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State Drought Water Bank

DELTA CROP SHIFT DEMONSTRATION PROJECT

CORN TO WINTER WHEAT IN THE SACRAMENTO-SAN JOAQUIN DELTA

Wildlife and Mitigation Compliance Monitoring Final Report

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INTRODUCTION 1

PROJECT DESCRIPTION 2
Figure 1 - Location of Rindge Tract 3
Figure 2 - Location of eligible cropland 4
Figure 3 - Location of cropland enrolled in the Project 5
Table 1 - Comparison of Agricultural Activities 6

SENSITIVE SPECIES - DESCRIPTION AND EXPECTED IMPACTS
Plants 7
Fish 7
Reptiles 10
Birds 10

WILDLIFE MITIGATION MEASURES - DESCRIPTION AND COMPLIANCE 13
Table 2 - Conversion Chart for Waste Corn 14

WILDLIFE MONITORING PROGRAM - METHODOLOGY
Sensitive Plants 16
Sensitive Fisheries 16
Giant Garter Snake 16
Greater Sandhill Crane 16
Aleutian Canada Goose 16
Swainson's Hawk 16
Tricolored Blackbird 16
Waterfowl 17
Grass-Supplemented Wheat 18
Figure 4 - Location of study plots 19

WILDLIFE MONITORING PROGRAM - RESULTS
The Crop Shift 21
Giant Garter Snake 21
Greater Sandhill Crane 21
Figure 5 - Location of 1992 corn vs. 1993 Project wheat 22
Table 3 - Summary of Sandhill Crane Observations 23
Aleutian Canada Goose 23
Swainson's Hawk 23
Tricolored Blackbird 23
Waterfowl 24
Table 4. Total Waterfowl Use 24
Table 5. Most Abundant Waterfowl 24
Grass-Supplemented Wheat and Waterfowl Use 25

WILDLIFE MONITORING PROGRAM - DISCUSSION
The Crop Shift 26
Sensitive Plants 26
Sensitive Fisheries 26
Giant Garter Snake 26
Greater Sandhill Crane 27
Aleutian Canada Goose 27
Swainson's Hawk 28
Tricolored Blackbird 28
Waterfowl 28
Grass-Supplemented Wheat and Waterfowl Use 29

WILDLIFE MONITORING PROGRAM - CONCLUSIONS 30

LITERATURE CITED 31

APPENDICES
Appendix b - Avian data sheet
Appendix c - Grass/wheat data sheet

WILDLIFE AND MITIGATION COMPLIANCE MONITORING
FINAL REPORT

INTRODUCTION

Under the direction of Governor Pete Wilson, the Department of Water Resources first formed the emergency drought water bank in 1991. The objective of the water bank project was directed to meet water demands that have been severely curtailed due to significant reductions in developed water supplies caused by drought conditions.

Three sources have been developed to provide water under the water bank program.

The first is ground water exchange or conjunctive use. A portion of a surface water supply would be purchased from a water district or farmer. The amount sold would then be replaced by the seller by pumping an equivalent of local ground water.

The second alternate source is surface water stored in local reservoirs.

The third alternate source is an agricultural water conservation program that can be under taken in three ways. The first is to curtail irrigation water to crops already planted. The second is to pay farmers not to plant crops that were planned for production. The third is crop substitution in which a lower water use crop such as winter wheat is substituted for a higher use crop such as corn.

To evaluate the crop substitution program, a crop shift project was proposed for one year starting November 1992. It was designed to determine the ability to save water through the substitution of winter grain crops for irrigated summer field crops in the Delta. Water savings should accrue from:

(1) the difference in consumptive use of the crops;
(2) the ability to meet all, or a portion of, the grain crops' water needs from precipitation or water diversions during surplus conditions in the winter;
(3) the requirement that Delta farmers not irrigate their wheat after a certain date.

A State Water Project operations study was run using the three factors listed above. A Delta-wide crop shift program was assumed in place when the combined October carry-over storage from Oroville and San Luis Reservoirs was less than 1.56 million acre feet. This resulted in a crop shift program in 14 of 70 years. On the average, a calculated 1.32 acre-feet of water per acre of shifted crop, was saved.

PROJECT DESCRIPTION

The Delta Crop Shift Demonstration Project was initiated in the winter of 1992. The pilot program took place on Rindge Tract in the Sacramento-San Joaquin Delta (figure 1). The biological assessment addressed crop shift activities from Winter 1992 through Fall 1993, although wildlife monitoring continued through April 1994. It was estimated that a maximum of 3,000 acres on Rindge Tract was eligible for the program (figure 2), but only 1600 acres were shifted (figure 3). (Note: A portion of the land "shifted" in the Project, owned by Klein, E&E Co., and Rindge Tract Partners, was not defined as eligible in figure 2, which evidently was not the case. In addition, a review of available data on Rindge Tract crop patterns [1977, 1982, 1988, 1992] indicates that most of the land Klein had enrolled in the Project never had corn grown on it).

Because of the experimental nature of this project, only a relatively small amount of acreage was involved. Any resultant water saved was to be used to help DWR meet Delta and Suisun Marsh standards and to supplement Delta outflow. The water saved was not slated for export by the SWP or CVP, nor were there any changes to export operations as a result of this study.

The estimated differences in farming activities between winter wheat and summer corn are shown by month in Table 1. The actual timing of those activities on Rindge Tract varied from those expected. The significant difference was that the final draining and actual planting of winter wheat on the project acreage did not occur until late February through March.

Because this project was a demonstration project, the monitoring program was extensive. DWR and DFG monitored the following:

- Compliance: Periodic inspections of the crop-shifted fields were conducted to ensure compliance with contract provisions (appendix a).

- Water Savings: California Irrigation Management Information System stations (CIMIS) were placed within project lands. These multi-parameter recording stations were used to estimate the amount of water saved.

- Impacts to Wildlife: Mitigation measures required by the Department of Fish and Game were implemented and monitored for compliance and success of mitigation.

