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Bear River Migratory Bird Refuge

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Habitat Management Plan

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AMERICA'S NATIONAL WILDLIFE REFUGES...
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Habitat Management Plan
Bear River Migratory Bird Refuge
Brigham City, Utah

March 4, 2004

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Bear River Migratory Bird Refuge
Habitat Management Plan

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Acknowledgment

This Habitat Management Plan has been a work in progress for over ten-years. Many, many individuals have contributed toward this Plan. My thanks go to these folks for their foresight in long-range planning long before it became policy. I had a biologically sound draft to start from. Special recognition goes to Karen Lindsey, Victoria Hirschboeck, Bob Green, Al Trout and John Kadlec for their significant contributions.

I. Introduction

A. Scope and rationale

In order to clarify Bear River Migratory Bird Refuge's (Refuge) role in contributing toward conservation of wildlife at the local, regional, and ecosystem levels while preserving biological integrity, diversity, and environmental health of the National Wildlife Refuge System, Refuge staff have devised a Habitat Management Plan. The Plan is intended to be a dynamic document providing a decision-making process and guidance for the management of refuge habitat.

The Habitat Management Plan (Plan) was a process by which the most appropriate management direction or best use of refuge lands was evaluated. In the evaluation process, the Refuge's contribution to biological integrity, diversity and environmental health was examined from several landscape scale perspectives. The Refuge's role in addressing conservation issues within the context of the Intermountain West, Great Basin, and the Great Salt Lake ecosystems was assessed. Priority species and species groups were developed during the evaluation process. Species were elevated to priority when the Refuge played an obvious role in accomplishing population and habitat objectives for a particular species as outlined in various landscape scale conservation plans. These priorities were then used to guide us in the development of habitat objectives based on priority species needs and finally, in the development of implementation strategies to achieve objectives. The Plan provides a vehicle by which Refuge staff use key historical Refuge data, scientific literature, expert opinion, and staff expertise to make habitat management decisions.

B. Legal Mandates

Bear River Migratory Bird Refuge was established by a 1928 Presidential Proclamation and Public Law 304 of the 70th Congress as "a suitable refuge and feeding, and breeding grounds for migratory wild fowl". This act required the approval of the State of Utah. The state legislation (Utah Code Ann. 23-21-6(1), enacted in 1929, required the U.S. Fish and Wildlife Service to provide a management plan for these lands to the governor.

Several Public Land Orders withdrew public lands for inclusion in the Bear River Migratory Bird Refuge. The orders withdrew these lands from all forms of appropriation under public land laws, including mineral laws. However, mineral leasing laws pertaining to drilling are applicable if known geological resources, such as oil and gas, exist. More recently, conflicting opinions concerning the ownership of lands within the refuge boundary below the surveyed meander line have been addressed in a settlement agreement that has been accepted in principle by the State of Utah and the Department of the Interior. Legislation is pending before Congress (House Resolution 3958) to authorize the funds necessary to implement the terms of the agreement.

There are outstanding easements for power lines, roads, telephone lines and natural gas pipelines. There are no outstanding mineral reservations on any of the refuge lands. None of these easements will interfere with refuge management.

The Refuge Improvement Act of 1997 established for the first time, a singular conservation mission for the National Wildlife Refuge System (System):

> "*To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans".*

The legislation requires that the mission of the National Wildlife Refuge System and purposes of the individual refuges are carried out. Therefore, Refuges are faced with the challenge of meeting their establishing purposes, while finding ways to contribute toward broader System and ecosystem needs.

C. Relationship to other plans

The Comprehensive Management Plan (USFWS 1997) for the Bear River Migratory Bird Refuge provides management direction for each portion of the refuge by identifying important groups of wildlife and their associated habitats to be emphasized for management.

The Habitat Management Plan for the Bear River Migratory Bird Refuge is a step-down plan of the Comprehensive Management Plan and the Environmental Assessment for the Restoration and Enhancement of Bear River Migratory Bird Refuge (Hansen 1991).

The purpose of this plan is to guide the management, protection, and restoration of wildlife habitat on the refuge while integrating goals and objectives with other pertinent landscape scale plans. This long-range plan will be evaluated after ten years but may be updated earlier as better management information is developed, or resource priorities change.

The following landscape scale conservation plans were reviewed and where appropriate, habitat and population objectives were integrated with this Plan; Utah Partners in Flight (Parrish et al. 2002), Intermountain West Joint Venture (Utah steering committee 2003), U.S. Shorebird Conservation Plan (Brown et al. 2000), Intermountain West Regional Shorebird Plan (Oring et al. 2000), U.S. Waterbird Conservation Plan (Kushlan 2002), Intermountain West Waterbird Plan (Ivey et al. 2002 Draft), Great Salt Lake Comprehensive Management Plan (Utah Department of Natural Resources 2000), and the Great Salt Lake Shorebird Management (Paul et al. 1999 Draft).

The mission of Bear River Migratory Bird Refuge is to: *provide the feeding, breeding, and resting habitat for migratory birds and other wildlife while maintaining the natural diversity of plants and animals native to the Bear River Basin.*

To fulfill the Refuge mission, the goal for the habitat program at Bear River Migratory Bird Refuge will be to provide a spatial and temporal distribution of habitats to meet breeding, feeding and resting needs for species using the refuge with an emphasis on the priority species (USFWS 1997).

D. Time period

June 1, 2003 to June 1, 2013

II. Background

The Intermountain West region is comprised by portions of eight states including eastern Washington and Oregon, northeast California, northern Nevada and Utah, western Wyoming and Montana, and Idaho. Due to its arid to semi-arid climate, wetlands are scarce in the region (Ratti and Kadlec 1992). Wetlands in the Intermountain West region account for about 1 percent of the surface area (1.6 million acres) compared to 6 percent (22.5 million acres) in the Midwest region (Dahl 1990).

The Great Basin, considered part of the Intermountain West region, is a closed basin that falls between the Cascade and Rocky Mountain ranges, principally in Oregon, California, Nevada, and Utah. It stretches over 435 miles from north to south and 370 miles from east to west. In the Great Basin, wetlands also account for less than 1 percent of the surface area. Although mostly a remote desert ecosystem, the wetlands in the region are critical to migrating and breeding shorebirds. Over 48 percent of North America's waterbird diversity and 63 percent of shorebird diversity are represented in this region (Haig and Oring 1998).

The saline waters and freshwater marshes of the Great Salt Lake comprise one of the most critical breeding and staging sites for colonial waterbirds, waterfowl and shorebirds in the Great Basin. Oring et al (2000) stated "the Great Salt Lake stands out as probably the most important inland shorebird site in North America". Shuford et al (2002) found that in the fall, 78 percent of the Intermountain West region's Black-necked Stilt, *Himantopus mexicanus*, 79 percent of the American Avocets, *Recurvirostra americana*, 86 percent of the Marbled Godwits, *Limosa fedoa*, and 39 percent of the dowitchers, *Limnodromus* spp., were concentrated at the Great Salt Lake. The Great Salt Lake, is also the largest staging area in the world for Wilson's Phalaropes, *Phalaropus tricolor*, (Jehl 1988). Paul and Manning (2002 *in press*) estimated 63,000 American Avocets were potential breeders at the Great Salt Lake, which accounts for about 14 percent of the continental population. The marshes of northern Utah attract 50-60 percent of the continent's population of breeding Cinnamon Teal, *Anas cyanoptera*, annually and host thousands of molting Northern Pintail, *Anas acuta*, (Bellrose 1980). The Great Salt Lake hosts 7,500 breeding White-faced Ibis, *Plegadis chihi*, (USFWS 1982) which constitutes the world's largest breeding population.

Bear River Migratory Bird Refuge is located in the northeast arm of the Great Salt Lake known as the Bear River Bay. The Bay encompasses 112,000 acres of the Bear River delta (Kadlec and Adair 1993). The delta is a mosaic of freshwater marshes, river channels and alkali salt flats. The Refuge encompasses about 71,000 acres of the Bear River delta. The Bear River delta interrupts the shrub lands of the arid Great Basin acting as a freshwater oasis that hosts high populations of nesting waterbirds and attracts large flights of migrant grebes, waterfowl, and shorebirds. The Bear River delta has long been recognized as a wetland of great value to waterbirds in the Intermountain West region. Early explorer John C. Fremont witnessed such a large concentration of birds that he wrote in 1843, "...the waterfowl made this morning a noise like thunder...as the whole morass was animated with multitudes of waterfowl" (Fremont 1845). Captain Stansbury while completing a survey of the Great Salt Lake remarked on October 22, 1849 as he looked out over Bear River Bay that "it was covered by immense flocks of wild geese and ducks among which many swans were seen being distinguishable by

their size and the whiteness of their plumage. I had seen large flocks of these birds before, in various parts of the country, and especially on the Potomac, but never did I behold anything like the immense numbers here congregated together. Thousands of acres, as far as the eye could reach, seemed literally covered with them, presenting a scene of busy, animated cheerfulness" (Stansbury 1852).

Bear River Refuge is the largest freshwater component of the Great Salt Lake ecosystem and hosts large population segments of Pacific Flyway waterfowl, shorebirds, and other waterbirds during their annual cycles. Band returns indicate the Refuge also hosts large numbers of Central Flyway birds. In the fall, the Refuge may host up to 500,000 ducks and upwards of 200,000 shorebirds (unpublished refuge records). Mid-winter waterfowl surveys indicate that roughly 30 percent of the western population of Tundra Swans, *Cygnus columbianus*, (more than 30,000 birds) use the Refuge for fall staging and wintering in mild years (unpublished refuge records).

In 1992, the Refuge, in conjunction with other portions of the Great Salt Lake, was recognized for its importance to shorebirds when it was designated a Western Hemisphere Shorebird Reserve Network Site. Shorebird numbers often reach into the hundreds of thousands during fall migration (unpublished refuge records). Shuford et al. (1994), referring to a peak count of 30,000 Marbled Godwits recorded on the refuge, noted that the Great Salt Lake provides the only major staging area for Marbled Godwits in the interior of North America.

The average breeding population of American Avocets on the refuge is about 4,800 birds (1956-2002, unpublished refuge records). The mean number of Avocets detected on the Refuge during the non-breeding season is greater than13,000 (Paul and Manning 2002). These figures represent 1 percent and 13 percent respectively, of the continental population (Brown et al. 2000).

The Refuge, as part of the delta, has sustained large numbers of nesting ducks throughout its history. Weller (1964) noted the delta marshes had the most outstanding concentrations of breeding Redheads, *Aytha americana*, reported anywhere in North American, while Bellrose (1980) recognized northern Utah marshes as important to breeding Cinnamon Teal.

The Refuge serves a vital role in the Bear River delta ecosystem by protecting, developing and managing over 71,000 acres of freshwater wetlands and alkali mudflats. Waterfowl, shorebirds, and other waterbirds, utilize the refuge as a breeding, staging, and wintering area. The Bear River delta is unmatched for diversity and productivity of migratory birds. Two hundred ten species of birds regularly visit the Refuge. Sixty-seven bird species are known to nest and another 10 species are considered accidental or rare.

The Refuge wetlands sustain aquatic plant and animal food resources for birds. The invertebrate populations provide protein the birds require for egg laying and molt during and after the breeding season. Midge, *Chironomid* spp., are so abundant, the flying adults often form tornado like, black clouds along the Refuge roads (B. Olson, pers.obsv.). The nearby salt laden environment of the Great Salt Lake produces high-quality protein in the form of brine flies, *Ephydra cinerea,* and brine shrimp, *Artemia fransiscana*. John C. Fremont, while

approaching Fremont island in the Great Salt Lake, noted "a 10-20 foot swath of dark-brown color" on the beach. "Being more closely examined, this was found to be composed, to the depth of seven or eight, and twelve inches, entirely of the larvae of insects or in common language, of the skins of worms, about the size of a grain of oats, which had been washed up by the waters of the lake" (Fremont 1845). These invertebrate species are important food resources for shorebirds (Helmers 1992).

Refuge impoundments support dense stands of sago pondweed, *Stuckenia pectinatus*. All parts of this plant, the leaves, seeds, and tubers, are eaten to obtain energy for long migration treks. The plant is recognized worldwide as an important waterfowl food (Kantrud 1990). The fish population (primarily carp and shad) provides food for fish-eating birds like American White Pelican, *Pelecanus erythrorhynchos*, egrets, herons, and the threatened Bald Eagle, *Haliaeetus leucocephalus*. The Refuge is likely the most important or key foraging location for the Great Salt Lake breeding colony of American White Pelican (Frank Howe, Utah Department of Wildlife Resources, personal communication).

In addition to the Bear River delta wetlands, the Refuge also encompasses approximately 2,750 acres of uplands adjacent to the delta. When restored to historic vegetation community composition (70-75 percent grasses and 25-30 percent shrubs), these uplands are expected to contribute to local and regional breeding bird diversity, abundance and success.

Taking into consideration the paucity of freshwater wetlands in the Intermountain West, Great Basin, as well as the Great Salt Lake ecosystem, and the documented importance of the refuge to the conservation of a number of nesting, resting, feeding, and staging waterbirds, the highest and best use would be to continue managing the refuge as a functioning freshwater wetland. Management practices will include active manipulation of wetland habitats in order to mimic, as closely as possible, the historic and natural hydrologic processes of the Bear River delta and adjacent grasslands.

A. Inventory and description of habitat

Habitat is the ecological sum of the vegetative, physical and topographic features associated with a given area (Odum 1971). The following information is provided as the ecological factors that describe the habitat of Bear River Migratory Bird Refuge.

(1) Location

Bear River Migratory Bird Refuge is located at the north end of the Great Salt Lake at the mouth of the Bear River, in Box Elder County near Brigham City, Utah (Figure 1). The cities of Logan and Ogden are within 30 miles and the large metropolitan area of Salt Lake City is 60 miles to the south.

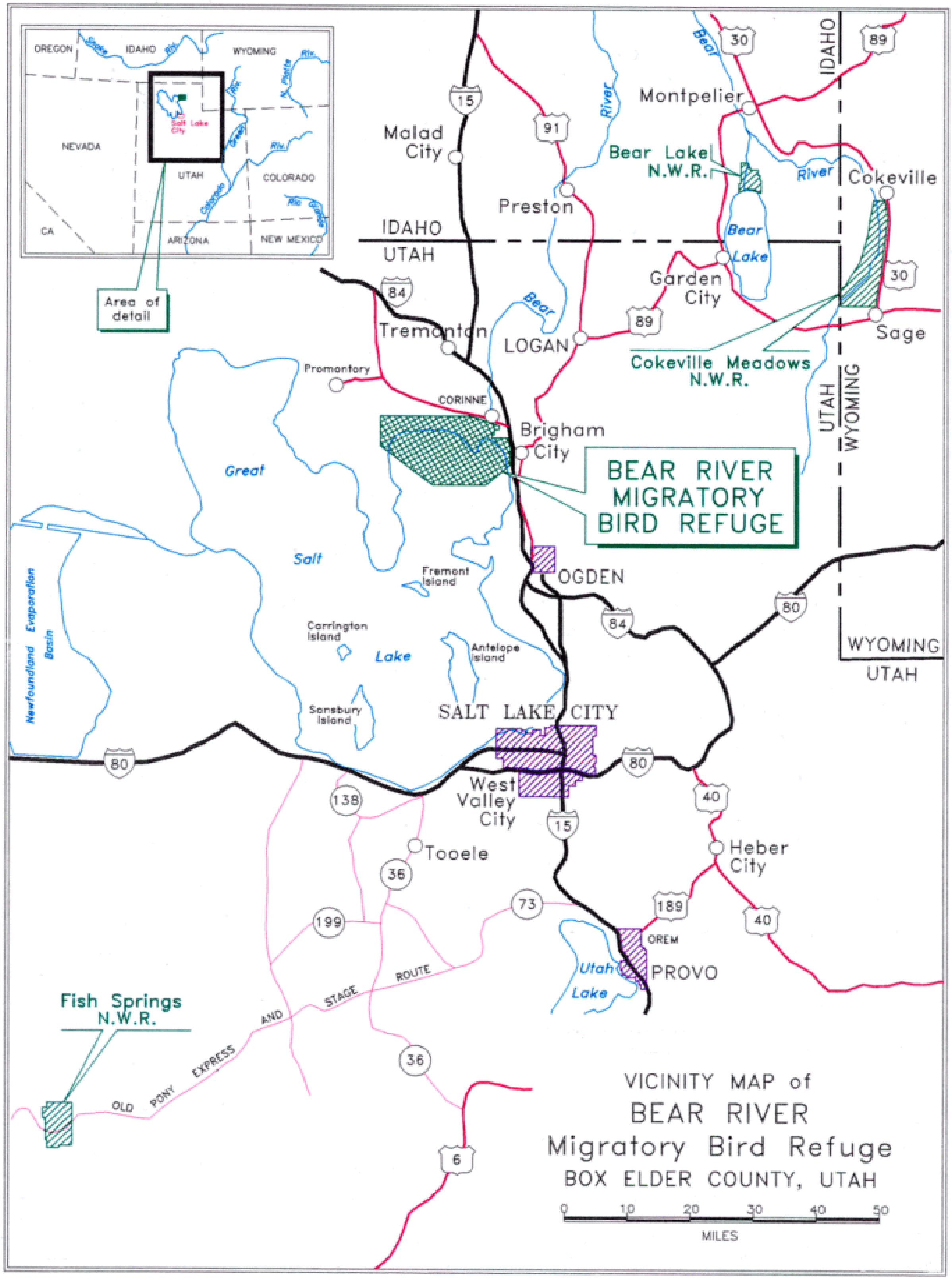

Figure 1. Location of Bear River Migratory Bird Refuge, Brigham City, Utah.

The Refuge currently encompasses about 74,000 acres. Additional acres have been identified and prioritized for acquisition on a willing-seller basis that could bring Refuge acreage to 103,200 acres (USFWS 1992). Lands to be acquired include both marshland and upland habitat. The proposed increase will include 8,776 acres in fee title and 21,309 acres protected under easement agreements.

(2) Management Units

The Refuge and its environs support a number of diverse plant and animal species in a mosaic of upland, mudflat, river delta, brackish and freshwater marshes, ephemeral ponds and other habitat types. The Refuge wetlands consist of 26 wetland management units surrounded by dikes comprising about 40,000 acres of marsh and mudflat habitat (Figure 2). The current design of the these units allows for independent filling and draining. There are another five wetland units totaling 30,400 acres, downstream of the perimeter dike (D-Line) which have limited management capabilities, but are important to wildlife. These units are influenced by water spilled through the D-Line into the Great Salt Lake.

Recent purchases of former pasture land are designated as the Nichols, White, and Stauffer units, named after the former, primary landowner (Figure 2). These units encompass about 2,700 acres. The units are dominated by irrigated grassland communities.

Another upland type of habitat present on the Refuge are a series of scattered knolls that support a bunchgrass and shrub plant community (511 acres). These knolls are a unique ecological community in the Bear River delta. Due to their unique nature, these knolls, known as semi-desert alkali knolls according to their soil type, will be considered distinct management units though they are encompassed by larger units.

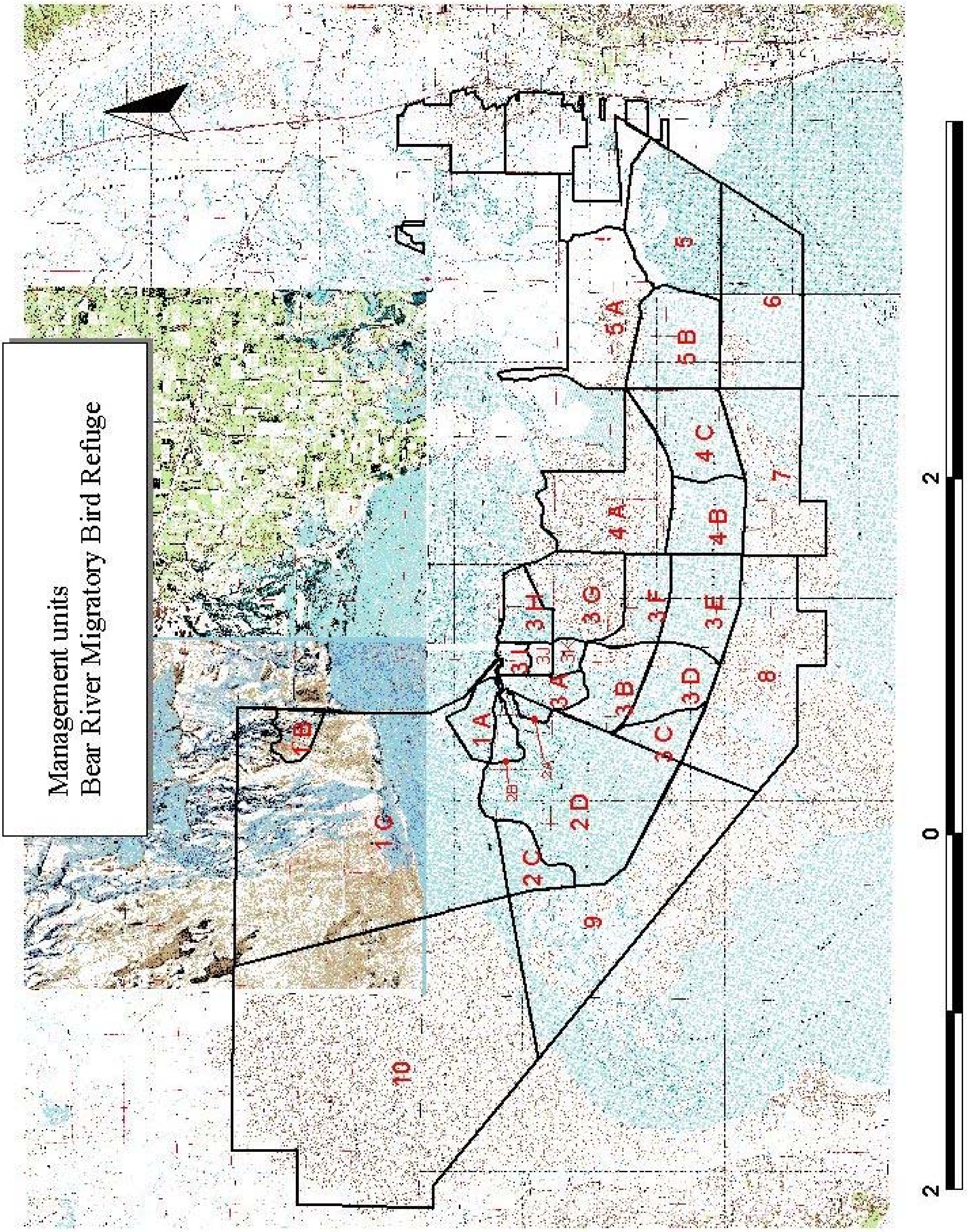

Figure 2. Management units, Bear River Refuge.

Detailed descriptions of the habitat types in the management units are found in Section II B. *Current Condition*.

IMPOUNDED UNITS

Unit 1 is located in the northwest corner of the Refuge and contains 12,745 acres (including subunits 1A and 1B) (Table 1). The northern boundary is located on the 4207 foot elevation contour. Water is spilled into Unit 1 from the Malad River via the Bear River Hunt Club and Salt Creek to the north. About 60 percent (7,338 acres) of the unit consists of unvegetated mudflats which are located above the 4205 foot contour. An important zone for emergent vegetation in Unit 1 is the 2,400 acres that fall within the 4204 foot contour in the south end of the unit. Unit 1A, located on the eastern side of Unit 1, consists of 544 acres of open water and emergents. Unit 1B (Jamison), totaling 424 acres, consists of shallow submergent habitat. The 280 acre Greasewood Knolls Research Natural Area is located along the northeast border of Unit 1. This scrub-shrub community grows mainly in very dry soil removed from the effects of seasonal flooding due to abrupt elevation changes. Salinity appears to be very low.

Unit 2 is southeast of Unit 1 and contains 5,768 acres in four subunits (2A-D). Existing habitat consists primarily of shallow and mid-depth emergent and submergent marsh.

Unit 3 is east of Unit 2 and contains about 8,342 acres in ten subunits (3A-I). Existing habitat consists primarily of shallow submergent and emergent marsh and vegetated mudflat.

Unit 4 is east of Unit 3 and contains 5,468 acres in three subunits (4A-C). Existing habitat consists primarily of vegetated mudflat, mid-depth and shallow emergent marsh and deep submergent marsh.

Unit 5 is located on the eastern side of the Refuge, and contains 7,685 acres in four subunits (5A-D). Existing habitat consists primarily of vegetated mudflat and shallow and mid-depth emergent marsh.

UNIMPOUNDED UNITS

Unit 6 is located directly south of Unit 5 separated by the D-line dike and contains 3,185 acres. This area downstream of the D-Line is also known as the Willard Spur. About 74 percent or 2,300 acres of the area in this unit is shallow and deep submergent marsh comprised of beds of sago pondweed. About 800 acres of shallow emergent marsh is located along the D-Line and toward the west side of the unit.

Unit 7, located downstream of the D-Line and south of Unit 4, contains 2,581 acres. This unit has stands of shallow emergent vegetation intermixed with open, shallow submergent wetland.

Unit 8 is downstream of the D-Line south of Unit 3, and contains 4,158 acres. Prior to the flood (1983-1989), it had stands of emergent vegetation intermixed with open shallow water. At the present time, it consists primarily of a mix of emergent and submergent shallow marsh.

Unit 9, downstream of the D-Line and southwest of Unit 2, contains 5,171 acres. This unit encompasses a large channel, a remnant of the original Bear River, in which water flows toward the Great Salt Lake. The unit is a mixture of mid-depth emergent wetland and shallow, open water.

Unit 10 is west of Unit 1, separated by the D-line. This unit contains 15,262 acres. The north end of the unit is dry, unvegetated mud flats (14,000 acres) but will hold sheet water in early spring. The southeast corner has about 1,000 acres of mid-depth emergent marsh associated with the water-control-structure and channel that spills from Unit 1. Unit 10 also encompasses 310 acres of knolls.

Nichols Unit contains 1,462 acres located south of Forest Street and west of Interstate 15. It also includes the Jensen parcel (20 acres of irrigated cropland) and the Christensen parcel (64 acres without a water right). Habitat types consist of salt meadow, loamy alkali bottom (supporting grasses, forbs and shrubs), wet meadow, and saltair mudflats. The unit also includes seven constructed wetlands or "ponds" (N1-7) that range in size from 6-85 acres. The ponds provide emergent marsh habitat.

White Unit contains 1,100 acres immediately west of Interstate 15 and south of the Nichols Unit. The habitat consists mainly of salt meadow (64 percent), wet meadow, and alkali bottom. This unit also has constructed ponds (W1-6) of emergent marsh.

Stauffer Unit encompasses 185 acres immediately west of Interstate 15 and north of the interstate weigh station. The habitat consists of 105 acres of alkali bottom, 76 acres of salt meadow and 3 acres of wet meadow, with two constructed ponds (S1-2) of emergent marsh.

Table 1. Bear River Migratory Bird Refuge unit acres.

Unit	Acres
1	11,780
1A	544
1B	424
Knolls	280
Unit 1 Total	**12,748**
2A	135
2B	294
2C	720
2D	4,619
Unit 2 Total	**5,768**
3A	505
3B	1,085
3C	549
3D	1,045
3E	1,448
3F	903
3G	1,545
3H	655
3I	211
3J	166
3K	230
Unit 3 Total	**8,342**
4A	2,698
4B	1,242
4C	1,528
Unit 4 Total	**5,468**
5A	2,405
5B	1,783
5C	2,558
5D	939
Unit 5 Total	**7,685**
6	3,185
7	2,581
8	4,158
9	5,171
10	15,262
Nichols	1462
White	1100
Stauffer	185
GrandTotal	**73,115**

(3) Physical or geographic setting

Watershed

Bear River Migratory Bird Refuge encompasses most of the valley floor between the Wellsville Mountain Range to the east and the Promontory Mountain Range to the west. All refuge lands are part of the floor of the ancient Lake Bonneville.

The Refuge lies in the delta of the Bear River where it enters the Great Salt Lake, the world's second largest inland body of salt water. The Bear River originates in the Uintah Mountains of northeastern Utah and flows northerly in a loop through parts of Wyoming and Idaho and then back into Utah before emptying into the north end of the Great Salt Lake at Bear River Bay.

Waters from the Bear River account for over 50 percent of the annual flow into the Great Salt Lake (Sigler et al.1996). The Bear River is the western hemisphere's largest river system not flowing into an ocean. The Bear River drainage basin covers an area about 4.8 million acres in size in three states.

Annual precipitation on the Refuge is relatively light (about 12.5 inches) therefore, residual snow in the surrounding Wasatch Mountains is critical to recharge the Bear River watershed which supplies the water to the Refuge throughout the summer. A reliable and sufficient fresh-water supply is necessary to sustain the long term health of the Bear River delta. Management or manipulation of the water supply is key to successful habitat management on the Refuge and adjacent wetland areas, therefore diligent attention to water issues that may impact the Refuge's supply and use are critical.

Ecoregion

Bear River Refuge is located in the Great Basin ecoregion (Figure 3). This area is dry due to its position in the rain shadow of the Cascade Range and the Sierra Nevada. These ranges relieve the air of most of its moisture before it reaches the Great Basin. Each mountain range provides an altitudinal series of climates. The plant species and subsequent bird species of this province change as a function of altitude. The wide range of altitudes in the Great Basin allows for diverse vegetative communities. Grasslands, sagebrush, and other xeric shrubs dominate the flats and lowlands, with pinyon-juniper, *Pinus-Juniperus*, woodlands and open ponderosa pine, *Pinus ponderosa*, forests on higher slopes. Lodgepole pine, *Pinus contorta*, sub-alpine fir, *Abies* spp., forests occur at higher elevations on north-facing slopes. Big sagebrush, *Artemisia tridentata,* dominates much of the landscape though other shrubs such as rabbitbrush, *Chrysothamnus spp.*, saltbush, *Atriplex spp.,* and greasewood, *Sarcobatus vermiculatus*, may dominate some areas.

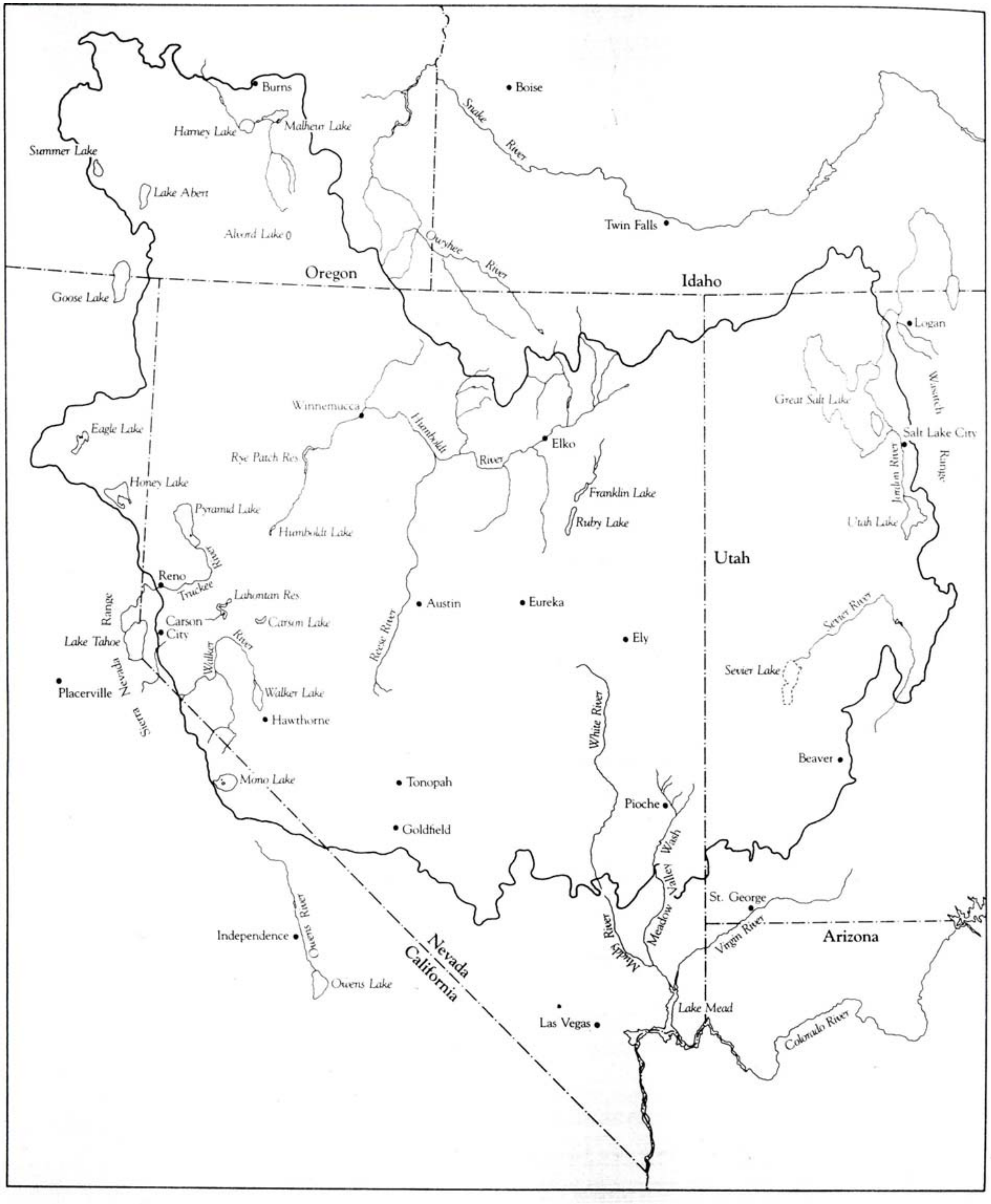

Figure 3. The Great Basin.

Despite it's aridity, the Great Basin has some marshes like Bear River Refuge that add aquatic plant species to the already diverse vegetative community. Kaltwasser (1977) identified ten plant community types in a detailed study of Bear River Refuge.

Urban and agricultural habitats occur at the lower elevations of the Great Basin, primarily along the Wasatch front on the eastern side of the ecoregion. More than 70 percent of the population of Utah lives in this area of the state.

Soils

There are 21 soil types on the Refuge. These soil types are grouped into six ecological or range sites; Wetland, Saltair Mudflat, Semi-desert Alkali Knoll, Wet Meadow, Alkali Bottom, and Salt Meadow. Each ecological site produces a unique plant community. The ecological sites are important to differentiate as they afford the opportunity to examine the potential climax plant community and subsequent potential wildlife use. Detailed ecological site descriptions can be found in Appendix A. The climax plant community descriptions were used to devise habitat goals, objectives and strategies.

Topography

The topography of the Refuge is nearly flat, with a gradient of approximately one foot per mile fall to the south. There is only about six feet of fall in the river from the northern boundary of the refuge to the mouth of the delta. The river area is represented by many oxbows and meanders. Water tables in the vicinity are high, and groundwater aquifers receive recharge from high flows of the river and seepage losses from the river system. Maximum natural elevation on the Refuge occurs in the northwest corner where knolls raise to an elevation of about 4215 feet msl. Most of the refuge is around the 4202 feet msl contour.

Climate

In general, the area has a semiarid climate with four well-defined seasons typified by moderate spring and fall seasons, short cold winters, and hot dry summers. National Weather Service records for Salt Lake City indicate an annual mean relative humidity of 43 percent. Humidity levels are lowest during July and August at 22 percent and 23 percent respectively. The average annual evaporation is about 54 inches on the refuge.

Maximum temperatures of 90 degrees or higher occur an average of 53 days each year with July and August being the hottest months (Table 2). Evening and nighttime temperatures during the summer range in the 40s-60s. Winters are cold, though not normally severe, averaging 128 days at or below freezing, yet no days at or below zero. Evening and nighttime temperatures during the winter months range in the 20s-30s. There are, on average, 151 freeze-free days on the Refuge (1937-1984).

Table 2. Monthly temperature and precipitation summary, Bear River Refuge, 1948-1984. Temperature data is presented in degrees Fahrenheit, precipitation data is in inches.

	Temperature Average				Precipitation Average	
Month	Max.	Min.	Mean		Total	Average Snowfall
January	34.7	14.4	24.5		1.15	7.10
February	40.7	18.6	29.5		0.92	4.50
March	50.7	29.0	39.7		1.09	1.60
April	61.4	37.0	49.3		1.38	0.70
May	71.9	46.2	59.2		1.44	0.00
June	81.9	53.4	67.7		1.07	0.00
July	91.5	59.6	75.5		0.43	0.00
August	89.4	57.2	73.3		0.69	0.00
September	79.8	48.0	63.9		1.09	0.00
October	65.9	38.2	52.1		1.23	0.10
November	48.7	28.4	38.8		1.08	1.70
December	37.4	20.0	28.7		1.09	5.50
				Total	**12.65**	**21.40**

Annual precipitation at the west end of the Refuge is approximately 12.7 inches, while the average at the eastern end near Brigham City is 17.8 inches. The bulk of the moisture falling over the area can be attributed to the movement of Pacific storms during the winter and spring months (cold season). Due to the winter precipitation pattern, the spring growing season is short (about six weeks). Most summer precipitation comes from thunderstorms. Snowfall is generally light on the refuge, compared to the higher elevations, averaging 21 inches. Winds are generally moderate (less than 20 mph) though strong gusty winds may be present during summer thunderstorms. The average annual wind speed is 8.9 mph. The prevailing wind is SE or SSE.

(a) Historic condition

Historic Bear River delta

There is no single published description of the historic habitat conditions and hydrologic functions of the Bear River delta. The following description is the expert opinion of Dr. John Kadlec (retired Utah State University professor). Dr. Kadlec and his students spent over 25 years conducting research on the wetlands of the Bear River delta. Many of the resulting thesis and dissertation publications are housed in the Refuge library.

The Bear River delta, was likely a large braided system of river channels, natural levees (created by silt deposits on the banks), and scour holes (ponds), coupled with the playas natural marshes and alkali mudflats covering approximately 112,000 acres. This mixture of wetland types based on water depths, duration and soil types would have supported a diverse aquatic vegetation community.

In early spring (March-April) there was likely an increase in Bear River water flows due to snow melt in the low elevation areas from the surrounding Wasatch mountain range. A second pulse of increased river flow would have occurred in May or June from snow melt in the high elevations of the mountains in the watershed. This period of high water was noted by Captain Howard Stansbury in his exploration of the Great Salt Lake, "The ford of Bear River at this point is not very good. In the spring and early part of summer, the waters are too high to admit of fording, and temporary ferries become necessary" (Stansbury 1852). During these two periods of increased river flow, water would have been high enough to flow over the natural levees and flood the delta, thereby recharging the isolated river channels, marshes, ponds and playas. The river inflows would likely have supplied water to the Bear River delta through June and July. There may have been a drying period in late July and August when evaporation losses were not off-set by river inflows, causing the wetlands to dry. In September and October, the river levels would again rise to refill delta wetlands due to precipitation events. The precipitation during the fall and winter months would likely have been sufficient to maintain wetlands through the winter months until the cycle began again the following spring.

In years of average and above average precipitation, it was likely that the delta functioned as described above. In below average precipitation years, water would likely have flowed from the mountains to the delta and straight into the Great Salt Lake via the delta river channels as there was not enough water to flood over the natural levees and fill up or recharge the surrounding wetlands.

The salinity levels of the delta wetlands likely remained low during periods of high river flow which supplied a continuous influx of fresh water. However, if the level of the Great Salt Lake was high, it is likely there was a zone of wetlands with higher salinities located in the lower elevations of the delta where the fresh water from the river met the saltier water of the Great Salt Lake. The habitat condition and wetland function of the Bear River delta would change with settlement.

Mormon pioneers, enjoined by Brigham Young to "make the desert bloom like a rose", set to clearing sagebrush and irrigating land near Brigham City. At first they diverted Box Elder Creek, but as greater numbers of people arrived they turned to the Bear River. The Bear River water users entered into a formal agreement in 1958. The agreement known as the Bear River Compact establishes the framework under which the waters of the Bear River are divided (Jibson 1991).

As waters from the Bear River were diverted, the network of natural marshes of the Bear River delta began drying. By 1920, only 2,000-3,000 acres of the original 100,000 acres of marshlands were left (refuge records). Around the turn of the century, sportsmen formed duck hunting clubs and began to acquire lands within the Bear River delta (Ringholz 1990). Though a few clubs were able to acquire established marshlands, the majority of clubs were required to undertake extensive diking and water-control programs to maintain and develop their hunting areas (Behle 1958).

Extensive loss of marsh acreage and subsequent concentration of waterfowl flocks into the few remaining wet acres in the Bear River delta set the stage for severe botulism outbreaks. Behle (1958) estimated seven million ducks died on the Bear River marshes between 1910 and 1925 from what was termed locally as "alkali poisoning". Research would later identify this disease as avian botulism, caused by a bacteria rather than by alkali (Clarke 1987).

Completion of the transcontinental railroad in 1869 brought a transportation corridor connecting eastern markets for fresh waterfowl with the vast supply of birds in the Bear River marshes. The era of the market hunter had arrived. Nelson (1966) estimated that over 200,000 ducks were harvested annually from Bear River marshes from 1877 to 1900. With an increased interest in hunting, large losses of waterfowl to botulism, increasing demand for water for irrigation power projects, and diminishing wetland habitat, it became evident to local sportsmen that conservation measures should be initiated to ensure good hunting for the years to come. The sportsmen rallied to the cause and made the first efforts to preserve the Bear River delta marshes (Refuge records).

Citizens petitioned Congress to establish a wildlife refuge. Congress responded by establishing the Bear River Migratory Bird Refuge in 1928. Aggressive development began immediately to reestablish thousands of acres of delta marshes with construction of over 50 miles of dikes and numerous canals to impound the fresh water of the Bear River and to exclude the saline water of Great Salt Lake. The completed system created five impoundments of about 5,000 acres each (Refuge records).

The development design was the first of its kind and initially appeared to be a success. Wildlife production and migration use were high. Over 200 species of birds were recorded and approximately 60 species were breeding on the refuge. Historic refuge records (Halloran 1965) shows that between 1953 and 1964, an average of 41,266 ducklings and 1,992 Canada Geese, *Branta canadensis*, were produced annually. In 1964 duck production reached a record 79,000 birds. A study by Williams and Marshall (1938) found nine species of nesting ducks. Gadwall, *Anas strepera*, were the most abundant nesting species (39 percent), followed by Cinnamon Teal (22 percent), Redhead (14 percent), Mallard, *Anas platyrhynchos*, (13 percent), Northern Pintail (9 percent), Ruddy Duck, *Oxyura jamaicensis*, (2 percent), Northern Shoveler, *Anas clypeata*, (1 percent), Blue-winged Teal, *Anas discors*, (0.2 percent) and American Wigeon, *Anas americana*, (0.2 percent). Nest success averaged 70 percent for all duck species. The majority of nests were located in hardstem bulrush, *Schoenoplectus acutus*, (39 percent), followed by saltgrass, *Distichlis spicata* (22 percent), weeds (10 percent), willow, *Salix* spp., (9 percent), alkali bulrush, *Schoenoplectus maritimus*, (5 percent), cattail, *Typha latifolia* and *T. angustifolia*, (4 percent), sedge, *Carex* spp., (4 percent), cane, *Phragmites australis*, and foxtail, *Hordeum jubatum,* (3 percent each) and arrowgrass, *Triglochin maritimum*, (1 percent). Avian and mammalian predation was considered a minor contributing factor to nest failure accounting for less than 7 percent of clutch loss.

Refuge records from 1953-1964 show that other waterbird species were nesting on the refuge. An average of 5,870 California Gull, *Larus californicus*, nests, 653 American Avocet, 184 Black-necked Stilt, 11 Caspian Tern, *Sterna caspia*, and 55 Double-crested Cormorant, *Phalacrocorax penicillatus*, nests were found on the refuge each breeding season (Halloran 1965).

In 1983, the rising waters of the Great Salt Lake topped refuge dikes, inundating wildlife habitats with salt water and destroying marsh vegetation. Dikes and water control structures were heavily damaged. The newly dedicated refuge visitor center, shop and refuge houses were inundated with high water and destroyed by winter ice flows down the Bear River and had to be demolished.

Refuge lands were inundated for almost a six-year period. During this period of high water, refuge staff and equipment were slowly transferred to other western refuges. The Great Salt Lake had receded enough by 1988 that the tops of the remaining refuge dikes became visible. A decision to restore and enhance the Refuge was made and detailed in an Environmental Assessment (Hansen 1991). As the flood waters receded, refuge employees, aided by a crew of volunteers, began working to rebuild the Bear River Migratory Bird Refuge. Service biologists and engineers devised methods aimed at improving Refuge water management capabilities and thereby optimizing biological productivity to drive the rebuilding process. The improvements were detailed in the Long Range Water Management Plan (USFWS 1993).

The approved environmental assessment included a combination of restoration, enhancement, and expansion alternatives. Restoration would return the refuge to conditions existing prior to the damage caused by the flood. Enhancement added the design and construction of new cross dikes and water control structures to subdivide the existing large units into smaller units to further refine water management activities. Water diversion canals were designed and constructed to accommodate or bypass excess spring river flows. Expansion included the purchase of several thousand acres of uplands and wetlands north and east of the original refuge boundary (McCue 1989). These pasture lands were historically ditched and flood irrigated to provide forage for grazing cattle.

Breeding bird populations were all but absent from the refuge during the flood years (1983-1988), but have recolonized the refuge post-flood as nesting habitat recovered. White-faced Ibis and Double-crested Cormorant have rebounded to numbers higher than those prior to the flood years. An average of 960 Ibis nests were found on the Refuge from 1935-1984. The post-flood average (1993-2004) is about 2,000 nests (refuge records).

Upland nesting waterfowl species however, have been slow to reestablish pre-flood population levels on the refuge. Nesting surveys conducted from 1942-1978, located an average 336 duck nests on 12-16 transects representing about "10 percent of available nesting area," (1947 annual narrative). Nest searches of greater than 70 percent of the entire network of Refuge dikes (550 acres) conducted sporadically from 1992-2002 yielded an average of 1.8 duck nests.

Before the flood, apparent nesting success was calculated at 31.8 percent from nest-block surveys conducted from 1979-1983. Dummy nesting studies conducted post-flood, in 2001 and 2002 yielded a 7.8 percent apparent nesting success rate. High mammalian and avian predator populations on the Refuge are thought to be the major contributing factor to low duck nesting density and success rates based on observations by staff, refuge surveys and current research. These current low rates of success are disturbing given the fact that Cowardin et al.(1985) and Klett et al. (1988) calculated that a nest success rate greater or equal to15-20 percent is the minimum required to sustain local waterfowl populations.

Refuge mammalian predator populations are different from historic populations both in species diversity and abundance. The fox subspecies native to Utah is *Vulpes fulva macroura*. Durrant (1952) noted the red fox as rare in Utah. The range of the native race of red fox was thought to "occur sparingly throughout the mountainous sections of the state". Durrant attributed the appearance of fox in the northern part of the state to escapees from fox farms (non-native species). The first red fox, *Vulpes vulpes*, was noted on the Refuge in 1971. The raccoon, *Procyon lotor*, Durrant noted, were also rare mammals in Utah. Raccoon were first observed in northern Utah in Weber County (county immediately south of Box Elder County) in 1953 (pers. comm. Jack Renzel, retired Utah Division of Wildlife Resource Area supervisor). Raccoon were first noted on the Refuge in 1983 just prior to the flood (Refuge records). These predators are thought to have high populations on the Refuge based on track counts, sighting indices, and trapping efforts. Frey and Conover (2004 *in prep*.) found that red fox on the Refuge had an average home range size of 3.5 km^2. This estimate indicates that the Refuge has one of the highest red fox densities in the United States.

Noxious and invasive species have gradually become more abundant since the flood. Four state listed noxious weeds are found on the Refuge: whitetop, *Lepidium latifolium,* Canada thistle, *Cirsium arvense,* dyers woad, *Isatis tinctoria* and a recent discovery of medusahead, *Taeniatherum caput-medusae.* Another noxious weed species, purple loosestrife, *Lythrum salicaria,* though not found on the Refuge, is found within the Bear River watershed. The aggressive and invasive, salt cedar, *Tamarix ramosissima*, threatens the Refuge's riparian zones and limits recolonization by native willow. In addition, stands of phragmites can become a problem species as stands become so dense as to exclude other wetland plant species and limit use by wildlife.

Besides plants, common carp, *Cyprinis carpio*, is also considered a pest species on the Refuge. Carp are well established and have can limit productivity of some wetland units. Carp uproot vegetation while foraging for food, causing solids to be suspended in the water column, thereby reducing water clarity and decreasing favorable growing environs for desirable aquatic plant species. Specific management actions to control these pest species are detailed in the *Integrated Pest Management Plan* (Hicks 2003).

Historic range condition

Beginning in 1993, the Refuge purchased adjacent upland areas in an attempt to encourage more nesting and increase nest success. Prior to purchase by the Refuge, these lands were grazed all season long by cattle which resulted in poor range condition as evidenced by low species diversity and sparse ground cover. The grasslands provided little to no suitable nesting habitat for upland nesting birds. In fact, no successful nests or broods were observed during nest search efforts in the grasslands in 1995 and 1996 (West 2002).

Vegetation of the Great Basin is most often described as sagebrush-steppe or shrub-steppe. This habitat ranges from semi-arid grasslands with a scattering of sagebrush to arid sagebrush-dominated with few grasses. Refuge uplands would be best characterized as semi-arid grasslands with a component of sparse shrub land dominated by members of the goosefoot family, *Chenopodiaceae*.

Ecological site descriptions based on soil types describe the potential climax plant community for a particular area (USDA 1993). Based on the soil types found in the Refuge uplands, the climax plant community prior to settlement and the subsequent introduction of domestic livestock would have consisted of about 75 percent grasses and forbs and 5 percent shrubs. The remaining 20 percent of the area consists of alkali soils high in salt that would have fluctuated annually between bare ground to supporting communities of salt tolerant plants like pickleweed, *Salicornia rubra* and *S. utahensis*, and seepweed, *Suaeda calceoliformis* and *S. moquinii*.

The dominant grasses would have been saltgrass, alkali sacaton, *Sporobolus airoides*, alkali bluegrass, *Poa secunda*, Great Basin wildrye, *Leymus cinereus*, wheat grasses, *Agropyron* spp., sedges and rushes, *Juncus* spp. Common forbs would have been goldenweed, *Pyrrocoma lanceolata*, fiddleleaf hawksbeard, *Crepis runcinata*, Nuttall’s Sunflower, *Helianthus nuttallii*, silverscale saltbush, *Atriplex argentea*, kochia, *Kochia scoparia*, annual Indian paintbrush, *Castilleja minor*, and alkali marsh aster, *Almutaster pauciflorus*. Common shrubs would have been iodinebush, *Allenrolfea occidentalis*, rabbitbrush, *Chrysothamnus nauseosa* and *C. viscidiflorus*, and greasewood.

A widely accepted theory in the west is that native plant communities in the sagebrush steppe west of the Rockies did not evolve under pressure from large numbers of grazing ungulates and are not adapted for concentrations of large herbivores (Tisdale and Hironaka 1981; Mack and Thompson 1982). Early explorer accounts suggest that large native grazers were relatively rare and localized in the region. Though perhaps limited in numbers, large herbivores included bison, *Bos bison*, elk, *Cervis elaphus*, pronghorn antelope, *Antilocapra americana*, and mule deer, *Odocoileus hemionus*. Other grazers included small mammals such as jackrabbits, *Lepus californica,* cottontails, *Sylvilagus auduboni*, and other rodents. Sage grouse, *Centrocercus urophasianus*, were also important grazers on sagebrush and understory plants.

The spring growing season is short (about six weeks) in the vicinity of the Refuge due to lack of spring and summer precipitation. The low soil moisture causes the curing or drying of grasses in late spring, as they go dormant until moisture again becomes available (October). Historically, this situation likely would have resulted in the departure of the large herbivores from the Great Salt Lake valley to the mountains as they "followed the green" in pursuit of suitable forage. The animals would have followed the melting snows up the mountains in the spring and beat the drifting snow back down the mountains in the fall, creating a seasonal grazing pattern (Burkhardt 1996).

Based on review of the scientific literature and experience garnered through experimental grazing on the Refuge grasslands with cattle, Refuge staff believe that herbivory is a fundamental biological process and is required to maintain biological diversity and energy flow in the system.

Fires were relatively infrequent in sagebrush habitats. As bunchgrasses generally do not provide a continuous fuel layer to carry fire long distances, fire in presettlement times were probably patchy and small except in very dry years. Presettlement fire intervals have been estimated at 20 to 25 years in wetter regions, and 60 to 110 years in the arid sagebrush steppe of southern Idaho (Tisdale and Hironaka 1981; Whisenant 1990 *in* Paige and Ritter 1999).

(b) Current condition

The following is a detailed list of habitat types found on Bear River Refuge (Figure 4). The habitats were devised using the soil types and associated ecological site descriptions as a guide.

WETLAND

Borrowing from Cowardin et al. (1979), wetland is a general habitat type used to describe lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The Refuge contains 29,259 acres of wetlands. Refuge staff have devised their own wetland classification system and divided wetlands into the following five management categories: deep submergent, shallow submergent, deep emergent, mid-depth emergent and shallow emergent. Detailed descriptions follow.

Deep Submergent (18" to 36") Deep, open submergent marshes, with 18 to 36 inches of water, contain mostly sago pondweed with very little emergent vegetation. Fish populations survive in the deeper water of these marshes. Species that are most attracted to the increased depth of water include swans, molting geese and ducks, diving ducks, cormorants, grebes, and pelicans. Fish also provide an important source of food for wintering Bald Eagles.

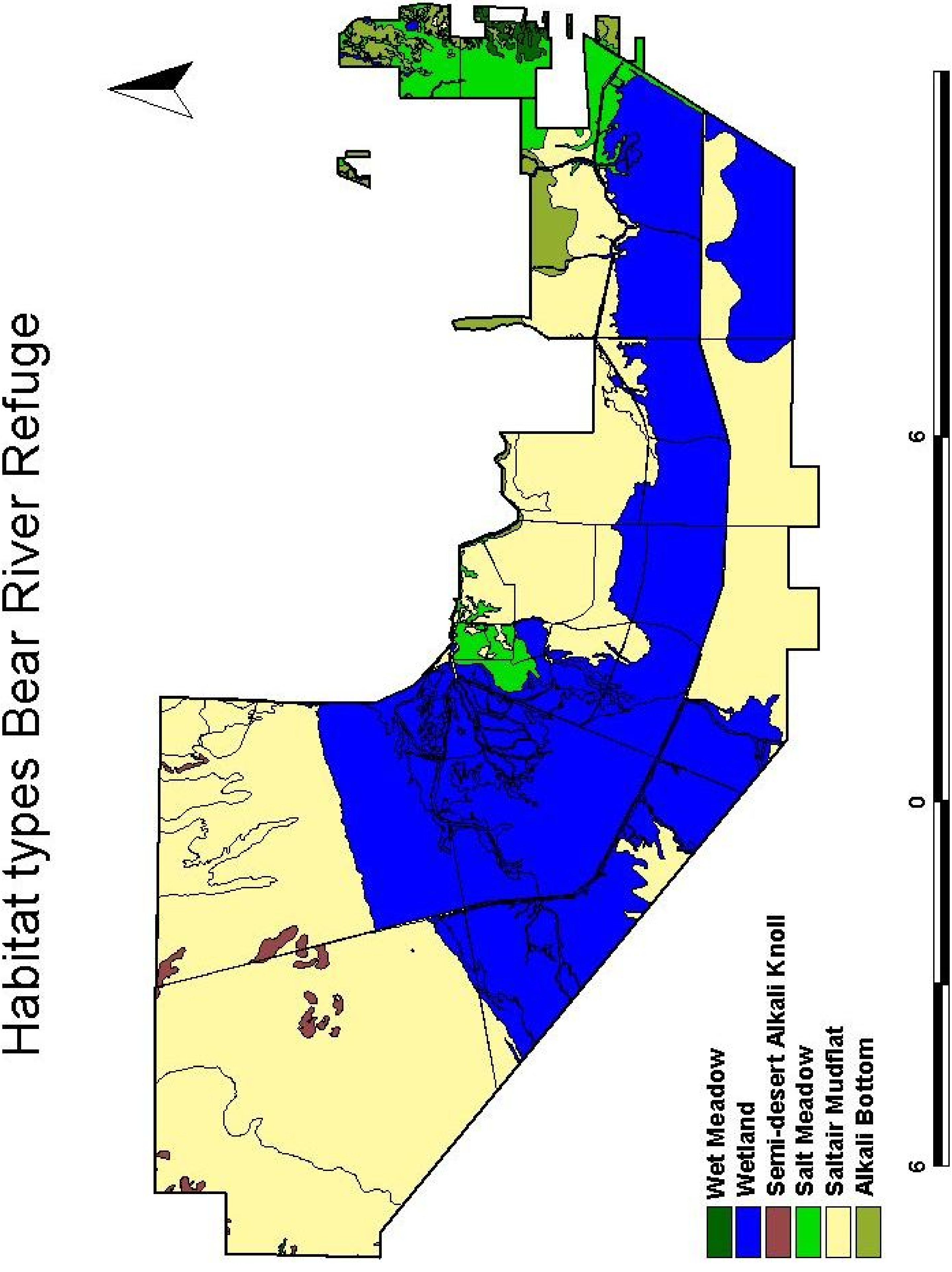

Figure 4. Habitat types, Bear River Refuge.

