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Great Salt Lake Ecosystem Program

Great Salt Lake Waterbird Survey

Five-Year Report (1997-2001)

Publication Number 08-38

Great Salt Lake Ecosystem Program
Utah Division of Wildlife Resources
1594 West North Temple
Salt Lake City, Utah 84114

James F. Karpowitz, Director

Great Salt Lake Waterbird Survey

Five-Year Report (1997-2001)

by

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James F. Karpowitz, Director

Preface

The Great Salt Lake Ecosystem Program was instituted by the Utah Division of Wildlife Resources (UDWR) in July of 1996. Our goal was to study Great Salt Lake (GSL) and its biota. An important part of this objective was understanding the biology of brine shrimp and how it relates to three important questions. How many brine shrimp cysts should remain in the lake after their commercial, fall harvest in order to sustain shrimp populations the following spring? What are the food needs of the birds? What is the remaining cyst availability for the subsequent harvest?

We determined that for a survey of the birds associated with the lake, it would be necessary to quantify what species utilized the lake, how many, and where they occurred throughout the year. Habitat conditions were also of interest. As the levels of the lake fluctuate, so do the habitats and bird use. A five year study helped to account for this critical influence along with normal bird population fluctuations. For that period of time, over 150 personnel, many of them volunteers, conducted surveys of 53 sites up to 17 times per year. The five year survey resulted in an enormous data set.

After the five years of surveys, two years were spent assembling, analyzing, editing, and presenting the data. After preparing a preliminary report, we decided color graphics best represented the data, however, the size of the report (313 pages) made comparisons between species, sites, and times of the year cumbersome. We discovered a similar representation of data done by the Oregon Department of Fish and Wildlife in an interactive CD. That format presented the data and allowed comparisons much better than the written report and permitted an easier and more cost effective method to distribute and share the information. At that time, the popularity of the internet was growing quickly, and we saw the opportunity for presenting the information on the UDWR website as well on CD.

A tremendous amount of work was done by UDWR staff and Matt Cole to construct the interactive CD. The result of all these efforts culminated in the end product you are viewing now. We believe this presentation of the data is in a form that is most user friendly and easy to understand. Studying bird use at the lake for five years gave us tremendous resolution on what species, and their populations, use specific places around the lake over time. With this information, biologists are able to offer the best advice about habitat conservation and continue monitoring populations in an effort to realize our goal of understanding GSL biota.

We gratefully acknowledge the help and assistance that many offered to achieve this goal. First and foremost, we recognize all of those that trudged through mud, bugs, and salt for many survey periods over the five years of the project. Matt Cole worked for a long time to develop the CD and suffered through many edits and changes until we had the best possible product. Suzanne Fellows, of the U. S. Fish and Wildlife Service, provided funding to cover a portion of the costs to develop the CD. Jon Bart, of the USGS Snake River Field Station, provided technical interpretation of the data. All of the Great Salt Lake Ecosystem Program staff over the years have developed and contributed, especially Don Paul, Ann Manning, John Luft, John Neill, and Clay Perschon. With an effort this size, there are undoubtedly others that lent a hand. To all of you, a very sincere thank you. Your efforts have resulted in the conclusive success of the project.

