Chapter 3. Refuge and Resource Descriptions

Geographic/Ecosystem Setting

Fish Springs NWR, located in western Utah in Juab County (Figure 1 and Figure 2), is one of the most isolated refuges in the lower 48 states. The nearest neighbors reside in Callao, Utah, a ranching community of about 45 people 24 miles west of the Refuge. The nearest communities with services are Dugway Proving Ground, Utah, 63 miles to the northeast and Delta, Utah, 78 miles to the southeast. The Refuge consists of 17,992 acres of fee-title land surrounded on the east, west, and south by Bureau of Land Management (BLM) holdings and on the north by the U.S. Army's Dugway Proving Ground. Springs flowing from the eastern base of the Fish Springs Range feed a 10,000-acre saline marsh divided into nine impoundments (Figure 3). The remaining of the Refuge comprises 6,000 acres of mud and alkali flat and 2,000 acres of semidesert upland.

The Refuge lies entirely within the Interior Basins ecoregion. Within the expanse of that ecoregion, the Refuge is within the subunit known as the Bonneville Basin. The Bonneville Basin comprises the area once covered by the prehistoric Lake Bonneville (Figure 2). Lake Bonneville, a landlocked basin about the size of the State of Montana, was filled about 35,000 years ago and fluctuated with wet and dry cycles until about 15,000 years ago, inundating much of the eastern portions of the Great Basin. At that time, the lake rose to a level that breached a pass in southern Idaho, eroded a large cut, and began draining into the Snake and Columbia Rivers. After a period of about 6 months, Lake Bonneville dropped an estimated 400 feet.

Over the next 4,500 years, Lake Bonneville continued to drop from evaporative losses exceeding inflows. Based on consistent carbon dating for the first organic layer in soil coring samples, the University of Utah has determined that the lake receded to the point where Fish Springs became a marsh type wetland about 11,400 years ago.

Wetlands found at the Refuge are associated with of a series of thermal springs that emerge from a fault line at the base of the east slope of the Fish Springs Range. Five major and several minor springs and seeps provide an average flow of about 29 cubic feet per second resulting in an average annual inflow of about 22,000 acre-feet of water. All Refuge springs exhibit thermal influence with the average spring water temperature being 74 degrees Fahrenheit. The springs are high in dissolved minerals, which results in a water pH of about 7.8. Groundwater recharge for the Refuge springs is believed to be regional rather than local due to the large volume in such an arid climate. Carbon-14 analysis aging indicates that water emanating from the Refuge springs probably fell as precipitation from 9,000 to 14,000 years ago.

The wetlands of Fish Springs NWR are about 75 miles south of the Great Salt Lake and are a major migration point for wetland birds migrating to and from the

lake. The wetlands of Fish Springs NWR comprise a greater acreage than all of the wetlands combined in all directions for a distance of more than 70 miles. As such, the Refuge provides critical migration habitat for a diverse array of wetland birds. Located on the eastern edge of the Pacific Flyway, the Refuge receives waterfowl from the Canadian Arctic and several Prairie Provinces, as well as birds originating in Idaho, Montana, Wyoming, and Utah.

Topography

Fish Springs NWR is located in a valley at the eastern front of the Fish Springs Range. The Great Salt Lake Desert to the north, the small Thomas and Dugway Ranges to the east, and the House Range to the south close the basin. The valley is about 10 miles wide and 20 miles long. The Fish Springs Range is characterized by rocky outcroppings and lava peaks with some areas devoid of vegetation. The peaks are full of caves and crevices.

The Great Basin is composed topographically of long, narrow, and steep mountain ranges running north-south with fairly flat basins between these mountain ranges. The basin, where the Fish Springs marsh is found, is bordered on the west by the Fish Springs Range and on the east by the Dugway and Thomas Ranges. The Refuge Headquarters sits at an elevation of 4,330 feet and the highest point in the surrounding mountains is 8,523 feet. The portion of the Refuge supporting wetlands is very flat with a minimum elevation of 4,287 feet and a maximum elevation of 4,305 feet.

Between the marsh and the Fish Springs Mountains to the west is a belt (about 6,000 acres) of semidesert uplands composed primarily of greasewood and shadscale. These uplands are flat to gently rolling and soon give way to the shallow marsh.

Ancient Lake Bonneville once covered the area except for the peaks of the ranges. The elevation of the Refuge varies from 4,285 to 4,700 feet with a small portion of the Fish Springs Range accounting for elevations above 4,350 feet.

The Refuge's topography was significantly altered in the 1960s with the construction of nine dikes at varying distances from the springs. The dikes created nine impoundments on the Refuge (clockwise from Refuge headquarters: Mallard, Shoveler, Pintail, Harrison, Gadwall, Ibis, Egret, Curlew and Avocet (Figure 3).