Shallow Submergent (4" to 18") Open submergent marshes, with 4 to18 inches of water, are dominated by sago pondweed with sparse emergent vegetation. Dense stands of sago pondweed attract waterfowl species, swans, pelicans, cormorants, grebes, and a variety of waterbirds for feeding and resting. These marshes are particularly important resting areas during spring and fall migrations for waterfowl and during July and August for molting Northern Pintails.

Deep Emergent (12" to 24") Deep emergent marshes, with 12 to 24 inches of water, are vegetated mostly with dense stands of hardstem bulrush and small amounts of alkali bulrush. Clumps of bulrush provide structure for high populations of insects. Open water areas contain sago pondweed. Primary use is by diving ducks, especially Redheads, for nesting and brood rearing. White-faced Ibis, herons, egrets, Franklin's Gulls, *Larus pipixcan*, and other waterbirds nest here also. Winter cover is provided for resident birds in thick stands of emergent vegetation. Alkali bulrush seed is an important waterfowl food source and the plants provide cover for invertebrate species.

Mid - Depth Emergent (8" to 12") Mid-depth emergent marshes are covered with 8 to 12 inches of open water with a 50 percent interspersion of emergent vegetation. Vegetation is a mix of alkali bulrush in shallower areas and hardstem bulrush in the deeper zones. Some locations may contain large stands of cattail or phragmites. Food supplies for birds include high populations of insects and seed from bulrush. Deeper zones of open water support sago pondweed. These marshes function as brood habitat for waterfowl, and support a wide variety of waterbirds throughout the year. Waterbirds, grebes, coot, *Fulica americana*, and passerines nest in these marshes. Emergent vegetation provides winter cover for year-round resident birds.

Shallow Emergent (2" to 8") Shallow emergent marshes, with 2 to 8 inches of standing water, contain predominately alkali bulrush. Some locations may contain dense stands of cattail or phragmites. Water depths remain stable throughout the growing season. High populations of insects and seed from alkali bulrush provide food resources for waterbirds. These areas are used predominately by dabbling ducks during migrations and feeding. Long billed shorebirds also use the area for feeding.

SALTAIR MUDFLAT

Saltair mudflats consist of strongly saline soils and are nearly barren of vegetation. Plants that grow on mudflats normally have a shallow rooting system. Though generally bare, the mudflats can support scattered plants of pickleweed, *Salicornia rubra* and *S. utahensis*, seepweed, *Suaeda calceoliformis* and *S. moquinii*, and patches of saltgrass. Mudflats include playas which are low flat depressions. These closed basins usually collect water in the spring, which gradually evaporates leaving salt and mineral deposits behind. Playas are also mostly devoid of vegetation. Mudflats cover 38,064 acres on the Refuge. For management purposes, Refuge staff consider two types of mudflats; vegetated and unvegetated. Detailed descriptions follow.

Vegetated Mudflat (0" to 2") Vegetated mudflats receive up to two inches of surface water during seasonal high river flows or heavy precipitation events. These areas contain an interspersion of zones with no vegetation, saltgrass, pickleweed, and seepweed. Where this type of habitat is present within the Nichols, White and Stauffer units, vegetated mudflat may be invaded by the noxious weed, medusahead. Salicornia or pickleweed provides a valuable food source in early spring and late fall to waterfowl. Soils are high in salinity, but occasional sheet flows flush the salts out often enough to allow germination of the above salt tolerant species. Vegetation is short (less than 8") and structural diversity is low. Shallow water areas are interspersed with exposed soils. This habitat may be dotted with playas. Waterfowl and shorebirds utilize these areas early in the spring when they receive runoff waters and as invertebrate resources are concentrated. Snowy Plovers, *Charadrius alexandrinus*, nest in this area. Primary use is by nesting Snowy Plover and migrating shorebirds and waterfowl when covered with water.

Unvegetated Mudflat Dry mudflats contain no vegetation and are exposed, bare soils. They receive small amounts of sheet water from snow melt or occasional rainfall events. Soil salinity is typically high because frequent drying cycles result in the upward movement of salts through the soil profile. This habitat provide security from predators for loafing birds and is a preferred nesting habitat for Snowy Plovers.

SEMIWET FRESH STREAMBANK (Riparian)

The riparian habitat on the Refuge consists of a stream bank zone about 15 feet wide along the Bear River channel, Reeder and Whistler canals (Figure 5). This habitat type consists of about 12.5 linear miles. Though the amount of this habitat type on the Refuge is small (45.5 acres), the benefits of undertaking management and restoration activities would be substantial to wildlife as lowland riparian (less than 5,500 feet elevation) is the habitat used most by Utah's avifauna (Parrish et al. 2002). The dominant aspect of this plant community at climax would be cottonwood trees, *Populus fremontii*, willows, and grasses. In a climax situation, shrubs would account for 30 percent of the canopy cover while trees cover 15 percent and forbs and grasses 5 percent each (USDA 1993).

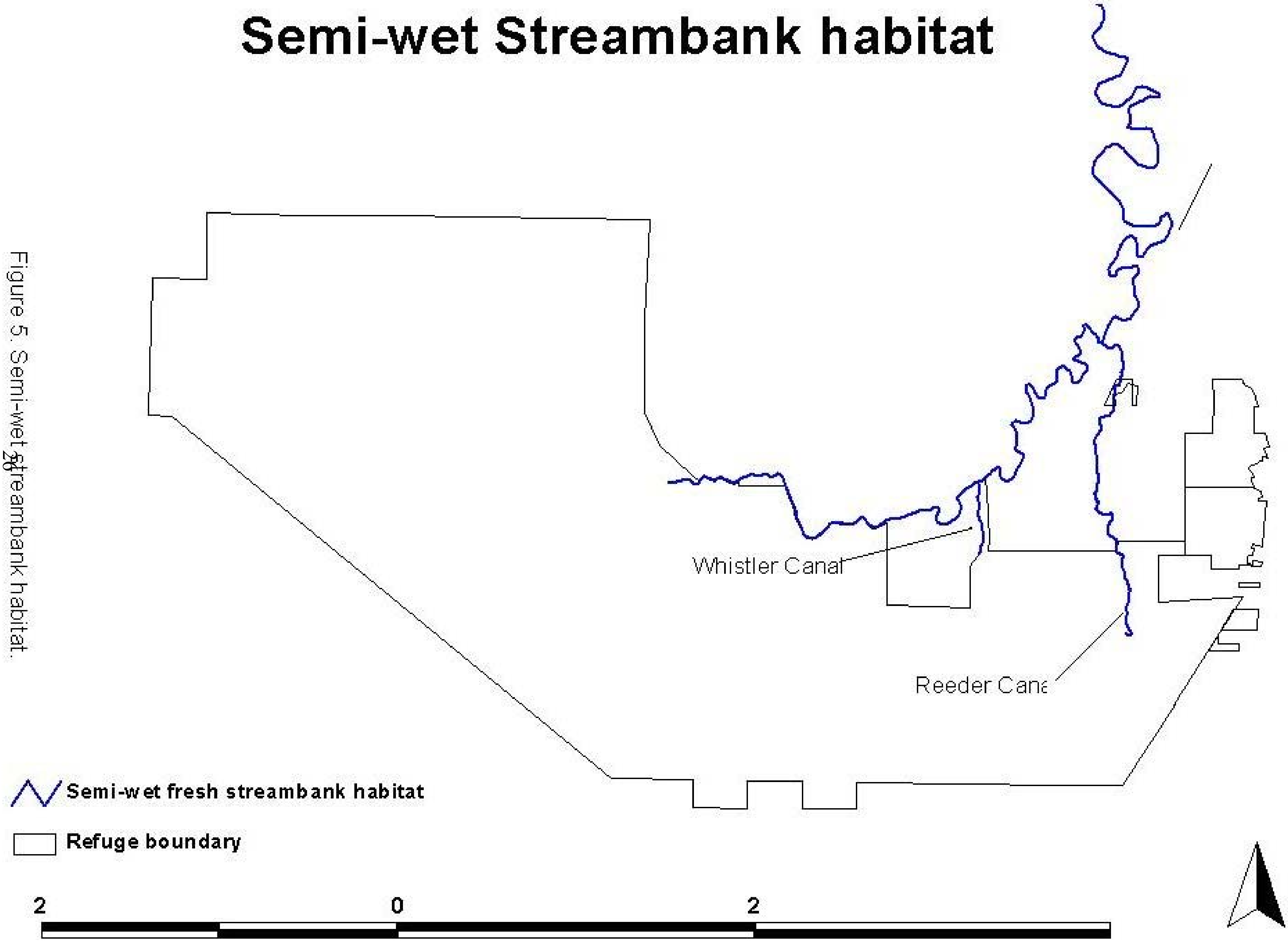

Figure 5. Semi-wet streambank habitat.

SEMI-DESERT ALKALI KNOLL (Greasewood)

This habitat type manifests itself as a series of scattered knolls that arise abruptly from the surrounding landscape of mudflat habitat. The semi-desert habitat type is found predominately in the northwest corner of the refuge and encompasses 511 acres, including the 280 acre Greasewood Knolls Research Natural Area (Figure 4). The dominant aspect of the plant community is greasewood. Climax plant community by percent canopy cover would be 1-5 percent forb, 15-30 percent grasses, and 35-40 percent shrubs. The remainder would be bare ground. Dominant shrubs would be greasewood and shadscale saltbush, *Atriplex confertifolia*, dominant grass species would be bottlebrush squirreltail, *Sitanion hystrix* and wheatgrass, *Agropyron spp.*, with a mixture of forbs such as seepweed, scarlet globemallow, *Sphaeralcea coccinea*, and shaggy fleabane, *Erigeron pumilus* (USDA 1993). It is currently not known what avian species utilize this habitat type though we speculate that it may support breeding populations of Utah priority passerine species like Brewer's Sparrow, *Spizella breweri*, and other shrub obligates and casuals such as Sage Thrasher, *Oreoscoptes montanus*, Loggerhead Shrike, *Lanius ludovicianus*, Vesper Sparrow, *Pooecetes gramineus*, and Burrowing Owl, *Anthene cunicularia*. As the ecological condition deteriorates due to overgrazing, squirreltail, alkali sacaton and shadscale decrease while greasewood, snakeweed, *Gutierrezia sarothrae*, and rabbitbrush increase. When the potential natural plant community is burned, squirreltail, alkali sacaton and shadscale decrease while greasewood, rabbitbrush and horesebrush, *Tetradymia*, increase. Annual forbs are most likely to invade this site.

SALT MEADOW

The vegetative community comprising salt meadow habitat consists of sedges, rushes and saltgrass. The climax plant community composition by percent canopy cover would be approximately 65-75 percent grasses and grass likes, 10 percent forbs and 1-3 percent shrubs. Common grass species include alkali bluegrass and saltgrass. This habitat may include saturated low areas of arctic rush, *Juncus articus*, and sedges as well as pockets of emergent marsh. Common forbs may be goldenweed, fiddleleaf hawksbeard, and Nuttall's sunflower. Shrubs species may include iodinebush, whiteflower rabbitbrush, *Chrysothamnus albidus* and greasewood. As the ecological condition deteriorates due to grazing pressure, alkali bluegrass, and sedges decrease while arctic rush, saltgrass and other unpalatable plants increase. Fire is not an important factor in this site. Plants that could invade this site are kochia, smotherweed, *Bassia hyssopifolia*, whitetop and salt cedar (USDA 1993).

The above description is what the habitat should look like at climax. Currently, the plant community composition by percent frequency of occurrence is 74 percent saltgrass, 21 percent emergent marsh, 4 percent non-native grass and 1 percent of noxious weed (medusahead). Forbs and shrubs are currently missing in this habitat. Non-native grasses such as rabbit's-foot grass invade salt meadow. The 2,625 acres of salt meadow habitat provides important cover for nesting waterfowl and songbirds as well as foraging White-faced Ibis.

ALKALI BOTTOM

The dominant plants in this habitat covering 973 acres, consists of salt and alkali tolerant grasses. Climax plant community composition by percent cover would be about 60 percent grasses and grass likes, 5 percent forbs, and 5 percent shrubs within the remainder bare ground.

Typical grass species include cool season bunchgrasses, *Agropyron, Stipa,* and *Poa,* saltgrass, alkali sacaton, alkali bluegrass, and Great Basin wild rye. Forb species at climax would include saltbush silverscale, kochia, annual Indian paintbrush, and hollyleaf clover, *Trifolium gymnocarpon*. Greasewood would be the dominant shrub species (USDA 1993).

The above description is what the habitat should look like at climax. The current condition is as follows (White and Nichols Units): comprised of 60 percent non-native grasses such as cheatgrass, *Bromus tectorum, B. japonicus,* and *B. commutatus*, rabbit's-foot grass, *Polypogon monspeliensis*, and bulbous bluegrass, *Poa bulbosa*, 35 percent native grasses such as wheatgrass (21 percent), squirreltail (5 percent), Nuttall's Alkali grass, *Puccinella nuttalliana*, (3 percent), and 4 percent forbs. Shrubs comprise less than 1 percent canopy cover.

This habitat is important for nesting waterfowl, especially dabbling ducks and nesting grassland birds such as Vesper's Sparrow, Savannah Sparrow, *Passerculus sandwichensis*, Western Meadowlark, *Sturnella neglecta*, Willet, *Catoptrophorus semipalmatus*, Wilson's Phalarope and potentially, Bobolink, *Dolichonyx oryzivorous*. As the ecological condition deteriorates due to overgrazing, alkali sacaton, alkali bluegrass, and wild rye decrease while annual forbs and rabbitbrush increase. When the potential natural plant community is burned, perennial grasses decrease while annual forbs and rabbitbrush increase. Cheatgrass is likely to invade this site.

WET MEADOW

The 374 acres of wet meadow habitat on the Refuge support predominantly sedges and rushes. The climax plant community composition by percent canopy cover would be about 80 percent grasses, 5 percent forbs, and 1 percent shrubs with the remainder as bare ground (14 percent). The most common grasslike species would be Nebraska sedge, *Carex nebrascensis* and clustered field sedge, *Carex praegracilis*. Forbs species may include alkali marsh aster and common silverweed, *Argentina anserina*. As this site deteriorates due to grazing pressure, sedges, grasses and forbs decrease while rushes, arrowgrass, foxtail barley and other unpalatable forbs increase. Arrowgrass, foxtail, and rabbitbrush are most likely to invade this site (USDA 1993).

The above description is what the habitat should look like at climax. Currently, the plant community composition by percent frequency of occurrence is 91 percent rush and sedges, 3 percent reed canary grass, *Phalaris arundinacea*, 1 percent non-native grass and 5 percent noxious weed (medusahead).

When this habitat is dry, the vegetation can provide cover for breeding ducks, Northern Harrier, *Circus cyaneus*, Short-eared owl, *Asio flammeus*, and passerines. Other bird use includes feeding Ibis, and shorebirds.

DIKES

The miles of constructed dikes around the impoundments provide most of the upland habitat over the western two-thirds of the refuge. There are about 96 miles of dikes (14 feet wide, averaging 4.5 feet in height, 6:1 side-slope) equating to 791 acres (Figure 6). The plant community is dominated by forbs such as sunflower, kochia, cocklebur, *Xanthium* spp., and curly dock, *Rumex crispus*. Less common are the grasses such as foxtail, saltgrass, wheatgrass, and phragmites, as well as the invasive shrub, salt cedar.

According to Hansen (1991), the seepweed, smotherweed, and clasping pepperweed, *Lepidium perfoliatum*, community occurs in seep areas of relatively high soil salinity on the side slopes of dikes. This community has an obvious vegetative zonation with seepweed lowest on the slope, smotherweed intermediate and pepperweed highest on the dike. The salt grass and foxtail barley community is characteristic of the ungravelled secondary silt dikes of the Refuge. This habitat is vital for upland nesting birds, but is subject to severe predation by fox, skunk *Mephitis mephitis*, and raccoon.

A small amount of upland habitat (8.5 acres) is available on 12 islands constructed within the sub-units. The plant communities of the man-made islands reflect their disturbed nature and range from bare ground to communities similar to those found on the dikes.

(c) Habitat changes from natural condition to current condition

The Bear River delta area went from a lush network of 45,000 acres of freshwater and estuarine marshes in the 1840s to a few scattered marshes totaling less than 3,000 acres by the early1900s. Recognizing this loss of wetlands as decimating to waterfowl populations, concerned citizens and organized conservationists undertook to restore many of these wetlands throughout the decade of the 1920s. Wetland restoration efforts were expedited with the establishment of Bear River Migratory Bird Refuge in 1928. By 1931, over 50 miles of dikes and numerous canals were constructed to impound water in five large units each 5,000 acres. The impoundments created the capacity to manage water levels to encourage growth by aquatic vegetation and increase food production of waterfowl. The impounded wetlands also provided open freshwater habitat for nesting waterbirds during the critical summer months when marshes would normally dry up.

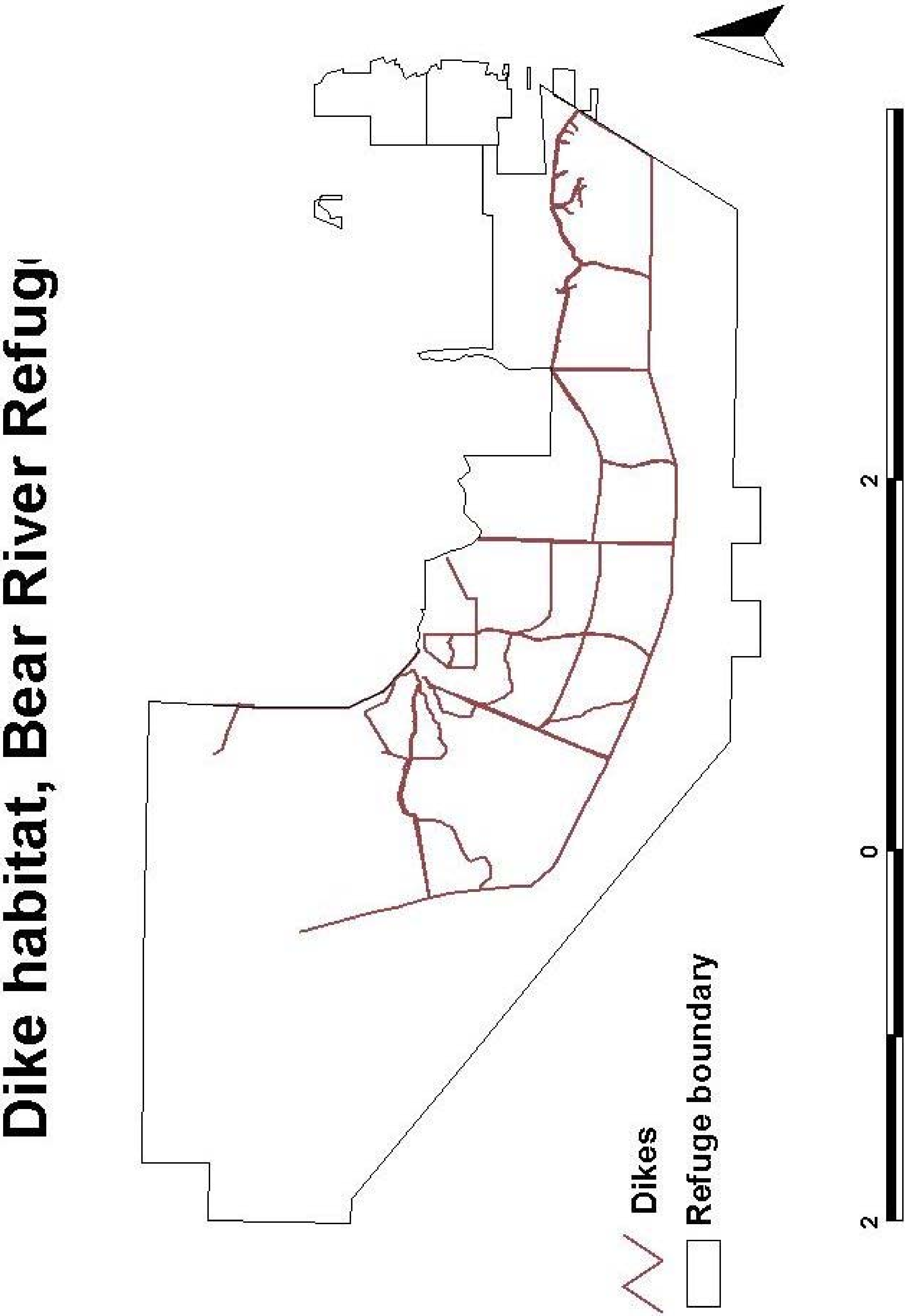

Figure 6. Dike habitat.

Historically, the impounded units were filled in the spring as soon as the ice broke (March). Having no set system of priorities, the order in which the units were filled varied from year to year, especially in the 1940s, when extensive botulism research was being conducted. Units were generally filled to elevation 4205.0 feet msl, flushed, and refilled to the management level. Water flushed from the units and spring flows occurring afterwards helped inundate the area downstream of the D-line dike, and filled approximately one-half of this acreage, creating shallow pools surrounded by temporary wetlands. Water levels inside the D-line were maintained as long as adequate water was available, with some pools being drained to provide water to other pools or to reduce severity of botulism outbreaks. In late September, or early October, the units were again flushed, and refilled to levels adequate for resting habitat for migrating waterfowl and for hunter access. The units were drained just prior to, or just after, ice-up in late November to avoid ice damage to water control structures and were maintained at these low levels until the following spring.

Vegetation composition within the units varied. Unit 1 had little emergent vegetation, but, when conditions were right (clear water and low salinity levels), had abundant stands of sago pondweed. Unit 1A had a mixture of emergent vegetation (alkali bulrush and hardstem bulrush) and open water. The northern end of units 2 and 3 also had a mixture of emergent vegetation and open water while the lower ends were open water with sago pondweed. Units 4 and 5 typically had little emergent vegetation but an abundant growth of submerged sago pondweed. Areas below the D-line contained stands of alkali bulrush where the water depths were adequate, while salt grass grew in the damp areas and open mudflats. Shallow mudflat habitat was generally abundant due to low inflows in the summer.

Throughout the next five decades, management activities were aimed at refining water management to increase production of aquatic vegetation and suitable nesting cover, attempting to control carp populations, controlling mammalian and avian predators, avian botulism research, water-control structure and dike maintenance and public education and outreach. The flood years of the 1980s (1983-1989) turned the freshwater marshes of the Refuge back into brackish marshes and eventually seamless open water of the Great Salt Lake as the dikes were dissolved and all Refuge facilities (water-control structures, housing, visitor center, observation towers, maintenance buildings, picnic areas) were destroyed by high water, wind, and ice action. For several years (late1987- mid1989), the Refuge was unstaffed as no management was possible.

In August of 1989, a Refuge Manager position was re-established to staff the Refuge and begin the process of rebuilding. The destruction wrought by the flood was viewed as an opportunity to redesign and improve the wetland habitats. Management activities were aimed at reconstructing impoundments and associated water delivery canals and throughout the decade of the 1990s and into the 21st century. Key features to the improved design included 1) bypass canals to divert excess water around impoundments, 2) subdivision of large units into smaller units, 3) increased ability to control carp due to bypass canals and independent water supply afforded by canals,

4) reduced need for winter drawdowns to minimize ice damage due to smaller unit size, and 5) greater diversity and juxtaposition of wetland types. Today, the new design is operational and about 90 percent complete. The land acquisition phase of adjacent uplands began in 1993. Activities to encourage a healthy and vigorous plant community in these uplands after years of over-grazing were undertaken to restore natural biological diversity which may equate to increased productivity by ground-nesting migratory birds.

The major differences between natural condition and current conditions of the Bear River delta portion of the Refuge are: 1) spring, fall and winter river flow patterns are determined primarily by releases from Cutler Dam. Daily releases are timed to generate electricity at peak demand hours, thus flows fluctuate widely each day, 2) summer river flows have been reduced due to upstream irrigation diversions, 3) shallow impoundments have been developed both on and off the Refuge to better manage the limited summer flows, 4) evaporation losses are higher due to increase in surface area of freshwater wetlands as water is spread out evenly across elevation contours in impoundments, 5) in low water years, little to no influx of water into the Great Salt Lake during the summer months due to impoundments, 6) carp have been introduced into the ecosystem, 7) siltation has likely increased due to agricultural practices within the watershed, 8) Bear Lake has been artificially connected to the Bear River and is used to augment summer flows (these waters are diverted for agriculture uses before ever reaching the Refuge) 9) non-native red fox and raccoons have invaded the delta depressing nesting success and 10) exotic plants have invaded the area altering the dynamics of natural plant communities.

Changes from natural condition and current condition of the grassland portion of the Refuge: 1) native vegetation removed and the ground leveled to aid in flood irrigation, 2) non-native cool-season annual grasses such as downy brome, *Bromus tectorum*, and wheatgrass cultivars have replaced native grass species, 3) cattle have replaced native grazers, 4) fire frequency (potential) has increased as the non-native cool-season grasses provide an uninterrupted fine fuel source when cured in the summer versus the sporadic and clumped characteristic of the historic fuels the vegetation community afforded.

Management activities for the next decade in the uplands will focus on strategies and activities that lead toward fulfillment of the goal to restore these areas to a biologically diverse, climax plant community. Marsh communities will be manipulated to encourage high productivity of aquatic vegetation and invertebrates. Management actions will be aimed at providing nesting habitat capable of sustaining breeding birds that increase population levels or act as a population “source” versus a “sink” (negative influence) as well as providing forage and loafing habitat for staging and migratory birds.

III. Resources of Concern

A first ever attempt to identify the role of Bear River Refuge in bird conservation from a landscape perspective began in 1993. A conference was held with local wetland and wildlife managers, university professors, and refuge staff. The attendees represented years of experience working with wetlands of the Great Salt Lake basin and were knowledgeable about the conditions on the Refuge prior to the flood. The purpose of the meeting was to identify the species using the Refuge, determine species habitat needs, and forge a management direction for the Refuge following the flood. The group identified species and species groups supported by refuge habitats (Appendix B). The group further identified the time of year and the major habitats that each species or group used. The planning group then detailed how each Refuge habitat type met the needs for each of the species.

The information from this early planning session was assembled and was used to write the Long Range Water Management Plan (USFWS 1993). The Water Plan guided post-flood management actions on the Refuge throughout the restoration, enhancement and land acquisition years of the 1990s. The Water Plan was the foundation used to develop the current Habitat Management Plan. However, some important updates were made and the list of species was prioritized in light of recent planning efforts aimed at integrating bird conservation across geopolitical boundaries, taxonomic groups and landscapes (North American Bird Conservation Initiative). The list of priority species from 1993 was refined and some species and species groups were dropped from the list as our knowledge of the status of continental bird populations has increased through landscape scale planning. Fourteen species and two bird groups were selected as priority species in need of special management emphasis and consideration at Bear River Refuge (Table 3).

Species and species groups were prioritized to ensure management efforts are focused on critical issues, to avoid directing management efforts toward resources that are not appropriate to manage for on Bear River Refuge, and to ensure that all involved parties agree on the management direction of the Refuge.

Table 3. Priority species, Bear River Migratory Bird Refuge.

Rank	Priority Species	Life Cycle Activity	Priority Status Noted
1	American Avocet	Breeding, Migration	UT PIF[1], IMWSP[2], IMWJV[3], GSL[4]
2	Cinnamon Teal	Breeding	IMWJV
3	Black-necked Stilt	Breeding	UT PIF, IMWSP, GSL
4	White-faced Ibis	Breeding	IMWB, GSL
5	Shorebirds	Migration	
6	Waterfowl	Migration	
7	Tundra Swan	Staging/Migration	IMWJV
8	Snowy Plover	Breeding	IMWSP, IMWJV, GSL
9	Marbled Godwit	Staging/Migration	IMWSP, GSL
10	Long-billed Curlew	Breeding	UT PIF, IMWSP, IMWJV, UT List
11	American White Pelican	Feeding	UT PIF, IMWJV, UT List[5], IMWB[6], GSL
12	Redhead	Breeding	IMWJV
13	Wilson's Phalarope	Staging/Migration	IMWSP, GSL, BCR 9[7]
14	Long-billed Dowitcher	Staging/Migration	IMWSP, GSL
15	Franklin's Gull	Breeding	IMWJV, IMWB, BCR 9
16	Black Tern	Breeding/Migration	IMWB, BCR 9

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1 Utah Partners in Flight Plan (Parrish et al. 2002); 2 Intermountain West Regional Shorebird Plan (Oring et al. 2000); 3 Intermountain West Joint Venture (Utah Steering Committee 2003); 4 Great Salt Lake Shorebird Management Plan, draft (Paul et al. 1999 DRAFT); 5 Utah Department of Natural Resources, Division of Wildlife Resources, sensitive species list (1998); 6 Intermountain West Waterbird Plan, draft (Ivey *in prep.* 2003); 7 Partners in Flight, Bird Conservation Region 9, Basin and Range (Pashley et al. 2000).

A. Identification of refuge resources of concern.

Effective and efficient management of natural resources on lands within the National Wildlife Refuge System means knowing the species and habitats most in need of our conservation efforts. Our approach to selecting priority species was to first assemble the landscape-scale bird conservation plans. Priority species were identified by comparing lists of priority species and habitats identified in the national plans, stepped down to Intermountain West regional plans, then to the Great Salt Lake basin and finally to the Refuge (Table 3). In this final step we considered the historic, current and potential of the Refuge to contribute toward the conservation of the species and/or species habitat. Information from various conservation plans and published literature on the priority species was assembled and used as ranking factors (Table 4). Species listed under the Endangered Species Act and the Utah Sensitive Species list were also evaluated.

The underlying ecological principle to prioritization is that focused management actions on priority species also benefits other avian species (and other forms of wildlife). In other words, focused action on priority species will extend benefits to most birds utilizing the Refuge.

Table 4. Priority species and ranking factors, Bear River Refuge.

Priority Rank & Species	Ranking Factors
1 American Avocet	* Refuge, as part of GSL hosts up to 14% of continental breeding population (Refuge alone 1%). * Refuge as part of GSL hosts up to 55% of continental population during migration (Paul and Manning 2002).
2 Cinnamon Teal	* Northern Utah marshes host up to 60% of continental breeding population (Bellrose 1980).
3 Black-necked Stilt	* Refuge, as part of GSL hosts 79% of IMW migrating birds (Shurford et al. 2002). * Refuge hosts 2% of continental breeding population (Refuge records).
4 White-faced Ibis	* Refuge, as part of GSL hosts world's largest breeding colony (USFWS 1982).
5 Shorebirds	* Refuge, as part of GSL recognized as WHSRN Hemispheric Site. * Refuge hosts an average spring (April-May) population of 18,000 shorebirds and hosts an average fall (July-September) population of 69,000 shorebirds.
6 Waterfowl	* Refuge hosts an average 11,000 (July 1-14) molting Northern Pintail. * Refuge hosts an average spring (March-April) peak population of 119,000 waterfowl and an average fall peak (1st week of Oct.) of 263,000 birds. * Refuge can host up to < 500,000 waterfowl in fall.
7 Tundra Swan	* Refuge and adjacent Bear River Club, host up to 30% of Western Population of Tundra Swan (Refuge15%).
8 Snowy Plover	* Refuge, as part of GSL hosts >50% of continental breeding population (Page et al. 1991).
9 Marbled Godwit	* Refuge and GSL hosts up to 86% of IMW region's Marbled Godwit (Shuford et al. 2002). * Refuge as part of GSL, only known inland staging area in North America (Shuford 1994). * Refuge peak (30,000) is 15-21% of continental population.
10 Long-billed Curlew	* Refuge historic records of 50 breeding pair makes Refuge important breeding site in IMW.
11 American White Pelican	* Refuge is most important foraging site in GSL for Pelican. * The GSL colony is one of three largest in North America (Parrish et al. 2002).
12 Redhead	* Bear River delta noted as having the highest breeding concentration known in North America (Weller 1964).
13 Wilson's Phalarope	* GSL recognized as largest staging area in world (Jehl 1988).
14 Long-billed Dowitcher	* The Refuge, as part of GSL hosts 39% of IMW population during migration which is equivalent to 3% of the continental population. * Refuge fall population is 1% of continental population.
15 Franklin's Gull	* The GSL staging population is 9.2% of continental population. * Refuge breeding population is 0.8% of continental population and 13% of the Utah population.
16 Black Tern	* Historic Refuge records indicate Refuge could host >20 pair which is 33% of Utah objective of 60 pair. * Refuge, as part of GSL may host 9% of Great Basin population during migration

B. Identification of habitat requirements

A review of the published literature for each priority species and species group was conducted to extract habitat related information. Table 5. illustrates how each Refuge habitat type functions in meeting the needs of each priority species and species group. In addition, seasonal habitat use of the Refuge by the priority species was evaluated (Table 6). Below is a general characterization of habitat requirements of the priority species and species groups.

The Refuge priority species require abundant and diverse species of aquatic and terrestrial invertebrates. They include species from the *Hemiptera*, *Corixidae*, *Coleoptera*, *Diptera*, *Chironomidae*, *Odonata*, *Orthoptera*, *Ephemeroptera*, and *Trichoptera* families, brine shrimp, brine fly, earthworms, leeches, snails, grasshoppers and crustaceans. Priority species also require an abundance of emergent and submergent, aquatic plant material (seeds, stems, tubers) such as hardstem bulrush, alkali bulrush, smartweed, *Polygonum*, cattail, sago pondweed, small fish (1-12 inches) and small mammals as food resources.

The majority of priority species forage in dry mud to shallow waters (0-7 inches) (American Avocet, Black-necked Stilt, Cinnamon Teal, White-faced Ibis, Shorebirds, Waterfowl, Marbled Godwit, Wilson's Phalarope, Long-billed Dowitcher) with less than 25 percent vegetative cover yet with proximity to medium density stands of emergent vegetation for brood cover. Nesting requirements include unvegetated mudflat (Snowy Plover), sparsely vegetated uplands and islands (Black-necked Stilt, American Avocet), short and sparsely to moderate density grasslands (Wilson's Phalarope and Long-billed Curlew), tall, dense grasslands communities (Cinnamon Teal) and moderately dense stands of emergent vegetation in water 20-59 inches deep (White-faced Ibis, Redhead, Franklin's Gull and Black Tern). Staging and migrating birds require unvegetated mudflat to shallow waters (0-7 inches) for undisturbed loafing and foraging opportunity.

The following biological accounts for the priority species detail distribution, ecology, habitat requirements, the Refuge's contribution to habitat needs, and research and monitoring needs. The information in the species accounts, unless specifically stated, should be attributed to the authors of the various species accounts of *The Birds of North America Series*. The authors and their publications are listed in the literature cited section of this Plan. For ease in reading and to shorten the length of the accounts, the authors were cited only once.

The Refuge population objectives were derived from historic weekly count data and nesting surveys. Breeding population objectives were derived by using the average count across years (1956-2002) during the breeding season or by using an average count of nests from colonial waterbird surveys. The average count across years (1956-2002) during the spring and fall was used to derive population objectives for staging and migrating priority species.

Habitat management strategies that lead to achieving the objectives listed in the priority species accounts can be found in Section V. *Habitat Management Strategies*. Habitat objectives were derived by linking species specific habitat needs to the type and amount of available Refuge habitats, while using historic and current Refuge habitat use and distribution data as a guide.

Refuge staff will select the most appropriate management strategy during the annual Habitat Management Planning process. Strategies will be selected after evaluation of the previous year's monitoring data, past and predicted response by priority species, the ranking order of the priority species, consideration of current habitat conditions, current and forecasted precipitation patterns, and special management concerns (e.g. invasive species and visitor use).

Priority Species			WETLAND					SALTAIR MUDFLAT					
	Streambank	Dikes	Deep Submergent	Shallow Submergent	Deep Emergent	Mid-Depth Emergent	Shallow Emergent	Vegetated Mudflat	UnVegetated Mudflat	Salt Meadow	Wet Meadow	Alkali Bottom	Semi-desert Alkali Knoll
American Avocet		B		F		F	F						
Black-necked Stilt		B		F_m				F_m					
Long-billed Curlew							F	F B	F	FB	B		
Snowy Plover		B R						B F R	B F R				
Wilson's Phalarope				F		F_m	F_m			F B	F B	B	
Long-billed Dowitcher				F		F	F	F	F				
Marbled Godwit				F			F			F B	F B	B	
American White Pelican		R	F		F	F			R				
Franklin's Gull		R			F B	F B							
Black Tern			F	B R		B R	B						
White-faced Ibis				F R			F R	F R	F	F	F		
Cinnamon Teal		B R		F R	R_m	F R	F R	F R		B	B F	B	
Tundra Swan			F R	F R				R	R				
Redhead			F R	F R	F R B	R B	R B						
Waterfowl	R	R		F R	R_m	F R	F R	F R					
Shorebirds		F R		F		F	F R	F R	F R				

B = Breeding R = Resting F = Feeding m = Molting

Table 5. Functional habitat use by priority species or group, Bear River MBR.

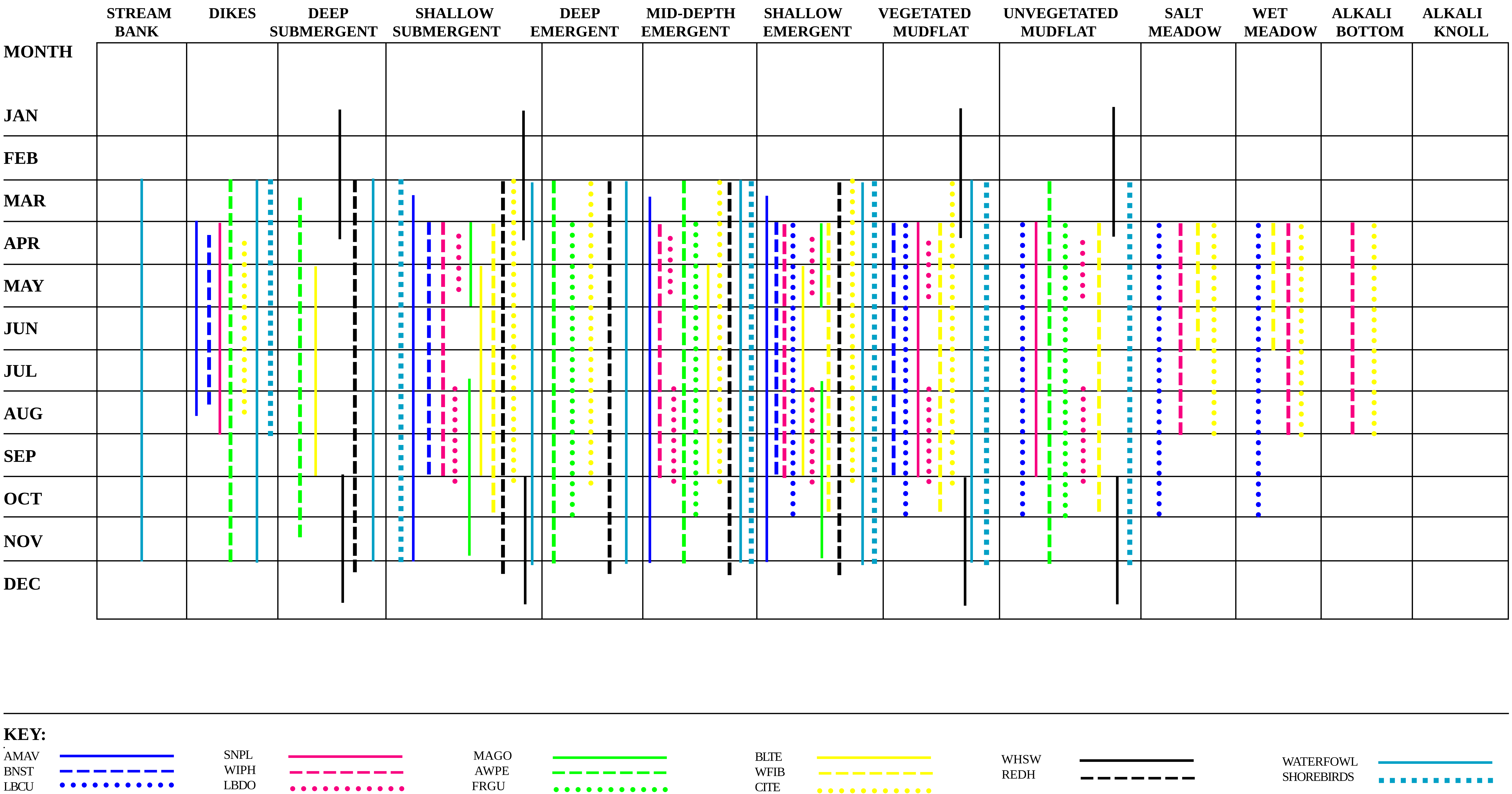

Table 6. Seasonal habitat use by priority species or group, Bear River Refuge.

Priority Species Accounts

AMERICAN AVOCET *(Recurvirostra americana)*

Associated Species: Other bird species that may respond similarly to habitat components used by the American Avocet are: Wilson's Phalarope, Black-necked Stilt, Long-billed Dowitcher, Marbled Godwit, Willet, Baird's, Least, and Western Sandpipers, and Greater Yellowlegs.

Distribution: The breeding range of the American Avocet lies in the western United States and in the southern prairie region of Canada (Ryser 1985). In the Great Basin, this species breeds in eastern Oregon, Honey and Mono Lakes in California, Humboldt and Carson Sink, Franklin and Ruby Lakes, and impoundments near Wendover in Nevada. In Utah, avocets breed at wetlands associated with the Great Salt Lake, and Bear and Snake Rivers in southern Idaho (Robinson et al. 1997).

Up to half of the individuals of this species breed in the Great Basin, and an even higher proportion of the continental population use the area for post-breeding molting and staging. Paul and Manning (2002) estimated 63,000 American Avocets were potential breeders at the Great Salt Lake. The average breeding population of Avocets on the Refuge is about 5,000 (Refuge files 1991-2002, early June).

Hundreds of thousands of Avocets stage and molt at Great Salt Lake in late summer/early fall with maximum counts of 250,000 (Paul et al. 1999). Bear River Refuge was a survey site in the Great Salt Lake Waterbird Survey (1997-2001). The mean number of Avocets detected on the Refuge during the non-breeding season was 13,626 (Paul and Manning 2002).

Ecology (Robinson et al. 1997): The primary foods for American Avocets are invertebrates of the water column and sediment including water boatmen (Hemiptera, Corixidae), beetle larvae (Coleoptera), fly larvae (Diptera), and particularly midges (Chironomidae); terrestrial invertebrates include grasshoppers, caterpillars, and spiders. In the more saline wetlands in Utah, avocets also feed on brine shrimp and brine flies. Avocets forage while wading in water depths of 6-8 inches and while swimming in depths up to 10 inches Although scything is the hallmark method, avocets have flexible feeding behaviors. Avocets employ three visual feeding methods: pecking, plunging, and snatching; and several tactile feeding methods: bill pursuit, filtering, scraping, and single scything (bill is held open slightly at the muddy substrate surface and moved from one side to the other).

The birds arrive in Utah in late March. Pair formation seems to occur before and during migration, and is usually complete before the arrival at a breeding site. The nesting site is selected jointly after nest-searching and scraping displays. Selected sites are usually in very sparse vegetation in an area affording an unobstructed view. The nest is scraped into the substrate with the breast and feet by either sex. Clutch size is 3-4 eggs and incubation averages 26.4 days. Both sexes incubate the eggs, alternating throughout the day and night. Chicks are hatched precocial, downy, and able to feed themselves. Young birds will remain in the nest for

24 hours after the last chick is hatched if undisturbed. The adults will then lead the chicks to a brood nursery area with shallow water and sufficient vegetation for cover. After about 27 days, the young avocets are capable of sustained flight, and spend their days in flocks with other fledglings and adults. Avocets leave Utah for wintering grounds beginning in August and continue through September.

Habitat Requirements: As evidenced by their spotty breeding range, American Avocets have fairly specific habitat regimes. Nesting occurs in areas with salt ponds, potholes, or shallow alkaline wetlands, as well as some mud flats of inland lakes and impoundments and evaporation ponds. Wetlands used by American Avocet are vegetated by common cattail, *Typha latifolia,* bulrushes *Scirpus* spp., or sedges *Carex* spp., but individuals spend most of their time in more open areas that have no vegetation, or that are characterized by glasswort, *Salicornia* spp., salt grass, *Distichlis* spp., and even greasewood, *Sarcobatus* spp. in more upland areas. American Avocet often nests on islands with relatively sparse vegetation, or along dikes. Avocets nest in areas of islands and dikes with the least vegetation, usually along the slope of crown. In desert wetlands, the Avocet may nest on open salt pans near playas. On Bear River Refuge, avocets nest along dikes, on mudflats and on islands with other species like Black-necked Stilt and Gadwall (K. Lindsey, pers. communication).

Seasonal Use/Refuge Habitats: Avocets utilize the Refuge as a nesting, brood-rearing and migration stopover. See Tables 5 and 6 for a summary of Refuge habitat type and seasonal use by avocets. Avocets build the majority of their nest along D-Line dike. More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: The North American population estimate is 450,000 with a tentative target population of 450,000 (Brown et al. 2000). Considered a Bird of Conservation Concern in Bird Conservation Region 9, Great Basin (Pashley et al. 2000).

Population Objective: Maintain American Avocet breeding population on the Refuge of about 2,500 nesting pair (1956-2002 average).

Habitat Objectives: 1) Maintain 800 acres of dikes (791 acres) and nesting islands (12 islands totaling 8.5 acres) as suitable nesting habitat (mudflats and sparsely vegetated areas close to water depths of 6-8 inches);
2) Maintain 8,600 acres of shallow emergent marsh (0-8 inches) and 31,200 acres of vegetated mudflat during peak shorebird migration to encourage use by migrating avocets at a population level of 13,600 birds (July-September).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Dikes, Wetlands, and Saltair Mudflat.

Refuge Specific Monitoring Needs:

1. Monitor number of breeding American Avocet on Refuge, and Great Salt Lake ecosystem.

2. Estimate relative density and species diversity of aquatic invertebrates in high American Avocet use units on the Refuge.

Landscape Scale Research Needs (Haig and Oring 1998):

1. Identify and develop habitat management techniques specifically aimed at increasing productivity.

2. Identify interactions among water quality and quantity, invertebrates, plants, and birds in Great Basin ecosystems.

3. Determine location of migratory routes and wintering sites.

4. Investigate the energetics and nutrition of the American Avocet.

5. Determine impacts of irrigation drain water contamination on adults and juveniles.

6. Develop statistically valid monitoring protocol to determine reproductive success, i.e. young/nest, nesting success rate, and fledgling survival rates.

7. Determine importance of brine flies and brine shrimp to shorebirds and waterbirds of the Great Salt Lake.

CINNAMON TEAL (Anas cyanoptera septentrionalium)

Associated Species: Other bird species that may respond similarly to habitat components used by the Cinnamon Teal are: Mallard, Gadwall, Northern Pintail, Green-winged Teal, Blue-winged Teal, Northern Shoveler, White-faced Ibis, Long-billed Curlew, Willet, Wilson's Phalarope, Western Meadowlark, Northern Harrier, Short-eared Owl, Horned Lark, Vesper and Savannah Sparrow.

Distribution: Though there are five subspecies only one, *A. c. septentrionalium* breeds in North America. This subspecies breeds primarily in the Great Basin and western intermountain regions of the U.S. and winters mainly on coastal marshes and interior wetlands in Mexico. Over half of the total North American population is said to breed in the marshes east and north of the Great Salt Lake in Utah (Bellrose 1980). The Cinnamon Teal rarely breeds in the midcontinent prairie-parkland region. Important breeding areas include Great Salt Lake and surrounding marshes in Utah; Malheur Lake, Summer Lake, and Klamath marshes in Oregon, and Ruby Lake and Carson Sink in Nevada.

Results of a five-year survey of the Great Salt Lake showed a mean population of 16,795 Cinnamon Teal for the period August-September (Paul and Manning 2002). The mean population for the Refuge during that same survey was 3,609.

Ecology (Gammonley 1996): Cinnamon Teal are seasonally monogamous, with most pairs forming before arriving on breeding areas. Females lay 4 to 16 eggs in a well-concealed nest near water in rushes, sedges, and grasses, or sometimes over water in dense bulrushes or cattails. Nests are often placed below matted, dead stems of vegetation so that the nest is completely concealed on all sides and above; female approaches through tunnels in vegetation. After 21-25 days of incubation, chicks are hatched precocial and down-covered. Within 24 hours the chicks will follow the hen directly to nearest water. Males remain with their mates until late incubation, and guard females and sometimes sites within wetlands near the nest. After breeding, molting males form small flocks on nearby wetlands or perform molt migrations to large marshes with abundant emergent vegetation. Females perform all brood-rearing duties, and usually remain with their young through fledgling. Hens with broods use seasonal and semi-permanent wetlands with abundant emergent cover. Broods often feed over dense submergent vegetation in deeper portions of semipermanent wetlands. Breeding period in Utah is late April to late July.

An omnivorous species, the Cinnamon Teal feeds primarily by dabbling in shallowly flooded zones (less than 8 inches) along wetland margins; in deeper water, feeds at surface or in emergent or submergent vegetation. Seeds of hardstem bulrush, alkali bulrush, and smartweed, *Polygonum* spp., are common in the diet in all seasons and provide a high-energy food source. To meet the protein costs associated with egg production, females increase their consumption of aquatic insects (Chironomidae and Corixidae), snails (Gastropods), and zooplankton (Cladocera) from spring migration through laying.

Habitat Requirements: Cinnamon Teal use freshwater (including highly alkaline) seasonal and semipermanent wetlands of various sizes including large marsh systems, natural basins, reservoirs, sluggish streams, ditches, and stock ponds. Appears to prefer basins with well-developed stands of emergent vegetation; uses emergent zones to a greater extent than open-water portions of basins. Nests near water in low, dense perennial vegetation such as Baltic rush, *Juncus balticus*, saltgrass, *Distichlis spicata,* spikerush, *Eleocharis macrostachya*, tufted hairgrass, *Deschampsia caespitosa*, western wheatgrass, *Agropyron smithii*, foxtail barley, *Hordeum jubatum*, and various forbs; less often at base of greasewood, *Sarcobatus vermiculatus* and other shrubs and over emergent marsh vegetation. Feeds primarily by dabbling in shallowly flooded zones (less than 8 inches) along wetland margins.

Seasonal Use/Refuge Habitats: Cinnamon Teal nest in dike and salt meadow habitats and utilize shallow emergent, mid-depth emergent and shallow submergent Refuge habitats for foraging and molting (Table 5). They are present on the Refuge from March-November (Table 6). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, late and peak dates).

Habitat and/or Population Objectives: An accurate continental population estimate is unavailable though data suggests a population size of 260,000-300,000. This estimate makes the Cinnamon Teal one of the least abundant dabbling ducks in North America (Gammonley 1996).

Population Objective: 1) Support 900 pair of breeding Cinnamon Teal on the Refuge; 2) Support staging/molting population at 8,200 (August).

Habitat Objectives: 1) Maintain 791 acres of dikes and 2,600 acres of salt meadow habitat throughout the nesting season (April-July) for breeding habitat.
2) Provide 8,600 acres of shallow emergent (2-8 inches) habitat for foraging, brood rearing and molting Cinnamon Teal (June-August).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Dikes, Wetlands and Salt Meadow.

Research and Monitoring Needs:

1. Develop protocols to accurately determine nesting density, distribution, and nesting success on the Refuge.
2. Determine factors limiting nesting and reproductive success (i.e. excessive predation rates, interspecific competition, etc.) on the Refuge.
3. Conduct brood surveys to estimate total Cinnamon Teal production.

Landscape Scale Research Needs (Gammonley 1996):

Determine nesting, brooding, feeding and staging site selection criteria that influences survival and reproductive success.

BLACK-NECKED STILT (Himantopus mexicanus)

Associated Species: Other species that may respond similarly to habitat components used by the Black-necked Stilt are: Wilson's Phalarope, American Avocet, Long-billed Dowitcher, Marbled Godwit, Willet, Baird's, Least and Western Sandpipers, and the Greater Yellowlegs.

Distribution: Distribution of the Black-necked Stilt, like that of the American Avocet, is highly dependent on suitable local habitat, making the breeding range somewhat spotty and localized. The Black-necked Stilt breeds in North America in the western and west-central United States, the Gulf and Atlantic Coasts, Baja California, western Mexico, southwest-central Canada, and portions of the Bahamas and West Indies.

Breeding in Utah occurs on mudflats and shorelines in the wetlands associated with the Great Salt Lake, Utah Lake, the Bear and Malad Rivers in northern Utah, the Logan and Little Bear River in Cache Valley, Bear River Refuge; and in the Uintah Basin at Ouray National Wildlife Refuge, and other reservoirs in Uintah County; and at Fish Springs National Wildlife Refuge (Parrish et al. 2002). The Black-necked Stilt is a year-round resident in portions of Mexico.

A five-year survey of the Great Salt Lake yielded a mean of 25,522 (July-September) (Paul and Manning 2002). The Refuge mean from the survey was 8,352. The average breeding population of Black-necked Stilt on the Refuge is about 3,000 (Refuge files 1991-2003, late May).

Ecology (Robinson et al. 1999): The primary foods for the Black-necked Stilt are invertebrates of the water column and flying insects near the water's surface including brine shrimp, *Artemia*, flies and fly larvae, *Diptera*, mosquitos and midges (Chironomidae); terrestrial invertebrates including grasshoppers; small fish, crayfish, and seeds, especially sago pondweed and bulrushes. Stilts forage on bare ground and while wading in water depths up to 6 inches, usually in water fresher than avocets prefer. They do not usually swim and forage as the avocet does. The stilt's principal hunting technique is pecking-seizing insects on or near the surface of the water or on land while standing still or walking slowly. Black-necked Stilt can be found foraging along the shallow borders of freshwater and alkaline lakes, brackish ponds, salt marshes, and wet pastures (Parrish et al. 2002).

The birds arrive in Utah in early April. Very little information exists as to where and when pair formation occurs among stilts. Observations made in the 1970s suggest Black-necked Stilts do not form pair bonds until reaching the breeding grounds. Further observation notes that some stilts remain in pairs after the breeding season at migration stopovers; however, it is also noted that males and females differ in their migratory behavior on wintering ranges.

Stilts build their nests in loose colonies, sometimes with avocets. However, it appears that stilts will put more distance between their nest and other stilts than do avocets. Nest site selection is similar to that of avocets; very sparse vegetation in an area affording an unobstructed view all around. Nesting locations are generally on islands, when available, on dikes, or other areas associated with the water's edge. Nests are built on the ground, scraped into bare mud usually near patches of saltgrass or salicornia, *Salicornia rubra*, and then lined with small bits of weeds,

grasses, twigs, shells, or bones. Average clutch size is four eggs. Incubation is shared by both sexes, alternating throughout the day and night, and lasts 22-26 days. Chicks are hatched precocial, downy, and able to feed themselves. After a day or two the parents move the brood to areas more suitable for feeding and hiding from predators. Similar to avocets, stilt juveniles will spend time in flocks with other stilts and depart for wintering grounds in small flocks beginning in August and throughout September. Stilts undergo molt of both body feathers and primaries during August and September.

