PANOCHE DRAINAGE DISTRICT

52027 WEST ALTHEA, FIREBAUGH, CA 93622 • TELEPHONE (209) 364-6136 • FAX (209) 364-6122

November 15, 2007

Susan P. Jones
US Fish & Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Michael Delamore
US Bureau of Reclamation
1243 N Street
Fresno CA 93721-1813

Subject: San Joaquin River Water Quality Improvement Project, 2006 Wildlife Monitoring Report

Enclosed is the 2006 Monitoring Report (2006 Report) for the San Joaquin River Water Quality Improvement Project (SJRIP) prepared by H. T. Harvey & Associates. This is the sixth year of bird egg monitoring at the project site. Eggs were collected from recurvirostrids (Black-necked Stilt and American Avocet), Killdeer, and Red-winged Blackbirds.

The overall geometric mean selenium egg concentrations for recurvirostrids from the project area in 2006 (17 eggs) was 23.0 ppm (dry weight). This is less than the geometric mean egg selenium concentrations for 2005, which were 35.3 ppm (dry weight). The geometric mean egg selenium concentration in 17 recurvirostrid eggs collected at an off-site reference location was 8 ppm. The following measures were implemented in 2006 to reduce exposure potential and mitigate exposure to birds.

1) **Reduced exposure potential by reducing attractiveness of drainage ditches for nesting**: Monitoring efforts detected that some drainage ditches within the project site were attracting nesting shorebirds. Shallow water pooling in unused drainage ditches was also observed to provide foraging habitat for Killdeer, Black-necked Stilts, and American Avocets, thereby serving as a pathway for selenium exposure. Additionally, silt collecting at the bottom of these drains was providing a nesting substrate for shorebirds. Irrigation and drainage ditches within the project site were, therefore, re-contoured prior to the nesting season to reduce their attractiveness to foraging and nesting shorebirds.

2) **Reduced exposure potential by hazing birds from nesting near, and foraging in, irrigation (and drainage) ditches**: A hazing program has been implemented by shooting "cracker shells" in the vicinity of birds to discourage nesting within the project area.

3) **Flooded field contingency plan:** Panoche Drainage District has had a flooded field contingency plan in place since a field was inadvertently flooded in 2003. A copy is included in Appendix H of the 2006 Report.

4) **Provide mitigation breeding habitat:** Fifty acres of mitigation habitat were constructed as described in the 2006 Report. The monitoring program was expanded to include monitoring of the mitigation site during the spring of 2006. Twenty-one recurvirostrids and seven Killdeer nested within the mitigation habitat off of the project site. The geometric mean selenium concentration for recurvirostrids was 10.6 ppm (dry weight).

Additional mitigation measures were implemented on the project site in 2007 as a result of monitoring during the Spring of 2006. These included closing and temporarily netting deep, open drains that were not needed for current project activities on the site. Seven miles of drains were closed and another four miles of drains were temporarily netted to exclude birds (see attached photos). Preliminary results from the 2007 sampling indicate that there were continued reductions in egg selenium levels. The attached figure shows that in 2007 recurvirostrid egg levels reduced to a geometric mean of 16.7 ppm (dry weight), compared to the 23.0 ppm in 2006. Reductions were also measured for killdeer and blackbirds.

The density of recurvirostrids on the project site continues to be low. In 2006, 19 pairs nested within the 4,000-acre project site, compared to 21 nesting at the 50-acre mitigation site.

Future plans include piping of drains that are needed for project operation to further reduce the exposure potential. This would occur in place of the temporary netting and in additional drains as they are identified.

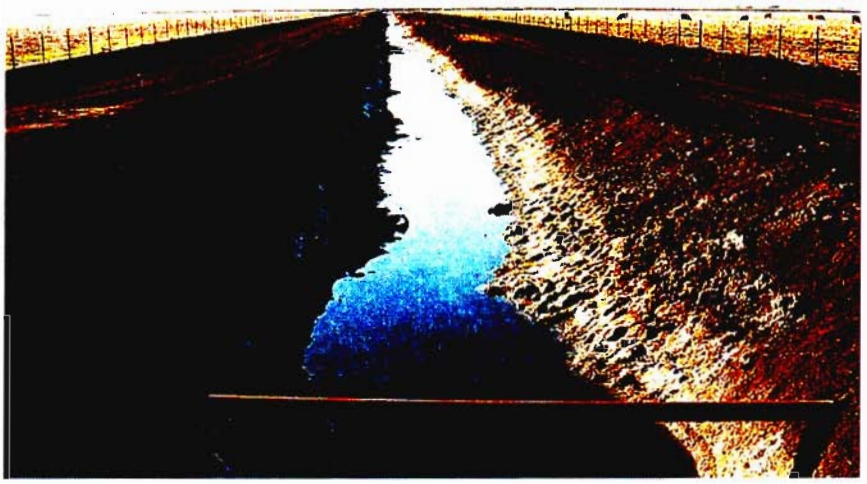
Questions regarding this data should be directed toward Joe McGahan, Drainage Coordinator for the Grassland Bypass Project. He can be reached at 559-582-9237.

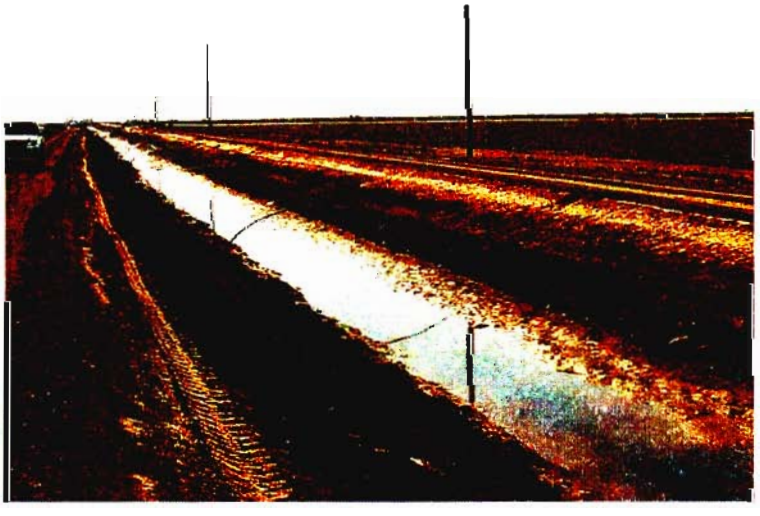
Very truly yours,

Dennis Falaschi
General Manager

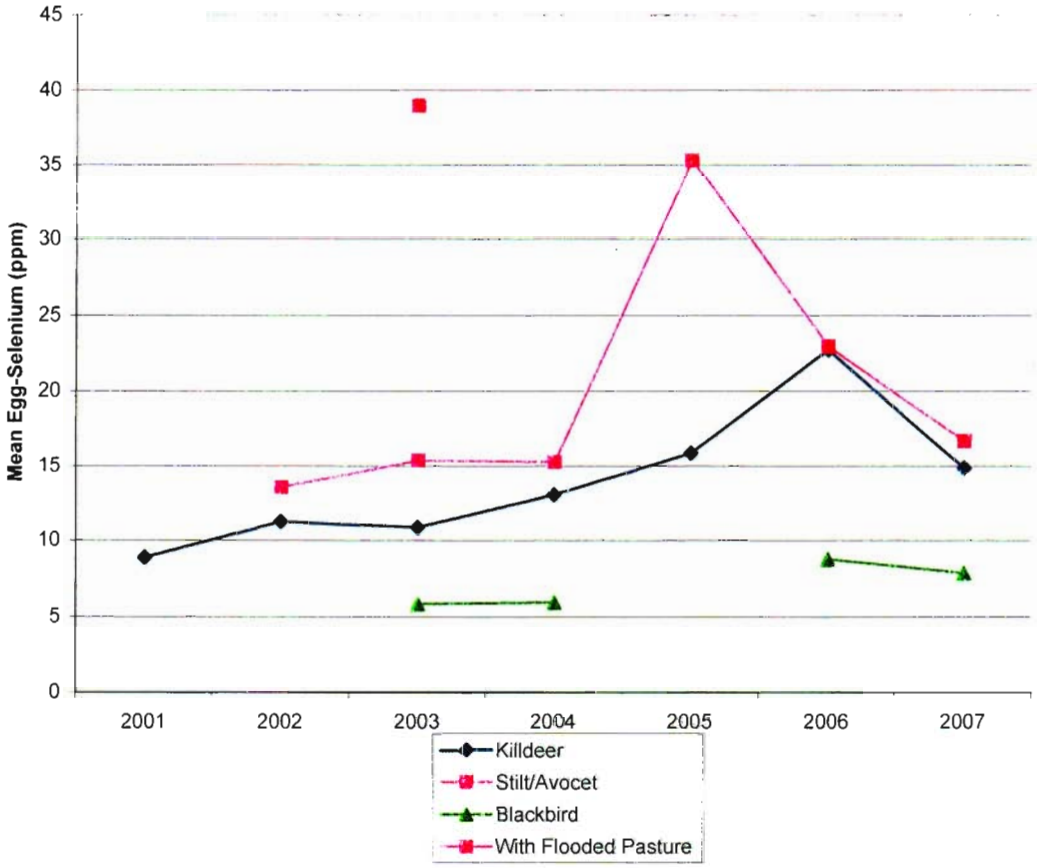
Cc: Kathy Wood
US Bureau of Reclamation
1243 N Street
Fresno CA 93721-1813

Tom Maurer
US Fish & Wildlife Service
2800 Cottage Way
Sacramento, CA 95825





SJRIP Egg Mean Selenium Levels



SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT, PHASE I WILDLIFE MONITORING REPORT 2006

Prepared by:

H.T. Harvey & Associates
423 W. Fallbrook Avenue
Fresno, CA 93711

Prepared for:

Panoche Drainage District
52027 W. Althea Avenue
Firebaugh, CA 93622

1 November 2007

File No. 1960-07

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FIGURES

CONTRIBUTORS

Scott B. Terrill, Ph.D.
Principal-in-charge / Senior Ornithologist

Brian B. Boroski, Ph.D.
Project Manager / Senior Wildlife Ecologist

Jeff Seay, B.A.
Wildlife Ecologist

Mark D. Meyer, Ph.D.
Wildlife Ecologist

INTRODUCTION

To reduce the amount of salt and selenium delivered to the San Luis Drain and Mud Slough through the Grassland Bypass Project, the Panoche Drainage District implemented Phase I of the San Joaquin River Water Quality Improvement Project (SJRIP). The Panoche Drainage District, acting as the lead agency under the California Environmental Quality Act (CEQA), prepared a Negative Declaration for SJRIP in September 2000. The Negative Declaration included the provision of a biological monitoring program, to be developed in collaboration with the U. S. Fish and Wildlife Service (USFWS), which would detect migratory bird impacts resulting from the project. This report represents the biological monitoring results for the fourth year (2006) of Phase I of the SJRIP.

PROJECT DESCRIPTION AND SETTING

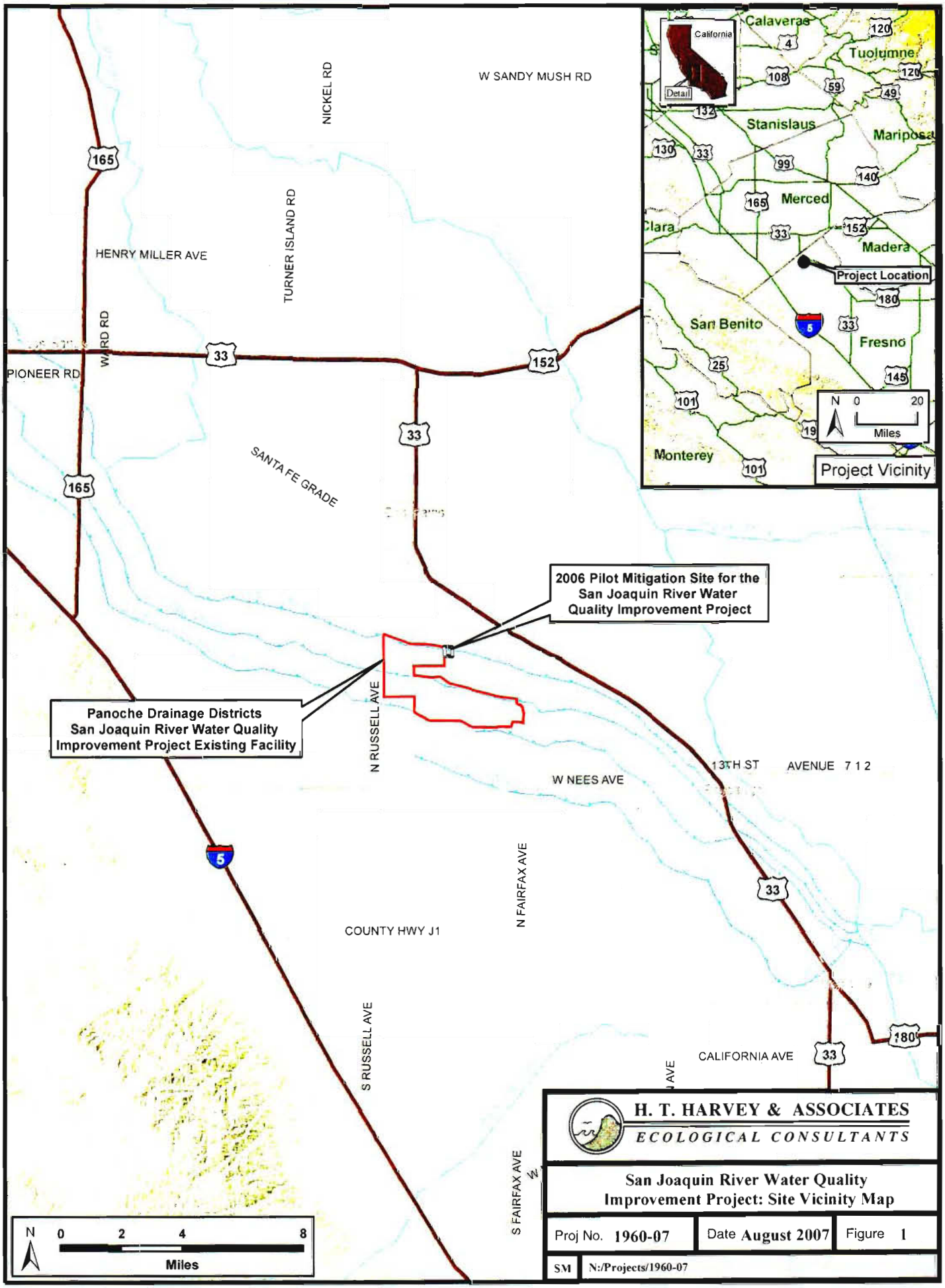
Existing Facility

Only a portion of Phase I was put into effect in 2006. Crops were planted on approximately 3,500 of the 4,000 acres obtained by the Panoche Drainage District. The project site is located west of the city of Firebaugh in Fresno County, California (Figure 1). The irregularly shaped project site is bordered on the north by the Main Canal and on the south by the Delta-Mendota Canal. Russell Avenue borders the eastern edge of the project site and the western edge extends nearly to Fairfax Avenue (Figure 2).

The project is the initial development of an In-Valley Treatment/Drainage Reuse Facility on up to 6,200 acres of land within the Grassland Drainage Area (GDA). The 6,200 acres of GDA land designated for purchase is made up of irrigated field crops and related irrigation ditches, drain ditches, conveyance canals, and farm structures. The topography is nearly level to grade and flood/furrow irrigated. The highest elevation is found near the southeast corner at 164 feet above mean sea level, while the lowest point is found near a north-central point at 136 feet above mean sea level. Thus, the elevation change within the 6,200-acre property is approximately 28 feet. The shape of the property is irregular, conforming to the area's adjacent canals. Russell Avenue provides access to the property via a paved county road. Typical, improved farm roads provide access to the interior of the site.

The reuse facility will dedicate specific lands for the irrigation of salt-tolerant crops with subsurface drainwater to reduce drainwater volume; treat the concentrated drainwater to remove salt, selenium and boron; and eventually dispose of the removed elements to prevent discharge into the San Joaquin River. The reuse facility will process up to one-quarter of the total drainwater produced in the GDA (25 percent of 52,000 acre-feet or approximately 15,000 acre-feet) and will be implemented in three phases.