Soils

The semidesert uplands leading from the Fish Springs Range to the marsh contain alluvial soils with a high gravel content. Mud and alkali flats surround the eastern, northern, and southern limits of the marsh areas. The marsh soils are generally sandy-clay, about 6 feet deep. These soils occur on top of an impervious hardpan layer. Peat deposits, 4 feet deep or less, occur in the drainage areas downstream from the major springs. These soils are mildly alkaline, having a pH of about 8.0.

In the southern part of the Refuge and along the northern boundary are extensive areas of extremely alkaline soil—the salt flats. On the western edge of the Refuge, rocky outcrops produce an accompanying ground cover of coarse fractured rock. Alluvial deposits of coarse gravel are located in two areas west of the marsh. These deposits were left when ancient Lake Bonneville receded.

Water

After establishment of Fish Springs NWR in 1959, the approximately 10,000-acre marsh was divided into nine units that receive their water supply from warm saline springs rising under artesian

pressure and emanating at the base of the Fish Springs Range. These springs receive recharge from precipitation falling on the Fish Springs Range and Deep Creek Range 25 miles to the west. In addition, some spring recharge may occur from deep ground-water movement from Deep Creek, Snake and Tule Valleys. Movement of groundwater over these large distances is through unconsolidated basin fill as well as solution openings and fractures in the deep, consolidated carbonate rock. The age of the spring water is estimated to be about 10,000 years.

All excess water flows into the Great Salt Lake Desert, which adjoins the Refuge to the north. The Refuge is in an arid environment and is the only source of water for many miles. This oasis attracts a variety of species not common to the rest of the Service's Mountain-Prairie Region.

Water Rights

The Service holds water rights to 43.88 cfs of spring flow originating on the Refuge. The United States acquired the following three Certificates of Appropriation of Water (state perfected water rights) when land was purchased for the Refuge:

Water Right Number 18-51
Certificate No: 1996
Application No: 9922
Flow Rate: 5.0 cfs North Spring
Priority Date: 04/16/1926

Water Right Number 18-59
Certificate No: 2077-a
Application No: 10661
Flow Rate: 10 cfs South Spring
Priority Date: 04/30/1929

Water Right Number 18-66
Certificate No: 2112
Application No: 11020
Flow Rate: 10 cfs Middle Spring
Priority Date: 11/13/1931

After Refuge establishment, the Service filed Application No. A33136 (later assigned as Certificate 13087, Water Right Number 18-215) for an additional 18.88 cfs from the springs. This right, included with the certificated 25 cfs, appropriates a total of 43.88 cfs from the springs. Application No. A-40386, Water Right Number 18-331, 0.1 cfs, is for a domestic well with a priority date of 10/08/1970.

The Service controls 100 percent of the water rights on the Refuge with no other users. While the Services' water right is roughly 44 cfs, the current annual flow from the springs is about 28.69 cfs. The spring water is warm (around 74 degrees Fahrenheit) and saline, with conductivity readings of 3,000 to 5,000 umhos at the source.

Climate

The climate at Fish Springs NWR is arid. The average annual precipitation is 8 inches, with most precipitation falling in the spring and fall. Wide temperature fluctuations typical of desert environments occur daily and seasonally. Temperatures can range from 109 degrees Fahrenheit in summer to minus 19 degrees Fahrenheit in winter. High moisture losses during the summer occur through evapotranspiration as a result of low humidity and high ambient temperatures. Dry thunderstorms are common during the summer. Winter temperatures can remain well below freezing for several days at a time with snowfall averaging 15 inches per year. The frost-free season generally runs from late-April through mid-October. Wind speeds are generally light to moderate.

Habitat and Vegetation

Six habitat types exist on the Refuge—five vegetation communities and open water (Figure 5). These habitat types are:

- Great Basin Arid Shrubland

- Great Basin Cold Desert Shrubland
- Great Basin Cold Desert Grassland
- Shallow Water Marsh and Wetland
- Alkali Mud Flat
- Open Water

The Great Basin Arid Shrubland habitat type (516 acres) is found on the west side of the Refuge in the uppermost reaches. Dominant species include Mormon tea (*Ephedra nevadensis*) and rabbit brush (*Chrysothamnus nauseous* and *C. albidus*). Forbs include globe mallow *(Sphaeralcea coccinea*) and evening primrose (*Oenothera caespitosa*).

The Great Basin Cold Desert Shrubland habitat type (1,577 acres) is found at slightly lower elevations than the Great Basin Arid Shrubland. This habitat type also occupies areas on the west side of the Refuge as well as much smaller patches along the north, east, and south sides of the marshlands. This community is dominated by greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), and fourwing saltbrush (*Atriplex canascens*).

The Great Basin Cold Desert Grassland habitat type (4,328 acres) is found in mostly large patches interspersed with open water, wetlands, and mud flats throughout the marsh area in all nine impoundments. The soil in these areas is sub-irrigated or flooded only seasonally. Primary plant species include saltgrass (*Distichlis stricta*), alkali sacaton (*Sporobolus airoides*), and Baltic rush (*Juncus arcticus*).