Habitat Requirements: Black-necked Stilts breed in fairly specific habitat regimes similar to the American Avocet. Nesting occurs in areas with salt ponds, potholes, or shallow alkaline wetlands. Nesting also occurs in some mudflats of inland lakes and impoundments and evaporation ponds. The alkaline wetlands are characterized by the presence of common cattail, bulrushes, and sedges; however, most time is spent in more open area with no vegetation or with sparse vegetation consisting of salicornia, saltgrass, or greasewood. The birds feed in open water generally fresher than that of avocets from 0-6 inches deep, or on dry ground. The nests are usually built on islands or dikes with sparse vegetation. In desert wetlands, Utah in particular, stilts nest along the lake shoreline among scattered patches of vegetation, along barren mudflats, or up on small patches of vegetation over water.

Seasonal Use/Refuge Habitats: The Refuge is an important breeding location for Black-necked Stilt in the Great Basin. They arrive in April and may be found as late as November on the Refuge (Table 6). Black-necked Stilt numbers peak on the Refuge in August likely due to staging and post-breeding birds. More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: The current continental population is estimated at 150,000 (Brown et al. 2000). Black-necked Stilt has been identified as a Priority Species by Utah Partners in Flight Plan (Parrish et al. 2002) and the Intermountain West regional shorebird plan (Oring et al. 2000). Utah population objective is *to strive to maintain a breeding population of Black-necked Stilt of at least 25,000 pairs within the Great Salt Lake Ecosystem. Fall staging numbers should be at least 40,000 birds.* The Refuge's contribution toward the Utah objective would be to:

Population Objective: Maintain breeding population at 1,500 pair.

Habitat Objectives: 1) Maintain 800 acres of dikes (791 acres) and nesting islands (12 islands totaling 8.5 acres) April-June, as suitable nesting habitat (mudflats and sparsely vegetated areas close to water depths of 15-20 cm) ;

2) Maintain 8,600 acres of shallow emergent marsh and 31,200 acres of vegetated mudflat (water-depths 0-8 inches) during peak migration to encourage use by migrating and staging stilts at a population level of at least 16,500 birds (July-September).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Dikes, Wetlands, and Saltair Mudflats.

Refuge Specific Monitoring and Research Needs:

1. Determine number of breeding pair on the Refuge.

2. Determine annual staging numbers of Black-necked Stilt on the Refuge.

3. Identify length-of-stay or turnover rates for staging and/or migrating Black-necked Stilt.

4 Determine nesting success and predation rates of breeding population on Refuge.

Landscape Scale Research Needs (Haig and Oring 1998 and Robinson et al. 1999):

1 Determine and describe migratory routes as well as wintering sites in Mexico.

2 Investigate interactions among water quality and quantity, invertebrates, plants, and birds in Great Basin ecosystems.

3 Investigate energetics and nutrition of the Black-necked Stilt.

4 Determine adult survival rates.

WHITE-FACED IBIS (*Plegadis chihi*)

Associated Species: Other bird species that may respond similarly to habitat components used by the White-faced Ibis are: Snowy Egret, Forster's Tern, Franklin's Gull, Redhead, Black-crowned Night Heron, Great Blue Heron, Western Grebe, Clark's Grebe, Eared Grebe, American Bittern and Long-billed Curlew, Red-winged Blackbird, Yellow-headed Blackbird.

Distribution (Ryder and Manry 1994): The White-faced Ibis has a discontinuous distribution. It is locally common, nesting in several marshes in the western U.S., especially in the Great Basin, and wintering in large flocks in Mexico, western Louisiana**,** and eastern Texas. The largest breeding colonies are usually located in Utah, Nevada, Oregon, and coastal Texas and Louisiana. Around the Great Basin, Ibis are located at Great Salt Lake, Ruby and Utah Lakes, in the Carson Lake-Stillwater area, at Honey Lake, and at Malheur National Wildlife Refuge (Ryser 1985).

Average breeding White-faced Ibis population for the Refuge (1956-2002, June) is 5,286 (Historic Refuge files). In a five-year survey of Great Salt Lake, mean population for July-August was 25,576, with a high count of 54,908 in 2000 (Paul and Manning 2002).

Ecology (Ryder and Manry 1994): White-faced Ibis frequent shallowly flooded pond margins, reservoirs, and marshes. In Nevada, they feed in recently flooded agricultural fields where vegetation is 2 to 35 inches high. The long legs, neck and decurved bill facilitate foraging, as these birds wade in shallow water or traverse moist soil. Prey on the surface of water or soil are located visually, while prey below the soil surface are captured by tactile probing. Two aquatic feeding methods have been identified for the White-faced Ibis:(1) a "ranging" method in which ibis walks back and forth and probes water like a "pecking chicken", and (2) stationary method in which ibis stands in one place and swings bill side-to-side. One author believed a ranging method is used to capture crayfish (Decapoda), beetles (Coleoptera), or other adult insects, whereas a stationary method is used to catch midge (Diptera) larvae. Aquatic and moist-soil invertebrates, especially earthworms and larval insects (mainly Orthoptera, Odonata, Hemiptera, Coleoptera, and Diptera) are major food items. They also take leeches and snails.

In northern Utah, pair formation and nest-site selection occur mostly mid-April to mid-May, shortly after ibis arrive from wintering areas. Eggs are laid from the last week of April through the second week of June. Mean clutch completion dates between 14 and 20 May (Kotter 1970, Kaneko 1972, Capen 1977, Alford 1978, Steele 1980 *in* Ryder and Manry 1994). Ibis are colony nesters and some colony sites are used repeatedly over several years. This species usually nests in emergent vegetation or low trees and shrubs over shallow water; sometimes on the ground on small islands. In a Utah colony, nests ranged between 8 and 39 inches above water 24 inches deep. Average clutch size on the Refuge is 4 eggs (K. Lindsey pers. comm. 2003). Incubation on average is 20 days for the terminal egg in the clutch and up to 26 days for the first-laid egg. Both sexes are thought to incubate. Young are altricial, wet upon emergence but dry within 2-3 hours. By day nine, young can climb out of nest and wander for short distances. By week four, the nestling is well covered with juvenile feathers. Young are fed directly by adults by crouching over nest and lowering partly-open bill into nest cup. Chicks insert their heads into adults mouth to feed on regurgitated food. Young are essentially independent at age eight weeks.

Habitat Requirements: This species inhabits primarily freshwater wetlands, especially cattail, *Typha* spp., and bulrush, *Scirpus* spp., marshes, although it feeds in flooded hay meadows, agricultural fields, and estuarine wetlands. In the Great Basin, the largest colonies are in stands of hardstem bulrush, *Scirpus acutus*, Olney's bulrush, *S. Olenyi*, and alkali bulrush, *S. paludosus*. Ibis frequently feed in shallowly flooded wetlands of short, emergent plants. Dominant plants are sedges, *Carex* spp., and spikerushes, *Elocharis* spp. as well as salt-tolerant glassworts, *Salicornia* spp., saltgrass, *Distichlis spicata*, and greasewood, *Sarcobatus vermiculatus*. Nearby irrigated crops, particularly alfalfa, barley, and native hay meadows, are important feeding sites in Nevada, Colorado, Utah, Idaho, and Oregon.

Seasonal Use/Refuge Habitats: White-faced Ibis may be present from April through September and use wet mudflats, wet meadows, and shallow emergent marshes for feeding and staging (Table 5 and 6). White-faced Ibis use mid-depth emergent (8-12 inches) and deep emergent marshes (12-24 inches) from May through July for nesting, mainly in hardstem bulrush dominated aquatic plant communities. In 2002, White-faced Ibis colonized hardstem bulrush stands in impounded units 1 and 5B (K. Lindsey pers. comm. 2003).

Habitat and/or Population Objectives: North American population estimated at greater than 100,000 breeding pairs. Great Basin population estimate at 25,908. Draft objective is to maintain 10,000 breeding pairs in Utah (Ivey and Herziger 2003, *in prep*.)

Population Objectives: Maintain breeding colonies on the Refuge at population level of 6,781 or roughly 3,300 breeding pair.

Habitat Objectives: 1) Provide 8,600 acres of shallow emergent marsh and 6,600 acres of mid-depth emergent marsh for suitable nesting habitat (May-June). As White-faced Ibis prefer hardstem bulrush stands for nesting on the Refuge, this objective may be refined upon further field investigations to state the optimal acreage of bulrush stands. The size of bulrush patches and likely stem density apparently effects suitability as colony site (probably affords cover from predators) on the Refuge.
2) Provide 876 acres of wet meadow and 2,625 acres of salt meadow habitat for foraging sites April-September.
3) Maintain 8,600 acres of shallow emergent marsh (2-8 inches) and 8,700 acres of shallow submergent marsh (4-18 inches) throughout period of April to September for foraging and staging White-faced Ibis at a mean population level of 15,500 (July-August).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands, Wet Meadow, and Salt Meadow.

Refuge Specific Research and Monitoring Needs:

1. Determine microhabitat nesting characteristics of White-faced Ibis on Bear River Refuge: nesting material, size of bulrush patch, stem density, distance from dike/water interface, water depth range.

2. Determine life history characteristics of White-faced Ibis on the Refuge: the role of gender in nest site selection and construction and incubation; average clutch size; mortality rates and parameters (predation rates).

3. Develop non-intrusive protocols to monitor breeding White-faced Ibis on Refuge without causing nest abandonment and other breeding locales in Utah.

4. Determine location, range, and habitat characteristics of preferred foraging locations on the Refuge.

5. Determine contaminant loading of breeding White-faced Ibis on the Refuge.

MIGRATORY SHOREBIRDS (Charadriiformes)

Associated Species: Migratory shorebirds common to the Refuge include: American Avocet, Black-necked Stilt, Marbled Godwit, Willet, Western, Least, and Baird's Sandpipers, Killdeer, Snowy Plover, Lesser Yellowlegs, Greater Yellowlegs, Long-billed Dowitcher, Long-billed Curlew, Red-necked Phalarope and Wilson's Phalarope.

Distribution: Many shorebirds migrate long distances from breeding grounds in the Arctic to wintering areas in Central and South America. Unlike waterfowl, it is largely unknown, for most species of shorebirds, which part of their breeding grounds they have left and where they go after stopping at Bear River Refuge.

The Great Salt Lake ecosystem has spring, summer and fall counts in excess of 500,000 shorebirds on a regular basis. Because of its recognized importance to shorebirds, the Refuge, as part of the Great Salt Lake ecosystem, was designated a Western Hemisphere Shorebird Reserve Network site of Hemispheric importance in 1991.

Ecology: Due to their wide range of morphological features, shorebirds exhibit a wide array of foraging techniques (probers, gleaners, terrestrial sight feeders and priers) and consequently have varying habitat requirements (partitioned habitats). During spring, summer and fall, large numbers of shorebirds concentrate at coastal and inland staging areas. Shorebirds have narrow habitat requirements that limit them to relatively few, highly productive stopover sites. Before departing, many shorebirds increase body mass up to 100 percent at these staging areas. Most of this increased mass is the fat required to fuel their long-distance migration. Because shorebirds have higher metabolic rates than other non-passerines of similar size, they must spend much of their day, during staging periods, foraging for maintenance and fat storage. The disappearance or degradation of spring stopover habitats can be detrimental to entire populations (Helmers 1992).

Habitat Requirements (Helmers 1992): During migration, shorebirds occur primarily in shallowly flooded coastal or freshwater wetlands (with water depths less than 4 inches) or on intertidal mudflats. Water depths for foraging shorebirds range from 0 inches (dry mud) for plovers and curlews, wet mud to 4 inches for sandpipers, 1-2.4 inches for yellowlegs and godwits to 3.5-7 inches for phalaropes and Avocet/Stilt. The majority of use occurs at sites with less than 25 percent vegetative cover. Habitat types also include sandy coastal beaches, shallowly flooded agricultural fields, and dry grasslands. Roosting habitats include sandbars, spits, or flats above the high tide line at coastal areas and shallowly flooded areas or islands free of vegetation at noncoastal sites. Macroinvertebrates are a key resource for shorebirds. In interior habitats, diptera (fly larvae) are an important invertebrate prey and many shorebirds will feed predominantly on chironomid larvae (blood worms) during migration and breeding.

Seasonal Use/Refuge Habitats: Shorebirds arrive in mid-March and are present until early October (Table 6). Wet mudflat and shallow emergent marsh are used for foraging and staging (Table 5). Shorebird use of the Refuge peaks in August. Vegetated and unvegetated mudflats, and wet meadows are used for nesting April through July. More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Population and/or Habitat Objectives:

Population Objective: 1) Maintain spring peak population of 18,000 shorebirds (April-May); 2) Maintain fall peak population at twenty-year average of 69,000 shorebirds (July-September).

Habitat Objective: To ensure a wide diversity and abundance of invertebrates, a wide array of wetland types will be provided for migrant shorebirds with at least 19,000 acres of mudflats, 4,350 acres of shallow submergent marsh, 3,300 acres of mid-depth emergent marsh, 4,300 acres of shallow emergent marsh, 1,700 acres of deep submergent marsh (July-September). Acreages derived from attaining 50 percent of overall habitat goals.

Habitat Management Strategy: See Section V. Habitat Management Strategies: Saltair Mudflats and Wetlands.

Refuge Specific Monitoring Needs:

1. Determine spring, summer, and fall population levels of shorebirds on the Refuge.

2. Coordinate shorebird surveys with Division of Wildlife Resources as part of the Great Salt Lake waterbird survey when appropriate.

3. Provide survey results to USGS for the Western Shorebird Survey and Manomet Center for Conservation Sciences, for the International Shorebird Survey.

4. Determine number of acres of shallow emergent and shallow submergent wetland habitat on the Refuge during spring, summer and fall peak shorebird use periods.

Landscape Scale Research Needs:

1. Initiate long-term banding program for fall migrant shorebirds to aid in identification of migration routes, turnover rates and life span.

MIGRATORY WATERFOWL (Anatidae)

Species: Migratory waterfowl common to the Refuge include: Mallard, Northern Pintail, Northern Shoveler, Gadwall, Green-winged Teal, Blue-winged Teal, Cinnamon Teal, American Wigeon, Common Goldeneye, Redhead, Canvasback, Common Merganser, Bufflehead, Ruddy Duck, Lesser Scaup, Canada Geese, and Tundra and Trumpeter Swans.

Distribution: Bear River Refuge, although located in the Pacific Flyway, hosts birds from both the Pacific and Central flyways. Band returns show that waterfowl stopping at the Refuge are likely returning to or originating from breeding grounds in other western states (western Minnesota being the eastern extent) and the western prairie provinces of Canada. The Tundra Swans that stop at the Refuge are part of the Western Population and the Canada Geese are part of the Rocky Mountain Population.

Ecology: Over 40 species of North American waterfowl use wetland habitats throughout their annual cycles. Survival, reproduction, and growth are dependent on the availability of foods that meet nutritional requirements for recurring biological events. The large body sizes of waterfowl enable them to store nutrients as body reserves. In some cases, nutrients for an upcoming stage in the life cycle are acquired at a distant wetland and transported as body reserves. Providing a diversity of wetland types (varying water depths) in an area is the best management strategy as not all species require similar resources simultaneously. In general, waterfowl foods include moist soil, submergent and emergent aquatic plant seeds and plant parts, aquatic invertebrates, grasses, molluscs, crustaceans, agricultural crops, and small fish.

Habitat Requirements: The surface-feeding ducks or "dabblers" favor the smaller, shallower inland lakes, ponds, and marshes (0-12 inches of water). The divers usually feed underwater in the open water portion of wetlands up to 13 feet deep, aided by larger feet and shorter legs; which are farther to the rear of the body than the dabbling ducks (Linduska *ed.* 1964).

Seasonal Use/Refuge Habitats: Dabbling ducks use wet mudflats, wet meadows, shallow and mid-depth emergent and shallow submergent marshes from April through November for feeding, staging, loafing, and breeding (Table 5 and 6). Wet meadows and all uplands are important for nesting May through mid-August. Shallow and mid-depth emergent marshes are used for brood rearing. Molting birds use large expanses of mid-depth emergent and shallow submergent marshes mid-June through mid-August.

Diving ducks use shallow and deep submergent marshes and open channels for feeding, loafing, and brood rearing from late March through November. In mild winters, deep submergent marshes and open channels provide feeding habitat. Diving ducks use mid-depth and deep emergent marshes for nesting May through July.

Habitat and/or Population Objectives:

Population Objectives: 1) Maintain spring migrant waterfowl peak populations at 20 year Refuge average of 119,000;
2) Maintain fall migrant waterfowl peak populations at 20 year Refuge average of 263,000.

Habitat Objectives: Provide a diversity of wetland habitats by providing at least 19,000 acres of mudflats, 4,300 acres of shallow submergent marsh, 3,300 acres of mid-depth emergent marsh, 4,300 acres of shallow emergent marsh, 1,700 acres of deep submergent marsh, and 1,400 acres of deep emergent marsh (February-April and August-November). Habitat acres derived from attaining 50 percent of overall habitat objectives by type and thought to be minimum amount of habitat needed to achieve objectives.

Habitat Management Strategy: See Section V. Habitat Management Strategies: Saltair Mudflat, and Wetlands.

Refuge Specific Monitoring Needs:

1. Determine spring and fall peak waterfowl populations on the Refuge (March-April; September-November).

2. Determine nesting density and success of waterfowl on the Refuge.

3. Determine relative density and diversity of aquatic invertebrates on Refuge units.

4. Estimate seed production of aquatic plants in the Refuge units.

5. Determine percent cover and diversity of emergent vegetation and open water per wetland unit.

6. Determine relative abundance of sago pondweed in wetland management units.

7. Participate in the mid-winter waterfowl count and coordinate with Division of Wildlife Resources staff (January).

8. Determine numbers and species of birds that die as part of avian botulism outbreaks on the Refuge.

TUNDRA SWAN (*Cygnus columbianus*)

Associated Species: Other bird species that may respond similarly to habitat components used by the Tundra Swan are: American White Pelican, Trumpeter Swan, Mallard, Gadwall, Wigeon, Redhead, Canvasback, Scaup spp., and Canada Geese.

Distribution: Breeding occurs on arctic wetlands while wintering occurs on estuaries along the east and west coasts. The Tundra Swans utilize traditional migratory routes inland across the continent. Interior stopovers areas are primarily in the Great Basin, upper Mississippi River Valley, southern Ontario, and Susquehanna River Valley in southeast Pennsylvania. Breeding range in the Arctic is from the Aleutian Islands across the northern tundra regions of Alaska, Yukon, Northwest Territories, northeast Manitoba, northern Ontario, and northwest Quebec. The birds that stop at the Refuge are considered part of the Western Population of Tundra Swans, while birds traveling to the east coast of the U.S. are considered part of the Eastern Population.

The average fall peak Tundra Swan population in Utah is 24,746 (1990-01) and occurs between November 26 and December 2. The Refuge average peak is 13,111 (1990-01) and occurs between November 8 and December 2 (Refuge records). More than 99 percent of Utah's migrant Tundra Swans utilize the freshwater wetland habitats in the Bear River Bay of the Great Salt Lake, which includes the Refuge. Based on mid-winter indices, northern Utah may host up to 30 percent of the Western Population of Tundra Swans at any one time, with the Refuge accounting for about one-half of that population (15 percent). Sporadic counts for the spring (1992-2002) show an average peak for the Refuge of 3,318 between February 15 and March 22.

Ecology (Limpert and Earnst 1994): Comments are restricted to migrating and staging birds as that is the role the Refuge supports. Tundra Swans form permanent, monogamous pair bonds. This swan migrates in flocks composed of family groups. Cygnets stay with parents throughout autumn and winter of first year. Parents continue to provide parental care by protecting cygnets from foraging competition and allowing cygnets to exploit foraging behavior (paddling to bring tubers to water surface).

Individuals preen extensively at all times of year. Swans molt body feathers over an extended period (June-December). Initiation and completion of body molt depends on several factors such as age, breeding status, and sex. Wing molt takes place on the breeding grounds. This species sleeps while sitting or standing on one or both feet, usually with head resting on back and sometimes with head partially under wing. This bird roosts more often on water than land during nonbreeding seasons. On a migratory stopover, most swans (81 percent) are roosting at any given time, only 19 percent are foraging, traveling, or interacting.

Habitat Requirements: In spring and fall, migrating swans prefer shallow ponds, lakes, and riverine marshes. Major food items for the Tundra Swan include plants, primarily seeds, stems, roots, and tubers of submerged and emergent aquatic vegetation. On migration and in winter, diet may include agricultural crops; waste grains and growing winter cereal grain crops (Limpert and Earnst 1994). Forages throughout the day, although some feeding will occur at night during a full moon. On migration and in winter, feeds as a flock by dabbling, submerging head and

neck, upending and grazing in and along margins of lakes and old channels. Feet used to excavate plant parts and mollusks from substrate. On migration, the seeds and tubers of Pondweed, *Potamogeton pectinatus*, are a major food item in Utah and in North Dakota, while tubers of cattail, *Sagitaria latifolia,* are consumed in western Minnesota. The long neck of the Tundra Swan permits feeding in water up to 3 feet deep.

Seasonal Use/Refuge Habitats: Tundra Swans use the Refuge as a staging area and migratory stopover before continuing their journey across the Great Basin to the central valley of California, where they normally over-winter; and on their return trip to Arctic breeding grounds. On the Refuge, Tundra Swans use wet mudflats and wet meadows for loafing (October - January, and March - April). Tundra swans use shallow submergent and deep submergent marshes for feeding (Table 5). In mild winters tundra swans may be present October through March (Table 6).

Habitat and/or Population Objectives: The ten-year average wintering population index for the Western Population of Tundra Swans is 84,605 (1992-2001). The long term mid-winter index is 59,706 (1955-2002). The target population size for the Western Population is 60,000 (Pacific Flyway Council 2001).

Population Objective: Support migratory population at 15 percent of total Western Population of Tundra Swan based on a five-year average mid-winter indices.

Habitat Objectives: 1) Provide 31,200 acres of vegetated mudflat, 6,800 acres of unvegetated mudflat, and 3,200 acres of wet and salt meadow for loafing swans (October-December);
2) Provide 8,700 acres of shallow submergent and 2,500 acres of deep submergent marsh for feeding swans (October-December, March-April).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands, Saltair Mudflats, Wet Meadow, and Salt Meadow.

Refuge Specific Monitoring Needs:

1. Determine number of swans harvested from the Refuge each year.

2. Determine number of swans utilizing Refuge habitats by method of weekly ground counts.

SNOWY PLOVER (Charadrius alexandrinus)

Associated Species: Other bird species which may respond similarly to habitat components used by the Snowy Plover are: Killdeer, Black-necked Stilt, and Black-bellied Plover.

Distribution (Page et al. 1995): In North America, the Snowy Plover is mainly found in some of the western states and along the Gulf Coast. The Snowy Plover is a summer resident and migrant in the Great Basin (Ryser 1985). It is considered to be an uncommon summer resident at some of its breeding locales in the Basin, such as in northern Utah, in northeastern Nevada, and at Malheur National Wildlife Refuge. It appears to be rather common at other locales such as in central Utah, at Pyramid Lake, and along the western edge of the Great Basin at Upper and Lower Alkali lakes, Honey Lake, and Mono Lake in California. Perhaps the majority of North American Snowy Plovers breed in the Great Salt Lake region (Page et al 1991).

The mean number of Snowy Plover detected during a five year survey (1997-2001) of Great Salt Lake was 363, with a high count of 1,228 in 1997 (Paul and Manning 2002). An occurrence estimate of 10,000 Snowy Plover at the Great Salt Lake was made for two separate years in the 1990s (Paton 1994). Historic Refuge surveys (1956-2002) show an average of 11 Snowy Plover detected during weekly waterbird surveys for the month of June.

Ecology (Page et al. 1995): The Snowy Plover inhabits beaches, lagoons, and salt-evaporation ponds on coasts and barren to sparsely vegetated salt flats and braided river channels inland. Snowy Plover nest in the open on the ground. Their clutches are frequently destroyed by predators, people, or weather, but they renest readily after these losses, up to six times in some locations. Double brooding is common and triple brooding regular where the breeding season is long. In such circumstances, females desert their mates and broods about the time the chicks hatch and initiate new breeding attempts with other mates. Despite this species' breeding tenacity, its numbers are small. Along the U.S. Pacific and Gulf coasts, the population is shrinking because of habitat degradation and expanding recreational use of beaches. The Pacific Coast population is now designated as Threatened by the U.S. Fish and Wildlife Service (Page et al. 1995).

In Great Basin saline and alkaline lakes, the Snowy Plover feeds on flies, beetles, hemipterans, and brine shrimp. The feeding behavior, typical of plovers, is to pause, look, run, and then seize prey from the surface of beach or tide flat. The Snowy Plover will probe in certain circumstances. This species sometimes lowers it's head and charges with an open mouth into dense aggregations of adult flies on the ground, and snapping it's bill at those flushed.

Males usually make multiple scrapes within a territory. The scrape selected for most copulations typically becomes the nest site. Usual clutch size is 3 eggs. Though both sexes incubate complete clutches, there is evidence that the females incubate during the majority of daylight hours. The incubation period varies by location and early versus late season nests, but is in the range of 25-28 days. Chicks are precocial, and leave the nest 1-3 hours after hatching. They forage unassisted from parents, but require periodic brooding for many days after hatching. Females generally desert mates and broods by 6 days after hatching, leaving males in sole care of young. Males stay with young until they are 29-47 days old.

Habitat Requirements: Snowy Plovers nest in the open on barren to sparsely vegetated ground at alkaline or saline lakes, reservoirs and ponds. Nests are often located with respect to some conspicuous feature of otherwise barren landscape; e.g., near a piece of kelp, driftwood, clam shell, cow pie, or tumbleweed; or on small rises. At inland locations, this bird feeds on shores of lakes, reservoirs, ponds, river deltas and playas. Most feeding is in shallow (less than 1 inch deep) water or on wet mud or sand. On playas, some foraging occurs on dry flats.

Seasonal Use/Refuge Habitats: See Tables 5 and 6 for a summary of Refuge habitat and seasonal use by shorebirds. Snowy Plovers nest and feed on large expanses of remote, undisturbed mudflats with nearby water sources. They also nest on the cross-dikes of Units 3E, F and G. Snowy Plover may be present from mid-April to the end of September. More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used, timing of use (arrival, departure, and peak dates) and nesting success.

Habitat and/or Population Objectives: North American population estimate is 16,000 birds (Brown et al. 2000). Considered a Bird of Conservation Concern by the Mountain-Prairie Region (6) of the Service and Bird Conservation Region 9, Great Basin (Pashley et al. 2000).

Breeding Snowy Plover are difficult to detect on Bear River Refuge without target monitoring efforts. Due to low detection rates, the breeding population on the Refuge is estimated at 20 pair (K. Lindsey pers. comm. 2003).

Population Objective: Maintain breeding population level at 20 pair.

Habitat Objective: Provide 50 acres of undisturbed dike habitat (Unit 3E, F, G. about 6 miles) and 6,800 acres of unvegetated mudflat habitat throughout the nesting season (April-July).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Dikes and Saltair Mudflat.

Refuge Specific Monitoring Needs:

1. Develop protocol to monitor breeding number of Snowy Plover on Refuge.

Landscape Scale Research Needs (Haig and Oring 1998 and Page et al. 1995):

1. Develop protocol to monitor breeding number of Snowy Plover in Utah and the Great Basin.
2. Develop statistically valid monitoring protocol to estimate reproductive success.
3. Develop management techniques specifically aimed at increasing productivity.
4. Investigate effects of predator control program on productivity.
5. Determine survival rates of one year old birds.
6. Determine juvenile dispersal patterns.
7. Determine level of reproductive success required for population stability.
8. Determine effects of food availability on breeding success.

MARBLED GODWIT (Limosa fedoa)

Associated Species: Other species that may respond similarly to habitat components used by the Marbled Godwit are: White-faced Ibis, Wilson's Phalarope, Cinnamon Teal, Mallard, Gadwall, and Long-billed Dowitcher.

Distribution: Marbled Godwits breed from central Alberta through central Manitoba, south through Montana, North Dakota, east-central South Dakota, north-central Nebraska, and east to north central Minnesota. Large flocks of wintering Marbled Godwits can be found in southern California and western Mexico. A five-year survey of the Great Salt Lake yielded a mean population of 15,125 (July-August) (Paul and Manning 2002). The Refuge mean from the five-year survey was 8,867 Marbled Godwits.

Ecology (Gratto-Trevor 2000): The breeding season extends from mid-April through late July. Most nests initiated during mid to late May. Godwits appear to make only one nesting attempt per breeding season. Normally a four egg clutch is laid in a shallow depression of a nest cup, often lined sparsely with dead grasses, occasionally dead grass and lichen. Incubation period thought to be 23-26 days. Both parents share in incubation and brood care. The Marbled Godwits is long-lived and has a monogamous, conservative breeding system, nesting in fairly low densities throughout its range. Banding studies have shown this species to live up to 25 years. Marbled Godwits begin flocking in mid to late July, and most flocks depart by late August.

Uncommon for shorebirds, Marbled Godwits sometimes forage almost exclusively on plant tubers during migration. Main food items taken on interior staging areas and breeding grounds are insects (particularly grasshoppers), aquatic plant tubers (sago pondweed), leeches, and small fish. In Idaho, foraging birds noted as common on large mudflats, occasional on moderate mudflats caused by lake reservoir drawdowns. In Manitoba in fall, Marbled Godwits fed in shallow water with soft mud substrate. Feeds primarily by probing substrate, but known to glean insects from water surface or terrestrial habitats, and small fish from shallow water.

Habitat Requirements: Breeding Marbled Godwits require short, sparse to moderately vegetated uplands for nesting and foraging, and wetland complexes for foraging. Marbled Godwits territories are characterized by a high percentage of grass cover, many wetlands, and high wetland diversity. Territories are large, and include both feeding and nesting areas. Areas must be large enough to provide both upland and a diverse range of wetland types. Marbled Godwits may be area sensitive, rarely occurring on blocks of contiguous grassland less than 247 acres in the northern Great Plains.

In both upland and wetland habitat, tall, dense cover is avoided. Within wetland habitats, Marbled Godwits avoid dense emergent vegetation, preferring shallow water areas with short, sparse to moderately dense shoreline vegetation. Suitable wetlands ranged in salinity from fresh to highly saline, and varied widely in size and permanence. In both upland and wetland habitats, Marbled Godwits with broods use somewhat taller, denser grass cover than do breeding pairs during nesting. During all seasons, most fed in fairly deep to shallow water (2-5 inches).

Marbled Godwits often feed with head completely submerged for up to 5-8 seconds (Gratto-Trevor 2000).

Seasonal Use/Refuge Habitats: The Refuge is an important staging area for the Marbled Godwit as part of the Great Salt Lake ecosystem. Refuge may host up to 6 percent of entire population during fall staging periods while entire Great Salt Lake system may host up to 19 percent (Oring et al. 2000). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: Continental population estimated to be 140,000 - 200,000. Considered a Bird of Conservation Concern by the Mountain-Prairie Region (6) of the Service and Bird Conservation Region 9, Great Basin (Pashley et al. 2000).

Population Objective: Maintain Refuge staging population at ten-year average of 6,800 (July-August).

Habitat Objective: Maintain shallow water with little or no emergent vegetation for pre and post breeding flocks (July-August) by providing 8,700 acres of shallow submergent habitat and 6,800 acres of unvegetated mudflat.

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands and Saltair Mudflat.

Refuge Specific Monitoring Needs:

1. Determine annual staging population levels.

2. Determine locations (management units) of high use and describe foraging microhabitat characteristics.

3. Estimate average annual mortality of Marbled Godwits to avian botulism on the Refuge from historical data (1928-2003).

Landscape Scale Research Needs (Haig and Oring 1998, Gratto-Trevor 2000):

1. Determine diet and foraging behavior during migration and staging on Great Salt Lake.
2. Determine age at first breeding in the Great Basin.
3. Determine survival from fledgling to first year in Great Basin.
4. Determine turnover rates or length-of-stay of Marbled Godwits at Refuge, Great Salt Lake and Great Basin.
5. Determine migration routes and identify staging areas.

LONG-BILLED CURLEW (Numenius americanus)

Associated Species: Other species that may respond similarly to habitat components used by the Long-billed Curlew are: Willet, Wilson's Phalarope, Western Meadowlark, and other upland grassland birds.

Distribution: Long-billed Curlews breed from south-central British Columbia, southern Alberta, southern Saskatchewan, and southern Manitoba south to east-central California, central Nevada, central Utah, central New Mexico, northern Texas, and east to southwest North Dakota, northwest South Dakota, north-central Nebraska, and southwest Kansas. It winters from Washington, extreme northern Mexico, southern Texas, southern Louisiana, southern Alabama, and coastal South Carolina south to southern Mexico.

The Long-billed Curlew is a fairly common summer resident and migrant in Utah, especially through the central and more northern valleys (Parrish et al. 2002). A five-year survey of the Great Salt Lake found a mean of 125 Long-billed Curlews in April-June (Paul and Manning 2002). The mean for the Refuge during the survey was only 0.1.

Ecology (Dugger and Dugger 2002): In Utah, most Long-billed Curlews that nested around the Great Salt Lake started to arrive on the breeding ground during the last week of March and established territories by mid-April. Birds in northern Utah arrived later and remained longer than curlews in other parts of its range, probably as a result of climate differences. Foods taken are diverse, including: crustaceans, mollusks, worms, toads, the adults and larvae of insects, sometimes berries and nesting birds. The Long-billed Curlew forages by probing and pecking. Clutch initiation dates also varied with climate, and in northern Utah were started from mid-April to mid-May. Nests found in Box Elder and Cache Counties, Utah were typically a grass-lined depression located in a clump of grass. Female Long-billed Curlews are monogamous and lay only one clutch each season. Clutch size is typically 4 eggs. Young are precocial and tended by both adults.

In western Idaho, mammalian carnivores were the most important predators of curlew eggs and clutches. Survival of very young chicks (0-5 days) probably depends more on their learning to feed effectively and receiving occasional thermoregulatory assistance from parents than on avoiding predation. There is a bias in natal philopatry in male curlews, but they do not return and attempt to breed until they are 3 or more years of age. Females breed for the first time at age 2-3 years. Average adult survival is approximately 85 percent per year, and the average longevity may be 8-10 years.

Habitat Requirements: Long-billed Curlews have 4 essential nesting habitat requirements in the northwestern U.S.: 1) short grass (less than 12 inches), 2) bare ground components, 3) shade, and 4) abundant vertebrate prey. Curlews seem to be most successful in mixed fields with adequate, but not tall, grass cover and fields with elevated points. Uncultivated rangelands and pastures support most of the continental Long-billed Curlews breeding population. Curlews tend to place their nests near manure piles or other conspicuous objects, camouflaging them from aerial predators. At the Great Salt Lake, the ground is relatively level and curlews prefer to nest

near the edges of barren alkali flats. Prefers firm mud substrate or high-tidal areas to soft mud, sand, or low-tidal areas for foraging. Moist, firm mud (water less than 0.5 inches deep) used most during all seasons, and use increased from 50 percent in fall to 100 percent in spring; use of wet mud habitats (0.7 -5 inches deep) declined during the same time period (California study). During breeding in Colorado, 55 percent of foraging observations occurred in short grass, 40 percent in crop fields. In Oregon, Long-billed Curlews used cheatgrass, *Bromus* spp., and freshly mowed alfalfa.

Seasonal Use/Refuge Habitats: Based on historic counts, the Refuge was at one time an important breeding site in the Great Basin for Long-billed Curlews at about 50 pair (Refuge records). Current nesting estimate is 3 pair (B. Olson, personal observation). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: The continental population estimate is 20,000 with a tentative target of 28,500 (Brown et al. 2000). Considered a species of Conservation Concern by the Mountain-Prairie Region (6) of the Service and Bird Conservation Region 9, Great Basin (Pashley et al. 2000), and a Partners in Flight, Priority Species in Utah (Parrish et al. 2002).

Population Objective: Encourage return of historic breeding population levels of 50 pair (1956-1966).

Habitat Objective: 1) Maintain saltair mudflat (6,800 acres of unvegetated mudflat and 28,000 acres of vegetated mudflat) for potential nesting and foraging habitat (May-June; August-September).
2) Provide 870 acres of wet meadow and 2,600 acres of salt meadow for foraging habitat (May-June; August-September).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Saltair Mudflat, Wet Meadow and Salt Meadow.

Refuge Specific Research and Monitoring Needs:
1. Identify Long-billed Curlews breeding pair density on the Refuge.
2. Identify Long-billed Curlews habitat use and foraging microhabitat characteristics.
3. Determine nesting success rate of Refuge Long-billed Curlews.
4. Identify major mortality factors of Long-billed Curlews on the Refuge.

Landscape Scale Research Needs (Dugger and Dugger 2002):
1. Identify Long-billed Curlews habitat use and breeding pair density within the greater, Great Salt Lake ecosystem.
2. Develop technique to implement range wide breeding surveys.
3. Investigate management effects (grazing, water-level manipulation) on Long-billed Curlews.
4. Determine annual and seasonal survival rates of chicks, subadults, and adults.

AMERICAN WHITE PELICAN (Pelecanus erythrorhynchos)

Associated Species: Other species that may respond similarly to habitat components used by the American White Pelican are: California Gull, Caspian Tern, and Double-crested Cormorant for nesting habitat. Other species that may use the same foraging habitat include Western and Clark's Grebes, Pied-billed Grebe, Forster's Tern, Great Blue Heron, Black-crowned Night Heron, Snowy and Cattle Egret and Common Merganser.

Distribution: The American White Pelican occurs mainly in western and southern portions of North America, breeding inland in colonies on remote islands and wintering along warm southern coasts. Pelicans migrate from northern breeding areas annually but are year round residents of Texas and Mexico. Populations breeding west of the Rocky Mountains move southwest into California and due south to the west coast and central states of Mexico. Spring returning occurs in late February in Nevada and early March in Utah. Further north in Yellowstone and Canada, birds arrive in April and May. Autumnal departure seems to be drawn out from October through December. In Utah, three factors seem to play a role when birds depart, the opening of the fall waterfowl hunting season, availability of fisheries, and ice up. In Utah, the only known breeding colonies are located in the northern portions of the state, specifically within the Utah Lake/Great Salt Lake ecological complex. Gunnison Island persists as the only colony nesting site for American White Pelican in Utah and currently ranks as one of the largest breeding colonies in North America (Parrish et al. 2002). During spring migration, breeding season and fall staging and migration periods, American White Pelican can be observed at many reservoirs throughout the state.

Ecology (Evans and Knopf 1993): American White Pelicans are highly social. Nesting in colonies, using cooperative flight and foraging strategies, pelicans are among the most gregarious of avian species. These birds are often observed sleeping, roosting and sun bathing together (Parrish et al. 2002). They are monogamous. Pair formation occurs after arrival in Utah, the last week in Marsh. Nest building occurs in less than 5 days. For the colony as a whole, nest initiation extends over three months in Utah. A two egg clutch is produced within a week of nest completion with an incubation period of 30 days. Nestling attendance by a parent occurs to three weeks of age, after which young congregate into pods of young or creches that often are mobile. Breeding begins at three years of age. Fledgling rates vary with type of cover near nest, range is from 0.89 to 0.34 young fledged per nest. Fledgling success decreases as nesting dates become later (one chick per nest in early April to about 0.4 per nest for eggs laid in June, Utah). There is significant mortality of second eggs or second young. In Utah, both young fledged at 9.7 percent and 9.4 percent of 195 and 374 nests (Knopf 1979 *in* Parrish et al. 2002). Forty-one percent mortality from fledgling through first year, 16 percent in second year. Maximum reported life span is 26.4 years.

Primary food is fish. American White Pelican are diurnal and nocturnal foragers. Capture rates are higher during the day and at the leading edge of foraging flocks, than at night. White Pelicans obtain their food by dipping their bills into the water and scooping up prey. They do not dive, unlike Brown Pelicans. American White Pelican are widely noted for their habit of cooperative foraging. Coordinated swimming groups encircle fish or drive them into the

shallows where they can be more easily caught with synchronized bill dipping. Traditional foraging areas for Gunnison Island adults have occurred to the east of the colony on Bear River Bay, including the Refuge and east and southeast at state waterfowl management areas.

Habitat Requirements: Preferred nesting habitats are islands, especially associated with fresh water lakes. Colonial nest sites are usually islands with flat or low gradient slopes so adults can access nest by flying in. Gravel or sandy, unconsolidated substrate are preferred for nesting. Foraging sites are shallow marshes, rivers, and lake edges, where mainly small fish of little commercial value are taken. Breeding colonies are often over 30 miles from foraging areas. Fish are often sought in water less than 8 feet deep. Pelicans forage mainly on “rough” fish often small, less than one-half their bill length.

Seasonal Use/Refuge Habitats: The Refuge is likely the most important or key foraging location for the Great Salt Lake breeding population (Frank Howe, Utah Division of Wildlife Resources, pers. comm.). These birds are present from March through November and use deep emergent and submergent marshes for feeding and loafing (Tables 5 and 6). Main use is in Unit 2, canals, and that part of Willard Spur within the Refuge boundary (parts of Units 6,7 and 8). Islands are also used for loafing. Use of the Refuge by breeding birds peaks the last week of June. The pelicans readily fly over the Promontory Mountain range from their breeding colony on Gunnison Island to the freshwater marshes of the Refuge where there is an abundant supply of carp and gizzard shad, *Dorosoma cepedianam*.

Habitat and/or Population Objectives: Though the species continental population has recently stabilized, it remains potentially vulnerable to habitat degradation and disturbance at colony sites. American White Pelican is considered a Priority Species in the Utah Partners in Flight Plan (Parrish et al. 2002) and a species of High Concern in the Intermountain West Waterbird Plan (Ivey et al. 2003 *in press*).

Utah objective is to *Maintain breeding and foraging habitat within the Great Salt Lake ecosystem so as to provide conditions that allow American White Pelican breeding adult populations to occur at the twenty-five year average of 10,120 per annum.*

Population Objective: Maintain summer foraging habitat to support at least 20percent of American White Pelican breeding population, based on the annual estimates (Division of Wildlife Resources) (recognizing some birds utilizing the Refuge are nonbreeders).

Habitat Objective: Maintain 2,800 acres of deep emergent marsh, 2,500 acres of deep submergent marsh, and 6,600 acres of mid-depth emergent marsh to provide water depths suitable for foraging American White Pelican and where fishery populations are abundant (April-October).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands.

Refuge Specific Monitoring Needs:

1. Determine number of American White Pelican utilizing Refuge during breeding and migration seasons.

2. Determine relative abundance and age classes (sizes) of carp and shad in Refuge units.

3. Participate in Utah Division of Wildlife Resources's distribution surveys of American White Pelican in western and southern Utah which emphasizes spring, fall and non-breeding migrants.

REDHEAD (*Aythya americana)*

Associated Species: Other bird species that may respond similarly to habitat components used by the Redhead are: Canvasback, Lesser Scaup, Ring-necked Duck, Common Goldeneye, White-faced Ibis, Black-crowned Night Heron, Great Blue Heron, Snowy Egret, Forster's Tern, Franklin's Gull, Western Grebe, Clark's Grebe, American Bittern, Red-winged and Yellow-headed Blackbird.

Distribution: The Redhead has limited breeding range in western North America. It is an abundant breeding species in the Great Basin, and the largest nesting concentration in North America is reported in the marshes around Great Salt Lake (Ryser 1985). A five-year survey of The Great Salt Lake yielded a mean population of 7,202 for the period of July-September (Paul and Manning 2002). The Refuge's contribution to that population was a mean of 644.

Ecology (Woodin and Michot 2002): Unlike diving ducks in general, Redheads inhabit marshes, sloughs, and other shallow-water feeding grounds. It commonly feeds in shallow water like a dabbling duck by upending or by submerging its head and neck. The vegetative parts and seeds of pondweeds are a major food staple. This species takes much less animal food than other diving ducks. Redheads are gregarious. There is little or no evidence that they defend either territory or parts of a home range.

During the nesting season, hen Redheads are brood parasites, often laying their eggs in the nests of other ducks. Redheads not only parasitize other Redheads, but they lay their eggs in the nests of other species of ducks including the Northern Pintail, Mallard, Canvasback, Cinnamon Teal and Gadwall. When they do raise young by themselves, they are poor parents. They are quick to desert the nest and eggs when threatened by flooding, repeated parasitic intrusions, or other disturbances. They desert their broods quite early in life, usually before the young are old enough to fly. The average clutch size of 12.5 eggs was calculated from historic Refuge surveys.

Habitat Requirements: Inhabits shallow-water wetlands. Feeds in shallow water mainly on vegetative parts and seeds of pondweeds. Construct nests over 1-3 inches of water in hardstem bulrush that is 6.5-10 feet in height. Redheads prefer interspersion of open water and emergent vegetation (35:65 ratio) in nesting marshes in Utah (Michot 1976). Preferred nesting locations are 30 feet of open water.

Seasonal Use/Refuge Habitats: Redheads use mid-depth and deep emergent marsh for nesting from May through July on the Refuge (Table 5). They may be present on the Refuge from early May through late October (Table 6). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, late and peak dates).

Habitat and/or Population Objectives: North American population estimated at 691,400.

Population Objective: Support 450 breeding pair of Redheads on the Refuge.

Habitat Objective: Provide 6,600 acres of mid-depth emergent marsh and 2,800 acres of deep emergent marsh throughout the nesting season (May-July) on the Refuge.

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands.

Refuge Specific Monitoring Needs:

1. Develop effective protocols to accurately determine nesting density, distribution, relative abundance and nesting success on the Refuge.

2. Conduct brood surveys to estimate Redhead production.

WILSON'S PHALAROPE (Phalaropus tricolor)

Associated Species: Other species that may respond similarly to habitat components used by the Wilson's Phalarope are: Western Meadowlark, Cinnamon Teal, Short-eared Owl, White-faced Ibis, and Marbled Godwit.

Distribution: Unlike other phalarope species, Wilson's Phalarope breeds exclusively within the Nearctic, and its non-breeding distribution is entirely continental. This species winters in Bolivia and Argentina. Breeding range includes wetlands of the western provinces and states. This phalarope is a common, often abundant breeding species in the Great Basin (Ryser 1985).

A five-year mean of Wilson's Phalarope on Great Salt Lake was 16,629 (June-August). The Refuge's contribution to this total was a mean of 5,590. The Great Salt Lake is considered a critical staging area for Wilson's Phalarope with estimates in excess of 500,000 (Jehl 1988).

Ecology (Colwell and Jehl 1994): Wilson's Phalarope are known for their reversed sex-role mating system. Larger and more brightly-plumaged females compete for mates and are sometimes polyandrous, whereas males provide all parental care. Following courtship displays, female lays first of normally 4 eggs in bare scrape; male lines scrape with vegetation during subsequent 3-4 days. Males appear to pull and shape vegetation canopy over nest. Males incubate eggs for about 23 days before hatching. Young leave nest within 24 hours of hatching and are capable of feeding themselves. Peak of clutch initiation in Saskatchewan was late May to early June.

After the breeding season, virtually all adults undertake a molt migration and stage, often in huge flocks, at hyper saline/alkaline lakes of western North America, before migrating to similar wintering habitats mainly in Bolivia and Argentina. Southward migration of adults characterized by rapid and direct nonstop flight from staging areas in U.S. to coastal western South America. Sex differences in habitat use vary seasonally. During incubation and brood rearing periods, males use a wider array of aquatic and terrestrial habitats; females more aquatic. Throughout staging period, females typically forage aquatically, spearing brine shrimp and brine flies from water's surface. In contrast, males and juveniles are more terrestrial, early foraging on brine flies on or nearer lakeshore, later becoming highly aquatic and (males) taking more shrimp (Colwell and Jehl 1994).

This phalarope whirls in tight circles in shallow or deep water, picking invertebrates from the water's surface or just below it. On land, Wilson's Phalarope makes short jabs to pick up food in open areas. An overview of the diet includes Dipetera, Heteropetera, Coleoptera, and Crustacea. At Great Salt Lake, diet shows sex and age differences with adult females feeding on brine shrimp (21 percent by volume), brine flies (70 percent), and other aquatic invertebrates (10 percent); adult males fed on brine flies (75 percent) and aquatic invertebrates (25 percent); juveniles fed only on brine flies.

Habitat Requirements: The Wilson's Phalarope breeds at shallow wetlands of interior western North America, but for most of the year is a salt-lake specialist. Species nests in sparse to dense vegetation of uplands (e.g., *Poa* spp.) and marshes (e.g., *Juncus balticus, Triglochin maritima*), and roadside ditches (*Hordeum jubatum*). Nests located within 300 feet of wetlands in taller, denser, and more heterogenous vegetation (e.g., *Juncus balticus, Distichlis spicata, Triglochin maritima)*, compared with random sites and surrounding vegetation. Forages in open-water and flooded meadows, less frequently in upland habitats and along beaches. Wilson's Phalaropes often occupied the peripheral low-prairie and wet-meadow areas of most classes of wetlands in North Dakota. Wilson's Phalarope were associated negatively with wetlands dominated by thick-stemmed plants (e.g., cattail and river bulrush).

Seasonal Use/Refuge Habitats: The Refuge is important for breeding and staging Wilson's Phalarope. During the breeding season they utilize salt and wet meadow habitat. They exploit shallow submergent, shallow emergent and mid-depth emergent wetland for foraging and staging (Table 5). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, late and peak dates).

Habitat and/or Population Objectives: Estimated North American population of 1.5 million birds in fall, based on counts from major staging areas. Considered a Bird of Conservation Concern by the Mountain-Prairie Region (6) of the Service and Bird Conservation Region 9, Great Basin (Pashley et al. 2000).

Population Objectives: 1) Maintain breeding population at a five-year average of 400 breeding pair;
2)Maintain staging Wilson's Phalarope at population level of 10,000 (July).

Habitat Objectives: Maintain 2,600 acres of salt meadow and 870 acres of wet meadow for breeding habitat (May-June);
2) Maintain 8,700 acres of shallow submergent, 6,600 acres of mid-depth emergent, and 8,600 acres of shallow emergent wetland for foraging and staging habitat (July-September).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Salt Meadow, Wet Meadow and Wetlands.

Refuge Specific Monitoring Needs:
1. Determine breeding population of Wilson's Phalarope on the Refuge.
2. Estimate annual staging population (spring and fall) on the Refuge.
3. Determine relative abundance and diversity of aquatic invertebrates in high use units on the Refuge.

Landscape Scale Research Needs (Haig and Oring 1998):

Determine turnover rates or length-of-stay for Wilson's Phalarope staging in locations within the Great Basin.

LONG-BILLED DOWITCHER (Limnodromus scolopaceus)

Associated Species: Other species that may respond similarly to habitat components used by the Long-billed Dowitcher are: Marbled Godwit, American Avocet, Green-winged Teal, Blue-winged Teal, Cinnamon Teal, Western Sandpiper, Baird's Sandpiper, Common Snipe and Yellowlegs spp.

Distribution: The Long-billed Dowitcher breeds in the tundra regions from northeastern Russia to northwestern Canada and migrates mainly west of the Mississippi River, spending the winter primarily along Pacific and Gulf Coasts of Mexico. The Long-billed Dowitcher is considered a common and abundant migrant in the Great Basin (Ryser 1985). A mean of 14,370 (August-September) was calculated from a five-year waterbird survey of the Great Salt Lake (Paul and Manning 2002). The Refuge mean for the same survey was 1,088.

Ecology (Takekawa and Warnock 2000): This dowitcher is considered a medium-distance migrant. There are no known resident populations. Generally migrates shorter distances than Short-billed Dowitcher, *Limnodromus griseus*, and most other Nearctic breeding shorebirds. Almost nothing is known about where specific breeding populations winter. Long-billed Dowitcher migrates later in fall than Short-billed Dowitcher and earlier in spring (most regions), probably because it nests farther north. The spring passage is more compressed than fall passage. In the eastern Great Basin, around Great Salt Lake, earliest arrivals are in late March. In northern Utah, arrival dates range from 8 July to 6 October.

Main foods taken at interior sites: insects such as midge fly and larvae, aquatic or moist soil worms, and small burrowing crustacea. Stomach content analysis throughout the west found 86 percent animal matter and 14 percent plant matter. Generally feeds in substrates with soft mud bottom. Feeding behaviors described as jabbing and probing. Probing behavior is a distinctive "sewing machine" motion. The tip of the Long-billed Dowitcher bill possesses tactile receptors that help locate prey by touch. The head of Long-billed Dowitcher often seen below surface of water. Life span and survivorship generally unknown for this species.

Habitat Requirements: In Great Basin, Long-billed Dowitchers are commonly found foraging in shallow, saline lakes and flooded playas, as well as complex wetlands (Oring and Reed 1996). At lakes and reservoirs in Idaho, this species was common on large mudflats (greater than 1600 feet), uncommon on moderate mudflats (66-656 feet), and muddy shores (less than 16 feet width). Long-billed Dowitcher used moist shoreline and water up to 1.6 inches in depth (12 percent) and water from 1.6 to 6.2 inches deep (88 percent) in Texas. Water depth is important in determining where species feed: managed wetlands of South Carolina, 1.6-2 inches deep; playa lakes of Texas, 0-6.2 inches; flooded rice fields in California, 1.6 to 4.7 inches.

Seasonal Use/Refuge Habitats: The Refuge is an important migratory stopover for the Long-billed Dowitcher for both the spring and fall. They are found on the Refuge March-November (Table 6). More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: The continental population of Long-billed Dowitchers is estimated at 500,000 (Brown et al. 2000).

Population Objectives: 1) Maintain spring migrant populations at ten-year average of 500 birds; 2) Maintain fall migrant population levels of 5,500 birds (August-October).

Habitat Objectives: 1) Maintain 31,200 acres of vegetated and 6,800 acres of unvegetated mudflat habitat for foraging Long-billed Dowitcher in spring and fall (May; August-October); 2) Maintain 8,600 acres of shallow emergent marsh for foraging migrants (August-October).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Saltair Mudflat and Wetlands.

Refuge Specific Monitoring Needs:

1. Determine number of migrating Long-billed Dowitchers utilizing Refuge (May; August-October).

2. Determine relative density and diversity of aquatic invertebrates in high use wetland units.

3. Determine turnover rates or length-of-stay of migrant Long-billed Dowitchers at Refuge.

Landscape Scale Research Needs (Takekawa and Warnock 2000):

1. Identify life span and survivorship rates of Long-billed Dowitchers.

2. Determine site fidelity characteristics of Long-billed Dowitchers.

FRANKLIN’S GULL (Larus pipixcan)

Associated Species: Other species that may respond similarly to habitat components used by the Franklin’s Gull are: Snowy Egret, Forster’s Tern, White-faced Ibis, Redhead, Black-crowned Night Heron, Great Blue Heron, Western Grebe, Clark’s Grebe, Eared Grebe, American Bittern, Long-billed Curlew, Red-winged and Yellow-headed Blackbird.

Distribution: This species’ breeding range is eastern Alberta, central Saskatchewan, southwest Manitoba, eastern North Dakota and western Minnesota south locally to east-central Oregon, southern Idaho, northwest Utah, northwest Wyoming, and northeast South Dakota. Franklin’s Gull winters primarily along the Pacific Coast of South America from central Peru to northern Chile with small numbers wintering regularly or occasionally in southern California, and south central U.S. Only North American gull that migrates south of the equator.

The breeding colonies found in the Great Basin are thought to reflect the westward expansion of this gull’s breeding range as ornithologists and collectors visiting the Basin in the 1800's and early 1900's did not encounter this species (Ryser 1985).

A five-year survey of the Great Salt Lake (1997-2001) yielded a July-September mean of 46,550 Franklin’s Gulls (Paul and Manning 2002). The Refuge’s contribution to this survey was a mean of 2,806.

