	2
31	13-Jan	East side of Northborough lake	Great Egret Canada Goose Mallard	2 18 8	28
32	13-Jan	West side of Northborough lake	Common Grebe Mallard	2 10	12
33	13-Jan	West side of Gateway lake			0
34	13-Jan	East side of Gateway lake			0
35	13-Jan	Alleghany lake	Mallard Canada Goose Common Merganser	6 18 8	32
36	14-Jan	East side of Northborough lake	Mallard Common Grebe Great Blue Heron	14 2 1	17
37	14-Jan	West side of Northborough lake	Mallard Canada Goose Green Heron	8 10 2	20

38	14-Jan	West side of Gateway lake			0
39	14-Jan	East side of Gateway lake			0
40	14-Jan	Alleghany lake	Canada Goose Green Heron	14 1	15
41	16-Jan	East side of Northborough lake	Canada Goose Mallard	12 8	20
42	16-Jan	West side of Northborough lake	Canada Goose Great Blue Heron Green Heron	8 1 2	11
43	16-Jan	West side of Gateway lake	Common Grebe Unknown Gull Species	1 9	10
44	16-Jan	East side of Gateway lake			0
45	16-Jan	Alleghany lake	Mallard Green Heron Common Grebe	12 1 2	15
46	17-Jan	East side of Northborough lake	Western Grebe Canada Goose	1 16	17
47	17-Jan	West side of Northborough lake	Mallard Canada Goose Great Blue Heron Common Grebe	14 8 1 2	25
48	17-Jan	West side of Gateway lake			0
49	17-Jan	East side of Gateway lake			0
50	17-Jan	Alleghany lake	Mallard Common Grebe	8 1	9

Natomas Rice Field Waterbird Survey Point Counts					
Survey #	Date	Survey Point	Species Detected	Number	Total per Point Count
1	2-Jan	Sankey Rd., half way between Pacific and E. levee	Black-necked stilt	16	64
			Unknown Gull Species	1	
			Mallard	39	
			Northern Pintail	1	
			Greenwing Teal	2	
			Greater Yellow leg	4	
			Great Blue Heron	1	
2	2-Jan	Levee Rd., Dewit Farms	American Coot	250	707
			Unknown Gull Species	57	
			Northern Pintail	360	
			Mallard	8	
			Greenwing Teal	32	
3	2-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	950	968
			Unknown Gull Species	18	
4	2-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	95	221
			Unknown Gull Species	126	
5	2-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	76	102
			Northern Shoveler	26	
6	2-Jan	Elverta Rd., 200 Meters west of last point	American Coot	1000	2652
			White-fronted goose	750	
			Northern Pintail	900	
			Great Egret	2	
7	2-Jan	Elverta Rd., 200 Meters west of last point	American Coot	95	98
			Double-crested Cormorant	3	
8	2-Jan	Elverta Rd., 200 meters west of last point	Common Grebe	1	86
			Unknown Gull Species	82	
			Curlew	3	
9	2-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	8	140
			Great Egret	1	
			Northern Pintail	127	
			Double-crested Cormorant	4	
10	2-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	4	4
11	2-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	1	178
			Curlew	47	
			Unknown Gull Species	130	
12	2-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	1
13	4-Jan	Sankey Rd., half way between Pacific and E. levee	White-fronted Goose	250	451
			Northern Pintail	120	
			Black-necked Stilt	32	
			Unknown Gull Species	49	
14	4-Jan	Levee Rd., Dewit Farms	American Coot	300	487
			Northern Pintail	180	
			Great Blue Heron	1	
			Great Egret	5	
			Common Grebe	1	
15	4-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	83	117
			Great Egret	2	
			Northern Shoveler	26	
			Mallard	6	
16	4-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	12	14
			Double-crested Cormorant	2	
17	4-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	135	257
			American Coot	78	
			American Wigeon	44	
18	4-Jan	Elverta Rd., 200 Meters west of last point	American Coot	67	76
			Great Egret	9	