Table 1. Comparison of Agricultural Activities between Winter Wheat and Summer Corn on Rindge Tract

Expected and *Actual* Within Study Plots (if different)

MONTH	SUMMER CORN	WINTER WHEAT
JANUARY	<u>Mid-month</u> Fields drained for leaching. *Fields flooded.*	Fields drained for leaching. Fields disked Wheat planted *Fields draining all month.*
FEBRUARY	Fields with corn stubble *Fields flooded to mid-month.*	Wheat growing *Fields disked and planted mid-month and later.*
MARCH	Fields with corn stubble	Wheat growing *Wheat planted to mid-month*
APRIL	Fields disked Corn planted	Wheat growing
MAY	Corn growing	Wheat growing
JUNE	<u>Late month</u> First irrigation	Wheat maturing
JULY	<u>Late month</u> Second irrigation	Harvested - stubble remains *Wheat maturing*
AUGUST	<u>Mid-month</u> Third irrigation	Fields with wheat stubble *Wheat harvested*
SEPTEMBER	Corn harvest initiated *Corn still maturing*	Fields with wheat stubble
OCTOBER	Corn harvest completed Field-flooding initiated *Harvest initiated - fields dry*	Field-flooding initiated
NOVEMBER	Fields continually flooded for duck hunting *Harvest continues - fields dry*	Fields continually flooded for duck hunting
DECEMBER	Fields remain flooded *Harvest completed* *Field-flooding initiated*	Fields remain flooded *Draining initiated*

SENSITIVE SPECIES - DESCRIPTION AND EXPECTED IMPACTS

The biological assessment and resulting report address only those impacts expected from the demonstration project; should the project become larger in scale, the expected impacts would increase substantially, as would the number of species potentially impacted.

Plants

The sensitive plant species listed below are found in the area of the demonstration project but were not expected to be impacted as no non-agricultural habitat was to be affected, e.g., no new land was to be cultivated.

SUISUN ASTER
Aster lentus
Status: Federal Candidate Species
CEQA Requirement

CALIFORNIA HIBISCUS
Hibiscus lasiocarpus
Status: CEQA Requirement

DELTA TULE PEA
Lathyrus jepsonii jepsonii
Status: Federal Candidate Species
CEQA Requirement

MASON'S LILAEOPSIS
Lilaeopsis masonii
Status: Federal Candidate Species
State Listed as Rare

Fish

WINTER RUN CHINOOK SALMON
Oncorhyncus tshawytscha
Status: Federal Listed as Endangered
State Listed as Endangered

The winter run spawn in the main stem of the Sacramento River, primarily above the Red Bluff Diversion Dam. Spawning and egg incubation occur in the late spring and summer and outmigration from the upriver areas in fall and early winter. Migrants pass through the Delta mostly during the February through April period. A main cause of the decline of the winter run is attributed to loss of spawning habitat due to construction of Shasta Dam and the Red Bluff Diversion Dam. The drought of 1976-1977 and the current drought that began in 1987 have exacerbated problems associated with high water temperatures and low river flows. Additional concerns include entrainment at diversions, toxics, and fishing pressure. Passage of outmigrating smolts through the Delta may also be detrimental to their survival. Passage through the central Delta exposes fish to potential problems such as increased predation, longer migration routes, areas of reverse flows in river channels, and entrainment by agricultural and export pumps (Brown and Greene 1992).

The demonstration project probably did not result in any adverse impacts to Chinook salmon, including the winter run. An analysis of mid-water trawl data for the period 1985-1990 at Stations 909, 910 and 911 (on the San Joaquin River adjacent to the west side of Rindge Tract) for the period September through December indicated that one Chinook was caught at Station 910 on October 14, 1986. The length of the fish was 140 mm, not within the winter run size range category for the Delta at that time of year.

This demonstration project could have impacted Chinook salmon through diversions by the siphons when fields were flooded in the fall. However, sparse historic data indicates that outmigrating winter run salmon are not in the interior Delta during dry fall periods though early fall storms have the potential to bring rearing fry into the Delta in November and December (Kjelson, pers. comm.). Based on the low densities of fish in the river channels during the fall, flooding of project fields in October probably did not result in any adverse impacts to winter run.

DELTA SMELT
Hypomesus transpacificus
Status: Federal listed as Threatened
State listed as Threatened

In 1993, the delta smelt was listed as threatened under both the federal Endangered Species Act and State Endangered Species Act. This native species is found only in the Sacramento-San Joaquin estuary, usually in Suisun Bay and the Delta.

The upstream limits of delta smelt extend to Sacramento on the Sacramento River, and Mossdale on the San Joaquin River. The lower limit in most years is western Suisun Bay (Moyle et al. 1992).

Delta smelt inhabit open surface and shoal waters, presumably in schools. During the spawning period, adults move from Suisun Bay or river channels in the lower Delta to spawning areas upstream. Spawning occurs from about February through June (peaks in April and May) at temperatures ranging from 45 to 59 degrees Fahrenheit. Spawning occurs along river margins, flooded islands, and adjacent sloughs. The demersal, adhesive eggs, descend and attach to hard substrates such as submerged tree branches, roots, gravel, and vegetation (Wang 1986).

Newly hatched larvae are buoyant and drift downstream near the surface. Growth is rapid through the summer. Juveniles reach 40 to 50 millimeters by early August. Adults reach 55 to 70 millimeters in seven to nine months (DWR 1992). Most delta smelt mature, spawn and die within one year (Wang 1986).

An analysis of mid-water trawl data for the period 1967-1993 at Stations 909, 910 and 911 (on the San Joaquin River adjacent to the west side of Rindge Tract) for the period September through December indicate that delta smelt were caught only in 1967, 1970, and 1980, all wet years. It therefore appears that delta smelt are present, at least occasionally, in the channels adjacent to the crop shift demonstration site (San Joaquin River by Rindge Tract).

Delta smelt were not caught during midwater trawl surveys in 1992 in the adjacent river channels during the fall, so flooding of project fields in October probably did not result in any adverse impacts to the those fish.

OTHER FISH

The splittail (*Pogonichthys macrolepidotus*) is a candidate for protection under the Federal ESA. It is a large minnow distributed in the Bay/Delta and a number of upstream rivers. Adults spawn from late January to July in rivers and sloughs of the Delta, Napa Marsh, Suisun Marsh, and upstream areas (Moyle 1976).

Flooding the fields in October had the potential to divert splittail. However, because the data are sparse, it is not possible to quantify this potential impact (T. Sommer, pers. comm.). The overall impact of this project to the fish was likely less than that for the normal irrigation of summer corn as there were no diversions during the spring and summer months.

The distribution of longfin smelt (*Spirinchus thaleichthys*) appears to change seasonally; in early summer they are primarily in San Pablo and San Francisco Bays, in August they move into Suisun Bay, and in winter they spawn in upper Suisun Bay and the lower Delta. Spawning appears to occur from December through February. In April and May young smelt migrate downstream into the Bays (Moyle 1976).