- Phase I: Purchase of land and planting of salt-tolerant crops
- Phase II: Installation of subsurface drainage and collection systems, initial treatment system
- Phase III: Complete construction of treatment removal and salt disposal systems



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San Joaquin River Water Quality Improvement Project: Site Vicinity Map

Proj No. 1960-07	Date August 2007	Figure 1
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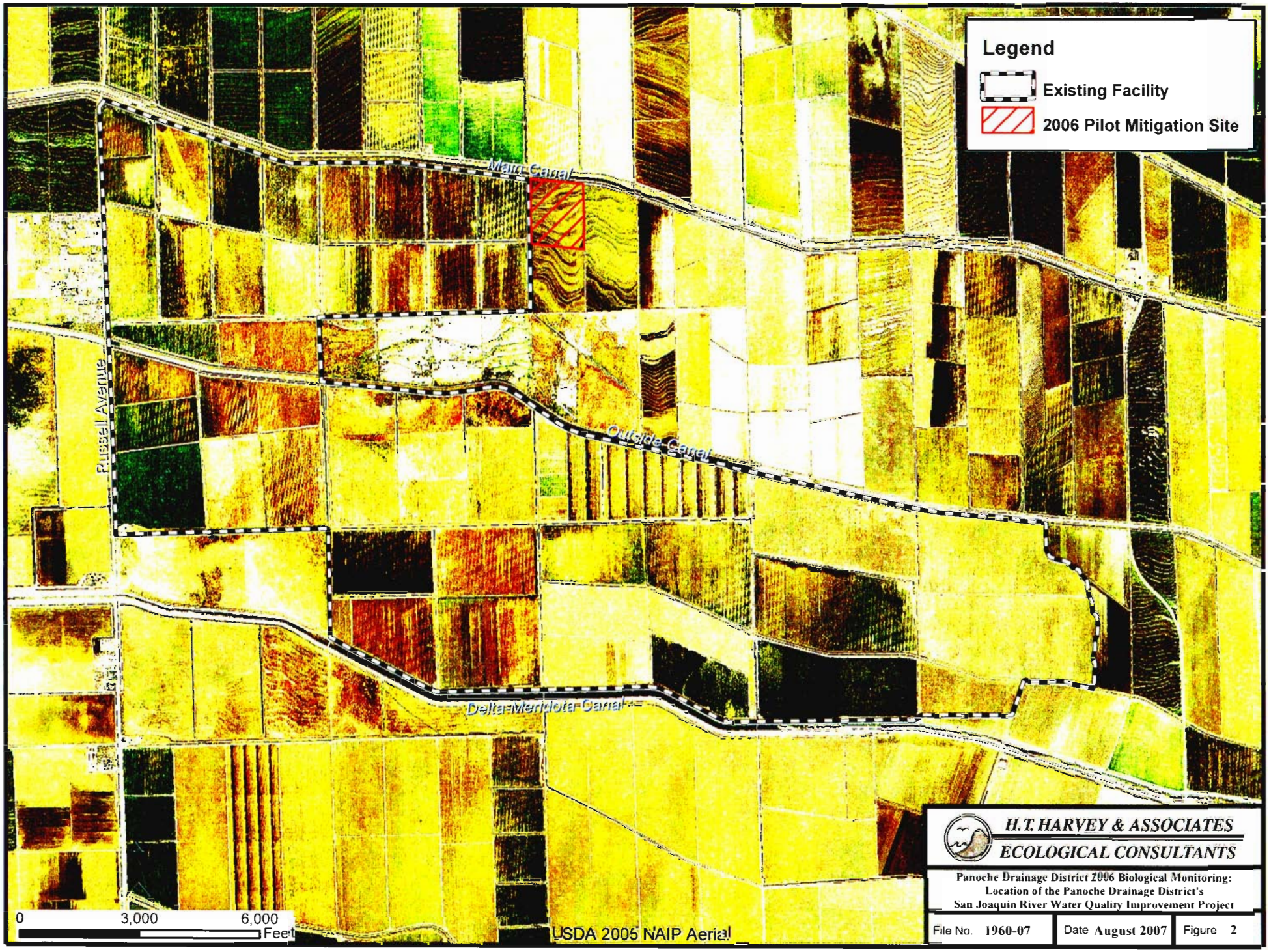

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Panoche Drainage District 2006 Biological Monitoring:
Location of the Panoche Drainage District's
San Joaquin River Water Quality Improvement Project

File No. 1960-07 | Date August 2007 | Figure 2

In Phase I, subsurface drainwater from the GDA is used to irrigate salt-tolerant crops on ideally situated land. Channels containing collected drainwater flow adjacent to this location, so water can easily be captured and placed on the land. Also, because this land is at the lowest elevation within the drainage area, collected water can be applied without excessive pumping costs.

Approximately four thousand acres have been purchased by the Panoche Drainage District to date. Approximately 3,500 acres of crops have been planted since 2001 and irrigated with water that otherwise would have been discharged into the San Joaquin River. Soil and water constituents at this project site will continue to be monitored to prevent irreversible soil changes and to protect groundwater from contamination.

In Phase II of the SJRIP, the application of saline water to lands developed in Phase I will continue. Subsurface drainage systems will be installed to leach the land and maintain a favorable salt balance. The water percolating below the root zone will be captured in the drainage system and passed on to more salt-tolerant crops. In Phase II, the system will sequentially reuse drainwater on increasingly salt-tolerant crops to concentrate, and decrease, the volume of drainwater produced. Salt, selenium, and other constituents will be conveyed by water exiting the subsurface drainage systems. An initial treatment phase will remove the salt, the selenium, and much of the other constituents, leaving water for beneficial uses such as agriculture. The treatment system will be designed to incorporate into the reuse system at any point. The remaining salt will be deposited into approved waste units that will result in additional reductions in salt and selenium discharges into the San Joaquin River.

The third and final phase of the SJRIP will maximize improvement in water-quality and meet reductions needed for future water-quality objectives. This phase will expand the initial treatment (under Phase II) to include additional treatment facilities and waste-disposal units.

Each phase of the facility will significantly reduce the amount of drainwater discharged to the San Joaquin River. Water sufficient for reuse on GDA agricultural lands could also be produced by the treatment systems. The project will be designed to assist Grasslands Area Farmers in meeting applicable water-quality objectives for the 2006 water year (October 1, 2006). The 2006 annual, selenium-load limit, based on the current applicable total maximum monthly load, is 3,087 pounds (lbs). In comparison, the load value for the 2001 water year was 5,661 lbs. This reduction in load size requires implementation of additional drainage management methods.

An Initial Study and Negative Declaration adopted September 9, 2000 by Panoche Drainage District, evaluated Phase I of the facility. The second and third phases of the facility were evaluated in the Grassland Bypass Project EIS/EIR, finalized May 25, 2001 and a Biological Opinion issued by the U. S. Fish and Wildlife Service on 27 September 2001. In Phase I is independent and does not exclude the consideration of alternatives to the larger project or project site. Even if the In-Valley Treatment/Drainage Reuse Project progress was to halt at Phase I, the drainage management alone would be valuable. In addition, the proposed cropping patterns are reversible should later phases of the project not be implemented.

In 1997, a portion of the project site was evaluated for conversion to salt-tolerant crops and drainage reuse by Mercy Springs Water District, which encompasses 3,392 acres (55 percent) of the site. The Mercy Springs Water District prepared an Environmental Assessment for the

transfer of its Central Valley Project Class I water supply to the Pajaro Valley Water Management Agency (ESA 1997). A Finding of No Significant Impact approved the transfer of 13,300 acre-feet of annual water supply to the Pajaro Valley Water Management Agency on November 6, 1998. In 1999, a Final Environmental Assessment and Finding of No Significant Impact were issued for the transfer of 6,260 acre-feet per year of annual Central Valley Project contract water to the Pajaro Valley Water Management Agency, Santa Clara Valley Water District, and Westlands Water District (Provost & Pritchard 1999). These documents covered the impact of water transfers, including drainwater reuse, groundwater pumping, and cumulative effects. The current phase of the proposed In-Valley Project does not include water transfers or additional groundwater pumping over existing conditions.

Pilot Mitigation Site

The Negative Declaration for SJRIP adopted in September 2000 included provisions for wildlife monitoring capable of assessing project related impacts to wildlife. Provisions were also included for appropriate mitigation measures to be adopted if the monitoring program detected project related negative impacts.

Based on waterborne and egg-selenium levels at the existing project site, lethal and sublethal effects on waterbirds breeding at the proposed project site are probable. Water samples from the sources of drainwater used to irrigate the existing project site ranged from 43 to 761-ppb selenium from 2003 to 2005 (Panoche Drainage District data). Such levels are well above the level of waterborne selenium (32-ppb) associated with a high probability of reduced hatchability and increased probability of teratogenesis (CH2M-Hill *et al.* 1993). Egg-selenium monitoring at the existing project site has found elevated egg-selenium levels in both recurvirostrids and Killdeer. Egg-selenium levels in both groups have been higher than in similar sets of reference eggs collected from the project vicinity. Annual geometric mean, egg-selenium levels from recurvirostrid eggs have varied, but from 2003 to 2005, most means were also above the level (18-ppm) associated with an increased probability of reduced hatchability and teratogenesis. The repeated and prolonged exposure of breeding shorebirds in this region to selenium resulting in lethal and sublethal effects constitutes a significant impact.

This year the Panoche Drainage District began implementation of 3 mitigation measures to reduce impacts to nesting shorebirds. The first measure consisted of dredging the bottom of open drains that had been consistently used by shorebirds to eliminate potential feeding and nesting substrates. The next measure consisted of Panoche Drainage district personnel attempting to discourage shorebird use in areas where shorebird nesting had been concentrated in the past by discharging cracker shells. The hazers patrolled the project site throughout the day to discourage breeding birds from establishing nests at the project site. The third measure consisted of enhancing habitat for nesting shorebirds outside the project site at a site with clean (non-seleniferous) water.

The Panoche Drainage district improved 50 acres of cultivated rice for breeding habitat for shorebirds as a pilot mitigation site in 2006. Sixteen islands approximately 30 ft long and 7 ft wide were constructed within 50 acres of cultivated rice flooded with irrigation quality water, adjacent to the project site (Figures 2 and 3). The islands were constructed to enhance the attractiveness and utility of the existing rice field for shorebirds by providing nesting habitat.

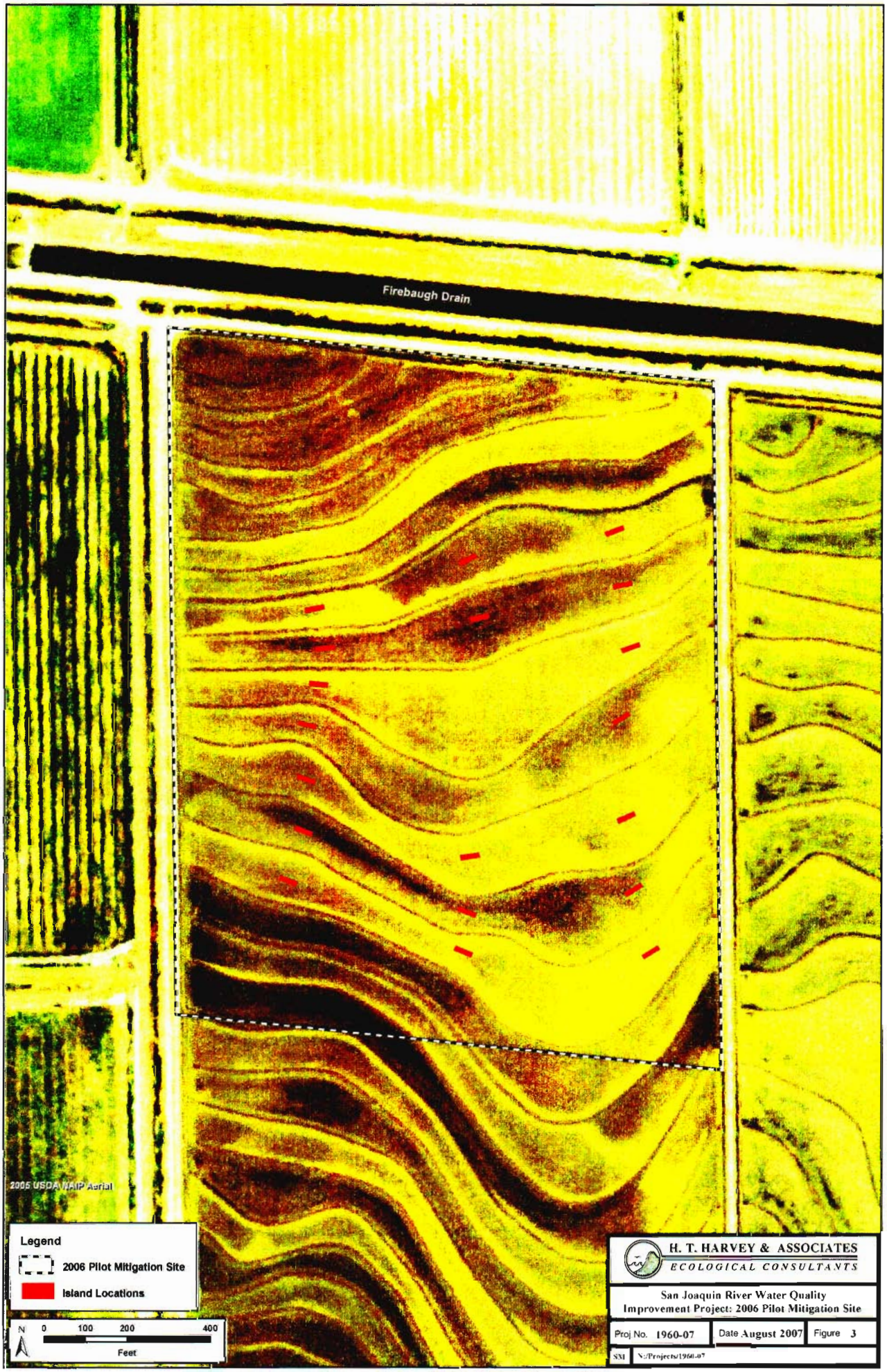
Firebaugh Drain
2005 USDA NAIP Aerial
Legend
2006 Pilot Mitigation Site
Island Locations
N
0
100
200
400
Feet
H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS
San Joaquin River Water Quality
Improvement Project: 2006 Pilot Mitigation Site
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Figure 3
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MATERIALS AND METHODS

BIRD CENSUSES

An ornithologist from H. T. Harvey & Associates monitored bird use at the project site on 6 occasions from 21 April to 14 June 2006. Censuses were completed by driving the perimeter roads of each field. Birds were identified and counted using 10X binoculars and a 20-60X spotting scope mounted on a tripod. Censuses were conducted to determine species composition and relative abundance of bird species on the project site during the breeding season.

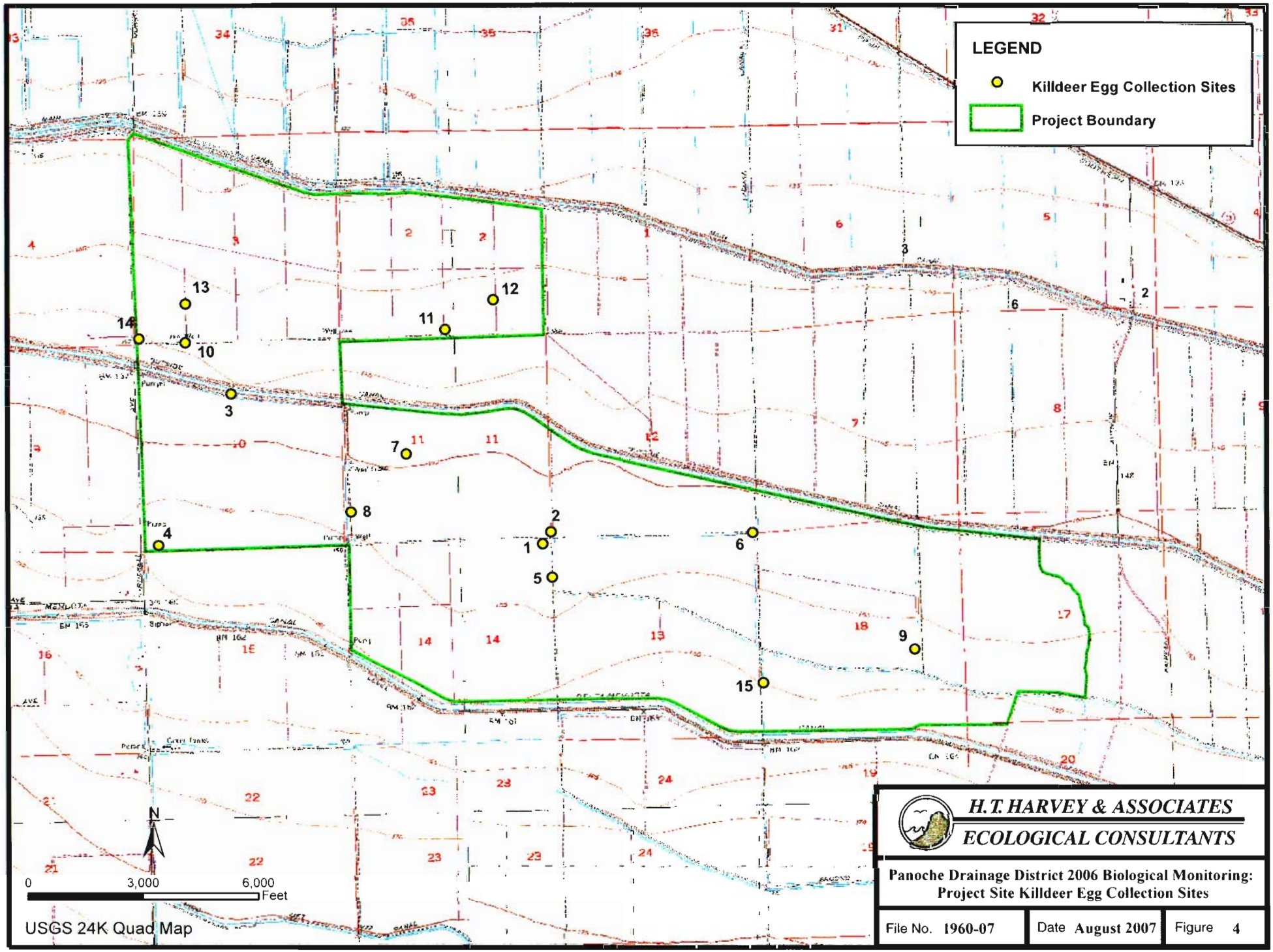
EGG COLLECTION AND PROCESSING

Fifteen Killdeer (*Charadrius vociferus*) eggs, 17 eggs from American Avocets (*Recurvirostra americana*) or Black-necked Stilts (*Himantopus mexicanus*) (recurvirostrids), and 11 Red-winged Blackbird (*Agelaius phoeniceus*) eggs were collected from the project site for selenium and boron analysis. The locations from which Killdeer, recurvirostrid, and Red-winged Blackbird eggs were collected from the project site are illustrated in Figures 4, 5, and 6; respectively. Scientific collecting permits were obtained from the California Department of Fish and Game (CDFG) and the U. S. Fish and Wildlife Service (USFWS) for the collection of bird eggs on the site. One egg was randomly collected from separate, full-clutch (four eggs) nests. Three additional sets of 15 reference Killdeer eggs (Figure 7), 17 recurvirostrid eggs (Figure 8), and 11 Red-winged Blackbird eggs (Figure 9) were collected from the project vicinity to provide reference data on regional selenium and boron concentrations outside the project area. Five recurvirostrid (3 Black-necked Stilts and 2 American Avocets) eggs were also collected from the mitigation site for selenium and boron analysis.

All eggs were labeled with a permanent marker, placed in an egg carton, and transported from the field. Upon returning to the lab, all of the egg contents (including membranes) were removed from the shell and transferred to 1-ounce Dynalon jars. The embryos were photographed and examined for abnormalities and to determine the stage of incubation (age). Eggs were also examined to determine whether embryos were alive or dead. Egg contents were stored by freezing (0° C).

