CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

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CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

4.1 INTRODUCTION

This chapter describes the existing and baseline environmental resources of the EIS study area and identifies and provides an evaluation of the potential environmental impacts of the alternatives, described in Chapter 3, on these resources. For each resource, existing and baseline conditions are described, followed by a comparison of how each alternative would affect the resource, as compared to baseline and existing conditions. This chapter only addresses the environmental resources in the study area that could be affected by one or more of the alternatives, not the entire existing environment.

The environmental characteristics of both basins have been thoroughly described in three recent environmental documents that are incorporated by reference: WRAP EIS (USFWS 1996a); *Draft Environmental Impact Statement Truckee River Operating Agreement* (USDI 1998); and *Environmental Assessment Adjusted 1988 Newlands Project Operating Criteria and Procedures* (*Federal Register, Vol. 61, No. 237, 64815 - 64958*; cited as USBOR 1997). These publications were used extensively in describing baseline conditions in this chapter, and information has been updated where necessary. These documents are available to the public at several area public libraries and at the Stillwater NWRC office in Fallon.

Environmental consequences are direct and indirect impacts (positive or negative) that would result from implementing the action alternatives. Direct consequences are those that are caused by the action, and occur at the same time and place. Indirect consequences are also caused by the action, but occur later in time or are further removed from the action. In addition to assessing the potential impacts on the environment, an assessment of the effects of the alternatives on the Service's capability to meet relevant legal mandates has been made.

The evaluation in this chapter includes the potential consequences of alternatives on Newlands Project operations and other environmental resources in the Final EIS study area; physical components of the refuge complex environment (e.g., water resources); fish, wildlife, plants, and their habitats; public uses on the refuge complex; cultural resources and Indian trust assets; Naval Air Station Fallon operations; and the local socioeconomy. Also assessed is the Service's ability to meet relevant legal and policy mandates under each alternative and potential limitations of the alternatives on a refuge manager's ability to manage. At the end of the chapter, cumulative effects are summarized, and other impacts, including conflicts with Federal, State and local policies or plans, as well as unavoidable and irretrievable effects of the alternatives are discussed.

The following resources were examined during scoping and the impact analysis process and found not to be affected by any of the alternatives: geology, climate and meteorology, groundwater, and secondary wetlands.

4.1.1 DEFINITIONS OF EXISTING AND BASELINE CONDITIONS

Assessments were made of the potential effects of alternatives on existing and baseline conditions. Existing conditions are those conditions that exist now and that existed in the recent past, or that could happen in the near future with the continuation of existing management on the Stillwater NWR Complex and land use practices outside the complex. Existing conditions assume that the 20,000 acre-feet of water rights acquired for Stillwater NWR have been transferred to wetlands and that 17,000 acre-feet are available for wetland use on the refuge. At present, about 15,300 acre-feet of water rights are permitted for delivery to Stillwater NWR. Due to the high year to year variability and the early stages of the water rights acquisition program, the existing hydrologic conditions presented in this Final EIS are modeled conditions and are used to estimate changes in environmental conditions due to changes in management that would occur under different alternatives. Modeling, using the Below Lahontan Reservoir model (BLR; ver. 3.4, July 1996), was used over evaluation of recent monitoring data because the model generates a 95 year data set based on past Newlands Project operations (as modified to reflect current operating criteria) while recent operations incorporate either high water years (1997-1999) or normal water years (2000-01) only. These past few years are not representative of long-term Newlands Project operations; however, these are the only years where actual monitoring data can realistically be evaluated based on recent changes to the Newlands Project OCAP (USBOR 1997).

Baseline conditions are those conditions that would result from continued operation under Alternative A (No Action Alternative) and existing land use practices outside of the refuge complex. Therefore, they are the same as existing conditions except as affected by the ongoing water rights acquisition program. Whereas existing conditions are limited to the volume of water rights that have been acquired to date, baseline conditions assumes: (1) completion of the water rights acquisition program detailed in Alternative 5 of the WRAP EIS and ROD (USFWS 1996a,b) and associated effects, including a long-term average of 14,000 acres of wetland habitat on Stillwater NWR, and (2) that the Newlands Project 1988 OCAP efficiency targets, as adjusted in 1997 (USBOR 1997), have been fully achieved. Baseline conditions also assume that a long-term average of 25,000 acres of wetland habitat would be maintained in the Lahontan Valley at Stillwater NWR (14,000 acres, as identified above), Carson Lake (10,200 acres), and the Fallon Paiute-Shoshone Indian Reservation (800 acres). Baseline conditions assume that Anaho Island NWR would be managed as it has been in the recent past.

Baseline conditions assume the completion of the WRAP and these conditions are not anticipated to occur for another 15 to 20 years or more. Therefore, the changes from existing conditions to projected conditions for each alternative are presented. For each action alternative, this percent change is compared with the percent change estimated to occur under the No Action Alternative. This is done to give readers an indication of the difference in change that would occur under the No Action Alternative (Alternative A) as compared to the action alternatives. With respect to the water rights acquisition program, the effects of Alternative A have already been analyzed in the Final WRAP EIS (USFWS 1996a).

4.1.2 USE OF SUPPORTIVE INFORMATION

Many sources of information were used in evaluating the potential effects of the alternatives on the resources addressed in this chapter, including inventories of vegetation and wildlife; analyses of wildlife, habitat, and public use monitoring data; scientific literature; computer modeling; staff reports; geographic information system (GIS) analysis; socioeconomic analyses; and professional judgement.

Rather than providing extensive references to scientific and other information in this chapter, readers are referred to technical appendices (Volume II). Two literature reviews were conducted to address sources of effects on wildlife and their habitat: potential effects of human disturbance (Appendix L) and potential effects of livestock grazing on wildlife and habitat (Appendix M). Another report included as an appendix identifies the major underlying problems limiting achievement of refuge purposes and summarizes pertinent scientific literature on the effects of these underlying problems (Appendix N). The seasonal delivery patterns in the alternatives were based on different sets of assumptions and were designed to meet different needs (Appendix G). Appendix G presents the development of monthly inflow figures for each alternative for several representative years. Compatibility determinations in Appendix O can be consulted for more detailed information on the potential effects of public uses, livestock grazing, and farming practices on wildlife and habitat.

Existing and baseline hydrologic conditions were modeled for a variety of reasons including: (1) the water rights acquisition program is new and ongoing (no long-term data is available on trends), (2) not all acquired water purchased is presently available for delivery to the wetlands, and (3) the hydrology in the Great Basin is highly variable, and (4) the Newlands Project OCAP have been adjusted several times since 1967. Effects that alternative Stillwater NWR water delivery schedules could have on key elements of Newlands Project operations, Carson Division resources associated with Newlands Project water, and lower Truckee River resources were estimated using the Below Lahontan Reservoir model. The model used U.S. Bureau of Reclamation supplied water data for a 95-year hydrologic simulation of the Carson and Truckee Rivers. The model therefore provides the ability to apply existing, baseline, and alternative water management scenarios to historical hydrologic data, which allowed long-term monthly and annual averages to be calculated for comparative purposes.

4.2 PHYSICAL ENVIRONMENT — STUDY AREA

4.2.1 WATER SUPPLY

4.2.1.1 WATER QUANTITY

Total water supply in both the Carson River and Truckee River basins consists of surface water and groundwater sources. Because supply depends, in large part, on precipitation falling in the Sierra Nevada mountains, total supply in both basins varies annually. Potential effects on groundwater and secondary wetlands were not identified as an issue for this planning effort and no potential effects were identified with respect to the actions being evaluated in this Final EIS. Therefore, additional information is not provided on these resources and readers are referred to the WRAP EIS (USFWS 1996a) for this information.

Carson River flows, recorded at the Fort Churchill gaging station since 1912, have averaged about 289,820 acre-feet per year. Flow volumes have varied widely during the period of record, with a high annual flow at Fort Churchill of 804,300 acre-feet (1983 water year) and a low annual flow of 26,300 acre-feet (1977 water year). In the absence of any diversions or water control structures during the period of record, an estimated average of about 410,000 acre-feet would have flowed past Fort Churchill into the Lahontan Valley (Kerley et al. 1993). The flow volumes under these natural conditions would have ranged from an estimated low of 90,000 acre-feet (1977 water year) to an estimated high of about 940,000 acre-feet (1983 water year).

Currently, the Carson River channel downstream from Lahontan Reservoir is used to convey irrigation water, drainflows, and spills. The natural hydrologic cycle of the river flow downstream from Lahontan Dam has been altered and is now primarily controlled by the Newlands Project operations. The present day pattern of Lahontan Valley hydrology, including that of Stillwater NWR and Fallon NWR, is dominated by the effects of more than 80 years of surface water irrigation.

Surface water released from Lahontan Reservoir for irrigation is distributed throughout the Carson Division by approximately 381 miles of irrigation canals. The volume of water delivered through the irrigation system varies daily depending on weather, amount of farmland being irrigated, and groundwater elevation. Annually, delivery volumes vary depending on available water supply and number of irrigated acres. The Truckee-Carson Irrigation District Water Master is responsible for scheduling Newlands Project irrigation deliveries.

Drainwater consists of runoff from farm fields (return flows) and groundwater seepage into drains. Drainflow volume to the wetlands changes from year to year depending on Newlands Project delivery efficiency, the irrigated acreage base, and Lahontan Reservoir releases. Prior to the acquisition of water rights for wetlands, drainwater was the only water entering Lahontan Valley wetlands during most years (all years except those when excess or spill water was released from Lahontan Reservoir during high water years). Upon completion of the water rights acquisition program, it is anticipated that drainwater would comprise an annual average of about 16 percent of wetland inflow. During extreme droughts, drainflows do not reach the wetlands.

Surface water resources in the study area are subject to the high evaporative loss rates of the desert climate. Lahontan Reservoir, other Newlands Project regulating reservoirs, and the primary wetland areas show evaporative losses of 60 or more inches per year. The long-term average (1940 to 1990) evaporative loss rate for Fallon is 53 inches per year (University of Nevada Agriculture Station monitoring data). Evaporation rates in wetland areas differ from readings in town and are generally 5 to 30 percent higher in May, June, and July based on preliminary data collected at Stillwater NWR and Carson Lake. One explanation for these higher evaporation rates is that the primary wetlands are adjacent to, and downwind of, large expanses of dry, sparsely vegetated, desert land. The hot, dry winds from these areas may increase evaporation rates above those recorded at the University of Nevada Agriculture Station monitoring site, which is adjacent to irrigated farm fields near Fallon.

Surface runoff of precipitation is the primary source of water supply in the Lower Truckee River basin. Most of the available water supply is generated upstream of the USGS stream gaging station at Farad, California, and is produced primarily during the spring runoff season (generally April-July) by the melting snowpack in the Sierra Nevadas. Annual streamflow recorded at Farad has ranged from a low of 133,460 acre-feet in 1931 to a high of 1,768,980 acre-feet in 1983. Average annual streamflow at Farad is about 543,400 acre-feet.

Truckee River flows are controlled by several reservoir operations, including Boca, Donner, Lake Tahoe, Stampede, and Prosser Creek Reservoirs. Under baseline conditions, an estimated average of 563,500 acre-feet per year would flow down to Derby Dam. An estimated 74,410 acre-feet per year would be diverted to the Truckee Canal and the remainder would flow past Derby Dam, most of which would flow downstream to Pyramid Lake. There would be an estimated average annual inflow rate of about 496,700 acre-feet of water flowing into Pyramid Lake each year.

Water demands and allocations of Truckee River water are complex. Resources above Derby Dam would not be affected by implementation of any of the alternatives considered in this Final EIS and therefore are not addressed in detail. For further information, readers are referred to the Adjusted OCAP (*Federal Register, Vol. 61, No. 237, 64815 - 64958*) and associated EA (USDOI 1997) and the Truckee River Operating Agreement Draft EIS (USDOI and State of California 1998) for further information.

Prior to the construction of the Newlands Project and other water diversions from the Truckee River, the water surface of Pyramid Lake was at a much higher elevation than it is today. The lake level remained relatively stable, with inflow and evaporation about equal. In 1870, the lake level was about 3,887 feet in elevation. The lake level began to decline in 1910 due to upstream diversions. By 1967, the elevation reached a low of 3,784, a 100-foot drop in elevation. The

1988 OCAP, as adjusted in 1997 (USBOR 1997a), are anticipated to result in the water surface of Pyramid Lake stabilizing at about 3,841 feet, within 50 feet of its pre-1900 elevation. In October 2001, the elevation of the water surface was about 3,814 feet.

4.2.1.2 WATER QUALITY

Although none of the actions proposed in this Final EIS would affect water quality outside the refuge complex, this section was included to provide background on the sources of constituents found in water entering Stillwater NWR, Stillwater WMA, and Fallon NWR. In this Final EIS, care was taken in using the term water quality because high quality water to one group of wildlife species is poor quality to another group of species. In some cases, the term water chemistry was used as a neutral term, so as not to imply “high quality” or “low quality.” There is no one set of criteria that identifies high quality water for wildlife in a Great Basin wetland complex. Fresh water having a neutral pH level and few dissolved solids, which has come to be synonymous with high quality water, provides high quality water conditions for wildlife and plant species associated with fresh water, such as in the historic Carson River and wetlands at its delta. However, these water conditions provide poor conditions for the many other wildlife and plant species associated with water having high concentrations of total dissolved solids or a more basic (alkaline) pH, such as in the lower end of the wetland complex where the Carson River terminates (e.g., Carson Sink, off channel areas of the historic Stillwater Marsh). This large gradation of water chemistry from fresh water to very highly alkaline or saline is characteristic of many Great Basin wetland complexes. This aspect of water chemistry (total dissolved solids in the water and pH levels) is a different issue than environmental contaminants.

The Carson River from Lahontan Reservoir to the Carson Sink and Stillwater Marsh are classified as Class C waters of the State (Nevada Administrative Code 445A.126). Beneficial uses for class C waters include: municipal or domestic supply, or both, following complete treatment, irrigation, watering of livestock, aquatic life, propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply. Water quality standards for these beneficial uses are given in Table 4.1. Table 4.1 also provides water quality criteria recommended by the EPA, but not adopted by the State. Concentrations of ammonia, chloride, dissolved solids, pH, sodium, and the trace elements arsenic, boron, copper, mercury, and molybdenum commonly exceed Federal criteria and State standards for the protection of aquatic life or the propagation of wildlife and/or concentrations associated with adverse effects to aquatic organisms and wildlife. Water in certain drains entering Stillwater NWR was found to be toxic to aquatic invertebrates and fish larvae. Toxicity was not attributed to a single element, but appeared to be related to a mixture of dissolved constituents, including arsenic, boron, lithium, molybdenum, and total dissolved solids.

The chemistry of water varies with source. Water released from Lahontan Reservoir is generally fresh, but may contain elevated concentrations of mercury. The highest concentrations of

Table 4.1. Regulatory standards applicable to designated waters in Nevada. Standards are from Nevada Administrative Code (NAC) 445A.119 and 445A.144.

Constituent	Municipal Or Domestic Supply	Propagation of Aquatic Life		Irrigation	Watering Of Livestock	Propagation Of Wildlife
		1-hour Avg.	96-hour Avg.			
pH	5.0 -9.0	6.5 -9.0	6.5 - 9.0	4.5 - 9.0	5.0 - 9.0	7.0 - 9.2
TDS (mg/L)	500	-	-	-	3,000	-
Ammonia (mg/L)	0.5	[a]	[a]	-	-	-
Chloride (mg/L)	250	-	-	-	1,500	1,500
Sulfate (mg/L)	250	-	-	-	-	-
Aluminum (: g/L)	-	750[a]	87[a]	-	-	-
Arsenic (: g/L)	50	342[b, c]	180[b, c]	100	200	-
Barium (: g/L)	1,000	-	-	-	-	-
Beryllium (: g/L)	0	-	-	100	-	-
Boron (: g/L)	-	-	-	750	5,000	-
Cadmium (: g/L)	10	[c, d]	[c, d]	10	50	-
Chromium (: g/L) Total Chromium+6 Chromium+3	-	[c, d]	[c, d]	100	1,000	-
Copper (: g/L)	-	[c, d]	[c, d]	-	-	-
Fluoride (: g/L)	-	-	-	1,000	2,000	-
Iron (: g/L)	-	1,000	1,000	5,000	-	-
Lead (: g/L)	50	[c, d]	[c, d]	5,000	100	-
Manganese (: g/L)	-	-	-	200	-	-
Mercury (: g/L)	2	2[c]	0.012	-	10	-
Molybdenum (: g/L)	-	19	19	-	-	-
Nickel (: g/L)	13.4	[c, d]	[c, d]	200	-	-
Selenium (: g/L)	10	20	5	20	50	-
Silver (: g/L)	50	[c, d]	[c, d]	-	-	-
Zinc (: g/L)	-	[c, d]	[c, d]	2,000	25,000	-

[a] Aquatic life criterion recommended by the U.S. Environmental Protection Agency. Ammonia criteria depend on pH. A pH range from 8 and 9 corresponds to a Criteria Maximum Concentrations (1-hour average) between 1.3 and 8.4 mg/L and a Criteria Continuous Concentration (96-hour average) between 0.25 and 1.27 mg/L.

[b] The arsenic standards for aquatic life are specific for As+3.

[c] The standard applies to dissolved fraction only.

[d] Standards for aquatic life are based on water hardness (H), which is expressed as mg/L $CaCO_3$. Formulae are as follows:

Cadmium:	1-hour:	0.85exp[1.128 ln(H)-3.828]	Nickel:	1-hour:	0.85exp[0.8460 ln(H)+3.3612]
	96-hour:	0.85exp[0.7852 ln(H)-3.490]		96-hour:	0.85exp[0.8460 ln(H)+1.1645]
Chromium(+3):	1-hour:	0.85exp[0.8190 ln(H)+3.688]	Silver		0.85exp[1.72 ln(H)-6.52]
	96-hour:	0.85exp[0.8190 ln(H)+1.561]	Zinc:	1-hour:	0.85exp[0.8473 ln(H)+0.8604]
Copper:	1-hour:	0.85exp[0.9422 ln(H)-1.464]		96-hour:	0.85exp[0.8473 ln(H)+0.7614]
	96-hour:	0.85exp[0.8545 ln(H)-1.465]			
Lead:	1-hour:	0.50exp[1.273 ln(H)-1.460]			
	96-hour:	0.25exp[1.273 ln(H)-4.705]			

dissolved solids, arsenic, boron, molybdenum, and ammonia are typically found in agricultural drainage water. The concentrations of constituents in agricultural drainwater vary seasonally. In general, the highest concentrations, and presumably the greatest potential for toxicity, are found prior to the irrigation season. Concentrations of dissolved constituents decline as drain flow volumes increase through the irrigation season. However, because of increased drain flows, the largest contaminant loads in drainwater typically enter Stillwater NWR later in the irrigation season. In arid areas, persistent contaminants may accumulate and become concentrated in wetlands through evaporative processes.

At times concentrations may reach toxic levels. Wetlands in closed hydrographic basins, such as Lahontan Valley, are particularly susceptible to contaminant accumulation and concentration. The occurrence of such effects and the potential to adversely affect fish, wildlife, and habitat quality on Stillwater NWR are discussed under Section 4.3.3.5.

The historic release of mercury to the Carson River continues to affect the quality of water conveyed to Stillwater NWR, particularly during large upriver flood events, although questions still exist as to the actual effects that mercury contamination is having on refuge wildlife. Between 1859 and 1900, elemental mercury was used during gold and silver ore milling operations in the Comstock Mining District in the Virginia Mountain Range approximately 70 miles west of Stillwater NWR. As much as 7,500 tons of mercury may have been lost during milling operations. Most was discarded in mill tailings or discharged to the Carson River or its tributaries in mill effluent. Mercury has since become widely distributed in the lower Carson River basin.

Mercury has an affinity for particulate material. As a result, the bulk of the mercury in aquatic system is typically found in sediment. Transport of mercury in the Carson River basin largely occurs through the transport of sediments and suspended solids. In Lahontan Valley, the highest mercury concentration in aquatic sediment generally correspond to Carson River channels that existed after 1860 and the construction of Lahontan Dam in 1915, suggesting that mercury was deposited prior to construction of the dam. However, elevated mercury concentrations in Stillwater Point Reservoir, Newlands Project reservoirs, and other wetlands created after construction of Lahontan Dam indicate that transport and redistribution of mercury continued after 1915. Certain agricultural drains, such as Diagonal Drain and Stillwater Slough, incorporate sections of these historic river channels. As a result, mercury is frequently detected in the water column of the drains. High mercury concentrations have also been detected in D-Line Canal. Aquatic sediment may act as both a sink and a source of mercury. In Lahontan Valley, mercury concentrations in the water and biological samples generally correlate with concentrations in sediment.

Large amounts of mercury may be mobilized from river banks and stream bed sediments during flood events. In 1997, the USGS estimated that 10,000 pounds of mercury entered Lahontan Reservoir during an exceptionally large flood. The bulk of the mercury was the direct result of flooding in January of that year. Between January and September, 1997, an estimated 2,000 pounds was released from Lahontan Dam and available for transport to wetlands in the Lahontan Valley.

Pesticides, especially herbicides, are used in some cases in the Newlands Project. However, information on pesticide concentrations in water delivery canals and drains is sparse. One investigation detected pesticides in the majority of water samples (17 of 19) collected from agricultural drains. The herbicides atrazine, simazine, and prometon were the most frequently detected pesticides (79, 68, and 47 percent of the samples, respectively). Concentrations were less than levels associated with mortality. This investigation was conducted in August, when heavy use of herbicides would not be expected. The aquatic herbicide, acrolein, is used to control submergent and emergent vegetation in Newlands Project water delivery canals. Although this herbicide is highly toxic to aquatic organism, it is not persistent in aquatic systems (the half life ranges from 14 to 92-hours, depending on temperature and pH). The Truckee-Carson Irrigation District has indicated that acrolein is only applied to waters delivered to agricultural fields, and not to water delivered to wetlands. It is uncertain if acrolein enters Stillwater NWR in supply water through direct or indirect routes.

Sewage effluent and confined animal feeding operations have been identified as significant sources of nutrients, especially nitrogen and phosphorus, dissolved constituents (calcium, sodium, magnesium, iron, and sulfur), suspended solids, and pathogens in aquatic systems. Domestic septic systems located near agricultural drains may also represent potential sources of these constituents. The City of Fallon and the Naval Air Station-Fallon are permitted to discharge treated sewage effluent to drains entering Stillwater NWR Under the Clean Water Act and the Nevada Water Pollution Control Law, dischargers are required to comply with water quality standards and permit conditions. An unknown number of confined animal feeding operations are located near or adjacent to drains entering Stillwater NWR. Environmental Protection Agency is currently developing policy for controlling the quality of drainage from confined animal feeding operations.

The accidental release of a hazardous or other toxic material to the Carson River or the surface water routes entering Stillwater NWR has the potential to adversely affect fish, wildlife, or habitat quality on Stillwater NWR. However, the highly controlled water delivery system offers an opportunity to prevent or otherwise control such materials entering Stillwater NWR. The successful management of an accidental release would require timely recognition and notification of the release and close coordination with emergency response personnel to ensure adequate consideration of the fish and wildlife resource. Advanced emergency response planning would increase the possibility of successfully managing a toxic release to avoid adverse impacts to Stillwater NWR.

4.2.2 NEWLANDS PROJECT OPERATIONS AND INFRASTRUCTURE

This section presents a comparison of the potential consequences of the action alternatives on various aspects of Newlands Irrigation Project (Newlands Project) operations and infrastructure. The Service relied on calculations from the Below Lahontan Reservoir Model to make these analytical comparisons. The Below Lahontan Reservoir Model used a 95-year hydrologic simulation period to estimate long-term averages for each alternative.

All Alternative water budgets are based on sources identified in Alternative 5 of the 1996 WRAP EIS and ROD, as adjusted to account for current water rights acquisition activity and modifications to the base water allocation patterns presented in the Draft CCP EIS. The Below Lahontan Reservoir (BLR) Model and Truckee River Operations Model (TROM; the original model developed by USBR in the 1980's and directly attached to BLR Model runs) were used in these analyses because they have the capacity for more robust data analysis (95 year hydrologic cycle) and allow for direct data comparability to examine multiple parameters in the Truckee and Carson River Basins, simultaneously. The Below Lahontan Reservoir Model and TROM use 95 years of historic hydrologic data to develop long-term average values for numerous factors related to Newlands Project Operations, listed species requirements, and implementation of the P.L. 101-618 wetlands acreage mandate. The Service acknowledges that individual year values may, in reality, fall far below or above the long-term averages presented in this analysis; however, these models cannot be used to predict individual future year conditions nor can they be compared with past years operations. They represent the best available tools for comparing differences among broad management Alternatives, and allow for direct comparison with other analyses performed for this Final CCP EIS.

Except where noted, mitigation measures were not identified in the following sections because none of the action alternatives would have significant impacts on Newlands Project operations and infrastructure.

4.2.2.1 NEWLANDS PROJECT IRRIGATED ACREAGE BASE

No adverse impacts to the irrigated acreage base would be anticipated. Alternatives B, C, and E would maintain slightly more farmland acreage in the Carson Division of the Newlands Irrigation Project compared to baseline conditions, but would not increase the farmland acreage that is irrigated in any given year. This is because water rights would have to be temporarily transferred from other lands in the project to farmland on Stillwater NWR, and thus, would result in a temporary change in the point of use, not an increase in irrigated acreage.

4.2.2.2 NEWLANDS PROJECT HEADGATE DEMAND AND DELIVERIES

Newlands Project water rights are primarily used for agriculture and for wetlands protection and enhancement. This does not include other non water righted uses of Carson River water, such as the natural functioning of river, riparian, and marsh wetlands and their associated biological communities along the lower Carson River, nor does it account for recreational use and intrinsic values of the river system. Hydropower generation occurs at Lahontan Dam but is incidental to normal project operations.

Irrigation deliveries in the Newlands Project represent the primary water demand in Lahontan Valley. Newlands Project deliveries are based on the number of acres of land to be irrigated, the headgate entitlement (i.e., bench, bottom, pasture, or wetland), and the actual requests for irrigation water by the different water users. While the number of irrigated acres in the Newlands Project varies from year to year, current data indicate the number of irrigated water righted acres is about 59,000 (Table 4.2).

Table 4.2. Baseline Newlands Project irrigation acreage for purposes of this EIS.

	Farmland[A]	Wetland[B]	Total[C]
Carson Division	34,055	21,020	55,075
Truckee Division	4,000	0	4,000
Total (Newlands Project)	38,055	21,020	59,075

[A] Figures in this column derived from the 10/2/97 run of the Below Lahontan Reservoir model.

[B] This column designates the estimated number of acres from which water rights will be acquired for Lahontan Valley wetlands, obtained from the WRAP EIS/ROD (USFWS 1996 a, b). This figure does not represent the acreage of primary wetland habitat to be maintained in the Lahontan Valley.

[C] Obtained from the Adjusted Operating Criteria and Procedures EA (USDI 1997).

Under baseline conditions, Carson Division demand at Lahontan Reservoir is 251,900 acre-feet per year while Truckee Division demand is 23,000 acre-feet annually. Carson Division water users receive, at their headgates, an average annual supply of 97.8 percent of their headgate demand. Truckee Division averages 98.7 percent of demand and is not expected to experience a substantial change with the actions being evaluated in this Final EIS.

Most of the water available to serve the Carson Division is supplied by the Carson River, which provides an average volume of approximately 289,800 acre-feet annually to Lahontan Reservoir. Water from the Truckee River is diverted at the Derby Diversion Dam, in accordance with provisions of OCAP, as necessary to meet Truckee Division demand and to supplement Carson River flows to satisfy Carson Division demand. Differences between baseline conditions of Alternative A in this Final EIS and the estimated outcome of Alternative 5 presented in the WRAP EIS (USFWS 1996a) are in part due to adjustments made to OCAP (USBOR 1997).

Headgate demand and delivery are based on acres of irrigated land, headgate entitlement, irrigation use rates, and requests for irrigation water. Under existing conditions, the Carson Division headgate demand is estimated to be 174,500 acre-feet. Upon completion WRAP EIS, a headgate demand of 170,100 acre-feet per year would be the same for all alternatives (Table 4.3). Under all alternatives, headgate deliveries are lower than the entitlement and irrigation demand due to shortages resulting from changing hydrologic conditions, climatic factors, and from water rights that go unused. Under all of the action alternatives, Truckee Division demands and deliveries are assumed to remain unchanged from the No Action Alternative. Figures in Table 4.3 assume no winter deliveries under Alternative C, but the results of analyses are discussed in the text.

Table 4.3 Potential effects of alternative water delivery schedules on Carson Division of the Newlands Irrigation Project parameters, based on Below Lahontan Reservoir Model results.

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Headgate Demand (AF)	174,500	170,100	170,100	170,100	170,100	170,100
Headgate Delivery (AF)	169,200	167,530	167,340	168,750	161,780	167,760
Shortage (%)	3.04	1.51	1.62	0.80	4.89	1.38
Project Efficiency (%)	63.8	71.0	71.0	71.1	70.8	71.1
Demand Distribution[A] (% of annual demand)						
March	0	0	2	6	1	4
April	12	12	11	12	12	13
May	15	15	13	14	19	15
June	17	18	16	16	20	16
Total	44	45	42	48	52	48

Source: Below Lahontan Reservoir Model results

[A] Carson Division demand distribution for Lahontan Reservoir storage target calculations.

Alternative A: Carson Division headgate deliveries under baseline conditions are calculated to be 167,530 acre-feet per year, which is an estimated decline of 1 percent from existing conditions (already evaluated in the WRAP EIS). Average shortages due to hydrologic factors, such as drought, are estimated to be about 1.5 percent under this alternative (Table 4.3).

Alternative B: Under this alternative, Carson Division headgate deliveries would be similar to those under baseline Alternative A. This alternative would result in an estimated 167,340 acre-feet per year headgate deliveries which is 0.1 percent lower than baseline Alternative A (190 acre-feet reduction). This slight reduction in headgate deliveries under this alternative is caused by a higher Carson Division demand after Lahontan Reservoir fills (see Section 4.2.2.4, below), as compared to Alternative A, which results in less carryover going into a potential drought.

Alternative C: As with alternative B, Carson Division headgate deliveries would be similar to Alternative A. This alternative would result in an estimated 0.7 percent increase in headgate deliveries from Baseline Alternative A. A slightly higher estimated headgate delivery under Alternative C, as compared to Alternative A, is a consequence of a higher delivery volume for the Carson Division earlier in the year, which results in more carryover going into a potential drought. It is estimated that an even higher, albeit slight, headgate delivery for the Carson Division would result from delivering water to Stillwater NWR between mid-November and mid-March if off season deliveries were authorized (as outlined in Chapter 3).

Alternative D: Under this alternative, it is estimated that Carson Division headgate deliveries could be slightly lower than they would under the No Action Alternative. This alternative would result in an estimated 3.4 percent decrease in headgate deliveries from Baseline Alternative A. Because peak deliveries occur during late spring and early summer (May through July) under this Alternative, there would be less carryover in Lahontan Reservoir to maintain storage through the next year which is similar to Alternative B.

Alternative E: Similar to Alternative C, Alternative E would result in slightly more headgate delivery than would occur under Baseline Alternative A. This alternative would result in an estimated 0.1 percent (230 acre-feet) increase in headgate delivery when compared to Baseline Alternative A. Although there would be slightly more carryover in Lahontan Reservoir resulting from spring deliveries associated with implementation of Alternative E, there would be virtually no difference in headgate delivery between Baseline Alternative A and Alternative E.

4.2.2.3 NEWLANDS PROJECT EFFICIENCY

Changes in efficiency involve a complexity of factors, such as distance, timing, frequency, routing, and dispersal of water righted deliveries relative to Lahontan Reservoir releases. Another factor is the seasonal pattern of deliveries in the Carson Division. Because the different alternatives explored in this Final EIS include different delivery schedules for Stillwater NWR, and because Stillwater NWR would have a large portion of the water rights in the Carson Division, the seasonal delivery pattern has the potential to affect the efficiency of the Newlands Project.

The Below Lahontan Reservoir Model estimates Newlands Project efficiency based upon a systematic comparison of physical and hydrologic parameters, including monthly delivery schedules. The Below Lahontan Reservoir Model results offer a long-term estimate of the end result and impacts of the various alternatives upon Newlands Project efficiency, but these results should not be considered estimates of what would actually occur relative to Alternative implementation.

All Alternatives: Under all alternatives, Newlands Project efficiency would increase from an estimated 63.8 percent for existing conditions to an estimated 71 percent, based on the 95-year hydrologic simulation period (Table 4.3). Alternative B would be equal to the estimated 71.0

percent efficiency for Alternative A. Alternatives C and E would be slightly higher than Alternative A (71.1 percent), while Alternative D would result in a slightly lower efficiency when compared to baseline (70.8 percent). If, under Alternative C, water is authorized to be delivered during winter (between mid-November and mid-March), Project efficiency could increase slightly, to an estimated 71.2 percent. Increased efficiency would result from delivery of larger blocks of water distributed through 1 or 2 canals as opposed to having all delivery canals and laterals flooded during the irrigation season.

4.2.2.4 LAHONTAN RESERVOIR OPERATIONS

Lahontan Reservoir operations parameters evaluated in this section include inflows, outflows, and storage. Lahontan Reservoir inflows consist of Carson River basin runoff and Truckee River imports via the Truckee Canal. Reservoir outflows consist of controlled releases to satisfy headgate demands, plus associated reservoir losses (evaporation and seepage), and, in some years, spills (in the form of accidental, precautionary, or operational releases not destined to meet headgate demands). Some of the water spilled during precautionary releases can be used to meet headgate demands by capturing the water in a down gradient regulating reservoir for release later in the irrigation season.

Storage is the volume of water held in Lahontan Reservoir at any particular time. For the purposes of this Final EIS, estimated storage volumes occurring on June 30 and November 30 are used to index the potential effects on Lahontan Reservoir storage. Lahontan reservoir storage targets, revised under the Adjusted OCAP (Federal Register, Vol. 61, No. 237, 64815 - 64958; USDI 1997), prescribe when water may be diverted from the Truckee River to supplement Carson River inflow to Lahontan Reservoir. Storage targets are projected for the end of each month. January through June storage targets are based on estimated Carson River runoff forecasts for the months of April through July and have been adjusted to account for Carson Division demand during the months of March through June. The targets were intended to assist in the effective management of Truckee River water resources by minimizing unnecessary spills and moderating shortages while providing a supplemental water supply for irrigation in the Carson Division when necessary. Average June 30 storage volumes for each alternative represent the effects that each alternative has on storage during this period. The storage at the end of each irrigation season (represented by estimated average November 30 storage volumes) is considered carryover storage and is the foundation for the next year's storage.

Alternative A: Carson River inflow averages about 300,420 acre-feet per year based on the 95-year hydrologic simulation period (Table 4.4). This would not differ under any alternative. Truckee River imports (diversions at Derby Dam) are estimated to decline from existing conditions to an average of about 30,510 acre-feet per year under the No Action Alternative (an estimated decline of 39 percent) following completion of the WRAP. Lahontan Reservoir releases to meet headgate demands would average about 235,820 acre-feet per year over the long-term. The long-term average June 30 Lahontan Reservoir storage volume, under the No Action Alternative, would be an estimated 227,860 acre-feet (6 percent higher than estimated existing conditions). Average November 30 storage volumes would be an estimated 124,380 acre-feet over the long term, which represents an increase over existing conditions of about 20 percent. The effects of these changes from existing conditions are evaluated in the WRAP EIS, Section 4.2.5.

Table 4.4. Potential effects of alternative water delivery schedules on Lahontan Reservoir operations, including inflow, outflow, and storage, based on Below Lahontan Reservoir Model results (numbers are expressed in long-term averages; 1901-95).

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Inflow from:						
Carson River (AF)	292,050	300,420	300,420	300,420	300,420	300,420
Truckee Canal (AF)[A]	49,750	30,510	30,900	30,070	26,410	29,990
Outflow						
Releases for Deliveries (AF)	265,320	235,820	235,640	236,030	228,560	236,020
Spills (AF)	41,370	56,790	57,770	56,230	58,020	56,100
Losses (AF)	34,340	37,450	36,060	37,330	39,250	37,380
Average Storage (AF) on:						
June 30	213,860	227,860	230,890	226,050	225,410	225,500
November 30	103,180	125,030	121,280	129,060	144,470	129,780

Source: Below Lahontan Reservoir Model results

[A] represents the diversion amount entering Lahontan Reservoir.

Alternative B: Truckee Canal inflows under this alternative would decrease from baseline conditions by an estimated 1.8 percent. Carson River flow would remain constant, which would result in an average total reservoir inflow of about 330,410 acre-feet per year (similar to baseline). The volume of water released from Lahontan Reservoir to meet headgate demands would, under Alternative B, be nearly identical to that occurring under Alternative A (a calculated 180 acre-feet less) primarily because headgate demand would not change (all alternatives assume an identical headgate demand). A shift in the seasonal delivery pattern in the Carson Division during March-June (an overall reduction in demand during this period; Table 4.3) would result in long-term average June 30 storage volumes (Table 4.4) 1.3 percent higher than baseline conditions. The shift in the demand distribution during March-June could affect calculations used to project May or June storage targets under the Adjusted OCAP (USBOR 1997); however, in consultation with USBOR it was determined that considering changes to OCAP would not be warranted until after the water rights were acquired and the water management strategy had been implemented. In years when these calculations are necessary, this could be remedied by revising the C2 coefficients specified in the Adjusted OCAP. Long-term average November 30 storage volumes would decrease by 3.0 percent when compared to Alternative A, due to the fall emphasis of the water delivery schedule of this alternative.

Alternative C: Truckee Canal inflows would decline from baseline conditions by an estimated 1.4 percent under Alternative C. Carson River flow would remain constant, which would result in an average total reservoir inflow of about 330,490 acre-feet per year (nearly identical to Alternative A). The volume of water released from Lahontan Reservoir to meet headgate demands would also be nearly identical to that occurring under Alternative A, as explained under Alternative B. Although the shift in the seasonal delivery pattern for Stillwater NWR would increase demand earlier in the irrigation season (March), the overall March-June demand would not change markedly from existing conditions and Alternative A (Table 4.3). This would result in a long-term average June 30 storage volume 0.7 percent lower than that estimated for baseline conditions. The slight shift in Carson Division demand distribution during March-June would likely not affect calculations used to project May or June storage targets under the Adjusted OCAP (USBOR 1997). Revisions could be made to the C2 coefficients specified in the Adjusted OCAP, if necessary. November 30 storage volumes would increase by 3.2 percent, as compared to Alternative A, due to the spring delivery emphasis of Alternative C's water-delivery schedule. According to the Below Lahontan Reservoir model, delivering water to Stillwater NWR during winter, as outlined in Chapter 3, would not change the average June 30 storage volume, but the average November 30 storage volume would be higher (an estimated 129,640 acre-feet).

Alternative D: Truckee Canal inflows would decline from baseline conditions by an estimated 13.4 percent under this Alternative. Carson River flow would remain constant, which would result in a long-term average total reservoir inflow of about 326,830 acre-feet per year. Under Alternative D, the volume of water released from Lahontan Reservoir to meet headgate demands would be 3.1 percent lower than baseline Alternative A. An increase in the early summer demand (Table 4.3) would result in the long-term average June 30 storage volume (Table 4.4) declining from baseline conditions by an estimated 1.1 percent. The shift in the demand distribution during March-June could contribute to errors in meeting May or June storage targets under the Adjusted OCAP (USBOR 1997) by overestimating the end of month storage volumes for May and June. This could be remedied by revising the C2 coefficients specified in the Adjusted OCAP. November storage volumes would increase by 15.5 percent, as compared to Alternative A. Water deliveries would occur later in the season than under Alternative C, but Alternative D would result in much greater volumes of water being delivered prior to late summer and fall, thus contributing to higher fall storage in Lahontan Reservoir.

Alternative E: Truckee Canal inflows would decline from baseline conditions by an estimated 1.7 percent under Alternative E. Carson River flow would be roughly the same as baseline Alternative A, which would result in an average total reservoir inflow of about 330,410 acre-feet per year (nearly identical to Alternative's A and C). The volume of water released from Lahontan Reservoir to meet headgate demands would also be nearly identical to that occurring under Alternative's A and C. Although the shift in the seasonal delivery pattern for Stillwater NWR would increase demand earlier in the irrigation season (March), the overall March-June demand would not change markedly from Alternative A (Table 4.3). This would result in a long-term average June 30 storage volume being very similar to that estimated for baseline conditions (1.0 percent lower). Similar to Alternative C, the slight shift in Carson Division demand distribution during March-June would likely not affect calculations used to project May or June storage targets under the Adjusted OCAP (USBOR 1997). Revisions could be made to the C2 coefficients specified in the Adjusted OCAP, if necessary. November 30 storage volumes would increase by 3.8 percent, as compared to Alternative A, due to the spring delivery emphasis of Alternative E's water-delivery schedule.

4.2.2.5 HYDROPOWER RESOURCES

Hydropower generation associated with the Newlands Project facilities is a function of Lahontan Reservoir releases, which are determined by irrigation demand. Money received from hydropower generation is used to offset Newlands Project Operation and Maintenance costs. Therefore, reductions in hydropower revenues would adversely impact the project operator. If such losses occurred, the Newlands Project operator could potentially increase project water user operations and maintenance fees to make up the shortfall. A portion of this increased cost would be passed on to the Service and the State of Nevada as Newlands Project water users.

Two power plants located at Lahontan Dam, with capacities of 1.92 and 4.8 megawatts can receive water from the Truckee Canal or Lahontan Reservoir. Controlled releases at Lahontan Dam are made preferentially through the Old Lahontan Power Plant, a 1.9 megawatt power plant leased to Sierra Pacific Power Company. Releases are made secondarily through the New Lahontan Power Plant, a 4.8 megawatt facility completed in 1989 by Truckee-Carson Irrigation District and Lahontan Hydropower, Inc. TCID receives monthly payments from Sierra Pacific Power Company for electricity sold within TCID's franchise area. These payments are not tied to the amount of power generated by the Old Lahontan Plant. TCID renegotiated their contract with Sierra Pacific Power in July 2000, which may affect the operation and revenues generated from operating the Old Lahontan Power Plant. All BLR Modeled hydropower statistics are based on operating conditions as of July 1996 (BLR ver. 3.40, July 1996). A third, small power plant on the V-Line Canal at the 26-Foot-Drop structure also generates power. The power plants do not have specific water rights, so irrigation demands, not hydropower needs, dictate when releases are made. The revenues associated with long-term annual power generation vary with hydrologic flow.

Alternative A: Under Alternative A, the average amount of energy generated at the Old Lahontan, New Lahontan, and 26-Foot-Drop (V-Line Canal) Power Plants would decline from existing conditions by an estimated 12.3 percent to about 19,520 megawatt hours per year (Table 4.5). Hydropower revenues associated with the 26-Foot-Drop Power Plant is based on fixed rates and does not vary with Newlands Project releases. These revenues would remain unchanged under the No Action Alternative and other alternatives. The revenues associated with hydropower generation correlate to reservoir releases and would decline from existing conditions by an estimated 12.4 percent to about $782,910 per year on average (Table 4.5).

Alternative B: Energy generation at the Old Lahontan, New Lahontan, and V-Line Canal power plants, combined, would decline from baseline conditions by an estimated 1.6 percent. However, because of timing differences, revenues would decline from baseline conditions by an estimated 5.7 percent. In the long term, Alternatives A and B would differ by about $44,750 per year.

Table 4.5. Potential effects of alternative water delivery schedules on Newlands Project hydropower generation and revenues, based on Below Lahontan Reservoir Model results.

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Old Hydro. Plant (GWh)	7,850	7,760	8,060	8,780	7,510	8,340
26-Foot-Drop (GWh)	2,350	1,270	1,290	1,280	1,410	1,280
New Hydro. Plant (GWh)	11,660	10,230	9,590	8,820	9,630	9,260
Total (Gwh)	21,860	19,260	18,940	18,880	18,550	18,880
New Hydro. Revenues ($)[A]	893,600	782,910	738,160	671,220	724,490	700,350

Source: Below Lahontan Reservoir Model results

[A] - revenues would vary with the cost of energy and contract negotiation. Generated energy (GWh) from the 3 plants may be calculated by the current rate to provide better hydropower revenue estimates.

Alternatives C: Energy generation under Alternative C would decline from baseline conditions by an estimated 2 percent. Due to reduced annual energy generation combined with differences in timing of releases, revenues decline from estimated baseline conditions by an estimated 14.3 percent under Alternative C. Revenues would decline more under Alternative C than under Alternative A because more water would be passed through the Old Lahontan Power Plant (reducing water volume through the New Lahontan Power Plant) due to the delivery pattern being more spread out across the irrigation season, and more water would be released from Lahontan Reservoir during lower reservoir levels (less power being generated by the water that does pass through the New Lahontan Power Plant). The Below Lahontan Reservoir Model defaults to flowing water through the old Lahontan Power Plant based on month and flow amounts, thus, the Alternative C water delivery strategy would result in more flow through the Old Lahontan Power Plant vs. the New Lahontan Power Plant based on modeling assumptions. In the long-term, revenues generated by Alternative C would differ from Baseline Alternative A by an estimated $111,690 per year.

Alternative D: Power generation at the Old Lahontan Power Plant under Alternative D would be less than under Alternative A because higher volumes of water would be released within a shorter period of time. Alternatives A and D would differ by an estimated $58,420 per year which represents a 7.5 percent decline from baseline conditions. As under all action Alternatives, revenue values only represent the difference in revenues paid to TCID from Sierra Pacific Power and not revenues used to offset TCID Operations and Maintenance costs. Energy generation under Alternative D would decline by 3.7% from baseline Alternative A.

Alternative E: Similar to Alternative C, power generation would decline by 2% when compared to baseline Alternative A, but revenues would decline by 10.5% based on the increased utilization of the Old Lahontan Power Plant under this Alternative. From combined sources, Alternative E would result in 18,880 GWh produced (19,260 under baseline Alternative A) and $700,350 in revenue ($782,910 under baseline Alternative A).

Mitigation Measures

There are a number of mitigation measures that could minimize, or compensate for, the estimated losses in energy generation and associated revenue. Several mitigation measures are described in the WRAP EIS (USFWS 1996a), pages 4-20 and 4-21.

Switching generation priorities at the Old and New Lahontan Power Plants has the potential to increase power generation and the revenues associated with power generation at the New Power Plant. This action would entail making Lahontan Reservoir releases through the New Lahontan Plant (a 4.8 megawatt facility) first and then the Old Lahontan Plant (a 1.9 megawatt facility) secondarily. Such a change in priority would require changes in licensing by the Federal Energy Commission for the two power plants, as well as the agreement between TCID and the Sierra Pacific Power Company.

4.2.2.6 NEWLANDS PROJECT CANAL OPERATION AND CAPACITY

The infrastructure of the Carson Division of the Newlands Project was designed to store water in Lahontan Reservoir and deliver this water to water righted farmland in the Lahontan Valley. Because there are progressively fewer headgates with greater distances from Lahontan Reservoir, the capacity of delivery canals was largest at the top of the project (nearest Lahontan Reservoir) and smallest at the peripheries of the project. At the time of construction in the early 1900s, there was no perceived need to maintain the large capacities of delivery canals to the ends of the project. However, with the enactment of P.L. 101-618, wildlife conservation is now a designated purpose for which the Newlands Project is to be operated and maintained and Lahontan Valley wetlands, located at the peripheries of the Project, are now a major water user. The ongoing water rights acquisition program (USFWS 1996a) could result in potential delivery conflicts because larger volumes of water must now be delivered to the peripheries of the project. Changes to the seasonal pattern of wetland deliveries to better achieve the purposes of Stillwater NWR and wildlife conservation in general, has the potential to contribute further to delivery conflicts resulting from canal capacity limitations if canal capacities leading to wetland areas are not enlarged to meet the expanded purposes of the Newlands Project.

Potential problems with canal capacity are already surfacing with only the existing volume of water rights being delivered to Stillwater NWR. As additional water rights are acquired and transferred to Stillwater NWR under the water rights acquisition program, additional problems are anticipated. U. S. Bureau of Reclamation has contracted the Irrigation Training and Research Center (Univ. California Polytechnic) to examine methods to facilitate greater irrigation deliveries to Stillwater NWR. The final report was released January 17,2002. USBOR, in consultation with TCID and Stillwater NWR, will determine the most feasible means to accomplish refuge deliveries.

Alternative A: Under Alternative A, which would assume the seasonal delivery pattern identified in the WRAP EIS (USFWS 1996a), up to as much as 200 cubic feet per second would have to be delivered to Stillwater NWR at times to meet the headgate demand of this alternative. This peak in demand corresponds to the peak in demand for the Carson Division as a whole, as it was patterned after this seasonal pattern. To meet headgate demands of other, upstream users, canal capacity leading to the refuge would have to be well in excess of 200 cubic feet per second to allow concurrent delivery to other users. At present canal capacity leading onto the refuge at all diversion points is approximately 450 cubic feet per second.

Although the acquisition of additional water rights for Stillwater NWR under the Service's water rights acquisition program (USFWS 1996a) would contribute further to canal capacity conflicts near the refuge, most of the water rights being acquired are from the Stillwater NWR end of the Carson Division, which would tend to diminish conflicts. However, for the water users that remain near Stillwater NWR and farmers within the approved boundary of Stillwater NWR, there could be increasing competition for canal space under the No Action Alternative.

Alternative B: Effects of this alternative would be similar to Alternative A, except that peak demand would not be as high and it would occur shortly after the peak in demand for the rest of the Carson Division.

Alternatives C and D: Under Alternative C, the Service would call for more water primarily during a period when few farmers are calling for water (e.g., late March and early April), which would tend to reduce conflicts with other water users as compared to Alternative A. However, the volume of water to be delivered in a short period during the latter half of March would be substantial and the capacity of canals may be inadequate for this purpose, given other delivery demands. Needs could be as high as 450 cubic feet per second during peak wetland water demand under Alternative C because only two weeks are available for delivery during March, and wetland habitat acreage must peak by April 1 to minimize nest flooding. In the absence of enlargements of the canals to accommodate larger delivery volumes during March under this alternative, the delivery period of a portion of this block of water would have to be done in April. Without modifications to canals leading to the refuge, limited inflow of spill water into Stillwater NWR would continue to hamper achievement of refuge purposes and goals under this alternative.

Under Alternative D, impacts would be similar to those of Alternative C, except there could be more effects on other water users because the peak delivery months would be May and June, as compared to March and early April. An estimated peak inflow of 350 cubic feet per second for operational deliveries would be anticipated for Alternative D, compared to the peak of >200 cubic feet per second under Alternative A. Although Alternative D could result in an increased peak demand (in terms of inflow rate into Stillwater NWR) of up to 40 percent beyond that of Alternative A, this peak demand would occur during a month when overall demand in the Carson

Division is about 20 percent lower than when the peak deliveries would occur under Alternative A.

To the extent that water is delivered to Stillwater NWR during the winter under either alternative, the potential for damage due to freezing would increase. The Newlands Project contractor (TCID) performs various maintenance and repair activities on Newlands Project facilities during mid-November through mid-March, which is the non-irrigation season for farmland in the Lahontan Valley. Many of these activities require the draining of water from water conveyance facilities (e.g., canals) and facilities being maintained or repaired during this time may not be available for deliveries. Furthermore, *"Winter operation of a canal system where temperatures are subfreezing may require additional canal and structure freeboard to permit wintertime design capacity to flow under an ice cover. At subfreezing temperatures, an ice cover readily forms when velocities are less than 2.2 feet per second. If velocities are fast enough to prevent formation of ice cover, frazil ice may form, and if allowed to accumulate on racks at inlets to structures will cause backwater. Additional forces caused by expansion of the ice cover or by ice lenses in clayey foundation materials should be considered"* (Aisenbrey et al. 1987). Before Sheckler Reservoir could be used for winter deliveries, it would likely need to be modified (e.g., heated).

Winter operations could increase costs to TCID, primarily in terms of personnel costs. During the nonirrigation season, ditch riders are on accrued annual vacation for up to two months. When ditch riders are not on vacation during the nonirrigation season, they are involved in maintenance activities such as burning and cleaning ditches. Additional staff time would be required to deliver water outside the traditional irrigation season of mid-November through mid-March.

Alternative E: Similar to Alternative C, the Service would call for more water primarily during a period when few farmers are calling for water (e.g., late March and early April), which would tend to reduce conflicts with other water users as compared to Alternative A. This Alternative would call for maximum operational flow velocities of approximately 400 cubic feet per second, primarily during the last 2 weeks of March into early April, however, this would result in an 11 percent reduction in maximum flow capacity when compared to Alternative C. In the absence of canal enlargements canals to accommodate larger delivery volumes during March under this alternative, the delivery period of a portion of this block of water would have to be completed in April. Without modifications to canals leading to the refuge, limited inflow of spill water into Stillwater NWR would continue to hamper achievement of refuge purposes and goals under this alternative. Off season deliveries would only be used under Alternative E if authorized by USBOR and the Newlands Project Operator and are not assumed under implementation of this alternative.

Mitigation Measures: It is possible that Alternative C, and to a lesser extent, Alternative E as outlined in Chapter 3, would further limit canal capacities, beyond that which would occur under the No Action Alternative. These canal restrictions could be resolved in several ways. Canals could be enlarged to accommodate higher flow volumes beyond the enlargements required by Alternative A, which would also allow for larger volumes of spill water to be conveyed to the refuge. Allowing the irrigation season to begin on March 1 or March 7, rather than on March 15 would increase the amount of time to deliver Alternative C and E's March water demand, which would reduce the needed canal capacity (for operational deliveries) below that needed under Alternative A. Large volume deliveries to the refuge in March could be accommodated with lower canal capacities than could lesser deliveries during peak irrigation months. Another possibility would be to extend the delivery period of March water into April, which could result in higher nest flooding. To reduce the impacts of nest flooding, the peak acreage targeted for April 1 could be reduced somewhat, and the water not delivered during March could be delivered in April (as proposed under Alternative E) and even into May to maintain a more stable wetland habitat acreage during the nesting season. Some of these options could also resolve canal capacity limitation and delivery conflicts under Alternative D, but not all would apply because the peak delivery period (May) occurs in a high use period for other water users.

The U.S. Army Corps of Engineers is currently studying the feasibility of modifying existing infrastructure to reduce flood potential in this area. If this effort was coordinated with canal enlargement to meet the increasing headgate demands of Stillwater NWR (under the ongoing water rights acquisition program), the two projects could complement each other. Enlargement of Newlands Project canals to convey larger volumes of water to Stillwater NWR during precautionary releases and spills from Lahontan Reservoir could augment efforts to reduce flood potential in the Fallon area and, depending on design, could accommodate the larger volumes of water to be delivered to Stillwater NWR in the future and thereby reduce delivery conflicts with other water users.

Additionally, the Irrigation Training and Research Center (ITRC) has developed a proposal that would accommodate the water flow requirements proposed under Alternative's C and E, while improving delivery efficiency within the Carson Division of the Newlands Project. The proposal has recently been finalized; however, no decision has been made thus, implementation of proposed modifications is not subject to analysis in this Final EIS. Proposed mechanisms considered in the ITRC analysis include enlargement of targeted sections of east side water delivery canals to the southern end of the refuge, use of D-line canal to convey water to the west side of the refuge, and several drainwater reuse points to increase efficiency of the irrigation system. If this latter modification were implemented, there would be impacts to the estimated drainwater supply amounts projected in the following sections. Impacts to other Carson Division water users would be minimal as increases in Newlands Project efficiency could lead to fewer shortage amounts and years by retaining efficiency credit water in Lahontan Reservoir.

To minimize operational and facility impacts of delivering water during the winter, refuge deliveries, including delivery route, and maintenance work performed by TCID on canals could be coordinated. Water needed to meet winter demands could be stored in regulating reservoirs below Lahontan Reservoir. To minimize damage caused by freezing, water conveyance facilities could be modified or delivery rates and delivery points could be coordinated with TCID.

4.2.2.7 DERBY DAM AND TRUCKEE CANAL

In this section, the potential effects of the alternatives on the diversion of Truckee River water into the Truckee Canal at Derby Dam are discussed. Irrigation deliveries to the Truckee Division would remain unchanged across the action alternatives.

Alternative A: Under Alternative A, the long-term average volume of Truckee River diversions at Derby Dam would decline from estimated existing conditions by about 25 percent to a long-term average of about 66,250 acre-feet per year (Table 4.6).

Table 4.6. Potential effects of alternative water delivery schedules on the Truckee Canal (Derby Diversions), lower Truckee River (Derby Releases), and Pyramid Lake inflow and elevation, based on Below Lahontan Reservoir Model results.

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Derby Diversions (AF)	88,180	66,250	67,660	65,700	61,570	65,590
Supply to Lahontan Reservoir	49,750	30,510	30,900	30,070	26,410	29,990
Derby Release (AF)	475,760	497,440	496,900	497,480	502,190	497,610
Pyramid Lake Inflow (AF)	483,340	504,950	504,420	504,970	509,630	505,100
Pyramid Lake Elev. (ft)	3,836.84	3,842.11	3,841.97	3,842.11	3,843.27	3842.14

Source: Below Lahontan Reservoir Model results, U.S. Fish and Wildlife Service.

Alternative B: Under this alternative, the average volume of water to be diverted into the Truckee Canal at the Derby Dam would increase from baseline Alternative A by an estimated 2.1 percent. The water delivery schedule under this alternative is somewhat flexible. Delivering higher volumes of water in the latter part of the summer and fall would contribute to fewer reductions in Derby diversions than shown in Table 4.6. In contrast, delivering higher volumes of water in the spring and early summer would result in greater reductions in Derby diversions, primarily because the Carson River has less capacity to meet Lahontan Reservoir storage objectives during the late summer and early fall.

Alternative C: The average volume of water to be diverted into the Truckee Canal at the Derby Dam under Alternative C would decline from Alternative A by an estimated 0.8 percent. The water delivery schedule under this alternative is also somewhat flexible. Delivering higher volumes of water toward the latter part of the summer and fall would contribute to fewer reductions in Derby diversions than shown in Table 4.6, while delivering higher volumes of water in the spring and early summer would result in greater reductions in Derby diversions.

Alternative D: Under this alternative, the average volume of water to be diverted into the Truckee Canal at Derby Dam would decline from Alternative A by an estimated 7.1 percent, which is the highest reduction in diversion among action Alternatives. This further decline in Derby diversions is attributed to proportionately less water being delivered near the latter end of the irrigation season when Carson River flow is at its lowest. Greater volumes of water delivered in the early spring and fewer deliveries in the late summer and fall would result in higher Lahontan Reservoir storage levels in the fall (e.g., November 30 levels, Table 4.4) and greater carryover to the following irrigation season.

Alternative E: Similar to Alternative C, the amount of water diverted from the Truckee River would decline by an estimated 1.0 percent when compared to Alternative A. Delivering higher volumes of water toward the latter part of the summer and fall would contribute to fewer reductions in Derby diversions than shown in Table 4.6, while delivering higher volumes of water in the spring and early summer would result in greater reductions in Derby diversions.

Mitigation Measures: Under all action Alternatives, the difference in the amount of water diverted from the Truckee River when compared to baseline Alternative A, would result in little change, with the exception of Alternative D. Flexibility in action Alternative water delivery schedules could be used to reduce diversion amounts.

4.2.3 LOWER TRUCKEE RIVER AND PYRAMID LAKE

This section covers the potential effects of the alternatives on hydrology of the lower Truckee River and Pyramid Lake. Mitigation measures were not identified in the following sections because the action alternatives would have no significant impacts on the Lower Truckee River or Pyramid Lake.

Alternative A: Under this alternative, the long-term average volume of Truckee River diversions at Derby Dam identified above would leave approximately 497,440 acre-feet per year to flow through Derby Dam down the lower Truckee River (Table 4.6), which is 4.6 percent more than is estimated to occur under existing conditions. The water surface elevation of Pyramid Lake would be an estimated 3,842.11 feet under baseline conditions, compared to the long-term estimate of 3,836.84 feet under existing water management assumptions (an increase of more than 5 feet). The lake elevation was 3,809 feet in July 1997 and it would take an estimated 60 to 70 years to attain an elevation of 3,840 feet (USBOR 1997), assuming a long-term average of 480,500 acre-feet of inflow.

Alternative B: Under this alternative, lower Truckee River flows would be similar to flows that would occur under Alternative A (a 0.1 percent decline from baseline conditions). Effects to the eventual water surface elevation of Pyramid Lake would be negligible (the lake elevation would eventually be an estimated 0.14 feet lower than would occur under baseline Alternative A management assumptions.

Alternative C: The estimated increased flow volumes in the lower Truckee River that could occur under Alternative C would be negligible, but they would not conflict with the objectives of the 1988 OCAP as amended (1997; slightly higher flows than estimated for Alternative A). Similarly, there would be no measurable impacts to the eventual elevation of Pyramid Lake.