The Shallow Water Marsh and Wetland habitat type (3,225 acres) is found in much of the Refuge marsh where water depth is less than 18 inches. Included in this type are Olney's three-square bulrush *(Scirpus americanus*), alkali bulrush (*Scirpus paludosus*), hardstem bulrush (*Scirpus acutus*), common reed (*Phragmites australis*), cattail species (*Typha domingensis* and *T. latifolia*), and spike rush (*Eleocharis rostellata*).

Alkali Mud Flat (6,437 acres), where subsaturated soils and very high salt levels are predominant, are found primarily on the east and south side of the Refuge. Vegetative diversity is severely limited under these conditions with pickle weed (*Allenrolfea occidentalis*) and samphire (*Salicornia utahensis*) being common in the lower portions and alkali sacaton, saltgrass and greasewood found in areas where dunes have formed.

Many Open Water (1,784 acres) areas contain submerged plant species. These communities are the most robust and diverse on the southern end of the Refuge where salt levels are lowest, and the least diverse in the northern reaches where salt levels in the late summer can be quite high. Plant species include wigeongrass (*Ruppia maritima*), coontail (*Ceratophyllum demersum*), spiny najad (*Najas marina*), sago pondweed (*Potamogeton pectinatus*), muskgrass (*Chara* spp.), and filamentous algae.

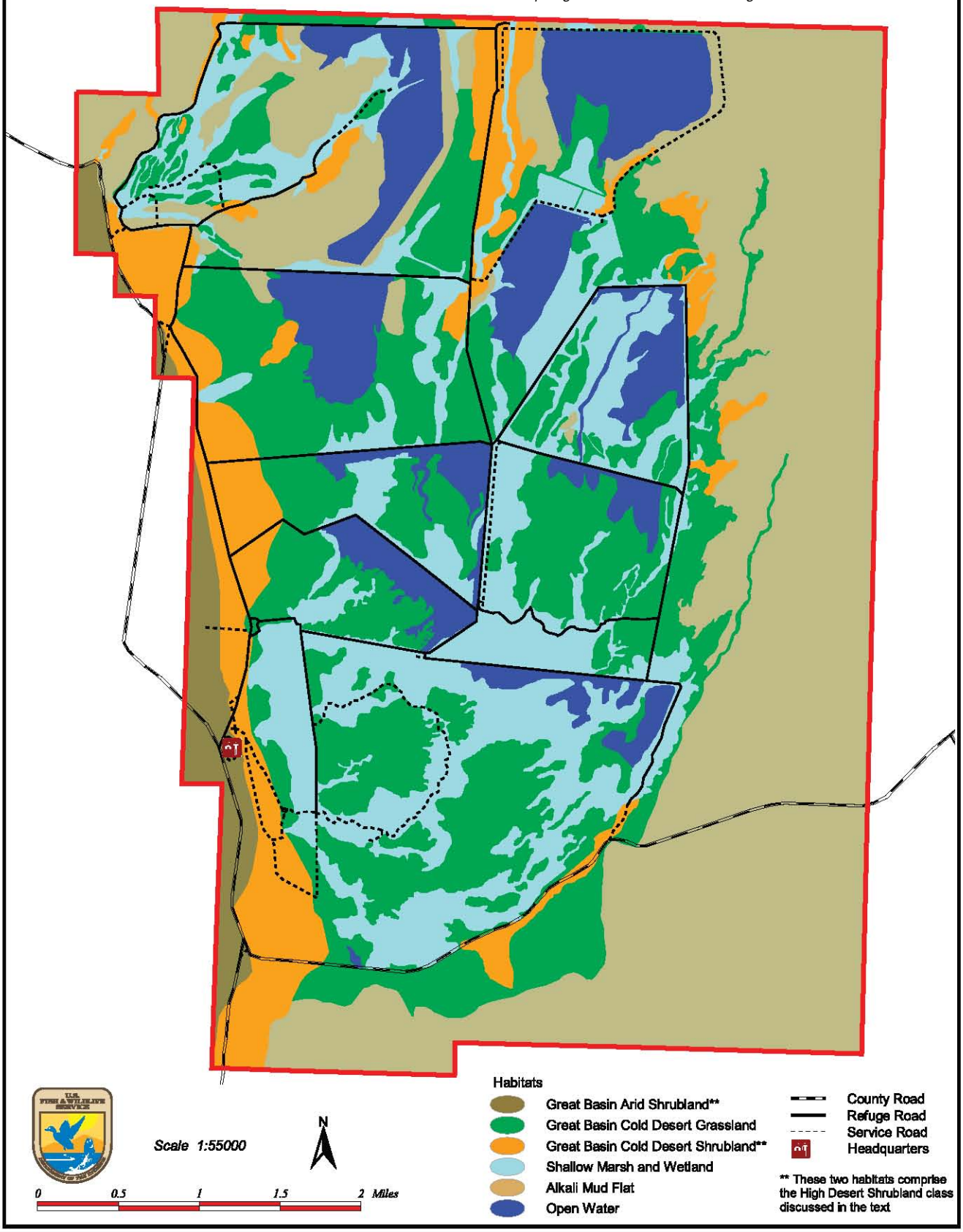
The only trees native to the Fish Springs area are a few scattered junipers in the higher portions of the uplands. A turn of the century planting consisting of Fremont cottonwoods (*Populus fremonti*) and silverleaf poplars (*Populus alba*) exists at the Thomas Ranch Watchable Wildlife Area. This planting is of cultural significance because although Fremont cottonwoods are not native to Fish Springs, these were planted by early settlers to the area and provide a historical context for the Refuge consistent with the Refuge mission. A thin shelterbelt of Russian olive (*Elaeagnus angustifolia*) and