With a single diversion that occurred in October, it does not appear that this project had the potential to impact longfin smelt. As with splittail, the project may have been beneficial to the species due to the lack of diversions during the spring and summer months (D. Sweetnam, pers. comm.).

Reptiles

GIANT GARTER SNAKE
Thamnophis gigas
Status: Federal Listed as Threatened
State Listed as Threatened

The giant garter snake, the largest of the North American garter snakes, lives in marshes, seasonal wetlands, sloughs and irrigation canals within the Central Valley (Steinhart 1990). It has been substantially impacted by agricultural and urban development which has resulted in the loss and/or fragmentation of the vast majority of valley riparian habitat. In the Sacramento Valley, rice fields and irrigation ditches have become the snakes' last retreats.

This snake would not have been impacted by the project unless: 1) Rindge Tract's irrigation canals are indeed habitat to the snake, and 2) irrigation canals used for summer corn irrigation dried as a result of the crop rotation. Giant garter snakes have not been found in the interior Delta, likely due to the Delta's large waterways with abundant predators acting as a barrier. It is unlikely that the snake occurs on Rindge Tract (J. Brode, pers. comm.). In addition, since the tract elevation is below water level, it is passively irrigated; the canals were not expected to dry out, so potential habitat should not have been affected.

Birds

ALEUTIAN CANADA GOOSE
Branta canadensis leucopareia
Status: Federally Listed as Threatened

The Aleutian Canada goose is one of the smallest of the 10 subspecies of Canada goose recognized by the American Ornithological Union that occur in North America. Once breeding by the thousands on North Pacific Islands, the Aleutian subspecies was reduced to near extinction through the introduction of Arctic foxes to those islands by fur trappers. Little information was known about the bird outside its breeding range until the mid-1970s when it was finally determined that it wintered in the San Joaquin Valley and had a major migration route through the Sacramento Valley. Current protective measures, especially the elimination of introduced predators from its breeding grounds, have resulted in a tenfold increase in Aleutian Canada goose populations from 1975 to 1989 (Steinhart 1990) and the downgrading of its status from endangered to threatened.

The project potentially impacted the Aleutian Canada goose through the loss of winter forage as they regularly feed on waste corn from the summer crops. Although this subspecies does not usually winter on the project-affected islands, it may forage there on an irregular basis, and thus may have been affected by the loss of waste corn. The impact was to be compensated for by a mitigation package, which included the addition of unharvested corn, designed to offset waterfowl forage loss.

SWAINSON'S HAWK
Buteo swainsoni
Status: State Listed as Threatened

Swainson's hawks are a highly migratory buteo, "wintering" in South America and breeding in California's Central Valley. They nest in large cottonwoods, sycamores, oaks and willows often associated with riparian corridors. They forage in grassland, alfalfa fields, grain fields and row crops for small mammals, birds and insects; freshly disked cropland is especially attractive for large flocks of Swainson's hawks, as many prey species are flushed to the surface for easy capture (D. Anderson, pers. comm.). The main causes of their decline in their breeding range are loss of nest sites and the conversion of agricultural areas to urban development (Steinhart 1990).

The Crop Shift project potentially benefitted Swainson's hawks. The project resulted in the conversion of agricultural land from a low quality forage type to a moderate quality forage type (J. Estep, pers. comm.). As the earlier harvest associated with winter wheat was initiated, it exposed large numbers of prey to any Swainson's hawks using the area. In addition, since less crops were planted in the Spring, there was less chance of disturbing any nearby Swainson's hawk's nest site during the critical nest site selection and construction period.

CALIFORNIA BLACK RAIL
Laterallus jamaicensis corturniculus
Status: Federal Candidate Species
California Listed as Threatened

The black rail is the most secretive of rails, moving through and hiding under dense marsh vegetation. The population of the California black rail subspecies has been reduced to just a few thousand individuals, the bulk of which is now limited to the north San Francisco Bay (Steinhart 1990). The black rail will not be affected by this project since there will only be a rotation of crop types within already agriculturally developed fields. No undeveloped land will become cultivated because of this project, so no black rail habitat will be lost.

GREATER SANDHILL CRANE
Grus canadensis tabida
Status: State Listed as Threatened

The greater sandhill crane is the largest of six subspecies of sandhill cranes in North America. There are 4 to 5 isolated breeding populations of greater sandhill cranes; one (*G. c. tabida*) nests in the northeast corner of California and south-central Oregon. This population overwinters throughout the Central Valley of California from the Chico area south to and including the Carrizo Plain; 95% of the wintering population occurs from the Sacramento-San Joaquin Delta north (Pogson and Lindstedt 1988). The important winter grounds in the Delta include Staten Island, Tyler Island and Brack Tract. The crane's overwinter period is from October through March.

During winter the cranes forage primarily in harvested grain fields, e.g., on waste corn and waste rice; grass shoots and wheat sprouts have also been identified as important food sources (Cogswell 1977). Night roosts are shallow wetlands, harvested agricultural fields and winter wheat fields.

Although the known Delta wintering area, identified by Pogson and Lindstedt, 1988, does not include Rindge Tract, it appeared that greater sandhill cranes might occur there irregularly. Potential project impacts to greater sandhill cranes included loss of forage (waste corn), and mechanical disturbances during winter wheat cultivation. Each of the above was unlikely to impact greater sandhill cranes for the following reasons:

1. The loss of forage would be compensated for by project mitigation measures as well as the addition of a winter crop as cranes will readily forage in the winter wheat fields (Pogson and Lindstedt 1988).

2. Sandhill cranes become acclimated to many mechanical disturbances associated with winter wheat cultivation; they should not have been significantly impacted by these disturbances. Note: the use of crop dusters was to be avoided as the species may be sensitive to aerial disturbances (Pogson and Lindstedt 1988).

TRICOLORED BLACKBIRD
Agelaius tricolor
Status: Federal Candidate Species (C3)
State Species of Special Concern

The Tricolored Blackbird is one of the most gregarious bird species of North America. It is found primarily in California west of the Sierra Nevada, but occasionally in southern Oregon or northwestern Baja California. It is a highly nomadic species during the nonbreeding season within this range as it forages for seeds and insects in marshes, grasslands, and fields. The Tricolored Blackbird's population had declined approximately 50% from the 1930s to the 1970s due to the loss of preferred wetland breeding habitat (Beedy et al. 1991).

