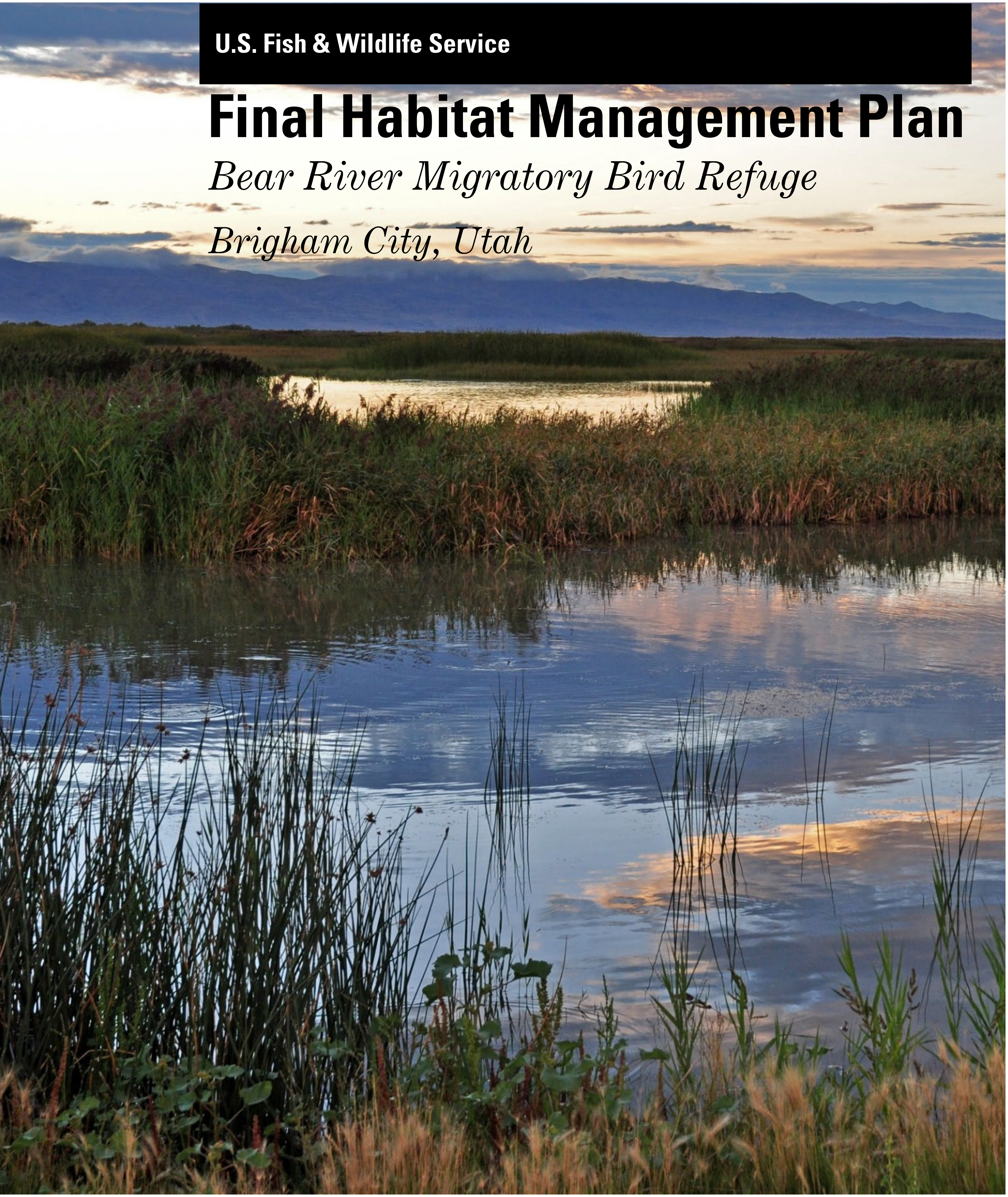
U.S. Fish & Wildlife Service

Final Habitat Management Plan

Bear River Migratory Bird Refuge

Brigham City, Utah



The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.

The mission of the National Wildlife Refuge System is 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.

Final Habitat Management Plan

Bear River Migratory Bird Refuge

Utah

March 2021

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Abbreviations

°F degrees Fahrenheit

% percent

mi² square mile

Improvement Act National Wildlife Refuge System Improvement Act of 1997

AWP Annual Work Plan

BIDEH Biological Integrity, Diversity, and Environmental Health Policy

BRCC Bear River Canal Company

cfs cubic feet per second

CCP Comprehensive Conservation Plan

CEQ Council on Environmental Quality

CMP Comprehensive Management Plan

EA Environmental Assessment

EDRR Early Detection and Rapid Response

EIS Environmental Impact Statement

ELU Equivalent Livestock Unit

FONSI Finding of No Significant Impact

GSL Great Salt Lake

HMP Habitat Management Plan

MBR Migratory Bird Refuge

msl mean sea level

NEPA National Environmental Policy Act of 1969, as amended

Refuge Bear River Migratory Bird Refuge

Refuge System National Wildlife Refuge System

Service United States Fish and Wildlife Service

SP State Park

USDA United States Department of Agriculture

USEPA United States Environmental Protection Agency

USFWS United States Fish and Wildlife Service

USGS United States Geological Survey

UTDAF Utah Department of Agriculture and Food

UTDWR Utah Division of Water Resources

WRCC Western Regional Climate Center

WMA Waterfowl Management Area

Executive Summary

The U.S. Fish and Wildlife Service has prepared a Habitat Management Plan (HMP) for the Bear River Migratory Bird Refuge (Refuge or Bear River MBR) in Utah. The following summary provides a brief overview of the plan including (1) a general description of the Refuge, (2) purpose of plan, (3) goals and objectives, and (4) the proposed projects.

The Refuge

As part of the National Wildlife Refuge System, the Bear River MBR was established by Presidential Proclamation in 1928 and Public Law 304 of the 70th Congress as "a suitable refuge and feeding, and breeding grounds for migratory wild fowl". Currently, the Refuge encompasses 77,102 acres and is comprised of deltaic wetlands that make up numerous wetland impoundments, wet meadows, and uplands. Located at the terminus of the Bear River and part of the Great Salt Lake (GSL) ecosystem, the Refuge is a priority area within the Bear River Watershed and plays a critical role in providing habitat for migratory birds along the Central Flyway. More than 210 species of birds have been documented during migration on the Refuge, and 70 species are known to nest there. During migration, the GSL ecosystem provides habitat for an estimated 217 million waterfowl use-days in the fall and 60 million waterfowl use-days in spring (Intermountain West Joint Venture 2013). Refuge habitats alone may support up to 500,000 waterfowl and 200,000 shorebirds annually during migration. In addition, about 15% of the western population of tundra swan utilize Refuge habitats during fall and may remain throughout the winter in mild years (Refuge records).

The GSL ecosystem also is one of the most critical breeding and staging sites for colonial waterbirds, waterfowl, and shorebirds (Downard 2010). In addition, the ecosystem also supports the largest breeding colony of white-faced ibis in the world (Paul and Manning 2002), as well as one of the three largest American white pelican breeding colonies in North America (Parrish et al. 2002). Refuge contributions to GSL breeding statistics include up to 1% and 2% of the continental breeding populations of American avocet and black-necked stilt, respectively, and an average of 11,000 molting northern pintail (Refuge records). In addition, the Refuge historically has provided important breeding habitat for long-billed curlew and is the most important foraging site in the GSL ecosystem for American white pelican.

Terrestrial habitats on the Refuge, although limited in size, support several mammalian species. Among the most common are mule deer, long-tailed weasel, muskrat, raccoon, striped skunk and several species of mice and voles. Less common are badger, beaver, coyote, red fox, and yellow-bellied marmot. Alkali knolls, meadows, and wooded riparian habitats also support limited numbers of other bird species including vesper sparrow, savannah sparrow, western meadowlark, sage thrasher, loggerhead shrike, northern harrier, short-eared owl, and burrowing owl.

Mission and Purpose

To effectively manage a diverse and widespread system of lands in the National Wildlife Refuge System, Congress passed various laws, including the National Wildlife Refuge Administration Act (1966), that not only established the Refuge System but provided specific guidance for its administration and management. The National Wildlife Refuge Systems Improvement (Improvement Act), passed in 1997, amended the National Wildlife Refuge Administration Act and established a singular conservation mission for the Refuge 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”.

Every refuge within the Refuge System has a purpose for which it was established. The purpose is the foundation upon which to build all refuge programs, including biology and habitat management. No uses of a refuge may be allowed if they are determined to materially detract from or interfere with the purposes for which the refuge was established or the mission of the National Wildlife Refuge System. The refuge purpose is found in the legislative acts or administrative orders that allow authorities to either transfer or acquire a piece of land to establish a refuge. The goals and objectives identified in this HMP are intended to support the purpose for which the refuge was established.

The legislative purpose for Bear River MBR is as follows:

1. As "a suitable refuge and feeding, and breeding grounds for migratory wild fowl". (Presidential Proclamation 1928 and Public Law 304 of the 70th Congress)

2. “For the establishment and maintenance of migratory waterfowl refuges”. (Utah Code Annotated 23-21-6(1))

Future of the Refuge

The goals and objectives developed for the HMP were developed to support the mission of the National Wildlife Refuge System and the purposes for which the Refuge was established. They are based on the principle of ecological sustainability, which requires ensuring the long-term productivity of habitats. In this context, the Refuge HMP is focused on providing habitats necessary to provide the resources (e.g., foods and plant structure) needed to fulfill life cycle events (e.g., migration, staging, feeding, and breeding) of species using the Refuge, with an emphasis on focal species and guilds. Focal species and guilds identified include, 1) American white pelican, 2) American avocet, 3) black-necked stilt, 4) cinnamon teal, 5) white-faced ibis, 6) tundra swan, 7) snowy plover, 8) migratory waterfowl, and 9) migratory shorebirds. The goals of this HMP are as follows.

GOAL 1. Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds and shorebirds.

GOAL 2. Restore and manage wet meadow and upland habitats in the Wasatch Front to produce native grasses, sedges, rushes, and forbs, where possible, to provide foraging and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

GOAL 3. Prevent further physical alterations to maintain the existing hydrologic and topographic integrity of the Refuge.

GOAL 4. Maintain and expand partnerships that contribute to the conservation and enhancement of Refuge habitats, the Bear River watershed, and the GSL Ecosystem.

Within the goals are a series of objectives to support spring/fall migration and breeding. These objectives emphasize water depths, potential habitat, vegetation cover, and breeding habitats. The overarching intent of all the goals and objectives is to manage Refuge habitats based on current vegetation composition, availability of water, and the opportunity to vary water management depending on those current conditions.

Projects

Achieving these goals and objectives will require completing restoration and infrastructure improvement projects. These infrastructure improvement projects are necessary to institute annual management strategies (e.g., water management) that better emulate natural processes (e.g., sheetflow), with the least intensive management possible. There are a total of five projects that have been identified to complete within the 5-year life of this HMP.

Project #1 – Partial Hydrologic Restoration of Unit 2A

Project #2 – Restoration of Sheetflow Hydrology on the Canadian Goose Club and Unit 4

Project #3 – Partial Hydrologic Restoration of 3I and 3J

Project #4 – Improve the Ability to Manage Hydrology of Impounded Units

Project #5 – Native Plant Community Restoration in 3 Bar Unit

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Goal 2. Restore and manage wet meadow and upland habitats in the Wasatch Front to produce native grasses, sedges, rushes, and forbs, where possible, to provide foraging and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds. 41

Goal 3. Prevent further physical alterations to maintain the existing hydrologic and topographic integrity of the Refuge. 43

Goal 4. Maintain and expand partnerships that contribute to the conservation and enhancement of Refuge habitats, the Bear River watershed, and the Great Salt Lake ecosystem. 44

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Chapter 1. Introduction

1.1 Scope and Rationale

This Habitat Management Plan (HMP) is a revision of the 2004 HMP that was written to implement the goals and objectives of the 1997 Bear River Migratory Bird Refuge (Refuge or Bear River MBR) Comprehensive Management Plan (CMP). The scope and rationale for this revised HMP is to contribute to conservation of wildlife at the local, regional, and ecosystem scales while preserving the biological integrity, diversity, and environmental health of Refuge lands. Although U.S. Fish and Wildlife Service (USFWS, Service) planning policy (620 FW1 2002) identifies a 15-year timeframe for the HMP, the intent of this HMP is to provide a strategic, operational guide to focus future management during the next 5 years on infrastructure improvements and restoration of habitats to improve ecological function in specific areas of the Refuge. Accomplishing these tasks will benefit priority species and help ensure the long-term ecological sustainability of Refuge lands.

During HMP development, the management direction of Refuge lands was evaluated based on the enabling legislation of the Refuge in the context of the Central Basin and Range and the Great Salt Lake (GSL) ecosystems. Priority species and guilds were identified (Chapter 3) and the habitat requirements of these species were used to guide development of goals and objectives (Chapter 4). Current ecological function of Refuge lands was evaluated, and restoration and improvement projects that will contribute to the achievement of the objectives, address priorities of both the Regional Director and Assistant Regional Director, and improve the capacity to manage for ecological sustainability were selected for inclusion (Chapter 5). Projects were developed based on historic Refuge data, scientific literature, expert opinion, and staff expertise.

1.2 Legal Mandates

1.2.1 Refuge Purpose

Bear River Migratory Bird Refuge was established by Presidential Proclamation in 1928 and Public Law 304 of the 70th Congress as "a suitable refuge and feeding, and breeding grounds for migratory wild fowl". As required by Utah Code Ann. 23-21-6(1), the State of Utah gave consent for "the acquisition of lands and water…as the United States may deem necessary…for the establishment and maintenance of migratory waterfowl refuges" and required the Service to provide a management plan for these lands to the governor. Currently, the Refuge encompasses 77,102 acres, of which 75,857 acres were acquired under the authority of the Migratory Bird Conservation Act of 1929 and 1,245 acres under the Fish and Wildlife Coordination Act of 1956 (Table 1). Acquisitions from 1929 to 1989 (65,075 acres) consisted of lands that were classified as wetland or barren, whereas from 1990 to 2014 acquisitions primarily were classified as farming and ranching. In addition to a 7-acre inholding, the Refuge contains several easements permitting existing power lines, roads, telephone lines, and petroleum pipelines that traverse the Refuge.

Table 1. Bear River Migratory Bird Refuge land acquisition history

Acquisition period	*Acres*	*Authority*	*Prior land use*
1929-1939	60,420	Migratory Bird Conservation Act (1929)	Wetland or barren
1940-1989	4,655	Migratory Bird Conservation Act (1929)	Wetland or barren
1990-2014	10,782	Migratory Bird Conservation Act (1929)	Farming and ranching
1990-2014	1,245	Fish and Wildlife Coordination Act (1956)	Farming and ranching
Total	**77,102**		

1.2.2 National Wildlife Refuge System Mission

The Refuge is part of the National Wildlife Refuge System (Refuge System), which is the largest and most diverse network of lands and waters dedicated to ensuring the long-term future of America's rich fish and wildlife heritage. Managed by the Service, the Refuge System include more than 565 refuges, 38 wetland management districts, and other protected areas that encompass more than 835 million acres of land and water from the Caribbean to the remote Pacific. There is at least one national wildlife refuge in every state and territory.

To effectively manage such a diverse and widespread system of lands, Congress passed various laws, including the National Wildlife Refuge Administration Act (1966), that not only established the Refuge System but provided specific guidance for its administration and management. The National Wildlife Refuge Systems Improvement (Improvement Act), passed in 1997, amended the National Wildlife Refuge Administration Act and established a singular conservation mission for the Refuge 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 Improvement Act also required preparation of a Comprehensive Conservation Plan (CCP) for each refuge and required that the Secretary of Interior maintain the biological integrity, diversity and environmental health of the Refuge System while ensuring that any proposed uses of any refuge do not materially detract from the purpose(s) for which it was established. This HMP and any future planning documents must adhere to the statutes within this law and other refuge-specific laws and Executive Orders, as well as the policies and regulations written to implement these laws.

1.2.3 Other Legal Mandates

Several additional legal mandates also govern the management of units within the Refuge System. With respect to Bear River Migratory Bird Refuge, these mandates include, but are not limited to, the following acts:

- Migratory Bird Treaty Act (1918)
- Fish and Wildlife Act (1956)
- Refuge Recreation Act (1962)
- National Historic Preservation Act (1966)
- National Environmental Policy Act (NEPA, 1970)
- Endangered Species Act (1973)

1.3 Relationship to Other Plans and Memoranda

A CCP for the Refuge has not been completed and will not be initiated until after completion of this HMP. Therefore, the goals, objectives, and management projects identified in this HMP will form the foundation for management in the interim. Relevant information from the 1997 Refuge CMP and the 2004 HMP were considered in this revision, but modifications were necessary to address impacts that have occurred since completion of these plans (e.g., land-use changes that affect ecological processes).

According to Service planning policy (620 FW1 2002), the HMP must be re-evaluated after 15 years but may be updated earlier as better management information is developed or resource priorities change. This HMP will cover a 5-year timeframe and concentrate on restoration and infrastructure improvement projects. Each project will require several years to complete, dependent on funding availability and capacity. In addition, Refuge staff will continue to prepare Annual Work Plans (AWP) that identify specific habitat management strategies and prescriptions to be applied during a single year. The AWPs will help fulfill the habitat management objectives and strategies identified in this HMP while allowing for adaptive management based on dynamic habitat conditions and available resources.

The goals and objectives in this HMP will help achieve Refuge purposes, fulfill the Refuge System mission, meet other Service mandates, and comply with all applicable laws, regulations, and policies governing the management of Service lands. In 2013, the Service established the Bear River Watershed Conservation Area in Idaho, Utah, and Wyoming and developed a land protection plan (USFWS 2013). This plan, which includes the Refuge, describes important resources of the watershed, provides direction for evaluating potential easement properties, and coordinates conservation at a landscape scale by establishing up to 920,000 acres of voluntary conservation easements with private landowners (Figure 1). The HMP goals and objectives were developed to be consistent with this watershed conservation plan and other geographically relevant conservation plans to ensure Refuge management contributes to conservation at multiple spatial scales. Additional plans consulted during the planning process included the following:

- Utah Wildlife Action Plan (2015)
- Utah Partners in Flight Avian Conservation Strategy (2002)
- Intermountain West Joint Venture Implementation Plan (2013)
- Final Bear River Comprehensive Management Plan (2017)
- U.S. Shorebird Conservation Plan (2001)
- Intermountain West Regional Shorebird Plan (2001)
- U.S. Waterbird Conservation Plan (2002)
- Intermountain West Waterbird Conservation Plan (2006)
- Great Salt Lake Comprehensive Management Plan and Record of Decision (2013)

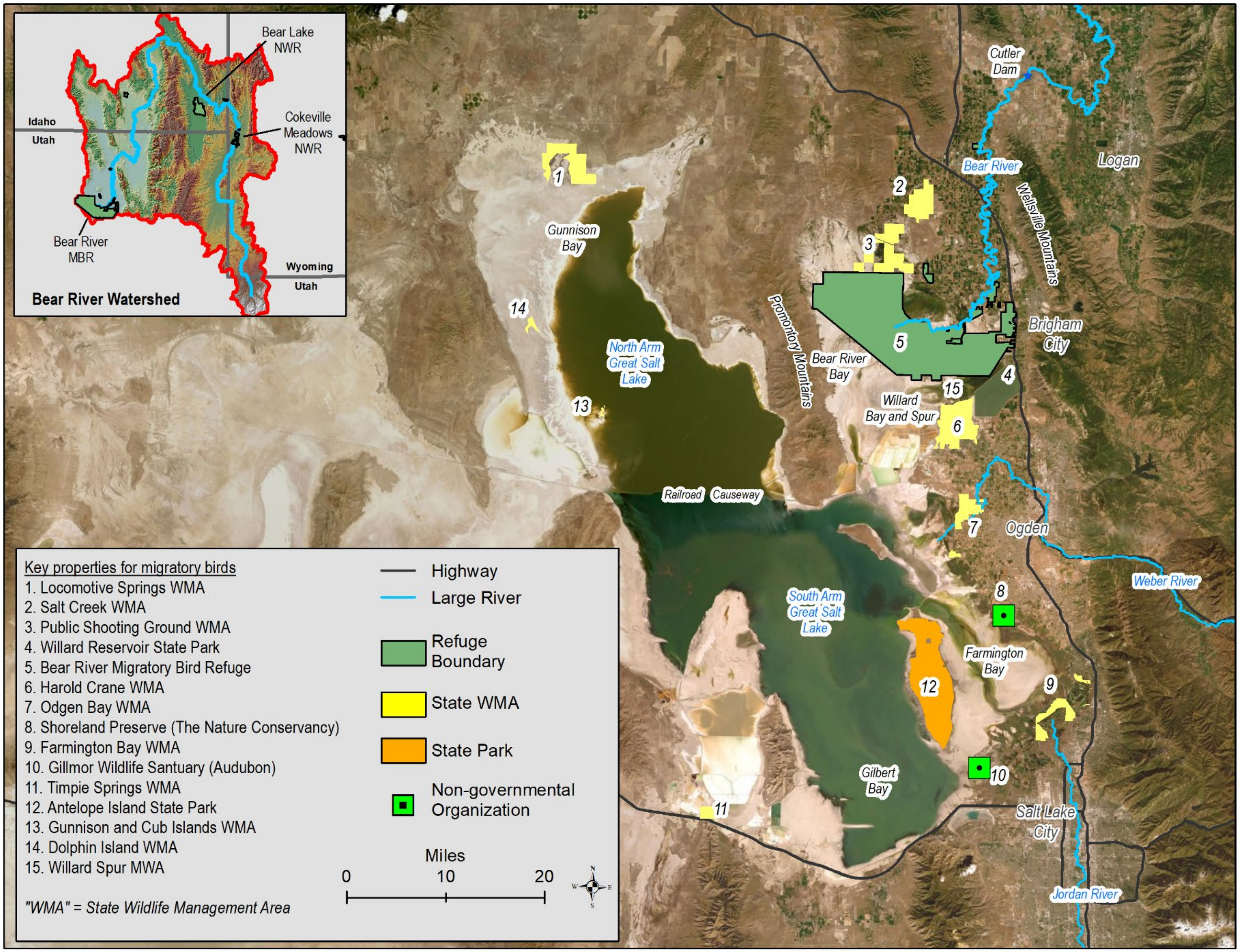

Figure 1: General location of the Bear River Migratory Bird Refuge and nearby protected areas.

Chapter 2. Background

2.1 Inventory and Description of Habitat

2.1.1 Location

The Refuge encompasses 77,102 acres at the north end of the GSL and includes most of the valley floor between the Wellsville Mountain Range to the east and the Promontory Mountain Range to the west. The Refuge is bordered by GSL to the south and a combination of private duck clubs and agricultural land to the north. Interstate 15 is adjacent to the Refuge on the east and is a major transportation corridor. Located in Box Elder County near Brigham City, Utah, the cities of Logan and Ogden are within 30 miles of the Refuge, and Salt Lake City is 60 miles to the south (Figure 1). The Salt Lake City – Ogden – Provo Combined Statistical Area has a population of more than 2.5 million people.

2.1.2 Management Units

The Refuge sits in a delta formed by the Bear River and other water sources and empties into the GSL. The Refuge currently consists of 26 wetland impoundments on the main delta (Units 1 – 5 and subunits, Canadian Goose Club tract), five unimpounded units south of the D-Line dike (Units 6-10), five Wasatch Front units, and three units near the river that contain both impounded and unimpounded sections (Table 2; Figure 2). Due to an increase in elevation, the northwest portion of Unit 10 supports a shrubland community (i.e. alkali knolls) of approximately 511 acres. The primary purpose of these units is the provision of foods (i.e., plants and invertebrates) and the vegetation structure necessary to support a diverse migratory waterbird community during spring and fall migration, as well as during the breeding season. The terrestrial portions of the Refuge, including dikes, support several species of mammals and upland birds.

Table 2. Bear River Migratory Bird Refuge management units, their corresponding surface area, and water source.

Unit	*Acres*	*Water Source*
Impounded Units		
1	517	Bear River, L-Line, Upland springs and tributaries
1A	591	Bear River, L-Line, Upland springs and tributaries
1B	11,716	Salt Creek, Sulfur Creek
Unit 1 Total	12,824	
2A	126	Bear River
2B	291	L-Line
2C	702	L-Line
2D	4,601	Bear River
Unit 2 Total	5,720	
3A	540	Bear River
3B	1,067	H-Line
3C	537	H-Line
3D	1,036	H-Line
3E	1,396	O-Line
3F	956	O-Line
3G	1,437	O-Line, Bear River
3H	672	Bear River
3I	136	Bear River
3J	169	Bear River
3K	203	Bear River
Unit 3 Total	8,149	
4A	2,568	O-Line
4B	1,265	O-Line
4C	1,562	Whistler
Unit 4 Total	5,395	
5A	2,344	Reeder, Whistler, Black Slough
5B	1,703	Reeder, Whistler
5C	2,542	Reeder, Black Slough, springs and tributaries
5D	879	Reeder, Black Slough, springs and tributaries
Unit 5 Total	7,468	
Canadian Goose	1,804	Whistler, Bear River
Wasatch Front Units		
Nichols	1,367	Wasatch Front springs and tributaries, ditch and shares
White	1,302	Wasatch Front springs and tributaries
Stauffer	182	Wasatch Front springs and tributaries
3-Bar	57	Bear River Canal Company
Jensen	21	Bear River Canal Company
Wasatch Front Total	2,929	
River Corridor Units		
Christensen	250	Reeder, irrigation return flows
Pintail/ Lucky 7	581	Bear River
Yates	681	Bear River, irrigation return flows
River Corridor Units Total	1,512	
Canals		
Reeder	78	Bear River
Whistler	127	Bear River
O-Line	68	Bear River
H-Line	54	Bear River
L-Line	72	Bear River
3-Drain	77	Unit 3
Canals Total	476	
Unimpounded Below D-Line		
6	3,218	5B, 5C, Reeder, Whistler, Wasatch Front springs and tributaries
7	2,536	4B, 4C, Whistler, O-Line
8	4,170	3C, 3D, 3E, O-Line, H-Line
9	5,186	2C, 2D, L-Line, H-Line
10	15,016	1, Upland springs and tributaries
Below D-Line Total	30,126	

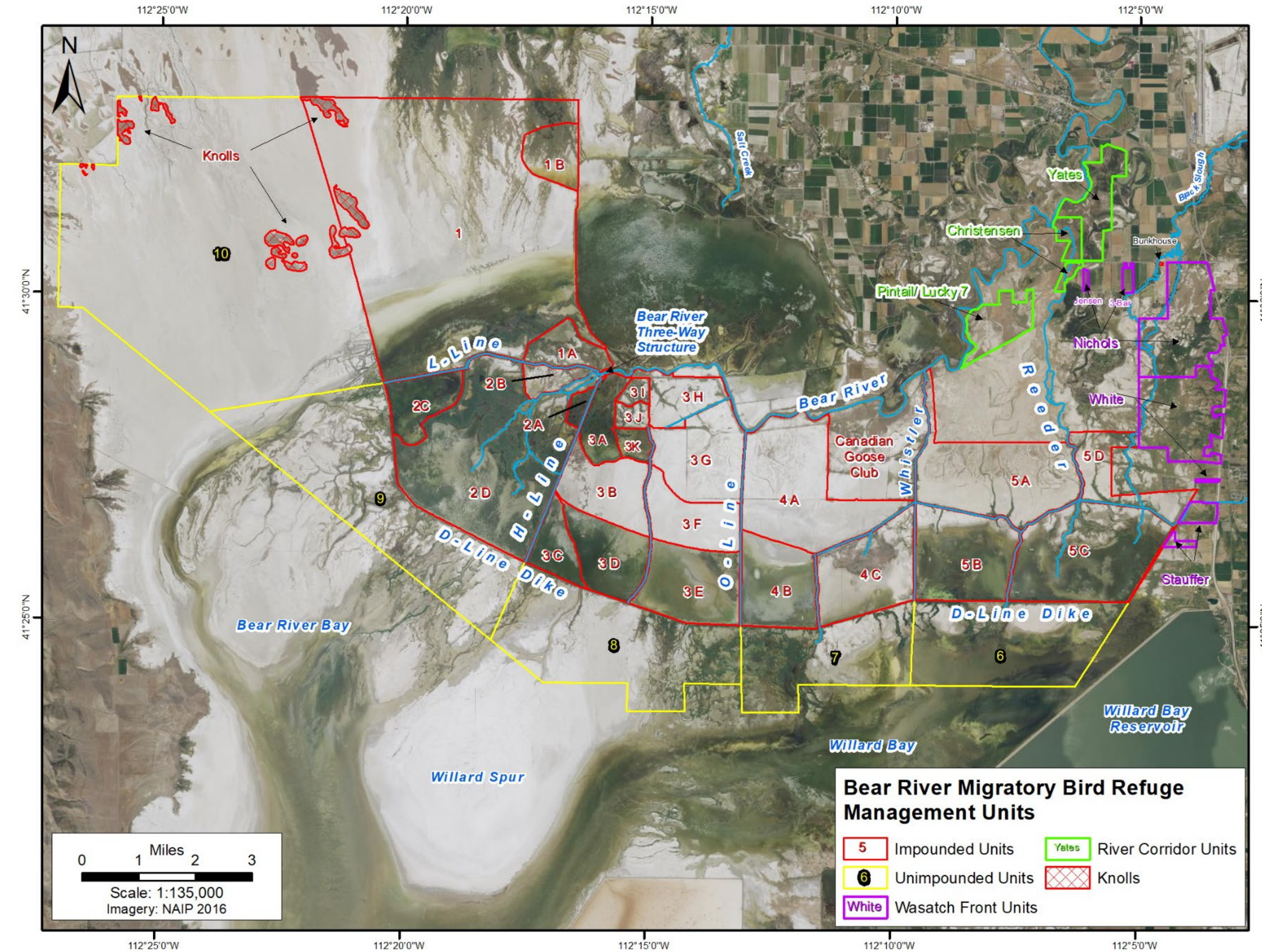

Figure 2: Management Units at the Bear River Migratory Bird Refuge.

2.2 Physical Setting

2.2.1 Ecoregion

The Refuge is in the Intermountain West Region, which is 750,000 mi^2 that ranges from the Rocky Mountains in the east to the Sierra and Cascade Mountains in the west, and from the Canadian border on the north to the Mexican border on the south. Within this region is the Great Basin, 217,000 mi^2 located between the Cascade and Rocky Mountain ranges, principally in Oregon, California, Nevada, Idaho, and Utah. Due to the arid- to semi-arid climate, wetlands are scarce in the region and account for about 1% (1.6 million acres) of the surface area (Dahl 1990; Ratti and Kadlec 1992; Soulard 2012). Within these larger landscapes, the Refuge is part of the "Central Basin and Range" Level III Ecoregion, an area that occupies approximately 120,000-mi^2 primarily in Nevada and western Utah with small extensions into California, Oregon, and Idaho (Omernik 1987; USEPA 2010; Wiken et al. 2011; Figure 3). The ecoregion is characterized by north-south trending mountain ranges that are separated by broad xeric basins and valleys (Soulard 2012). The high elevation and location of the ecoregion between mountain ranges influences climate as the Sierra Nevada to the west blocks moisture from the Pacific Ocean and the Rocky Mountains to the east restricts moisture from the Gulf of Mexico (Rogers 1982). The basins have playas, salt flats, low terraces, sand dunes, or scattered low hills, and are often bordered by long, gently sloping alluvial fans. Because wetlands account for less than 1% of the ecoregion, the Refuge is unique because it is one of the few locations in the Bear River Watershed that supports freshwater wetlands.

2.2.2 Bear River Watershed

The Bear River Watershed encompasses 7,500 mi^2, of which 2,700 mi^2 are in Idaho, 3,300 mi^2 in Utah, and 1,500 mi^2 in Wyoming (UTDWR 2004). The Bear River, which is the western hemisphere's largest river system not flowing into an ocean (Gerner and Spangler 2006), is the primary river in the watershed. The Bear River originates in the Uinta Mountains of northeastern Utah, flows northerly through parts of Wyoming and Idaho, and then reenters Utah and flows southerly through the Refuge before emptying into the GSL at Bear River Bay (Figure 4). Near the city of Evanston, Wyoming, the topography in the floodplain flattens, and the river begins a dramatic transformation from a fast-flowing, cold, clear river in narrow valleys to a slow-moving, cool, meandering course on the valley floor.

Discharge from the Bear River accounts for the majority of water entering the Refuge and more than 50% of the annual flow into the GSL (Sigler and Sigler 1996). Other inflows to the Refuge include water from Sulphur Creek, Salt Creek, Malad River (a tributary that discharges water to the Bear River below Cutler Reservoir before entering the Refuge), Black Slough, and various springs and small streams originating in the Wasatch Front and northwestern uplands (USGS 2017a; Figure 4), in addition to return flows from impoundments that are part of private land holdings. Return flows from irrigation canals that terminate upstream of the Refuge and other drainage canals also provide localized water inputs on the northern end of the Refuge.

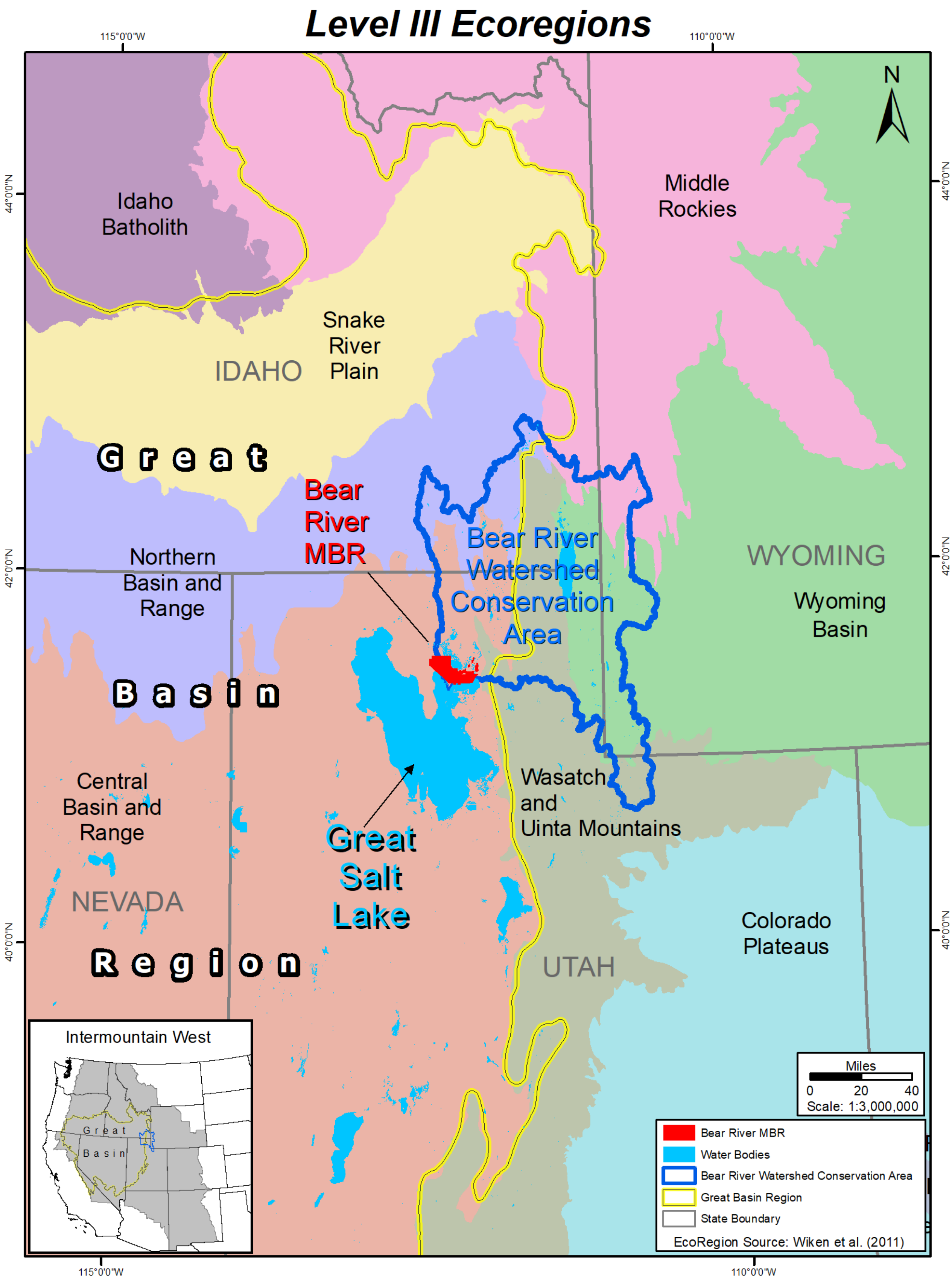

Figure 3: Ecoregions near the Bear River Migratory Bird Refuge.