--Clay Perschon, Fmr. Great Salt Lake Ecosystem Program Manager

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Glossary

anthropogenic Caused by or relating to human intervention.
antithetical Of, relating to, or marked by the direct or exact opposite.
arid Lacking moisture, especially having insufficient rainfall to support trees or woody plants.
aridity The state or quality of being arid or without moisture; dryness.
avifauna The birds of a specific region or period.
biomass The total mass of living matter within a given unit of environmental area.
cryptic Tending to conceal or camouflage.
ephemeral Existing or lasting only a short time; short-lived or temporary.
filamentous algae Algae suspended in water with a thread-like root system.
fledgling A young bird that has recently acquired its flight feathers.
foraging To wander in search of food or provisions.
geo- Of or relating to the earth.
geomorphic Of or relating to changes in the earth.
halophile An organism that requires a salty environment.
halophyte Any terrestrial plant that is adapted to grow in high concentrations of salt, such as in salt marshes.
hydrology The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.
inorganic Involving neither organic life nor the products of organic life.
invertebrate An animal, such as an insect or mollusk, that lacks a backbone or spinal column.
leeward On or toward the side to which the wind is blowing.
limnology The scientific study of bodies of water for their biological and physical and geological properties.
molt To shed periodically part or all of a coat or an outer covering, such as feathers, cuticle, or skin, which is then replaced by a new growth.
obligate Able to exist or survive only in a particular environment or by assuming a particular role.
organic Of, relating to, or derived from living organisms.
paleoclimatic Of or relating to ancient or prehistoric climate.
passerine Of or relating to birds of the order Passeriformes, which includes perching birds and songbirds such as the jays, blackbirds, finches, warblers, and sparrows.
phylogenetic Of or pertaining to the evolutionary relationships among species.
piscivorous Habitually feeding on fish; fish-eating.
playa A nearly level area at the bottom of an undrained desert basin, sometimes temporarily covered with water.
pupae The nonfeeding stage between the larva and adult in the metamorphosis of holometabolous insects, during which the larva typically undergoes complete transformation within a protective cocoon or hardened case.
recurvirostrid Any shorebird species within the family Recurvirostridae (i.e., stilts and avocets). Bills are recurved or bend up.
saline Of, relating to, or containing salt; salty.

topography Graphic representation of the surface features of a place or region on a map, indicating their relative positions and elevations.
transitory Existing or lasting only a short time; short-lived or temporary.
ubiquitous Being or seeming to be everywhere at the same time; omnipresent.
vagrant Moving in a random fashion; not fixed in place.
xeric Of, characterized by, or adapted to an extremely dry habitat; being deficient in moisture.

List of Abbreviations

AC	Area Count
AR	Aerial Survey
ASL	Above Sea Level
ATV	All-terrain Vehicle
BCR	Bird Conservation Region
BLM	Bureau of Land Management
DNR	Department of Natural Resources
GIS	Geographic Information System
GPS	Global Positioning System
GSL	Great Salt Lake
GSLEP	Great Salt Lake Ecosystem Program
ha	Hectare
ISSR	Inland Sea Shorebird Reserve
MBR	Migratory Bird Refuge
ppt	Parts per Thousand
PS	Point Sample
TC	Total Count
UDWR	Utah Division of Wildlife Resources
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WBS	Waterbird Survey
WHA	Wildlife Habitat Area
WMA	Waterfowl/Wildlife Management Area
YBP	Years Before Present

See Appendix 1 for four- and six-letter avian species codes.

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Abstract

The Great Salt Lake (GSL) Waterbird Survey (WBS) is a five-year study (1997-2001) that examines the relationships of migratory waterbirds with the GSL ecosystem through the spring, summer and fall seasons, between years, and across a variety of habitats. An important part of this ecosystem is the dynamic lake elevation, which during the study period ranged from 4199.3' to 4204.6' above sea level (ASL). This shift in water level causes dramatic changes in the availability and quality of habitat used by more than 55 species of waterbirds. During the study the high lake elevation was in 1999. As a result, many stands of emergent vegetation were inundated with lake water, and became salt burned. As the lake receded to its lowest point during the study period in 2001, extensive mud bars void of vegetation were exposed. For five years researchers completed counts of waterbirds at GSL every ten days from April through September. The counts included the following families: *Gaviidae, Podicipedidae, Pelecanidae, Phalacrocoracidae, Ardeidae, Threskiornithidae, Anatidae, Rallidae, Gruidae, Charadriidae, Recurvirostridae, Scolopacidae, Laridae*. Avian use of the GSL ecosystem was measured by bird use days (one bird use day equals one bird spending 24 hours within the study area during the study period). The five-year mean bird use days is 86,752,258. Bird use days for all GSL survey areas combined were lowest during the high water year (1999).

Introduction

The discovery of the GSL by Jim Bridger in 1824, as he explored the Bear River Delta, introduced European man to the lake's abundant waterbird resources (Miller 1980). Since that time, valley residence interests in GSL bird life changed from the eclectic practices of egg collection, guano harvest and market shooting to contemporary scientific investigation. With increasing human populations in the GSL valley came an elevated awareness in GSL bird life. It was difficult to ignore the extent and richness of waterbird presence. The establishment of numerous duck clubs within the delta complexes of the Jordan, Weber, and Bear River systems is evidence of the abundant migratory waterfowl moving through the lake's wetlands. The creation of State and Federal wildlife management areas followed on the heels of duck club development. These areas were originally established to enhance, protect, and manage waterfowl habitat. Currently, there are nine wildlife management areas including eight State areas and one, large Federal wildlife area. Over time each management system has carried out a variety of primarily independent bird surveys to assess use at individual complexes.