Alternative D: Under this alternative, the average volume of water to flow through Derby Dam to the Truckee River could result in an estimated 0.9 percent increase, from baseline conditions, in lower Truckee River flows. Based on the BL R Model, the surface of Pyramid Lake could potentially increase to 3,843.27 feet, a 1.16 foot increase. Because Pyramid Lake would begin flooding highways above a water surface elevation of 3,840 feet (USDI 1997), this alternative could potentially contribute toward flooding some highways near Pyramid Lake over the long-term.

Alternative E: Water flow through Derby Dam into the lower Truckee River would only differ by an estimated 130 acre-feet (much less than 1%) under this Alternative when compared to Alternative C, therefore, the impacts of implementing Alternative E would be the same as for Alternative C and baseline Alternative A.

4.2.4 AIR QUALITY

The air quality of a given area is determined by the amount of pollutants released into the atmosphere and the atmosphere's ability to transport and dilute the pollutants. The Federal Clean Air Act, as amended in 1970, 1977, and 1990, established air quality standards and the authority of the EPA to enforce the standards. In Nevada, the State has the authority to implement the air quality program with the Nevada Revised Statues (445.401 to 445.601). The Nevada standards are equal to, or more stringent than, the Federal National Ambient Air Quality Standards set by the EPA. The pollutants addressed by Federal and State air quality standards are: nitrogen dioxide, total suspended particulates, inhalable particles (PM_{10}), sulfur dioxide, ozone, carbon monoxide, lead, and hydrogen sulfide. Dust, soot, ash, and chemicals given off by burning are key factors affecting inhalable particulates (PM_{10}), which is the only element that State air quality officials have identified as a potential pollutant of concern in the affected area.

Air quality in the study area is good overall, and is "in attainment" for all monitored air quality pollutants. Some concern has been expressed about the concentration of inhalable particulates (PM_{10}) in the region, although data recorded at a sampling station in Fallon from 1993 to 1994 indicate PM_{10} levels in the region generally do not exceed Nevada air quality standards. Suspended particulates are derived from numerous sources but particulate emissions in Churchill County originate from desert lands that are naturally low in vegetative cover, and consequently are subject to wind erosion. For more detail on the air quality in the study area, readers are referred to the Final WRAP EIS (USFWS 1996a; 4-51).

Potential impacts of the water rights acquisition program on inhalable particulates in Churchill County were addressed in the WRAP EIS (USFWS 1996a), and therefore are not addressed here. No additional farmland would be taken out of production as a consequence of actions being evaluated in this Final EIS. The greatest potential for EPA standards to be exceeded would occur during wildfires, the potential of which would be similar between all alternatives The Fire Management Plan (Appendix K), addresses prescribed burning as well as wildfire abatement.

As of the writing of this plan, the State of Nevada is in the process of developing a State Smoke Management Plan to address air quality issues. There are no nonattainment areas near Stillwater NWR. Smoke sensitive areas include roads on Stillwater NWR Complex, County, and State roads. The community of Fallon, Nevada (population 20,000) is approximately six miles southwest of Stillwater WMA and about 14 miles southwest of Stillwater NWR. The Naval Air Station-Fallon is approximately 15 miles south of the Stillwater NWR. Private and Tribal lands adjacent to the Refuge are primarily agricultural with some single family residences. Agricultural burning in and around Stillwater NWR is widespread, frequent, and commonly accepted by the public.

Alternative A: For the purposes of this analysis, it is assumed that prescribed burning would not be carried out under Alternative A. No prescribed burns were completed during the 1990's on the Stillwater NWR, Fallon NWR, or Stillwater WMA. A fire management plan, primarily to address potential wildfires, is included in Appendix K of this Final CCP EIS.

Table 4.7. Representative prescribed fire emissions.

Burn Type	Average Size of Burn	PM10 Emissions per Burn
wetland	75 acres	2.25 tons
restored native upland	30 acres	.45 tons
maintenance	20 acres	.1 tons

Source: Fire Management Team, Sheldon-Hart Mountain NWR Complex, Oregon.

Alternatives B and C: Under these alternatives, prescribed burning would occur an average of three to five days each year, although prescribed burning would not occur in many years. No significant impacts to air quality would be anticipated. Temporary air quality impacts from smoke may occur, but measures to reduce smoke emissions would be incorporated into prescriptions, including techniques that have a low rate of spread (allowing fires to burn longer, thus reducing the length of time nonburned fuel will smolder), burning when fuel moisture levels are sufficiently low.

Prescribed fire operations would be conducted in compliance with the Nevada State Smoke Management Plan. Individual prescribed burn plans would specifically address smoke management concerns and actions required to ensure public safety and prevent negative impacts from smoke. The public would be informed of prescribed fire activity on the refuge through several methods including; (1) in person or by telephone calls to refuge neighbors, (2) refuge press releases, (3) bulletins posted at information kiosks, (4) warning signs and other traffic control devices. Tribal, military, and county entities will be contacted, by phone or in person, prior to burning as part of the required elements of each prescribed burn plan.

Burn plans would also include contingency plans which would be implemented in the event of unexpected negative smoke conditions. In general, prescribed burns would be small (average 50 to 100 acres), have light fuel loads (0.25 to 3 tons of fuel per acre), would be burned under low fuel moisture conditions, and would be burned under specific wind direction and atmospheric stability conditions.

Prescribed burns on the refuge would fall into the following Prescribed Fire Units: wetlands, restored native uplands, and maintenance. Table 4.7 illustrates representative PM_{10} emissions in tons per average burn.

Alternative D: No prescribed burning would occur under this alternative, and therefore adverse impacts due to prescribed burning would not occur.

Alternative E: The impacts associated with implementation of Alternative E have been previously covered under the discussion regarding implementation of Alternative's B and C. A fire management plan has been developed for this Alternative (Appendix K of this Final EIS).

Mitigation Measures

Mitigation measures to minimize or reduce smoke emissions during prescribed burning would be an integral part of the fire management plan (Appendix K).

4.3 PHYSICAL ENVIRONMENT — REFUGE LANDS AND WATERS

4.3.1 ACREAGE BASE

4.3.1.1 STILLWATER NWR, STILLWATER WMA, AND FALLON NWR

Alternative A: At present, Stillwater NWR is about 79,570 acres of Federal land, Stillwater WMA is about 65,603 acres, and Fallon NWR is about 17,848 acres, for a combined total of 163,021 acres of Federal land. Non-Federal inholdings within the existing boundaries make up about 59,708 acres (Table 4.8; Map 1.4).

Alternatives B-E: Each alternative would retain differing amounts of Federal land within the Stillwater NWR Complex in the Lahontan Valley, with Alternative B retaining the least amount and Alternative D the most. Alternatives C and D would encompass the largest amount of Federal land in the long term, but much of the western and northwestern sides of Alternative D's boundary would likely continue to be checkerboarded well into the future. Alternative E would be identical to the proposed boundary under Alternative C. The change in status of Federal lands due to a boundary revision would have no marked impacts, although changes in management due to the shift in management authorities could potentially have impacts. Mitigation measures associated with these potential impacts are addressed in discussions of these resources.

Table 4.8. Approximate acreages of Federal and non-Federal lands[1] within alternative boundaries of Stillwater NWR and other Federal wildlife areas within the Lahontan Valley.

	Approximate Acreages				
	Alternative A (Existing)	Alternative B	Alternative C	Alternative D	Alternative E (Preferred)
Federal Lands					
Stillwater NWR	79,570	79,570	137,504	167,806	137,504
Stillwater WMA	65,603	0	0	0	0
Fallon NWR	17,848	17,848	0	0	0
Subtotal	163,021	97,418	137,504	167,806	137,504
Non-Federal Lands					
Private	41,224	9,249	22,661	42,881	22,661
County	12,717	9,600	8,242	15,277	8,242
State	5,767	1,287	3,847	5,767	3,847
Subtotal	59,708	20,136	34,750	63,925	34,750
TOTAL	**222,729**	**117,554**	**172,254**	**231,731**	**172,254**

[1] This table illustrates the extent to which Federal and non-Federal lands would fall within approved boundaries of Federally-managed wildlife areas in the Lahontan Valley under each alternative.

4.3.1.2 ANAHO ISLAND NWR

Anaho Island NWR encompasses the entire island, the size of which is determined by the level of Pyramid Lake. In 1913 when the refuge was established, the island was 247 acres. When Pyramid Lake was at its lowest point in 1977, the potential for the formation of a land bridge between the island and the nearby shoreline became a concern. Cessation of winter hydroelectric generation, implementation of the 1988 OCAP, and high water years during the mid 1980s raised the lake level, which resulted in the island shrinking back to 575 acres by the summer of 1997 and to 490 acres by the summer of 1999.

Alternative A: Under this alternative, which assumes full implementation of the 1997 adjustments to OCAP, Anaho Island is expected to average 245 acres over the long term.

Alternatives B and C: The water level of Pyramid Lake is not expected to be affected measurably by these alternatives, as compared to Alternative A. Modeled results estimate a slightly lower water level under Alternative B in the long-term (Table 4.6), which would result in slightly higher acreage than under Alternative A. Conversely, modeled results for Alternative C estimate a slightly higher water level, which would result in slightly less island acreage. Both alternatives would result in less than a 1 percent change in acreage.

Alternative D: Under this alternative, the water level of Pyramid Lake could be as much as 1 foot higher than under Alternative A in the long term. This would result in a slightly smaller island on average (less than 10 fewer acres) than under Alternatives A, B, and C. Even under this alternative, the size of the island would be larger than it was prior to the 1900s.

Alternative E: The impacts associated with implementing Alternative E would be identical to Alternative C.

4.3.2 TOPOGRAPHY AND SOILS

While there would be few, if any, changes to topography and soils, alterations could occur in localized areas. Topographic features and soils that could potentially be affected include the shape and location of Stillwater Slough and the lower Carson River, berms that were built up to the side of canals (during canal cleaning operations), wetland units in which deeper canals could be constructed, and wetland soils that could change in composition due to altered water flow regimes. Over the long-term, sand dunes will continue to move across the landscape, and without a sand source, sand dune dynamics may be affected.

Few alterations would occur under all alternatives. Under Alternatives C, D, and E, efforts would be undertaken to lower or remove berms adjacent to on-refuge canals to restore a more natural appearance, otherwise enhance aesthetics, and to remove perches from which common ravens scan for waterbird nests. Consideration would also be given to recontouring Stillwater Slough and possibly parts of the lower Carson River, but before this is undertaken, potential effects on cultural resources, surrounding lands, and water users would be evaluated.

The alternatives considered in this Final EIS would have no measurable effects on wetland soils. Changes to wetland soils over time, if any, would result from larger volumes of fresh water entering the system as a consequence of the water rights acquisition program. Although this is anticipated for all alternatives, it would only occur to the extent that salts from groundwater sources do not totally replace lost salts.

4.3.3 REFUGE WETLANDS

In general, wetlands are areas that are at least periodically saturated or covered with water. More than 300,000 acres of land in the Lahontan Valley have been classified as wetlands. Primary wetland areas are those wetland areas specified in P.L. 101-618. The four areas identified were Stillwater NWR, Stillwater WMA, Carson Lake, and wetlands on the Fallon Paiute-Shoshone Indian Reservation. Other wetlands in Lahontan Valley are referred to as secondary wetlands. Although background information is provided below on all Lahontan Valley wetlands, this section focuses on the wetlands of the Stillwater NWR Complex.

Archaeological evidence and pollen cores indicate that a relatively permanent marsh has existed in the Stillwater area for at least 4,000 years. Prior to Euro-American settlement, there was an estimated average of 150,000 acres of wetland habitat in the Lahontan Valley (Kerley et al. 1993). The Carson River and its riparian corridor, Carson Lake, Stillwater Marsh, and Carson Sink are remnants of the historic Lahontan Valley wetlands.

When they have water, the Lahontan Valley wetlands are some of the most productive in the western United States. They are unique in that they provide expansive areas of shallow wetland habitat with waters of varying salinity. The Lahontan Valley wetlands are characterized by shrinking and swelling, both seasonally and annually, as well as over geologic time. This fluctuation creates a diverse Great Basin wetland ecosystem, which encompasses a wide range of wetland habitat types within a localized area. Within the span of one season, these wetlands can be transformed from shallow lakes with clear, freshwater, to shallow, brackish marshes with high salt concentrations.

Historically, runoff from the Sierra Nevadas (via the Carson River) constituted the primary inflow to the Lahontan Valley wetlands. Runoff from April through June accounted for about 40 to 60 percent of the total annual flow. In most years, the maximum spring flow volumes flushed the initial wetland habitat of accumulated salts and other dissolved solids. On average, roughly 15-20 acre-feet of water per year flowed into Stillwater Marsh for every acre of wetland habitat (based on information in Kerley et al. 1993), meaning that about 10-15 acre-feet of water per acre, per year flowed through the marsh into the Carson Sink. During the summer, as Carson River inflow decreased and the evaporation rate increased, the wetlands shrank, leaving shallower, more saline marsh habitats. These seasonal fluctuations created a variety of riparian and wetland habitats, including braided river channels, closed oxbows, perennial and ephemeral marshes and wetted playas in Lahontan Valley's terminal wetlands. This diversity of habitats attracted a wide range of animal species, including vast populations of ducks, geese, pelicans, wading birds and shorebirds.

The Newlands Project and other upstream diversions have completely altered the natural hydrologic regime in the Lahontan Valley wetlands. Upstream diversions required for agriculture have steadily dried Stillwater Marsh, Carson Lake, and Carson Sink in all but the wettest years. From the early 1900s to the late 1960s, the Lahontan Valley wetlands have subsisted on seepage losses and drainflows from the Newlands Project irrigation system, water from winter power generation (primarily Truckee River water), and periodic spills in high water years.

Episodic flooding, which once sent voluminous spring flows into the marshes, was contained by Lahontan Dam and stored in Lahontan Reservoir for irrigation use. Newlands Project drainwater inflows allowed the wetlands to survive, but water chemistry was altered compared to Carson River inflows, with increased dissolved solids and contaminants from agricultural use. Most of the water that did reach the wetlands arrived gradually, over a six- to seven-month period in the summer. These flow volumes have generally been too low to flush accumulated salts and contaminants from the wetlands.

By 1948, with the number of migratory birds in the marshes decreasing, the Service, Nevada Fish and Game Commission (now the Nevada Department of Wildlife), and TCID entered into an agreement to manage the marshes. A series of dikes, canals, and water control structures were built in Stillwater Marsh to better manage the shrinking supply of water making it to the wetlands. With significantly lower volumes of water reaching the wetlands, dikes and water control structures have allowed managers more control over water for producing wetland habitat of benefit to wetland wildlife. The significantly reduced water volumes and increased concentrations of dissolved solids and toxic elements have substantially reduced the number of freshwater vegetative communities.

Flow patterns to the wetlands were again altered in the late 1960's when the Secretary first implemented the Newlands Project OCAP. This action eliminated diversions for winter power generation and limited Lahontan Reservoir releases for irrigation. Without releases for winter power generation, large volumes of quality water that had previously flushed and sustained the wetlands during the winter months were no longer available. Due to the decreased flow, the wetland manager's options for flushing salt accumulations were reduced, leading to fewer, less effective spring flushes. As a result, the marshes became saline. Marsh vegetation shifted to those species which could tolerate higher concentrations of dissolved salts, and many stands of hardstem bulrush were lost.

Between 1972 and 1975, an average of about 40,300 acres of wetland habitat (primary and secondary) remained in the Lahontan Valley. Since then, the Department of the Interior has implemented more efficient OCAP and there have been floods, and a drought. As a result, wetland acreage has fluctuated widely. By 1992, the effects of a six year drought had caused wetland acreage to drop to a record low of about 2,400 acres valley wide. Following three consecutive years (1995-1997) of above average runoff, the amount of primary wetland habitat (Stillwater NWR, Carson Lake and Pasture, and Tribal wetlands) had increased to approximately 24,100 acres as of August 1997.

Because the water rights acquisition program is new and ongoing, thus, no long-term data is available on trends, and given the highly variable nature of hydrology in the Great Basin, existing and baseline wetland habitat conditions are modeled. Except where noted, no mitigation measures, with respect to the hydrology of refuge wetlands, would be necessary for the action alternatives because no significant adverse impacts would be anticipated. To the extent that biological, recreational, and socioeconomic resources would be adversely impacted by changes in seasonal wetland habitat acreages, they are addressed in the appropriate sections. As pointed out in the WRAP ROD (USFWS 1996b), future monitoring could find that a different volume of water is needed than has been anticipated. Should any significant change be proposed as a result of future monitoring, there would be a public review process and additional NEPA documentation would be completed if necessary.

4.3.3.1 WETLAND HABITAT ACREAGE

This section presents estimates of the potential effects that alternative water delivery schedules would have on several wetland habitat parameters, including (1) long-term average wetland habitat acreage on Stillwater NWR; (2) seasonal pattern of wetland habitat acreage, and (3) water chemistry in the wetlands.

Section 206 of P.L. 101-618 directs the Secretary of the Interior, in conjunction with the State of Nevada and other entities, to acquire sufficient water and water rights to sustain a long-term average of 25,000 acres of primary wetland habitat in Lahontan Valley. An Environmental Impact Statement and Record of Decision (USFWS 1996a,b) evaluated the impacts of acquiring 125,000 acre-feet of water, including 20,000 acre-feet of water rights addressed in an earlier environmental assessment (USFWS 1991), to sustain the targeted amount of primary wetland habitat. Based on assumptions described in the WRAP EIS, sufficient water rights have been acquired thus far to sustain a long-term average of about 15,000 acres of primary wetland habitat in the Lahontan Valley (based on October 2001 runs of the BLR Model ver. 3.40 and acquisition and transfer patterns as of September 2001). Below Lahontan Reservoir Model runs incorporate projected acreages for low water years and spill years, thus, the range of primary wetland habitat acreage, generated from the 95 year hydrologic period of analysis (high and low acreage values), would vary dramatically.

Each of the alternative water delivery schedules would result in a different long-term average wetland habitat acreage given a long-term average of 70,000 acre-feet per year of available water. Thus, each alternative would influence differently the Service’s ability to maintain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR.

In this Final CCP EIS, nonspill years and spill years are combined although it is recognized that the amount of wetland habitat could differ considerably between nonspill and spill years. The Service decided to incorporate average wetland acreage produced over the 95 year hydrologic period, assessed by the BLR Model, primarily because the data set used for analysis is more robust than would be provided by using other evaluation tools. The BLR Model (ver. 3.40, July 1996), generates long term average acres of wetland habitat, based on past operation of the Newlands Project. While generated outputs cannot be used to definitively project that a future condition would exist, it does allow for a consistent analysis among Alternatives analyzed in this Final CCP EIS using a time proven analytical tool.

In addition to fluctuations in wetland habitat acreage between spill and nonspill years, wetland habitat acreage would continue to vary annually due to a variety of factors, including carryover storage in Lahontan Reservoir and snowpack in the Sierra Nevadas. To some extent, reductions in deliveries of water rights acquired in fee title, due to drought, could be offset by leasing additional water rights. Whether leasing will realistically provide such an option has yet to be determined.

The following evaluation of alternatives is included to give an indication of the Service's ability to achieve the 14,000 acre target for Stillwater NWR given a long-term average annual supply of 70,000 acre-feet. Several assumptions were made in this assessment. A long-term average of 13,500 acres of wetland habitat would be maintained in Stillwater Marsh, in addition to a long-term average of 500 acres of wetland habitat in the Battleground Point area and along the Carson River and Stillwater Slough (these wetland areas are currently encompassed within the wetland areas identified in P.L. 101-618). The targeted 13,500 acres of wetland habitat, would occur under all alternatives at the completion of the water rights acquisition program.

Estimates for spill years and long-term averages assume that a considerable volume of spill water would continue to reach Stillwater NWR and Fallon NWR, which would occur to the extent that excess water is conveyed to Stillwater NWR and Fallon NWR according to the 1997 Emergency Release Criteria for Lahontan Reservoir (USBOR 1997). If these criteria are not followed, additional water from other sources may be needed.

Following this section, all remaining assessments would assume a long-term average of 13,500 acres of wetland habitat in Stillwater Marsh and a long-term average of 500 acres of wetland habitat in Battleground Point area and along the lower Carson River and Stillwater Slough. An assumption of this Final EIS is that a long-term average of about 14,000 acres will be maintained in Stillwater NWR. The estimates in this section represent our best understanding of conditions, given the available data, and are estimates of what could happen. The estimates are presented for the purposes of assessing gross differences between the alternatives. Modeling was conducted to aid the decision maker and the public in understanding gross differences between the alternatives being considered. Assumptions used in BLR Model runs are detailed in Appendix G. Potential future changes to the water rights acquisition program would be based on long-term monitoring data, which would be used to refine the estimated volume of water needed to maintain the targeted acreage as identified in the 1996 WRAP ROD and are not subject to discussion in this Final CCP EIS (USFWS 1996b).

Wetland acreage values presented in the following analyses are based on delivery of 35,880 acre-feet of acquired, Carson Division water rights (42,000 acre-feet acquired and transferred at 2.99 acre-feet per acre); 3,700 acre-feet of acquired middle Carson River water rights (6,800 acre-feet acquired and transferred at 2.5 acre-feet per acre), approximately 7,100 acre-feet of water leased from Carson Division water rights holders in non-spill years, agricultural return flows, and Lahontan Reservoir precautionary release flows.

It is assumed that other sources of water identified and defined in Alternative 5 of the 1996 WRAP EIS (USFWS 1996a; 2-30 - 34), would contribute to providing an average of 70,000 acre-feet of water inflow to maintain 14,000 acres of primary wetland habitat on Stillwater NWR. For comparative purposes, the modeled wetland acreage values presented in Table 4.9 were adjusted to achieve the 13,500 Stillwater Marsh primary wetland acreage target. For a detailed discussion on water sources, refer to Appendix G of this Final CCP EIS.
BLR Model outputs include an estimate of wetland acreage for all primary wetland areas in the Lahontan Valley. Estimates generated for Stillwater NWR include approximately 800 acres of

primary wetland habitat on the Fallon Paiute-Shoshone Tribal wetlands. To remove this acreage from the Stillwater NWR analysis, a correction factor was generated assuming that Stillwater Marsh would account for 13,500 acres of primary wetland habitat while the Tribal wetlands would account for 800 acres (13,500 / (13,500 + 800) = 0.9441). Raw outputs were multiplied by this correction factor to adjust for acreage attributed to Stillwater Marsh only. The Stillwater Marsh wetland objective of 13,500 acres was then divided by the corrected Stillwater Marsh total generated by the BLR Model (excluding the Fallon Tribal wetlands). This conversion factor was then multiplied by the corrected monthly acreage values for each Alternative to ensure that 13,500 wetland acres were maintained under all Alternatives. This correction was adopted to allow for easy comparison of seasonal wetland acreage differences among the Alternatives analyzed. Corrected acreage values reached a peak of 23,500 acres in June under Alternative D. While historically, excess water would have flowed to the Carson Sink at this volume, in this analysis, it is assumed that excess acreage would be absorbed in the Big Water Unit at the northeast corner of Stillwater NWR.

Given some of the alternative water delivery schedules being considered, the timing of wetlands monitoring can affect the results of the monitoring program. Because of this, the monitoring program is reevaluated in this Final EIS. August was adopted in the WRAP ROD, as the time for a once per year survey to monitor long-term wetland habitat acreage (USFWS 1996b).

The alternatives explored in this Final EIS would have no effects on primary wetland habitat on Carson Lake or the Fallon Paiute-Shoshone Reservation, nor would they have any effects on secondary wetlands. Therefore, the assessment of potential effects on wetland habitat is limited to the wetlands that currently exist within the boundaries of Stillwater NWR, Stillwater WMA, and Fallon Refuge.

All Alternatives: Under all alternatives, average wetland habitat acreage in Stillwater Marsh would increase from 9,200 acres (estimated existing conditions) to an estimated average of 13,500 acres at completion of the WRAP (USFWS 1996a,b). The following discussion explains how the delivery schedules of each alternative would affect seasonal habitat acreage assuming that 14,000 acres of wetland habitat would be maintained on Stillwater Marsh (13,500 acres) and the Carson River and delta (500 acres) given a long-term supply of approximately 70,000 acre-feet per year over the long term. Increasing or decreasing the volume of water presented in the WRAP EIS and ROD is not considered in this Final EIS because actual changes to the water rights acquisition program would be based on long-term average measurements of wetland habitat acreage and associated water volumes (USFWS 1996b). The figures presented below are estimates based on BLR Model runs.

Alternative A: When Fallon Tribal wetlands are excluded from the analysis, a long-term average of 13,626 acres would be maintained on Stillwater marsh over the long term. Corrected seasonal wetland acreage would range from a low of 12,940 acres during spring (April through June) to a peak wetland habitat acreage of 14,600 during winter (October through December). Under this alternative, the timing of wetland monitoring would not be critical (Table 4.10), even when only one survey per year is conducted in August (USFWS 1996b), due to the relatively stable seasonal acreages.

Alternative B: Under this alternative's water delivery schedule, approximately 14,705 acres would be maintained on Stillwater marsh over the long-term. Corrected wetland acreage would range from a low of 11,300 acres (spring) to 15,900 acres (fall). August monitoring would underestimate the average acreage of wetland habitat that could be produced under this alternative (Table 4.10) because August estimates resulted in the second lowest monthly acreage projected by the BLR Model (11,670 acres during August as opposed to 16,333 acres in November). Substantially more water would be needed to elevate the August acreage while maintaining this alternative's water delivery schedule. Quarterly or monthly monitoring would alleviate this problem, although costs of monthly monitoring may be prohibitive (i.e., quarterly observation would require obtaining four sets of aerial/satellite images for analysis as opposed to one). No provisions would be made under this alternative to increase the water supply to Fallon NWR and therefore, this alternative would continue to provide breeding habitat only during spill years.

Alternative C: Wetland acreage under Alternative C would average 13,600 acres when the Fallon Tribal wetland acreage is excluded from the analysis, with corrected wetland acreage ranging from a low during summer (10,111 acres) to a high of 15,264 acres during spring. As under Alternative B, August monitoring of wetland habitat would appear to result in the need for more water under Alternative C to achieve the 13,500 acre target. If an August wetland survey continues to be the sole survey used to calculate wetland habitat acreage, more water would be needed to elevate the August acreage (Table 4.10). Monthly monitoring would alleviate this problem; however, quarterly monitoring beginning in January would also indicate that more water would be needed to sustain the targeted acreage based on the months used to develop the quarterly average.

Alternative D: Alternative D would result in the lowest calculated acreage among the Alternatives examined in this analysis, with an annual uncorrected average acreage of 10,464 acres (an estimated 22 percent below the estimated target of 13,500 acres). Corrected acreage would range from a low of 8,800 acres during fall to a high of 20,500 acres during spring (a monthly peak of 24,500 acres was calculated for June based on BLR Model outputs). August monitoring of wetland habitat under this Alternative would underestimate the actual average amount of wetland habitat being sustained, but quarterly monitoring would markedly underestimate the average amount (Table 4.10). Monthly monitoring would be the only mechanism to accurately monitor wetland acreage under this Alternative based on the wide range of projected monthly wetland acreage values generated from BLR Model runs.

Alternative E: Uncorrected annual wetland acreage under this Alternative would average 13,367 acres when the Fallon Tribal wetland acreage is subtracted which is less than 1 percent below the 13,500 acre target. Corrected wetland acreage would range from a low of 10,300 acres during summer to a peak of 16,200 acres during the spring (April through June). August surveys would

Table 4.9. Potential effects of alternative water delivery schedules on long-term average annual and seasonal wetland habitat acreages in Stillwater Marsh, assuming a target of 13,500 acres of wetland habitat.

		Existing	(No Action) Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Model generated average[A]		9,213	14,434	15,577	14,407	11,085	14,160
Annual average (minus FTW)[B]		8,700	13,626	14,705	13,600	10,464	13,367
Annual Target[C]		n/a	13,500	13,500	13,500	13,500	13,500
Seasonal acreages:							
Jan-Mar	Ave.	9,200	13,000	14,700	15,200	12,000	14,000
	(Range)	(7,800-10,300)	(10,900-14,600)	(13,700-15,800)	(12,900-18,700)	(11,100-12,800)	(12,400-16,100)
Apr-Jun	Ave.	8,000	12,900	11,300	15,300	20,500	16,200
	(Range)	(7,400-8,600)	(11,600-14,400)	(10,600-12,100)	(13,900-16,900)	(14,300-24,500)	(14,700-17,500)
	Peak Month	*June*	June	April	April	June	April
Jul-Sep	Ave.	8,000	13,500	12,200	10,100	12,900	10,300
	(Range)	(7,800-8,100)	(13,300-13,700)	(11,700-13,300)	(9,300-10,900)	(9,300-17,700)	(9,600-11,000)
Oct-Dec	Ave.	9,600	14,600	15,900	13,400	8,600	13,400
	(Range)	(8,600-10,200)	(13,600-15,100)	(15,200-16,300)	(11,400-14,500)	(8,400-8,900)	(12,800-13,900)

A – includes total model generated acreage for Stillwater Marsh and Fallon Paiute-Shoshone Tribal wetlands (FTW) acreage. Carson River wetlands (approximately 500 acres over the long term, are addressed later in Chapter 4)

B – corrected to exclude Fallon Tribal wetlands following Alternative A delivery pattern (13,500/14,300 = .944 correction factor).

C - P.L. 101-618 target objective for Stillwater marsh not including 500 acres to be maintained at the Carson River delta..

Table 4.10. Alternative ways to monitor long-term average wetland habitat acreage on Stillwater NWR wetlands. Figures represent the long-term average wetland habitat acreage during nonspill years that would result from each of several alternative monitoring programs, based on results of a seasonal wetland habitat model. Spill years were not included due to their high variability.

	(No Action) Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
August[A]	13,336	11,670	9,296	11,624	9,597
Monthly	13,500	13,500	13,500	13,500	13,500
Quarterly beginning in January[B]	12,413	13,716	12,289	9,403	12,374

A The approach adopted in the Final EIS and Record of Decision for the Water Rights Acquisition for Lahontan Valley Wetlands (USFWS 1996), which would continue the ongoing August surveys.
B Quarterly measurements beginning in January and continuing in April, July, and October.

greatly underestimate annual wetland acreage (9,597 acres) while quarterly monitoring would reduce this shortfall but would still fall short of the 13,500 acre target (12,374 acres when January, April, July, and October estimates are averaged. Similar to Alternative D, monthly wetland monitoring would be the most reliable method to obtain estimates of wetland acreage on Stillwater marsh.

4.3.3.2 WETLAND DELIVERY AND INCIDENTAL INFLOW

Under the WRAP for Lahontan Valley wetlands, the Service, State of Nevada, and other parties will ultimately have an average supply of 125,000 acre-feet per year to sustain a long-term average of 25,000 acres of wetland habitat in Stillwater NWR, Carson Lake, and the Fallon Paiute-Shoshone Indian Reservation. This will entail four major sources of water supply: Carson River water deliveries, agricultural drainwater, spills from Lahontan Reservoir, and groundwater. Of the four sources, only Carson River water deliveries represent an actual deliverable demand on surface water resources in the Lahontan Valley. Carson River water deliveries would consist of acquired Carson Division water rights (purchase, exchange, donation, and transfers from Naval Air Station-Fallon), acquired Segment 7 water rights, and leased Carson Division water rights. Acquired water rights are more secure than leased water rights, drainwater, and spillwater. An average inflow of 125,000 acre-feet of water represents baseline conditions, although it may take 20 years to complete the program.

For the purposes of this Final EIS, Stillwater NWR is assumed to receive 56 percent of the amount to be obtained from each source as delineated in the Final WRAP EIS (USFWS 1996a). Therefore, up to 42,000 acre-feet of Carson Division water rights and up to 12,190 acre-feet of Segment 7 (middle Carson River) water rights would be acquired for Stillwater NWR wetlands, of which a combined total of about 38,200 acre-feet per year would be available for wetland deliveries. Supplementing this would be water rights transferred from the Naval Air Station-Fallon (up to 3,290 acre-feet) and as many as 12,100 acre-feet of Carson Division water rights to be leased in low water years. No water rights would be leased in spill years. In total, up to an average of 43,700 acre-feet per year of delivered water is estimated to reach the Stillwater NWR wetlands upon completion of the program. As of October 2001, about 20,886 acre-feet of Carson Division water rights have been acquired for Stillwater NWR from the Carson Division and 4,005 acre-feet have been acquired from the middle Carson River (segment 7). Wetland deliveries are defined as scheduled irrigation deliveries to the Stillwater NWR (and other primary wetland areas). They include water rights obtained in fee title and leasing within the Carson Division, and water rights obtained in fee title from the middle Carson River (Segment 7).

Delivery of this water would supplement an estimated 11,200 acre-feet per year of drainwater, 5,700 acre-feet per year of spillwater, and up to 7,800 acre-feet per year of groundwater for Stillwater NWR (baseline conditions). Drainwater inflows include seepage, tailwater, and other sources that are incidental to agricultural irrigation deliveries. All drainflow figures for analysis are calculated estimates based on BLR Model assumptions and are used for comparative purposes only. Drainflows could change due to variables, such as drainflow assurances or other changes in water management in the Carson Division of the Newlands Project. The volume of drainwater entering Stillwater NWR wetlands could be affected slightly by water management at Stillwater NWR. Given the existing volume of water rights that have been acquired so far in the Carson Division, an estimated 15,000 acre-feet per year is estimated to flow into Stillwater NWR under existing conditions.

Spillwater is estimated to reach the wetlands in 24 out of 95 years. In years when spills occur, an average of about 24,400 acre-feet of water would reach Stillwater NWR wetlands. Spills refer to precautionary and operational releases from Lahontan Reservoir for safety reasons, as well as accidental spills. They do not include releases to satisfy irrigation or wetland water demands. Spills provide a potentially large, but intermittent and unreliable, source of water for wetland areas in Lahontan Valley. Whether spills occur depends on many factors including snowpack in the Sierra Nevadas, amount of carryover water in Lahontan Reservoir, and the timing, rate, and duration of run-off. Whether spill water reaches the primary wetland areas, and the amount of spill water that reaches these areas, depends on many factors including the timing and volume of the spill, limited capacity of canals leading to primary wetland areas, partial or total use of these canals to convey water to farmland (a frequent occurrence), and the ability of wetland managers to capture and route spill water through the wetlands.

Spills are routed through Newlands Project canals and drains. Most spills are controlled and do not result in flooding. Currently, wetlands at Stillwater NWR can safely receive a maximum of 700 to 800 acre-feet per day of water (or about 450 cubic feet per second at any given time) during spills, while Carson Lake wetlands can receive about 450 to 500 acre-feet per day, even during periods when larger water volumes are available. For example, in response to flood conditions, more than 40,000 acre-feet of water was released from Lahontan Reservoir during the period of January 3 to 31, 1997. Of the total released, about 14,000 acre-feet (approximately 35 percent) was directed to Stillwater NWR and Carson Lake due to restricted carrying capacities of project canals delivering water to the wetlands. The remainder of the spilled water flowed through the lower Carson River to Fallon NWR and into the Carson Sink. During a flood in 1995, Stillwater NWR and Carson Lake were able to capture 20 percent of the total spill volume due to concurrent agricultural deliveries that reduced TCID's ability to route spill water to the wetlands. Canal capacity is the largest constraint to making water deliveries prior to March. Conveyance of spill water to the wetlands after this point is limited by (1) conveyance of excess water to farmlands, (2) delivery of irrigation water to farmlands, and (3) limited canal capacity. The primary wetland areas are at the end of the Newlands Project water delivery system.

Because spills occur on an infrequent and irregular basis, and because only a portion of spills actually reach wetlands, they are incorporated into the average annual wetland inflow volumes as "useable spills". The frequency and volume of calculated "useable spills," based on the 95-year hydrologic simulation period, are affected by reservoir storage levels and carryover (which are linked to diversion, irrigation demand and deliveries).

The volume of water to be delivered to Stillwater NWR and other primary wetland areas, as identified in the WRAP EIS, would not be affected by any of the alternatives considered in this Final EIS, except as noted under Alternatives B and D.

Alternative A: Under this alternative, baseline conditions, the total amount of water rights needed to sustain the targeted acreage would remain unaffected. The amount of water flowing into Stillwater NWR wetlands would increase from an estimated average of 43,190 acre-feet per year to an estimated average of 70,000 acre-feet per year (USFWS 1996a,b), or a 75 percent increase. Drainwater inflows would decline from an estimated average of 16,000 acre-feet per year under existing conditions to 10,170 acre-feet per year (36 percent reduction); however, the average annual "useable spills to Stillwater NWR would increase by about 2,970 acre-feet per year, a 43 percent increase (Table 4.11). Spills are estimated to occur in 24 years out of the 95-year hydrologic period under existing and baseline conditions, or one of four years. Changes in drainwater and spill water inflow under this alternative's seasonal delivery pattern were evaluated in the WRAP EIS (USFWS 1996a). The estimated wetland water demand under this alternative would be about five acre-feet per acre, per year, as identified in the WRAP EIS (USFWS 1996a).

Alternative B: Under this alternative, water demand would be somewhat less than it would be under Alternative A because higher wetland habitat acreages would be maintained during periods of lower evaporation while seasonal lows in wetland habitat acreage would occur during periods of high evaporation. The water demand would be an estimated 4.6 acre-feet per acre, per year (e.g., 64,263 acre-feet of water would sustain 13,500 acres of wetland habitat), meaning that an estimated 5,700 acre-feet less water may be needed to sustain 13,500 acres of wetland habitat. Due to contaminant concerns, groundwater would be the first water source to be reduced from Alternative A (Table 4.11).

Under Alternative B, drainwater flows to Stillwater NWR wetlands would decline from baseline conditions by an estimated 90 acre-feet. The average annual "useable spills" to Stillwater NWR under Alternative B would increase by an estimated 11 percent when compared to baseline Alternative A. Wetland deliveries would not be adversely impacted by irrigating farmland on Stillwater NWR because wetland water rights would not be used for this purpose.

Table 4.11. Potential effects of alternative delivery schedules on long-term average volumes of water to be acquired from different sources (expressed in average acre-feet per year).

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Deliveries						
Carson Division[A]	17,000	43,600	43,600	43,600	43,600	43,600
Segment 7	0	up to 3,500	up to 3,500	up to 3,500	up to 3,500	up to 3,500
Drainwater	16,000	10,170	10,080	10,160	11,220	10,190
Spill water	6,900	9,870	11,020	10,260	8,760	10,130
Groundwater	0	3,800-8,000	0-3,000	3,800-8,000	3,800-8,000	3,800-8,000
Additional Water	n/a	n/a	n/a	n/a	up to 13000[B]	n/a
TOTAL	39,900	70,000	64,400	70,000	86,300	70,000

[A] Includes leased water rights (approximately 7,100 acre-feet in non-spill years) and Naval Air Station-Fallon conserved water (assumed to average approximately 2,300 acre-feet per year).

[B] Could include additional groundwater, or additional leased or acquired Carson Division water rights.

Alternative C: The amount of water rights needed to sustain the targeted acreage would remain unaffected under this alternative, similar to Alternative A. Drainwater flows to Stillwater NWR wetlands would decline from baseline conditions by 10 acre-feet when compared to baseline Alternative A. Usable spills would increase slightly under Alternative C (about 390 acre-feet) or approximately 4 percent; however, this does not account for any additional volume of spill water that could be accommodated if the capacity of canals leading to the refuge is increased. To the extent that additional spill water increases wetland habitat acreage, it would result in less water being needed from other sources, such as groundwater. Wetland deliveries would not be adversely impacted by irrigating farmland on Stillwater NWR because wetland water rights would not be used for this purpose. The water demand of 5 acre-feet per acre, per year would be similar to Alternative A.

Alternative D: Under this alternative, which would assume a long-term average 6.4 acre-feet per acre, per year water demand (slightly reduced due to a lower demand in spill years) and assuming additional drainwater and spill water being available (as compared to Alternative A), up to an additional 13,000 acre-feet per year of water may be needed over the long-term to sustain a long-term average of 13,500 acres of wetland habitat in Stillwater Marsh (Table 4.11). A higher water demand would result from larger wetland habitat acreages being provided during a period of high evaporation and low acreages being provided during a period of low evaporation, as compared to Alternative A. A higher amount of groundwater (higher than identified in the WRAP EIS) could be used to offset the deficiency, but additional leasing or acquisition of Carson Division water rights would also be needed. Drainwater flows to Stillwater NWR would decline from existing conditions by about the same amount estimated to occur under Alternative A. Usable spills would decline by an estimated 11 percent when compared to baseline Alternative A. As with Alternative C, this does not account for any additional volume of spill water that could be accommodated if the capacity of canals leading to the refuge is increased. To the extent that additional spill water increases wetland habitat acreage, it would result in less water being needed from other sources (e.g., groundwater) under this alternative.

Alternative E: The amount of water rights needed to sustain the targeted acreage would remain unaffected under this alternative, similar to Alternatives A and C. Drainwater flows to Stillwater NWR wetlands would increase by 20 acre-feet when compared to baseline Alternative A (Alternatives A, C, and E would not differ by more than 30 acre-feet). Usable spills would increase slightly from Alternative A (about 260 acre-feet) or approximately 2.6 percent; however, this does not account for any additional volume of spill water that could be accommodated if the capacity of canals leading to the refuge is increased. To the extent that additional spill water increases wetland habitat acreage, it would result in less water being needed from other sources, such as groundwater. Wetland deliveries would not be adversely impacted by irrigating farmland on Stillwater NWR because wetland water rights would not be used for this purpose. The water demand of 5 acre-feet per acre, per year would be similar to the Alternative A.

Mitigation Measures: The slightly lower estimated volumes of water flowing into Stillwater NWR from drainwater under Alternatives B, C, and E could be mitigated by increased spill water flowing into the refuge by enlarging the capacity of canals leading to the refuge (see mitigation under Section 4.2.2.6).

4.3.3.3 SEASONAL WETLAND HABITAT ACREAGE AND WATER LEVEL FLUCTUATIONS

For the purpose of this Final EIS, four seasons were broken out as follows: January-March, April -June, July-September, and October-December. The following assessment focuses on three of these seasons, corresponding to important life history stages of wetland wildlife: April-June (nesting season), July-September (early: brooding period; and later: shorebird migration), October -December (waterfowl migration and wintering) (Table 4.9). The evaluation of impacts in this section assumes that a long-term average of 13,500 acres of wetland habitat would be sustained in all alternatives. Under estimated existing conditions, wetland habitat acreage would range from 8,000 acres in late summer to 10,300 acres in late winter. April-June acreage would also be an estimated average of 8,000 acres and during October-December there would be an estimated average of 9,600 acres.

Water level fluctuation is one factor affecting plant and invertebrate communities, which has the potential to affect vertebrate (fish, bird, and mammal) communities. This fluctuation likely had a considerable influence on plant and animal communities under natural conditions. Under these conditions, water levels rose during January-March if they had dropped the previous year, or remained at a high level if water levels did not drop considerably the previous year. In years when water levels were high coming into April, the spring pulse of Carson River water would have raised water levels somewhat during April-June in high water years. If water levels had dropped considerably the previous year, water levels would have risen during April-June. In all years, water levels would have dropped or remained stable during July-September. Most years would have seen declining water levels during this period. If this did not occur on Stillwater marsh, it would have occurred somewhere in the valley. Water level fluctuations during October-December were variable, depending on water levels leading into this period and volumes of water flowing into Stillwater Marsh.

Water levels can be fluctuated substantially in particular wetland units while maintaining a relatively consistent wetland habitat acreage through the year. As an example, water levels in some wetland units can be dropped considerably while the overall wetland habitat acreage of Stillwater NWR remains at a constant level. However, this would require raising the water level in other wetland units to offset the reduced acreage in the units specified above.

The following assessment only addresses effects in Stillwater Marsh, and does not include the wetlands at the delta of the Carson River, lower Carson River, Stillwater Slough, or Leter Reservoir. Potential effects of the alternatives on the lower Carson River and its delta wetlands, and Stillwater Slough are discussed under the Vegetation section. Also, the lower Carson River and the wetlands at its delta (now within Fallon NWR) are generally only inundated in spill years.

Alternative A: Under Alternative A, wetland habitat during a full water, nonspill year would range from a low of about 10,787 acres in March to a peak of about 13,100 acres in January (Table 4.9). In April-June, an estimated average of 12,900 acres would be available; an increase from existing conditions of about 61 percent. In most years, the increase in flow rate into Stillwater NWR during this period would be just enough to offset evapotranspiration, and therefore most wetland units would not experience rising water levels during April-June (Table 4.12).

Wetland habitat acreage would decline somewhat during July-September, but increased deliveries during this period would offset much of the effects of evapotranspiration. Water levels in some wetland units would decline, while in others water levels would remain stable.

There would be an estimated 13,600 to 15,100 acres of wetland habitat during October-December, an increase of about 52 percent compared to existing conditions. Water could be managed under this alternative in a variety of ways, including lowering some units during this period in order to raise water levels in lower units.

Alternative B: Variability in wetland habitat acreage from season to season would, compared to Alternative A, increase slightly under this alternative (primarily by lowering acreage during July-September, the season of highest evapotranspiration; Table 4.9). April-June acreage during a full water, nonspill year would be an estimated 12 percent lower than baseline conditions. Water levels would decline in most units during this period, although some units could be stabilized (Table 4.12).

Under this alternative, wetland habitat acreage would reach an annual low in June, and would increase through the July-September period. Wetland habitat acreage would decrease by about 9.6 percent, when compared to baseline Alternative A. In contrast to Alternative A, nearly all units would see rising water levels through this period, especially the latter end, and declining water levels would occur only on a limited basis.

October-December acreage would increase over baseline conditions by an estimated 8.9 percent. By December, there were would be 1,025 or more acres than would occur under Alternative A. Many units would experience rising water levels during the fall and winter (Table 4.12).

Alternative C: Under this alternative, seasonal fluctuation would be considerably higher than under Alternatives A and B. As compared to Alternative A, the amount of wetland habitat available in April-June would be an estimated 19 percent higher (about 2,400 acres of additional habitat). Wetland habitat acreage would peak in late March or early April, and acreage would decline from this point through the breeding season, although water deliveries could be managed to attain a slightly lower peak to sustain more stable water levels through June (Table 4.12). Thus, water levels would remain stable or would decline during April-June in all wetland units in nonspill years under this alternative. From July - September, there would be an estimated 25 percent decrease in wetland habitat as compared to Alternative A. However, the amount of wetland habitat available during the brooding period would be higher under this alternative and water levels would decline more during shorebird migration than under baseline management (Table 4.12).

During October-December, wetland habitat acreage would decline from baseline conditions by an estimated 8 percent. However, the water delivery schedule is flexible enough to provide nearly as much wetland habitat during October-December as could be provided under Alternative A. Water levels during this period would decline in some wetland units, rise in other units, and remain stable in still other units (Table 4.12).

Alternative D: Seasonal fluctuations in wetland habitat acreage and water levels would be higher under this alternative than under any other alternative. Wetland habitat available during April-June would be an estimated 59 percent higher when compared to baseline conditions (Table 4.9). Wetland habitat acreage would nearly double during April-June, peaking in June. Water levels would rise fairly quickly during this period in many wetland units (Table 4.12). Under this alternative, July-September wetland acreage would decline by an estimated 4 percent but acreage would range from 17,700 acres to 8,900 acres over this period. The amount of wetland habitat available during the waterbird brooding period would be higher under this alternative and water levels would decline more during shorebird migration than they would under baseline management, or any other alternative. All units would experience dropping water levels under this alternative (Table 4.12).

During October-December, wetland habitat acreage could decline from baseline conditions by an estimated 41 percent (about 6,000 fewer acres), but with some flexibility in the delivery schedule, wetland habitat provided during this period could be comparable to estimated existing conditions (Table 4.9). Water levels during this period would decline in most wetland units, but would remain stable in limited areas (Table 4.12).

Alternative E: Under this, the Service preferred Alternative, seasonal fluctuation would be considerably higher than under Alternatives A and B and similar to Alternative C. As compared to Alternative A, the amount of wetland habitat available in April-June would be an estimated 26 percent higher (about 3,300 acres of additional habitat). Wetland habitat acreage would peak in early April, and acreage would decline from this point through the breeding season, although water deliveries could be managed to attain a slightly lower peak to sustain more stable water levels through June (Table 4.12). As compared to Alternative C, the highest fluctuation would occur in one of four identified flow corridors representing roughly 25 percent of available refuge wetland units, while water would be more stable in two other corridors, and declining in the fourth. From July - September, there would be an estimated 4 percent decrease in wetland habitat as compared to Alternative A.
During October-December, wetland habitat acreage would decline from baseline conditions by an estimated 8 percent. However, the water delivery schedule is flexible enough to provide nearly as much wetland habitat during October-December as could be provided under Alternative A. Water levels during this period would be increasing in units identified to contain suitable habitat for migratory and wintering waterbirds, the number and amount of increase would be dependent on the amount of remaining water available for distribution (Table 4.12).

Mitigation Measures: Significantly fewer wetland habitat acres would be provided under Alternative D during October-December. Alternative C and to a lesser extent, Alternative E could also result in a somewhat lower acreage during this period. Mitigation could include shifting the water delivery pattern in a way that favors higher volumes of flow being delivered during the late summer and fall. Although flexibility is built into each alternative's seasonal delivery pattern, changes beyond the specified ranges would result in a delivery pattern more representative of a different alternative (e.g., Alternative A or B). Another potential mitigation measure would be to use some of the water delivered in fall and winter to create temporary shallow water habitat during these seasons, which would allow larger acreages to be sustained during the fall and winter, a period of low evaporation. Mitigation could also include providing additional waterfowl foraging areas in the agricultural lands.

4.3.3.4 FLUSHING ACTION AND WETLAND WATER CHEMISTRY

Seasonal wetland inflow rate (inflow volume per unit area of wetland habitat) of Carson River water (as opposed to drainwater) also influences wetland habitat and other elements of marsh ecology by flushing salts and reducing total dissolved solids concentrations in wetland water. Flushing of dissolved and suspended solids may also remove potentially toxic trace elements from some wetlands. Under natural conditions, peak runoff during April-June resulted in four to

Table 4.12. Potential effects of alternative water delivery schedules on long-term average annual and seasonal wetland habitat acreages in Stillwater Marsh during nonspill years, assuming a target of an average of 12,500 acres of wetland habitat in nonspill years (and 16,500 acres in spill years to result in 13,500 acres per year on average).

		Estimated Average Conditions						
		Existing (for comparison)	(No Action) Alternative A	Alternative B	Alternative C	Alternative D	Alternative C	Natural (for comparison)
Water-level Fluctuations:								
Jan-Mar	Stable/Declining:	majority	majority	majority	few	some	few	some
	Rising:	few	few	few	nearly all	many	nearly all	many
Apr-Jun	Stable/Declining:	all	nearly all	all	all	few	majority	some
	Rising:	none	few	none	none	majority	few	many
Jul-Sep	Stable/Declining:	majority	majority	few	majority	all	majority	all
	Rising:	few	few	majority	few	none	few	none
Oct-Dec	Stable:	most	few	many	-1/3	few	-1/4	few
	Declining:	none	none	few	-1/3	many	-1/4	none-some
	Rising:	few	few	many	-1/3	none	-1/2	some
Estimated Flow Rate (cfs)								
Operational		30-150	30-150	30-150	50-450	50-375	50-400	*70-2,000*
Spill (maximum)		450	450	450	800-1,000	1,000	>750	4,000-10,000

16 acre-feet of water flowing into Stillwater Marsh for every acre of wetland habitat during this three month period. In general, about 80 to 90 percent of the water flowed through Stillwater Marsh and out into the Carson Sink during this season (during years when the Carson River flowed directly into Carson Lake or Stillwater Marsh). This resulted in a tremendous amount of water replacement, which flushed salts and other dissolved and suspended solids from many areas of the marsh. Wetland inflows reached an annual high of 1,000 to 2,500 cubic feet per second even in low water years. During large floods, peak inflows into Stillwater Marsh may have exceeded 10,000 cubic feet per second.

During the late summer and fall, the amount of water flowing into the marsh would have dropped off considerably, especially during August, September, and October (the lowest water inflow period). Wetland inflow during this time would have dropped to an estimated 70 to 150 cubic feet per second, even during low water years. When the Carson River flowed directly in Carson Lake, water flow into Stillwater Marsh would have ceased during August-October in most years. Under natural conditions during October-March, wetland inflows would have increased somewhat over the previous season, but would have remained fairly low until March.

Upstream water diversion and the discharge of agricultural drainwater have contributed to increased total dissolved solids and trace element concentrations entering Stillwater NWR. Trace elements are discussed in the next section. High levels of total dissolved solids and high pH levels do not equate to poor water quality. For example, several native invertebrates thrive in waters that exceed the “effect” level for total dissolved solids, and many thrive in waters that exceed the Nevada State pH standard for propagation of aquatic life and wildlife (Table 4.1). In a recent study, brine shrimp and brine flies were found to inhabit waters exceeding total dissolved solids concentrations of 30,000 mg/L, and brine flies, brine shrimp, and some species of mosquitos inhabit waters with pH values exceeding 10 (Bundy 1996). However, even though brackish water conditions are a natural component of the Lahontan Valley wetland ecosystem, extensive freshwater wetlands, including marsh and river, are a critical component of the wetland ecosystem. Historically, Stillwater Marsh would have been a relatively freshwater marsh in most years.

Elevated concentrations of total dissolved solids is attributed to a combination of factors that resulted in the modification of the way water flows in the Carson River basin. Following development of the Newlands Project and regulation of the Carson River, inflow of fresher water directly from the Carson River was reduced and the inflow of irrigation drainage containing elevated dissolved solids was increased. Increased irrigation efficiencies mandated under OCAP further reduced the inflow of fresh water. Because of reduced inflows, wetland acreage declined. During the late 1980s, about 10 percent of the historic wetland acreage remained. Concentrations of dissolved solids in wetlands increased due to increased dependence on irrigation drainage. Dependence on drainwater resulted in a shift in water delivery patterns to wetlands, with inflows to wetlands generally corresponding to the release of irrigation water from Lahontan Reservoir over the agricultural growing season. Reduced inflow of water resulted in the hydrologic isolation of some wetlands while diking and flow regulation within the wetlands disrupted the flow through character and increased the hydrologic retention time of other wetlands. Such changes reduced the frequency and efficiency of dissolved solids flushing through the wetlands and some constituents became concentrated in wetlands through evaporative processes.

Limited flushing has allowed these materials to accumulate in wetlands, which has shifted Stillwater Marsh from a freshwater marsh to a more alkaline or saline marsh. Therefore, restoration of the flushing characteristics is vital to the restoration and maintenance of the natural biological diversity on Stillwater NWR. Under existing and baseline conditions, the volume of water that can be received during spill years will dictate the reestablishment of effective flushing of the wetlands. However, potential benefits of flushing must be weighed against potential detriments. Although increased flows during periods of flooding would help to flush dissolved and suspended solids through the wetlands, flood water from the Carson River contains elevated concentrations of mercury that are mobilized from upstream bank and bottom sediments during high water. The relationships between flushing of dissolved and suspended solids from Stillwater Marsh and the loading of mercury to the marsh are as yet to be resolved.. Further research is needed to more fully understand the actual effects of mercury on wetland wildlife.

Water released from Lahontan Reservoir is derived from both the Carson and Truckee Rivers and is characterized as calcium-sodium-bicarbonate or sodium-sulfate type water. Dissolved solids concentrations in released waters generally range from 150 mg/L to 500 mg/L.

Under all alternatives, water chemistry of any particular area within Stillwater Marsh would vary considerably from season to season and from year to year, and water chemistry would vary even more markedly from one end of the marsh to the other. Given this highly variable nature of water chemistry, only broad scale differences between alternatives can be examined.

Alternative A: As additional water rights are acquired, the concentration of total dissolved solids in the wetlands would decline. Water in the refuge's wetlands under baseline conditions, assuming completion of the water rights acquisition program, would be substantially more fresh than under existing conditions.

Under the ongoing water rights acquisition program, wetland inflow would be provided by deliveries of Carson River water, agricultural drainwater, and spills, but would also consist of other sources, such as groundwater pumping to meet the 14,000 acre wetland objective for Stillwater NWR. As established in the WRAP EIS, groundwater could be used to the extent that it does not adversely impact the quality of wetland inflow. Groundwater in the Carson Lake and Stillwater NWR area where pumping may occur has a high level of total dissolved solids and trace elements (Maurer et al.1994). Groundwater total dissolved solids concentrations from wells in Stillwater NWR area range from 4,000 mg/L to 8,000 mg/L (Maurer et al. 1994), which is four to eight times higher than drainwater inflow to the wetlands.

Using these values, a rough estimate of the quality of wetland inflow was calculated using weighted averages. Under the WRAP, up to 10 percent of the 70,000 acre-foot program is anticipated to consist of groundwater and about 70 percent of the total wetland inflow would consist of Carson River water (i.e., irrigation water). At this level of groundwater pumping, concentrations of total dissolved solids and trace elements could be comparable to that of existing conditions.

Alternative B: Concentration of total dissolved solids in wetlands would decline from existing conditions to the same degree as would occur under Alternative A.

Alternative C: Concentration of total dissolved solids in wetlands would decline from existing conditions to the same degree or higher than would occur under Alternative A. Long-term average concentrations of total dissolved solids may be slightly lower than would occur under Alternative A to the extent that higher volumes of water pass through the marsh during spill events. Total dissolved solids concentrations in upper wetland units would, over the long-term, be lower than those expected under Alternative A. Rates of flow through Stillwater Marsh would be higher, seasonally, than would occur under Alternative A.

Alternative's D and E: Concentrations of total dissolved solids and rates of flow through the marsh would be similar to those of Alternative C.

4.3.3.5 ENVIRONMENTAL CONTAMINANTS IN WETLANDS

Previous investigations identified concerns with un-ionized ammonia, and 12 trace elements in water, sediment, and biological samples from Stillwater NWR (Table 4.13). The trace elements aluminum, arsenic, boron, and mercury were identified as contaminants of primary concern. The occurrence of environmental contaminant concerns in Stillwater NWR wetlands is largely attributed to human modification of natural hydrologic characteristics and processes of wetlands, and wetland water supplies. Contaminants at concentrations identified in water, sediment, and biological samples from Stillwater NWR have the potential to produce a range of direct and indirect adverse effects to fish, wildlife, and habitat quality in Stillwater NWR. Effects may stem from direct toxicity of water and sediment, or may result from exposure of higher organisms to elevated concentrations through food chains. Potential effects to organisms may include altered behavior, biochemical and histological effects, immunosuppression, reduced growth, reduced reproductive success, malformation of embryos, and mortality. Interactive effects of these contaminants may also modify toxicity and organism response. Effects at higher levels of biological organization are more difficult to quantify. However, certain contaminants, at levels found on Stillwater NWR, have been associated with community level effects, such as loss of habitat variability, reduced species abundance and diversity, and effects to community functions.

Previous investigations in Lahontan Valley identified aluminum, arsenic, boron, mercury, and selenium as trace elements of primary concern in Lahontan Valley wetlands (Table 4.13). Aluminum concentrations in a large percentage of food chain organisms exceeded levels associated with adverse effects to avian species. Concentrations in food chain organisms correlate with concentration in sediment, suggesting that aluminum in the food chain originates from sediment. Aluminum concentrations in wetland sediments are uniformly high throughout

Lahontan Valley, including wetlands unimpacted by human activities. As such, high concentrations of aluminum in wetland components probably reflect natural soil conditions. High concentrations of aluminum in sediment combined with the lack of correlation with water suggests that little can be done to alleviate elevated aluminum in the wetland food chain.

Arsenic concentrations in wetland water, sediment, and vegetation commonly exceeds concentrations associated with adverse effects to sensitive aquatic invertebrates, fish, amphibians, and birds. Correlations between arsenic concentrations in unfiltered water and concentrations in sediment and vegetation suggest that reducing water-borne arsenic would contribute to reduced arsenic concentrations in these other wetland components. The correlation between total dissolved solids and arsenic in unfiltered water suggests that arsenic in the water column could be achieved by controlling dissolved solids.

Table 4.13. Chemical elements of concern in water, sediment, and biological matrices collected from four wetlands on Stillwater NWR, 1986-1996. "S" indicates that >10% of the samples exceeded water quality standards or criteria; "E" indicates that >10% of the samples exceeded a level associated with an adverse biological effect; "C" indicates >10% of the samples exceeded a biological concern level; "N" indicates that <10% of the samples exceeded water quality standards or biological effect or concern levels; and "-" indicates that data were not available.

				Avian Diet				
Constituent	Water	Sedi-ment	Whole Fish	Vegeta-tion	Invert-ebrate	Fish	Avian Egg	Avian Liver
TDS	S, E	-	-	-	-	-	-	-
Ammonia	S, E	-	-	-	-	-	-	-
Aluminum	S, E	-	-	E	E	N	-	-
Arsenic	S, E	C	C	E	N	N	-	N
Boron	S, C	-	-	E	C	C	N	E
Chromium	N	N	C	C	C	C	-	N
Copper	N	N	C	-	-	-	-	-
Lead	S, C	C	C	N	N	N	-	N
Mercury	S, E	E	E	E	E	E	E	E
Molybdenum	S, C	-	-	N	N	N	N	N
Selenium	N	C	N	N	C	C	N	C
Zinc	E	N	C	N	N	C	-	N

Boron concentrations in aquatic vegetation and invertebrates commonly exceed levels associated with adverse effects to avian species. Boron concentrations in pondweed correlate with sediment. However, concentrations in sediment and pondweed do not correlate with concentrations in unfiltered water. The lack of correlation suggests that managing wetlands with higher quality water may not eliminate concerns with boron in aquatic vegetation.