Large breeding colonies occur regularly in the Central Valley. The breeding season is normally from early April to mid-July, although some breeding occurs in October or November (with low reproductive success) if insect populations are conducive. Breeding usually occurs in freshwater marsh vegetation or in irrigated fields. The potential impacts to Tricolored Blackbirds included the loss of nest sites and the loss of winter forage.

It was unlikely that the Tricolored Blackbird would be adversely affected by the proposed project. There were no known breeding colonies on any of the Delta islands; the nearest colony was over 10 miles away at Marsh Creek Reservoir in Contra Costa county (Beedy et al.. 1991). Corn is not used extensively by these blackbirds (T. Beedy, pers. comm.) as corn stands are not preferred nest sites and corn kernels are not heavily consumed. Conversely, wheat is readily consumed by Tricolored Blackbirds and was available at the time the species was most likely to be in the area.

WILDLIFE MITIGATION MEASURES - DESCRIPTION AND COMPLIANCE

A mitigation program was developed by DFG to offset any potential impacts of the program on the wildlife resources of the project area. The following are the descriptions of the mitigation measures required of the participants (farmers and/or landowners) and DWR, and the results of the compliance monitoring program.

1. Persons authorized by DWR were to be allowed on all agricultural fields associated with the Project and owned by Project participants for the purpose of monitoring the required mitigation measures and the biological effects of the Project. The participants were in compliance with this requirement.

2. Winter grain crops qualifying for this shift program were limited to wheat and barley. The participants were in compliance with this requirement, using wheat as the sole winter crop.

3. No fallowing was allowed for any lands within the Project. The participants were in compliance with this requirement.

4. The wheat grown in project fields was subject to the provision of leaving 10% unharvested. Unharvested areas were to be uniformly distributed in the fields enrolled in the Project. The participants provided a plan for the location of wheat to be left unharvested to DWR and DFG who commented, modified and approved the plan. Dean Reynolds (DWR, Central District) confirmed that the farmers complied with the approved plan leaving approximately 160 acres of wheat unharvested, or 10% of the 1611.4 acres enrolled in the program.

5. In the Fall of 1993, additional waste corn was to be provided on Rindge Tract to offset losses resulting from the Crop Shift Program. The waste corn was to be provided as unharvested corn uniformly distributed throughout the corn field(s), equivalent to the rate of 5% per acre for every acre enrolled in the program (see table 2). The unharvested standing corn was to be chopped or mowed immediately following the draining of the field(s) in mid-January. The participants, as a group, left more than the required amount of corn in the project fields. Approximately 80.6 acres of waste corn was required for the 1611.4 acres enrolled in the program. Approximately 95.7 acres was left unharvested. The participants were unable to comply with the chopping of the unharvested corn in January as a large portion of the project fields remained flooded until mid-February and were too wet to safely operate machinery in them until March.

6. Up to 300 acres or 10% of Project acreage planted in wheat was to be, on an experimental

basis, seeded with annual blue grass, *Poa annua*, at a rate of 5 to 10 pounds per acre in order to supplement sprout growth for waterfowl to mitigate for that which was lost as the fields were prepared for the planting of the wheat. The participants complied with the requirement. Approximately 160 acres of wheat was planted with *Poa* included. However, due to high rainfall, the wheat (and grass) was not planted until mid-February to mid-March, much later than the optimum date to plant *Poa*.

Table 2. Conversion Chart for Waste Corn

Acres Enrolled in Crop Shift Program	Acres in Corn Used to Offset Loss	Percent of Corn to be Left Unharvested
3000	**3000**	**5%**
3000	**1500**	**10%**
3000	**750**	**20%**

7. Disking was not to occur post-harvest until immediately prior to the planting of corn, wheat or barley. The participants complied with this requirement.

8. Harvested crop height should not have been greater than 12 inches. The participants complied with this requirement in the wheat fields, but harvested corn may have averaged closer to 16 inches in height after harvest.

9. Where feasible based on the topography, fields were to be flooded to an average depth of 2 to 10 inches. Participants complied to the extent possible. Due to topography, some project fields (with corn) remained virtually unflooded.

10. The flooding of winter grain fields grown the previous year and being converted back to corn was to begin on October 1. These fields were allowed to be drained in mid-January for purposes of leaching. The participants complied with this requirement.

11. Corn fields that were to be converted to winter grains were to be flooded as soon as harvest was completed, and kept flooded until just prior to cultivation in December or January. This did not apply to the pilot program, but was done as a matter of practice.

12. Immediately after harvest, the project corn fields with mitigation waste corn were to be flooded. (Article 5). The fields were allowed to be drained in mid-January for purposes of

leaching. The participants complied with this requirement. Harvest was not completed until mid-December, and project fields with waste corn remained flooded as late as mid-February.

13. A wildlife mitigation Project Monitor, mutually agreeable to the Department of Water Resources and the Department of Fish and Game was to be selected to ensure compliance. Dean Reynolds and Michael Bradbury from DWR headed the compliance monitoring with intermittent assistance from Steve Cordes of DFG.

14. A report summarizing the results of compliance monitoring was to be submitted by DWR to DFG and U.S. Fish and Wildlife Service by November 1, 1993. Compliance monitoring was not terminated until late March, resulting in the delayed report. DFG was contacted with oral reports of compliance on a periodic basis.

15. A report summarizing the results of the Wildlife Monitoring Program was to be submitted by DWR to DFG and USFWS by April 1, 1994. Due to time conflicts with other projects, the report has been delayed.

16. Non-compliance with the provisions listed in the mitigation measures were to result in doubling the percentage of unharvested crop during the next harvest cycle.

17. If DWR had determined that banked water was not required prior to entering into the year's crop shift, the participants would have been allowed to replant back into corn during the spring of the same period. The participants would still have been bound by Article 5 for any acreage of corn stubble disked under in preparation for wheat/barley planting. This requirement did not pertain to the pilot project as it was slated for one growing season (year) only.

WILDLIFE MONITORING PROGRAM - METHODOLOGY

The objective of the Wildlife Monitoring Program was twofold: 1) to attempt to determine if the project had any detrimental effects on the wildlife resources on the island, and 2) to determine if the mitigation requirements were adequate, appropriate, and/or necessary. The program was developed to determine the project's effects, both positive and negative, on the listed terrestrial species noted in the description section of this report and on waterfowl.

Sensitive Plants

None of the sensitive plant species described above were surveyed for or monitored.