U.S. Fish & Wildlife Service

Figure 5 -

Habitat Types

Fish Springs National Wildlife Refuge



Siberian elm (*Ulmus primula*) surrounds the Headquarters and residential area. Unlike other areas of the Great Basin, Russian olive does not readily spread into the marsh at Fish Springs (likely due to unfavorable soils). Several isolated patches of willow exist near the springs.

The primary noxious weeds in the area are saltcedar (*Tamarix ramossisima*), whitetop (*Cardaria draba*), and squarrose knapweed (*Centaurea virgata*). Mature stands of saltcedar exist along the north boundary with the majority of the Refuge containing only scattered young plants.

Whitetop is a recent invader that is confined to multiple small and discrete stands. This plant is a concern in other parts of the State because it is a noxious weed. It is hoped that annual chemical treatments by the Refuge staff will eradicate the plant. The isolation of the Refuge from other seed sources makes reinfestation in the near future unlikely.

Squarrose knapweed is also a recent invader. This plant first became established along the county road skirting the south and west boundaries of the Refuge. It can now be found in the western uplands of the Refuge, as well as throughout the Fish Springs Range. Sheep, along the mandated livestock driveway, are believed to be the most important factor in its continued spread.

A list of plants on the Refuge can be found in Appendix G.

Wildlife

Birds

The Refuge was established because of the historical attraction of waterfowl to its wetland habitat. During fall migrations, up to 30,000 ducks— predominantly mallard, pintail, wigeon, and green-winged teal—have been recorded (Table 1). During the fall and winter, Great Basin Canada geese average around 1,000 birds, and 40 to 100 tundra swans are also present. Recent production records are indicated in Table 2.

Since establishment, more than 278 species of birds have been observed at Fish Springs (Appendix G); 61 are known to nest on the Refuge. The Refuge provides the only important wetland habitat for a 70-mile radius. Consequently, the Refuge attracts hundreds of wetland-dependent species during migration. More than 40 species spend the winter at the Refuge. Great blue herons and black-crowned night herons are year-round marsh residents. A large variety of shorebirds are present during the summer months.

The Refuge hosts a surprisingly wide variety of songbirds. Breeding species include common yellowthroat, yellow warbler, marsh wren, house finch, yellow-headed and red-winged blackbirds, savannah sparrow, and Say's phoebe. Migrant and wintering species include loggerhead shrike, Wilson's warbler, yellow-rumped warbler, western tanager, pine siskin, and American goldfinch.

Commonly observed year-round Refuge residents include northern harrier, golden eagles, bald eagles, red-tailed hawks, rough-legged hawks, and prairie falcons. Winter residents include rough-legged hawk, American kestrel, and prairie falcons. Great horned and short-eared owls are found on the Refuge but are seldom seen.

Colonial nesting wading birds were monitored at Fish Springs NWR from 1994 through 1996 (Ward and Ward 1996). The Service currently manages the marsh system to provide high quality habitat for colonial nesting birds, including white-faced ibis, snowy egret, black-crowned

Table 1. Estimated waterfowl populations from 1997 to 2002.

Waterfowl	1997	1998	1999	2000	2001	2002
Coot	12,361	3,695	11,235	2,891	7,280	9,800
Tundra Swan	103	120	101	79	87	102
Canada Goose	847	598	858	445	760	1,060
Mallard	1,705	1,669	1,088	435	1,272	1,398
Gadwall	2,052	974	1,102	572	1,862	2,000
Pintail	4,275	1,927	4,609	1,333	7,895	3,267
Green-winged Teal	3,661	1,458	3,120	1,539	1,778	2,032
Cinnamon Teal	1,234	524	1,256	142	376	272
American Wigeon	4,805	281	2,367	495	2,754	5,443
Shoveler	804	883	847	389	374	180
Redhead	1,102	1,206	780	600	455	480
Canvasback	141	91	109	126	128	141
Ring-necked Duck	243	800	280	550	201	316
Lesser Scaup	11	58	140	89	222	72
Bufflehead	137	168	206	239	87	97
Ruddy Duck	287	96	440	119	128	79

Table 2. Estimated waterfowl production from 1988 to 1995.