Selenium is generally not detected in water samples from Stillwater NWR. Concentrations in biological samples are not indicative of selenium contamination or impaired avian reproduction.

Research in other areas has demonstrated that the increased flow of fresh water to wetlands has reduced concerns with selenium contamination. Therefore, it is likely that water acquisition would further reduce selenium concerns on Stillwater NWR.

Mercury, which exceeds fish and wildlife effect concentrations in water, sediment, food chain organisms, fish, and bird tissues, represents the greatest hazard to avian species in Lahontan Valley. Additionally, concentrations in fish and certain bird tissues exceed concentrations recommended for human consumption. Although mercury concentrations are highly elevated in Lahontan Valley, direct effects to wildlife appear less than expected when compared with other mercury contaminated areas. Mercury concentrations in sediment correlate with concentrations found in aquatic invertebrates and vegetation, suggesting that food chain contamination originates from sediment. Because sediments act as both a sink and a source of mercury in aquatic systems, the acquisition of water is unlikely to mitigate mercury contamination. Therefore, other measures would be needed to reduce fish and wildlife exposure and the potential for adverse effects.

As indicated in section 4.2.1, the Service is currently working in conjunction with the EPA, the USGS, and the University of Nevada, Reno, to identify measures to reduce mercury transport and wildlife exposure. Several potential measures to reduce wildlife exposure are under consideration. Some potential management options are offered below. Continuing investigation would enable the refinement of some alternatives or the development of others.

Like contamination of the refuge, the highest concentrations of mercury in sediment are found in wetlands most closely associated with historic Carson River channels. Therefore, a de-emphasis on the management of wetlands with the highest levels of contamination (e.g., west side of the refuge) coupled with an emphasis on the management of wetlands further removed from historic channels (i.e., wetlands on the eastern side of the refuge) may reduce wildlife exposure to mercury. Additionally, natural depressions on the east side of the refuge offer the opportunity to create wetlands in uncontaminated areas.

Sampling in the Carson Lake area has demonstrated that the highest levels of contamination are associated with surficial sediment. Therefore, wildlife exposure to mercury in some wetlands may be reduced through the removal of surficial sediment. Cost of off-site disposal of contaminated sediment may be prohibitive, therefore on site disposal, such as burial or capping, may be necessary.

The toxicity of mercury depends on chemical form. Organic forms of mercury (e.g., methylmercury) are considered the most biologically available and most toxic forms. The methylation of inorganic mercury generally occurs in or near aquatic sediment. The rate of mercury methylation (and subsequent demethylation) is controlled by a variety of factors, including microbial activity, oxygen availability, concentration of organic carbon, concentration of oxyanions such as selenium and molybdenum, and concentrations of mercury. Ongoing research by the USGS and the EPA is attempting to characterize dominant factors controlling methylation and demethylation rates in Stillwater NWR wetlands. Results of this research may provide additional options for controlling wildlife exposure to mercury. The Service, in conjunction with EPA, expects to evaluate the effects of such hydrologic changes to methylation rates on Stillwater NWR. Findings of this investigation may provide additional management options to reduce fish and wildlife exposure to mercury on Stillwater NWR.

Although all alternatives are expected to benefit the quality of water delivered to Stillwater NWR, differences among alternatives may results in relatively minor variations in water chemistry. Potential differences are discussed below.

Alternative A: The acquisition of water is expected to reduce concerns with most environmental contaminants in the wetlands of Stillwater NWR. As indicated under Section 4.3.3.4, (Flushing Action and Wetlands Water Chemistry), groundwater may be used to supplement water supplies to Stillwater NWR. Concentrations of arsenic, boron, selenium, and other potentially toxic trace elements in groundwater in the Stillwater NWR area are comparable to, or higher than, drainwater (Hoffman, 1994). The use of poor quality groundwater may increase the loading of dissolved solids and trace elements in refuge wetlands. Increased loading may exacerbate contaminant exposure and adverse effects, as compared to existing conditions.

Alternative B: Because of a lower reliance on groundwater, this alternative may reduce the concentration and loads of agricultural related contaminants entering the refuge. Lower concentration and loads may contribute to a lower potential for aquatic life and wildlife toxicity. Conversely, the bulk of the water is delivered during the summer. Therefore, less freshwater is available to dilute concentrated drainwater or dissolved constituents accumulated and concentrated in wetland water. As a result, nesting and hatchling birds may be exposed to higher contaminant concentrations, which could lead to lower nesting success and recruitment.

Alternative C: Under this alternative, concentrations of total dissolved solids and trace elements associated with agricultural drainage would be expected to be lower in wetlands higher on the hydrologic gradient. Therefore, exposure to, and effects from these contaminants would be expected to be lower in these wetlands as compared to Alternative A. As such, the potential to reestablish populations and communities sensitive to elevated dissolved solids and trace elements would be enhanced. Conversely, the increased use of water spilled from Lahontan Reservoir during flooding may increase the loading of mercury to the refuge, which may exacerbate concerns with mercury.

Alternative D: Full simulation of the historic hydrological conditions would result in the more efficient movement of dissolved constituents though sequential wetlands. Like Alternative C, contaminant exposure in wetlands higher on the hydrologic gradient would be reduced and the potential to reestablish sensitive organisms would be increased. Conversely, the increased reliance of ground water may offset some of these potential benefits. Similar to Alternative C, an increased use of spill water during floods may contribute to the increased loading of mercury to the refuge.

Alternative E: Under this alternative, concentrations of total dissolved solids and trace elements associated with agricultural drainage would be expected to be lower in wetlands receiving spring pulse flows. The location of these flows would vary based on which of the four flow corridors were selected to receive water thus, flushing would not be as effective in units located higher on the hydrologic gradient as under Alternative C, but benefits would be distributed throughout Stillwater Marsh over the long-term. Therefore, exposure to, and effects from contaminants would be expected to be lower throughout the marsh as compared to Alternative A. As such, the potential to reestablish populations and communities sensitive to elevated dissolved solids and trace elements would be enhanced. Mercury input relative to spill flows would be similar to Alternative C.

Measures to Reduce Contaminant Loading of Wetland Inflows

No adverse impacts, above and beyond baseline conditions, would be expected under any of the alternatives. Nevertheless, due to ongoing contaminant concerns, several measures were identified that would improve the quality of inflow into the primary wetlands, as compared to baseline conditions. Improving drainwater quality over existing conditions would benefit the Stillwater NWR wetlands under all alternatives. Eliminating or closing drains that are known to produce poor quality water, such as TJ Drain, would reduce the impacts associated with poor quality drainwater reaching the primary wetlands. Structural improvements could be made to prevent groundwater seepage, an identified source of contaminants, from entering the deeper drains. Water management strategies could be carried out to dilute drainwater by adding better quality water (this would be done as part of any alternative). Routing of poor quality drain water to wetlands lower on the hydrologic gradient would reduce total dissolved solids in wetlands higher on the hydrologic gradient (also a component of all alternatives). Wetlands higher on the hydrologic gradient historically supported many saline intolerant species.

Implementation of measures recommended by the Department of the Interior's Irrigation Water Quality Program (Hoffman et al. 1990; Hallock and Hallock, eds. 1993; Hoffman 1994; Lico 1992) to improve drainwater quality would reduce the adverse effects associated with use of drainwater for wetlands protection. Eliminating drains can be accomplished by retiring the irrigated lands adjacent to problem drains. One method to retire irrigated lands would be to enact an acquisition strategy that would focus wetland water right acquisitions in irrigated areas where poor quality drainwater occurs. Currently, there is insufficient data to identify those irrigated lands contributing to drainwater quality problems.

Potential water quality impacts associated with use of groundwater for wetlands protection can be lessened by reducing reliance on groundwater, or by locating wells in areas where better water exists. If wetland water supplies are comprised of less than 6 percent groundwater or, if to supplement wetland inflows, it is estimated that degradation of water quality of wetland inflow would not occur, well water quality would be tested initially and monitored to ensure that water quality of wetland inflow would not be impacted by using groundwater. The actual amount of groundwater that could be used before water quality begins to deteriorate would depend on the characteristics of the water being pumped from a particular well. In effect, this mitigation would constrain the scope of the current water rights acquisition program by limiting, or eliminating, groundwater use, but would avoid the possible adverse effects associated with greater reliance on groundwater for wetland protection. This strategy can be implemented under the framework of the existing water rights acquisition program by placing more reliance on acquiring water from other sources, such as increasing canal capacity to convey greater volumes of spill water to the refuge during spills and acquiring additional middle Carson River corridor water rights.

Locating wells closer to the City of Fallon, or on the west side of the Carson Division of the Newlands Project could potentially provide better quality water for wetlands protection. The intermediate aquifer north and northwest of Fallon has total dissolved solids concentrations that range from 100 mg/L to 1,000 mg/L, which is comparable to water quality that would result under implementation of the other action alternatives.

However, down gradient groundwater users could be adversely impacted by groundwater pumping in this area, which encompasses most Churchill County water users. In addition, pumping in the recharge zones of the intermediate aquifer west and northwest of Fallon would most likely affect recharge of the basalt aquifer which provides water for the City of Fallon, the Naval Air Station-Fallon, and the Fallon Paiute-Shoshone Tribes. Because of the many potential adverse impacts associated with locating wells in these areas, it is unlikely that the Service would choose to implement such mitigation.

4.4 BIOLOGICAL COMMUNITIES

Extensive references to scientific and other information were not used in Chapter 4 in order to enhance readability. Two literature reviews were conducted to address to sources of effects on wildlife and their habitat: potential effects of human disturbance (Appendix L) and potential effects of livestock grazing on wildlife and habitat (Appendix M). Another report included as an appendix identifies the major underlying problems limiting achievement of refuge purposes, and also summarizes pertinent scientific literature on the effects of these underlying problems (Appendix N). Evaluations of the alternatives on vegetative communities, and resulting populations of wildlife, relied heavily on BLR Model projected wetland acreage. The basis of the numbers used in this model is described in Appendix G. Compatibility determinations in Appendix O can be consulted for more detailed information on the potential effects of visitor services, livestock grazing, and farming practices on wildlife and habitat.

4.4.1 VEGETATION

Vegetation is covered in four main sections: basin wetland, riparian wetland, upland, and agricultural. The first two address wetland vegetation communities. Forty-nine wetland plant communities have been identified within lacustrine (lake), palustrine (marsh), and riparian wetland areas in Lahontan Valley (Bundy et al. 1996). Forty-four of these can still be seen within the Lahontan Valley landscape; however, five historically described communities were not sampled during recent inventories (Donohue and Baumgartner 1995, Bundy et al. 1996, Charlet et al. 1998). While the communities were not sampled, dominant species within these communities were observed suggesting that these associations could reestablish given suitable wetland conditions.

Three different types of upland communities are addressed, encompassing 22 different vegetative communities. There are a number of possible agricultural vegetative communities that can exist on Stillwater NWR, depending on what is planted.

Because the action alternatives would not result in any significant adverse impacts to vegetation, no mitigation measures were identified, except where noted.

4.4.1.1 BASIN WETLAND PLANT COMMUNITIES

Generally, the basin wetland plant communities fall into six main categories, each associated with different water depths and salinity levels. The categories are:

- **Submergent marsh** - Dominated by various species of pondweed, *Chara* and wigeon grass;
- **Deep emergent marsh** - Dominated by hardstem bulrush, cattail, pondweed, and duckweed;
- **Shallow emergent marsh** - Dominated by alkali bulrush, common three-square, and common cane;
- **Moist-soil** - Dominated by five-hook bassia, swamp timothy, summer cypress, wild millet, smartweed, and red goosefoot;
- **Wet meadow** - Dominated by wirerush, sedges, spikerush, water clover, muhly grass, and saltgrass;
- **Shrub** - Dominated by greasewood, quailbush and saltgrass; or saltcedar with variable understories.

Three additional habitat types which typically are not vegetated include:

- **Unvegetated alkali mudflat;**
- **Deep-open water;**
- **Playa** - typically unvegetated but can include components of all previously mentioned types through longer periods of flooding.

The preceding list describes common plant communities occupying each wetland habitat type encountered at the Stillwater NWR complex. Habitat types are arranged in order of decreasing water demands and water depth. While water depth and permanence generally dictate distribution of habitat types, other factors, such as salinity, regulate the plant communities and species which occupy a given type. The following discussion provides descriptions of the wetland plant communities found within each habitat type, the communities which may have been present historically, and possible reasons for any changes. All descriptions are based on intensive field surveys conducted during the summers of 1993 (Donohue and Baumgartner 1995), 1995 (Bundy et al. 1996), and 1997 (Charlet et al. 1998).

These field surveys were used to provide estimates of wetland habitat acreages and percentages under estimated existing and baseline conditions. Existing conditions assume an annual average of 8,700 acres of wetland habitat in the Stillwater Marsh while baseline conditions assume an annual average of 13,500 acres at completion of the water rights acquisition program.

Submergent Marsh: Submergent vegetation is typically located in more permanently flooded sections of Stillwater NWR and requires higher amounts of water to maintain. At present, this habitat type represents 10 to 35 percent of Stillwater NWR marsh habitat and is comprised of western pondweed, sago pondweed, wigeongrass and horned pondweed submergent vegetation communities (Table 4.14).

While these species represent the most common plant community members in submergent habitats, other species, such as long-leaved pondweed, mosquito fern, and duckweed are often encountered.

Historically described communities, no longer present on the Stillwater NWR complex, include the coontail and watermilfoil submergent vegetation communities. These species typically require less saline water than currently exists and have likely declined in response to less frequent flushing water flows. However, coontail has been observed in other parts of the Lahontan Valley where fresher water inputs occur. It is likely that submergent vegetation community percentages have increased since establishment of Stillwater NWR as a result of increased amounts of shallow water during the growing season.

Deep Emergent Marsh: Deep emergent marsh is also located in more permanent water and thus, has similar water requirements. This habitat type encompasses about 15 to 30 percent of Stillwater NWR marsh habitats and is comprised of three dominant emergent vegetation communities; hardstem bulrush, southern cattail, and broad-leaved cattail. Additional species which are often encountered include: alkali bulrush, common three square, and duckweed which are present in transition zones between deep and shallow emergent habitats. In general, these communities form large, homogenous bands with 90% of the community consisting of one species.

While deep emergent marsh percentages are similar to historic estimates, changes in species composition have likely occurred in relation to modified hydrology and water salinity levels. Past inventories suggest that this habitat type was dominated by hardstem bulrush while the present community structure has shifted toward dominance by the two cattail species (USFWS

1952, Giles 1953, Bundy et al. 1996). It is possible that higher wetland water salinity and decreased water depths have led to this result. This trend has been monitored since the inception of Stillwater NWR and appears to continue at present.

Even within cattail species, there has been a shift in species with several pre-1950s researchers commenting on the abundance of narrow-leaf cattail (Marshall 1949). At this time, southern cattail was just beginning to appear in the marsh landscape and was considered "a newly described species" by Marshall. Narrow-leaf cattail has not been observed during any recent vegetation studies (Bundy et al. 1996, Charlet et al. 1998). While no solid answers are available on this shift, it is possible that narrow-leaf cattail hybridized with broad-leaf cattail, resulting in southern cattail, which may have been better adapted to changing marsh conditions in the Stillwater Marsh.

Shallow Emergent Marsh: Shallow emergent marsh is generally located at the edge of the more perennial submergent and deep emergent habitat types, where water permanence is less stable. This habitat type covers between 10 to 35 percent of the Stillwater NWR marsh area and is comprised of two vegetative communities; alkali bulrush and common cane. Similar to deep emergent communities, these communities typically occur in homogenous bands with few other species present, and generally in low percentages. Examples of other observed species include five-hook bassia, red goosefoot, and bearded sprangletop which are indicative of fluctuating water levels and, with the exception of bassia, adapted to fresher water.

This habitat type has likely increased from historic conditions, because less water currently enters the refuge, creating more fluctuation in water levels. Additionally, higher salinity levels have led to increased dominance by the alkali bulrush community which appears to thrive in highly saline environments (Bundy et al. 1996). In the current Stillwater NWR marsh system, more than 90 percent of the shallow emergent habitat type is comprised of this species.

Moist-soil: Moist-soil habitats are recently described in the Stillwater Marsh; however, some form of this community likely existed prior to Newlands Project development. Typically resulting from summer drawdowns on unvegetated mudflats, species encountered include five-hook bassia, summer cypress, swamp timothy, and a variety of other annual weeds and grasses. Since each species has a different set of germination requirements, such as soil salinity, soil temperature, day length, and soil moisture content, timing of drawdown is directly related to the species that will grow, thus, managers, through determining water distribution schedules, have more influence on producing desirable plant combinations in this habitat type than all others.

Historically, there would have been portions of the Stillwater Marsh that would slowly dry during summer months through natural evaporation processes. Considering heavy spring water flows preceding this drying period, much of the salt would have been flushed from the marsh creating conditions suitable for freshwater adapted species, such as wild millet, swamp timothy, and smartweed. At present, most of these habitats are covered by salt tolerant exotic species, such as prickly lettuce and five-hook bassia which covered more than 10 percent of Stillwater NWR

Table 4.14 Wetland Plant Community Representation by Community Dominants and Community Type Among 21 Plant Communities Sampled on Stillwater NWR, Summer 1995.

	Community Dominant(s)			
Wetland Community Type	*Scientific Name*	Common Name	Percent [a] (Community)	Percent (Wetland Type)
Submergent Communities				14%
	Potamogeton filiformis	Western pondweed	6%	
	Potamogeton pectinatus	Sago pondweed	2%	
	Ruppia maritima	Wigeongrass	4%	
	Zannichellia palustris	Horned pondweed	2%	
Deep Emergent Communities				19%
	Scirpus acutus	Hardstem bulrush	5%	
	Typha domingensis	Southern cattail	6%	
	Typha latifolia	Broad-leaf cattail	8%	
Shallow Emergent Communities				20%
	Phragmites australis	Common Reed	2%	
	Scirpus maritimus	Alkali bulrush	18%	
Wet Meadow Communities				4%
	Eleocharis macrostachya	Creeping spikerush	2%	
	Juncus balticus	Baltic rush	2%	
Grass Communities				21%
	Distichlis spicata	Saltgrass	20%	
	Muhlenbergia asperifolia	Muhly grass	1%	
Shrub Communities				8%
	Allenrolfea occidentalis	Iodinebush	4%	
	Sarcobatus vermiculatus	Big greasewood	1%	
	Sarcobatus vermiculatus-	Big Greasewood-	1%	
	Suaeda moquinii	Torrey's seepweed	2%	
Tree Communities				1%
	Populus fremontii	Fremont Cottonwood	1%	
Annual Herbaceous and Invasive Communities				14%
	Bassia hyssopifolia	five-hook Bassia	12%	
	Various Annuals	various annual species	1%	
	Tamarix ramosissima	Saltcedar	1%	

marsh habitat in 1995. Therefore, this community likely always existed, but the species commonly associated with moist-soil habitats have shifted form freshwater adapted to salt water tolerant. This habitat type is estimated to cover more marsh area at present than it did historically.

Wet Meadow: Wet meadow habitats are divided into two components based on water depth and permanence: (1) wet meadow communities, consisting of creeping spikerush and baltic rush communities, and (2) grass communities which are dominated by the saltgrass and mixed meadow grass communities. While both groups are best supported by temporary water that is generally limited to spring and early summer months, the two rush communities seem to flourish in relatively deeper water that remains for longer periods. Conversely, saltgrass can survive up to several years without surface water. In combination, all of these communities represent 0 to 30 percent of Stillwater NWR wetland vegetation; however, saltgrass is by far, the most common species in this habitat type.

The amount of area covered by the saltgrass community is probably more extensive than historic estimates suggest. However, the historically described mixed meadow grass community, consisting of foxtail barley, rabbitfoot grass, and wirerush, has not been sampled recently within the Lahontan Valley. This community may have been displaced by the saltgrass community related to livestock grazing and higher water salinity levels. All historically documented species are currently present in the Lahontan Valley and the mixed meadow grass community type could be restored.

Shrub Communities: Shrubs can occur within any habitat where dry conditions extend through most of the year. As a result, this community type can be present in upland, playa, riverine floodplain, wet meadow, mudflat, and even shallow emergent habitats following extended dessication periods. Common shrub communities associated with refuge wetland habitats include the iodinebush, big greasewood, and Torrey's seepweed communities. Iodinebush and Torrey's seepweed appear to thrive at higher salinity levels while big greasewood is more of a generalist and is distributed throughout a wider range of salinity. Iodinebush and big greasewood were the only shrub communities sampled in standing water throughout the Lahontan Valley.

At present, shrub communities occupy about 0 to10 percent of marsh habitats; predominately, in seasonally moist bands around wetlands and alkali playas. Coverage by shrub communities is likely similar to historic estimates considering that coverage moves with the water line. In other words, as wetlands dessicate through drought cycles, shrub habitat would follow the receding water line. Conversely, as the wetlands expanded through flood periods, they would flood out shrubs in previously dry areas. This pattern is similar to estimated historic functioning of the marsh.

Playa, Deep Open Water, and Unvegetated Alkali Mudflat Communities: Unvegetated habitats occur in a variety of locations throughout Stillwater NWR. At present, salinity levels appear to be the primary driving force as heavy salt crusts are invariably linked to these unvegetated habitats. Examples would be most of the Carson Sink and numerous playas located throughout the current boundaries of the Stillwater WMA and Fallon NWR. These habitats can change with water conditions as repeated high water pulses can lower salinity to concentrations that support wetland vegetation. Vegetation within nearly all previously mentioned habitat types can be present during long periods of flooding; however, saltgrass and shrubs are typically the only groups which survive.

It is likely that unvegetated habitat coverage at the Stillwater NWR complex has increased from historic estimates, primarily related to decreased water flows and increased salinity of water inputs. While this trend is evident at Stillwater, other areas of the Lahontan Valley have likely experienced a decrease, related to water depth. At water depths greater than six feet, vegetation establishment is greatly inhibited (Mitsch and Gosselink 1992). As a comparison, a large percentage of the historic Carson Lake (80 percent) was six to ten feet deep when the lake was full. Additionally, portions of Stillwater Slough as it entered and progressed through the historic Stillwater Marsh maintained depths in excess of six feet. No current wetland habitat at the Stillwater NWR complex exceeds six feet.

Native/Nonnative Dominated Communities: Several wetland plant communities currently present at Stillwater NWR are not representative of the habitats that would have occurred under natural conditions. For example, several native and nonnative annual forbs have become established along saline mudflats during receding water conditions. Common plants within this habitat type include five-hook Bassia, kochia, red goosefoot, swamp timothy, sea purslane, and several other annual grasses and forbs. These habitats probably did not exist during the pre-Newlands Project era, at least not in their present form. However, there appears to be wildlife benefits related to the forage base provided by these plants.

Another factor related to annual forb abundance is the increase in the number of nonnative plant species. At present, 72 of 192 recognized wetland species have been introduced into the Lahontan Valley; most of which are annual forbs and grasses. While these annuals appear to have at least some habitat value to native wildlife, other species, such as saltcedar and tall whitetop, have spread and formed large homogenous blocks that exclude native plant establishment. Saltcedar will continue to be a management concern at Stillwater NWR along with tall whitetop and the potential encroachment of purple loosestrife. Similar to saltcedar, these two species can form large homogenous bands that inhibit growth of native species. Tall whitetop has been observed on Stillwater NWR while purple loosestrife has been documented on the Truckee River canal.

Effects of Alternatives

Wetland vegetation undergoes a variety of cyclic events. Percentages of a given habitat type within wetland complexes change by year, season, and vary in geographic location between years in relation to timing, amount, salinity, and alkalinity of water input. Therefore, the percentages and ranges in percentages identified in this section should be viewed with an understanding of these factors. The rough estimates offered throughout the wetland habitat section represent our best understanding of habitat conditions, given the available vegetation data, and estimates of what would happen during an average, nonspill year under each alternative. The estimates are presented for the purposes of assessing gross differences between alternatives.

Wetland habitat is the portion of a wetland basin that contains surface water at any given time (i.e., after water has evaporated from a part of a wetland basin, this part of the basin no longer provides wetland habitat). Therefore, acreages of wetland habitat change seasonally relative to different water management strategies outlined under each alternative. Conversely, wetland basins are lands that are at least periodically saturated or covered with water (Cowardin et al. 1979). Acreages of wetland basins are the same each year, regardless of water management scenarios. Therefore, wetland basins are the areas that could potentially be flooded while wetland habitat is the portion of the basin that is flooded at a given time.

The following discussion focuses on habitats in the Stillwater Marsh complex which is located in the existing Stillwater NWR. Additional wetland habitat occurs at Fallon NWR and throughout the Stillwater WMA, primarily in the Indian Lakes area. Most of this habitat is seasonal and would not be greatly affected by the alternative water management strategies, with the exception that the Carson River delta on Fallon NWR could benefit from completion of the water rights acquisition program and use of water for riparian restoration. At present, this delta wetland complex only receives water during spill years (an estimated one of four years) and provides considerable floodplain meadow and riverine channel habitats when floods occur. The Indian Lakes area is not within any of the action alternative boundaries, but the lakes would continue to provide unique habitats and plant communities during spill years.

Spill years would have much wider range of effects on habitat composition than the average conditions presented in the following discussion. More seasonally flooded habitat types, such as wet meadows and greasewood, would be temporarily flooded during spill years, which would increase their overall acreage and their percent coverage during spring. Habitat conditions in Stillwater Marsh during spill years would be much more influenced by the volume of water entering the marsh as a consequence of the spill than they would be influenced by the alternative that is implemented. However, to the extent that off-refuge canal capacity is increased (to accommodate the additional water rights being acquired and possibly to convey larger volumes of spill water) and on-refuge water conveyance facilities are enlarged (Alternatives C, D, and E), there could be some differences in effects among alternatives.

The following discussion considers gross differences in the amount of different habitat types that would occur under each alternative. All comparisons are based on modeled water estimates for an average, full allocation water year assuming completion of the water rights acquisition program. These differences are presented and compared to existing conditions in Table 4.14.

Assumptions When Comparing Alternatives: Considering the dynamic nature of Great Basin wetland complexes, readers should recognize that estimates identified in the following discussion are for comparative purposes only. This was found to be the simplest way to communicate gross differences among alternatives. Vegetation changes with differing environmental conditions with wet areas in one year supporting different vegetative species than they would in years where dry conditions prevail. This is particularly true with seasonal habitats where flooding/drying cycles vary almost every year. The assumptions used in estimating the response of vegetation to the alternatives is described below.

First, in making comparisons, we only estimated conditions that would occur in an average, full allocation, nonspill water year, assuming completion of the water rights acquisition program. It is also assumed that spill events would tend to equalize the alternatives. Estimates of total wetland habitat acreage during full allocation, nonspill years were derived from BLR Model generated estimates of monthly wetland habitat acreage (Appendix G). Model outputs depict a wide range of conditions including high water and low water years. Variability is the rule rather than the exception in Great Basin habitats and it is assumed that this variability would affect each alternative similarly.

Second, factors contributing to vegetative germination and growth were considered. It was assumed that timing, duration, salinity, and alkalinity of water inputs have the most direct effects on the type and amount of vegetation produced by a given alternative's water management strategy. While information is available for many of Stillwater NWR's plant species, all of the factors involved in the continued presence of a particular plant or set of plants within a given habitat type or plant community are not known. Experimentation, which is ongoing in Stillwater Marsh, is an important means to obtain this information.

Third, through analysis of vegetation studies conducted over the last 60 years, we identified a range of habitat type distributions that could occur from year-to-year and within a season based on vegetation response to hydrologic conditions that have occurred in recent years. These conditions were extrapolated to the larger acreages of wetland habitat estimated for each alternative, accounting for seasonal differences in acreages and other factors. Estimates are provided in Table 4.15.

In Table 4.15, the percent of marsh habitat that would be seasonally wetted, the number of acres associated with this acreage (presented as a range), and the season when peak wetland habitat acreage would be anticipated are presented for each habitat type. The percentages are a combination of annual and seasonal estimates, which allow for variability during both periods. Acreage ranges were calculated by multiplying the estimated seasonal peak water availability (at the top of each column) by the estimated proportion of the marsh comprised of that particular habitat type during that season. Similar calculations were performed with low periods to establish range highs and lows.

With seasonal habitats, including shallow emergent through shrub habitats, we are assuming the peak season generally corresponds to the peak acreage. Conversely, permanent habitats, such as submergent and deep emergent habitats, do not always follow this trend, particularly when it is assumed that low acreage during fall would result in the highest habitat percent coverage, but the lowest acreage (particularly with Alternative D). The assumption is that under all alternatives, water would rarely be completely removed from these permanent water zones. Thus, acreage would remain relatively constant through seasons. Removal of other habitat types through drying would increase the percentage of permanent water habitats simply because that is all that remains.

4.4.1.1.1 Submergent Vegetation

Under existing conditions, submergent vegetation is estimated to cover 10 to 40 percent of wetland habitat in Stillwater Marsh during nonspill years (870 to 3480 acres). Most plant species within this type are salt tolerant and can survive in water ranging from a few inches deep to three to four feet. Most wetland units within Stillwater NWR and Fallon NWR have at least some submergent vegetation, with any given wetland unit's percent cover directly related to the amount of permanent water available in the unit and the amount of emergent vegetation carried over from the previous year. Because water management under existing conditions focuses on maintaining habitats through all seasons, little change in percent cover would occur seasonally. Some freshwater associated plant communities, such as coontail and water milfoil are no longer present in Stillwater Marsh.

Alternative A: Similar to existing conditions, stable water management would produce little variability in seasonal percent of total wetland habitat in Stillwater Marsh (20 to 40 percent). However, because the amount of wetland habitat available would nearly double by the time the water rights acquisition program is completed, the amount of submergent vegetation would also double, up to an estimated 2,700 to 5,400 acres.

Alternative B: This alternative would result in slightly lower amounts, 15 to 30 percent of the total wetland habitat acreage on Stillwater Marsh, or, an estimated 1,695 to 4,770 acres, of submergent vegetation compared to Alternative A, due to summer drawdown and the fall water management emphasis. However, the amount of submergent vegetation would be higher than under existing conditions. With less perennial water during the growing season, as compared to Alternative A, there would be less suitable habitat for submergent vegetation germination and growth; thus, there would be less submergent vegetation on an annual basis.

Alternative C: An emphasis in simulating natural ecological processes would result in a shift from more salt tolerant submergent vegetation communities, such as wigeon grass and chara, to more freshwater tolerant, such as western pondweed, sago pondweed, and the historically described coontail community. Overall, percentages would be similar to baseline with 20 to 35 percent (2,700 to 4,725 acres) of Stillwater Marsh's wetland habitat in submergent vegetation, meaning that the amount of this habitat would double as compared to existing conditions. A relatively low emphasis on wetland burning could allow deep emergent vegetation to encroach into areas producing submergent vegetation. However, muskrat grazing is anticipated to keep deep emergent vegetation in check, and limited controlled burns would also be used for this purpose.

Alternative D: Similar to Alternative C, there would be an anticipated shift from salt tolerant to fresher water associated communities under Alternative D. Conversely, the minimal amount of fall water inflow would result in less acreage of submergent vegetation during fall and winter, as compared to Alternative A, but a higher percentage of submergent vegetation in remaining wetland habitat. Under Alternative D, an estimated 8,600 acres of wetland habitat in Stillwater Marsh would remain during the fall and winter, of which greater than 50 percent would probably consist of submergent vegetation (4,300 acres).

Alternative E: Alternative E would be similar to Alternative C in that an emphasis in simulating the natural hydrologic regime would result in a shift from more salt tolerant submergent vegetation communities to more freshwater tolerant communities in the flow corridor selected to receive spring pulse flows. Overall, percentages would be similar to baseline with 20 to 35 percent (2,700 to 4,725 acres) of Stillwater Marsh's wetland habitat in submergent vegetation. A higher level of controlled burns in wetland habitats under Alternative E, as opposed to Alternative C, and similar levels of muskrat grazing are anticipated to keep deep emergent vegetation in check.

4.4.1.1.2 Deep Emergent Vegetation

Under existing conditions, deep emergent vegetation is estimated to cover 15 to 30 percent of wetland habitat during nonspill years (1,305 to 2,610 acres). While only three primary species occur within this habitat type, broad-leaf cattail, southern cattail, and hardstem bulrush, emergent vegetation forms the foundation of the wetland complex and provides numerous benefits for the seasonal needs of wetland-dependent wildlife. Past monitoring efforts provide evidence that hardstem bulrush once dominated this habitat type; however, increasing salinity, alkalinity, and decreased water depth have led to increased dominance by the two cattail species. Similar to

Alternative A: With water management similar to existing management, deep emergent vegetation would cover 15 to 30 percent of Stillwater Marsh's wetland habitat under baseline conditions (2,025 to 4,050 acres). With increases in available water and the resulting "freshening" of the system, there would be an anticipated shift in community dominance with hardstem bulrush slowly increasing in coverage. Because little variability in wetland habitat acreage would occur under this alternative, little change in seasonal acreage and percent coverage would be anticipated under Alternative A. Some units would be periodically drained through management prescription under Alternative A; however, acreage would be maintained as some units are flooded while others are drawn down.

Alternative B: Similar to Alternative A, 15 to 30 percent of wetland habitat on Stillwater Marsh would be covered by deep emergent vegetation (1,695 to 4,770 acres). Under this alternative, the water management focus would be on the need to provide fall habitat which would result in wetland drawdowns at a time conducive to deep emergent vegetation growth and establishment. This could result in deep emergent vegetation encroaching into areas consisting of submergent habitat. However, burning of residual vegetation would be used to keep percentages in check. Seasonal evaporative drawdowns would reduce coverage during the summer. A higher amount of wetland habitat during the fall, as compared to Alternative A, would result in all of the emergent vegetation zone being covered with water during this period in most wetland units.

Alternative C: Under Alternative C, a slightly higher amount of deep emergent vegetation could occur during spring and early summer, as compared to that which would occur under Alternative A. An estimated 15 to 35 percent (2,025 to 5,400) of wetland habitat on Stillwater Marsh would be covered by this type. The slightly higher amount compared to Alternatives A and B is related to higher spring flows and lower emphasis on controlled burning (as compared to Alternative B) which may result in deep emergent vegetation encroachment into other habitat types. It is anticipated that muskrat grazing would keep this encroachment in check while limited prescribed

Table 4.15. Estimates of percent representation, acreage, and seasonal peak for habitat types in wetland units of Stillwater Marsh.

Habitat Type Annual Spring Fall		Existing 8,700 8,000 9,600	Altern. A 13,500 12,900 14,600	Altern. B 13,500 11,300 15,900	Altern. C 13,500 15,300 13,400	Altern. D 13,500 20,500 8,600	Altern. E 13,500 16,200 13,400
Deep, Open Water	%	0-1	0-1	0-1	1-4	2-5	0-4
	acres[1]	0-80	0-129	0-113	134-612	172-1025	0-648
	Peak	Spring	Spring	Spring	Spring	Spring	Spring
Submergent	%	10-40	20-40	15-30	20-35	20-50	20-35
	acres	870-3480	2700-5400	1695-4770	2700-4725	2700-4300	2700-4725
	Peak	Similar	Similar	Fall	Similar	Similar	Similar
Deep Emergent	%	15-30	15-30	15-30	15-40	15-45	15-40
	acres	1305-2610	2025-4050	1695-4770	2025-5400	2025-6075	2025-5400
	Peak	Similar	Similar	Fall	Similar	Similar	Similar
Shallow Emergent	%	10-35	10-25	10-30	10-30	0-35	10-30
	acres	870-3045	1350-3375	1130-4770	1340-4590	0-7175	1340-4860
	Peak	Similar	Similar	Fall	Spring	Spring	Spring
Moist-Soil	%	10-30	5-15	15-30	10-25	0-20	10-30
	acres	800-2880	645-2190	1695-4770	1340-3825	0-4100	1620-4,860
	Peak	Fall	Fall	Fall	Spring	Spring	Spring
Wet Meadow	%	0-20	0-10	5-15	10-25	0-30	10-25
	acres	0-1600	0-1290	565-2385	1340-3825	0-6150	1340-4050
	Peak	Spring	Spring	Fall	spring	Spring	spring
Unvegetated Mudflat	%	5-10	5-10	5-10	5-15	0-15	5-15
	acres	435-870	675-1350	565-1590	670-2295	0-3075	670-2430
	Peak	Similar	Similar	Fall	Late Spring	Late Spring	Late Spring
Shrub	%	0-5	0-5	0-3	0-5	0-5	0-4
	acres	0-435	0-675	0-477	0-765	0-1025	0-648
	Peak	Similar	Similar	Fall	Spring	Spring	Spring

burning would be used when muskrat populations are low. Similar acreages would occur during spring and fall periods, as adequate water would be available in the fall.

Alternative D: Wide seasonal ranges in total wetland habitat acreages would be anticipated under this alternative, with annual percentages of deep emergent vegetation ranging from 15 to 45 percent of Stillwater Marsh's wetland habitat (2,025 to 6,075 acres). As water recedes during

[1] The percentage range was multiplied by the seasonal total wetland acreage value based on the peak season identified in this table. If the peak was estimated to be in spring, then the high percentage was multiplied by the spring acreage and the low percentage was multiplied by the fall acreage. Similar peak seasons were multiplied by annual acreage.

summer and early fall, it is unlikely that water would be completely removed from the deep emergent habitat type. Therefore, acreages would decrease slightly into the fall while the overall percentage would increase, due to markedly lower wetland acreage during the fall and winter. Approximately 30 to 45 percent of remaining fall wetland habitat would be in deep emergent vegetation (2,580 to 3,870 acres). Lack of controlled burning could increase emergent vegetation encroachment into other habitat types; particularly, into submergent vegetation. However, muskrat grazing would keep this in check when muskrat populations are high.

Alternative E: Alternative E would be similar to Alternative C with an estimated 15 to 35 percent (2,025 to 5,400) of wetland habitat on Stillwater Marsh covered by deep emergent vegetation. Using one of the four flow corridors to focus spring flows would tend to decrease salinity and increase water permanence within the corridor selected to receive these flows. This could change community composition to more fresh water adapted species such as broad leaf cattail and hardstem bulrush while maintaining baseline community composition within the two stabilized corridors. It is anticipated that most of the time, muskrat grazing would keep deep emergent vegetation encroachment into submergent wetland habitat zones in check; however, when muskrat populations are low, more prescribed burning would be used than in Alternative C. Similar acreages would occur during spring and fall periods, as adequate water would be available in the fall.

4.4.1.1.3 Shallow Emergent Vegetation

Under existing conditions, shallow emergent vegetation ranges widely in relation to the amount of water entering the refuge marshes and that lost to evapotranspiration. This habitat type requires shallow water conditions to germinate and once established, can survive in shallow water or dry conditions. At present, germination sites are made available through natural summer evaporative drawdowns which are typically reflooded during fall when evapotranspiration rates go down. An estimated 10 to 35 percent of Stillwater Marsh's wetland habitat, 870 to 3045 acres, is occupied by shallow emergent vegetation under existing conditions.

Alternative A: Although water management would remain similar to existing conditions, there would be an anticipated decrease in shallow emergent vegetation due to increased flow of irrigation quality water into wetland units. Less evaporative drawdown would occur resulting in more stabilized water levels throughout summer months, leaving less shallow water habitat for germination and growth. Approximately 10 to 25 percent (1,350 to 3,375 acres) of wetland habitat acreage on Stillwater Marsh would be covered by this habitat type. Although overall percentages would decrease from existing conditions, acreage would be somewhat higher than existing due to the increased wetland habitat acreage.

Alternative B: This alternative would likely be the best for shallow emergent vegetation growth and availability during the fall. Water management would be focused toward shallow water levels during summer and higher levels during fall, which would provide optimal conditions for shallow emergent vegetation growth. Approximately 10 to 30 percent (1,130 to 4,770 acres) of wetland habitat on Stillwater Marsh would be comprised of shallow emergent vegetation. Little change in percentages or acreages would occur between fall and spring, which would be similar to Alternative A in most years.

Alternative C: Similar to Alternative B, summer evaporative drawdowns would provide optimal conditions for shallow emergent vegetation germination and growth. However, much of this habitat type would not be reflooded during the fall, resulting in seasonal differences. An estimated 10 to 30 percent of Stillwater Marsh's wetland habitat (1,340 to 4,590 acres) would be comprised of shallow emergent vegetation, with fall percentages below baseline and spring percentages above baseline. Although spring wetland habitat acreage (up to an estimated 18,700 acres in March) would be considerably higher than baseline, a substantial portion of the water applied during the spring would be used to decrease salinity and would end up in northern units, such as Big Water, where little vegetative growth would be anticipated. Nearly all shallow emergent vegetation established during summer evaporative drawdown would be reflooded during the spring.

Alternative D: This alternative would produce the highest amount of shallow emergent vegetation, up to 35 percent (6860 acres) of Stillwater Marsh's wetland habitat in the spring, but as little as zero percent of the wetland habitat during the fall (i.e., no standing water in the shallow emergent zone in fall). The higher amount of spring wetland habitat, as compared to Alternative A, would be related to flushing flows during spring months and would result in freshening the Big Water unit. It is anticipated that shallow emergent vegetation would develop in this unit.

Alternative E: Similar to Alternative C, summer evaporative drawdowns would provide optimal conditions for shallow emergent vegetation germination and growth. An estimated 10 to 30 percent of Stillwater Marsh's wetland habitat (1,340 to 4,860 acres) would be comprised of shallow emergent vegetation, with fall percentages similar to baseline and spring percentages above baseline. When compared to Alternative C, this Alternative would likely result in less shallow emergent vegetation in the flow corridor selected to receive spring flows and more in the remaining corridors relative to lower and higher salinity levels, respectively. Nearly all shallow emergent vegetation established during summer evaporative drawdown would be reflooded during the following fall or spring and a higher overall shallow emergent vegetation acreage would be anticipated as compared to baseline.

4.4.1.1.4 Moist-Soil Vegetation

Moist-soil vegetation represents a relatively new, or at least a modified habitat type in the Stillwater wetlands. Most plant species occurring within this type under existing conditions are nonnative to Lahontan Valley, but they provide substantial benefits to a variety of migrating and wintering waterfowl and other waterbirds. It is estimated that some form of moist-soil vegetation existed under natural conditions, which was likely comprised of fresh water adapted annual broad-leaved plants and grasses. Increases in salinity throughout the marsh have likely contributed to a shift toward salt tolerant annual plants, most of which are nonnative species. Under existing conditions, approximately 10 to 30 percent (880 to 2,880 acres) of wetland habitat in Stillwater Marsh is comprised of moist-soil vegetation during nonspill years.

Alternative A: Increased water deliveries to the refuge would tend to freshen the system under Alternative A, which may lead to the establishment of more native species within this habitat type. However, stabilized water throughout the growing season would tend to reduce availability of mudflat habitat which moist-soil plants require for germination and growth. It is anticipated that only 5 to 15 percent (645 to 2,190 acres) of available wetland habitat in Stillwater Marsh would be comprised of moist-soil vegetation, which represents a decrease in acreage from existing conditions, and a substantial decrease in percent coverage on an annual basis.

Alternative B: Considerable emphasis would be placed on active management to produce moist-soil vegetation under Alternative B. Wetland habitats would slowly dry over summer months, producing suitable germination habitat throughout the growing season. Emphasis on fall flooding and maintenance through the winter and spring would make this habitat type available through fall, winter, and spring. It is estimated that 15 to 30 percent (1,695 to 4,770 acres) of Stillwater Marsh's wetland habitat would be comprised of moist-soil vegetation on an annual basis. This change in management emphasis would result in a much higher acreage of moist-soil habitat as compared to baseline and existing conditions.

Alternative C: Moist-soil vegetation management would be practiced under Alternative C, and while less of this habitat would be provided than under Alternative B, more of this habitat type would be produced than under Alternative A. Approximately, 10 to 25 percent (1,340 to 3,825) of wetland habitat in Stillwater Marsh would be covered by moist-soil vegetation; however, more would likely be produced, but not flooded during fall and winter months under this alternative. The management focus under Alternative C would provide for evaporative drawdown in most units during summer months. During fall and winter, an average of about two-thirds of the wetland acreage would be flooded, including wetland areas that had produced moist-soil vegetation during the growing season. Units under each of these water management options would be rotated periodically.

Alternative D: No emphasis would be placed on producing moist-soil vegetation under Alternative D. Management emphasis would be on simulating the natural hydrology which is estimated to produce mudflat habitat throughout the growing season, but virtually none of this habitat type would be reflooded during the fall and winter. Moist-soil vegetation would be reflooded during the spring, which would provide some benefits to spring migratory waterbirds. Approximately 0 to 20 percent (0 to 4,100 acres) of wetland habitat in Stillwater Marsh would be comprised of moist-soil vegetation under Alternative D, which would only be wetted only during the spring.

Alternative E: Moist-soil vegetation management would be emphasized under Alternative E, and while less of this habitat would be provided than under Alternative B, more of this habitat type would be produced than under Alternative A. Approximately, 10 to 30 percent (1,340 to

4,860 acres) of wetland habitat in Stillwater Marsh would be covered by moist-soil vegetation and attempts would be made to re flood much of this habitat during the fall. The management focus under Alternative E would provide for evaporative drawdown in most units during summer months. During fall and winter, reflooding summer produced moist-soil vegetation would be a focus of habitat management.

4.4.1.1.5 Wet Meadow Vegetation

Under existing conditions, wet meadow vegetation covers a relatively small proportion of annually wetted habitat. However, substantial amounts of wet meadow vegetation can be produced seasonally, particularly in spring, when high water conditions occur over a period of years. This habitat type has changed considerably from natural conditions. Under existing conditions, a single species (inland saltgrass) occupies most wet meadows. At present, approximately 0 to 30 percent (0 to 1,600) of wetland habitat acreage in Stillwater Marsh is comprised of wet meadow habitat, which is primarily flooded during spring months.

The effects of livestock grazing on meadow vegetation were studied along the lower Carson River in Fallon NWR. Near Battleground Point, five sample plots located inside a 1 hectare livestock grazing exclosure and four of five sample plots located outside the exclosure were characterized in April 1997 as a saltgrass dominated plant community with few other species present. From April 1997 to September 1999, sample plots within the exclosure changed to a more native mix of plant species, with a higher diversity of plant species within the community, while the outside sample plots retained the same vegetative composition throughout this period (Bundy and DeLong In Prep.). The number of species within plant communities, the average amount of the ground covered by vegetation, and the average height of plants within the sample plots were roughly equal at the time the livestock grazing exclosures were constructed (2.4/3.6 species, 15%/13% ground cover, and 10cm/12cm average height, for inside plots/outside plots respectively), but, these values had changed to 8.4/4.8 species, 72%/61%, and 44cm/20cm by September 1999. Compositional differences were not as apparent on an exclosure located roughly one mile south of the one near Battleground Point. The southern area had fewer grasses and more shrubs, which would not be expected to change to the same degree over the three year sample period.

Concealment cover near ground level (e.g., up to 16 cm) was measured inside and outside the north and south livestock grazing exclosures. At the time the exclosures were constructed in April 1997, concealment cover below 16 cm was nearly equal between the inside and outside plots for both the northern and southern exclosures. After one growing season, concealment cover remained unchanged outside the livestock grazing exclosure, but increased inside the exclosure at both locations. By the end of the third growing season, concealment cover had more than doubled inside of the exclosure, but still had not changed to any great extent outside the exclosure.

Alternative A: The tendency toward stable water levels under Alternative A would not provide for much seasonal flooding of wet meadow habitats, which is required to maintain these habitats over the long term. Therefore, much of the wet meadow habitat type available at present, would likely slowly change to other habitat types, such as shallow emergent vegetation (for those areas that are annually flooded) or upland vegetation (for those areas not being annually inundated). This would result in low percentages of wet meadow vegetation, estimated to range from 0 to 10 percent of Stillwater Marsh's annual wetland habitat (0 to 1,290 acres). This habitat would only be wetted during high water periods, related to slightly higher water during spring and late fall months when evapotranspiration is low. Saltcedar would continue to invade this community during spill years followed by drawdown. The seeds for saltcedar are distributed by flood water, and when the water is gone, remain in the mud, thus allowing establishment of new colonies. Cattle grazing in localized areas would continue to keep vegetation short, as shown in the study described above.

Alternative B: There are several possible ways that wet meadow habitats could function under this alternative. With little emphasis on spring flooding, followed by evaporative drawdown, conditions beneficial to development of wet meadow vegetation, it is possible that this habitat type would decrease in distribution. Conversely, fall flooding would be a management focus, which could promote growth of saltgrass. It is thought that this latter scenario would be the anticipated result, providing flooded wet meadow habitat during fall, but rarely during spring months. Approximately 5 to 15 percent (565 to 2,385 acres) of available wetland habitat in Stillwater Marsh would be comprised of wet meadow vegetation, occurring almost entirely during fall months. Reductions in cattle grazing pressure would result in a greater diversity of plant species in wet meadow communities and more structural diversity.

Alternative C: This alternative would provide ideal conditions for development and maintenance of wet meadows. Simulation of natural hydrology would provide spring wetting of wet meadow vegetation, followed by summer evaporative drawdown. Simulation of high spring flows would also freshen water in upper wetland units, which would provide suitable conditions for the development of natural wet meadow communities in addition to saltgrass. Species comprising these other communities have decreased in abundance since Newlands Project development. Additionally, fall water management could provide a minimal amount of wet meadow habitat in some years during fall and winter months, although it is likely that water would not flood this habitat type in most wetland units during the fall. Approximately 10 to 25 percent (1,530 to 3,825 acres) of available wetland habitat in Stillwater Marsh would be comprised of wet meadow vegetation during the spring. Saltcedar control would stop the expansion of the saltcedar into this habitat and the exclusion of cattle grazing, where it is currently permitted in Stillwater Marsh and at the delta of the Carson River (Battleground Point area), would result in a more natural vegetative community.

Alternative D: This alternative would likely provide the best conditions for maintenance of wet meadows. Full simulation of the natural hydrology would provide the best conditions of any alternative for the restoration of native vegetative composition in wet meadow communities. None of this habitat type would remain flooded from late summer through the early spring, similar to estimated natural conditions (aside from years when flooding occurred). Up to 30 percent (up to 6,150 acres) of Stillwater Marsh's wetland habitat would be wet meadow habitat during the spring. However, limitations on controlling saltcedar could potentially result in some of this acreage being converted to saltcedar communities. Exclusion of cattle grazing from the locations where it is currently permitted in Stillwater Marsh and at the lower end of the Carson River would result in a more natural vegetative structure in this community.

Alternative E: The prevalence of wet meadow vegetation under this Alternative would be similar to that anticipated to occur under Alternative C. Approximately 10 to 25 percent (1,340 to 4,050 acres) of available wetland habitat in Stillwater Marsh would be comprised of wet meadow vegetation during the spring with an estimated 2,000 -3,000 acres reflooded during fall. Saltcedar control would stop the expansion of saltcedar into this habitat while the exclusion of cattle grazing, where it is currently permitted in Stillwater Marsh and at the delta of the Carson River (Battleground Point area), would result in a more natural vegetative community. Similar to moist-soil vegetation, wet meadow vegetation would be an emphasized habitat to receive fall water.

4.4.1.1.6 Wetland Shrub Vegetation

The wetland shrub habitat type is extremely variable, with shrub habitat following the shoreline during multi-year, drought/flood cycles. Typically related to uplands (and therefore not flood tolerant), some species are transitional between uplands and wetlands and can survive short-term seasonal flooding. Wetland shrubs usually become established during long-term droughts, die off during extended flooding periods, and, in areas where they became established during droughts, typically remain in those areas where short-term, seasonal flooding or no flooding occurs. At present, these habitats can be extensive, covering 0 to 5 percent; 0 to 435 acres of wetland habitat, related to annually fluctuating water availability. Common wetland shrub communities include big greasewood, iodinebush, and desert blight; however, quailbush, rubber rabbitbrush, and dotted dalea also occur in these communities. The shrub habitat type was likely not as prevalent under natural conditions, except when the entire Stillwater Marsh remained dry for extended periods. Natural wetland shrub communities have likely been displaced by invasive saltcedar throughout much of their historic range.

Alternative A: Stable water management under Alternative A would not provide for extended dry periods throughout the Stillwater Marsh, resulting in little establishment of wetland shrub communities. This habitat type would only be found along wetland shorelines, and would only be flooded during periodic spill years. Annual drying periods would not be sufficient to maintain shrub habitats as many species require several years to mature. Therefore, approximately 0 to 5 percent (0 to 675 acres) of available wetland habitat in Stillwater Marsh would be comprised of shrubs. Very little saltcedar control would be practiced in this habitat type.

Alternatives B, C, D, and E: While these alternatives would all provide drawdown conditions during summer months, where shrubs could potentially establish, seasonal flooding provided under each alternative would not provide suitable conditions for maturation of shrubs. Some seasonal habitat might be provided; however, only a thin strip of shoreline habitat would be maintained which would likely only comprise 0 to 5 percent (0 to 980 acres) of available wetland habitat in Stillwater Marsh. Shrub habitat could be flooded periodically under Alternatives B, C, and E when wetland units are reflooded after several dry years. There would be a slight decrease in shrub habitat from baseline under all alternatives. However, higher levels of invasive vegetation control would be practiced under Alternatives C and E.

4.4.1.1.7 Unvegetated Alkali Mudflat Habitat

At present, considerable wetland habitat acreage can be covered by unvegetated alkali mudflats. Highly saline water is strongly related to development of this habitat type, as it occurs in areas where salt contents exceed levels where wetland vegetation can survive. Although wetland vegetation is absent, this habitat type is quite valuable for migrating shorebirds and would continue to provide habitat for a number of other waterbird species. Large open flats can currently be seen throughout most of the northern refuge units; however, only a portion is wetted at any given time. Approximately 5 to 10 percent (435 to 870 acres) of Stillwater Marsh's wetland habitat is seasonally comprised of unvegetated alkali mudflat habitat, particularly during summer and early fall.

Alternative A: Under this alternative, the water management focus would be on sustaining marsh vegetation. While unvegetated alkali mudflat habitats would continue to be a component of the overall wetland complex, less water fluctuation would occur under this alternative, which would result in a constant unvegetated alkali mudflat zone as opposed to the more productive fluctuating zone provided under summer evaporative drawdown conditions. Similar to existing conditions, approximately 5 to 10 percent of unvegetated alkali mudflat habitat would still be provided, but the amount would increase to an estimated 675 to 1,350 acres. However, the value of this habitat to wildlife would be altered somewhat because water level fluctuations would be reduced.

Alternative B: Under this alternative, acreages and percentages would be similar to Alternative A (5 to 10 percent; 565 to 1,590 acres). However, under Alternative B, a higher proportion of the unvegetated alkali mudflat habitat would be colonized by shallow emergent and moist-soil vegetation during summer evaporative drawdowns when compared to Alternative A. Summer drawdowns would ensure that some of this habitat type was available throughout summer months. Based on the shape of wetland depressions, the width of this band would increase as water receded; however, the length would decrease as wetland acreage decreased, therefore, equal availability of unvegetated alkali mudflat habitat would be available throughout the summer for shorebird use. As water levels increase during fall flooding, the same progression would occur in reverse, but the quality of this habitat for shorebirds would be reduced because of the previous waterbird use of habitat during summer drawdown. As a result, unvegetated alkali mudflat habitat for shorebirds would primarily be available during summer months under Alternative B.

Alternative C: There are a few possible outcomes with unvegetated alkali mudflats under Alternative C, which would vary in relation to the salinity and alkalinity of water entering the wetlands. First, it is likely that simulation of the natural hydrology and associated summer drawdown would result in a similar progression to that described under Alternative B. Because Alternative C would result in lower salinity in wetland units, which would allow marsh vegetation to become established on many of these mudflats, much of the excess water used to reduce water salinity would flow out to the Big Water unit, where additional alkali mudflat habitat would become established. Approximately 5 to 15 percent (670 to 2,295 acres) of summer wetland habitat in Stillwater Marsh would be occupied by this habitat type. Overall, this alternative would provide for higher acreages of unvegetated alkali mudflat than baseline but less summer acreage than under Alternative B, because there would be more receding mudflat habitat under Alternative C than there would be with rising late summer/fall water levels in Alternative B.

Alternative D: Full simulation of the natural hydrology would increase potential for producing vegetation on mudflats through wetland units. However, implementation of this alternative would also increase acreage on the Big Water Unit, and thus, provide seasonally higher acreages and percentages than under Alternative C (0 to 15 percent; 0 to 3,075 acres). At peak water flow during early summer, the higher end of this range would be achieved. No fall flooding of this habitat would be anticipated under Alternative D.

Alternative E: Similar to Alternative C, the Alternative E water management strategy would optimize acreage of this habitat type during late summer with approximately 5 to 15 percent (670 to 2,430 acres) available for fall shorebird migration. Some wetland units would be stabilized to maintain submergent and deep emergent habitat while most units would be allowed to slowly drawdown during the course of the summer, thus providing new unvegetated mudflat for shorebird use. An increased emphasis on fall flooding would occur when compared to Alternative's A and C; however, this should occur at a time when most shorebirds have left the refuge and the emphasis would shift towards providing moist-soil habitat for migrating and wintering waterbirds.

4.4.1.1.8 Deep, Open Water Habitat

Under existing conditions, virtually no deep, open water habitat is available. Open water habitat is defined as being devoid or nearly devoid of vegetation and typically greater than six feet deep; however, low water clarity can reduce this depth to three to four feet. Related to an inconsistent water source, water depths which would inhibit growth of submergent and deep emergent vegetation are currently not maintained. In some years and in some wetland units, this habitat is produced seasonally with high water inflows; however, vegetation would typically establish in these seasonal zones as the summer progresses. It is estimated that less than 200 acres of Stillwater Marsh's wetland habitat is comprised of deep, open water habitat at present.

Alternative A: Even with increased water inflow related to the water rights acquisition program, it is unlikely that deep, open water habitat would be maintained under this alternative. In some years and wetland units, it is possible that this habitat type would occur seasonally; however, only 0 to 1 percent (0 to 129 acres) of available wetland habitat in Stillwater Marsh would be comprised of deep, open water. This habitat would be seasonal, as submergent and deep emergent vegetation would become established as the summer progressed.

Alternative B: This alternative would be similar to baseline (Alternative A).

Alternative C: Through simulation of the natural hydrology, an increase in deep, open water habitat would be anticipated under Alternative C. Similar to Alternative A, this habitat type would be seasonal in most locations; however, it is possible that some channels would be restored through wetland units which would produce additional deep, open water habitat, as compared to Alternative A. Approximately 1 to 4 percent (134 to 612 acres) of available wetland habitat in Stillwater Marsh would be maintained as deep open water.

Alternative D: This alternative would produce the highest percentage of deep, open water habitat. Through full simulation of the natural hydrology and restoration of channels through some wetland units, approximately 2 to 5 percent (175 to 1025 acres) of available wetland habitat in Stillwater Marsh would be maintained as deep, open water, primarily during early summer. Although much of the seasonal habitat would become vegetated during summer evaporative drawdown it is anticipated that channels would remain unvegetated throughout the year.

Alternative E: Through simulation of the natural hydrology, an increase in deep, open water habitat would be anticipated over baseline Alternative A. Focusing spring pulse flows through one of four flow corridors is anticipated to increase deep open water habitat availability over Alternative C; however, the location of these flows would vary over the long term providing the possibility for no deep open water habitat in some years. Approximately 0 to 4 percent (0 to 648 acres) of available wetland habitat in Stillwater Marsh would be maintained as deep open water.

4.4.1.1.9 Playa Habitats

At present, playa habitats are distributed throughout Stillwater NWR, Fallon NWR, and Stillwater WMA. Including the Carson Sink (within Stillwater WMA and Fallon NWR), seasonally flooded playa habitats account for the largest acreage of Stillwater WMA and Fallon NWR wetland habitats. The scattered alkali playas not receiving water from the Carson River are more closely tied to local precipitation and shallow groundwater movement and annual rainfall. These playa habitats are typically closed basins with overland flow limited to runoff from the immediate surrounding uplands. Therefore, the timing of flooding would not change markedly under any of the alternatives, with the exception that increased inflows to wetlands after completion of the water rights acquisition program, might raise the shallow groundwater table in some locations, thus, increasing the duration of playa habitat flooding. To the extent this is true, Alternative D would result in the largest increase in seasonal playa habitat acreage.

Boundary revisions, associated with different levels of protection afforded playa habitat, would have the most marked effect on this habitat type (Table 4.16). Each alternative would incorporate a different amount of playa habitats. Although Alternative A would retain the most acreage of playa habitat within a Federal wildlife area, this alternative along with Alternative B would provide the least protection to playa habitat. Alternatives C, D, and E would protect playas from livestock grazing and would afford additional protection from off-road vehicles.