19	4-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	1
20	4-Jan	Elverta Rd., 200 Meters west of last point	Mallard	22	123
			American Wigeon	44	
			American Coot	56	
			Common Grebe	1	
21	4-Jan	Elverta Rd., 200 Meters west of last point	Curlew	47	68
			Snowy Egret	21	
22	4-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	98	134
			Northern Shoveler	17	
			American Coot	19	
23	4-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	39	70
			Curlew	31	
24	4-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	4
			Common Grebe	2	
			Double-crested Cormorant	1	
25	7-Jan	Sankey Rd., half way between Pacific and E. levee	Unknown Gull Species	31	56
			Phallarope	19	
			Mallard	6	
26	7-Jan	Levee Rd., Dewit Farms	American Coot	400	496
			Northern Pintail	92	
			Mallard	4	
27	7-Jan	Elverta Rd., Near shed on south side of road	White-fronted Goose	180	630
			Snow Goose	250	
			Northern Pintail	200	
28	7-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	9	43
			Great Blue Heron	1	
			Northern Pintail	33	
29	7-Jan	Elverta Rd., 200 Meters west of last point	American Coot	48	48
30	7-Jan	Elverta Rd., 200 Meters west of last point	Snowy Egret	22	23
			Common Grebe	1	
31	7-Jan	Elverta Rd., 200 Meters west of last point	White-faced Ibis	33	114
			Black-necked Stilt	14	
			American Coot	67	
32	7-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	48	91
			Curlew	31	
			Great Egret	12	
33	7-Jan	Elverta Rd., 200 Meters west of last point	Great Egret	7	42
			Snowy Egret	15	
			Great Blue Heron	2	
			Unknown Gull Species	18	
34	7-Jan	Elverta Rd., 200 Meters west of last point	Unknown Gull Species	5	196
			Northern Pintail	130	
			American Wigeon	26	
			Mallard	12	
			Northern Shoveler	23	
35	7-Jan	Elverta Rd., 200 Meters west of last point	Double-crested Cormorant	1	45
			Great Egret	11	
			Curlew	33	
36	7-Jan	Elverta Rd., 200 Meters west of last point	Great Blue Heron	1	7
			Unknown Gull Species	6	
37	8-Jan	Sankey Rd., half way between Pacific and E. levee	White-fronted Goose	350	1015
			Snow Goose	450	
			Mallard	34	
			Northern Pintail	90	
			American Wigeon	35	
			Green-winged Teal	18	
			Great Egret	9	
			Unknown Gull Species	29	

38	8-Jan	Levee Rd., Dewit Farms	American Coot	123	231
			Great Egret	4	
			Northern Pintail	46	
			Mallard	8	
			Western or Least Sandpiper	50	
39	8-Jan	Elverta Rd., Near shed on south side of road	Northern Pintail	97	220
			American Coot	43	
			Western or Least Sandpiper	80	
40	8-Jan	Elverta Rd., 200 Meters west of last point	Uknown Gull Species	6	8
			Great Blue Heron	2	
41	8-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	61	61
42	8-Jan	Elverta Rd., 200 Meters west of last point	American Coot	34	50
			Snowy Egret	7	
			Great Egret	9	
43	8-Jan	Elverta Rd., 200 Meters west of last point	Phallarope	12	79
			Black-necked Stilt	8	
			Great Blue Heron	1	
			Unknown Gull Species	58	
44	8-Jan	Elverta Rd., 200 Meters west of last point	Mallard	6	30
			American Coot	24	
45	8-Jan	Elverta Rd., 200 Meters west of last point	Northern Pintail	33	44
			Mallard	2	
			Northern Shoveler	9	
46	8-Jan	Elverta Rd., 200 Meters west of last point	American Coot	11	35
			Great Blue Heron	1	
			Common Grebe	2	
			White-faced Ibis	21	
47	8-Jan	Elverta Rd., 200 Meters west of last point	Curlew	36	66
			Snowy Egret	16	
			Great Egret	8	
			Unknown Gull Species	6	
48	8-Jan	Elverta Rd., 200 Meters west of last point	Western or Least Sandpiper	80	105
			Curlew	25	