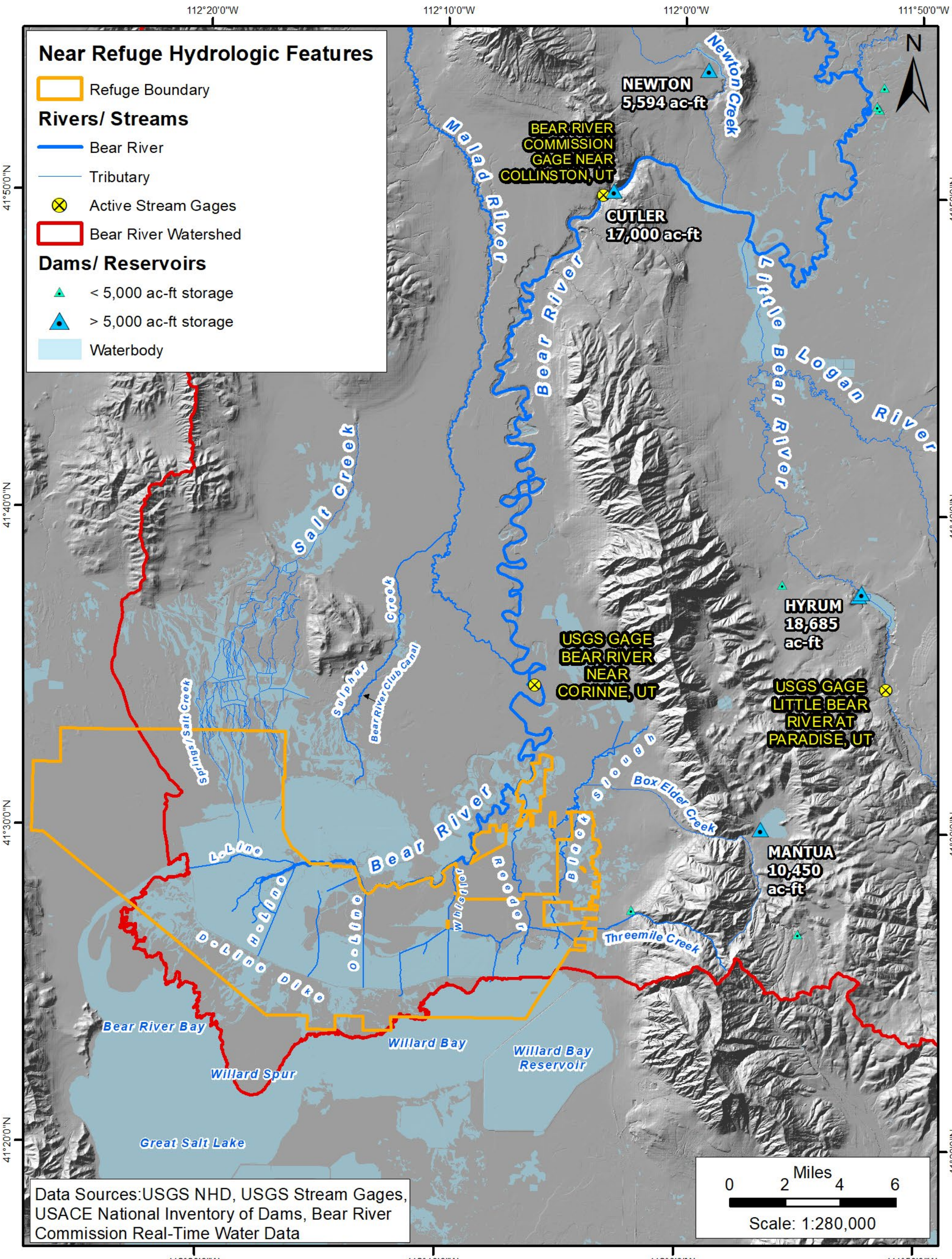

Figure 4: Regional water features (stream gages, reservoirs, etc.) near the Refuge.

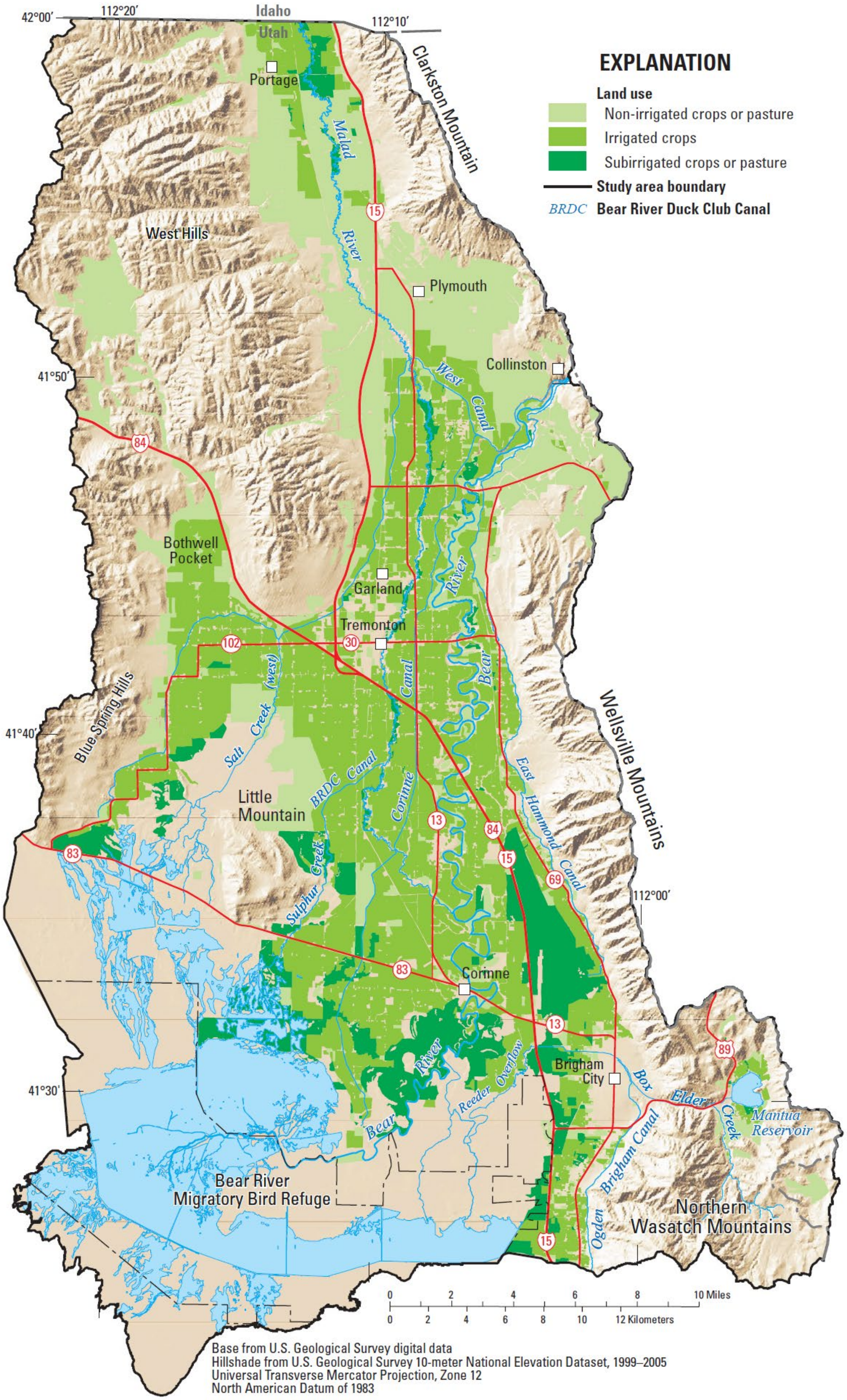

Figure 5: Irrigated lands in lower Bear River Watershed (Courtesy USGS).

Development of water resources in the watershed to facilitate agricultural and urban expansion started as early as 1889 with the construction of Wheelon Dam in the Bear River Canyon (UTDNR 2017). Currently, there are five reservoirs that generate hydroelectric power (Soda, Last Chance, Grace, Oneida, and Cutler), another 155 lakes with a minimum storage capacity of 20 acre-feet, and more than 450 irrigation companies (SWCA 2010; UTDNR 2017; Figure 4). Upstream of the Refuge in the Malad and lower Bear River watersheds, agriculture currently accounts for 7% of the land use but more than 80% of the water usage (USFWS 2013; Utah Water Resources Laboratory 2017; Figure 5). These changes have drastically altered the flow regime and character of the river (UTDNR 2017). Quantifying the impacts is difficult due to limited data, but flow records between 1902 and 2006 at the United States Geological Survey (USGS) Collinston gage (ID 10118000) located about 2,000 feet downstream of the Cutler hydropower provide some indication of long-term changes. This record shows a net negative trend in annual runoff from 1903 – 2005, with a negative slope of about 4,000 acre-feet per year ($p = 0.06$). In addition, based on average monthly decadal discharge, the amount of water present during the peak runoff season (April – June) has decreased in the last 100 years. The reduction in peak flows partially is due to water storage in reservoirs coupled with water diversions for agricultural irrigation during the growing season.

The real-time stream gage (ID 10126000) nearest the Refuge is located near Corinne, approximately 6 miles upstream from the Refuge. Operated by the USGS and paid for by the Service, the gage is the reference point for quantifying the Service's primary water right on the Bear River (WR# 29-1014). The annual median flow at the gage is approximately 1,298 cubic feet per second (cfs) or about 940,000 acre-feet per year, while the average annual flow is around 1.2 million acre-feet (USGS 2017b). Regression analysis of the annual yearly discharge from 1950-2016 (excluding 1957-1963) indicates a negative trend in river discharge flowing into the Refuge (confidence level of 95%), with the slope of a best fit line suggesting an approximate decrease of 10,300 acre-feet per year (Figure 6).

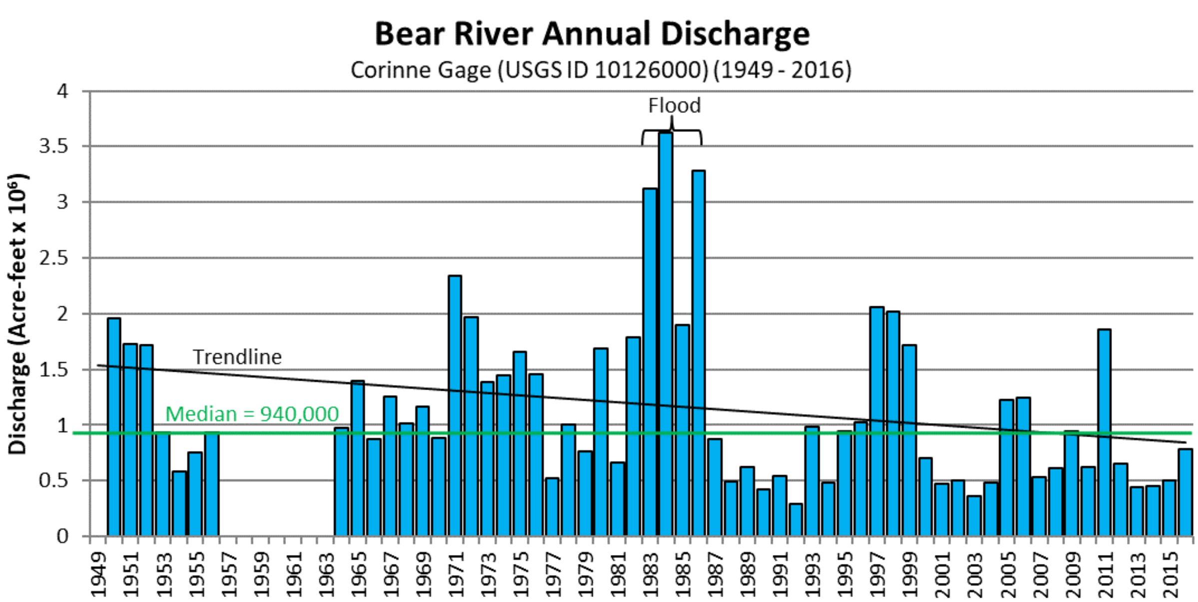

Figure 6: Annual measured discharge of the Bear River at the Corinne USGS Gage.

Groundwater levels tend to be near the surface and are connected with streams and springs near the Refuge (Stolp et al. 2017). Monitoring and analysis by the USGS and Utah Department of Natural Resources show that groundwater levels have remained nearly the same since 1960 and that there are no appreciable trends in groundwater levels near the Refuge. Total groundwater withdrawal in the Malad and Bear River Basins up to the Cutler Dam are about 7,400 acre-feet per year and have only increased by about 100 acre-feet per year since 1970 (Stolp et al. 2017).

2.2.3 Geology

All Refuge lands are part of the ancient Lake Bonneville floor, a pluvial (glacial) lake that was once up to 1,000 feet deep and covered an area of approximately 20,000 square miles (USGS 1966). About 17,400 years ago, approximately 50% of water in the Lake Bonneville drained into the Snake River, and the Provo shoreline was established about 335 feet lower than the Bonneville shoreline. Subsequently, Lake Bonneville briefly stabilized at a slightly lower elevation and formed a second Provo shoreline, before eventually receding to form the present-day GSL (Janecke and Oaks 2011).

The Bear River, which enters Cache Valley at the mouth of Oneida Narrows, has been the main source of water to the region during this period, and three sets of deltas formed: a major delta during the Bonneville highstand, a larger composited delta during the occupation of two Provo shorelines, and at least one smaller delta during recession from the Provo shoreline (Janecke and Oaks 2011). The delta was at least partially deposited on the Tertiary Salt Lake Group and is comprised of three architectural elements: delta-front sheet sands, beach gravels, and lacustrine clays. The distribution and stratigraphy of these elements were influenced by the long, low-gradient ramp geometry of the delta, as well as wave and fluvial deposits (Lemons and Chan 1999).

2.2.4 Soils

There are 21 soil types on Refuge lands, with 4 primary soil series occupying more than 66% of the Refuge (ordered from most to least saline: Playa (39%), Saltair (6%), Eimarsh (10%), and Pintailake (11%) (Figure 7). (Note: 28% of the Refuge is mapped as water.) Playa soils are intermittently flooded, strongly saline, and very poorly drained; as a result, they generally contain limited vegetation cover (less than 10%) and only the most salt-tolerant vegetation (Rohal et al., 2017). Similarly, Saltair soils are deep and poorly drained, occurring on nearly flat topography, and may contain a thin salt crust on the surface. These soils are typically saturated within 40 inches of the surface during most of the year, but the surface is dry during the summer months in normal years (National Cooperative Soil Survey 2006). Eimarsh and Pintailake soils are also very deep and poorly drained, occurring on flat, historic lake plains. Both are usually wet for much of the growing season (March – October) and are susceptible to frequent ponding (up to 6 inches depth) for long durations (National Cooperative Soil Survey 2006). The remaining soils (6%) are mostly silt-loams within the Beariver Series and are characteristic of floodplains located predominantly within the River Corridor units. These areas are occasionally flooded for brief periods during March through June.

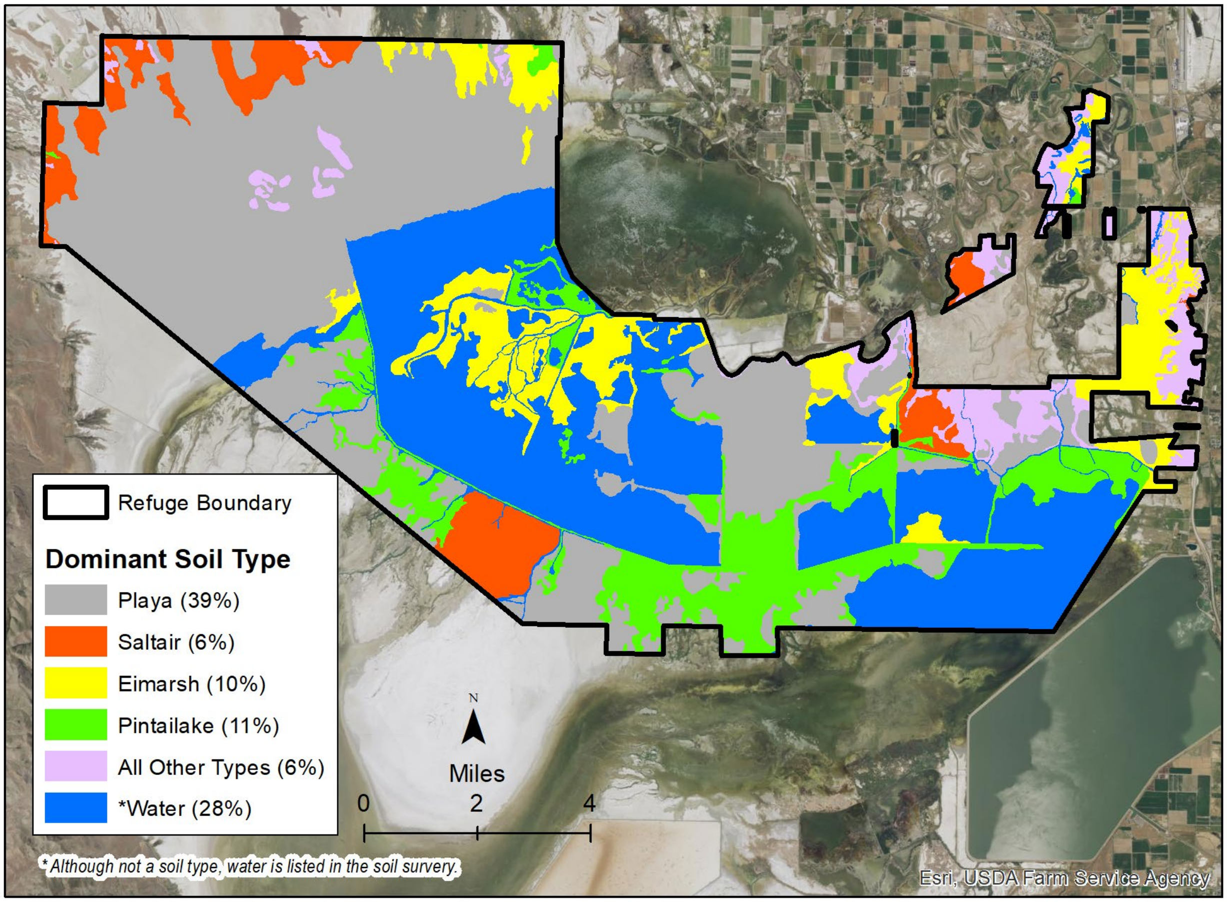

Figure 7: Soils present on the Refuge.

2.2.5 Topography

The natural elevation on the Refuge varies from a maximum of 4,215 feet above mean sea level (msl) in the northwest corner in the greasewood knolls area to a minimum of 4,200 feet above msl below the D-Line dike (National Geodetic Vertical Datum of 1929). The natural topography of the Bear River delta is nearly flat with a gradient of approximately one foot per mile fall to the south, but microtopography is highly variable (Figure 8). As a result, topographic depressions that pool water are common on the delta and range in size from less than one to more than 100 acres. There is only about six feet of fall in river elevation from the northern boundary of the Refuge to the mouth of the delta. However, the topography has been disrupted by dikes, borrow pits, and canals. Water flow over the delta now is largely controlled by this infrastructure, and many of the natural splays and flow paths of the deltaic arms of the Bear River no longer function.

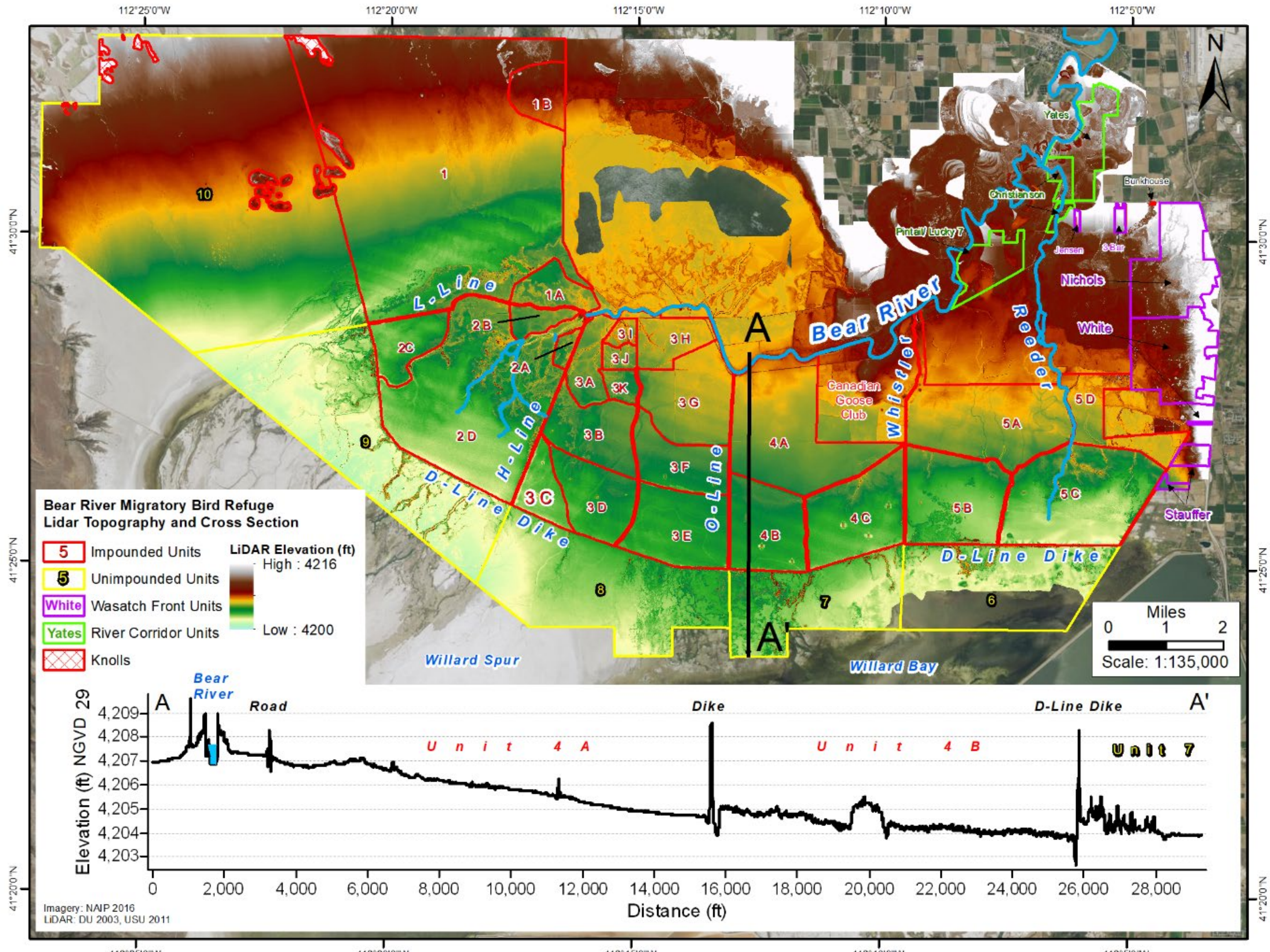

Figure 8: Topography (derived from Lidar data) on the Refuge. The cross-section A-A' shows the elevation profile from north to south for a portion of the Refuge.

2.2.6 Climate

The Refuge has a semiarid climate with four defined seasons characterized by moderate spring and fall seasons, short cold winters, and hot dry summers. Based on climatic records for the period 1896-2006 at Corinne, average annual precipitation is 15.36 inches, with an average of 30.8 inches of snow counting towards the total (WRCC 2012; Table 3; Figure 9). Most precipitation during winter and early spring occurs as snowfall, whereas late summer and early fall precipitation is monsoonal rainfall. May tends to be the wettest month and July is typically the driest. The majority of precipitation can be attributed to the movement of Pacific storms bringing in moisture from the west and southwest.

Temperatures vary seasonally, with mean summer temperatures around 71°F with typical daily high and low temperatures of 88°F and 53°F, respectively. Summers typically include 52 days with high temperatures above 90°F, with maximum recorded temperatures of 110°F. The growing season averages about six weeks and average annual evaporation is about 54 inches. Winters on the Refuge are generally cold, though not normally severe, with an average of 162.5 days with temperatures below freezing and around 9 days at or below 0°F (WRCC 2012). Temperatures on the Refuge may be slightly moderated compared to those measured at the Corinne station due to the thermal capacity of nearby water bodies.

Table 3. Monthly temperature and precipitation summary at Corinne, Utah (Station ID 421731), 02/02/1986 to 6/30/2006.

	Temperature Average (°F)				*Precipitation Average (in.)*	
Month	*Max.*	*Min.*	*Mean*		*Total*	*Snowfall*
January	35.0	14.2	24.6		1.49	11.2
February	40.7	19.5	30.1		1.35	5.9
March	50.8	27.4	39.0		1.46	2.8
April	62.0	34.4	48.2		1.57	1.1
May	72.1	42.0	57.0		1.83	0.1
June	82.4	49.1	65.8		1.05	0.1
July	92.0	56.2	74.1		0.58	0
August	90.1	54.7	72.4		0.75	0
September	79.6	44.7	62.1		1.07	0
October	65.9	34.4	50.2		1.43	0.3
November	49.1	25.3	37.2		1.31	2.2
December	37.6	17.5	27.6		1.47	7.1
Annual	63.1	34.9	49.0	Total	15.36	30.8

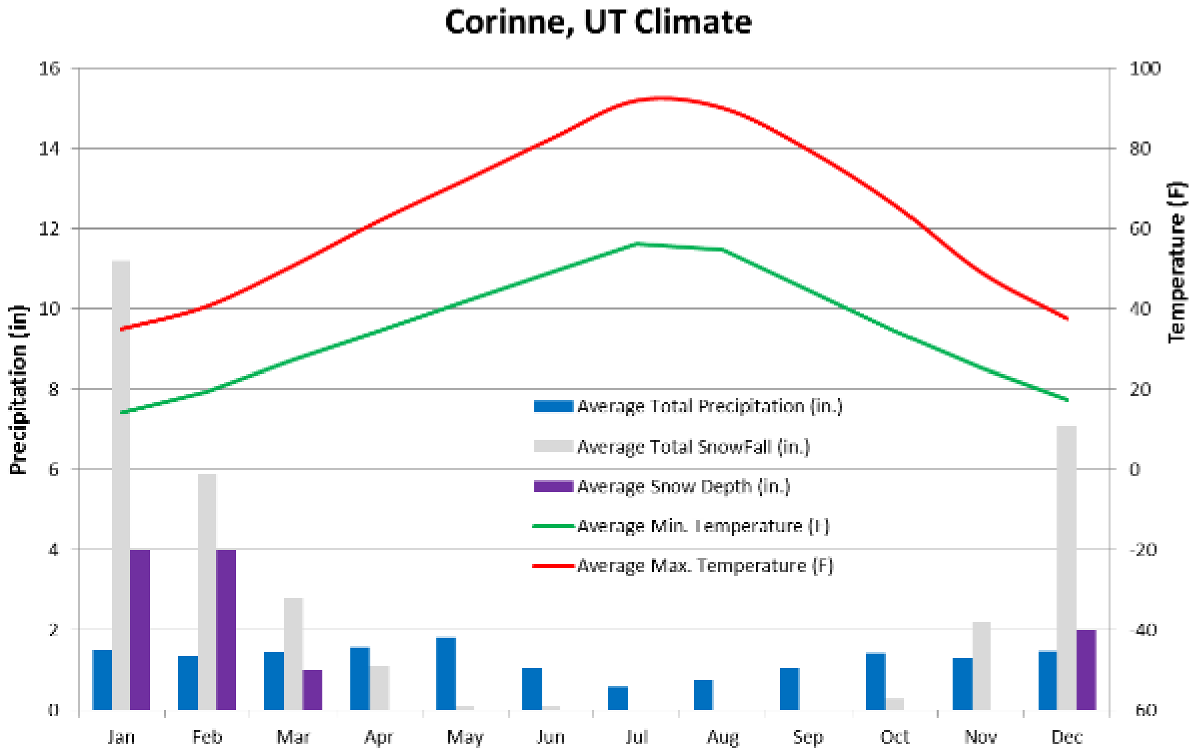

Figure 9: Climate data from station at Corinne, UT from 02/02/1896 to 06/30/2006.

2.2.7 Proximity to Other Protected Areas

In addition to the GSL and Bear River Watershed Conservation Area, there are several other areas in the GSL Ecosystem that are managed for, or benefit, wildlife (Figure 1). More than 160,000 acres of public and private wetlands are managed on the eastern side of the GSL (UTDNR 2013). The state of Utah manages several state waterfowl management areas (WMA) and state parks (SP) around the perimeter of the GSL, including the Locomotive Springs WMA, Salt Springs WMA, Public Shooting Ground WMA, Willard Spur WMA, Ogden Bay WMA, Harold S. Crane WMA, Farmington Bay WMA, Timpie Springs WMA, GSL SP, Antelope Island SP, and Willard Bay SP. In addition, The Nature Conservancy administers the GSL Shorelands Preserve and Audubon manages the Gillmor Sanctuary and Lee Creek Area. Collectively, these areas are recognized as a site of hemispheric importance by the Western Hemispheric Shorebird Reserve Network (https://whsrn.org/whsrn_sites/great-salt-lake/). In addition, the Audubon Society recognizes Gunnison Bay, Bear River Bay, Ogden Bay, Gilbert Bay, and Farmington Bay, all of which are part of the GSL, as globally important bird areas (https://www.audubon.org/important-bird-areas/state/utah). In addition to the areas indicated in Figure 1, there are also numerous private duck clubs and other entities that play an important role to preserve and provide habitat for waterfowl along the GSL.

2.3 Habitat Condition of the Refuge

2.3.1 Pre-Settlement Condition

Historically, the Bear River delta consisted of a large, braided system of river channels with natural levees (created by silt deposits on the banks of natural channels), oxbows, and scour holes (ponds) coupled with playas, natural marshes, and mudflats covering approximately 112,000 acres. Numerous wet meadows at higher elevations adjacent to the delta where natural springs and seeps originated on mountain slopes were present. The hydrology and salinity of these wetland types varied annually depending on the volume of river water that flowed across the delta.

In most years, there was likely an increase in Bear River flows in spring (March-April) due to snowmelt in the low elevation areas of the Wasatch mountain range and a second pulse in May or June from snowmelt at higher mountain elevations in the watershed (USFWS 2004). This period of high water was noted by Captain Howard Stansbury in his exploration of the GSL: “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 pulses, water would have been high enough to flow over the natural levees, flood the delta, and recharge isolated river channels, marshes, ponds and playas. The river inflows would likely have supplied water to the Bear River delta through June and July. During years of extremely high spring flows, new channels would form and sediment deposition would change the topography of the delta, resulting in the filling of some wetlands and formation of new wetlands (e.g., playas and oxbows). In contrast, during years of below average inflows, water likely would have flowed directly into the GSL via the delta river channels, as there was not enough water to overtop natural channel levees.

During summer (July – August), the extent of flooding on the delta was determined by the volume of river inflows relative to evaporation and transpiration losses (USFWS 2004). During most years, it is likely that depressional wetlands (e.g., mudflats and playas) dried in late July and August, whereas shallow marshes would have either dried up or exhibited significant decreases in flooded surface area. Deeper wetlands (e.g., ponds, oxbows and deeper portions of river channels) likely remained flooded, but water depths likely decreased.

During fall (September – October), precipitation would cause river flows to increase again. This water would flood wetlands at lower elevations adjacent to the river and flow into Bear River Bay. Therefore, the duration and extent of fall flooding on the delta depended on the amount of precipitation. However, in most years, it is likely that depressional wetlands were at least partially flooded and shallow marshes exhibited an increase in surface area and flooding depth.

The salinity of delta wetlands depended on wetland location and type, as well as hydrology. Permanent wetlands associated with the river (e.g., oxbows and abandoned river channels) likely were fresh to slightly brackish in most years due to the constant input of fresh water from the river. In contrast, depressional wetlands on the delta likely were fresh during years that high river flows supplied a continuous influx of freshwater, but became increasingly brackish to saline during successive years of below average flows. In addition, if the GSL was high, it is likely there was a zone of wetlands with higher salinities at lower elevations of the delta where fresh water from the river met the saltier water of the GSL.

It is not possible to accurately depict the historic location of plant communities on the delta because the distribution, hydrology and salinity of various wetland types was dynamic. However, a botanical survey conducted in 1934 soon after Refuge establishment provides insight regarding historic plant community composition in relation to hydrology and salinity (Flowers 1934). In general, the GSL region was characterized by an absence of trees, with broad and barren salt flats bordered by halophytic plant species and low, shrubby vegetation on saline plains. However, there was substantial variation in plant community composition across the delta in response to microtopography that influenced annual hydroperiods and salinity.

The surface of the delta, characterized as a broad, gently sloping plain, was interrupted by playas, sloughs, drainage canals, and streams. Playas were classified into three groups: barren flats with pioneer vegetation encroaching from the margins, intermediate playas completely invaded by vegetation, and playas reclaimed by halophytic flora (Flowers 1934). Barren playas were characterized as devoid of vegetation in the lower elevations with various plant species invading from higher elevations, primarily saltworts but also iodine bush, seepweeds, and saltgrass (see Appendix A for scientific names). Intermediate playas had plant communities that occurred in either two defined zones or as a homogenous mix of plants throughout the depression. In playas exhibiting plant zones, common plants in the lower zone included arrow-grass, Nuttall's alkaligrass, saltbush, seepweed, fivehook bassia, and Russian thistle, whereas the upper zone supported annual hairgrass, clasping pepperweed, alkali pepperweed, ovalpurse, prairie plantain, and slender woollyheads. In contrast, reclaimed playas were dominated by a single species, the most common being saltwort, iodine bush, or saltgrass.

Marshes, sloughs, ponds, and river channels supported a range of plant species. Sago pondweed, widgeon grass, and various species of algae dominated semi-permanently flooded open water areas, whereas emergent and meadow species (e.g., cattail, bulrush, and phragmites and arrow-grass, dropseed, cordgrass, and baltic rush, respectively) occurred along wetland margins that remained flooded longer in the growing season. Channel banks and slough margins supported saltgrass, Nuttall's alkaligrass, curly and greater water dock, Baltic rush, spikerush, beardless rabbitfoots grass, and Nebraska sedge (Flowers 1934).

Refuge lands at the lowest elevations occurring in Bear River Bay and Willard Spur consisted of expansive mudflats interspersed with numerous slight depressions that retained water for longer periods during years of average to above average flows. Mudflats were inhabited almost exclusively by red saltwort, some iodine bush, and irregular zones of saltbush at slightly higher elevations. A mixed association of grasses and a few shrubs were documented at even higher elevations, including foxtail barley, common knotweed, common sunflower, and greasewood.

The plant community composition of wet meadows adjacent to the delta (e.g., Wasatch Front units) also varied depending on salinity. Areas of more constant spring flow were less saline due to leaching, and supported sedge, common knotweed, showy milkweed, and cutleaf waterparsnip. In contrast, areas of higher salinity were dominated by saltgrass, Baltic rush, foxtail barley, arrow-grass, seepweed, iodine bush, and dropseed (Flowers 1934).

2.3.2 Development History

The habitat condition and wetland function of the Bear River delta changed with settlement in the mid-1850s. Mormon pioneers cleared sagebrush and irrigated land near Brigham City by diverting water from local rivers, primarily Box Elder Creek. As greater numbers of people arrived, water was diverted from larger rivers and the network of natural marshes on the delta were dry except during years of high flows. In addition, many lands adjacent to the delta that were influenced by natural springs and seeps were land-leveled, ditched, and flood-irrigated to produce hay and for cattle grazing (McCue 1989). Completion of the transcontinental railroad in 1869 established a transportation corridor connecting eastern markets desiring fresh waterfowl with the vast supply of birds in the Bear River marshes. Market hunting began in the Bear River marshes, and Nelson (1966) estimated that over 200,000 ducks were harvested annually from 1877 to 1900.

By 1920, only 2,000-3,000 acres of the original 100,000 acres of marshlands in the Bear River marshes remained (Refuge records). The extensive loss of marsh and subsequent concentration of waterfowl into the few remaining wet acres on the 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", but later identified as avian botulism (Clark 1987).

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. Citizens petitioned Congress to establish a wildlife refuge, and Congress responded by establishing the Bear River Migratory Bird Refuge in 1928. By 1931, more than 50 miles of dikes and numerous canals were constructed to impound water in five units encompassing about 39,500 acres. The impoundments enabled the management of water levels to encourage waterfowl food production and waterbird nesting habitat during those times when marshes historically were flooded but were now normally dry. In addition, planting of vegetation was documented by Flowers (1934) at this time, noting an “introduction of seeds and plant cutting beneficial to ducks and other birds”. Species specifically mentioned as being introduced included sago pondweed, widgeon grass, chairmaker’s rush, softstem bulrush, lakeshore bulrush, cosmopolitan bulrush, giant burreed, and Nuttall’s alkaligrass. Russian olive also was planted along some secondary dikes during the 1930s (Kaltwasser 1978).

Initially, the units were flooded in the spring as soon as the ice melted in March, flushed, and refilled. Water flushed from the units and spring river flows occurring after refilling units helped inundate the area downstream of the impoundments. Impoundment water levels were maintained as long as adequate water was available, but some pools were drained to provide water to other pools or to reduce severity of botulism outbreaks when water was limited. In late September or early October, the units were again flushed and refilled to provide waterfowl resting habitat and hunter access. The units were drained just prior to, or just after, ice formation in late November to avoid damaging water control structures and were maintained at these low levels until the following spring.

Refuge records from 1953-1964 documented an average nest success of 70% for all duck species with annual production of 41,266 ducklings and 1,992 Canada geese (see Appendix A for scientific names). In 1964, duck production reached a record 79,000 birds. During this same period, an average of 5,870 California gull, 653 American avocet, 184 black-necked stilt, 11 Caspian tern, and 55 double-crested cormorant nests were documented on the Refuge each breeding season (Halloran 1965).

Table 4. List of water rights held by the Bear River Migratory Bird Refuge.