Table 4.16. Approximate acreage of playa habitat included under each alternative are as follows, excluding the Carson Sink.

Alternative	Playa Acres Included
A	8,900 acres
B	4,520 acres
C	6,450 acres
D	8,470 acres
E	6,450 acres

4.4.1.2 RIVERINE RIPARIAN PLANT COMMUNITIES

Historically, the banks of the Carson River in the Lahontan Valley were dominated by cottonwoods, willows, cattails, buffaloberry, grasses, rushes, and sedges. At present, saltcedar and Russian olive, which are introduced and highly invasive species, also inhabit riparian areas. Both native and introduced species occur along the Carson River corridor and along a few project drains and canals. Cottonwoods have become more widespread in the valley due to the high water table and the use of the trees for landscaping and windbreaks. Buffaloberry, a valuable forage and cover shrub, has been nearly eliminated from the affected area as a result of clearing and grazing.

While drains and canals provide additional riparian habitat outside refuge boundaries, the Carson River corridor provides the majority of riparian habitat within the refuge. Habitat along the river corridor can be divided into several different categories based on water depth, water permanence, and geographic location. These categories include:

- **Riverine Channel** - permanently flooded portion of the river corridor dominated by duckweed, cattails, hardstem bulrush, and sandbar willow.

- **Seasonal Overflow Habitats** - includes the river bank, oxbow lakes, and floodplain habitats dominated by various trees, shrubs, grasses, and previously mentioned wetland plants.

- **Riverine Delta** - located at the end of the Carson River as it enters the Carson Sink, dominated by saltgrass, sea purslane, alkali bulrush, cattails, and hardstem bulrush.

At present, distribution of riparian habitat is seasonal with annual snowpack and associated flows down the Carson River regulating habitat abundance. During low water years, few of these habitats would become or remain flooded during spill years, all habitats would remain flooded for some portion of the year. Therefore, riverine systems likely contain the most dynamic habitats at Stillwater NWR which are potentially the most productive. The following discussion is based on recent surveys conducted by Donohue and Baumgartner (1995), Bundy et al. (1996), and Charlet et al. (1998).

Riverine Channel: Historically, the Carson River channel likely maintained at least some flow throughout the year. At present, storage in Lahontan Reservoir and associated diversion have led to seasonal dry periods, often extending through much of the year. However, when flooded, the channel is comprised of a mosaic of wetland species including duckweed, broad-leaved cattail, hardstem bulrush, and sandbar willow. Seasonal high flows can scour the channel, removing residual vegetation and providing germination sites for new plants to grow. This cycle of high pulses followed by periods of drought maintains riparian productivity.

At present, periods of drought occur at more frequent intervals and flows during floods are limited to less than 800 cubic feet per second. When drought occurs, germination sites are provided for a variety of annual forbs and saltcedar. While the forbs generally wash out during spill periods, saltcedar and willows remain. Saltcedar has slowly encroached into native willow habitat reducing willow coverage from historic estimates.

Seasonal Overflow Habitats: During periods of high water flow, the Carson River can overflow its banks producing a mosaic of temporary habitats. Representative examples include tree, shrub, and grass plant communities along the river's bank; wet meadow and shrub communities along the rivers floodplain, and oxbow lakes where the river channel changes in relation to flow patterns. Bank and floodplain habitats are similar in that seasonal high water determines which areas are flooded and for what duration. Oxbow lakes are created when segments of the previous river channel are cut off during high flow periods, which creates deep, narrow depressions that fill during flooding. When these depressions remain flooded for extended periods, almost any of the previously mentioned plant communities can occupy this habitat type.

At present, floods that produce these habitats occur only in spill years, and only when water flows exceed the channel's capacity. This has been a rare occurrence over the past several decades with little formation of new oxbow lakes apparent. River channelization and lack of adequate flows are largely responsible for this result. Additionally, considerable encroachment by invasive species has been observed with large stands of saltcedar, Russian olive, cocklebur, and tall whitetop located throughout the rivers length. Most floodplain meadow habitats have either been converted to agriculture, reverted to upland shrub communities, or are in private ownership. Livestock grazing has contributed to reduced abundance of native communities.

Riverine Delta: In Great Basin systems, riverine deltas form between the river basin and terminal interface. Under natural conditions, the delta occurred throughout a transition from a single channel to a braided channel to meadow habitats. Continuous changing within braided channels resulted in a topographic variation which produced a variety of plants adapted to differing levels of water permanence. At present, this habitat type is dominated by saltgrass but also contains Parishes spikerush, red goosefoot, swamp timothy, and several other freshwater adapted species. This habitat is one of the few representative examples of freshwater habitat remaining at Stillwater NWR. However, salt tolerant species, such as alkali bulrush and saltcedar are becoming more prevalent at the Carson River delta.

Encroachment by saltcedar and other nonnative species is currently spreading. As the river brings freshwater to the delta, it also brings seeds from a variety of nonnative plants. Tall whitetop has been increasing along the rivers length and cocklebur, prickly lettuce, and five-hook Bassia are becoming more abundant. Seed source, decreasing water input, and associated higher salinity content are slowly changing the structure of this habitat. Continuous grazing throughout the growing season has likely added to this shift.

Riparian habitats considered in this section include a 15-mile stretch of the lower Carson River, the Carson River delta, a four-mile stretch of Stillwater Slough at the southern end of the existing Stillwater NWR, and a seven-mile stretch associated with the D-Line Canal through the southern end of the Stillwater WMA. Presently, none of these habitats are actively managed and the lower Carson River and D-Line Canal rely on spill years for any water input. Except possibly under Alternatives C, D, and E, many of these habitats would remain dependent on spill water

Alternative A: Under Alternative A, all previously described segments of riparian habitat would continue to be included in the Stillwater NWR and Stillwater WMA boundaries. Quality and availability of this habitat type would be dependent on spill water as no water rights would be used for restoring riparian habitats on the lower Carson River and D-Line Canal. Approximately 15 miles of the lower Carson River, four miles of Stillwater Slough, and eight miles of the D-Line Canal would be retained in Stillwater WMA and Stillwater NWR. Much of this habitat is currently in private ownership. No management emphasis would be placed on riparian habitats.

Alternative B: Only the four-mile segment of Stillwater Slough and the Carson River delta would be retained in this alternative. Because no active management would be placed on restoration of riparian habitats, riparian habitat along the Stillwater Slough would remain in poor condition. Furthermore, without protection and restoration efforts, river and riparian habitat along the lower Carson River and the D-Line Canal, neither of which are included in this alternative, would remain in poor condition or continue to deteriorate.

Alternative's C and E: All previously described segments of riparian habitat, in addition to a three-mile stretch of the Carson River south of the existing Stillwater WMA boundary, would be within the boundary of Alternatives C and E. Restoration of native riparian vegetation would be enhanced by the removal of cattle grazing from riparian corridors, control of invasive species, revegetation efforts aimed at restoring cottonwoods and willows and other riparian shrubs. Other possibilities include the conveyance of water through the Stillwater Slough and D-Line Canal and acquisition of additional land and water rights, from willing sellers along the lower Carson River within the Alternative C and E boundary. Even if additional water is not made available for riparian restoration, the other actions identified above would enhance the composition and structure of riparian vegetation. Survival of cottonwood and willow seedlings, which have germinated along the banks of the lower Carson River during recent spill years, would be higher and these, and other native woody plants, would be higher in abundance, as compared to Alternative A. Over time, cottonwoods and willows would begin to replace saltcedar and Russian olive. Native grasses, such as creeping wild rye, which are now heavily grazed, would increase in composition and tall, dense stands would be produced along some portions of the lower river. Similar habitat conditions would eventually be produced along the Stillwater Slough, after intensive efforts to restore the channel are completed. To the extent that additional lands are acquired and additional water is secured for riparian habitat along the Carson River, these alternatives have the potential, over the long term, to greatly enhance this habitat.

Alternative D: This alternative would result in similar riparian habitat conditions as would occur under Alternatives C and E, except invasive species would likely comprise a larger proportion of plant community composition since herbicides, and goat and sheep herbivory would not be allowed.

4.4.1.3 DESERT SHRUB PLANT COMMUNITIES

Below is a description of the desert shrub plant communities in the study area. The shrub communities of Stillwater NWR, Stillwater WMA, and Fallon NWR are described first, followed by the shrub plant communities of Anaho Island NWR.

Desert shrub plant communities on Stillwater NWR, Stillwater WMA, and Fallon NWR typically consist of plant species that can tolerate moderate to highly alkaline soils and can survive on minimal precipitation (about five inches per year). They are the most common vegetation type in the Lahontan Valley. The distribution of desert shrub plant communities is determined by water availability, salinity, and substrate. These three factors, in turn, are related to the topography of the landscape. Topographic depressions tend to have saline, clayey soils which pond water, where raised areas tend to have sandy, less saline, more well drained soils.

Three different upland desert shrub habitat types have been identified on Stillwater NWR, Stillwater WMA, and Fallon NWR. They are greasewood shrublands, saltbush desert shrublands, and dunes. In general greasewood shrublands occupy finer textured, more saline soils and are more frequently flooded where dune plant communities occur on course textured (sandy), well drained soils. Saltbush shrublands occur on soils that are intermediate between those occupied by greasewood and dune communities.

Greasewood shrubland communities cover a greater area than any other plant community mapped on the three Federal wildlife areas. Fourteen different greasewood shrubland communities were identified during recent surveys (Charlet et al. 1998). While most of these communities can be found on Stillwater WMA, very few are represented on Stillwater NWR. Total cover of these communities ranges from less than 5 percent to nearly 90 percent. Most greasewood shrublands are multi-layered shrub communities, often possessing an understory of annual herbs and saltgrass. Greasewood typically dominates the overstory of these communities while other smaller shrubs, such as desert blight, shadscale, Torrey's saltbush, four-wing saltbush, catclaw horsebush, winter fat, budsage, and spotted dalea form a midstory. Historically, Indian ricegrass was more abundant in the understory of these communities. However, past grazing practices appear to have reduced the distribution and abundance of this native grass.

Saltbush desert shrubland in the study area is a low, multi-layered shrub community often accompanied by the perennial herb desert-mallow and an understory of widely scattered native annuals. Five different saltbush desert shrubland communities were identified during recent surveys (Charlet et al. 1998). This plant community is abundant at the southern end of Stillwater NWR. Saltbush desert shrublands are typically dominated by Torrey's saltbush or shadscale. Other shrubs found in this community include rabbitbrush, budsage, desert blight, catclaw horsebush, winterfat, greasewood, spotted dalea, and white burrobush.

Three different shrub communities have been identified on active dunes on Stillwater NWR, Stillwater WMA, and Fallon NWR. Two of the communities, which occur at the base of active dunes, are dominated by greasewood. Indian rice grass can be abundant in both the understory and areas of open sand. A third dune plant community is dominated by invasive species including annual herbs such as Russian-thistle and barbwire Russian-thistle. This common community appears to be spreading to many formerly bare areas and may be stabilizing some active dune surfaces, such as the tops of small dunes west of North County Road (Charlet et al. 1998).

Anaho Island NWR harbors desert shrub communities and can be characterized by dominant shrub species, such as shadscale, spiny hopsage, big greasewood, and winterfat; nonnative annual grass species including red brome and cheatgrass; and native bunch grasses and forbs, such as desert needlegrass and buckwheat. Forty-eight species of flowering plants and nine species of nonflowering plants were identified on Anaho Island (Woodbury 1966 and Tauch, per. comm.) (Appendix C). Map 2.4 depicts the distribution of annual grass communities, respectively.

Anaho Island is currently undergoing a change in plant community dominance from desert shrubs and perennial bunch grasses to nonnative annual grasses. Dominant vegetation has changed in the last 30 years. In 1966, eight species of grasses were found primarily on the upper parts of the island, except saltgrass which was common along the water's edge. Shrubs once dominated the vegetation of the island; however, a 1998 inventory showed that annual grasses are rapidly increasing in abundance.

Mature shrubs are often robust plants with phenomenal leader growth. However, shrub regeneration is very poor. Although a few stands of native grasses on the island appear viable and healthy, the majority of Anaho Island is dominated by cheatgrass and red brome. Litter accumulation of annual grasses has effectively reduced the reproduction of native desert shrubs, grasses, and forbs, by forming a mat of litter virtually impenetrable to native seeds thereby inhibiting seed germination. In addition, dense stands of annual grasses may out compete any native seedlings that are able to germinate for water and nutrients. Photographs taken over the years document the loss of shrubs and increasing density of annual grasses (Tausch, pers. comm.). There is a noticeable lack of native shrubs, grasses, and forbs establishing in the area.

Fire on Anaho Island would be detrimental to the native plant community. Historically, fire was an infrequent and insignificant ecological process influencing the desert shrub plant communities. Desert shrubs, bunch grasses and forbs were scattered and fuel loads were insufficient to carry a fire. In contrast, the majority of Anaho Island contains a dense layer of annual grasses and litter within the desert shrub community at present, that would rapidly carry a fire and the existing grass communities would thrive following a fire. If a fire were to occur on Anaho Island, the desert shrubs would most likely be replaced by annual grasses within the burned area. However, even in the absence of fire, this conversion from desert shrubs to annual grasses is progressing, although at a slower rate than if it were burned.

Under existing conditions, approximately 57,400 acres of Stillwater NWR, Stillwater WMA, and Fallon NWR upland habitats are divided between greasewood shrubland, saltbush desert shrubland, and sand dunes. These habitats tend to be geographically separated with saltbush desert shrublands located in the southeast corner of Stillwater NWR, sand dunes located along the northern boundary, and greasewood shrublands located throughout the refuges and management area. Acreages for each upland habitat type are provided in Table 4.17.

Alternative A: Under this alternative, similar acreages would be provided as under existing conditions with 40,100 acres of greasewood shrubland, 8,100 acres of saltbush desert shrub, and 9,200 acres of sand dunes. With management similar to existing, livestock grazing, up to 11,000 AUM's annually, would continue throughout upland habitats. This could result in continued encroachment of cheatgrass throughout upland habitats and limit production of native species once common to these sites. Overall, upland habitats would remain similar, in distribution and appearance, to what exists at present.

Table 4.17. Acres of upland habitats included in alternative boundaries.

	Acres of Habitat Included within Alternative Boundaries				
Habitat Type	Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
Greasewood Shrubland	40,100	6,300	26,500	34,600	26,500
Saltbush Desert Shrubland	8,100	8,100	8,100	8,100	8,100
Sand Dunes	9,200	6,500	10,000	11,200	10,000
Total	57,400	20,900	44,600	53,900	44,600

Alternative B: With this alternative, the Stillwater WMA would no longer be managed as part of Stillwater NWR Complex, resulting in a much lower acreage of greasewood shrubland being managed by the Service as compared to baseline. Saltbush desert shrub acreage would be identical to baseline while less sand dune habitat would remain within refuge boundaries. This would result in the dune system being managed under different jurisdictions. Remaining upland habitats would have a greater level of protection from livestock grazing, with 500 to1,000 AUMs grazed annually, and only for specific management purposes. Therefore, the canopy cover of native vegetation would be higher and the spread of invasive species in these habitats would be lower. Overall, lower amounts of upland habitat acreage would be included in the boundary, but with higher levels of protection than under baseline.

Alternative's C and E: Exclusion of the Indian Lakes area would lower acreage of greasewood shrublands; however, the boundary revision would provide for higher sand dune acreage than Alternative A. Livestock grazing would be eliminated throughout upland habitats allowing for regeneration of native vegetation, such as Indian rice grass. Recommendation of the northern sand dunes as a research natural area would provide for increased protection of these habitats through additional law enforcement and elimination of vehicle access. Saltbush desert shrubland acreage would remain similar to Alternative A. Overall, both these alternatives would retain a higher sand dune, similar salt desert shrubland, and lower greasewood acreage than baselines, but would afford a higher level of protection throughout upland habitats.

Alternative D: This alternative would provide for the highest acreage of sand dune habitats (11,200 acres), with identical and slightly lower acreages of saltbush desert shrub and greasewood shrubland, respectively. Similar to Alternative C, grazing would be completely removed from upland systems and sand dunes would be additionally protected through the creation of a Research Natural Area.

4.4.1.4 AGRICULTURAL VEGETATION

Irrigated agriculture generally maintains large acreages comprised of one dominant plant species. Within an agricultural area, cultivated species, introduced species of weeds, and to a limited extent, native grasses and forbs occur. Although several hundred acres of farmland have been cultivated during the last few years on refuge lands, the assumption of this EIS is that no farming occurs on Stillwater NWR. There are about 60,000 acres of irrigated farmland in the affected area (lower Carson and Truckee River basins).

Alternative A: Under this alternative, no agricultural vegetation would be maintained on refuge lands, as described in the WRAP EIS (USFWS 1996a).

Alternative B: Under this alternative, up to 300 to 400 acres of agricultural vegetation would be provided on refuge lands for waterfowl forage. Alfalfa and grain crops (barley, oats, wheat) would be the primary crops.

Alternative's C and E: Similar to Alternative B, 200 to 300 acres of agricultural vegetation would be provided for waterfowl under these alternatives.

Alternative D: This alternative would entail no change from Alternative A, as no farmland would be cultivated for waterfowl.

4.4.1.5 NATIVE COMMUNITY ABUNDANCE

Under existing conditions, approximately 192 wetland plant species have been identified in the Lahontan Valley, 74 of which are currently listed as nonnative (nearly 40%). Most, if not all, of these have been documented on Stillwater NWR, Stillwater WMA, and Fallon NWR, or are thought to occur on these areas. Nonnative species have been introduced to the Lahontan Valley for a variety of reasons and causes. Unstable water availability, increased salinity of inflows, and livestock grazing practices have likely contributed to their spread throughout the Stillwater NWR Complex, by reducing vigor and survival of native vegetation. Most of these species are annual weeds which rely on seasonal, usually spring, water pulses to grow and set seed; however, tree and tall shrub species, such as saltcedar, Russian olive, and Siberian elm and grass species, such as cheatgrass, have encroached on native habitats as well. Irrigation of agricultural fields, reduced inflow, fluctuation of marsh habitats, continuous growing season long cattle grazing, and increased water and soil salinity levels have all contributed to their increased presence among marsh and riparian habitats.

Most of the nonnative species are generalists, which means that they can survive in a variety of habitats in the Stillwater area, but they also form plant communities. Some species have become so abundant that they are the most common members of some plant communities. Of the 38 described plant communities for Stillwater NWR, Stillwater WMA, and Fallon NWR, seven are considered nonnative dominated, such as saltcedar, Russian olive, five-hook Bassia, and these contribute to a large percentage of wetland acreage.

Most native communities have at least some representation by nonnative plants. The boundary revision effort could have some effect on the representation of native communities within refuge borders, as many communities are currently only found at sites that would not be retained under some alternatives. Aside from different boundaries, the primary differences between alternatives regarding survival and perpetuation of native plant communities are water delivery schedules to Stillwater Marsh, potential for acquiring additional water for the lower Carson River, livestock grazing practices, and practices for controlling invasive species.

While most native species are still present in the Lahontan Valley, at least to some extent, they no longer exist in sufficient quantities to constitute a plant community. Some of the missing native communities and/or species include:

Basin-Wetland	**Riparian-Wetland**	**Upland**
Pickelweed	Cottonwood/Great Basin wild rye	Indian rice grass
Northern arrowhead	Cottonwood/Willow	
Long-leaved pondweed	Cottonwood/mixed deciduous shrub	
mixed meadow grass	Buffaloberry	
water hyssop		
Parish’s spike rush		

Alternative A: With the completion of the water rights acquisition program, more freshwater would enter the system which would provide conditions suitable for many native plants. Some native communities, such as the arrowweed, coontail, and long-leaved pondweed plant communities, are no longer present in Stillwater Marsh. It is anticipated that freshwater added to the marsh would provide conditions suitable for their reestablishment. Less water level fluctuation would occur under this alternative, which would reduce the amount of wetland habitat available for growth of nonnative, annual weed dominated communities, such as five-hook Bassia, prickly lettuce, strawberry clover, and saltcedar. However, this same reduction in water level fluctuations could deter reestablishment of native wet meadow communities, such as mixed meadow grasses, water hyssop, and Parish's spikerush.

Riparian corridors would continue to be flooded only during spill periods which, in conjunction with continued livestock grazing, would deter restoration of native tree, shrub, and grass species. Similar results would be anticipated for Indian ricegrass communities in upland habitats. Overall, freshwater would aid in the restoration of freshwater associated wetland plant communities but lack of natural water level fluctuations would not help to restore native communities associated with these fluctuations under this alternative. Riparian and upland communities would remain largely unchanged from existing conditions.

Alternative B: This alternative would focus on providing fall and winter habitat for waterfowl, thus, summer drawdown and fall flooding would be the primary water management objectives. Similar to baseline, more freshwater would enter the system which would increase habitat availability for many native species over existing conditions. However, summer drawdown would again provide suitable habitat for nonnative annual weeds and without spring water to flush salt from the system, many of these drawdown habitats would still facilitate nonnative vegetation growth.

Of the major riparian habitats only Stillwater Slough would remain within the refuge boundary under this alternative. While riparian restoration efforts, such as artificial plantings of native trees and shrubs, would be practiced, only four miles of this habitat would be available. Indian rice grass would benefit from reduced levels of livestock grazing in uplands; however, little habitat available for its regeneration would remain within refuge boundaries. Overall, increased freshwater inputs would increase freshwater habitat quality from existing conditions. Even so, native community abundance would likely be lower than baseline under this alternative. Restoration of riparian and upland habitats would produce higher quality, but less available habitat than existing.

Alternative C: Through simulation of the natural hydrology, considerable amounts of freshwater would enter the system which would likely benefit efforts to restore native communities. These spring floods, along with the reduction in livestock grazing, would provide conditions suitable for the survival of a mixed meadow grass community within wet meadow habitat. While summer drawdown would still occur under this alternative, spring floods would reduce salinity in marsh habitats, which would lower salinity on mudflats where nonnative annual weeds have become more prevalent. This could result in a shift from five-hook Bassia and prickly lettuce to native devils beggartick, smartweed, and wild millet within moist-soil habitats. Fall water management would promote equal percentages of drawdown, stable water, and flooded habitat which would provide a mix of habitats, from those representative of native communities to those with a high composition of nonnative species. While this would not necessarily follow the natural hydrology, it would occur very late or after the growing season, on habitats where salinity levels had already been reduced through spring flooding.

In riparian areas, and over the long term, native plant communities with limited distribution would return as a consequence of eliminating cattle grazing along the lower Carson River and Stillwater Slough, aggressive control of saltcedar and noxious weeds, and especially securing additional water for the lower Carson River. Eliminating cattle grazing from upland areas would assist in preventing cheatgrass from further expansion into greasewood, other desert shrub communities, and dunes. However, even under this alternative, without efforts to address the cheatgrass problem, some of these upland plant communities could shift to annual cheatgrass dominated communities, and some upland communities may be lost. Overall, this alternative would likely provide the best conditions for restoring native communities and reducing the extent of nonnative species coverage.

Alternative D: Similar to Alternative C, this alternative would promote native community growth in spring flooded habitats and reduce mudflat salinity during evaporative summer drawdowns. This would simulate a natural ecological process which should provide the best conditions for restoring a natural mix of marsh vegetation. It is unknown what the effects on marsh vegetation would be from attempting a full simulation of natural flow patterns with an estimated 15 to 20 percent of the average historic water. Therefore, spring and summer habitat conditions would be optimal for restoration of native community abundance. However, the effects of artificially low water levels during fall are unknown. Riparian and upland native community response would be similar to Alternative C, except that restoration of native riparian communities would be more limited under Alternative D.

Alternative E: This Alternative would be identical to Alternative C in wetland and riparian habitats except that native species establishment would be enhanced in the flow corridor selected to receive spring flows and would decline slightly in remaining wetland units. Native species establishment would be greatly enhanced when compared to Baseline Alternative A.

4.4.1.6 INVASIVE PLANT SPECIES

Under existing conditions, ten species of invasive plants are currently found throughout the affected area, three of which require immediate attention (saltcedar, Russian olive, and tall whitetop; Table 4.18). Additionally, purple loosestrife has been observed on the Truckee canal which often provides additional water rights to nearby Lahontan Reservoir. Russian olive does not appear to be spreading at present. Under existing conditions, tall whitetop is sporadically distributed at low densities. Control of all of these species and other potential invasive species will be covered in the station's integrated pest management plan.

Alternative A: The primary management techniques to control invasive plants under this alternative would include water level management, mechanical treatments, chemical treatments and biological control techniques. While this alternative would not identify specific target areas on an annual basis, spot control of problem concentrations would still be practiced. Enhanced water level control through increased water rights and management for less fluctuating water levels would tend to reduce shoreline saltcedar concentrations by flooding out existing communities. Therefore, even without active control, saltcedar distribution would, in the long-term, be lower under this alternative than the others.

Alternative B: The level of control under this alternative would be similar to baseline except that summer drawdowns would be conducive to saltcedar germination, and could result in higher amounts of saltcedar acreage. Active management would focus on specific locations with control techniques often used opportunistically. Overall, this alternative would provide for a lower level of control than baseline as evaporative summer drawdowns could promote saltcedar growth. All available management tools could be used.

Alternative C: Invasive plant control would be emphasized under this alternative, considering the increased focus on management for natural biodiversity. Water level management, especially evaporative summer drawdowns, would promote saltcedar growth. However, specific communities, identified in an integrated pest management plan to be completed (Appendix J), would be annually targeted for control. Water level management between years (with approximately one third of the units fall flooded, one third stable, and one third drawing down) would allow for rotation of saltcedar flooding strategies, while drawdown units could be targeted for active control techniques. Active invasive species control would be used along the Carson River riparian corridor, with different segments targeted annually. There would be a decreased reliance on chemical treatments under this alternative with the understanding that some level of chemical control would be required during early stages of control. All identified species would be considered in annual habitat management plans. Overall, this alternative would provide a higher level of active control than under Alternative A. Passive control, such as providing stable water levels through the growing season, would be lower than baseline.

Alternative D: Full simulation of natural hydrologic processes (such as natural spring flooding and scouring) would either directly flood or uproot invasive species where scouring occurs. However, summer evaporative drawdown (conducive to saltcedar growth) and lack of fall flooding would provide for higher annual germination rates than under baseline. Similar to Alternative C, active invasive species control would be practiced annually along the Carson River riparian corridor and marsh shoreline habitats; however, there would be a lower reliance on active management techniques, such as chemical and mechanical treatments. This alternative would allow natural processes to function, assuming that they would reduce invasive species distribution and increase native vegetation acreages over existing conditions. It would take time to determine whether these processes are completing this task and monitoring protocol would be implemented to ensure that this goal is being met. Overall, the level of invasive species control would be lower than baseline under the assumption that natural processes would provide control.

Alternative E: This Alternative would be similar to Alternative C except that opportunities to rotate units for drawdown and control of invasive species would be enhanced. Rotation of the flow corridor selected to receive spring pulse flows would allow for intensive control throughout the marsh over the long term.

4.4.1.7 HUMAN ACTIVITY IMPACTS ON VEGETATION

Visitor Services management strategies identified for each alternative would have varying effects on vegetation community distribution, composition, and structure. These effects would include direct impacts [for example vegetation trampling; (Liddle and Scorgie 1980) and introduction and/or spread of invasive species (Lonsdale and Lane 1993)] and indirect impacts (for example, changes in community composition, height, and density in areas of high use over time; Liddle 1975, Liddle and Scorgie 1980). Some habitats, such as those found in most wetland areas, change rapidly regardless of human intrusion while upland habitats require many years to reach maturity and are thus, less tolerant of human activity impacts. For example, cryptogammic soils, which are assumed to occur in upland areas, require hundreds of years to form and would likely be an irretrievable loss if human activities were allowed on these sites.

Table 4.18. Invasive Plant Species that Occur on the Stillwater NWR Complex and Vicinity.

		Noxious Weed Lists		
Common Name	Scientific Name	Federal	State	Distribution
Saltcedar	*Tamarix ramosissima*	no	no	Primarily distributed along water delivery canals, the periphery of wetlands, and the Carson River and delta, Anaho Island
Perennial pepperweed	*Lepidium latifolium*	no	yes	Isolated spots within refuge and along the lower Carson River
Russian olive	*Elaeagnus angustifolia*	no	no	
Purple loosestrife	*Lythrum salicaria*	no	no	Lower Truckee River
Red brome	*Bromus madritensis* spp. *rubens*	no	no	Anaho Island,
Cheatgrass	*Bromus tectorum*	no	no	Anaho Island,
Russian thistle	*Salsola tragus*	no	no	Dunes
Diffuse knapweed	*Centaurea diffusa*	no	yes	Recently acquired agric. lands
Russian knapweed	*Centaurea repens*	no	yes	Recently acquired agric. lands
Hoary cress	*Cardaria draba*	no	yes	Recently acquired agric. lands

Several visitor services activities were evaluated in relation to vegetation responses including hunting, fishing, hiking, boating, camping, and off-road vehicle use (Appendix L). Effects include creation of unvegetated zones on heavily used trails, total removal or decreased coverage of vegetation in isolated areas from boat propellers and vehicle travel, soil compaction and resulting inhibition of seedling emergence, long-term changes in vegetative community composition, and providing disturbed soils that are more favorable for the establishment of invasive species. Timing of visitor activities is critical because any activity during the growing season would have more impact than when plants are dormant (Liddle and Scorgie 1980). However, cumulative impacts from long-term use, growing season or not, can result in vegetative community changes over time. Other potential impacts in upland habitats includes introduction and spread of nonnative plants from vehicles and horses. Similar adverse impacts can result from management (e.g., road maintenance) and research activities.

Although most human activity impacts on native vegetation are adverse, albeit slight in most cases, some activities would be specifically designed to benefit native vegetation. Some groups have been actively involved in riparian restoration at the refuge, combining efforts to reestablish native willow and cottonwood with environmental education and wildlife observation. In some instances, hunter foot travel through the marsh can create minor openings in emergent habitat. Soil disturbance related to this activity can bring seeds to the surface which allows them to grow during the next low water period. Additionally, low levels of boat use can aid in distribution of submergent vegetation by spreading seeds to previously uncolonized areas (Liddle and Scorgie 1980). These types of impacts are analyzed in the following discussion.

Alternative A: Under this alternative, all wildlife-dependent recreational activities (hunting, fishing, wildlife observation, photography, environmental education, and interpretation) and all other existing uses (camping, boating, horseback riding) would continue. Habitat would be subject to all of the previously described detrimental and beneficial impacts. Environmental education would continue to increase which would allow an opportunity to educate the public about use effects on vegetation. Similar to slightly higher levels of public use than under existing conditions would occur which would result in slight to moderate impacts to native vegetation; however, these impacts would be noticeable only in isolated areas where high levels of human activity were allowed. Sand dune habitats would remain open to public use but would have no additional access roads developed or maintained. Limited unauthorized off-road vehicle use would continue to have localized adverse impacts (e.g., soil compaction, nonnative vegetation seed dispersal) on native vegetation in dune areas. Overall, this alternative would result in little vegetative change from existing conditions, with some additional protection afforded through environmental education.

Alternative B: This alternative would be similar to alternative A with a few exceptions. First, a full time law enforcement officer would be hired to ensure that vehicles remain on roadways and other applicable rules and regulations are adhered to. Second, there would be a complete closure of refuge habitats to public uses from April 1 to July 31 which would protect aquatic and upland vegetation from public use impacts throughout the growing season. Additionally, motorized boat use would be eliminated from August 1 to the beginning of waterfowl season which would provide protection for emergent and submergent plant communities toward the end of the growing season. While sand dunes within refuge boundaries would remain under Service protection and there would be increased law enforcement, part of the sand dune system that is now under Service administration would no longer receive this level of protection. This could result in additional impacts to native vegetation and increases in the occurrence of invasive species in these dunes. Overall, this alternative would provide slightly higher vegetation protection from public use activities on lands retained in the Refuge System as compared to baseline, but much less habitat, particulary upland, riparian, and sand dune systems would be protected by the Service.

Alternative C: Two different visitor services management options are being considered under this alternative with anticipated equal effects on Stillwater NWR complex vegetation. Under Option 1 of Alternative C, two additional wetland units would be maintained as inviolate sanctuary, thus, protecting sensitive plants and habitats in this area. Part of the area now within the sanctuary would be opened to wildlife observation, photography, and other activities, which could result in additional impacts to vegetation. However, these activities would be conducted only on designated trails, pullouts, and roadways. The new trails created under this alternative could impact vegetation communities in localized areas. Concentrating use along designated trails would reduce adverse impacts in other areas of the refuge. All trails and roads would be designed to minimize impacts to vegetation. Access to riparian areas and the Carson River delta would be closed south of Timber Lake which would eliminate human activity impacts in this area. The sand dunes at the northern edge of the refuge, including dunes that are now outside the refuge boundary, would be retained as a research natural area allowing vegetation establishment processes to function without human disturbance.

Under both options, watercraft would not be allowed anywhere on the refuge from March 1 to August 1 with the exception that one or two canoe trails would be established in Goose Lake. These trails would be designed such that vegetative disturbance would be at a minimum. Additionally, boats would be limited to no wake and, in Option 1, would not be allowed on Goose Lake, which would help protect emergent and submergent communities throughout wetland habitats. Vehicle travel would be maintained on established roadways only, with seasonal road closures provided in certain areas. An environmental education center would be established on either the former Kent property. This would increase disturbance on habitats adjacent to center trails but could reduce impacts to core wetland habitats by reducing the public use burden and associated vegetation impacts currently associated with these areas. Overall, both options would result in similar human activity impacts as would occur under Alternative A; however, a different set of disturbance effects would be anticipated.

Alternative D: Human Activity impacts on vegetation under this alternative would be similar to Option 1 of Alternative C with the following exceptions. The Carson River delta and the western edge of the sand dunes would be interpreted and subject to slight, localized hiking impacts. No less than 40 percent of wetland habitat would remain as inviolate sanctuary providing complete protection of this area. The remaining 60 percent would be split between hunting and other public uses maintaining slight vegetation disturbance through hiking and boating. With development of observation areas, trampling effects would be increased in these locations, but this would likely reduce public use impacts throughout refuge habitats. Overall, this alternative would localize disturbance effects over all other alternatives but would increase the severity of impacts at specific locations.

Alternative E: Human Activity impacts on vegetation under this alternative would be similar to Alternative B in that the majority of Stillwater NWR would be open to visitor use throughout the year. Boating would not be allowed outside of the waterfowl hunting season except that Swan Lake Check would be open to non-motorized watercraft throughout the year. During hunting season, boat access would be subject to zones allowing different access types in specific wetland units. Motorized boats would not be allowed in Swan Lake, the north 1/3 of North Nutgrass, the north 1/3 of Pintail Bay, Willow Lake, Swan Check, and West Nutgrass which would afford more vegetation protection than under Alternative's A and B, but less than under Alternative's C and D. All other human activity impacts on vegetation would be similar to those anticipated under Alternative C (option 2).

4.4.2 WILDLIFE

The following section describes the baseline status of all wildlife groups and potential impacts of each alternative on various wildlife population parameters. This section covers birds, mammals, reptiles, amphibians, fish, and invertebrates. Discussions of impacts address the effects of changing the boundary of Stillwater NWR, implementation of alternative management strategies, other habitat alterations such as the spread of invasive species, impacts to water quality, and the effects of human activities on wildlife.

The major factors currently limiting wetland wildlife diversity are an inadequate supply and altered timing of water, and the presence and spread of nonnative species (including carp, bullfrogs, and cattle), as discussed in Appendix N. Contaminants also have the potential to impact wildlife diversity. Effects of changing Stillwater NWR's boundary would affect wildlife primarily through differences in the level of protection and restoration potential. Although some management strategies can affect wildlife populations directly (e.g., muskrat trapping, predator control, mosquito control), most refuge management activities are geared to habitat management, and therefore, most of the discussion in this section focuses on the effects of changes in management on wildlife habitat. Except where noted, the action alternatives would have no significant adverse impacts to wildlife populations or communities, and therefore, no mitigation measures would be needed.

Recreational use and visitor services management also affect wildlife and their habitat. For example, providing opportunities for hunting, wildlife observation, and other wildlife-dependent public uses on Stillwater NWR in the past, ultimately contributed to more water flowing into the refuge because, if it were not for the support of people using Stillwater NWR and other Lahontan

Valley wetland areas for wildlife-dependent recreation, it is unlikely that the Service would be acquiring needed water rights for refuge wetlands. Another way that people affect wildlife happens while people are engaged in a recreational activity in wildlife habitat (this can also be said of refuge personnel while they are working on the refuge). This aspect of public use, which is referred to as human disturbance, is evaluated because the Service is responsible for ensuring that all public uses are compatible with (i.e., do not detract from) the achievement of refuge purposes. The effects of human activity are treated extensively in this Final EIS due to Service requirements to evaluate the compatibility of public uses before they are permitted and because of the high level of interest by the public on this issue.

4.4.2.1 BIRDS

Most bird populations at the Stillwater NWR Complex are migratory and, thus, the various habitats have different levels of importance to different species depending on which seasons they inhabit the area and the reasons they are using the area's resources. For example, waterfowl species, such as mallards and Canada geese, can be observed year round, if wetland habitat does not freeze completely for extended periods. These species utilize different wetland habitats for cross seasonal events such as breeding, spring and fall migration, molt, winter maintenance while species such as Tundra swans are typically only here for migration and winter maintenance. All wetland dependent wildlife species have different seasonal habitat requirements and, between species, different habitat needs. Using breeding habitat as an example, dabbling ducks, such as mallards, require uplands adjacent to wetland habitats while diving ducks, such as redheads and canvasbacks, prefer flooded emergent vegetation interspersed with submergent vegetation to build their nests.

Migratory birds using Stillwater NWR Complex wetland habitats are part of continental populations which may fluctuate widely given conditions in other regions of the country. Many shorebird species nest in other locations and only migrate through the Stillwater area. If these birds experience poor habitat conditions in their nesting areas or suffer disease losses at traditional wintering areas, fewer birds may migrate through the Stillwater NWR Complex, even though local habitat conditions may be optimal for their use. This concept must be considered when reading the following sections, as the assessment of impacts for each alternative assumes that off-refuge conditions are the same between alternatives and, for wetland habitats, habitat acreage is directly linked to the number of birds using the wetlands in a given year. This assumption was made so that gross differences between alternatives could be examined.

As in discussions of possible effects on habitat, the following assessment focuses on potential impacts during nonspill years. Existing conditions assume that a long-term average of 8,700 acres of wetland habitat can be maintained given the volume of water rights that have been acquired thus far. It is assumed that the same relative differences in effects between alternatives may be apparent during spill years, but many of the effects of any given alternative would be outweighed by the volume of spill water entering the wetlands. Timing and volume would be nearly identical between alternatives. Generally, spill years would be highly beneficial to wetland birds.

4.4.2.1.1 Waterfowl

The Lahontan Valley wetlands offer the most important and productive waterfowl habitat in the affected area. In many years, up to 70 percent of Nevada's migratory waterfowl pass through and feed in these wetlands (N. Saake, State Waterfowl Biologist, NDOW, oral communication, 1993). Peak populations of migrating waterfowl are generally recorded in the fall. The major species of ducks that use the wetlands during migration are northern pintails, mallard, gadwalls, green-winged teal, northern shovelers, American widgeon, canvasbacks, ruddy ducks, and redheads. Canada geese, snow geese, tundra swans, and the occasional trumpeter swan, migrate through the affected area as well. Peak population levels of most of these species occur during the fall, with several exceptions including ruddy ducks (spring), geese, and swans (winter) (Bundy 2000).

Waterfowl use at Pyramid Lake is greatest during fall and winter. Pyramid Lake also becomes important waterfowl habitat in drought years when other nearby wetlands are dry. The northern end of Pyramid Lake, which provides shallow feeding areas and receives less disturbance from recreationists, and the southern end near the mouth of the Truckee River, are the most important feeding areas for waterfowl. Up to five pairs of Canada geese have nested on Anaho island NWR in the recent past (Stillwater NWR files).

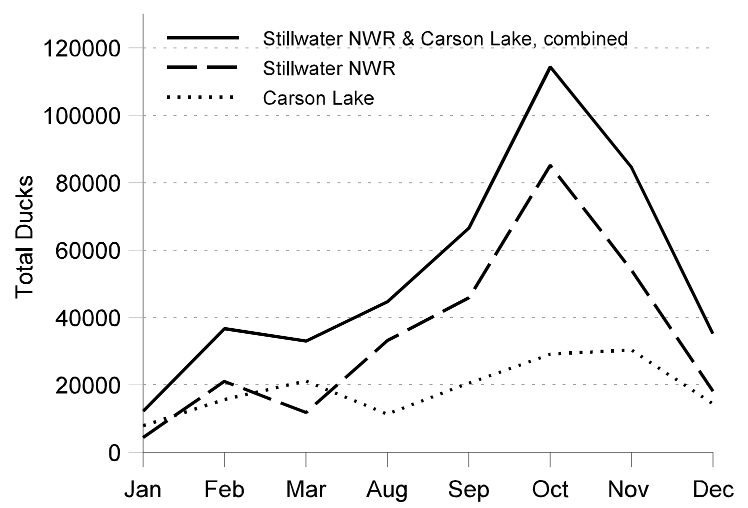

Figure 4.1. Average number of ducks counted on Stillwater National Wildlife Refuge, Carson Lake, and both areas combined during Nevada Division of Wildlife waterfowl surveys conducted during the period August-March, 1970-1998. (Bundy 2000)

Under existing conditions, waterfowl occupy wetland habitats of Stillwater NWR, Stillwater WMA, and Fallon NWR during all times of the year except when the area completely freezes over for extended periods. Several different populations use the wetlands, with distinct breeding populations (many of which migrate from the area during early fall), often followed by migratory populations that have completed breeding in more northern areas. As a result, when these two populations occur together on the wetlands during early fall, waterfowl populations of the Stillwater NWR complex would typically peak at approximately 90,000 total waterfowl in October (Figure 4.1). In spill years, waterfowl populations have peaked as high as 250,000 total waterfowl during the fall. Spring migration is generally the second highest use period while breeding populations are considerably lower. Although breeding populations are relatively low compared to migratory populations, approximately 3,000 to 5,000 ducklings and goslings are produced at Stillwater NWR in any given year.

Waterfowl production rates are highly dependent on the amount and type of wetland habitat acreage available and the quality (measured in composition and structure of grass species) of upland nesting habitat during the spring and summer. Most available nesting habitat currently exists along delivery canals with little upland habitat in suitable condition for waterfowl nesting. Livestock grazing is one factor that has contributed to this condition. Nest concentration along these canals provides predators with easy access to large numbers of nests. Results of a 1997 monitoring effort along canals show that nest success ranged from 24 percent (cinnamon teal) down to 3 percent (mallards; Bundy and Henry 1997). Other refuge nesting studies are consistent with this result (Marshall 1952, Napier 1970, Evans 1983, Bowman 1989).

All marsh habitats are used depending on the seasonal requirements of a given species. During summer, most species require a mix of deep emergent and submergent habitat to provide protection and foraging habitat for waterfowl broods. An even mix of these two habitat types (often referred to as hemi-marsh) provides optimal conditions for brood survival (Weller and Spatcher 1965). Diving ducks, such as redheads, canvasbacks, and ruddy ducks, typically nest in deep emergent habitat while dabbling ducks nest in adjacent uplands. Under existing conditions, approximately 25 to 55 percent (2,000 to 4,400 acres) of the wetland habitat would be comprised of deep emergent and submergent habitat during summer months. This would accommodate production of 3,000 to 5,000 ducklings annually.

Following breeding, waterfowl species enter a flightless stage (known as molt) where they replace the previous years flight feathers with new feathers for the upcoming fall migration. During molt, waterfowl are vulnerable to both disease and predators and seek deep emergent habitats where they can hide, or open habitats where they can see predators coming. Marsh habitats typically used include submergent, deep emergent, or alkali mudflat habitat types. Submergent vegetation provides feeding habitat while deep emergent vegetation provides cover from predators. Under existing conditions, an estimated 1,950 to 4,300 acres of these habitats would be available for waterfowl molting use.

During fall migration, an estimated 100,000 to 150,000 waterfowl would use wetland habitat on Stillwater NWR under existing conditions. Similar to breeding requirements, most species use submergent and deep emergent habitats for foraging, protection, and resting; however, other habitats become equally important during this period. Many dabbling ducks, including green-winged teal, pintail, mallards, gadwall, and wigeon, prefer to feed in moist-soil, wet meadow, and other shallow water habitats where plant seeds are abundant (Kadlec and Smith 1989). Water depths between 1 and 12 inches are optimal for these species (Fredrickson and Taylor 1982). Under existing conditions, an estimated 800 to 4,500 acres of these habitats would be provided.

Winter maintenance habitat is similar to fall migration habitat for many species; however, submergent vegetation is important for tundra swans and snow geese while agricultural lands provide grain and green forage for Canada geese and mallards. Sago pondweed, the most common plant community within submergent vegetation, produces underground roots (tubers) which tundra swans prefer to eat. Under existing conditions, an estimated 870 to 3,480 acres of this habitat type would be available during late fall and winter months.

To complete the cycle, nearly all marsh habitats are used by all waterfowl species for spring migration. During spring, most waterfowl species eat invertebrates to gain protein for upcoming breeding and molting periods (Swanson et al. 1979). Invertebrates are found in all wetland habitats, with invertebrate community composition and abundance dependent on habitat type (Bundy 1996).

Habitats providing this resource vary from year to year, but all wetland habitats (approximately 8,700 acres) would be used during spring migration.

Overall, an estimated eight- to ten-million waterfowl use days would be supported annually at the Stillwater NWR under existing conditions during nonspill years. After consecutive spill years, Stillwater NWR and Fallon NWR have supported up to 30 million waterfowl use days (1986 estimates).

Waterfowl use days in relation to existing available wetland habitat are included in Figure 4.2. It would be difficult to provide an exact number of waterfowl use days that would occur under each alternative. However, based on our knowledge of monthly waterfowl use at Stillwater NWR over the last 30 years (Bundy 2000) and our understanding of waterfowl life history requirements, it is possible to estimate, within a range, waterfowl use-days anticipated to occur relative to available wetland habitat. Considering annual variation in waterfowl fall flights, weather, and other factors such as disease die-offs at migration and wintering areas, waterfowl use-days were used as an index of the number of birds Stillwater NWR habitats could potentially support under each alternative. Therefore, waterfowl use-days, in this discussion, are used to compare differences among alternatives, are based on what Stillwater NWR wetland habitats could potentially support, and should not be interpreted as estimates of the number of waterfowl projected to occur under each alternative.

Components of the Service's visitor services program could, depending on how it is designed and managed, affect the number, distribution, and duration that waterfowl species remain on refuge wetland habitats. A review of the scientific information was undertaken to gain a better understanding of the effects of human activity on waterfowl and other wildlife (Appendix L). The following discussion assumes baseline wetland habitat acreage in a nonspill year. Besides direct impacts associated with waterfowl hunting (such as harvest), indirect impacts also occur. For example, hunters influence the distribution of waterfowl (Appendix E), which generally use nonhunted habitats during the day (including portions of units open to hunting that hunters are

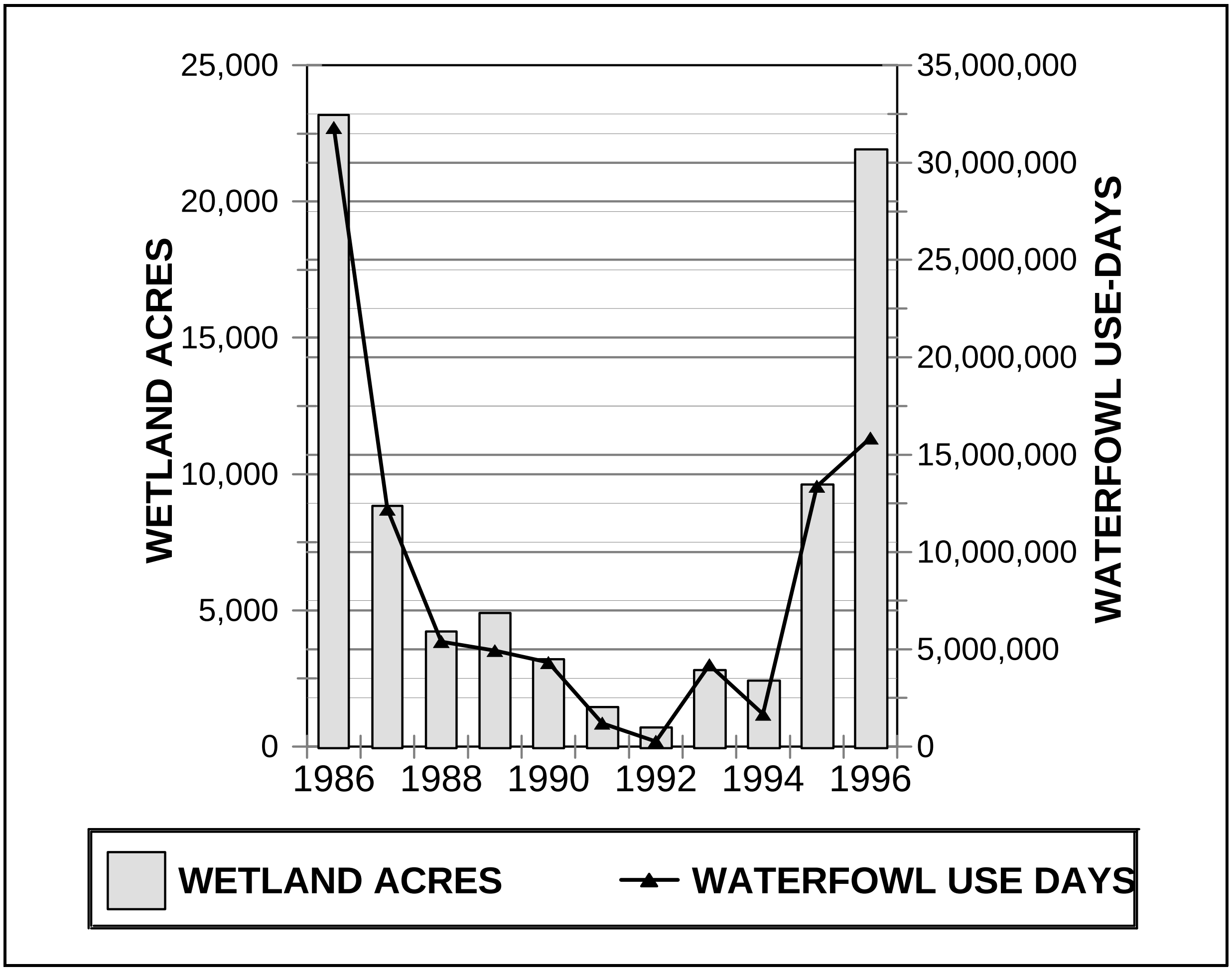

Figure 4.2 Comparison of wetland habitat acres and waterfowl numbers on Stillwater NWR.

not using) while foraging at night to gain much of their required energy for migration. It is not certain whether this is solely related to hunting pressure, or more likely, a combination of public use pressure and behavioral traits of the birds. However, studies summarized in Appendix L have shown that hunting and other public use activities can influence the distribution and feeding patterns of waterfowl.

Although wildlife observation and general visitation of Stillwater NWR, Stillwater WMA, and Fallon NWR currently is at a relatively low level, there are no mechanisms in place to prevent or minimize adverse impacts to breeding waterfowl and other waterbirds, except for the sanctuary on Stillwater NWR. The breeding season is one of the most critical life history stages of waterfowl using Stillwater NWR, the timing of which corresponds with peaks in visitation for wildlife observation. Environmental education and interpretation activities can contribute further to these effects, but the impacts of these activities are likely at a more localized and limited extent. Considerable energy must be obtained for successful nesting. Nesting attempts can potentially be impacted by wildlife-dependent activities that occur during this time. These impacts range from distributional changes associated with increased waterfowl/visitor contact, to direct effects related to habitat degradation and/or nest abandonment.

The timing of hunting (fall/early winter) places this activity during a period when waterfowl are maintaining body weight for upcoming events, a time period that is less critical than the breeding season. However, hunting has the added impacts of direct and indirect mortality of waterfowl. In recognition that hunting has been identified as a priority public use of the Refuge System when shown to be compatible, this adverse impact to waterfowl using the refuge is viewed as an acceptable impact to the extent it does not result in measurably reduced abundance of any waterfowl species on the refuge.

As with other uses, there are few restrictions on hunting on Stillwater NWR beyond State published waterfowl regulations. At present, up to 72 percent of wetland habitats have been hunted (no maximum amount has been set); there are no restrictions on hunter numbers or densities; airboats and other boats are allowed throughout the marsh with few restrictions; one to three boat landings are located at each wetland unit; all-day hunting, seven days per week is allowed; and roads encircle most wetland units. The sanctuary area of the Stillwater NWR Complex is relatively small (in the Western United States, the average amount of wetland habitat in sanctuary on national wildlife refuges is 55 percent, but most wetland refuges have at least 60 percent in sanctuary). Nearly half of the sanctuary is comprised of a single wetland unit (Stillwater Point Reservoir) that has in the past, primarily served as a regulating reservoir with limited habitat value. The refuge will have considerably more management capacity on this unit in the future and will have the ability to improve habitat condition. Therefore, there are few mechanisms in place to prevent or minimize adverse impacts summarized in Appendix L. Of most concern are the effects of boating, density of hunters, and the apparent inadequacy of the refuge's existing sanctuary to provide for the majority of waterbird needs, relative to the new purposes of the refuge.

Alternative A: Completion of the water rights acquisition program and an associated wetland habitat acreage increase in Stillwater Marsh (an estimated average of 13,500 acres) would provide habitat to support approximately 15 to 20 million waterfowl use-days, with peak populations occurring during fall migration. Additionally, an estimated 5,000 to 10,000 ducklings and goslings could be produced, up to twice as high as duck production estimated for existing conditions. Water management under this alternative would result in little fluctuation in water levels, which would be optimal for breeding waterfowl. However, this management strategy would be less likely to produce ideal feeding habitat for fall migratory and wintering dabbling ducks. The proportion of moist-soil, shallow emergent, and wet meadow habitat to be drawn down in summer (producing conditions favorable to fall migratory waterfowl) would decline from existing conditions, but the overall acreage of this habitat would increase. Spring migration habitat would average about 12,900 acres and would provide a moderate diversity and density of invertebrates.

Visitor services management would continue as it has in the past with sanctuary provided south of Division Road only. All wetland units open to visitor services (about 60 to 70 percent under baseline conditions) would be subject to direct and indirect adverse impacts associated with boating and other activities during the hunting season. Boating would continue to occur throughout the majority of the available wetland habitat, which would affect waterfowl even at low hunter densities. This may be one reason why waterfowl habitat use and distribution has shifted during the hunting season over the past several years (Appendix E) even when hunter density was relatively low. Effects would include alterations in waterfowl species distributions and habitat use, vegetation trampling, nest abandonment, changes in feeding patterns, effects on the amount of time available for feeding, and possibly even altered nutritional status or premature departure from the area (Appendix L). To the extent that fishing pressure would increase with more consistent wetland habitat and enhanced fisheries, nesting waterbirds would be adversely impacted. While it is unclear whether the level of disturbance has exceeded a tolerable threshold during the past few years, when wetland habitat acreage has been exceptionally high and public use levels were relatively low, it is anticipated that public use densities would increase with a more reliable wetland habitat acreage base, increased demands for wildlife-dependent recreation, and a growing urban population. These factors, combined with few limitations placed on visitor services under the existing program, could limit the Service's ability to provide secure places for waterfowl to nest, feed, rest, and escape inclement weather and to otherwise provide for the seasonal needs of waterfowl species.

Alternative B: This alternative was developed to benefit fall migratory and wintering waterfowl and, therefore, peak waterfowl populations would increase beyond those anticipated for Alternative A. Drawdown management during summer months would provide ideal conditions for the development of unvegetated, alkali mudflats for late summer and fall staging waterfowl and moist-soil, shallow emergent, and wet meadow habitats for migratory and wintering populations. Annually producing 300 to 400 acres of grains and green forage in the farmland area of Stillwater NWR would further benefit Canada geese. There would be more spring migration habitat (January through March) available under Alternative B (an estimated average 13,700 to 15,800 acres) with a moderately higher diversity and density of invertebrates resulting from higher habitat diversity (higher proportion of flooded moist-soil, shallow emergent, and wet meadow vegetation), as compared to Alternative A.

There would be less breeding habitat available to waterfowl under this alternative, as compared to Alternative A. A predator control program would further enhance nesting success of waterfowl. An estimated 5,000 to10,000 ducklings and goslings could be produced during nonspill years under this alternative upon completion of the water rights acquisition program. Summer drawdown would decrease the amount of brooding habitat, but a sufficient amount should be available to accommodate broods. Waterfowl use days could increase to 20 to 25 million, primarily resulting from an increase in the amount and quality of fall and winter wetland habitat, as compared to Alternative A.

Similar to Alternative A, up to 60 or more percent of refuge wetland habitat would be open to visitor services, resulting in similar impacts to those identified above. All wetland areas would be closed to foot traffic and boat use from March 1 to August 1, minimizing impacts on breeding waterfowl, while fishing would be prohibited throughout the refuge, thus minimizing disturbance and vegetation trampling associated with this activity during the breeding season. Considering the emphasis on maximizing fall habitat, it is possible that hunter and other public user group densities could be lower than under Alternative A, although substantially higher consistency in providing large acreages of wetland habitat during the hunting season could attract additional hunters. Although impacts from boating would be reduced under this alternative, waterfowl would continue to be affected by boats accessing a large majority of wetland habitats during the fall and winter. Because this alternative has few provisions to ensure that waterfowl and other waterbirds would not be adversely affected by boating and other activities beyond an acceptable level, further restrictions may be necessary in the future based on annual monitoring. It is possible that higher waterbird populations associated with increased fall habitat could result in food in the sanctuary being depleted earlier in the season. This could result in increased waterfowl use at night in areas that are open to visitor services during the day.

Alternative C: Under this alternative, peak populations during nonspill years would be similar to Alternative A, and moderately lower than those anticipated for Alternative B. In general, the higher amounts of water level fluctuations that would occur under this alternative would tend to enhance marsh productivity and therefore would benefit waterfowl, as compared to Alternative A. The quality of fall and winter habitat would be higher than under baseline, but there would be less overall acreage available for fall migratory and wintering populations. Fall and winter wetland habitat available for waterfowl would decrease by an estimated 8 percent when compared to Alternative A. Annually producing 200 to 300 acres of grains and green forage in the farmland area of Stillwater NWR would further benefit migrating and wintering Canada geese. The higher amount of wetland habitat that would exist during the breeding season (estimated 15 percent more than under baseline) would greatly enhance waterfowl nesting. The spring pulse of water would be timed to minimize nest flooding and an estimated 5,000 to 15,000 ducklings and goslings or more would be produced, related to more habitat available for nesting and brood rearing. To the extent that even a small amount of water is secured for the lower Carson River and the riparian corridor is restored, wood ducks would benefit and waterfowl nesting in the wetlands at the delta of the Carson River would be slightly enhanced, due to a small amount of water reaching the delta. Increased water supplies to the lower river, combined with removal of cattle and control of saltcedar and perennial pepperweed would enhance waterfowl nesting habitat in this area. Overall, waterfowl use-days would be similar to Alternative A, based on the relatively higher amounts of preferred fall migration and winter maintenance habitat and changes in visitor services management (especially boating restrictions and reduction in the amount of area affected by boats) even though overall wetland habitat acreage during fall and winter would be less than anticipated for Alternative A.

Two options for visitor services are being considered under this alternative. Option 1 of Alternative C would increase the proportion of wetland habitat closed to hunting, with additional sanctuary units located in the historic Stillwater Marsh. This action could increase densities of people in open units, potentially increasing disturbance to birds in the open area. It is anticipated that this would be counteracted by higher amounts of undisturbed feeding habitat. Overall, this option would provide proportionally more secure habitat for feeding, nesting, and resting waterfowl and other waterbirds, which would reduce the chances or degree of premature departures, altered feeding patterns, and lowered productivity. Additional nonhunting, public use opportunities would be provided in part of the area now encompassed by the sanctuary through inclusion of an auto tour loop, which could potentially increase disturbance levels in this area. However, this could reduce disturbance in the hunt area which has typically supported the highest waterfowl production. Visitors would be restricted to their vehicles, identified pullouts, and established trails to minimize direct impacts, including vegetation trampling and nest abandonment which should minimize adverse impacts to waterfowl.

Option 2 of Alternative C would allow visitor services to occur in all existing open areas, but would focus on restricting access points and methods of travel in certain wetland units. While this would not provide the same positive benefits as creating additional inviolate sanctuary, it would reduce hunter densities within identified units and the existing sanctuary would remain inviolate throughout the year. Although Option 1 would provide the most positive benefits to waterfowl, both visitor services alternatives would provide lower levels of human activity impacts than would occur under baseline.
Because the amount of sanctuary would continue to be relatively low under both options, a program would be implemented to monitor the effectiveness of the changes compared to Alternative A.