Sensitive Fisheries

None of the sensitive fish species listed above were surveyed for or monitored as part of this program. The Interagency Ecological Program completed surveys in adjacent channels which resulted in data that was used to indicate potential impacts from the project.

Giant Garter Snake

The cross-channel canals were monitored to determine if the change in diversions would result in the drying of those channels, and therefore, result in reduced potential habitat.

Greater Sandhill Crane
Aleutian Canada Goose
Swainson's Hawk
Tricolored Blackbird

Each of these four species (or subspecies) was surveyed for the duration of each survey period and the tallies were marked under the station counts or in the comment section of the data sheet. The survey route followed the island's levees counter-clockwise from the entry bridge, and included the entire perimeter of the island. Whenever safe passage was possible, the island's east-west bisecting road was also driven to ensure thoroughness of the surveys. Included with the number of individuals observed was the vegetation type each was utilizing and the amount of standing water in the area used.

Initially, these species were to be counted within survey plots only, but due to the potential for very small sample sizes and the resulting ambiguity of the data, the plan was modified to include all individuals observed on the island on a survey day. Relatively thorough surveying was in part ensured by each species' size, color, foraging habits, and/or flocking tendencies.

The observers did not distinguish between Aleutian Canada geese and the other subspecies as differentiation is difficult since the various subspecies use much the same habitat and forage, and because the resulting sample size would likely be too small to draw any conclusions.

The observers differentiated between greater and lesser sandhill cranes in year-1 to ensure that greater sandhill cranes were found on the island on more than an irregular basis (contrary to Pogson and Lindstedt 1988). The differentiation was discontinued in year-2, as sufficient evidence existed to conclude that greater sandhill cranes were regular visitors to Rindge Tract, that both subspecies used identical habitats, and that inclusion of the lesser subspecies would result in more significant conclusions regarding foraging habitat preference.

Waterfowl

Six survey plots (1 per 270 acres enrolled in the project), approximately 275 acres in size and planted in corn only, were established in winter, 1992-93 (year-1). The original 6 plots were used in winter, 1993-94 (year-2), but plots 3 and 4 had a combination of wheat and corn: plot 3 had less than 10% wheat and plot 4 had approximately 33% wheat. In year-2, 3 additional plots (numbers 7-9) with wheat only were established for comparison (figure 4).

Waterfowl using the defined plots were identified and tallied on data sheets for each survey plot from both a permanent station and while driving to and from the station (duplicate counts were avoided to the greatest extent possible); other avian species were tallied to the extent possible, but were included in the counts as incidental information only. Monitoring stations were established on the levee crown, positioned to maximize count accuracy and visibility of the entire plot. The stations were also positioned to observe the unharvested corn and wheat left for mitigation. Plots were surveyed in order from 1 to 6 or 9, with the observers surveying the plots in a counter-clockwise direction around the perimeter of the island. When conditions permitted, the island's north-south bisecting road was also driven to insure that waterfowl on the outer edges of the survey plots and potentially hidden by vegetation were seen.

Waterfowl surveys were to occur biweekly beginning 1 November and ending 31 March of the following year for each survey period. In year-1, surveys did not begin until mid-December, delayed by the finalizing of the project contracts. The surveys began as proposed in year-2. Survey dates were determined based on optimal conditions for observing avian species: just prior to waterfowl hunting, "shoot days," and those without rain or fog. Originally, 1 monitoring day was to be established within ± 1 day of the Audubon Society Christmas bird count for each of the two winters. The Audubon counts were to be compared to the DWR counts to establish a count ratio that might be used with past Audubon's population data for baseline information. However, the Audubon counts were not compiled in a format that allowed the observer to separate Rindge Tract data from other areas' data, making it incomparable. Surveys were initiated at between 0700 and 0900, unless delayed by weather or other unforeseen/uncontrollable circumstances; in those instances surveys were initiated as soon as possible.

Waterfowl were identified and counted using binoculars and spotting scopes. Waterfowl induced to fly out of a survey plot as the observer(s) approached were included in the tally, as well as those flying into the plot during the count. As each species was counted, the number (either actual or estimated to the nearest 10, 100, or 1000) was recorded on data sheets (appendix b) in addition to the following information: the type and condition (harvested, unharvested or disked, if applicable) of vegetation the species was utilizing, the water level in the utilized field, and the estimated percentage of the survey plot flooded with > 4 inches of water (estimated).

Waterfowl totals were calculated for the entire group and by species for each of the two comparable study periods, then averaged per survey plot. It is understood that different waterfowl have different food consumption rates and volumes, e.g., swans eat considerably more than pintails per individual. It was originally intended that each species be defined with a consumption index, e.g., ducks = 1 waterfowl "unit," geese = 2, and swans = 3, but the complexity of such a system was considered unnecessary given the enormous difference in waterfowl populations between the two study years and the inexactness of the counts. American coots were not included in any "waterfowl" comparisons other than comparing their numbers from year to year as they were not considered a target species for which DFG and DWR were concerned. It is understood, however, that coots affected food supplies within the study plots.

In order to compare the relative value of flooded fields to that of dry fields, waterfowl were totalled for each of two plot types: those flooded to a depth of 4 inches or greater on 25% or more of the survey plot; and those plots that did not meet that criteria. The totals were then averaged to get the number of waterfowl per plot type per visit.

The average number of waterfowl were calculated per acre of flooded cropland per day for each study period to compare relative waterfowl use between year-1 and year-2. An average number of waterfowl were also calculated per acre of flooded corn and per acre of flooded wheat per day for year-2 data to compare the relative value of each crop type as forage.

Grass-Supplemented Wheat
(Waterfowl, cont.)

Forty vegetation point sample locations were established (uniformly random) in the project wheat fields: 20 in two wheat fields with grass (*Poa annua*) added (treated) and 20 in wheat fields without the grass seed (control), which were immediately adjacent to the grass-added fields to insure similar growing conditions (figure 4). Fourteen days after the wheat was planted and once a week thereafter, estimates of percent ground cover were made at each of the 40 established locations. Percent ground cover was estimated using a 50 cm by 50 cm grid with 25 cells, held in place by permanent grid holders. Estimates were recorded on data sheets (appendix c). In the first two sample periods, percent ground cover was estimated for each of the 25 cells; the cells were averaged to determine the percent ground cover for each location; the locations were averaged to determine the percent ground cover for the plot type. In the last sample period, vegetation was abundant enough to estimate percent ground cover using the grid as a whole instead of estimating cell by cell. Sampling continued until crop height reached an average of 12 inches. On the final survey day, percent *Poa* was estimated for each point sample location.