WR Number	*Priority Date*	*Source*	*Diversion Rate (cfs)*	*Seasonal Diversion Limit (acre-feet)*
29-768	12/31/1900	Groundwater	1.59	
29-769	12/31/1900	Groundwater	1.114	
29-770	12/31/1920	Groundwater	0.01	
29-936	12/29/1928	Groundwater	3.06	
29-937	12/29/1928	Perry spring stream	0.56	
29-951	12/29/1929	Perry spring stream	1	
29-952	12/31/1903	Walker spring stream	3.06	
29-973	12/29/1929	Unnamed stream	2.4	
29-980	10/25/1907	Unnamed slough, wells	0.5	
29-1014	11/11/1928	Bear River	1,000	425,771
29-1165	8/16/1955	Groundwater	0.011	
29-1330	7/11/1961	Groundwater	0.134	
29-1450	12/29/1902	East slough	7.37	
29-1473*	1/11/1966	Bear River	140	
29-1637	8/29/1997	Surface water		133
29-1697	12/29/1918	Unnamed spring stream	1	
29-1912	12/29/1908	Bear River	30	
29-1914	12/30/1911	Underground water drain	3	
29-1915	12/29/1913	Underground water drain	1.5	
29-1916	12/29/1913	Underground water drain	1.5	
29-1919	12/29/1902	Unnamed stream	2.4	
29-2451*	7/25/1925	Bear River		177
29-2452*	7/25/1925	Bear River		110
29-2453*	7/22/1925	Bear River	3.5	131
29-2622	12/29/1918	Unnamed spring stream	0.015	
29-2646*	1/1/1903	Surface drainage	2	
29-2647*	1/1/1935	Underground water drain	2	
29-2792*	5/10/1982	Reeder overflow	3	267
29-3054	12/29/1904	Unnamed streams	0.34	
29-3056	12/29/1942	Spring area	0.02	
29-3060	12/29/1917	Unnamed spring	1	
29-3061	12/29/1928	Underground water drain	0.002	
29-3157	12/31/1902	Unnamed stream	0.002	
29-3172	12/29/1938	Stauffer-Packer spring	1.04	
29-3435	12/29/1938	Bear River-Reeder overflow		Stock – 50 ELU
29-3437*	12/29/1938	Bear River and unnamed sloughs		Stock – 100 ELU
29-3484	12/29/1902	Black Slough	45	940
29-3485	12/31/1902	Bear River	15.9	3,841
29-3668	11/11/1991	Salt Creek		2,468
29-3698	12/31/1902	Bear River		2,000
29-3824	12/8/1995	Underground water drain	1	
29-3825	12/8/1995	Stauffer-Packer spring	1.04	
29-3849	9/17/1996	Burnt slough	1	73
29-4328*	12/29/1908	Bear River and unnamed streams		316
29-4478*	3/4/2010	Three-Mile Creek	13.1	

** Values listed may not match final quantities owned by the Service due to ownership issues, perfection, etc.*
ELU – Equivalent Livestock Unit

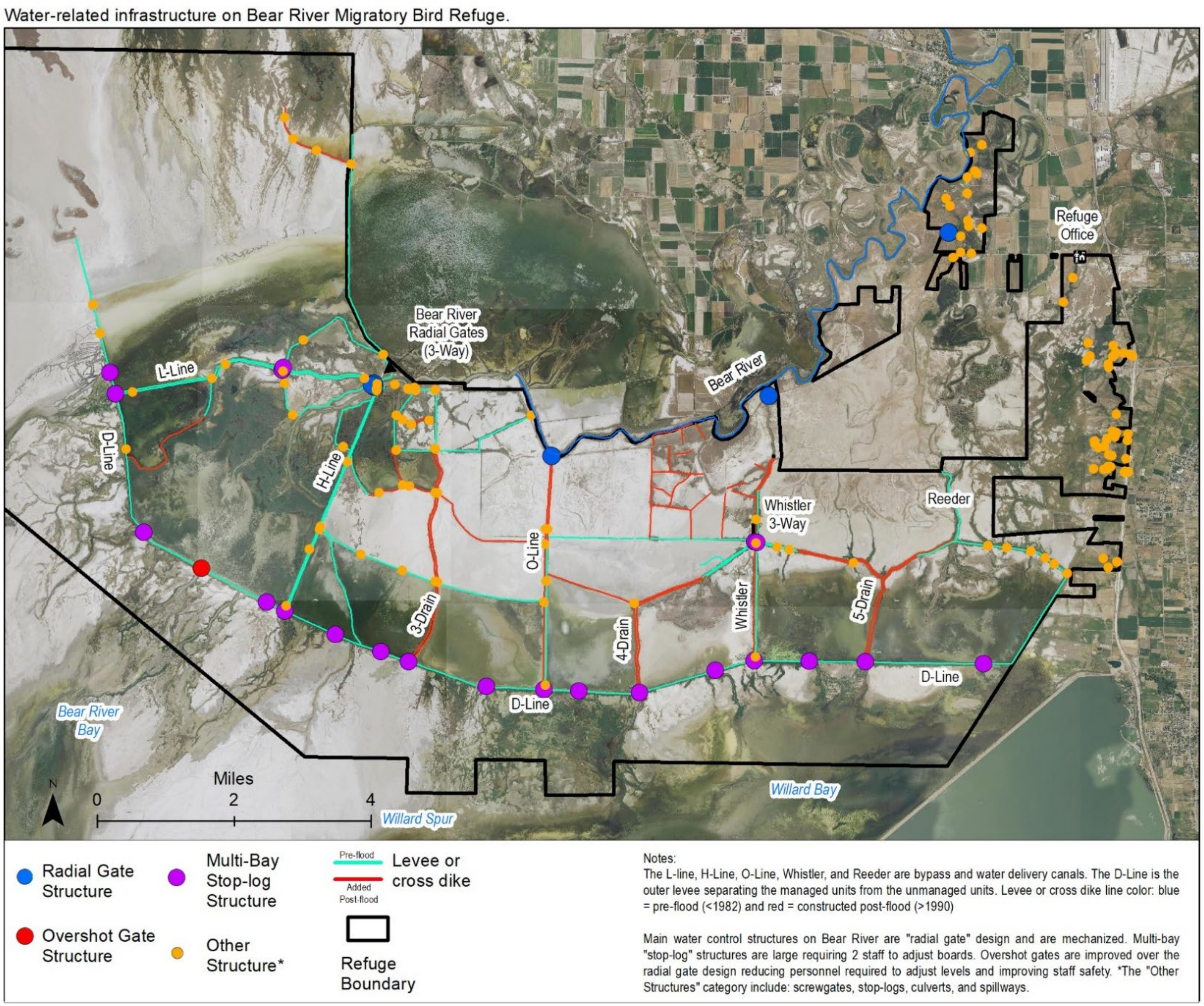

Figure 10: Current water-related infrastructure on the Refuge.

Also during this time, a series of ponds and associated ditches were constructed in the Wasatch Front to transport water from natural springs units with the goal of improving waterfowl brood habitat. Additional water control structures and ditches were constructed to flood meadows and move water between oxbows in the River Corridor units. In addition, twelve islands were constructed to promote waterbird nesting.

The current design of the water management infrastructure requires filling units from the bottom via backflooding from five main canals (Reeder, Whistler, O-Line, H-Line, and L-Line). These canals are also used to discharge water below the perimeter dike (D-Line) to the units in Willard Bay, Willard Spur, and Bear River Bay, where approximately 30,125 acres are owned in fee title. Management of the spur and bays is limited, but these areas provide some of the most productive habitat on the Refuge.

Since completion of the new impoundment system, additional infrastructure has been added to improve water management capabilities in other areas of the Refuge. Ditches and short dikes were created below the D-Line dike to facilitate movement of water from canals to Bear River Bay and Willard Spur.

2.3.4 Water Rights and Water Management Infrastructure

The Refuge holds several water rights for the purpose of wildlife habitat management (Table 4). All rights are state-based claims that have been acquired through application and perfection by the Service, via transfer from buying land associated with a water right, by donation, or mitigation. The primary water right (state water right number 29-1014) has a priority date of 11/11/1928 and allows the Refuge to divert up to 1,000 cfs from the Bear River from January 1 to December 31, up to a maximum quantity of 425,771 acre-feet per year. However, summer flows are often too low for the Refuge to divert 1,000 cfs due to upstream uses. Water rights of lower quantities associated with springs, tributaries, groundwater, and shares within the Bear River Canal Company (BRCC) supplement water diverted from the Bear River. The shares of the BRCC convert to a certain quantity of water based on the yearly allotment to all shareholders that may vary (Table 5).

Water rights within the state of Utah are going through the process of adjudication, where the historical claims of use are being verified by the state. In 2005, the Utah Division of Forestry, Fire and State Lands objected to several of the Refuge’s water right claims in Area 29, Book 4 of the Box Elder County Subdivision. The issue of land title ownership (and by proxy water rights ownership) is still in litigation. The State of Utah has filed quiet title action to lands within the Refuge that lie below the Ordinary High Water Mark of the GSL. Because of the ongoing litigation, several of the Refuge’s water rights are not adjudicated and may be changed in the future.

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29-1473*	1/11/1966	Bear River	140	
29-1637	8/29/1997	Surface water		133
29-1697	12/29/1918	Unnamed spring stream	1	
29-1912	12/29/1908	Bear River	30	
29-1914	12/30/1911	Underground water drain	3	
29-1915	12/29/1913	Underground water drain	1.5	
29-1916	12/29/1913	Underground water drain	1.5	
29-1919	12/29/1902	Unnamed stream	2.4	
29-2451*	7/25/1925	Bear River		177
29-2452*	7/25/1925	Bear River		110
29-2453*	7/22/1925	Bear River	3.5	131
29-2622	12/29/1918	Unnamed spring stream	0.015	
29-2646*	1/1/1903	Surface drainage	2	
29-2647*	1/1/1935	Underground water drain	2	
29-2792*	5/10/1982	Reeder overflow	3	267
29-3054	12/29/1904	Unnamed streams	0.34	
29-3056	12/29/1942	Spring area	0.02	
29-3060	12/29/1917	Unnamed spring	1	
29-3061	12/29/1928	Underground water drain	0.002	
29-3157	12/31/1902	Unnamed stream	0.002	
29-3172	12/29/1938	Stauffer-Packer spring	1.04	
29-3435	12/29/1938	Bear River-Reeder overflow		Stock – 50 ELU
29-3437*	12/29/1938	Bear River and unnamed sloughs		Stock – 100 ELU
29-3484	12/29/1902	Black Slough	45	940
29-3485	12/31/1902	Bear River	15.9	3,841
29-3668	11/11/1991	Salt Creek		2,468
29-3698	12/31/1902	Bear River		2,000
29-3824	12/8/1995	Underground water drain	1	
29-3825	12/8/1995	Stauffer-Packer spring	1.04	
29-3849	9/17/1996	Burnt slough	1	73
29-4328*	12/29/1908	Bear River and unnamed streams		316
29-4478*	3/4/2010	Three-Mile Creek	13.1	

** Values listed may not match final quantities owned by the Service due to ownership issues, perfection, etc.*
ELU – Equivalent Livestock Unit

Table 5. Irrigation shares of the Bear River Canal Company owned by the Bear River Migratory Bird Refuge.

Certificate No.	*Shares*	*Original Sources/Previous Owner*
10006	42.65	Acquired by the Western Rivers Conservancy (36,a-c)
9096	6	Acquired by the Trust For Public Land (155a)
6675	18	Acquired by Clela B. Jenson (58). Listed under WR-29-2633
10387	140	Acquired per Mitigation Water Agreement and Water Share Transfer Agreement between FWS and The Proctor & Gamble Paper Products Company when Application No. 29-4398 (A77425) was protested

Water management on the Refuge primarily is dictated by Bear River flows (i.e., frequency, timing, duration, magnitude), which is now regulated by releases from the Cutler Dam and Bear Lake. Water from the Bear River is supplied to the Refuge through the following six major points of diversion (list from upstream to downstream): Reeder Overflow Canal, Whistler Canal, O-Line Canal, H-Line Canal, Unit 2D inlet, and L-Line Canal. The H-Line and L-Line canals, and the inlet to Unit 2D, is collectively known as the “Three-Way” River Control gates at the old headquarters site in the northeast corner of Unit 2D (Figure 10). The total length of canals is approximately 31 miles. In addition, several miles of smaller canals associated with springs, irrigation turnouts, and other small tributaries are used to distribute water on the Refuge.

To facilitate management, approximately 96 miles of dikes (14 feet wide, averaging 4.5 feet in height, 6:1 side-slope) covering 791 acres were constructed. This is accompanied by an approximately equal length of “borrow ditches”, adjacent to dikes where fill for dikes was extracted. The borrow ditches vary in size based on the dike construction technique, and most function as conduits for surface water flow (i.e., shallow canals that follow the path of dikes). In addition, a 2008 survey identified 149 water control structures on the Refuge with additional structures necessary to obtain water from other sources (e.g., ditches, springs) located off-refuge. Most structures used to control water inflow to management units from canals or transfer among units are stop-log structures. The majority of inlet structures are located at the lower elevations of the units.

2.3.5 Vegetation

A comprehensive vegetation survey of Refuge lands has not been recently conducted, but monitoring during the past decade, recent satellite images, and Refuge staff observations provide insight regarding current distribution and composition of plant communities. Many playas at upper elevations of the delta exhibit minimal zonation and are either barren or comprised primarily of saltwort and seepweed, although saltgrass occurs in limited areas. The extent of other native species, including Nuttall’s alkaligrass, saltbush, fivehook bassia, alkali pepperweed, and prairie plantain, appear to be limited in extent.

Areas of impounded units that are semi-permanently or permanently flooded to depths more than 8 inches are primarily open water that support scattered, but extensive, stands of submerged aquatic vegetation. Vegetation includes sago and horned pondweed, widgeon grass, and some coontail. In contrast, areas that are semi-permanently flooded to depths less than 4 inches or seasonally flooded are comprised of emergent species. Phragmites is the dominant emergent plant, often establishing adjacent to borrow areas and encroaching into units via rhizomes, but scattered stands of bulrush also occupy these areas in some units (Vanderlinder et al. 2014; Figure 11). Areas within units exhibiting temporary flooding are comprised of species typical of playas (saltwort, seepweed, saltgrass), whereas dikes are dominated by common sunflower, kochia, cocklebur, curly dock, foxtail, saltgrass, phragmites, and salt cedar. Man-made islands within the units support plant communities similar to dikes, although areas of bare ground are common.

The open water portion of sloughs, ponds, oxbows, and river channels support submerged aquatic vegetation (primarily sago pondweed) and several species of algae. The toeslopes of these sites are dominated by grasses, sedges, rushes, and scattered stands of emergent species, primarily phragmites and cattail. Saltcedar and Russian olive are present along short reaches of river channels, but distribution is limited due to active management to remove these species.

Plant community composition in the Bear River Bay and Willard Spur portions of the Refuge are mudflats dominated by red saltwort and lesser amounts of iodine bush intermixed with scattered stands of bulrush, Baltic rush, and spikerush. Sago pondweed and widgeon grass occupy areas that have been flooded for extended periods. Phragmites has become established along the ditches created south of the D-Line Dike and is expanding south along natural channels into Willard Spur, Willard Bay, and Bear River Bay (Figure 11).

Meadow plant communities in the River Corridor and Wasatch Front units include a combination of native and non-native species. Refuge staff recently altered the infrastructure in some of these units to restore sheetflow of water down the natural gradient. The vegetation response has been an increased area of sedges and rushes with a concomitant decrease in cheatgrass, pepperweed, medusahead, and hoary cress. In combination with herbicide application, phragmites around the perimeter of created ponds in the Wasatch Front units also has been reduced. However, frequent herbicide treatment of reed canarygrass is necessary to prevent establishment. Units that have not been restored support similar species, but there is a higher incidence of non-native species, including Canada thistle and hoary cress.

Refuge personnel expend considerable resources in terms of funding and staff and volunteer time managing invasive and nuisance species each year to provide quality habitat for native species. The Refuge has a responsibility to respond to the spread of invasive species and uses the practice of “Early Detection and Rapid Response” (EDRR). Preventing the introduction of invasive species is the first line of defense in the battle against new invasions. However, it is inevitable that new invasive plant introductions will occur, so the Refuge utilizes the next best line of defense through EDRR. EDRR is the principle of targeting noxious weed infestations when they first arrive in a given area, while their populations are small and localized. This effort greatly increases the likelihood that new invasions are addressed immediately, before the species can become established and widespread.

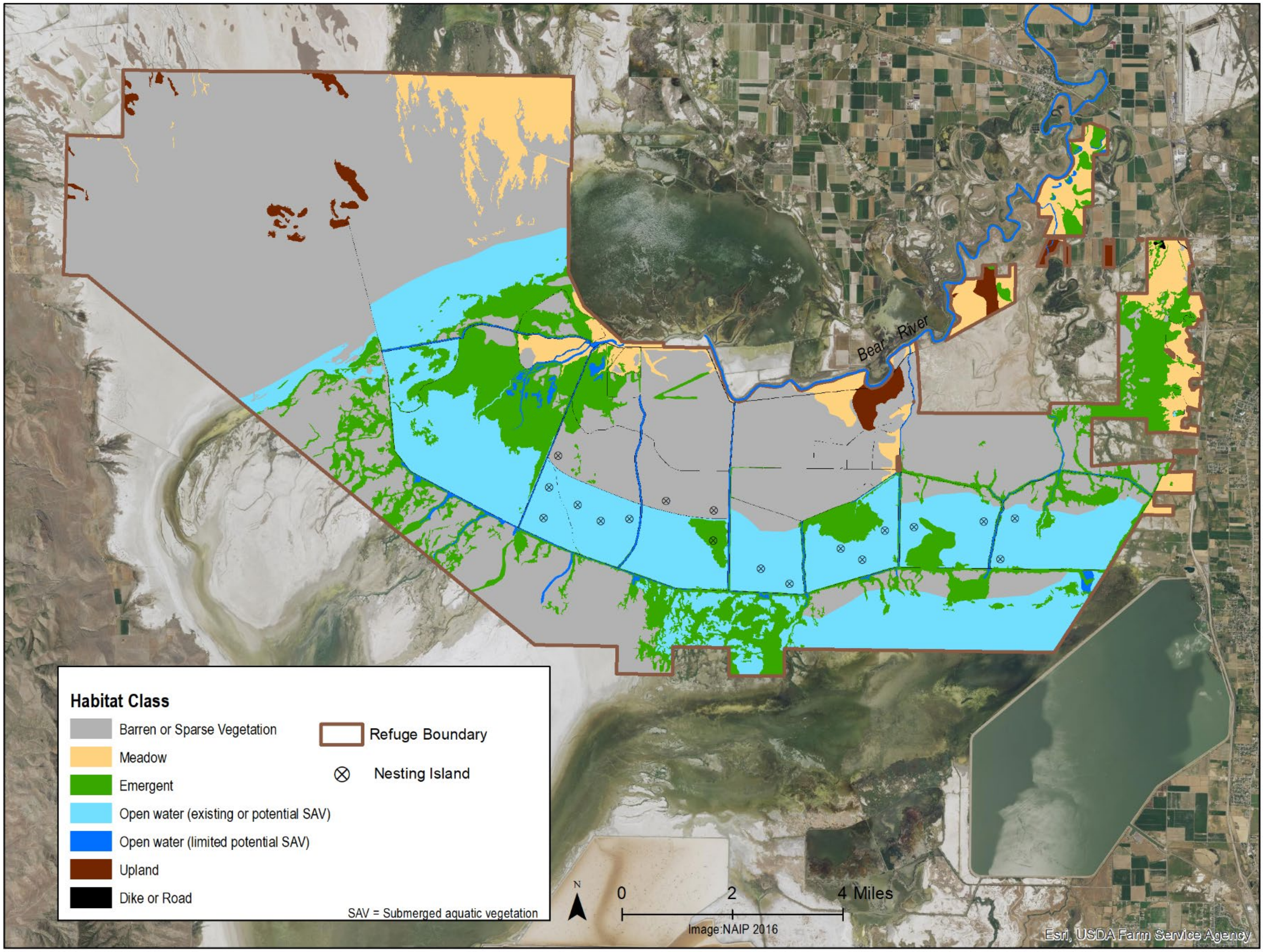

Figure 11: Habitat classes on the Refuge.

2.3.6 Wildlife

More than 210 species of birds have been documented using the Refuge and 70 species are known to nest within the Bear River MBR. The Refuge has long been recognized as a wetland of great value to waterbirds in the Intermountain West Region, providing habitat for large population segments of Pacific Flyway waterfowl and other waterbirds. Band returns also indicate the Refuge hosts large numbers of Central Flyway waterbirds as well. During migration, the GSL ecosystem provides habitat for an estimated 217 million and 60 million waterfowl use-days in fall and spring, respectively (Intermountain West Joint Venture 2013). In addition, the ecosystem hosts up to 79% of black-necked stilt, 55% of American avocet, 86% of marbled godwit, and 39% of long-billed dowitcher populations in the Intermountain West Region (Paul and Manning 2002; Shuford et al. 2002). Refuge habitats alone may support up to 500,000 waterfowl and 200,000 shorebirds annually during migration. Average spring peak populations are 119,000 waterfowl and 18,000 shorebirds, whereas average fall peak populations are 263,000 waterfowl and 69,000 shorebirds (Refuge records). The Refuge supports peak counts of up to 30,000 marbled godwit (Shuford et al. 1994) and more than 13,000 (13% of continental population) non-breeding American avocet (Brown et al. 2001; Paul and Manning 2002). In addition, about 15% of the western population of tundra swan utilize Refuge habitats during fall and may remain throughout the winter in mild years (Refuge records).

The GSL ecosystem also is one of the most critical breeding and staging sites for colonial waterbirds, waterfowl and shorebirds (Downard 2010), including cinnamon teal (up to 60% of the continental breeding population; Bellrose 1980), American avocet (14% of the continental breeding population; Paul and Manning 2002), and snowy plover (greater than 50% of the continental breeding population; Page et al. 1991). In addition, the ecosystem also supports the largest staging population of Wilson's phalarope (Jehl 1988) and largest breeding colony of white-faced ibis in the world (Paul and Manning 2002), as well as one of the three largest American white pelican breeding colonies in North America (Parrish et al. 2002).

Refuge contributions to GSL breeding statistics include up to 1% and 2% of the continental breeding populations of American avocet and black-necked stilt, respectively, and an average of 11,000 molting northern pintail (Refuge records). In addition, the Refuge historically has provided important breeding habitat for long-billed curlew and is the most important foraging site in the GSL ecosystem for American white pelican. In contrast, the success of breeding waterfowl on the Refuge has apparently declined following the flood years of 1983-1989, based on nesting studies conducted during 1979-1983 and 2001-2002 that indicate apparent nest success declined from 31.8% to 7.8%, respectively (Refuge records). Post-flood nest success rates are of concern because a nest success rate equal to or greater than 15-20% is the estimated minimum required to sustain local waterfowl populations (Cowardin et al. 1985; Klett et al. 1988). Loss and degradation of emergent vegetation coupled with an increase in the populations of mammalian and avian predator populations on the Refuge (e.g., fox, skunk, and gull) are thought to be the major factors contributing to low duck nest density and success based on observations by staff.

Terrestrial habitats on the Refuge, although limited in size, support several mammalian species. Among the most common are mule deer, long-tailed weasel, muskrat, raccoon, striped skunk and several species of mice and voles. Less common are badger, beaver, coyote, red fox, and yellow-bellied marmot. Alkali knolls, meadows, and wooded riparian habitats also support limited numbers of other bird species including vesper sparrow, savannah sparrow, western meadowlark, sage thrasher, loggerhead shrike, northern harrier, short-eared owl, and burrowing owl (see Appendix A for scientific names).

2.3.7 Habitat Changes from Historic to Current

Historically, the hydrology of Bear River was dynamic, as described in Section 2.3.1. Variability in the magnitude and duration of flows, coupled with high sediment loads transported by the river, resulted in frequent changes in the location and morphology of channels and altered the microtopography of the delta surface. Collectively, these factors affected the distribution, hydrology, and soil salinities of various wetland types (e.g., oxbows, playas, and meadows), which subsequently influenced the distribution and composition of plant communities (Flowers 1934; Kaltwasser 1978). Establishment of woody riparian vegetation on the delta was limited and herbaceous plant communities changed in response to annual hydroperiods that influenced soil salinities. During years when flows overtopped natural channel levees, soil salinities decreased and a greater diversity of plants tolerant of both brackish and saline conditions flourished. In contrast, during years of low flows, water remained in natural channels and discharged to Bear River Bay, soil salinities on the delta increased, and only the more salt-tolerant plants could germinate and survive. Natural springs and seeps along the Wasatch Front provided a reliable source of water that enabled establishment of wet meadows. Species adapted to low soil salinities were more common near the spring, and species tolerant of brackish and saline soils established as water continued to move down the elevation gradient toward the delta.

Land use changes in the watershed to facilitate agriculture and human development significantly altered Refuge lands prior to acquisition. River flows were depleted due to construction of storage reservoirs and irrigation diversions, spring flows were captured in ditches, and meadows were leveled to improve irrigation efficiency for hay production. These changes resulted in the loss and modification of wetlands due to stabilized river channels, reduced the frequency, duration, and extent of overbank flooding on the delta, and altered the timing, duration, and flow patterns of surface water in meadows. In addition, some wetlands were lost due to agricultural conversion.

Following Refuge establishment and continuing into the 1990s, the topography of Refuge lands has been directly altered by construction of infrastructure to control water movement, including dikes, borrow ditches, bypass canals, water control structures, and ponds (Figure 10). Much of the infrastructure design has been in response to continued land use changes in the watershed. Development of additional water storage facilities and diversions, additional conversion of natural habitats to agriculture, and an increasing human population along the Wasatch Front continue to affect the hydrology of Bear River and natural springs. Although river flows fluctuate seasonally, the volume and timing of water the Refuge receives has been reduced compared to historical conditions (Figure 6). Consequently, overbank flooding of delta habitats does not occur with the same frequency or duration. Similarly, spring flows are shared among landowners to maximize water use efficiency, which has altered the frequency, timing, and depth of surface flooding.

Due to changes in hydrology, intensive water management strategies are required to promote plant and invertebrate communities required by waterbirds to meet annual life cycle events.

However, the existing infrastructure (canals, borrows, dikes, and water control structures) is difficult to maintain and creates several persistent management challenges that negatively impact the ability of Bear River MBR managers to achieve long-term ecological sustainability and productivity of wetlands. Bypass canals and borrow ditches must be filled prior to flooding wetlands, impounded units must be flooded by backing water up the gradient of the delta, and some units at higher elevations are rarely flooded except during precipitation events due to infrastructure design. As a result, the hydroperiod of many impounded units has been stable for at least 20 years (Figure 12). Infrastructure in other portions of the Refuge have had similar impacts. Small dikes constructed on the Canadian Goose Club tract prior to acquisition prevent movement of water in natural flow paths, ditches connecting oxbows and wet meadows in the Yates tract prevent independent hydrologic control and limit the ability to emulate the proper frequency, depth, and time of flooding, and prior land leveling and creation of ponds in the Wasatch Front units has altered the distribution and duration of flows originating from natural springs.

Collectively, topographic disruption of Refuge lands and altered hydrology of spring and river flows have affected the distribution and composition of vegetation types, as well as wildlife use of these lands. Impounded units on the delta that have been flooded throughout the growing season for many years support minimal emergent vegetation, whereas units at higher elevations support native plant species but are only rarely flooded. Consequently, the biomass of plant foods available to waterbirds has likely been significantly reduced compared to historic conditions. Dikes, borrow ditches, and canals created suitable sites for the establishment and, in some cases, expansion of noxious weeds (e.g., phragmites, Canada thistle, and pepperweed) and other non-native and/or invasive plant species. Although nutrients, such as nitrogen and phosphorous, and contaminants, such as mercury, are not known to impact Refuge wetlands to date, future impacts (e.g., algal blooms and methylmercury concentrations toxic to waterbirds) could occur in units that are repeatedly flooded. In addition, the deposition of sediment into areas of lower elevation where canals and inlet structures occur is gradually reducing the capacity to manage water and facilitate movement of common carp from the river into units. Common carp is a non-native fish species that can uproot vegetation and increase turbidity, limiting establishment and growth of submerged aquatic vegetation. Dikes also have provided travel corridors for mammals (e.g., fox, skunk, raccoon) that are efficient predators of ground-nesting birds nesting along these areas. Although restoration of sheetflow in portions of some Wasatch Front units has increased the extent of wet meadow communities, historic communities in unrestored areas, and many areas of the River Corridor units, have been invaded by non-native and/or invasive plant species (phragmites, hoary cress, Canada thistle) that impact nesting substrate, reducing nesting and foraging habitat for waterbirds (Refuge records).

Water availability in spring (May) and summer (August) over 1990-2016 using Landsat imagery (2012 excluded).

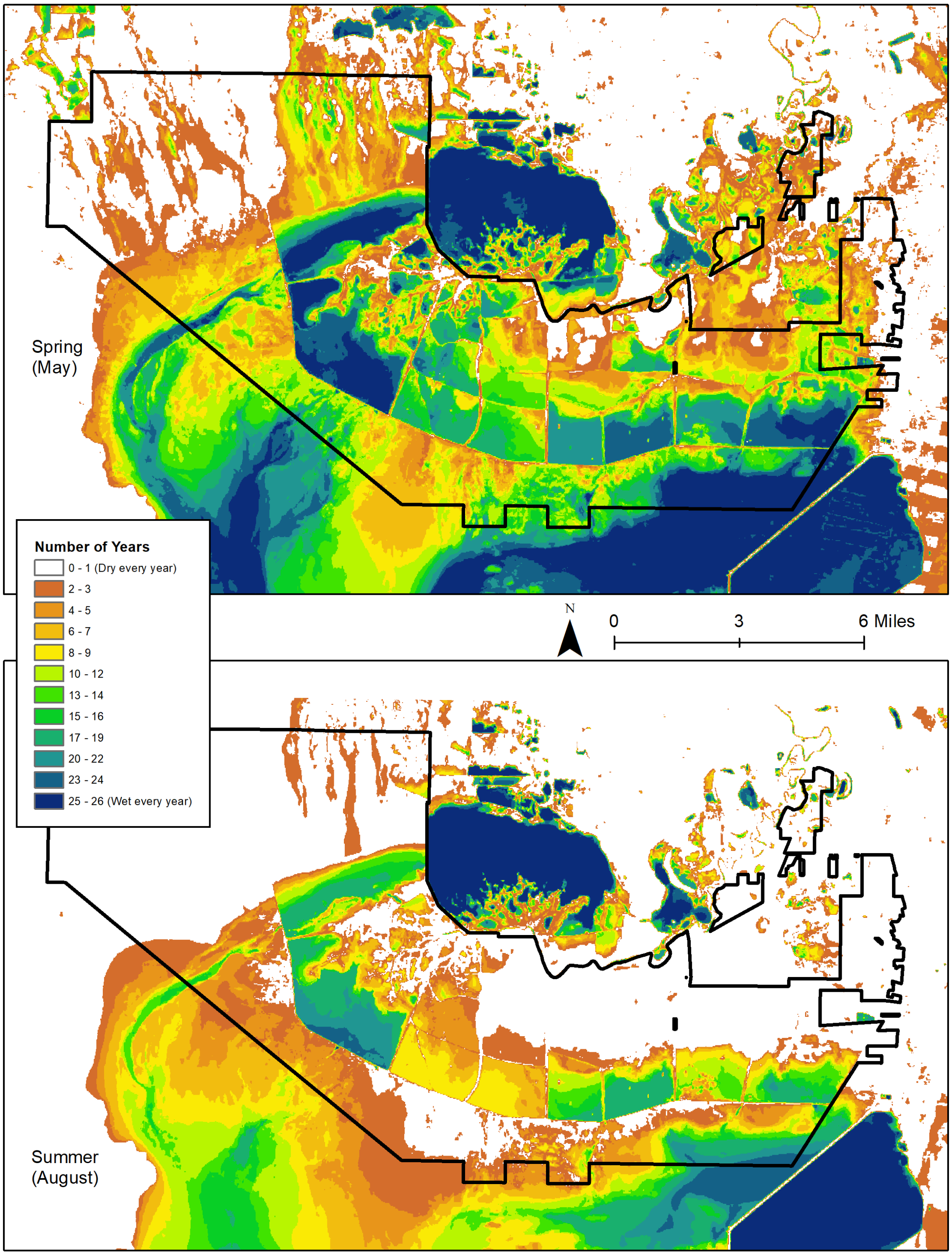

Figure 12: Spring and summer long-term water frequency from 1990-2016 in the Refuge and surrounding area based on Landsat satellite imagery.

Chapter 3. Resources of Concern

The Refuge regularly supports more than 210 bird species annually, of which 70 species nest on or near the Refuge, as discussed in Section 2.3.6. The majority are wetland-dependent or wetland-associated species, although some terrestrial species also regularly use Refuge habitats. Habitat conditions (e.g., forage, cover, and water depth) which provide for various life cycle events for all these species (e.g., migration, staging, feeding, breeding, and wintering) varies widely, and the necessary conditions to support maximum populations of all species cannot be consistently and reliably provided every year. Therefore, the Service uses the concept of "resources of concern" to focus management on the highest priorities of the Refuge System and the Refuge as set forth in applicable laws and policies.

3.1 Identification of Refuge Resources of Concern

Resources of concern were identified using a focal species approach whereby a suite of species (individual or guilds of species) is used to define spatial, compositional, and functional attributes characteristic of the landscape (Lambeck 1997). Initially, Refuge staff developed a list of potential priority species based on the enabling legislation of the Refuge, the most recent priorities of the Regional Director and Assistant Regional Director of Refuges in the USFWS Mountain-Prairie Region, various plans and acts (see Section 1.3) relevant to the Refuge, and the priority species identified in the 2004 HMP. The species list was then evaluated in relation to contribution of Refuge lands to regional and national population goals and the ability of Refuge lands to provide necessary resources required to complete life cycle events without compromising long-term ecological sustainability (i.e., processes and abiotic factors fundamental to sustained biological function). Of the species that met these criteria, the number was further reduced to the minimum required to represent the natural range of landscape variability (e.g., spatial and temporal distribution of plant and animal communities) characteristic of Refuge lands (see Appendix B for information regarding other species represented by each focal species).

Based on this review, the focal species identified in this plan revision were similar to the 2004 HMP, but the number of species was reduced from 14 to 7 species and the number of species guilds increased from two to three because the waterfowl guild was separated into dabbling and diving ducks (Table 6). The seven focal species identified in the 2004 HMP that are not included in this revision are marbled godwit, long-billed dowitcher, long-billed curlew, redhead, Wilson's phalarope, Franklin's gull, and black tern. These species were not considered focal species in this revision, for the following reasons.

1) They are not necessary to adequately characterize Refuge habitats during migration (long-billed dowitcher, marbled godwit, Wilson's phalarope, redhead, black tern) or breeding (snowy plover, long-billed curlew, Franklin's gull).
2) Recent information regarding management capacity indicated an inability to reliably produce and sustain suitable habitats to support specific life cycle events (redhead and black tern breeding).

Although redhead and black tern breeding habitat will not be the focus of management, some suitable habitat will be available on Refuge lands at Bear River Bay, Willard Spur, and small portions of some delta units in most years.

Table 6. Habitat attributes of focal species and guilds used to guide development of goals and objectives for Bear River Migratory Bird Refuge.

		Habitat attributes		
Species/guild	*Life cycle event*	*Plant community*	*Water depth (inches)*	*Foods*
Tundra Swan	Migration	Open water, submergent vegetation	< 36	Seeds, tubers
Cinnamon Teal	Nesting, brood rearing	Short-to-medium vegetation with open water nearby	< 18	Seeds, invertebrates
Snowy Plover	Migration, nesting, brood rearing	Bare or sparsely-vegetated mudflats	0-2	Invertebrates
Black-necked Stilt	Migration, nesting, brood rearing	Bare-to-short, sparsely-vegetated mudflats with open water	0-6	Invertebrates
American Avocet	Migration, nesting, brood rearing	Bare-to-short or sparsely-vegetated mudflats with open water	0-6	Invertebrates
American White Pelican	Migration	Open water, submergent vegetation	> 10	Fish
White-faced Ibis	Nesting, brood rearing	Mid-to-tall emergent	8-24	Invertebrates
Waterfowl (dabblers)	Migration	Open water, submergent and emergent vegetation	< 18	Seeds, tubers invertebrates
Waterfowl (divers)	Migration	Similar to dabblers	< 36	Seeds, tubers, invertebrates

Shorebirds	Migration	Bare or sparsely vegetated mudflats	0-6	Invertebrates

3.2 Identification of Habitat Requirements

Habitat requirements of focal species were assessed using scientific literature, including species accounts published in "Birds of North America Online" (https://birdsna.org/Species-Account/bna/home and The Cornell Lab of Ornithology 2018). Refuge data and expert opinion were used to supplement scientific literature when necessary. For each focal species, information on migration and breeding chronology, as well as vegetation structure, foods, and foraging depths during different life cycle events were summarized. Accounts for each focal species and species guild can be found in Appendix B.

Habitat requirements (e.g., plant community composition and structure, area, and water depths) were used in conjunction with management capabilities to identify Refuge lands that could potentially provide habitat for each focal species. The intent was to assess the minimum and maximum area that potentially could be managed for each species without disrupting processes (e.g., stabilization of hydrology) that are critical to sustaining long-term habitat viability (Euliss et. al. 2004; Laubhan et al. 2012). This information was subsequently used to develop management goals and objectives that are specific, measurable, achievable, results-oriented, and time-specific (i.e., SMART objectives) (Chapter 4).

3.3 Reconcile Conflicting Habitat Needs

Occasional conflicts will arise between optimizing visitor services and ensuring the long-term sustainable productivity of wetlands to meet the Refuge purpose. The Refuge tour road and hunting units are located in specific areas to promote quality public use. However, wetlands must be dewatered periodically to facilitate nutrient recycling, stimulate germination of desirable plants, and control succession of non-native and/or invasive plants (Mitsch and Gosselink 1993). In addition, dewatering is an effective method for flushing or distributing sediment. As a result, not all Refuge wetlands can be flooded continuously throughout the year nor can the same wetland be flooded at the same time every year (Laubhan and Fredrickson 1993). Although there will be fewer opportunities to have all wetlands in public use areas flooded at all times, there will still be some opportunities to support public use (e.g., not all wetlands will be dewatered in a given year).

Refuge staff will evaluate wetland conditions annually to determine the units that provide quality habitat for focal species and those that must be managed more intensively to restore or maintain ecological processes. These decisions will be documented in the Refuge's Annual Work Plan (AWP). However, activities may occasionally diverge from the AWP due to unforeseen events, including disease outbreaks, unexpected vegetative responses, or critical maintenance or repair activities that jeopardize infrastructure or safety of Refuge staff and the public. If necessary, temporary losses of habitat in a particular unit can be offset by adjusting objectives for other units.

Chapter 4. Goals and Objectives

The goals and objectives for this HMP were developed based on the principle of ecological sustainability, which requires ensuring the long-term productivity of habitats. In this context, the Refuge habitat management program is focused on providing a spatial and temporal distribution of habitats necessary to provide the resources needed, such as food and plant structure, to fulfill life cycle events such as migration, staging, feeding, and breeding, with an emphasis on focal species and guilds. Achieving the objectives will require completion of restoration and infrastructure improvement projects. These projects are necessary to institute annual management strategies that better emulate natural processes with the least intensive management possible (Chapter 5). (Note: Unless cited, information presented in rationale sections is derived from Appendix B.)

Goal 1. Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

Rationale:

The historic hydrology of the delta has been significantly altered due to upstream water diversions. The Refuge was established to protect remaining deltaic wetlands and restore or enhance wetland habitats that had been lost. Dikes and canals were put in place to capture reduced Bear River flows and deliver water to managed wetland units across the delta. However, the current infrastructure requires backing water up the delta from downstream dikes, and past management has emphasized holding water throughout the summer on many wetland units. Although this approach has provided valuable waterbird habitat, there are several long-term impacts resulting from this approach that threaten wetland sustainability and productivity, including: reduced distribution of emergent plant species; expansion of invasive plant species that are difficult and costly to control; altered sediment dynamics that promote non-native and/or invasive plants; reduced ability to manage water; and increased potential for nutrient enrichment and contaminant accumulation that can negatively affect wetland and wildlife health.

Restoring historic delta hydrology to the extent possible will increase the flood frequency of impounded units adjacent to the river, promote more natural deposition of sediment, enable better control of soil salinity, and facilitate nutrient cycling. In addition, implementation of new annual water management strategies will be possible, including the ability to sheetflow water across some units rather than backflooding and dewatering units periodically to help control phragmites and common carp. Collectively, this will improve wetland sustainability and productivity of impounded units, as well as provide more habitat for a diversity of waterbirds.