Ecology (Burger and Gochfeld 1994): Males set up territories and select display a site where they can stand on floating vegetation at the center of the territory. From here they begin platform nest construction, anchoring it to old, emergent vegetation. By mid-May, the nearest nesting neighbor may only average 6-9 feet away. Modal clutch size is three eggs; incubation period 23-26 days. During incubation and chick phase, at least one parent is on the territory at all times. Chicks move around on the nest platform but don’t leave until 20 days of age. Eggs and chicks are vulnerable to rapid increases in water level following rains and to hailstorms.

Predators on chicks and adults may include Black-crowned Night Heron, *Nycticorax nycticorx*, Coot, *Fulica americana*, mink, *Mustela vison*, Northern Harrier, *Circus cyaneus*, and Peregrine Falcon, *Falco peregrinus*. Franklin’s Gulls deserts breeding colonies mid to late July and wanders widely in all directions over large prairie region. In September and early October, flocks begin coalescing into larger flocks, and a directed, southward migration begins.

Eats earthworms, grubs, insects (particularly midges [Chironomidae] and grasshoppers), seeds and other vegetable matter (breeding grounds); mice, fish, fish offal, crabs, snails, and other invertebrates (wintering grounds). During breeding season, feeds aerially on swarming insects; also forages on ground for earthworms and insects and on water for aquatic insects (Burger and Gochfeld 1994). Not reported to prey on ducklings or any birds. Franklin’s Gulls are sensitive to human disturbance early in breeding cycle and will entirely desert a colony site with excessive exposure to humans. They’re particularly vulnerable in prenest period and again in chick phase.

Habitat Requirements: Franklin's Gulls always nest over water, on floating mats built on water's surface, on muskrat houses, or on floating debris in inland freshwater marshes or lakes. Preferred vegetation for colonies is bulrushes, cattails, phragmites, or other emergent vegetation. Most reported nest depths are 12-24 inches Prefers to nest in areas of low vegetation density or at edges of dense clumps. Optimal habitat is intermediate density vegetation with patches of open water of varying sizes. Nest dispersion is related to visibility from nest. Water depth under nest reported as 16-71 inches.

Seasonal Use/Refuge Habitats: More details will be added to this section in subsequent updates as time permits. Updates may include which Refuge units the species has historically and currently used and timing of use (arrival, departure, and peak dates).

Habitat and/or Population Objectives: North American population probably about 500,000. Considered a High Concern species in the Bird Conservation Region 9 as part of the Intermountain West Waterbird Plan (Ivey et al. 2003 *in press*). Current population estimate in Utah thought to be around 30,600 individuals. Utah population objective is to *maintain, restore and enhance traditional breeding sites to support 15,000 pair.*

Population Objective: Maintain breeding population level of ten-year average of 4,000 pair.

Habitat Objective: Maintain 3,600 acres of mid-depth and/or 2,800 acres of deep emergent marsh with stable water levels for suitable colony sites throughout the breeding period (May-July).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands.

Refuge Specific Monitoring Needs:

1. Investigate and implement survey protocols to estimate size of breeding colonies on the Refuge without causing desertion.

2. Coordinate surveys to determine breeding population sizes of colonially nesting species on Refuge with Utah Division of Wildlife Resources personnel.

Landscape Scale Research Needs (Burger and Gochfeld 1994):

1. Investigate age-specific and lifetime breeding success of Franklin's Gulls.

2. Determine mate fidelity, age distribution of breeding adults, and life span.

BLACK TERN (Chlidonias niger)

Associated Species: Other species that may respond similarly to habitat components used by the Black Tern are: American Bittern, Red-winged Blackbird, Yellow-headed Blackbird, Pied-billed Grebe, Black-crowned Night Heron, Great Blue Heron, Snowy Egret, Forster's Tern, Franklin's Gull, Western Grebe, Clark's Grebe, and White-faced Ibis.

Distribution: The Black Tern is a localized breeder from northern United States through central Canada and overwinters south of the United States. Black Terns are found concentrated in zones of highly productive wetlands. The core of breeding abundance is in Alberta, Saskatchewan, Manitoba, the Dakotas and Minnesota (Dunn and Agro 1995). The Black Tern migrates through the United States, then shifts to primarily marine habitats in winter. There it favors productive marine waters, especially off the Pacific Coast of Panama, and often concentrates where predatory fish have driven small prey to the surface. The Black Tern is considered an uncommon to common nesting species at Great Basin marshes (Ryser 1985). This species is considered uncommon throughout the summer on the Refuge, though its breeding status is unknown.

A five year study of the Great Salt Lake classified the Black Tern as "fairly common" with a July-August mean of 426 birds (Paul and Manning 2002). The five-year mean for the Refuge during the same survey was 123.

Ecology (Dunn and Agro 1995): The Black Tern nests semicolonially amidst emergent vegetation in biologically rich wetlands. Nests are flimsy, often floating, and are easily destroyed by wind or fluctuating water levels. Reproductive success is highly variable. Adaptations to marsh nesting include frequent renesting, low site tenacity, and eggshell morphology suited to damp conditions.

Nest is usually built on floating substrate of matted dead marsh vegetation, detached root masses of predominant vegetation, boards, or muskrat-built feeding platforms of fresh-cut vegetation. Normally three eggs are laid in a nest of material resembling a small pile with a shallow cup. Eggs hatch after about 21 days with fledglings leaving the nest after about a week. Family groups move to areas of open water where feeding territories are defended by parents and young.

Black Terns do not breed before their second summer when some (but not all) first attain black plumage. In Wisconsin, birds with white underparts made up about 1-3 percent of birds on the breeding range. Some birds may delay breeding beyond age 2 and/or skip breeding occasionally.

This highly social species often forages in flocks. On the breeding grounds, feeds primarily on insects and freshwater fish. Circles low (3-6 feet) over foraging areas with slow, shallow wingbeats and bill pointed down. May hover briefly before sudden drop or swoop to surface, then dips bill into water or picks insects off vegetation. May catch insects in air. Main summer insect foods are damselflies (Odanata) and dragonflies, but also mayflies (Ephemeroptera), caddisflies (Trichoptera), and beetles (Coleoptera). Eats small fish in summer where available. Fish include cyprinid minnows.

Habitat Requirements: Breeding Black Tern prefer marshes or marsh complexes larger than 50 acres; smallest reported is 13 acres. Nest-site characteristics reduce effects of wind and waves which are major causes of nest loss. Main clusters of nests are in an area of still water, usually with 25-75 percent of surface covered with emergent vegetation. Predominant emergent vegetation is usually cattails, bulrush, or less often burreed. Also found in sedge, reed canary grass, horsetail, and rushes. Water depth at nests typically is 1.5- 4 feet. Nests are usually adjacent to or within 1.5-6.5 feet of small to large expanses of open water. Emergent vegetation is less than 0.8-0.1.6 feet high when nest site is chosen. Snags and posts are used for copulation, resting, and feeding fledglings; and their availability may figure into choice of nest site.

Seasonal Use/Refuge Habitats: Black terns are present during migration and use wet mudflats, and shallow and deep submergent habitats for feeding (Table 5). Although breeding is rare, they use shallow and mid-depth emergent marshes for nesting during June and July. They may be found on the Refuge from mid-April through mid-September (Table 6).

Habitat and/or Population Objectives: An estimated 5,000 or less individuals breed in the Great Basin Bird Conservation Region (9) (Ivey et al. 2003 *in prep.*). A draft population objective for Bird Conservation Region 9 is to provide enough habitat to support at least 2,750 pairs among six states (California, Idaho, Nevada, Oregon, Utah and Washington). Utah proposes to support 60 breeding pair as a partner in accomplishing that objective.

Population Objective: Provide habitat to support/encourage Black Tern nesting at 20 pair.

Habitat Objective: 1) Attempt to provide stable water levels during nesting season (June and July) in 2,000 acres of shallow and 6,600 acres of mid-depth emergent marsh;
2) Provide 2,000 acres of shallow and 6,600 acres of mid-depth emergent marsh for foraging birds during spring and fall migration (April and August).

Habitat Management Strategy: See Section V. Habitat Management Strategies: Wetlands.

Refuge Specific Monitoring Needs:

1. Estimate annual breeding population of Black Terns on the Refuge.

2. Estimate number of non-breeding Black Terns using Refuge during breeding period based on plumage patterns.

Landscape Scale Research Needs (Dunn and Agro 1995):

1. Determine effects of wetland management activities on Black Terns.

2. Determine first-year and adult annual survival.

C. Reconcile conflicting habitat needs for Bear River Refuge resources of concern.

In a normal water year, Bear River Refuge has the capacity to meet the habitat needs for the priority species and groups. A complex of different wetland habitat types are provided through the manipulation of water levels in the impounded units and by directing flow-through waters into unimpounded units (units 6-10). The manipulation of water levels influence aquatic invertebrate and plant species diversity, abundance, production and colonization. Upland nesting habitat is manipulated through grazing (non-breeding season) to attain climax plant communities based on the soil type. Climax communities will provide nesting species optimal amounts of concealment cover and foraging opportunity.

During low water years, however, the Refuge is likely to focus on the needs of spring and fall migrants as the availability and timing of river flows are a limiting factor. In summer months with low river inflow, the Refuge is unable to keep water levels stable to offset losses due to evaporation. As a consequence, most units are allowed to dry out, with the remaining water and small amount of inflow being diverted to the highest priority units. The shallow emergent and shallow submergent wetland habitats are the two highest priority wetland types, as they receive the greatest use by priority species (Table 5).

The management units are prioritized each year in the Annual Habitat Management Plan. Prioritization is based on current and historic use by priority breeding birds, breeding bird density, priority breeding bird diversity as well as aquatic plant community succession, productivity, structure, and density.

Though unit priorities are largely influenced by predicted river flows each spring, we occasionally diverge from established priority goals to adapt to events such as disease outbreaks, unexpected vegetative response, or to undertake maintenance activities. If necessary, temporary losses of habitat in a particular unit can be offset by adjusting objectives for other units.

IV. Habitat Goals and Objectives

HABITAT GOAL

The goal for the habitat program at Bear River Migratory Bird Refuge will be to provide a spatial and temporal distribution of habitats to meet breeding, feeding and resting needs for species using the refuge with an emphasis on the priority species (USFWS 1997). To achieve that goal, the habitat should consist of a complex of wetland types with varying water depths, diverse plant communities and an abundance of aquatic invertebrates for foraging, resting and staging birds.

The following table lists the Refuge habitat types and area goals based on optimal inflows from the Bear River, management unit acreage, bottom elevations and contours, soil type, and desired plant response.

Table 7. Habitat goals and acres, Bear River Migratory Bird Refuge.

Bear River Refuge Habitats	Acreage Goal
WETLAND	**29,259**
Deep Submergent Marsh	2,500
Shallow Submergent Marsh	8,700
Deep Emergent Marsh	2,800
Mid-Depth Emergent Marsh	6,600
Shallow Emergent Marsh	8,659
SALTAIR MUDFLAT	**38,064**
Vegetated Mudflat (0-2 inches)	31,213
Unvegetated Mudflat (dry)	6,852
SEMI DESERT ALKALI KNOLL	**511**
ALKALI BOTTOM	**973**
SALT MEADOW	**2,625**
WET MEADOW	**876**
SEMIWET STREAMBANK	**45**
DIKES	**791**
TOTAL	**73,144**

HABITAT OBJECTIVES

WETLANDS

Vision: **Manage wetland habitat at Bear River Refuge to provide a diversity of wetland types, a diverse and abundant population of aquatic macro invertebrates, and a range of aquatic plant communities from early to late successional stages.**

The key to highly productive wetlands at Bear River Refuge is the amount of sago pondweed and alkali bulrush. These two species are good indicators of a mid-succession aquatic plant community. Sago pondweed is the cornerstone aquatic species on the Refuge as its seeds, leaves, stems, tubers and roots are a highly favored food source for many species of avifauna. Invertebrate associations are influenced by the leaf shape, structure, and surface area of aquatic vegetation. As sago pondweed has a high surface area and its structure is diverse, pondweed supports a greater invertebrate assemblage than other macrophyte species.

A general wetland goal is to maximize acreage for this highly productive mid-successional stage while maintaining lesser amounts of early and late successional plant stages. One strategy employed is to manage for soil salinities that favor germination, tuber and vegetative growth and seed production by pondweed and alkali bulrush but inhibit the germination, growth and production of hardstem bulrush and cattail.

Goal: **Manage for 29,259 acres of wetland habitat on Bear River Refuge.**

Objectives: Based on the functional use of wetland habitat by priority species, the wetlands should be managed for 9 percent deep submergent, 28 percent shallow submergent, 14 percent deep emergent, 23 percent mid-depth emergent and 26 percent shallow emergent marsh, annually (Figure 7).

1. 2,500 acres of deep submergent marsh with 18 to 36 inches of water, 60-80 percent coverage by sago pondweed and less than 15 percent coverage by emergent vegetation (March-December).

2. 8,700 acres of shallow submergent marsh with 4 to18 inches of water, 60-80 percent coverage by sago pondweed and less than 15 percent coverage by emergent vegetation (February-December).

3. 2,800 acres of deep emergent marsh with 12 to 24 inches of water, 50-70 percent coverage by emergent vegetation (predominantly hardstem bulrush and alkali bulrush) interspersed with 40-50 percent open water with submerged sago pondweed (February-November).

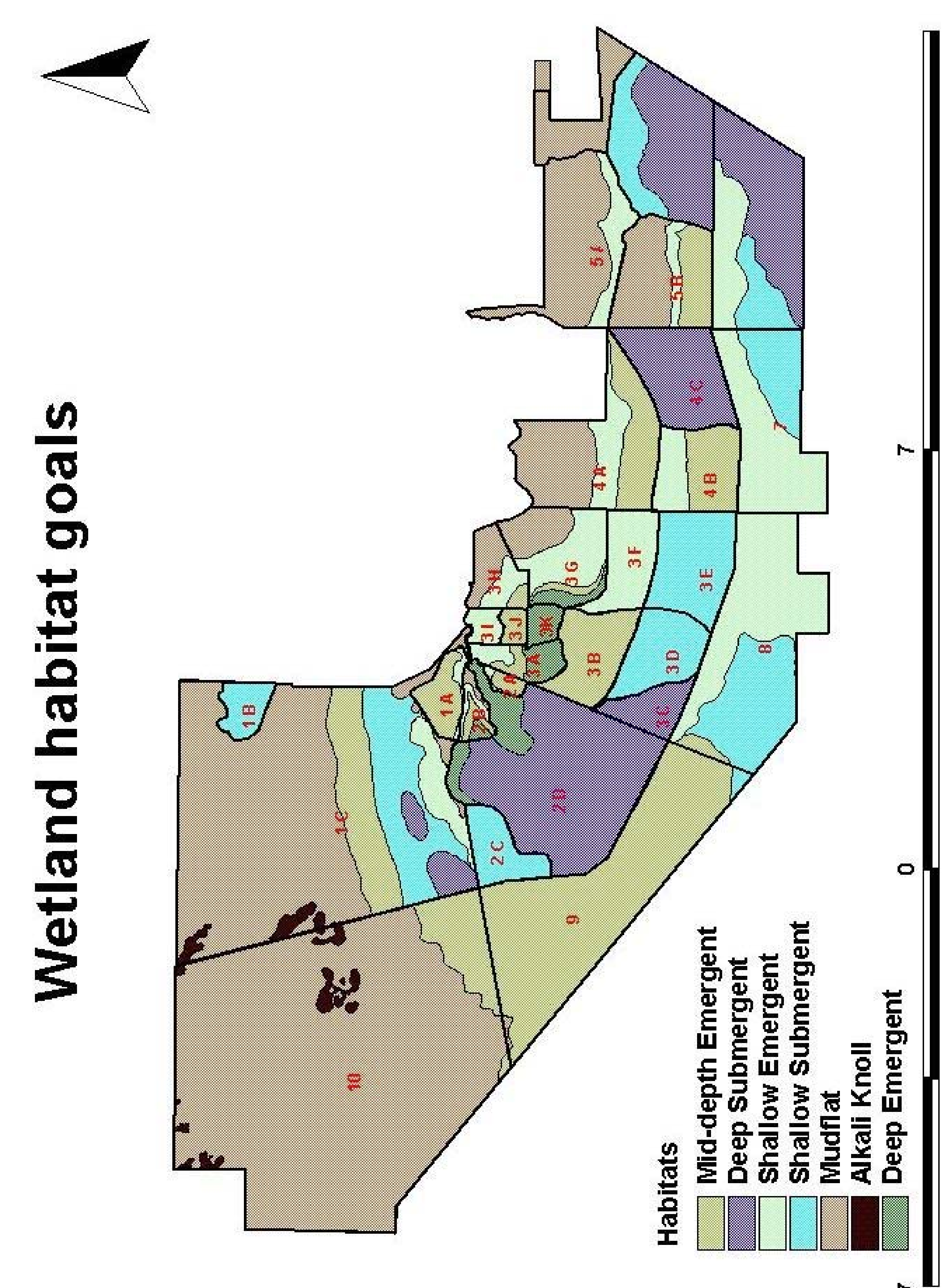

Figure 7. Wetland habitat goals, Bear River Refuge.

4. 6,600 acres of mid-depth emergent marsh with 8 to 12 inches of water with 50 percent emergent vegetation (alkali bulrush in shallower areas and hardstem bulrush in deeper zones, phragmites, and cattail) and 50 percent open water with sago pondweed (February-November).

5. 8,659 acres of shallow emergent marsh with 2 to 8 inches of water with 50-70 percent coverage by emergent vegetation (90 percent alkali bulrush, 10 percent phragmites and/or cattail) and the remainder open water (February-November).

SALTAIR MUDFLAT

***Goal:* Manage for 38,064 acres of Saltair Mudflat habitat.**

O*bjectives:* Based on functional use of mudflats by priority species, mudflats should be managed to achieve 66-76 percent vegetated mudflat and 24-34 percent unvegetated mudflat, annually.

1. 31,213 acres of vegetated mudflat with 0-2 inches of water in the playa basins, 80-95 percent bare soil, and 5-20 percent vegetated with mix of saltgrass and salicornia each year (February-November).

2. 6,852 acres of unvegetated or dry mudflat with no standing water and 95-100 percent bare soil each year (April-December).

SEMI DESERT ALKALI KNOLL

***Goal:* Manage for 511 acres of Semidesert Alkali Knoll with a climax plant community.**

Objective: Increase shrub cover (greasewood and shadscale) to 35-40 percent of area, grasses (bottlebrush squirreltail and alkali sacaton) to 15-30 percent, and forb (shrubby seepweed, scarlet globemallow and shaggy fleabane) to1-5 percent by 2015. Shrubs should average 4 feet in height with grasses and forbs an average of one foot tall.

ALKALI BOTTOM

***Goal:* Manage for 923 acres of Alkali Bottom upland with a climax plant community**.

Objectives:

1. Alkali Bottom plant community cover should be 60 percent salt and alkali tolerant grasses (saltgrass, alkali sacaton, alkali bluegrass, Great Basin wild rye), 5 percent forbs (silverscale, *Atriplex argentea*, fireweed, *Kochia scoparia*, hollyleaf clover, *Trifolium gymnocarpon*, and annual Indian paintbrush, *Castilleja minor)*, and 5 percent greasewood as dominant shrub species with remainder bare ground by 2015. Grasses should average 2 feet tall, forbs one foot and shrubs 2.5 feet tall.

2. Decrease cheatgrass cover to less than 10 percent by 2015.

Within this habitat type, there is an area dominated by big sagebrush on the White unit.

***Goal:* Manage this unique habitat for a sagebrush or sagebrush steppe plant community with a co-dominant sagebrush/bunchgrass community.**

Objectives:

1. Increase size of big sagebrush dominated plant community to five acres by 2015.

2. Increase occurrence and percent cover of sagebrush to 40-50 percent and native bunchgrasses to 30-40 percent cover, increase native forbs to 10 percent cover, and decrease non-native cheatgrass, *Bromus tectorum*, to less than 10 percent cover by 2015. Common grasses should include bluebunch wheatgrass, *Agropyron spicatum,* and bluegrasses, *Poa secunda, Poa nevadensis,* and *Poa cusickii*. Other bunchgrasses could include needle-and-thread, *Stipa comata*, Indian ricegrass, *Oryzopsis hymenoides*, and sand dropseed, *Sporobolus cryptandrus*. Forb species should be balsamroot, *Balsamorhiza sagittata and B. macropylla*, yarrow, *Achillea millifolium*, Indian paintbrush, milk vetch, *Astragalus* spp., gloebmallow, and penstemon, *Penstemon* spp.

SALT MEADOW

***Goal:* Manage for 2,625 acres of Salt Meadow with a climax plant community.**

Objective: Salt Meadow plant community should be 65-75 percent grasses and grasslikes averaging two feet in height, 10 percent forbs (average 2 feet tall) and 1-3 percent shrubs (average 2 feet tall) by 2015. Common grass species include alkali bluegrass, *Poa secunda*, and saltgrass. This habitat may include saturated low areas of arctic rush, *Juncus articus*, and sedges as well as pockets of emergent marsh. Common forbs may be lanceleaf goldenweed, fiddleleaf hawk's-beard, *Crepis runcinata*, and Nuttall's sunflower, *Helianthus nuttallii*. Shrubs species may include iodinebush whiteflower rabbitbrush, *Chrysothamnus albidus* and greasewood.

WET MEADOW

***Goal:* Manage for 876 acres of Wet Meadow habitat with a climax plant community.**

Objective: Wet Meadow plant community composition 80 percent grasses, 5 percent forbs, and 1 percent shrubs with the remainder as bare ground (14 percent) by 2015. The most common grasslike species would be Nebraska sedge, *Carex nebrascensis* and clustered field sedge, *Carex praegracilis* and average two feet in height. Forbs species may include alkali marsh aster, *Almutaster pauciflorus* and common silverweed, *Argentina anserina*.

SEMIWET STREAMBANK (Riparian)

***Goal:* Manage for 45 acres (12.5 linear miles) of streambank habitat with a lowland riparian climax community.**

Objectives:

1. Semiwet Streambank plant community composition 30 percent shrub, 15 percent trees, and forbs and grasses each constitute 5 percent by 2020. Common shrub species would be coyote willow, buffaloberry, and sagebrush and should average 5 feet in height. Common tree species would be box elder, *Acer negundo*, fremont cottonwood, *Populus fremontii*, and narrow-leaf cottonwood, *Populus angustifolia*, averaging 30 feet tall. Common grasses should be alkali bluegrass, clustered field sedge, *Carex praegracilis*, and arctic rush, *Juncus arcticus*, while common forbs should be common silverweed, field horsetail, *Equisetum arvense*, and alkali marsh aster.

2. Decrease tamarisk spp. to less than 5 percent of area by 2005.

DIKES

***Goal:* Manage the 791 acres of dikes (96 miles) for a plant community that provides a range of short and sparse to tall and dense cover for nesting birds.**

Objectives:

1. Dike plant community composition 80 percent grass (2 feet), 15 percent forb (2-4 feet), and 5 percent bare ground, annually. Common forbs should be sunflower, *Helianthus spp.*, kochia, cocklebur, *Xanthium strumarium*, and curly dock. Grass species should include foxtail, saltgrass, wheatgrass, and phragmites.

2. Decrease tamarisk spp. to less than 5 percent of area by 2005.

POPULATION OBJECTIVES

To achieve the population objectives noted in the priority species accounts, predator management activities are essential. Predation is a major limiting factor to breeding bird production on Bear River Migratory Bird Refuge. The strategy is to reduce nest depredation using lethal and non-lethal methods.

***Goal:* Increase nesting success of Refuge priority breeding bird species.**

***Objectives:* Noted in the priority species accounts.**

V. Habitat Management Strategies

A. Potential Management Strategies

The following management strategies will be employed to fulfill the habitat objectives stated in Section *IV. Habitat Goals and Objectives* and the population objectives stated in the priority species accounts. Management strategies are described by habitat type.

WETLAND

Potential wetland management strategies on the Refuge include managing salinity levels, and water clarity, reducing silt loads, controlling aquatic vegetation community composition, and managing invertebrate abundance and diversity while maintaining and protecting impoundment structures and levees.

Strategy 1. Manage salinity levels. Salinity levels in soils and water affect aquatic plant species diversity, germination, growth, and production. Managing and monitoring soil salinities is a more effective marsh management technique than is management based on water salinities (John Kadlec pers. comm.).

Three primary water management strategies are employed at Bear River Refuge to manage soil salinity levels; flushing units with constant flows of freshwater, filling a unit to target levels and only adding enough water to replace amounts lost to evapotranspiration, and periodic drawdowns.

Strategy 1a. Flushing requires continually adding freshwater to a unit and equalizing inflow and out-flow volumes. Another method is to completely replace water that has been in a unit for several months with freshwater. Flushing freshwater through a unit continually washes the salts from the top few centimeters of surface soil, thereby "freshening" this portion of soil strata that is the most influential to plant growth. This freshening of surface soils is cumulative and would take several years to significantly influence the soil salinity ranges.

Strategy 1b. Maintain existing water levels. Adding only enough water to a unit to offset evapotranspiration losses can help maintain soil salinity levels once desired levels have been achieved. Salt concentrations in the soils change very slowly, even as the salts dissolve into the water column due to diffusion (John Kadlec pers. comm.).

Strategy 1c. Drawdown. Soluble salts present in the soils wick, or rise to the surface and crystalize, sometimes forming a crust in areas lacking water. Periodic drawdowns of impounded units allows drying of soils, thereby concentrating salts on the surface and/or within the top few centimeters, prohibiting germination and growth for all but the most tolerant of aquatic and semi-aquatic plant species (*Salicornia* spp.). With alternate flooding and drying, large amounts of salt can be moved to the surface of the sediment during dry periods. This dissolves rapidly on re-flooding, and may give a sharp

rise in surface water salinity if water movement is slow or absent (Kadlec 1982). Conversely, re-flooding of dry areas can help to decrease salt concentrations at the soil surface as salts are dissolved in water or washed away by employing the flushing strategy.

Strategy 2. Manage water clarity. Water clarity is another factor affecting aquatic plant germination, growth and vigor. Turbid waters inhibit sunlight penetration, thus negatively affecting photosynthesis. The major factors that influence water clarity are silt loads from the Bear River (addressed below), wind and wave action, and common carp presence and activity with the wetlands.

Strategy 2a. Restrict carp. Carp uproot vegetation while foraging for food, causing solids to be suspended in the water column, reducing water clarity, and decreasing favorable growing conditions for desirable aquatic plant species.

The strategy to increase water clarity is to keep carp out of most wetland units by installing carp screens over the inlet and outlet structures. The mesh size of the screens allows for the passage of small fish, but restricts movement of larger fish. Another strategy to decrease carp abundance in management units is to conduct winter drawdowns resulting in direct loss of carp and increasing mortality risk due to winter kill of those few that do find deep water pockets.

Strategy 2b. Reduce silt loading. Silt loads are highest in waters of the Bear River during the spring runoff. The silt loads not only affect water clarity, inhibiting the growth of pondweed and invertebrates associated with this plant, but have the potential to change the bottom elevations of wetland management units. The deposition of silt reduces management effectiveness by altering the contours of the pool bottoms, creating high spots that channel water rather than spreading it out.

The silt is not only high in nutrients, but can bury highly saline soils, thereby "freshening" soils and providing optimum germination and growth conditions of non-desirable emergent plant species such as cattail and phragmites. Excess silt levels can smother aquatic plant seeds and larvae of aquatic invertebrates.

The strategy to decrease silt loading on the Refuge is to bypass silt laden spring flows through the Refuge canals (L, H, O, Reeder and Whistler (P)) and to fill the units with the clearer waters of late winter before Bear River becomes laden with silt from high spring runoff.

Strategy 3. Control aquatic vegetation community composition. At Bear River Refuge, some of the main factors influencing aquatic plant species diversity, density and productivity are soil and water salinity levels, water depth, water clarity, and the presence or absence of carp. This strategy details how water depth and salinity levels influence the aquatic plant community.

Strategy 3a. Manage water depths. Water level manipulations are one of the most effective tools in wetland management, provided fluctuations are well-timed and controlled. Manipulations are most effective on sites with: (1) a dependable water supply, (2) an elevation gradient that permits water coverage at desired depths over a majority of the site, and (3) the proper type of water control structures that enable water to be supplied, distributed, and discharged effectively at desired rates (Fredrickson 1991). The impoundments at Bear River Refuge meet all three of these criteria. In addition, each unit has an independent water supply and discharge to optimize food production, maintain the potential to control problem vegetation, exclude carp, and make food resources available to wildlife. Water levels are managed to provide optimum growing conditions for a variety of wetland plants while concurrently providing water depths within the foraging range of our priority species. Optimum growing conditions for desirable plant species are addressed below, while foraging depths for priority species are found in the species accounts.

Strategy 3b. Match salinity levels with tolerance ranges of desired macrophytes. Management strategies are designed to encourage colonization and productivity of sago pondweed, alkali bulrush, and hardstem bulrush while inhibiting the growth of cattail and *Phragmites*. Optimum germination condition for all of the emergent plant species is on freshwater mudflats. In general, as salinity levels increase, germination, growth and production by these aquatic macrophytes are inhibited, though each plant species exhibits some degree of tolerance to salinity (Figure 8). *Phragmites* and cattail are the least tolerant of saline conditions, followed by hardstem bulrush. Alkali bulrush and sago pondweed exhibit the greatest tolerance for high salinity levels. Therefore, salinity ranges that do not inhibit life stages of sago pondweed, alkali bulrush and hardstem bulrush, but do negatively affect cattail and *Phragmites*, are often targeted to achieve plant community objectives.

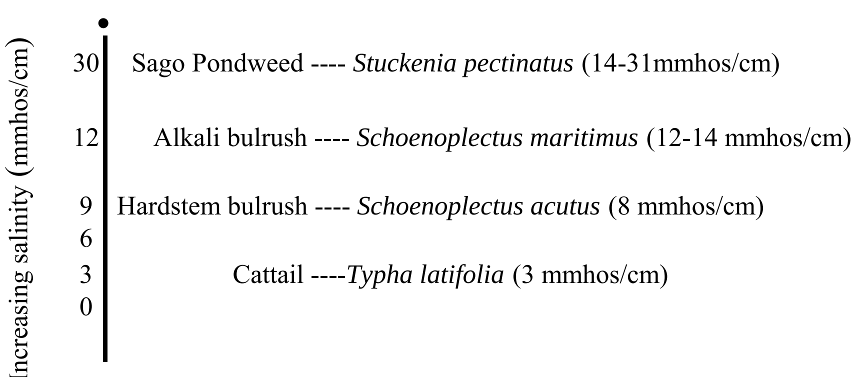

Figure 8. Sequence of aquatic plant species seedling tolerance on a gradient of increasing soil salinity.

To encourage pondweed (*Potamogeton pectinatus, P. nodosus)* colonization, germination, growth, tuber and seed production in wetlands, water levels will be managed for depths 4-36 inches and soil salinity levels of 5,000-9,000 ppm (8-14 mmhos/cm) (Teeter 1963). Maximum soil salinity tolerance range for productivity is 9,000-20,000 ppm (14-31 mmhos/cm) (Christiansen and Low 1970).

To encourage alkali bulrush stands in wetlands, water levels will be managed for depths of 2-12 inches and soil salinity levels of 5,000-8,000 ppm (8-12 mmhos/cm) (Kaushik 1963). Freshwater and low soil salinity provides optimum growth, germination and seed production conditions though this species can thrive under higher salinity levels. Maximum soil salinity tolerance range is about 9,000 ppm (14 mmhos/cm) (Christiansen and Low 1970).

To encourage hardstem bulrush stands in wetlands, water levels will be managed for depths of 2-24 inches with soil salinity levels ranging from fresh soils to 2,000-5,000 ppm (3.3-8.3 mmhos/cm). Freshwater and low soil salinity provides optimum growth, germination and seed production conditions though it can tolerate salinity levels up to 8,000 ppm (12.6 mmhos/cm) (Christiansen and Low 1970).

Once stands of desirable plant species are established, water salinity levels may be increased or maintained at high levels to discourage germination and seedling growth by undesirable species with lower tolerance levels.

To encourage cattail stands in wetlands, water levels will be managed from 2-36 inches and soil salinity levels as fresh as possible. Freshwater and low soil salinity levels provide optimum growth, germination and seed production conditions. Seedling cattails have a low tolerance to salt concentrations and show signs of stress at concentrations higher than 2,000 ppm (3 mmhos/cm). Established stands can withstand much higher salinity levels around 6,000 ppm (Christiansen and Low 1970).

Phragmites may be controlled in wetland units by increasing soil salinity levels, as established phragmites stands have a low tolerance of saline conditions. Deep flooding of plants, stems and roots to deprive the plant of oxygen may be another effective control option.

Strategy 3c. Set back succession. Where stands of emergent vegetation become too dense and overabundant, tools to reduce percent cover of these stands and set back succession may include periodic drawdowns, prescribed fire, and mechanical disturbance. Established stands of cattail and phragmites can tolerate higher concentration of soil salinity than seedlings.

Strategy 3c i. Periodic drawndown. Periodic drawdowns maintain salts on the soil surface, favoring salt tolerant plant species like *Salicornia* and saltgrass and prohibiting germination and growth for salt intolerant species like cattail and phragmites. Drawdown length should be one to two years.

Strategy 3c ii. Use of prescribed fire or mechanized equipment. Prescribed fire and/or mechanical disturbance could be applied in conjunction with a complete drawdown to help return nutrients bound in the residual emergent vegetation back into the soil and atmosphere making them available to other plants. However, Smith (1983) found that prescribed fires in Great Salt Lake marshes do not heat the inorganic soils to high enough temperatures to damage or otherwise stress the dense and fibrous root and rhizome systems of emergents.

Besides the release of nutrients, fire acts to reduce the height and density of cattail and phragmites stems. This facilitates the use of mechanical equipment (bulldozers, tractors, and discs) to break up the dense root and rhizome systems of the emergents. These units should receive treatments in the late summer or fall (non-growing season).

The units that have been treated with fire or mechanical disturbance or both need to be immediately flooded to further stress the root systems through oxygen deprivation. The units should be flooded throughout the winter months at levels higher than the growth from any surviving stems. The use of prescribed fire is detailed in the Refuge Fire Management Plan (Saenz 1999).

Another benefit of this strategy is the increased availability of food to aquatic invertebrate herbivores and detritivores. This group of invertebrates may feed on fine and coarse particulate organic matter (undesirable emergent vegetation) that is shredded by late-summer or fall discing.

Strategy 3c iii. Encourage muskrat, *Ondatra zibethicus*, colonization. Muskrats utilize emergent vegetation to build shelter (muskrat houses) and as a food source. The use of emergent vegetation by muskrats helps to keep areas of wetlands in open water conditions. Maintaining shallow water in management units encourages colonization by muskrats.

Strategy 4. Manage aquatic invertebrate abundance and diversity. Aquatic invertebrate associations are influenced mainly by vegetative structure (leaf shape, height, and surface area), water regimes (timing, depth, and duration of flooding), and water chemistry. Macrophytes with highly dissected leaves tend to support greater invertebrate assemblages than do plants with more simple leaf structure (Fredrickson and Reid 1988).

The composition of invertebrate populations is associated with plant succession, salinity levels, and dissolved oxygen levels. Invertebrates are important to nutrient cycling and detrital processing (Andersson et al. 1988) and provide an important food source for breeding marsh birds (Murkin and Batt 1987 *in* Murkin et al. 1991).

Strategy 4a. Manage for a diversity of wetland types. While few specific management strategies will be employed to influence aquatic invertebrate abundance and diversity, their role in overall marsh productivity at Bear River Refuge is important enough to warrant further explanation. Aquatic invertebrate abundance and diversity is more of a by-product of the water and vegetative management strategies rather than direct population manipulation. Therefore, managing for a variety of wetland types with a range of macrophyte communities and water depths should result in abundant and diverse invertebrate populations.

Strategy 4b. Prohibit pesticide use. Enforcement and/ or maintenance of a policy that prohibits the spraying of pesticides on the Refuge, especially for mosquito control, will benefit invertebrates and increase available food for filter feeder, scraper, and grazer communities upon which the macro invertebrates feed.

Strategy 5. Protect and maintain structures and levees. Historically, water levels were lowered in late fall and throughout the winter months to protect dikes and water control structures from ice damage. Dividing the wetland units into smaller units has minimized the need to conduct winter drawdowns, since ice sheets are smaller and less damaging. Reducing the number of wetland units that are drawn down over the winter reduces the amount of water needed in the spring for refilling, helps to ensure overwinter survival of invertebrates, encourages colonization by muskrats in shallow areas to help control emergent vegetation, and helps reduce siltation and maintain salinity.

SALTAIR MUDFLAT

Strategy 1. No Management Action. Mudflat habitats within the managed units are situated within their higher elevations or contours, though the vast majority of mudflat habitat on the Refuge is located in the unimpounded units. These mudflats are mainly influenced by spring runoff and precipitation events. Refuge staff have little ability to actively manage the mudflats, with the exception of periods of high river flows, when excess water can be moved through the canals and out onto the mudflat areas below the D-line dike.

Strategy 2. Spring drawdown. Mudflat habitat can be improved by drawing down an impounded unit in the spring to concentrate invertebrates for migratory waterbirds, then re-flooding the unit after the peak flow has passed. This strategy could not be implemented in the fall, as the drying and re-flooding of moist soils may encourage a botulism outbreak.

Strategy 3. Construction of contour furrows. A series of contour furrows were constructed on the Refuge throughout the 1960s. The furrows help divert and spread water across alkaline mudflats, altering their physical structure, soil conditions and water patterns. These changes resulted in increased wildlife use during the migration, nesting and brood rearing time periods (Mobley 1976). This method will be further researched and considered as a possible management strategy.

SEMI DESERT ALKALI KNOLL

Potential management strategies to achieve a climax plant community could include clipping of herbaceous understory, wildfire suppression, planting of desired herbaceous species, grazing, and no action.

Strategy 1. Clipping of herbaceous understory. Clipping the herbaceous understory favors the germination of shrub seeds, eventually leading to increased shrub cover. Repeated clipping or removal of understory (mainly invasive cheatgrass) before seed set could help reduce the density of this species as it reproduces from seeds. The clipping of cheatgrass may open up areas to be colonized by native grasses or encourage invasions of desirable forb species.

Strategy 2. Wildfire suppression. Burning favors increases in the shrub community at the expense of the herbaceous understory. The knolls will be protected from wildfire to prevent these conditions. The susceptibility of knolls to wildfire can be reduced by removing continuous fuels of cheatgrass. Repeated clipping or removal of cheatgrass stems before seed set could help reduce the density of this species as it reproduces from seeds.

Strategy 3. Planting of desired herbaceous species. Desired grass and forbs species may be hand-harvested off other Refuge locations or purchased and sown on site. Timing of planting will depend on the species and will likely be completed following Strategy 1. treatment.

Strategy 4. No Action. The current stage of the semi desert alkali knoll plant community may already reflect a climax community and would therefore require no management actions.

Strategy 5. Prescribed grazing. A short-duration, high intensity (high stocking rate) spring graze may be employed to help control invasive cheatgrass and provide open spaces for native grass species to colonize.

ALKALI BOTTOM

Potential management strategies to achieve a climax plant community as described in the objective would include grazing, mowing, haying, prescribed fire and planting of desired species.

Strategy 1. Prescribed grazing. In general, grazing may be employed during the late fall, winter, and early spring months (October-February) while grasses are dormant. In the desert climate, dead plant material tends to decompose slowly, due to lack of moisture, which can result in a deep thatch. Grazing removes thatch and increases vigor of herbaceous plants through nutrient cycling as well as increased exposure to sunlight. As most of the grass species in the west did not evolve under heavy, ungulate grazing pressure, most species can easily be degraded or eliminated by overgrazing during the

growing season. Overgrazing should be prevented to leave adequate plant litter for soil protection and to moderate soil moisture and temperatures for improved germination of perennial grasses.

Cheatgrass is a short, exotic, cool-season grass that has invaded the Refuge grasslands due to years of overgrazing. In areas where native perennial bunchgrasses remain to provide seed or vegetative reproduction, the perennials will replace cheatgrass in mixed stands over time if season and intensity of grazing is based on optimizing the perennial grasses. Grazing animals are removed during the flower and seed formation stages of the desirable plants (April-July). There is a narrow window of opportunity in early spring to use defoliation by grazing to suppress cheatgrass growth, seed production, and excessive mulch buildup. The opportunity exists when perennial grasses are still dormant or can recover later from limited defoliation by regrowing and reaching maturity before the end of the growing season (Vallentine and Stevens 1992) or before depletion of the soil moisture. In the event spring grazing is employed, use should be light and of short duration to leave at least 10 inches of stubble to avoid damage to plants that have high growth points (Basin wild rye, bluebunch wheatgrass). To enhance the return of native bunchgrasses, Pechanec and George (1949) recommended two-thirds of the bunchgrasses and 40 to 60 percent of associated desirable grasses should remained ungrazed each year. As the plant community moves toward climax, grazing may be employed less frequently.

Strategy 2. Mowing. Solid stands of cheatgrass with little or no desirable native bunchgrasses nearby to provide a seed source may be mowed before seeds are formed to degrade the stand. Seeding may need to be employed in conjunction with mowing.

Strategy 3. Haying. The grasslands may be hayed during the late fall, winter and early springs months (October-February) while grasses are dormant to remove thatch to optimize soil moisture and temperature conditions for germinating perennial grasses.

Strategy 4. Prescribed fire. Because bunchgrasses do not provide a continuous fuel to carry fire long distances, fires in presettlement times were probably patchy and small except in very dry years. Fire intervals have been estimated at 20 to 25 years in wetter regions, and 60 to 110 years in the arid sagebrush steppe (Tisdale and Hironaka 1981; Whisenant 1990 *in* Paige and Ritter 1999). Prescribed fire may be used infrequently in late fall or winter months when plants are dormant in the event that grazing is not an option.

Strategy 5. Planting of desired species. Local ecotype seed (seed harvested or from a source within two counties and similar elevations of the Refuge) could be purchased or harvested from other locations on the Refuge and planted following haying and burning. Native bunchgrasses are slow to establish following a seeding, therefore grazing should be deferred until the fall or winter of the second growing season or until seedlings reach 10 inches in height.

SAGEBRUSH COMMUNITY

Potential management strategies to achieve desired plant community as described in the objective may include grazing, wildfire suppression, planting of desired herbaceous species, and hand-harvest of seed from desired species on-site.

Strategy 1. Prescribed grazing. Grazing by cattle during the fall, winter and early spring, when native bunchgrasses are dormant, can help remove or decrease litter depth of understory grasses around sagebrush, thereby creating openings for sagebrush seeds to germinate in or encouraging colonization by native grasses and forbs. Grazing should be avoided during the active growing season of native bunch grasses, as this prohibits seed set or reproduction (Paige and Ritter 1999). These grasslands have never been noted for an abundance of large animals, and probably because there were few native grazers, the bunchgrasses did not evolve resistance to grazing (Mack and Thompson 1982).

Strategy 2. Wildfire suppression. Sagebrush recovers slowly from fire, as this species must be re-established by seeds in the soil or wind dispersed seed. No prescribed burns will be conducted in the area. Further, the susceptibility of the sagebrush community to wildfire can be decreased by removing continuous fuels of cheatgrass. Frequent fires and heavy grazing, especially in the spring, provide favorable growing conditions for invading cheatgrass and other undesirable annual grasses and forbs. Wildfire suppression can help maintain a balance of sagebrush, grasses and forbs and protect area from invading cheatgrass.

Strategy 3. Planting of desirable herbaceous species. Once the herbaceous understory has been removed or decreased through grazing, a mix of native bunchgrasses and forbs could be purchased and sown. Factors such as cool or warm season growth period, seeding rate and germination requirements would dictate the planting season.

Strategy 4. Hand harvest and seed dispersal. Seed from sagebrush could be hand harvested from on-site specimens during peak maturity (October-November) to increase dispersal area and to ensure local ecotype seed source. Sagebrush will sprout from seeds only. The seeds disperse about 3 feet from the source plant with some additional seeds dispersing farther distances due to wind (up to 90 feet). Increasing the current size of the sagebrush community by 3 feet per year would take 25 years to achieve a 5 acre patch size. Hand-harvesting and dispersal of sagebrush seed over a larger area would help to achieve the objective stand size (5 acres) in a shorter time frame (12-15 years).

SALT MEADOW

Potential management strategies to achieve climax plant community as described in the objective would include grazing and prescribed fire.

Strategy 1. Prescribed grazing. In general, grazing may be employed during the late fall, winter, and early spring months (October-February) while grasses are dormant. Grazing removes thatch and increases vigor of herbaceous plants. Alkali bluegrass is a desirable plant species in this habitat type. Alkali bluegrass can be kept vigorous and productive if early spring grazing removes no more than about 40 percent of the top growth.

Strategy 2. Prescribed Fire. Prescribed fire can be utilized as a management tool during the late fall, winter, and early spring months when desirable grasses are still dormant. Fire removes thatch and increases vigor of herbaceous plants. Saltgrass can be managed by burning between September 1 and February 1 biannually, when the water level is just above the soil surface yet conditions are dry enough to carry fire. Following burning, four inches of re-growth should be obtained before grazing is allowed.

WET MEADOW

Potential management strategies to achieve the climax plant community described in the objective include maintaining the water supply and prescribed grazing.

Strategy 1. Maintain Water Supply. A good supply of water is the most important factor in maintaining wet meadow habitat. Maintain water supply to these areas by cleaning the water delivery canals and ditches and not diking and changing wetland type from wet meadow to shallow, open water ponds.

Strategy 2. Prescribed grazing. In general, grazing may be employed during the late fall, winter, and early spring months (October-February) while grasses are dormant. Grazing removes thatch and increases the vigor of herbaceous plants.

SEMIWET STREAMBANK

Strategies to achieve the climax plant community described in the objective include planting the desired mix of species along the streambank, and controlling tamarisk by chemical and mechanical means.

Strategy 1. Plant desired species. Purchase local ecotype tree and shrub species and plant along the streambanks in the spring.

Strategy 2. Treat tamarisk. Depending on the density of the stand, tamarisk species can be cut mechanically with a “wet-blade” and the stumps treated with an herbicide, or isolated patches of tamarisk can be sprayed with herbicide.

DIKES

The plant community described in the objective can be achieved by planting desired grass species (e.g. *Agropyron* spp.), periodic mowing, and prescribed fire.

Strategy 1. Planting desired grass species. Purchase desirable grass species (wheatgrass, wild rye) and sow 1/4 to 3/4 inches deep in late fall (dormant) or early spring at a rate of about 10 pounds per acre if drilled or 20 pounds per acre if broadcast.

Strategy 2. Periodic Mowing. Mowing the dikes will maintain the integrity of the dikes, allow traffic flow and increase aesthetic appeal on the Auto Tour Route portion of the dike system. Mowing should take place in the late summer or fall after the waterbird breeding season is complete.

Strategy 3. Prescribed Fire. Prescribed fire can remove thatch and increase vigor of grasses and forbs by influencing soil moisture and temperature regime to favor germination of desirable herbaceous species.

POPULATION OBJECTIVES

Nesting density and nesting success of Refuge priority species can be increased through lethal and non-lethal methods of removing predators and excluding predators from high density nesting areas.

Strategy 1. Removal of Predators. Mammalian predators may be removed or controlled through a combination of quick killing traps and night-lighting and shooting. Animals may then be disposed at remote locations on the Refuge.

Strategy 2. Exclusion of Mammalian Predators. Mammalian predators may be excluded from high density nesting locations by enclosing the area(s) with a predator exclusion fence. The mesh fence has an electric wire at the top and bottom.

B. Management Strategy Constraints.

WETLAND

Strategy 1. Manage salinity levels. The major constraint associated with this strategy is the amount and timing of water from the Bear River. Spring flows supply more water than can be retained by existing facilities. Summer flows tend to be too low to maintain desirable pool elevations on constructed units because net evaporation is about 54 inches annually and the river flow is reduced by upstream irrigation demands. The Refuge holds a state-certified water right with a priority date of 1928 for 1,000 cfs from January 1 through December 31. However, this flow amount is rarely available in late summer.

Lack of freshwater drys some units in mid-summer and strands breeding waterbirds. Drying increases the risk of mortality to both eggs, young and adults due to predation, lack of food resources, and the increased distance to brood rearing areas. Drying also causes dessication of sago pondweed prior to seed and tuber production, leading to a decrease in food availability to migrant waterbirds in the fall, when river flows increase and the units are reflooded.

Lack of water and drying of soils may cause salinity levels to rise above tolerance levels for germination and seedling survival of desirable wetland plants. High salinity levels may also depress aquatic invertebrate abundance and diversity.

Strategy 2a. Manage water clarity by restricting carp. This strategy is limited because fish screens are expensive and can become clogged with river flotsam, impeding water flow and necessitating removal during high flow events both to allow flow through and to avoid damage to the screens. In addition, because the screens slow the movement of water during the re-filling of units in the fall, often they are be removed to quickly fill the units to ensure quality and quantity of available habitat for migrant waterbirds.

Strategy 2b. Reduce silt loading. The main impediment for this strategy is that the Refuge may need to take advantage of high river flows, regardless of the silt load, if precipitation forecasts are low.

Strategy 3. Control aquatic vegetation community composition. The major impediment to controlling aquatic vegetation communities is, like strategy 1, the amount and timing of water from the Bear River.

Average water supplies are insufficient to maintain all units at their target levels through the summer. The water shortage inhibits the ability to influence the aquatic vegetation community. Each year, Refuge staff set the order for filling the units and maintaining their water levels based on the runoff forecasts, with the objective of providing an adequate amount of habitat types and spatial distribution to meet the needs of the Refuge priority species. In dry years, the emphasis should be on maximizing the number of acres of emergent marsh for over-water nesting priority species.

Avian botulism is a persistent problem on the Refuge which has a significant impact on waterfowl and other migratory birds. Water management strategies that were carefully designed to achieve specific aquatic vegetative community goals often have to be abandoned and become secondary during a botulism outbreak. Once an outbreak has occurred, the best strategy is to drain and dry out the affected units, forcing birds to utilize other units free of the disease. A unit could be flooded to diminish the effect of a botulism outbreak if sufficient water were available, but since the outbreaks usually occur in August and September, that rarely happens.

The best strategy to prevent botulism outbreaks that can limit our ability to manage vegetative wetland communities is to maintain constant water levels in the units throughout the growing season and the fall. This will avoid drying the higher elevations in the units and abruptly re-flooding them, thereby creating favorable growing environments for the *Chlostridium botulinum* Type C bacteria that causes avian botulism.

Strategy 4. Manage invertebrate diversity and abundance. Like strategies 1 and 4, the major impediment to influencing invertebrates is the amount and timing of water from the Bear River. Too little water could result in fewer macrophytes to host and feed invertebrates. Lack of water could also reduce the availability of invertebrate populations for feeding by priority species by direct mortality in units that dry out or by burrowing in sediments (to avoid dessication) to depths greater than can be reached by probing waterbird species.

Experience with water manipulation suggests that management for specific aquatic or semi-aquatic plant communities may be the most practical means of increasing invertebrate production (Fredrickson and Reid 1988). As lack of water diminishes our capacity to manage for specific plant successional stages and communities, it also indirectly negatively affects our ability to manage invertebrates.

Strategy 4b. Prohibit use of pesticides. The down side of not allowing spraying for mosquito control on the Refuge is a public image issue and not a biological one. Prohibiting mosquito control activities on Refuge lands adjacent to nearby residential areas may negatively affect working relationships with public officials as the Refuge tries to purchase new lands within the approved Legislative boundary. In light of the recent arrival of West Nile Virus to the western states, prohibiting mosquito control on the Refuge could be perceived as a threat to public health by nearby residents.

SALTAIR MUDFLAT

Strategy 2. Spring drawdown. The constraint associated with a spring drawdown to provide wet mudflat habitat would be the risk of being unable to re-fill the unit due to lack of water. Another potential problem would be the clarity of water upon refill.

SEMI DESERT ALKALI KNOLL

Strategy 1. Clipping of herbaceous understory. This strategy may be labor intensive as the areas are too small to graze. A mechanical means would have to be investigated and employed that would allow the clipping of understory in small, narrow openings between sage plants as well as the perimeter of the sage dominated habitat.

Strategy 2. Wildfire suppression. Staff training and availability of qualified personnel and equipment would be the constraints associated with this strategy.

Strategy 3. Planting of desired herbaceous species. This strategy can also be labor intensive to collect enough of the target species, as seeds would have to be hand-harvested. If there is local ecotype seed available for purchase it is often cost prohibitive.

ALKALI BOTTOM

Strategy 1. Prescribed grazing. The constraints associated with prescribed grazing are the quality of grazing permittee and the ability to move the cattle off of areas in a timely fashion when prescription grass levels have been reached.

Strategy 2 and 3. Mowing and/or Haying. Portions of this habitat include areas vegetated by low quality forage species. Refuge may have difficulty attracting private individuals willing to hay entire units.

Strategy 4. Prescribed Fire. Constraints associated with prescribed fire include staff training, availability of qualified personnel, and equipment. The habitat that needs to be burned is along a U.S. Interstate Highway (15). Prevailing wind direction would have to be westward to prevent blowing smoke eastward across the interstate. This would be a high risk, high complex burn requiring the burn boss to have higher credentials than the current staff. Fire may increase runoff, decrease soil moisture, and remove much needed soil cover during the summer. Smoke may be a human safety/health hazard when burns occur close to highways and residences. Improperly timed fires may reduce plant vigor or cause death in bunch grasses and shrubs. Frequent fires may be detrimental to perennials while benefitting annuals such as cheatgrass. Fire temporarily removes nesting and escape cover.

SEMIWET STREAMBANK

Treat Tamarisk. This species is very resistant to many types of treatment. The chemicals and equipment associated with treatment can be cost prohibitive.

POPULATION OBJECTIVES

Strategy 1. Predator Removal. Constraints associated with predator removal include controversy and unpopularity with certain segments of the society and ineffectiveness if not conducted in the proper season. It is hard to measure success/effectiveness, it may be expensive and it involves killing some species of predators that are part of the natural system when in balance.

Strategy 2. Predator Exclusion. The predator exclusion fences are expensive to acquire and require a considerable amount of staff time to maintain in proper working order by keeping the wires free of vegetation.

C. Impacts to Resources of Concern

The following is a discussion on the potential positive and negative impacts of the strategies to resources of concern (priority species) as well as nontarget resources.

Wetland and mudflat management at Bear River Refuge involves the manipulation of water levels and timing of fill to affect soil salinities, water clarity, aquatic invertebrate populations and vegetative communities. Each April, a streamflow forecast is obtained from the National Weather Service, Salt Lake City, Utah. Refuge staff develop an annual water management plan based on the predicted streamflow. The impounded wetland units are assigned a priority order and the fill and maintenance of the units is based on this priority order.

In years when the forecasted streamflow in the Bear River is very low, water levels will be maintained during the summer months only in the highest priority units. The priority units are those that maintain breeding colonies of waterbirds. These birds are positively affected by maintaining water around the rookeries and increased protection from mammalian predators. As low priority units go dry, other breeding birds will suffer from a decrease in available breeding, foraging and brooding habitat and will be subject to higher predation rates.

The clipping of herbaceous understory may temporarily remove nesting and camouflage cover used by Mallards, Gadwalls, Cinnamon Teal, Short-eared Owls, and Western Meadowlarks. Understory removal may also reduce over-winter and nesting cover as well as travel corridors for small mammals, perhaps negatively influencing their populations which serve as the prey base for raptors. In the long-term, this strategy helps to maintain a balance between the shrub and grassland communities. This balanced community provides habitat for shrub obligate species like the Brewer's Sparrow.