EGG CHEMISTRY ANALYSIS

All egg contents collected by H. T. Harvey & Associates were shipped overnight, on dry ice, to the Oscar E. Olson Biochemical Laboratory at South Dakota State University. Selenium concentrations were determined using the Association of Official Analytical Chemists (AOAC) method 996.16. The boron was done on a nitric acid/peroxide digest in a microwave oven and quantitation by an inductively coupled plasma optical emission spectrometer (ICPOES). All egg-selenium and egg-boron concentrations were presented as parts per million (ppm) based on dry tissue weight (dry weight). For quality control, selected sub-samples were divided into 2 aliquots. The duplicate was spiked with known amounts of selenium or boron, and the samples were tested to determine the accuracy of the analysis.



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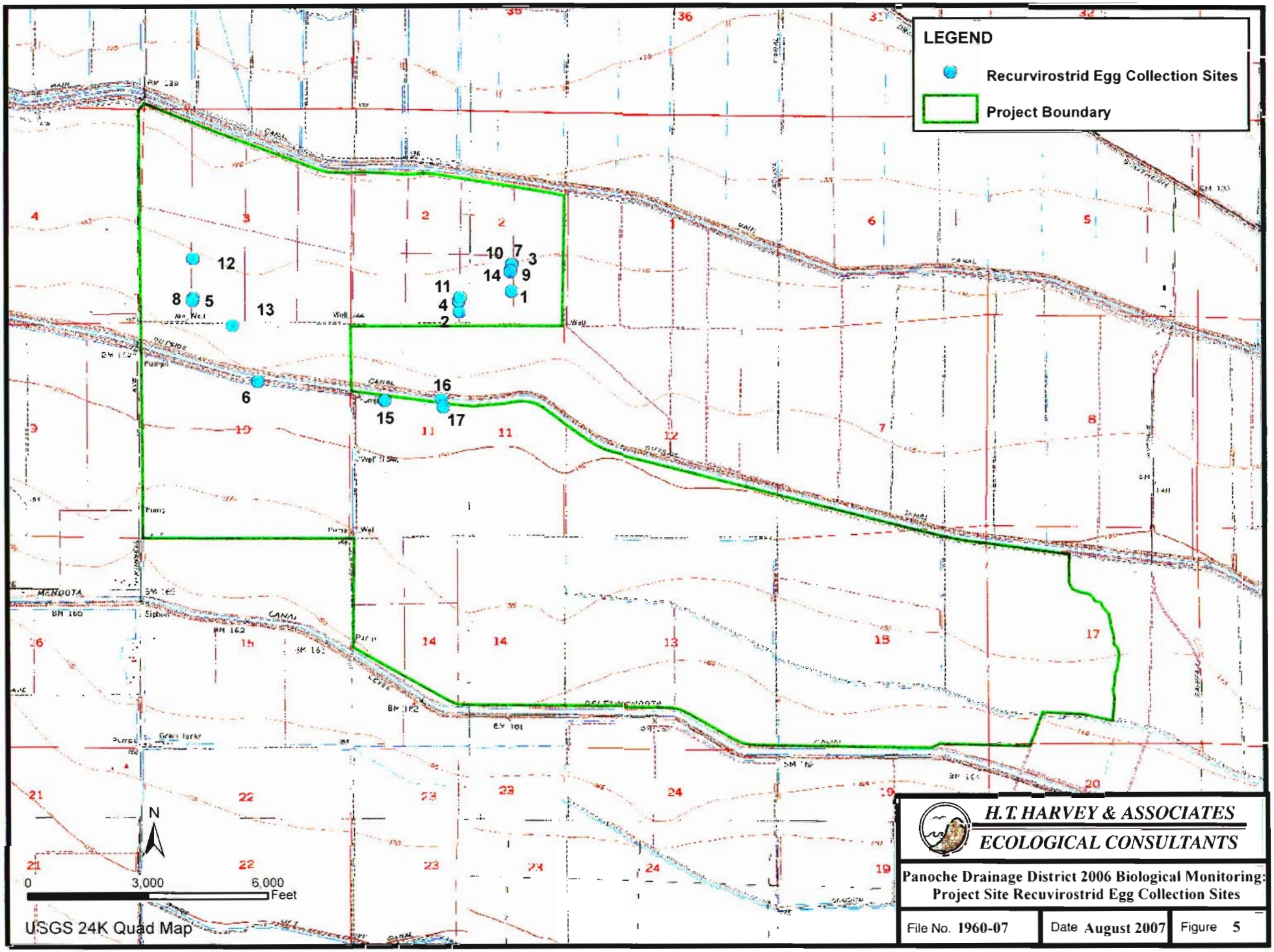
Panoche Drainage District 2006 Biological Monitoring: Project Site Killdeer Egg Collection Sites

File No. 1960-07	Date August 2007	Figure 4



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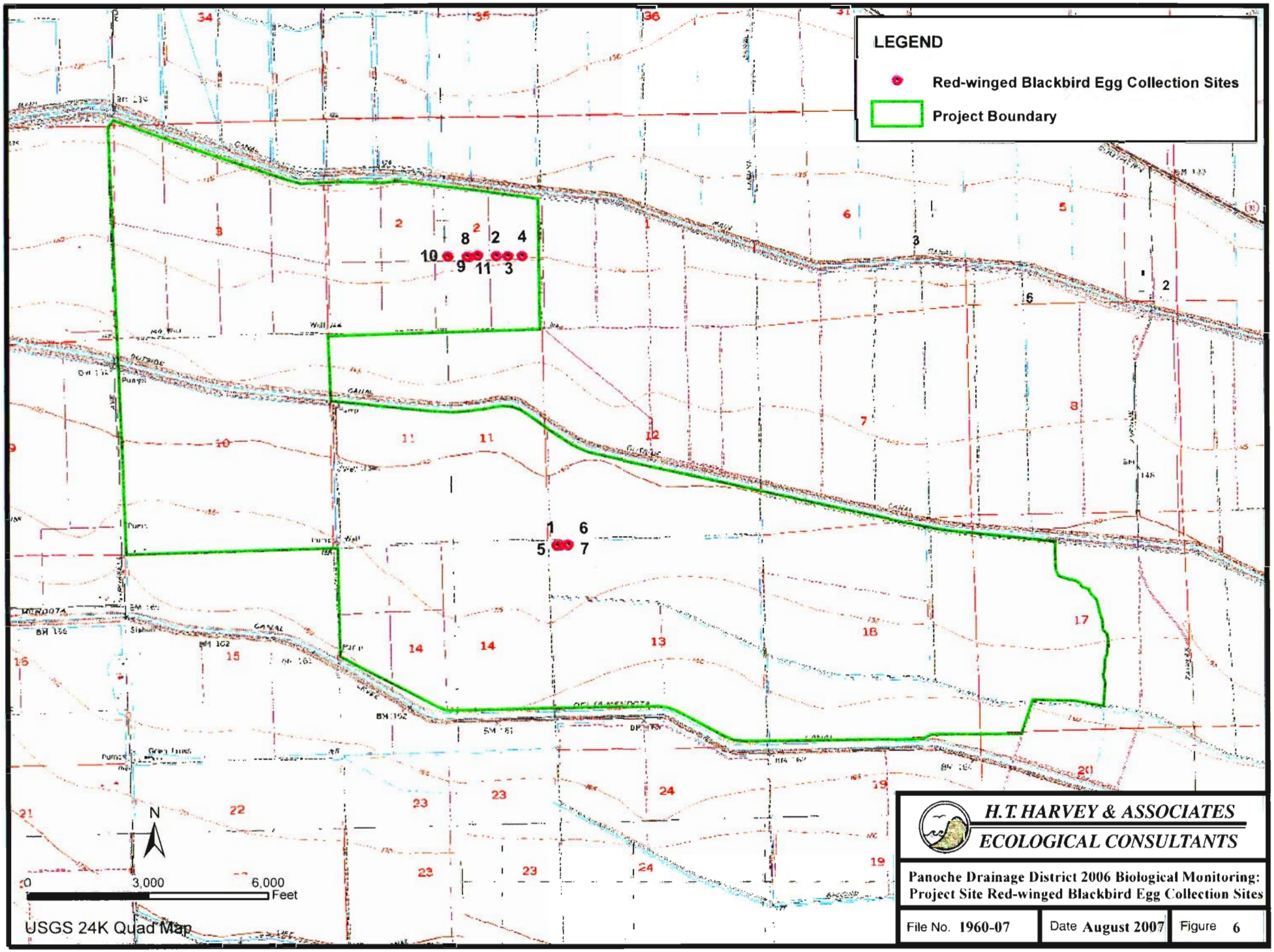
Panoche Drainage District 2006 Biological Monitoring: Project Site Recurvirostrid Egg Collection Sites

File No. 1960-07	Date August 2007	Figure 5



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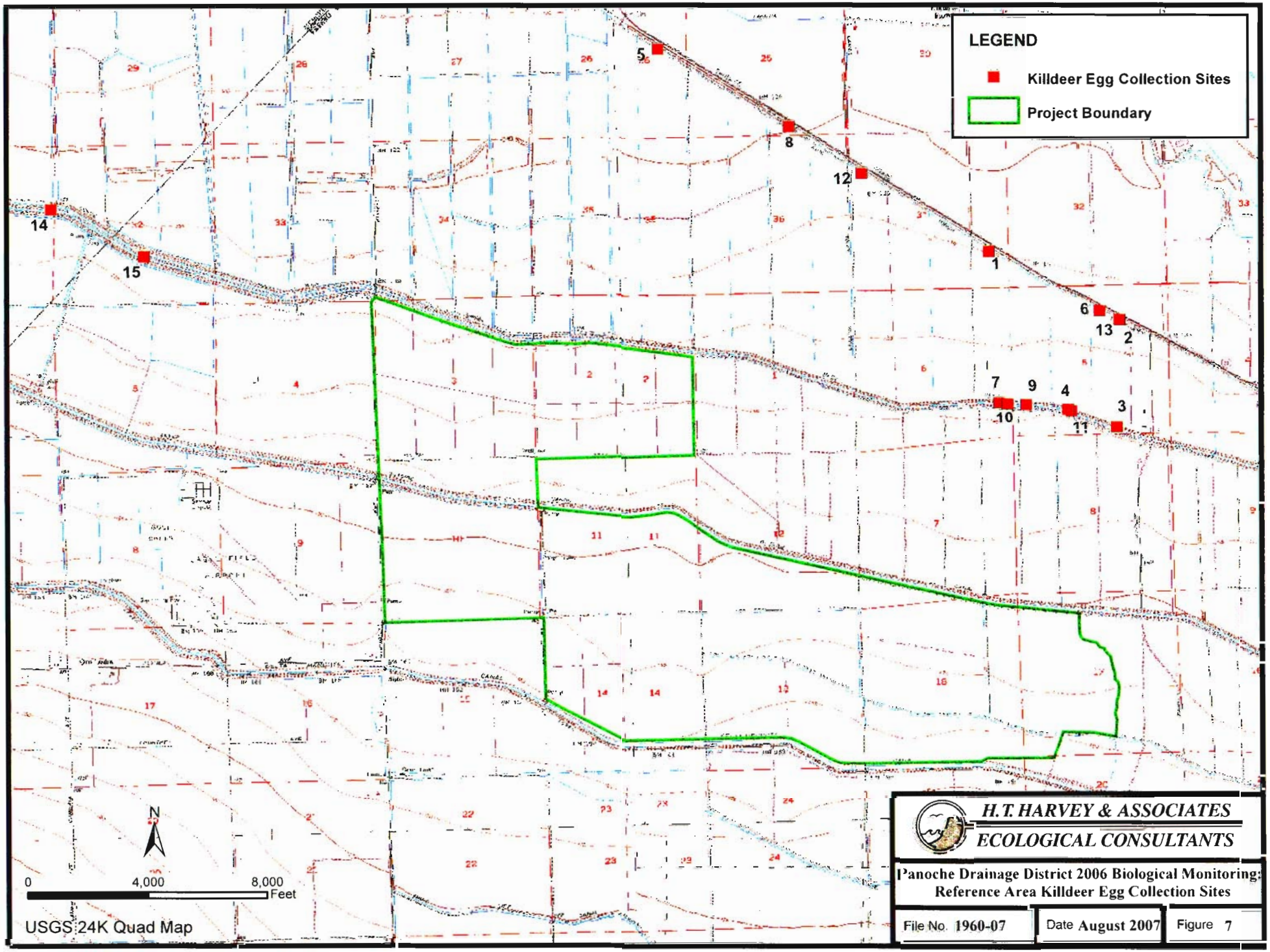
Panoche Drainage District 2006 Biological Monitoring: Project Site Red-winged Blackbird Egg Collection Sites

File No. 1960-07	Date August 2007	Figure 6



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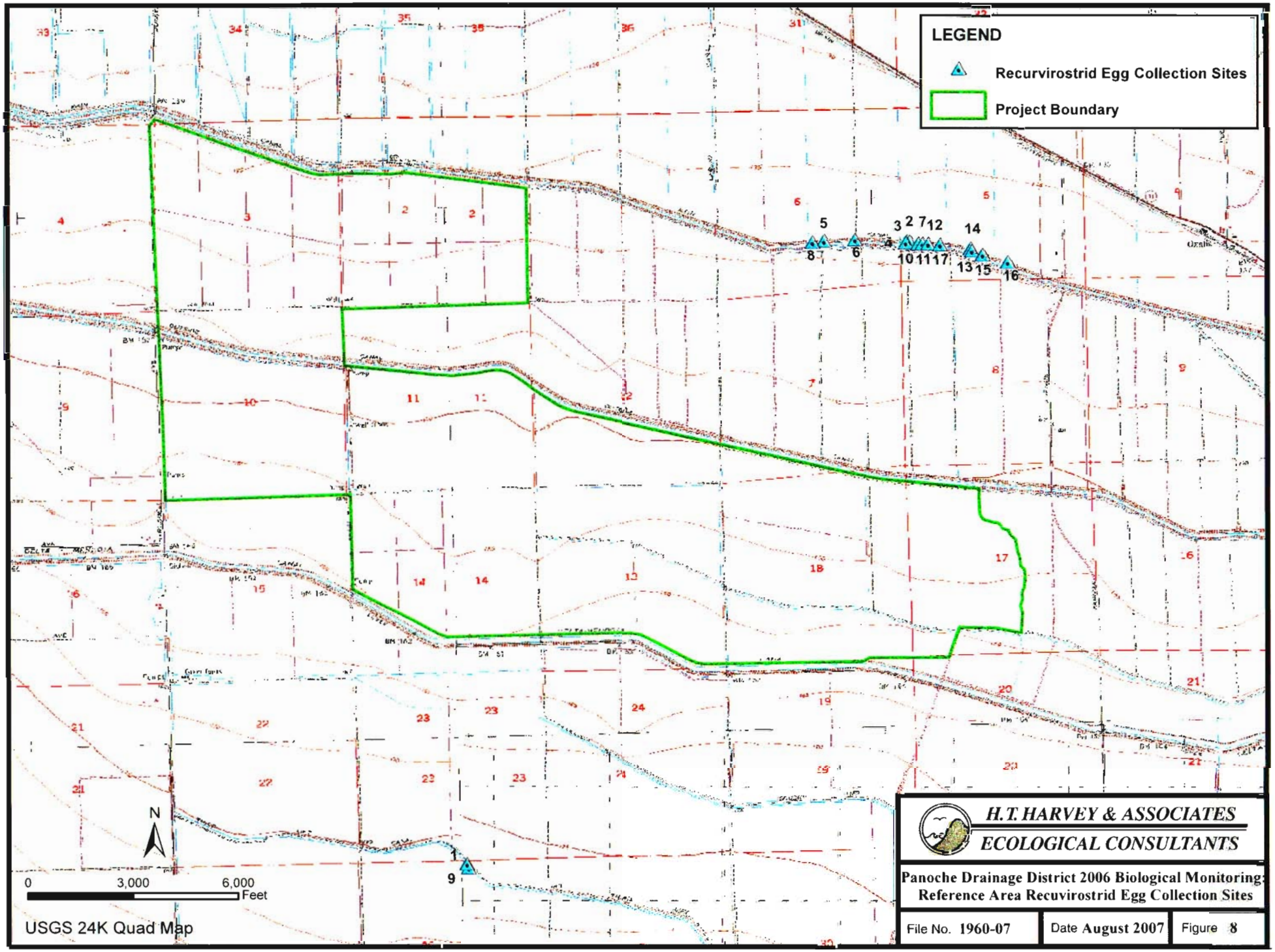
Panoche Drainage District 2006 Biological Monitoring:
Reference Area Killdeer Egg Collection Sites