Though numerous species nest on the Refuge, most waterfowl and shorebirds utilize Refuge habitats during spring and fall migration. Therefore, habitat objectives in managed units will emphasize migration habitat for waterfowl, shorebird, and other waterbird species. This shift in focus is not anticipated to effect the area of suitable shorebird breeding habitat (e.g., snowy plover, American avocet, white-faced ibis) or ground-nesting waterfowl (e.g., cinnamon teal). This shift, however, will likely reduce nesting habitat for some over-water nesting species (e.g., redhead). Breeding habitat for focal species will also be available below the D-Line dike (e.g., Willard Spur and Bear River Bay) in most years.

Spring Migration Objectives (Objectives also include potentially available areas on other Refuge lands)

1) **Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May 1.**

2) **Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, long-billed curlew, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.**

Fall Migration Objectives (Objectives also include potentially available areas on other Refuge lands)

1) **Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.**

2) **Provide 50-75% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans), and American white pelican from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.**

Rationale:

The Refuge is a critical stopover site for waterbirds in both the Pacific and Central Flyways during both spring and fall migration. During spring migration, the Refuge supports tens of thousands to hundreds of thousands of waterfowl along with tens of thousands of shorebirds representing up to 40 species of shorebirds. The spring waterfowl migration begins in mid-to-late winter as wetlands thaw, and peak populations typically occur in March. In contrast, spring shorebird migration generally begins in March and extends into mid-May with peak numbers for all species generally recorded in April. However, the migration period varies for different species, with American avocets arriving in March and long-billed dowitchers arriving in late April. Other focal waterbirds, including white-faced ibis and American white pelicans, also begin arriving in April.

During fall migration, the Refuge provides habitat for many thousands of shorebirds and hundreds of thousands waterfowl. Shorebirds arrive in July and are present into October, but the majority of fall migrating birds are present on the Refuge during July and August. Waterfowl fall migration begins in August with the arrival of molting northern pintail and green-winged teal, but the majority of migrating waterfowl generally are present from September through November. September migrants primarily are dabbling ducks and Canada geese, whereas diving ducks and tundra swans arrive in large numbers in October and November until ice forms.

Effectively meeting the migration needs of these species during both spring and fall requires providing adequate food resources in areas that are accessible to the birds. Carbohydrates are critical because flight requires significant energy. Protein also is important because females of some species accumulate protein reserves for egg production at stopover sites in spring and several species complete molt on the Refuge in fall. Foods consumed by waterbirds to meet these nutritional requirements vary. Waterfowl diets are comprised of plant foods, such as seeds and tubers, and invertebrates, whereas the diet of shorebirds and white-faced ibis is almost exclusively invertebrates. The diet of the American white pelican is primarily small fish.

Producing these foods requires creating environmental conditions that promote establishment and survival of appropriate plant communities and habitats that support appropriate invertebrate and fish populations. These conditions vary depending on the ecology of individual plants. For example, seed germination of many annual species (e.g., red saltwort) requires creating moist mudflats, whereas many perennials (e.g., sago pondweed) can become established from tubers or rhizomes under flooded conditions as long as water clarity is adequate.

The appropriate environmental conditions to make foods available for consumption by waterbirds is also required. Primary considerations are foraging method, vegetation structure, and preferred foraging depth. Dabbling and diving ducks are capable of foraging in a variety of vegetation types ranging from open water to dense vegetation. However, dabbling ducks prefer to forage by tipping-up in water less than 18 inches deep, whereas diving ducks can acquire food by tipping-up or diving to depths of 5 feet or more. In contrast, most shorebirds do not swim (phalaropes being a notable exception) and can only forage in water less than the length of their legs. Further, most species forage by sight or probing moist to shallowly flooded substrates. Therefore, most species prefer sparsely vegetated habitats (less than 25% vegetation cover) flooded to depths less than 6 inches (except for the smallest species that prefer less than 2 inches). White-faced ibis also forage visually or by probing while standing or walking. However, due to longer legs and a decurved bill, suitable foraging sites for this species include more densely vegetated sites (e.g., wet meadows, hay meadows) as well as sparsely vegetated mudflats and agricultural fields flooded to depths less than 10 inches. American white pelicans are highly social and use cooperative foraging strategies. Swimming groups encircle fish or drive them into shallow water where they can be captured by synchronized bill dipping (unlike brown pelicans, American white pelicans do not dive). Foraging depths vary, but often water is less than 8 feet deep. Therefore, in addition to habitat provide in managed wetland areas, suitable habitat will also be available in permanently flooded habitats, including oxbows, canals, and the Bear River.

The spring and fall migration objectives described in this HMP characterize the dynamic hydroperiods (timing, depth, duration) and vegetation required to meet the foraging needs of focal species. In addition, not all available habitat will be flooded during spring and fall migration, which will provide the flexibility necessary to produce the appropriate foods and habitat structure. The proportion of area flooded during each migration period was determined based on historic delta hydrology (e.g., more habitat flooded in spring) and current hydrographs that depict the current seasonal availability of water in recent years. Each year, some wetlands, or portions of wetlands, will be dewatered to treat invasive species, promote nutrient cycling that will enhance invertebrate production, stimulate germination of annual plants, and allow consolidation of suspended sediment to improve water clarity for growth of submerged aquatic vegetation. Decisions regarding the units (or portions of units) that will be dewatered or remain dry will be determined annually based on water quality and plant conditions, as well as water availability from the Bear River. Water that is not needed to meet these objectives will be discharged to the Bear River Bay or Willard Spur to provide additional habitat.

Breeding Objectives (Breeding Objectives 2 and 3 also include potentially available areas on other Refuge lands)

1) **Provide a minimum of three suitable nesting sites (> 1 acre stands of native emergent vegetation > 3 feet in height with minimum water depths of 6 inches) for breeding white-faced ibis from April 15 to August 15.**

2) **Provide up to 600 acres of suitable nesting habitat (bare to < 40% vegetation cover, maximum vegetation height < 5 inches) within 50 feet of suitable brood foraging habitat (< 25% vegetation cover that is < 8 inches tall; water depths < 2 inches; abundant invertebrate resources) for nesting black-necked stilts and American avocets from May 1 to August 15.**

3) **Provide up to 400 acres of suitable nesting habitat (emergent vegetation cover with average visual obstruction > 20 inches) within 200 feet of suitable brood habitat (flooded emergent cover, abundant invertebrate resources) for nesting cinnamon teal from May 1 to August 30.**

Rationale:

Although providing migration habitat is the primary focus of management, Refuge wetlands also support breeding of several focal species, including some of the largest white-faced ibis colonies in the Great Basin, several thousand American avocets and black-necked stilts, and hundreds of cinnamon teal. The nesting periods (defined to also include egg laying and brood rearing) of these species range from April 15 to August 30, which overlaps with both the end of spring shorebird and waterfowl migration (May 1) and the beginning of the fall shorebird migration period (August 31). As a result, some foraging habitat provided for migratory species will also be available for adult breeding pairs and broods of nesting species.

Suitable breeding habitat can be characterized as an area of sufficient size that provides appropriate vegetation structure for nest site construction and cover with food resources nearby that are available for adults and broods. White-faced ibis nest in colonies over water in stands of tall emergent plants, primarily hardstem and alkali bulrush, and occasionally cattail. The number of breeding pairs is determined by the area of suitable vegetation. In one Utah colony, nests were placed 8-39 inches above water that was 24 inches deep, but shallower water depths (6 inches) and deeper water depths (71 inches) for white-faces ibis nests have been documented. The average clutch size is four eggs, which are incubated for about 20 day before hatching. Both white-faced ibis parents feed young in the nest for about three weeks, and young spend considerable time in vegetation away from the nest about 10 days after hatching. At an age of five weeks chicks can fly, and by eight weeks the young are independent.

Nests of American avocets and black-necked stilts typically are located on slightly elevated sites that are bare or sparsely vegetated within 50 feet of water (less than 40% vegetation cover and less than 6 inches vegetation height). Nests are scraped into the substrate and three to four eggs are laid. After an incubation period of about 26 days, eggs hatch and chicks remain in the nest less than 24 hours prior to being led to foraging sites by adults. Suitable foraging habitat for American avocets and black-necked stilts is characterized by vegetation height that is taller than chicks but shorter than adults, vegetation density that permits chicks to move while foraging, and water depths less than 2 inches (e.g., margins of wetlands).

Cinnamon teal nest on the ground in dense vegetation that can completely conceal the nest from the sides and above. Vegetation height varies, but often is less than 24 inches. Most nests also are located within 165 feet of water, but distance can vary depending on location. Clutch size averages 10 eggs and the incubation period is 21-25 days. After hatching, cinnamon teal ducklings leave the nest within 24 hours and travel with the female to brood habitat, which is characterized as seasonal and semi-permanent wetlands with abundant emergent cover that provides invertebrates and seeds. During the first 16 days, young feed almost exclusively by pecking the water surface, whereas older birds submerge their head or tip-up. Young are capable of flight at 49 days.

The breeding objectives define the range of habitat requirements that must be met for focal species to successfully nest and raise young. However, achieving these objectives also will benefit numerous other species. For example, maintaining stands of tall emergent vegetation to benefit white-faced ibis also will provide some habitat for other species that nest over water, including redheads and grebes.

The wetland units that will provide habitat for breeding species will vary annually depending on vegetation conditions (type, height, density). During the past 10 years, one large and two smaller white-faced ibis colonies have been documented on the Refuge in Units 1, 3B, 3K, 5B, and 7. Primary nesting locations of American avocet and black-necked stilt have been dikes and small constructed islands above D-Line dike, but playas and small natural islands south and west of D-Line also have been used. In contrast, cinnamon teal have nested primarily on dikes because it is the only upland habitat within the delta units, a location that results in high predation of nests. However, proposed changes in water management will increase the ability to manage additional areas for breeding, as well as for migratory species. For example, restoration of sheetflow on portions of the Wasatch Front has resulted in the development of dense wet meadow vegetation suitable for cinnamon teal nesting. As additional restorations are completed in this area along with the Canadian Goose Club and Yates tracts, the area and distribution of potential cinnamon teal nesting habitat will increase. Similarly, restoration of overbank flooding in portions of the Refuge will result in the flooding of playas at upper elevations that have previously remained dry except for precipitation. These areas support large expanses of short vegetation (e.g., saltwort, saltgrass) intermixed with dry mudflats, which will provide ideal habitat for nesting shorebirds when flooded in late spring.

Goal 2. Restore and manage wet meadow and upland habitats in the Wasatch Front to produce native grasses, sedges, rushes, and forbs, where possible, to provide foraging and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

Rationale:

Historically, water originating from springs and small streams flowing from Wasatch Front flowed downslope toward the delta creating shallowly flooded or sub-irrigated wetlands and meadows with fresher water and a greater plant diversity compared to delta wetlands. Water diversions for irrigation on private lands and urban development, along with the adjacent interstate highway, have changed the pattern and timing of water flows. Water now enters Refuge lands via water control structures and ditches, often ending in diked impoundments in some areas. Impoundments and permanently saturated areas below impoundment levees have become dominated by tall emergent species such as cattail and phragmites that provide limited resources for waterbirds compared to historic vegetation.

Restoring sheetflow across the meadows where possible will increase the wet meadow area, improve native plant community composition by increasing sedges, grasses, and forbs, and help reduce the incidence of non-native and/or invasive plant species adapted to drier soil conditions. Impoundments will be allowed to dry for extended periods to help control dense tall emergent vegetation, especially non-native and/or invasive plants (e.g., phragmites and cattails), and recycle nutrients to improve invertebrate production. This will benefit focal species as well as other wetland-dependent birds by providing better quality foraging and nesting habitat.

Spring Migration Objectives

1) **Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May 1.**

2) **Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, white-faced ibis) from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.**

Fall Migration Objectives

1) **Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.**

2) **Provide 50-75% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans) from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.**

Breeding Objectives

1) **Provide up to 600 acres of suitable nesting habitat (bare to < 40% vegetation cover, maximum vegetation height < 5 inches) within 50 feet of suitable brood foraging habitat (< 25% vegetation cover that is < 8 inches tall; abundant invertebrate resources) for nesting black-necked stilts and American avocets from May 1 to August 15.**

2) **Provide up to 400 acres of suitable nesting habitat (emergent vegetation cover with average visual obstruction > 20 inches) within 200 feet of suitable brood habitat (flooded**

emergent cover, abundant invertebrate resources) for nesting cinnamon teal from May 1 to August 30.

Rationale:

Although lands comprising the Wasatch Front units are at a higher elevation and natural springs are the primary source of water, the native plant communities of this area provide similar resource benefits to focal waterbird species. For example, restored meadows on the Wasatch front support large areas of Baltic rush that provide spring and fall migration foraging habitat for shorebirds, waterfowl, and white-faced ibis and nesting habitat for cinnamon teal. Notable exceptions include the lack of large, open water habitats that support submerged aquatic vegetation and fish, and areas of native tall emergent habitat. Therefore, the objectives and rationale for the Wasatch Front units (Goal 2) are identical to the objectives defined for the Bear River deltaic wetland and upland habitats (Goal 1), with the exception that migration habitat for tundra swans and breeding habitat for white-faced ibis cannot be provided on the Wasatch Front units.

Goal 3. Prevent further physical alterations to maintain the existing hydrologic and topographic integrity of the Refuge.

Rationale:

Refuge lands have been significantly altered by infrastructure development in an attempt to maintain habitat quality in response to changes in river and natural spring hydrology caused largely by agricultural development and urbanization. Although these efforts have been successful in many respects, the existing infrastructure has also caused habitat degradation in many areas, and the cost of maintaining existing infrastructure is increasing as it ages. Refuge staff currently spend considerable time and funds repairing or replacing dikes and water control structures. New ecological information has become available since the existing infrastructure was constructed that provides ideas and solutions for maintaining and improving wetland habitat quality using less intensive and disruptive methods. This goal was developed recognizing that further infrastructure development was not the most efficient or beneficial solution to water management on the Refuge, given past experiences, and that new approaches to achieve sustainable wetland productivity have emerged that will benefit wildlife and require less intensive management.

Objective: Maintain topographically unaltered deltaic wetlands (natural playas, mudflats, and other temporarily flooded wetlands) in their current physical condition to provide foraging, shorebird nesting, and resting areas for waterfowl, shorebirds, and other waterbirds.

Rationale:

Refuge lands comprising the delta still encompass large areas of playa and mudflat habitats that are naturally flooded periodically from snowmelt, rainfall, and overbank flooding during high flows in the Bear River. When flooded, these habitats are used by shorebirds, waterfowl and other waterbirds. Although existing infrastructure has impacted the hydroperiod of these wetlands to varying extents, the topography remains largely intact, and no further developments will occur that alter current topographic conditions. Rather, attempts will be made to restore hydrology using less disruptive methods, such as increasing the frequency of overbank flooding, removing existing infrastructure, or passing flows through structures to maintain the long-term productivity of these areas.

Goal 4. Maintain and expand partnerships that contribute to the conservation and enhancement of Refuge habitats, the Bear River watershed, and the Great Salt Lake ecosystem.

Rationale:

Managing Refuge lands is becomingly increasingly complex. The watershed continues to be altered by water use/developments, land use change, an increasing human population, and changing societal values. Each of these external pressures affect natural resources on the Refuge, most notably water resources. Developing innovative and cost-efficient solutions to achieve current habitat objectives and ensure the long-term sustainability of habitat for wildlife and the enjoyment of the public will require coordination with other watershed stakeholders (e.g., private landowners, cities, industry, and other state and federal agencies), as well as knowledge from numerous disciplines (e.g., ecology, hydrology, human dimensions, planning, engineering).

Objective: Work with partners to identify natural resource conservation issues and develop appropriate solutions that will help ensure sustainability and productivity of Refuge lands.

Rationale:

Refuge staff continue to work with numerous partners to improve understanding of natural resources on the Refuge, Bear River watershed, and the GSL ecosystem, including universities, Utah Division of Wildlife Resources, and other state and federal agencies. Staff have participated in regional surveys (wildlife and habitat) and planning efforts at various scales and numerous research projects have been conducted on the Refuge to inform management. In addition, staff have collaborated with other conservation organizations, such as Ducks Unlimited, to implement habitat improvement and enhancement projects on Refuge lands. Visitor Services staff on the Refuge work with the Friends of the Bear River and Brigham City to promote the appreciation and conservation of natural resources, and partner with local school districts to develop and implement educational programs focusing on the Bear River MBR. These partnerships are valuable and will be maintained, but additional partnerships are needed to address ecological knowledge gaps in hydrology, water quality, restoration ecology, and engineering. Additional expertise brought by partnerships that address these knowledge gaps will help to develop solutions to existing and future challenges, such as water availability, sediment dynamics, contaminants, infrastructure modification, and infrastructure removal. In addition, partners with expertise in human dimensions and communications are needed to assist Visitor Services staff in developing effective techniques for informing the public about resource conservation efforts being conducted on the Refuge and surrounding areas.

Chapter 5. Management Strategies

Based on the goals and objectives identified in Chapter 4, a list of potential restoration and infrastructure improvement projects at specific Refuge locations were identified that would contribute to achieving habitat objectives and improve ecological function while minimizing annual management intensity to the extent possible. Each project was evaluated for possible inclusion in the HMP based on the following criteria: contribution to the Service mission, regional priorities, and Refuge purpose; compliance with Service policies, mandates, and legal agreements pertaining to remediation; and feasibility relative to Refuge-specific management constraints (e.g., water resources). Projects that met these criteria were considered feasible and an analysis was conducted of potential positive and negative impacts of these strategies on resources of concern and non-target resources. Based on this analysis, a final set of projects were selected that would contribute to accomplishing priorities with the fewest direct and in-direct effects on all Refuge resources (Table 7). Those effects are analyzed in the Environmental Assessment provided in Appendix C.

Selected projects were designed based on scientific literature and by consulting individuals with expertise in appropriate disciplines (e.g., hydrology, ecology, and engineering). Specific actions that will be required to implement each project were identified, and the ecological benefits, and safety benefits, management efficiencies gained, and key monitoring metrics were documented (Table 8). To ensure success, specific actions that would be required for completion of projects, including additional data and consultations required to finalize designs of more complex projects, were documented (Table 9). Implementation of projects in this HMP will occur simultaneously, with annual activities (e.g., water management, prescribed fire, grazing) documented in the AWP, and both plans will be integrated with the Refuge Inventory and Monitoring Plan following completion of this HMP. Refuge staff will use this HMP as a working document to apply adaptive management concepts; therefore, periodic revisions are expected as projects are implemented and the response of the system is monitored.

Table 7. Bear River Migratory Bird Refuge Habitat Management Plan projects support multiple USFWS priorities. [a]

<table>
<tr><th>Project</th><th>Regional Director Priorities</th><th>Assistant Regional Director – Refuges Priorities</th><th>Bear River Watershed Conservation Area Goals</th></tr>
<tr><td>I. Partial hydrologic restoration of Unit 2A</td><td>Advance the Principles of Strategic Habitat Conservation as our conservation delivery paradigm</td><td rowspan="5">Realignment Goal: Ecologically Sustainable Management

Realignment Goal: Connected Conservation Community</td><td rowspan="5">NWRS Priority: Develop the Bear River Migratory Bird Refuge into a focal point for the public

Refuge contributes to the conservation goals of American avocet and emergent wetlands

Refuge contributes to the purposes by maintaining healthy populations of migratory birds, maintaining water quality and quantity, conserving wetland habitats, and increasing resiliency of the watershed</td></tr>
<tr><td>II. Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4</td><td>Advance the Principles of Strategic Habitat Conservation as our conservation delivery paradigm</td></tr>
<tr><td>III. Partial hydrologic restoration of Unit 3I/3J</td><td>Advance the Principles of Strategic Habitat Conservation as our conservation delivery paradigm</td></tr>
<tr><td>IV. Improve the ability to manage hydrology of impounded units</td><td>Have the safest, most environmentally sound workplace possible</td></tr>
<tr><td>V. Native plant community restoration in Three Bar Unit</td><td>Advance the Principles of Strategic Habitat Conservation as our conservation delivery paradigm</td></tr>
</table>

[a] *Additional priorities for Bear River MBR will be identified during development of the Comprehensive Conservation Plan.*

Table 8. Bear River Migratory Bird Refuge Habitat Management Plan projects, sub-activities, ecological and/or human safety benefits, efficiency gained, and key metrics.

	Activity/sub-activity (sequential order)	*Ecological and/or Human Safety Benefits*	*Efficiency Gained*	*Key Metrics*
Project I. Partial hydrologic restoration of Unit 2A				
A	Remove dike and fill adjacent borrow ditch	Improved hydrology	Increased water-use efficiency; Reduced management and maintenance costs	Plant community composition; Water flow and depths on restored area
B	Partially fill ditch and remove dikes	Improved hydrology	Increased water-use efficiency; Reduced management and maintenance costs	Plant community composition; Area flooded and water depths
C	Remove man-made islands	Restored sheetflow	Reduced management and maintenance costs	Plant community composition; Water flow and depths on restored area
Project II. Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4				
A	Construct weir and replace structure	Restored hydrology	Reduced management costs; Improved operational safety	Frequency and extent of flooding
B	Remove levees, islands, and borrow ditches	Restored sheetflow	Reduced management and maintenance costs	Extent and distribution of flooding; Plant community composition
C	Raise elevation of outlet and create short dikes	Improved flow to Willard Spur; Improved sediment transport	Increase water-use efficiency	Water discharge to Willard Spur
D	Restore original height of Bear River levee	Overbank flooding during high flows	No increase in management or maintenance costs	
Project III. Partial hydrologic restoration of Unit 3I/3J				
A	Replace inlet structures and install ditch plug	Improved management capability	Increased operational efficiency; Reduced maintenance costs	
B	Remove interior dike, structures and borrow ditch	Partially restored sheetflow	Reduced management and maintenance costs	Extent and distribution of flooding; Plant composition
C	Fill interior ditch and perimeter borrow ditch	Improved hydrology	Improved water-use efficiency; Reduced management and maintenance costs	Extent and distribution of flooding; Plant composition
Project IV. Improve the ability to manage hydrology of impounded units				
A	Install and retrofit water control structures	Improved hydrology; Increased area of flooding; Improved safety	Reduced management costs; Increased water-use efficiency	Extent and distribution of flooding; Water depths

	Activity/sub-activity (sequential order)	*Ecological and/or Human Safety Benefits*	*Efficiency Gained*	*Key Metrics*
Project V. Native plant community restoration in Three Bar Unit				
A	Repair headgate and install fencing	Improved hydrology; Ability to implement herbivory	Eliminate impacts to adjacent landowners	Distribution of surface water
B	Site preparation and plant seed	Increased seed germination; Improved plant composition	Minimize need to conduct subsequent reseeding; Reduced treatment of invasive species	Soil conditions; Plant establishment and survival

Table 9. Bear River Migratory Bird Refuge Habitat Management Plan projects, sub-activities, timeline, and operational considerations.

Activity/sub-activity (sequential order)	*Year*	*Month*	*Station Staff* Personnel (hours)	*Station Staff* Cost ($)	*Station Other (Equipment; Material; Contract)* Item (hours)	*Station Other* Cost ($)	*Refuge Sharing* Type (hours)	*Refuge Sharing* Cost ($)	*Total* Cost ($)
Project I. Partial hydrologic restoration of Unit 2A									
A Remove dike and fill adjacent borrow ditch									
Administration (permits, contracts, oversight)	2022/2023	All	[3] Refuge staff oversight = 22 hours	$1,378					$1,378
Public outreach/ communication	2022/2023	Nov-May	[4] 20 hours	$878					$878
Collect survey data to determine topography and estimated fill required	2023	June-Oct	[1] 16 hours/2 WG	$542					$542
Complete restoration and shape topography	2023	June-Oct	160 hours/2 WG	$5,420	Dozer Excavator	[2] Fuel – 1,200 gal = $3,700			$9,120
B Partially fill ditch and remove dikes									
Administration (permits, contracts, oversight)	2022/2023	All	Refuge staff oversight = 12 hours	$751					$751
Public outreach/ communication	2022/2023	Nov-May	40 hours	$1,758					$1,758
Collect survey data to determine topography and estimated fill required	2023	June-Oct	16 hours/ 2 WG	$542					$542
Complete restoration and shape topography	2023	June-Oct	80 hours/2 WG	$2,710	Excavator Dump Truck	Fuel – 150 gal = $500			$3,210
C Remove man-made islands									
Administration (permits, contracts, oversight)	2022/2023	All	Refuge staff oversight = 12 hours	$751					$751
Public outreach/ communication	2022/2023	Nov-May	20 hours	$878					$878
Collect survey data to determine topography and estimated fill required	2023	June-Oct	16 hours/2 WG	$542					$542
Complete restoration and shape topography	2023	June-Oct	80 hours/2 WG	$2,710	Excavator Dump Truck	Fuel – 450 gal = $1,350			$4,060

Project I Total = $24,410

Activity/sub-activity (sequential order)	*Year*	*Month*	*Station Staff* *Personnel (hours)*	*Cost ($)*	*Station Other (Equipment; Material; Contract)* *Item (hours)*	*Cost ($)*	*Refuge Sharing* *Type (hours)*	*Cost ($)*	*Total* *Cost ($)*
Project II. Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4									
A Construct weir and replace structure									
Administration (contracts, grants, oversight, permits)	2023	All	Refuge staff oversight - 75 hours	$4,697					$4,697
Public outreach/ communication	2023	Jan-Oct	80 hours	$3,515					$3,515
Evaluate Whistler Canal flow data (seasonal inflows, capacity)	2023	June-Oct	Refuge and RO staff - 30 hours	$1,879					$1,879
Collect survey elevation data	2023	June-Oct	80 hours/2 WG	$2,710					$2,710
Structure design (elevation, width)	2023	June-Oct	Engineering contract	$300,000					$300,000
Retrofit existing structure with overshot gate	2024/2025	June-Oct	240 hours/2 WG	$8,131	3 new gates - $35,000 each Demo of existing gate Concrete - 7 yards Rebar	$105,000 $2,500 $1,000 $2,000	360 hours/3 WG	$12,197	$130,828
Weir design (elevation, width, length)	2024	Jan-Oct	Engineering contract	$300,000					$300,000
Weir construction	2024/2025	June-Oct	240 hours/3 WG	$8,131	Riprap Excavator, Dozer, Dump Truck Fuel – 900 gal	$10,000 $2,700			$20,831
B Remove levees, islands, and borrow ditches									
Administration (permits, contracts, grants, oversight)	2023/2024	All	Refuge staff oversight - 410 hours	$25,674					$25,674
Collect survey data to determine topography and estimated fill required	2024	June-Oct	80 hours/2 WG	$2,710					$2,710

Activity/sub-activity (sequential order)	*Year*	*Month*	<u>*Station Staff*</u> *Personnel (hours)*	*Cost ($)*	<u>*Station Other*</u> *(Equipment; Material; Contract)* *Item (hours)*	*Cost ($)*	<u>*Refuge Sharing*</u> *Type (hours)*	*Cost ($)*	<u>*Total*</u> *Cost ($)*
Complete restoration and shape topography	2024/2025	June-Oct	2 WG's for 2 summers = 1600 hours over 20 weeks / summer	$54,208 / summer = $108,116	Dozer, Excavator, Dump Truck Fuel – 21,000 gal	Fuel - $63,000	MAT TEAM – 3 WG for 2 summers = 2400 hours over 20 weeks / summer Dozer	$81,312 / summer = $162,624 $5,000 rental or transportation from another refuge	$338,740
C Raise elevation of D-Line structure and construct short dikes									
Administration (permits, contracts, grants, oversight)	2024/2025	All	Refuge staff oversight = 30 hours	$1,879					$1,879
Collect survey data to determine structure elevation and estimate fill required for dikes	2024	June-Oct	80 hours/2 WG	$2,710					$2,710
Retrofit existing structure to correct elevation	2025	June-Oct	160 hours/2 WG	$5,421	Concrete - 10 yd Excavator Dump Truck Fuel – 600 gal	$150/yd = $1,500 Fuel - $1,800			$8,721
Construct two short dikes	2025	June-Oct	Included above						
D Restore original height of Bear River levee									
Administration (permits, contracts, grants, oversight)	2024/2025	All	Refuge staff oversight = 42 hours	$2,630					$2,630
Collect survey data to estimate fill removal	2025	June-Oct	16 hours/2 WG	$1,002					$1,002
Lower Levee/dirt removal	2025	June-Oct	320 hours/2 WG	$10,842	Dozer Excavator Dump Truck Fuel – 1520 gal	Fuel - $4,560			$15,402
								Project II Total =	**$1,163,928**

			Station Staff		*Station Other (Equipment; Material; Contract)*		*Refuge Sharing*		*Total*
Activity/sub-activity (sequential order)	*Year*	*Month*	*Personnel (hours)*	*Cost ($)*	*Item (hours)*	*Cost ($)*	*Type (hours)*	*Cost ($)*	*Cost ($)*
Project III. Partial hydrologic restoration of Unit 3I/3J									
A Replace inlet structures and install ditch plug									
Administration (permits, contracts, grants, oversight)	2021/2022	All	Refuge staff oversight - 40 hours	$2,505					$2,505
Public outreach / communication	2021/2022	Jan-Oct	40 hours	$1,758					$1,758
Collect survey data to determine proper structure elevation and estimate fill required for ditch plug	2021/2022	June-Oct	80 hours/2 WG	$2,710					$2,710
Replace structures and construct ditch plug	2022	June-Oct	240 hours/3 WG	$8,131	2 structures Concrete - 10 yd Excavator Dump Truck Fuel – 600 gal Riprap Pipeline	$5,000 each = $10,000 $1,500 Fuel - $1,800 $10,000 $2,000			$33,431
B Remove interior dike, structures and borrow ditch									
Administration (permits, contracts, oversight)	2021/2022	All	Refuge staff oversight = 50 hours	$3,131					$3,131
Public outreach / communication	2021/2022	Jan-Oct	20 hours	$879					$879
Collect survey data to determine topography and estimated fill required	2021	June-Oct	80 hours/2 WG	$2,909					$2,909
Complete restoration and shape topography	2021/2022	June-Oct	320 hours/2 WG	$10,842	Dozer Excavator Fuel – 3880 gal	Fuel – $11,640			$22,482
C Fill interior 3I interior ditch and 3J perimeter borrow ditch									

Activity/sub-activity (sequential order)	Year	Month	Station Staff Personnel (hours)	Station Staff Cost ($)	Station Other (Equipment; Material; Contract) Item (hours)	Station Other Cost ($)	Refuge Sharing Type (hours)	Refuge Sharing Cost ($)	Total Cost ($)
Administration (permits, contracts, grants, oversight)	2023/2024	All	Refuge staff oversight - 84 hours	$5,260					$5,260
Public outreach / communication	2021/2022	Jan-Oct	20 hours	$879					$879
Complete restoration and shape topography	2021/2022	June-Oct	Estimate 250 dump truck loads at 6 loads a day = 42 days. 672 hours/2 WG	$22,767	Dump Truck Excavator Fuel – 2700 gal	Fuel - $8,100			$30,867
								Project III Total =	$106,811
Project IV. Improve the ability to manage hydrology of impounded units									
A Install and retrofit water control structures									
Administration (permits, contracts, grants, oversight)	2023/2024/2025	All	Refuge staff oversight - 124 hours	$7,749					$7,749
Public outreach / communication	2024/2025	Jan-Oct	30 hours	$1,318					$1,318
Collect survey data to determine proper structure location and elevation	2024	June-Oct	80 hours/ 2 WG	$2,710					$2,710
Evaluate H-Line and O-Line canal flow data (seasonal, inflows, capacity)	2024	June-Oct	Refuge and RO staff - 30 hours	$1,879					$1,879
Retrofit three water control structures with overshot gates	2025	June-Oct	3 structure = 240 hours/2 WG/ structure = 720 hours/2 WG	$24,394	3 new gates for 3 structures - $35,000 each Demo of existing gate Concrete – 21 yd Rebar Excavator fuel – 500 gal	Gates = $315,000 $7,500 $3,000 $6,000 Fuel - $1,500			$357,394

Activity/sub-activity (sequential order)	Year	Month	Station Staff Personnel (hours)	Station Staff Cost ($)	Station Other (Equipment; Material; Contract) Item (hours)	Station Other Cost ($)	Refuge Sharing Type (hours)	Refuge Sharing Cost ($)	Total Cost ($)
Install overshot gates in H-Line and O-Line	2025	June-Oct	2 WG/160 hours	$5,818	Materials based on prior project Excavator Dump Truck Backhoe fuel – 500 gal	$500,000 ea = $1,000,000 Fuel - $1,500	2 WG/160 hours	$5,818	$1,013,136
								Project IV Total =	$1,384,186
Project V. Native plant community restoration in Three Bar Unit									
A Repair headgate and install fencing			**COMPLETED**						
B Site preparation and plant seed									
Design seed mix and treatment plan	2021/2022	All	40 hours/1 WG Refuge staff oversight = 5 hours	$1,355 $313					$1,668
Annual treatment to prepare site	2021 start	June-Oct	40 hours/1 WG	$1,355	Herbicide Tractor fuel 333 gal	$2,500 Fuel - $1,000			$5,855
Interseed unit	2021/2022	June-Oct	Included above						
								Project V Total =	$7,523
								Grand Total All Projects =	**$2,686,858**

[1] *Note – all WG personnel were estimated at a WG-8 step 5 salary level. Total number of hours/X WG needed.*

[2] *Diesel fuel is estimated at $3/gallon with added contingencies for delivery and increase in prices.*

[3] *Refuge staff oversight on administration was estimated using 1 hour for every 8 hours of field time and estimated at a GS-13/5.*

[4] *Public communications and outreach was calculated at a Visitor Services Manager salary of GS – 11/5.*

yd = yards; gal = gallons; WG = Wage Grade

5.1 Project I: Partial hydrologic restoration of Unit 2A

Associated HMP Goals and Objectives

HMP Goal 1: Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

> Spring Migration Objective 1: Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May.
>
> Spring Migration Objective 2: Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.
>
> Fall Migration Objective 1: Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.
>
> Fall Migration Objective 2: Provide 50-75% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans) and American white pelican from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.

Contribution to HMP

The portion of the delta that is now Unit 2A historically supported wet meadow and playa plant communities. Flooded primarily in spring due to overbank flooding of the Bear River and to a lesser extent in fall due to precipitation, these habitats provided important foraging habitat for a diversity of waterbirds, including shorebirds, waterfowl, and white-faced ibis. However, the construction of dikes, borrow ditches, and islands have created various management challenges that have reduced habitat quality. The current vegetation community is largely comprised of phragmites interspersed with lesser amounts of cattail and bulrush. The four constructed islands in the impoundment also are extensively vegetated (Figure 13). Use by foraging shorebirds is limited due to the relative lack of open water and sparsely vegetated habitats that are shallowly flooded, and the density and height of vegetation on islands precludes nesting. The value of the unit as waterfowl foraging habitat also has decreased because phragmites encroachment throughout the unit has limited seed production. In addition, this unit is within the public use area, but wildlife observation, photography, and use by waterfowl hunters is limited due to extensive, impenetrable stands of tall emergent vegetation (i.e., phragmites). Completing this project will partially restore the hydrology of the unit, which will improve management capability to control robust emergent vegetation and create conditions suitable for establishment of wet meadow plant communities intermixed with shallow open areas that provide foods for a diversity of migratory birds. This effort will provide greater opportunity for visitors to view the wildlife within the unit. Additionally, when flooded in fall, the unit also will be more accessible to waterfowl hunters.

A. Remove dike and fill adjacent borrow ditch to improve sheetflow of water through the unit.

Summary: The natural hydrology of Unit 2A has been significantly altered by a dike, an adjacent borrow ditch, and one water control structure that serves as an outlet (Figure 13). Flooding the unit requires filling the borrow ditch first and then backing water up from the lowest elevation of the unit. Dewatering occurs via the one water control structure located in the southern portion of dike, which is not adequately sized to discharge water in a timely manner. These physical alterations, coupled with past water management strategies, resulted in the creation of saturated, bare soils late in the growing season that stimulated germination of phragmites and cattail, particularly on the margins of dikes and borrow areas. Once established, these species expanded into the unit via rhizomes, which occurred even when the unit was shallowly flooded. This dike will be removed and the material from this removal will be used to fill the adjacent borrow ditch. The water control structure also will be removed. The topography of these areas will be restored to facilitate movement of water down the delta gradient when flooded.

Management Efficiencies: Restoration of more natural water flow will increase the capacity to promote growth of native wet meadow and playa plant communities, reducing the incidence of robust emergent species such as phragmites. Further, when treatment of non-native and/or invasive plant species must occur, the ability to achieve dry soil conditions will increase the effectiveness of annual habitat management strategies (e.g., grazing, fire, herbicide applications). In addition, removal of the dike and water control structure will reduce management and maintenance costs, as there will no longer be a need for general upkeep and repairs such as mowing and riprap placement.

B. Partially fill ditch adjacent to H-Line canal levee and remove dikes forming the Settling Ponds.

Summary: The dike and associated ditch on the eastern border of the unit is a potential phragmites establishment site. The dike is part of the canal system and cannot be removed. However, the borrow ditch will be filled to force water entering the unit onto the historic delta surface and travel down gradient. Fill material will be obtained from the Settling Pond dikes adjacent to Unit 2, because those ponds are no longer used. Following removal, the topography of the area will be contoured and vegetation will be allowed to establish naturally (Figure 13).

Management Efficiencies: Filling the ditch will reduce maintenance costs. Restoration of more natural water flow will improve the ability for native plant species to thrive.

C. Remove man-made islands and fill adjacent borrow ditches.

Summary: Four islands were constructed using soil from adjacent areas, and the resulting borrow ditches are below the surface of the delta, interrupting the natural flow of water down the delta gradient. In addition, soils adjacent to the ditches remain saturated into the growing season and are sites of phragmites and cattail establishment. The islands will be removed by placing material in the surrounding borrow areas and contouring the area to restore natural topography and flows.

Management Efficiencies: Removal of the islands and borrow ditches will reduce the frequency of annual habitat management necessary to control robust emergent vegetation (e.g., phragmites and cattail) in the unit.