Wildfire suppression can lead to a build-up of thatch or residual vegetation. Residual vegetation affects soil moisture and temperature regimes. A cool and moist micro-climate could favor germination of undesirable herbaceous species while suppressing or restricting conditions favorable to perennial bunchgrasses. A deep thatch layer can also impede movement of fledgling ground nesting birds as they relocate to foraging areas or flee from predators. A deep thatch, however, may favor some species of ground nesting birds and provide cover and food for insects, invertebrates and small mammal populations. Wildfire suppression will favor the tall, native bunchgrass and shrub communities that provide nesting and foraging habitat for nesting species.

Planting of desired herbaceous species should have only positive affects on priority species as the structure and abundance should increase amount of suitable nesting habitat.

Prescribed grazing may result in lower production of early nesting species like Mallards on areas grazed the previous winter because of loss of residual cover. Later nesting species such as Cinnamon Teal and Gadwall will benefit from the improved vegetation structure after green-up in the spring. Grazing during the early spring after on-set of nesting could lead to nest loss due to trampling or abandonment. Cattle may also attract Brown-headed Cowbirds leading to an increase in nest parasitism by this species in grazed areas. This strategy benefits nesting species such as Wilson's Phalarope and Cinnamon Teal and other grassland nesting species by improving the density, vigor and persistence of native grasses and forbs that provide cover and foraging opportunities.

Mowing and haying could have a short-term negative impact on some ground-nesting priority species by the removal of residual vegetation for nesting cover.

Prescribed fire may cause a short-term negative effect by eliminating or reducing the quality of nesting cover due to short and sparse vegetative structure for ground nesting priority species such as Cinnamon Teal and Long-billed Curlew. Also, burning may decrease the soil moisture due to enhanced exposure of the soil surface to sunlight thereby negatively impacting vegetative growth. However, fire is effective in removing accumulations of mulch and dead plant material in order to expose the soil surfaces to sunlight and increasing early spring plant growth when soil moisture levels are adequate. Fire can also help create greater plant diversity. Fire may invigorate some grass plants and wood shrubs and result in more vigorous regrowth of marsh plants. This equates to more structure for breeding birds and cover from predators.

Removal of tamarisk is a step toward balanced riparian area plant communities. This would include a diverse grass, shrub and tree layer providing a wider array of nesting and foraging habitat. Some species that have adapted to nesting in tamarisk may lose nesting sites while the shrub and tree layer recovers to its former stature.

D. Management Strategy Selection.

Refuge staff will select the most appropriate management strategy during the annual Habitat/Water Management Planning process. Strategies will be selected after evaluation of the previous year's monitoring data, past and predicted response by priority species, consideration of current habitat conditions, current and/or forecasted streamflow patterns, and special management concerns (e.g., invasive species and visitor use).

E. Management Strategy Prescriptions.

The management strategy prescriptions are described on a unit by unit basis in Appendix C.

F. Management Strategy Documents.

The present staff of twelve full-time employees can successfully implement the Habitat Management Plan. Reaching all the goals and objectives in the Plan will require an additional 4.6 FTE's (noted in the Refuge Operations Needs program).

Present Staff	Staff Needed to Reach all Goals
Project Leader	Refuge Operations Specialist
Deputy Project Leader	Biologist
Refuge Operations Specialist	Biological Technicians (2 at 0.5 FTE)
Lead Wildlife Biologist	Temporary Law Enforcement (0.6 FTE)
Outdoor Recreation Planner (2)	Equipment Operator
Law Enforcement Officer	
Administrative Officer	
Temporary Equipment Operator	
Maintenance/Equipment Operators (3)	
Total Staff - 12 FTE	Total Additional Staff - 4.6 FTE

Funding needs for full implementation of the Habitat Management Plan are: $1.5 million in annual operations and maintenance (FY2004 dollars), $200,000 for equipment, and an additional $1 million in special appropriations to complete the remaining post-flood reconstruction projects ($500,000 in FY2004 and $500,000 in FY2005).

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Appendices

A. Refuge Soil Associations and Ecological Sites

B. Bird Species utilizing Bear River Migratory Bird Refuge, 1993.

C. Unit Management Strategies

D. Annual Habitat Management Plan

E. Inventory and Monitoring Plan

F. Long-Range Water Management Plan (1993)

G. Fire Management Plan (2001)

H. Integrated Pest Management Plan (2003 Draft)

I. Comprehensive Management Plan (1997)

J. Environmental Assessment (1991)

K. Public Use Management Plan (1997)

L. Predator Management Plan

M. Metadata

Appendix A

Bear River Migratory Bird Refuge Soil Associations and Ecological Sites.

Ecological Sites[2]

A range or ecological site is a distinctive kind of rangeland differing from other rangeland in producing a particular kind and amount of vegetation unique to itself. The natural plant community of a site in the absence of abnormal disturbances and physical site deterioration is the climax plant community for that site. Bear River Refuge has seven types of Ecological Sites: Wetland, Saltair Mudflat, Semi-desert Alkali Flat, Wet Meadow, Alkali Bottom, Semiwet Fresh Streambank, and Salt Meadow.

These ecological sites are important to differentiate as they provide land managers with a glimmer of the potential of the plant community and subsequent wildlife use from which to devise habitat management goals, objectives and strategies.

Ecological Site Descriptions

Wetland
Vegetation is dominantly sedges, cattails, and bulrushes. Climax plant community composition by percent cover would be approximately 50% emergent vegetation and 50% open water.

Saltair Mudflat
Consists of very strongly saline soils and are nearly barren of vegetation. These soils are usually saturated with water, but the water available for plant growth is only 2-4 inches because of the very high salt content. Plants that grow on Saltair soils normally have a shallow rooting system. Generally, it is nearly bare but supports scattered plants of pickle-weed and a few patches of saltgrass. Includes playas and vegetated and non-vegetated mudflats.

Semi-desert Alkali Flat (Knoll)
The dominant aspect of the plant community is greasewood. Climax plant community composition by Percent Canopy Cover would be approximately 1-5% Forb, 15-30% Grasses, and 35-40% Shrubs. Remainder is bare ground.

Wet Meadow
General view of this site is Nebraska Sedge and Arctic Rush. Climax plant community composition by percent Canopy Cover would be approximately 80% grasses and grasslikes, 5% forbs, and 1% shrubs.

Alkali Bottom
The dominant aspect of the plant community is salt and alkali tolerant grasses. Climax plant community composition by percent canopy cover would be approximately 60% grasses and grasslikes, 5% forbs, and 5% shrubs.

Semiwet Fresh Streambank
The dominant aspect of this plant community is cottonwood trees, willows, and grass or grasslike plants. The climax plant community could be 15% trees, 30% shrubs, and 5% each for forbs and grasses.

Salt Meadow
The general view of this site is sedges, rushes and saltgrass. The climax plant community composition by percent canopy cover would be approximately 65-75% grasses and grasslikes, 10% forbs and 1-3% shrubs.

Map Symbol	Soil Association[1]	Correlating Ecological Site
W	Water	Wetland
SA	Saltair Silty Clay	Saltair Mudflat
PU	Playa	Saltair Mudflat
PVC	Pogal Silt Loam	Semi-desert Alkali Knoll
Ru	Roshe Springs Silt Loam	Wet Meadow
PT	Placeritos Silt Loam	Alkali Bottom
Lc	Lasil Silt Loam	Alkali Bottom
SC	Saltair Logan Soil	Salt Meadow
BR	Bram Silt Loam	Semi-desert Alkali Knoll
Pr	Payson	Alkali Bottom
SB	Saltair-Freshwater Marsh	Wetland
Lt	Logan Silty Clay Loam	Wet Meadow
FT	Fresh Saltwater Marsh	Wetland
Ao	Airport Silt Loam	Alkali Bottom
Ap	Airport Silt Loam, sandy substratum	Alkali Bottom
Cy	Cudahy Silt Loam	Wet Meadow
Gh	Gooch Silt Loam	Salt Meadow
PbA	Parley's Loam	Alkali Bottom (Irrigated Cropland)
PlA	Parley's Silty Clay Loam	Alkali Bottom (Irrigated Cropland)
TmA	Timpanogos Loam	Alkali Bottom (Irrigated Cropland)
Wo	Woods Cross Silty Clay Loam	Wet Meadow

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[1] Based on digital soil survey generated from the *Soil Survey of Box Elder County, Utah Eastern Part*, 1975 by the USDA Natural Resources Conservation Service and available at: http://www.ftw.nrcs.usda.gov/ssur_data.html.

[2]Ecologic Site descriptions from USDA-NRCS Field Office Technical Guide, Section IIE or Site Descriptions for Major Land Resource Area E28A, Great Salt Lake Area, September 1993. For those associations without an Ecological Site description, range site descriptions were used from the 1975 Box elder County Soil Survey.

Appendix B

Priority Bird Species Using Bear River Migratory Bird Refuge, 1993.

Species or Group	Management Status
Bald Eagle	Federally listed as *Threatened* under Endangered Species Act
Snowy Plover	Limited breeding distribution concentrated at Great Salt Lake (Paton 1992)
White-faced ibis	Limited breeding distribution concentrated at refuge (USFWS 1982)
Northern Pintail	Requires early spring sheet water; large molt migration to refuge (Bellrose 1980)
Cinnamon Teal	Historically, 60% of production in Great Salt Lake Basin (Bellrose 1980)
Redhead	Historically critical production area (Bellrose 1980)
Canada Geese	Large numbers
Black Tern	Declining across entire range
Dabbling Ducks	Large numbers
Diving Ducks	Large numbers
Swans (Tundra)	78% western population stages at refuge
Shorebirds	Large numbers
Fish-eating Birds	Large numbers
Wading Birds	Large numbers
Raptors	Important migration corridor
Passerines	Feeding during migration

Appendix C.

Strategy Prescription and Implementation
Unit Management Strategies

Unit 1

Goal: Maximize deep and shallow submergent wetland types to provide optimum conditions for production of sago pondweed (Figure 9).

Objectives:

1) Maintain soil salinity levels at 5,000 - 10,000 ppm (8-15 mmhos/cm), April 1-December 15.
2) Maintain water level at 4204.5' msl, April 1-December 15.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 440 acres of deep submergent and 2,160 acres of shallow submergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes.
4: Manage aquatic invertebrate abundance and diversity implementing strategy 4a. Manage for a diversity of wetland types and 4b. Prohibit pesticide use.

Desired Habitats: Deep submergent, 18- 24"= 440 acres
Shallow submergent, 4-18" = 2160 acres

Other Habitats: Mid-depth emergent, 8-12"= 1491 acres
Shallow emergent, 2-8" = 547 acres
Vegetated mudflat, 0-2"= 7803 acres
Alkali Knolls = 235 acres

Prescription :

The goal for unit 1 is to maximize deep and shallow submergent wetland acreage to encourage the production of sago pondweed by holding the water elevation at the structure at 4204.5' msl April 1 - December 15. Water clarity is critical to production of submergent plants. Carp screens and filling in winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000- 10,000 ppm, by limiting flow through of fresh water. Over time the unit may become too fresh, favoring cattail and limiting alkali bulrush. Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation. Unit 1 is usually drawdown to about 4204.0 in late fall (November or early December) when the weather is cold enough to create ice. The drawdown protects the dikes and water-control structures from ice damage.

Unit 1A

Goal: Manage shallow and mid-depth emergent wetlands for 50% interspersion of emergent vegetation and 50% open water (Figure 9).

Objectives:

1) Manage water levels to achieve 454 acres of mid-depth emergent and 90 acres of shallow emergent wetland habitat and 50% open water.
2) Maintain water level at 4205' msl, year-round (January 1-December 31).
3) Maintain soil salinity levels around 5000 ppm (8 m.mhos/cm) June-August.
4) Decrease amount of emergent vegetation to cover ≤ 50% of unit.
5) Decrease amount of Phragmites and cattail to account for ≤ 50% of emergent vegetation.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Control aquatic vegetation community composition by using strategy 3a. Manage water depths, 3b. Match salinity levels with tolerance ranges of desired macrophytes,
3c i. Periodic drawdown, 3c ii. Use of prescribed fire or mechanized disturbance and
3c iii Encourage muskrat colonization to set back succession (Strategy 3c.).

Desired habitats: Mid-depth emergent 6-12" = 454 acres

Other habitats: Shallow emergent 0-6" = 90 acres

Prescription:

Unit 1A is directly connected to the Bear River by a large drive-through spillway. Fresh water flows through the unit at river elevations above 4206' msl. The flushing lowers salinity and encourages the growth of dense cattail, hardstem bulrush and *Phragmites.* Salinity will be increased by holding a stable water level through the summer (June-August). This will require blocking the drive-through spillway and filling from the L-line canal. To help create open water conditions, water levels will be maintained above 4205' msl through the winter to encourage over-wintering of muskrats. Muskrat activity will help keep the cattail in check. Other methods of vegetation management such as prescribed fire or discing, then flooding may be used to set back the vegetation.

Bear River Migratory Bird Refuge
Habitat Goals
Unit 1

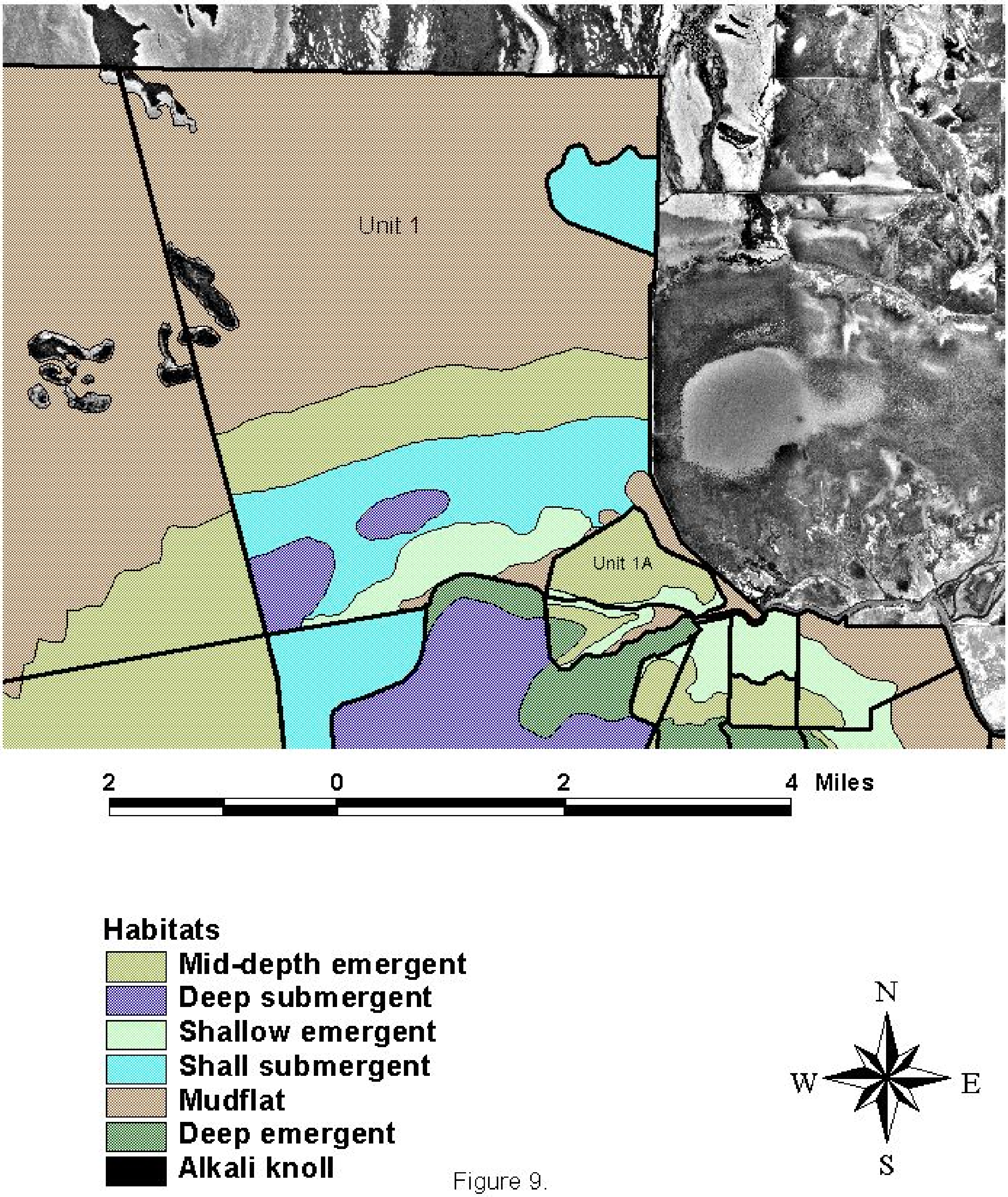


Figure 9.

Unit 2A

Goal: Manage marsh for mid-depth emergent wetland type to encourage colonization of alkali bulrush (Figure 10).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), June-August.
2) Maintain water level at 4205.5' msl, year-round.
3) Increase amount of alkali bulrush to cover 75% of unit.
4) Manage water levels to achieve 103 acres of mid-depth emergent and 32 acres of shallow emergent wetland habitat.
5) Decrease Phragmites to cover < 5% of unit.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Control aquatic vegetation community composition by using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession (Strategy 3c).

Desired habitats: Mid-depth emergent 6-12" = 103 acres

Other habitats: Shallow emergent 0-6" = 32 acres

Prescription:

Unit 2A will be maintained at a mid-successional vegetational stage dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level through the summer (June-August). Inflows will just offset evaporation. In some years, unit 2A will be allowed to go dry to further increase soil salinity.

Unit 2B

Goal: Manage marsh for deep, mid-depth and shallow emergent wetland types to encourage colonization of alkali bulrush (Figure 10).

Objective:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), June-August.
2) Maintain water elevation of 4202.5' msl, April 1-December 15.
3) Increase amount of alkali bulrush to cover 60% of unit.
4) Manage water levels to achieve 55 acres of deep emergent, 96 acres of mid-depth emergent, and 86 acres of shallow emergent habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Control aquatic vegetation community composition using strategy 3a. Manage water depths, 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3c i. Periodic drawdown to set back succession (Strategy 3c).
3: Manage aquatic invertebrate abundance and diversity implementing strategy 4a. Manage for a diversity of wetland types and 4b. Prohibit pesticide use.

Desired habitats: Deep emergent 12-18" = 55 acres
Mid-depth emergent 6-12" = 96 acres
Shallow emergent 0-6" = 86 acres

Other habitats: Vegetated mudflat 0-2" = 57 acres

Prescription:

Unit 2B will be maintained at a mid-successional vegetative stage dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level through the summer (June-August). Inflows will just offset evaporation. In some years, unit 2B will be allowed to go dry to further increase soil salinity.

Unit 2C

Goal: Maximize shallow submergent wetland type to provide optimum conditions for production of sago pondweed (Figure10).

Objectives:

1) Maintain soil salinity levels at 5,000-10,000 ppm (8-15 m.mhos/cm), June-August.
2) Maintain water level at 4204.5' msl, April 1-December 15.
3) Increase sago pondweed to cover 70% of unit.
4) Manage water levels to achieve 4029 acres of shallow submergent wetland.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes.

Desired habitats: Shallow submergent 4-18" = 720 acres

Prescription:

The goal for unit 2C is to maximize the production of sago pondweed by holding the water elevation at the structure at 4204.5' msl April 1-December 15. Shallow submergent is the desired habitat. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000-9,000 ppm by limiting flow through of fresh water. To set back vegetative succession, strategies may include the use of prescribed fire and/or mowing followed by deep flooding.

Unit 2D

Goal: Maximize deep submergent wetland habitat to provide foraging opportunity for fish eating birds such American White Pelican, Double-crested Cormorant and grebes (Figure 10).

Objectives:

1) Maintain soil salinity levels around 2,000 ppm (3 m.mhos/cm), April 1-October 15.
2) Maintain water at target elevation 4206' msl, April 1-December 15.
3) Manage water levels to achieve 4029 acres of deep submergent and 590 acres of deep emergent habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1a. Flushing.
2: Manage water clarity using strategy 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths.

Desired Habitats: Deep submergent 18.1-24" = 4029 acres

Other Habitats: Deep emergent 12-18" = 590 acres

Prescription:

As Unit 2D acts as the mouth of the Bear River, silt laden spring flows must flow through it. Carp have abundant over-wintering habitat in the main river channel. Management options are limited because of the necessity of using Unit 2D as a flow through for high spring run-off and abundant carp populations. Therefore, the best use of unit 2D is as a sacrifice unit to bypass early spring flows. The unit will provide foraging habitat for fish-eating birds, but both emergent and submergent habitats will be in poor condition. The unit will be kept as deep as possible to discourage growth of cattail. However, the upper delta will likely be colonized by dense stands of cattail because of the nutrients deposited with the silt. This unit is subject to ice damage from wind fetch and will be drawn down to 4205' when ice begins to form. The lower elevation will be maintained until after spring thaw (March-April) when threat of ice damage has diminished.

Bear River Migratory Bird Refuge
Habitat Goals
Unit 2

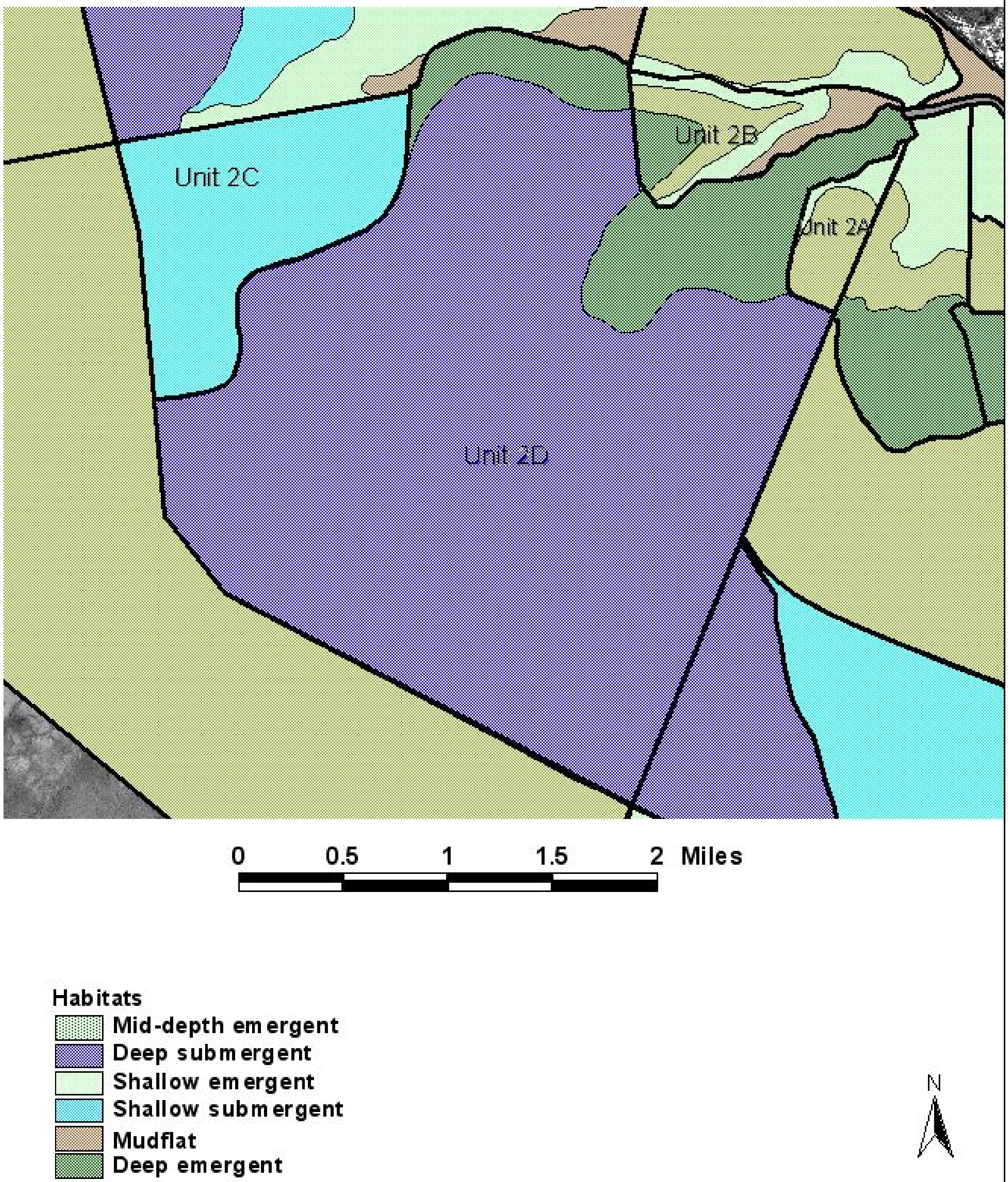


Figure 10.

Unit 3A

Goal: Maximize emergent wetland habitat to provide optimum growing conditions for alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at about 5,000 - 8,000 ppm (8-12 m.mhos/cm), April 1-October 15.
2) Maintain water around target elevation of 4206' msl, April 1-December 15.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation.
4) Manage water levels to achieve 253 acres of deep emergent, 110 acres of mid-depth emergent and 142 acres of shallow emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.
4: Manage aquatic invertebrate abundance and diversity implementing strategy 4a. Manage for a diversity of wetland types and 4b. Prohibit pesticide use.

Desired habitats:
Deep emergent 12-24" = 253 acres
Mid-depth emergent 8-12" = 110 acres
Shallow emergent 2-8" = 142 acres

Prescription:

Unit 3A will be maintained at a mid-successional range dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level through the summer. Inflows will just offset evaporation. In some years, unit 3A will be allowed to go dry to further increase soil salinity.

Unit 3B

Goal: Maximize mid-depth emergent wetland habitat to provide optimum growing conditions for alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), April 1-October 15.
2) Maintain water level at target elevation 4205' msl, year-round.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation.
4) Manage water levels to achieve 1085 acres of mid-depth emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Control aquatic vegetation community composition using strategy 3a. Manage water depths, 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3c i. Periodic drawdown to set back succession (Strategy 3c).

Desired habitats: Mid-depth emergent 8.1-12" =1085 acres

Prescription:

Unit 3B will be maintained at a mid-successional range dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level through the spring, summer and early fall (April-October). Inflows will just offset evaporation. In some years, unit 3B will be allowed to go dry to further increase soil salinity.

Unit 3C

Goal: Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000 -10,000 ppm (8-15 m.mhos/cm), April 1- October 15.
2) Maintain water at target water elevation of 4206' msl, year-round.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 549 acres of deep submergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3cii. Use of prescribed fire and/or mechanical disturbance to set back succession.

Desired habitats: Deep submergent 18.1-36" = 549 acres

Prescription :

The goal for Unit 3C is to maximize the production of sago pondweed by holding the water elevation at the structure at 4206' msl year-round. Deep submergent wetland is the desired habitat. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000 - 10,000 ppm (April 1- October 15), by limiting flow through of fresh water. Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation.

Unit 3D

Goal: Maximize shallow submergent wetland habitat to provide optimum conditions for production of sago pondweed (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000 -10,000 ppm (8-15 m.mhos/cm), April 1-October 15..
2) Maintain water at target elevation of 4205' msl, year-round.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 1045 acres of shallow submergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3cii.Use of prescribed fire and/or mechanical disturbance to set back succession.

Desired habitats: Shallow submergent 4-18" = 1045 acres

Prescription :

The strategy for Unit 3D is to maximize the production of sago pondweed by holding the water elevation at the structure at 4205' msl year-round. Shallow submergent wetland is the desired habitat. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000 - 10,000 ppm (April 1- October 15), by limiting flow through of fresh water. Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation.

Unit 3E

Goal: Maximize shallow submergent wetland habitat to provide optimum conditions for production of sago pondweed (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000 -10,000 ppm (8-15 m.mhos/cm), April 1-October 15.
2) Maintain water at target elevation of 4205 msl. year-round.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 1448 acres of shallow submergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3cii.Use of prescribed fire and/or mechanical disturbance to set back succession.

Desired habitats: Shallow submergent 4-18" = 1448 acres

Prescription :

The strategy for Unit 3E is to maximize the production of sago pondweed by holding the water elevation at the structure at 4205' msl year-round. Shallow submergent wetland is the desired habitat. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000 - 10,000 ppm (April 1-October 15), by limiting flow through of fresh water. Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation.

Unit 3F

Goal: Manage marsh for shallow emergent wetland type to encourage colonization of alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), April 1-October 15.
2) Maintain water at target elevation of 4205.2' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 903 acres of shallow emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.

Desired habitats: Shallow emergent 2-8" = 903 acres

Prescription:

Unit 3F will be maintained at a mid-successional wetland stage dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level April 1 - October 15. Inflows will just offset evaporation. In some years, unit 3F will be allowed to go dry to further increase soil salinity.

Unit 3G

Goal: Maximize emergent wetland types to encourage colonization of alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), April 1-October 15.
2) Maintain water at target elevation of 4205.7' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 175 acres of deep emergent, 97 acres of mid-depth emergent and 775 acres of shallow emergent wetland habitats.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.
4: Manage aquatic invertebrate abundance and diversity implementing strategy 4a. Manage for a diversity of wetland types and 4b. Prohibit pesticide use.

Desired habitats: Deep emergent 12-20" = 175 acres
Mid-depth emergent 8-12" = 97 acres
Shallow emergent 0-8" = 775 acres

Other habitats: Vegetated mudflat 0-2" = 498 acres

Prescription:

Unit 3G will be maintained at a mid-successional wetland stage which is dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 9,000 ppm by holding a constant water level April 1 - October 15. Inflows will just offset evaporation. In some years, unit 3G will be allowed to go dry to further increase soil salinity.

Unit 3H

Goal: Maximize emergent wetland types to encourage colonization of alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), April 1 - October 15.
2) Maintain water at target elevation of 4206' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 71 acres of mid-depth emergent and 224 acres of shallow emergent wetland habitats.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.
4: Manage aquatic invertebrate abundance and diversity implementing strategy 4a. Manage for a diversity of wetland types and 4b. Prohibit pesticide use.

Desired habitats: Mid-depth emergent 8-12" = 71 acres
Shallow emergent 2-8" = 224 acres

Other habitats: Vegetated mudflat 0-2" = 360 acres

Prescription:

Unit 3H will be maintained at a mid-successional wetland stage, dominated by alkali bulrush. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level April 1 - October 15. Inflows will just offset evaporation. In some years, unit 3H will be allowed to go dry to further increase soil salinity.

Unit 3I

Goal: Manage marsh for mid-depth emergent wetland type to encourage colonization of alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), April 1 - October 15.
2) Maintain water at target elevation of 4205.5' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 211 acres of shallow emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.

Desired Habitats: Shallow emergent 0-6"= 211 acres

Prescription:

Unit 3I will be maintained at a mid-successional plant stage dominated by alkali bulrush. The salinity will be kept in the range of 5,000-8,000 ppm by holding a constant water level April 1 - October 15. Inflows will just offset evaporation. In some years, unit 3I will be allowed to go dry to further increase soil salinity and set-back vegetation succession.

Unit 3J

Goal: Manage marsh for mid-depth emergent wetland type to encourage colonization of alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at 5,000-8,000 ppm (8-12 m.mhos/cm), Aril 1-October15.
2) Maintain water at target elevation of 4206.' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 166 acres of mid-depth emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.
Production of alkali bulrush

Desired habitats: Mid-depth emergent 6-12" = 166 acres

Prescription:

Unit 3J will be maintained at a mid-successional wetland stage, dominated by alkali bulrush by maintaining the water at 4206' msl at the structure, year-round. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level April 1- October 15. Inflows will just offset evaporation. In some years, unit 3J will be allowed to go dry to further increase soil salinity thereby enabling us to set back plant succession.

Unit 3K

Goal: Maximize deep emergent wetland habitat to provide optimum growing conditions for alkali bulrush (Figure 11).

Objectives:

1) Maintain soil salinity levels at about 5,000 - 8,000 ppm (8-12 m.mhos/cm), April 1- October 15.
2) Maintain water around target elevation of 4206' msl throughout the year.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation.
4) Manage water levels to achieve 230 acres of deep emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.

Desired habitats: Deep emergent 12-24" = 230 acres

Prescription:

Unit 3K will be maintained at a mid-successional plant stage dominated by alkali bulrush by maintaining water level at 4206' msl at the structure throughout the year. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level April 1 - October 15. Inflows will just offset evaporation. In some years, unit 3K will be allowed to go dry to further increase soil salinity thereby setting back aquatic plant succession.

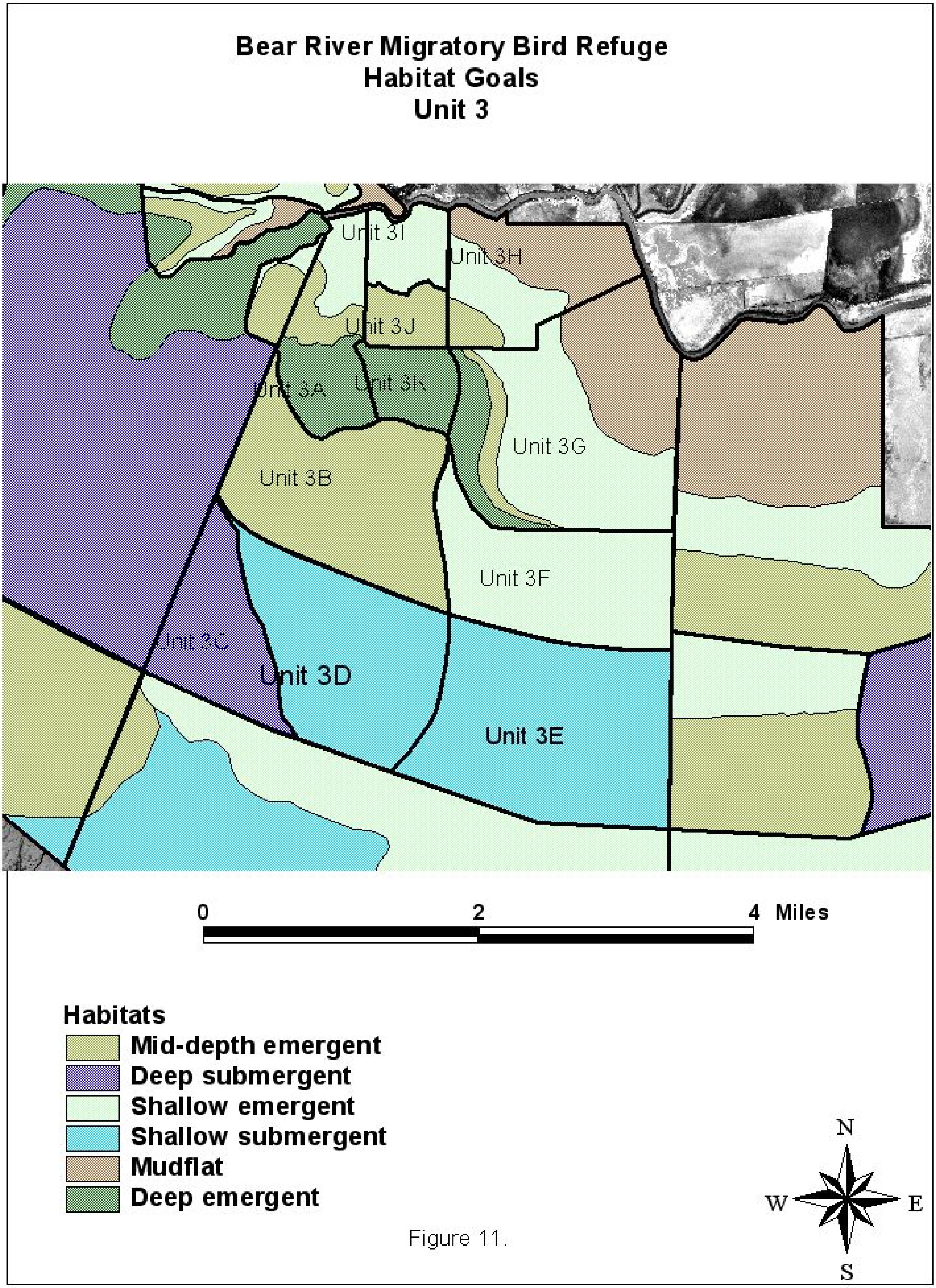

Bear River Migratory Bird Refuge
Habitat Goals
Unit 3
Unit 3I
Unit 3H
Unit 3J
Unit 3A
Unit 3K
Unit 3G
Unit 3B
Unit 3F
Unit 3C
Unit 3D
Unit 3E
0
2
4 Miles
Habitats
Mid-depth emergent
Deep submergent
Shallow emergent
Shallow submergent
Mudflat
Deep emergent
N
W
E
S

Figure 11.

Unit 4A

Goal: Maintain mudflat habitat for foraging and loafing waterbirds (Figure 12).

Objectives:

1) Maintain soil salinity levels at 10,000-15,000 ppm (15-23 m.mhos/cm) year-round.
2) Set stoplogs to capture precipitation events throughout the year to temporarily achieve target elevation of 4205.5'.
3) Allow precipitation events to flood and evaporate without management action to create 1,175 acres of vegetated mudflat habitat.

Strategy:

1: Manage saltair mudflat habitat by implementing strategy 1. No management action.

Desired habitats: Vegetated mudflat 0-2" = 1175 acres

Other habitats: Mid-depth emergent 6" = 942 acres
Shallow emergent 0-6" = 581 acres

Prescription:

Water flows over unit 4A during spring flood events. The unit generally goes dry by mid-summer (July) keeping the soil salinity high. No management actions will be required to maintain this unit in its natural state.

Unit 4B

Goal: Maximize mid-depth emergent wetland habitat to encourage colonization of alkali bulrush (Figure 12).

Objectives:

1) Manage soil salinity levels at about 5,000-8,000 ppm (8-12 m.mhos/cm), April 1 - October 15.
2) Maintain water at target elevation of 4204.5' msl year-round.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 784 acres of mid-depth emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3c i. Periodic drawdown to set back succession.
Production of alkali bulrush

Desired habitats: Mid-depth emergent 6-12" = 784 acres

Other habitats: Shallow emergent 0-6" = 458 acres

Prescription:

Unit 4B will be maintained at a mid-successional plant stage, dominated by alkali bulrush by maintaining water at elevation 4205.5' msl at the structure year-round. The salinity will be kept in the range of 5,000 - 8,000 ppm by holding a constant water level April 1-October 15. Inflows will just offset evaporation. In some years, unit 4B will be allowed to go dry to further increase soil salinity.

Unit 4C

Goal: Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed (Figure 12).

Objectives:

1) Maintain soil salinity levels at 5,000 - 10,000 ppm (8-15 mmhos/cm), April 1-October 15.
2) Maintain water level at 4206' msl, throughout the year.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 1528 acres of deep submergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, 3b. Match salinity levels with tolerance ranges of desired macrophytes, 3cii.Use of prescribed fire and/or mechanical disturbance, and 3ciii. Encourage colonization by muskrats.

Desired habitats: Deep submergent 18-30" = 1528 acres

Prescription :

The strategy for Unit 4C is to maximize the production of sago pondweed by holding the water elevation at the structure at 4206' msl throughout the year. Deep submergent wetland is the desired habitat. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000 - 10,000 ppm (April 1-October 15), by limiting flow through of fresh water. Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation.

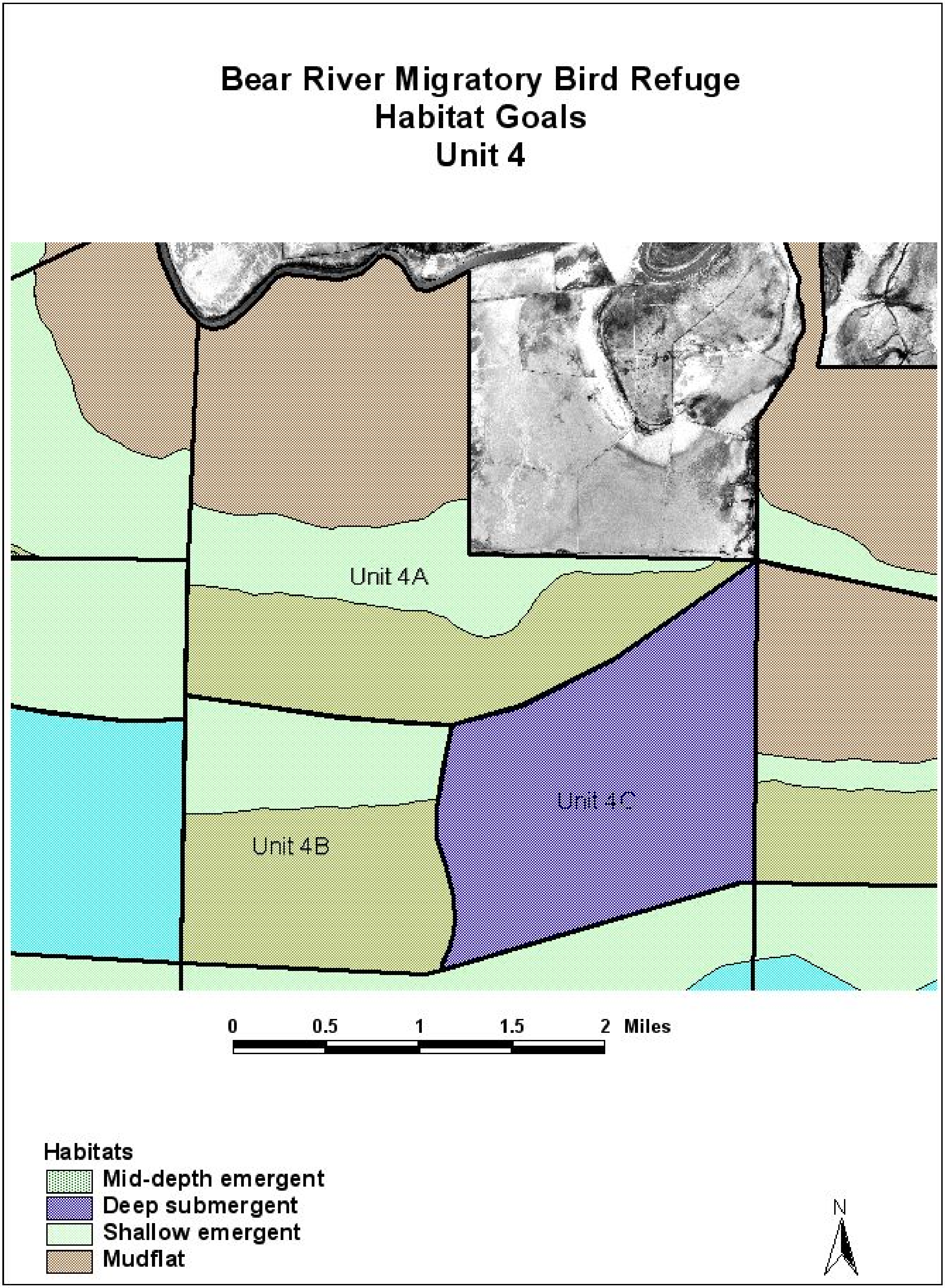

Bear River Migratory Bird Refuge
Habitat Goals
Unit 4
Unit 4A
Unit 4B
Unit 4C
0
0.5
1
1.5
2
Miles
Habitats
Mid-depth emergent
Deep submergent
Shallow emergent
Mudflat
N

Figure 12.

Unit 5A

Goal: Maintain mudflat habitat for foraging and loafing waterbirds (Figure 13).

Objectives:

1) Maintain soil salinity levels at 10,000-15,000 ppm (15-23 m.mhos/cm) year-round.
2) Set stoplogs to capture precipitation events throughout the year, to temporarily achieve target elevation of 4205.5'.
3) Allow precipitation events to flood and evaporate without management action to create 1,175 acres of vegetated mudflat habitat.

Strategy:

1: Manage saltair mudflat habitat by implementing strategy 1. No management action.

Desired habitats: Vegetated mudflat 0-2" = 1910 acres

Other habitat Shallow emergent 2-8" = 495 acres

Prescription:

Water flows over unit 5A during spring flood events. The unit generally goes dry by mid-summer (July) keeping the soil salinity high. No management actions will be required to maintain this unit in its natural state.

Unit 5B

Goal: Maximize mid-depth emergent wetland habitat to encourage colonization of alkali bulrush (Figure 13).

Objectives:

1) Manage soil salinity levels at about 5,000-8,000 ppm (8-12 m.mhos/cm) April 1-October 15.
2) Maintain water at target elevation of 4204.5' msl year-round.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 582 acres of mid-depth emergent wetland habitat.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, and 3b. Match salinity levels with tolerance ranges of desired macrophytes and 3ci. Periodic drawdown to set back succession.

Desired habitats: Mid-depth emergent 6-12" = 582 acres

Other habitats: Shallow emergent 2-8" = 207
Vegetated mudflat 0-2" = 994 acres

Prescription:

Unit 5B will be maintained at a mid-successional plant stage dominated by alkali bulrush by holding water at elevation 4204.5 at the structure year-round. The salinity will be kept in the range of 5,000 - 8,000 ppm, (April 1-October 15) by holding a constant water level. Inflows will just enough to offset evaporation. In some years, unit 5B will be allowed to go dry to further increase soil salinity. The northern portion of the unit will be maintained as vegetated mudflat, receiving water from precipitation and flood events, but drying by mid-summer.

Unit 5C

Goal: Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed (Figure 13).

Objectives:

1) Maintain soil salinity levels at 5,000 - 10,000 ppm (8-15 mmhos/cm) April 1-October 15.
2) Maintain water level at 4206' msl, April 1-December 15.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 1752 acres of deep submergent and 806 acres of shallow submergent wetland habitat.

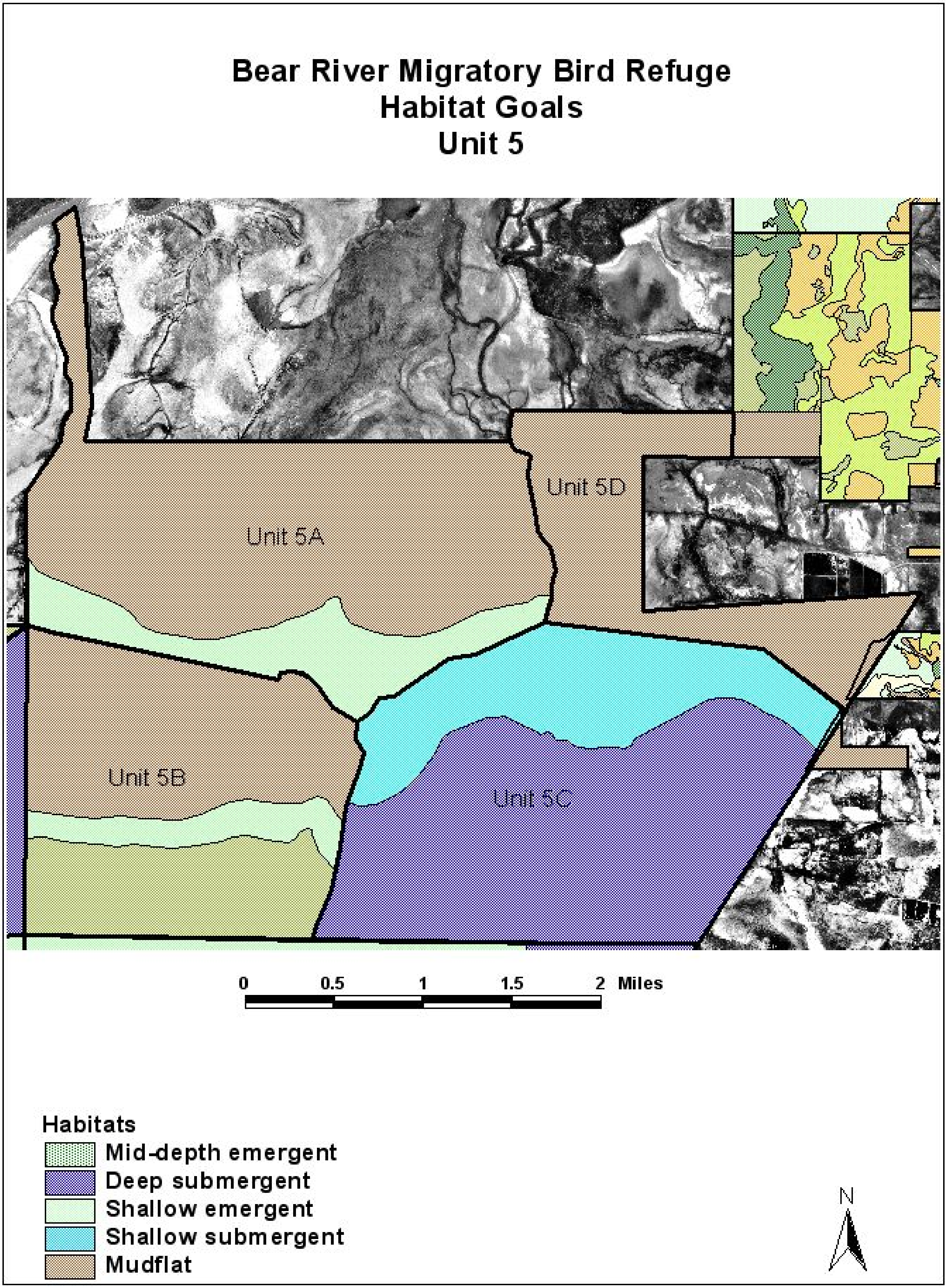
Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage water clarity using strategies 2a. Restrict carp and 2b. Reduce silt loading.
3: Control aquatic vegetation community composition using strategy 3a. Manage water depths, 3b. Match salinity levels with tolerance ranges of desired macrophytes, and 3cii.Use of prescribed fire and/or mechanical disturbance to set back vegetation succession.

Desired habitats: Deep submergent 18-42" = 1752 acres
Shallow submergent 12-18" = 806 acres

Prescription :

The strategy for unit 5C is to maximize the production of sago pondweed by holding the water elevation at the structure at 4206' msl, April 1-December 15. Deep and shallow submergent are the desired habitats. Water clarity is critical to production of submergent plants. Carp screens and filling in the late winter with clear, pre-peak flows will be used to maximize water clarity. Salinity will be kept in the range of 5,000 - 10,000 ppm, by limiting flow through of fresh water (April 1-October 15). Vegetation management such as fire or mowing, followed by flooding may be needed to set back vegetation. The Reeder canal that empties into the north end of Unit 5C is a constant source of salt cedar seed. Unit 5C will be kept deep for 4-5 years to prevent the establishment of vast stands of salt cedar. Unit 5C due to it's large size is subject to ice damage by wind fetch. The unit will be drawn down to about 4205' when ice begins to form in late fall (November-December). The unit will be held at the lower level throughout the winter and re-filled in the spring (March-April) to target elevation when danger of damage by ice has diminished.



Bear River Migratory Bird Refuge
Habitat Goals
Unit 5
Unit 5A
Unit 5B
Unit 5C
Unit 5D
0
0.5
1
1.5
2 Miles
Habitats
Mid-depth emergent
Deep submergent
Shallow emergent
Shallow submergent
Mudflat
N

Figure 13.

Units 6 - 10

Goal: Provide a diversity of wetland types by maximizing submergent wetland types in median or above median precipitation years to encourage colonization and growth of sago pondweed and alkali bulrush and to maintain mudflats in years with below median precipitation (Figures 14-18).

Objective:

1) Maintain salinity levels at 5,000 - 10,000 ppm (8 -15 m.mhos/cm) year-round.
2) Manage water levels to achieve 1,836 acres of deep submergent, 3,076 acres of shallow submergent, 6,206 acres of mid-depth emergent, and 4,962 acres of shallow emergent in median or above median precipitation years.

Strategy:

1: Manage salinity levels by implementing strategy 1b. Maintain existing water.
2: Manage saltair mudflat by using strategy 1. No management action.

Desired Habitats:	Deep submergent (18-24") = 1,836 acres
	Shallow submergent (4-18") = 3,076 acres
	Mid-depth emergent (8- 12") = 6,206 acres
	Shallow emergent (2-8") = 4,962 acres
Other Habitats:	Vegetated mudflat (0-2") = 13,967 acres

Prescription:

Units 6 through 10 are managed only by flowing water into them from units located above the D-line dike. There are no means to maintain water levels as there are no dikes or water-control structures. These units are directly linked to the Great Salt Lake. Habitat type maintenance in these units will depend on water management strategies utilized in units above them (i.e. constant or limited fresh water flow). During seasons or years of high water flow, these units will may be inundated when high river flows are diverted from the interior units through bypass canals in order to avoid flooding or over-filling the impounded units. Units 6-10 are also subject to flooding by rising water levels of the Great Salt Lake. Unit 10 contains a large area of vegetated mudflat. This area is subject to inundation by shallow sheet water during precipitation events or the rare occasion when the water level in the Great Salt Lake is high enough to reach the elevation in this area. There is no other means of getting water to the higher elevations of this unit.

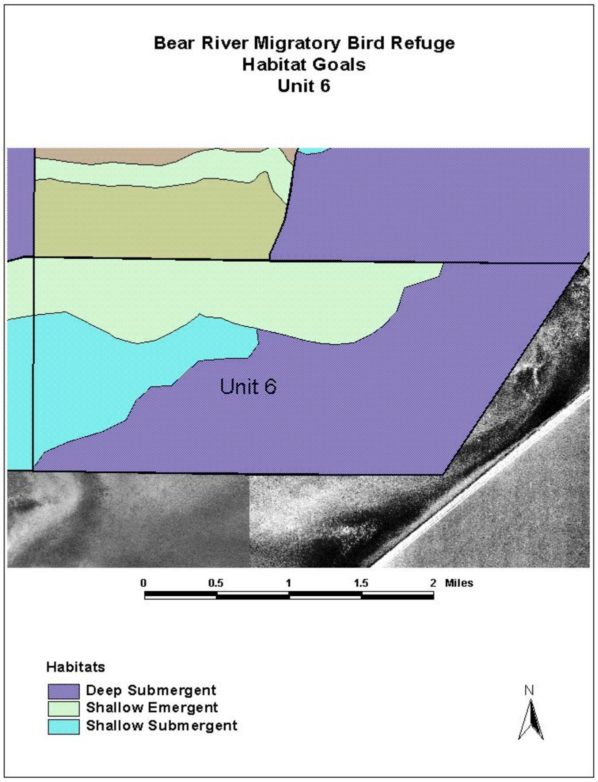


Figure 14.

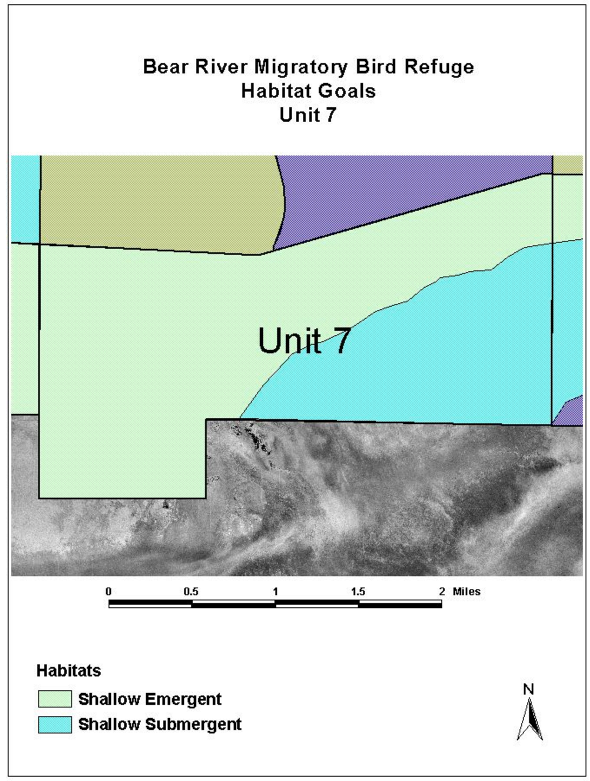


Figure 15.