In addition to curiosity in migratory birds, some valley resident academics, visiting scientists, and hobbyists have developed an interest in GSL breeding bird populations, especially colonial species. The most prominent figure emerging from a colorful history of GSL bird study is William H. Behle, who over the course of several decades studied California gulls, American white pelicans and other breeding colonial species (Behle 1958).

Behle's systematic survey of some colonial nesting populations, the State of Utah's fall waterfowl aerial surveys, and some limited but intensive species and suite population surveys have contributed to the collective avian knowledge. Many of these early surveys have made significant contributions to the present knowledge of the GSL's importance to continental migratory bird populations. These include American white pelican (Behle 1958, Knopf 1975, Paul et al 2000a), tundra swan, cinnamon teal, ruddy duck, redhead, pintail ducks (UDWR unpublished reports), white-faced ibis (Paul and Manning 2000, 2001a; Ivey 2001), snowy plover, American avocet and black-necked stilt (Shuford et al. 1995, Paton 1994), Wilson's and red-necked phalaropes and eared grebes (Jehl 1988, Paul et al. 1999, 2000c). Even so, until now there has not been a comprehensive survey of all waterbird use in all habitat types conducted within the GSL ecosystem during the same time frame.

Study Objectives

It became evident to those working with GSL avian resources that to more fully understand how birds distribute across the landscape and how each habitat complex contributes to occurrence and abundance of waterbirds through time, a comprehensive study was in order. In 1996, wildlife biologists and managers met on several occasions to develop plans for an ecosystem-based waterbird survey. The Great Salt Lake Ecosystem Program (GSLEP) of the Utah Division of Wildlife Resources (UDWR) managed the project. The GSLEP terrestrial Wildlife Biologist was assigned to oversee the project, but the project was founded in the community with community participants sharing ownership. Several decisions were made at the beginning to assist in narrowing the focus including setting the survey period, and limiting the target species to waterbirds of the families: *Gaviidae, Podicipedidae, Pelecanidae, Phalacrocoracidae, Ardeidae, Threskiornithidae, Anatidae, Rallidae, Gruidae, Charadriidae, Recurvirostridae, Scolopacidae, Laridae*. A detailed list is included as Appendix 1. Passerine marsh birds were excluded. Except for a few small sections associated with wetland surveys, uplands were excluded from the inventoried habitat types.

A primary objective was established and inventory protocols were developed to address it. The primary project objective as stated in the Great Salt Lake Waterbird Survey Narrative is:

> For migratory waterbird species using the Great Salt Lake Ecosystem, we hope to estimate individual species populations during the migration period, their periods of use, location, and habitat characteristics of use areas plotted against Great Salt Lake elevation (1997-2001).

The collection of data for use in conservation planning for the GSL was a secondary objective that evolved through the development of the protocol and which was of particular interest to the drafters of GSL avian plans, especially the Draft Shorebird Management Plan, and to habitat managers. The protocols developed to address these objectives will be discussed in the methods section of this report.

Community-Based Participation

Community participation in this project was essential and desired. A large number of surveyors were required because of the enormity of the task and the desire to build ownership in the conservation of this unique ecosystem. Salt water covers 3,885 km^2 of lake bottom and the wetlands occupy 1,600 km^2. In order to conduct extensive surveys within all waterbird habitats some 40-50 survey teams would need to be enlisted.

There were not enough professional biologists in the area to staff the effort. Surveyors representing Federal and State agencies, several non-profit organizations, GSL associated industries, and a significant number of Salt Lake valley citizens assisted through the five-year study period.

Regional, Physical and Ecological Setting

The GSL is located at the lowest point of a 35,000 km^2 drainage basin (between 40º and 41º N, 113º and 112º W). This places the lake on the eastern edge of the Great Basin embracing the west escarpment of the Wasatch Range. One of the four largest terminal lakes in the world, the GSL varies in size as it expands and contracts in cadence to changing moisture patterns.