One station was to be established adjacent to a border between the experimental grass-added wheat plot and a wheat-only plot to monitor any differential in waterfowl use and establish the effectiveness of that mitigation. In order to more accurately compare the two types of plots, the observer searched the entire control and treated plots for waterfowl during the vegetation monitoring activities (see below) in lieu of the single station method.

WILDLIFE MONITORING PROGRAM - RESULTS

The Crop Shift

Although over 1600 acres were enrolled in the corn-to-wheat Crop Shift Program, only 55% of the acreage "shifted" had corn on it the previous growing season. Approximately 45% of the shifted acreage was identified in 1992 to be non-corn crops which included wheat, barley, safflower, and beets (figure 5). Even so, wheat acreage on Rindge Tract increased from approximately 14% in year-1 to 34% in year-2 and corn acreage was reduced from 77% to 58%, a result in part from the Project, and in part from normal crop fluctuations on the island.

Giant Garter Snake

Only about 20% of the total corn acreage on Rindge Tract in 1992 was shifted to wheat in 1993, so few irrigation canals were left unused; water seeping onto the island from the surrounding channels (passive irrigation) resulted in the collection of water in the unused irrigation canals; none of the canals went dry, and thus no potential giant garter snake habitat was affected.

Greater Sandhill Crane

Lesser and greater sandhill cranes were found on Rindge Tract in large numbers by November 1 and appear to use the island through the end of February. Cranes were observed in groups as small as 2 and as large as 252. A total of 1631 observations were made of individual sandhill cranes during the monitoring program: 179 (25.6 per day, average) in year-1 and 1452 (145.2 per day, average) in year-2. To better compare year-2 results to year-1 results, observations from the first 3 survey periods of year-2 (Nov. 2 to Nov. 30) were subtracted from the total so that each study period in which cranes were observed is defined as mid-December to the end of February and represent 7 survey days. Thus, for year-2 the comparable number of observations is 1130 with an average of 161.4 individuals observed per day.

In year-1, 98 (55%) crane observations were in corn and 80 (45%) were in non-corn (wheat, fallow fields, canal banks and grass roadways/field borders). Corn made up approximately 77% of island acreage in year-1; wheat, approximately 14%; other row crops, approximately 7%; and "other" (fallowed fields, grass covered roads, and canal banks), approximately 2%. (Note: the levee and levee embankments are not included in island acreage and no cranes were observed using them). Cranes were observed in vegetation with no more than trace amounts (< 4 inches) of water and usually no standing water.

In year-2, 1238 (85%) crane observations were in harvested wheat, 127 (9%) were in newly planted wheat, 59 (4%) were in "other," and 2% were in harvested corn. Through most of the monitoring period, the island's acreage composition was approximately: 51% harvested corn, 34% harvested wheat, 7% newly planted wheat (see note), 6% other row crops, and 2% "other." (Note: In November, approximately 7% of the island's previous year's corn crop (not associated with the Crop Shift Project) was disked and in December that acreage was planted to wheat).

Table 3. Summary of Sandhill Crane Observations

Year	# observed mid-Dec to end of Feb	Average # observed per day	% of cranes foraging in corn	% of cranes foraging in non-corn	% corn acreage on island	% non-corn acreage on island
1	179	25.6	55%	45%	77%	23%
2	1130	161.4	2%	98%	51%	49%

Aleutian Canada Goose

Sixty-nine and 74 Canada geese (sub-species unlikely *leucopareia* based on size) were seen on Rindge Tract in the first and second formal study periods, respectively. Seventy-eight percent were observed foraging in unflooded, harvested corn acreage in year-1 and 54% were observed using flooded, harvested wheat in year-2. In addition, on the first scouting survey in early December 1992, a flock of approximately 50 individuals were observed southwest of the bridge in unflooded, harvested corn.

Swainson's Hawk

Swainson's hawks were observed on only one occasion during the two study periods: on 9 March 1994 a kettle of approximately 25 individuals were foraging with as many red-tailed hawks over and in a harvested wheat field and in an adjacent disked corn/new wheat field. No Swainson's hawks were observed nesting on Ridge Tract or in the immediate vicinity, and no nesting (or potentially nesting) individuals were observed foraging on Rindge Tract.

Tricolored Blackbird

Tricolored Blackbirds were observed on Rindge Tract only once during the two study periods: a flock of approximately 100 individuals was seen foraging with approximately 500 red-winged blackbirds along the levee slope and in harvested corn on 16 December 1992.

Waterfowl

In year-1, a total of 6600 waterfowl sightings were tallied for the 6 study plots over 8 surveys from mid-December to the end of March (an average of 140 per plot per day). In year-2, approximately 102,000 waterfowl sightings were tallied for the original 6 plots plus the 3 additional plots over 11 surveys from the first of November to the end of March (an average of 1000 per plot per day); approximately 86,500 were tallied for the 8 surveys which equate to the year-1 monitoring period (an average of 1200 per plot per day). Extrapolated to the entire island, the waterfowl population of Rindge Tract increased almost 9-fold from year-1 to year-2. The year-2 tally for waterfowl in the 3 wheat-only plots over the first 3 survey periods was 15,600, over 2X more than the entire year-1 tally. Notes: counts should be considered ± 25% estimates of actual waterfowl numbers; American coot numbers are not included in these figures.

Table 4. Total Waterfowl Use

Year	Total	Total (equivalent period)	Average/Plot/Day (equivalent period)
1	6600	6600	140
2	102,000	86,500	1200

The 5 most abundant waterfowl species using Rindge Tract during comparable study periods were, year-1 and year-2, respectively: Northern pintails, 1300 and 40,000; mallards, 600 and

16,000; tundra swans, 3100 and 12000; canvasbacks, 50 and 12000; and Northern shovelers, 40 and 4800. In year-1, the second most abundant waterfowl were white-fronted geese, with almost 1500 sightings. Relatively large flocks of the geese were observed after the other wintering waterfowl had left; they utilized the harvested corn fields that had never been flooded.

Table 5. Most Abundant Waterfowl

Year	Northern Pintails	Mallards	Tundra Swans	Canvasbacks	Northern Shovelers
1	1300	600	3100	50	40
2	40,000	16,000	12,000	12,000	4800

Incidentally, the number of American coot sightings on Rindge Tract increased from 156 (with 6 plots studied) in year-1 to 6900 (with 9 plots studied) in year-2.