Alternative D: Similar to Alternative C, this alternative would focus on the simulation of the natural hydrology. Few attempts would be made to alleviate anticipated detrimental impacts to waterfowl populations. With an estimated 8,600 acres of marsh habitat remaining during fall (similar to estimated existing conditions), there would be fewer waterfowl use days and peak populations would be lower than would occur under all other alternatives, and possibly even compared to existing conditions. It is estimated that the marsh would support approximately seven to eight million total waterfowl use-days. While breeding populations may be higher than other alternatives with higher amounts of spring habitat (estimated 20,000 acres in June), production may be lower due to nest flooding. Increased water supplies to the lower Carson River, combined with removal of cattle and limited efforts to control saltcedar and perennial pepperweed, would enhance waterfowl nesting habitat in this area. This alternative would benefit many species of wildlife but would have an as yet unmeasurable, detrimental impact on waterfowl resources.

Human activity impacts would be minimized under this alternative due to the following factors. First, high water during spring periods would allow maximum dispersal of waterfowl resulting in fewer human/waterfowl contacts. Second, no less than 40 percent of wetland habitats would be in inviolate sanctuary, providing disturbance free zones throughout the year. Furthermore, low water availability during the fall would likely result in fewer waterfowl remaining during this period. This would increase disturbance on habitats open to hunting and other visitor services, particularly during fall, although most of the available wetland habitat during nonspill years would be provided in sanctuary. Overall, this alternative would have positive effects during the breeding season and negative impacts during the fall. However, effects of visitor services during the fall would be far outweighted by the negative impacts of water management during this time.

Alternative E: Under this alternative, peak populations during nonspill years would be similar to Alternative's A and C, and moderately lower than those anticipated for Alternative B. In general, the higher occurrence of water level fluctuations that would occur and the focus on adaptive management to provide fall habitat, would tend to enhance marsh productivity and therefore would benefit waterfowl, as compared to Alternative A. However, the amount of fall and winter wetland habitat available for waterfowl would decrease by an estimated 8 percent. Annually producing 200 to 300 acres of grains and green forage in the farmland area of Stillwater NWR would further benefit migrating and wintering Canada geese. The higher amount of wetland habitat that would exist during the breeding season (estimated 15 percent more than under baseline) would greatly enhance waterfowl nesting. In normal water years the spring pulse of water would be timed to minimize nest flooding and would likely occur in only one of four identified flow corridors representing approximately 25% of refuge wetland units. Similar to Alternative C, an estimated 5,000 to 15,000 ducklings and goslings or more would be produced, related to more habitat available for nesting and brood rearing. Overall waterfowl use-days would be similar to Alternative A, based on the relatively higher amounts of preferred fall migration and winter maintenance habitat and changes in visitor services management (especially boating restrictions and reduction in the amount of area affected by boats) even though overall wetland habitat acreage during fall and winter would be less than Alternative A. Carson River wetland habitat effects would be identical to Alternative C.

The visitor services options proposed under Alternative E are based on a combination of action Alternative strategies analyzed in the Draft CCP EIS. These activities are loosely based on strategies proposed under Alternative C (option 2), but have been modified to reflect public sentiment. Similar to Alternative's A and B, the portion of Stillwater Marsh located north of Division Road would be open to visitor services during the waterfowl hunting season; however, zonation of access options is anticipated to enhance waterfowl use of the refuge over Alternative's A and B, but would slightly decrease the benefits that would be realized under Alternative C (option 2). Motorized boat access would be allowed on approximately 60% of the area open to waterfowl hunting, which would be similar to Alternative C (option 2), but, lower than under Alternative A. In combination with adaptive water management to optimize fall habitat for waterfowl, this zonation strategy should provide for increased waterfowl use of the entire wetland complex when compared to Alternative A. The potential impacts of Alternative E's visitor services programs on waterfowl are addressed in more detail in compatibility determinations included in Volume II of this Final CCP EIS (Appendix O).

Mitigation Measures: The increase in wetland habitat available for waterfowl during October-December is not anticipated to be as large under Alternative's C and E as it would be under

Alternative A. Although this would not be a significant adverse impact, especially considering enhanced wetland habitat conditions under Alternative E compared to Alternative A, several possible mitigation measures would ensure that waterfowl benefit further, especially in low water years. Additional water could be dedicated for fall use during drought years, rather than emphasizing spring deliveries. Additional farmland planted in waterfowl forage crops would enhance conditions for some waterfowl species. Consistency with the management program would have to be evaluated. A monitoring program would be implemented as an important part of Alternative's C and E where the effectiveness of the sanctuary and boating access options would be periodically assessed. The CCP and subsequent visitor services management plan would provide flexibility to make adjustments to minimize impacts if unacceptable impacts are detected. Alternative D would have detrimental effects on the ability of the Service to provide for the needs of fall and winter waterfowl and many of these impacts would be unavoidable under this alternative, although some of the aforementioned mitigation strategies could be pursued.

4.4.2.1.2 Shorebirds

The Lahontan Valley wetlands provide critical habitat for a variety of migrating shorebirds. The value of these wetlands to shorebirds was recognized in 1988 when Stillwater NWR and the Carson Lake wetlands were identified as a reserve in the Western Hemispheric Shorebird Reserve Network (WHSRN), one of only 14 designated sites. These reserves are comprised of North, Central, and South American wetlands and coastal sites considered to be critical habitat for migrating shorebirds.

Shorebird numbers vary from spring to fall and from year to year depending on water depth and wetland habitat available. A comparison of wetland habitat acres in Lahontan Valley (surveyed each August), to August shorebird migration counts between 1989 and 1993 indicates that shorebird populations have declined as wetland habitat acreage has decreased (Figure 4.3). Stillwater NWR and Carson Lake are the two areas within the Lahontan Valley that attract major concentrations of shorebirds. Shorebird and colony nesting bird use data for 1972 to 1975 showed that Stillwater NWR and Carson Lake supported 79 percent of the use by these birds in the Lahontan Valley, with the remainder of use occurring in secondary wetlands at Fernley WMA, Massie and Mahala Sloughs and Soda Lakes.

In the spring of 1987, extensive areas of prime shorebird habitat were available in the Lahontan Valley wetlands as flooded playa wetlands receded. Through a coordinated survey involving several entities, more than 250,000 shorebirds were observed. Long-billed dowitchers, American avocets, and sandpipers were the three most abundant shorebird species. Other species, such as black-necked stilt, least sandpiper, marbled godwit, dunlin, and phalarope, are also numerous during migration peaks. Willets, greater and lesser yellowlegs, long-billed curlew, killdeer, plovers, and several species of sandpipers have been observed in the Lahontan Valley during fall and spring migrations, but in fewer numbers than the other shorebird species. American avocet and black-necked stilts are the major species of migratory shorebirds that nest in the Lahontan

Valley in substantial numbers. Other shorebirds that nest in, or near, the wetlands include snowy plover, killdeer, common snipe, long-billed curlew, and Wilson's phalarope. However, there are few records of these species nesting in the Lahontan Valley.

Long-billed curlew nest in limited numbers in uplands and drier areas of the Lahontan Valley wetlands. Curlew nesting sites have been documented in the Carson Lake and Stillwater marsh areas and these birds typically forage in wet meadow habitats. Fall migration counts conducted at Stillwater between 1989 and 1994, show that the number of long-billed curlew dropped from 195 in 1989, to 25 in 1994 (although this coincides with long term drought in the Lahontan Valley). Long-billed curlews occasionally forage at the Truckee River delta in Pyramid Lake and have been sighted along the Truckee River.

Western snowy plover have dramatically decreased in the Lahontan Valley since 1980. Intensive snowy plover surveys were conducted on wetland areas within the Lahontan Valley in 1980, 1988, and 1991. The surveys showed that the number of these birds dropped from 761 in 1980, to 74 in 1991. Western snowy plover are a spring and summer resident and transient species. Limited nesting has been documented in Stillwater NWR and Stillwater WMA.

Under existing conditions, the vast majority of shorebirds visit the Stillwater NWR wetlands for three specific purposes; spring migration, breeding, and fall migration. During spring migration, water levels typically increase, which include shallowly floods unvegetated alkali playa, wet meadow, and moist-soil habitats. These habitats contain eggs of the previous year’s invertebrate populations which, when the area is flooded, hatch and provide food for shorebirds. Because waterfowl and spring migration populations of shorebirds also vary by year, only rough estimates can be provided for spring use. With an annual average of approximately 8,700 acres of flooded wetland habitat in nonspill years, 50,000 shorebirds could use unvegetated alkali playa, wet meadow, and moist-soil habitats during spring migration. An average of 1,235 to 5,350 acres of these habitats would be provided during the spring.

Some species, such as American avocet, black-necked stilts, killdeer, snowy plovers, and long-billed curlews use the Stillwater NWR wetlands for nesting. Excluding curlew, these species typically select open to lightly vegetated habitats for nesting, where avocets and stilts will form loose colonies on dry, open mudflats. Killdeer and plovers select open habitats where they nest alone, while curlew prefer lightly vegetated uplands. All species select nesting habitats adjacent to unvegetated alkali mudflats (typically located at the northern end of the refuge) or playas where feeding opportunities are optimal. While numbers are not available, large avocet and black-necked stilt nesting colonies were documented throughout Pintail Bay, Swan Lake, Willow Lake, and the Nutgrass units during 1997 (Bundy and Henry 1997). Under estimated existing conditions, the extent of nesting habitat would be much lower than that of 1997, which was a spill year.

Fall migration spans across several summer months, with different species migrating through the wetlands during different periods. As a result, peak populations are not as high as in spring, but use would likely continue over a longer period of time. Unvegetated, alkali playas are most heavily used during late summer with summer drawdowns concentrating invertebrates and providing optimal foraging habitats for fall migratory shorebirds. Under existing conditions, approximately 435 to 870 acres of this habitat would be available during late summer.

Most shorebird species appear to be seasonally habituated to human activity throughout the Stillwater NWR Complex, which makes them a favorite observation target during spring and fall migrations (potential impacts of visitor services programs on shorebirds are addressed in more detail in compatibility determinations included in Volume II, Appendix O; and a review of scientific information, Appendix L). Although wildlife observers and photographers can get relatively close to most species of shorebirds without flushing them, the effects of people approaching shorebirds can have negative physiological effects even if the birds do not appear to be affected (Appendix L). Most species are less tolerant to disturbance during the breeding season with varying effects associated with different uses. For example, killdeer prefer to nest in open, gravelly habitat which often occurs on roadways. Increased vehicle traffic would increase the risk of nest loss for this species. American avocet and black-necked stilts form colonies on open to lightly vegetated flats and are relatively easy to see for the casual observer. While nest abandonment is uncommon, birds spend more time defending nests than feeding or incubating when observers approach. Alert behavior alone (which occurs any time predators including humans approach) requires more energy than would be used in the absence of predators, thus, requiring more feeding time to replenish depleted energy reserves. This factor is especially important during the nesting season.

Alternative A: Upon completion of the water rights acquisition program, wet meadow, moist-soil, and unvegetated alkali mudflat habitats would comprise an estimated 1,320 to 4,830 acres of shallow water habitat available for spring migratory shorebird populations. This would provide habitat for an estimated peak spring migratory shorebird population of 80,000 - 100,000. Management for less fluctuating water levels would provide optimal nest colony locations (lightly vegetated uplands in northern refuge units); but this alternative would not provide optimal foraging habitats. Limited summer drawdowns would concentrate invertebrate resources for fledgling shorebirds and fall migratory adults in some locations. While available unvegetated alkali playa acreage would be approximately 675 to 1350 acres, less concentration of remaining invertebrate resources would reduce foraging habitat quality. No estimates for breeding or fall migratory populations are available.

Much of the habitat used by nesting shorebirds would be open to wildlife observation and photography, which could result in a relatively high level of interaction between humans and shorebirds in some areas, such as where roads parallel shoreline areas. During fall migration, shorebirds would likely be minimally affected by people due to lower levels of human activity and large scattered habitats used by shorebirds.

Alternative B: Under this alternative, water levels would recede during spring migration, providing relatively little flooding of wet meadow and moist-soil habitats except those that were flooded the previous fall. Therefore, anticipated spring habitat acreage for migratory populations would be lower than that estimated for Alternative A. Habitat available for breeding populations would be slightly higher with summer drawdown used in this alternative; however, reflooding of habitats, particularly unvegetated alkali playa beginning in August, would provide less concentration of invertebrates for fall migratory populations. Therefore, the amount of spring and fall migration habitat would be lower while breeding habitat acreage would be higher than anticipated under Alternative A. The refuge would be closed to the public during the breeding season under this alternative, which would provide higher levels of protection for nesting shorebirds. Human activity impacts to shorebirds during other times of the year would be similar to Alternative A.

Alternative C: This alternative focuses on simulation of the natural hydrology which would provide rising water during spring migration and steadily receding water through breeding and fall migration periods. As a result, habitat acreages for spring migrating and breeding shorebirds would be much higher than Alternative A, and habitat acreage for fall migrating shorebirds would be similar to baseline. Receding water levels during late summer, by providing a concentration of invertebrates, would optimize feeding for fall migrating shorebirds. Therefore, while late summer and fall habitat acreage is lower than that of Alternative A, increased habitat quality would provide habitat for larger fall migratory populations. Overall, this alternative would provide more benefits to shorebirds than the previous two alternatives. Human activity impacts would be similar to Alternative A, except that slightly more adverse impacts would occur under Option 1 of Alternative C within the area that is now delineated as sanctuary, especially at East Alkali Lake. In other areas, fewer disturbances would occur during the fall migration due to higher amounts of available habitat.

Alternative D: Similar to Alternative C, simulation of the natural hydrology would produce much higher habitat acreages during spring, provide similar habitat acreages for breeding shorebirds, and result in higher habitat acreages for fall migratory populations. Starting with a higher acreage of wetland habitat at the outset of the migration period, water levels would decline fairly rapidly thereby concentrating invertebrate resources. This alternative would be similar to Alternative C in benefits provided for spring and summer shorebird populations. Human activity impacts would be similar to those described for Alternative C.

Alternative E: The flow corridor strategy to be implemented under Alternative E would provide a variety of habitats for shorebird utilization, and thus, enhance shorebird habitat quantity and quality over Alternative A. Water levels would be rising in one flow corridor, stabilized to slightly declining in two corridors, while remaining wetland units would be allowed to slowly recede during the spring migration period. This would greatly enhance invertebrate production in the flow corridor selected to receive spring pulse flows while concentrating fall and winter produced invertebrates in the other wetland units (approximately 75% of refuge wetland units). Therefore, Alternative E would be anticipated to provide the best spring habitat for shorebirds among the Alternatives analyzed. Remaining effects would be identical to those described under Alternative C.

4.4.2.1.3 Wading Birds

Under existing conditions, wading birds, including herons and egrets, (white-faced ibis are covered in a later section) use all habitats where fish, frogs, and other food resources are available for fall and spring migration and summer maintenance. These can include all described habitats at different times of the year (with the exception of deep, open water). Waders prefer relatively shallow habitats (6- to 24-inches) where they can wade slowly through the water in search of food. Therefore, wading birds would not be adversely affected by implementation of any of the alternative water management strategies, but may receive distinct feeding benefits from implementation of the different strategies. With 8,700 acres of wetland habitat estimated for existing conditions, about 90 percent would be available for wading bird foraging as water depths typically do not exceed 24 inches. Occasional droughts occurring with unstable water availability can affect fish resources which could make many habitats unsuitable for wader foraging use.

Wading birds vary in nest locations. Great blue herons form colonies in cottonwoods and snowy egrets, great egrets, and black-crowned night-herons typically form colonies in deep emergent vegetation. Breeding numbers vary according to the amount of nesting habitat available with deep emergent stands changing annually and great blue heron rookeries remaining relatively static. However, availability of feeding habitats near established rookeries appears to influence the number of pairs using the nesting site. At present, great blue heron rookeries are located along east canal (near Foxtail Lake), on Stillwater Slough south of Stillwater, near the Weishaupt property just south of the Canvasback Gun Club, and on the lower Carson River just south of the existing Alves property. Other wading bird colonies can change annually with approximately 1,305 to 2,610 acres of deep emergent habitat available.

American and least bitterns do not nest at Stillwater in high densities, but do use the marsh habitats as they migrate through the area. Few of these secretive birds are seen, as they prefer deep emergent habitats near shallow water for feeding. Waders can be present at the refuge during all seasons until the wetlands completely freeze over. As long as there is some relatively permanent water to support fish populations, waders can be observed throughout Stillwater NWR marsh habitats.

During fall and spring migration, herons and egrets are abundant along refuge canals, structures, and many wetland units. Observation suggests that they are tolerant of vehicle traffic during this period, but less tolerant of foot travel. However, as with shorebirds and waterfowl, studies have shown that adverse impacts due to human presence can take place even if birds do not flush. Also similar to shorebirds, there would be increased potential for human activity impacts on breeding wading birds related to wildlife observation, photography, and to a lesser extent, vehicle traffic. At least one great blue heron rookery is located near a frequently used road. The birds seem to be habituated to regular traffic but tend to flush when people get out of their vehicles.

Egrets and black-crowned night herons tend to nest in emergent vegetation. While vehicle and foot travel are unlikely to have adverse impacts, boat travel around established colonies tends to flush nesting waders. No estimates on nest abandonment associated with boating activity are available but this is a possible impact associated with boat use. Another factor is that when birds are flushed from their nests, there can be increased loss of eggs due to nest predation. It is possible that visitor services activities affect the distribution of fall migratory and wintering wading birds by influencing the timing of migration from the refuge or by changing the distribution of waders between sanctuary and open units on the refuge. However, this observation requires further monitoring to form accurate conclusions.

Alternative A: This alternative would benefit wading birds over existing conditions by providing more permanent water for fish populations, through management for less fluctuating water levels. Overall wetland habitat would be approximately 13,500 acres on Stillwater NWR with water depths averaging slightly deeper than existing conditions. Therefore, available marsh habitat acreage would greatly increase, but a slight decrease in optimal foraging habitat (6 to 24 inches) would result based on increasing water depths throughout the wetland units as compared to existing conditions. Nevertheless, there would be an increase in available foraging habitat under Alternative A. While breeding habitat for great blue herons would be similar to existing, there would be an increase in deep emergent habitat for other wading bird breeding colonies. Under this alternative, approximately 2,000 to 4,000 acres of deep emergent vegetation would be available, which would also provide additional migration habitat for bitterns. Boat traffic would continue during the breeding season under this alternative, which could result in increased flushing of nesting wading birds. Vehicle travel would continue near heron rookeries with no regulations protecting nesting great blue herons. Overall, human activity impacts would be similar to existing conditions with more water available for dispersion of nest colony sites.

Alternative B: Similar to Alternative A, more permanent water would be available, providing increased survival of fish populations over existing conditions. However, this alternative would result in summer drawdowns which could reduce fish populations in some management units. Tui chub, carp, and other fish species would continue to exist in most units, except those completely drawn down. This management strategy provides benefits for wading birds by concentrating fish during summer drawdowns. Therefore, foraging habitat quality during summer months would be higher than baseline, but lower throughout the annual cycle.

It is possible that heron rookeries might experience lower habitat quality than baseline if units adjacent to established rookeries are dewatered. However, higher densities of fish during drawdowns could improve foraging opportunities and the adult's ability to feed their young. Deep emergent habitat acreage would be similar to baseline with 1,700 to 4,700 acres of potential nesting habitat available. Although the adult's ability to feed their young could be higher than baseline, fall accessability to fish would be lower. Fall migratory and wintering populations would likely experience lower habitat quality, because there would be fewer fish dispersed over more acres, thus, providing lower densities of fish than under Alternative A. Under this alternative, cottonwood trees, used for nesting, would continue to be replaced, to a limited extent.

Boating impacts on marsh nesting species would be lower than baseline with restrictions on boating during March 1 to August 1. This would have additional benefits related to colonies established near areas that are easily accessible by foot travel. Because most of the river corridor would no longer be under Service protection, great blue heron rookeries along the lower Carson River could be subject to higher human activity than baseline. Hunting related disturbance would be lower than existing conditions because more wetland habitat would be available. This would result in a lower density of hunters within wetland habitats.

Alternative C: High spring water inflows resulting from simulation of the natural hydrology would decrease density of fish for spring migratory populations, but could help reestablish natural levels of fish reproduction under this alternative. In many marsh related fish populations, high water extending into wet meadow habitats provides optimal breeding conditions for native fish. Thus, it is possible that while fish densities would be lower than baseline throughout the marsh, higher densities could result in these newly flooded shallow habitats which are optimal foraging zones for wading birds. Summer drawdowns would result in similar foraging conditions to Alternative B. Breeding birds would benefit from this management strategy by similar concentration of fish through summer months. Flooding some units during fall would promote survival of fish throughout the annual cycle. Therefore, if native fish breeding occurred in newly flooded wet meadows, spring foraging opportunities would be higher than, breeding habitat quality would be higher than, and fall foraging habitat acreage would be lower than anticipated under Alternative A.

While this alternative would have little impact on previously established heron rookeries, it is likely that restoration of riparian habitats would provide additional rookery sites over the long-term. As cottonwoods, replaced through restoration efforts, mature, new sites would become available, especially where adjacent to ideal foraging habitat, such as along the Carson River.

Human activity impacts would be similar to Alternative B for breeding wading birds with the exception that riparian rookeries located along the Carson River corridor would be within the Alternative C boundary and would receive greater protection than under Alternative A. Trails along the lower Carson River would be designed and managed to minimize adverse impacts to nesting colonies. Hunting related disturbance would be lower than baseline with either the addition of two inviolate sanctuary units (Option 1) or two limited access units (Option 2). Higher levels of vehicle traffic associated with development of a tour loop within the existing sanctuary (Option 1) is anticipated to have few additional negative impacts on wading birds, except that adverse impacts could occur in localized areas.

Alternative D: Full simulation of the natural hydrology would result in conditions similar to Alternative C, with the exception that summer drawdowns would result in a much smaller "minimum pool." This could result in fish mortality between wetland units where deep channels are not available for overwintering fish populations. In addition, remaining fish populations would be spread over a larger acreage during the spring, thus, decreasing density and availability of fish populations to foraging wading birds. Similar to Alternative C, wading birds would benefit through restoration of the riparian corridor and associated creation of additional rookery sites. As compared to Alternative A, wading birds would be adversely affected on an annual basis, but would have some benefits through riparian restoration and spring habitat availability.

Visitor services opportunities would be higher during the spring and summer under this alternative as compared to Alternative A, possibly increasing levels of human activity impacts in wetland habitats. Access to the great blue heron rookery on lower Foxtail Lake would be facilitated through creation of a photo blind at this site, which has the potential to adversely impact nesting birds. A larger number of observation points would be constructed under this Alternative than under Alternative C, which could further increase disturbance in localized areas. Hunting disturbance would be lower refuge wide, but higher in huntable units with anticipated higher hunter densities in these areas. All other anticipated human activity impacts would be similar to Alternatives A, B, and C.

Alternative E: The flow corridor water management strategy proposed under Alternative E would enhance opportunities for wading bird migration use over those realized under the other Alternatives evaluated. Increasing water levels in the flow corridor selected to receive spring pulse flows would enhance prey production in this corridor while remaining wetland units would be either stabilized or dewatered which would provide enhanced foraging opportunities by concentrating the existing prey base. Riparian restoration benefits and human activity impacts would be identical to those described under Alternative C.

4.4.2.1.4 Colonial Nesting Waterbirds on Anaho Island

Under existing conditions, Anaho Island NWR provides nesting habitat for American white pelicans, California gulls, double-crested cormorants, Caspian terns, black-crowned night-herons, great blue herons, and a few Canada geese (Canada geese are not considered colonial nesters but individual nests have been documented on Anaho Island NWR). The same level of protection would be provided to Anaho Island NWR under all alternatives as it is provided under existing conditions. The amount of habitat on Anaho Island is affected by water levels of Pyramid Lake. When the refuge was first established, water levels were still relatively high in the lake and the refuge (island) measured approximately 247 acres. By 1977, when the level of the lake had declined to about 3,788 feet in elevation, the size of the island had increased to about 747 acres. Given the recent consecutive series of high water years, the elevation of the water surface rose to about 3,809 feet by July 1997, bringing the size of the island back down to an estimated 575 acres. Under baseline conditions, including increased lower Truckee River flows resulting from Adjustments to OCAP and water rights acquisitions for Lahontan Valley wetlands, the lake level would be an estimated 3,842 feet, which is similar to the elevation that would exist under Alternative's C and E over the long-term (Table 4.6). At this water level elevation, the size of the island would be about 425 acres. Under Alternative B, the lake level would be slightly lower (an estimated 3,841.8 feet), which would provide slightly more nesting habitat over the long term. Under Alternative D, it is estimated that the lake level could rise an additional 0.6 feet over that estimated for Alternative A, which would have negligible effects on the amount of available nesting habitat on the island (a difference of less than 10 acres).

Breeding success is related to feeding habitat that is located throughout Pyramid Lake (primarily the Truckee River delta), and in the case of white pelicans, Stillwater Marsh and other wetlands in the Lahontan Valley, lower Humboldt River, and other wetlands in western Nevada near Pyramid Lake. Therefore, the foraging habitat quality in Stillwater Marsh, resulting from each alternative being considered, could affect the ability of adult white pelicans to feed their young and to attain energy for migration. The effects of the alternatives on prey fish are addressed in the previous wading bird section, and the potential effects on white pelican feeding habitat on Stillwater Marsh is addressed in more detail in the following section. Alternative's C and E would likely provide the most benefits for white pelicans flying from Anaho Island to Stillwater Marsh to obtain fish. Because public access to Anaho Island is prohibited, few human activity impacts would be anticipated under any of the alternatives.

4.4.2.1.5 Other Waterbirds

All other groups of waterbirds are addressed in this section: American white pelicans, rails, gulls, terns, coots, grebes, and double-crested cormorants. Under existing conditions, an estimated average of 8,700 acres of wetland habitat would be provided during nonspill years. Because waterbirds would mainly be affected to the extent that their habitat is affected, readers are referred to the previous habitat section for information on potential effects of alternatives on wetland habitat acreage. This discussion focuses on impacts to each of these groups relative to implementation of each alternative.

American white pelicans: The importance of Anaho Island to this species has been previously discussed; however, pelicans also use Stillwater Marsh for foraging to either feed young or to gain energy for upcoming life history events. Pelican use of the marsh is closely tied to the availability of fish, which are typically optimized through a combination of permanent water management, followed by drawdown to concentrate fish for foraging. This combination would be best accomplished through implementation of Alternatives B, C, or E. However, all alternatives would provide more benefits to American white pelicans, over existing conditions, through increased foraging habitat acreage. Human activity impacts would be anticipated to be light under all alternatives, except in designated areas where visitor activity is concentrated (e.g., near roads and along tour loops), and where boating occurs during the breeding season.

Rails: Two rail species, sora and Virginia, are commonly heard within the Stillwater Marsh system. Although they are secretive and rarely observed, large populations can use the wetlands for spring and fall migration and, to a lesser extent, breeding. Rails are commonly associated with deep emergent habitats which they use for all of the aforementioned life history events, thus, Alternatives A, C, and E would likely provide the most seasonal benefit to rails. Human activity impacts would be similar to those described for breeding wading birds.

Gulls: Four gull species are commonly associated with the Stillwater Marsh including California, Franklin's, Bonapartes, and ring-billed. While each of these species has different habitat requirements, all use selected habitats (usually submergent vegetation) for migration. California and Franklin's gulls may breed in the area. Gulls are general in prey selection, but, will commonly seek small fish, thus, Alternatives C and E would provide the most foraging benefit by concentrating fish resources through summer and early fall. California gulls nesting in the marsh system can form colonies on open islands surrounded by unvegetated mudflats, thus, all alternatives subject to summer drawdown would provide habitat for nesting California gulls. More secretive during nesting, Franklin's gulls build nest platforms within deep emergent habitats. Alternatives A, C, and E would likely provide the best nesting conditions for this species. Closing refuge wetlands to foot traffic, except designated areas, and boating during the breeding season would minimize human activity impacts under all action Alternatives (B, C, D, and E).

Terns: Caspian, Forsters, and black terns are all common migratory visitors to the Stillwater NWR complex. Similar to gulls, all species typically select small fish as prey. While black terns are generally seen only during fall migration, Caspian and Forsters terns also breed in the Stillwater Marsh. Forsters terns are most abundant and select open shoreline directly adjacent to dense vegetation stands for nest sites. Caspian terns are an occasional nester at Stillwater and typically form colonies on open islands adjacent to foraging habitats, such as deep open water or submergent vegetation. Considering the similarities to gull species' requirements, Alternatives C and E would likely provide the most direct benefits to tern species. Closure of refuge wetlands to foot traffic, except in designated areas, and boating during the breeding season would tend to minimize human activity impacts under all action Alternatives.

Coots: At present, American coots are the most abundant waterbird species using the Stillwater Marsh. In most years, in excess of 100,000 coots are distributed throughout the refuge, with populations generally peaking during late summer. The largest concentrations are associated with open, submergent vegetation where they graze the leaves from various pondweed species; however, they also use adjacent, deep emergent habitats to build overwater nest platforms. While all alternatives would increase the amount of available habitat over existing conditions, all Alternatives would provide a submergent and deep emergent habitat mix because even under Alternatives proposing summer drawdown strategies, these habitat types would rarely ever be completely dry. Overall, Alternative A would likely offer the most benefit to American coots based on less fluctuating water levels throughout the year and the resulting establishment of submergent vegetation. Human activity impacts would be similar to those described for breeding wading birds.

Grebes: Four grebe species are common inhabitants of the Stillwater Marsh including Clark's, western, pied-billed, and eared. All species use deeper water habitats for migration and breeding with pied-billed grebes often seen throughout the year. Typically associated with high small fish populations, these species often forage in submergent, deep emergent, open water, and canal habitats where clear water conditions prevail for these sight feeders. Optimal habitat for grebe foraging would likely be produced through implementation of Alternatives A, C, D, and E. Human activity impacts would be similar to those described for breeding wading birds.

Clark's, western, and pied-billed grebes are solitary nesters, constructing overwater platforms in deep emergent vegetation. Eared grebes, on the other hand, form tight colonies in submergent vegetation, building nests from the leaves of various submergent aquatic plants. The former three species would obtain breeding benefits from Alternatives A, C, and E while eared grebes would receive more benefit from Alternatives A and B. Similar to all other waterbird species discussed, Alternative D's water management strategy of simulating the natural hydrology could adversely impact breeding species which build overwater nests in deep emergent habitat by flooding nests prior to hatch (Alternative C and E's spring flow strategies have been adjusted to minimize this possibility). This is particularly true with Clark's and western grebes which often begin nesting during early spring. While this alternative would provide benefits related to grebe foraging habitat and eared grebe nesting habitat, Alternative A would likely provide the best overall conditions for grebes.

Double-crested cormorants: Similar to grebe species, cormorants prefer foraging in clear, deep water with abundant fish populations. Seasonally, these habitats would be optimized through implementation of Alternatives C and D; however, overall benefits would most likely be realized through implementation of Alternative A. Cormorant nesting does not usually occur within the Stillwater Marsh; however, nesting colonies have been located in some of the Lahontan Valley's irrigation reservoirs (particularly S-Line) and in Lahontan Reservoir. Breeders rely on marsh habitats to provide fish for nesting young, adults are often observed leaving established colonies to pursue fish in shallower marsh habitats. Cormorants can be observed foraging in the marsh during spring, summer, and fall and would likely receive the most benefit from implementation of Alternative A. Human activity impacts would be similar to those described for pelicans.

4.4.2.1.6 Passerines

There are both upland dependent and marsh dependent passerine (or songbird) species that inhabit Stillwater NWR, Stillwater WMA, and Fallon NWR. Marsh dependent passerine species include marsh wrens, common yellowthroats, yellow-headed blackbirds, savannah sparrows, and song sparrows. Tree, bank, barn, and cliff swallows use marsh habitat for roosting and feeding. Savannah sparrows, Western meadow larks, and common nighthawks nest on the ground in meadow and upland areas, and forage in wet meadows consisting of rush and saltgrass plant communities.

The diversity of passerine species in the Stillwater NWR Complex is associated with riparian habitat. These areas provide a mix of cottonwood, willow, Russian olive, cattail, grass, and other streamside plant communities and act as transition zones between water, such as rivers, canals, and drains and upland habitats (e.g., desert, agricultural). This provides a diversity of habitats within a small area to support many species.

Many of the passerines associated with riparian areas on Stillwater NWR and Stillwater WMA are neotropical migrants (birds that winter in Central and South America but nest in North America, including the Lahontan Valley). Examples of species that depend on, or are associated, with riparian areas include Western wood peewees, house wrens, yellow warblers, MacGillivray's warblers, Bewick's wrens, black-headed grosbeaks, and Northern orioles. Many species associated with marsh, agricultural, and desert plant communities also make use of riparian habitats.

Streamflows affect the quality of riparian forest habitat by influencing corridor width, stand size, and age of cottonwood forest. The size and width of cottonwood-willow riparian forests along the lower Carson River have been reduced, in part, because of agricultural activities, livestock grazing, and a decline in periodic high streamflows necessary for cottonwood regeneration and maintenance. Furthermore, older, large diameter cottonwood trees which die, are not being replaced due to the lack of regeneration. As a result, species which require large diameter trees for nesting and/or roosting are adversely affected. Along the Carson River, sapsuckers, downy woodpeckers, and northern flickers require large cottonwoods in which they excavate their own nest cavity (primary cavity nesters). These species are important because their nest sites are subsequently used by secondary cavity nesters (i.e., they occupy cavities excavated by another species). Along the lower Carson River, native secondary cavity nesters include American kestrel, common merganser, house wren, tree swallow, violet-green swallow, and wood duck. Two introduced secondary cavity nesting species (house sparrow and European starling), which compete with native cavity nesters for nest sites, are common along the lower river.

Common ravens, black-billed magpies, and American crows are also found at Stillwater NWR, Stillwater WMA, and Fallon NWR. These birds commonly nest in riparian and upland areas but feed in and near the wetlands, and agricultural areas. Populations appear to be higher than they were prior to the introduction of agriculture and other developments in the Lahontan Valley.

Some species, such as sage thrashers, black-throated sparrows, and sage sparrows depend on desert plant communities where shrubs dominate the communities. Other species, such as water pipits, horned larks, and Western meadow larks, forage in plant communities dominated by such plants as alkali wild rye, saltgrass, and iodinebush. The loggerhead shrike is a species of concern that nests in greasewood but also uses riparian areas, areas bordering marshes, and agricultural areas.

Common passerines on Anaho Island include rock wren, house finch, white-crowned sparrow and Savannah sparrow. Appendix C lists passerines and other birds using Anaho Island.

Riparian areas under existing conditions are inhabited by common, widespread species. Several native passerine species, with narrow habitat requirements, no longer occur along the lower

Carson River or Stillwater Slough (e.g., yellow-billed cuckoo, yellow-breasted chat). Degraded riparian habitat conditions are a result of a significantly depleted water supply, season long cattle grazing, and encroachment by invasive vegetation species. Human activity in riparian areas and other habitats has the potential to adversely affect passerine birds, but in general effects do not appear to be as high as they can be on waterbirds. In the uplands, some passerine species may be affected by altered vegetation composition and structure. Passerine abundance data in all habitats are limited.

Human activity impacts on passerine species are thought to be minimal. Under all alternatives, passerine populations outside Stillwater NWR, Stillwater WMA, Fallon Refuge, and Anaho Island NWR would not be affected by the actions being considered in this Final EIS. Passerines using Anaho Island would not be affected any of the alternatives.

Alternative A: Passerine richness and abundance would be similar to existing conditions, except for the abundance of several marsh dwelling species, which would be substantially higher in the long-term under Alternative A. The average amount of marsh habitat is expected to increase by 55% through the completion of the water rights acquisition program (8,700 acres to 13,500 acres). Therefore, the local raven population would benefit, although increased wetland habitat acreage may not result in a higher population. With no water dedicated to the lower Carson River and without adequate control of cattle grazing and invasive vegetation, the native diversity of riparian birds along the lower Carson River and Stillwater Slough, and at the delta of the Carson River would continue to decline as cottonwood trees continue to die without being replaced, floodplain vegetation continues to be heavily grazed, and native vegetation is replaced by saltcedar, Russian olive, perennial pepperweed, and other nonnative species. Upland dwelling passerine species may also continue to be negatively affected by depleted Indian ricegrass and other perennial bunchgrasses, dominance by cheatgrass, and possibly in the long-term, conversion of greasewood and other desert shrub communities to cheatgrass communities.

Alternative B: Passerine richness and diversity would be similar to that under Alternative A over the long-term, except that reduced livestock grazing would, to a limited degree, positively affect passerine species associated with tall, dense floodplain meadow vegetation although most of the Carson River would not be included under the proposed Alternative B boundary. Without an aggressive control program for saltcedar and other noxious weeds in this habitat along Stillwater Slough, benefits of reduced livestock grazing in these areas would be limited. Use of Stillwater NWR by ravens would be lower under this alternative than under Alternative A due to the introduction of a predator control program. Impacts from visitor services would be similar to Alternative A.

Alternative C: Under this alternative, passerine diversity in Stillwater Marsh would be similar to Alternatives A and B, although the use of the marsh during the breeding season would be somewhat higher under Alternative C. There would be an estimated 36 percent more available habitat than under Alternative A and there would be more emergent marsh habitat. The raven population would be similar to that of Alternative A.

Along the lower Carson River (from Timber Lake north) and Stillwater Slough, riparian dependent birds would benefit slightly in the short term under Alternative C, due to the discontinuation of cattle grazing along riparian areas, control of saltcedar and noxious weeds, and restoration of native vegetation along riparian corridors. In the long-term, as additional areas are protected, livestock grazing is brought under control, saltcedar is reduced in abundance, and to the extent that water is secured for the lower Carson River, the use of riparian areas by passerines would increase. Furthermore, establishment of cottonwood and willow communities, especially large stands having considerable vegetative structure, would have the potential to increase the number of passerine species using the lower Carson River and Stillwater Slough, and could potentially result in reestablishment of breeding populations of yellow-billed cuckoos, yellow-breasted chat, and other species associated with this habitat.

Establishment of native floodplain meadow vegetation would add a missing component to the native passerine community. Relationships between upland vegetation condition, cattle grazing, and upland passerine communities are unclear on Stillwater NWR. It is hypothesized that passerine communities in upland areas would move closer to a native diversity under Alternative C, as cattle grazing is phased out and upland habitats recover. However, this would not apply to areas dominated by cheatgrass, which would be unaffected by any of the alternatives, except that exclusion of livestock from uplands could reduce the spread of cheatgrass. In the long-term, the potential would continue for greasewood and other desert shrub communities to convert to cheatgrass communities (due to fire), which would adversely affect upland passerine communities.

Some of the benefits of riparian restoration could be offset in localized areas due to the construction of wildlife observation trails and other observation points along the lower Carson River, and a visitor facility near the Stillwater Slough. However, overall adverse impacts are not anticipated to be of concern.

Alternative D: Under this alternative, passerine species would benefit to an extent, similar to Alternative C, except possibly in riparian areas where benefits would be somewhat lower due to restrictions on techniques to control saltcedar, perennial pepperweed, and other invasive nonnative species. Also, breeding populations in Stillwater Marsh would be greater under Alternative D than under Alternative C, and would be higher than under Alternative A. Effects of visitor services activities and facilities on passerine birds would be similar to those summarized under Alternative C.

Alternative E: Benefits to marsh passerine species would be enhanced under this Alternative when compared to Alternative A and action Alternatives C and D, primarily based on the adaptive management focus to promote moist-soil vegetation and wet meadow vegetation. All other effects are identical to those described under Alternative C.

4.4.2.1.7 Raptors

A variety of raptor species inhabit Stillwater NWR, Stillwater WMA, and Fallon NWR for breeding, migration, and wintering. The different species use marsh, riparian, upland, and agricultural habitats.

Wetland-dependent raptors found at Stillwater NWR, Stillwater WMA, and Fallon NWR, include bald eagles, northern harriers, peregrine falcons, ospreys, and short-eared owls. Raptor species, such as golden eagles, prairie falcons, red-tailed hawks, Swainson's hawks, rough-legged hawks, Cooper's hawks, sharp-shinned hawks, American kestrels, turkey vultures, great horned owls, long-eared owls, screech owls, and common barn owls inhabit Stillwater NWR, Stillwater WMA, and Fallon NWR as year round residents, migrants, and nesters. These species are not necessarily wetland dependent. However, because they are opportunistic hunters, some species can be found, at times, hunting in wetland habitats and during certain seasons, key species predominately search for prey in and near the wetlands.

Species associated with riparian tree communities include red-tailed hawks, Swainson's hawks, Cooper's hawks, sharp-shinned hawks, American kestrels, great horned owls, long-eared owls, screech owls, and common barn owls. Most of these species use trees provided in riparian areas, and other areas supporting trees, for nesting and for hunting perches from which to scan adjacent upland or agricultural areas for prey.

Short-eared owls and northern harriers nest near wetland habitats on Stillwater NWR, Stillwater WMA, and Fallon NWR. There are only three active osprey nests in Nevada, and one of those has existed on the Newlands Project's S-Line Reservoir since 1989. In 1993, osprey nesting in the area failed.

Burrowing owls nest in upland areas on Stillwater NWR, while American kestrels commonly nest in cavities of cottonwood snags along irrigation ditches, farm fields, river channels, reservoirs, and wetlands. Swainson's and red-tailed hawks, and great horned owls commonly nest in live cottonwood trees scattered throughout the Lahontan Valley. The nesting population of Swainson's hawk appears to be expanding. Ongoing conversion of agricultural land and associated riparian areas (where cottonwoods commonly grow) to housing subdivisions directly impacts raptors that use these lands and associated cottonwood trees.

Rough-legged hawks can be observed on Stillwater NWR, Stillwater WMA, and Fallon NWR from November to late March. Other raptor species, such as merlins and ferruginous hawks, are uncommon winter residents and migrants. Although not abundant, ferruginous hawks are infrequent, fall migrant and winter residents in Lahontan Valley. This species is regularly sighted in the area between Sagouspe Dam and Diversion Dam, in the Stillwater agricultural district, and at Indian Lakes. It has also been sighted along the Truckee River. Red-tailed hawks and golden eagles are commonly seen flying over Anaho Island. In addition, there are historic accounts of a bald eagle nest on Anaho Island and peregrine falcon nesting on Anaho Island.

Under existing conditions, a long term average of 8,700 acres of wetland habitat would exist in Stillwater Marsh during nonspill years, which would provide marsh habitat for a variety of raptor species. Readers are referred to the previous section for the discussion on riparian habitat. Human activity impacts are anticipated to be minimal under all alternatives with the exception that increased public use of Timber Lakes under alternatives C, D, and E could potentially impact wintering bald eagles in this area. Confining use to established trails and closing trails during peak bald eagle use periods should eliminate this impact.

Alternative A: Populations of raptors breeding in or near Stillwater Marsh (e.g., northern harriers and short-eared owls), and those using the marsh during winter (e.g., bald eagles) would be maintained at moderately high levels given favorable conditions in the marsh and long-term consistency in habitat availability from year to year. Wetland habitat acreage would be 55% higher as it is under estimated existing conditions. The status of those species associated with riparian areas and uplands would be similar to existing conditions in the short term, but would decline to the extent that riparian habitat continues to degrade.

Alternative B: Populations of raptors associated with marsh habitats would be similar to those under Alternative A, except that wintering populations, would benefit slightly more under Alternative B. Furthermore, wet meadow habitat would be enhanced in some areas due to reduced livestock grazing, this would benefit some species, such as northern harriers. While some raptors could be slightly affected by the establishment of a farming program (using lands that otherwise would have reverted to upland habitat in the long-term), others would benefit slightly.

Alternative C: Breeding populations of raptors associated with marsh habitats would benefit under this alternative over the long-term, through promotion of wet meadow and moist-soil habitats within the wetland complex. Additionally, wet meadow and floodplain meadow habitat would be enhanced to a greater degree than under Alternative A, due to significantly reduced cattle grazing in these habitats, and more flooded acres in the spring. Conversely, less wintering habitat, and associated prey species, for wetland associated species would be available under this alternative than under Alternative A (an estimated 8 percent less). However, with respect to bald eagles, riparian cottonwood communities (important for night roosts) would be enhanced; however, this is not anticipated to offset the effects of less wetland habitat. Another potential effect is increased human activity impacts to bald eagle roost sites and raptor nesting along the lower Carson River. Facilities would be designed to avoid or minimize these impacts.

In the long-term, enhanced riparian conditions resulting from exclusion of cattle grazing along riparian corridors, control of invasive vegetation, and possibly additional and more consistent water flowing down the Carson River would benefit raptor species associated with riparian areas. Effects of establishing a farming program on raptors would be similar to the effects identified under Alternative B.

Alternative D: The effects of Alternative D on raptor species would be similar to those described for Alternative C, except that breeding populations of marsh raptors would benefit more under Alternative D and riparian associated species would not benefit as greatly. Furthermore, wintering populations of raptors associated with marsh habitats would be lower, as compared to Alternative A and could be similar to those anticipated for existing conditions. Wintering habitat would decline slightly compared to existing conditions and would be an estimated 41 percent lower than Alternative A. Human activity impacts would be similar to those of Alternative C.

Alternative E: Primarily based on the promotion and focus on managing seasonal moist-soil and wet meadow habitats, prey availability is anticipated to be enhanced throughout the year under Alternative E when compared to Alternative's A, C, and D. All other associated effects would be identical to those described under Alternative C.

4.4.2.1.8 Other Bird Species

Alternative A: Populations of upland fowl species and mourning doves inhabiting the Stillwater NWR area would continue much as they are today, except that populations associated with farmland near the town of Stillwater could be adversely affected over the long-term, as farmland is converted to native upland habitats. These impacts are part of baseline conditions, however, as they were addressed in the Final WRAP EIS (USFWS 1996a). Human activity impacts continue to occur, but at relatively low levels for all species under existing and baseline conditions. Hunted species would continue to be affected during the hunting season, but hunting pressure is anticipated to be light.

Alternative B: Population levels would be similar to those of Alternative A, except that populations associated with farmland near the town of Stillwater would benefit from the establishment of farming on 300 to 400 acres within refuge boundaries (as compared to allowing this land to revert to upland plant communities).

Alternatives C, D, and E: Under these alternatives, species associated with riparian areas (e.g., California quail, mourning doves) would benefit from Alternatives C, D, and E especially Alternatives C and E. Riparian benefits would be highest under Alternative C and a limited amount of farmland would be established under Alternative C (200 to 300 acres), providing additional benefits to some species. All upland game bird species would be hunted under Alternative E while only California quail would be hunted under Alternative's C and D.

4.4.2.1.9 Avian Diseases

Under existing conditions, avian botulism, fowl cholera, and lead poisoning are the primary diseases of concern on Stillwater NWR, Stillwater WMA, and Fallon NWR. Avian botulism is typically an annual occurrence, the severity of which is determined by hot, dry summers and associated low water conditions. Two methods for control of this disease include drying units where outbreaks occur, and ensuring that diseased birds and carcasses are completely removed from infected units. Botulism bacteria are always present in the marsh system; our ability to control water levels is our best defense for preventing these bacteria from becoming active.

Fowl cholera generally occurs during late fall, winter, and early spring, with concentrations of birds directly associated with the severity of the outbreak. Typically transferred from bird to bird, the ability of waterbirds to spread out between marsh habitats and the Service's ability to reduce waterbird concentrations are the best mechanisms for control. Fewer cholera outbreaks occur compared to botulism outbreaks, but the severity can be similar when large numbers of birds concentrate in the same area.

Lead poisoning occurs when waterbirds ingest lead shot deposited in the marsh before steel shot became mandatory for waterfowl hunting. Lead tends to concentrate in surface sediments, where foraging waterbirds search for invertebrates, seeds, and grit. Mistaking the lead shot for food or grit, waterbirds consume it and the shot lodges in their gizzards, slowly decreasing the capacity for waterbirds to digest food. While little can be done for remaining lead shot in the marsh, the elimination of lead shot for hunting and sediment layers burying remaining lead shot in the marsh system are slowly decreasing the severity of this disease. The only management available for control is to flood units where considerable lead shot remains, above levels where waterbirds can effectively forage through the bottom sediments. Lead poisoning occurrences are fairly uncommon under existing conditions and would likely not be a factor over the next several years as sediments slowly build over lead shot deposits.

Alternative A: Under this alternative, water inflow would be an estimated 62 percent higher than under existing conditions, and water levels would fluctuate less than under existing conditions. This would maintain wetland unit water depths through late summer months, thus lowering the potential for severe botulism outbreaks as compared to existing conditions. Additionally, there would be a 55 percent increase in wetland habitat acreage which would allow waterbirds to spread out over additional marsh habitat which would decrease the potential for fowl cholera outbreaks. Lower waterbird concentrations would be provided through this acreage increase which would decrease the potential for infected waterfowl to come into contact with large waterfowl concentrations. Lead poisoning would be somewhat reduced with higher water levels than occurs under existing conditions.

Alternative B: Under this alternative, summer drawdowns would provide conditions for higher occurrences of botulism outbreaks than under Alternative A. This could be counteracted by flushing the affected marsh units with fresh water or by completely drawing these units down to eliminate waterbird use. No restrictions are imposed on water use for this purpose under this alternative. Fall, winter, and spring wetland habitat acreage would be higher than under Alternative A, which would provide more protection against fowl cholera outbreaks. Potential for lead poisoning would be similar to existing conditions. Management options would be similar to those provided under Alternative A to protect against and control disease outbreaks.

Alternative C: Simulation of the natural hydrology would provide higher water levels during the spring, but would result in evaporative summer drawdowns. Similar to Alternative B, this could potentially result in higher occurrences of botulism outbreaks than under Alternative A, which could be counteracted through freshwater inputs and/or complete draining of marsh units. Production of fall and winter wetland habitat could be somewhat lower than baseline, which could result in more opportunity for fowl cholera outbreaks. This assumes that less wetland habitat during these seasons would increase the potential of higher waterfowl concentration, which would lead to a higher possibility of disease transmission. To the extent this is true, the ability to passively control diseases (e.g., provide large acreages of habitat to disperse birds) would be limited. Use of control techniques would be somewhat lower than baseline due to a lower availability of water in the fall, but sufficient water would be available to control diseases.

Alternative D: Outbreak potential would be higher than under Alternative C; however, only limited levels of disease control would be initiated under this alternative (unless severe effects on local and/or continental waterfowl populations could be determined). This alternative recognizes that botulism and fowl cholera outbreaks were a natural part of historic Stillwater Marsh functioning, and natural levels of disease outbreak would be tolerated. Overall, potential for avian disease outbreaks is higher than would be anticipated under Alternative A, but numbers of birds would be far less.

Alternative E: The use of flow corridors to direct spring pulse flows under this Alternative, would either stabilize or allow water to slightly decline in roughly 75% of refuge wetland units. While this could increase the potential for botulism outbreaks as compared to Alternative A, the focus on adaptive management would allow application of individual wetland unit disease management strategies (e.g., flushing and drying) at a higher level than under Alternative C. Other effects to avian diseases would be the same as described under Alternative C.

4.4.2.2 MAMMALS

Mammals are found throughout Stillwater NWR, Stillwater WMA, and Fallon NWR, with the highest diversity occurring in upland desert plant communities. Specific data on mammal populations within the area are limited, but 49 species from 15 families have been recorded in the area. Appendix B lists the characteristic mammal species of Stillwater NWR, Stillwater WMA, and Fallon NWR.

Upland mammals comprise the largest number of species, have the widest distribution, and account for the largest mammal populations on Stillwater NWR, Stillwater WMA, and Fallon NWR. They range in size from pocket mice to mule deer. All nondomesticated species of upland mammals occurring in the area are native.

About two thirds of the upland mammal species in the affected area are rodents, and nearly all of these are primarily associated with desert upland plant communities (Appendix B). Examples of rodents that can be found in lower elevation greasewood communities are white-tailed antelope ground squirrels, pale kangaroo mice, and Great Basin kangaroo rats. Some species of desert rodents, such as Merriam's kangaroo rat, can be found in alkali flats that are nearly devoid of vegetation. Seed-eating rodents, such as kangaroo rats, kangaroo mice, and pocket mice are important seed dispersal agents for many desert plants, especially Indian ricegrass. These rodents gather seeds and store them in small caches in shallow depressions on the ground surface and cover them with soil. Under the right conditions, these seeds will germinate and new plants will grow.

Mule deer populations have increased in recent years in Stillwater NWR and Stillwater WMA area and are close to, or at record levels in the Lahontan Valley. Black-tailed jackrabbits are common throughout desert plant communities. The most common carnivore in the valley is the coyote and kit foxes also occur on Stillwater WMA. Striped skunks are uncommon at Stillwater NWR and Stillwater WMA and bobcats are rare. Long-tailed weasels were common in Lahontan Valley in the 1950s, but are now rare.

Beaver, mink, and raccoons were once common in the Stillwater NWR wetlands and other parts of the Lahontan Valley. Mink are now rare. However, beaver are likely more abundant at present than they have been in the past. Beaver may have been introduced into Lahontan Valley prior to the turn of the century as a means of increasing the fur harvest in Nevada, but this has not been substantiated. Beavers are frequently found along the Carson River and are occasionally seen in canals and drains. Raccoons were common along the Carson River and Newlands Project canals and drains in the 1950s, but are less commonly encountered now.

Muskrat are one of the most numerous wetland-dependent mammal species, and are found in marsh communities and along the Carson River, canals, and drains. Until the recent low water years, muskrats were trapped in considerable numbers. During the low water years of the late 1980s and early 1990s, the muskrat population dropped to a remnant of its former size due to the loss of wetland habitat. However, the muskrat population is increasing again as a result of Lahontan Reservoir spill water expanding the size of wetland habitat on Stillwater NWR during the high water years of 1994 to 1999.

Other mammals that inhabit marsh and riparian areas include the Western harvest mouse and the long-tailed vole. Western harvest mice prefer dense vegetation near water. Cavities in cottonwood snags (dead trees) serve as den or resting sites for mammals, such as bats, raccoons, and weasels. Rodents, rabbits, raccoons, weasels, and skunks use downed logs as hiding, feeding, and/or breeding areas.

Recent surveys of the Stillwater NWR Complex revealed the presence of seven different bat species. Most of the species surveyed roost in caves and abandoned mines in the Stillwater Range and forage over the wetlands and agricultural lands in the valley. Two of the observed species (pallid bat and hoary bat) may roost in crevices or cottonwood trees/snags along the Carson River. The most common bat found in the area was the little brown myotis (Rahn 1998).

The only small mammals trapped on Anaho Island were deer mice. Woodbury (1966) reported tracks and feces of coyote in 1966 and Refuge personnel observed coyote tracks on the island in 1996.

Alternative A: Mammal populations would be similar to those under existing conditions, except in Stillwater Marsh, where muskrat populations and populations of other marsh species would be higher (given a 55% increase in marsh habitat). However, because muskrat trapping would continue primarily for the purpose of providing opportunities to trappers, muskrat populations would be kept lower than potential (both at low populations and high populations). Small mammal species associated with riparian areas would continue to exist in degraded habitat conditions. The highest diversity of mammals is associated with upland desert shrub habitats, and therefore, overall diversity would largely remain the same as it exists today.

Alternative B: Mammal populations and overall diversity would be similar to that of Alternative A, except that muskrats may be somewhat impacted by lower acreage of wetland habitat during summer. Also, small mammal populations would be enhanced in some areas, including floodplain meadow and dune habitats in Fallon NWR due to significantly reduced livestock grazing in floodplain habitat and the elimination of livestock grazing in uplands.

Alternative C: Mammals inhabiting Stillwater Marsh would be affected to the same degree they would under Alternatives A and B, except that they may benefit more because muskrat trapping would be limited to the protection of water control facilities and roads, thus allowing for more natural population fluctuations. Riparian species would benefit greatly under this Alternative in the long-term, as compared to Alternative A. In the short-term, small mammal communities in riparian areas would benefit slightly due to cattle grazing being phased out and saltcedar control being initiated. Small mammals would further benefit under this alternative to the extent that additional lands are protected and water is secured for the lower Carson River. Restoration of the natural composition and structure of floodplain meadow vegetation would benefit small mammals associated with this habitat, and could potentially increase the number of native species occurring on the refuge. Upland communities of small mammals would also benefit under Alternative C, as cattle grazing is phased out and Indian ricegrass and other plant communities recover.

Alternative D: Benefits that would occur under this alternative would be similar to Alternative C, except that muskrats and other marsh dependent species would be adversely impacted by Alternative D. The seasonal low acreage of marsh habitat would slightly decline compared to existing conditions and would be considerably less than it would be under Alternative A. Also, long-term benefits in riparian areas would not be as high.

Alternative E: Wetland associated small mammal species would tend to benefit under this Alternative when compared to Alternative's A, C, and E, primarily based on the increased focus on producing seasonally flooded habitats. Muskrat trapping as a habitat management tool would be similar to that proposed for Alternative C, except that muskrat trapping would be allowed for vegetation control as well as for infrastructure protection as identified under Alternative C. All other effects would be similar to those described under Alternative C.

4.4.2.3 REPTILES

Under existing conditions, nine lizard species and five snake species can be observed throughout the Stillwater NWR, Fallon NWR, and Stillwater WMA. Most species are closely related to upland habitats, with some Stillwater WMA habitats providing the highest density and diversity of lizard species. Great Basin whiptail lizards, side-blotched lizards, and long-nosed leopard lizards are most common and can be observed in all upland habitat types. Great Basin collared lizards, zebra-tailed lizards, and desert horned lizards are associated with specific upland habitat types. While habitat management activities under the different alternatives would likely have little effect on lizard species, including additional lands within the boundary of Stillwater NWR would protect additional upland habitat and provide additional protection from the commercial collection of lizards. Alternatives C, D, and E would provide the greatest amount of habitat protection through exclusion of livestock grazing.

Snakes vary in their habitat relationships, most species are associated with wetland habitats. Wandering garter, western aquatic garter, and Great Basin gopher snakes are typically seen along shorelines. Racers and long-nosed snakes are less frequently encountered but can be observed throughout a variety of habitats. Fluctuation of shoreline habitats as anticipated under all action Alternatives could benefit garter snakes by increasing the abundance of their prey through elevated primary production in shoreline habitats.

4.4.2.4 AMPHIBIANS

Amphibians are sensitive to water having high concentrations of trace elements and other dissolved solids. Concentrations of certain trace elements and pesticides have been shown to adversely affect amphibian populations. Studies of local amphibian populations have shown that frogs have been impacted by the high concentrations of dissolved solids entering wetlands. However, specific data pertaining to the occurrence and distribution of amphibian species, either historically or currently, are not available for the affected area. Amphibian species that occur in the area are likely affected by concentrations of total dissolved solids reported from waters in the study area.

Under existing conditions, three species of amphibians can be found on Stillwater NWR, Stillwater WMA, and Fallon NWR: leopard frogs, western spadefoot toads, and bullfrogs. At present, leopard frogs have only been observed at Stillwater Point Reservoir (where relatively fresher water occurs), spadefoot toads have been observed at Timber Lake and wetlands in the Battleground Point area (which receive water only in spill years and are dry by late summer), while bullfrogs can be seen in all permanent water in the area. No abundance estimates are available for amphibian species. Little is known about the spadefoot toad population on the lower Carson River, but given the large number of tadpoles found in some locations, it is apparent that the toads rapidly adapt to and breed when the Carson River and delta floods. Vehicle traffic in these areas has been light, but many studies have shown that higher levels of traffic can have major impacts to toad populations.

The introduction of bull frogs and nonnative fish species has been shown to significantly impair native frog populations in other areas. Higher salinity and alkalinity of wetlands and altered hydrology can also influence native frog populations. Under existing conditions, these factors would likely continue to impair leopard frog populations. All species would be affected differently depending on which alternative was implemented, except that leopard frogs would continue to be adversely affected by introduced species, such as bullfrogs and game fish under all alternatives. Frog species would likely benefit most from permanent water management with seasonal spring pulses into wet meadow habitats while spadefoot toads would benefit more under simulation of the natural hydrology and associated drying of habitats.

Alternative A: Under this alternative, the amount of wetland habitat in Stillwater Marsh would be nearly doubled by the completion of the water rights acquisition program, as compared to existing conditions, and the freshness of inflow would increase substantially. This, along with increased permanent water, should benefit bullfrogs, and possibly leopard frogs. Of the alternatives, Alternative A would be most favorable to bullfrogs and least favorable to spadefoot toads. Seasonal habitats suitable for spadefoot toads may increase slightly from existing conditions with some water level fluctuation during spring months (northern parts of Stillwater Marsh, adjacent to the dunes). Spadefoot toad populations at Battleground Point would remain similar to existing as this area depends on, and would continue to rely on, spill water for seasonal flooding. Due to the limited amount of herbicides to be used under this alternative and limited distribution of native amphibians, use of herbicides under this alternative is not anticipated to adversely impact native amphibians.