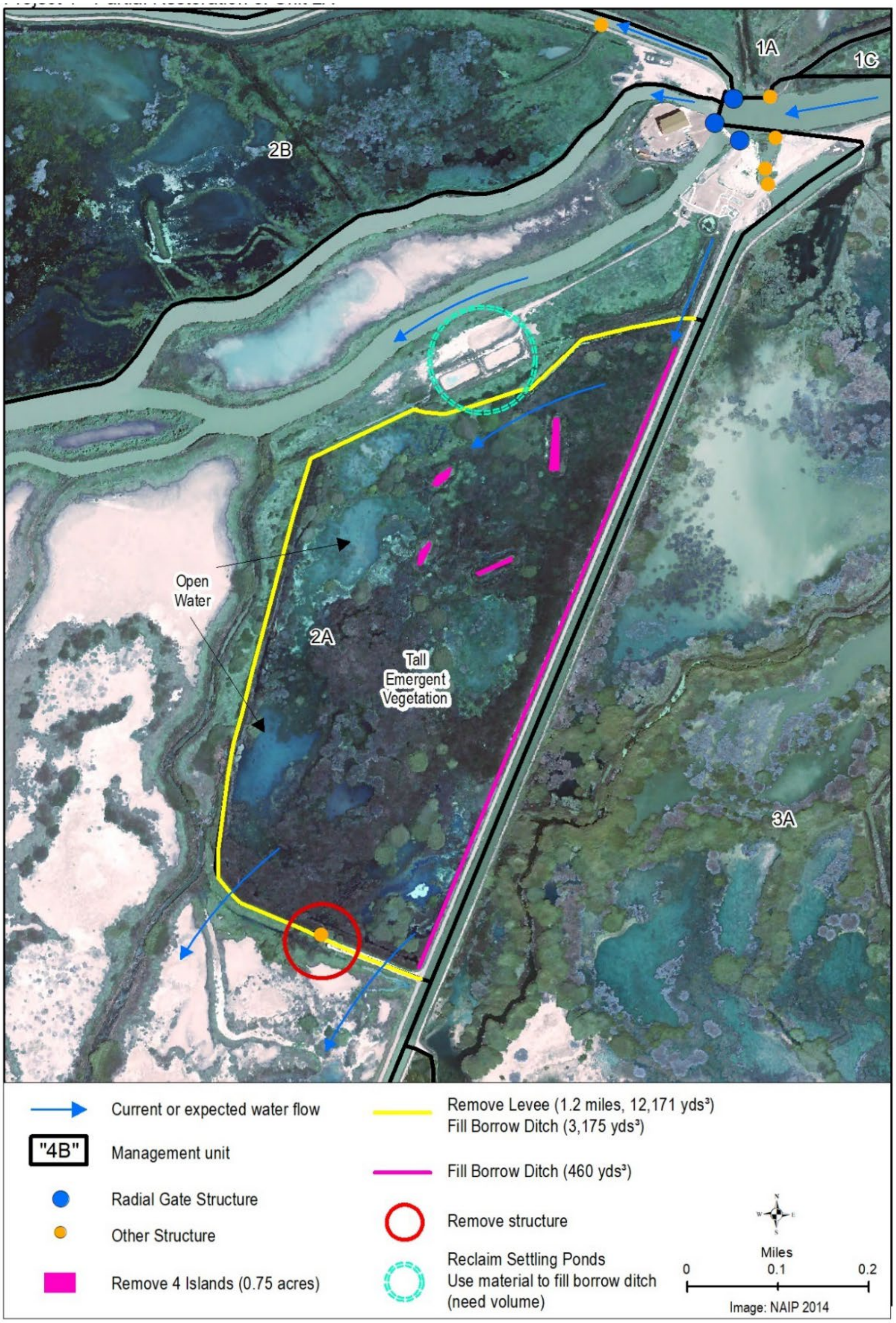

Figure 13: Project I Map - Partial Restoration of Unit 2A.

5.2 Project II: Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4

Associated HMP Goals and Objectives

HMP Goal 1: Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

> Spring Migration Objective 1: Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May.
>
> Spring Migration Objective 2: Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.
>
> Fall Migration Objective 1: Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.
>
> Fall Migration Objective 2: Provide 50-75% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans) and American white pelican from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.
>
> Breeding Objective 2: Provide up to 600 acres of suitable nesting habitat (bare to < 40% vegetation cover, maximum vegetation height < 5 inches) within 50 feet of suitable brood foraging habitat (< 25% vegetation cover that is < 8 inches tall; water depths < 2 inches; abundant invertebrate resources) for nesting black-necked stilts and American avocets from May 1 to August 15.
>
> Breeding Objective 3: Provide up to 400 acres of suitable nesting habitat (emergent vegetation cover with average visual obstruction > 20 inches) within 200 feet of suitable brood habitat (flooded emergent cover, abundant invertebrate resources) for nesting cinnamon teal from May 1 to August 30.

Contribution to HMP

Historically, the project area was flooded when flows in the Bear River caused overbank flooding. However, the frequency of river flooding has become rare due to changes in river hydrology and construction of Forest Street.

Therefore, the previous owners of the Canadian Goose Club, a privately owned duck hunting club, created dikes and flooded impoundments primarily during fall and winter using water from Bear River via a pump station and diversion ditch (Figure 14). Although the area was used by waterfowl during these periods, fall foraging habitat for shorebirds and spring foraging habitat for all waterbirds was limited. Following acquisition, the Refuge discontinued pumping due to inadequate funds and capacity, so the area only flooded in during spring snowmelt or large fall precipitation events. As a result, available habitat for all waterbirds is of limited duration. Similarly, construction of infrastructure to create impounded units 4A, 4B, and 4C altered hydrology south of the Canadian Goose Club tract (Figure 14). Flooding these units requires backing water up the gradient of the delta. However, sufficient water is rarely available to flood the upper elevations of these units, and phragmites has become established along many of the ditches, resulting in the reduced availability of flooded habitat in most years.

This project will restore sheetflow hydrology to increase the availability of spring and fall foraging habitat for waterfowl, shorebirds, and white-faced ibis, as well as provide potential breeding habitat for American avocets, black-necked stilts, and cinnamon teal. The area impacted includes a portion of the Canadian Goose Club extending south through units 4A, 4B, and 4C. The frequency, timing, and extent of flooding will emulate historic patterns (i.e., more frequent in spring than fall), but also will depend on Bear River flows and the volume of water that can be diverted into the Whistler canal. In addition, this project will help improve the discharge of water from these units into Willard Spur, which will help maintain this highly productive wetland area.

A. Construct fixed-crest weir and replace stoplog water control structure with an overshot gate on the Whistler canal.

<u>Summary</u>: Restoring frequent overbank flooding from the Bear River is not possible due to altered river hydrology and the construction of Forest Street, a county road south of the river. Therefore, a fixed-crest weir will be installed on the Whistler canal to emulate overbank flooding. Surveys will be conducted to identify an appropriate site that will allow water to enter a natural flow path on the Canadian Goose Club tract and travel down-gradient at a pre-determined elevation. The dimensions of the weir (e.g., elevation and width) will be evaluated relative to potential canal flows to ensure water will flow over the weir in at least 7 of 10 years. To help ensure appropriate flows can be obtained, the existing three-way water control structure on the canal will be replaced with an overshot gate (Figure 15a).

<u>Management Efficiencies:</u> Installation of a fixed-crest weir will eliminate the need to manually operate a structure, reducing management costs. Replacing the existing canal structure with an overshot gate will improve safety and decrease time required for operation.

B. Remove levees, islands, and borrow ditches to restore topography and facilitate sheetflow.

<u>Summary</u>: The configuration of existing infrastructure has altered topography and interrupted the flow of water down the natural gradient of the delta. Water impounded next to levees and in ditches promote the establishment of phragmites in many areas and islands receive minimal use by focal breeding species. This infrastructure (dikes, islands, borrow ditches) will be removed and the topography restored to allow water entering the project area from the fixed-crest weir to follow natural flow paths and fill natural depressions (Figure 15d).

<u>Management Efficiencies:</u> Removal of infrastructure will improve area and quality of flooded habitat while reducing management and maintenance costs.

C. Raise elevation of outlet structure and create two short dikes.

Summary: The purpose of the 4-drain, which is connected to a ditch below the D-Line dike, is to discharge water from units 4A, 4B, and 4C through the D-Line dike to Willard Spur (Figure 14). Both ditches were excavated below the delta surface. Therefore, although this design helps dewater the units, a large volume of water discharged through the D-Line dike stays in the ditch and moves laterally along the dike rather than entering the spur. During high flows, ditch water sometimes re-enters other units (Figure 15b). Over time, sediment deposition and phragmites establishment adjacent to the ditch below the D-Line dike has further decreased the ability to discharge water to the spur (Figure 15c). Restoring the topography of units 4A and 4B provides an opportunity to improve water discharge to the spur by raising the elevation of the existing structure in the D-Line dike to match the elevation of the spur and constructing short dikes across the ditch to prevent water from entering the ditch below the D-Line dike (Figure 14). Construction of short dikes was determined to be the best solution because filling the entire ditch below the D-Line dike is cost prohibitive.

Management Efficiencies: No management efficiencies will result from this sub-activity; however, the ability to transport water to the spur will improve habitat quality and help ensure sustainability of Willard Spur.

D. Restore original height of Bear River Levee

Summary: In the past, the height of the levee adjacent to Bear River was increased to limit flooding to the south (Figure 14). This levee will be restored to the original height to enable water from the Bear River to overbank flood during years of high flow. A low-water crossing on Forest Street will facilitate movement of floodwaters across the road and onto the Canadian Goose Club tract.

Management Efficiencies: Restoring the original levee height will allow high river flows to enter Refuge lands with no active management, and maintenance costs will not change.

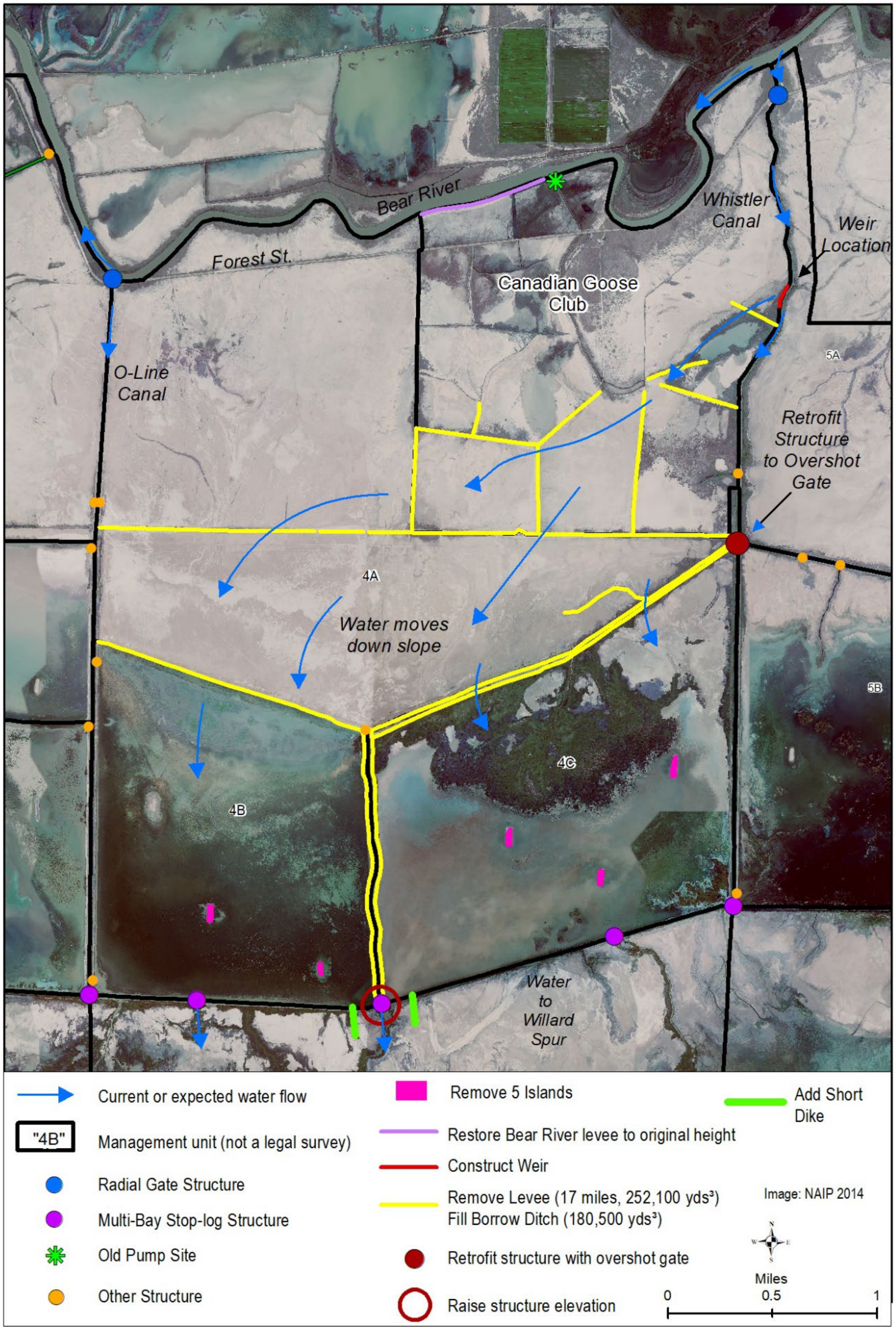

Figure 14: Project II Map - Restoration of Canadian Goose Club and Unit 4.

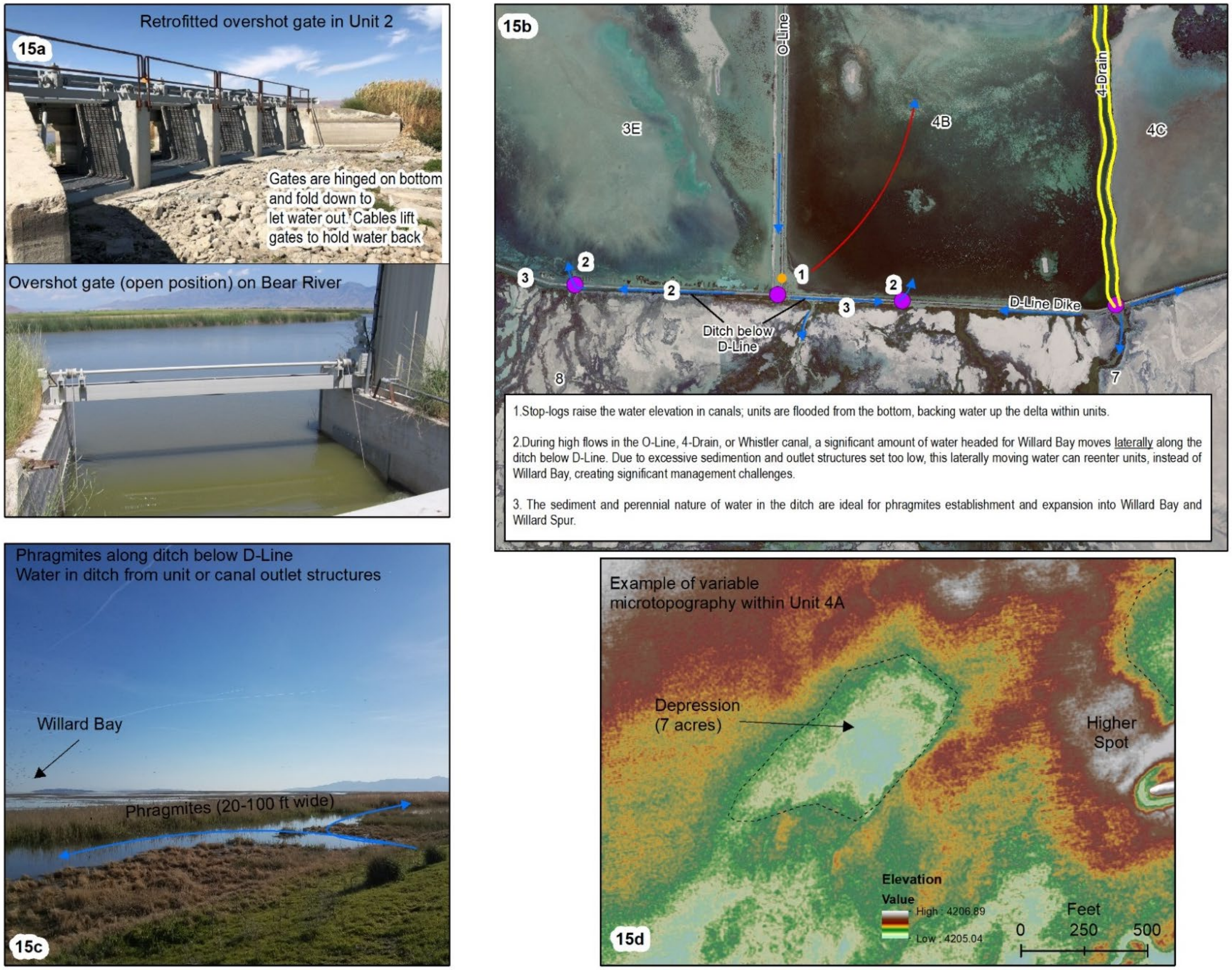

Figure 15: Project II - Composite showing four aspects of the Canadian Goose Club project: a) picture of overshot gate, b) lateral movement of water south of D-line and reentering units during high flows, c) phragmites along D-Line ditch, d) depressional features on the delta surface.

5.3 Project III: Partial hydrologic restoration of Unit 3I/3J

Associated HMP Goal

HMP Goal 1: Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

> Spring Migration Objective 1: Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May.
>
> Spring Migration Objective 2: Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.
>
> Fall Migration Objective 1: Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.
>
> Fall Migration Objective 2: Provide 50-75% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans) and American white pelican from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.
>
> Breeding Objective 2: Provide up to 600 acres of suitable nesting habitat (bare to < 40% vegetation cover, maximum vegetation height < 5 inches) within 50 feet of suitable brood foraging habitat (< 25% vegetation cover that is < 8 inches tall; water depths < 2 inches; abundant invertebrate resources) for nesting black-necked stilts and American avocets from May 1 to August 15.

Contribution to HMP

Historically, lands encompassed by Unit 3I and 3J primarily supported wet meadow and playa plant communities that were flooded primarily in spring when Bear River flows overtopped natural levees. These habitats provided important foraging habitat for a diversity of waterbirds, including shorebirds, waterfowl, and white-faced ibis. However, over time the construction of dikes and borrow ditches by a previous duck club, coupled with Refuge water management strategies implemented after acquisition, and altered hydrology has resulted in deeper water depths in playas and the establishment of robust emergent plant communities, primarily in Unit 3I. These changes reduced the area and quality of habitat for focal species (Figure 16). This project will improve sheetflow capacity that will help management promote establishment of native wet meadow and playa plant communities and achieve appropriate flooding depths to optimize foraging habitat during migration periods, as well as provide suitable breeding habitat for American avocets and black-necked stilts. In addition, this project will help avoid creating soil conditions, such as bare and moist or saturated soils, during late summer that are ideal for establishment of robust emergent plant species (e.g., cattail and phragmites). The perimeter dike and interior ditches in 3I will not be removed initially because the infrastructure is needed for ongoing Refuge maintenance. Removal of this infrastructure will be evaluated after completion of the initial project.

A. Replace two water inlet structures and install a ditch plug in Unit 3I.

Summary: The two current structures used to control water movement from the Bear River to Unit 3I are in disrepair and do not permit efficient passage of water into the unit. These structures will be replaced with new stop-log water control structures that will be properly sized and set at the correct elevation to improve control of water levels within the unit (Figure 16). In addition, a ditch plug will be installed in the east ditch to ensure water entering the unit is diverted onto the delta surface as soon as possible.

Management Efficiencies: Replacement of structures will reduce management and maintenance costs currently required to maintain existing structures.

B. Remove interior dike, water control structures, and borrow ditches between units 3I and 3J.

Summary: The water control structure in the dike separating units 3I and 3J do not function properly and both units are typically filled to the same water level. This static water level has created an environment where phragmites and other less desirable tall emergent species have flourished. The interior dike and associated borrow ditches, as well as the water control structures, will be removed, and the natural topography will be restored (Figure 16). The ditch will be filled using dike material supplemented by material from the dikes surrounding the Settling Ponds if necessary.

Management Efficiencies: Reduction of infrastructure will reduce management and maintenance costs while improving habitat quality for focal species. Restoring the natural topography will limit the establishment of phragmites, reducing costs associated with annual control treatments (e.g., grazing and chemical application).

C. Fill interior ditch in Unit 3I and borrow ditch around the perimeter of Unit 3J.

Summary: The interior ditch in Unit 3I is not functional and the borrow ditch adjacent to the Unit 3J dike must be filled prior to flooding the delta surface. These ditches, because they retain water in most summers, also are establishment sites for phragmites and cattail that reduce habitat quality for focal species. These ditches will be filled using material from ditch levees and dikes surrounding the Settling ponds.

Management Efficiencies: Eliminating ditches will reduce the quantity of water necessary to manage delta habitat.

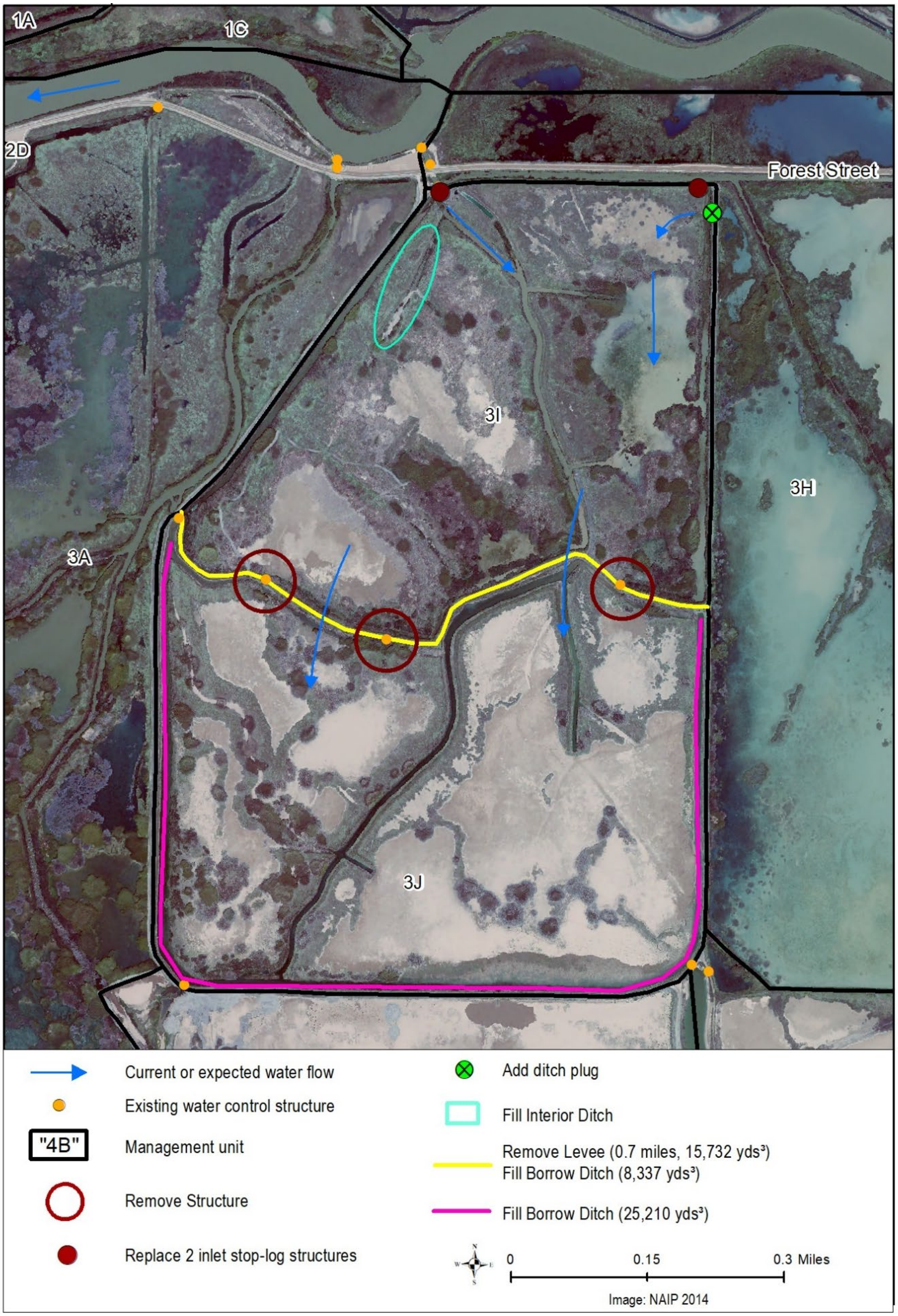

Figure 16: Project III Map – Unit 3I-3J Improvements.

5.4 Project IV: Improve the ability to manage hydrology of impounded units.

Associated HMP Goals and Objectives

HMP Goal 1: Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

> Spring Migration Objective 1: Provide up to 70% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for spring migrating shorebirds from March 15 to May.
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> Spring Migration Objective 2: Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.
>
> Fall Migration Objective 1: Provide 30-50% of potentially available habitat (water depth 0-6 inches; emergent vegetation cover < 25%; abundant invertebrate resources) for fall migrating shorebirds from July 15 to August 31.
>
> Fall Migration Objective 2: Provide 50-75% of potentially available habitat (e.g., water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for fall migrating waterfowl (dabblers, divers, tundra swans) and American white pelican from September 1 to November 30 and maintain phragmites cover < 10%; some acres may overlap shorebird acres.
>
> Breeding Objective 1: Provide a minimum of three suitable nesting sites (> 1 acre stands of native tall emergent vegetation with minimum water depths of 6 inches) for breeding white-faced ibis from April 15 to August 15.
>
> Breeding Objective 2: Provide up to 600 acres of suitable nesting habitat (bare to < 40% vegetation cover, maximum vegetation height < 5 inches) within 50 feet of suitable brood foraging habitat (< 25% vegetation cover that is < 8 inches tall; water depths < 2 inches; abundant invertebrate resources) for nesting black-necked stilts and American avocets from May 1 to August 15.

Contribution to HMP

Historically, water from the Bear River overtopped natural levees and moved down the delta gradient saturating soils and flooding depressions. The distribution, extent, and duration of flooding was highly variable and depended on the location of river channels and topography, as well as the volume and duration of river flows. During years of sustained high flows, much of the delta was flooded, at least during the spring, and water pooled in depressions. The duration of flooding varied, depending on temperature and precipitation. In contrast, during years of low river flows, water remained in channels and was transported to Bear River Bay (based on current channel location). Surface flooding of depressions during low flow years was limited to snowmelt and precipitation. This dynamic hydrology resulted in constantly changing soil salinities.

Collectively, these two factors determined the distribution of plant communities that, in turn, determined the distribution of waterbird breeding and foraging habitat (Flowers 1934). However, reduction in Bear River flows due to human developments, coupled with construction of dikes, canals, and borrow ditches on the Refuge, altered the hydrology of the delta. In general, lower elevations of impounded units must be flooded first and water backed up the delta gradient. As a result, lower elevations of impoundments tend to be flooded longer and more frequently, limiting the establishment of herbaceous plant communities, and creating sites for the establishment and encroachment of phragmites and cattail into some units where soils are constantly moist or saturated. In contrast, upper elevations are flooded for short durations only infrequently, which also limits development plant communities characteristic of playas (Figure 12). Although valuable foraging and breeding habitat for focal species is available, the area and diversity of these habitats has been reduced. This project will enable management to implement a more dynamic hydroperiod in impounded units that does not rely solely on backflooding. This will promote establishment of more diverse plant communities across a larger area that will increase foraging habitat for focal species during migration. In addition, there will be increased potential to establish additional bulrush stands for breeding white-faced ibis and flood natural playa habitats for breeding American avocet and black-necked stilt. Finally, the long-term sustainability of impounded units will be improved by minimizing sediment accumulation in static areas and improving nutrient cycling necessary to maintain wetland productivity.

A. Install overshot gates in O-Line canal, H-Line canal, Unit 1 outlet, 5-drain, and 5C outlet.

<u>Summary</u>: Currently, water from the Bear River is transported to the D-Line dike via five canals. Once the canals are filled, multiple water control structures sited along the canals are used to flood impounded units and additional structures in dikes are used to transfer water among units (Figure 10). Unfortunately, the canals were excavated several feet below the delta surface. Although spoil from excavation was used to construct ditch banks, the current design makes it difficult to build the hydraulic head necessary to move water out of the ditch and onto the delta surface at the upper elevation of units to move water down the delta gradient. As a result, most units must be flooded by backing water up the gradient of the delta through a limited number of structures. This has resulted in the deposition of sediment in the same general locations for multiple years, which is starting to further compromise the functionality of the water delivery system. Further, the water control structures in the D-Line dike that are used to discharge water from the canals are large, with multiple bays. When canals are full, tremendous pressure is exerted against the stop-logs, making it dangerous and difficult to manipulate water levels. Generally, it requires two employees and sometimes a backhoe to remove or install stop-logs. To help resolve these challenges, one overshot gate will be installed O-Line and H-Line canals (Figure 17). Structures will be located in the canal and set to an elevation that maximizes the hydraulic head of canal water upstream of the structure. This will enable discharge of canal water into units at higher elevations in order to promote sheetflow of water down the delta surface. The primary benefit will occur in units directly below the overshot gate, but sufficient head may occur higher in the canal system during high flow years to enable sheetflow in units above the canal as well. The existing gates in the D-Line dike will

be retained and operated to flow water into Willard Spur and Bear River Bay. In addition, existing stop-log water control structures at the Unit 1 outlet, 5-drain, and 5C outlet will be retrofitted with overshot gates (Figure 17). Although these structures will not alter hydrology, they are a priority to ensure water can be discharged to Willard Spur and Bear River Bay in a safe, efficient, and timely manner.

Management Efficiencies: Installation of overshot gates will improve operational safety and reduce management costs because they can be operated by a single person. The location of overshot gates above the D-Line dike in the O-Line, H-Line, and L-Line canal will reduce the volume of water required to fill the canals, which increases the water that can be used to flood habitat.

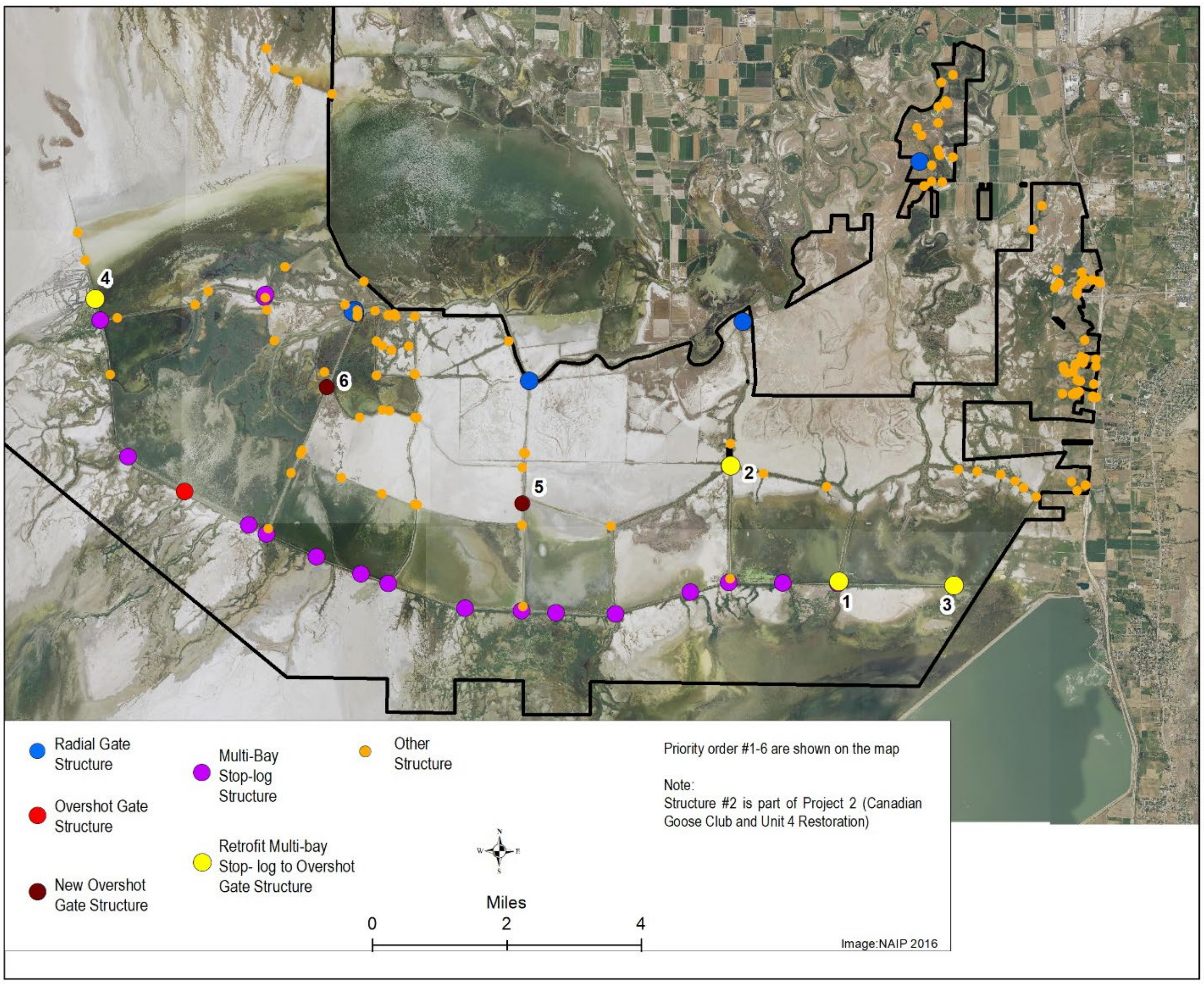

Figure 17: Project IV Map – Construction of two and retrofitting of four multi-bay stop-log structures with overshot gates.

5.5 Project V: Native plant community restoration in Three Bar Unit

Associate HMP Goals and Objectives

HMP Goal 1: Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

> Spring Migration Objective 2: Provide 50-80% of potentially available habitat (water depth 0-18 inches; emergent vegetation cover < 90%; abundant seed and invertebrate resources) for spring migrating waterbirds (dabblers, divers, tundra swans, white-faced ibis) and American white pelican from February 15 to May 1 and maintain < 10% cover of phragmites; some acres may overlap shorebird acres.

Contribution to HMP

Lands comprising the Three Bar Unit are located in the upper portion of the delta. Based on the current location of the Bear River, it is likely the area flooded only during very high flow events and only for short durations compared to other deltaic areas. If this assumption is correct, the plant community was comprised of terrestrial grasses interspersed with perennial wet meadow species (e.g., sedges and rushes) in shallow depressions that primarily provided spring foraging habitat for dabbling ducks and white-faced ibis. The topography of Three Bar Unit and surrounding lands was altered and converted to irrigated agriculture following settlement. Following Refuge acquisition, agriculture was discontinued to allow natural revegetation and, after several years, a mixture of forbs was interseeded (Refuge records). Currently, the vegetation is comprised of terrestrial grasses and wet meadow species, including several non-native species. Due to limited management, the vegetation has become degraded, but the area does provide limited foraging habitat for waterbirds, primarily white-faced ibis, when flooded during migration periods. The intent of this project is to improve the composition of native vegetation.

A. Repair headgate and install fencing

Summary: Two infrastructure improvements were completed prior to the comment period for this HMP. Water enters the northwest side of the unit near Forest Street via a headgate that no longer functions properly and causes flooding of the adjacent, privately owned hay meadow. Therefore, a new headgate connected to a pipe that moves the water inlet to the east side of the unit have already been installed to avoid impacting the private landowner (Figure 18). Similarly, the decision was made to use intensive cattle grazing to treat non-native and/or invasive plants prior to development of this project. This management action required installing a fence to avoid cattle trespassing on private property (Figure 18).

Management Efficiencies: No management efficiencies were achieved, but the infrastructure improvements were required to prevent impacting adjacent landowners.

B. Site preparation and plant seed

Summary: The current plant community is comprised of native grasses and forbs intermixed with several non-native and/or invasive plants. In addition, the lack of management in recent years has resulted in the development of residual plant matter that precludes germination of new seedlings. Therefore, treatment (e.g., grazing, prescribed fire and chemical application) of existing vegetation in the unit will be required to reduce the build-up of plant material, minimize the density of non-native and/or invasive plant species, and create areas of bare soil necessary to enable germination of planted seeds. Annual treatments will be applied until dead plant matter is reduced and enough exposed soil is achieved to restore the unit. The existing grass community has moderate cover of multiple native species, so a seed composition of 70 – 80% forbs and 20 – 30% grasses is appropriate. Refuge staff will develop a list of grass and forb species native to the area that are adapted to local soil type and soil moisture regimes. Refuge staff will select a high diversity of these species within the constraints of availability and cost. Individuals with restoration expertise in the area will be consulted to determine the appropriate seeding rate to estimate the amount of seed to purchase. The seed mixture will be broadcast into the existing plant community when soils are moist to saturated to ensure adequate moisture for germination.

Management Efficiencies: Developing a restoration plan based on site conditions improves success and is more cost-efficient. Improving the native floristic composition of the unit will reduce the frequency and intensity of treatments necessary to control non-native species.

Figure 18: Project V Map – Unit 3-Bar Restoration.

Chapter 6. Glossary

Altricial - Born or hatched in a helpless condition requiring prolonged parental care, as by being naked, blind, or unable to move about.

Adaptive management - The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities.

Annual Work Plan (AWP) - The specific management strategies and prescriptions applied during a single year's work plan. A process that provides specific information to refuge managers for implementation and fulfillment of habitat and other refuge management objectives or strategies identified and set forth in applicable HMP.

Biological diversity - The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.

Biological integrity - Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.

Comprehensive Conservation Plan (CCP) - A document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purpose(s) of the refuge; helps fulfill the mission of the System; maintains and, where appropriate, restores the biological integrity, diversity, and environmental health of each refuge and the System; helps achieve the goals of the National Wilderness Preservation System, if appropriate; and meets other mandates.

Delta - The low, nearly flat, area at the mouth of a river where it enters a water body or other terminal feature. A delta is formed from the deposition of sediment from the river and is commonly triangular in shape.

Diversity - The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.

Focal Species - A suite of species, each of which is used to define the characteristics of different landscape attributes (spatial, compositional, and functional) that must be represented in the landscape.

Goal - Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units.

Guild - A group of species that have similar requirements and play a similar role within a community.

Historic conditions – The composition, structure, and functioning of ecosystems resulting from natural processes that, based on sound professional judgment, were present prior to substantial human-related changes to the landscape.

Habitat Management Plan - A dynamic working document that provides refuge managers a decision-making process; guidance for the management of refuge habitat; and long-term vision, continuity, and consistency for habitat management on refuge lands. Each plan incorporates the role of refuge habitat in international, national, regional, tribal, state, ecosystem, and refuge goals and objectives; guides analysis and selection of specific habitat management strategies to achieve those habitat goals and objectives; and utilizes key data, scientific literature, expert opinion, and staff expertise.