Waterfowl	1988	1989	1990	1991	1992	1993	1994	1995
Mallard	70	59	160	96	44	39	119	233
Pintail	370	43	125	59	94	29	62	54
Redhead	350	153	375	173	474	49	128	175
Canvasback	50	5	53	16	157	7	5	23
Shoveler	20	35	64	51	115	15	43	56
Gadwall	110	146	226	129	435	50	236	254
Cinnamon Teal	120	123	328	161	209	35	144	156
Ruddy Duck	50	24	47	52	168	6	17	35
Subtotal	1,140	588	1,378	737	1,696	230	754	986
Canada Goose	75	22	33	18	31	34	24	19
American Coot	300	678	943	0	0	0	0	0
Total	1,515	1,288	2,354	755	1,727	264	778	1,005

night heron, and great blue heron. The marsh system is spring-fed, providing consistent, year-to-year nesting habitat that is independent of annual and seasonal fluctuations in precipitation (Ward and Ward 1996). The number and locations of rookery sites varied over the 3 years of monitoring (Table 3). In 1994 the main rookery was in Pintail Slough, shifting to the Mallard Unit with some birds nesting in the south Curlew Unit in 1995, and by 1996 the Mallard Unit was virtually the only active rookery (Ward and Ward 1996). The total number of nests and nest success also varied between years with nest success relatively high for all species (Table 4).

Mammals

Forty-eight species of mammals have been recorded on the Refuge. The majority of these species are small rodents (19) and bats (11). Coyotes, jackrabbits, and introduced muskrats are commonly seen residents. A small mule deer population uses the Refuge, primarily in late summer and fall. Pronghorn antelope are seen occasionally along the Refuge's western boundary.

Coyotes and badgers are regularly observed. Pocket gophers, wood rats, kangaroo rats, and antelope squirrels are among the more numerous smaller mammals. The Refuge supports a healthy muskrat population, which inadvertently assists in maintaining open water areas within the various units.

Reptiles, Fish, and Amphibians

Twelve reptiles, four fish, and two amphibian species are found at Fish

Table 3. Nest success of rookery sites for colonial wading birds by species for the years 1994-1996.

Unit	Number of Nests			Successful Nests			Nest Success (%)		
	1994	1995	1996	1994	1995	1996	1994	1995	1996
Pintail	295	0	0	181	N/A	N/A	70	N/A	N/A
Mallard	74	491	421	40	427	368	54	87	87
Egret	9	0	0	6	N/A	N/A	67	N/A	N/A
Curlew	0	21	2	N/A	5	0	N/A	24	0
Total	342	512	423	227	432	368	66	84	87

Table 4. Nest success of colonial wading birds in Refuge units for the years 1994-1996.

Species	Number of Nests			Successful Nests[†]			Nest Success (%)		
	1994	1995	1996	1994	1995	1996	1994	1995	1996
W.F. Ibis	164	200	147	108	169	121	66	85	82
S. Egret	135	204	191	85	159	174	63	78	91
B.C.N. Heron	37	99	76	28	95	64	76	96	84
B.G. Heron	1	7	7	1	7	7	100	100	100
C. Egret	5	2	2	5	2	2	100	100	100
Total	342	512	423	227	432	368	66	84	87

[†]A nest in which one or more eggs hatch.

Source: Ward and Ward 1996.

Springs NWR (Appendix G). The small mosquito fish and both amphibian species (bullfrog and leopard frog) were likely introduced in a bullfrog farm that operated in a major portion of the Middle Springs area from the early 1950s until about 1970 (Hovingh 1993; Service 1987). The mosquito fish is found throughout the canals and water units. Bullfrogs occur in House Spring and Walter Spring and areas connected to the main channel by permanent water flow (McKell et al. undated). Bullfrogs are found in springs and the main channel where water temperatures were greater than 66 degrees Fahrenheit; bullfrogs are not found in Avocet, Curlew, Shoveler, Egret, Ibis, Gadwall, Pintail or Harrison Units or road side pools with water temperature less than 50 degrees Fahrenheit (McKell et al. undated). Leopard frogs occur along the main channel and in dense vegetation at the edge of canals and pools with water temperatures greater than 60 degrees Fahrenheit (McKell et al. undated).

Leopard frogs are native to Utah; however, according to Hovingh (1993), leopard frogs are believed to be introduced into Fish Springs NWR from nearby populations. Bullfrogs are introduced predators that prey on other frogs, fish and waterbirds, sometimes leading to the extirpation of native fauna (McKell et al. undated; Lawler et al. 1999). Bullfrogs and leopard frogs have restricted patterns of distribution and abundance, possibly due to bullfrog predation on leopard frogs (McKell et al. undated). There is no evidence that bullfrogs impact least chub (Banta, pers. comm. 2004).