File No. 1960-07 | Date August 2007 | Figure 7


LEGEND
Recurvirostrid Egg Collection Sites
Project Boundary
5
8
6
3
4
2
7
10
11
12
17
14
13
15
16
9
N
0
3,000
6,000
Feet
USGS 24K Quad Map
H.T. HARVEY & ASSOCIATES
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Panoche Drainage District 2006 Biological Monitoring
Reference Area Recuvirostrid Egg Collection Sites
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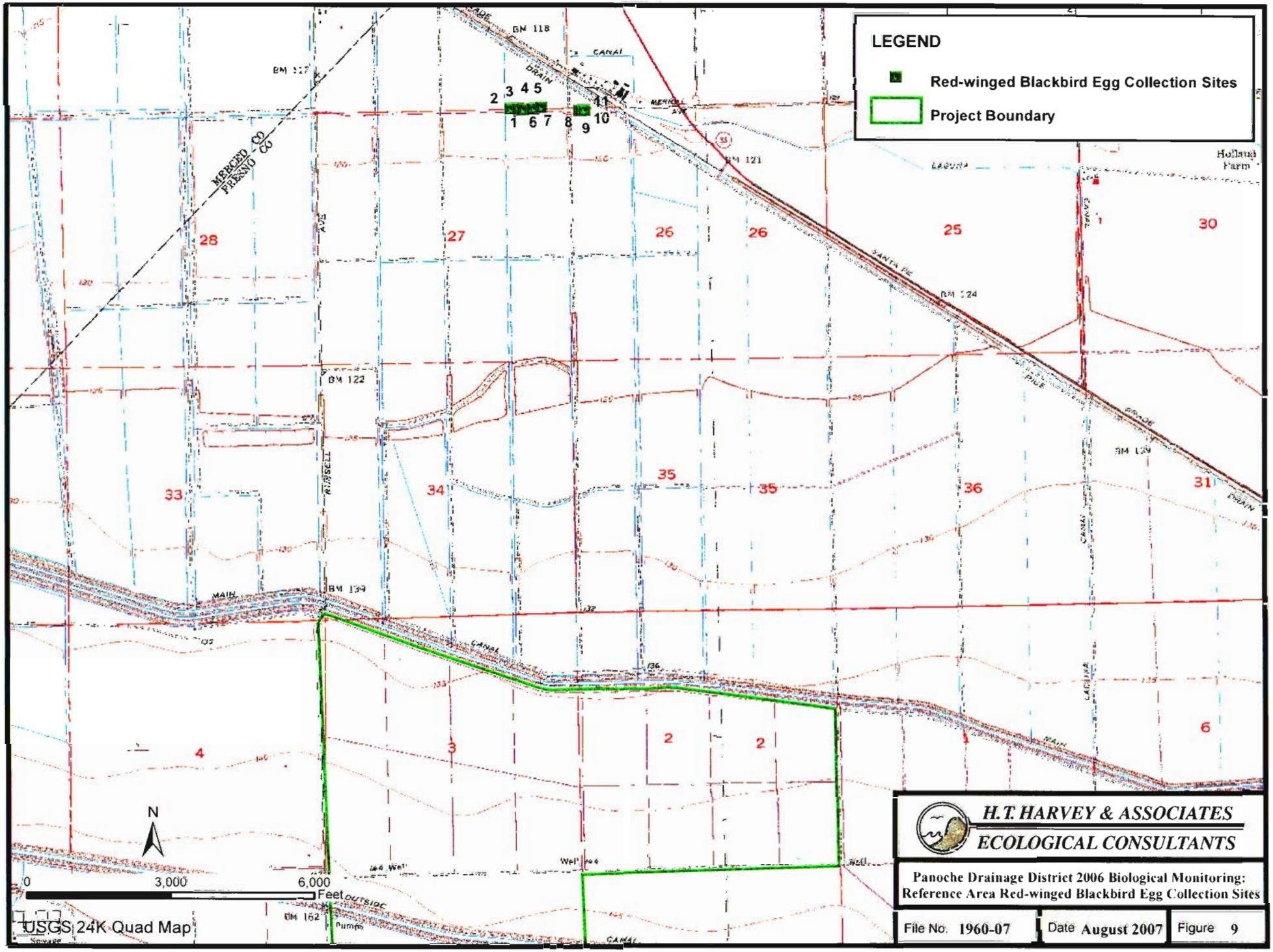
Figure 8



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Panoche Drainage District 2006 Biological Monitoring:
Reference Area Red-winged Blackbird Egg Collection Sites

File No. 1960-07 | Date August 2007 | Figure 9

Within species groups, a standard t-test was used to examine differences between means of project site and reference area egg-selenium and egg-boron concentrations. Selenium and boron concentration values were log-transformed (log base 10) to satisfy assumptions of normality.

Data were evaluated for normality with the Kolmogorov-Smirnov test and for homoscedasticity with Levene's test. Egg-selenium and egg-boron concentrations for all avian groups were Log_{10} transformed to improve the fit to parametric assumptions of homoscedasticity and normality. Although log-transformations improved the fit to parametric assumptions, egg-selenium data for recurvirostrids and Red-winged Blackbirds were marginally heteroscedastic ($P = 0.02$ to 0.03) and highly heteroscedastic for Killdeer ($P < 0.001$). We used model II 2-way analysis of variance (ANOVA) to test for the effect of location (project site, reference site) and year (2002 through 2006) on egg-selenium concentrations in recurvirostrids, and egg-selenium and egg-boron concentrations in Red-winged Blackbirds. Following these analyses, we used a Kruskal-Wallis nonparametric test to verify the results of the effect of location on egg-selenium and egg-boron concentration for these two groups ($P < 0.05$ in all cases). Because egg-boron data for recurvirostrids and egg-selenium and egg-boron data for Killdeer were highly heteroscedastic ($P \leq 0.001$), we used the Kruskal-Wallis test to examine the effect of location on egg-selenium/boron concentration and a second Kruskal-Wallis test to test the effect of year on egg-selenium/boron concentration in these species groups. Prior to these nonparametric analyses, we used a model II 2-way ANOVA to confirm the absence of an interactive effect between location and year. In all cases with the exception of recurvirostrids egg-boron concentration ($P = 0.02$), there was no significant interaction ($P > 0.10$). We also used a one-way ANOVA to test if Red-winged Blackbird egg-selenium concentration at the project site was greater 2006 than in 2003 and 2004. Calculated descriptive statistics presented below include the mean and standard error (SE). All analyses were conducted with Statistica 6.0 (StatSoft Inc., Tulsa, Oklahoma) and SYSTAT version 11. We used an α level of 0.05 for all analyses except where noted above.

We used model II 1-way analysis of variance (ANOVA) to test for the effect of location (project site, reference site, mitigation site) on egg-selenium and egg-boron concentrations in recurvirostrids. We also used Bonferroni's multiple comparison to test for differences between each pair of sites.

NEST FATE

In addition to egg-selenium monitoring, Killdeer and recurvirostrid nests on the project and mitigation sites were monitored to determine the nest fate. Active nests were located by driving the project site while looking for adult Killdeer and recurvirostrids. Once located, adults were monitored with a spotting scope or binoculars until a nest location could be determined. Nests were located at the mitigation site by walking searches of the levees and the islands. Nest locations were marked using a GPS unit (Garmin GPS 12 CX, 12 Channel, Olathe, KS). Nest location, stratum, date, number of eggs present, nest status, nest/clutch fate, and nest agent were recorded for each nest encountered. The nests were monitored to completion and nest fates were recorded. A completed nest was one that was empty (chicks presumed to have hatched or a predator took the eggs), chicks were present, the nest was abandoned, or the nest was destroyed.

PILOT MITIGATION SITE WATER QUALITY

Water samples were collected at the inlet to, and outlet from, the pilot mitigation site on 6 June 2006. The samples were sent to the Oscar E. Olson Biochemical Laboratory at South Dakota State University and analyzed for electrical conductivity and selenium and boron content.

RESULTS

BIRD CENSUSES

In the Phase I area, 42 avian species were observed between 21 April 21 and 14 June 2006 (Table 1). Avian numbers were highest in April and early May, when White-faced Ibis (*Plegadis chihi*) and migrating shorebirds such as Whimbrels (*Numenius phaeopus*) were present (Table 1). Red-winged Blackbird was the most numerous avian species observed on the project site. Eighteen species were either observed nesting, or were suspected of nesting on the site, based on observations of courtship behavior or young. Total bird numbers declined in late May and June as fewer migrants were detected.

EGG COLLECTION AND PROCESSING

Forty-three eggs, comprising 15 Killdeer, 17 recurvirostrid eggs, and 11 Red-winged Blackbird eggs were collected from the project site. Five of the Killdeer embryos were 15 or more days old and were alive and in normal condition. Another 4 Killdeer embryos were alive, but too young (3 to 9 days old) to determine their condition. The remaining 6 Killdeer embryos were less than 3 days old (Table 2). Six of the recurvirostrid eggs contained a live, normal, greater than 9-day-old embryo. Five stilt embryos were too young (less than 9 days old) to determine the embryo status, though 3 were old enough (more than 3 days old) to determine that they were alive. Four of the remaining recurvirostrid embryos were less than 3 days old and 2 were undeveloped (Table 3). One of the Red-winged Blackbirds was old enough, at 14 days old, to determine that it was alive and normal. Ten of the Red-winged Blackbirds were too undeveloped for their status to be assessed, though 3 were developed enough (they contained feathered embryos), to determine that they were alive (Table 4).

Forty-three eggs, 15 Killdeer, 17 recurvirostrid and 11 Red-winged Blackbird eggs were collected from the vicinity of the project site. Five of the Killdeer embryos from the reference area were 9 or more days old, were alive and in normal condition. Another 6 Killdeer embryos were alive, but too young (3 to 9 days old) to determine their status. The remaining 4 Killdeer embryos were less than 3 days old (Table 5). Two of the recurvirostrid eggs contained a live, normal, at least 15-day-old embryo. Five recurvirostrid embryos were too young (fewer than 9 days old) to determine the embryo status, though three were old enough (greater than 9 days old) to determine that they were alive. The remaining 10 recurvirostrid embryos were less than three days old (Table 6). All 11 of the Red-winged Blackbirds were too undeveloped for their status to be assessed, though 8 were developed enough (they contained feathered embryos), to determine that they were alive (Table 7).

Five recurvirostrid eggs, 2 American Avocet and 3 Black-necked Stilt, were collected from the mitigation site. One of the American Avocet eggs and all 3 of the Black-necked Stilt eggs were more than 10 days old, were alive and in normal condition. The embryo in the remaining American Avocet egg died at approximately 9 days old and had been dead long enough that its status could not be determined (Table 8).

Table 1. Avian census results at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

	2006					
Species	April 21	May 03	May 17	May 24	June 06	June 14
Great Blue Heron	1	1	1	2	2	
Great Egret	9	8	12		1	
Snowy Egret	11	17	29	3	2	1
Cattle Egret	22	33	46	10		
Black-crowned Night Heron	2	3	3	1		6
White-faced Ibis	32	108	141	14	21	
* Mallard	10	10	14	8	5	4
Cinnamon Teal		2	2			
Northern Harrier	4	2	2	2	4	4
Swainson's Hawk		1	1	26	1	1
Red-tailed Hawk	2	3	2	5	4	6
American Kestrel	2	3	1	2	1	2
* Ring-necked Pheasant	2	1		17		2
* Killdeer	24	26	37	39	47	41
* Black-necked Stilt	13	18	25	24	24	26
* American Avocet	7	5	4	2	12	12
Greater Yellowlegs	16	7	3			
Whimbrel	418	227	59	8		
Long-billed Curlew	31	8				
Black Tern			3	2	4	4
* Mourning Dove	8	10	6	3	13	9
* Burrowing Owl	16	15	25	35	42	49
* Western Kingbird	25	34	24	36	21	19
* Loggerhead Shrike	3	5	6	4	1	3
Common Raven	10	39	22	51	19	12
* Horned Lark	56	37	28	16	14	9
Tree Swallow	52	12				
Violet-green Swallow	4					
Northern Rough-winged Swallow	6	4	2			
Barn Swallow	2	5	8	4	5	
Cliff Swallow	5	9	15	6	2	
American Pipit	49	26				
Savannah Sparrow	25	41	8	4		
* Song Sparrow	22	27	21	28	24	25
* Blue Grosbeak			2	1	1	1
* Red-winged Blackbird	263	305	341	410	389	227
Tricolored Blackbird	87	26	63	8		
* Western Meadowlark	31	36	29	32	17	9
* Brewer's Blackbird	48	56	107	83	68	38
* Brown-headed Cowbird	17	21	15	24	14	11
* House Finch	13	15	39	34	35	31
* House Sparrow	6	7	5	13	8	
Total	**1354**	**1213**	**1151**	**957**	**801**	**552**
* = Species for which evidence of nesting was observed this year.						

Table 2. Project site Killdeer concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	K-03	Killdeer	May 17	L	U	6-9	36.7	1.5647	
02	K-04	Killdeer	May 17	U	U	<3	27.9	1.4456	
03	K-05	Killdeer	May 17	L	N	20+	15.4	1.1875	
04	K-07	Killdeer	May 24	L	U	6	4.37	0.6405	
05	K-08	Killdeer	June 1	L	U	6	42.9	1.6325	
06	K-09	Killdeer	June 1	U	U	<3	43.8	1.6415	
07	K-11	Killdeer	June 14	U	U	<3	50.4	1.7024	
08	K-12	Killdeer	June 14	U	U	<3	54.0	1.7324	
09	K-13	Killdeer	June 14	U	U	<3	54.7	1.7380	
10	K-14	Killdeer	June 21	U	U	<3	14.5	1.1614	
11	K-15	Killdeer	June 21	L	N	17-19	24.8	1.3945	
12	K-16	Killdeer	June 21	L	N	15	7.15	0.8543	
13	K-17	Killdeer	June 21	L	U	3	16.6	1.2201	
14	K-18	Killdeer	June 21	L	N	17	28.7	1.4579	
15	K-19	Killdeer	June 29	L	N	19	9.63	0.9836	
Arith/**Geo Mean**							28.8	1.3571	***22.8***
SD							17.4	0.3397	***2.2***
SE								0.1519	***1.4***
95% CI								1.0593	***11.5***
								1.6549	***45.2***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 3. Project site recurvirostrid egg-selenium concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	S-01	Black-necked Stilt	May 3	L	U	3-6	48.1	1.6821	
02	S-02	Black-necked Stilt	May 3	U	U	<3	12.6	1.1004	
03	S-03	Black-necked Stilt	May 3	L	U	3-6	19.6	1.2923	
04	S-04	Black-necked Stilt	May 12	L	N	9	34.4	1.5366	
05	S-05	Black-necked Stilt	May 12	U	U	<3	28.8	1.4594	
06	A-02	American Avocet	May 17	U	U	<3	27.5	1.4393	
07	S-06	Black-necked Stilt	May 24	L	U	6	56.9	1.7551	
08	A-03	American Avocet	June 1	L	N	17	33.4	1.5237	
09	A-04	American Avocet	June 1	U	U	<3	36.3	1.5599	
10	S-07	Black-necked Stilt	June 6	L	U	3-6	95.1	1.9782	
11	S-08	Black-necked Stilt	June 21	L	N	17	25.5	1.4065	
12	S-09	Black-necked Stilt	June 21	L	N	15	26.0	1.4150	
13	A-06	American Avocet	June 28	U	U	undeveloped	3.39	0.5302	
14	S-10	Black-necked Stilt	June 29	L	N	17-19	39.4	1.5955	
15	S-11	Black-necked Stilt	June 29	U	U	undeveloped	4.92	0.6920	
16	S-12	Black-necked Stilt	June 29	L	N	9	15.7	1.1959	
17	S-13	Black-necked Stilt	July 5	L	U	6-9	9.40	0.9731	
Arith/**Geo Mean**							30.4	1.3609	***23.0***
SD							22.2	0.3708	***2.3***
SE								0.1658	***1.5***
95% CI								1.0359	***10.9***
								1.6859	***48.5***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 4. Project site Red-winged Blackbird concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Red-winged Blackbird	May 17	U	U	<3	12.1	1.0828	
02	Red-winged Blackbird	May 17	U	U	<3	6.80	0.8325	
03	Red-winged Blackbird	May 17	U	U	<3	5.54	0.7435	
04	Red-winged Blackbird	May 17	U	U	<3	6.49	0.8122	
05	Red-winged Blackbird	June 1	U	U	<3	9.04	0.9562	
06	Red-winged Blackbird	June 1	L	U	3	12.7	1.1038	
07	Red-winged Blackbird	June 1	U	U	<3	15.9	1.2014	
08	Red-winged Blackbird	June 1	L	U	6	6.26	0.7966	
09	Red-winged Blackbird	June 1	L	U	6	8.10	0.9085	
10	Red-winged Blackbird	June 1	U	U	<3	7.04	0.8476	
11	Red-winged Blackbird	June 1	L	N	14	13.2	1.1206	
Arith/**Geo Mean**						9.4	0.9460	***8.8***
SD						3.5	0.1564	***1.4***
SE							0.0699	***1.2***
95% CI							0.8089	***6.4***
							1.0831	***12.1***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 5. Reference area Killdeer egg-selenium concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Killdeer	May 10	L	U	3	5.07	0.7050	
02	Killdeer	May 10	U	U	<3	1.86	0.2695	
03	Killdeer	May 10	L	U	3	3.05	0.4843	
04	Killdeer	May 10	L	N	19	8.89	0.9489	
05	Killdeer	May 24	L	N	20+	6.30	0.7993	
06	Killdeer	May 24	L	N	20+	2.46	0.3909	
07	Killdeer	May 24	U	U	<3	7.28	0.8621	
08	Killdeer	May 31	L	U	3	11.8	1.0719	
09	Killdeer	May 31	L	U	6	8.84	0.9465	
10	Killdeer	May 31	L	U	6-9	10.0	1.0000	
11	Killdeer	May 31	U	U	<3	5.99	0.7774	
12	Killdeer	June 6	L	N	9	6.71	0.8267	
13	Killdeer	June 6	L	U	6-9	2.59	0.4133	
14	Killdeer	June 13	L	N	17	8.89	0.9489	
15	Killdeer	June 13	U	U	<3	7.92	0.8987	
Arith/**Geo Mean**						6.51	0.7562	***5.7***
SD						3.0	0.2497	***1.8***
SE							0.1117	***1.3***
95% CI							0.5374	***3.4***
							0.9751	***9.4***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 6. Reference area Recurvirostrid egg-selenium concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	Black-necked Stilt	May 10	U	U	<3	20.2	1.3054	
02	Black-necked Stilt	May 10	U	U	<3	8.29	0.9186	
03	Black-necked Stilt	May 10	U	U	<3	2.79	0.4456	
04	American Avocet	May 10	U	U	<3	1.72	0.2355	
05	Black-necked Stilt	May 10	U	U	<3	10.8	1.0334	
06	Black-necked Stilt	May 24	U	U	<3	7.10	0.8513	
07	Black-necked Stilt	May 24	U	U	<3	5.16	0.7126	
08	Black-necked Stilt	May 24	L	U	3	7.70	0.8865	
09	Black-necked Stilt	May 31	L	N	17	26.4	1.4216	
10	Black-necked Stilt	May 31	L	U	3	4.49	0.6522	
11	American Avocet	May 31	U	U	<3	7.22	0.8585	
12	American Avocet	May 31	L	U	6	6.46	0.8102	
13	American Avocet	May 31	U	U	<3	18.5	1.2672	
14	American Avocet	May 31	L	U	3-6	9.86	0.9939	
15	Black-necked Stilt	May 31	U	U	<3	6.96	0.8426	
16	American Avocet	May 31	L	N	15	40.9	1.6117	
17	American Avocet	June 6	L	U	3-6	3.34	0.5237	
Arith/**Geo Mean**						11.1	0.9042	***8.0***
SD						10.1	0.3541	***2.3***
SE							0.1584	***1.4***
95% CI							0.5938	***3.9***
							1.2145	***16.4***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 7. Reference area Red-winged Blackbird egg-selenium concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	R.W. Blackbird	June 13	L	U	3-6	3.32	0.5211	
02	R.W. Blackbird	June 13	L	U	3-6	3.99	0.6010	
03	R.W. Blackbird	June 13	L	U	9+	4.68	0.6702	
04	R.W. Blackbird	June 13	U	U	<3	6.13	0.7875	
05	R.W. Blackbird	June 13	L	U	3-6	3.87	0.5877	
06	R.W. Blackbird	June 13	L	U	6	2.67	0.4265	
07	R.W. Blackbird	June 13	L	U	1-3	3.64	0.5611	
08	R.W. Blackbird	June 13	U	U	<3	4.09	0.6117	
09	R.W. Blackbird	June 13	U	U	<3	4.35	0.6385	
10	R.W. Blackbird	June 13	L	U	6-9	3.54	0.5490	
11	R.W. Blackbird	June 13	L	U	3	6.40	0.8062	
Arith/**Geo Mean**						4.2	0.6146	***4.1***
SD						1.1	0.1107	***1.3***
SE							0.0495	***1.1***
95% CI							0.5176	***3.3***
							0.7116	***5.1***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

Table 8. Mitigation Site Recurvirostrid egg-selenium concentrations at Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

ID Number	Field Number	Species	Date 2006	Embryo Condition[a]	Embryo Status[b]	Embryo Age (days)	Selenium (ppm dry wt)	Log base 10	Anti-log
01	MA-02	American Avocet	June 14	D	U	9	14.7	1.1673	
02	MA-07	American Avocet	June 14	L	N	20+	16.6	1.2201	
03	MS-03	Black-necked Stilt	June 14	L	N	10	7.59	0.8802	
04	MS-04	Black-necked Stilt	June 14	L	N	15-16	7.33	0.8651	
05	MS-07	Black-necked Stilt	June 14	L	N	20+	9.68	0.9859	
Arith/**Geo Mean**							11.2	1.0237	***10.6***
SD							4.2	0.1631	***1.5***
SE								0.0729	***1.2***
95% CI								0.8808	***7.6***
								1.1667	***14.7***

[a]) L= Live, D= Dead, U= Unknown, [b]) N= Normal, A= Abnormal, U= Unknown.