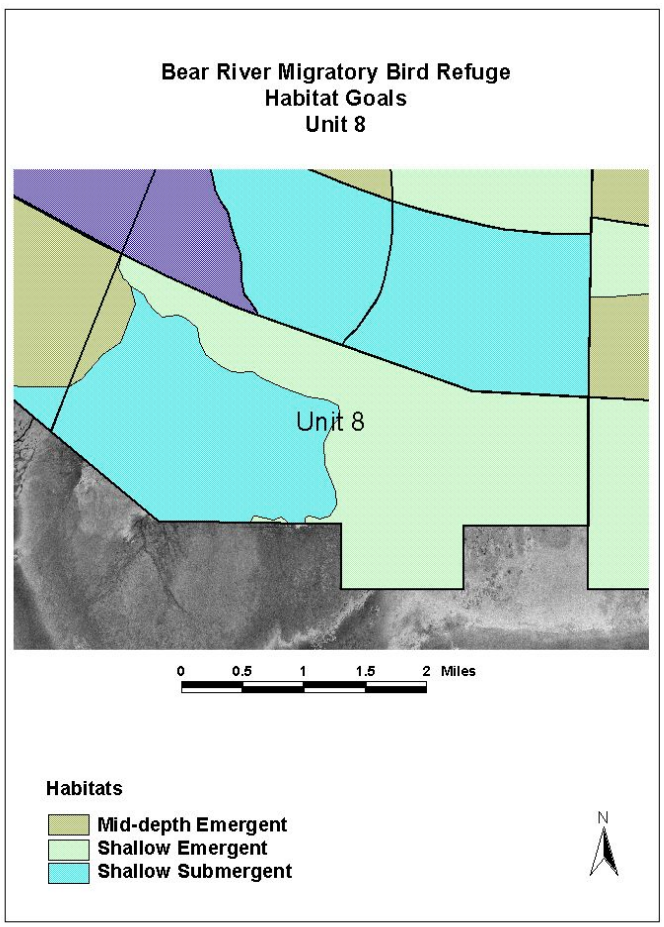


Figure 16.

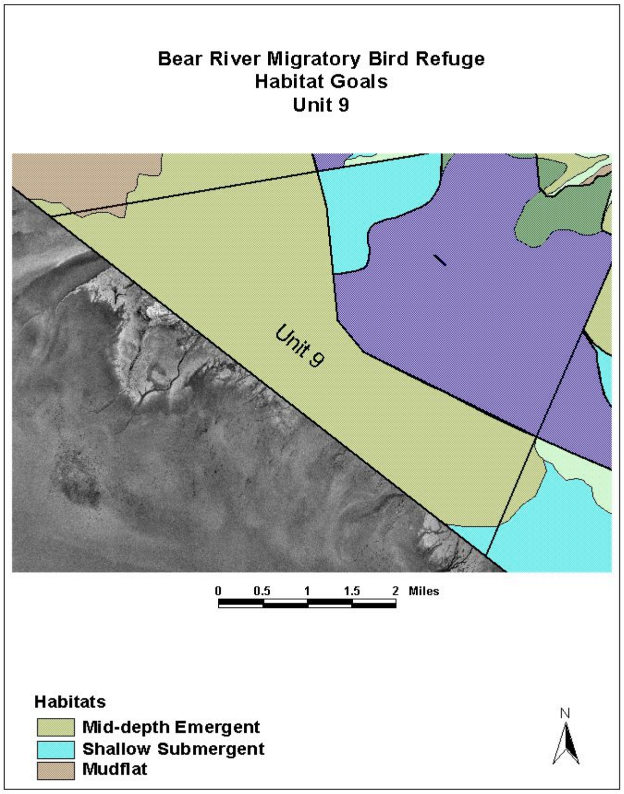


Figure 17.

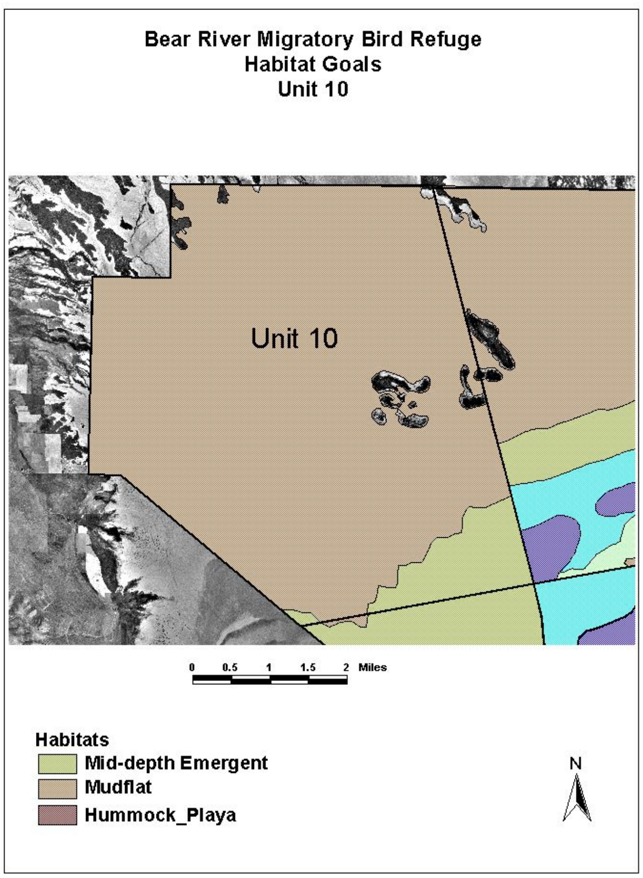


Figure 18.

Semi-desert Alkali Knolls

Goals: Manage for 511 acres of Semi-desert alkali knoll with a climax plant community (Figure 18).

Objectives:

1) Increase/maintain shrub cover at 35-40% (greasewood and shadscale) by 2015.
2) Increase/maintain grass cover at 15-30% (bottlebrush squirretltail and wheatgrasses).
3) Increase/maintain forb cover at 1-5% (shrubby seepweed, scarlet globemallow and shaggy fleabane).

Strategies:

1: Clipping of herbaceous understory in early spring (April-May).
2: Wildfire suppression (year-round).
3: Planting of desired herbaceous species (November-May).
4: No action.

Desired Habitats: Semi-desert alkali knoll = 511 acres

Prescription:

The frequency of occurrence per cover type (shrub, grass and forb) is currently unknown. A vegetation monitoring protocol will be drafted and implemented to help determine the most appropriate management strategy.

Dikes

Goal: Manage the dikes for a plant community that provides a range of short and sparse to tall and dense cover for nesting birds.

Habitat Objectives:

1) Increase grass cover to 80% (wheatgrasses, foxtail, and saltgrass) by 2008.
2) Increase forb cover to 15% (sunflower, kochia, curly-dock) by 2008.
3) Decrease tamarisk spp. to < 5% of cover area by 2005.
4) Decrease number of mammalian predators to allow for duck nesting success average of 18% and shorebird nesting success at 30% (minimum viable populations levels).

Strategy:

1: Planting desired grass species (November-May).
2: Periodic mowing. Only D-line and O-Canal will be mowed during nesting season (May 1-August 1).
3: Prescribed fire (April-May, November-December).
4: Mechanically and chemically treat tamarisk (April-October).
5. Predator control (March 1-June 1).

Prescription:

The dikes are an important habitat for ground nesting priority species such as American Avocet, Black-necked Stilt, Snowy Plover and Cinnamon Teal. All strategies will be implemented during the non-breeding season with the exception of predator control. A monitoring protocol will be written and implemented to determine effectiveness of management activities.

Semiwet Streambank

Goal: Manage for 45 acres (12.5 linear miles) of streambank habitat with a lowland riparian climax plant community.

Objectives:

1) Increase tree cover to 15% (boxelder and cottonwood) by 2015.
2) Increase shrub cover to 30% (willow, buffaloberry and sage) by 2015.
3) Increase grass and forb cover to 5% (bluegrass, field sedge, and common silverweed) by 2015.
4) Decrease tamarisk spp. to < 5% cover by 2005.

Strategy:

1: Plant desired species (March-May).
2: Treat tamarisk (April-October).

Prescription:

Currently, none of the streambank habitat is vegetated by woody species other than tamarisk. An aggressive tamarisk treatment/control program was implemented in 2002 and will continue as desired species are planted.

Unit: Nichols

Goal: Manage grasslands for alkali bottom and salt meadow climax plant communities that will provide a range of optimum habitat conditions for ground nesting birds (Figure 19).

Alkali Bottom Objectives:

1) Increase cover of grasses (saltgrass, alkali sacaton, wheatgrass, Basin wildrye) to 60% by 2015.
2) Increase forb cover to 5% (silverscale, fireweed, and hollyleaf clover) by 2015.
3) Increase shrub cover to 5% (greasewood) by 2015.
4) Decrease cheatgrass cover to < 10% by 2015.

Salt Meadow Objectives:

1) Increase grass cover (alkali bluegrass and saltgrass) to 65-75% by 2015.
2) Increase forb cover (lanceleaf goldenweed, fiddleleaf hawksbeard and sunflower) to 10% by 2015.
3) Increase shrub cover (iodinebush, rabbitbrush and greasewood) to 1-3% by 2015.

Strategy:

1: Prescribed grazing (November-May).
2: Mowing.
3: Haying.
4: Prescribed fire.
5: Planting of desired species.
6: Predator removal.

Wetland Objectives:

1) Manage ponds (N1-7) to achieve mix of 50% open water to 50% emergent vegetation or hemi-marsh conditions.
2) Maintain water level at 1' foot below the top of the dike year-round.

Wetland Strategy:

1: Control aquatic vegetative community composition using strategy 3a. Manage water depths, and 3ci. Periodic drawdowns in conjunction with 3cii. Use of prescribed fire and mechanical disturbance and prescribed grazing.

Desired habitats: Alkali Bottom = 118 acres
Salt Meadow = 763 acres
Mid-depth Emergent Marsh (8-12")=72 acres

Other habitats: Vegetated Mudflat = 22 acres
Wet Meadow = 2 acres

Prescription:

Alkali Bottom and Salt Meadow. Management emphasis on the alkali bottom and salt meadow habitats will be to achieve climax plant communities that provide diverse structure for optimum nesting conditions for a host of breeding birds. Currently, this unit is the process of recovering it's plant diversity that was lost through many years of overgrazing. Management is aimed at raising plant diversity as quickly as possible. In order to accomplish this, all management tools will be applied as necessary and results will be closely monitored. Primary management tools will be dormant season grazing of desired species (October-mid-May) and short duration (several days to two weeks), high intensity (1.25 - 2.0 A.U.M./acre) spring grazing of cheatgrass, prescribed fire, and mechanical manipulation.

Wetlands (Ponds N1-7). The Nichols unit has seven constructed wetlands or ponds (1-7). Five were created or modified in 2002. Each pond has a dike, water-control structure and water supply enabling water-level manipulation. However, water availability can be a limiting factor to habitat management in low water years. A variety of water rights acquired with the property, will be managed to provide water to these areas throughout the year. However, these rights do not guarantee an ample water supply to all areas during dry years. The new and modified ponds were filled in the spring of 2003. Water levels in the ponds will be maintained at 1' below the top of the dike year-round. This creates a variety of foraging depths for waterbirds and broods due to variations in topography. When the emergent vegetation (cattail spp.) becomes too dense over time, the unit will be drawndown in mid-summer, and then either burned, grazed, mowed or treated by all three strategies. The units will be re-flooded immediately following treatment if water supply is adequate. No more than two units per year will be in a state of drawdown for vegetation control.

Nichols unit habitat goals

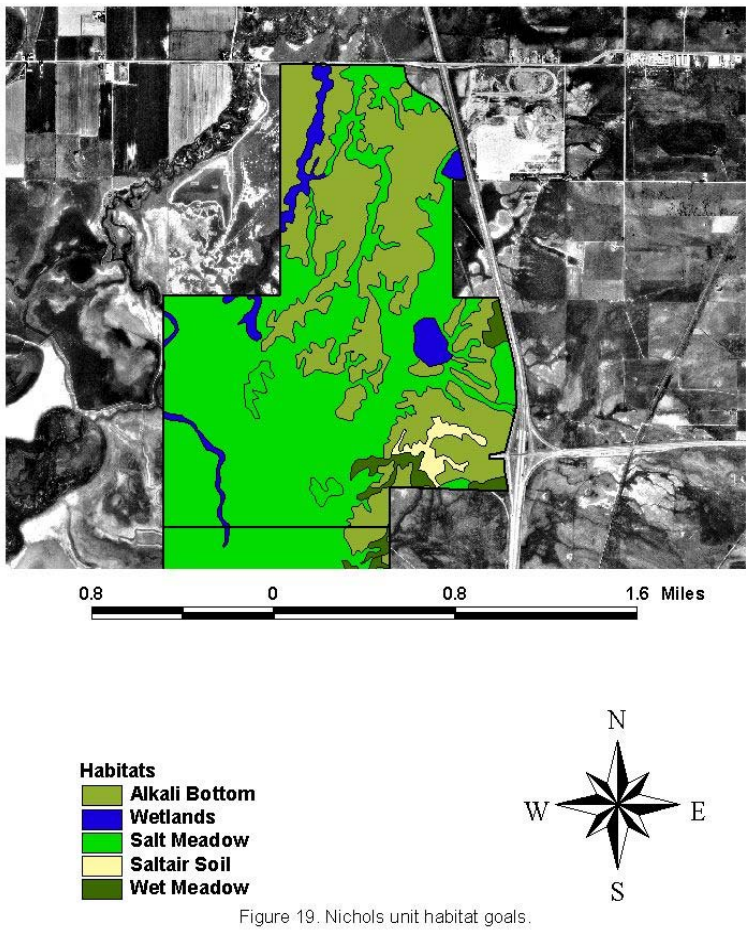


Figure 19. Nichols unit habitat goals.

Unit: White

Goal: Manage grasslands for salt meadow, wet meadow and alkali bottom climax plant communities that should provide optimum habitat conditions for an assortment of ground nesting birds (Figure 20).

Salt Meadow Objectives:

1) Increase grass cover (alkali bluegrass and saltgrass) to 65-75% by 2015.
2) Increase forb cover (lanceleaf goldenweed, fiddleleaf hawksbeard and sunflower) to 10% by 2015.
3) Increase shrub cover (iodinebush, rabbitbrush and greasewood) to 1-3% by 2015.

Wet Meadow Objectives:

1) Increase grass cover (*Carex* spp.) to 80% by 2015.
2) Increase forb cover (alkali marsh aster and common silverweed) to 5% by 2015.
3) Decrease shrub cover (rabbitbrush and greasewood) to 1% by 2015.

Alkali Bottom Objectives:

1) Increase cover of grasses (saltgrass, alkali sacaton, wheatgrass, Basin wildrye) to 60% by 2015.
2) Increase forb cover to 5% (silverscale, fireweed, and hollyleaf clover) by 2015.
3) Increase shrub cover to 5% (greasewood) by 2015.
4) Decrease cheatgrass cover to < 10% by 2015.

Strategy:

1: Prescribed grazing.
2: Mowing.
3: Haying.
4: Prescribed fire.
5: Planting of desired species.
6: Predator removal.

Desired habitats:	Salt Meadow = 708 acres Wet Meadow = 600 acres Alkali Bottom = 20 acres
Other habitats:	mid-depth emergent marsh (8-12") = 15 acres deep emergent marsh (12.1- 24") = 10 acres

Prescription:

Salt Meadow and Wet Meadow. Management emphasis on the salt meadow and wet meadow habitats will be to achieve climax plant communities that provide diverse structure for optimum nesting conditions for a host of breeding birds and foraging birds. Currently, this unit is the process of recovering it's plant diversity that was lost through many years of overgrazing. Management is aimed at raising plant diversity as quickly as possible. In order to accomplish this, all management tools will be applied as necessary and results will be closely monitored. Primary management tools will be dormant season grazing of desired species (October- mid-May) and short duration (several days to 2 weeks), high intensity (1.25-2.0 A.U.Ms/acre) spring grazing of cheatgrass, prescribed fire, and mechanical manipulation.

Wetlands (Ponds W1-7). The White unit has seven constructed wetlands or ponds (1-7). Two were created in 2002. Each pond has a dike, water-control structure and water supply enabling water-level manipulation. However, water availability can be a limiting factor to habitat management in low water years. A variety of water rights acquired with the property, will be managed to provide water to these areas throughout the year. These rights do not guarantee an ample water supply to all areas during dry years. All ponds were filled in the spring of 2003. Water levels in the ponds will be maintained at 1' below the top of the dike year-round. This creates a variety of foraging depths for waterbirds and broods due to variations in topography. When the emergent vegetation (cattail spp.) becomes too dense over time, the unit will be drawn-down in mid-summer, and then either burned, grazed, mowed or treated by all three strategies. The units will be re-flooded immediately following treatment if water supply is adequate. No more than two units per year will be in a state of drawdown for vegetation control.

Sagebrush Community

Goal: Manage area for a sagebrush or sagebrush steppe plant community with a co-dominant sagebrush/bunchgrass community.

Objectives:

1) Increase size of sagebrush dominated plant community to five acres by 2015.
2) Increase occurrence and cover of sagebrush to 40-50% by 2015.
3) Increase cover of bunchgrasses to 30-40% by 2015.
4) Increase cover of forbs to 10% by 2015.
5) Decrease cover of cheatgrass to < 10% by 2015.

Strategy:

1: Prescribed grazing.
2: Wildfire suppression.
3: Planting of desirable herbaceous species.
4. Hand harvest and seed dispersal.

Prescription:

This area is a small inclusion within the larger White Unit. It is currently about 1 acre in size. Prescribed grazing of this area will be within the context of the associated bunchgrass or alkali bottom ecological site. The above strategies are considered potential as the current vegetative composition is unknown. A vegetation monitoring protocol will be drafted and implemented to help determine the most appropriate management action and then following the affects of those actions.

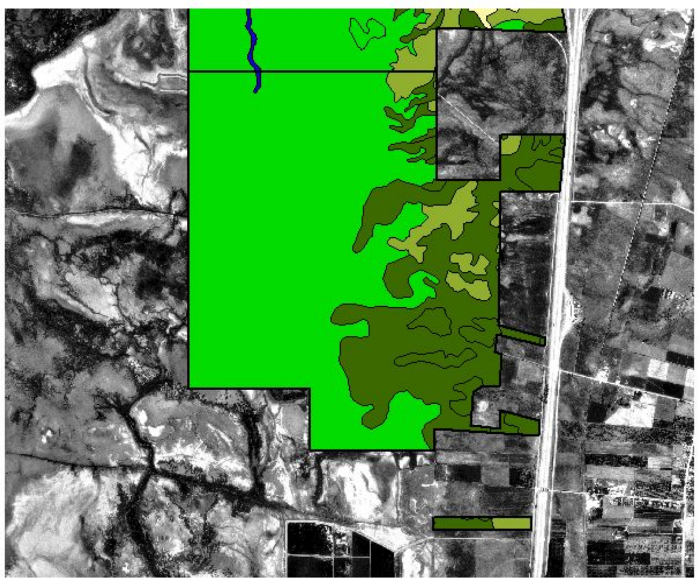


Figure 20. White Unit habitat goals.

Unit: Stauffer

Goal: Manage grasslands for wet meadow, salt meadow, and alkali bottom climax plant communities that should provide a range of optimum habitat conditions for ground nesting birds (Figure 21).

Wet Meadow Objectives:

1) Increase grass cover (*Carex* spp.) to 80% by 2015.
2) Increase forb cover (alkali marsh aster and common silverweed) to 5% by 2015.
3) Decrease shrub cover (rabbitbrush and greasewood) to 1% by 2015.

Salt Meadow Objectives:

1) Increase grass cover (alkali bluegrass and saltgrass) to 65-75% by 2015.
2) Increase forb cover (lanceleaf goldenweed, fiddleleaf hawksbeard and sunflower) to 10% by 2015.
3) Increase shrub cover (iodinebush, rabbitbrush and greasewood) to 1-3% by 2015.

Alkali Bottom Objectives:

1) Increase cover of grasses (saltgrass, alkali sacaton, wheatgrass, Basin wildrye) to 60% by 2015.
2) Increase forb cover to 5% (silverscale, fireweed, and hollyleaf clover) by 2015.
3) Increase shrub cover to 5% (greasewood) by 2015.
4) Decrease cheatgrass cover to < 10% by 2015.

Strategy:

1: Prescribed grazing.
2: Mowing.
3: Haying.
4: Prescribed fire.
5: Planting of desired species.
6: Predator removal.

Desired habitats: Wet Meadow = 263 acres
Salt Meadow = 29 acres
Alkali Bottom = 18 acres
Deep Emergent Marsh, 12" - 24" = 4 acres

Prescription:

Wet Meadow and Salt Meadow. Management emphasis on the wet meadow and salt meadow habitats will be to achieve climax plant communities that provide diverse structure for optimum nesting conditions for a host of breeding birds and foraging birds. Currently, this unit is the process of recovering it's plant diversity that was lost through
many years of overgrazing. Management is aimed at raising plant diversity as quickly as possible. In order to accomplish this, all management tools will be applied as necessary and results will be closely monitored. Primary management tools will be dormant season grazing of desired species (October- mid-March) and short duration (several days to two weeks), high intensity (1.25-2.0 A.U.Ms/acre) spring grazing of cheatgrass, prescribed fire, and mechanical manipulation.

Wetlands (Ponds S1-2). The Stauffer Unit has two constructed wetlands or ponds (1-2). Each pond has a dike, white-control structure and water supply enabling water-level manipulation. However, water availability can be a limiting factor to habitat management in low water years. A variety of water rights acquired with the property, will be managed to provide water to these areas throughout the year. These rights do not guarantee an ample water supply to all areas during dry years. All ponds were filled in the spring of 2003. Water levels in the ponds will be maintained at 1' below the top of the dike year-round. This creates a variety of foraging depths for waterbirds and broods due to variations in topography. When the emergent vegetation (cattail spp.) becomes too dense over time, the unit will be drawn-down in mid-summer, and then either burned, grazed, mowed or treated by all three strategies. The units will be re-flooded immediately following treatment if water supply is adequate. No more than 25% of all the ponds in the grassland units per year will be in a state of drawdown for vegetation control.

Stauffer Unit habitat goals

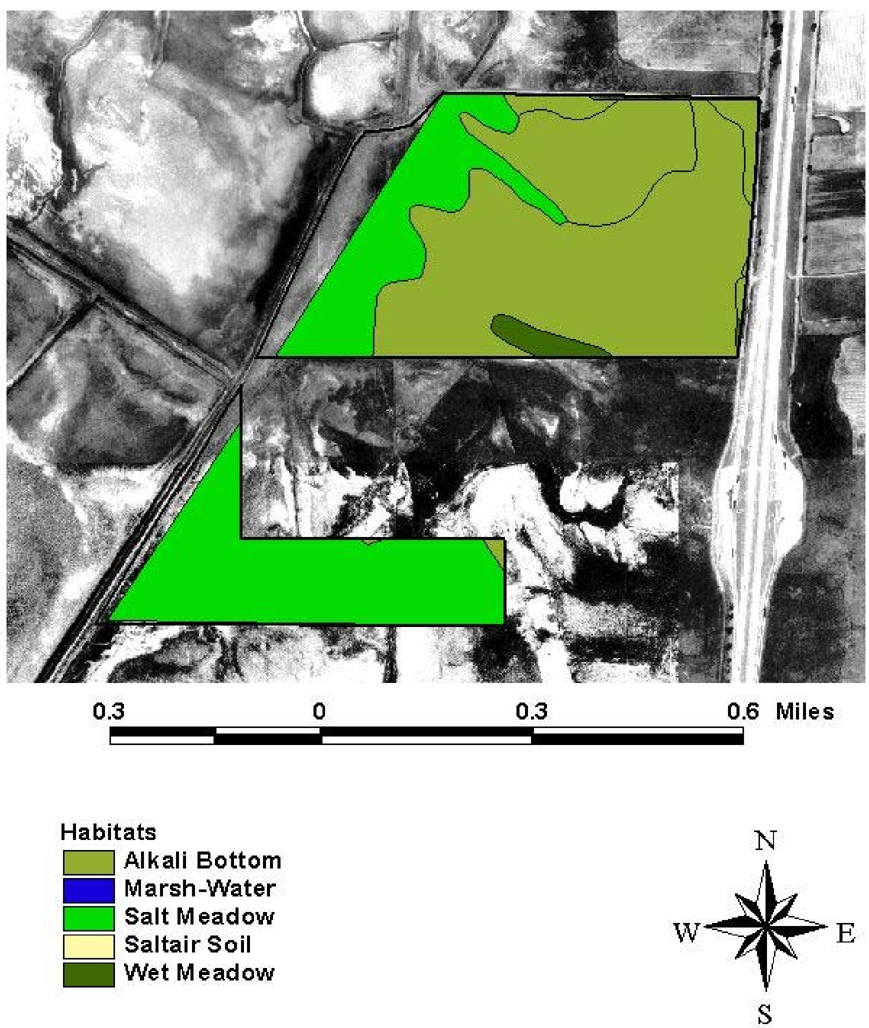


Figure 21. Stauffer Unit habitat goals.

Appendix D.
Annual Habitat Management Plan

U.S. Department of the Interior
Fish and Wildlife Service
Bear River Migratory Bird Refuge

58 South 950 West
Brigham City, Utah 84302
Phone: (435) 723-5887
Fax: (435) 723-8873

Annual Habitat Management Plan
2004

April 20, 2004

Annual Habitat Management Plan
2004
Bear River Migratory Bird Refuge
Brigham City, Utah

April 20, 2004

Prepared by:	______________________________ Wildlife Biologist, Bear River Migratory Bird Refuge	________________ Date
Recommended by:	______________________________ Project Leader, Bear River Migratory Bird Refuge	________________ Date
Concurred by:	______________________________ Section Chief, Water Resources Division	________________ Date
Reviewed by:	______________________________ Refuge Field Supervisor, Montana/Wyoming/Utah	________________ Date

Bear River Migratory Bird Refuge
2004 Annual Habitat Management Plan

HABITAT OBJECTIVE

WETLAND
The overall wetland habitat objective for Bear River Refuge is to manage the 29,259 wetland acres for 9% deep submergent, 28% shallow submergent, 14% deep emergent, 23% mid-depth emergent and 26% shallow emergent marsh, annually.

1) 2,500 acres of deep submergent marsh with 18.1 to 36 inches of water (March-December), 60-80% coverage by sago pondweed and < 15% coverage by emergent vegetation (June-October).

2) 8,700 acres of shallow submergent marsh with 4 to 18 inches of water (February-December), 60-80% coverage by sago pondweed and < 15% coverage by emergent vegetation (June-October).

3)2,800 acres of deep emergent marsh with 12.1 to 24 inches of water (February-November), 50-70% coverage by emergent vegetation (predominantly hardstem bulrush and alkali bulrush) interspersed with 40-50% open water with submerged sago pondweed (June-October).

4) 6,600 acres of mid-depth emergent marsh with 8.1 to 12 inches of water (February-November), with 50% emergent vegetation (alkali bulrush in shallower areas and hardstem bulrush in deeper zones, phragmites, and cattail) and 50% open water with sago pondweed (June-October).

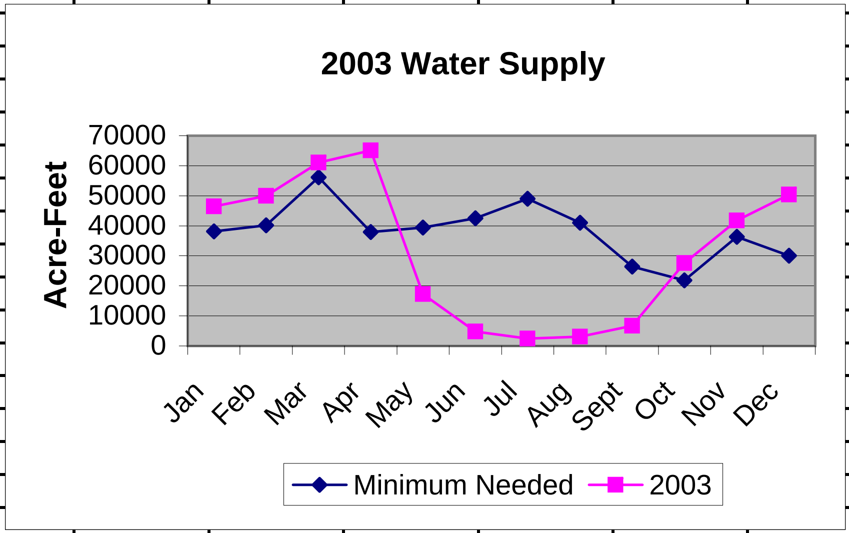
5)8,659 acres of shallow emergent marsh with 2 to 8 inches of water (February-November) with 50-70% coverage by emergent vegetation (90% alkali bulrush, 10% phragmites and/or cattail) and the remainder open water (June-October).

Water levels in the 26 management units are manipulated or influenced to achieve these objectives. In 2003 these objectives were unmet due to low water conditions. Target water levels (and associated habitat) were maintained in only three units through the summer months; Unit 5B, 2B and 1A. Unit 5B was the refuge's highest priority for 2003, as the emergent vegetation in the unit is occupied by a large waterbird colony of several Refuge priority bird species including White-faced Ibis and Franklin's Gull. Other units received water as available from the Bear River. The three units made up 2,564 acres of wetlands that were maintained through July and August out of a possible 29,259 acres. Graphs of the unit water levels for 2003 are found in Appendix A. Habitat and tamarisk treatment maps are found in Appendix B.

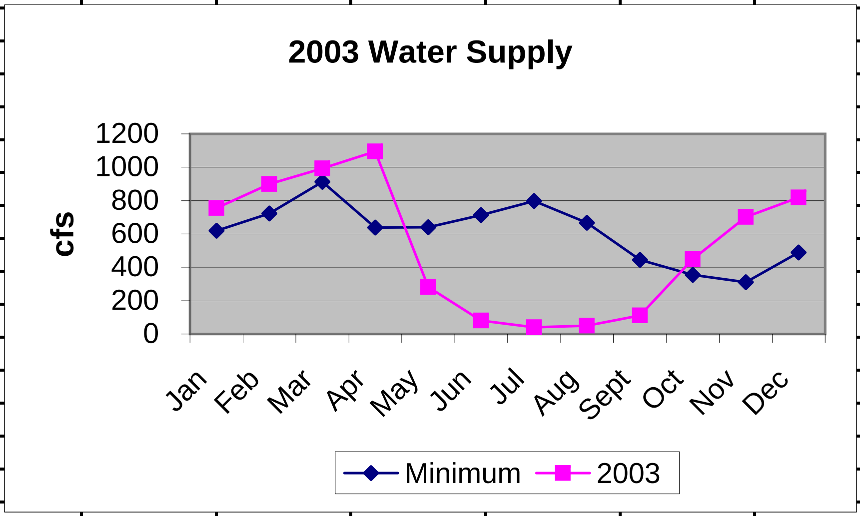
2003 Water Summary

The drought that began in 1997 with below normal snowpack, continued through 2003. The snowpack in the Bear River Basin by February of 2003 was only 67% of normal, down from 78% in 2002 and 68% in 2001. The National Weather Service forecast for streamflow based on snow-pack was for < 50% of normal amounts. The cumulative effects of six years of lower than average snowpack resulted in low soil moisture, low water levels in the reservoirs (most especially Bear

	Minimum Needed Ac.-ft.	2003 Actual Ac.-ft.	Water Year (Oct. 2002-Sept. 2003) Deficit	
Jan	38123	46460	8337	
Feb	40154	49930	9776	
Mar	56139	61070	4931	Total
Apr	37964	65110	27146	Deficit
May	39414	17250	22164.00	164011.00
Jun	42487	4810	37677.00	
Jul	48990	2490	46500.00	
Aug	41013	3100	37913.00	
Sept	26417	6660	19757.00	
Oct	21793	27600	5807	
Nov	36298	41770	5472	
Dec	30008	50370	20362	
Total	**458800**	**376620**		



	Minimum cfs	2003 cfs	Deficit	
Jan	620	756	136	
Feb	723	899	176	
Mar	913	993	80	Total
Apr	638	1094	456	Deficit
May	641	281	360.00	2699.00
Jun	714	81	633.00	
Jul	797	40	757.00	
Aug	667	50	617.00	
Sept	444	112	332.00	
Oct	354	449	95	
Nov	310	702	392	
Dec	488	819	331	
Total	**6821**	**5457**		



Lake) and decreased river flows. The 2003 (water-year) Bear River annual mean flow rate of 520 ft^3/s was the second lowest on record while the annual runoff of 376,600 ac-ft. was the lowest on the record. The monthly discharge for July and August at 40.4 ft^3/s and 50.4 ft^3/s respectively are the lowest on record. A new daily minimum daily discharge record was also set at 25 ft^3/s on June 13 and 14, 2003.

The October (2002)-April (2003) flows were all < 50% of normal. The Bear River flow "crashed" from 50% to 10% of normal from April to May due to early irrigation demand because of the dry winter (low soil moisture) and low snow pack in the mountains. Bear River flows during June, July, August (the peak nesting period for Refuge priority bird species and a critical time for aquatic plant germination, growth and production) averaged only 6% of normal at 57 ft^3/s. The low water supply and subsequent negative effects on Refuge habitats was further exacerbated by higher than normal evaporation rates due to record high temperatures in July and August. The National Weather Service reported that July was the hottest on record with 14 consecutive days above 100EF and August was the second hottest on record. Low Bear River flows continued throughout the fall which led to only a few units re-filled to target level before the onset of fall waterfowl migration. A cold snap in early December froze over the majority of each of the units but re-opened for a brief time in mid-December. Unit by unit details follow.

Summary of 2003 management effects

Unit 1 Objective

1. Manage water levels to achieve 440 acres of deep submergent, 2160 acres of shallow submergent, 1491 acres of mid-depth emergent and 547 acres of shallow emergent wetland habitat, April 1-December 15.

Strategy: Re-fill unit 1 with clear water (sans silt) to achieve target elevation of 4204.5 by April 1 and maintain target through December 15.

A. Management Strategy Prescriptions. Unit 1 was re-filled to target by March 1, 2003 with clear water after a winter drawdown of 4203.1 to protect dikes and water-control structures from ice-damage. The target water elevation was maintained around 4204.5 until June. As this unit was not one of the priority units it was allowed to dry-out. The unit went dry by mid-July and did not receive any water until mid-September. Re-filling of this unit was initiated on September 19 and reached the target of 4204.5 on October 9 and held until mid-December. On December 18, two layers of boards (equal to about 16") were pulled to begin winter draw-down. About 502 acres in Unit 1 were treated in 2003 for tamarisk. Eight acres were treated by pulling the trees and another 494 acres were sprayed.

B. Habitat Response. At elevation of 4204.5 there are 3,460 acres of surface water. April through June, wetland types were 1380 acres of shallow emergent, 1780 of shallow submergent and 300 acres of deep submergent. Sago pondweed germination and production was good though tuber and seed production was poor as the unit became dry during critical development stages. By mid-July the unit consisted of over 11,000 acres of dry mudflat.

C. Response of *Resources of Concern*. A colonial waterbird colony consisting of about 2500 nests of Refuge priority species White-faced Ibis and Franklin's Gulls along with Black-crowned Night Heron and Snowy Egret was noted in this unit. The effects of the drying conditions on this colony is unknown though nesting success was likely negatively impacted by ground predators and abandonment of eggs and young by adults was likely. Two Snowy Plover nests were found on the alkali flats in the north end of this unit in June. Unit1 is a traditional high use unit by Tundra Swans. This unit accounted for 31% of the total Swan use of the Refuge in the spring and 53% of the Swan use in the fall. The lack of food on the Refuge resulted in Tundra Swan flocks being more evenly spread out in the Great Salt Lake marshes during the fall. This behavior resulted in a higher total harvest over 2002 during the Utah swan hunting season and a significant decrease in the number of swans harvested from the Refuge. This unit accounted for about 20% of the total duck use throughout October. Unit 1 receives very little use (<3%) by spring and fall migrant shorebirds.

Units 1A, 3A and 3K Objective

1. Manage water levels to achieve 50% interspersion of open water to 50% emergent vegetation.
A. Management Strategy Prescriptions. Unit 1A No water elevation data is available as this unit has no water gauge. The water in this unit is dictated by the height of the Bear River. A low water crossing adjacent to the river allows water to flow into this unit at elevation 4206.0. The outlet structure on the west dike is at 4204.6 and acts as a low-water crossing. A single board can be added to the outlet structure to hold water around 4205.4. As a priority, this unit was kept full of water all year by keeping enough head on the river at the Headquarters three-way gate to spill into the unit. Units 3A and 3K No water elevation data is available as these units have no water gauges. In general, the units were filled with water in the spring and went dry by May 8. Re-filling began on October 8 via the Bear River inflatable water-control-structure.
B. Habitat Response. The habitat objective was met in Unit 1A. A survey of the unit indicated that 42% or 232 acres of the unit was open water and the remaining 48% (312 acres) was emergent vegetation. About 25% of the emergent vegetation was alkali bulrush. The remaining area was covered by stands of hardstem bulrush as well as stands of undesirable species of *Phragmites,* cattail and tamarisk.
About 90 acres of this unit were treated for tamarisk. Twenty-one acres were treated by pulling and the remainder was sprayed. The unit was frozen by November 26.
Habitat objectives for Units 3A and 3K were unmet due to dry conditions. Both units were treated for tamarisk. About 8 acres of tamarisk were pulled in 3K. A total of 149 acres were treated in 3A by both pulling (55 acres) and discing (94 acres). Unit 3A was frozen by November 26.
C. Response of *Resources of Concern.* The main use of Unit 1A by priority species is migratory waterfowl. Waterbird counts do not show significant use of this unit (<1%) though it is difficult to count as the emergent vegetation obstructs the view from the tour loop. Units 3A accounted for about 10% of dabbling duck and migrant shorebird use in the spring. 3K hosted about 8% of the Refuge total dabbling duck population in late January. A Long-billed Curlew was noted in the unit on June 8th.

Unit 2A and 2B Objectives
1. Manage water levels to achieve 75% cover by alkali bulrush.
A. Management Strategy Prescriptions. No water elevation data is available as these units have no water gauges. Unit 2A was full in the spring, dry by mid-July and full in late fall. The screw gate into the unit was closed on July 31. The inlet structure to 2A was cleaned out in July and the dike by the photoblind patched. Seventy-six acres of 2A was treated for tamarisk; 43 acres were disced, 5 acres were pulled and 27 acres sprayed. As a priority, Unit 2B was kept full throughout the year. Thirteen acres of 2B were treated by pulling tamarisk along the dikes. A large hole likely caused by a muskrat, was patched in the south dike of 2B.
B. Habitat Response. The habitat objective in unit 2A was unmet due to dry conditions. There was little to no production by alkali bulrush. The habitat objective was met in Unit 2B. A survey in October indicated that 75% of the unit was covered by alkali bulrush (217 acres) with the remainder open water (74 acres). The unit was frozen by November 26.
C. Response of *Resources of Concern.* Unit 2A accounted for 10% of the migratory waterfowl population and Tundra Swan population on February 14. The unit did not contribute significantly toward supporting priority species at any other time of the year. Unit 2B was consistently occupied by Redhead throughout the summer breeding months. This unit accounted for 3 to18% of the Refuge's Redhead population during May, June, July and early August. White-faced Ibis were also found foraging in Unit 2B throughout the breeding season (May-Aug.). This unit also hosted up to 33% of the Refuge's Franklin's Gull population on April 24. Three Long-billed Curlews (family unit) were noted in the unit on September 17. Unit 2B was a study site as part of an investigation into the nesting success of American Avocet and Black-necked Stilt's on the Refuge by Dr. John Cavitt, Weber State University, Ogden, UT. Twelve avocet and stilt nests were monitored. Mayfield nest success was %18 in Unit 2B. This success rate contrasts sharply to the success rate of 4% for unit 2C where the water levels were not maintained throughout the summer months. Flooding accounted for 8% of nest failures while predation was the most common cause of nest failure.

Unit 2C Objective

1.Maintain water-level at 4204.5' msl, year-round.
2. Increase sago pondweed to cover 70% of the unit.
3. Manage water levels to achieve 504 acres of shallow submergent wetland and 216 acres of shallow emergent wetland.
A. Management Strategy Prescriptions. The unit was full to target by mid-March, and went dry by latter July. Refilling was initiated October 9, with fish screens across the inlet structure to keep out large carp. Three of the five fish screens were pulled out of the WCS on October 10 as the screens were severely impeding the water flow. The unit reached target level on October 14. The unit was held about a foot above the target level of 4204.5 to further stress the treated tamarisk by depriving the roots of oxygen. Over 800 acres of this unit was treated for tamarisk by pulling (131 acres) and mowing (543 acres).
B. Habitat Response. The habitat objectives were unmet due to drying conditions with little to no sago pondweed production and emergent vegetation. The unit was frozen by November 26.
C. Response of *Resources of Concern*. This unit hosted from 4 to 8% of the migrant waterfowl population in the spring, 38% of the American White Pelican population on June 20, and 12% of the White-faced Ibis population in latter July. The unit was favored by Black-necked Stilts as the unit

hosted from 10 to 39% of the Refuge's total population before drying from mid-May to latter July. Unit 2C was a study site as part of an investigation into the nesting success of American Avocet and Black-necked Stilt on the Refuge. Fifty-seven avocet and stilt nests were monitored. Mayfield nest success was only 4%. This success rate contrasts sharply to the success rate of 18% for unit 2B where the water levels were maintained throughout the summer months. Flooding accounted for 9% of nest failures while predation was the most common cause of nest failure. Dropping water levels allow mammalian predators easier access to shorebird nests thus negatively impacting nesting success rates of these Refuge priority species. The only nesting attempt by Black Tern's on the Refuge was noted in this unit. The nest failed.

Unit 2D Objective

1. Manage water levels to achieve 4,029 acres of deep submergent and 590 acres of deep emergent habitat.
A. Management Strategy Prescriptions. The target elevation of 4206.0 was not achieved. This is an unrealistic target due to the amount of boards the structure will hold and will be changed in 2004. The unit was re-filled starting in January from a draw-down that was meant to protect it from ice-damage. The unit did not freeze in winter of 2002-2003. A maximum level of about 4205.3 was achieved on May 22. The unit steadily lost water to evaporation throughout late spring and summer until it went dry in latter August. All boards were pulled from the outlet structure in mid-August to de-water the unit in order to facilitate surveying crews shooting contour elevations. The unit was re-filled starting mid-September and achieved a maximum elevation of 4205.4 on November 21. Two layers of boards were pulled from the outlet structure on December 18 to begin winter draw-down. Two hundred and fifty-two acres of the unit were treated for tamarisk by spraying.
B. Habitat Response. The habitat objective was met only during early spring before drying out, as sago pondweed was noted as abundant during several airboat trips. The unit was unvegetated mudflat habitat from late August to mid-September. The unit was frozen by December 5th.
C. Response of *Resources of Concern.* This unit was utilized by all the refuge priority species. Significant numbers of Cinnamon Teal were found in this unit as 20 to 28% of the population in latter June and early July were observed in Unit 2D. This unit also accounted for 52% of the Redhead population on July 10. The unit was particularly important in July and August to shorebirds as it hosted, 2-20% of the Snowy Plovers, 55-74% of Black-necked Stilt, 8-68% of American Avocet, 11-36% of Marbled Godwit, 82-99% of Wilson's Phalarope, 7% of dowitchers, 54-80% of all migrant shorebirds, as well as 17-70% of the American White Pelicans, 29-77% of the White-faced Ibis, 66-76% of Franklin's Gull, 86% of migrant Black Tern, and 25% of the dabbling duck population on October 24. A single Long-billed Curlew was noted in the unit on August 7^{th} and 21^{st}.

Unit 3B Objective

1. Increase amount of alkali bulrush to account for 60% of emergent vegetation.
A. Management Strategy Prescriptions. No water elevation data is available as this unit has no water gauge. In general, the unit was filled with water in the spring, went dry by mid-July and was re-filled via H-canal starting October 9. Thirty-six acres of the unit were treated for tamarisk by pulling.

B. Habitat Response. The habitat objective was unmet due to drying of the unit. In spite of the dry conditions the stand of alkali bulrush was considered "good". The unit was 90% frozen by December 5.
C. Response of *Resources of Concern.* The unit provided staging habitat for migratory waterfowl in the spring (Feb.-Apr.), consistently hosting 4-12% of the Refuge population, 23% of the avocet population on April 24 and 21% of the Refuge population of Franklin's Gull. The unit received very little use by priority species the remainder of the year due to dry conditions in the summer and late filling of the unit in the fall.

Units 3C and 3D Objective

1. Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed.
A. Management Strategy Prescriptions. Unit 3C The target elevation of 4206.0 was never achieved. The unit reached a maximum elevation of 4204.2 on March 21and began a decline to dry-out by June 19. The unit remained dry throughout the summer months. The unit was re-filled beginning late October and reached a peak elevation of 4204.6 on December 12. The unit was 95% frozen by December 5. Tamarisk treatment in this unit consisted of pulling the plant from along the dikes for a total of 36 acres. Unit 3D The target elevation of 4205.0 was not reached in the spring. A maximum elevation of 4204.9 was noted on April 9. The unit was noted as dry by June 9 and re-filling wasn't initiated until after October 20. The 4205.0 target was achieved on November 21. The unit was frozen by November 26. About 240 aces of this unit were treated for tamarisk by pulling.
B. Habitat Response. The habitat objective was not achieved in either unit. There was little to no sago pondweed production in the units.
C. Response of *Resources of Concern.* Unit 3C This unit was favored by Redhead in early May, hosting 7-11% of the Refuge population. Eleven percent of the Pelican population was found in this unit on June 6th, while 50% of the avocet population was observed on June 20. This unit did not contribute significantly (> 5%) to any priority species during the fall. Unit 3D received fair use by migratory waterfowl in the spring hosting 11-21% of the Refuge population in February and March. The unit also hosted about 6% of the Cinnamon Teal population and 11% of the Franklin's Gulls on May 1, and 17% of Wilson's Phalaropes on June 6. There was no significant use of this unit in the fall by priority species.

Units 3E, 3F and 3G

No objectives were set for these units as they were low priority and would not be kept full of water throughout the summer months.
A. Management Strategy Prescription. Unit 3E target elevation of 4205.0 was reached by March 13, 2003. The unit slowly dried out until it was 100% dry by June 19. Re-filling of the unit did not start until after November 5th. There is no water level data available for unit 3F and 3G as they have no gauges. The same scenario described for unit 3E applies to 3F and 3G also. The units were frozen by November 26th. Both units were treated for tamarisk by pulling; 55 acres in 3F and 308 acres in 3G.
B. Habitat Response. Sago pondweed appeared to germinate in these units but no production was noted due to the dry conditions.

C. Response of *Resources of Concern*. Unit 3E This unit provided significant habitat to priority species only in April and May. The unit accounted for 9-29% of the Cinnamon Teal, 16-40% of the Redhead, 9-47% of the migratory waterfowl, 9% of White-faced Ibis, 18% of Black-necked Stilt, 8-36% of American Avocet, 18% of Dowitchers, 9-25% of migratory shorebirds and 14% of Franklin's Gull. A pair of Long-billed Curlew were noted in the unit on July 22nd. Unit 3E was a study site as part of an investigation into the nesting success of American Avocet and Black-necked Stilt on the Refuge. Fifty-four avocet and stilt nests were monitored. Mayfield nest success was 55%. This compares to 18% and 4% success rates found in units 2B and 2C respectively. Many of the avocet and stilts nesting in 3E nested in colonies. There was a significant positive relationship between nest density and nesting success. Nests of avocets, stilts, Killdeer and Snowy Plover were also monitored on the dikes around unit 3E. Mayfield nesting success on the dikes for avocets and stilts (36 nests) was 31%, Killdeer was 40% and Snowy Plovers was 54%. Unit 3F About 5% of the migratory waterfowl were found in this unit on April 6th, while 10% of the Refuge's population of Wilson's Phalarope was observed here on May 16. A pair of Long-billed Curlew were noted in the unit on July 10th. The most significant use of this unit was by post-breeding Snowy Plovers and chicks found on the alkali flats near the borrow area that was still covered by about 2" of water. 106 of the Refuge's 117 Snowy Plovers were found here on July 22nd while 16 of the total 20 were observed on August 7.
Unit 3G A pair of Long-billed Curlews were noted in the unit on July 10th and a single bird was noted on July 22nd. Also only July 22nd, the unit hosted 82% (170) of the Refuge population of Wilson's Phalarope.

Unit 3H, 3I and 3J Objective

1. Maximize emergent wetland type to encourage colonization of alkali bulrush.

A. Management Strategy Prescriptions. There is no water elevation data available as none of these units have water gauges. In general, the units were full in the spring, dry by late June and then re-flooded starting in October. The units were frozen by November 26th. A flap gate was installed in the canal from the Bear River into 3H to prevent water flowing out of 3H into the river during periods of low river flow. An outlet structure was installed in 3H to allow the unit to drain into the Unit 3 drain canal. Units 3H and 3J were both treated for tamarisk. About 131 acres in 3H and 12 acres in 3J were pulled.

B. Habitat Response. Unit 3H responded to drier than normal conditions with good growth of salt grass and pickleweed. Units 3I and 3J are about 70% emergent vegetation (cattail) and 30% open water.

C. Response of *Resources of Concern.* Unit 3H This unit hosted the 2003 Refuge peak count of 8 Long-billed Curlew on April 24. In March 3H held about 9% of the Refuge's Cinnamon Teal, 4 Snowy Plover and 27% (243) Franklin's Gull on June 20, 198 Marbled Godwit (19%), and 574 Wilson's Phalarope (95%), July 10. Unit 3I Priority species use of this unit included 14% of Refuge population of Cinnamon Teal (354) on March 28, and 11% (160) on July 10. In addition, the unit hosted 32% (306) of Refuge population of Dowitchers on August 7. Unit 3J received no significant use by priority species.

Unit 4A and 5A Objective

1. Maintain mudflat habitat for foraging and loafing waterbirds.
A. Management Strategy Prescriptions. These units have wet mudflats with less than 2 inches of standing water shortly after precipitation events otherwise they're dry, alkali mudflats. The Bear River did not flood above its banks and spread out into either of these units in the spring as it did historically. Unit 4A was treated for tamarisk mainly along the Bear River (35 acres pulled) and Whistler Canal (26 acres sprayed).
B. Habitat Response. Unit 4A had some sheet water in February. The units remained dry the rest of the year. The majority of both these units is dry alkali mudflat habitat. However, small portions of these units support scattered patches of saltgrass, pickleweed (*Salicornia rubra)* and an occasional iodinebush (*Allenrolfea occidentalis*).
C. Response of *Resources of Concern.* Though these units receive little use by priority species 4A did host 34% of the Refuge's population of migratory waterfowl on February 14 and 6 Snowy Plover on March 28th (earliest 2003 sighting).

Unit 4B Objective

As a low priority unit based on predicted water supply, no objectives were set for this unit. General goal was to provide habitat for migratory waterfowl during spring and fall.
A. Management Strategy Prescriptions. The unit was filled after November 2002 and was the first time this unit has had water since 2000 to facilitate construction of O-Canal. Unit reached a peak elevation of 4204.8 in March and began a decline until it was noted as dry on June 20. Re-filling of the unit did not began until after October 7 and was brought up to 4205. The unit was frozen by November 26th and re-opened briefly to 40% on December 12. Eight acres of tamarisk were pulled in the unit along the west dike.
B. Habitat Response. The majority of the unit is occupied by scattered patches of salicornia.
C. Response of *Resources of Concern*. This unit supported an Avocet colony on an island in the southeast corner. On May 23, 352 nests were counted as the chicks were emerging. 5-11% of the Refuge's population of migratory waterfowl were found in this unit in April while 6-14% of the Refuge's breeding population of avocets were noted here. Unit 4B also hosted migrating Marbled Godwit and Dowitchers on May 1 for a count of 9% (160) and 6% (94) of the Refuge population respectively. The unit was important in the fall once again to migratory waterfowl hosting 14-18% of the Refuge population in October and November as well as 50% of the Tundra Swan population on November 14.

Unit 4C Objective

1. Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed.
A. Management Strategy Prescriptions. The target elevation of 4204.5 was achieved by March 12 and was maintained until About mid-May when it began drying. The unit was noted as dry except for the borrow area immediately around the island on July 10 and completely dry by July 22. Re-filling of the unit started around September 2. Unit brought up to elevation around 4205.0 and maintained throughout the winter months. About 240 acres in the unit were treated for tamarisk by spraying (33 acres) and discing (207 acres). The unit was frozen on December 5th.

B. Habitat Response. The habitat objective was unmet due to drying out of the unit.
C. Response of *Resources of Concern.* Unit 4C hosted 14% of the migratory waterfowl during the spring migration (March-May 1) and 15% during the fall (September-November). The unit accounted for 23% of the annual Redhead use of the Refuge, mostly in the spring. During April-June from 6 to 25% of the Refuge avocet population could be found in this unit. A single Long-billed Curlew was noted on June 20. 4C also hosted about 14% (760) of the Refuge population of Marbled Godwits on September 26.

Unit 5B Objective

1. Maximize mid-depth emergent wetland habitat to encourage colonization of alkali bulrush.
A. Management Strategy Prescriptions. This unit was the highest priority unit so water in-flows were maintained throughout the summer to just off-set evaporation. The unit reached it's target elevation of around 4204.5 in March. The water level was maintained in the range of 4204.5 throughout the rest of 2003. Tamarisk stands were treated in the unit by spraying (36 acres).
B. Habitat Response. This unit had good to excellent colonization and production by both sago pondweed and alkali bulrush at this water elevation. A survey in October showed 1,033 acres of open water habitat and about 250 acres of emergent vegetation of which about 10% was alkali bulrush.
C. Response of *Resources of Concern.* The emergent vegetation attracted colony nesting birds such as priority species White-faced Ibis and Franklin's Gull. The colony was not formally surveyed though priority species nests likely numbered in the range of 1-3,000 nests each. Having water all-year round, this unit hosted 28% of the annual total migratory waterfowl, 28% of the annual total Cinnamon Teal, 40% of the Redhead, 13% of American White Pelican, and 8% of American Avocet.

Unit 5C Objective

1. Maximize deep submergent wetland habitat to provide optimum conditions for production of sago pondweed.
A. Management Strategy Prescriptions. This unit was filled to 4204.5 by early spring and remained around 4204.0 throughout most of the summer as upstream Machine Lake was drained to facilitate dike construction by the duck club. The unit did go about 80% dry for a brief period in late September-early October. The unit was again re-filled to 4205 by November. About 85 acres of tamarisk were treated by pulling (16 acres) and discing (69 acres). 30% of the unit was frozen on December 12.
B. Habitat Response. Sago pondweed colonization and production was thought to be fair to good.
C. Response of *Resources of Concern.* The unit received high use by priority species. The unit accounted for 9% of the annual total use by Tundra Swan, 10% Cinnamon Teal, 13% migratory waterfowl and American White Pelican, 11% use by White-faced Ibis, 19% use by both Black-necked Stilt and American Avocet, 22% Long-billed Curlew, 71% Marbled Godwit, 64% Dowitchers, 7% Wilson's Phalarope, 28% migratory shorebirds, 9% Franklin's Gull and 19% Black Tern.

2004 Wetland Management Plan

The wetland habitat goal at Bear River Refuge is to provide a diversity of wetland types, a diverse and abundant population of aquatic macro invertebrates, and a range of aquatic plant communities from early to late successional stages.

The following general management strategy applies to all wetlands to achieve the overall Refuge wetland habitat goal and objective. Unit by unit objectives and strategies follow for priority units.

General Management Strategy

In 2004, pools will be filled to target levels according to the availability and turbidity of water. Pools should be refilled to target levels just prior to the spring peak, to reduce sediment deposits in the pools and increased turbidity that can inhibit sago pondweed germination, growth, and production. Units should all be brought up to target elevation by April 1 and maintained, when water conditions allow, through December 15. Once at target levels, outflow should be restricted to maintain salinity levels appropriate for saline marsh vegetation (hardstem bulrush, alkali bulrush and sago pondweed). As pools are allowed to dry due to low water supplies, the dry units will filled beginning in September or when dependable water supply allows, and should be at target level by the first week in November. All units should be kept at target elevations until early December. The larger units, (Unit 1, 2D, 5B and 5C) which are subject to ice damage from wind fetch, will be lowered about 18" before ice-up and will remain in draw-down throughout the winter. All other units will be maintained at or near target levels through the winter.
Reliable streamflow forecasts are available on April 1 of each year. Using these forecasts, pools that will not be maintained through the summer will be allowed to dry naturally through evaporation.