The least chub, a candidate species, has been successfully reintroduced into Walter's Spring with additional releases planned in the coming years. The Utah chub is the most numerous fish on the Refuge.

Invertebrates

Aquatic invertebrates (aquatic insects) are an important part of the diet of breeding migratory birds. Drawdowns and burns of marsh ponds simulate the wet/dry cycles of a natural wetland and release stored nutrients (Faulkner and Cruz 1992; Kadlec 1962). Aquatic invertebrate populations were monitored in 1983, 1984, and 1990-1997. Sampling of invertebrates at Fish Springs NWR in 1997 and a summary of data from 1990 to 1997 indicated that invertebrate abundance increases following drawdown and burning (Halley 1997). Nonaquatic insects have not been inventoried or monitored. Thirty-eight families of aquatic invertebrates have been identified from Refuge waters.

Threatened, Endangered, and Candidate Species

Three federally listed threatened and endangered species are found in Juab County: bald eagle, yellow-billed cuckoo, and Ute ladies'-tresses orchid. The bald eagle is listed as a threatened species and is known to winter at Fish Springs NWR. The bald eagle was downlisted from endangered to threatened in 1995 and the Service has proposed to delist the species due to population recovery. The bald eagle is an opportunistic forager during winter, often relying on rabbits, injured waterfowl, and carrion and typically roosts communally during winter (Stalmaster 1987). Between two to five bald eagles are typically observed on the Refuge during winter. Currently, the trees at the Thomas Ranch Watchable Wildlife Area provide the only suitable roosting site for the eagles, although a recent pole planting near South Spring may provide an additional site in the future.

The yellow-billed cuckoo (cuckoo) is a neotropical migratory bird. The decline of the western population of the yellow-billed cuckoo due to loss of riparian habitat has been reported consistently (Tate and Tate

1982; Finch 1992). The Service identified a distinct western population segment of the cuckoo and determined that there was substantial information to indicate that the listing was warranted, but precluded by higher priority listing actions (66 Fed. Reg. 38611 (July 25, 2001)). This species has been added to the Service candidate list. Fish Springs NWR contains no potential habitat for the cuckoo.

The Ute ladies'-tresses orchid (orchid) is federally listed as threatened. The orchid occurs at elevations below 6,500 feet in moist to wet alluvial meadows, flood plains of perennial streams, and around springs and lakes (Service 1992). Once thought to be fairly common in low elevation riparian areas in Colorado, Utah, and Nevada, the orchid is currently rare in all three states. Generally, the vegetative cover surrounding the orchid is relatively open. Dense, overgrown sites are not conducive to orchid establishment. Where the orchid is found, soils are typically alluvial deposits of sandy, gravelly material that are saturated to within 18 inches of the surface for at least part of the growing season. No surveys have been conducted on the Fish Springs NWR to determine the potential occurrence of the orchid on the Refuge.

It is believed that Fish Springs NWR once harbored the least chub, currently a proposed endangered fish found only in springs of the Bonneville Basin. The fish has been reintroduced into Deadman and Walter's Springs. Only the reintroduction into Walter's Spring has been successful. These populations are considered by Utah Division of Wildlife Resources (Utah DWR) as experimental.

The Fish Springs pond snail was described in 1890. Some empty shells were found by Russell (1971). Dr. D.W. Taylor declared the pond snail extinct after a 1986 survey.

No known resident endangered, threatened, or candidate plant species exist on the Refuge.

The Pacific Coast population of the western snowy plover (*Charadrius alexandrinus*) is considered a distinct population segment and was listed as a federally threatened species in 1993 (58 Fed. Reg. 12864 (March 5, 1993)); however, the interior population of snowy plover was determined not to warrant listing (59 Fed. Reg. 58982 (November 15, 1994)). On March 22, 2004, the Service issued a 90-Day Finding on a Petition to Delist the Pacific Coast Population of the western snowy plover and initiated a 5-year review (69 Fed. Reg. 13326 (March 22, 2004)). The western snowy plover is a small shorebird that typically breeds on alkali flats and alongside reservoirs, sewage and evaporation ponds (Andrews and Righter 1992; Kingery 1998) in the interior U.S. This species nests on the ground on beaches, dry mud or salt flats and sandy shores of rivers lakes and ponds.