EGG CHEMISTRY ANALYSIS

Egg-Selenium Data Analysis Between Sites

Egg-selenium concentrations were significantly higher in eggs collected from the project site relative to eggs collected from the reference area in 2006 for all three species groups (Table 9).

Table 9. Geometric mean egg-selenium concentrations from Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

Selenium			
Species **Location**	**n**	**Geo. Mean** **ppm se (dry wt)**	**Range**
Killdeer			
Project Site	15	22.8	4.37-54.7
Off-site Reference Samples	15	5.7	1.86-11.8
Significance difference ($t = 5.520$, $P < 0.0005$) between sites.			
Recurvirostrids			
Project Site	17	23.0	3.39-95.1
Off-site Reference Samples	17	8.0	1.72-40.9
Significance difference ($t = 3.673$, $P = 0.001$) between sites.			
Red-winged Blackbirds			
Project Site	11	8.8	5.54-15.9
Off-site Reference Samples	11	4.1	2.67-6.40
Significance difference ($t = 5.736$, $P < 0.0005$) between sites.			

Egg-Selenium Data Analysis Across Years

Killdeer egg-selenium concentration was 3.1 times greater at the project site (14.8 ± 1.1 ppm mean egg-selenium 2002-2006) than at the reference site (4.7 ± 1.1 ppm mean egg-selenium 2002-2006; $\chi^2 = 66.438$, df = 1, $P < 0.001$; Figure 10). Egg-selenium concentrations in recurvirostrids were 2.4 times higher at the project site (33.7 ± 2.7 ppm mean egg-selenium 2003-2006) relative to eggs collected from the reference area (14.1 ± 1.2 ppm mean egg-selenium 2003-2006; Table 10, Figure 11). Egg-selenium concentrations in Red-winged Blackbirds were 1.6 times higher at the project site (6.9 ± 0.4 ppm mean egg-selenium 2003, 2004, and 2006) compared to the reference site (4.3 ± 0.2 ppm mean egg-selenium 2003, 2004, and 2006; Table 10, Figure 12).

There was no difference in Killdeer egg selenium concentration among years ($\chi^2 = 3.750$, df = 4, $P = 0.441$). Overall, recurvirostrid egg selenium concentrations differed among years (Table 10). There was also a significant interaction between year and location, with a notable drop in selenium concentration at the project site during 2004 (Figure 11). Red-winged Blackbirds egg-selenium concentration differed among years, and there was a significant interaction between site

and year (Table 10). Most notably, egg-selenium concentration in 2006 (9.4 ± 1.1 ppm) was1.5 times higher than egg-selenium concentration 2003 and 2004 (6.1 ± 0.3 ppm; $F_{1,73} = 19.747$, $P < 0.001$) for this species.

Table 10. Results of ANOVAs for effects of location and year on egg-selenium concentration in recurvirostrids, and egg-selenium and egg-boron concentrations in Red-winged Blackbirds at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2003 to 2006).

Avian species group	Element	Factor	*F*	df	*P*
Recurvirostrids*	Selenium	site	42.924	1,119	<0.001
		year	7.372	3,119	<0.001
		site year	1.909	3,119	0.0132
Red-winged Blackbird	Selenium	site	71.043	1,73	<0.001
		year	4.492	2,73	0.014
		site year	5.557	2,73	0.006
Red-winged Blackbird	Boron	site	1.683	1,73	0.199
		year	3.501	2,73	0.035
		site year	18.624	2,73	<0.001

*Egg-boron concentrations for recurvirostrids were analyzed using Kruskal-Wallis tests and are not presented on this table.

The interaction between "year" and "site" was tested after the main effects for the two respective variables had been tested.

Figure 10. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for Killdeer at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2002 to 2006).

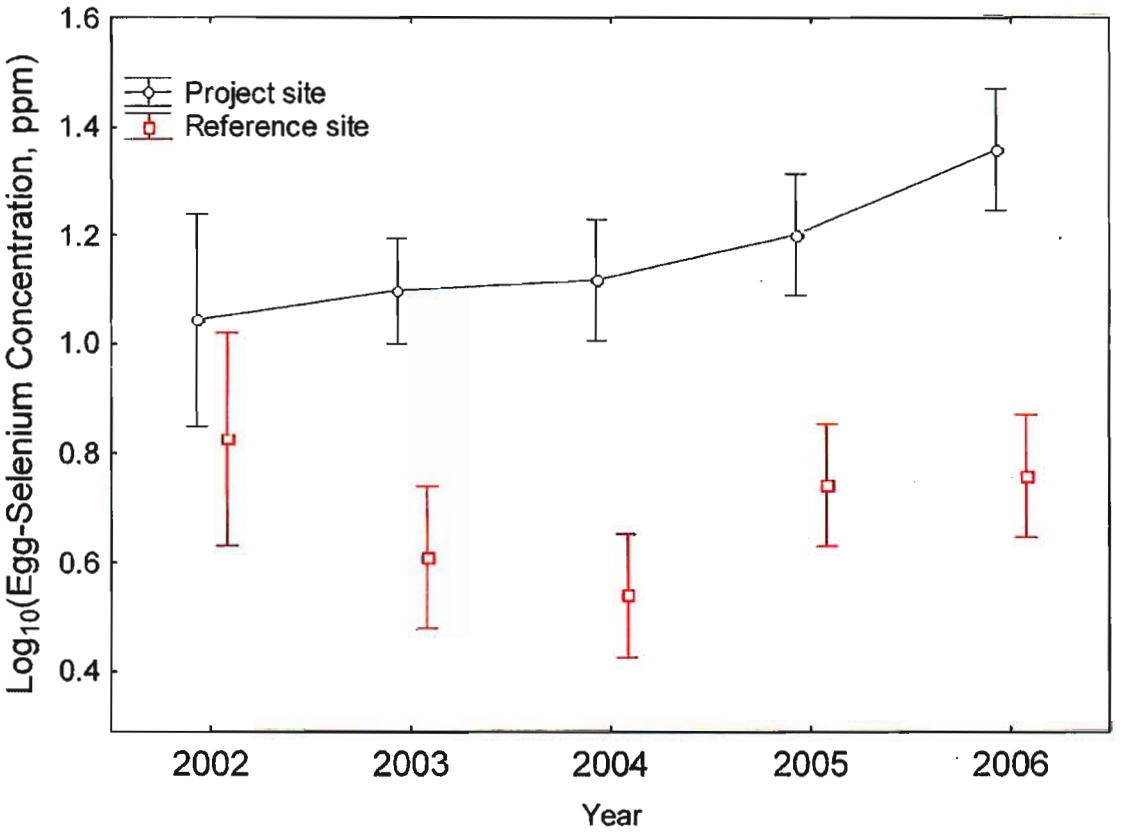


Figure 11. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for recurvirostrids at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2003 to 2006).

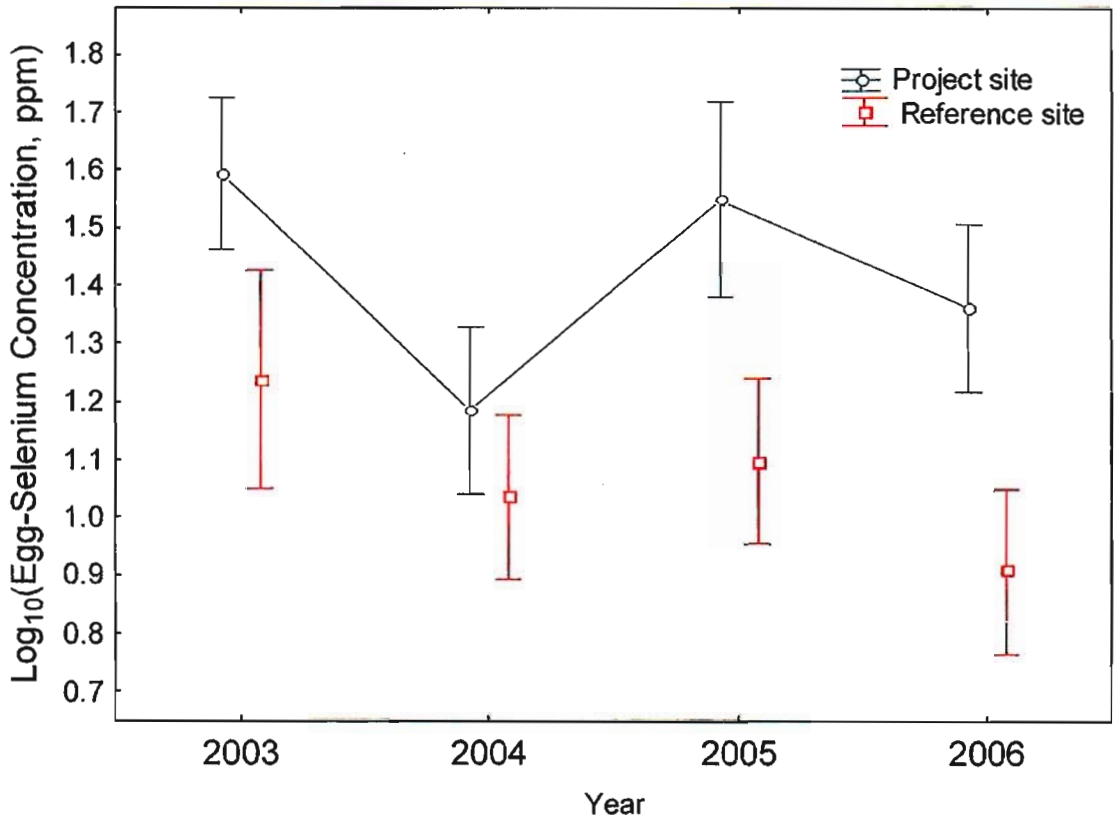
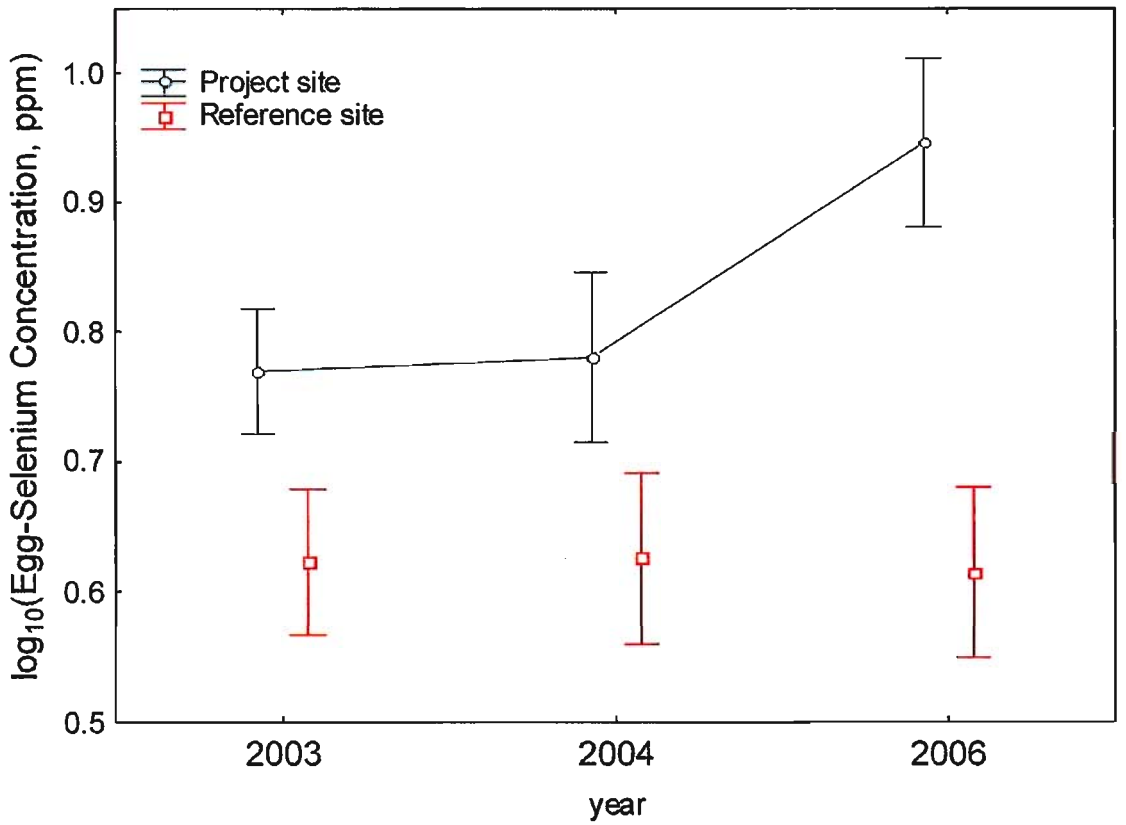


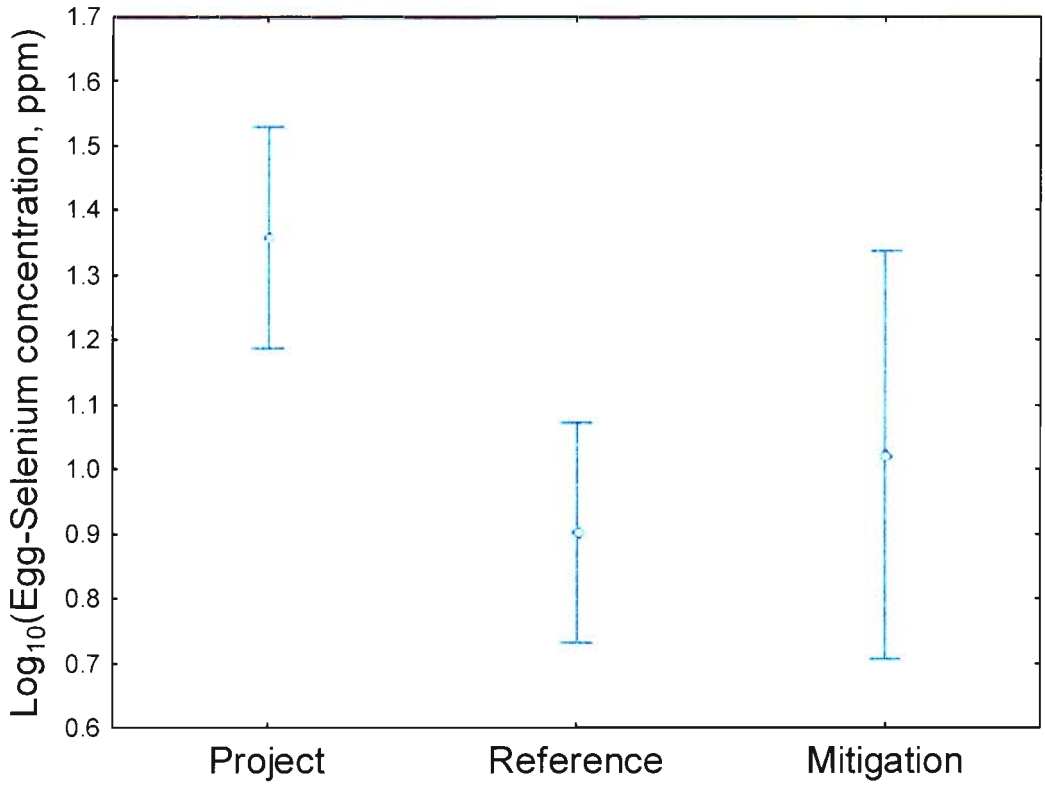
Figure 12. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for Red-winged Blackbirds at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2003, 2004, and 2006).



Recurvirostrid Mitigation Site Selenium Concentrations

In 2006, egg-selenium concentrations in recurvirostrids were different among sites ($F_{2,36} = 7.616$, $P = 0.002$), but project (30.4 ± 5.4 ppm) and reference sites (11.1 ± 2.5 ppm) did not differ from the pilot mitigation site (11.2 ± 1.9 ppm; $P > 0.05$; Figure 13).

Figure 13. Mean ± 95% Confidence Interval (CI) egg-selenium concentration for recurvirostrids at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2006).



EGG-BORON ANALYSIS

Egg-Boron Data Analysis Between Sites

Boron concentrations were significantly higher in eggs collected from the project site than eggs collected from the reference area for both Killdeer and Red-winged Blackbirds. There was no significant difference in recurvirostrid eggs collected from the two sites in 2006 (Table 11). The raw boron data are presented in Appendices A, B, and C.