Each year, target elevations are developed and the wetland management units are prioritized for filling (spring and fall) and water level maintenance. The following tables provide the priorities of fill and pool retention for 2004. The forecast for 2004 is for “Very Low” water supply which means < 50% of normal or about 40-50 cfs for July and August. Very low flows are a 25-year event, but the refuge has experienced several of these events during the last five years. Under very low forecast water conditions we would be able to maintain only Units 5B, 4C and possibly 2C throughout the driest period of July and August (Table 1). Unit objectives are listed only for those units that can be sustained at target levels throughout the driest part of the year. Only general management strategies are outlined for those units that the water supply allows to be filled only in the spring and fall.

Table 1. Priority order of water level maintenance of wetland management units under "very low water" condition forecast, Bear River MBR, 2004.

Very Low Forecast (<50% of average)			July-August	
Unit	Cumulative Acreage	Target Elevation	Maintenance Water Need (cfs) Unit/Cumulative	
5B	1,416	4204.6	24.4	24.4
4C	3,311	4205.5	26.3	50.7
2C	4,031	4204.5	12.4	63.1

Unit 5B Objectives

1) Manage soil salinity levels at about 5,000-8,000 ppm (8-12 m.mhos/cm).
2) Maintain water at target elevation of 4204.6' msl April 1-December 15.
3) Increase amount of alkali bulrush to account for 60% of emergent vegetation with a mix of 50% open water to 50% emergent vegetation over the entire unit.
4) Manage water levels to achieve 582 acres of mid-depth emergent wetland habitat, 207 acres of shallow emergent and 994 acres of vegetated mudflat.

Management Prescription:
1: Manage salinity levels by adding only enough water to offset evaporation losses.
2: Manage water clarity by restricting carp and reduce silt loading by filling with clear water in spring.
3: Control aquatic vegetation community composition through water depth management and by matching salinity levels with tolerance ranges of desired macrophytes.
If low water supply conditions persist in September and October, the target elevation is lowered to 4204.0.

Unit 4C Objectives

1) Maintain soil salinity levels at 5,000 - 10,000 ppm (8-15 mmhos/cm), April 1-October 15.
2) Maintain water level at 4205.75' msl, throughout the year.
3) Increase amount of sago pondweed to cover 60% of unit.
4) Manage water levels to achieve 1528 acres of deep submergent wetland habitat.

Management Prescription:
1: Manage salinity levels by adding only enough water to offset evaporation losses.
2: Manage water clarity by restricting carp and reduce silt loading by filling with clear water in early spring.
3: Control aquatic vegetation community composition through water depth management and by matching salinity levels with tolerance ranges of desired macrophytes.
The water elevation is to control tamarisk that were treated in the unit in 2003.

Unit 2C Objectives

1) Maintain soil salinity levels at 5,000-10,000 ppm (8-15 m.mhos/cm), June-August.
2) Maintain water level at 4204.5' msl, year-round.
3) Increase sago pondweed to cover 70% of unit.
4) Manage water levels to achieve 504 acres of shallow submergent wetland and 216 acres of shallow emergent wetland.
Management Strategy: After ice-out, the unit will be filled if needed, to the new target of 4205.25 to further control tamarisk. Water levels will be maintained at target for the entire calendar year.

The second table (Table 2.) illustrates the priority order of fill and maintenance of units should the water supply be better than the very low forecast.

Table 2. Management priority order of wetland units, Bear River MBR, 2004.

Unit	Total Acres	Wet Acres	Spring Target Elevation **2004**	Priority Order 2004	Maintenance Needs (July-Aug.) cfs	Fall Fill Order 2004	Fall Target Elevation **2004**
1	12,204	3,460	4204.50		59.7	6	4204.00
1A	544	544	4205.40		9.4	7	
2A	135	135	4205.50	5	2.3	5	
2B	294	237	4206.00	4	5.1	4	
2C	720	720	4204.50	3	12.4	3	
2D	4,619	4,619	4205.25		79.6	8	
3A	505	505	4206.00		8.7	13	
3B	1,085	1,085	4205.00		18.7	12	
3C	549	549	4205.00		9.5	11	
3D	1,045	1,045	4205.50		18.0	10	
3E	1,448	1,448	4205.00		25.0	14	
3F	903	903	4205.20		15.6	15	
3G	1,545	1,047	4205.70		18.1	16	
3H	655	295	4206.00		5.1	N/A	
3I	211	211	4205.50		3.6	N/A	
3J	166	166	4206.00		2.9	N/A	
3K	230	230	4206.00		4.0	N/A	
4A	2,698	1,523	4205.50		N/A		
4B	1,242	1,242	4205.50		21.4	17	4205.00
4C	1,528	1,528	4205.75	2	26.3	2	
5A	2,405	495	4205.50		N/A		
5B	1,416	789	4204.60	1	24.4	1	
5C	2,558	2,558	4205.50		24.4	9	4205.00
5D	939	0	N/A		N/A		
6	3,185	3,185	N/A		54.9	N/A	
7	2,581	2,581	N/A		44.5	N/A	
8	4,158	4,158	N/A		71.6	N/A	
9	5,171	5,142	N/A		88.6	N/A	
10	15,262	1,014	N/A		17.5	N/A	
Total	70,001	41,414			671.1		

Only general management strategies are outlined for the following units that the water supply is inadequate to maintain at target level through July, August and September.

Unit 1
Management Strategy: See general management strategy above. If by September 15, water supply is low, the target elevation of this unit will be changed to 4204.0.

Unit 1A
Management Strategy: The unit will be filled in the spring and drawn-down or allowed to dry in the summer. The drive-through inlet structure will be modified by installing a stoplog pier to allow regulation of inflows into the unit. After the nesting season (late July) the unit will be grazed with cattle to remove the above ground vegetation. Upon completion of the new inlet structure the unit will be re-filled to 4205.4 in an attempt to stress the emergent vegetation that had been reduced by grazing and maintained throughout the winter.

Unit 2A
Management Strategy: A water measurement gauge will be added to this unit in 2004. The unit will be filled in the spring to the maximum level allowed when all boards are put into the outlet structure (4205.5) to further stress any surviving tamarisk. It may be possible to hold the water even higher at about 4206.0 by keeping the radial gate shut. In low water supply conditions, the unit will be allowed to dry in the summer and re-filled in the fall as conditions allow.

Unit 2B
Management Strategy: After ice-out, the unit will be filled in the spring (4206) if needed and allowed to dry by mid-summer. The unit will be grazed post-breeding season (July 15-October1) to decrease density and height of undesirable emergent vegetation (cattail and phragmites). After grazing, the unit will be re-filled to the maximum by putting in all the boards (3) in the outlet structure. The elevation at the outlet structure needs to be determined.

Unit 2D
Management Strategy: The target elevation is 4205.25'. The unit will be re-filled from low winter level with clear water by April 1 and allowed to dry if water supply is low. Cattle will be grazed in the northern portion of the unit after the nesting season (July 15-October 1). The unit will be re-filled in the fall as water supply allows. After December 15, the unit will be drawn-down to about 4204 to prevent ice-damage.

Units 3A and 3K
Management Strategy: The units will be filled in early spring with clear water from the river. These units will be allowed to dry-out by mid-summer for maintenance work. The interior dike between these units will be breached to allow flow through waters, essentially creating a single unit. Both units may be grazed by cattle after the nesting season from July 15-October 1 to decrease height and density of emergent vegetation. If water supply is sufficient, water will be added until the target elevation is reached.

Unit 3B
Management Strategy: The unit will be filled to maximum pool (3 boards in outlet structure) in the spring and allowed to dry-out with low water supply.

Unit 3C
Management Strategy: The target elevation is 4205.0 based on observed stands of sago pondweed before drying out in 2003. The unit will be filled to the target, allowed to dry in the summer and re-filled as the water supply allows in the fall. Target elevation will me maintained through the winter.

Unit 3D
Management Strategy: The target elevation is 4205.5. The unit will be filled to the target, allowed to dry in the summer and re-filled as the water supply allows in the fall. Target elevation will me maintained through the winter.

Units 3E, 3F and 3G
Management Strategy: The units will be filled to maximum capacity (3 boards in outlet structure) in the spring, allowed to dry in the summer and re-filled as the water supply allows in the fall. These units are difficult to fill to maximum pool as O-Line Canal needs to be kept fully charged before water will flow into 3G as it's inlet structure is at a high elevation.

Units 3H, 3I and 3J
Management Strategy: Units 3H and I are both subject to fill by Bear River flows. No active management for filling. Unit 3J will be filled in the spring by lowering the inflatable gate on the Bear River.

Units 4A and 5A
Management Strategy: Both units receive water in the spring from sheet water. Unit 5A is subject to management actions of 5C. No active management for filling.

Unit 4B
Management Strategy: The unit will be filled in the spring to target elevation 4205.5, allowed to dry in the summer and re-filled as the water supply allows in the fall. Under low water conditions in September and October the target elevation becomes 4205.0.

Unit 5C
Management Strategy: The unit will be re-filled from winter low level to target of 4205.5 by April 1. A complete draw-down of the unit will be initiated on May 1 in order to treat the unit for tamarisk upon drying. The unit will be re-filled in the fall as the water supply allows to 4205.0.

In the fall the units will be filled in the following order: The units along L-Canal (2C, 2B, 2A, 1, 1A), 2D, charge Reeder and fill 5C, the H-Line units (3D, 3C, 3B and 3A), and finally the O-Line sub-units (3E, 3F, 3G, 4B and 4A). The unimpounded units (6-10) will only begin to receive water once the other units are full and we begin to bypass the excess water.

Grassland Ponds

In 2003, the objectives for the grassland ponds were:

1). Manage ponds to achieve mix of 50% open water to 50% emergent vegetation or hemi-marsh conditions, year-round.
2) Maintain water level at 1' below the top of the dike year-round unless otherwise stated.
A. Management Strategy Prescription. All the units were filled in the spring to the objective level. There are no water level data available as there are no staff gauges on the outlet structures. However, water inflow data was collected from April 1 to October 12 from the three flume gauges to each of the Nichols, White and Stauffer tracts. Nichols inflow was around 0.25 cfs in April, 0.05 in June, 0 in July, and 0.16 in September. White inflow averaged 0.22 cfs in April, May and June, 0.15 cfs in July, 0.16 in August and 0.14 in September. Stauffer inflow averaged 0.17 cfs in April, 0.25 cfs in May, 0.075 in June, 0.17 cfs in July, 0.10 cfs in August and 0.14 in September. With low water supply the units were mostly dry by July 11; N-1 75% dry, N-2 80% dry, N-3 95% dry, N-4 80% dry, N-5 90% dry, N-6 and N-7 100% dry, W-3 and W-6 100% dry, W-7 40% dry, S-1 100% dry. Units N1,3, 4,5,6, and 7 were disced to decrease density of cattail and phragmites in August. The units began to fill again in mid-October and reached maximum height by mid-December.
B. Habitat Response. The habitat objectives were not met due to drought conditions.
C. Response of *Resources of Concern*. The grassland ponds are utilized primarily by migratory waterfowl in the spring, Cinnamon Teal and Redhead as pair and brood rearing ponds throughout the spring and summer, as feeding areas for White-faced Ibis, Long-billed Curlew, and nesting, resting, feeding and brood rearing areas for Black-necked Stilts and American Avocet. Total 2003 count (15 surveys) of ducks for the ponds was 2,244, 499 White-faced Ibis, 4 Long-billed Curlew, 112 Black-necked Stilt, 94 American Avocet, and 20 Wilson’s Phalarope. Peak count of waterfowl was April 9. Peak count or highest use date by shorebirds was May 16. Ponds N1 and N5 consistently had the highest counts of waterfowl or received the most use by all waterbirds.

2004 Wetland Management Plan for Grasslands

The 2004 objectives for the grassland ponds remain the same as last year.

Management Prescription: To meet the first objective, the density of cattail needs to be reduced in several ponds. W5 and/or W7 will be drawn down in mid-summer and allowed to dry then disced or grazed to decrease amount of cover by cattail. All the other ponds on the Nichols, White, and Stauffer units will be kept as full as the available water supply will allow.

Grassland Uplands

Nichols, White, Stauffer Unit objectives
Based on the soils, each of the units supports three habitat types and associated plant communities. The objectives describe climax plant communities for each habitat type.

Alkali Bottom Objectives:
1) Increase cover of grasses (saltgrass, alkali sacaton, wheatgrass, Basin wildrye) to 60% by 2015.
2) Increase forb cover to 5% (silverscale, fireweed, and hollyleaf clover) by 2015.
3) Increase shrub cover to 5% (greasewood) by 2015.
4) Decrease cheatgrass cover to < 10% by 2015.

Salt Meadow Objectives:
1) Increase grass cover (alkali bluegrass and saltgrass) to 65-75% by 2015.
2) Increase forb cover (lanceleaf goldenweed, fiddleleaf hawksbeard and sunflower) to 10% by 2015.
3) Increase shrub cover (iodinebush, rabbitbrush and greasewood) to 1-3% by 2015.

Wet Meadow Objectives:
1) Increase grass cover (*Carex* spp.) to 80% by 2015.
2) Increase forb cover (alkali marsh aster and common silverweed) to 5% by 2015.
3) Decrease shrub cover (rabbitbrush and greasewood) to 1% by 2015.

A. Management Strategy Prescriptions. A dormant season graze was initiated in November 2002 and continued until late March 2003 on the Refuge grassland units. The goal of the grazing program is to invigorate perennial native grasses (wheatgrass species, salt grass, alkali sacaton, Great Basin wildrye and alkali cordgrass) while suppressing annual cheatgrass. Grazing is a tool to improve habitat for ground nesting migratory birds and to improve habitat conditions for other non-target grassland community species. Dormant season grazing reduces the litter layer that inhibits new plant growth. The removal of residual vegetation allows more sunlight penetration to raise soil temperatures. In addition, several areas were broadcast seeded with a native grass mix (Table 3) at about 20 lbs./acre (bulk) prior to being grazed with the thought that the animal impact during the graze period will set the seed. A test plot on the Nichols tract was seeded in December of 2003 and the site will be monitored in 2004 to determine success. The site was approximately 5 acres and the approximate center of the plot is photopoint N-5.

Table 3. Grass mixture and variety planted in 2003.

Species	Variety	Purity of mix	Germination Rate	Origin
Slender Wheatgrass	Revenue	28.38	93.00	MT
Bluebunch Wheatgrass	Secar	3.62	96.00	WA
Alkali Sacaton	VNS	2.56	94.00	CO
Western Wheatgrass	VNS	18.33	96.00	MT
Alkaligrass	Fults	2.50	90.00	CO
Alti Wildrye	VNS	22.76	94.00	CO
Thickspike Wheatgrass	Bannock	19.33	91.00	UT

The grazing areas and utilization rates for the winter of 2002-03 were as follows:

Nichols Unit

A total of 7 areas within the Nichols Unit were grazed (Figure 1). The N1 Unit consisted of 59 acres and was grazed for 17 days from November 12 - November 20, 2002. A total of 120 head grazed the unit from November 12-20 and then 160 head grazed from November 21–28. The total utilization rate for the unit was 1.3 A.U.M.'s per acre. A total of 79 A.U.M.'s were removed.

Unit N2 consisted of 150 acres and was grazed for 10 days from November 29, - December 8, 2002.

A total of 160 head grazed the unit from November 29 - December 3 and then 360 head grazed from December 4-8 with a utilization rate of 0.58 A.U.M.'s per acre. A total of 87 A.U.M.'s were removed from N2.

Unit N3 consisted of 239 acres and was grazed for 16 days from December 9-December 24, 2002. A total of 360 head grazed the unit with a utilization rate of 0.80 A.U.M.'s per acre. A total of 192 A.U.M.'s were removed from N3.

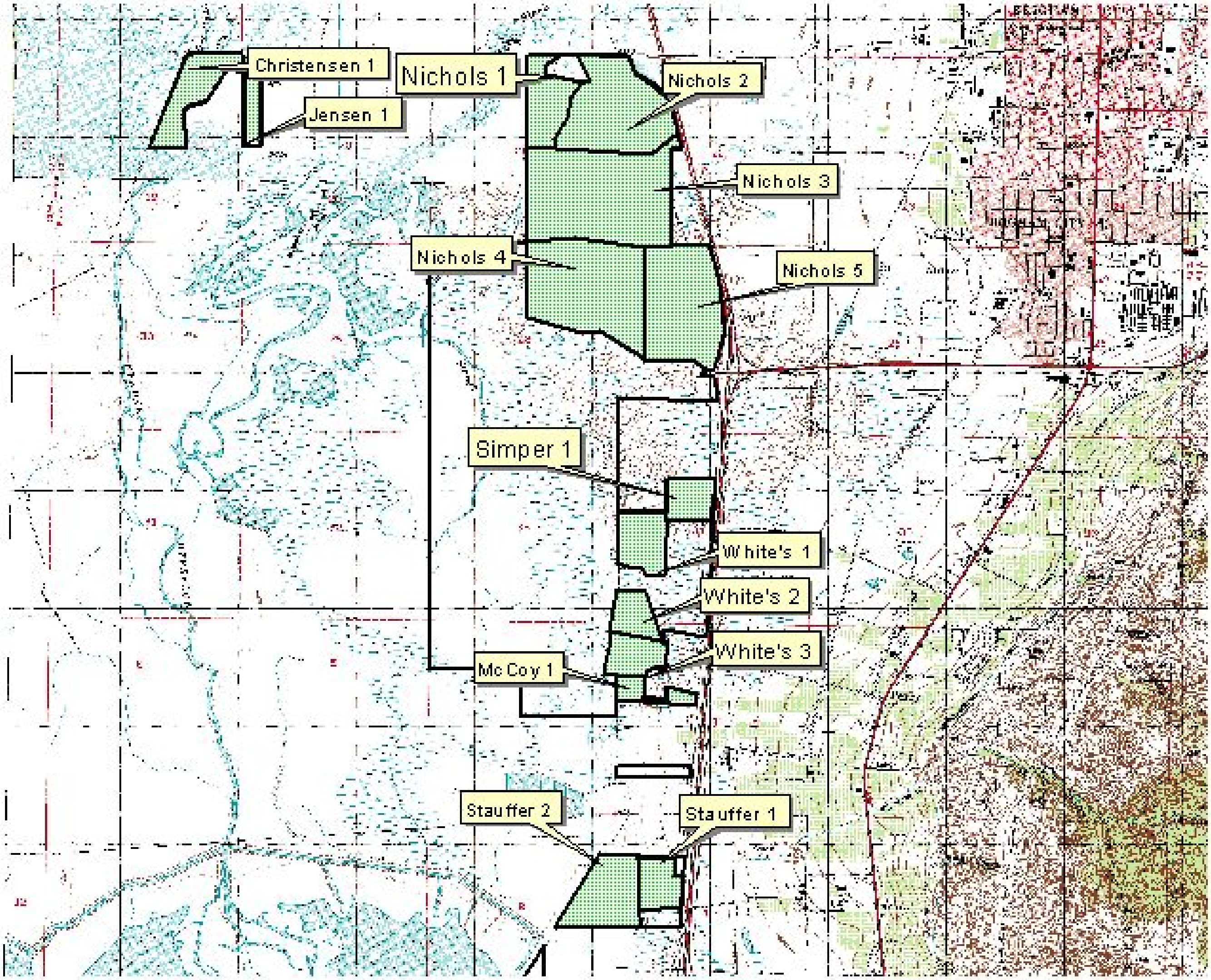
Unit N4 consisted of 194 acres and was grazed for 12 days from December 25, 2002-January 5, 2003. A total of 360 head grazed the unit with a utilization rate of 0.74 A.U.M.'s per acre. A total of 144 A.U.M.'s were removed from N4.

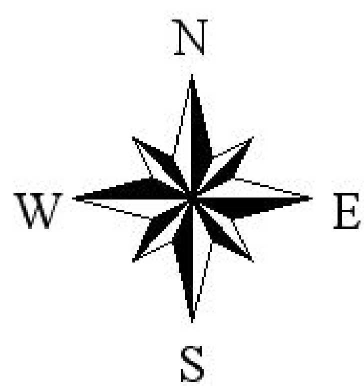
Unit N5 consisted of 156 acres and was grazed for 15 days from January 6 - January 20, 2003. A total of 360 head grazed the unit with a utilization rate of 1.15 A.U.M.'s per acre. A total of 180 A.U.M.'s were removed from N5.

The Christensen Unit consisted of 64 acres and was grazed for 26 days from December 17, 2002-January 11, 2003. A total of 52 head grazed the unit with a utilization rate of 0.70 A.U.M.'s per acre and a total of 45 A.U.M.'s.

The Jensen Unit consisted of 22 acres and was grazed for the first time since it was seeded to native grasses in the spring of 2001. The unit was grazed for 17 days from January 12-28, 2003. A total of 52 head grazed the unit with a utilization rate of 1.36 A.U.M.'s per acre and a total of 30 A.U.M.'s.

2002-03 Grazing Map





White Unit

A total of 5 areas within the White Unit were grazed (Figure 1). The W1 Unit consisted of 50 acres and was grazed for 9 days from February 27- March 7, 2003. A total of 319 head grazed the unit with a utilization rate of 1.9 A.U.M.'s per acre. A total of 96 A.U.M's were removed.

The W2 Unit consisted of 33 acres and was grazed for 7 days from January 29- Feb. 4, 2003. A total of 360 head grazed the unit with a utilization rate of 2.55 A.U.M.'s per acre. A total of 84 A.U.M's were removed from W2.

The W3 Unit consisted of 38 acres and was grazed for 7 days from Feb. 5-11, 2003. A total of 10 bulls grazed the unit with a utilization rate of 2.2 A.U.M.'s per acre. A total of 84 A.U.M's were removed from W3.

The Simper Unit consisted of 34 acres and was grazed for 8 days from January 21-28, 2003. A total of 360 head grazed the unit with a utilization rate of 2.82 A.U.M's per acre. A total of 96 A.U.M.'s were removed from the Simper Unit.

The McCoy 1 Unit consisted of 22 acres and was grazed for 36 days from December 6, 2002 - January 10, 2003. A total of 48 head grazed the unit with a utilization rate of 2.59 A.U.M's per acre. A total of 57 A.U.M.'s were removed from McCoy 1 unit.

Stauffer Unit

The Stauffer Unit 1 consisted of 36 acres and was grazed for 6 days from Feb. 12-17, 2003 (Figure 1). A total of 360 head grazed the unit from Feb. 12-13 and then 319 head grazed from Feb. 14-17. The total utilization rate for the unit was 1.86 A.U.M.'s per acre. A total of 67 A.U.M.'s were removed from S1.

The Stauffer Unit 2 consisted of 80 acres and was grazed for 9 days from February 18-26, 2003. A total of 319 head grazed the unit with a utilization rate of 1.2 A.U.M.'s per acre. A total of 96 A.U.M.'s were removed from S2.

B. Habitat Response. A vegetation survey was conducted in the fall of 2003. Preliminary results of the survey show that currently, the current condition of the Alkali Bottom community on the White and Nichols Units is comprised of 60 % non-native grasses such as cheatgrass, *Bromus tectorum, B. japonicus,* and *B. commutatus*, rabbitsfoot grass, *Polypogon monspeliensis*, and bulbous bluegrass, *Poa bulbosa*, 35% native grasses such as wheatgrass (21%), squirreltail (5%), Nuttall's Alkaligrass, *Puccinella nuttalliana*, (3%), and 4% forbs. Shrubs comprise <1% canopy cover. Salt Meadow plant community composition by percent frequency of occurrence is 74% saltgrass, 21% emergent marsh, 4% non-native grass and 1% of noxious weed (medusahead). Forbs and shrubs are currently missing in this habitat. The Wet Meadow plant community composition by percent frequency of occurrence is 91% rush and sedges, 3% reed canarygrass, *Phalaris arundinacea*, 1% non-native grass and 5% noxious weed (medusahead).

C. Response of *Resources of Concern*. No formal surveys of the upland portions of the units was conducted. In general, the units support upland nesting waterfowl. A pair of Long-billed Curlew as evidenced by a chick seen in August, were thought to nest in the White unit, north and west of the Perry sewer ponds.

2004 Grassland Upland Management Plan

The objectives for 2004 in the upland grasslands remain the same as last year.
Management prescription: A late spring graze will be implemented in 2004 on the Nichols unit as an experiment in the control of cheatgrass. Dormant season grazing (November-January) of western portions (marshy areas) of the three grassland units will be attempted for cattail and phragmites control in 2004.

MONITORING AND EVALUATION

Weekly waterbird surveys of the 26 wetland management units and the grassland ponds will be conducted to determine use by priority species on a unit by unit basis. Canada Goose pair counts, waterfowl nesting transects and brood counts will be conducted to estimate nesting success as a measure of the success of the predator control program.

Soil salinity probes will be purchased and installed in the priority wetland units and weekly readings will be taken.

The water depth at the outlets of priority units will be recorded regularly, to determine amounts and types of habitat associated with the different water depths.

In late June at the peak of sago pondweed flowering, airboat surveys of the priority units will be conducted with the aid of a GPS unit. The amount of habitat occupied by submergent and emergent vegetation as well as the aquatic plant species diversity will be calculated in order to determine if habitat objectives are being met.

Plots where different salt cedar treatments were employed in 2003 will be marked and monitored for re-sprouting by salt cedar or re-colonization by native species. The salt cedar in the main river delta of unit 2D and a along D-Line will be the focus of saltcedar control efforts in 2004. Treatment methods will include herbicide spraying, discing, mowing and pulling.

The photo points on the Nichols, White, and Stauffer Units should be maintained to monitor any changes in upland habitat.

On the grasslands, the amount of water flowing through the measurement flumes should be recorded regularly, and note made of the amount of water in unmeasured diversions. The condition of gates (open, closed, partly open) should be noted at the same time. Records of diversions that are shared with other water right holders should be particularly noted. Staff gauges need to be installed on all of the ponds and the water depths recorded regularly.

UNMET NEEDS AND STRATEGIES TO ADDRESS THEM

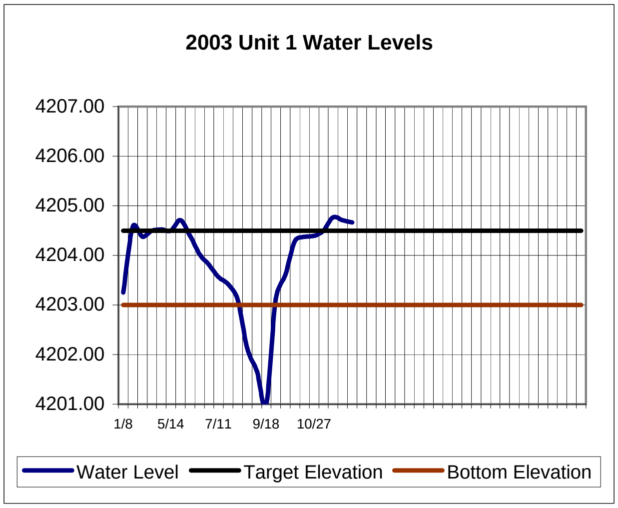
The chief impediment to improved habitat on the Bear River Migratory Bird Refuge is the shortage of water during the summer months, especially July and August. Many strategies have been advanced to remedy this problem, most recently a plan to increase the storage pool at Hyrum Reservoir by 50,000 acre-feet, or a yield of 24,200 acre-feet delivered to the refuge in July and August. This amount of water would allow the refuge to maintain an additional 8-10,000 acres of wetland habitat.

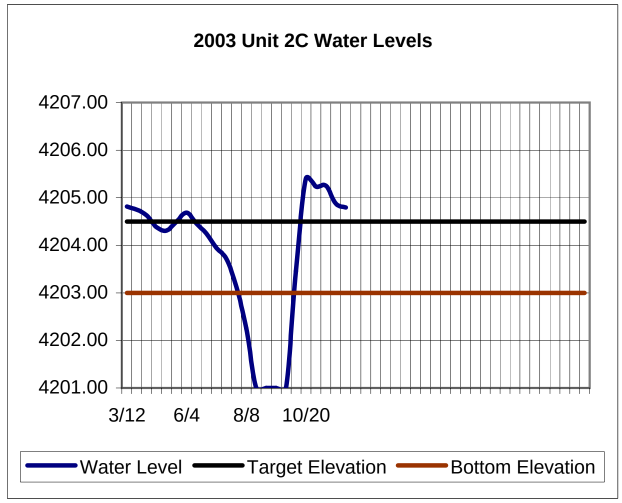
Water is limited on the Nichols, White, and Stauffer Tracts as well. Any opportunity to acquire additional water for those units (such as water under subdivisions in Perry and Brigham City) should be pursued actively.

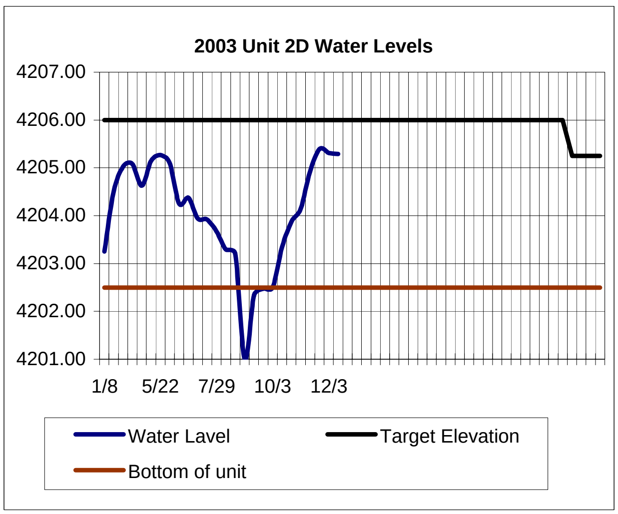
Populations of small mammalian predators have continued to increase on the refuge. The striped skunk has always been on the refuge, but large populations of red fox and racoon have inhabited the refuge only since the flood. Wildlife management efforts through predator control activities will be implemented again in 2004 in partnership with USDA Wildlife Services, Salt Lake City, UT. Canada Goose pair counts, waterfowl nesting transects and brood counts will be conducted to estimate nesting success as a measure of the success of the predator control program.

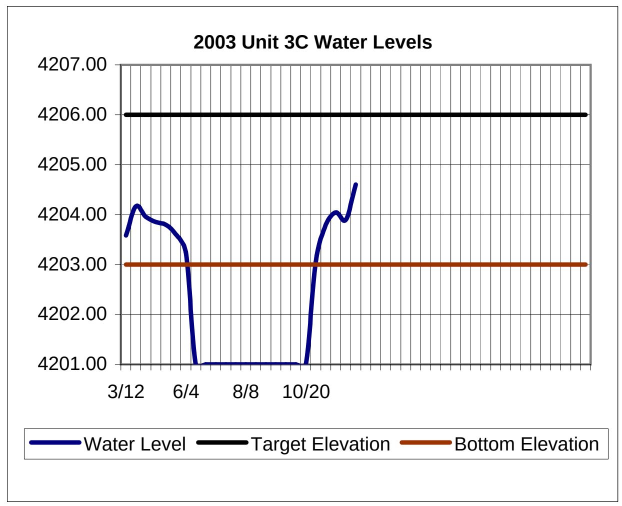
Another permanent, year-round staff position is needed at the Biologist or Biological Technician level to accomplish all the necessary monitoring activities. Currently, only portions of needed monitoring activities are completed in a timely manner with little to no inventory work being completed.

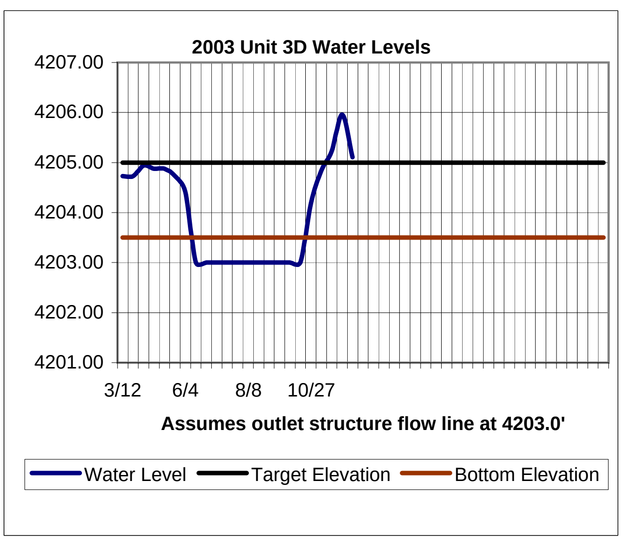
Appendix A.
2003 Unit Water Levels

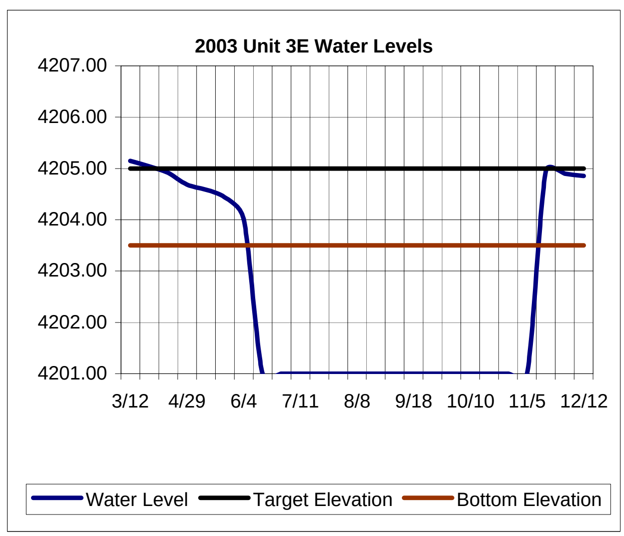

2003 Unit 1 Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
1/8
5/14
7/11
9/18
10/27
Water Level
Target Elevation
Bottom Elevation

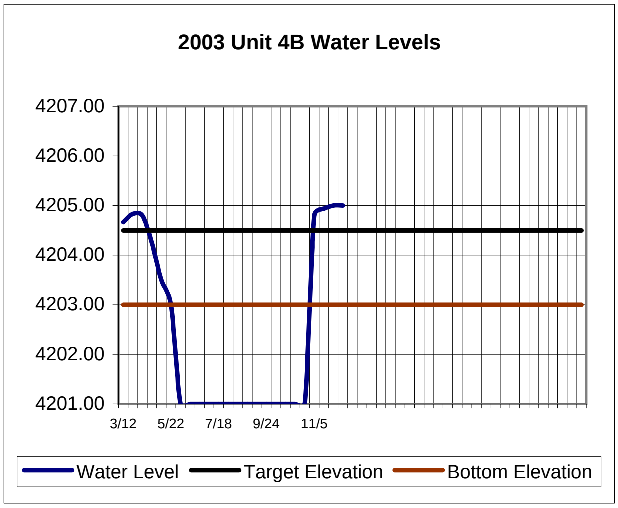

2003 Unit 2C Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
6/4
8/8
10/20
Water Level
Target Elevation
Bottom Elevation

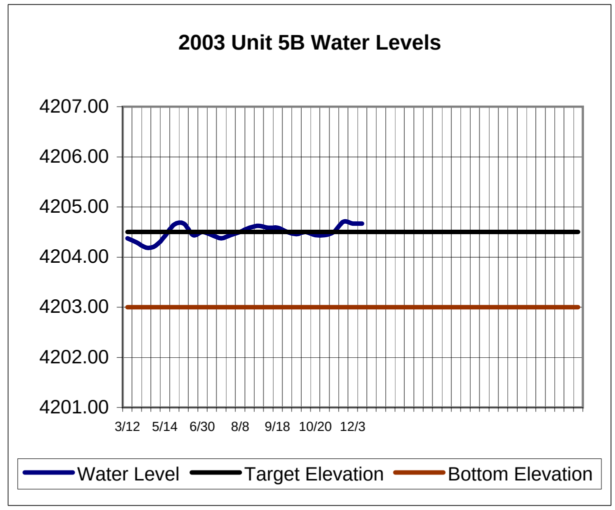

2003 Unit 2D Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
1/8
5/22
7/29
10/3
12/3
Water Lavel
Target Elevation
Bottom of unit

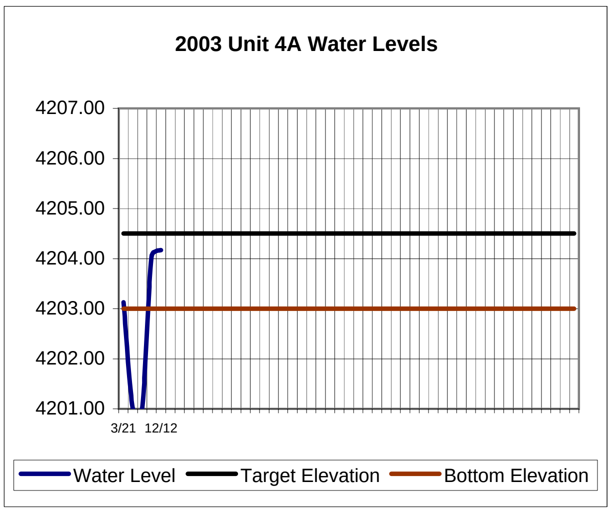

2003 Unit 3C Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
6/4
8/8
10/20
Water Level
Target Elevation
Bottom Elevation

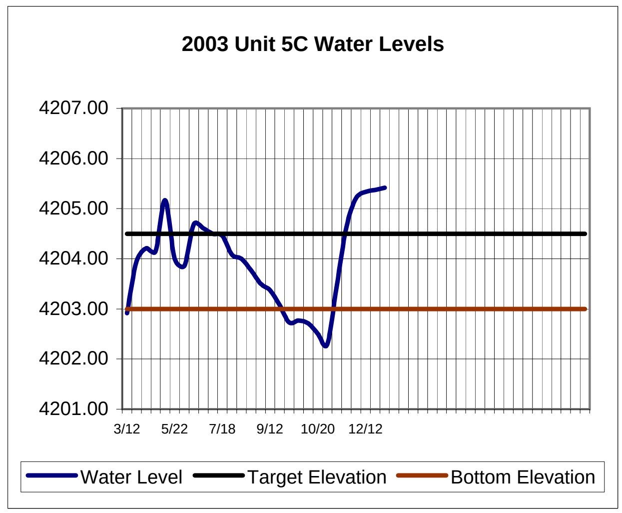

2003 Unit 3D Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
6/4
8/8
10/27
Assumes outlet structure flow line at 4203.0'
Water Level
Target Elevation
Bottom Elevation

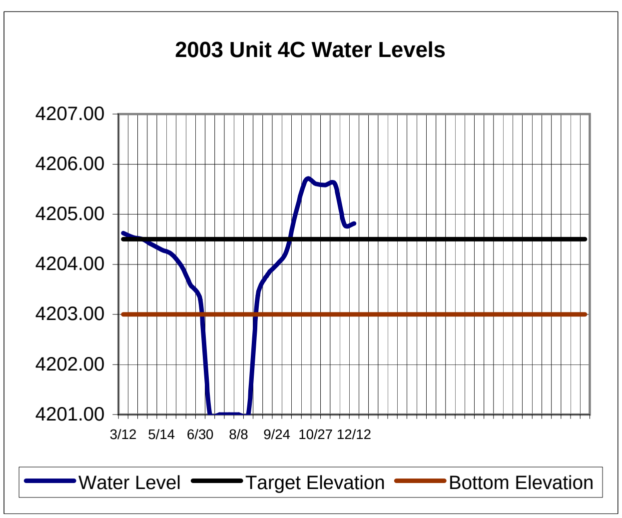

2003 Unit 3E Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
4/29
6/4
7/11
8/8
9/18
10/10
11/5
12/12
Water Level
Target Elevation
Bottom Elevation


2003 Unit 4B Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
5/22
7/18
9/24
11/5
Water Level
Target Elevation
Bottom Elevation


2003 Unit 5B Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
5/14
6/30
8/8
9/18
10/20
12/3
Water Level
Target Elevation
Bottom Elevation

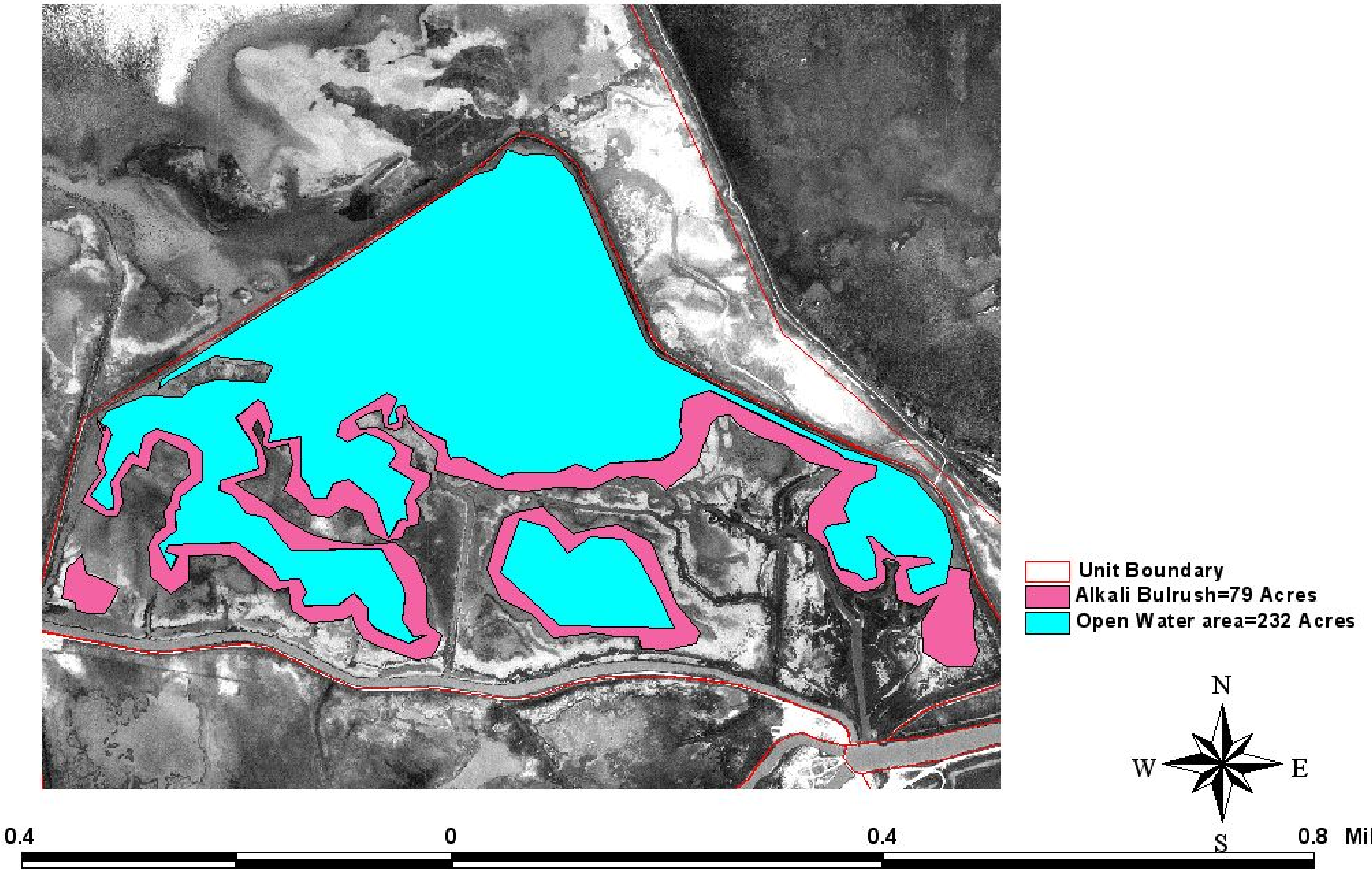

2003 Unit 4A Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/21
12/12
Water Level
Target Elevation
Bottom Elevation


2003 Unit 5C Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
5/22
7/18
9/12
10/20
12/12
Water Level
Target Elevation
Bottom Elevation

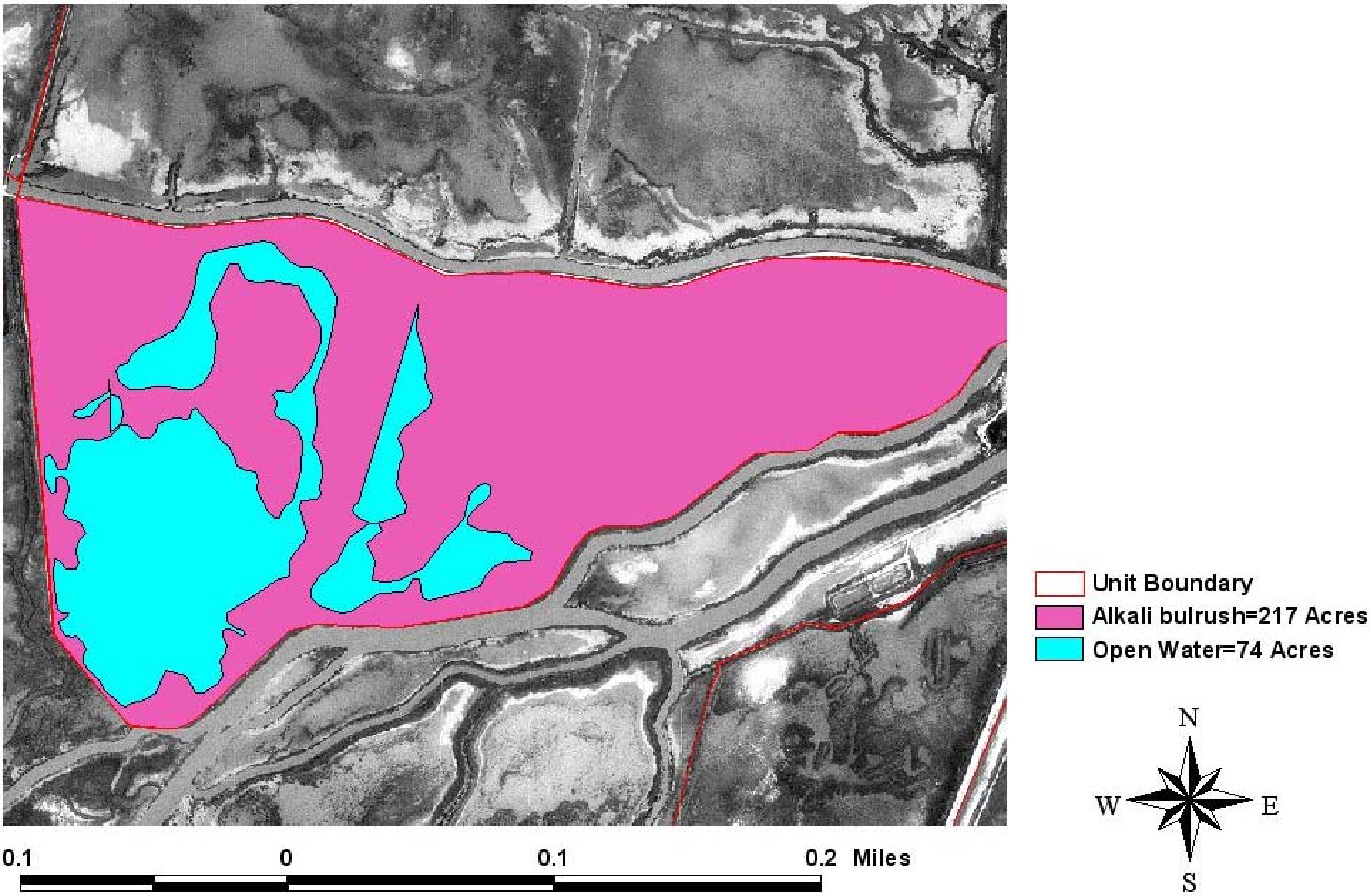

2003 Unit 4C Water Levels
4207.00
4206.00
4205.00
4204.00
4203.00
4202.00
4201.00
3/12
5/14
6/30
8/8
9/24
10/27
12/12
Water Level
Target Elevation
Bottom Elevation

Appendix B.
2003 Habitat Conditions
and
Tamarisk Treatments

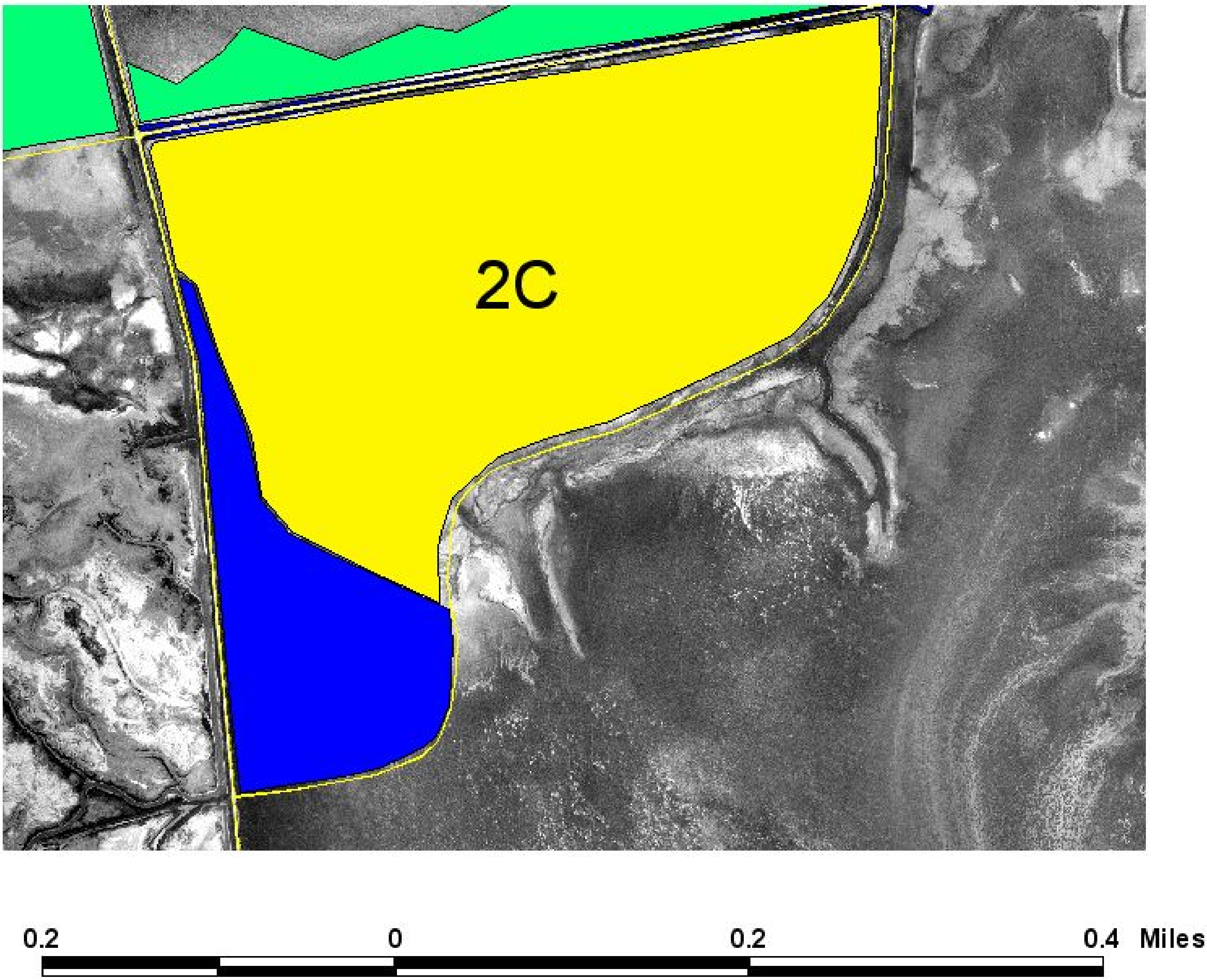
Unit 1A Habitat Conditions, October 2003.



Unit 2B Habitat Conditions, October 2003.