The GSL sits in a high elevation, cold desert region modified by arid mountain-framed basins. Temperatures range from 38º C in summer to -18º C in winter. Great Salt Lake's west side habitats are xeric, receiving less than 25 cm of annual moisture. In contrast, the east side receives 38 cm. The east margins of the lake fall under the influence of the "Lake Effect:" as warmer air lifts off the GSL, it condenses at higher elevations of the Wasatch Mountains.

The GSL ecosystem is an extensive complex of salt water, wetlands, uplands and drainage systems occupying roughly 7,800 km^2; it becomes more impressive as one considers its regional and hemispheric setting. Except for the moister mountain ranges and high elevation valleys, the GSL sits in an expansive dry sweep of land in Western North America. This region extends from the Canadian Prairies to the Tropic of Cancer and receives less than 50 cm of precipitation annually. Because of the surrounding desert, the GSL acts as an oasis for waterbirds as they explore breeding habitats and establish migratory pathways within and across this arid expanse. For many species the lake is their migratory "halfway point" between northern breeding grounds and southern wintering locations. In this case, the lake is an important refueling site with seasonally abundant invertebrate resources.

GSL habitats are varied and in some cases unique among salt lakes of Western North America. The following is a description of GSL habitat types (Aldrich and Paul 2002).

> The terminal nature of the lake with its various saline systems and associated halophiles contribute greatly to the uniqueness of the natural wonders that happen there. The Great Salt Lake is a playa lake with an extremely low-gradient bottom. When the surface elevation is 4202 feet above sea level, the average depth of the lake is four meters. With the seasonal recharge of water from rivers and other drainages and subsequent evaporation, the effect of this shallow flat bottom is most apparent in the highly transitory shoreline. The result is ephemeral pools, expansive mud flats and sand bars that warm quickly in spring and easily reach temperatures around 29º C in summer. Some parts of the lake shoreline migrate more than 800 m from spring to fall depending on the levels of water recharge and evaporation that year. These water depth and shoreline fluctuations are fundamental ingredients in the creation of highly productive habitats for wading waterbirds.

Lake Elevation Fluctuation

When considering the history of bird use within the GSL region, it is important to consider its climate and geomorphic history. The GSL is a recent lake, dating approximately 10,000 years before present (YBP). Its Pleistocene predecessor, Lake Bonneville, with its enormous size, abundant fresh water, and cool climate, was significantly different from today's GSL. Avian paleontological evidence indicates that Bonneville supported, in part, a different avifauna complex than what currently persists in this more arid climate (Miller 2002).

Between 19,000-10,000 YBP the climate changed and a catastrophic hydraulic breaching of weaker geologic substrate at Red Rock Pass spilled 105 vertical meters of water from Lake Bonneville into the Columbia River Basin. These events soon led to a salt lake environment. Much paleoclimatic evidence indicates two periods of aridity occurred during the mid-Holocene Epoch. These periods were between 7,500 and 5,000 years ago (Street and Grover, 1979). Evidence suggests that the GSL was a playa landscape, at least briefly, during mid-Holocene time (Currey 1980). Even in the absence of a salt water body, salt marshes and saline ponds would have existed especially along the near-mountain, east margins of the lake basin. This is important when considering the potential history of long-term waterbird presence in the area during profound periods of dryness.

Records of lake elevations have been kept since 1847. In this period the lake has fluctuated within a range of six meters (20 feet), reaching a high of 4212 feet in the mid 1980s and a low of 4191.35 in 1963. Under present climatic conditions, the GSL tends to fluctuate in dynamic equilibrium between water recharge and evaporation. Studies of water consumption within the GSL drainage basin indicate that without human water use, the lake would have an additional 1.5 m (five feet) of elevation (Arnow 1980). However, climatic trends in the GSL area still are the main driving force in lake elevation and volume.

Physical and Biological Relationships

The limnology of the GSL, and its subsequent effect on birds using the system, is in large part a consequence of physical and chemical conditions. Many of the current physical features of the lake that pose major influences upon lake biology are human-produced. Among these are trans-lake causeways, solar pond impoundments for mineral extraction, and the dikes, levees, roadways, and impoundments constructed for wildlife habitat management. Each of the three major river deltas, as well as other significant wetland complexes, have been modified significantly through water diversion, distribution, and impoundment. The GSL offers a unique relationship between fresh and salt water habitats that is particularly attractive to birds. In some areas this relationship is compromised through development and in others it is enhanced. This salt water/fresh water interface is often allied with the GSL shoreline. The degree of salt and fresh water association is mostly dependant on lake elevation. At any one point in time, parts of the GSL can be removed from fresh water by hundreds of meters of exposed mud or sand bars, while at other elevations, salt and fresh water may be continually mixing along the lake. Additionally, flooding by the GSL during periods of high water elevation can cause salt water intrusion into fresh water impoundments.