Table 11. Geometric mean egg-boron concentrations from Panoche Drainage District's San Joaquin River Water Quality Improvement Project.

	Boron		
Species **Location**	**n**	**Geo. Mean** **ppm B (dry wt)**	**Range**
Killdeer			
Project Site	15	2.4	0.472-5.88
Off-site Reference Samples	15	1.1	0.050-5.61
Significance difference ($t = 2.462$, $P = 0.021$) between sites.			
Recurvirostrids			
Project Site	17	4.6	0.697-11.3
Off-site Reference Samples	17	3.3	0.050-24.8
No significant difference ($t = 0.823$, $P = 0.420$) between sites.			
Red-winged Blackbirds			
Project Site	11	9.5	5.30-16.8
Off-site Reference Samples	11	4.0	1.41-6.74
Significance difference ($t = 5.071$, $P < 0.0005$) between sites.			

Egg-Boron Data Analysis Across Years

Egg-boron concentration in Killdeer was 1.9 times greater at the project site (3.7 ± 0.4 ppm mean egg-boron) than at the reference site (1.9 ± 0.2 ppm mean egg-boron; $\chi^2 = 13.483$, df = 1, $P = 0.009$, Figure 14) from 2002 to 2006. From 2003 to 2006, egg-boron concentrations in recurvirostrids averaged 1.1 times higher from the project site (4.5 ± 0.4 ppm mean egg-boron) relative to eggs collected from the reference area (4.1 ± 0.6 ppm mean egg-boron), although this difference was not significant in any year except 2005 ($\chi^2 = 4.945$, df = 1, $P = 0.026$; Figure 15). Though egg-boron concentrations in Red-winged Blackbirds collected from the project site in 2006 were significantly higher at the project site than at the reference area (Table 11), there was no significant difference when analyzed across years (Table 10). There was a significant interaction between site and year (Table 10, Figure 16). Interestingly, egg-boron concentration in this species was apparently similar between sites in 2003, greater at the reference site in 2004, and greater at the project site in 2006.

Killdeer egg-boron concentrations were different among years (χ^2 = 13.483, df = 4, P = 0.009; Figure 14). Recurvirostrid egg-boron concentrations differed among years (χ^2 = 3.750, df = 4, P = 0.004), although this was probably influenced by a significant (P = 0.021) interaction between year and site (Figure 14). In Red-winged Blackbirds, egg-boron concentration differed among years, although there was a significant interaction between site and year as mentioned above.

Figure 14. Mean ± 95% Confidence Interval (CI) egg-boron concentration for Killdeer at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2002 to 2006).

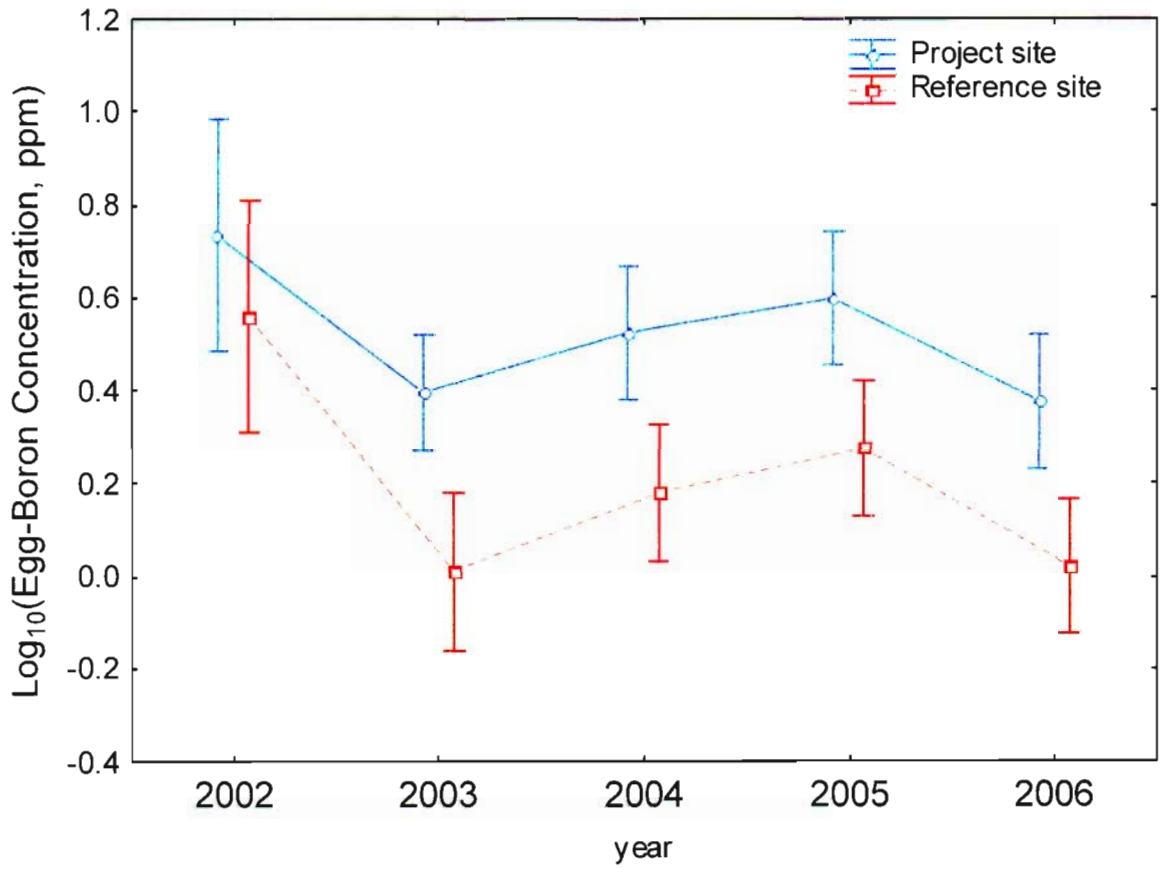


Figure 15. Mean ± 95% Confidence Interval (CI) egg-boron concentration for recurvirostrids at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2003 to 2006).

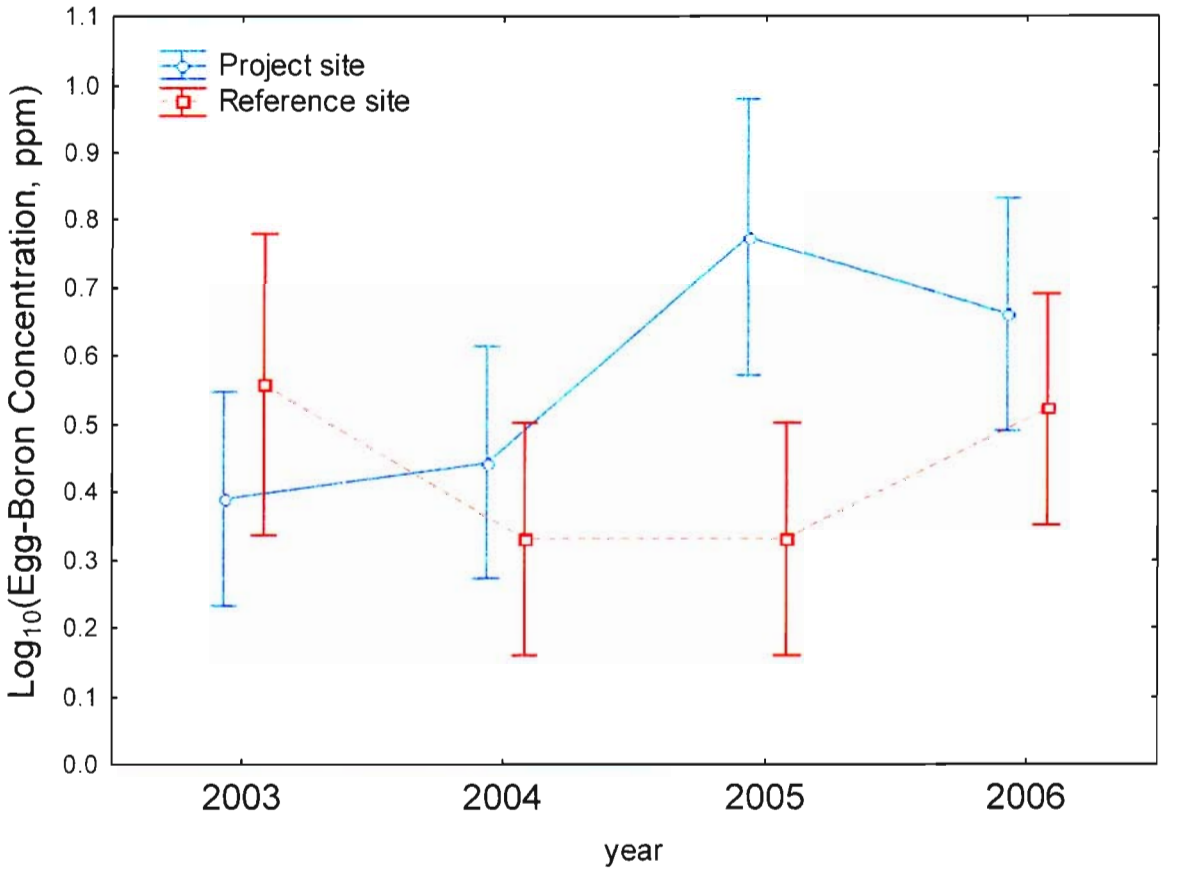
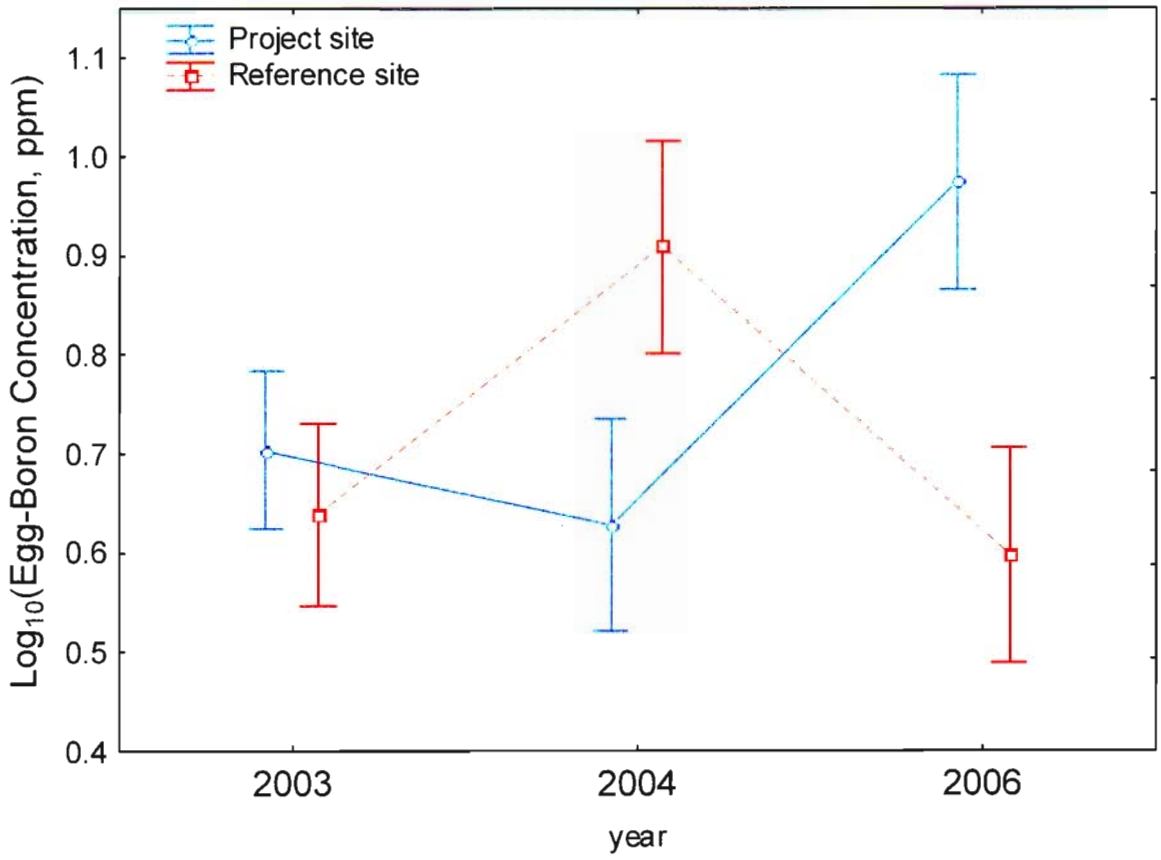


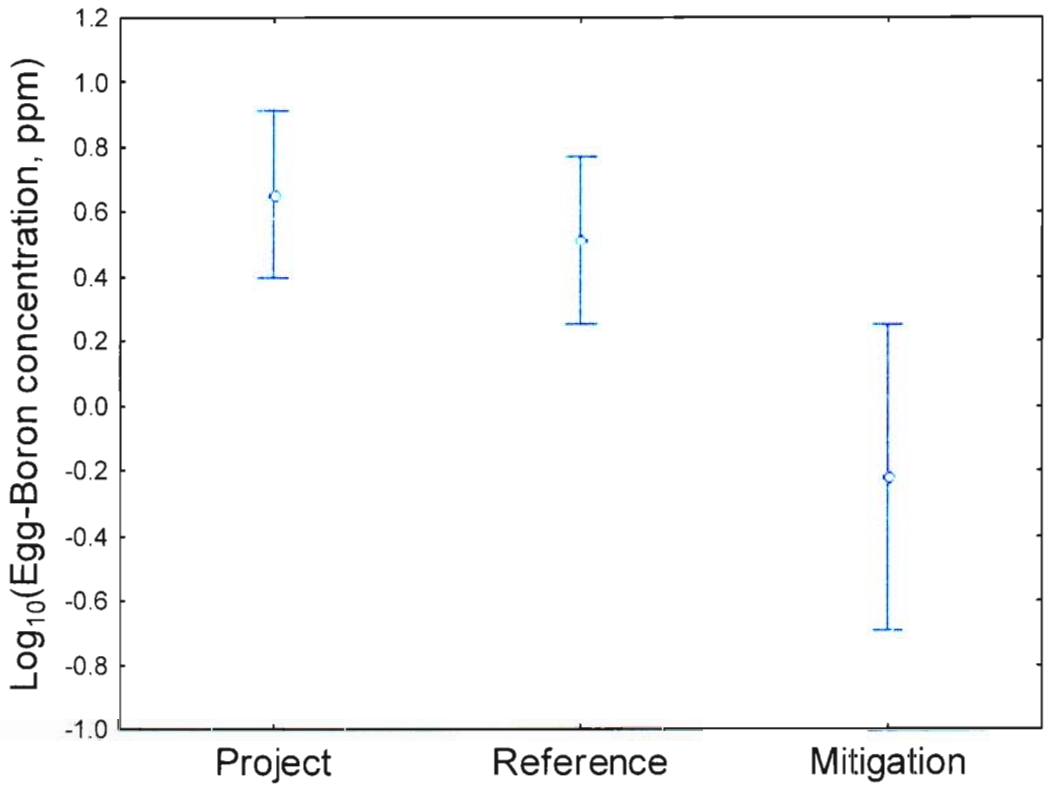
Figure 16. Mean ± 95% Confidence Interval (CI) egg-boron concentration for Red-winged Blackbirds at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2003, 2004, and 2006).



Recurvirostrid Mitigation Site Boron Concentrations

In 2006, egg-boron concentrations in recurvirostrids were different among sites ($F_{2,36} = 5.486$, $P = 0.008$), and both the project site (5.2 ± 0.6 ppm) and reference site (6.7 ± 1.7 ppm) were 4.2 and 5.4 times greater on average, respectively, in boron concentration than the pilot mitigation site (1.2 ± 0.7 ppm, $P < 0.05$; Figure 17).

Figure 17. Mean ± 95% Confidence Interval (CI) egg-boron concentration for recurvirostrids at Panoche Drainage District's San Joaquin River Water Quality Improvement Project (2006).



CONTROL EGGS

The selenium recovery rate for 15 egg samples spiked with selenium ranged between 93 % and 116 %, with a mean selenium recovery rate of 102 % (Appendix D). Additionally, an average value of 0.712 ug/g Se was obtained on NIST Standard Reference Material 1577b (certified value = 0.73 ± 0.06 ug/g). The standard deviation of duplicate egg samples ranged between 0.0000 and 3.7477 with a mean standard deviation of 0.4658 (Appendix E).

The boron recovery rate for 4 egg samples spiked with boron ranged between 92.9 percent and 104 percent, with a mean selenium recovery rate of 97.2 percent (Appendix F). The standard deviation of boron results from 22 duplicate egg samples ranged between 0.0000 and 0.7778, and the mean standard deviation was 0.3069 (Appendix F).

NEST FATE

Nineteen Killdeer and 19 recurvirostrid nests were followed to completion on the project site in 2006 (Table 12 and Appendix H). Four of the Killdeer nests hatched, 12 were lost to predators and 3 were destroyed by vehicles. Ten of the recurvirostrid nests were depredated and one was destroyed by a vehicle. The remaining 8 recurvirostrid nests hatched at least 1 chick, though one Black-necked Stilt nest that appeared to hatch also contained 2 eggs that failed to hatch (Appendix G)

Seven Killdeer nests and 20 recurvirostrid nests were monitored at the mitigation site. Four of the Killdeer nests and 8 of the recurvirostrid nests hatched successfully. The Killdeer and recurvirostrid nests that were located on the islands within the rice field hatched successfully with the exception of 1 American Avocet nest that was abandoned. All of the nests that were located on the levees of the rice field were taken by predators (Appendix G).

Table 12. Nest fates and agents that caused nest/clutch success or failure at the Panoche Drainage District's San Joaquin River Water Quality Improvement Project Site and Mitigation Site in 2006.