Invasive species - Any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem and whose introduction does or is likely to cause economic or environmental harm or harm to human health. Rarely, a native species may be treated like an invasive species if it extremely aggressive and threatens native diversity.

National Wildlife Refuge System (Refuge System) lands - All lands, waters, and interests therein administered by the Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish and wildlife including those threatened with extinction, as determined in writing by the Director or so directed by Presidential or Secretarial Order. The Director may not delegate the determination.

Objective - A concise statement that is derived from goals and provides the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies.

Playa – A dry, level area or plain in an arid or semiarid region. Playas commonly occur as vegetation-free flat areas at the lowest part of an undrained desert basin.

Resources of concern - Each plant and/or animal species, species groups, or communities specifically identified as worthy of specific management in refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts.

Sheetflow – Unconfined water flowing down a slope (down gradient) across the landscape.

Strategy – A specific action, tool, technique, or combinations of actions, tools and techniques used to meet unit objectives.

Appendix A: Common and Scientific Names of Animal and Plant Families and Species Referenced in Text

Table 10. Common and scientific names of species listed in HMP.

Class	*Family*	*Common name*	*Scientific name*
Aves	Anatidae	Canada geese	*Branta canadensis*
	Anatidae	tundra swan	*Cygnus columbianus*
	Anatidae	cinnamon teal	*Spatula cyanoptera*
	Anatidae	northern pintail	*Anas acuta*
	Anatidae	redhead	*Aythya americana*
	Podicipedidae	western grebe	*Aechmophorus occidentalis*
	Podicipedidae	Clark's grebe	*Aechmophorus clarkii*
	Phalacrocoracidae	double-crested cormorant	*Phalacrocorax auritus*
	Threskiornithidae	white-faced ibis	*Plegadis chihi*
	Accipitridae	northern harrier	*Circus cyaneus*
	Charadriidae	snowy plover	*Charadrius alexandrines*
	Recurvirostridae	black-necked stilt	*Himantopus mexicanus*
	Recurvirostridae	American avocet	*Recurvirostra Americana*
	Scolopacidae	long-billed curlew	*Numenius americanus*
	Scolopacidae	marbled godwit	*Limosa fedoa*
	Scolopacidae	Wilson's phalarope	*Phalaropus tricolor*
	Laridae	gull	
	Laridae	California gull	*Larus californicus*
	Laridae	Caspian tern	*Hydroprogne caspia*
	Strigidae	burrowing owl	*Athene cunicularia*
	Strigidae	short-eared owl	*Asio flammeus*
	Laniidae	loggerhead shrike	*Lanius ludovicianus*
	Mimidae	sage thrasher	*Oreoscoptes montanus*
	Emberizidae	vesper sparrow	*Pooecetes gramineus*
	Emberizidae	savannah sparrow	*Passerculus sandwichensis*
	Ichteridae	western meadowlark	*Sturnella neglecta*
Teleostei	Cyprinidae	common carp	*Cyprinus carpio*
	Clupeidae	gizzard shad	*Dorosoma cepedianam*
Mammalia	Canidae	coyote	*Canis latrans*
	Canidae	red fox	*Vulpes vulpes*
	Castoridae	beaver	*Castor canadensis*
	Cervidae	mule deer	*Odocoileus hemionus*
	Cricetidae	muskrat	*Ondatra zibethicus*

	Mephitidae	skunk	
	Mephitidae	striped skunk	*Mephitis nephitis*
	Muridae	mice	
	Muridae	voles	
	Mustelidae	long-tailed weasel	*Mustela frenata*
	Mustelidae	badger	*Taxidea taxus*
	Procyonidae	raccoon	*Procyon lotor*
	Sciuridae	yellow-bellied marmot	*Marmota flaviventris*
Magnoliopsida	Amaranthaceae (Amaranth)	redroot pigweed	*Amaranthus retroflexus*
	Amaranthaceae	kochia	*Kochia spp.*
	Apiaceae (Carrot)	cutleaf waterparsnip	*Berula erecta*
	Asclepiadaceae (Milkweed)	showy milkweed	*Asclepias speciosa*
	Asteraceae (Sunflower)	common sunflower	*Helianthus annuus*
	Asteraceae	cocklebur	*Xanthium strumarium*
	Asteraceae	prickly lettuce	*Lactuca serriola*
	Asteraceae	slender woollyheads	*Psilocarphus chilensis*
	Asteraceae	Canada thistle	*Cirsium arvense*
	Brassicaceae (Mustard)	clasping pepperweed	*Lepidium perfoliatum*
	Brassicaceae	alkali pepperweed	*Lepidium dictyotum*
	Brassicaceae	ovalpurse	*Hornungia procumbens*
	Brassicaceae	hoary cress	*Lepidium draba*
	Ceratophyllaceae (Hornwort)	coontail	*Ceratophyllum demersum*
	Chenopodiaceae (Goosefoot)	red saltwort	*Salicornia rubra*
	Chenopodiaceae	iodine bush	*Allenrolfea occidentalis*
	Chenopodiaceae	greasewood	*Sarcobatus vermiculatus*
	Chenopodiaceae	saltbush	*Atriplex spp.*
	Chenopodiaceae	pursh seepweed	*Suaeda calceoliformis*
	Chenopodiaceae	Russian thistle	*Salsola tragus*
	Chenopodiaceae	fivehook bassia	*Bassia hyssopifolia*
	Chenopodiaceae	hopsage	*Grayia spp.*
	Cladophoraceae	green algae	*Cladophora spp.*
	Cyperaceae (Sedge)	chairmaker's bulrush	*Schoenoplectus americanus*
	Cyperaceae	softstem bulrush	*Schoenoplectus tabernaemontani*
	Cyperaceae	lakeshore bulrush	*Schoenoplectus lacustris*
	Cyperaceae	cosmopolitan bulrush	*Bolboschoenus maritimus*
	Cyperaceae	harsdstem bulrush	*Schoenoplectus acutus*

	Cyperaceae	spikerush	*Eleocharis spp.*
	Cyperaceae	Nebraska sedge	*Carex nebraskensis*
	Cyperaceae	sedge	*Carex spp.*
	Elaeagnaceae (Oleaster)	Russian olive	*Elaeagnus angustifolia*
	Fabaceae (Pea; Legume)	white sweetclover	*Melilotus albus*
	Juncaginaceae (Arrow-grass)	arrow-grass	*Triglochin maritima*
	Juncaginaceae	Baltic rush	*Juncus balticus*
	Malvaceae (Mallow)	alkali mallow	*Malvella leprosa*
	Plantaginaceae (Plantain)	prairie plantain	*Plantago elongata*
	Poaceae (Grass)	foxtail barley	*Hordeum jubatum*
	Poaceae	Nuttall's alkaligrass	*Puccinellia nuttalliana*
	Poaceae	phragmites	*Phragmites communis*
	Poaceae	saltgrass	*Distichlis spicata*
	Poaceae	alkali cordgrass	*Spartina gracilis*
	Poaceae	beardless rabbitsfoot grass	*Polypogon viridis*
	Poaceae	cheatgrass	*Bromus tectorum*
	Poaceae	annual hairgrass	*Deschampsia danthonioides*
	Poaceae	dropseed	*Sporobolus spp.*
	Poaceae	crested wheatgrass	*Agropyron cristatum*
	Poaceae	medusahead	*Taeniatherum caput-medusae*
	Poaceae	reed canarygrass	*Phalaris arundinacea*
	Polygonaceae (Buckwheat)	common knotweed	*Polygonum aviculare*
	Polygonaceae	curly dock	*Rumex crispus*
	Polygonaceae	greater water dock	*Rumex britannica*
	Potamogetonaceae (Pondweed)	sago pondweed	*Stuckenia pectinata*
	Potamogetonaceae	horned pondweed	*Zannichellia palustris*
	Ruppiaceae (Ditch-grass)	widgeon grass	*Ruppia maritima*
	Sparganiaceae (Bur-reed)	giant burreed	*Sparganium eurycarpum*
	Tamaricaceae (Tamarix)	saltcedar	*Tamirix spp.*
	Typhaceae (Cattail)	broadleaf cattail	*Typha latifolia*
	Typhaceae	narrowleaf cattail	*Typha angustifolia*

Appendix B: Focal Species and Guild Accounts

Focal species are defined as a suite of species, each of which is used to define the characteristics of different landscape attributes (spatial, compositional, and functional) that must be represented in the landscape (Lambeck 1997). A guild is defined as a group of species that exploit the same class of environmental resources in a similar way (Root 1967), for example, in this plan shorebirds are considered as a guild. Each account is specific to a species and provides details regarding the distribution, ecology, and habitat requirements. The information in the following accounts, unless specifically stated, is attributed to the authors of the Birds of North America Series (https://birdsna.org/Species-Account/bna/home).

American Avocet (*Recurvirostra americana*)

Abundant and easily recognized, the American avocet can be considered the signature bird at the refuge. Avocets arrive in March and peak in August during the fall migration.

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 GSL, and in southern Idaho at wetlands associated with the Bear and Snake Rivers (Ackerman et al. 2013).

The North American population estimate is 450,000 (Morrison et al. 2006, Andres et al. 2012). Up to half of the individuals breed in the Great Basin and an even higher proportion of the continental population, use the Great Basin for post-breeding molting and staging (Oring et al. 2000). Paul and Manning (2002) estimated 63,000 American avocets were potential breeders at the GSL. Refuge surveys (1992-2015) estimated an average of 7,300 avocets during waterbird and shorebird surveys for the month of June.

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

Ecology (Ackerman et al. 2013): 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 generally about 6-8 inches and while swimming in depths up to 10 inches. Shallower water is used as well, especially by chicks (0-4 inches, Dole 1986). 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).

Avocets 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 continuing through September. A few avocets will linger into November and even December before wetlands ice over.

Habitat Requirements: As evidenced by their spotty breeding range, American avocets have 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, bulrushes, or sedges, but individuals spend most of their time in more open areas that have no vegetation, or that are characterized by salicornia, salt grass, and even greasewood 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 the refuge, avocets nest along dikes, on mudflats and on islands with other species like black-necked stilt, cinnamon teal and gadwall.

Seasonal Use/Refuge Habitats: Avocets utilize the refuge as a nesting, brood-rearing and migration stopover. Avocets build the majority of their nests along dikes and at the margins of wetlands (particularly in Unit 3). Additionally, small sparsely vegetated islands in Unit 3 (especially 3E) support large numbers of nesting avocets.

Associated Species: Other bird species that may respond similarly to habitat components used by the American avocet include Wilson's phalarope, black-necked stilt, long-billed dowitcher, marbled godwit, willet, Baird's sandpiper, least sandpiper, and Western sandpiper, and greater yellowlegs.

American White Pelican (*Pelecanus erythrorhynchos*)

The American white pelican does not breed on the refuge, but is common from late March through October. The closest breeding colony is on Gunnison Island about 40 miles west of the refuge. Due to the lack of forage near the colony site, pelicans utilize the refuge for feeding and loafing sites during both the breeding season and migration.

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. Populations breeding west of the Rocky Mountains move southwest into

California and south to the west coast and central states of Mexico. Spring arrival occurs during late February in Nevada and March in Utah. Further north in Yellowstone National Park and Canada, birds arrive in April and May. Autumn departure appears to extend 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 fish as a food source, and ice. In Utah, the only known breeding colonies are located in the northern portions of the state, specifically within the Utah Lake/GSL ecological complex. Gunnison Island persists as the only colony nesting site 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. 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 and Herziger 2006).

Ecology (Knopf and Evans 2004): American White Pelicans are highly social. Nesting in colonies, and using cooperative flight and foraging strategies, pelicans are among the most gregarious of avian species. These birds are often observed sleeping, roosting and basking together (Parrish et al. 2002). They are monogamous. Pair formation occurs after arrival in Utah, which typically occurs the last week in March. 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, but range 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) and second clutches suffer significant mortality. In Utah, both young fledged in only 9.7% and 9.4% of 195 and 374 nests, respectively (Knopf 1979). There was 41% mortality reported for first year birds compared to 16% in second year birds (Strait and Sloan 1974). The maximum reported life span is 26.4 years.

The primary food is fish. Pelicans are diurnal and nocturnal foragers. Capture rates are higher during the day and at the leading edge of foraging flocks than at night. 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 WMAs.

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 nests. Gravel or sandy, unconsolidated substrate are preferred for nesting. Foraging sites are shallow marshes, rivers, and lake edges, where mainly small “rough” fish (less than one-half of their bill length) 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.

Seasonal Use/Refuge Habitats: The refuge is likely the most important or key foraging location for the GSL breeding population. These birds are present from March through November and use deep emergent and submergent marshes for feeding and loafing. 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 peak 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.

Associated Species: Other species that may respond similarly to habitat components used by the American white pelican include California gull, Caspian tern, and double-crested cormorant for nesting habitat. Other species that may use the same foraging habitat include double-crested cormorant, Western grebe, Clark's grebe, pied-billed grebe, Forster's tern, great blue heron, black-crowned night heron, snowy egret, cattle egret, and common merganser.

Black-necked Stilt (*Himantopus mexicanus*)

The black-necked stilt is typically the second most abundant shorebird inhabiting the refuge. Often found in association with American avocets, stilts arrive later (April) and leave the refuge earlier (September) than avocets.

Distribution: Distribution of the black-necked stilt, like that of the American avocet, is 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. The current continental population is estimated to be 150,000 to 200,000 (Morrison et al. 2006, Andres et al. 2012). The 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).

Breeding in Utah occurs on mudflats and shorelines in wetlands associated with the GSL, Utah Lake, the Bear and Malad Rivers in northern Utah, the Logan and Little Bear River in Cache Valley, Bear River Migratory Bird Refuge, the Uinta Basin at Ouray National Wildlife Refuge, other reservoirs in Uinta County, and 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 GSL yielded a mean of 25,522 (July-September) (Paul and Manning 2002). The refuge mean was 8,352. Refuge waterbird surveys (1992-2015) detected an average of 3,600 stilts for the month of June during the nesting season.

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 forage 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 and includes very sparse vegetation in an area affording an unobstructed view all around. Nesting locations are generally on islands, when available, on dikes, wetland margins, 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 and then lined with small bits of weeds, grasses, twigs, shells, or bones. Average clutch size is four eggs. The incubation is 22-26 days and 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 specific habitats 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 open or sparsely vegetated areas consisting of glassword, saltgrass, or greasewood. The birds feed in open water generally fresher than that of avocets. Water depths range from dry ground to 6 inches. 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 on small, elevated 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 not depart the Refuge until October. Black-necked stilt numbers peak on the refuge in August, likely due to staging and post-breeding birds. Maintaining vegetated dikes, wetland margins and nesting islands near shallow wetlands from April-June is important for nesting black-necked stilts. Providing shallow emergent marsh and sparsely vegetated mudflats during late summer (July-September) would be beneficial for staging and migrating stilts.

Associated Species: Other species that may respond similarly to habitat components used by the black-necked stilt include Wilson's phalarope, American avocet, long-billed dowitcher, marbled godwit, willet, Baird's sandpiper, least sandpiper, western sandpiper, and the greater yellowlegs.

Cinnamon Teal (*Anas cyanoptera septentrionalium*)

Though cinnamon teal is one of the least abundant dabbling ducks in North America (Baldassarre 2014), it is one of the most common duck species inhabiting the refuge during the breeding season. Cinnamon teal are present on the refuge generally from March through September.

Distribution: Though there are five subspecies, only *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. Important breeding areas include GSL and surrounding marshes in Utah. Historically, over half of the total North American population has been said to breed in the marshes east and north of the GSL in Utah (Bellrose 1980). Other important breeding areas include Malheur Lake, Summer Lake, and Klamath marshes in Oregon (Gilligan et al. 1994), Ruby Lake and Carson Sink in Nevada (Alcorn 1988), Central Valley of California (Small 1994), eastern Washington (Bellrose 1980) and the San Luis Valley of Colorado (Kingery 1988).

Bellrose (1980) estimated the North American breeding population to be 260,000-300,000. A more recent estimate is a breeding population of 100,414 for blue-winged/cinnamon teal for the Pacific Flyway states (Collins and Trost 2009). For the GSL area, numbers of cinnamon teal were notably less than before the floods of the 1980s (Stephens 1990). Results of a five-year survey of the GSL 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 2012): Cinnamon teal are seasonally monogamous, with most pairs forming before arriving in breeding areas. The breeding period in Utah is late April to late July. 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; the 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 semi-permanent wetlands. 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 semi-permanent wetlands of various sizes including large marsh systems, natural basins, reservoirs, sluggish streams, ditches, and stock ponds. Cinnamon teal appear to prefer basins with well-developed stands of emergent vegetation and tends to use emergent zones more than open water portions of basins. Nest locations are near water in low, dense perennial vegetation such as Baltic rush, saltgrass, spikerush, tufted hairgrass, western wheatgrass, foxtail barley, and various forbs. Nests are placed less often at base of greasewood and other shrubs and over emergent marsh vegetation. The species forages primarily by dabbling in shallowly flooded zones (less than 8 inches) along wetland margins.

Seasonal Use/Refuge Habitats: Cinnamon teal are present on the refuge from March to November. They nest on dikes and in salt meadow habitats and utilize shallow emergent and shallow submergent refuge habitats for foraging and molting. Maintaining salt meadow habitat throughout the nesting season (April to July) for breeding habitat and providing shallow emergent habitat from June-August would be beneficial for Cinnamon teal.

Associated Species: Other bird species that may benefit from similar habitats include 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.

Migratory Shorebirds

Tens of thousands of shorebirds representing 30 species use the refuge annually during migration, including American avocet, black-necked stilt, marbled godwit, willet, spotted sandpiper, Western sandpiper, least sandpiper, Baird's sandpiper, killdeer, snowy plover, lesser yellowlegs, greater yellowlegs, long-billed dowitcher, long-billed curlew and red-necked and Wilson's phalarope.

Distribution: Shorebirds are the kings of long-distance migrants, with many shorebirds migrating thousands of miles from breeding grounds in the Arctic to wintering areas in Central and South America.

Stopover sites, therefore, are very important for resting and refueling along the way. The GSL ecosystem is recognized as an extremely import stopover site in the western hemisphere, and has spring, summer and fall counts in excess of 500,000 shorebirds on a regular basis (http://www.whsrn.org/whsrn-sites). Because of its recognized importance to shorebirds, the refuge, as part of the GSL ecosystem, was designated a Western Hemisphere Shorebird Reserve Network site of Hemispheric importance in 1991 (http://www.whsrn.org/site-profile/great-salt-lake).

Ecology: Due to their wide range of morphological features, shorebirds exhibit a diverse 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% at staging areas and most of this increased mass is 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 to maintain body condition and increase 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% 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. Wet mudflat and shallow, sparsely vegetated emergent marsh are used for foraging and staging. Shorebird use of the refuge peaks in August. Mudflats and wet meadows are used for nesting April through July. To ensure a wide diversity and abundance of invertebrates, a wide array of wetland types should be provided for migrant shorebirds consisting of mudflats, shallow submergent marsh, and shallow emergent marsh.

Migratory Waterfowl

Hundreds of thousands of ducks, geese, and swans use the refuge annually during migration. Common species include mallard, northern pintail, northern shoveler, gadwall, green-winged teal, cinnamon teal, blue-winged teal, American wigeon, common goldeneye, redhead, canvasback, common merganser, red-breasted merganser, bufflehead, ruddy duck, lesser scaup, canada geese, and tundra and trumpeter swans.

Distribution: Bear River Migratory Bird 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.

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, agricultural crops, and small fish.

Habitat Requirements: The surface-feeding ducks or "dabblers" favor the smaller, shallower inland lakes, ponds, and marshes from several inches in depth and up to about 3 feet. (Osborn et. al. 2017), though most foraging will be at shallower depths. Divers usually feed underwater in the open water portion of wetlands (Linduska 1964).

Seasonal Use/Refuge Habitats: Dabbling ducks use wet mudflats, wet meadows, emergent and submergent marshes from April through November for feeding, staging, loafing, and breeding. Wet meadows and upland grasslands/forb habitats are important for nesting May through mid-August. Emergent marshes are used for brood rearing. Molting birds use large expanses of emergent and submergent marshes mid-June through mid-August. Diving ducks use open submergent marshes and open water for feeding, loafing, and brood rearing from late March through November. In mild winters, submergent marshes and open channels provide feeding habitat. Diving ducks use emergent marshes for nesting May through July.

Snowy Plover

Distribution: The snowy plover is one of the rarest shorebirds in North America. As a ground nesting bird, it is found primarily on the shores of the GSL, utilizing unvegetated shorelines of saline waters throughout their annual cycle. This dependence on shorelines have made them vulnerable to negative effects of habitat loss or degradation and increased human disturbance (Thomas et. al 2012).

The North American breeding population estimate is 25,869, and approximately 42% of all breeding snowy plovers in North America reside in two locations (Great Salt Lake, Utah, and the Salt Plains National Wildlife Refuge in Oklahoma). The wetlands of the GSL supported 5,511 birds or 23% of the total international populations (Thomas et. al 2012).

Ecology: The primary foods for snowy plovers are invertebrates. In Utah, feeding occurs mostly in shallow (1-2cm deep) water or on wet mud, sand, and playas. During the daytime, plovers feed by pausing, looking, running, and then seizing their prey from the surface of the ground. Shallow probing in the mud flats and sand for other invertebrates also occurs. Behavior preceding feeding can sometimes be observed as a foot trembling in shallow water or wet sand/mud to aid in pulling up their prey. They also forage regularly at night. In the Great Basin, the snowy plover feeds on flies, beetles, and brine shrimp (USFWS 2004).

Plovers build their nest by scraping a shallow depression in the ground. Nests are often located in fairly barren landscapes but near a feature such a kelp, a piece of driftwood, or a small plant. Nests can be found on small rises, small dunes, or located under overhanging branches of plants. During courtship, the male will build multiple scrapes, or nests, and then one is selected as a nest site. Both male and female plovers line the nest with debris, such as shells, mud ship, pebbles, or vegetation fragments. Average clutch size is 3 eggs. Incubation period varies with location and season but can range from 27 days to 29 days. Both sexes of the snowy plover sit or stand over the clutches and both have an abdominal incubation patch. If there is a death or desertion of a mate, the remaining snowy plover parent usually deserts the clutch. However, if its late in the season, some will stay to incubate alone.

When the chicks hatch, they are pale or creamy buff color mixed with light gray. They have a distinct white band that encircles their neck and a black line that extends behind the eye. Leg and bill are gray to pinkish gray. Young snowy plovers leave the nest 1-3 hours after hatching and the leave the nest permanently within hours after the 1st chick hatches. They can walk, swim, and run well and forage by themselves but require brooding for many days after hatching. Adults to not feed their chicks but rather act as sentinels to warn them of dangers. Females generally desert their mates by 6 days after hatching, while the males are the sole caregiver and stay with the young until they are 29-47 days old.

Habitat Requirements: Snowy plovers nest on barren to sparsely vegetated ground and salt evaporation ponds along the GSL. Also now uses man-made, agricultural wastewater ponds and reservoir margins.

Seasonal Use/Refuge Habitats: The refuge is an important breeding location for snowy plovers in the Great Basin, with the Great Salt Lake ecosystem supporting more than 50% of the continental breeding population. They arrive in mid-April and may not depart the Refuge until the end of September (2004 UFWS).

Associated Species: Other bird species which may respond similarly to habitat components used by the snowy plover include killdeer and black-necked stilt.

Tundra Swan (*Cygnus columbianus*)

Tundra swans are common to abundant on the Refuge during fall and spring migration. Fall migrating tundra swans begin arriving in late October and generally peak in late November. Refuge surveys (1992-2016) estimated an average spring and fall population of 5,600 and 10,200 tundra swans, respectively. Peak numbers can exceed 30,000 birds prior to freeze-up in late November/early December.

Distribution: Breeding occurs on arctic wetlands, while wintering occurs on estuaries along the east and west coasts. The tundra swan utilizes 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.

More than 99% of Utah's migrant tundra swans use freshwater wetland habitats in the Bear River Bay of the GSL, which includes the refuge. Based on mid-winter indices, northern Utah may host up to 30% of the Western Population of tundra swans at any one time, with the refuge accounting for about one-half of that population (15%).

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 and 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. Tundra swans roost more often on water than land during nonbreeding seasons. On a migratory stopover, most swans (81%) are roosting at any given time; only 19% are foraging, traveling, or interacting.

Habitat Requirements: In spring and fall, migrating swans prefer shallow ponds, lakes, and riverine marshes. Major food items include plants, primarily seeds, stems, roots, and tubers of submerged and emergent aquatic vegetation. During migration and in winter, diet may include agricultural crops; waste grains and growing winter cereal grain crops (Limpert and Earnst 1994). Swans forage throughout the day, although some feeding will occur at night during a full moon. During migration in the winter, swans feed as a flock by dabbling, submerging head and neck, upending and grazing in and along margins of lakes and old channels. Feet are used to excavate plant parts and mollusks from substrate. During migration, the seeds and tubers of pondweed are a major food item in Utah and in North Dakota, whereas cattail rhizomes 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 to deep submergent marshes for feeding. In mild winters, tundra swans may be present October through March.

Associated Species: Other bird species that may respond similarly to habitat components used by the tundra swan include American white pelican, trumpeter swan, mallard, gadwall, American widgeon, redhead, canvasback, scaup, and Canada geese.

White-faced Ibis (*Plegadis chihi*)

White-faced ibis are arguably the most abundant breeding waterbird species on the refuge, other than waterfowl. Ibis begin to arrive in early April and generally have left the refuge by mid-September.

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. In the Great Basin, ibis are located at GSL, Ruby and Utah Lakes, the Carson Lake-Stillwater area, Honey Lake, and Malheur National Wildlife Refuge (Ryser 1985).

The Western Colonial Waterbird survey conducted in 2009-2010 estimated 90,600 pairs in the 8 western interior states (Cavitt et al. 2014). In a five-year survey of GSL, the mean population for July-August was 25,576, with a peak count of 54,908 in 2000 (Paul and Manning 2002). The Utah portion of this estimate was 23,600 pairs. Refuge data (1992 to 2015) from surveys conducted in June during the breeding season indicate an average of 5,660 ibis.

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. Their 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: a "ranging" method in which ibis walks back and forth and probes water like a "pecking chicken", and a 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 consume 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 date of clutch completion is between 14 and 20 May (Kotter 1970; Kaneko 1972; Capen 1977; Alford 1978; Steele 1980). Ibis are colony nesters and some colony sites are used repeatedly over several years. Ibis usually nest 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 (USFWS 2004). Incubation averages 20 days for the last 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 the adult's mouth to feed on regurgitated food. Young are essentially independent at age eight weeks.

Habitat Requirements: This species inhabits primarily freshwater wetlands, especially cattail and bulrush 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, Olney's bulrush, and alkali bulrush. Ibis frequently feed in shallowly flooded wetlands supporting short emergent plants. Dominant plants are sedges, spikerushes, and salt-tolerant species such as glasswort, saltgrass, and greasewood. 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 and submergent marshes for feeding and staging. White-faced ibis use emergent marshes flooded to depths of 8-24 inches from May through July for nesting, mainly in hardstem bulrush or alkali bulrush dominated plant communities.

Associated Species: Other bird species that may respond similarly to habitat components used by the white-faced ibis include snowy egret, Forster's tern, Franklin's gull, redhead, black-crowned night heron, great blue heron, western grebe, Clark's grebe, American bittern, long-billed curlew, red-winged blackbird, and yellow-headed blackbird.

Appendix C: Environmental Assessment for the Habitat Management Plan, Bear River Migratory Bird Refuge, Box Elder County, Brigham City, Utah

Environmental Assessment

Habitat Management Plan
Bear River Migratory Bird Refuge

March 2021

Prepared by

Bear River Migratory Bird Refuge
Brigham City, Utah

Estimated Lead Agency Total Costs Associated with Developing and Producing This Environmental Assessment: $21,000

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FINDING OF NO SIGNIFICANT IMPACT
AND DECISION TO IMPLEMENT HABITAT MANAGEMENT PLAN

Bear River Migratory Bird Refuge
Brigham City, Utah

The U.S. Fish and Wildlife Service (Service) has prepared a Habitat Management Plan (HMP) for the Bear River Migratory Bird Refuge (Refuge or Bear River MBR) in Utah. The goals and objectives developed for the HMP support the mission of the National Wildlife Refuge System and the purposes for which the Refuge was established. The intent of the HMP is to provide a strategic, operational guide to focus future management on infrastructure improvements and restoration of habitats to improve ecological function in specific areas of the Refuge. Accomplishing these tasks will benefit priority species and help ensure the long-term ecological sustainability of Refuge lands.

Selected Action

Alternative 2—Proposed Action Alternative

The 2021 HMP is a revision of the 2004 HMP that was developed to support implementation of the goals and objectives of the 1997 Bear River MBR Comprehensive Management Plan (CMP). The scope and rationale for this revised HMP is to contribute to conservation of wildlife at the local, regional, and ecosystem scales while preserving the biological integrity, diversity, and environmental health of Refuge lands.

The 2021 HMP identifies goals and objectives aimed at supporting key life cycle requirements of focal species and guilds during spring and fall migration, as well as their breeding habitat requirements, and implementation of these is the Proposed Action. These focal species and guilds have different habitat requirements (e.g., water depth, vegetation composition and structure, and cover) during their migration and breeding periods. Focal species and guilds identified in the 2021 HMP include, 1) American white pelican, 2) American avocet, 3) black-necked stilt, 4) cinnamon teal, 5) white-faced ibis, 6) tundra swan, 7) snowy plover, 8) migratory waterfowl, and 9) migratory shorebirds. The goals of the 2021 HMP are as follows:

GOAL 1. Restore and manage Bear River deltaic wetland habitats and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds and shorebirds.

GOAL 2. Restore and manage wet meadow and upland habitats in the Wasatch Front to produce native grasses, sedges, rushes, and forbs, where possible, to provide foraging and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.

GOAL 3. Prevent further physical alterations to maintain the existing hydrologic and topographic integrity of the Refuge.

GOAL 4. Maintain and expand partnerships that contribute to the conservation and enhancement of Refuge habitats, the Bear River watershed, and the GSL Ecosystem.

Within the goals are a series of objectives to support spring/fall migration and breeding. These objectives emphasize water depths, potential habitat, vegetation cover, and breeding habitats. The overarching intent of all the goals and objectives is to manage Refuge habitats based on current vegetation composition, availability of water, and the opportunity to vary water management depending on those current conditions.

The spring and fall migration objectives described in the 2021 HMP characterize the dynamic hydroperiods (timing, depth, duration) and vegetation required to meet the foraging needs of focal migratory bird species. In addition, not all available habitat will be flooded during spring and fall migration, which will provide the flexibility necessary to produce the appropriate foods and habitat structure. The breeding objectives define the range of habitat requirements that must be met for focal species to successfully nest and raise young. However, achieving these objectives also will benefit numerous other species. For example, maintaining stands of tall emergent vegetation to benefit white-faced ibis also will provide some habitat for other species that nest over water, including redheads and grebes.

Based on the goals and objectives identified in the 2021 HMP, a list of potential restoration and infrastructure improvement projects were identified that will contribute to improving ecological function while minimizing annual management intensity to the extent possible. There are five key projects/actions identified in the 2021 HMP.

Project I: Partial hydrologic restoration of Unit 2A - Overall, this project aims to remove water control structures (i.e., levees and dikes) and fill in adjacent borrow ditches in order to improve sheetflow of water throughout the unit. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites), increased diversity of native vegetation, and ultimately benefit migratory birds.

Project II: Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4 - This project aims to replace two water control structures with more efficient structures, allowing for sheetflow of water from the top of the unit, rather than relying on backflooding. Levees, islands, and borrow ditches will be removed and filled and topography will be restored to facilitate sheetflow. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites) and increased composition of native vegetation. At the northern end of the unit, the original height of the Bear River levee will be restored. At the southern end of the unit, two short dikes will be created to facilitate water moving into other units.

Project III: Partial hydrologic restoration of Unit 3I/3J - This project will replace improve two existing water control structures, remove an interior dike, and fill in borrow ditches both in the interior and the perimeter. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites) and increased composition of native vegetation.

Project IV: Improve the ability to manage hydrology of impounded units - This project will replace five key water control structures with overshot gates. The overshot gates are easier and safer for staff to manipulate, allow for increased efficiency in moving water, and provide the ability to manage the hydrology of the units in alignment with the objectives of the HMP.

Project V: Native plant community restoration in Three Bar Unit - This project will repair the headgate and install fencing to facilitate grazing as a management tool. Currently comprised of mostly non-native grasses, the project will identify site preparation options and a seed mix of native grasses to plant for restoration.

This alternative was selected over the other alternative because it offers the best opportunity to contribute to conservation of wildlife at the local, regional, and ecosystem scales while preserving the biological integrity, diversity, and environmental health of Refuge lands.

The Service has determined that the selected action helps meet the purpose and needs of the Service as described in the EA because it would restore and mimic, to the best practical extent possible, natural hydrology across the landscape. This will result in improved habitat for migratory birds and resident wildlife, and a high quality experience for visitors.

Other Alternatives Considered and Analyzed

Alternative 1—No Action Alternative

Under the No Action Alternative, the Refuge would continue to implement the action and goals set forth in the 2004 HMP. This plan (USFWS 2004) has goals similar to the Proposed Action (2021 HMP) but with more specificity aimed at plant species and less capacity for adaptive management.

Under the No Action Alternative, the Refuge would continue to manage for 32 wetland impoundments and 10 upland/wet meadow units with consistent water levels, as water availability allows, with an emphasis on growing alkali bulrush, sago pondweed, and other plant species for 14 different focal species. Existing water control features, such as levees, dikes, and canals, would remain in place, and maintenance of those features would continue. There would be no adaptive management occurring based on conditions, as the 2004 HMP calls for specific water levels in specific areas of the Refuge at regulated times. It is likely that encroachment of non-native species, such as phragmites, would continue in the wetland units, causing a loss of available open water and desirable sub-emergent and emergent vegetation. The upland units would continue to see invasive plants as well, mostly cheatgrass and pepperweed, as the native vegetation declined. Habitat degradation would ultimately result in a loss of wildlife diversity and abundance.

This alternative was not selected, because the No Action Alternative would not improve the Service's ability to meet its legally mandated mission to protect trust resources and preserve and enhance wildlife habitat.

Summary of Effects of the Selected Action

An Environmental Assessment (EA) was prepared in compliance with the National Environmental Policy Act (NEPA) to provide a decision-making framework that 1) explored a reasonable range of alternatives to meet project objectives, 2) evaluated potential issues and impacts to the refuge, resources and values, and 3) identified mitigation measures to lessen the degree or extent of these impacts. The EA evaluated the effects associated with two reasonable alternatives: a No Action Alternative and a Proposed Action Alternative. The EA is incorporated as part of this finding.

The selected action is to implement the 2021 HMP and associated projects. These projects aim to increase ecological function of the delta by addressing infrastructure needs. Implementation of the agency's decision is expected to result in the following environmental, social, and economic effects:

- The selected action's potential impacts to affected resources (habitat and wildlife, vegetation, hydrology, and topography) includes short-term impacts and disturbance due to project work being done utilizing heavy equipment, the need to drawdown wetlands to conduct the work, and changes in topography.
- The selected action's potential impacts to visitor use and services includes the drawdown of wetlands popular for wildlife observation and photography, and hunting during the fall.
- The selected action helps meet the purpose and needs of the Service because it will restore and mimic, to the best practical extent possible, natural hydrology across the landscape. This will result in improved habitat for migratory birds and resident wildlife, and a high quality experience for visitors.

Measures to mitigate and/or minimize adverse effects have been incorporated into the selected action. These measures include:

- The Refuge will conduct outreach and interpretation during the project work to communicate the restoration that is occurring and the long -term benefits to wildlife resources.
- Other areas will remain available for visitor use and services, including the 12-mile auto tour route.

While refuges, by their nature, are unique areas protected for conservation of fish, wildlife and habitat, the selected action will not have a significant impact on refuge resources and uses for several reasons:

- The action will result in beneficial impacts to the human environment, including the biodiversity and ecological integrity of the refuge, with only negligible adverse impacts to the human environment as discussed above.
- The adverse effects of the selected action on air, water, soil, habitat, wildlife, and aesthetic/visual resources are expected to be minor and short-term. The benefits to long-term ecosystem health that these efforts will accomplish outweigh any of the short-term adverse impacts discussed in this document.
- The Service uses an adaptive management approach to wildlife management on refuges to ensure that Refuge programs continue to contribute to the biodiversity and ecosystem health of the Refuge.

- Individual projects will be reviewed under Section 106 of the National Historic Preservation Act on a case-by-case basis in consultation with the Utah SHPO, and adverse effects to historic properties will be resolved prior to project implementation.
- The action, along with mitigation measures, will ensure the health and safety of refuge staff and visitors.
- The action is not in an ecologically sensitive area;
- The action will not impact any threatened or endangered species; or any federally-designated critical habitat;
- The action will not impact any wilderness areas;
- There is no scientific controversy over the impacts of this action and the impacts of the proposed action are relatively certain.
- The action is not expected to have any significant adverse effects on wetlands and floodplains, pursuant to Executive Orders 11990 and 11988, because implementing the HMP will ensure that actions are taken to preserve and enhance existing wetlands while minimizing any loss or degradation to wetlands.

Public Review

The proposal has been thoroughly coordinated with all interested and/or affected parties. Parties contacted include:

- Bear River Club, Utah Waterfowlers Association, Wasatch Widgeons, and other hunt clubs
- Friends of the Bear River Refuge
- Local stakeholders
- National Audubon Society
- State of Utah
- Utah State University
- U.S. Fish and Wildlife Service, Mountain-Prairie Regional Office

Prior to the release of the Draft HMP and EA, coordination and communications occurred with key partners and stakeholders. Meetings took place with the State of Utah, Utah State University, and internal groups within the USFWS. Informal meetings took place with local waterfowl hunt clubs, such as the Utah Waterfowlers Association and the Bear River Club, and with other groups, like the Friends of the Bear River Refuge. The purpose of these meetings was to update the stakeholders and partners on the status of the HMP, future planning efforts for the Bear River MBR, and opportunities that will exist for public comment. The Refuge also conducted an Open House on December 3, 2019, inviting several hundred people in the communities, partners, and congressional representatives. Representatives from local, state, and federal government attended, along with private landowners, teachers, neighbors, and other interested stakeholders.

The Draft HMP and EA were available to the public for a review and comment period from May 28 to July 5, 2020. The Service received comments from one individual and six organizations. Most of the comments focused on supporting focal species life cycle needs, and water management on the Refuge. Several clarifications and minor editorial changes were made to the HMP or EA as a result of these comments.