Lake volume and elevation affect brine concentrations. In recent years brine concentrations are also a product of intra-lake diking. These dikes, in conjunction with lake volume, have essentially created four distinct limnological units. Each of these lake units harbors its own halophyte and halophile community. Some of these lake complexes are important as waterbird foraging sites. These conditions within the Great Salt Lake Ecosystem provide for diverse habitat conditions that are dynamic through climatic cycles. There are four and one half billion tons of salt in the GSL system, distributed throughout the lake in solution or as bottom precipitants.

There is also an important relationship between shoreline conditions and brine fly production. When brines exceed 60 ppt at the shoreline and there is an appropriate substrate, impressive populations of brine flies are produced in the warm seasons. Thousands of brine fly adults can occur per square meter. A recent survey of brine fly pupae casings estimated nine billion casings washed up on shore along a six-mile stretch of the Antelope Island State Park Causeway (Paul et al. 2001c). Hundreds of waterbirds may be found when these brine conditions and associated brine fly populations are located in close proximity with the distinct emergent vegetation and abundant macroinvertebrate populations of fresh water wetlands or drainages.

When brine concentrations and other factors are appropriate, populations of brine shrimp persist throughout the water column and occupy open water environments. These conditions are most often located within the South Arm portion of the GSL. Where healthy populations of brine shrimp occur, so do foraging waterbird populations, often in significant numbers. Eared grebes, phalaropes, gulls, and wintering ducks are especially attracted to this condition.

The Great Salt Lake's Importance to Birds

Before this study, data had been collected for individual species that brought to light the local, regional, continental, hemispheric, and world importance of GSL to the species occurring here. For some species, the GSL ecosystem is important for breeding, for others the area is important during migration, and for still others, the lake provides important wintering habitat (Table 1). Some species use the lake for combinations of these reasons. Implicit in these uses of lake environments, depending on the species, is the need for a place to molt, fatten, court, and stage for migration. Significant numbers of American bald eagles and peregrine falcons forage at the lake on its concentration of waterbirds. Several species of swallows and other passerines exploit the robust populations of brine flies and midges at the lake.

The importance of the GSL to birds is underscored by the levels of local, regional, and national planners that have included the GSL in their scope of concern and conservation action. The GSL is prominently featured in the U.S. Shorebird Conservation Plan and the Intermountain West Regional Shorebird Plan. The GSL ecosystem is also featured in the Intermountain West regional and Continental Waterbird Conservation Plans. The GSL and associated wetlands have long been recognized by the North American Waterfowl Management Plan as key to the habitat integrity of the Pacific Flyway. The GSL is one of the few ecosystems in western North America that is recognized as a site of hemispheric importance within the Western Hemisphere Shorebird Reserve Network.

Recently, avian values of the GSL were recognized by the GSL Comprehensive Management Plan developed under the auspices of the Utah Department of Natural Resources. Currently, a GSL Shorebird Plan is being developed as a tool in lake wide conservation planning for use by the various GSL resource users.

Table 1. Noteworthy avian resources of the Great Salt Lake.