Project Site									
Species	**Hatched**		**Depredated**		**Abandoned**		**Vehicle**		**Total**
	Nests	Percent (%)	Nests	Percent (%)	Nests	Percent (%)	Nests	Percent (%)	
Killdeer	4	*21*	12	*63*			3	*16*	19
Recurvirostrids	8	*42*	10	*53*			1	*5*	19
Black-necked Stilt	*(4)*		*(8)*				*(1)*		*(13)*
American Avocet	*(4)*		*(2)*						*(6)*
Total	**12**	***32***	**22**	***58***			**4**	***11***	**38**
Mitigation Site									
Killdeer	4	*57*	3	*43*					**7**
Recurvirostrids	8	*40*	11	*55*	1	*5*			**20**
Black-necked Stilt	*(5)*		*(6)*						*(11)*
American Avocet	*(3)*		*(5)*		*(1)*				*(9)*
Total	**12**	***44***	**14**	***52***	**1**	***4***			**27**

PILOT MITIGATION SITE WATER QUALITY

The results of the water quality analysis for the pilot mitigation site are summarized in Table 13. Selenium and boron concentrations in the water samples from the inlet and outlet of the pilot mitigation site were well below the 2.3 ppb selenium and 5 ppm boron thresholds for safe exposure to wildlife in freshwater (Eisler 1990, Skorupa and Ohlendorf 1991, and Suter 1996).

Table 13. Water quality in samples from the pilot mitigation site.*

Pilot Mitigation Site Inlet Water Sample	
Electrical conductivity, uhmos/cm	230
Selenium concentration (ppb)	<0.400
Boron concentration (ppm)	0.065
Pilot Mitigation Site Oulet Water Sample	
Electrical conductivity, uhmos/cm	834
Selenium concentration (ppb)	1.00
Boron concentration (ppm)	1.46

* Water quality sampled on 6 June 2006

DISCUSSION

The census data indicate that the project site is utilized by bird species common in San Joaquin Valley agricultural habitats. Both species diversity and relative abundance are lower than expected in native, undisturbed habitats. The tall vegetation within some pastures provided nesting habitat for Red-winged Blackbirds. Irrigation of pastures and alfalfa provide temporary foraging opportunities for birds such as White-faced Ibis, Whimbrels, and blackbirds.

Swainson's Hawks (*Buteo swainsoni*), which are listed as threatened by the state of California, were observed foraging on the project site. In 2006, as in each year since 2002, one pair of Swainson's Hawks successfully nested just north of the project site. Two species listed as "species of concern" by the state of California, the Burrowing Owl (*Athene cunicularia*), the Loggerhead Shrike (*Lanius ludovicianus*) were observed nesting on the project site. The Black Tern (*Chlidonias niger*), another "species of concern" was observed foraging, but not nesting, on the project site.

The mean egg-selenium levels in Killdeer and recurvirostrid eggs at the project site in 2006 were above selenium levels associated with a high probability of reproductive effects, including reduced hatchability and increased occurrence of embryo deformities (teratogenesis) within a population (CH2M-Hill *et al.* 1993). For a more thorough discussion of established egg-selenium thresholds see the monitoring report for 2005 (H. T. Harvey & Associates 2006). In 2006 the Panoche Drainage District implemented 3 measures to avoid and minimize impacts to nesting shorebirds. These measures included hazing of shorebirds from the project site, modification of open drains to discourage shorebirds from using traditional nest sites, and installation of a pilot mitigation site to provide clean water nesting habitat for shorebirds.

The implementation of 2 of these measures was hampered by heavier than normal spring rains throughout April. The resulting wet ground conditions delayed ground-moving equipment from modifying the open drains and from constructing the rice field where the pilot mitigation site was placed. As soon as the roads dried, the drain between Sections 2 and 3 was dredged, as was the westernmost of the three drains that run north/south in Section 2. The dredging removed nesting substrate in the bottom of the drains. Before the remaining drains could be dredged, Black-necked Stilt and American Avocet nests were detected there, so the work was halted. No Shorebird nests were located in the drains that were modified.

The delay in preparing the rice field and pilot mitigation site resulted in the field not being flooded until late May. The wet conditions also limited the choices of fields where the islands of the pilot mitigation site could be built, and, as a result, the pilot mitigation site was sited adjacent to the project site. Nest initiation by recurvirostrids did not occur there until the last week of May. It is probable that the late start shortened the period when nesting could occur at the pilot mitigation site and therefore reduced the number of shorebird nest attempts at the pilot mitigation site.

The pilot mitigation site contained as many islands as possible without having to bring in additional dirt. The 16 islands that were constructed throughout the 50-acre pilot mitigation site provided improved nesting habitat for recurvirostrids and Killdeer. All but one of the nests

located on the islands successfully hatched, while all of the nests located on the rice levees were depredated.

The mean egg-selenium content of recurvirostrid eggs sampled from the pilot mitigation site was between the project site and reference area samples. This result indicates that the pilot mitigation site may have had a dilution effect on recurvirostrid egg-selenium levels and that the birds that nested there likely foraged at the project site prior to nesting. In this way, the pilot mitigation site acted more as alternative habitat than as compensation habitat mitigation. Constructing and flooding the mitigation site sooner to increase the length of time during which shorebirds can nest and locating the mitigation site further from the project site would likely result in its functioning more as compensation habitat rather than alternative habitat.

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APPENDIX A. 2006 KILLDEER EGG-BORON CONCENTRATIONS AT PANOCHE DRAINAGE DISTRICT'S SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area			
ID Number	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**	**ID Number**	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**
01	2.64	0.4216		01	1.13	0.0531	
02	5.88	0.7694		02	0.491	-0.3089	
03	4.99	0.6981		03	1.11	0.0453	
04	1.93	0.2856		04	0.866	-0.0625	
05	1.80	0.2553		05	1.53	0.1847	
06	3.01	0.4786		06	1.72	0.2355	
07	1.81	0.2577		07	1.17	0.0682	
08	1.56	0.1931		08	1.19	0.0755	
09	2.51	0.3997		09	1.99	0.2989	
10	2.65	0.4232		10	3.37	0.5276	
11	4.86	0.6866		11	0.885	-0.0531	
12	0.689	-0.1618		12	0.533	-0.2733	
13	3.41	0.5328		13	0.05	-1.3010	
14	5.43	0.7348		14	5.61	0.7490	
15	0.472	-0.3261		15	1.36	0.1335	
Arith/**Geo Mean**	2.91	0.3766	***2.4***	Arith/**Geo Mean**	1.53	0.0248	***1.1***
SD	1.7	0.3135	***2.1***	SD	1.4	0.4560	***2.9***
SE		0.1402	***1.4***	SE		0.2039	***1.6***
95% CI		0.1018	***1.3***	95% CI		-0.3749	***0.4***
		0.6514	***4.5***			0.4246	***2.7***

APPENDIX B. 2006 RECURVIROSTRID EGG-BORON CONCENTRATIONS AT PANOCHE DRAINAGE DISTRICT'S SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area				Mitigation Site			
ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log	ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log	ID Number	Boron (ppm dry wt)	Log Base 10	Anti-log
01	4.73	0.6749		01	1.64	0.2148		01	0.05	-1.3010	
02	4.13	0.6160		02	24.8	1.3945		02	0.785	-0.1051	
03	4.95	0.6946		03	3.02	0.4800		03	0.655	-0.1838	
04	3.95	0.5966		04	6.76	0.8299		04	0.884	-0.0535	
05	3.99	0.6010		05	13.7	1.1367		05	3.83	0.5832	
06	7.23	0.8591		06	5.65	0.7520					
07	7.69	0.8859		07	19.3	1.2856					
08	5.45	0.7364		08	15.1	1.1790					
09	11.3	1.0531		09	0.05	-1.3010					
10	5.51	0.7412		10	4.67	0.6693					
11	5.61	0.7490		11	1.79	0.2529					
12	3.70	0.5682		12	3.7	0.5647					
13	0.697	-0.1568		13	0.755	-0.1221					
14	5.98	0.7767		14	4.30	0.6335					
15	3.64	0.5611		15	2.34	0.3692					
16	3.10	0.4914		16	5.46	0.7372					
17	5.93	0.7731		17	0.573	-0.2418					
Arith/Geo Mean	5.15	0.6601	*4.6*	Arith/Geo Mean	6.68	0.5197	*3.3*	Arith/Geo Mean	1.2	-0.2121	*0.6*
SD	2.27	0.2521	*1.8*	SD	7.19	0.6566	*4.5*	SD	1.5	0.6811	*4.8*
SE		0.1127	*1.3*	SE		0.2936	*2.0*	SE		0.3046	*2.0*
95% CI		0.4391	*2.7*	95% CI		-0.0558	*0.9*	95% CI		-0.8091	*0.2*
		0.8810	*7.6*			1.0952	*12.4*			0.3850	*2.4*

APPENDIX C. RED-WINGED BLACKBIRD EGG-BORON CONCENTRATIONS AT PANOCHE DRAINAGE DISTRICT'S SAN JOAQUIN RIVER WATER QUALITY IMPROVEMENT PROJECT.

Project Site				Reference Area			
ID Number	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**	**ID Number**	**Boron (ppm dry wt)**	**Log Base 10**	**Anti-log**
01	9.96	0.9983		01	4.23	0.6263	
02	9.27	0.9671		02	4.62	0.6646	
03	5.30	0.7243		03	2.70	0.4314	
04	9.20	0.9638		04	1.41	0.1492	
05	6.35	0.8028		05	3.33	0.5224	
06	6.43	0.8082		06	6.74	0.8287	
07	11.8	1.0719		07	4.16	0.6191	
08	9.18	0.9628		08	4.16	0.6191	
09	16.8	1.2253		09	3.94	0.5955	
10	9.88	0.9948		10	5.40	0.7324	
11	16.5	1.2175		11	6.37	0.8041	
Arith/**Geo Mean**	10.06	0.9761	***9.5***	Arith/**Geo Mean**	4.28	0.5994	***4.0***
SD	3.76	0.1589	***1.4***	SD	1.54	0.1884	***1.5***
SE		0.0711	***1.2***	SE		0.0842	***1.2***
95% CI		0.8368	***6.9***	95% CI		0.4343	***2.7***
		1.1153	***13.0***			0.7644	***5.8***

APPENDIX D. CONTROL EGGS SELENIUM SPIKE RESULTS

ID Number	Tissue	Spiked Selenium (ug)	% Recovery
PD-P-K-02	egg		92.9
PD-P-K-03	egg		102
PD-P-K-09	egg		112
PD-R-K-05	egg		94.6
PD-R-K-08	egg		106
PD-P-R-07	egg		116
PD-R-Rc-12	egg		104
PD-R-B-01	egg		101
PD-R-B-05	egg		107
PD-M-R-05	egg		99
BZA-04	egg		101
BGR-04	egg		100
LHM-04	egg		101
LHM-05	egg		95.4
TL-H-02	egg		97.8
		Mean	102.0
		Standard deviation	6.3

Additionally, an average value of 0.712 ug/g Se was obtained on NIST Standard Reference Material 1577b (certified value = 0.73 $\pm$ 0.06 ug/g).

APPENDIX E. CONTROL EGGS SELENIUM DUPLICATE RESULTS

(SD = Standard Deviation)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDP-K-01	1	36.7	PDP-B-01	1	11.5
	2	36.6		2	12.7
SD*		***0.0707***	***SD***		***0.8485***
PDP-K-02	1	27.4	PDP-B-02	1	7.13
	2	28.7		2	6.46
SD		***0.9192***	***SD***		***0.4738***
PDP-K-03	1	15.0	PDP-B-03	1	5.63
	2	15.8		2	5.46
SD		***0.5657***	***SD***		***0.1202***
PDP-K-04	1	4.24	PDP-B-04	1	6.72
	2	4.62		2	6.27
SD		***0.2687***	***SD***		***0.3182***
PDP-K-05	1	42.7	PDP-B-05	1	9.30
	2	43.1		2	8.78
SD		***0.2828***	***SD***		***0.3677***
PDP-K-06	1	42.2	PDP-B-06	1	13.8
	2	45.3		2	11.5
SD		***2.1920***	***SD***		***1.6263***
PDP-K-07	1	50.2	PDP-B-07	1	16.4
	2	50.9		2	15.4
SD		***0.4950***	***SD***		***0.7071***
PDP-K-08	1	53.2	PDP-B-08	1	6.20
	2	55.5		2	6.32
SD		***1.6263***	***SD***		***0.0849***
PDP-K-09	1	53.9	PDP-B-09	1	7.98
	2	55.9		2	8.21
	3	54.3	***SD***		***0.1626***
SD		***1.0583***	PDP-B-10	1	7.04
PDP-K-10	1	14.7		2	7.04
	2	14.2	***SD***		***0.0000***
SD		***0.3536***	PDP-B-11	1	12.9
PDP-K-11	1	25.1		2	13.5
	2	24.5	***SD***		***0.4243***
SD		***0.4243***			

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDP-K-12	1	7.26	PDR-B-01	1	3.35
	2	7.19		2	3.29
	3	6.99	***SD***		***0.0424***
SD		***0.1401***	PDR-B-02	1	3.79
PDP-K-13	1	16.3		2	4.19
	2	17.2	***SD***		***0.2828***
SD*		***0.6364***	PDR-B-03	1	4.50
PDP-K-14	1	29.7		2	4.85
	2	27.7	***SD***		***0.2475***
SD		***1.4142***	PDR-B-04	1	6.19
PDP-K-15	1	9.90		2	6.07
	2	9.36	***SD***		***0.0849***
SD		***0.3818***	PDR-B-05	1	3.46
PDR-K-01	1	5.07		2	4.28
	2	5.07	***SD***		***0.5798***
SD		***0.0000***	PDR-B-06	1	2.36
PDR-K-02	1	1.79		2	2.98
	2	1.93	***SD***		***0.4384***
SD		***0.0990***	PDR-B-07	1	3.35
PDR-K-03	1	3.00		2	3.81
	2	3.15		3	3.77
SD		***0.1061***	***SD***		***0.2548***
PDR-K-04	1	8.98	PDR-B-08	1	3.85
	2	8.80		2	4.36
SD		***0.1273***		3	4.06
PDR-K-05	1	6.40	***SD***		***0.2563***
	2	6.44	PDR-B-09	1	4.65
	3	6.05		2	4.05
SD		***0.2146***	***SD***		***0.4243***
PDR-K-06	1	2.45	PDR-B-10	1	3.54
	2	2.45		2	3.54
	3	2.47	***SD***		***0.0000***
SD		***0.0115***	PDR-B-11	1	5.75
				2	6.40
			SD		***0.4596***

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDR-K-07	1	7.36	BZA-01	1	1.62
	2	7.11		2	1.60
SD		***0.1768***	***SD***		***0.0141***
PDR-K-08	1	12.0	BZA-02	1	1.50
	2	11.6		2	1.55
SD		***0.2828***	***SD***		***0.0354***
PDR-K-09	1	8.67	BZA-03	1	2.72
	2	9.18		2	2.90
SD		***0.3606***	***SD***		***0.1273***
PDR-K-10	1	9.91	BZA-04	1	1.66
	2	10.3		2	1.83
SD		***0.2758***	***SD***		***0.1202***
PDR-K-11	1	5.90	BZA-05	1	3.39
	2	6.16		2	3.56
SD		***0.1838***	***SD***		***0.1202***
PDR-K-12	1	4.97	BZG-01	1	1.170
	2	7.56		2	1.250
	3	8.03	***SD***		***0.0566***
	4	5.11	BZG-02	1	0.785
	5	7.88		2	0.770
SD		***1.5347***		3	0.842
PDR-K-13	1	2.50	***SD***		***0.0380***
	2	2.68	BZG-03	1	1.18
SD		***0.1273***		2	1.27
PDR-K-14	1	8.89	***SD***		***0.0636***
	2	8.89	BZG-04	1	1.28
SD		***0.0000***		2	1.30
PDR-K-15	1	7.90	***SD***		***0.0141***
	2	7.94	BZG-05	1	0.944
SD		***0.0283***		2	1.04
PDP-R-01	1	48.5	***SD***		***0.0679***
	2	47.7	LHE-01	1	24.3
SD		***0.5657***		2	24.0
PDP-R-02	1	12.5		3	24.0
	2	12.7		4	24.3
SD		***0.1414***	***SD***		***0.1732***

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDP-R-03	1	19.1	LHE-02	1	50.6
	2	20.1		2	53.1
SD		***0.7071***		3	49.4
PDP-R-04	1	34.5	***SD***		***1.8877***
	2	35.1	LHE-03	1	24.4
SD		***0.4243***		2	22.8
PDP-R-05	1	28.5	***SD***		***1.1314***
	2	29.0	LHE-04	1	28.7
SD		***0.3536***		2	28.2
PDP-R-06	1	27.1		3	29.8
	2	27.9		4	29.2
SD		***0.5657***	***SD***		***0.6850***
PDP-R-07	1	57.9	LHE-05	1	6.91
	2	55.9		2	6.59
SD		***1.4142***		3	6.51
PDP-R-08	1	33.0		4	6.47
	2	34.5	***SD***		***0.1997***
	3	32.6	LHM-01	1	4.53
SD		***1.0017***		2	7.81
PDP-R-09	1	36.2	***SD***		***2.3193***
	2	36.4	LHM-02	1	2.78
SD		***0.1414***		2	2.83
PDP-R-10	1	97.7	***SD***		***0.0354***
	2	92.4	LHM-03	1	1.66
SD		***3.7477***		2	1.60
PDP-R-11	1	25.9	***SD***		***0.0424***
	2	24.7	LHM-04	1	6.56
	3	26.8		2	7.94
	4	24.5		3	8.70
SD		***1.0782***		4	6.35
PDP-R-12	1	25.0	***SD***		***1.1238***
	2	26.2	LHM-05	1	9.65
	3	26.9		2	10.5
SD		***0.9609***	***SD***		***0.6010***