Alternative B: Summer drawdown followed by fall flooding would likely provide no additional benefits over baseline and could provide for lower populations of permanent water species, such as leopard and bullfrogs. While not documented in the core wetland area subject to water management schedules, it is possible that summer drawdowns could slightly benefit spadefoot toads by simulating natural reproduction conditions. Due to the limited amount of herbicides to be used under this alternative and limited distribution of native amphibians, use of herbicides and pesticides under this alternative is not anticipated to adversely impact native amphibians. Precautions would be taken to minimize any possible effects.

Alternative C: Spring water inflow, followed by a considerable amount of permanent water through the rest of the year, would simulate natural reproduction habitat and could provide for slightly higher populations of bullfrogs and leopard frogs than baseline. Similar to Alternative B, summer drawdown could potentially provide additional benefits for spadefoot toads with approximately one-third of refuge units drawing down until the following spring. By incorporating the lower Carson River into Stillwater NWR, the potential exists to secure additional water for the Battleground Point wetlands, which would benefit spadefoot toads in the long-term, so long as the wetlands remain seasonal. It is estimated that Alternative C would have more benefits to amphibian species than Alternative A. Due to the limited amount of herbicides to be used under this alternative and limited distribution of native amphibians, use of herbicides and pesticides under this alternative is not anticipated to adversely impact native amphibians. Precautions would be taken to minimize any possible effects.

Alternative D: Less permanent water would be available to maintain permanent water associated frog populations; however, at least some permanent water would remain throughout the year (approximately 5,000 acres of marsh habitat during the fall and winter). Through increased freshwater input, leopard frog populations could be higher than baseline, but it is not known how this species would respond to low fall water levels. Furthermore, filling of wetland units (peak in June) would be later than occurred naturally, which may lower the benefits that otherwise would result from a spring pulse. This could affect the potential benefits to spadefoot toads at the northern end of Stillwater Marsh where the higher amount of wetland habitat during spring would result in more of these areas being flooded. Under this alternative, a considerable amount of Stillwater Marsh would dry through summer and fall. Herbicides would not be used under this alternative, and therefore no impacts would occur.

Alternative E: As compared to Alternative A, Alternative E seasonal habitat would enhance habitat quality for spadefoot toads and leopard frogs while decreasing habitat suitability for bullfrogs. Focusing spring water deliveries through one of four flow corridors would provide additional seasonal habitat for leopard frogs. Maintaining or allowing water to decline slightly in 50% of the wetland units would provide permanent habitat for amphibian survival. Adjusting management to select different flow corridors to receive spring pulse flows would enhance suitability throughout Stillwater marsh over the long-term, but would not allow amphibian populations to adjust to consistent fresh water input in the same location as would occur under Alternative's C and D. All other anticipated impacts would be identical to those described under Alternative C.

4.4.2.5 FISH

Twenty-nine different species of fish have been documented on Stillwater NWR, Stillwater WMA, and Fallon NWR (Appendix B). Native fish expected to occur in the wetlands include Lahontan tui chub, Lahontan speckled dace, and Lahontan red-side shiner. Tui chub are listed as a species of concern, while carp and mosquito fish are introduced species. The tui chub population has likely decreased from pre-Newlands Project conditions due to the introduction of carp, mosquito fish, and other nonnative fish, along with the reduced acreage of wetland habitat. Lahontan red-side shiner have been observed in the Stillwater marsh over the past several years (W. Henry, Wildlife Biologist, USFWS, personal communication, 2000), but Lahontan speckled dace have not been recorded for about 20 years.

Recent gill net surveys at the Canvasback Gun Club revealed the presence of seven different species. Carp and Sacramento black fish were most common followed by black bullheads and channel catfish. Also present were walleye and white bass. Canvasback Gun Club members stocked channel catfish and largemouth bass in Big and Little Mallard Ponds in 1996. In the Indian Lakes area, NDOW has been stocking a variety of fish species in Likes Lake, Papoose Lake, and Big Indian Lake, including rainbow trout, white bass, largemouth bass, white crappie, yellow perch, green sunfish, bluegill, black bullhead, and channel catfish. All of these species, except white crappie and bluegill, have been stocked since 1989.
Under existing conditions, three primary fish species occur in Stillwater Marsh; Lahontan tui chub, European carp, and mosquito fish. Carp comprise the majority of the fish biomass in Stillwater Marsh, but mosquito fish and tui chub are also common to abundant. European carp displace native fish and also increase water turbidity which reduces the ability of vegetation to germinate (Robel 1961). Under stable water management, the carp population can become very large which can reduce the quality of all marsh habitats through vegetation inhibition and destruction. Water level control is the only technique currently used, although chemicals, such as Rotenone can also be applied when populations exceed maximum acceptable levels.

Mosquito fish also compete with native fish, and, because they consume insect larvae, also compete with waterbirds that feed on these larvae. However, controls to eliminate these fish would also reduce native fish populations. Mosquito fish are commonly stocked in water delivery systems throughout the Carson Division of the Newlands Project to reduce mosquito populations. No mosquito fish control is currently practiced on the refuge.

Several game fish are continuously introduced into the marsh through the conveyance of water into Stillwater Marsh, Indian Lakes, and the lower Carson River from Lahontan Reservoir. Although not nearly as plentiful as nongame fish, several species of game fish are periodically conveyed into Stillwater Marsh and into lower stretches of the Carson River, including white bass, largemouth bass, white crappie, yellow perch, green sunfish, bluegill, black bullhead, and channel catfish. At this time, wetland conditions continue to be less than optimum for most game fish.

Alternative A: Through completion of the water rights acquisition program, a 55 percent increase in wetland habitat acreage in Stillwater Marsh would enhance fish habitat over existing conditions. Water levels would fluctuate less than they do now, creating additional permanent water habitats, which would enhance carp populations. Less fluctuation in water levels, along with a fresher marsh, would improve conditions for game fish populations. Similarly, fresher water in the marsh system would enhance habitat suitability for tui chub, but higher populations of carp, mosquito fish, and introduced game fish would adversely affect tui chub populations due to competition, altered habitat, and predation. Overall, native Lahontan tui chub would benefit over existing conditions from implementation of this alternative; however, promoting nonnative fisheries through more stable water levels would tend to increase competition for limited resources.

Alternative B: Summer drawdown under this alternative would tend to reduce the amount of permanent water habitat through summer months and would expose fish populations to waterbird predation. This drawdown, followed by reflooding in the fall and winter, would produce higher populations of invertebrates, which are a preferred food of many fish species. This would benefit tui chub and mosquito fish as compared to Alternative A. Reduced permanency of water would not be sufficient to adversely impact carp, but may adversely impact game fish, as compared to Alternative A. Overall, carp populations would be maintained at lower levels than under Alternative A, primarily due to increased efforts to control them and less management emphasis on maintenance of semi-permanent marsh. As compared to Alternative A, game fish populations would be reduced through increased water level fluctuations.

Alternative C: This alternative focuses on simulation of the natural hydrology which also produces summer drawdowns. Additional fish benefits would be provided through spring and limited fall flooding of shallow water habitats which would enhance fish foraging opportunities. Many wetland units would be drawn down during the summer. Drawdowns would continue into the fall in one third of the wetland units and water levels would be maintained in another one third of the units (the remaining one third would be flooded during the fall). These drawdowns, including periodic drying of wetland units, would have the added benefit of maintaining lower populations of carp, control of which would be supplemented through limited use of chemicals. Game fish populations would also be lower than under Alternative A due to periodic drying of wetland units, which would not be favorable to maintaining game fish. While a lower percentage of permanent water would be provided compared to Alternative A, tui chub would benefit from this alternative, due to the increased invertebrate populations and adverse impacts to nonnative fish species.

Alternative D: Potential effects would be similar to Alternative C except that much less permanent water would be provided on an annual basis and no chemical control would be used for carp. Due to the much lower acreage of permanent water, fish populations would be lower than those anticipated under Alternatives A and C.

Alternative E: Anticipated affects would be similar to those described under Alternative C except that changing the flow corridor selected to receive spring pulse flows would alter the primary location of permanent habitat over the long-term. An emphasis on adaptive management during fall would enhance invertebrate production, but, would also allow some units where fish populations had become established to drawdown or dry completely. This would enhance the ability to control nonnative species but may temporally contribute to loss of the native species component as well.

4.4.2.6 INVERTEBRATES

Three broad categories of invertebrates are considered in this section; marsh, riparian, and upland communities. Relationships between marsh invertebrates and wetland habitat types are complicated. Effects of water management on marsh invertebrates are influenced by life history strategies used by different invertebrate groups and the habitats where many of the invertebrates spend all or part of their lives. Life history strategies range from overwintering in mudflats and emerging in spring or summer flooded habitats, migrating to summer habitats as adults, and to spending their entire life cycle in permanently flooded habitat. Each alternative would have a different effect on marsh invertebrate diversity.

Recent studies within the Lahontan Valley lentic and benthic wetland zones have found the presence of invertebrate species representing at least 25 families from four separate classes including insects, crustaceans, arachnids, and mollusks (Bundy 1996; Bundy 1997a,b). In the flowing water habitats sampled, more families of invertebrates were found in freshwater samples (from the Carson River) than drainwater samples, with 15 families represented versus nine in drainwater. Mayflies, mosquitos, and crustaceans dominated freshwater samples while water boatman overwhelmingly dominated drainwater samples. Among wetland habitats, four different wetland communities were sampled including mud flat - alkali playa, wet meadow, emergent, and submergent. Aquatic invertebrate diversity was highest in emergent wetlands (18 families represented) and lowest in mud flat - alkali playa wetlands (11 families). Wet meadows maintained the highest abundance (3,099 individuals/m^2) while mud flat - alkali playa wetlands had the lowest (500 individuals/m^2). Snails appeared to prefer deeper water while crustaceans (e.g., shrimp, water fleas) preferred intermediate to deep water.

Benthic invertebrate communities were found to be high in abundance but with relatively few families represented (only eight families sampled). Samples were typically dominated by two snail families, Physidae (pond snails) and Planorbidae (orb snails). Orb snails appeared to prefer fresh moving water while pond snails showed a preference for slower, more saline water (Bundy 1997). Chironomids were more closely associated with ephemeral habitats such as wet meadows and alkali mudflats (213 individuals/m^2) while Physid and Planorbid snails were more dominant in semi-permanent habitats (672 and 278 individuals/m^2, respectively). Stillwater marsh benthic invertebrate sample composition varied by location with historic marsh samples dominated by Chironomids (511 individuals/m^2) and sanctuary wetland unit samples comprised primarily of Planorbid snails (654 individuals/m^2).

Under existing conditions, 25 aquatic invertebrate families would be anticipated to inhabit Stillwater Marsh habitats. These range throughout all habitat types with individual families showing preference for different habitats. Water level fluctuations common to the present Stillwater Marsh system may have decreased the abundance of many species as compared to estimates of pre-Newlands Project conditions, primarily because extended droughts may have temporarily eliminated permanent water associated populations. Over time, there may have been a decrease in the abundance of many species adapted to fresher water; however, diversity of invertebrate species has likely increased through addition of nonnative plant species and a wider range of salinity levels.

An important group of wetland invertebrates in the study area is mosquitos. Within Churchill County, there are 11 mosquito species in four different genera (Table 4.19). They can be separated into those that can lay their eggs on soil and debris, and those that lay their eggs on the water. Fluctuating water levels are favorable to *Aedes* species, which lay their eggs on the soil. By keeping water at a particular level for several weeks or longer, *Aedes* mosquitoes do not develop succeeding generations. By keeping water levels constant, *Culex*, *Culiseta*, and *Anopheles* species will develop succeeding generations. *Culex tarsalis*, a standing water species, is the most abundant mosquito in the affected area, and is a known carrier of Western equine and St. Louis encephalitis, diseases that affect humans and horses. To date, there have been few cases of human and horse mosquito-borne encephalitis in Nevada (Churchill County Mosquito Abatement District, written communication, dated September 1, 1995). Each year, encephalitis is detected in sentinel chickens in Churchill County, but cases of encephalitis in humans are rare in the county. Generally, mosquitoes can disperse five to ten miles from where they hatch. One species found in the area has a range of more than 20 miles (ibid). Mosquitoes can be transported greater distances by the wind and can be problematic throughout Lahontan Valley during the warmer months of spring and summer.

Riparian invertebrate communities have experienced the greatest change from historic conditions. Lack of spring flows through the existing river channel and associated lack of seasonal flooding of riparian wetlands has led to changes in vegetation community structure. This change has been further exacerbated by continuous, growing season long livestock grazing and encroachment by invasive plant species, such as saltcedar. While a different set of riparian invertebrate species has adapted to these altered vegetative conditions, native species preferring fresh, moving water such as mayflies have been reduced in abundance. Reduced coverage by native willow species may have lowered habitat suitability for the Nevada viceroy, a butterfly species of special concern. The Nevada viceroy is dependent on Coyote willow, which has been impacted by saltcedar competition along both the Humboldt and Carson rivers (Herlan 1971).

Upland invertebrate communities are divided between sand dune specific species and those associated with upland shrublands (most of the Stillwater WMA). Surveys conducted on Stillwater NWR, Stillwater WMA, and Fallon NWR during 1998 revealed the presence of 12 different species of beetles. All of the widely distributed dune beetle species known from the Great Basin were found during the surveys. A newly described beetle species for the Great Basin, *Aphodius* parapyriformis, was also collected and may be endemic to the Stillwater dunes. In addition, a potentially new cricket species from the genus *Stenopelmatus* was documented. This species may also be endemic to the Stillwater dunes (Rust 1998). Another endemic species of sand obligate beetle, *Novelsis sabulorum*, known from Sand Mountain and Blow Sand Mountains in the Walker River Basin, has been collected at the Stillwater dunes (Beal 1984 as cited by Rust 1998).

Sand dune insects use the sand around the root systems of vegetation as a micro habitat within the active dune. Of the 12 species of beetles collected, four are carnivores, four are detritivores (species that eat dead and decaying organisms), one is a herbivore, and three have unknown eating habits. The beetles collected can be categorized into three different groups based on their seasonal activity patterns: six species are active all year, two species are active during the warm summer months, and one species is active during the cold winter months, three species have unknown activity patterns (Rust 1998). No inventories have been completed on upland shrub associated invertebrate communities

Alternative A: This alternative would result in a low amount of water level fluctuation, which would increase habitat for invertebrates favoring permanent water such as snails, mollusks, water mites, and shrimp. Conversely, only a limited amount of seasonally flooded habitat would be available for insect species which typically over winter in dry mudflats and emerge when spring water saturates unvegetated alkali mudflats, wet meadow, and shallow emergent habitats. While this alternative would increase density of permanent water invertebrates, less fluctuating water levels, as compared to existing conditions, would tend to reduce habitat availability for invertebrates, such as spring and summer emerging insects, which prefer seasonal habitat.

Invertebrate communities in riparian areas and floodplain meadows along the lower Carson River would continue to be affected by low water supplies, heavy livestock grazing, and expansion of saltcedar. Some species of upland invertebrates would continue to be impacted by reduced abundance of native vegetation, such as Indian ricegrass, and altered structure of understory vegetation.

Alternative B: Similar to Alternative A, spring water level increases would not occur to any great extent (except in spill years). Therefore, spring and summer emerging invertebrates would not benefit from this alternative. Between mosquito species, several different emergence strategies are used so that units flooded in the fall would benefit later emerging species; however, most species would not benefit. Considering an emphasis on producing moist-soil vegetation under this alternative, considerable amounts of vegetation would remain flooded during the spring, which would provide habitat for many overwintering invertebrate species. Overall, marsh invertebrate density and diversity would be higher than under Alternative A through implementation of this alternative.

This alternative would result in similar effects on invertebrate communities in riparian and upland habitats as those discussed for Alternative A, assuming no substantial change in management of the area within the Stillwater WMA, except the following. Invertebrates associated with dune habitat in the Fallon NWR and northern end of Stillwater NWR would benefit to some degree due to addition of a full time law enforcement officer, thus reducing impacts associated with off-road vehicle use in dune habitat, and enhanced production of native grasses and other native herbaceous plants.

Alternative C: Simulation of the natural hydrology would benefit the majority of invertebrate species; particularly those associated with spring flooded shallow water habitats. Seasonal habitats, in combination with permanent water throughout the year, would provide habitat for larval invertebrates to emerge and adults to survive through the summer. This simulation of seasonal dynamics would allow a more native diversity of invertebrates to colonize Stillwater Marsh habitats as spring water pulses would reduce salinity in wetland units, especially upper units. Although not to the extent as would occur under Alternative B, fall flooding of approximately one third of the wetland units may provide conditions for later emerging species while providing invertebrate food (in the form of moist-soil vegetation), for spring adults. Overall, abundance and diversity of invertebrates would be higher than baseline through implementation of this alternative.

Native invertebrate communities in riparian areas and floodplain meadows along the lower Carson River would benefit from enhanced native riparian communities due to the elimination of livestock grazing and control of saltcedar. Incorporation of the lower Carson River into Stillwater NWR would create the potential to secure water for the river and wetlands near Battleground Point, which would further benefit riparian associated invertebrates, possibly including the Nevada viceroy. Elimination of livestock grazing could adversely impact some species of butterflies associated with annual vegetation, such as mustards. As under Alternative B, invertebrates associated with dune habitat would benefit due to addition of a full time law enforcement officer (which would reduce impacts associated with off-road vehicle use in dune habitat) and enhanced production of Indian ricegrass and other native herbaceous plants throughout the dune complex. Because Alternative C would incorporate the entire dune complex within Stillwater NWR, as opposed to Alternative B (which would only include two large parts of the system), greater, long-term protection to the system would be afforded.

Alternative D: Effects of this alternative would be similar to Alternative C except that considerably less permanent water would be provided for annual residents, such as snails and mollusks. While approximately 5,000 acres would remain during fall, there would be less permanent water available than under all other alternatives. Spring flooding, during nonspill years, would be more extreme than would occur under other alternatives, and water management would simulate more aspects of the natural hydrology. Therefore, a more natural diversity of invertebrate species would be anticipated. Overall, natural invertebrate diversity would be higher than baseline while abundance would likely be similar to baseline with a different complement of species. Benefits to riparian and upland invertebrate communities would be similar to Alternative C.

Alternative E: Alternative E would be anticipated to provide the greatest benefits to wetland invertebrate species when compared to all other Alternatives. Providing differing water level and permanence conditions among the four flow corridors would provide at least some habitat for nearly all wetland adapted invertebrate species in most years. Altering which flow corridors receive which water flow treatments (spring pulse, stable, or declining), would allow simulation of natural flood/drought cycles within each individual flow corridor. Enhanced emphasis on producing seasonal habitats such as wet meadow and moist-soil wetland habitat types would provide decaying vegetation during spring for wetland invertebrates specializing in consuming plant matter. Because these invertebrate species form the base of wetland invertebrate food chains, it is anticipated that community structure would be greatly enhanced over Alternative A. All other effects associated with implementing Alternative E would be identical to those identified under the Alternative C discussion.

Table 4.19: Local abundance, larval presence periods, preferred habitats, preferred prey, and disease transmission potential for 11 mosquito species known to occur in Churchill County, Nevada (adapted form table provided by Mike Wargo, Churchill County Mosquito Abatement).

Species	Local Abundance	Larval Presence	Preferred Habitat	Preferred Host	Diseases Carried
Aedes campestris	Abundant	Feb-June	Alkali Ponds, Lake margins	mammals, including humans	none known
Aedes dorsalis	Common	Apr-Nov	Irrigated fields, Alkali seepage	mammals, including humans[A]	Western Equine Encephalitis (2ndary vector)
Aedes melanimon	Common	Feb-Dec	Sloughs, ditches, irrigated pastures	rabbits, cattle	Western Equine Encephalitis (2ndary vector)
Aedes nigromaculis	Common	Apr-Oct	Irrigated pastures	cattle, humans	none known
Aedes niphodopsis	Common	Feb-Apr	Alkali pools, ponds, seepages	mammals, including humans	none known
Aedes vexans	Rare	Apr-Nov	Roadside ditches, sloughs	mammals, birds	Heartworm
Culex erythrothrax	Rare	Sep-July	Pools, springs, cattails	mammals	none known
Culex peus	Rare	May-Nov	Polluted, stagnant water	birds, humans	none known
Culex tarsalis	Abundant	Apr-Dec	Irrigated fields, ditches, pools	birds, mammals	Western Equine and St. Louis Encephalitis
Anopheles freborni	Common	Apr-Oct	Lake margins, algal mats, swamps, spring pools, irrigated pastures	cattle, rabbits	Western Malaria
Culiseta inornata	Common	All Year	Irrigated fields, ditches	livestock	none known

[A] Very few reported cases in Churchill County.

4.4.2.7 ENDANGERED, THREATENED, AND SPECIES OF SPECIAL CONCERN

Under existing conditions, 20 endangered, threatened, proposed for listing, and species of concern may use Stillwater NWR, Stillwater WMA, and Fallon NWR. Included are mammals (six species of bats), birds (seven species), reptiles (one species), fish (three species), Invertebrates (one species), and plants (two species). Most of these broad groups have been previously covered in other sections of this chapter (and further detailed in Chapter 3), so this section discusses how the alternatives would impact the different broad groups with some representative members used as examples.

Mammals (bats), invertebrates (Nevada viceroy), plants (Nevada orycytes and Nevada dune beardstongue), and the western burrowing owl would not be impacted to any large degree by any of the alternatives with the following exceptions. Protecting dune habitats under Alternatives C, D, and E would benefit plants associated with the dunes, and restoration of the coyote willow plant community along riparian corridors would benefit the Nevada viceroy. The increase in available marsh habitat during the spring and summer would provide additional insects for bat foraging. Western burrowing owls could be impacted by reductions in grazing and associated low stature meadows. However, sufficient upland habitat throughout the affected area would provide considerable acreage in suitable burrowing owl habitat.

Bald eagles rely on riparian areas, where mature cottonwoods exist, for night roosting during winter on Stillwater NWR, Stillwater WMA, and Fallon NWR. They also frequent marsh habitats, especially where suitable perches are available. Bald eagles occur most commonly on the Stillwater NWR Complex during winter months (generally November-March), with their stay generally corresponding to high waterfowl use during this season. Therefore, bald eagles would benefit from alternatives that would provide for the long-term health of riparian areas (Alternatives C, D, and E) and that would provide for large migratory and wintering populations of waterfowl (Alternatives A, B, C, and E, especially B). Bald eagles would also benefit from alternatives that would increase fish availability during winter, such as those using winter drawdowns. Human activity impacts have the potential to adversely impact bald eagles in the area, especially at night roosts. Traditional roost sites would have the strongest protection under Alternatives C, D, and E due to Stillwater NWR boundary expansion and added law enforcement. Wildlife observation trails in the vicinity of bald eagle roost sites (Alternatives C, D, and E) would be closed during winter, and therefore would not impact bald eagles. Disturbance by hunters (especially those using boats) in the marsh area is also a potential (Appendix L), and would be lessened under Alternative C due to the higher amount of wetland habitat that would be in sanctuary or a low density hunt zone, where disturbance impacts would be minimal. Because of their sensitivity to boats, bald eagles would benefit from Alternatives B, C, D, and E due to zonation patterns for boat use. However, bald eagles would tend to benefit under any alternative that increases wetland habitat acreage over existing conditions (all alternatives).

Because peregrine falcons primarily feed on wetland-dependent birds, such as shorebirds and small ducks, while they inhabit the Stillwater area (typically February-November), peregrine falcons could benefit most from implementation of Alternatives B, C, and E and possibly

Table 4.20. Endangered, threatened, proposed for listing, and species of concern in the affected area.

Common Name	Scientific Name	Federal Status[1]	Habitat[2]
Mammals			
Pygmy rabbit	*Brachylagus idahoensis*	*	up
Long-eared myotis	*Myotis evotis*	*	wet/rip/up
Fringed myotis	*Myotis thysanodes*	*	wet/rip/up
Long-legged myotis	*Myotis volans*	*	wet/rip/up
Yuma myotis	*Myotis yumanensis*	*	wet/rip/up
Pale-Townsend's big-eared bat	*Plecotus townsendii pallescens*	*	wet/rip/up
Pacific Townsend's big-eared bat	*Plecotus townsendii townsendii*	*	wet/rip/up
Birds			
Western burrowing owl	*Athene cunicularia hypugea*	*	up
Ferruginous hawk	*Buteo regalis*	*	wet/rip/up/a
Western snowy plover	*Charadrius alexandrinus*	*	wet
Mountain plover	*Charadrius mountanus*	P	up/ag
Black tern	*Chlidonias niger*	*	wet
Yellow-billed cuckoo	*Coccyzus americanus*	*	rip
American peregrine falcon	*Falco peregrinus anatum*	*	wet/up/ag
Bald eagle	*Haliaeetus leucocephalus*	T	wet/rip/up/a
Least bittern	*Ixobrychus exilis*	*	wet
Loggerhead shrike	*Lanius ludovicianus*	*	up/ag
Long-billed curlew	*Numenius americanus*	*	wet/up
Trumpeter swan	*Olor buccinator*	*	wet
White-faced ibis	*Plegadis chihi*	*	wet/ag
Reptiles			
Northwestern pond turtle	*Clemmys marmorata marmorate*	*	rip/wet
Fish			
Cui-ui	*Chasmistes cujus*	E	lak/str
Lahontan tui chub	*Gila bicolor obesa*	*	lak/str
Lahontan cutthroat trout	*Oncorhynchus clarki henshawi*	T	str/lak
Invertebrates			
Nevada viceroy	*Limenitus archippus lahontani*	*	rip
Plants			
Nevada oryctes	*Oryctes nevadensis*	*	up
Nevada dune beard tongue	*Penstemon arenarius*	*	up

[1]Status - Federal: E = endangered, T = threatened, P =proposed for listing; and * = species of concern.
[2]Habitat: wet = wetland, rip = riparian, up = upland, ag = agricultural, lak - lake, str = stream.

Alternative D. The abundance of peregrine falcons would remain sparse and human disturbance would not appear to be a factor in their use of the Stillwater Marsh. Peregrine falcons have been removed from the endangered species list but are still a species of management concern.

Mountain plover are rare visitors to the affected area and western least terns could visit the area (although no documented sightings of western least terns are available for Stillwater NWR but they have been documented in southern Nevada). There are no reports of mountain plover on the Stillwater NWR Complex, although they have been observed on Carson Lake during winter. Because they favor barren fields, they would benefit most from Alternative A due to heavy livestock grazing pressure along the lower Carson River. Due to their low use of the refuge, they would not be markedly affected by any of the alternatives. Black terns are more common (uncommon now, but at one time were abundant). Because they nest in emergent vegetation, but are at low densities under existing conditions, all of the alternatives would produce suitable nesting habitat. However, Alternatives C, D, and E may encourage restoration to their former abundance more so than the other two alternatives.

White-faced ibis use a variety of habitats in the affected area including deep emergent habitat for breeding, and wet meadow, shallow emergent, moist-soil, and unvegetated alkali playa habitats for foraging. They also feed in irrigated agricultural fields where invertebrates are brought to the surface during flooding. This provides an abundant food source in the Lahontan Valley. Alternatives that would optimize a complex of deep emergent habitat (Alternative C and E) and shallowly flooded foraging habitats (Alternatives B, C, D, and E) would most benefit white-faced ibis. The best alternatives for this species would be Alternative's C and E related to their combination of the previously mentioned habitats, combined with availability of fall foraging habitats for migratory populations not breeding at the Stillwater Marsh. Boating restrictions (zonation of boating access under Alternative E) and closure of wetland areas to off-road hiking would benefit breeding ibis under Alternatives B, C, D, and E.

Northwestern pond turtles have only been observed along the Carson River, upriver of the Stillwater WMA. Alternatives C, D, and E would provide the most potential for restoring habitat for Northwestern pond turtles by encompassing the lower Carson River within the boundary of Stillwater NWR, which would allow for the future potential of securing water for this part of the river. Furthermore, riparian restoration under Alternatives C, D, and E, and the associated control of saltcedar would tend to provide fresher water to the system and increase shallow groundwater availability. Annual water consumption by saltcedar is estimated at 1.4 to 10.4 acre-feet per acre, per year (USBOR 1992).

Lahontan tui chub populations in the Stillwater Marsh system were previously covered in the fish section of this chapter. Alternatives B, C, and E are thought to provide the best habitat conditions for Lahontan Tui chub through enhanced control of non native fish populations, enhanced prey production, and provision of seasonal habitats for breeding.

Benefits to cui-ui would be highest under Alternatives C, D, and E (especially D), somewhat lower under Alternative A, and lowest under Alternative B when the ending adult female cui-ui population is considered. Under Alternative A, the average number of cui-ui produced each year would increase from estimated existing conditions by about 88 percent and the number of adult female cui-ui at the end of the 95-year simulation period would increase over existing conditions by about 123 percent (Table 4.21). The number of spawning years would remain at an estimated 75 years out of 95 years for Alternatives C and E, but would increase to 77 years under Alternatives A, B, and D. These changes are primarily attributable to reductions in Truckee River diversions as more water rights are acquired for Lahontan Valley wetlands (USFWS 1996a).

Under Alternatives C, D, and E, Truckee River diversions to the Newlands Project decline slightly more than they would under Alternative A (Table 4.6), which would contribute toward a greater increase in the average number of cui-ui produced each year, as compared to the increases estimated for Alternative A (Table 4.21). Effects of Alternatives C, D, and E, as compared to Alternative A, would not be anticipated to worsen in drought years, and no changes are estimated for the number or frequency of spawning years. Alternatives A, B, and D would result in 2 additional spawning years (77 years) when compared to Alternatives C and E (75 years); however, the ending population would be higher under Alternatives C and E than it would under Alternatives A and B. Using these modeled calculations, four of the spawning years projected for Alternatives A, B, and D failed, which reduced the number of female spawners entering the lower Truckee river the following year.

Table 4.21. Cui-ui population response to Alternatives.

	Existing	(No Action) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
No. of Cui-ui Spawning Years	75	77	77	75	77	75
Ending No. of Adult Female cui-ui	677,793	1,511,350	1,510,057	1,555,540	1,637,549	1,554,864

Source: Below Lahontan Reservoir Model results, U.S. Fish and Wildlife Service.

The increases over existing conditions in the number of adult female cui-ui at the end of the 95-year simulation period and the average number of cui-ui produced each year under Alternative B would be comparable to that estimated for Alternative A, although the percent increase in the number of adult females would possibly be slightly lower. Mechanisms affecting lower Truckee River flows are described in Sections 4.2.2.7 Derby Dam and Truckee Canal and 4.2.3 Lower Truckee River and Pyramid Lake.

Buchanan (1987, as cited in USFWS 1995b) estimated that it would take 478,500 acre-feet per year of water to provide suitable spring spawning habitat for Lahontan cutthroat trout in the lower Truckee River. This volume of flow would be needed on nearly an annual basis. Completion of the water rights acquisition program for Lahontan Valley wetlands (USFWS 1996a), cumulative with Adjusted OCAP (USBOR 1997), would result in an estimated long-term average of 480,500 acre-feet per year of water flowing into Pyramid Lake. As a consequence of additional reductions in Truckee River diversions resulting from implementation of Alternatives B, C, D, and E, lower Truckee River flow volumes into Pyramid Lake would increase further to long-term estimates of 503,890; 504,540; 507,310; and 504,630 acre-feet per year, respectively. Flows of 478,500 acre-feet per year would be anticipated in 32 (Alternative A) to 34 years (Alternative E) over the 95 year cycle based on BLR Model runs.

The most critical period for Lahontan cutthroat trout, with respect to small changes in lower Truckee River flows is July-September followed by October-December, which are the periods of lowest water flow in the Truckee River. Even small changes in river flow at these times could affect trout populations. Under Alternative A, flow in the lower Truckee River would increase over existing conditions by an estimated 8.4 percent (an increase of about 9,610 acre-feet) during the period July-December (Table 4.22). Alternative B, would result in a decrease of an estimated 430 acre-feet when compared to baseline Alternative A. Lower Truckee River flows during July-September and October-December under Alternatives C, D, and E would increase by an estimated 2.1%, 3.1%, and 1.8% respectively when compared to baseline Alternative A.

Table 4.22. Potential effects of alternative water delivery schedules on seasonal lower Truckee River flows (shown in acre-feet), as indexed by Truckee River flow through Derby Dam, based on Below Lahontan Reservoir Model results.

	Existing	(Baseline) Altern. A	Altern. B	Altern. C	Altern. D	Altern. E
January-March	138,470	143,750	143,510	144,380	143,800	144,520
April-June	222,700	229,040	229,090	225,840	227,990	225,610
July-September	39,210	41,970	42,250	42,720	42,220	42,160
October-December	75,370	82,220	81,510	84,120	85,820	84,250
Annual	475,760	496,980	496,370	497,040	499,840	497,140

Source: Below Lahontan Reservoir Model results, U.S. Fish and Wildlife Service.

As a consequence of implementing Alternative E, the long-term average flow volume of the lower Truckee River during July-September would increase from an estimated 41,970 acre-feet (baseline conditions) to 42,160 acre-feet during this period which would produce very little change from Alternative A (Table 4.22). October-December flows would also increase from an estimated 82,220 acre-feet (baseline conditions) to an estimated 84,250 acre-feet, a 2.5 percent increase. Lower Truckee River flows during April-June would decrease slightly (1.5 percent) from an estimated 229,040 acre-feet (baseline conditions) to an estimated 225,610 acre-feet. The slight changes in lower Truckee River flows during January-June are not of concern due to the higher levels of runoff occurring at this time of year (although the Service acknowledges that in some years, much of the Truckee River flow could be diverted to Lahontan Reservoir during this period, as per OCAP). Mechanisms affecting lower Truckee River flows are described in Sections 4.2.2.7 Derby Dam and Truckee Canal and 4.2.3 Lower Truckee River and Pyramid Lake.

4.4.2.8 FISH AND WILDLIFE TOXICITY

As indicated in Section 3.9 (Environmental Contaminants), dissolved solids and several trace elements have been identified at potentially toxic concentrations in water, sediment, or biological tissues. A reconnaissance investigation of wetlands in and near Stillwater NWR was initiated in 1986 to determine if agricultural drainage had caused, or had the potential to cause, adverse effects to human health, fish and wildlife, or affect the suitability of water for beneficial uses (Hoffman et al. 1990). Water in some areas affected by agricultural drainage contained concentrations of arsenic, boron, dissolved solids, sodium, and un-ionized ammonia in excess of baseline conditions or Federal and State criteria for the protection of aquatic life or the propagation of wildlife. Sediment from some affected wetlands contained elevated levels of arsenic, lithium, mercury, molybdenum, and zinc. Additionally, concentrations of arsenic, boron, copper, mercury, selenium, and zinc in biological tissues collected from some affected wetlands exceeded levels associated with adverse biological effects in other studies. This study concluded that arsenic, boron, mercury, and selenium were of primary concern to human health and fish and wildlife in and near Stillwater NWR. Subsequent investigations have generally supported the findings of the reconnaissance investigation (Lico, 1992; Hallock and Hallock, 1993, Tuttle et al. 1996; Lico and Pennington 1997).

Pesticides are also a concern in the water supply to the Refuge. Previous investigations have examined occurrence of historic and current pesticides in water and sediment. Hoffman et al. (1990) detected organochlorine compounds in sediments collected from wetlands of Stillwater NWR and surrounding areas. Of greatest concern was lindane in normalized concentrations which exceeded the EPA's sediment quality criteria in three samples. Less persistent pesticides were not examined in this study. In a survey of water chemistry and contaminant loads in drains in the Carson Division of the Newlands Project, Lico and Pennington (1997) detected a variety of pesticides in water samples. However, concentrations were generally lower than existing standards or concentrations associated with toxicity. Because of the low persistence and sporadic use of pesticides currently used in agriculture, characterization of pesticides in the wetland water supply is difficult. Sampling should coincide with actual application of pesticides to agricultural fields or irrigation canals. Additional research is needed to more fully characterize pesticide concerns.

Changes in the wetland water supply and wetland management practices would affect the concentration and load of dissolved solids, trace elements, and possibly pesticides entering wetlands and concentrations in at least some of the wetlands within the Stillwater Marsh complex. These changes may affect fish and wildlife exposure to the contaminants. Under all alternatives, the increased inflow of Carson River, water as authorized under the water rights acquisition program, is expected to generally reduce concentrations of total dissolved solids and trace elements associated with agricultural drainwater (i.e., arsenic, boron, molybdenum, and selenium) throughout most of the wetlands within the Stillwater Marsh complex. However, because of the continued loading of natural and agricultural induced dissolved solids in water supplies coupled with evaporative concentration of dissolved solids in wetlands, concerns with total dissolved solids and these trace elements would not be eliminated. However, difference in dissolved solids loading to wetlands under some alternatives may result in a difference in contaminant exposure and effects. Elevated aluminum concentrations are pervasive throughout the Lahontan Valley. Changes in the wetland water supply would likely have little effect on aluminum availability and concerns with aluminum is expected to be similar under all alternatives. Similarly, mercury is elevated in sediment in most wetlands within Stillwater Marsh. Exposure of fish and wildlife to mercury is expected to continue under all alternatives. However, differences in wetland management practices, such as periodic flushing and wetland desiccation, may affect mercury in biological communities. Therefore, fish and wildlife exposure to, and effects from mercury may differ under some of the alternatives. Because all alternatives rely on agricultural drainage water, concerns with pesticides are expected to be similar under all alternatives.

Alternative A: As indicated under Section 4.6.3. (Flushing Action and Wetland Water Chemistry), groundwater may be used to supplement water supplies to Stillwater NWR. The use of poor quality groundwater may increase the loading of dissolved solids and trace elements, such as arsenic, boron, molybdenum, and selenium, to the refuge. Increased loading may exacerbate problems with fish and wildlife toxicity related to these contaminants.

Alternative B: Fish and wildlife exposure to environmental contaminants would be expected to be generally similar to Alternative A. A farming program on the refuge would additionally involve the use of herbicides in some cases. However, measures would be taken to lessen impacts of pesticides through integrated pest management.

Alternative C: Under this alternative, concentrations of trace elements associated with agricultural drainwater would be expected to be lower in wetlands higher on the hydrologic gradient. Therefore, exposure to, and effects from these contaminants would be expected to be lower in these wetlands. Mercury may be mobilized from bottom and bank sediments during floods in the Carson River basin. Therefore, the use of water spilled from Lahontan Reservoir during flooding may increase mercury loading to the refuge, which may exacerbate concerns with mercury. A farming program on the refuge would additionally involve the use of herbicides in some cases. Measures would be taken to lessen impacts of pesticides through integrated pest management.

Alternative D: Fish and wildlife exposure to environmental contaminants would be expected to be similar to Alternative C.

Alternative E: Effects associated with implementing Alternative E would be similar to those described for Alternative C, except that instead of reducing concerns in wetlands located higher on the hydrologic gradient. Concerns would be lessened within the flow corridor selected to receive spring pulse flows. Alternating which corridor received these flows would allow for reduction across the marsh over the long term; however, not to the extent as would occur through the Alternative C and D strategies that focus water through the same point annually.

Mitigation Measures

Under all alternatives, no adverse impacts above baseline conditions are expected. Additional measures could be implemented to minimize the potential contaminant related impacts to fish and wildlife. Because of uncertainties in the dynamics of contaminants in this shallow marsh system, continued monitoring has been recommended. It is anticipated that contaminant concentrations in water, sediment, and biological tissues would be periodically assessed. If monitoring demonstrates the continuance of impacts, additional contaminant reduction measures would be evaluated.

As indicated under Section 4.3.3.4, measures recommended by the Department of the Interior's Irrigation Water Quality Program (USDI 1985) to improve drainwater chemistry should reduce the adverse effects associated with use of drainwater for wetlands. Implementation of such measures is recommended.

Mercury appears to represent the greatest contaminant threat to fish, wildlife, and their habitat in the wetlands of Stillwater NWR. Because of mercury contamination, the Carson River to, and including, Stillwater NWR, is on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund). The U.S. Environmental Protection Agency, with assistance from the U.S. Geological Survey and the Service, are continuing to investigate measures to reduce the impacts of mercury. Remedial measures may be implemented if and when they are identified.

4.4.3 BIOTIC PROCESSES

In addition to the diversity of fish, wildlife, plants and their habitats (addressed above), biological diversity also includes the diversity of biotic processes. Some of the more prominent natural biotic processes in the Stillwater area include vegetative succession, herbivory (including grazing and browsing), production, predation, mortality, and nest loss. Many of these have been addressed earlier.

Alternatives A and B: Under baseline conditions, several biotic processes would continue to be outside the scope of naturalness, including grazing rates by large ungulates (i.e., cattle), low recruitment of certain species (e.g., leopard frogs), and possibly nest loss. Although nest loss due to flooding may be somewhat lower under baseline conditions, as compared to natural conditions, nest loss due to depredation may be higher under Alternative A. Depredation of nests may be lower than natural under Alternative B due to more emphasis on predator control. Whether overall nest loss would be higher or lower than natural conditions is not clear.

Disturbances to wildlife (e.g., disturbances causing flushing from nests, increased alert behavior, increased flying time, changes in feeding patterns, etc.) due to human activity would continue to be elevated as compared to natural conditions.

Alternative C: Under this alternative, herbivory rates and the distribution of herbivory would be closer to natural herbivory rates than under Alternative A due to the exclusion of cattle grazing from riparian areas and uplands, and the reduction in other areas. Nest loss due to flooding would be similar to Alternative A. Although the timing of water deliveries could increase the risk of nest flooding, the larger water control structures would allow more water to pass through the marsh without raising water levels, this would be difficult to do with the existing infrastructure. A limited, or lack of a predator control program, would result in similar nest loss rates as Alternative A, except that restored wet meadow and floodplain meadow habitat and lack of cattle grazing in these areas would enhance nest success of some species. Taking down perches used by ravens and other techniques would act to reduce depredation rates.

Recruitment and survival of leopard frogs and other wildlife would likely continue to be low unless a control technique for bullfrogs (or other competitors) is developed. With greater amounts of habitat in areas protected from high levels of human disturbance, restrictions on boats, and fewer roads, disturbances due to human activity would be lessened.

Alternative D: Effects on biotic processes would be similar to those of Alternative C, except that nest loss due to flooding would be substantially higher under Alternative D.

Alternative E: Effects on biotic process would be similar to those of Alternative C, except that the potential for nest flooding would be highest in one of four flow corridors selected to receive spring pulse flows.

4.5 RECREATIONAL OPPORTUNITIES

Most outdoor recreation in the study area occurs on federal lands that are under the jurisdiction of the BLM, Bureau of Reclamation, and the Service, and State lands administered by the Nevada Division of State Parks and Nevada Division of Wildlife. Stillwater NWR, Carson Lake, and Lahontan State Park are the primary recreational use areas in the Lahontan Valley. Recreational use also occurs at Newlands Project regulating reservoirs, Soda Lakes, Stillwater WMA, Fallon NWR, along the Carson River, and in the Carson Sink, but these sites have no public facilities.

Wetland habitat at Stillwater NWR, Stillwater WMA, and Fallon NWR offer opportunities for waterfowl hunting, wildlife observation, boating, and sightseeing. Some fishing occurs in these areas when water conditions are conducive to sustaining game fish populations, but a Nevada State Health Advisory has been issued cautioning against the consumption of fish in the Lahontan Valley. Wetland areas that provide opportunities for recreational use include Stillwater NWR, Stillwater WMA, Fallon NWR, and Carson Lake. Most available data relate to recreational use at Stillwater NWR, Stillwater WMA, and in Churchill County.

Although Carson Lake is a Federal property, it has been operated jointly by TCID and the Greenhead Hunt Club through coordination with NDOW for the past 68 years. Access to the area is controlled by the Greenhead Club, a private gun club operating the area under a joint agreement with TCID and NDOW. The public is allowed access into the Carson Lake wetlands but the Greenhead Club continues to monitor and regulate use of the area. Current recreational use at Carson Lake wetlands is predominately waterfowl hunting. Pursuant to P.L. 101-618, the Secretary is authorized to transfer Carson Lake to the State of Nevada, and it is anticipated that the area would be transferred, managed and operated for wildlife by Nevada Division of Wildlife in the near future.

There are a number of other private gun clubs that own, or have exclusive access to, wetland areas used primarily for waterfowl hunting. The Canvasback Gun Club (Stillwater Farms), which is located on private lands within the Stillwater NWR boundary, is the largest of these gun clubs.

Newlands Project regulating reservoirs include Harmon, Sheckler, S-Line/Ole's Pond, Old River, Sagouspe, and Indian Lakes. Recreational use of the reservoirs is limited by water availability. These reservoirs are generally small (400 to 1,000 acres in most years but seasonally higher in some instances) and are managed as part of the Newlands Project. At full pool, the following acreages can be achieved: Harmon - 1,275 acres, Sheckler - 2,835 acres, S-Line/Ole's Ponds-1,480 acres, Old River -2,290 acres, and Indian Lakes -820 acres; however, these acreages can only be met during spill periods at present. Recreation in these areas is a secondary use not specifically authorized as a Newlands Project purpose. Use of these reservoirs is generally unregulated, and people hunt, fish, boat, observe wildlife, hike, conduct dog trials, and operate radio-controlled boats and planes.

An average of 35,000 people visited Fallon and Stillwater NWRs and Stillwater WMA each year during the period of 1972- 2001, ranging from 17,000 to nearly 50,000 per year.

The riparian and desert shrub communities of the study area are conducive to activities, such as dove, quail, coyote, jackrabbit, and turkey hunting. They also provide excellent wildlife observation opportunities. These upland areas are found throughout Stillwater WMA, as well as Fallon and Stillwater NWRs. Present visitation is not monitored and restrictions are few.

The Truckee River flows into Pyramid Lake, which is 20 miles northwest of Fernley. Distinctive geological tufa formations and the contrasting beautiful blue of the water, abundant wildlife, and two islands, make this area a popular destination for photographers, wildlife observers, fishing enthusiasts and sightseers. Anaho Island NWR, one of the two islands on the lake, is the 248 acre host to one of the largest breeding colonies of American white pelicans in the United States. The lake holds a unique population of Lahontan cutthroat trout and the endangered cui-ui. Pyramid Lake management falls under the jurisdiction of the Pyramid Lake Paiute Tribe and visitors are required to purchase day-use, camping, or seasonal permits.

4.5.1 HUNTING

With the exception of Alternative D, there would be more wetland habitat available to hunters under all of the alternatives by the time the water rights acquisition program is completed. Furthermore, there would be much more consistency in available wetland habitat acreage from year to year. In the past, the amount of wetland habitat available for hunting has varied tremendously over time. Even during the period when waterfowl hunting was at a high in the Lahontan Valley (1950s through the 1970s), the number of hunters in any given year varied markedly. In the late 1950s, the number of visits to Stillwater NWR was around 10,000, but it dropped well below 1,000 during the drought in the early 1960s, but it rebounded again later that decade and exceeded 10,000 visits in the 1971-1972 hunting season. Then numbers dropped to the low thousands in the mid 1970s to rebound again to over 10,000 visits in the 1979-1980 season. In the late 1980s and early 1990s, hunter visits reached an all-time low, and no waterfowl hunting was available during one especially dry year. The amount of wetland habitat open to hunting has ranged from several hundred acres in a number of years (and zero in one year) up to more than 12,000 acres in exceptionally high-water years.

According to output from the Below Lahontan Reservoir model, water shortages would only occur in nine out of 95 years, which, along with water rights for Stillwater NWR wetlands, means that a near average amount of wetland habitat (the actual amount varying by alternative) or more would be available in an estimated 88 of 95 years (assuming climatic conditions over the past 95 years). In 24 of these years, there could be substantially more wetland habitat than the average amount due to precautionary releases and spills from Lahontan Reservoir. The estimated acreage of wetland habitat open to hunting under each alternative is presented below.

Alternative A. Under Alternative A, hunting would continue to be the priority recreational use on Stillwater NWR, Stillwater WMA, and Fallon NWR. Hunting opportunities would increase due to a 55% increase in the amount of wetland habitat in Stillwater Marsh available to waterfowl hunters in nonspill years, as compared to existing conditions. Given the volume of water rights that have been acquired to date, an estimated 6,900 acres of wetland habitat would be open to hunting over the long-term (assuming 72% of the available wetlands are hunted and that 9,600 acres of wetland habitat are maintained during the fall over the long-term). At the completion of the water rights acquisition program, an estimated average of 10,500 acres of wetland habitat would be available for hunting in nonspill years. Assuming 14,600 acres of wetland habitat, about 10,500 acres of wetland habitat would be open for hunting.

Based on the number of hunters using Stillwater NWR during the 1998-1999 hunting season, hunter densities within an area of 8,900 acres would approximate one hunter per 400 acres during the week and one hunter per 175 acres on weekends. These densities represent the minimum anticipated under Alternative A. An increase in density would be expected due to lower wetland acreages during nonspill years until the water rights acquisition program is completed. As an illustration of densities that can occur under the existing program, densities of hunters in the 1971 season, when there were 12,850 acres of huntable habitat, approached one hunter for every

35 acres of habitat on many weekends and opening weekend it was one hunter per 8.6 acres. Although hunter numbers would likely not approach those of the early 1970s, numbers would probably continue to increase as wetland habitat acreage increases and as the population increases in the nearby cities of Fallon, Reno, and Carson City and as more hunters from adjacent states continue to discover Stillwater NWR. Additional hunting opportunities would be provided when the terminal delta of the Carson River (Battleground Point wetlands) contains water, although this is expected to only happen on rare occasions. By continuing to not impose hunter density limits and boating regulations for safety purposes, hunter safety could be of concern in years of lower wetland acreage, and possibly at higher acreages if hunter numbers increase markedly.

The riparian and upland habitats of the Stillwater WMA would continue to provide hunters the opportunity to hunt for coyotes, black-tailed jack rabbits, mourning doves, California quail, mule deer, and turkeys along the lower Carson River and D-Line Canal, and other parts of Stillwater WMA. The density of these hunters is assumed to be less than that in the marsh, due to the expanse of available habitat found in Stillwater WMA. These hunters have not been monitored except by casual observation, and an estimate of the actual density has not been determined. The number of hunters using these areas is not expected to increase to any great extent beyond what they have been in the recent past because no additional opportunities would be provided or facilitated.

Alternative B: This alternative would offer the highest acreage of huntable waterfowl habitat of all the alternatives. As compared to existing conditions, the amount of huntable habitat in a full allocation, nonspill year would more than double over the next 15-20, or more years when the water rights acquisition program is completed (an estimated 11,400 acres). Hunter density would be slightly lower than under Alternative A. Assuming 15,900 acres of wetland habitat during October-December, about 11,400 acres would be open to hunting, similar to Alternative A. Factoring in shortage years, 9,000-10,000 or more acres of wetland habitat could be open to hunting in 8-9 out of 10 years on average. Densities of hunters would not be substantially affected under this alternative, except that by the end of the season, densities could decline as wetland habitat acres increase. The wetlands in Fallon NWR would infrequently provide additional waterfowl hunting opportunities. When a sufficient amount of wetland habitat exists during the hunting season, the area south of the existing dike would be open to hunting, with the northernmost portion of the wetland habitat acting as sanctuary.

The entire Stillwater NWR may be closed to waterfowl hunting if the total amount of wetland habitat were to fall below 3,000 acres, which could possibly displace hunters to alternate hunt areas, such as Carson Lake and Humboldt Sink. Construction of an all weather tour route could result in more people hunting in Stillwater Marsh during and immediately following heavy rains or snows, which would increase the range of experiences and opportunities available. The increase in opportunity would not significantly increase density in these areas because there would be more huntable acreage available under this alternative as compared to Alternative A. Additional waterfowl and upland game hunting opportunities on lands administered by the

Service would be fewer than under Alternative A, due to Stillwater WMA areas, such as the lower Carson River, Indian Lakes area, and D-Line Canal not being included under Alternative B. However, it is anticipated that opportunities currently taking place in these areas would not be affected greatly by implementation of Alternative B because hunters would likely still have the opportunity to hunt in these areas.

With more stringent boating regulations, hunter density limits, and increased law enforcement, the satisfaction of the hunting experiences for some would decrease slightly. Safety would improve, from conditions in Alternative A. Under this alternative, hunters using airthrust boats (an estimated 1 percent during the 1999-2000 season; Chaney 2000) could be displaced. This could result in hunters seeking opportunities to use their airthrust boats in other areas, such as Carson Lake and Humboldt Sink. Due to the low numbers of hunters using airthrust boats, the density of hunters in these other areas are not expected to increase measurably. Alternately, with the exclusion of airthrust boats from the marsh, these hunters could opt to change to other means of transportation and continue to use Stillwater NWR and would have no appreciable effect on the hunting in other areas in Lahontan Valley.

Alternative C, Option 1: Hunting opportunities in Stillwater Marsh under this alternative could decrease by as much as 50 percent as compared to Alternative A (Section 3.4.C.4.1.1.1) under the ongoing water rights acquisition program. Reasons for this lower amount of huntable wetland habitat, as compared to Alternatives A and B include less wetland habitat in the fall and winter, and the addition of a nonhunted tour loop. Several small units would be converted from sanctuary to a wildlife observation/environmental education area, and two formerly huntable wetland units would be converted to sanctuary. Assuming mid-points in the seasonal delivery pattern (Section 3.4.C.4.1.1.1), an estimated average of 13,400 acres of wetland habitat would exist in Stillwater Marsh during the hunting season, of which an estimated 4,500 acres would be available for hunting. This could result in higher densities of hunters as compared to Alternative A (e.g., one hunter per 75 acres on an "average" weekend versus one per 175 acres, based on 1998-1999 hunter numbers). Factoring in shortage years, an estimated 4,000-4,500 acres of wetland habitat could be open to hunting in 6 out of 10 years, and up to 7,000 or more acres in another 2-3 out of 10 years on average. The amount of wetland habitat available for hunting during a nonspill year followed by a spill year would be higher than the amount indicated above.

Opportunities for hunting in Willow Lake and Lead Lake, a traditional hunt area for some, would no longer exist under this alternative. This could affect a combined total of about 18-25 percent of hunters using Stillwater Marsh, based on data collected on hunter use during the 1998-1999 and 1999-2000 seasons (Santy 1999, Chaney 2000). More limited boat use (due to the prohibition of their use on several units and the prohibition of airthrust boats) would decrease the quality of the experience for some hunters, but would add to the quality of the experience for others. Some hunters may be displaced due to more stringent boating regulations to be adopted under this alternative, or they may be influenced to change or buy additional equipment. An estimated 1 percent of hunters used airthrust boats during the 1999-2000 season (Chaney 2000), and therefore a small number of hunters would be affected by the exclusion of airthrust boats.

Opportunities for California quail hunting would be slightly lower than under Alternative A due to the Carson River below Timber Lake not being included in the hunt area. However, upland hunting along the lower Carson River, and D-Line Canal within the hunt area would improve over the long-term, as compared to Alternative A, due to increased acres of riparian habitat to be included in Stillwater NWR (future acquisitions) and the restoration of riparian habitat. Dataisnot available for hunter density in the riparian and upland areas.

Alternative C, Option 2: This alternative would provide more hunting opportunities than under Option 1. As compared to baseline conditions, the amount of huntable habitat would decrease by an estimated 20 percent by the time the water rights acquisition program is completed. The amount of huntable habitat would increase when compared to Option 1 of Alternative C, but would be reduced when compared to Alternatives A and B. Assuming mid-points in the seasonal delivery pattern (Section 3.4.C.4.1.1.1), an estimated average of 13,400 acres of wetland habitat would exist in Stillwater Marsh during the hunting season, of which an estimated 8,400 acres would be available for hunting (an increase of 46 percent over existing conditions). This could result in slightly higher densities of hunters as compared to Alternative A (e.g., one hunter per 120 acres on an “average” weekend versus one per 150 acres, based on 1998-1999 hunter numbers). Factoring in shortage years, an estimated 6,000-7,000 acres of wetland habitat could be open to hunting in 6 out of 10 years, and up to 10,000 or more acres in another 2-3 out of 10 years on average. The amount of wetland habitat available for hunting during a nonspill year followed by a spill year would be higher than the amount indicated above.

Under this option, none of the area now within the hunt area would be converted to sanctuary and the addition of a walk-in only hunt zone within the existing hunt area would increase opportunities for this type of hunting experience. Additional road closures would increase quality of the hunt for some by providing the opportunity for a more “primitive” hunt in nonboating wetland units, thus broadening the opportunity for a wide spectrum of hunters. Conversely, it would provide for fewer opportunities for hunters wanting to drive or boat to all hunting sites. Converting West Marsh and Swan Lakes to low density hunt units where only walk-in hunters would be permitted, could affect the hunters that used Willow Lake and Swan Lake. An estimated 9 percent of total number of hunters in the 1998-1999 season used Willow Lake and Swan Lake (Santy 1999). This figure went up somewhat during the 1999-2000 season, when an estimated 19 percent used these units (Chaney 2000). Assuming 20 percent of hunters used boats in these units (based on a refuge wide average), an estimated 2-4 percent of the hunters using Stillwater NWR during the last two seasosn could be affected by converting Willow Lake and Swan Lake to a walk-in only hunt area. Until several years ago, and in most years in the past, Willow Lake has not had water in it during the hunting season and therefore has supported few hunters. All other factors (boating, upland hunting) would be similar to Option 1. A small number of hunters would be affected by the exclusion of airthrust boats, as noted under Alternatives B and Option 1 of Alternative C.

Alternative D: Hunting opportunities under Alternative D would likely not increase from existing conditions to any large degree, primarily due to differences in water management, but also because of the minimum sanctuary size of 4,000 acres and the wetland habitat to be maintained in the general public use (nonhunted) area. With the majority of water delivered during spring and the acreage threshold imposed, huntable habitat would be minimal in many years and it may not reach supportable acreages during many other years because wetland habitat acreage during full allocation, nonspill years at the completion of the water rights acquisition program would only reach an estimated total wetland habitat acreage of approximately 5,800 acres. Assuming 5,000 acres would be available for the sanctuary and nonhunt area, only 800 acres would be available for hunting during nonspill years. Opportunities for upland game hunting would be less than there would be under Alternative A because wildlife observation trails would be established in the riparian zones along the Carson River near the property formerly owned by the Alves family, prompted by the need to separate the user groups for reasons of health and safety. Boating opportunities would include those boats either without motors or with electric motors in open units, thus diminishing the experience for people that use motorized boats (up to 20 percent of hunters could be affected). However, in years when adequate habitat is available, the experience would be enhanced for hunters wanting a more primitive experience. All other components of the hunting program would be run as in Option 1 of Alternative C.

Alternative E: The amount of wetland habitat open to hunting and the estimated density of hunters on the marsh would be similar to those discussed under Alternative C (option 2), with a few notable exceptions. Because the minimum acreage in the sanctuary was dropped to 3,000 acres and an equal distribution of water between the sanctuary and open area following 6,000 acres of total habitat (3,000 in the sanctuary - 3,000 in the open area), there would be more huntable wetland acreage in low water years under Alternative E than under Alternative C (option 2). However, there would still be a reduction in huntable acres when compared to Alternatives A and B based on less water delivered during the fall than under these Alternatives. Additional acreage following meeting the 3,000 acre minimum sanctuary threshold would no longer be targeted for walk-in only hunt units (Alternative C option 2) therefore, there could be annual shifts in the location and amount of habitat available for hunting based on adaptive management principles to hydrate the best available habitat for waterbirds first.

This may also affect the ability to use boats under the boating zonation options described under Alternative E. Over the long-term average (low, normal, and spill water years), there would be approximately 13,400 acres on Stillwater Marsh of which 8,400 acres would be available for hunting. This would provide for all forms of boating access throughout the marsh in the proportions (by wetland unit) presented in Chapter 3. In low water years, wetland units would be hydrated according to existing habitat conditions and the chronological needs of waterbirds, which could result in fewer opportunities for some boating access options in low water conditions. Because airboats would be allowed on some units of Stillwater marsh and motor size and speed restrictions would not be imposed, boating access opportunities would be enhanced over those proposed under Alternative C (both options) and Alternative D but would be reduced when compared to Alternatives A and B. The reduced opportunities from baseline conditions are directly attributable to no boating and nonmotorized boating designations for some huntable wetland units; however, it is anticipated that alternative E boating access options would provide the greatest range of opportunity for boating access among the alternatives analyzed.

Hunting opportunities for big game and upland game would be greatly enhanced when compared to Alternatives B, C, and D and would be similar to slightly lower than those provided under Alternative A. Opportunities to hunt all species at Stillwater NWR would be allowed as per state law, in all areas open to hunting. This would include all areas previously described for Alternative C and the remainder of the existing WMA to be incorporated into Stillwater NWR under the Alternative E boundary proposal.