State Coordination

Meetings and phone calls were held with the State of Utah to describe the efforts being put forward with the 2021 HMP and EA. In October of 2019, a meeting was held to provide information on the process and preferred direction of the Refuge for habitat management. Attendees included a Waterfowl Management Area (WMA) manager and a State non-game biologist. The Service received a letter expressing support for the Bear River Migratory Bird Refuge HMP from the Utah Division of Wildlife Resources on October 6, 2020. The Service will continue to collaborate with the Utah Division of Wildlife Resources to create habitats for the variety of waterbirds found on the Great Salt Lake.

Tribal Consultation

The Service reached out to several different Tribes about the Bear River HMP and EA, in an effort to consult with them and to determine how they would like to be involved. The Service did not receive any comments or questions from them.

Finding of No Significant Impact

Based upon a review and evaluation of the information contained in the EA as well as other documents and actions of record affiliated with this proposal, the Service has determined that the proposal to implement the 2021 Habitat Management Plan on the Bear River Migratory Bird Refuge does not constitute a major Federal action significantly affecting the quality of the human environment under the meaning of section 102 (2) (c) of the National Environmental Policy Act of 1969 (as amended). As such, an environmental impact statement is not required.

Decision

The Service has decided to implement the 2021 Habitat Management Plan for the Bear River Migratory Bird Refuge. The action is consistent with applicable laws and policies.

STACY ARMITAGE Digitally signed by STACY ARMITAGE Date: 2021.03.31 10:22:53 -06'00'

Stacy Armitage
Assistant Regional Director
U.S. Fish and Wildlife Service
National Wildlife Refuge System
Interior Regions 5&7

Date

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See the complete Bear River Migratory Bird Refuge Habitat Management Plan for abbreviations, glossary, and references. This Environmental Assessment is included as an Appendix to the Habitat Management Plan.

Chapter 1. Purpose and Need for Action

1.1 Introduction

The U.S. Fish and Wildlife Service (Service, USFWS) is the primary federal agency responsible for conserving and enhancing the nation's fish and wildlife populations and their habitats. Although the Service shares this responsibility with other federal, state, tribal, local, and private entities, the Service has specific trust responsibilities for migratory birds, federally listed threatened and endangered species, and certain anadromous fish and marine mammals. Service efforts over the last 100 years to protect wildlife and their habitats have resulted in a network of protected areas that form the National Wildlife Refuge System (Refuge System). This network of protected areas is the largest and most diverse in the world. Refuge System lands provide essential habitat for numerous wildlife species, wildlife-dependent recreational opportunities for the public, and a variety of benefits to local communities.

Bear River Migratory Bird Refuge (Refuge) in Brigham City, Utah was established in 1928 through a Presidential Proclamation. Consisting of 77,102 acres, the Refuge is comprised of wetlands and uplands that make up the deltaic landscape and support a variety of migratory birds and resident wildlife. The Service prepared a revised Habitat Management Plan (HMP) to guide management actions of habitat for a period of five years. The 2021 HMP is a revision of the 2004 HMP that was written to implement the goals and objectives of the 1997 Refuge Comprehensive Management Plan.

1.2 Purpose and Need for Action

The purpose of the 2021 HMP is to provide a strategic, operational guide to focus future management on restoring habitats and improving ecological function in specific areas that will benefit waterfowl, shorebirds, and other priority migratory bird species on the Refuge. The need for this Proposed Action is to meet the Service's priorities and mandates as outlined by the Refuge Administration Act as Amended by the National Wildlife Refuge System Improvement Act of 1997. The Administration Act directs the Service to ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans. To meet this mandate, the Service developed their Biological Integrity, Diversity, and Environmental Health Policy (BIDEH) to provide refuges with guidance for consideration and protection of the broad spectrum of native fish, wildlife, and habitat resources on refuges and in associated ecosystems. This policy provides refuges with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and to restore lost or severely degraded environmental components. In evaluating these factors, the Service looks at historic conditions and compares them to the current ones. This provides a benchmark of comparison for the relative intactness of ecosystems' functions and processes, as well as an assessment of the opportunities and limitations to restoring biological integrity, diversity, and environmental health.

1.3 Proposed Action

The Service has completed this Environmental Assessment (EA) for the 2021 HMP. The Service has prepared the 2021 HMP, which is incorporated herein by reference and contains this EA, to provide more details regarding the Proposed Action for the restoration and enhancement of ecological function for the habitats of the Refuge. The Service discloses anticipated effects for each alternative (No Action and Proposed), pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended. Two alternatives were prepared for this EA; a No Action Alternative and a Proposed Action Alternative. For details on the specific components and actions constituting the alternatives, see Chapter 2 of this EA.

The Proposed Action Alternative may be modified between the draft and the final EA depending on the comments received from the public and other agencies and organizations. The Service's Regional Director for Interior Region 7 will decide which alternative will be implemented.

Should the Service decide to implement the 2021 HMP, the analysis in this EA will inform the decision of whether a Finding of No Significant Impact (FONSI) can be reached. The FONSI would identify the alternative selected for implementation and the rationale behind the decision. If a FONSI cannot be reached, an Environmental Impact Statement (EIS) would be prepared.

1.4 Development of the Alternatives

In developing the alternatives for this EA, the Service considered a variety of natural and cultural resources; social, economic, and organizational information; and ideas, and concerns important for restoring and managing the Refuge. Much of this information is more fully described in the 2021 HMP, to which this EA is appended. As is appropriate for a national wildlife refuge, biological resource considerations were paramount in designing the alternatives. A U.S. House of Representatives report accompanying the Refuge System Improvement Act stated, "the fundamental mission of our [Refuge] System is wildlife conservation: wildlife and wildlife conservation must come first." Refer to the 2021 HMP, Chapters 2 and 3, for background information on the Refuge, current environmental conditions, and resources of concerns.

The Refuge planning team considered all of the above information and input, and identified and described two reasonable alternatives: a No Action Alternative and a Proposed Action Alternative. A reasonable alternative is one that is technically and economically practical or feasible, would fulfill the purpose and need for action without violating minimum environmental standards, and could be implemented. Each alternative was then evaluated for environmental and social effects. Following public review and comment, the Service will select an alternative for implementation. This selected alternative may include elements from both of the alternatives evaluated herein.

Chapter 2. Alternatives

2.1 Introduction

This chapter describes the alternatives considered for the EA; these include the No Action Alternative and the Proposed Action Alternative. The alternatives are carried forward for further analysis in Chapters 3 and 4 of this EA. NEPA requires analysis of the No Action Alternative to provide the reader an understanding of baseline conditions without the Proposed Action and how these compare to the effects resulting from the Proposed Action.

2.2 Alternative 1: No Action

Under the No Action Alternative, the Refuge would continue to implement the actions and goals set forth in the 2004 HMP. This plan (USFWS 2004) has goals similar to the Proposed Action (2021 HMP) but with more specificity aimed at plant species and less capability for adaptive management. Under the No Action Alternative, the Refuge would continue to manage for 32 wetland impoundments and 10 upland/wet meadows units with consistent water levels, as water availability allows, with an emphasis on growing alkali bulrush, sago pondweed, and other plant species for 14 different focal species. Existing water control features, such as levees, dikes, and canals, will remain in place, and maintenance of those features will continue.

2.3 Alternative 2: Preferred Alternative – Implementation of the HMP

The 2021 HMP identifies goals and objectives aimed at supporting key life cycle requirements of focal species and guilds during spring and fall migration, as well as their breeding habitat requirements, and implementation of these is the Proposed Action. The focal species and guilds have different habitat requirements (e.g., water depth, vegetation composition and structure, and cover) during their migration and breeding periods. The 2021 HMP goals and objectives are as follows:

> <u>Goal 1:</u> Restore and manage Bear River deltaic wetland and River Corridor units to emulate historic natural hydrology, where possible, to provide migration and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.
>
> <u>Goal 2:</u> Restore and manage wet meadow and upland habitats on the Wasatch Front to produce native grasses, sedges, rushes, and forbs, where possible, to provide foraging and breeding habitat for a diversity of waterfowl, wading birds, and shorebirds.
>
> <u>Goal 3:</u> Prevent further physical alterations to maintain the existing hydrologic and topographic integrity of the Refuge.
>
> <u>Goal 4:</u> Maintain and expand partnerships that contribute to the conservation and enhancement of Refuge habitats, the Bear River watershed, and the Great Salt Lake Ecosystem.

Objectives to support each of these four goals were developed as well. The spring and fall migration objectives described in the 2021 HMP characterize the dynamic hydroperiods (timing, depth, duration) and vegetation required to meet the foraging needs of focal migratory bird species. In addition, not all available habitat will be flooded during spring and fall migration, which will provide the flexibility necessary to produce the appropriate foods and habitat structure. The breeding objectives define the range of habitat requirements that must be met for focal species to successfully nest and raise young. However, achieving these objectives also will benefit numerous other species. For example, maintaining stands of tall emergent vegetation to benefit white-faced ibis also will provide some habitat for other species that nest over water, including redheads and grebes. More information on the goals and objectives can be found in Chapter 4 of the 2021 HMP.

Based on the goals and objectives identified in the 2021 HMP, a list of potential restoration and infrastructure improvement projects at specific Refuge locations were identified that would contribute to achieving objectives and improving ecological function while minimizing annual management intensity to the extent possible. More detail on the selection of the projects can be found in Chapter 5 of the 2021 HMP. The Preferred Action Alternative, the implementation of the 2021 HMP projects, is summarized in Table 1, below.

Table 1. Key projects/actions identified in the 2021 HMP

Project I: Partial hydrologic restoration of Unit 2A
Overall, this project aims to remove water control structures (i.e., levees and dikes) and fill in adjacent borrow ditches in order to improve sheetflow of water throughout the unit. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites), increased diversity of native vegetation, and ultimately benefit migratory birds.
Project II: Restoration of sheetflow hydrology on Canadian Goose Club and Unit 4
This project aims to replace two water control structures with more efficient structures, allowing for sheetflow of water from the top of the unit, rather than relying on backflooding. Levees, islands, and borrow ditches will be removed and filled and topography will be restored to facilitate sheetflow. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites) and increased composition of native vegetation. At the northern end of the unit, the original height of the Bear River levee will be restored. At the southern end of the unit, two short dikes will be created to facilitate water moving into other units.
Project III: Partial hydrologic restoration of Unit 3I/3J
This project will replace improve two existing water control structures, remove an interior dike, and fill in borrow ditches both in the interior and the perimeter. This will allow for improved hydrological function and management capability, resulting in better control of invasive species (primarily phragmites) and increased composition of native vegetation.
Project IV: Improve the ability to manage hydrology of impounded units.
This project will replace five key water control structures with overshot gates. The overshot gates are easier and safer for staff to manipulate, allow for increased efficiency in moving water, and provide the ability to manage the hydrology of the units in alignment with the objectives of the HMP.
Project V: Native plant community restoration in Three Bar Unit
This project will repair the headgate and install fencing to facilitate grazing as a management tool. Currently comprised of mostly non-native grasses, the project will identify site preparation options and a seed mix of native grasses to plant for restoration.

Chapter 3. Existing Environment

The Refuge encompasses 77,102 acres at the north end of the Great Salt Lake (GSL) in Box Elder County, Utah and includes most of the valley floor between the Wellsville Mountain Range to the east and the Promontory Mountain Range to the west. It primarily consists of deltaic wetlands and wet meadows that provide critical habitats for migratory birds and resident wildlife (Figure 1). The Refuge is unique because it is one of the few locations in the GSL ecosystem that supports freshwater wetlands and sits within the Bear River Watershed. The Refuge has a semiarid climate with four defined seasons characterized by moderate spring and fall seasons, short cold winters, and hot dry summers. Based on climatic records for the period 1896-2006 at Corinne, average annual precipitation is 15.36 inches, with an average of 30.8 inches of snow counting towards the total (WRCC 2012).

In 1983, the rising waters of the GSL topped and damaged Refuge dikes and water control structures, and the newly dedicated Refuge visitor center. The Refuge maintenance building and Refuge houses were also destroyed by winter ice flows in 1983. The flood years of 1983-1989 turned the freshwater marshes of the Refuge into brackish marshes, which eventually transitioned to open waters of the GSL. During the1990s, the focus was on reconstructing impoundments and associated water delivery canals in order to manage water on the Refuge. Key features of the impoundment design are depicted in Figure 2.

The key features completed in the 1990s included construction or rehabilitation of bypass canals to divert excess water around impoundments and establishment of 25 units to facilitate more independent water control. This was intended to provide greater diversity of wetland types, reduce the need to conduct winter drawdowns to minimize ice damage, and increase the ability to control the invasive common carp. In addition, 12 islands were constructed to promote waterbird nesting. The current design of the water management infrastructure requires filling units from the bottom by backflooding from five main canals (Reeder, Whistler, O-Line, H-Line, and L-Line). These canals are also used to discharge water below the perimeter dike (D-Line) to the units in Willard Bay, Willard Spur, and Bear River Bay, where approximately 30,125 acres are owned in fee title. Management of the spur and bays is limited, but these areas provide some of the most productive habitat on the Refuge.

Since completion of the new impoundment system in the 1990s, additional infrastructure was added to improve water management capabilities in other areas of the Refuge. Ditches and short dikes were created below the D-Line dike to facilitate the movement of water from canals to Bear River Bay and Willard Spur. A series of ponds and associated ditches were constructed in the Wasatch Front units which transport water from natural springs to improve waterfowl brood habitat. In addition, water control structures and some ditches were constructed to flood meadows and move water between oxbows in the River Corridor units. To facilitate water management, approximately 96 miles of dike (14 feet wide, averaging 4.5 feet in height, 6:1 side-slope) covering 791 acres were constructed. This was accompanied by a similar length of "borrow ditches" adjacent to dikes where fill for dikes was acquired. For more information regarding the existing and affected environment, refer to Chapters 2 and 3 of the 2021 HMP.

The Proposed Action would focus on restoration and infrastructure improvement projects at specific Refuge locations that would contribute to achieving habitat objectives and improve ecological function while minimizing annual management intensity to the extent possible. These specific areas and projects are further described in Chapter 5 of the 2021 HMP.

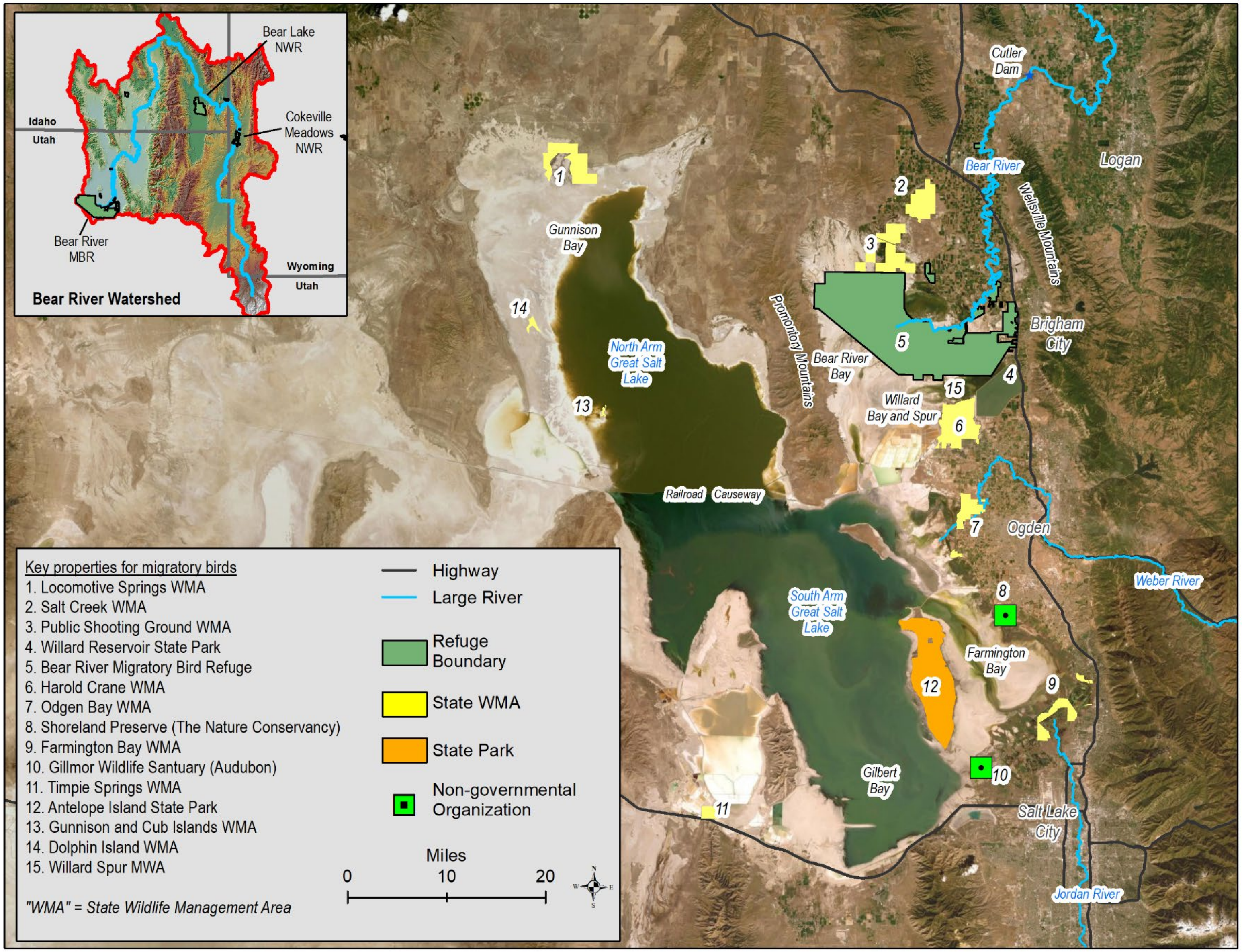

Figure 1: General location of the Bear River Migratory Bird Refuge and nearby protected areas.

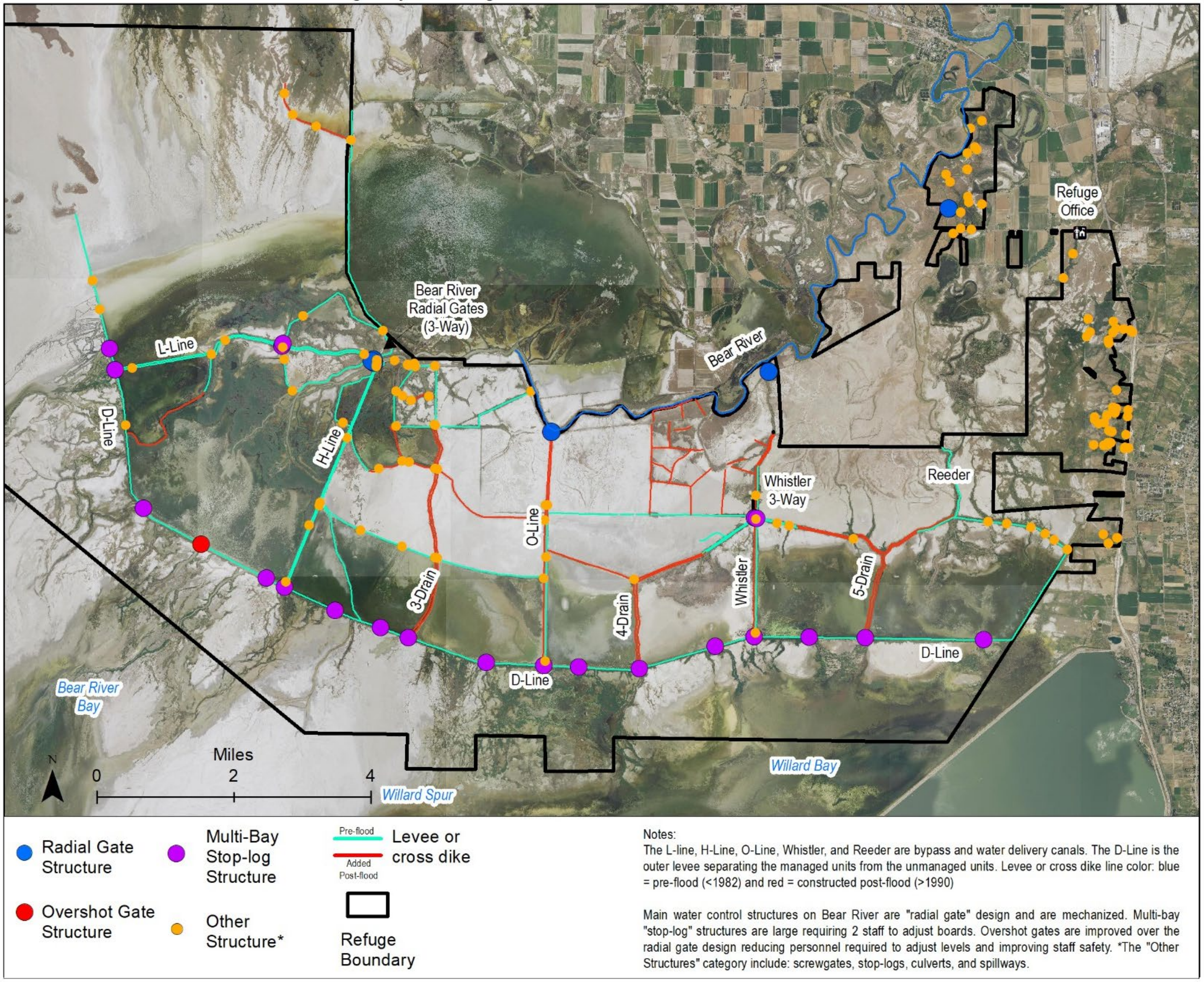

Figure 2: Water-related infrastructure on the Bear River Migratory Bird Refuge.

Chapter 4. Environmental Effects

This chapter provides an analysis of the environmental effects, or impacts, of implementing the alternatives described in Chapter 2. Effects are described for the main aspects of the environment, including physical, biological, cultural, and socioeconomic resources. The alternatives are compared under each aspect, and both the adverse and beneficial effects of implementing each alternative are described that are reasonably foreseeable and have a reasonably close causal relationship to the proposed action or alternatives. For the Preferred Alternative (Proposed Action), the key management projects/actions described above in Table 1 are analyzed.

This EA only includes the written analyses for the environmental consequences on a resource when the impacts on that resource could be more than negligible. The resource is then considered an "affected resource" and is otherwise considered important as related to the Proposed Action. Any resource that is not considered to be more than negligibly impacted by the Proposed Action is considered to have been identified as not otherwise important as related to the Proposed Action and is dismissed from further analyses. The following resources either (1) do not exist within the project area or (2) would either not be affected or only negligibly affected by the proposed action:

- Geology and Soils
- Air Quality
- Floodplains
- Threatened and Endangered Species
- Wilderness

An overview of the affected resources is presented in Tables 2 through 6, along with a description of the effects of both alternatives. Table 2 covers natural resources, Table 3 covers visitor use, Table 4 covers cultural resources, Table 5 covers Refuge operations, and Table 6 covers socioeconomics.

Table 2. Affected natural resources and anticipated impacts of the Alternatives

Habitat and Wildlife	
The Refuge plays a key role in providing habitat for over 210 bird species during both spring and fall migration, and 70 species use the Refuge for nesting. The Refuge also supports terrestrial mammalian wildlife species, such as mule deer, long-tailed weasel, muskrat, raccoon, striped skunk, and several species of mice and voles. The Refuge does not have any federally threatened or endangered wildlife or plants and, therefore, this section does not contain any analysis of impacts to those species.	
Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Under this action, management strategies would remain the same, and would utilize the 2004 HMP. The Refuge would continue to manage wetland impoundments for the 14 priority wildlife species identified in the 2004 plan using water management aimed at certain plant	**Projects #1-4** – These projects are aimed at removing water management infrastructure (levees, dikes, and water control structures, and borrow ditches) to restore historic natural hydrology in the wetlands of the Refuge, while allowing for management flexibility dependent on current conditions. These projects will enable management to implement a more dynamic hydroperiod

species but would have less capability for adaptive management.

Direct Impact - Restoration and infrastructure improvements would not occur and would likely result in no changes to wildlife and fish diversity and abundance compared to current conditions described in the 2021 HMP. There would be less diverse habitat to support the life cycle needs of migratory birds.

Uplands would continue to be managed with a grazing program which does provide benefits to the habitat by encouraging native grass re-growth. However, no further restoration efforts would occur.

Indirect Impacts - Invasive plants (both native and non-native) would continue to encroach into the wetlands and uplands, and reduce the overall habitat availability for wildlife. Infrastructure (water control structures, levees, dikes, and canals) would continue to need regular maintenance and costly repair.

in impounded units that does not rely solely on backflooding.

Direct Impacts – These projects will partially restore the hydrology of the units, which will improve management capability to control non-native vegetation and create conditions suitable for establishment of plant communities intermixed with shallow open areas that provide foods for a diversity of migratory birds. This will promote establishment of more diverse plant communities across a larger area that will increase foraging habitat for focal species during migration. In addition, there will be increased potential to establish additional bulrush stands for breeding white-faced ibis and flood natural playa habitats for breeding American avocet and black-necked stilt

Indirect Impacts – Increased numbers and diversity of migratory birds contributes to the overall health and ecological function of the Bear River Watershed and the GSL Ecosystem. The long-term sustainability of impounded units will be improved by minimizing sediment accumulation in static areas and improving nutrient cycling necessary to maintain wetland productivity, which ultimately provides key life cycle requirements for migratory birds.

Project #5 - The intent of this project is to improve the composition of native vegetation and improve the ecological function of the 3 Bar uplands.

Direct Impacts –Improving the native floristic composition of the unit will reduce the frequency and intensity of treatments necessary to control non-native species. This will result in increased foraging habitat for waterbirds, primarily white-faced ibis, marbled godwit, and other waterfowl and geese when flooded during migration periods.

Indirect Impacts - Developing a restoration plan based on site conditions improves success and is more cost-efficient.

Vegetation

Impounded units that are semi-permanently or permanently flooded with greater than 8 inches of water are primarily open water areas that support extensive stands of submerged aquatic vegetation, including sago and horned pondweed, and widgeon grass. In areas flooded to less than 4 inches, emergent species are dominant, with non-native phragmites being the dominant emergent plant. The upland/wet meadow units of the Refuge include a combination of native and non-native species of sedges, rushes, cheatgrass and pepperweed.

Alternative 1 – No Action

The Refuge would continue to manage for 32 wetland impoundments and 10 upland/wet meadows units with consistent

Alternative 2 – Implementation of 2021 HMP

ALL PROJECTS

water depths of 0 to 48 inches. The emphasis would be on growing alkali bulrush, sago pondweed, and other plant species for 14 different priority species from the 2004 HMP.

Direct Impacts – Invasive plants, primarily phragmites, would continue to encroach onto Refuge lands. This would cause monocultures to spread, reducing the variability of vegetation composition and outcompeting native vegetation (grasses, rushes and sedges). Plant community diversity and structure would be low.

Indirect Impacts - Refuge personnel expend considerable resources in terms of funding and staff and volunteer time managing invasive and nuisance species each year to provide quality habitat for native species. By continuing to manage under the No Action Alternative, these mechanisms by which invasive plants benefit will not be changed, and it will be increasingly difficult to decrease invasive plants and increase desirable native vegetation for priority species. Monocultures of non-native plants will reduce the available habitat for migratory birds.

As with the Habitat and Wildlife, above, these projects focus on the removal of levees and dikes, and removal or improvement of water control structures to allow for mimicking of historic natural hydrology, allowing for more efficient management of water, increasing the upland/wet meadow habitat.

Direct Impacts – Restoring the hydrologic function of these units will allow for management of semi-permanently and permanently flooded wetlands. The ability to more efficiently manage the water in key Refuge areas will enable efforts at control of invasive species. By managing the water more efficiently, deep standing water, optimal conditions for invasive plant species, will be reduced, and soils will be allowed to dry, improving nutrient cycling This will encourage the growth and germination of a more diverse plant community and will improve invertebrate production. Plant community diversity and structure would be high across the landscape.

Indirect Impacts – Improved plant composition of native plants will provide a healthier and more functioning ecosystem on the Refuge. This will produce more foraging, nesting, and other life cycle needs for wildlife.

Hydrology

The Refuge is in an area that is in a river delta, rich with wetlands that form as the Bear River and other water sources empty their water into the GSL. Discharge from the Bear River accounts for the majority of water entering the Refuge and more than 50% of the annual flow into the GSL (Sigler and Sigler 1996). The Refuge utilizes water rights from the Bear River and return flows as the main water inputs into the Refuge's various units. The Refuge currently consists of 26 wetland impoundments on the main delta, five unimpounded units, five Wasatch Front units, and three units near the river that contain both impounded and unimpounded sections.

Alternative 1 – No Action

Direct Impacts - The Refuge would continue to manage per the 2004 HMP. Some of the units will be flooded with shallow water depths and some will be flooded with deep water depths. Water would be left standing in the borrow ditches and canal system due to reliance on backflooding. Sheetflow will not be possible.

Indirect Impacts – Standing water would continue to promote monocultures of phragmites and encroachment of other

Alternative 2 – Implementation of 2021 HMP

ALL PROJECTS

Direct Impacts – Removal of levees and dikes, filling in borrow ditches, and removing water control structures or replacing them with more efficient designs would allow the Refuge to emulate and restore historic natural hydrologic conditions. This will increase the flood frequency of impounded units adjacent to the river, promote more natural deposition of sediment, enable better control of soil salinity, and facilitate nutrient cycling. In addition, implementation of new annual water management strategies will be possible, including the ability to sheetflow water across some units rather than

non-native and/or invasive species. Plant diversity and structure would remain low.	backflooding, and dewatering units periodically to help control invasive phragmites and common carp. This will promote establishment of more diverse plant communities across a larger area that will increase foraging habitat for focal species during migration. Indirect Impacts - This will improve wetland sustainability and productivity of impounded units, as well as provide more habitat for a diversity of waterbirds. In addition, there will be increased potential to establish additional bulrush stands for breeding white-faced ibis and flood natural playa habitats for breeding American avocet and black-necked stilt. Finally, the long-term sustainability of impounded units will be improved by minimizing sediment accumulation in static areas and improving nutrient cycling necessary to maintain wetland and upland productivity.

Topography

Topography refers to shape and features of land surfaces. The topography of the Bear River delta is near flat, with a gradient of approximately one foot per mile fall to the south. From the northern boundary of the Refuge to the mouth of the delta, there is only about 6 feet of fall in the river. The maximum natural elevation is about 4,215 feet above mean sea level, while minimum elevation is around 4200 above mean sea level.

Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Under this alternative, sediment will continue to accumulate along the levees, dikes, and borrow ditches, providing conditions that will continue the expansion of phragmites and a reduction in the ability to promote desirable native vegetation.	**ALL PROJECTS** Direct Impacts - Removal of water control infrastructure – particularly levees, dikes, and borrow ditches – will help restore natural topography, which is required to emulate more natural hydrologic processes. This will improve wetland productivity by promoting native vegetation composition and distribution, increasing the area of suitable habitat for numerous focal species, including shorebirds and waterfowl. Promoting natural movement and pooling of water in shallow, natural depressions (rather than in ditches) will also improve nutrient cycling and sediment distribution patterns, as well as limit areas suitable for invasive species, including phragmites and common carp. Indirect Impacts– Restoring natural topography to the extent possible will improve wetland sustainability and productivity, while also reducing funds and staff time required to control invasive species and manage sediment loads that currently accumulate in static locations.

Table 3. Affected visitor use and experience and anticipated impacts of the Alternatives

Visitor Use and Experience

The six priority public uses of the National Wildlife Refuge System are: wildlife observation, hunting, fishing, wildlife photography, interpretation, and environmental education. In 2018, there were 107,448 visitors on the Refuge. There is a 12-mile auto tour route with interpretive and informational kiosks, pullouts, and wildlife viewing platforms. Abundant wildlife observation is available along the tour route. A variety of interpretive programs and events occur at the Refuge Visitor Center throughout the year. Wildlife observation, followed by hunting and fishing, are the most popular activities on the Refuge.

Alternative 1 – No Action

Under the No Action Alternative, management of the Refuge habitat would continue under the 2004 HMP.

Direct Impacts – It is likely that under this alternative, visitors to the Visitors Center or participating in interpretation and environmental education activities will not experience any change. However, visitors engaged in wildlife photography and wildlife observation using the drive on Forest Street to the Observation Tower or the auto tour route will not be able to observe as much wildlife. The wetland units visible from these areas will continue to be dominated by nearly impenetrable stands of invasive phragmites and other large monocultures of less desirable species such as cattail and hardstem bulrush. These dense stands of vegetation, which surround the cheatgrass covered islands in the wetlands, would continue to preclude nesting and limit viewing for visitors.

Visitors engaging in fishing will not experience a change under this alternative. Visitors engaging in hunting may see a decreased opportunity as the available habitat decreases due to spreading invasive species. This may cause migratory birds to seek loafing and foraging opportunities elsewhere, thus decreasing hunting and wildlife viewing opportunities on the Refuge.

Indirect Impacts –Refuge visitors will experience a less satisfactory visit to the Refuge, with a lack of native plants and animals impeding their understanding of the ecology of the area. Reduced visitation to the Refuge will result in lost opportunities to for visitors to experience a National Wildlife Refuge and understand the mission and conservation message of the Refuge.

Alternative 2 – Implementation of 2021 HMP

ALL PROJECTS

Direct Impacts - With the restoration of native vegetation, hydrology and improvement management capability, additional opportunities for wildlife observation, environmental education, and photography would occur due to improved viewing conditions associated with a reduction in dense, tall stands of phragmites and improved plant/food diversity for a myriad of migratory birds. When flooded in fall, the unit will be more accessible to hunters and will likely attract greater concentrations of migrating waterfowl due to improved and more diverse foraging options. Visitors fishing experiences are not likely to experience any change.

Indirect Impacts – The initial restoration phase of these projects would potentially require the auto tour loop road and other areas to be closed temporarily during active equipment work. This would impact visitors in the short term.

However, long-term impacts from the Proposed Action is expected to improve wildlife observation, photography, and hunting opportunities, resulting in higher visitor satisfaction. Outreach and educational opportunities with visitors and communities could increase in the long-term, especially as management encourages and attracts more native plants and animals.

Table 4. Affected cultural resources and anticipated impacts of the Alternatives

Cultural Resources	
The 2021 HMP proposed projects include removal of water control infrastructure, which includes levees, dikes, and other features that may be historic (over 50 years old). A Refuge-wide cultural resource survey of all water control features will be completed for the Refuge in 2020.	
Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Direct/Indirect Impacts – There will be no anticipated impacts to any cultural resources.	ALL PROJECTS A Refuge-wide cultural resource survey of all water control features will be completed for the Refuge in 2021. Individual projects will be reviewed under Section 106 of the National Historic Preservation Act on a case-by-case basis in consultation with the Utah SHPO, and adverse effects to historic properties will be resolved prior to project implementation.

Table 5. Affected Refuge management and operations and anticipated impacts of the Alternatives

Land Use and Infrastructure	
In 1983, the rising waters of the GSL topped and damaged Refuge dikes and water control structures. In addition, the newly-dedicated Refuge visitor center, shop, and refuge houses were destroyed by winter ice flows. During the 1990s, the management on the Refuge focused on reconstructing impoundments and associated water delivery canals. Key features of the design included bypass canals to divert excess water around impoundments, and subdivision of the original large units into 25 smaller units to facilitate water management. The subdivision design has led to the current water management infrastructure requiring filling units from the bottom via backflooding from five main canals (Reeder, Whistler, O-Line, H-Line, and L-Line). These canals are also used to discharge water below the perimeter dike (D-Line) to the units in Willard Bay, Willard Spur, and Bear River Bay, of which approximately 30,125 acres are owned in fee title. Management of the spur and bays is limited, but these areas provide some of the most productive habitat on the Refuge.	
Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Under this Alternative, the Refuge would continue to manage wetland impoundments for the 14 priority wildlife species using water management aimed at plant species but providing for less capability for adaptive management. Direct Impacts – Water management would remain the same, and most units would continue to be filled from the bottom by backflooding. Dense stands of non-native and/or invasive species, such as phragmites, and other tall non-native and/or invasive species would remain difficult to manage and would limit the forage and nesting value of the Refuge for a variety of migratory bird species. Mammalian carnivores would continue to	**ALL PROJECTS** Replacing water control structures, removal of the dike, man-made islands, levees, dikes, and settling ponds, along with filling of borrow areas would restore these areas and provide an opportunity to implement a more natural water management strategy. Implementation would allow for more optimal habitat during spring and fall migration and breeding periods. This change in management would allow for units to be dried at key times during the growing season so that grazing, prescribed fire, herbicide applications, and other management activities could be conducted where appropriate to control phragmites and other non-native and/or invasive species. Indirect Impacts – Temporary closure of roads and disruption of visitor services is likely to occur during some phases of equipment work. This would be done to facilitate efficiency of the work and promote safety for

use the dikes as travel corridors and would remain abundant and difficult to manage.

Indirect Impact – The cost and physical manipulations of the water control structures and other features would continue to pose a safety hazard and would be costly to manage and maintain.

both Refuge employees and visitors. Once the projects are completed, management of the Refuge would be conducted following the principles of adaptive management.

Administration	
Refuge staff is currently comprised of twelve employees (one Refuge Manager, one Deputy Refuge Manager, two Visitor Services professionals, three Maintenance Professionals, three Fire Management Professionals, and two Fish and Wildlife Officers). This Refuge is also part of a complex, and Fish Springs NWR is managed out of Bear River MBR. Total budget allocated to the Refuge annually is approximately $1.55 million. Operating dollars, those that are used to pay overhead (electricity, fuel, supplies) and habitat work (pesticide, replacing/repairing structures, gravel, etc.), are $387,000 annually for Bear River MBR and Fish Springs NWR combined.	
Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Under the No Action Alternative, there is not likely to be any direct or indirect impact to the administration of the Refuge. Budget and operations will remain the same.	**ALL PROJECTS** There is not likely to be any changes to the base budget of the Refuge Complex. Direct Impacts - Initial cost to complete all five projects identified in the 2021 HMP is estimated at a total of $2.6 million. This covers salary, equipment, engineering, surveys, supplies, and materials. There may be opportunities to seek partnerships and other funding opportunities and support to complete the projects. Indirect Impacts – Long-term maintenance cost will be reduced due to the removal of water control features that require continual maintenance (water control structures, levees, and dikes). Staff time necessary for structural maintenance would be eliminated and reduced numbers of invasive plant species would result in fewer staff hours required to perform control efforts. Overall, this would allow for more sustainable and efficient management over the long-term, with decreased chemical use, reduced maintenance, reduced staff time, and reduced funding needed for maintenance of the projects.