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDP-R-13	1	3.42	TL-C-01	1	2.17
	2	3.36		2	2.19
SD*		***0.0424***	***SD***		***0.0141***
PDP-R-14	1	39.0	TL-C-02	1	2.13
	2	39.8		2	2.20
SD		***0.5657***	***SD***		***0.0495***
PDP-R-15	1	4.98	TL-C-03	1	2.80
	2	4.86		2	2.86
SD		***0.0849***	***SD***		***0.0424***
PDP-R-16	1	16.0	TL-C-04	1	2.17
	2	15.4		2	2.11
SD		***0.4243***	***SD***		***0.0424***
PDP-R-17	1	9.56	TL-C-05	1	3.82
	2	9.25		2	3.58
SD		***0.2192***	***SD***		***0.1697***
PDR-Rc-01	1	20.2	TL-H-01	1	11.7
	2	20.3		2	11.5
SD		***0.0707***	***SD***		***0.1414***
PDR-Rc-02	1	8.45	TL-H-02	1	7.70
	2	8.13		2	7.29
SD		***0.2263***	***SD***		***0.2899***
PDR-Rc-03	1	2.81	TL-H-03	1	7.40
	2	2.77		2	7.48
SD		***0.0283***	***SD***		***0.0566***
PDR-Rc-04	1	1.74	TL-H-04	1	12.6
	2	1.71		2	13.3
SD		***0.0212***	***SD***		***0.4950***
PDR-Rc-05	1	12.4	TL-H-05	1	4.51
	2	9.29		2	4.39
SD		***2.1991***	***SD***		***0.0849***
PDR-Rc-06	1	7.29	TL-S-01	1	19.2
	2	6.90		2	17.1
SD		***0.2758***		3	18.1
PDR-Rc-07	1	5.28		4	18.7
	2	5.03	***SD***		***0.9032***
SD		***0.1768***			

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDR-Rc-08	1	7.43	TL-S-02	1	34.8
	2	8.47		2	32.0
SD		***0.7354***	***SD***		***1.9799***
PDR-Rc-09	1	25.3	TL-S-03	1	19.2
	2	27.4		2	19.8
SD		***1.4849***	***SD***		***0.4243***
PDR-Rc-10	1	4.55	TL-S-04	1	32.3
	2	4.43		2	31.9
SD		***0.0849***		3	28.1
PDR-Rc-11	1	7.24		4	35.3
	2	7.20	***SD***		***2.9530***
SD		***0.0283***	TL-S-05	1	32.5
PDR-Rc-12	1	7.53		2	31.6
	2	5.54	***SD***		***0.6364***
SD		***1.4071***	WLS-01	1	3.36
PDR-Rc-13	1	18.9		2	3.46
	2	18.2	***SD***		***0.0707***
SD		***0.4950***	WLS-02	1	2.71
PDR-Rc-14	1	10.2		2	2.72
	2	9.51	***SD***		***0.0071***
SD		***0.4879***	WLS-03	1	2.21
PDR-Rc-15	1	7.42		2	2.29
	2	6.51	***SD***		***0.0566***
SD		***0.6435***	WLS-04	1	3.84
PDR-Rc-16	1	41.1		2	3.99
	2	40.9	***SD***		***0.1061***
SD		***0.1414***	WLS-05	1	3.76
PDR-Rc-17	1	3.24		2	3.76
	2	3.45		3	3.52
SD		***0.1485***	***SD***		***0.1386***
PDM R-01	1	15.0			
	2	14.7			
	3	14.0			
SD		***0.5132***			
PDM R-02	1	16.4			
	2	16.8			
SD		***0.2828***			

Appendix E. Control Eggs – Selenium Duplicate Results (continued)

ID Number	*Replication*	*Result Selenium*	*ID Number*	*Replication*	*Result Selenium*
PDM R-03	1	7.59			
	2	7.59			
SD		***0.0000***			
PDM R-04	1	7.37			
	2	7.30			
SD		***0.0495***			
PDM R-05	1	9.85			
	2	9.61			
	3	9.57			
SD		***0.1514***			

Mean SD:	0.4658
Low SD:	0.0000
High SD:	3.7477

APPENDIX F. CONTROL EGGS BORON RESULTS

Boron Control Spikes.

ID Number	Tissue	Spiked Selenium (ug)	% Recovery
PDP-K-13	egg		92.9
PD-R-K-09	egg		97
PD-R-Rc-12	egg		104
PD-M-R-02	egg		95
		Mean	97.2
		Standard deviation	4.8

Control Eggs – Boron Duplicate Results.

(SD = Standard Deviation)

ID Number	Replication	Result Selenium	ID Number	Replication	Result Selenium
PDP-K-01	1	2.57	PDP-R-08	1	5.27
	2	2.70		2	5.64
SD*		***0.0919***	***SD***		***0.2616***
PDP-K-12	1	1.04	PDP-R-11	1	5.44
	2	0.336		2	5.56
SD		***0.4978***		3	5.84
PDR-K-01	1	1.12	***SD***		***0.2053***
	2	1.63	PDP-R-17	1	6.24
	3	1.20		2	5.61
	4	0.580	***SD***		***0.4455***
SD		***0.4311***	PDR-Rc-01	1	2.08
PDR-K-02	1	0.631		2	1.45
	2	0.351		3	1.37
SD		***0.1980***	***SD***		***0.4455***
PDR-K-05	1	1.53	PDR-Rc-02	1	24.6
	2	1.53		2	25.1
SD		***0.0000***		3	24.7
PDR-K-06	1	2.01	***SD***		***0.3536***
	2	1.40	PDR-Rc-07	1	19.4
	3	1.75		2	19.5
SD		***0.4313***		3	18.8
			SD		***0.3786***

Appendix F. Control Eggs – Boron Duplicate Results (continued)

ID Number	*Replication*	*Result Boron*	*ID Number*	*Replication*	*Result Boron*
PDR-K-08	1	1.12	PDR-Rc-08	1	14.5
	2	1.26		2	15.6
SD		***0.0990***	***SD***		***0.7778***
PDR-K-13	1	0.000	PDR-Rc-11	1	1.97
	2	0.000		2	2.63
SD		***0.0000***		3	1.26
PDR-K-14	1	6.01		4	1.30
	2	5.21	***SD***		***0.6478***
SD		***0.5657***	PDR-Rc-16	1	5.43
PDP-R-01	1	5.00		2	5.48
	2	4.46	***SD***		***0.0354***
SD		***0.3818***	PDM-R-05	1	3.89
PDP-R-06	1	7.31		2	3.77
	2	7.15	***SD***		***0.0849***
SD		***0.1131***			
SD		***0.1131***			

Mean SD:	0.3069
Low SD:	0.0000
High SD:	0.7778

Appendix G. Killdeer And Recurvirostrid Nest Survey Results For The San Joaquin River Water Quality Improvement Project And Pilot Mitigation Sites

Killdeer Nest Survey Results For The San Joaquin River Water Quality Improvement Project Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Killdeer														
001	Section 14		05/03	2	05/09	0					depredated	5	5	4
002	Section 2		05/03	1	05/09	0					depredated	5	5	4
003	Section 14		05/17	4	05/24	3	06/06	3	06/14	0	PK-01 collected 5/17, ph	1	4	1
004	Section 11		05/17	4	05/24	0					PK-02 collected 5/17, depredated	5	5	4
005	Section 10		05/17	4	05/24	0					PK-03 collected 5/17, ph	1	4	1
006	Section 2		05/24	1	05/31	0					depredated	5	5	4
007	Section 10		05/24	4	05/31	3	06/06	0			PK-04 collected 5/24, tractor	5	5	7
008	Section 14		06/01	4	06/07	3	06/14	0			PK-05 collected 6/1, depredated	5	5	4
009	Section 12		06/01	4	06/07	0					PK-06 collected 6/1, depredated	5	5	4
010	Section 2		06/07	3	06/13	0					depredated	5	5	4
011	Section 11		06/14	4	06/21	3	06/29	0			PK-07 collected 6/14, depredated	5	5	4
012	Section 11		06/14	4	06/21	3	06/29	0			PK-08 collected 6/14, depredated	5	5	4
013	Section 18		06/14	4	06/21	3	06/29	0			PK-09 collected 6/14, tractor	5	5	7
014	Section 3		06/21	4	06/28	3	07/05	0			PK-10 collected 6/21, tractor	5	5	7
015	Section 2		06/21	4	06/28	3	07/05	0			PK-11 collected 6/21, depredated	5	5	4
016	Section 2		06/21	4	06/28	3	07/05	0			PK-12 collected 6/21, ph	1	4	1
017	Section 3		06/21	4	06/28	3	07/05	0			PK-13 collected 6/21, depredated	5	5	4
018	Section 3		06/21	4	06/28	3	07/05	0			PK-14 collected 6/21, depredated	5	5	4
019	Section 18		06/29	4	07/05	3	07/17	0			PK-15 collected 6/29, ph	1	4	1

Codes for nest status, nest fate, and nest agent.

Nest status:
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc.)

Nest fate:
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column:
fth = Egg that has failed to hatch
ph = Presumed hatched

Recurvirostrid Nest Survey Results For The San Joaquin River Water Quality Improvement Project Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Black-necked Stilt														
001	Section 2	Drain	05/03	4	05/12	3	05/17	0			PR-01 collected 5/3, depredated	5	5	4
002	Section 2	Drain	05/03	4	05/12	3	05/17	3	05/24	3	PR-02 collected 5/3, 5/31 0 eggs ph	1	4	1
003	Section 2	Drain	05/03	4	05/12	3	05/17	0			PR-03 collected 5/3, depredated	5	5	4
004	Section 2	Drain	05/12	4	05/17	0					PR-04 collected 5/12, depredated	5	5	4
005	Section 3	Drain	05/12	4	05/17	3					PR-05 collected 5/12, depredated	5	5	4
006	Section 2	Drain	05/24	4	05/31	3	06/07	3	06/14	2	PR-07 collected 5/24, 2 fth	1	4	1
007	Section 2	Drain	06/06	4	06/14	3	06/21	0			PR-10 collected 6/6 depredated	5	5	4
008	Section 2	Drain	06/21	4	06/28	3	07/05	0			PR-11 collected 6/21, ph	1	4	1
009	Section 3	Drain	06/21	4	06/29	3	07/05	0			PR-12 collected 6/21, depredated	5	5	4
010	Section 2	Drain	06/29	4	07/05	0					PR-14 collected 6/29, depredated	5	5	4
011	Section 11	Field edge	06/29	4	07/05	3	07/19	0			PR-15 collected 6/29, ph	1	4	1
012	Section 11	Levee	06/29	4	07/05	3					PR-16 collected 6/29, vehicle	5	5	7
013	Section 11	Field edge	07/05	4	07/19	0					PR-17 collected 7/5, depredated	5	5	4
American Avocet														
001	Section 3	Drain	05/03	4	05/09	0					hathing on 5/3, ph	1	4	1
002	Section 10	Levee	05/07	4	05/24	3	05/31	0			PR-06 collected 5/7, depredated	5	5	4
003	Section 3	Drain	06/01	4	06/07	3	06/14	0			PR-08 collected 6/1, ph	1	4	1
004	Section 2	Drain	06/01	4	06/07	3	06/14	3	06/21	3	PR-09 collected 6/1, 6/28 1 fth, ph	1	4	1
005	Section 2	Drain	06/01	2	06/07	0					depredated	5	5	4
006	Section 3	Drain/Levee	06/28	4	06/07	3	07/19	0			PR-13 collected 6/1, ph	1	4	1

Codes for nest status, nest fate, and nest agent.

Nest status:
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc.)

Nest fate:
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column:
fth = Egg that has failed to hatch
ph = Presumed hatched

Killdeer and Recurvirostrid Nest Survey Results For The San Joaquin River Water Quality Improvement Mitigation Site.

Nest ID	Cell	Strata	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Date	No. of Eggs	Comments	Nest Status	Nest Fate	Nest Agent
Killdeer														
001		Levee	06/01	3	06/07	4	06/14	0			depredated	5	5	4
002		Levee	06/01	4	06/07	4	06/14	0			depredated	5	5	4
003		Levee	06/07	4	06/14	4	06/21	0			depredated	5	5	4
004		Island	06/07	4	06/14	4	06/21	4	06/28	4	7/19 0 eggs - ph	1	4	1
005		Island	06/07	4	06/14	4	06/21	4	06/28	4	7/19 0 eggs - ph	1	4	1
006		Island	06/07	4	06/14	0					ph	1	4	1
007		Island	06/14	3	06/21	4	06/28	4	07/19	0	ph	1	4	1
Black-necked Stilt														
001		Levee	06/01	1	06/07	4	06/14	0			depredated	5	5	4
002		Levee	06/01	1	06/07	4	06/14	0			depredated	5	5	4
003		Island	06/01	1	06/07	4	06/14	4	06/21	3	MR-03 collected 6/14, 6/28 0 eggs - ph	1	4	1
004		Island	06/01	4	06/07	4	06/14	4	06/21	3	MR-04 collected 6/14, 6/28 0 eggs - ph	1	4	1
005		Levee	06/01	3	06/07	4	06/14	0			depredated	5	5	4
006		Levee	06/01	2	06/07	4	06/14	0			depredated	5	5	4
007		Island	06/01	4	06/07	4	06/14	4	06/21	0	MR-05 collected 6/14, ph	1	4	1
008		Island	06/07	4	06/14	4	06/21	4	06/28	4	7/19 0 eggs - ph	1	4	1
009		Island	06/07	4	06/14	4	06/21	4	06/28	0	ph	1	4	1
010		Levee	06/07	4	06/14	0					depredated	5	5	4
011		Levee	06/14	2	06/21	4	06/28	0			depredated	5	5	4
American Avocet														
001		Levee	06/01	4	06/07	4	06/14	0			predation	5	5	4
002		Island	06/01	4	06/07	4	06/14	4	06/21	3	MR-01 collected 6/14, abandoned	1	6	2
003		Levee	06/01	4	06/07	4	06/14	0			predation	5	5	4
004		Levee	06/01	4	06/07	4	06/14	4	06/21	0	predation	5	5	4
005		Island	06/01	4	06/07	4	06/14	0			1 chick, 2 nearby	1	3	1
006		Levee	06/07	4	06/14	0					predation	5	5	4
007		Island	06/07	4	06/14	4	06/21	0			MR-02 collected 6/14, ph	1	4	1
008		Levee	06/07	4	06/14	0					predation	5	5	4
009		Island	06/14	3	06/21	4	06/28	4	07/19	0	ph	1	4	1

Codes for nest status, nest fate, and nest agent.

Nest status:
1 Undisturbed/normal
2 Investigator damaged
3 Partially destroyed
4 Some eggs missing
5 Totally destroyed
6 Other (poachers, Etc.)

Nest fate:
1 Lost (not relocated)
2 Fate uncertain
3 Hatched (certain)
4 Presumed hatched
5 Destroyed
6 Abandoned
7 Past term/unviable
8 Terminated

Nest agent:
1 None
2 Unknown
3 Observer
4 Predator
5 Livestock
6 Flooding
7 Vehicle
8 Levee maintenance

Abbreviations used in comment column:
fth = Egg that has failed to hatch
ph = Presumed hatched

Appendix H. Contingency Plan For Biological Monitoring Of Accidental Flood Events Within The Project Site

San Joaquin River Water Quality Improvement Project
Biological Monitoring Contingency Plan
Prepared 9 February 2006

Background

Panoche Drainage District adopted a negative declaration for the Phase I San Joaquin River Water Quality Improvement Project on September 19, 2000. This project provided for the application of subsurface drainage water on salt tolerant crops on lands within the in-valley treatment area known as San Joaquin River Water Quality Improvement Project (SJRIP). The negative declaration was adopted with the following impact avoidance measure: "A biological monitoring program will be developed in collaboration with U.S. Fish and Wildlife Service that would be capable of detecting migratory bird impacts and, if necessary, capable of providing the data for formulating project adjustments to avoid such impacts" (Negative Declaration, page 2, paragraph 5. Impact Avoidance Measures).

The monitoring program was developed with input from the US Fish & Wildlife Service and H. T. Harvey & Associates was contracted to perform the monitoring. Monitoring began in the spring of 2001. The monitoring program has been modified based on the initial monitoring in 2001 to respond to the conditions within the SJRIP and has been ongoing annually since then. Modifications have included sampling Red-Winged Blackbird eggs in addition to Black-necked Stilt, American Avocet, and Killdeer eggs, sampling eggs from within the project site and from non-project lands in the vicinity of the project, and to significantly increase the number of eggs sampled and analyzed. It was known that the subsurface drainage water that would be applied to the crops within the SJRIP would be fairly high in selenium and it was indicated in the initial study for the project that "...irrigation with drainwater will be monitored/controlled to avoid the ponding of water such that wetlands containing water high in selenium would not be created on the site." (Page 12, CEQA Initial Study). In the spring of 2003, a pasture at the SJRIP attracted waterfowl when it was inadvertently flooded. Stilt and avocet eggs collected near the pasture had elevated selenium concentrations.

Immediate instructions to field staff that operate the SJRIP were not to allow ponding that inadvertently occurred in 2003, consistent with statements in the CEQA Initial Study to avoid ponding water. A procedure has been established to prevent future ponding of this sort. This document further identifies those procedures and establishes a contingency plan in the unlikely event that ponding reoccurs in the future.

Contingency Plan in the Event of Inadvertent Flooding

If inadvertent flooding occurs due to the breakage of a supply canal or delivery facility, ponded water shall be eliminated through the discharge of the water into a tail-water return system or by pumping the water into one of the supply channels in SJRIP or a tail-water return system. This will be performed to prevent any ponding of water over 24 hours on any lands within the SJRIP.

Project field personnel will be tasked with daily monitoring of water conditions on the project site during the breeding season for birds (March through July). Any ponding that occurred would be

reported to the Drainage Coordinator and through him to the U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (DFG). Immediate collection of water samples would be made and analyzed for selenium and boron content.

In the event of inadvertent flooding for a period longer than 24 hours, an event specific monitoring plan will be developed to monitor the impacts to bird species resulting from exposure to ponded water. Any monitoring program will include:

1) the date of the event,
2) selenium concentration of the floodwater,
3) number of birds using the flooded area,
4) duration of exposure,

and, if nesting occurs, will also include:

5) selenium and boron concentrations in eggs,
6) hatchability of eggs, and
7) the assessment of collected embryos.

The results would be included in the annual monitoring report and incorporated into the three-year mitigation assessment reports. The exposure effects will be determined using the egg effect equation provided in the Environmental Impact section of this report. This equation was modified for use at this project site from the equation developed by the U.S. Fish and Wildlife Service for use at evaporation basins (USFWS 1995). The number of birds exposed (number of nest attempts at the project site) and the degree of exposure (egg-selenium content) are the biggest factors determining the amount of required mitigation. The USFWS and/or DFG would have the option of collecting supplemental monitoring data and biological samples in full coordination with Panoche Drainage District.

References

[USFWS] U.S. Fish and Wildlife Service. 1995. Compensation habitat protocol for drainwater evaporation basins. Sacramento, CA. 20 pp.