In northern Utah, snowy plovers usually nest in areas devoid of vegetation, generally in recently exposed alkaline flats (Paton and Edwards 1992). Nesting in northern Utah occurs from mid-April to mid July (Paton and Edwards 1991, 1992). Complete clutches may be lost due to high water, adverse weather, trampling by cattle and large mammals or disturbance by humans. Predation by gulls, common raven, red fox, skunk, raccoon and coyote can result in high rates of clutch failure in some years (Page et al. 1985; Paton and Edwards 1991, 1992). Predation by mammalian and avian predators, including coyote, ravens and possibly Great Basin gopher snakes, appears to contribute to low production of plovers at Fish Springs NWR (Banta, pers. comm. 2004). The current annual success rate for snowy plovers nesting on Fish Springs NWR is

unknown. Predator exclusion fences have proven effective for reducing mammalian predation on piping plovers (Mayer and Ryan 1991; Andrews et al. 1999) and have been proposed as a management tool to reduce nest losses for snowy plover (TNC 1998).

Cultural Resources and History of Refuge Lands

Fish Springs NWR has a very rich and diverse human history. Archaeological investigations on the Refuge have documented use of the area to the Early Archaic Period (ca. 7,000-8,000 B.P.). Recent studies have indicated that Lake Bonneville receded to expose the Fish Springs marsh about 11,400 years ago, which have led archaeologists to conclude that Paleoindian occupation within a few hundred years of that date was likely.

USFWS

Pony Express Marker

Evidence of human use of the area through the Late Archaic has been found on the Refuge. Evidence of more recent occupation by the Fremont culture has been documented at Fish Springs NWR as well. There are few Fremont culture sites from western Utah but they likely occupied the area from 700 to 1,500 years ago. The Goshiute tribe, an ethnographic branch of the Western Shoshonean culture, occupied the Refuge from the 1400s to the 1900s.

Two caves within the Refuge boundary, located on the east face of the northern tip of the Fish Springs Range, are part of a National Archeological District. Numerous other sites, evidenced by large expanses of lithic scatter, support occupation over thousands of years. Inventory efforts by the University of Utah Archaeology Field School over the last several years have documented 11 major sites. Most of the activity around the marsh is attributed to chipping artifacts and hunting, which assumes that the marsh supported a substantial wildlife population during the prehistoric period.

The first documented Euro-American occupation of the marsh was in 1859. George Chorpenning established a station on his mail route to Nevada. This outpost was little more than a thatched shed.

In 1860, the Pony Express and Overland Stage purchased Chorpenning's mail obligations, and Fish Springs became a stop of note on a very inhospitable section of that arduous route. In 1861, the Transcontinental Telegraph line passed through Fish Springs and that entity proved to be the death knell for the Pony Express. The Pony Express assets were sold and the mail delivery route shifted north of the Great Salt Lake to parallel the transcontinental railroad. The route through Fish Springs, however, proved to

be a superior stage route for transporting passengers, and some form of stage service was maintained through the area until the 1920s.

There is little record of activities in the marshes of Fish Springs from 1870 through 1890. By the early 1890s, John Thomas established a ranch on the edge of the marsh and was raising cattle and horses, which he provided to the adjacent Utah and Galena mining operations. He also provided lodging, meals, and hay to the stage service, and sold supplies to the shepherds who wintered enormous flocks of sheep in the region during the winter. Thomas occupied the ranch until his death in 1917.

In 1913, the Lincoln Highway, the nation's first transcontinental automobile road, was built across the Thomas Ranch. This route became a very lucrative source of income for Thomas for several years. In 1919, the completion of the Goodyear Cutoff, about 20 miles north of the marsh, eliminated much of the Lincoln Highway traffic. However, due to the precariousness of that section during winter, a substantial amount of Lincoln Highway traffic continued to pass through the Fish Springs route until 1927. It is estimated that at the peak usage period for the Lincoln Highway more than 5,000 cars passed each year, compared to less than 2,500 cars currently. Several segments of the Lincoln Highway are still visible in Refuge uplands.

Between 1917, when John Thomas died, and 1925, the patented land around the marsh passed through several owners. By 1925 most of that land was owned by Tass Claridge and Jim Harrison, doing business as the Fish Springs Livestock and Fur Company. This property remained in their possession until 1959 when it was purchased fee-title by the Service for inclusion in the Refuge.

Fire Occurrence and History

Fire records prior to Refuge establishment are not readily available. Due to topography and the sparse vegetation surrounding the Refuge, fire in the area was probably a localized phenomenon. With the abundant fuel in the form of dead dry marsh vegetation, frequent lightning storms, and the use of the area by nomadic tribes, all of the ingredients necessary for fires were present. It is assumed that fire historically was a relatively common occurrence in the marsh area and was a determinant in the existing vegetation. It is known that post-settlement landowners periodically burned the marsh to improve its grazing potential. Wildfires were "apparently not a problem" for these prior landowners (Service 1960).

Since Refuge establishment in 1959, 54 fires have been reported on the Refuge (50 prescribed burns within marsh units and four wildfires - all human caused). Prescribed burns have varied from 1 acre to 1,630 acres. Based on a review of the fire history, a wildfire frequency of one fire every 10 years has been established.