Table 6. Affected socioeconomics and anticipated impacts of the Alternatives

Local and Regional Economies
The Bear River MBR is near Brigham City, Utah, the cities of Logan and Ogden are 30 miles away, and Salt Lake City is 60 miles away. As of 2010, approximately 2.5 million people lived within 75 miles

of Bear River MBR. The Refuge has been identified as an Urban Refuge due to its proximity to Salt Lake City. The Brigham City Chamber of Commerce lists the Refuge as one of the area's main attractions, and in 2018 the Refuge hosted 107,448 visitors.

Maintaining a variety of public uses on the Refuge stimulates the local economy, as tourists usually buy a wide range of goods and services while visiting an area. Major expenditure categories include lodging, food, supplies, and gasoline. In fiscal year 2011, 46.5 million visits were made to refuges; these visits generated $2.4 billion in sales, more than 35,000 jobs, and $792.7 million in employment income in regional economies (Caudill and Carver 2013).

During two sampling periods, 44% of surveyed visitors to Bear River MBR indicated that they live within the local 50-mile area, while the remaining 56% of nonlocal visitors stayed in the local area for an average of three days. During the two sampling periods, nonlocal visitors spent an average of $56 per person per day, and local visitors spent an average of $31 per person per day.

Alternative 1 – No Action	*Alternative 2 – Implementation of 2021 HMP*
Under this alternative, phragmites and cattails would continue expanding in waterways, along with other non-native and/or invasive species, which would negatively impact waterfowl and shorebird habitat and abundance. In turn, this will result in fewer viewing and hunting opportunities for visitors due to the dense and tall growth habitat of this invasive vegetation. Poor habitat management on a wildlife refuge translates into lost opportunities for wildlife and people. Non-consumptive and consumptive uses by Refuge visitors would likely decline under this scenario due to a decrease in visitor satisfaction. Businesses dependent on Refuge visitation driven by healthy habitats and abundant wildlife would likely suffer financially, and this would negatively impact the local economy and make the Refuge less relevant to local communities.	**ALL PROJECTS** – Direct Impacts - Visitors come to Bear River MBR to observe and/or hunt healthy, abundant wildlife. The Proposed Action is expected to improve habitat conditions for a myriad of migratory bird species. Increased visitor satisfaction and use is expected from a variety of Refuge user groups. The increase in consumptive and non-consumptive visitor use translates into more dollars being spent in this area, leading to job growth, which will benefit local communities. Indirect Impacts - Playing an increased role in the local, regional, and national economy is expected to benefit the Refuge and wildlife by increasing the relevance of the Refuge System to visitors, local businesses, and others who are dependent on these resources.

Chapter 5. Cumulative Effects

Cumulative effects can result from the incremental effects of a project when added to other past, present, and reasonably foreseeable future projects in the area. Cumulative impacts can result from individually minor but cumulatively significant actions over a period of time. This analysis is intended to consider the interaction of activities at the Refuge with other actions occurring over a larger spatial and temporal frame of reference.

The Council on Environmental Quality (CEQ) regulations for implementing the provisions of NEPA define several different types of effects that should be evaluated in an EA, including direct, indirect, and cumulative effects. Direct and indirect effects, or impacts, were addressed in the resource-specific sections of this draft EA in Chapter 4. This section addresses cumulative effects.

CEQ (40 Code of Federal Regulations § 1508.7; 1997) provides the following definition of cumulative effects as:

> *The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*

It should be noted that the cumulative effects analysis has essentially been completed by virtue of the comprehensive nature by which direct and indirect effects associated with implementing the various alternatives were presented. The analysis in this section primarily focuses on effects associated with reasonably foreseeable future events and/or actions regardless of what entity undertakes that action. Analysis is summarized in Table 7, below.

The area considered in the evaluation of the Preferred Alternative's contribution to cumulative effects is the Bear River watershed and the GSL ecosystem.

Table 7. Anticipated cumulative impacts of the Proposed Action and Preferred Alternative

Other Past, Present, and Reasonably Foreseeable Activity Impacting Affected Environment	*Descriptions of Anticipated Cumulative Impacts*
Wildlife-dependent Recreation	
Located along a major transportation corridor that connects people to Yellowstone National Park and the Grand Teton National Park to the north, and Salt Lake City and numerous National Parks to the south, the Refuge serves as a stopping point. It also serves to provide wildlife-dependent recreation opportunities. The Refuge has a visitor center, interpretive panels and kiosks at numerous pullouts along Forest Street, and a 12-mile long auto tour route. There is one walking trail located at the visitor center.	As described above in the socioeconomic section of the analysis, wildlife-dependent opportunities that are provided by the Refuge contribute to the local and regional economy. Implementation of the 2021 HMP will provide improved and enhanced opportunities to view and photograph wildlife and landscapes, participate in waterfowl hunting and fishing in the Bear River, and participate in environmental education and interpretation. The 2021 HMP will contribute to a potential increased visitation and economic growth.

Other Past, Present, and Reasonably Foreseeable Activity Impacting Affected Environment	*Descriptions of Anticipated Cumulative Impacts*
Land Use Changes	
By 2050, Utah's population is expected to nearly double to 5.4 million, with most of this growth occurring along the Wasatch Front and surrounding communities (Utah Foundation 2014). This population growth will continue to place stress upon the GSL and surrounding ecosystems, both through direct loss of remaining habitats, and indirectly through increased demands on water resources and fragmentation and degradation of the area's remaining parcels of wildlife habitat. Management can do nothing to stem this trend, but refuges and other tracts of habitat will become even more important in protecting the area's biodiversity. Development and human population growth are the events which are most likely to affect waterfowl. The continuing loss of wetland habitat to urbanization together with declining lake levels will result in smaller numbers of waterfowl, shorebirds, and wading birds over time.	Due to agricultural and residential uses, water input into the GSL has declined by approximately 40% since the middle of the 19th Century, which has caused the lake to reach record lows in size and surface elevation above sea level (Wurtsbaugh et al. 2016). Cumulative Impacts associated with the removal of dikes, manmade islands, settling ponds, and associated borrow areas, along with replacement of water structures to improve water flow and distribution, and the reseeding of an upland unit are expected to have positive impacts on wildlife. These actions are being proposed to improve habitat and survival conditions for a myriad of wetland-dependent migratory bird species. An exploding human population in this area and its associated development will put more and more strain on remaining wildlife habitat. No negative cumulative impacts are expected. It is likely the Proposed Action will be a net benefit by improving habitat conditions for wildlife, thus increasing the value of these remaining conservation areas.
Agricultural Land Uses	
Agricultural lands near the GSL along the Wasatch Front have provided an important source of forage and habitat for migratory waterfowl, shorebirds, and wading birds in the past. However, this area is seeing a dramatic decline in agricultural lands that is expected to continue into the future. Continued loss of agricultural lands, mostly to urbanization and associated infrastructure, will further concentrate these migratory birds (mostly waterfowl) on remaining agricultural areas. Concentrating birds into smaller and smaller areas also has the potential to more readily allow disease to spread within overwintering goose populations, which can result in increased bird mortality.	Cumulative impacts are similar to those described above in Land Use Changes.
Climate Change	
Climate change is expected to affect a variety of natural processes and associated resources. However, the complexity of ecological systems means that there is a tremendous amount of uncertainty about the impact climate change will actually have. The combination of increased frequency and severity of drought throughout the Bear River drainage and altered timing of precipitation events as well as mountain snowmelt could dramatically alter water and habitat	Climate change refers to the increasing changes in the measures of climate over a long period of time – including precipitation, temperature, and wind patterns (USGS 2019). Moderate- to long-term effects of climate change in Brigham City, Utah will likely include: increases in average temperature, a reduction in the duration and distribution of snow cover, an increase in the number of frost-free days, increased wildfire frequency, and changes in plant community composition and structure (including an

Other Past, Present, and Reasonably Foreseeable Activity Impacting Affected Environment	*Descriptions of Anticipated Cumulative Impacts*
availability on the Refuge and surrounding areas. Climate-driven changes in temperature, precipitation events, and water availability have the potential, in combination with other current and potential future environmental stressors, to lead to an unraveling of present ecosystem function.	increase in invasive plants) (Riginos and Newcomb 2015). Although temperature and precipitation changes are anticipated, there are many unknowns. Consequently, the Service does not fully understand the potential impacts that climate change may have on terrestrial and aquatic habitats and their associated wildlife species. Using available and emerging science, the Service continues to assess predictions of these complex effects. The Service will continue to use an adaptive management approach to implementation of the Proposed Action to ensure that it does not add to negative impacts of climate change on forage or breeding habitat at Bear River MBR.

Chapter 6. Monitoring and Summary of Analysis

6.1 Monitoring

The Service will hire a Senior Wetland Ecologist for the Refuge to implement the 2021 HMP. A primary component of the implementation of the 2021 HMP will include development of an Inventory and Monitoring Plan, establishment of baseline data, and establishment of procedures to evaluate effectiveness of management actions. Implementation of projects in this 2021 HMP will occur simultaneously with annual activities (e.g., water management, prescribed fire, grazing) documented in the annual work plan (AWP), and both plans will be integrated with the Refuge Inventory and Monitoring Plan following completion of this 2021 HMP. Refuge staff will use this plan as a working document to apply adaptive management concepts. Periodic revisions are expected as projects are implemented and the response of the system is monitored.

6.2 Summary of Analysis

The purpose of this EA is to briefly provide sufficient evidence and analysis for determining whether to prepare an EIS or a FONSI.

Alternative A – No Action Alternative

The No Action Alternative means that the Refuge will continue to manage the habitat following the guidance put forth by the 2004 HMP. The Refuge would manage for 32 wetland impoundments and 10 upland/wet meadows units with consistent water levels with an emphasis on growing alkali bulrush, sago pondweed, and other plant species for 14 different priority species. There would be no adaptive management occurring based on conditions, as the 2004 HMP calls for specific water levels in specific areas of the Refuge at regulated times. It is likely that encroachment of non-native species, such as phragmites, would continue in the wetland units, causing a loss of available open water and desirable sub-emergent and emergent vegetation. The upland units would continue to see invasive plants as well, mostly cheatgrass and pepperweed, as the native vegetation declined. Habitat degradation would ultimately result in a loss of wildlife diversity and abundance. Overall, the No Action Alternative would not improve the Service's ability to meet its legally-mandated mission to protect other trust resources and preserve and enhance wildlife habitat

Alternative B – Proposed Alternative – Implementation of the HMP

As described above, the Proposed Action is to implement the 2021 HMP and associated projects. These projects are aimed at increasing ecological function of the delta by addressing infrastructure needs. The Proposed Action's potential impacts to affected resources (habitat and wildlife, vegetation, hydrology, and topography) includes short-term impacts and disturbance due to project work being done utilizing heavy equipment, the need to drawdown wetlands to conduct the work, and changes in topography. The Proposed Action's potential impacts to visitor use and services includes the drawdown of wetlands popular for wildlife observation and photography, and hunting during the fall. However, the Refuge will conduct outreach and interpretation during the project work to communicate the restoration that is occurring and the long -term benefits to wildlife resources.

In addition, other areas will remain available for visitor use and services, including the 12-mile auto tour route. This Proposed Alternative helps meet the purpose and needs of the Service as described above because it would restore and mimic, to the best practical extent possible, natural hydrology across the landscape. This will result in improved habitat for migratory birds and resident wildlife, and a high quality experience for visitors.

Chapter 7. Communications, Consultation, and Coordination

7.1 Sources, Agencies, and Persons Consulted

Name	*Position*	*Institution*
Chad Cranney	Waterfowl Management Area Manager	State of Utah
Rich Hansen	Waterfowl Management Area Manager	State of Utah
Karin Kettering	Associate Professor	Utah State University
Mike Conover	Professor	Utah State University
Adam Brewerton	Non-Game Biologist	State of Utah
Mike Artmann	Wildlife Biologist	Regional Office (Lakewood, CO), U.S. Fish and Wildlife Service
Murray Laubhan	Regional Refuge Biologist	Quivira NWR (Stafford, KS), U.S. Fish and Wildlife Service
Jaron Andrews	Hydrologist	Regional Office (Lakewood, CO), U.S. Fish and Wildlife Service

Additional preparers and reviewers of the 2021 HMP are listed in Appendix D of the HMP.

A review for potential effects to federally listed threatened and endangered species was completed; however, no listed species are known to occur at Bear River MBR so the Section 7 determination was "no effect".

State Coordination:

Meetings and phone calls have been held with the State of Utah to describe the efforts being put forward with the 2021 HMP and EA. In October of 2019, a meeting was held to provide information on the process and preferred direction of the Refuge for habitat management. Attendees included a Waterfowl Management Area (WMA) manager and a State non-game biologist. Contacts for the State were invited to the December Open House as well (see Public Outreach, below).

The Utah Division of Wildlife Resources (UDWR) provided comments to the Refuge on its draft HMP. UDWR comments expressed concerns with water management actions proposed in the HMP that could negatively impact water flows and wetland vegetation on the Great Salt Lake.

Subsequent to providing these comments, UDWR staff followed up with Bear River MBR staff and other federal wetland specialists to discuss their concerns. The discussion clarified several strategies and provided UDWR with more details about the proposed activities and clarified that the HMP includes extensive utilization of the best available science, along with emphasis on the need to monitor projects and allow for adaptive management, if desired results are not achieved.

Each of UDWR's concerns were satisfactorily addressed during the follow-up meeting with Refuge managers. The clarifications were helpful in understanding the long-term management strategies that the BRMBR desires to implement on the refuge. UDWR's specific concerns were addressed as follows:

- Infrastructure removal -- The discussion revealed that only a few interior dikes, which are not currently serving any management purposes, would be removed. Refuge staff clarified that their intention is to reclaim areas that have been dry for several years by removing dikes that may serve as seed banks for the invasive common reed. Removal of these dikes will allow for the creation of seasonally flooded wetlands. Additionally, Refuge staff indicated that water-control structures would be replaced with new, more efficient structures to improve their ability to manage the water.

- Sheetflow water – Sheet flowing water across Refuge wetlands would create conditions conducive to growing common reed, similar to what is observed on most managed area dikes around GSL. Refuge personnel explained that sheet-flowing water would be limited to a few specific areas, which have not been productive under the current management strategy. In addition, some of the acreage proposed for this strategy has received little to no water for several years, and Refuge staff are hoping this new strategy will create productive, seasonally flooded wetlands. Refuge staff further clarified that sheet flowing water will only be implemented in early spring, with the area then allowed to dry naturally throughout the summer. This strategy follows sound scientific evidence and observations, and the strategy will be carefully monitored throughout the summer to ensure that it does not encourage common reed production.

- Mimicking historic GSL wetland hydrology -- As explained during the meeting, this strategy would only be used on a targeted area at the top of the delta, which periodically flooded in the past when the river exceeded its banks or when a pump was used to bring water into this location. The pump strategy was cost prohibitive and has been discontinued, so this area has remained dry for many years. The new project aims to modify infrastructure (either move the location of a culvert or remove dikes) to get water from the Bear River back onto the land at the top of the unit, and then let it sheetflow toward GSL. The flooding will occur in the springtime, and the area will naturally dry up after flooding, thereby mimicking historic natural flooding.

The Service received a letter expressing support for the Bear River MBR HMP from the UDWR on October 6, 2020.

Tribal Consultation:

The Service has reached out to several different Tribes about the Bear River HMP and EA, in an effort to consult with them and to determine how they would like to be involved. The Service did not receive any comments or questions from them.

Public Outreach:

Prior to the release of the draft HMP and EA, coordination and communications occurred with key partners and stakeholders. Meetings took place with the State of Utah, Utah State University, and internal groups within the USFWS. Informal meetings took place with local waterfowl hunt clubs, such as the Utah Waterfowlers Association and the Bear River Club, and with other groups, like the Friends of the Bear River Refuge. The purpose of these meetings was to update the stakeholders and partners on the status of the HMP, future planning efforts for the Bear River MBR, and opportunities that will exist for public comment. The Refuge also conducted an Open House on December 3rd, 2019, inviting several hundred people in the communities, partners, and congressional representatives. Representatives from local, state, and federal government attended, along with private landowners, teachers, neighbors, and other interested stakeholders. On May 28, 2020, the Service made the HMP and EA available to the public for a 30-day public review and comment period. Due to technical issues, the date was extended past 30 days to end on July 5, 2020. The Service received comments from one individual and six organizations. Comments were largely supportive of the proposed HMP with some organizations offering assistance to the Refuge in its implementation of the new HMP. Several clarifications and minor editorial changes were made to the HMP or EA as a result of these comments. We discuss the comments we received below by topic.

Purpose and Need

Comment (1): The Refuge is not emphasizing all migratory birds and focusing only on waterfowl – Introduction.

Response: Section 1.2.1 states that the Refuge was established as "a suitable refuge and feeding, and breeding grounds for migratory wild fowl" but it does in fact emphasize providing habitat for all species of migratory birds. That is demonstrated in this document by the diversity of focal species that were selected for this plan in Section 3.1.

Comment (2): Aggressive plan to manage invasive phragmites is needed and is missing from the plan.

Response: This purpose of this plan is to outline restoration projects. It is not intended to serve as a management plan for the entire Refuge. It is our purpose that by trying to emulate natural hydrology where possible we will help to inform our management strategies for *Phragmites australis.*

Comment (3): How were breeding objectives determined? 1,000 acres seem very small. Section 4.1.

Response: Specific habitat requirements were developed by looking at species accounts and their life cycle requirements. The habitat areas were estimated by evaluating the overall Refuge acreage available and where those conditions required by the species could be achieved using the resources available. This was done looking at the holistic picture of providing multiple habitats for migratory birds throughout the year.

Comment (4): Questions on Project I - what is the cost saving, what is the timing; can the river overbank flooding occur in the fall? Urge cautions in our claim of benefits.

Response: This purpose of this plan is to outline restoration projects. It is not intended to serve as a cost benefit analysis of each project.

Comment (5): Same comments as for Project I, and states that decrease in fall waterfowl habitat will be the cost of reduction of infrastructure and estimated cost savings.

Response: The Refuge's primary mission is to provide habitat that provides the resources needed to fulfill life cycle events of the migratory bird species using the Refuge, including waterfowl. We are committed to providing a changing mosaic of habitat for all migratory birds utilizing the Refuge.

Comment (6): No explanation on how the original height of the Bear River levee was obtained. It is unclear why this elevation was targeted or appropriate. Section 5.2.

Response: Historically, the project area identified for Project II was flooded when the Bear River flows were so high that there was overbank flooding. At some point, the original height of the levee was altered in this area and overbank flooding is no longer possible. This original height is unknown but what we do know is that it is much higher than the adjacent levees and prevents any river floodwater from entering a portion of the project area during high river flows. As discussed in Chapter 5, Project II, we will strive to create a uniform levee height along the river that allows floodwater to enter the upper portions of this area and increase the availability of spring and fall foraging habitat for migratory birds. Timing, frequency, and the extent of flooding will depend on water availability in the Bear River.

Comment (7): Concerned the purpose of this HMP is to reduce operations and maintenance liabilities first and foremost.

Response: We do believe that once the projects are implemented there will be some operational costs savings but the primary purpose of the HMP is to improve habitat for the benefit of migratory birds.

Comment (8): Page 5 &18 do not mention Duck Clubs at all, they preserve 10's of thousands of acres of habitat. Failure to recognize them is dismissive of their role in the lake's habitat.

Response: We agree with this comment and have added language regarding Duck Clubs and their importance to Section 2.2.7 of the HMP.

Comment (9): Provide more information on the difference between a CCP and a CMP.

Response: A CMP is a comprehensive management plan which is developed to broadly outline the goals of the Refuge. A CCP is a comprehensive conservation plan which is developed to outline specific goals, objectives, and outcomes for various programs on the Refuge (Habitat, Visitor Services, Law Enforcement, Maintenance, etc.). A CCP lasts for 15 years and includes NEPA, cultural resources, and endangered species analyses.

Comment (10): Question #1 - Overlap of shorebird and waterfowl areas.

Response: The Refuge's primary mission is to provide habitat that provides the resources needed to fulfill life cycle events of the migratory bird species using the Refuge, including waterfowl. Hunting is one of the NWRS "Big Six" recreational activities and we are aware of the importance and tradition of hunting at the Refuge. We are committed to providing a changing mosaic of habitat for migratory birds including waterfowl. Providing habitat for both sanctuary and hunting units will be including in annual planning activities. It is not anticipated that the current boundaries of the hunt units will change on an annual basis. The Refuge is committed to providing adequate access to hunters including access by boats to hunt areas. Although there will likely be some variability in access due to the time and duration of putting water into the hunt units, we are confident that hunting access and hunting opportunities will continue to be of a high quality. We will continue to monitor feedback from hunters on an annual basis.

Comment (11): Question #6 - Are timelines flexible? Listed by priority? Is the start depending on completion and what happens if a project is delayed?

Response: The life span of this HMP is 5 years. There are a total of 5 projects intended to be completed within those 5 years. The projects are not listed in order of priority and timelines are flexible within the 5-year period. There are many variables that must occur prior to beginning a project; including but not limited to, acquiring the funds to complete the project, staffing, and obtaining the necessary US Army Corps of Engineer permits per the Clean Water Act, to work in wetlands, and cultural resources permits from the State Historic Preservation Office. If it is not possible to complete these projects within the 5-year timeline, there may be an option to extend the HMP.

Proposed Action

Comment (12): The shorebird focal species of AMAV and BNST are too similar in their habitat needs and doesn't capture other shorebirds needs with shorter bills and legs. Suggest adding other shorebirds such as the SNPL and LBCU. Focal Species

Response: We agree with this comment and will add in the Snowy Plover as a focal species.

Comment (13): Consider one of the projects a "Test" project and use it to evaluate and adjust other projects as needed; do a phased approach to demonstrate value of new management.

Response: We agree with this recommendation. The Refuge is planning on using what is learned as we implement each project to inform future projects. The use of adaptive management is a key concept of Strategic Habitat Conservation and required to be used by FWS policy.

Comment (14): Instead of stating that the natural hydrology will be restored, change it to 'emulate'. Goal 1 Concerned about trying to restore a very altered system when the hydrology doesn't function the way it use to. Restoring to natural is impractical or impossible. Suggest stating 'restoring habitat function and values", rather than restoring hydrologic processes Goal 3; Chapter 5 page 56, concerns about claims to restore...its emulating instead.

Response: There are many definitions for the term (ecological) restoration. One of the most common being from the Society of Ecological Restoration (SER): "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed" (SER Primer on Ecological Restoration, 2002). We feel that the definition of restoration is in alignment with the language included in the HMP.

Comment (15): Proposed short dikes and more should be added to encourage sheet flow into the spur and bay; add more to the area outside 5C.

Response: Chapter Five explains that these five projects were selected from a larger list of projects based on a select number of criteria. The final list of projects does not include a project for management unit 5C or Unit 6. We agree that looking for ways to improve water flows into our management units south of the D-line dike is something that should be investigated further.

Comment (16): Would like to see a plan specific to the upland areas (Nichols, Stauffer, White). Areas are valuable for shorebirds and teal nesting; a predator plan, grazing plan, ability to utilize water out of black slough is needed.

Response: These are all good suggestions, and we will take them under consideration in the future.

Comment (17): How is the overlapping period of shorebirds and waterbirds habitat going to be managed? For Spring and Fall migration.

Response: Chapter 4 of the HMP outlines the goals and objectives, that were developed based on the principle of ecological sustainability, to guide the Refuge's habitat management program to provide distribution of habitats needed for shorebirds and waterbirds during spring and fall migrations. There are overlapping periods of time where needs will differ between the focal species and guilds. This will require the Refuge to look at the entirety of the Refuge holistically, to determine what areas of the Refuge could provide the different types of habitats, in any given year. These areas will change annually based on invasive species and other land management actions, water availability, and other factors. With careful consideration and planning, a habitat management plan is developed every year and this annual plan identifies the areas to be managed for different habitat needs.

Comment (18): How is "potentially available habitat" being defined and measured? How will we know if the objective has been met?

Response: Potentially available habitat utilizes the wetland's geometry, topography, vegetation cover, ability to add water to the wetland impoundments on the Refuge, and water depth to understand the available habitat. For example, Unit 2D is about 2,600 acres in size in total, however, the maximum number of acres of water that can be impounded by the unit that is less than 6 inches deep and contains little to no vegetation is about 1,070 acres. Modeling of the maximum available habitat for each unit was conducted using LiDAR to understand the number of acres of potentially available habitat. (Note that these calculations do not capture habitat that is available due to sheet flooding, seiche action, and other cases where water is moving across the landscape, nor the amount of habitat available south of the D-Line Dike.) The percentage factor below 100% is to allow for drying and cycling of wetlands such that the same area is not flooded constantly year after year on the Refuge.

For monitoring, we can use staff gauge levels and aerial imagery to try and capture the habitat available based on the tables we produced regarding water depth, vegetation, and the number of acres present.

Comment (19): Rewrite the migration objectives to state "provide the maximum available habitat given habitat management needs", document doesn't state clearly what will happen; vague in "not all habitats will be flooded each year".

Response: The goals and objectives of the HMP were developed to allow for maximum flexibility to utilize adaptive management principles. The location of where breeding and migration habitat will be provided, with different depths of water to meet the various life cycle requirements, will vary from year to year depending on water availability and other management actions, such as invasive species treatment or water control structure updates/repairs. Annually, using previous habitat management action, observations of vegetation response, and other monitoring parameters, a habitat management plan will be developed to achieve the goals and objectives set forth in the HMP.

Comment (20): Include a table with objectives to compare the 2004 HMP to this HMP; to highlight the changes being made.

Response: The 2004 HMP is available upon request for any individual or organization.

Comment (21): Redhead ducks, or a representative diver, should be included in the list of target species.

Response: Resources of concerns were identified using a focal species approach as well as guilds to represent the natural range of landscape variability and habitat attributes needed for life cycle events. Waterfowl (divers) were identified as a guild. For more information, see page 35 of the draft HMP and Table 6.

Comment (22): Encourage the water depth to be greater than 24" along 40% or more of the D-line.

Response: We believe the target of 0-18" of water will provide for dabbling and diving ducks for their habitat and feeding needs. Some diving ducks, such as redheads, feed most often by head tipping or dipping up. Feeding by diving requires more energy and takes more time. Water levels long the D-line in the impoundments will be aimed at the target levels in the objectives described with Goals #1 and #2. However, water levels below the D-line in the Willard Spur area and the bay may see periods of higher water levels due to high water flows and availability.

Comment (23): Project #1 - leave the natural depressions south and west of the proposed dike removal.

Response: There are no plans in Project #1 to remove the natural depressions outside of Unit 2A. The emphasis of this project is to remove the levee, fill in the borrow ditch, reclaim the settling ponds, and remove the artificial nesting islands within Unit 2A.

Comment (24): Project #1 concern on sheet flooding of islands between Unit 2 channels.

Response: Sheetflooding of the island between the Unit 2 channels is not part of this project. However, this will be considered for future HMP projects.

Comment (25): Project #3 - Do not fill in internal channel in Unit 3I.

Response: There are no plans in Project #3 to fill in the internal channel. Only the borrow ditches will be filled using the material from the removal of the adjacent levees.

Comment (26): Question #2 - Acceptable percentage of cinnamon teal nesting area.

Response: On page 41 of the HMP, the following breeding objective is identified to provide up to 400 acre of suitable nesting habitat within 200 feet of suitable brood habitat for nesting cinnamon teal from May 1 to August 30.

Comment (27): Question #4 - What role can the public play and will there be a planned public outreach component?

Response: The public can play a crucial role in helping to conduct interpretation and environmental education prior to and during a project. Prior to the 'dirt moving' component of each project and during the time of acquiring necessary permits, there will be public outreach components to showcase the projects and their benefits.

Comment (28): Question #5 - Is the budget solely on government funding? Challenges for full funding? Projects be held up?

Response: Funding for these projects is primarily federal. The challenges for funding will be that it is dependent on allocations. However, the goal would be to leverage federal funding with opportunities to work with partners (state, non-profits, and others) to obtain non-federal funding in support of these projects.

Potential Effects

Comment (29): There is a risk of spreading phragmites and decreased ability to manage water flows to combat this spread - Goals 1-3,5.

Response: The goals and objectives in Chapter 4 are aimed at restoring and managing hydrology to provide migration and breeding habitat for focal species. This will require varying water levels at specific times of the year and at specific depths. The goals are not aimed at providing water year-round, as this will increase the chance of phragmites spread. Additionally, removing and updating infrastructures are not planned Refuge wide, but rather in the specific areas identified in the HMP in Chapter 5. These areas contain infrastructure that are no longer functional (i.e., levee is too narrow or low, or as in the case of Project II – they are not used at all), used, or are possible traps as a phragmites seed source.

Comment (30): Sheetflowing will transport sediments downstream and the unique topography will be lost. Salts will be flushed from sediments, allowing cattail and phragmites to establish. Goal 3.

Response: The transport and deposition of sediment on a delta is a natural process that constantly changes the topography. Historically this occurred on Bear River MBR, but now the sediment is being trapped unnaturally. The unique topography created on the Refuge is in response to deltaic processes that have largely been lost due to intensive water management techniques and the capture of sediment by upstream dams. The goal of the sheet flooding is to better emulate the natural hydrology and mimic historic deltaic processes that we believe will enhance the habitat present on the delta. The germination of phragmites and cattail is a constant concern that will be monitored by Refuge staff. The HMP promotes the distribution of water on the delta outside of key germination times for these tall emergent species (e.g., application of water during warm soil and water temperatures). The HMP promotes sheet flooding only during the spring or late fall to avoid germination of phragmites.

Comment (31): Habitat management may come at the expense of hunting opportunities. Prioritize flooding to ensure equitable distribution of flooded areas amongst sanctuary and hunt units; Concerned about hunting access and how proposed management changes may alter access; will hunt plan be modified? Will there be sufficient water for people to use boats? If water management significantly limits hunting opportunities, then changes are opposed.

Response: The Refuge's primary mission is to provide habitat that provides the resources needed to fulfill life cycle events of the migratory bird species using the Refuge, including waterfowl. Hunting is one of the NWRS "Big Six" recreational activities and we are aware of the importance and tradition of hunting at the Refuge. We are committed to providing a changing mosaic of habitat for migratory birds including waterfowl. Providing habitat for both sanctuary and hunting units will be included in annual planning activities. It is not anticipated that the current boundaries of the hunt units will change on an annual basis. The Refuge is committed to providing adequate access to hunters including access by boats to hunt areas. Although there will likely be some variability in access due to the time and duration of putting water into the hunt units, we are confident that hunting assets and hunting opportunities will continue to be of a high quality. We will continue to monitor feedback from hunters on an annual basis.

Comment (32): Sheet flowing conflicts with the need for more sustained water levels to sustain vegetation that serve as food resources for waterfowl; need to be able to hold water longer; need to have both sheet flowing and season long ponded units to provide for varied habitat; there has been a loss of sago pondweed, changes should not come at the expense of sago growth.

Response: The HMP identified goals aimed at infrastructure improvements in a portion of the Refuge and also identifies new targets for water levels to support migratory and breeding birds during their life cycles. These target levels will be implemented on a rotational basis throughout all 77,000 acres of the Refuge to provide a myriad of habitat conditions for the migratory birds that utilize the Refuge during all stages of their life cycles. The decision on where and what unit will get a specific amount of water will be determined annually in order to best respond to current environmental conditions, such as: water availability, vegetation response, invasive species management, and other resources. The ability to manage water more efficiently is ultimately the goal of all projects and goals identified in the HMP.

Comment (33): Too extensive of a dike removal will limit ability to manage water; Suggest increasing the number of dikes to be able to create more shallowly flooded units. Allows for precise water management.

Response: The goals and projects identified in the HMP are aimed at ecological sustainability to improve efficiency of managing water, as well as to mimic or emulate historic deltaic processes. While some areas of the Refuge will see infrastructure removed due to no longer being effective, functional, or even used, it is possible that other areas may need improved water control structures and levees. For example, Project IV in Chapter 5 identifies locations on the Refuge that will require infrastructure improvements and Project II identifies a few short dikes that are needed to achieve the projects objectives.

Comment (34): Consider overwater and diving duck habitat for redhead recovery Resource of Concern, Section 3.1.

Response: Chapter 4 outlines goals and objectives for providing breeding habitat on the Refuge utilizing various water depths and emergent vegetation cover. Redheads nest overwater within bulrush (emergent species). Yet historically, the delta did not typically host large group stands of bulrush. In order to facilitate large stands of bulrush, a unit would need to be flooded for the entire year and creating a reliable stand of bulrush is not possible given the limited water resources. However, there will still be some of this habitat available as we rotate water levels throughout the Refuge.

Comment (35): No assessment for why to remove islands, no assessment of their importance, suggest deferring decision to remove until a monitoring effort is conducted.

Response: During the development of the goals and objectives of the HMP, discussions were held with various staff that have worked and observed bird use at the Refuge. While there is no empirical data available, anecdotal evidence from staff observations show that the artificial islands serve as staging ground for predators and are not a natural topographic features of historic wetlands conditions. In short, they are sinks, rather than a benefit. Primarily gulls predate on the desired species that utilize the islands and have done so such that the islands are no longer used be desired species. The breeding objectives in the HMP are aimed at creating habitat in areas that are flat and have water in the summer so as to replace the need for artificial nesting islands. Another benefit of removing the islands is eliminating the ditches around the islands that are serving as 'traps' for water and creating an environment that favors invasive phragmites growth.

Comment (36): Plan doesn't provide for any projections of impacts of reduced Bear River flows and other water sources on proposed action. Suggest a complete feasibility analysis including a comprehensive Refuge-wide hydraulic modeling effort to forecast changes to numbers.

Response: The Refuge utilizes many different water rights to provide habitat and divert water from the Bear River. These water rights come from the Bear River, Malad River, and springs as shown in Chapter 2, Table 4. The Service will continue to seek administrative protection of these water rights and relief from junior inquiries that may reduce availability. The changes in the Bear River flows are impacted by many different factors; climate change and increase in residential and agricultural uses. The Service continues to be engaged in discussions with Bear River watershed partners.

Comment (37): Do not object to changing infrastructure, filling in canals and rotating. Yet, concerns about the effects of these changes. Needs of waterfowl must remain an important management objective.

Response: The needs of waterfowl still remain an important management objective.

Comment (38): Lower water levels could increase for botulism outbreaks and severity/duration.

Response: We agree that in general, lower water levels combined with high temperatures could lead to botulism outbreaks. We feel that when we desire to provide shallow water habitat for migratory birds, we will be able to control the timing and duration of the events to not facilitate botulism outbreaks. Additionally, the Refuge will still have the ability to drain or fill wetland units (if water is available) to manage for botulism concerns if they did occur.

Comment (39): What is the impact of Project 2 on Willard Spur? Provide additional info on amount, quality, and timing of water discharged to the Spur, and the benefits of this to the birds using the Spur.

Response: Part of Project II is to direct water more directly out into the Willard Spur area at the water control structure at the D-Line Dike via short stub dikes, rather than the water moving along the D-Line Dike borrow pit. It is thought that this approach will help in spreading water out within the Spur and increase the amount of habitat available south of the D-Line. This may change some of the locations where water enters the Spur once it has left the Refuge boundary due to topography and sediment deposition. The spreading of water out higher along the Whistler Canal is somewhat experimental in nature and the direct impacts to water flows will have to be assessed after initial implementation. If the project works as intended, it is thought that this may allow for more water to be applied in the spring to Unit 4 to create habitat via sheet flow throughout Unit 4 and within Unit 7 south of the D-Line. This may result in a change in the timing of when water enters the Spur - more water delivered in the spring and at higher volumes than traditionally experienced. Again, these impacts will have to be assessed after project completion.

Comment (40): How will the HMP impact the BRCC?

Response: Implementation of the HMP will not impact the BRCC.

Comment (41): Sheetflowing was a management strategy that is no longer used in the GSL managed wetlands. What has changed now where this strategy would work and it wouldn't in the past?

Response: The transport and deposition of sediment on a delta is a natural process that constantly changes the topography. Historically this occurred on Bear River MBR, but now the sediment is being trapped unnaturally. The unique topography created on the Refuge is in response to deltaic processes that have largely been lost due to intensive water management techniques and the capture of sediment by upstream dams. The goal of the sheet flooding is to better emulate the natural hydrology and mimic historic deltaic processes that we believe will enhance the habitat present on the delta.

Comment (42): Questions about the Bear River overbank flooding…will it flood the project area, what is the timeframe, questions on the viability of this project and if it's possible. How often will it flood, how will it impact waterfowl use, where will it overflood, doe.

Response: Historically, the project area identified for Project II was flooded with the Bear River flows were so high that there was overbank flooding. At some point, the original height of the levee was altered in this area and overbank flooding is no longer possible. This original height is unknown but what we do know is that it is much higher than the adjacent levees and prevents any river floodwater from entering a portion of the project area during high river flows. As discussed in Chapter 5, Project II, we will strive to create a uniform levee height along the river that allows floodwater to enter the upper portions of this area increase the availability of spring and fall foraging habitat for migratory birds. Timing, frequency, and the extent of flooding will depend on water availability in the Bear River.

Comment (43): Hunting management - do not draw down two units in the same year, and if a unit is drawn down then would like to see another unit opened.

Response: The Refuge's primary mission is to provide habitat that provides the resources needed to fulfill life cycle events of the migratory bird species using the Refuge, including waterfowl. Hunting is one of the NWRS "Big Six" recreational activities and we are aware of the importance and tradition of hunting at the Refuge. We are committed to providing a changing mosaic of habitat for migratory birds including waterfowl. Providing habitat for both sanctuary and hunting units will be including in annual planning activities. It is not anticipated that the current boundaries of the hunt units will change on an annual basis. The Refuge is committed to providing adequate access to hunters including access by boats to hunt areas. Although there will likely be some variability in access due to the time and duration of putting water into the hunt units, we are confident that hunting assess and hunting opportunities will continue to be of a high quality. We will continue to monitor feedback from hunters on an annual basis.

Comment (44): Question #3 - Are there specific water depth goals for each unit/season and at what point will emergency water measures be taken?

Response: The goals and objectives in Chapter 4 of the HMP are aimed at restoring and managing hydrology to provide migration and breeding habitat for focal species. This will require varying water levels at specific times of the year and at specific depths. The goals are not aimed at providing water year round, as this will increase the chance of phragmites spread. We do not have emergency measures for water as our water comes from shares and water rights. An annual water management plan is developed each year to prioritize which unit of the Refuge will be flooded depending on water availability, climate condition, and management action (i.e. grazing and phragmites).

7.2 References

See the 2021 HMP Bibliography section. In addition, see the 2021 HMP for abbreviations and glossary.

7.3 List of Preparers

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