In year-2 between 1 November and 10 February, wheat plots (7 - 9) attracted an average of 1200 waterfowl per plot per day; corn plots (1 - 6) attracted an average of 1500 waterfowl per plot per day, 1.25 times more than the wheat plots.

In both years combined, flooded (submerged) survey plots had an average of 2200 waterfowl per plot per day; dry survey plots had an average of 17 waterfowl per plot per day. (Submerged study plots were defined as having > 4 inches of water over 25% or more of the survey plot; dry plots were defined as those with less than the above).

In year-1, there were 2 waterfowl per submerged acre per day (> 4 inches of water) within the survey plots over the peak use period of 15 December to 10 February; in year-2, there were 22 waterfowl per submerged acre per day for the same period, an 11X increase over year-1. In year-2, there were 14 waterfowl per submerged acre of wheat per day, 7X more than in corn in year-1.

In year-1, the corn flooding was not initiated until late November; flooded corn acreage was present over a 10-week period. In year-2, corn-flooding was initiated in the middle of December and flooded corn acreage was present through 5 survey days or over approximately 10 weeks while wintering waterfowl used the island; wheat acreage was submerged through 7 survey days, or approximately 14 weeks during wintering waterfowl use. (Note: wheat was flooded and probably used by wintering waterfowl from the first of October, an additional 4 weeks). In year-2, there was an average of 14 waterfowl per submerged acre of wheat per survey day; there was an average of 31 waterfowl per submerged acre of corn. Wintering waterfowl had access to flooded crop acreage for approximately 10 weeks in year-1 and approximately 16 weeks in year-2.

There was no indication that waterfowl populations were concentrated due to the placement of mitigation waste corn or wheat; the waste corn, which was never chopped, was virtually unused as was the unflooded portion of the waste wheat. Waterfowl were obviously concentrated due to the placement of water; specifically, flooded fields of at least 50 acres in size with > 4 inches of water. (Note: the water level in the fields did not exceed 16 inches in depth).

Grass-Supplemented Wheat and Waterfowl Use

The vegetation point sampling began on 31 March 1993 and terminated 2 weeks later on 16 April 1993. Only 3 sample periods were completed between the two-week-after-planting initiation and the time at which the wheat reached an average height of 12 inches. The average percent ground cover for the control verses treated fields was as follows: week 1, control - 14.1%, treated 16.3%; week 2, control - 31.24%, treated - 33.65%; week 3, control - 44.75%, treated - 50.5%. In week 3, the percent *Poa* was estimated to be 2.85% for the control plot and 3.6% for the treated plot.

No waterfowl were observed using the experimental fields with or without *Poa* added.

WILDLIFE MONITORING PROGRAM - DISCUSSION
The Crop Shift

It was unlikely that the crop shift resulted in adverse impacts to wildlife. Only 55% of the land "shifted" actually had corn grown on it the previous year. In addition, while reviewing available information on Rindge Tract's past years' crop patterns (1982, 1988, and 1992), it was noted that a large portion of Jack Klein's property (north-central block) never had corn on it. Nor was corn grown on Rindge Tract Partners' project land in 1988 or 1992. It was also noted that corn acreage historically made up a similar proportion of Rindge Tract's cropland to that of the project year: only 62% and 52% in 1982 and 1988, respectively. This suggests that waterfowl had access to similar amounts of corn in the project year to that which they have had in the past.

Sensitive Plants

Since no new ground was cultivated as the result of the project and no natural habitat along the levees was disturbed due to the crop shift, the potential for impacting sensitive plants was nominal.

Sensitive Fisheries

Based on current information, the potential for impacting the sensitive fish species was nominal, as was the potential to determine if any fish species was impacted via a reasonably sized monitoring program. The lack of sensitive fish species near Rindge Tract pumps during fall diversions in the past, the potential benefit to the fisheries from reduced spring/summer diversions, and the relatively small change in water diverted likely resulted in no determinable impacts to the fisheries.

Giant Garter Snake

It is unlikely that giant garter snakes inhabit Rindge Tract based on current range information available on the species, specifically the lack of observations in the Delta. If they had inhabited the island in the past, current agricultural practices including the constant disturbance of the irrigation canals during maintenance make the canals highly improbable habitat. In any case, the canals were not effectively dried during the crop shift project; any potential habitat on the island remained so, and thus the species was unlikely affected by the project.

Greater Sandhill Crane

The sandhill crane data collected in winter 1992-93 and 1993-94 indicate that Rindge Tract is a regular foraging site for greater sandhill cranes, and may be an important extension to their defined wintering grounds (Pogson and Lindstedt 1988), with as many as 100 individuals foraging there in a day.

Sandhill crane use of Rindge Tract increased from an average of 25.6 birds per day in year-1 to 161.4 birds per day in year-2, more than a 6X increase, for the period from mid-December to the end of February. The only notable change in the physical composition of Rindge Tract between study periods was the increase of harvested wheat acreage from 14% to 34%, the 7% addition of newly planted wheat, and the corresponding decrease of harvested corn from 77% to 51%.

Although corn acreage made up 77% of Rindge Tract in year-1, only 55% of the observations of cranes were in corn. Conversely, 45% of crane observations were in wheat/grass habitat, which made up only 16% of the island's acreage. In addition, cranes were observed using wheat fields 94% of the time in year-2, although wheat made up only 41% (including harvested and newly planted fields) of the island's acreage.

These data strongly suggest that the sandhill crane's preferred forage on Rindge Tract was fields of low-growing/cut wheat- and grass-type vegetation with little or no standing water, as opposed to harvested corn fields. Pogson and Lindstedt, 1988, indicate that the sandhill crane's main source of carbohydrates in the Delta region is waste corn, based on observations made of foraging cranes. However, the study does not include the percent of harvested corn acreage in the study area and therefore does not indicate what the preferred forage of cranes is. It appears that the importance of wheat and fallowed fields may have been underestimated or understated in prior reports.

Aleutian Canada Goose

Canada geese are one of the few waterfowl species that readily forage (and were observed) in unflooded fields. Unflooded, harvested corn and wheat acreage on the island was virtually unused by waterfowl; an average of only 17 waterfowl (mostly Canada and White-fronted geese) were observed foraging in survey plots with little or no water, compared to an average of 2200 waterfowl using survey plots with flooded fields. The combination of the small number of Canada geese (and few, if any, *B. c. leucopareia*) using the island, the 100's of acres of corn that remained unflooded and relatively unused throughout the winter that was available to them, and the high use of the wheat fields strongly suggest that the Aleutian Canada goose was not impacted by the project.