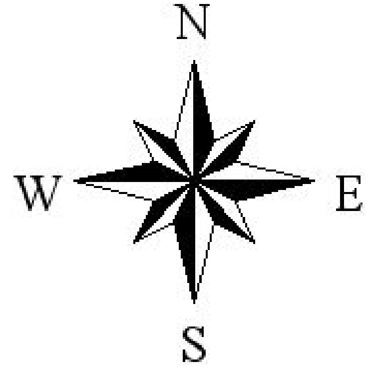


Tamarisk Treatment 2003
Unit 2C

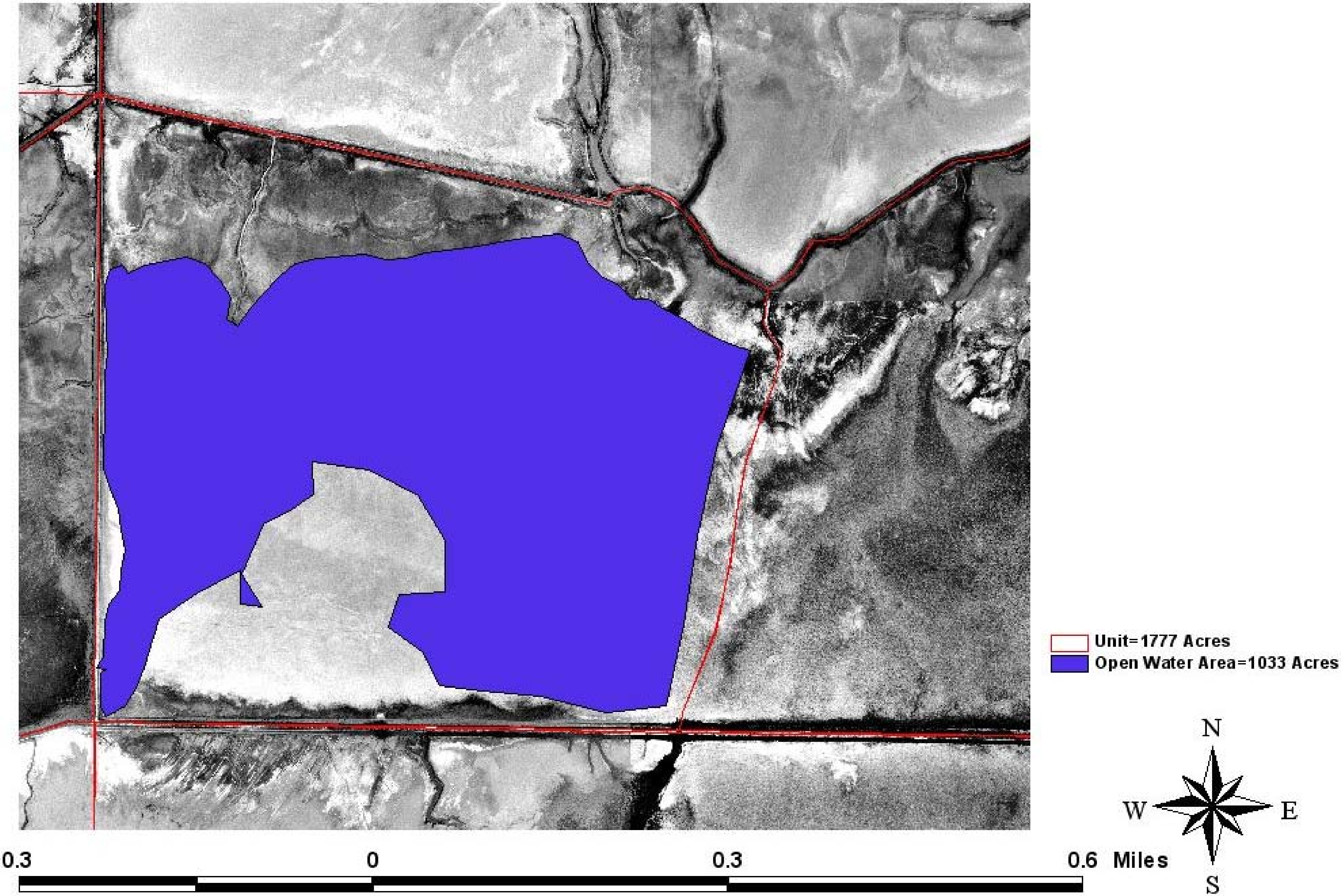


Treatment Method

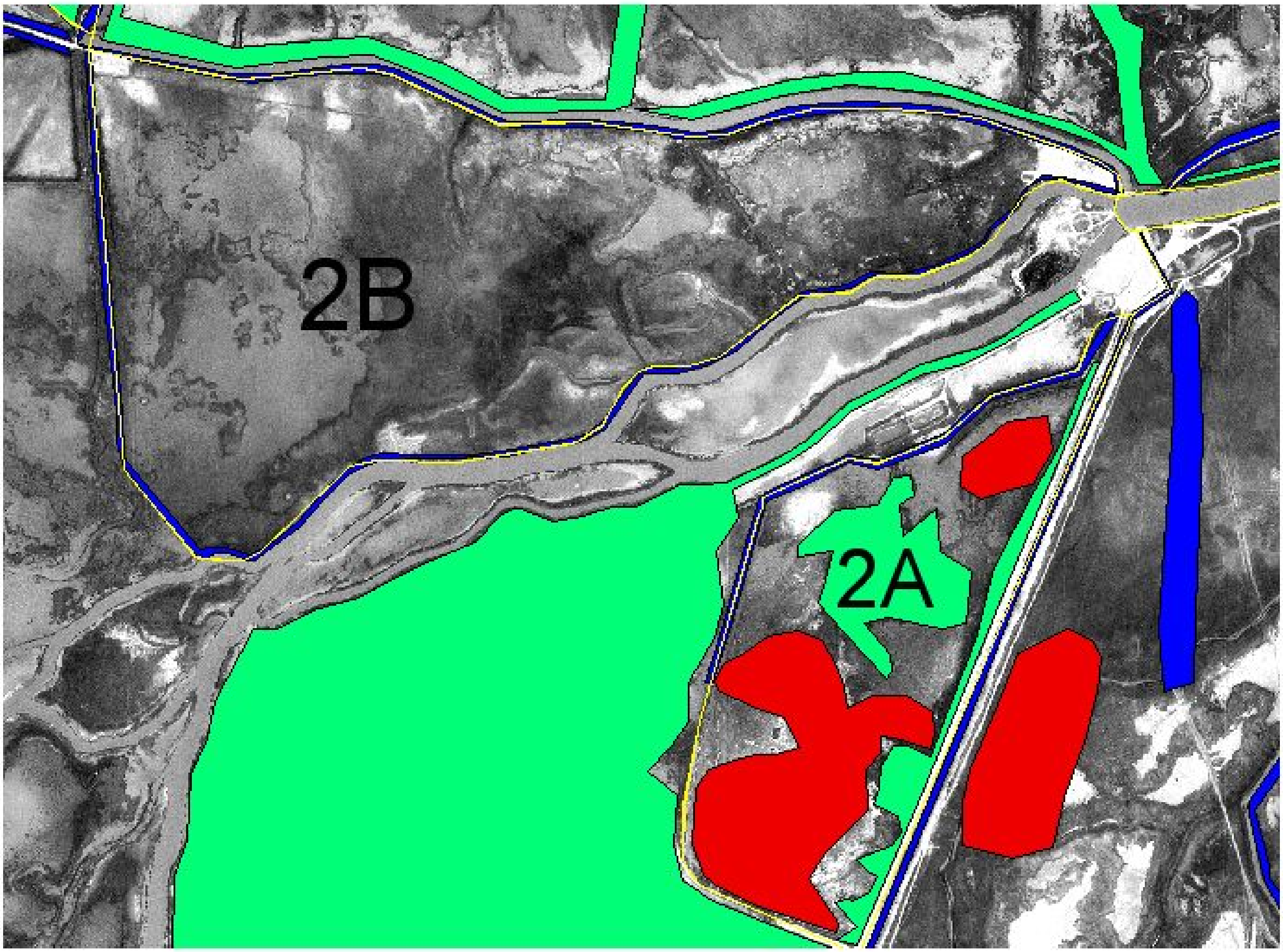
- Pull = 131 acres
- Spray
- Disc
- Mow = 543 acres



Unit 5B Habitat Conditions, 2003



Tamarisk Treatment 2003
Units 2A & 2B



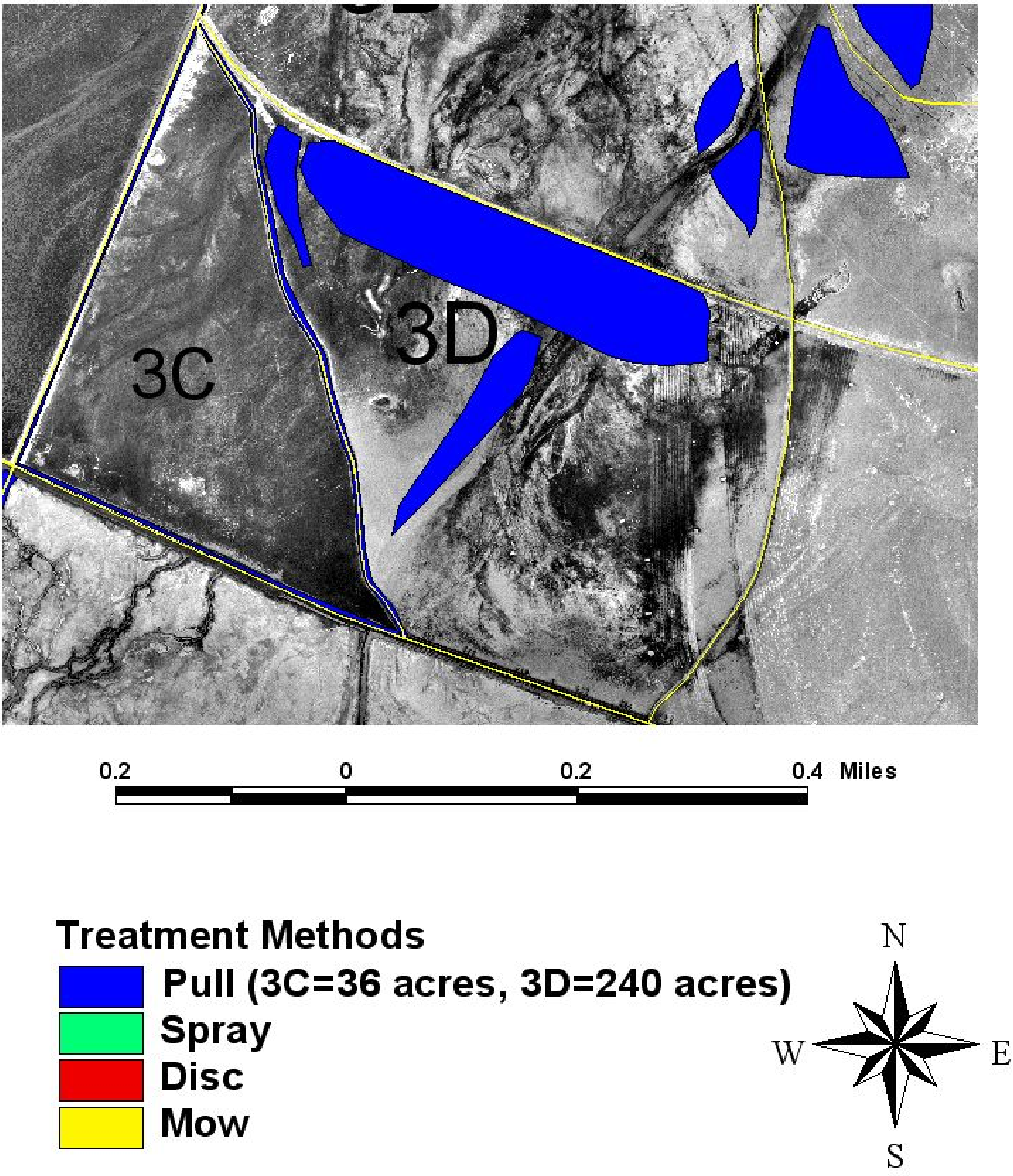
0.09 0 0.09 0.18 Miles

Treatment Method

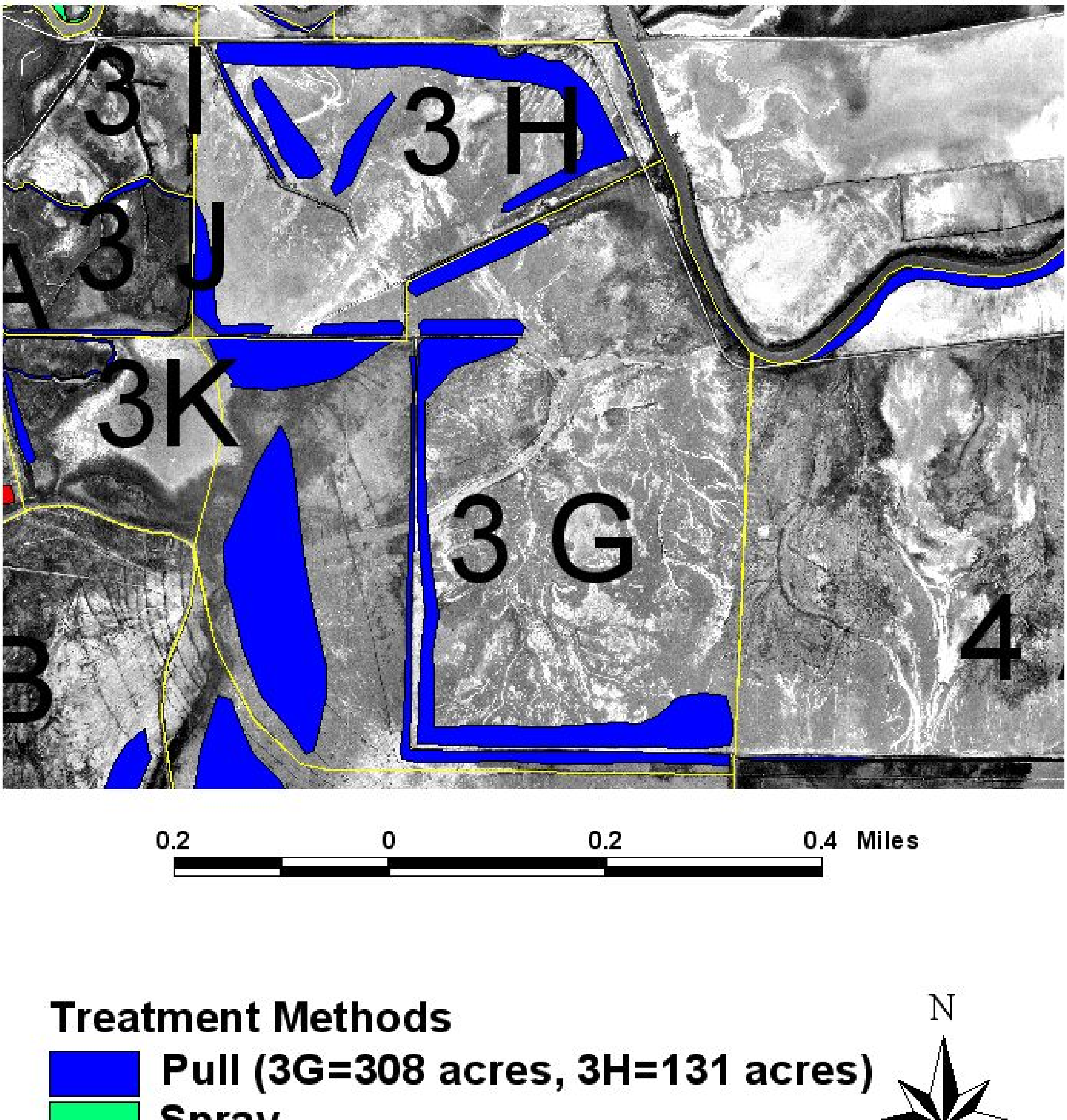
- Pull (2A 5 acres, 2B 13 acres)
- Spray (2A 27 acres)
- Disc (2A 43 acres)
- Mow

N
W E
S

Tamarisk Treatment 2003
Units 3C & 3D



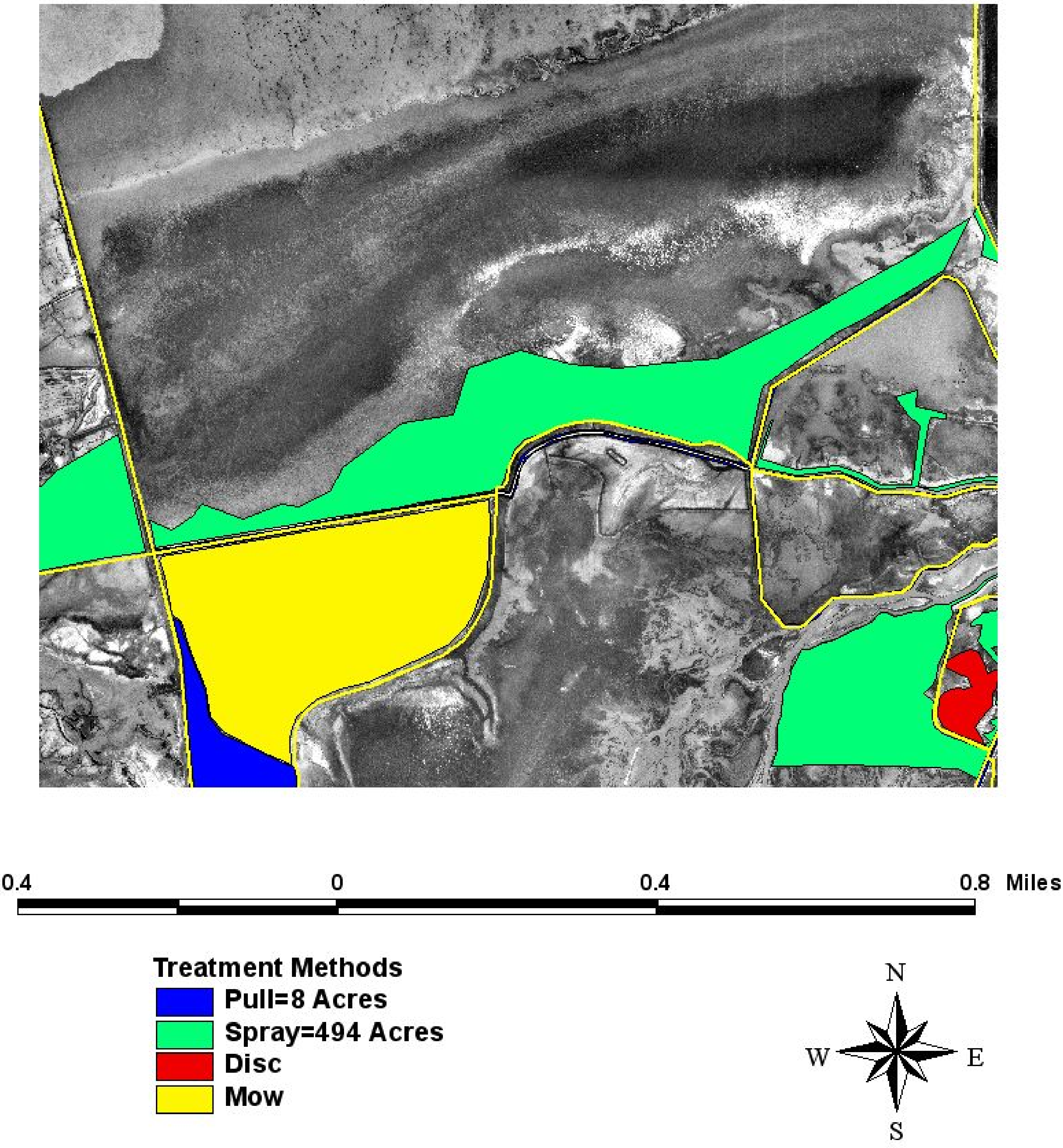
Tamarisk Treatment 2003
Units 3G & 3H



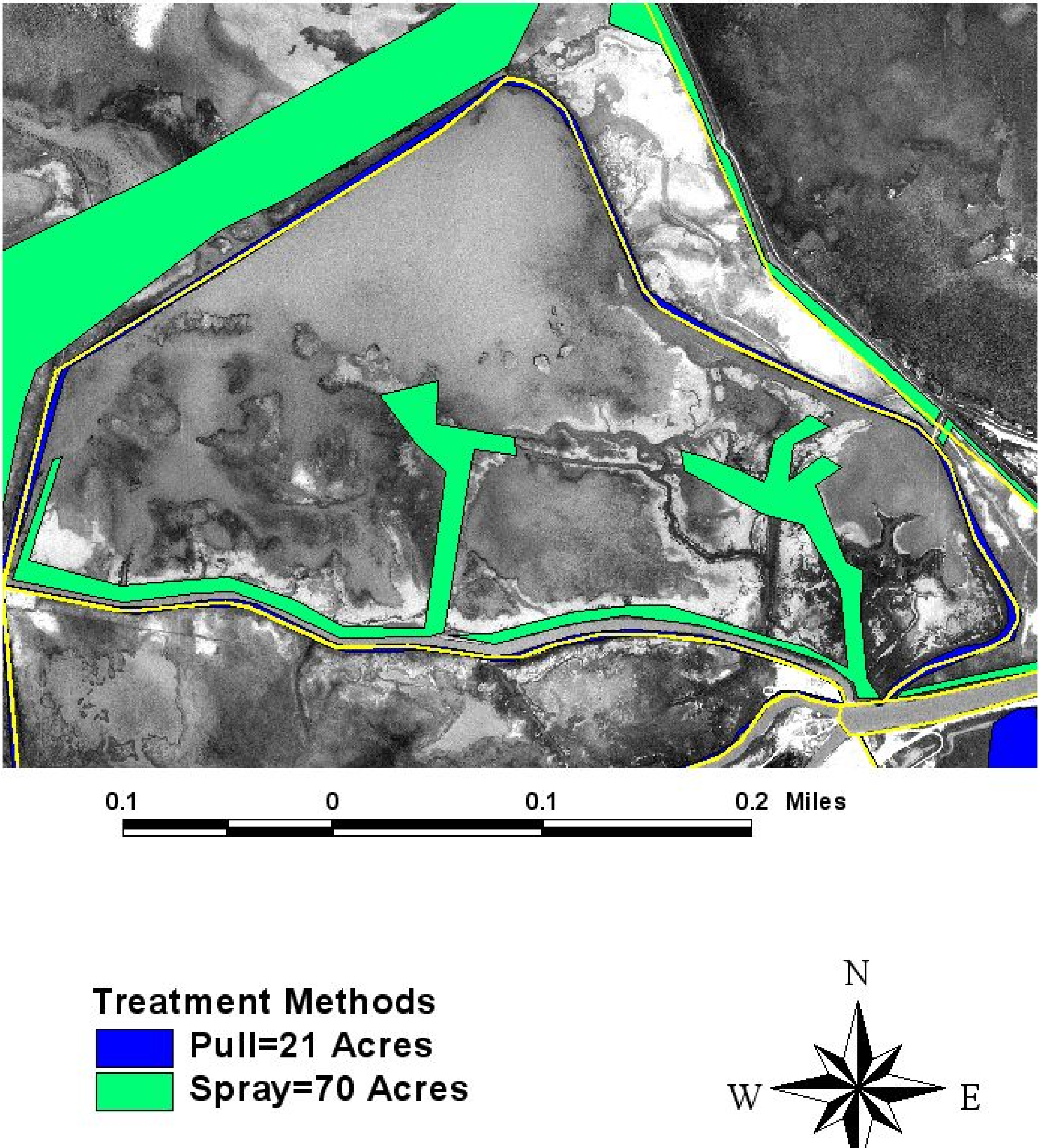
Treatment Methods

- Pull (3G=308 acres, 3H=131 acres)
- Spray
- Disc
- Mow

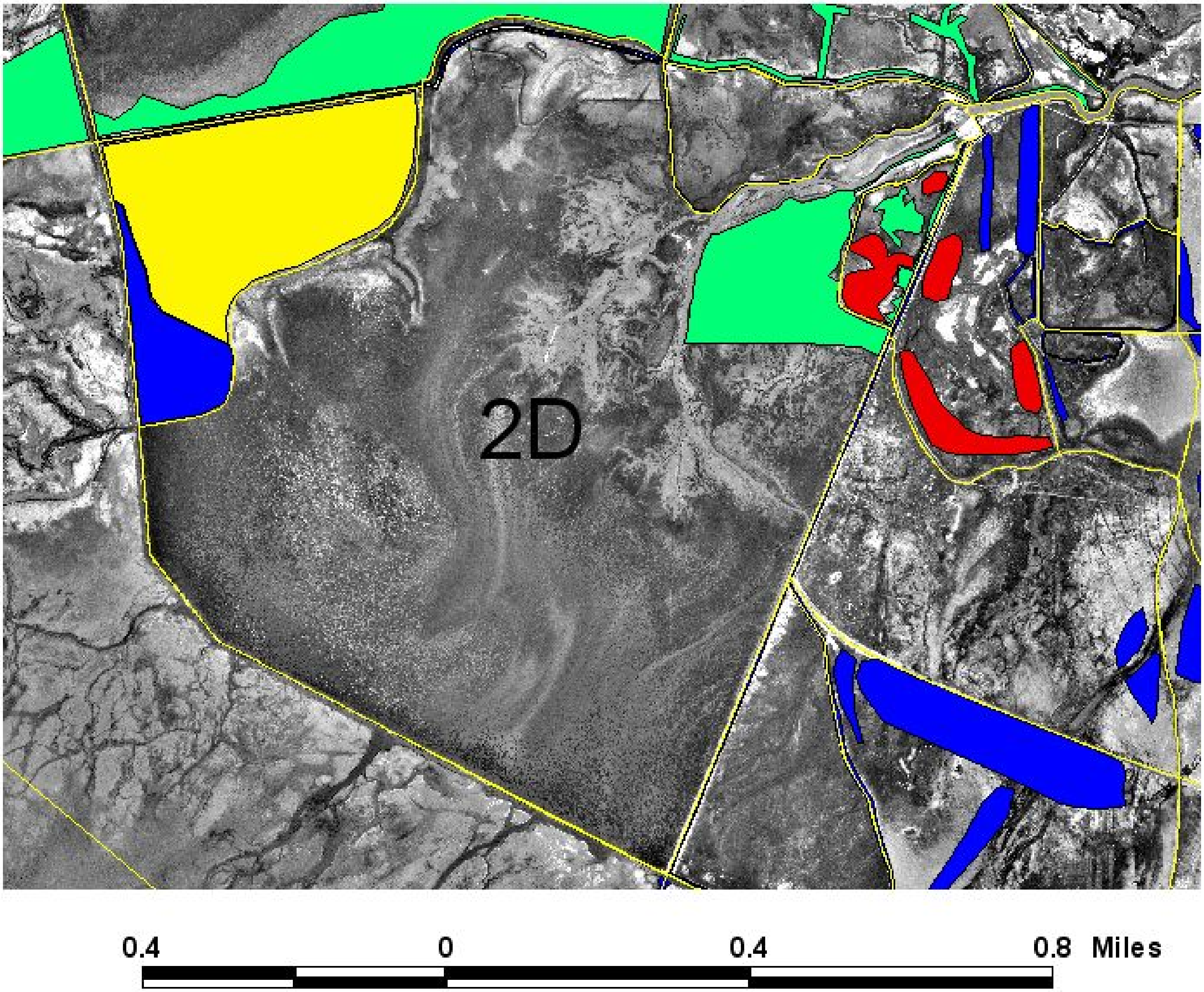
Tamarisk Treatment 2003
Unit 1



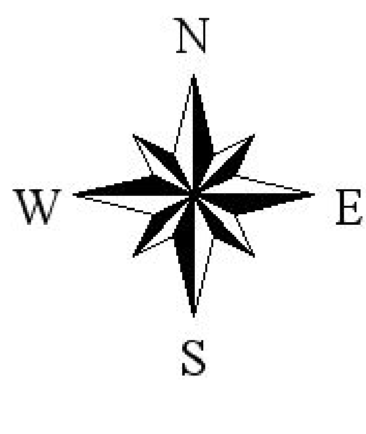
Tamarisk Treatment 2003
Unit 1A



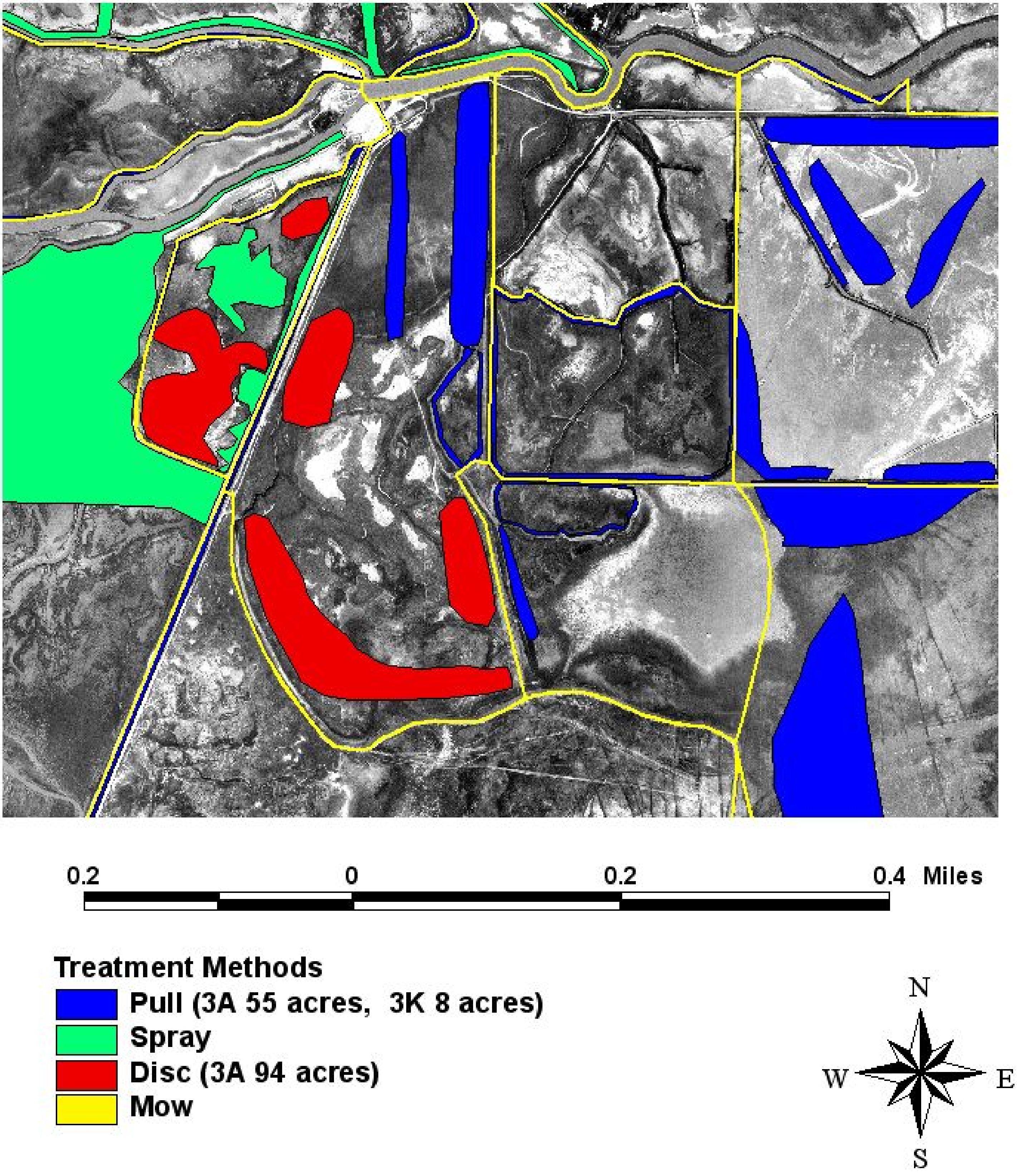
Tamarisk Treatment 2003
Unit 2D



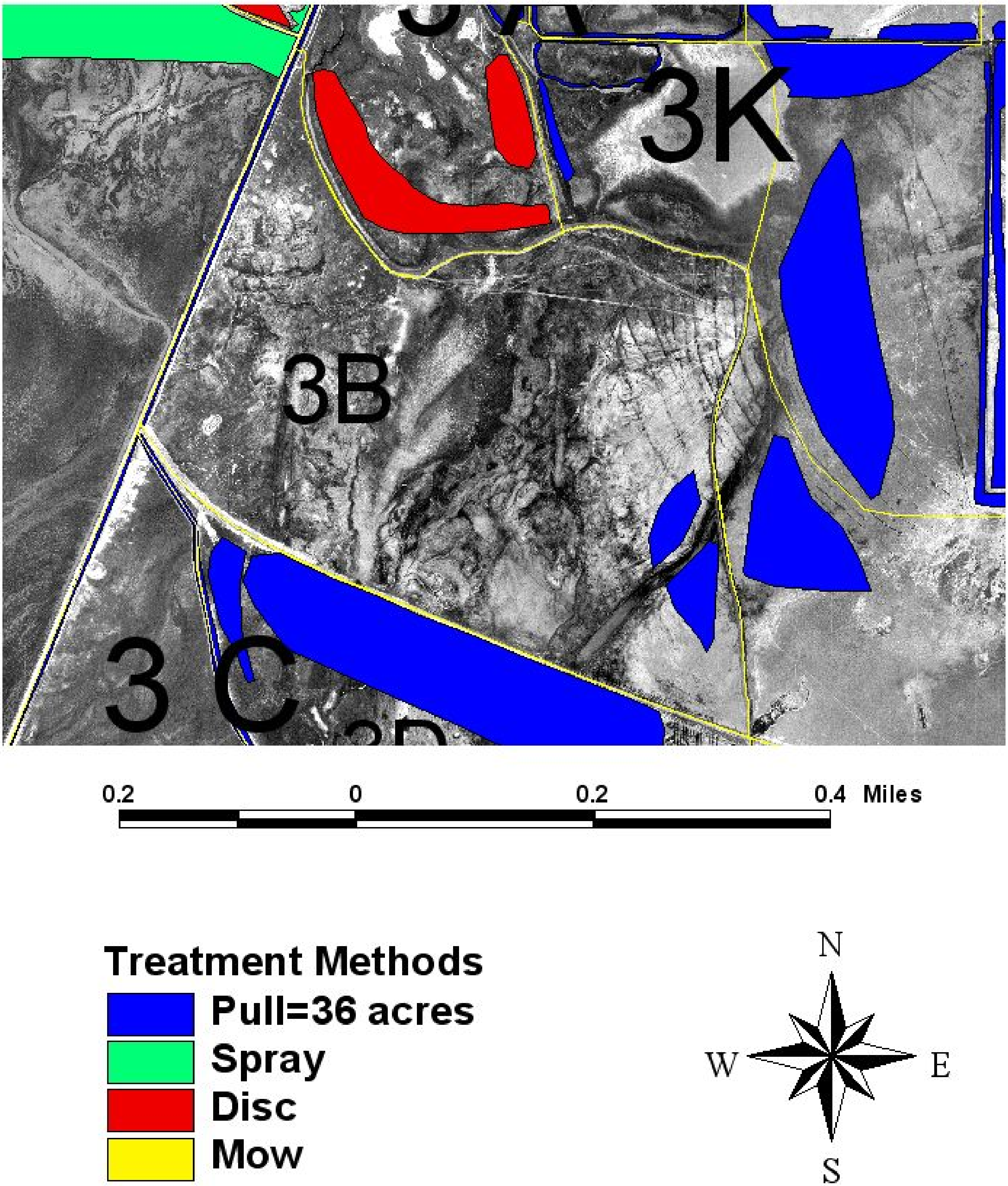
Treatment Method



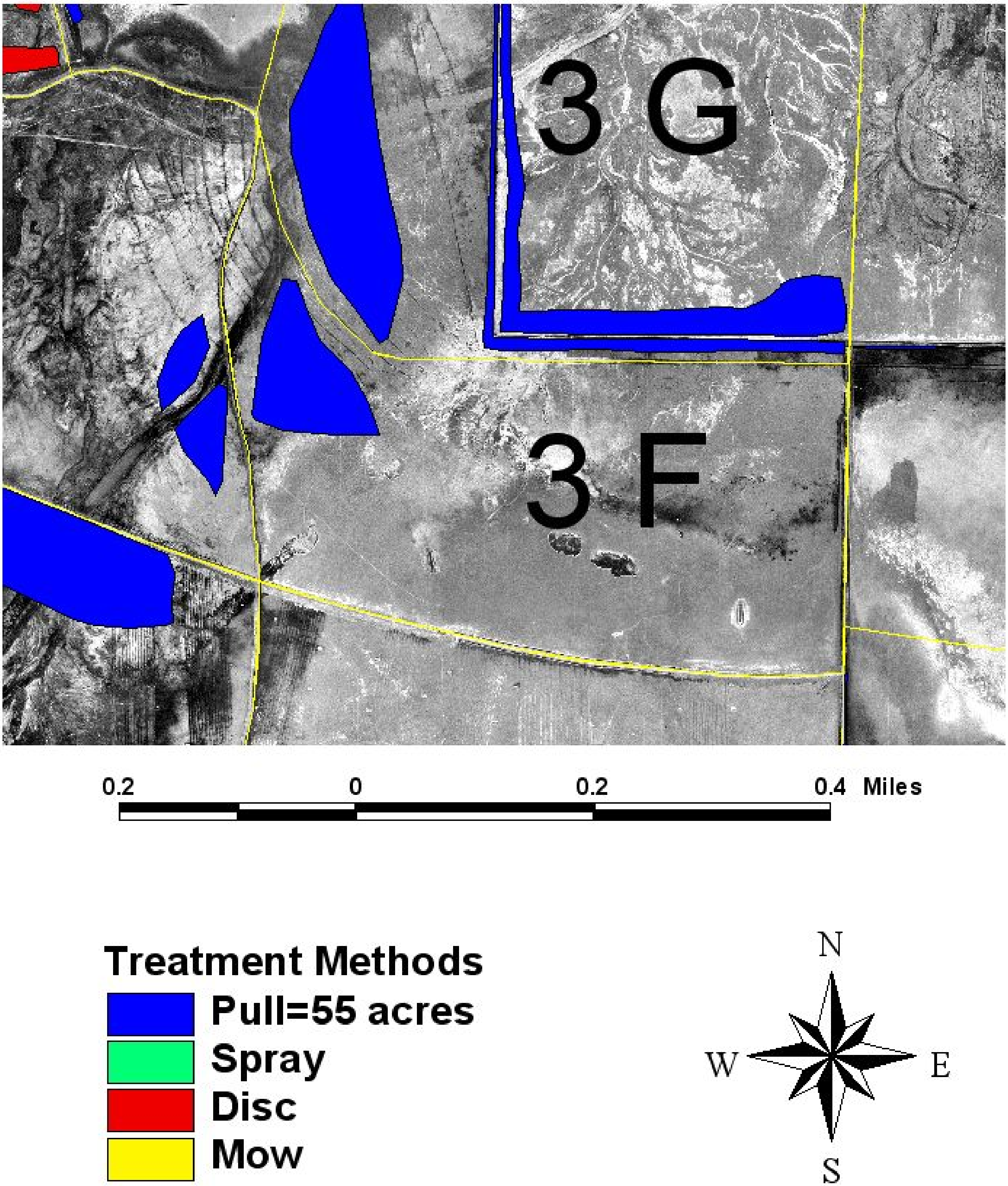
Tamarisk Treatment 2003
Units 3A and 3K



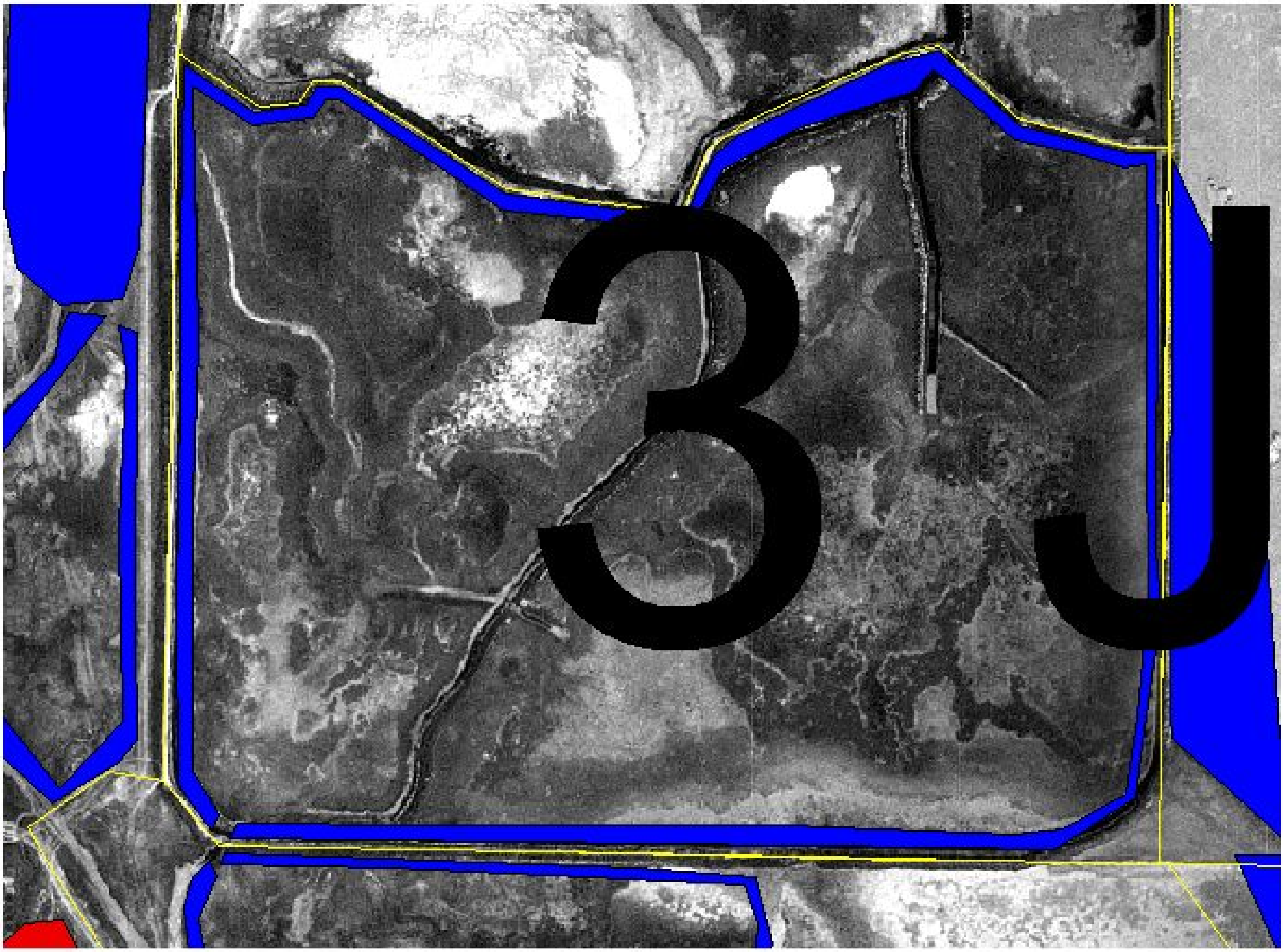
Tamarisk Treatment 2003
Unit 3B



Tamarisk Treatment 2003
Unit 3F

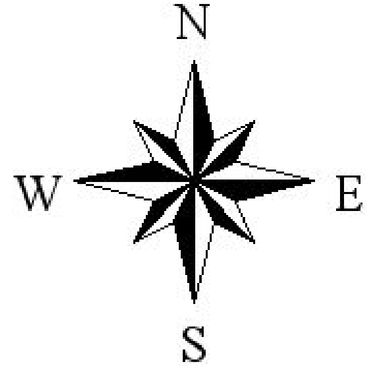


Tamarisk Treatment 2003
Unit 3J

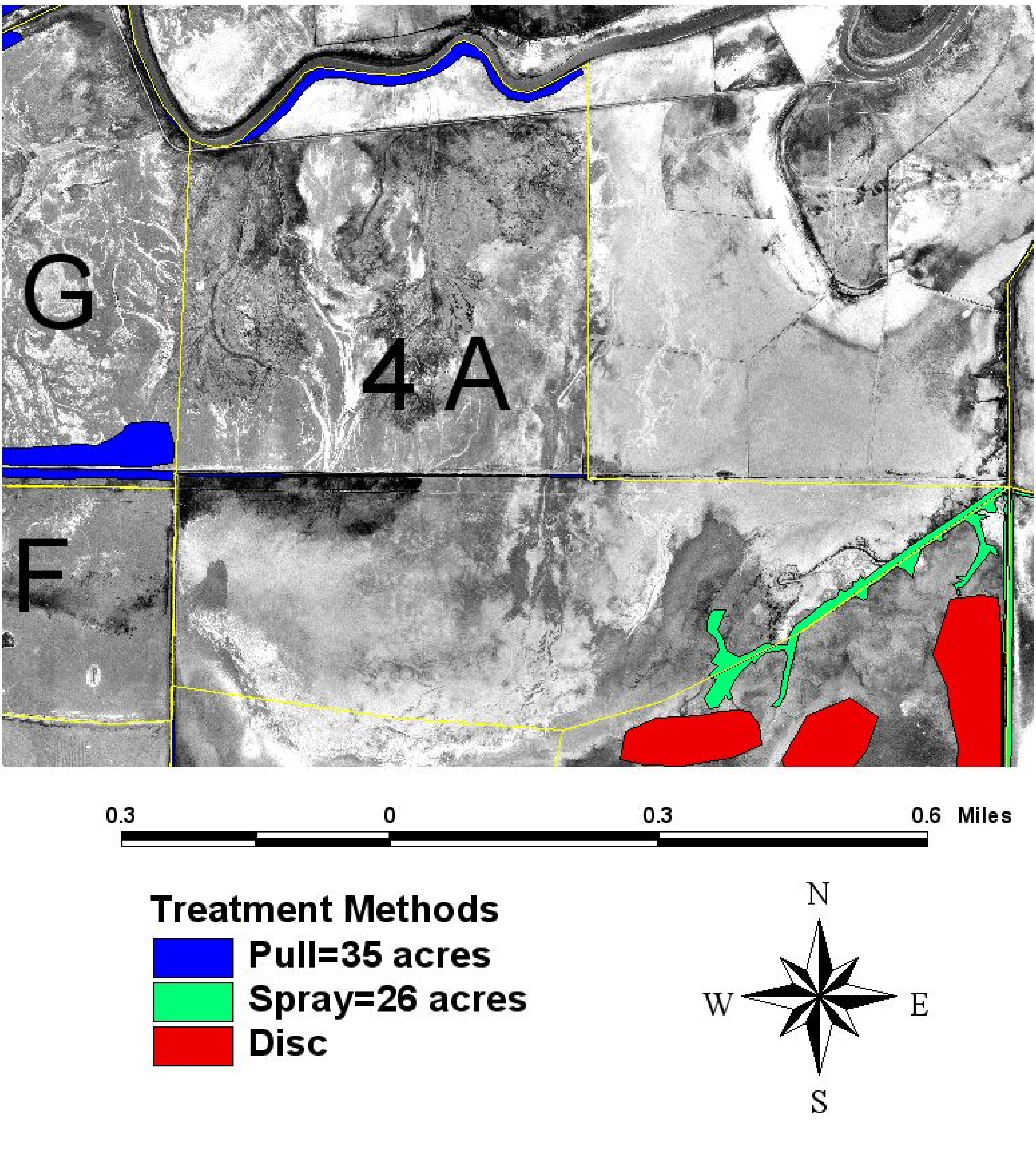


Treatment Methods

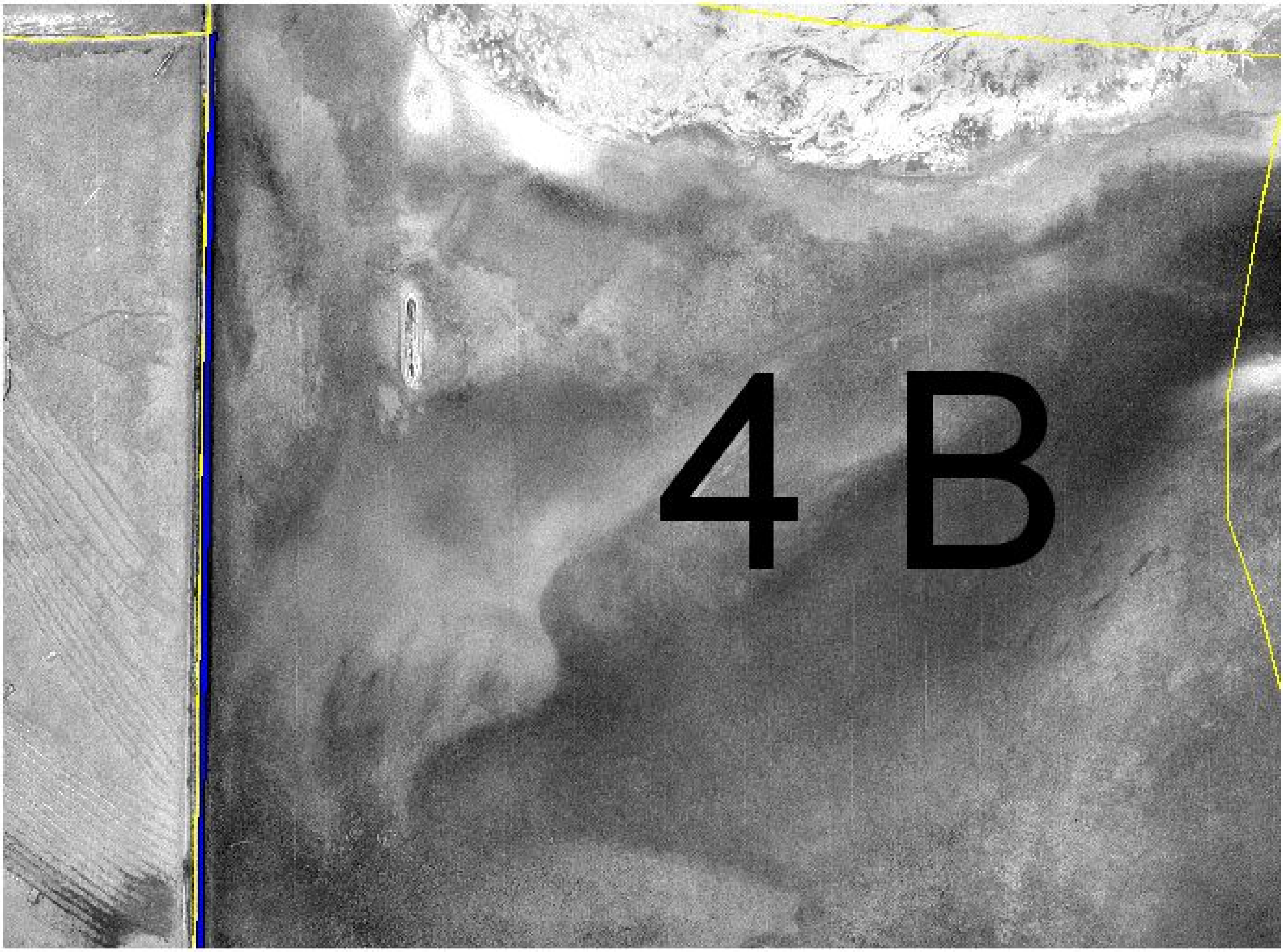
- Pull= 12 acres
- Spray
- Disc
- Mow



Tamarisk Treatment 2003
Unit 4A



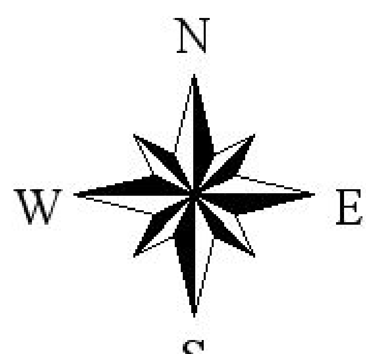
Tamarisk Treatment 2003
Unit 4B



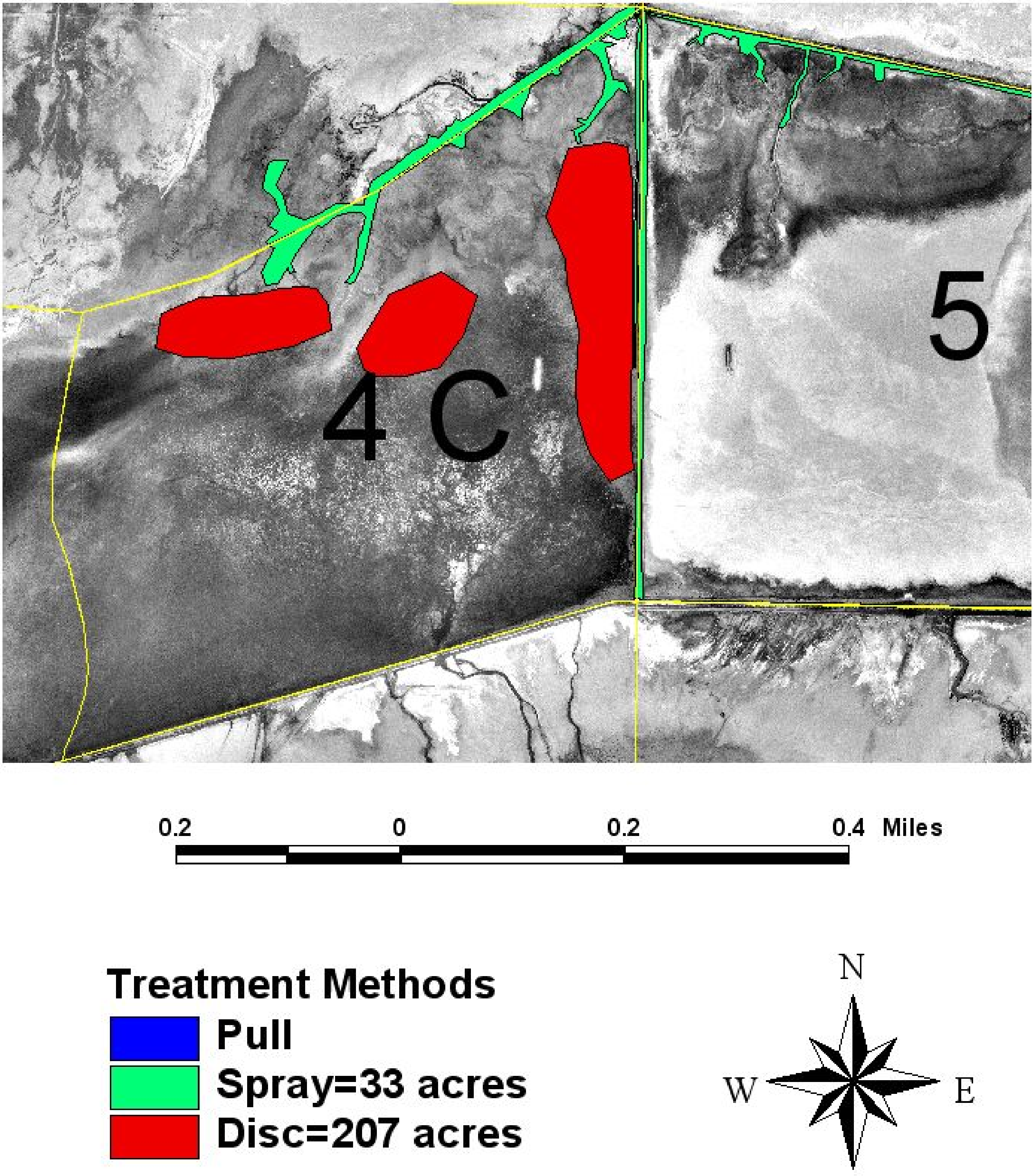
0.1 0 0.1 0.2 Miles

Treatment Method

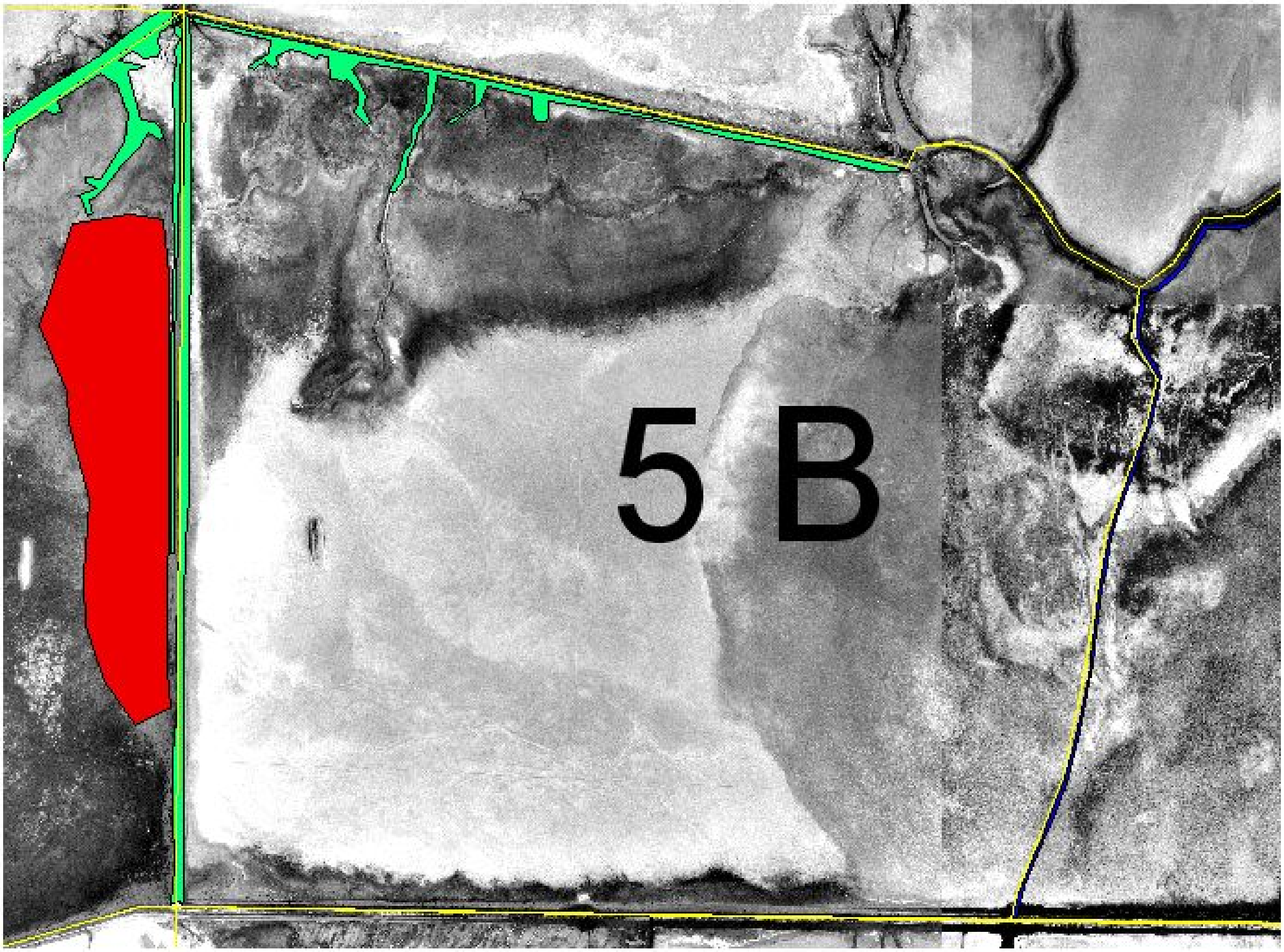
Pull=8 acres



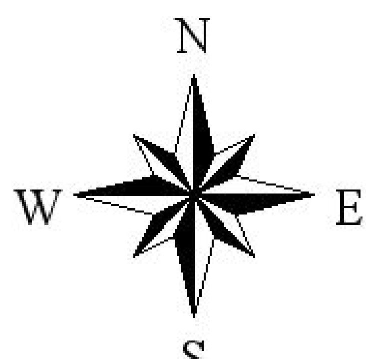
Tamarisk Treatment 2003
Unit 4C



Tamarisk Treatment 2003
Unit 5B



Treatment Method



Tamarisk Treatment 2003
Unit 5C