Mitigation Measures

Although hunting opportunities would increase as compared to existing conditions, implementing Alternatives C or D could result in fewer hunting opportunities as compared to Alternative A, especially if Alternative D or Option 1 of Alternative C were implemented. Alternative E would provide a range of opportunity for a variety of hunting strategies, from nonboating units to units accommodating airthrust boats. Several of the possible mitigation measures that could lessen the impacts of implementing a hunt program that is consistent with P.L. 101-618, other laws, and Service policy have already been built into the two options of Alternative C and Alternative E. Establishment of a limited goose hunt (permit system) could be implemented to offset the lower level of wetland habitat acreage that would be available under Alternatives C and E as compared to baseline. Another possibility to mitigate impacts of reduced huntable habitat under Option 1 of Alternative C would be to provide half day hunts or alternative days open for hunting and for other uses, rather than reducing the size of the hunt area to provide an area for other, nonconsumptive uses. A “sliding” open area could be implemented. As waterfowl use declines during the season, the amount of sanctuary could be reduced, allowing additional acres to be hunted. Although there are numerous possibilities to mitigate adverse impacts to hunting opportunities, some of these would result in unacceptable biological impacts, would be complicated to administer or enforce, or would result in implementation of another alternative such as Alternative A or B. Mitigation measures that would reduce impacts to hunting opportunities to the greatest degree would be a further increase in fall water deliveries and a reduction in the minimum amount of sanctuary to be maintained. These measures are evaluated under Alternatives A and B.

Monitoring would be a critical part of Alternatives C, D, and E. As more information becomes available on the relationships between hunting and related activities and the achievement of refuge purposes and goals, the hunting program could be adjusted. This is would be a long-term process.

4.5.2 ENVIRONMENTAL EDUCATION AND INTERPRETATION

Alternative A: This alternative offers a wide variety of habitats available for exploration and research. Current conditions provide touring opportunities for an average of 17 groups of approximately 60 people per tour, per year. These tours occurred in 2001 during January-November, with April through June being the favored months. Under this alternative, numbers should remain similar because existing facilities for environmental education and interpretation would not be enhanced. The current practice is to take environmental education groups into the hunt area during hunting season because it would be the only area open to the public at that time, but some teachers and group leaders would continue not to visit the historic marsh when they learn the available viewing areas are in the hunt area. This would inhibit increased use of the area during the fall by visitors. Teachers would probably seek an area with more amenities. The mobile interpretation program, including presentations to schools and organizations, would continue to be improved and enhanced as warranted, but on-site programs would not provide for the needs of the local schools due to lack of interpretive facilities and sites.

Alternative B: Alternative B would provide additional opportunities for environmental education and interpretation with the construction of a comprehensive visitor and environmental education center. The center would provide services currently missing from the Stillwater NWR experience, such as restrooms, learning center, museum dioramas, and observation and study opportunities. This would afford teachers of younger children, grades one through three, an opportunity they have previously foregone due to lack of restroom facilities. Visitation would increase due to the availability of an environmental education site removed from the hunting public (providing additional opportunities for those who declined to tour at this time under the current program). On-site educational programs, particularly trips into the historic marsh, which would be allowed only during the spring in order to avoid conflicts with the hunting public, would diminish opportunity for year round environmental education throughout the marsh. The mobile interpretation program would continue as in Alternative A.

Alternative C: The visitor facility provided in this alternative would provide similar opportunities as described in Alternative B. The environmental education program would be increased under Options 1 and 2 due to the addition of a site near the historic marsh to conduct activities and to afford more comfort for the public (addition of restroom/comfort facilities). Under Alternative C, the addition of the tour loop through what is now sanctuary and creation of wetland habitat along Hunter Road would allow visitors to see the marsh as soon as they enter the refuge. Retaining the lands within the present Stillwater WMA would present opportunities for studying local species of reptiles and amphibians by adding the vegetated dune habitat to Stillwater NWR. Interpretation opportunities would be higher than under Alternative A because interpretative facilities would be developed along the Carson River corridor in the Timber Lake area. Interpretation of the Timber Lake area would be crucial in satisfying the public's curiosity about breeding birds, such as great blue herons, and educating people about the need for adaptive management planning where the trails would be changed to provide for the least amount of disturbance during nesting. Allowing year round access would greatly increase the potential for comprehensive study and research on the life cycles of local plant and animal species.

Alternative D would result in a marked increase in environmental education and interpretation opportunities as compared to Alternative A. An extensive, all weather tour route, with signs and corresponding media (tapes, radio broadcasting) would provide the most comprehensive tour of this Great Basin ecosystem of all the alternatives. This could provide an increased awareness of the natural processes found in this area delivered through a well developed interpretive venture. A variety of viewing possibilities would exist under this alternative with the development of a riparian bird watching trail, several towers along the auto tour route, and intensive interpretation of the Battleground Point cultural resource area. This extensive education of the public on natural processes and cultural resources would result in a greater understanding of the area and of reasons why the naturalness should not be disturbed and result in satisfying the curiosity of those publics who would have unwittingly caused much damage by their explorations. The upgraded version of the Visitor Center would provide increased benefits to the educational aspects of the program with more space for programs, laboratories, an accessible second level observation platform, and research materials. As facilities are enhanced, the possibilities for a quality experienceisenhanced, and as more quality experiences are reported to additional publics, visitation would increase.

Alternative E: The effects of implementing Alternative E would be similar to those discussed for Alternative C, Option 2.

4.5.3 WILDLIFE OBSERVATION AND PHOTOGRAPHY

Alternative A: Stillwater NWR is currently open year round for wildlife observation and photography. With the current nationwide upward trend in nonhunting or fishing recreational activity, the density of users is anticipated to rise under Alternative A. The acreage of wetland habitat would increase due to the completion of the acquisition program. The primitive opportunities available, limited to fair weather only with no improvements to existing roads, would continue to draw people interested in these conditions. Further increases in observation and photography at Stillwater Marsh during the spring and summer due to increased habitat acreage would be expected, but upland and riparian opportunities would remain at status quo because of limited interpretive and directional signs. Waterbird observation opportunities would continue to be limited during the fall and winter due to all available units for observation being open to hunting. Birdwatchers would not have access to areas in which waterfowl and other birds could become habituated to vehicles and other human activity associated with birdwatching.

Increased camping and boating in the Indian Lakes area of Stillwater WMA, anticipated because of the population increases in Fallon, Carson City, and Reno, could result in a localized decrease in quality for observation and photography opportunities with no additional restrictions placed on these activities. One to three days every few years, controlled burns could affect visitors, and other people in the area (e.g., minor eye or skin irritations, problems with breathing, and visibility).

Alternative B: This alternative would increase observation opportunities in Stillwater Marsh somewhat with the construction of an all weather tour route and construction of towers. Although fall and winter viewing opportunities would increase under this alternative's water management strategy, some viewers' opportunities would be limited because the tour route would continue to be inside the hunt area. The quality of the experience for spring and summer viewing would be hampered because additional areas would be closed during the breeding season and because restrictions would require people to remain on the tour route and in designated areas during the nonhunt periods. The restrictions placed on use of the refuge in other than hunting seasons would severely curtail photography opportunities. In consideration of a broad spectrum of users, this alternative offers little for those who wish to see the historic marsh in a fairly primitive state, but does provide opportunity for those users who prefer to frequent formal facilities. Development of an all weather tour route would increase observation and photography opportunities to include days of inclement weather. With the decrease in upland habitat effected by the boundary exclusion of the Stillwater WMA, opportunities for observation and photography of some sought after species, such as the California quail on refuge lands would be limited. Also missing from observation and photography opportunities on refuge lands would be the unique diversity of landscapes and fauna found in conjunction with vegetated dune habitat. However, opportunities for wildlife observation and photography in the area now within the Stillwater WMA would continue as they would under Alternative A. One to three days every few years, controlled burns could affect visitors, and other people in the area. This could take the form of eye and skin irritations, problems with breathing, and could affect visibility. Similar to Alternative A, waterbird observation opportunities would continue to be limited during the fall and winter because all available units for observation would be open to hunting.

Alternative C: Year round opportunities for observation and photography would increase in Options 1 and 2 with a balanced emphasis on the six priority recreational uses. The shift in water management, as compared to Alternative A, would offer increased potential for shorebird viewing and photography. An all weather tour route would increase access during all weather conditions, compared to the "fair weather only" access afforded under Alternative A. Viewing opportunities would be enhanced by a tour loop through the area currently regarded as sanctuary, due to the less complex shoreline configuration and low vegetation, which would afford the opportunity for a shorter trip to view the marsh. The addition of wetland habitat along Hunter Road would also add to the viewing potential. The development of observation facilities in the Timber Lake area would facilitate the opportunity to view a wide variety of passerines, raptors, and other riparian species. Specific visitation data is not precise enough to address trends, but it is expected that this alternative would provide a more satisfying observation or photographic experience, than Alternative A, due to the availability of interpreted sites throughout the refuge. This interpretation emphasis would presumably result in repeat visitation by observers and photographers. Similar to Alternative A, waterbird observation opportunities would continue to be hampered during the fall and winter because many of the units for observation would be open to hunting. One to three days every few years, controlled burns could affect visitors, and other people in the area. This could take the form of minor eye or skin irritations, problems with breathing, and could affect visibility.

Alternative D: Spring photography and observation opportunities would abound under Alternative D. Photography would be enhanced by the placement of a blind near the great blue Heron rookery by the Lower Foxtail unit. An increase in trails and interpretative facilities would afford an increased level of satisfaction for the visitor in this alternative when compared to Alternative C, and a vast increase compared to Alternative A. Shorebird viewing opportunities during fall migration would be higher than those under Alternative C and would be much higher than those under Alternative A, with high mid-summer wetland habitat acreage declining through the fall shorebird migration period.

Alternative E: The effects of implementing Alternative E would be similar to those discussed for Alternative C, Option 2.

4.5.4 FISHING

Under existing conditions and Alternative A, fishing is permitted on Stillwater NWR and Stillwater WMA. With the acquisition of water rights for Stillwater NWR, wetland habitat has become more favorable to game fish populations. However, at this time, wetland conditions continue to be less than optimum for most game fish (large seasonal and annual fluctuations in wetland habitat acreage, and high salinity and alkalinity). Nevada Division of Wildlife stocks some species of game fish in the Indian Lakes area. Fish stocked in Lahontan Reservoir and other reservoirs can make their way to Stillwater Marsh. Other fishing opportunities in the affected area include regulating reservoirs, such as Harmon Reservoir, Lahontan Reservoir, and Pyramid Lake. Fishing is not permitted in Carson Lake.

Alternative A: Game fish populations are anticipated to increase as more water rights are acquired, thereby enhancing recreational fishing on the area (WRAP EIS 1996:page 4-111). However, the Nevada State Division of Health issued a health advisory in 1997 for game fish taken from waters in the Lahontan Valley. The health advisory warns that consumers should "refrain from eating fish caught from the Carson River in the vicinity of Dayton to the Lahontan Dam and all waters in the Lahontan Valley" due to elevated levels of mercury.

Alternatives B, C, D, and E: Fishing would not be permitted under these alternatives. This is not anticipated to have any significant impacts on recreational fishing in the Lahontan Valley because little fishing occurs on Stillwater NWR and Fallon NWR at present. The Indian Lakes area would not be included in these boundary revision alternatives, and fishing would presumably continue as it has in the past.

Mitigation Measures: The action alternatives would have few adverse impacts to fishing on Stillwater NWR because little fishing occurs at present. To lessen the impacts of totally excluding fishing from Stillwater NWR, fishing could be permitted in designated areas during noncritical times for birds, such as August-October, although molting areas should be avoided. Opportunities for fishing could also potentially be provided during the hunting season without adding substantially to human disturbance effects on birds. However, two of the primary reasons for not allowing fishing, the mercury health advisory and the absence of native game fish, are difficult to mitigate.

4.5.5 CAMPING AND BOATING

Alternative A: Most camping on Stillwater NWR would be in conjunction with the waterfowl hunting season, but it could occur all year long. Camping on Stillwater WMA, primarily the Indian Lakes area, most often occurs during the spring and summer months. In Alternative A, camping during October-December would likely increase with hunter densities, causing hardening of sites and minor pollution problems reducing quality of the camping experience for the next users. Camping during the breeding season would likely increase from existing conditions in response to rise in nonconsumptive users. Boating in Stillwater Marsh, under this alternative, would continue with little restriction. The Indian Lakes area of Stillwater WMA would continue to see an increase in camping and boat use all year long with an increase in the local population and nationwide upward trend in participation in outdoor activities. Quality of these experiences would be directly affected due to degradation of boat launching sites and hardening of camping sites (becoming devoid of vegetation).

Alternative B: This alternative would provide for camping and boating during the hunting season in support of the priority recreational uses. Increased restrictions on boating within the marsh would provide a higher quality experience for some people during the hunting season, but would reduce the quality of experience for others. Boating in support of wildlife observation, during seasons other than hunting, would be limited due to seasonal restrictions as compared to Alternative A. Camping and boating opportunities would presumably continue on the Indian Lakes area.

Alternative C: Because people would be allowed to spend nights on Stillwater NWR in self-contained units and only in designated areas under this alternative, fewer opportunities would be provided as compared to Alternatives A and B. Boating opportunities would be enhanced as compared to Alternatives A and B for the nonhunting public with the development of canoe trails during the spring breeding and summer seasons (Alternative C). Camping and boating opportunities would presumably continue on the Indian Lakes area, and due to added restrictions on camping, camping at the Indian Lakes area could increase as could camping on lands adjacent to Stillwater NWR.

Alternative D: No camping would be permitted under this alternative. Opportunities for boating would be reduced considerably because use would be restricted to motorless or electric-powered crafts during all seasons. Further limitations would occur during the hunting season as a result of the reduced wetland acreage in nonspill years. These restrictions would cause a limit in the recreational experiences provided during the hunting season when compared to the other alternatives. Camping and boating opportunities would presumably continue on the Indian Lakes area, and due to added restrictions on camping, camping at the Indian Lakes area could increase as could camping on lands adjacent to Stillwater NWR.

Alternative E: The effects of implementing Alternative E would be similar to those discussed for Alternative C, Option 2, with the exception that non-motorized boating would be allowed all year in Swan Lake Check.

Mitigation Measures: Measures for mitigating adverse impacts to camping opportunities have already been built into Options 1 and 2 of Alternative C and Alternative E, such as the potential for camp sites on BLM lands, private lands, or other lands adjacent to the refuge.

4.5.6 OTHER USES

Other uses are those uses that are not wildlife-dependent recreational uses or do not directly support one or more of the six priority recreational uses. These include but are not necessarily limited to: off-road vehicle use, horseback riding, retriever training, and model airplane flying

Alternatives A: Current management allows licensed off-road vehicles on existing roads and horseback riding to occur throughout the land now managed by the Service. These uses and others occur on Service managed lands, the majority of the use is concentrated in Stillwater WMA. While these activities would not be promoted, no further restrictions would be placed on them Under Alternative A.

Alternative B: Under this alternative, the Indian Lakes area would no longer be within the jurisdiction of the Service and the frequency of other uses in the Stillwater NWR Complex would decline. Within the boundaries of Stillwater NWR and Fallon NWR, under Alternative B, restrictions would be imposed to limit access during all but the hunting season, but since very little use occurs other than in the Stillwater WMA, this alternative would have little impact on these uses.

Alternatives C, D, and E: Most uses would see no marked change, because most other uses take place in the Indian Lakes area, which would not be included in these alternatives. Horseback riding would be more restricted, however, on any area other than the Indian Lakes area, as horses would be confined to open roads and designated trails only. This would reduce some riders' opportunity, but most would presumably continue to ride in the area and abide by the rules rather than seek an alternate location. With adoption of the purposes outlined in P.L. 101-618 and conforming to guidance provided in the Refuge System Administration Act, other uses would be increasingly difficult to allow and would have to be deemed appropriate and compatible before allowed. It is possible that some uses would not be deemed appropriate and compatible and would have to be prohibited. In that case, other areas within the Lahontan Valley would see a slight increase in these uses.

4.6 CULTURAL RESOURCES AND INDIAN TRUST ASSETS

4.6.1 CULTURAL RESOURCES

Cultural resources, especially archaeological sites, are fragile and nonrenewable. Most of these sites consist of artifacts and such things as seeds and bones, found within a sedimentary soil deposit laying at, or close to, the surface of the ground. Archaeological sites are small, subtle, and thin, when compared to the surrounding landscape and contemporary cultural features, such as roads, ditches, and structures.

The value of cultural resources derives from the interrelationship of the artifacts and ecological remnants such as seeds and bones in soil deposits. Through analysis of these relationships, archaeologists and geologists obtain data that allows an assessment of the age, content, function, and activities represented by the site. Any disturbance to the site will damage these relationships and thus destroy their information potential. Therefore, any activity identified in the alternatives being considered, including land development, grazing, hunting, and changes in public use have the potential to impact cultural resources. However, as discussed previously, there is a host of Federal legislation that protects cultural resources and requires agencies, such as the Service, to consider, and if necessary, mitigate the impacts of its projects on cultural resources before implementation. The Service will comply with these laws, and thus maintain a cultural resource program, regardless of the alternative chosen.

Cultural Resources Defined: Cultural resources are physical remains, sites, objects, records, oral testimony, and traditional life ways that connect us to our past. Cultural resources include archaeological and historical artifacts, sites, landscapes, plants, animals, sacred locations, and traditional cultural properties that play an important role in the traditional, but continuing, life way of a community. Most of the recorded cultural resources at the Stillwater NWR are archaeological sites.

Archaeological evidence shows that human beings have lived in and around Stillwater Marsh for at least 12,000 years. The historic descendants of this legacy are the *Toedokado* or Cattail-eater Northern Paiute of Stillwater Marsh and vicinity. The modern descendants of the *Toedokado* are represented by the Fallon Paiute-Shoshone Tribe whose reservation borders Stillwater NWR. Cultural resources at Stillwater remind us that people were a part of the American wildlife landscape long before European contact.

Stillwater NWR and its surrounding area have hosted pioneering anthropological and archaeological studies throughout the twentieth century. Much of this work is summarized in *In the Shadow of Fox Peak: An Ethnography of the Cattail-Eater Northern Paiute People of Stillwater Marsh* (Fowler 1992). The reader should consult this document for a comprehensive overview of cultural resources at Stillwater NWR. The Service maintains a complete library of cultural resource information relevant to Stillwater NWR and WMA including maps, photographs, site record forms, technical and professional reports, literature, compliance documents, and correspondence. Most of the artifacts are curated at the Nevada State Museum in Carson City. Human remains are reintered in an underground vault on a portion of Stillwater NWR closed to the public.

Northern Paiute of Stillwater: Toedokado origin myths place Jobs Peak in the Stillwater Range at the center of creation. From there the first people were dispersed to Stillwater Marsh (and other places) which was filled with water by the tears of the Creator because of warring between his children (Fowler 1992).

The explorers, settlers, and journalists who came into *Toedokado* territory all remarked on the vibrant American Indian population at Stillwater Marsh. The marsh was alive with Indians as much as it was with wildlife and fish. Archaeological research has shown that the marsh has been a human landscape for thousands of years. Archaeological remains of *Toedokado* culture pervade the soil of every island, peninsula, and dune of the marsh. Even the barren playas have yielded evidence of the people.

The *Toedokado* were year round residents of the marsh. They were not nomads who somehow eked out a living in a harsh environment. They understood the complexities of the ecosystem and were able to extract all the necessary food and raw materials to maintain a rich and thriving culture. For *Toedokado* descendants and members of the Fallon Paiute-Shoshone Tribe, the archaeological sites, sacred places, plants, and animals of Stillwater Marsh are basic elements of individual and group identity. Thus, the management of the Stillwater NWR and its cultural resources is of particular concern to the Fallon Paiute-Shoshone Tribe. As the CCP compels us to contemplate our interaction with the Stillwater environment today, we must remember that the *Toedokado* and their ancestors have been doing this for millennia.

Archaeological Sites at Stillwater: More than 535 cultural resources, primarily archaeological sites, have been identified and recorded on Stillwater NWR and Stillwater WMA. However, only 7 percent of Stillwater NWR and Stillwater WMA has been searched for cultural resources. If the entire area were systematically inventoried, the total number of cultural resources would tally into the thousands. Few other places in the Great Basin exhibit such a high abundance and diversity of cultural resources in such a small area.

Evidence indicates that most of the Stillwater area archaeological sites date to the last 4,000 years. The flood of the mid-1980s, which brought national attention to Stillwater Marsh archaeology, revealed many sites dating to a period of 2000 to 1000 years ago (Tuohy et al.1987, Raymond and Parks 1989, 1990). In terms of size and function, the archaeological sites at Stillwater show a lot of diversity. Some sites are represented by a single isolated arrow point, which mark the loss of a hunter's arrow which missed its target. Other sites are packed with the remnants of bustling marshland villages containing dense accumulations of discarded stone tools, food debris, and the remains of house foundations, storage pits, and human burials (Raven 1990).

Research between these sites has helped rewrite traditional depictions of Great Basin prehistory. Gone is the belief that Great Basin Indians were constantly on the move, searching for food in a harsh environment. Stillwater has yielded abundant evidence of a relatively stable adaption to wetland resources in semi-sedentary hamlets supported by food storage. The marsh and the surrounding countryside met all the needs of the Toedokado and their ancestors. Archaeological deposits show a reliance on the abundant resources of the area including: hardstem and alkali bulrush, *Sueda*, cattail, freshwater mussel, tui chub, jackrabbits, mice, voles, ducks, coots, geese, swans, pelicans, deer, wolf, mink, and otter (Tuohy et al 1987, Raven and Elston 1988).

The archaeological deposits have the potential to reveal the details of environmental change since the last Ice Age, and human adaptation to that change. The Stillwater archaeological sites are reservoirs of data concerning environments, habitats, plants, and animals that have occurred at Stillwater wetlands since the last ice age. Cultural resources research at Stillwater has yielded excellent baseline data on habitats and wildlife that characterized the refuge prior to the European incursion into Nevada.

Archaeologists have developed a model to predict the number, contents, and function of archaeological sites within any defined area at Stillwater depending on the native habitat within that area (Raven and Elston 1989). A field test of the model (Raven 1990) confirms that habitat type is correlated with the abundance, diversity, and content of archaeological material found in the particular habitat. Some of the model predictions confirmed by archaeological fieldwork at Stillwater include the following: Islands and peninsulas in the marsh have the most abundant and diverse archaeological record. They contain the greatest incident of prehistoric habitations, highly diverse artifacts, storage facilities, hearths, abundant food debris, and burials. Habitats characterized by sandy fans and sheets display the least evidence for habitation of all the watered upland habitats at Stillwater. Dry sodic flats, and similar habitats, host evidence of prehistoric hunting stands and game butchering locations. Prehistoric seed gathering and processing locations are most prominent in habitats characterized by sodic sands and gravely loams.

National Register District: In recognition of the cultural resources at Stillwater, the Department of the Interior established the Stillwater Marsh National Register Archaeological District in 1974. This 42,000 acre district includes most of Stillwater NWR and small portions of private and Federal (BLM) land. Although only a small fraction of the district has been systematically inventoried for cultural resources, more than 150 archaeological sites have been recorded in the District. From a management perspective, the National Register District implies that all cultural resources within it are eligible to the National Register of Historic Places until proven otherwise. The Service, the Nevada State Historic Preservation Office, the Advisory Council on Historic Preservation, and the Fallon Paiute-Shoshone Tribe have formal written agreements concerning the management of cultural resources at Stillwater NWR and Stillwater WMA.

Human Burials: One of the salient features of Stillwater archaeology is an abundance of human burials (Brooks et al. 1988, Larsen and Kelly 1995). The flood of the mid-1980s revealed more than 4,000 human bones representing at least 140 people. Overnight, the number of known archaeological human remains in the Great Basin doubled. It is safe to infer that hundreds more human burials lie just below the surface of greasewood studded islands and peninsulas of the Stillwater wetlands. The archaeological pattern appears to be that any residential archaeological site may contain one or more human burials. There is a high possibility of encountering human remains almost anywhere in and around the marsh. The exposure of burials does not require a massive erosion event like the flood of the mid-1980s. Localized wind or sheet wash erosion occasionally brings bones or a burial to the surface.

The complexity of managing human burials cannot be overemphasized. They incite more intense emotions and scientific curiosity than most other cultural resources. As physical remains of once living people, linked to descendants represented by members of the Fallon Paiute-Shoshone Tribe, burials require a level of respect and deference that most scientists and land managers do not confer to other resources. Burials are labor intensive to recover, describe, store (temporarily), and rebury. Considerable consultation with the Fallon Paiute-Shoshone Tribe is essential for all human remains. Specific laws, such as the Native American Graves Protection and Repatriation Act (NAGPRA), in addition to the usual suite of historic preservation legislation come to bear upon their discovery. Procedures for identification, recovery, storage, study, and reburial of human remains from Stillwater have been codified in an agreement between the Service and the Fallon Paiute-Shoshone Tribe. Nevertheless, human remains, a constant at Stillwater, require considerable staff time and careful consideration.

Alternatives A and B: The need to comply with the many Federal laws, regulations, executive orders, and agreements concerning cultural resources means that the Service would maintain a basic level of cultural resources management under these alternatives. In practice, this means that compliance with Section 106 of the National Historic Preservation Act would be the focus of most cultural resource management at the refuge. Cultural resource management under these alternatives can best be described as reactionary. When a project is proposed or when there is a question concerning cultural resources, the Service calls in either the Regional Archaeologist or a contractor to address the issue. The main difference between Alternatives A and B is the addition of a law enforcement officer under Alternative B, would benefit cultural resources protection. No adverse impacts to cultural resources are anticipated to occur with respect to the Alternative B boundary because land status in the area of Stillwater WMA would remain the same as it is now (public lands with a primary withdrawal by the Bureau of Reclamation).

Additional land developments are anticipated under both alternatives and, therefore, the Service would exercise more of the Section 106 process of the National Historic Preservation Act. For example, the construction of water delivery facilities such as canals, dikes, and control structures can impact cultural resources. Therefore, the Service would carry out the National Historic Preservation Act, Section 106 process to ensure that cultural resources are considered in project planning and avoided or treated appropriately before construction is approved.

Water levels under normal operations are not anticipated to reach levels that would inundate archaeological sites (Table 4.23), and therefore would have few detrimental effects on these cultural resources. (The archaeological sites at Stillwater do not occur within the wetlands; they occur on the upland islands and peninsulas that are surrounded by wetlands.) Alternative B calls for intensive management of water levels in wetland units. However, with the possible exception of Pintail Bay, none of the estimated, normal management levels for particular units would exceed the lowest elevation of the archaeological sites in that unit. Alternative B would have more potential than Alternative A for exceeding critical elevations under normal water management operations, but even under Alternative B, this would not occur except under unusual circumstances.

Detrimental effects could still occur during a series of high water years that resulted in sustained high water levels, over which the Service would have little control. Sustained high water levels that inundate archaeological sites cause the most erosion, which is the most serious impact. Waves and ice scour the landforms and sediments holding the cultural deposits and destroy their information potential. High water can wash away wind deposited topsoil and vegetation that cover archaeological deposits. Stripped of this protective layer, the archaeological sites suffer further erosion from wind and water. They also become easy targets for looters. Increased cover of vegetation along shorelines containing sites would alleviate some of these impacts, but because water levels under normal operations would generally not exceed elevations of archaeological sites, vegetation cover would not increase in these areas.

Fire alone is not considered to have a direct effect on cultural resources. However the excavation of fire lines, staging of vehicles, use of high powered water hoses, and other fire control techniques can have adverse impacts on cultural resources. Therefore, the Service would

Table 4.23. The minimum elevation of archaeological sites in several wetland units of Stillwater National Wildlife Refuge and equivalent staff gauge readings, and anticipated maximum operation water-surface elevations for each of the units.

	Point at which Sites become Flooded		Anticipated Maximum Operational
Wetland Unit	Staff Gauge (feet)	Water-surface Elevation	Water-surface Elevation
Goose Lake	7.42	3873.5	3872.4
South Nutgrass	7.80	3872.2	3871.8
North Nutgrass	7.48	3871.7	3870.7
West Nutgrass	7.41	3871.6	3870.7
Swan Check	7.40	3871.6	3871.2
Tule Lake	8.37	3872.9	3871.7
Swan Lake	7.87	3872.2	3871.4
Pintail Bay	6.00	3870.2	3870.5

comply with Section 106 of the National Historic Preservation Act. If wildfire suppression activities impact cultural resources, the Service will also comply with Section 106 of the Act.

Where livestock grazing occurs in the vicinity of cultural resources, it represents a considerable threat to the integrity of these resources. Cattle trampling damages the sediments that hold cultural resources, especially when cattle congregate near water sources or moist soil. Therefore, cattle grazing under Alternatives A and B in the area now encompassed by Stillwater WMA would continue to pose a threat to cultural resources. Under Alternative B, cattle grazing would be reduced in Fallon NWR. Little cattle grazing occurs in the historic Stillwater Marsh.

Recreational use under these alternatives can inflict serious damage to cultural resources. Some impacts, such as trampling of archaeological sites by hikers, campers, boat landing and launching, wave action by boat, and the erection of blinds, are unintentional. Other impacts are opportunistic, such as artifact collecting while hunting or birdwatching. Professional and avocational archaeologists and the Fallon Paiute-Shoshone Tribe are particularly concerned about illegal looting of archaeological sites at Stillwater NWR. This has been a documented problem for decades at the refuge. For people intending to find and take artifacts, recreational activities provide the perfect cover. Facilitating or increasing access to the refuge poses a serious threat to cultural resources. Under the existing network of roads, few restrictions on access (all parts of the refuge being open every day, all day, except in the designated sanctuary), the potential for impacts is high. Restricting people to roads and other designated areas under Alternative B would greatly benefit cultural resources protection because people would not be able to walk around the wetlands for most of the year.

Alternative C: This alternative includes the basic cultural resources protection and compliance requirements of Alternatives A and B. However, under Alternative C, steps would be taken to proactively manage cultural resources as identified in the goals and strategies discussed in Chapter 3. This alternative calls for the employment of a full time refuge archaeologist who would carry out many of the strategies identified in Chapter 3, which would benefit cultural resources. The refuge would work with the Fallon Paiute-Shoshone Tribe on research, interpretation, and educational activities with cultural resources. Cultural resources would be integrated into environmental education and outreach programs. Furthermore, the needs of and concerns for cultural resources would play a more important role in setting management priorities for the refuge. The presence of an archaeologist onsite would allow cultural resources to be more closely monitored, which would allow more immediate action being taken to prevent damage. Also, cultural resources would receive enhanced protection from looters, as compared to Alternative A, because of the presence of a law enforcement officer. No adverse impacts to cultural resources are anticipated to occur with respect to the Alternative C boundary revision because land status in the areas of Stillwater WMA not incorporated into Stillwater NWR would remain the same as it is now (public lands with a primary withdrawal by the Bureau of Reclamation). Parts of Fallon NWR not incorporated into this alternative are located in the Carson Sink, which does not have any known archaeological sites. Potential transfer of the Indian Lakes area to a non-Federal entity are described in another environmental document (USFWS 1996c).

The construction of water delivery facilities such as canals, dikes, and control structures, can impact cultural resources. However, the Service would carry out the Section 106 process of the National Historic Preservation Act to ensure that cultural resources are considered in project planning and avoided or treated appropriately before construction is approved.

As under Alternative B, this alternative calls for intensive management of water levels in wetland units. However, with the possible exception of Pintail Bay, none of the estimated, normal management levels for particular units would exceed the lowest elevation of the archaeological sites in that unit (Table 4.23), except for a brief period in the early spring. Therefore, it appears that the water levels under this alternative would only inundate known archaeological sites or upland landforms that may contain unrecorded archaeological sites in the early spring for a brief period.

Detrimental effects could still occur during a series of high water years that resulted in sustained high water levels, over which the Service would have little control, although impacts could potentially be lower than anticipated impacts under Alternatives A and B during high water events. Erosion is the most serious potential problem affecting cultural resources. Sustained high water levels that inundate archaeological sites cause the most erosion. Waves and ice scour the landforms and sediments holding the cultural deposits and destroy their information potential. High water can wash away wind-deposited topsoil and vegetation that cover archaeological deposits. Stripped of this protective layer, the archaeological sites suffer further erosion from wind and water. They also become easy targets for looters. The increased cover of vegetation along shorelines containing sites, as compared to Alternatives A and B, would alleviate some of the above impacts. The springtime pulse of water that would occur in many years in a number of wetland units would allow vegetation to become established above the normal high water elevation (which is below most archaeological sites). Establishment of vegetation above this elevation would provide additional protection because emergent vegetation slows the erosive power of wave fetch. Upland plants like saltgrass and greasewood trap wind and waterborne sediments that cover and stabilize the sites. Plants also obscure cultural deposits from the eyes of looters. Vegetation plays an important role in protecting archaeological sites.

Effects of cultural resources from fire would be similar to those under Alternatives A and B, and the impacts associated with cattle grazing would be reduced under Alternative C, due to the exclusion of cattle grazing from the riparian corridors and all upland areas. Although cattle grazing could be used in Stillwater Marsh, electric fences or other technique would be used to keep cattle away from shorelines, which would provide protection to cultural resources. Cattle grazing under this alternative would primarily be restricted to disturbed areas, such as farmland.

Further restrictions on visitor services under this alternative would further alleviate impacts to cultural resources, even more so than would occur under Alternative B. Some impacts, such as trampling of archaeological sites by hikers, boat landing and launching, wave action by boats, and the erection of blinds, foot traffic around the marsh during much of the year, and unrestricted camping would lessen, which would greatly benefit cultural resources protection. Other impacts noted in Alternative B would be reduced. Closing Willow Lake (Option 1) and restricting access to Willow and Swan Lake during the hunting season to foot traffic only (Option 2) would reduce impacts in these wetland units. Alternative C would continue to allow people to walk around and into all parts of the most sensitive places for cultural resources (e.g., Nutgrass, Swan Check, and Pintail Bay units) throughout the hunting season.

The environmental education and interpretation program of Alternative C would incorporate cultural resource information that would increase the public's appreciation for: (1) the discipline of archaeology - the methods of turning archaeological facts into information about the past, (2) the role of the Stillwater Marsh in prehistoric human ecology, (3) the importance of cultural resource conservation, and (4) the perspective of the Fallon Paiute-Shoshone Tribe on cultural resources and their cultural heritage at Stillwater. The public education and interpretation program would benefit markedly from the preservation, protection, and management of cultural resources at Stillwater NWR.

The construction of visitor facilities, kiosks, trails, roads, etc. can have direct impacts on cultural resources by physical alteration and damage of cultural deposits. However, the Service would carry out the Section 106 process of the National Historic Preservation Act to ensure that cultural resources are considered in project planning and avoided or treated appropriately before construction is approved. The indirect effects of visitor facilities include increasing access and numbers of people to the wetlands and its cultural resources.

Alternative D: The effects of implementing this alternative would be similar to Alternative C, except that much higher fluctuations in water levels, under normal operations, could increase the susceptibility of some archaeological sites to damage. Conversely, removing Goose Lake, Tule Lake, and the South Nutgrass unit from the hunt area would provide a much higher level of protection for cultural resources in these units because people would only be able to observe these units from the road.

Alternative E: Implementation of Alternative E would have the same affects as Alternative C except that focus of spring flows through one of four identified flow corridors would make it easier to control water elevations than if flows were distributed throughout the marsh as would occur through implementation of Alternative C. Additionally, no boating areas would be provided; however, engine size and speed of motorized boats would not be regulated thus providing the potential for wake disturbance of archaeological sites located near the waters edge. Most sites are located above normal operating pool elevations and the activities of boats are not anticipated to result in impacts to archaeological resource sites.

Mitigation Measures: The habitat, visitor services, and cultural resource management programs of Alternatives C and E were designed, in part, to minimize adverse impacts to cultural resources, to correct problems stemming from past land use activities, and to provide increased protection for cultural resources. For example, maximum water surface elevations for normal operations was influenced by the elevation of archaeological sites, and some of the adverse impacts of visitor activities on cultural resources would be mitigated through increased education and interpretation of cultural resources that includes a conservation message. Mitigation would be considered on a case-by-case basis for future construction and other activities.

4.6.2 INDIAN TRUST ASSETS

4.6.2.1 FALLON PAIUTE-SHOSHONE INDIAN RESERVATION

Trust assets of the Fallon Paiute-Shoshone Tribe (primarily in the form of cultural resources) would not be affected by any of the alternatives being considered.

4.6.2.2 PYRAMID LAKE PAIUTE INDIAN RESERVATION

Alternative A: Model results show that lower Truckee River flows under baseline conditions would be about 496,980 acre-feet per year (Table 4.6) and the water level of Pyramid Lake would be an estimated 3,842 feet above sea level. The average number of adult female cui-ui at the end of the 95 year hydrologic period is estimated to be 1,511,350. No actions would be taken under Alternative A that would change Truckee River flows or the water level of Pyramid Lake, or would affect cui-ui. Anaho Island NWR would continue to be managed as it has in the past. The Service would continue to coordinate with the Pyramid Lake Paiute Tribe as outlined in the 1992 Memorandum of Understanding, and this would not change under any alternative. Implementation of Alternative A would have no adverse impacts to trust assets of the Pyramid Lake Paiute Tribe.

Alternative B: Under this alternative, it is estimated, that long-term average Truckee River flows could be slightly lower and the water level of Pyramid Lake in the long-term could be slightly lower than Alternative A, but any effects on these parameters would likely not be measurable (Table 4.21). The cui-ui index would also be slightly lower under this alternative. Overall, this alternative could potentially have slight adverse effects on assets of the Pyramid Lake Paiute Tribe.

Alternative C: Under this alternative it is estimated, that Truckee River flows could be slightly higher than they would be under Alternative A and the water level in Pyramid Lake would be about the same in the long-term (Table 4.6). Therefore, implementation of Alternative C would have no adverse impacts on assets of the Pyramid Lake Paiute Tribe. It is not expected that this alternative would have any negative affects on land assets, water rights, or fish and wildlife resources of the Pyramid Lake Paiute Tribe.

Alternative D: Under this alternative, it is estimated, that Truckee River flows would be slightly higher than they would be under Alternative A and the long-term water level of Pyramid Lake would be slightly higher as well (Table 4.6). This could potentially benefit cui-ui in the long term. Overall, this alternative would have slight beneficial effects on the assets of the Pyramid Lake Tribe. It is not expected that this alternative would have any negative effects on land assets, water rights, or fish and wildlife resources of the Pyramid Lake Paiute Tribe.

Alternative E: The anticipated effects of implementing Alternative E are similar to those described under Alternative C.

4.7 COMMERCIAL HARVEST OF NATURAL RESOURCES

Commercial uses of the Stillwater NWR Complex currently include livestock grazing, muskrat trapping, and harvest of European carp and Sacramento blackfish. Under all action alternatives (Alternatives B, C, D, and E), these uses would only occur to the extent they are needed to manage wildlife and their habitat. Although there would be a monetary gain by the permittees, the uses would not be managed as commercial uses under Alternatives B, C, D, and E.

4.7.1 LIVESTOCK GRAZING

Livestock primarily graze in Stillwater WMA and Fallon NWR, but there is some livestock grazing on Stillwater NWR. Since 1948, livestock grazing on Stillwater WMA, Stillwater NWR, and Fallon NWR has been managed according to direction provided in the Tripartite Agreement that established Stillwater WMA. The agreement stated that livestock grazing would be managed commensurate with the primary purposes of the area, which were to conserve and manage wildlife, provide a public hunting area, and to establish and maintain a sanctuary. According to the Tripartite Agreement, the maximum amount of livestock grazing to be permitted on the area was to be determined annually, "having due regard for the condition of the range, and the wildlife requirements thereon."

During the period of 1988-1997, the number of Animal Unit Months (AUM's) that have been grazed on the Stillwater NWR Complex has ranged from about 6,530 to 9,470 (averaging 7,970 AUMs). In the most recent five-year period, AUMs have averaged about 7,200. Less than 400 of these have been on Stillwater NWR, the remainder occurring on Stillwater WMA and Fallon NWR. Most livestock grazing occurs in the Indian Lakes area and a considerable amount also occurs in the Fallon NWR. Most of the upland areas of Stillwater WMA and Fallon NWR are not grazed by livestock, although some areas have been heavily impacted.

The livestock grazing season runs from April through February, with livestock numbers fairly constant throughout the period (about 9 percent of the total AUMs are removed each month) with a slight increase during October-December and a small reduction during January and February. March is the only month in which there is no livestock. On Stillwater WMA and Fallon NWR, three permittees generally graze from April through February and the other three, from April through December.

Alternative A: This alternative assumes a continuation of the existing amount of AUMs being removed (7,200 AUMs per year on average).

Alternative B: Most of the livestock grazing that occurs on the lands now within the Stillwater NWR Complex would not be affected by this alternative, as most of the grazing occurs within the Stillwater WMA outside of Fallon NWR. Therefore, assuming a three-year phasing out of livestock grazing on Fallon NWR and Stillwater NWR, except for use as a habitat management

Table 4.24. Estimated cumulative effects of the alternatives on livestock grazing (measured in AUMs) occurring on lands now within Stillwater NWR, Stillwater WMA, and Fallon NWR.

		Cumulative Reductions from Alternative A (AUMs)			
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
First year	7,200	470-710	880-1,120	2,890-3,610	880-1,120
Second year	7,200	940-1,420	1,760-2,240	no add'l reductions	1,760-2,240
Third year (final)	7,200	1,420-2,140	2,640-3,360	no add'l reductions	2,640-3,360

tool, the number of AUMs that could be grazed in the area would decline by 20 to 30 percent, as compared to existing conditions, the final row in Table 4.24 shows the total amount by which AUMs would be reduced under this alternative.

Alternative C: Because most of Stillwater WMA would be within the boundary of Stillwater NWR and because less cattle grazing would occur on Stillwater NWR, reductions in the amount of livestock grazing would be greater than under Alternative B. Reductions from existing conditions would be about 37 to 47 percent by the third year of the phase out, as shown in the final row in Table 4.24. The actions proposed under this alternative would not affect livestock grazing in the Indian Lakes area.

Alternative D: Under this alternative, in which no livestock grazing would be permitted within Stillwater NWR, AUMs grazed by livestock on the lands now within Stillwater NWR Complex would decline by an estimated 40 to 50 percent (Table 4.24). The actions proposed under this alternative would not affect livestock grazing in the Indian Lakes area.

Alternative E: The effects of implementing Alternative E would be identical to those described for Alternative C.

Mitigation Measures: No mitigation measures were identified to mitigate the adverse impacts associated with reducing livestock grazing in the action alternatives, other than to provide some cattle grazing opportunities on the refuge and provide additional opportunities for sheep and goats on an intermittent basis. Significantly reduced livestock grazing opportunities would be an unavoidable adverse impact of these alternatives.

4.7.2 MUSKRAT TRAPPING

Alternatives A and B: Under these alternatives, 4,000 to 40,000 muskrats would be trapped each year, assuming a long-term average of 14,000 acres of wetland habitat.

Alternative C: It is estimated that up to 3,000 muskrats would be trapped each year under this alternative, up to 92 percent lower than Alternative A. Under this alternative, muskrats would primarily only be trapped in the vicinity of water control structures and roads to prevent damage to these facilities. It is possible that considerably more muskrats could be trapped in some years, but this would happen infrequently.

Alternative D: Because no muskrat trapping would be permitted under this alternative, trapping opportunities would be reduced by 100 percent (Muskrat trapping has not occurred in the Indian Lakes area for at least the last ten years).

Alternative E: Effects of implementing Alternative E are similar to those described under Alternative C except that muskrat trapping would receive increased emphasis as a vegetation management tool as well as for protecting refuge water control structures and roads.

Mitigation Measures: No mitigation measures were identified in reference to reduced muskrat trapping opportunity under the Preferred Alternative, other than providing some muskrat trapping opportunities on the refuge in some years.

4.7.3 COMMERCIAL FISHERY

European carp and Sacramento blackfish are periodically harvested from several lakes, including Likes Lake, Papoose Lake, and Big Indian Lake. The emphasis of the commercial fishing program is to control carp and Sacramento blackfish populations. Several hundred to several thousand pounds are removed about every one to three years under a special use permit issued by the Service.

Alternative A: Commercial harvest of carp and blackfish would continue on a periodic basis.

Alternatives B, C, D, and E: Commercial harvesting of carp and blackfish would not be directly impacted by the implementation of these alternatives because all of the commercial fishing in the Stillwater NWR Complex occurs in the Indian Lakes area, which would not be included in any of the boundary revision alternatives. Commercial fishing would be regulated by the Bureau of Reclamation and their contractor (TCID) in the short-term..

4.8 SOCIOECONOMIC RESOURCES

Historically, farming, ranching, livestock production, and a rural lifestyle have characterized the social and economic environment in the study area. In recent years however, rapid population growth, increased commercial and light industrial development, and expansion of the Naval Air Station-Fallon have changed Fallon, and the surrounding areas of Churchill County. Generally, these changes represent a transition toward a more urban lifestyle.

Several components of the socioeconomic environment, namely the study area population and social structure, are not expected to experience any measurable change as a result of implementing any of the management alternatives considered in this document. Although management alternatives discussed in this document include Anaho Island NWR, the changes being considered would not measurably affect the social and economic resources in the Truckee River Basin. Thus, for the purposes of this document, the social and economic study area is generally defined as the lower Carson River Basin, primarily Churchill County, Nevada.

4.8.1 ECONOMICS AND EMPLOYMENT

According to a report prepared by the University of Nevada, Reno Department of Applied Economics and Statistics (Englin 1999), the major employers in Churchill County are Federal, State, and local governments; the service industry; and wholesale and retail trade. Federal, State, and local governments account for nearly one third of the jobs in the County and as of June 1996, Naval Air Station-Fallon reported 2,516 active duty military and civilian personnel, including contractors, (oral and written communication, Petty Officer Collins, May 1996). The total number of Federal and State jobs in the County is approximately 3,290.

According to the Nevada Division of Water Planning (1999), the service sector provides about 34 percent of the total jobs in the community. This is followed by wholesale and retail trade with 24 percent of the employment. Agriculture and its associated service sector account for an estimated 8 percent of jobs in the county, while construction provides 7 percent. Mining, manufacturing, transportation and public utilities, finance, insurance and real estate make up the remainder of employment in Churchill County.

Churchill County's total personal income is approximately $176 million (Harris, written communication, 1995). Annual payroll at the Naval Air Station-Fallon, which hosts more than 22,000 military personnel annually, is reported at $77.2 million. In addition to employment dollars, NAS-Fallon on-base purchases and contracts were in excess of $45 million and contributed to the 1998 total economic impact of $125 million for the region (NAS Fallon Environmental Newsletter, Spring 1999). Federal, State, and local government employment accounts for more than one third of the total personal income in Churchill County. Other personal income sources correspond to the employment figures, with service industry second, wholesale and retail trade third, transportation and public utilities fourth, construction fifth, and manufacturing and agriculture sixth.

Employment and income estimates note that about 7 percent (780) of the jobs in Churchill County are full and part-time agricultural employment. Livestock production accounts for 30 percent of those jobs; dairy and crop production, 35 percent. An additional 600 full and part-time jobs are created indirectly as a consequence of agricultural production (MacDiarmid et al. 1994a; Nevada Division of Water Planning 1999).

Net agricultural income (agricultural receipts plus other income from agricultural production less agricultural production expenses) ranged from a single-year loss of $1.5 million in 1983 to a high of $9.75 million in 1990 (MacDiarmid et al. 1994b). Personal income in the agricultural sector (farmer's income and farm labor income in the form of wages and salaries) was also reported at $8.4 million annually.

In a report published by University of Nevada, Reno (MacDiarmid et al 1994b), total economic activity in Churchill County is estimated to be in excess of $442 million annually (excluding the State and Federal sectors). Of this total, the service sector contributes about 18 percent, followed by mining (14 percent), construction (13 percent), agriculture (12 percent), wholesale and retail trade (11 percent), and transportation and utilities (11 percent). Other sectors comprise the balance (21 percent).

Cattle ranching and dairy production are the primary livestock related agricultural activities in the study area. Total cash receipts in 1996 for Churchill County's Livestock and Livestock Products were $30 million; dairy production, $42 million. In terms of crop production, alfalfa represents the dominant crop, although some wheat and barley are grown in the area. In 1996, cash receipts from crop production were $7.3 million (Nevada Agricultural Statistics 1997-98, October 1998).

4.8.2 POPULATION

Communities in the lower Carson River Basin, like much of Nevada, are experiencing population increases at a steady annual rate. Churchill County's population, for example, grew by more than 3 percent annually between 1990 and 1996 and almost 6 percent between 1996 and July 1, 1997 (Nevada Division of Water Planning 1999). In 1997, Churchill County's population base was approximately 23,860 residents, which included residents of the Fallon Paiute-Shoshone Indian Reservation. Fallon is the largest city in the county, in which approximately 35 percent of the County's population reside. Growth is projected to continue at a rate of about 2 percent over the next five years.

Another indicator of population growth is the number of building permits issued annually. A 1996 Lahontan Valley News article stated that the number of permits issued was up 32 percent during the period January 1-October 31 when compared to the same period in 1995. With population increases, comes an increase in demand for social services, such as schools, police and fire protection, water and sewer service, and other community infrastructure requirements.

The study area's population and social structure are not expected to experience any measurable change as a result of implementing any of the alternatives considered in this Final CCP EIS.

4.8.3 LAND USE

There are 13 different land use zones in Churchill County, patterns which can best be described as discontinuous. It is common to find residential use adjacent to industrial or commercial use, all of which are surrounded by agricultural lands. This diverse land use mix is less prevalent in the City of Fallon.

Growth in Churchill County develops as new commercial and industrial land use radiates out from the City of Fallon's core along major transportation corridors. New residential areas develop along these transportation routes as well. As a result, this expansion of industrial, commercial and residential land use pattern displaces the prior land use, typically agricultural (irrigated farm lands or grazing lands).

In terms of tax assessment classification purposes, the Churchill County Assessor's Office differentiates between lands for agricultural and nonagricultural uses. Those lands classified as agricultural are further separated into five categories, by use and production, including intensive use and farmsteads, cultivated, wild hay, pasture, and grazing. Grazing is the largest of the categories. Nonagricultural parcels are classified as vacant (parcels with minor or no improvements), residential, commercial, industrial, and mining.

More than 80 percent of Churchill County's 3.1 million acres is classified as fourth-class grazing lands or rangelands. The balance, or approximately 355,000 acres, remain classified as agricultural. As of mid-1995, cultivated and pasture lands accounted for 54,147 acres in the area, a decline of 16.3 percent from 64,698 acres as reported in 1987. Most of the irrigated agriculture in Churchill County is in the Newlands Irrigation Project, of which about 91 percent occurs on lands with recorded water rights.

In other land classification matters, residential units in Churchill County increased 29 percent between 1989 and 1995; 23 percent increase for the same time period in the city of Fallon. Commercial and industrial parcels grew by 19 percent over the eight years prior to 1995. Mobile home permits increased 24 percent during the same period.

Alternatives A and B: There would be few changes to land use within the boundaries of Stillwater NWR and Stillwater WMA, beyond those of the water rights acquisition program.

Alternatives C, D, and E: Under these alternatives, additional private lands along the Carson River could potentially be acquired, which could potentially affect Churchill County’s tax base.

4.8.4 COMMERCIAL USES ON STILLWATER NWR COMPLEX

Livestock grazing is permitted on portions of the Stillwater NWR, Stillwater WMA, and Fallon NWR. Over a five-year period, the number of AUM’s associated with grazing permits issued for the Refuge complex averaged 7,200. The primary grazing season generally extends across a six month period (April-September); however, livestock grazing occurs throughout the year. Available forage supports on average, approximately 640 cow/calf units across the grazing season, translating into a market value of $62,000 (based on a cow to calf ratio of 1:1, at $65/cwt market price, and a 300-pound market weight) and contributing about 0.2 percent of the total 1996 livestock receipts for Churchill County. It is likely that this value is overstated, because the assumptions consider that livestock grazing is permitted year round, with a constant AUM rate, and that no alternative grazing opportunities exist. Permits are issued annually for a fee, which is generally based on the numbers of AUMs and the current market rate for public land grazing.

Cultivatable lands managed by the Service have been leased to area farmers during the last two seasons. Typically, alfalfa is grown and benefits not only the lessee (in terms of revenues from alfalfa sales), but also waterfowl that use the crops as a food source. For the purposes of this Final EIS, it is assumed that no lands are leased to farmers, as no Service water rights are available to irrigate refuge farmland over the long term and mechanisms for getting water to refuge farmland have not been determined.

Other consumptive use activities associated with the Stillwater NWR Complex include muskrat trapping and commercial fishing. The Service has issued several permits annually, to the highest bidder. There are no limits established on the numbers of pelts harvested and the market price fluctuates considerably (over the last several years, the average price paid for a muskrat pelt was between $0.75 to $2.50). The Service does not receive a fee for trapping, but collects revenues from limited permits that are issued to the highest bidders. According to Service records, 2,400 muskrat pelts were harvested in 1997, with a market value of approximately $3,700 (assuming an average price per pelt of $1.55). No muskrats have been harvested during 2000 or 2001. Trapping activity fluctuates with market price and muskrat populations. None of the alternatives would affect commercial fishing operations.

Economic effects from the management alternatives identified in this document is expected to involve primarily the commercial and recreational activities that occur on Service managed lands. In some cases, economic benefits are anticipated from visitation enhancing activities; in other cases, some economic losses may occur. The intent of this section is not only to identify those effects, but also to quantify the attendant changes as appropriate.

Alternative A: Under this alternative, livestock grazing is expected to continue as it has in the recent past. Although some leasing of cultivatable lands currently exists, this practice is not expected to continue beyond the immediate time frame (two to three years). Continuation of this program is conditional on the availability and elected use of nonwetlands water rights. Due to the anticipated short tenure of this program, this section does not delve on the economic impacts associated with vegetative production for commercial purposes. Muskrat trapping would also continue as in the recent past, except that considerably more pelts would be harvested under baseline conditions, as compared to existing conditions due to increased water supplies.

Table 4.25. Potential changes to revenues from livestock grazing on the Stillwater NWR Complex.

		Estimated Changes from Alternative A			
	Alternative A (No Action)	Alternative B (Modified No Action)	Alternative C	Alternative D	Alternative E
Contribution to Livestock Sector Industry Output	$62,000	reduced by $12,000 to $18,000 (20% to 30%)	reduced by $23,000 to $29,000 (37% to 47%)	reduced by $25,000 to $31,000 (40% to 50%)	reduced by $23,000 to $29,000 (37% to 47%)

Note: Percentages in parentheses represent the percentage change from Alternative A.

Alternatives B, C, D, and E: Other alternatives would result in a reduction in livestock grazing, subject to identified refuge management purposes and priorities. The direct impacts of the alternatives on livestock grazing are based on the baseline levels of forage, as identified above. Under liberal assumptions (i.e., that livestock is permitted year round at a constant forage rate with no alternative forage opportunities), the forage identified within areas of the refuge where grazing is authorized and occurs, contributes about $62,000 annually toward the livestock sector economic output in Churchill County. Reductions in livestock grazing levels (in terms of permitted AUM's) on refuge managed lands range from 20 to 50 percent, depending on the management alternative. Although these impact estimates suggest reductions in cash receipts from livestock grazing from Alternative A, up to 50 percent in Alternative D, in fact, reductions in grazing levels would be phased in over a three year time frame, except for Alternative D. By phased reductions in grazing levels over time, the economic burden on the affected permittee, in terms of finding alternative forage sources, is tempered. Nonetheless, under those management alternatives in which reductions in grazing levels are called for, those permittees affected must necessarily locate alternative forage sources or reduce herd sizes.

Under the four management activities advanced in this planning document, Alternatives C, D, and E introduce more restrictive limitations on muskrat trapping. Table 4.26 illustrates the economic impacts of this activity across management activities. The estimated revenues shown in the table is likely overstated, mostly because of the numbers of pelts expected to be harvested under each of the alternatives; it is unlikely that the upper extent of the estimated revenues would be realized. Market prices for pelts fluctuate greatly and even while pelts were selling for $2.00 to$2.50, a total of 2,400 pelts were harvested.

Clearly, when compared to current conditions, Alternatives C, D, and E impose restrictions on this activity; Alternative D more so as it prohibits trapping altogether. Estimated revenues identified for each alternative assume a long-term average of 14,000 acres of wetland habitat.

Table 4.26. Potential changes to revenues from muskrat trapping on Stillwater NWR.

	Alternative A (No Action)	Estimated Changes from Baseline Conditions			
		Alternative B	Alternative C	Alternative D	Alternative E
Muskrat Trapping Revenues	$6,200 to $62,000	$0	reduced by $6,200 to $57,350	reduced by $6,200 to $62,000	reduced by $6,200 to $57,350

Note: Revenue estimates assume a muskrat pelt market value of $1.55 each.

4.8.5 WETLANDS AND RELATED OUTDOOR RECREATION ECONOMICS

In addition to the more visible activities associated with wetlands that contribute to a local and regional economy, such as birdwatching, hunting, and general recreation, there are other social

benefits that may accrue. Between these benefits, as they relate to the Lahontan Valley wetlands complex, are (1) the role of the wetlands in the Pacific Flyway in terms of its contribution to the quality of waterfowl hunting throughout the flyway and (2) the impact of the wetlands on nongame species of birds
Wetland habitat acreage at Stillwater NWR has varied considerably, ranging from 30,000 acres in 1983-84 to 700 acres in 1992. The availability of water to the Service is one variable related to the size of the wetlands, in terms of actual wetland habitat acreage. As additional water rights are acquired for Stillwater NWR and the Lahontan Valley wetlands complex, up to the 25,000acre annual average, the variability in wetlands acreage is expected to decline. Because water affects the amount of wetland habitat acreage, both water and wetland habitat acreage contributes directly to annual visitation rates. The number of hunters, anglers, and general recreationists fluctuates in response to wetland habitat acreage to a point (such as during high water years, when an increase in the number of places to hunt and engage in other recreational activities occurs).

According to visitation records kept at the Stillwater NWR office for a five year period from 1993 to 1998, of the total recorded visits to Stillwater NWR, over half were associated with non-consumptive activities such as nature observation and environmental education. The balance of visits were recreational, typically consisting of hunting, fishing, muskrat trapping, and general recreation.. The results, from an on-site survey conducted by the University of Nevada-Reno in 1998, comport with the Refuge's visitation information.

This survey also examined visitation and recreation expenditure patterns exhibited by visitors to the Lahontan Valley wetlands complex. On a per-capita expenditure basis, hunters generally spent almost $38 per day, people engaging in general recreation activities spent $21. Using this per-capita information for a basis, expenditures associated with both general recreation uses and hunting activities at Stillwater NWR alone exceeded $615,000 during the 1997-98 season and would include expenditures generally associated with lodging, food, gasoline, firearms, and the like.

Alternatives B, C, D, and E represent management activities that would change the present management of the refuge, in terms of recreation and other wetlands based outdoor activities. Some of the changes identified in the various management alternatives are quantifiable; others are not. Of the former category, hunting and fishing are consumptive activities and can be examined with respect to expenditures by the individuals who participate. Other recreational activities that are nonconsumptive (in terms of the resource), yet economically meaningful, include birdwatching, picnicking, and other nonmarket, and thus, less quantifiable benefits associated with the wetlands complex (value of the wetlands to nongame bird species and the Pacific Flyway and the existence value identified with the wetlands complex).

Hunting opportunities, and to some extent general visitation, on refuge managed lands are dependent on several factors including accessibility (controlled either by management or water levels) and the number of game (and nongame) birds and other wildlife in the area. Insofar as the quality of hunting opportunities is concerned, then possibly, that value would be reduced across

Table 4.27. Potential effects on hunter and other expenditures, and on nonmarket benefits.

	Alternative A (No Action)	Alternative B	Alternative C	Alternative D	Alternative E
Hunter Expenditures	72% of area open; . $250,000	67% of area open; . $250,000	50% of area open; . $250,000	40% of area open; expenditures reduced by $110,000	60% of area open; . $250,000
Other Recreation Expenditures	$490,000	+ $5,000 (+1%)	+$120,000 (+25%)	+ $147,000 (+30%)	+$120,000 (+25%)
Nonmarket Benefits & Attributes	+	+	++	+++	++

Alternatives A, B, and C. However, numbers of hunters, and therefore related expenditures, may not be necessarily affected. According to refuge data, hunter density is relatively low on weekends under current access management. Under such an assumption, no reductions in hunter numbers and thus, expenditures, is expected for Alternatives A, B, C, or E. The amount of area identified as open to hunting under Alternative C (Table 4.27) was based on Option 1 of that alternative, and therefore would be a conservative estimate for Option 2 which would provide for a greater proportion of habitat open to hunting.

Activities involving birdwatching and environmental education at the refuge are likely to experience increased levels of visitation, with the anticipated construction of a visitor's center, interpretative trails, boardwalks, observation towers, road signs, and the like. The highest levels of visitation, all other things held equal, are associated with Alternative D, when compared against current Refuge visitation. Further, Alternative D also represents an enhancement of nonmarket benefit attributes over the other alternatives; these benefits are, at present, not readily quantifiable.