Swainson's Hawk

Rindge Tract has high potential for Swainson's hawk use. It is relatively close to known nesting and foraging sites within and around the perimeter of the Delta, and it has numerous appropriately-sized nest trees on and around the island. Although only one observation of Swainson's hawks was recorded, and that being a flock probably moving further north to nest, Rindge Tract appears to be a potentially important forage site during migration. Based on previous studies, the shift from a corn crop to a wheat crop is highly beneficial to the species, whether nesting in the area or just passing through; hence, the potential for this project or others like it to benefit the species is high.

Tricolored Blackbird

Although relatively few Tricolored Blackbirds were observed on Rindge Tract, 100,000s of other blackbirds (Brewer's and red-winged) were observed foraging on the island. Enormous flocks were observed foraging in freshly disked corn and wheat fields that were being prepared for the planting of winter wheat. Based on current information concerning Tricolored Blackbirds and the use of the island by other blackbird species, the crop shift from corn to wheat potentially benefitted the species.

Waterfowl

A large number of waterfowl use the agricultural waste products of Rindge Tract for food during their overwinter in the Delta. The population appears to naturally fluctuate to greater extremes than other areas within the Delta; other sources within the Delta reported increases in local waterfowl numbers from Winter 1992/93 to Winter 1993/94, but not to the extent Rindge Tract experienced: 8.5-fold increase from year-1 to year-2. Nor is it likely that the waste corn and wheat left as mitigation was solely responsible for the extreme differential in the two years' population sizes, especially considering that much of the mitigation grain was virtually unused/unusable by the majority of waterfowl.

The exceptionally large increase may have been due in part to the addition of the wheat as a major crop on the island. It was obvious that waterfowl preferred (if not needed) to forage in flooded fields, and it was equally obvious that food was not in itself the limiting factor on the island; hundreds of acres of unflooded corn and wheat went virtually unused. The limiting factor appeared to be access to the food, access resulting from the flooding of the fields. The wheat fields were flooded up as early as October, two months prior to the flooding of corn fields. As wintering waterfowl entered the Delta, Rindge Tract provided immediate forage via the flooded wheat fields. Corn fields were then flooded in December, prior to the draining of the wheat fields. This flooding rotation provided consistent forage throughout the winter period (16 weeks of flooded wheat and corn combined verses 10 weeks of flooded corn alone). A consistent, long-term food supply is likely to be much more attractive than an inconsistent and/or short-term supply.

The relative value of wheat as a forage did not appear to be as poor as it was believed prior to the study. Although flooded wheat had an average of only 14 waterfowl per acre verses 31 waterfowl per acre in flooded corn in year-2, the three wheat plots in year-2 attracted more waterfowl in three weeks than did all six corn plots in 8 weeks in year-1. In addition, waterfowl were counted in flooded corn from the point of flooding; the wheat had been flooded for weeks prior to initiating counts within it, allowing for depletion of its food stores. This potentially resulted in underestimating the number of waterfowl that the wheat actually supported. This is not to suggest that wheat may be used to replace corn all together; the raw data suggests that flooded corn may attract extraordinary numbers of waterfowl for short periods: on 14 and 28 December, a single 275-acre plot had an estimated 23,000 and 16,500 waterfowl, respectively. No attempt was made in this study to determine the nutritional value of corn verses wheat to species of concern.

The data are conclusive on one important question: there is no indication that waterfowl were negatively impacted from the Crop Shift Project as implemented. Conversely, there is significant data indicating that the Project, at least potentially, benefitted waterfowl.

Grass-Supplemented Wheat and Waterfowl Use

Poa annua is a winter grass with a small seed and substantial seed head that may be a useful forage for wintering waterfowl. It was added to the wheat in the experimental plot in order to determine if it would benefit the waterfowl that theoretically lost forage when the fields were prepared for planting. Unfortunately, the wheat and *Poa* was planted so late in the winter season (late February to March) that very little germinated and grew. There was virtually no difference in the grass volume of the *Poa* added wheat and the wheat without it. *Poa* occurs naturally on Rindge Tract in relatively small amounts.

The *Poa's* usefulness, even if it had grown, is highly suspect due to the lateness of the planting; no waterfowl were seen in the fields during its growth and in fact, the vast majority of waterfowl were gone by the end of February, leaving behind a few mallards and substantial other forage. Because of this and the fact that few waterfowl forage dry fields on Rindge Tract, the addition of *Poa* to the wheat seed appears to have been pointless.

WILDLIFE MONITORING PROGRAM - CONCLUSIONS

The Crop Shift Project, as implemented on Rindge Tract in the 1993 growing season, resulted in no determinable negative impacts to the species of concern which were studied, or to wildlife in general. Conversely, there was substantial evidence that the increase in wheat acreage benefitted a number of species.

Sandhill cranes and waterfowl appeared to fare better with the additional wheat, increasing its acreage to major proportions on the island. The combination of corn and wheat may result in a more diverse food supply, feeding a larger cross section of waterfowl, cranes, and other wildlife. This combination may continue to be beneficial at corn to wheat ratios close to 1 to 1. However, the data does not suggest that corn may be replaced by wheat completely; on the contrary, flooded corn appears to attract extraordinary numbers of waterfowl for short durations, a property apparently not shared equivalently by flooded wheat. (Note: an evaluation of the nutritional differences between corn and wheat was not attempted).

A modification in the mitigation requirements may be in order, considering the conclusions, complications, and observations resulting from this pilot project. It may be appropriate to develop a heavily controlled flooding program that would insure that a larger portion of the naturally occurring waste grain left after harvest was made accessible to waterfowl in place of requiring the addition of waste grain, much of which was unaccessible. The addition of grass seed (*Poa*) to the wheat seed should be deleted from the mitigation package if the location of the crop shift is such that the wheat planting occurs later than January.

Increasing the size of the Crop Shift Program geometrically increases the potential impacts to wildlife exponentially. Not only does the potential for impacts increase, the number of species potentially impacted increases: on the fore-front of those species are the fish. The small size of this pilot program precluded the assessment of impacts to protected fish species, the numbers of which are increasing. The impacts of a Delta-wide change in irrigation patterns resulting from a large scale Crop Shift Program would have to be assessed before proceeding.

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