Visitor Services

In spite of its isolation, Fish Springs NWR has historically hosted 2,000 to 3,000 visitors each year (Table 5). Most come to enjoy wildlife-oriented recreational opportunities in the Refuge's uncrowded environment. Fish Springs public uses include waterfowl hunting, wildlife observation, wildlife photography, environmental education and interpretation.

Table 5. Public use at Fish Springs NWR, 1995-2002.

Year	Visits
1995	2,642
1996	2,982
1997	2,890
1998	2,957
1999	3,092
2000	2,881
2001	2,049
2002	2,376

Fish Springs NWR provides one of the highest quality public waterfowl hunting opportunities to be found in the western United States. Waterfowl hunting opportunities include ducks, geese, and coots, in accordance with State regulations. Hunter densities rarely exceed one hunter per 200 acres. Opportunities exist for waterfowl hunting by hunters with mobility impairment. The hunting seasons do not conflict with the waterfowl nesting season.

Recreational use other than hunting in the spring and summer months have contributed to an overall increase in visitor numbers. Many come to the Refuge in the process of exploring the rich human history of the area, reaching back into time to more than 11,000 years before present. The Refuge hosts two events annually to provide the public with special opportunities to learn first-hand about the Refuge's resource-rich environment.

The Refuge maintains an auto-tour route that traverses a good cross section of the diverse habitats and provides exceptional opportunities for wildlife viewing and photography. The Thomas Ranch Watchable Wildlife Area provides a welcomed shady respite for visitors who have traveled through the dusty, hot, and dry conditions that must be traversed from any cardinal direction to reach the Refuge.

While visits by scout groups and schools are not as frequent as is the case on many refuges, those that do visit find the Refuge to be a wonderful outdoor classroom. Providing service projects, merit badge counseling, and environmental education enhances the visitor experience and understanding of the Refuge for most of these young visitors.

Wilderness

A wilderness review is the process used by the Service to determine whether to recommend lands or waters in the National Wildlife Refuge System to Congress for designation as wilderness. The Service is required to conduct a wilderness review for each refuge as part of the CCP process. Land or waters that meet the minimum criteria for wilderness are identified in a CCP and further evaluated to determine whether they merit recommendation for inclusion in the Wilderness System. According to Section 13 of the Service's Director's Order No. 125 (July 2000), in order for a refuge to be considered for wilderness designation, all or part of the Refuge must:

- Be affected primarily by the forces of nature, with the human imprint substantially unnoticeable
- Have outstanding opportunities for solitude or primitive and unconfined type of recreation
- Have at least 5,000 contiguous acres or be sufficient in size to make practical its preservation and use in an unimpaired condition, or be capable of restoration to wilderness character through appropriate management, at the time of review
- Be a roadless island

Fish Springs NWR is not recommended for inclusion in the Wilderness System because it does not meet the above criteria. The Refuge has considerable evidence of past human use, and is not roadless.

Socioeconomics

Population and Demographics

Utah's 2003 population was estimated to be 2.39 million, increasing 2.0% from 2002. Although the state continues to experience net in-migration, natural increase accounts for the majority of Utah's population growth (State of Utah 2004). According to the U.S. Census Bureau, Utah ranked eighth among states with a population growth rate of 1.4% from 2002 to 2003. During the same period, the U.S. rate of growth was 1.0%.

The Western region grew the fastest in the 1990s, with the population in the State of Utah growing from 1,722,850 in 1990 to 2,233,169 in 2000, an increase of 29.6%, while the national population growth rate was slightly less at 13.2%. The population in Juab County grew from 5,817 in 1990 to 8,238 in 2000, an increase of 42% for the 1990s (U.S. Census Bureau 2000). Utah's population is expected to increase about 2.6% annually through 2010.

About 96.6% of the Juab County population consider themselves to be white (compared to 75% nation wide). About 2.6% consider themselves to be Hispanic or Latino in origin (compared to 12.5% nation wide), and 1.0% consider themselves to be American Indian (compared to 0.9% nationwide) (U.S. Census Bureau 2000).

Employment

With about 22,000 employees, the State of Utah is the largest employer in Utah. Health care services and education are the next three top employers while the federal government (mainly defense) occupies the number five rank.

Since 1994, the rate of job growth has fallen from 6.2% to 0.9% in 2001. This is Utah's slowest job growth since 1983 and well below the long-term average of 3.5%. Education and health services led the state in job growth from 2000 to 2003. Financial activity, professional and business services, and government (except state government) experienced positive job growth, while many industries experienced a decline in job growth. Utah's 2003 unemployment rate was 5.8%. On average, there were 68,900 Utahans unemployed in 2003.

Income

Utah's average annual nonagricultural pay was $30,500 during 2003, up 1.4% from 2002. After seven years of solid gains in which wages grew faster than inflation, wages matched inflation during 2002, but grew less than inflation during 2003.