4.8.6 POTENTIAL CHANGES TO THE LOCAL AND REGIONAL ECONOMY

Although slight, direct changes in the output of any local economic sectors results in a "ripple" effect throughout the other sectors. By examining the anticipated changes in these sectors, the regional (direct, indirect, and induced) economic effects can be better identified and described.

4.8.7 EMPLOYMENT AND POPULATION

Additional refuge staff would be required to carry out several management alternatives. Since these additional employees would likely live in Fallon, or the immediate vicinity, they and their families would add to the population and employment base of Churchill County. Management

Table 4.28. Direct, indirect, and induced changes associated with each alternative.

Activity	Alternative A	Change from Alternative A: Alternative B	Alternative C	Alternative D	Alternative E
Livestock Grazing	$130,000	–20% to –30%	–37% to – 47%	–40% to –50%	–37% to – 47%
Muskrat Trapping	$12,000 to $120,000	no change	–90%	–100%	–90%
Hunting	$515,000	no change	no change	–55%	no change
General Recreation	$1,030,000	+1%	+25%	+30%	+25%
Contribution to Local Economic Activity (Total of Above)	$1,675,000	– 0.9% to –1.7%	+5.2% to +11.8%	–2.3% to –9.5%	+5.2% to +11.8%
Change in Hydropower Resources (Total for New Lahontan Reservoir plant)	$1,120,000	–2.8%	–14%	–3.7%	–14%

Notes: Alternative A, as representing the No Action Alternative, is assumed to depict baseline conditions, to which the estimated changes associated with the other alternatives are compared. Numbers have been rounded.

Definitions:
- Direct Impacts: Activities or changes in production levels of the impacted industry
- Indirect Impacts: Changes occurring in the local business sector as a result of providing inputs to the impacted industry
- Induced Impacts: Economic activity caused by household consumption in a local economy from the direct and indirect effects.

alternatives would add from three (Alternative B) to five (Alternatives C, D, and E) additional employees, resulting in the addition of approximately eight to 13 people to the Churchill County population base. This change to the population base is not expected to result in any negative impacts on the community social structure or Fallon's infrastructure. Other than employment gains from several of the alternatives considered, there are no significant employment impacts anticipated from the implementation of any management alternative (in terms of losses from grazing opportunities, hunting, etc.).

In summary, the alternatives considered in this Final CCP EIS would, in all likelihood, result in small, overall changes to the local economy, either positive or negative, from the conditions prevalent today.

4.8.8 GEOTHERMAL LEASING

The known geothermal resource area in the vicinity of Stillwater, Nevada (Stillwater KGRA) comprises 28 sections of land, or about 17,920 acres. Eleven of these sections are within the existing approved boundary of Stillwater NWR, and 3 are within the Stillwater WMA, just north and to the east of the Fallon Indian Reservation. Within an approved refuge boundary, the Geothermal Steam Act requires that any geothermal leases that existed on Federal land prior to the establishment of an approved refuge boundary or that existed on nonFederal lands prior to their acquisition will remain valid through the duration of the lease. However, such leases would not be renewed on any Federal lands within the refuge. Geothermal leases on Federal lands within Stillwater NWR would be managed subject to the Geothermal Steam Act. An approved refuge boundary does not have any bearing on the potential to lease geothermal resources on nonFederal inholdings within the boundary or to extend such leases.

Boundary revision Alternative B would not have any effect on geothermal leasing. To the extent that boundary revision Alternatives C and E are revised to include a known geothermal area and other adjacent areas in which geothermal resource could be leased, future opportunities for leasing geothermal resources could be diminished in the Stillwater KGRA, except where valid rights exist (whereby the terms of the lease would be honored). One additional section (640 acres) of the Stillwater KGRA would be included in Stillwater NWR, as compared to the existing approved boundary, although there are additional lands on which leases have been submitted to the Bureau of Land Management for consideration. Potential adverse effects under Alternatives C and E could include lost opportunities for increased economic activity and revenues in Churchill County. This is not expected to have any significant adverse impacts as compared to existing or baseline conditions.

Alternative D would have similar potential effects, except that an additional four sections (2,560 acres) of the Stillwater KGRA would be included in Stillwater NWR, as compared to the existing approved boundary. Leases have also been proposed outside of the Stillwater KGRA within the Alternative D boundary revision.

Mitigation Measures:

One way to avoid any potential loss in opportunities to increase revenues and economic activity in Churchill County would be to adjust part of the southern boundary of Alternative C, D, and E so that the known geothermal resource area and other areas encompassing proposed lease sites are not included within the new additions to the Stillwater NWR.

4.8.9 OTHER POTENTIAL EFFECT

Under an agreement between the U.S. Department of Agriculture's Wildlife Services Division (formerly known as Animal Damage Control) and several landowners within the existing approved boundary of the Stillwater NWR, Wildlife Services conducts measures to prevent or reduce impacts on private lands from several species of wildlife species on private lands, especially during the calving season (Wildlife Services, USDA, letter dated February 26, 1999). The agreement covers coyotes, striped skunks, beavers, blackbirds, and common ravens, and several control techniques including aerial and ground shooting, trapping (leghold, cage, conibear, and snares), denning, and DRC 1339. Wildlife Services has proposed that they be permitted to continue control operations on the parcels that are acquired by the Service within the existing approved boundary of Stillwater NWR.

No plans have been made under baseline conditions (Alternative A) to continue this program on refuge lands. Therefore, slight increases in predation rates on adjoining properties could occur. Continuing the agreements on lands acquired by the Service within the approved refuge boundary could be done under Alternative B, with modification. Such a program under Alternative B could be melded with the predator control program designed to enhance waterbird production. This could help to alleviate predation of young livestock on calving grounds and to reduce damage to crops. Effects under Alternatives C, D, and E would be similar to those under Alternative A except that the possibility for increased predator control is an element of Alternative E as long as the plan is accompanied by the proper public notification procedures. Alternative E would also allow recreational coyote hunting within the refuge.

4.9 NAVAL AIR STATION-FALLON OPERATIONS

The potential expansion of Stillwater NWR boundary northward toward the Bravo Twenty Bombing Range has raised concerns by the Naval Air Station-Fallon. Under existing and baseline conditions, the bombing range is seven miles north of Stillwater NWR and about seven miles northeast of Fallon NWR. A 3,000 foot ceiling (aircraft are not permitted to fly lower than 3,000 feet) exists over Stillwater NWR, Fallon NWR, and Stillwater WMA.

Alternatives A and B: The existing agreement would be carried forwarded, except that the lands now within Stillwater WMA would be removed under Alternative B.

Alternatives C, D, and E: Under these alternatives, the distance from the Bravo Twenty Bombing Range would diminish to one mile, but the distance to the northern edge of the west side of the refuge (where Fallon NWR is now located) would increase to about 9-1/2 miles. The Service would continue to coordinate with the Navy and would finalize an amendment to the existing memorandum of understanding to address the Navy's concerns. In particular, the 3,000 foot ceiling would not apply to the extended portion of Stillwater NWR. Therefore, the boundary expansion toward the Bravo Twenty Bombing Range would not affect Naval Air Station-Fallon operations.

4.10 EFFECTS ON REFUGE MANAGEMENT

4.10.1 HABITAT MANAGEMENT TECHNIQUES

This section, is included because restrictions on the use of management tools are of concern to managers. A variety of habitat management techniques (also known as management tools) can be used to help control invasive species, promote wildlife and habitat, simulate ecological processes, and provide different mixes of habitat types. These tools include biological controls (livestock grazing, muskrat herbivory, and insects), fire, management of wetland water levels, mechanical treatments (mowing, discing, root plowing), chemical treatments, explosives, and wildlife population control (ravens, muskrats). For any given set of management tools available at a particular area, each tool is used at differing levels based on need, ability, aesthetics, and regulation. Many of these tools have been used in the past based on identified resource needs, but some, like prescribed burning and saltcedar control, have only been used to a limited degree during the last ten years. Also, livestock grazing and muskrat trapping are not being used as management tools in the existing program (they are provided as commercial uses). Management tools used would vary under each alternative based on the focus of each alternative's management direction.

Alternative A: This alternative would allow the manager to use a wide variety of management tools with few restrictions imposed. However, the actual use of management tools at present is less than what can potentially be implemented. Under this alternative, water level management would be the primary means to manage marsh habitats. However, all of the above management tools could be used depending on identified resource needs and completion of appropriate compliance documents. A predator control plan could potentially be developed and implemented to promote waterfowl production. Water management and limited use of Rotenone could provide a control technique for European carp. Livestock grazing would continue to be a commercial use near marsh habitats, but would not be implemented with specific vegetation management goals in mind. Release of beetles, which consume the leaves of saltcedar, would be considered part of the biological control program if clearance were received to use this method; however, chemical and mechanical treatment on a limited basis would remain viable methods to control saltcedar and other invasive species. Explosives would continue to be a means of keeping channels open and provide other openings within deep emergent habitat.

Alternative B: Management tool use would be higher than under Alternative A under this alternative with few restrictions imposed. This alternative would place primary management emphasis on creating quality fall and winter foraging habitats for waterfowl and retaining summer deep emergent vegetation habitat for the production of redheads. Water management and prescribed burning would be the primary management tool used with a focus on summer drawdown to promote moist-soil habitat while providing enough water to maintain some deep emergent and submergent vegetation through summer months. To ensure that deep emergent habitat is at an optimal 50/50 mix with submergent vegetation, prescribed burning, controlled livestock grazing, mechanical treatments, and muskrat trapping would all remain in the toolbox. Herbicides and explosives would rarely be used to obtain this mix. Additional management tools that could be used include controlling invasive vegetation through mechanical and chemical methods. An integrated pest management plan would be implemented to provide guidance on optimum invasive species control treatment combinations.

Alternative C: Management tool use would be higher than Alternative A, although more restrictions would be placed on the use of the more intensive management tools. None of the tools currently being used on Stillwater NWR would be excluded from use and a few may be added, such as sheep and goat herbivory. While Alternatives A and B emphasize management for populations of species of special interest (key species), this alternative focuses on the entire native marsh community with a key strategy of simulating the natural hydrology and associated processes. Therefore, management activities would be conducted in such a way as to promote the functioning and appearance of a natural system. Similar to the previous alternatives, water level management would be the primary tool used; however many of the previously mentioned management techniques could also be used, such as prescribed burning, livestock grazing, and mechanical treatments. Under this alternative, most applications of management tools would be employed to mimic natural ecological processes or to otherwise approximate ecological conditions. Considerable biological justification would be required before techniques, such as controlled livestock grazing, chemical treatments, large scale mechanical treatments, or predator control would be implemented. Reasons for use of these tools are instances where it can be shown that habitats or wildlife populations deviate considerably from estimated historic conditions. Less reliance on chemical treatments and cattle grazing would be practiced under this alternative as compared to Alternative B, but more so than under Alternative A. Integrated pest management (including weed management) methods and techniques would be available for use subject to further examination of specific target and nontarget effects as per Service review and approval.

Alternative D: Use of management tools would be much lower than baseline under this alternative, and intensive management tools, such as livestock grazing and chemicals would not be permitted. All management tools would be implemented to approximate natural ecological processes, emphasizing the least intensive tool available to fulfill specific, identified management needs. Similar to Alternative C, the management focus would be on simulation of natural processes to help restore a natural biodiversity of wildlife and habitats, although this alternative emphasizes this aspect more so than Alternative C. More reliance on water level management over any other management tool would be achieved. No management tools would be used unless management plans are specifically designed to simulate natural ecological processes at natural levels of occurrence.

Alternative E: Management tool application would be similar to the levels described under Alternative C except that there would be more flexibility to use the full complement of available management tools ranging from least to most intensive. Predator control could be used to control species other than coyotes and ravens if biological monitoring indicates that there is a need to control additional species to enhance waterbird species production. Any predator control program would be documented in a step down predator control plan and public notification would occur prior to implementing such a plan. Muskrat trapping would be used not only to protect the refuge infrastructure (roads, canals, and water control structures), but also as a habitat management tool when excessive "eat-outs" are documented. While chemical application to control invasive species was de-emphasized under Alternative C, this alternative would recognize that chemical application is often the best available method to facilitate cost and labor efficiency. As under Alternative C, the least intensive tool to accomplish the desired habitat objective would be used; however, intensive tools would receive equal consideration when developing habitat management strategies to accomplish documented habitat objectives under Alternative E.

4.10.2 EFFECTS ON THE ABILITY OF THE SERVICE TO MEET LEGAL MANDATES

Alternative A: Continued management under Alternative A would limit the Service's ability to achieve the purposes of Stillwater NWR and Fallon NWR, as well as directives under the Refuge System Administration Act, as amended. The existing management program for Stillwater

WMA and much of the area within Stillwater NWR and Fallon NWR was designed under the tenants of the 1948 Tripartite Agreement and has not addressed the Refuge System Administration Act.

From the standpoint of achieving refuge purposes, the seasonal pattern of delivery of Alternative A would be more desirable than Alternative B, but less desirable than Alternatives C, D, and E. With respect to restoring natural biological diversity, opportunities for protecting and restoring the lower Carson River, an entire dune ecosystem, and a considerable amount of upland desert shrub habitat would be impaired, but not foregone as it would be in Alternative B. The hydrology of Stillwater Marsh would be markedly different from the natural seasonal flow pattern, and attempts to convey more water through the marsh during early spring would not be attempted. However, the seasonal pattern of wetland habitat acreages would be similar to some years under natural conditions when the Carson River flowed directly into Stillwater Marsh, although the volume of inflow would be considerably different.

Given the change in purposes and shift in priorities, Alternative A would forego an opportunity to permanently protect additional habitat and would continue to place relatively little emphasis on restoring these habitats, and would continue to place relatively little emphasis on providing sanctuary for migratory birds during the hunting season. For similar reasons, fulfillment of international treaties would be hindered under this alternative. Next to Alternative B, alternative A would be least desirable as a strategy for management as a component of the Western Hemispheric Shorebird Reserve Network.

Because the visitor services program would continue to be dominated by the hunting program, Alternative A, along with Alternative D (which would severely restrict the hunting program), would be least desirable from the standpoint of the visitor services purpose and related provisions of the Refuge System Administration Act.

It is anticipated that the Service could achieve the 14,000 acre target under the existing water rights acquisition program.

Alternative B: Of the alternatives considered, Alternative B would be the least desirable from the standpoint of achieving most refuge purposes. With respect to restoring natural biological diversity, opportunities for protecting and restoring the lower Carson River, an entire dune ecosystem, and a considerable amount of upland desert shrub habitat would be foregone. Furthermore, the hydrology of Stillwater Marsh would be markedly different from the natural seasonal flow pattern, and attempts to convey more water through the marsh during early spring would not be attempted. The emphasis would be to provide high quality fall and winter habitat for waterfowl and waterfowl hunting.

Some improvements would be made toward the conservation and management of fish and wildlife in general, but this alternative would forego an opportunity to protect additional habitat (riparian, dunes, greasewood shrublands) and would continue to place relatively little emphasis on providing sanctuary for migratory birds during the hunting season. For similar reasons, fulfillment of international treaties would be hindered under this alternative. Of the action alternatives, this alternative would be the least desirable for shorebirds, and therefore would be least desirable as a strategy for management as a component of the Western Hemispheric Shorebird Reserve Network. This is primarily because water levels would be rising in wetland units during fall migration.

Although opportunities for wildlife-dependent recreation would be enhanced under this alternative, as compared to Alternative A, it would not be the most desirable alternative from the standpoint of the visitor services purpose of the refuge. Opportunities for hunting would be enhanced, but opportunities for enhancing wildlife observation and environmental education along the lower Carson River would be foregone. Furthermore, large areas of the refuge would be closed to visitors during the breeding season, which is the most popular time for wildlife observers and school groups to visit the refuge. Therefore, Alternative B would not be consistent with the provisions of the Refuge System Administration Act, with respect to facilitating all wildlife dependent public uses.

Strictly from the standpoint of achieving the 14,000 acre wetland habitat target for Stillwater NWR, Alternative B would be the most desirable because the targeted acreage could be achieved with a lesser amount of water than under any other alternative considered. This would make it easier to achieve the 25,000 acre primary wetland habitat target for Lahontan Valley, as required in P.L. 101-618.

Alternative C: Of the alternatives being considered, Alternative C would be the best for achieving refuge purposes. If implemented, it would result in the most progress toward mimicking ecological and biological processes and approximating natural biological diversity. The natural seasonal flow pattern would be mimicked, as adjusted in recognition of markedly less water than natural conditions and to minimize nest flooding and to ensure that wetland habitat is provided in the fall and winter for waterfowl and waterfowl hunting. The addition of the lower Carson River, the 25-mile long dune system, and additional upland desert shrub habitats would contribute greatly toward the achievement of refuge purposes (a criterion of the boundary revision provision of P.L. 101-618). For similar reasons, including the restoration of river-riparian systems, efforts to restore the biological integrity and environmental health of the Stillwater NWR ecosystem, as required by the Refuge System Administration Act, would be best under Alternative C. Under Alternative C, implementation of the core reserve concept would be better under Option 1 as compared to 2 (neither alternative follows this principle to any large degree, however).

Alternative C would be better than Alternatives A, B, and D for achieving the purpose providing for the conservation and management of fish and wildlife, but not as beneficial as implementation of Alternative E (although each alternative differs in philosophies and assumptions). This alternative is somewhat better than Alternative B because it would protect and restore additional wildlife habitat, especially river-riparian habitat and dune habitat, and Alternative C would provide additional secure habitat for waterfowl and other waterbirds. Alternative C would contribute most toward fulfilling international treaty obligations for some of the same reasons listed above: restoration of natural habitat conditions (including wetlands), additional habitats being protected and restored, and providing suitable sanctuary for migratory birds. Due to differences in the management of human activity impacts, Option 1 would be the best from the standpoint of fulfilling international treaty obligations, as this option would be more beneficial to migratory birds during the hunting season. With respect to the Western Hemispheric Shorebird Reserve Network, Alternative's C and E would benefit fall migrating shorebirds to a greater degree than Alternatives A and B because of relatively high wetland habitat acreage in late July followed by receding water levels through August and September.

Option 1 of Alternative C, would be the best alternative, of those considered, in terms of balancing visitor services on Stillwater NWR. Compared to Alternative B, it would provide additional opportunities for wildlife observation and photography, and environmental education and interpretation. Even so, it would be slightly more restrictive to waterfowl hunters (more regulations, less available habitat for hunting). Option 2 would improve conditions for wildlife observation and environmental education to a lesser degree than would Option 1 (e.g., the wetland tour route would be farther from the refuge entrance, no separation of uses during the hunting season), but hunters would not be impacted as much as they would be under Option 1. For similar reasons, Option 1 would best meet requirements of the Refuge System Administration Act. However, given the current interest of the people and groups that provided scoping comments, separation of uses is not viewed as a desirable condition at this time.

Alternative C would be the best alternative of those considered for achieving purposes of Fallon NWR (even though these would likely be replaced by Stillwater NWR purposes under this alternative). Retaining the lower Carson River would allow for the acquisition of additional land and water along the river, which would result in more water reaching the wetlands at the delta of the Carson River (Battleground Point area).

According to wetland water delivery modeling, the amount of water to be acquired through the Service's water rights acquisition program would be sufficient to sustain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR, meaning that Alternative C would have no adverse effects on the acquisition program.

Alternative D: The Service's ability to achieve Stillwater NWR purposes would be hindered under this alternative for several reasons, as compared to Alternative C. There would not be an opportunity to provide higher amounts of wetland habitat acreage during the late summer, fall, and winter, except in spill years. Under natural conditions, wetland habitat was available in Stillwater Marsh year round in most years when the Carson River flowed into Stillwater Marsh or Carson Lake. Although the proportional amount of inflow would have been similar to that mimicked by Alternative D, the volumes were significantly higher, allowing more habitat to remain through the year. Another reason is that the control of invasive vegetation, a significant threat to native plant community composition and structure, would be hindered under this alternative because of restrictions on the use of herbicides and biological controls. Higher variability in water levels would exacerbate the problem by increasing the distribution of saltcedar. For similar reasons, efforts to restore the biological integrity and environmental health of the Stillwater NWR ecosystem, as required by the Refuge System Administration Act, would be impaired. Conversely, implementation of the core reserve principle would be best under this alternative.

Alternative D would similarly be the least desirable from the standpoint of conserving and managing wildlife and fulfilling international treaty obligations. Conversely, this alternative would provide the most benefits to fall-migrating shorebirds.

The markedly higher acreages of wetland habitat during the late spring and early summer, along with higher access to wetland habitat and additional facilities, this alternative would provide the most benefits for wildlife observation and environmental education during these seasons. However, on balance, the achievement of the visitor services purpose would be impaired under this alternative due to very few if any hunting opportunities being provided in most years. Therefore, of the alternatives considered, this would be the least desirable from the visitor services standpoint.

Implementation of Alternative D would impair the Service's ability to achieve the 14,000 acre wetland habitat target, and thus would compromise the achievement of the 25,000 acre wetland habitat target for the Lahontan Valley. Up to an estimated 16,300 acre-feet per year of additional water would have to be secured to attain a long-term average of 14,000 acres of wetland habitat on Stillwater NWR. This would require additional NEPA analysis.

Alternative E: Similar to Alternative C, this Alternative would come closest to meeting the intent of all four purposes of Stillwater NWR. When compared to Alternative C, adjustments in the Alternative E strategy would provide more benefits towards achieving some purposes (conserving and managing fish and wildlife and their habitats), less for others (fulfilling international treaty obligations of the U.S. with respect to fish and wildlife), and similar to modified benefits associated with the natural biological diversity and visitor services objectives. Simulation of natural hydrological processes would be similar to Alternative C except that historic spring pulse flows would be channeled through one of four identified flow corridors which would allow for higher velocity flows through the selected corridor, but would allow for less simulation of this process throughout the marsh than Alternative C. It is anticipated that by varying where spring pulse flows occur over the long term that all segments of the marsh would ultimately benefit from this strategy, but potentially, not as much as if water flow were directed through the same wetlands annually (Alternative C) which is estimated to be how the historic marsh functioned. This Alternative would attempt to simulate flood (through one corridor), stable water conditions (through two corridors), and drought (through one corridor), in the same year thus simulating all elements of the Great Basin marsh ecosystem annually.

Alternative E would be the best Alternative for achieving the conservation and management of fish and wildlife and their habitats goal, primarily through enhanced implementation of adaptive management during fall periods. By simulating all stages of historic marsh function within the same year (flood, drought, and stable conditions), it is anticipated that a wider range of habitat conditions would be provided than under the other Alternatives evaluated, which should provide for the needs of a wider diversity of wildlife species. During fall, hydration of individual units with remaining water, would largely be based on the existing habitat conditions and the chronological needs of key waterbird guilds, thus, Alternative E would provide more water for maintaining habitat during the critical fall migration and winter maintenance periods than would be provided under Alternative C.

While shorebird habitat would be emphasized for spring management and summer drawdowns would concentrate prey for fall migration, Alternative E would not contribute to providing sanctuary to the level that would occur under Alternatives C and D. Therefore, fulfilling the intent of international treaties with respect to fish and wildlife would not be fulfilled to the extent as it would under Alternative C. Providing for overall biodiversity would be enhanced through the combination of simulating natural ecological process and providing for the needs of the range of wetland-dependent wildlife, but, natural biological diversity would not be achieved to the extent anticipated under Alternative C.

The full range of visitor services opportunities would be provided under this Alternative; however, hunting would still be the primary refuge use during the waterfowl hunting season, therefore, balancing wildlife dependent public uses would not be achieved to the extent it would under Alternative C (option 1) or Alternative D. However, the visitor services purpose would be met to a greater extent than under Alternatives A and B. Balancing wildlife-dependent public uses during the remainder of the year would be similar to Alternative C (option 2). Meeting the 25,000 acre wetland mandate identified in P.L. 101-618 would also be similar to Alternative C.

4.11 CUMULATIVE EFFECTS

The cumulative impacts analysis considers possible impacts to the environment from past, present, and reasonably foreseeable future actions or activities. A variety of interacting factors, identified below, are expected to have cumulative impacts on environmental resources in the study area. The following assessment focuses on the cumulative impacts on acreage and condition of wetland habitat, migratory bird populations, lower Truckee River and Pyramid Lake resources, opportunities for wildlife-dependent recreation, Newlands Project operations, air quality, local economy, Indian trust assets, and cultural resources.

The actions and other factors considered in this cumulative impact analysis include:

- Regional, flyway, and hemispheric effects on migratory birds (past, present, future).
- Upper Carson River water use (past, present, and future).
- Water use in the Carson Division (past, present, and future).
- Mining during the Comstock era (past).
- Closure of highly contaminated drains (past, future).
- 1988 OCAP (past action).
- Acquisition of water rights for Lahontan Valley wetlands (past, present, future).
- Recovery plans for endangered and threatened Pyramid Lake fish.

- 1997 Adjustments to OCAP (past, present, future).
- Protests of water right transfers.
- Truckee River Water Quality Agreement (future).
- Truckee River Operation Agreement, or TROA (future).
- Newlands Project Recoupment (future).
- U.S. Army Corps of Engineers study – flood control for the City of Fallon (potential future).
- Transfer of Carson Lake (future).
- Growth and diversification in Churchill County (past, present, and future).
- Climatic variability (past, present, and future).

More detailed information on many of the above actions can be found in the WRAP EIS (USFWS 1996a), Adjusted OCAP (USDI 1997), and the Truckee River Operating Agreement Draft EIS (USDI and State of California1998).

4.11.1 PRIMARY WETLAND HABITAT ACREAGE

Historically, an estimated 410,000 acre-feet per year on average flowed down the Carson River into the Lahontan Valley, which sustained an estimated average of up to 150,000 acres of wetland habitat in the valley (Kerley et al. 1993). Even in the driest of years, the volume of water flowing into the Lahontan Valley would have been sufficient to create annual peaks of 50,000 acres of wetland habitat in the valley. Although climatic variability is a factor affecting wetland habitat, it is an important part of the natural functioning of the wetland system.

The major factors that significantly altered the volume and timing of waterflow into the Lahontan Valley wetlands were diversions from the upper Carson River (agricultural, municipal, and industrial uses), construction and operation of Lahontan Reservoir, and water use in the Carson Division (for agricultural, municipal, and industrial uses). Beginning in the early 1900s, diversions from the Truckee River offset adverse impacts to the wetlands to some degree, but also contributed to more land being put into agricultural production in the Carson Division. This lowered the amount of freshwater going to the wetlands, but increased the amount of drainwater flowing into them. Unregulated diversions from the Truckee River also allowed water to be released from Lahontan Reservoir during winter for hydropower generation, which ultimately offset some of the impacts to Lahontan Valley wetlands because much of this water ended up in the wetlands. Winter hydropower generation ended in the late 1960s. Approval of the 1988 OCAP by the Secretary of the Interior in effect reduced the offsetting effects of Truckee River water. As a consequence, prior to any water rights being acquired for the Lahontan Valley wetlands, it is estimated that an average of about 42,000 acre-feet of water would flow into the primary wetland areas, an overall reduction of about 90 percent. Assuming a wetland demand of five acre-feet per acre, per year, this would result in a long-term average of about 8,400 acres of wetland habitat remaining in the primary wetland areas (an estimated 4,700 acres on Stillwater NWR). Except in spill years, these wetlands would have been maintained solely by agricultural drainwater, which would have lead to contaminant problems. Although climatic variability is currently a major factor that influences the amount of wetland habitat in the Lahontan Valley, the severity of these effects is a consequence of alterations to the Carson River's hydrology. For example, during the recent drought, the Carson River basin produced enough water each year (over 150,000 acre-feet of water even in the driest years), which would have sustained an average of more than 25,000 acres of wetland habitat in the Lahontan Valley during this period.

Reduced volumes of water into Lahontan Valley wetlands has also resulted from construction and operation of irrigation canals and drains in the Carson Division of the Newlands Irrigation Project, which prevent large volumes of water from reaching the wetlands. Where natural seasonal peak flows of the Carson River into Stillwater Marsh were on the order of several thousand cubic feet per second, upwards to 20,000 or more cubic feet per second, the maximum capacity of the canals and drains leading to the marsh is less than 450 cubic feet per second from several different points of entry. Similarly, a maximum of only 800 cubic feet per second can reach the lower Carson River below Sagouspe Dam.

In 1991, freshwater began to be delivered to the Lahontan Valley wetlands, after the first water rights had been acquired by the Nevada Waterfowl Association. The wetlands water rights acquisition program will eventually maintain a long-term average of about 25,000 acres of primary wetland habitat in the valley (including 14,000 acres on Stillwater NWR). The eligible portion of acquired water rights are currently transferred at 2.99 acre-feet per acre (as per the consumptive use rate specified in the Alpine Decree), which may slightly increase the amount of time required to attain the acquisition targets specified in Alternative 5 of the Final WRAP EIS and ROD (USFWS 1996a,b). At present, sufficient water rights have been acquired to supplement drainflows and spill water to sustain a long-term average of about 15,100 acres of primary wetland habitat, of which about 8,700 acres would be in the Stillwater Marsh.

Adjustments to the 1988 OCAP as amended (1997), are anticipated to offset a small amount of the benefits of the water rights acquisition program by reducing the number of spill years from one in three years to one in four years, and slightly reducing headgate deliveries and drainwater flows, but it is also anticipated that future modifications to the Service's water rights acquisition program could be made to minimize these effects (USDI 1997). To the extent that challenges to water right acquisitions and transfers to Stillwater NWR are successful, future increases in wetland habitat acreage would not be as high as anticipated. Alternative E of this Final EIS is not expected to hinder the attainment of the 25,000 acre primary wetland habitat target. Other future actions that could possibly increase costs, delay, or hinder the attainment of the required 25,000 acres of wetland habitat include Newlands Project Recoupment, increased recycling of agricultural drainwater, and efforts by the U.S. Army Corps of Engineers to reduce flood potential in the City of Fallon. Depending on how the flood control project is designed, it could also increase the flow of water to Stillwater NWR (including the alternative boundaries of Stillwater under Alternatives C, D, and E), which would contribute toward the attainment of the 25,000 acre target. Enlarged canals leading to Stillwater NWR would enhance the Service's ability to achieve refuge purposes and to achieve the 14,000 acre wetland habitat target. The Truckee River Operating Agreement, now in draft, could potentially slightly offset benefits of the Lahontan Valley water rights acquisition program (an estimated 0.1 percent fewer wetland habitat acres).

4.11.2 CONDITION OF WETLAND HABITAT

The composition of basin wetland habitat generally parallels the above discussion (i.e., as wetland habitat declines, the amount of each wetland type also declines). However, the proportional amount of a few basin wetland habitat types have declined considerably since pre-Newlands Project times, including deep-water habitat (primarily at Carson Lake, but also in Stillwater Marsh), and shallow unvegetated habitat and shallow emergent marsh (annually in Carson Sink). The reductions, or loss, of these habitats are consequences of the loss of Carson Lake as a lake, deeper channels in Stillwater Marsh being filled in by sediments, and Carson Lake only receiving water when Lahontan Reservoir spills. Prior to water rights being acquired for wetlands, the loading of total dissolved solids and contaminants had increased significantly because drainwater replaced freshwater inflows in most years. Closure of Hunter Drain, formerly along Hunter Road, reduced some of the adverse impacts of drainwater entering the refuge. The permanent closure of the TJ Drain would eliminate a substantial source of poor quality water entering Stillwater NWR, which would improve water conditions as a consequence. Furthermore, total dissolved solids and contaminants in wetland inflows is anticipated to decline as additional water rights are acquired. However, mercury contamination could potentially increase if the volume of spill water reaching Stillwater Marsh and Battleground Marsh increases under Alternatives C, D, and E.

The degradation of riparian habitat along the lower Carson River also is, in large part, due to significantly lower volumes of water reaching this part of the river when spills occur, and the significantly reduced frequency of flooding. Aside from the construction of Lahontan Reservoir, which had major consequences on the lower Carson River, adoption of the 1988 OCAP further restricted water flows to the lower river. Under the 1988 OCAP, the lower river received water on average in one of three years, but the 1997 adjustments reduced this to an average of one of four years. Due to Lahontan Reservoir and operation of the Newlands Project, the timing of flood flows is later than would occur under natural conditions. Mercury is an ongoing problem in the lower Carson River. Past livestock grazing is another major contributing factor to the degradation of riparian habitat and the existing livestock grazing program maintains the habitat in poor condition. The introduction of saltcedar, Russian olive, and other nonnative vegetation is yet another major contributor to the degraded habitat conditions along the lower Carson River. (Appendix N)

Extension of the Stillwater NWR boundary, and initial riparian restoration efforts under Alternatives C, D, and E would halt further degradation of the riparian zone and would result in improvements in localized areas. To the extent that pre-Newlands Project water rights and the appurtenant lands are acquired (water rights to be used to restore the riparian zone) along the lower Carson River, the potential for restoring this habitat would increase. To the extent that additional lands are acquired along the river within the Alternative C, D, and E boundaries, more riparian habitat could be protected from livestock grazing, which would further benefit native riparian vegetation. Any reductions in the frequency or volume of spillwater reaching the lower Carson River would offset benefits associated with implementing Alternatives C, D, or E.

Depending on how it is designed, the U.S. Army Corps of Engineers' project to reduce the flood potential for the City of Fallon, more or less spill water would reach this part of the river.

4.11.3 MIGRATORY BIRD POPULATIONS

Migratory bird populations that use the Stillwater NWR Complex are affected by a host of other factors beyond those that affect basin wetland, riparian, and other habitats on the refuge complex. The diversity of birds on the Stillwater NWR Complex is affected by land use practices throughout the Western Hemisphere. Many species of birds that use the refuge complex only spend part of their time on the area. Although habitat conditions on the refuge complex plays a large role in determining the level of use by any given species, the overall population size of the species in the Pacific Flyway is a dominant factor affecting abundance on the refuge complex. For instance, if a particular species or given population of a species, is low, its abundance on Stillwater NWR would correspondingly be low, regardless of habitat quality on the refuge.

Some species of migratory birds have been adversely impacted by significant reductions in the amount of habitat, degradation of habitat, and pesticide use and other contaminant problems in other parts of North, Central, and South America. In the Great Basin in particular, wetland habitat has declined by an estimated 80 percent and riparian cottonwood and other riparian communities have been significantly impacted by land use practices since the mid 1800s, which likely has affected the same populations of migratory birds that use the Stillwater NWR Complex.

On a local level, some species have benefitted from changes in the habitat in the Lahontan Valley. So long as adequate nesting habitat remains available on Stillwater NWR and other Lahontan Valley wetlands, surrounding land use practices, such as flood irrigation, appear to have increased the white-faced ibis population. Thus, use of the refuge by white-faced ibis may be higher now than it was prior to agricultural production in the Lahontan Valley. It has also been speculated that common ravens are more abundant in the Lahontan Valley now as compared to natural conditions, although this is unsupported as yet, likely due to higher food availability during winter. To the extent that raven populations are higher than they were under natural conditions, depredation of waterbird nests may be higher than under natural conditions, regardless of nesting habitat quality.

Another factor that has had a considerable effect on Stillwater NWR wetlands and other Lahontan Valley wetlands is visitor services. Providing opportunities for hunting, birdwatching, and other wildlife-dependent recreation on Stillwater NWR and WMA and the attachment that these visitors developed for Lahontan Valley wetlands may ultimately have led to the increasing amount of wetland habitat on Stillwater Marsh. It is quite possible that, without efforts by a Western Nevada based coalition of hunting, environmental, and other conservation groups, the Service would not be acquiring water rights for Stillwater NWR. The effect of increasing the long-term wetland habitat acreage in the Lahontan Valley was evaluated in the WRAP EIS (USFWS 1996a), and therefore is not addressed further in this Final EIS.

Each of the different alternatives considered in this Final EIS would affect migratory birds in different ways. These are identified earlier in this chapter. In general, Alternative B would enhance fall and wintering waterfowl populations beyond the benefits anticipated under Alternative A, but would have fewer benefits to migrating shorebirds and similar benefits to breeding waterbirds as compared to Alternative A. Alternative C would enhance breeding habitat for waterbirds and fall migration habitat more so than anticipated under Alternative A, but would have neutral or slightly lower benefits to fall and winter waterfowl than anticipated under Alternative A. Alternative D would have fewer benefits to most migratory bird groups as compared to Alternative A, except that it would benefit fall migrating shorebirds more than under Alternative A. Alternative E would result in the most habitat benefits to all waterbird species when compared to the other Alternatives analyzed but would provide less protected habitat than under Alternatives C and D.

4.11.4 LOWER TRUCKEE RIVER AND PYRAMID LAKE RESOURCES

4.11.4.1 PYRAMID LAKE

In the early years of record (1880 to 1910), the water level of Pyramid Lake remained fairly stable, as Truckee River inflow and evaporation were roughly in balance (California, Department of Water Resources, 1991). From a peak of about 3,887 feet in elevation in 1870, the lake level began to decline in 1910 due to increased upstream diversions and Newlands Project operations which diverted an average of 239,700 acre-feet per year from the Truckee River between 1910 and 1966 (Federal Water Master's Gaging Station, Sierra Hydrotech data, 1980). In 1967, when the water level reached the lowest recorded elevation of 3,784 feet (a decline of about 103 feet), operating criteria for the Newlands Project curtailed winter power generation, which reduced Truckee River diversions. Fewer diversions to the Newlands Project and record runoff from the Sierras during the 1980s resulted in the water level in Pyramid Lake to increase by about 30 feet. Lake levels again dropped during the late 1980s and early 1990s, but the level is rising again due to record runoff from the Sierras.

Adjustments to the 1988 OCAP, implemented in 1997, were modeled to show a rise in Pyramid Lake water level of about nine feet. Increased Newlands Project efficiency anticipated to result from implementing all Alternative water management strategies, could result in additional efficiency credit water awarded to the Truckee-Carson Irrigation District; however, credit water amounts would be similar under all Alternatives and is as yet, an unmeasurable variable in Newlands Project Operations. Efficiency credit water is not considered by any of the models used in this Chapter 4 analysis and could result in additional diversion of Truckee River water above what has been considered in this EIS. The Truckee River Operating Agreement and Truckee River Water Quality Agreement are anticipated to result in further benefits to Pyramid Lake.

The Preferred Alternative is estimated to slightly increase Truckee River flows below Derby Dam, but effects on Pyramid Lake would not be anticipated to be measurable as a result of the proposed action.

4.11.4.2 FISH POPULATIONS

Cui-ui were Federally listed as endangered in 1967 due to a sharp decline in numbers and an aging population (USFWS 1992), a consequence of diverting large volumes of Truckee River water to the Newlands Project (at Derby Dam) and other upriver diversions. Implementation of OCAP (USBOR 1997) is anticipated to increase the population of cui-ui in the long term. Full implementation of the 1988 OCAP with 1992 assumptions would result in an estimated 217,100 cui-ui at the end of the simulation period. (The number of adult female cui-ui that would exist at the end of a 95-year (1901-1995) computer simulation is used as an index of the reproductive response of the cui-ui population to varying instream flow and Pyramid Lake levels.)

Adjustments to OCAP (USBOR 1997) and the Lahontan Valley water rights acquisition program (USFWS 1996a) would result in further long-term increases in the number of adult female cui-ui. Under the Adjusted OCAP and given the volume of water rights acquired to date for the wetlands, and assuming they are transferred to the wetlands and delivered according to the agricultural delivery pattern, an estimated 677,793 adult female cui-ui would exist at the end of the 95-year simulation period, a 212 percent increase. Under baseline conditions of this Final EIS (Alternative A; completion of water rights acquisition program delivered to wetlands according to the agricultural delivery pattern), the cui-ui index would more than double to an estimated 1,511,350. As a consequence of additional reductions in Truckee River diversions resulting from implementation of Alternatives B, C, D, or E, the cui-ui index would increase to an estimated 1,510,057, 1,555,540, 1,637,549, or 1,554,864, respectively. Cumulatively, this would be nearly a 500 percent increase (or, in the case of Alternative D, more than a 500 percent increase) over long-term conditions anticipated under the 1988 OCAP with 1992 assumptions. Implementation of a Truckee River Operating Agreement and Truckee River Water Quality Settlement Agreement, now in draft stages, and Newlands Project Recoupment, pending a court decision, could further enhance the cui-ui population. The Truckee River Operating Agreement is expected to change the timing of flows in the Truckee River to provide more water during cui-ui spawning seasons. Water rights acquired as part of the Truckee River Water Quality Settlement Agreement would further enhance flows in the lower Truckee River, improve water quality in the lower river, and increase the level of Pyramid Lake. Recoupment would result in more water for the lower Truckee River, thereby facilitating fish passage across the Truckee River delta, and would further enhance cui-ui spawning and rearing habitat, and increase the frequency of cui-ui spawning opportunities.

Due to the combined effects of Truckee River water diversions at Derby Dam, pollution, commercial harvest, and introductions of nonnative species, the original Pyramid Lake Lahontan cutthroat trout population was extinct by 1944 (USFWS 1995b). Lahontan cutthroat trout have been stocked in Pyramid Lake since this time (this practice actually began three decades before the original population became extinct). Buchanan (1987, as cited in USFWS 1995b) estimated that it would take 478,500 acre-feet per year of water to provide suitable spring spawning habitat for Lahontan cutthroat trout in the lower Truckee River. This volume of flow would be needed on nearly an annual basis. From 1918 through 1970, the average annual flow was roughly 300,000 acre-feet, with approximately 250,000 acre-feet being diverted at Derby Dam to the Newlands Project (USFWS 1992).

Full implementation of the 1988 OCAP with 1992 assumptions would result in an estimated average of 441,300 acre-feet of lower Truckee River flows (USDI 1997). Completion of the water rights acquisition program for Lahontan Valley wetlands would result in this amount increasing to an estimated average of 458,300 acre-feet per year (USFWS 1996a), and cumulative with Adjusted OCAP (USBOR 1997), would be anticipated to increase to an estimated long-term average of 496,980 acre-feet per year, which is above the amount estimated for providing suitable spawning habitat (recognizing this is a long-term average). As a consequence of additional reductions in Truckee River diversions resulting from implementation of Alternatives B, C, D, or E, lower Truckee River flows would increase further to long-term estimates of 496,397; 496,370; 499,840; or 497,140 acre-feet per year, respectively. Flows of at least 478,500 acre-feet per year would be anticipated in many years, and Alternatives C, D, and E would further benefit Lahontan cutthroat trout by providing slightly higher flows during July through December, a critical period for trout maintenance. Implementation of a Truckee River Operating Agreement and Truckee River Water Quality Settlement Agreement, now in draft stages, would further enhance the Lahontan cutthroat trout population. The actual effects are described above for cui-ui.

4.11.5 OTHER WILDLIFE ISSUES

4.11.5.1 MOSQUITO POPULATIONS

The Lahontan Valley historically was a fertile ground for several species of mosquitos, with seasonally flooded wetlands along the banks of the Carson River as well as Stillwater Marsh, Carson Lake, and other wetlands. The significant reductions in acreage of Lahontan Valley wetland habitat discussed previously reduced natural breeding habitat for mosquitos, but created other breeding areas (e.g., agricultural drains, seasonally flooded pasture). However, the Churchill County Mosquito Abatement District controls mosquitos in many of these more recent habitats. In total, the net result of changes in water distribution was probably a reduction in habitat, and thus, fewer mosquitos. The wetlands water rights acquisition program, once completed, would create additional breeding habitat for mosquitos northeast of the city of Fallon. The Preferred Alternative of this Final EIS may increase the suitability of wetland habitat for some species of mosquitos beyond baseline conditions due to peak acreages in spring followed by declining water levels later in the spring and summer.

4.11.6 OPPORTUNITIES FOR WILDLIFE-DEPENDENT PUBLIC USES

4.11.6.1 WATERFOWL HUNTING

In many ways, cumulative effects on waterfowl hunting opportunities in the Lahontan Valley parallel the cumulative impacts on wetland habitat and waterfowl populations. Use of Stillwater WMA (including areas now inside Stillwater NWR) for waterfowl hunting was high in various periods during the 1950s, 1960s,1970s, and into the early 1980s. Until the late 1960s, water flowed into Stillwater Marsh during winter months as a consequence of winter hydroelectric power generation which made use of Truckee River water. Although the curtailment of winter power generation at Lahontan Reservoir eliminated the flow of large volumes of fresh water into Stillwater Marsh during winter months, most of the eight years following curtailment of this water supply were high water years, many of which saw precautionary releases or spills from Lahontan Reservoir.

Beginning with further reductions in Truckee River diversions to the Newlands Project in the late 1980s and additional actions to increase water delivery efficiency in the project, as a consequence of the 1988 OCAP, wetland habitat acreage in Stillwater NWR and WMA declined further. A compounding factor was the drought that lasted from 1987 through 1994. During the drought, very little of the water flowing down the Carson River made it to the wetlands, and the little that did was in the form of drainwater. This brought wetland habitat acreage in Stillwater NWR and WMA to less than 500 acres in one year (nearly all in the WMA). No waterfowl hunting occurred on Stillwater NWR this year due to very limited habitat available for waterfowl.

Since the drought, the number of people interested in hunting has not rebounded to the numbers prior to the drought. Other factors include a downward trend nationwide in the per capita number of hunters. However, it is anticipated that increased acreage and reliability of wetland habitat on Stillwater NWR and other primary wetland areas in the Lahontan Valley would contribute toward an increase in hunter numbers. The degree of benefits depends in part on how Stillwater NWR is managed, which is the subject of this Final EIS. Under all the alternatives considered in this Final EIS, except Alternative D, the water rights acquisition program would have large benefits to waterfowl hunters, with Alternative B providing the most benefits and Option 1 of Alternative C providing the least. Another consequence of the water rights acquisition program is the enhanced waterfowl hunting opportunities that would be available at Carson Lake, especially to the extent that fall and winter wetland habitat are emphasized. Mine dewatering activities in the Humboldt River drainage, anticipated to last more than 10 years, would also contribute to hunting opportunities in the area by providing additional wetland habitat in the area of Humboldt Sink and Humboldt Slough.

4.11.6.2 WILDLIFE OBSERVATION AND PHOTOGRAPHY

National trends for nature tourism have been steadily on the rise (USDOI et al. 1996). Given the limited amount of data collected for Stillwater NWR on these activities, a definitive number is not available. However, an assumption could be made that the number of these visitors would grow to mirror the nationwide direction. The 1987-1994 drought no doubt had an effect on viewing wildlife in the form of wetland-dependent species, but the upland ecology did not suffer the same level of effects as the wetland areas and maintained its compliment of species, and those interested in viewing a Great Basin ecosystem at work would have had no problem. With the implementation of an active water rights acquisition program, the more stable wetland communities would attract a constant viewing public. Variety is an important component for many of these viewers, so added facilities and opportunities provided elsewhere in the valley would have negligible effects.

4.11.6.3 ENVIRONMENTAL EDUCATION AND INTERPRETATION

Environmental education and interpretation has occurred within the Stillwater NWR since the management area was established in 1948 and a meager staff was in place. However, it has never been a priority consideration and was performed on an as-warranted, as staff time allowed basis. The program began to grow in the early 1990s corresponding to a heightened interest in the Lahontan Valley wetlands and in response to environmental education being named one of the purposes of Stillwater NWR. With the passage of the Refuge System Administration Act, these uses have taken on a new importance and will be facilitated at a much greater level. Opportunities would abound on Stillwater NWR.

4.11.6.4 FISHING

Fishing was a very common activity on Stillwater NWR and WMA during the 1950s and 1960s when water flowed into Stillwater Marsh and other wetlands due to winter hydroelectric power generation at Lahontan Reservoir. During this period, considerable amounts of fresh water flowed into the refuge during winter months, which maintained relatively freshwater conditions in parts of the Stillwater Marsh. In 1959, “approximately 4,000 fisherman use days occurred...” (USFWS 1960) within Stillwater NWR and WMA, and much of this use occurred in Willow Lake.

When winter power water no longer flowed into the refuge in the late 1960s, water conditions began to decline. In the 1976 Annual Narrative Report for the Stillwater NWR Complex (Refuge files), it is noted that the large bass fishery that once occurred on the refuge had declined and that very little fishing continued in Stillwater Marsh. By that time, most of the fishing took place in the Indian Lakes area. Then beginning with further reductions in Truckee River diversions to the

Newlands Project in the late 1980s, as a consequence of the 1988 OCAP, wetland habitat acreage in Stillwater NWR and WMA declined further and the freshness of the marsh also declined due to reliance on drainwater in most years. A compounding factor was the drought that lasted from the mid-1980s through the early 1990s, which brought wetland habitat acreage in Stillwater NWR and WMA to less than 1,000 acres. Populations of sport fish had declined significantly.

Overlain on top of these, are the effects that mercury contamination of the Carson River system has had on fishing in the Lahontan Valley. Between 1859 and 1900, mercury amalgamation was used in the milling of gold and silver ore from the Comstock Mining District near Carson City, Nevada (Smith 1943). As much as 7,500 tons of elemental mercury may have been lost during milling operations (Bailey and Phoenix 1944), and most was discarded in mill tailings or discharged directly into the Carson River and its tributaries. Since this time, mercury has spread throughout the Carson River drainage below the Virginia Mountain Range, including the Lahontan Valley wetlands. The State of Nevada has issued a health advisory noting that eating any fish caught in the Lahontan Valley is not safe due to mercury contamination.

As a consequence of the above described factors, very few people have been fishing in Stillwater NWR and WMA since the drought, even in the Indian Lakes area where most of the fishing has occurred during the last 10 years. Although the number of people fishing on Stillwater NWR appears to have increased slightly over the last few years, the exclusion of fishing on Stillwater NWR under the action alternatives due to mercury contamination would not contribute substantially to the already depleted opportunities for fishing in the Lahontan Valley.

4.11.7 OTHER USES AND RESOURCES

4.11.7.1 NEWLANDS PROJECT OPERATIONS

Several past and ongoing activities and actions, in combination, have or are anticipated to contribute to higher Newlands Project delivery efficiency rates: 1988 OCAP, Adjusted OCAP, implementation of Naval Air Station-Fallon's modified land management plan, growth of Churchill County (including the Naval Air Station-Fallon expansion), and wetlands water rights acquisition program (USFWS 1996a). Changes in the seasonal delivery pattern for Stillwater NWR, as proposed under Alternatives C, D, and E would contribute further to this rising efficiency rate, while Alternative B could slightly detract from it. Increased efficiency resulting from water rights acquisition and delivery to Stillwater NWR and other primary wetland areas, could result in increased efficiency credit water being awarded to the Truckee-Carson Irrigation District, although, the modeled efficiency levels cannot be validated at this time. Additionally, efficiency credit would be similar among the Alternatives evaluated in this Final EIS, with all Alternatives modeled to achieve approximately 71% delivery efficiency.

The Adjusted OCAP (USBOR 1997), lowered Lahontan Reservoir storage targets below those identified in the 1988 OCAP. Conversely, the acquisition of water rights for Lahontan Valley wetlands is anticipated to result in somewhat higher storage volumes in early summer and fall (USFWS 1996a). Furthermore, by shifting water deliveries to earlier in the year and possible winter deliveries, storage volumes in Lahontan Reservoir during the fall would increase further (Alternatives C, D, and E), although early summer storage volumes could remain nearly the same (Alternative C) or could be lower (Alternative D), than would be anticipated under baseline conditions. If implemented, the Truckee River Operating Agreement could further reduce Lahontan Reservoir storage volumes. Newlands Project Recoupment, if decided in favor of the Federal government, and to the extent that Truckee River diversions are reduced, could potentially lower storage volumes in Lahontan Reservoir. The Truckee River Water Quality Settlement Agreement would have negligible effects on the Carson Division.

4.11.7.2 AIR QUALITY

Sources of airborne particulates in the area of Fallon include the surrounding desert lands (a major source); agricultural plowing, disking, and burning; dust blown off of dirt roads; combustion from vehicles and home heating units; and trash burning. As urban expansion continues and more farmland is converted to residential and other developments in the Fallon area, degradation of air quality due to agricultural activities should decline in the immediate vicinity of Fallon, although urban related air quality problems related to such things as trash burning, dust from roads, combustion from vehicles and home heating units, and construction activities would increase. The water rights acquisition program, initiated in 1990, would also result in less particulates being released into the air from plowing, disking, and burning, short term increases in wind erosion may result to the extent that vegetation cover on vacated farmland declines (USFWS 1996a). However, although this could result in short term impacts to air quality, the prevailing winds are out of the west and southwest which would minimize any potential problems because the acquired farmlands are primarily to the east and south of Fallon.

Under Alternatives B, C, and E, prescribed burning could reduce air quality slightly, but only during a few days each year. The amount of burning proposed is small compared to the amount of agricultural and other burning that occurs in the vicinity of Fallon.

4.11.7.3 LOCAL ECONOMY

As a consequence of the ongoing wetlands water rights acquisition program, agricultural production, agricultural sales, and agricultural related jobs would continue to decline in Churchill County. Another major impact to the agricultural sector of Churchill County is encroachment of residential development into the heart of the area’s farmland. These impacts are in addition to those incurred by the 1988 OCAP and adjustments in 1997. Newlands Project Recoupment, depending on how it is carried out, could also affect the local economy. In addition, the Truckee River Water Quality Settlement Agreement could lead to several thousand acres of other agricultural lands in the region being taken out of production, further affecting the agricultural sector. Alternatives B, C, D, and E of this Final EIS would slightly impact agricultural production in Churchill County due to cattle grazing being phased out of the Federal lands within the respective boundary alternatives. Livestock grazing would continue in the areas not incorporated into the refuge under Alternatives B, C, and E, and limited livestock grazing would continue under these three alternatives. Therefore, impacts to the local economy would be relatively slight. Any changes in livestock grazing practices on Carson Lake, pending a transfer to the State of Nevada, could also affect livestock grazing opportunities in the Lahontan Valley.

Some of the reductions in agricultural economic activity and jobs due to existing water rights acquisitions for wetlands, residential development, and other future actions would be at least partially offset by increased economic activity (including new home construction) and jobs resulting from income gains associated with water rights purchases, Naval Air Station-Fallon expansion, construction, and economic diversification. Furthermore, increased visitation of Stillwater NWR and Carson Lake due to increased wetland acreage and enhanced visitor facilities would contribute to the local economy.

4.11.7.4 INDIAN TRUST ASSETS AND CULTURAL RESOURCES

Pyramid Lake and lower Truckee River resources are anticipated to benefit slightly from higher Newlands Project efficiencies due several past and ongoing actions (1988 OCAP, 1997 Adjusted OCAP, water rights acquisition program for Lahontan Valley wetlands), thus benefitting the Pyramid Lake Paiute Tribe. The full benefits of increased efficiency could be slightly offset by credit water awarded to TCID for exceeding efficiency requirements. Changes to the water delivery schedule for Stillwater NWR under Alternatives C, D, and E of this Final EIS would further benefit these resources. To the extent they are implemented or undertaken, these resources would also benefit further from the Truckee River Operating Agreement, Truckee River Water Quality Settlement Agreement, and Newlands Project Recoupment. The acquisition of water rights for wetlands on the Fallon Paiute-Shoshone Indian Reservation would enhance trust resources on the Fallon Paiute-Shoshone Indian Reservation.

The protection of cultural resources on Stillwater NWR, Stillwater WMA, and Fallon NWR is anticipated to be enhanced by several ongoing actions, but could also be negatively affected by others. The continued acquisition of water rights for Stillwater NWR wetlands would enhance the preservation of prehistoric cultural resources at Stillwater NWR as a consequence of more water covering cultural resource sites in Stillwater Marsh. Closing portions of the marsh to visitor use, or restricting visitor access (e.g., boating restrictions, walk-in only area during hunting season, additional sanctuary, and requiring people to stay on roads during the breeding season) would add to the protection of cultural resources. Shifting the water delivery pattern to one approximating a natural flow pattern (Alternatives C, D, and E) or one emphasizing late summer deliveries (Alternative B), would result in benefits of the acquisition program not being as seasonally high as they would if the wetland water levels remained more static through the year. Population growth in Churchill County could adversely impact cultural resources as a consequence of land development in some areas and as a consequence of more people recreating in the area around Fallon, including the Stillwater area.

4.12 POSSIBLE CONFLICTS WITH AGENCY, TRIBAL, COUNTY OR STATE PLANS OR POLICIES

Alternative E does not appear to markedly conflict with the 1990 Churchill County Master Plan, as amended (Churchill County 1995). The Policy Plan for Public Lands included in the master plan specified that Stillwater WMA should be managed primarily for wildlife values. Potential conflicts include additional regulations on recreational activities and slightly reduced road access, although these changes under Alternative E do not appear to deviate substantially from Churchill County's Policy Plan for Public Lands. The policy, which recognizes that there are conflicts between livestock grazing and wildlife, states that livestock grazing should continue on public rangelands where compatible with multiple use objectives.

4.13 UNAVOIDABLE ADVERSE EFFECTS

Implementing Alternative E may result in some adverse environmental effects that could not be avoided, even with mitigation measures. In the previous sections of this chapter, the effects of Alternative E on the various components of the Lahontan Valley environment, including the social and economic environment, were identified. Possible relevant and reasonable mitigation measures were described in general terms for each of the major affected resources. Since the Service cannot ensure or determine that the identified mitigation measures will be fully implemented, there are likely to be situations where unavoidable effects would occur.

Although the amount of wetland habitat to be retained through the fall and winter would be increased considerably from existing conditions, it would not increase to the extent that it would under baseline conditions (Alternative A). Given the interest in waterfowl during the fall and winter for observation and hunting, this would be an adverse impact, as compared to baseline conditions. This lesser amount of fall and winter wetland habitat could result in fewer waterfowl during this time of year.

Construction of an administrative and visitor facility would have unavoidable adverse impacts to the immediate site on which it would be located. Enhanced facilities for refuge visitors, including the visitor facility, would increase the number of people visiting the refuge. Even under a carefully designed program, increased visitation would result in higher levels of disturbance to wildlife, but most increased disturbance would occur in localized areas. Although this is an unavoidable adverse impact (given the emphasis on encouraging and facilitating visitor services), the visitor services program under Alternative E would be designed to minimize these effects.

Use of pesticides to control saltcedar and other invasive vegetation could have adverse, short-term impacts to native vegetation. These impacts would be minimized through prescription and through the development and implementation of an integrated pest management program. Most direct impacts of pesticides would occur to target species. Smoke from a limited amount of prescribed burning may negatively impact visual quality for some people for a short time each year, fewer than five days per year.

Hydropower generation would be decreased and adversely impacted as a result of the Service's action. The loss of revenues associated with hydropower generation could be mitigated. New power generating facilities could be constructed, but this is highly unlikely because hydropower generation is not an authorized purpose of the Newlands Project. Water electric power generation is considered incidental to other water uses. It is unlikely that power loss could be mitigated under this action alone, and therefore it is identified as one of the unavoidable adverse effects that would result as a consequence of implementing Alternative E.

4.14 IRREVERSIBLE AND IRRETRIEVABLE RESOURCE COMMITMENTS

An irreversible commitment of resources results from an action that changes resources to the extent that they are either lost or would take an extremely long time to replace or recover. Any accidental damage or loss of a cultural resource would constitute an irretrievable commitment of resources. Management actions on Stillwater NWR, regardless of alternative selected, would be carried out in ways that ensure this would not happen. A potential irreversible commitment of resources could include areas that are not within the Alternative E boundary of Stillwater NWR. Once the boundary is revised, it would be difficult to change it in the future. The level of protection for lands not included in the boundary would be less than that of lands within the refuge.

An irretrievable commitment of resources refers to losses of production or use of a renewable resource for a period of time. This can occur when land or resources are allocated to other uses during this period. Elimination of livestock grazing from extensive areas now within Stillwater NWR, Stillwater WMA, and Fallon NWR constitutes an irretrievable loss to the livestock grazing industry because vegetation growing on the lands included in an approved refuge boundary would not be consumed by livestock into the foreseeable future under Alternative E. Although this vegetation would not be eaten by livestock, the change in land use practices would allow this vegetation to once again be used by wildlife for nesting, thermal cover, hiding cover, and forage, as well as enhancing the health of the land through soil formation and restoration of native plant communities. Road closures, increased boating restrictions, and any additional areas closed to hunting and other activities would similarly constitute an irretrievable loss of resources for some members of the public visiting the refuge in the future. For example, foregone opportunities would be those opportunities that could now be experienced in areas open to the public for a variety of opportunities, but would be unavailable for certain uses such as boat-in hunting (e.g., Swan Lake, the north 1/3 of North Nutgrass, and the north 1/3 of Pintail Bay under Alternative E). This presents an example of expanded opportunities for other members of the public (e.g., those wanting to hunt in an area not accessible by boats). Any opportunities that now may exist for future leasing of geothermal resources in the Stillwater known geothermal resources area (KGRA) would be irretrievable upon revising the boundary of Stillwater NWR to the extent the overlying Federal lands are encompassed within the approved boundary.

4.15 RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Long-term productivity, in the case of Stillwater NWR, refers to the capability of the land to provide resources into the future. One of the intents of Alternative E is to enhance the long-term productivity of the refuge ecosystem to contribute toward the maintenance of healthy populations of native wildlife into the future. Long-term objectives require short-term actions, such as water management, maintenance of delivery canals, and prescribed use of herbicides to control saltcedar.