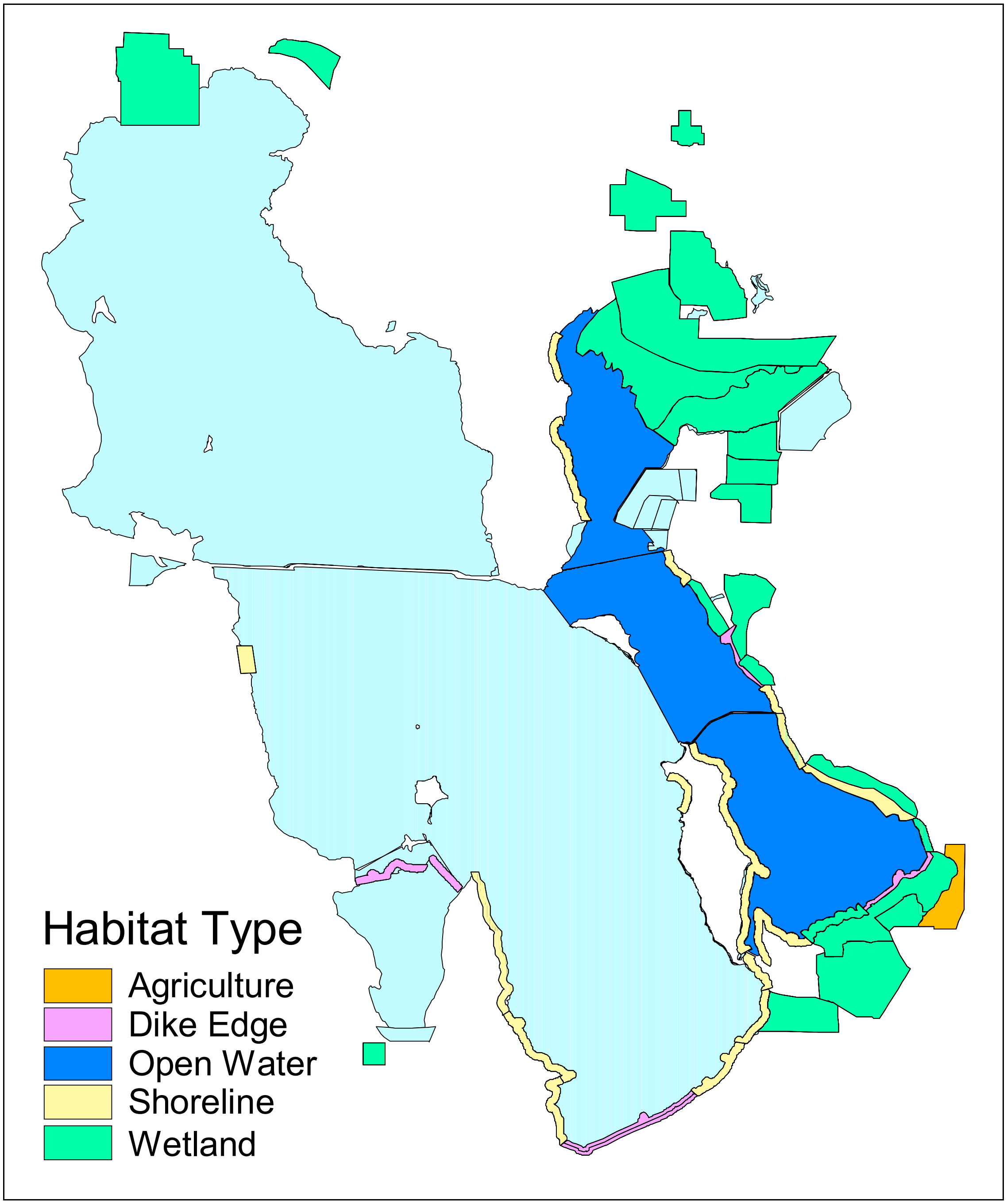
Species	**Population and Status Values**
Wilson's Phalarope	500,000: largest staging concentration in the world (Jehl 1988)
Red-necked Phalarope	240,000: single day estimate (Paul 1982)
American Avocet	250,000: many times higher than any other wetland in the Pacific Flyway (Shuford et al 1995)
Black-necked Stilt	65,000: many times higher than any other wetland in the Pacific Flyway (Shuford et al 1995)
Marbled Godwit	30,000: the only staging area in the interior United States (Shuford et al 1995); 43,000 peak period count (this report)
Snowy Plover	10,000: the world's largest assemblage, representing 55% of the entire breeding population west of the Rocky Mountains (Paton 1994)
Western Sandpiper	150,000: single day count (this report)
Long-billed Dowitcher	32,000: single day count (Shuford et al 1995)
American White Pelican	20,000 breeding adults: one of the three largest colonies in the western United States (Paul et al 2000a)
White-faced Ibis	21,600 breeding adults: world's largest breeding population (Paul et al 2000b)
California Gull	160,000 breeding adults: world's largest breeding population in North America (Robinette et al 1993)
Eared Grebe	2,200,000: one of two of the largest staging populations in North America (Neill et al 2006)

Methods

Study Area

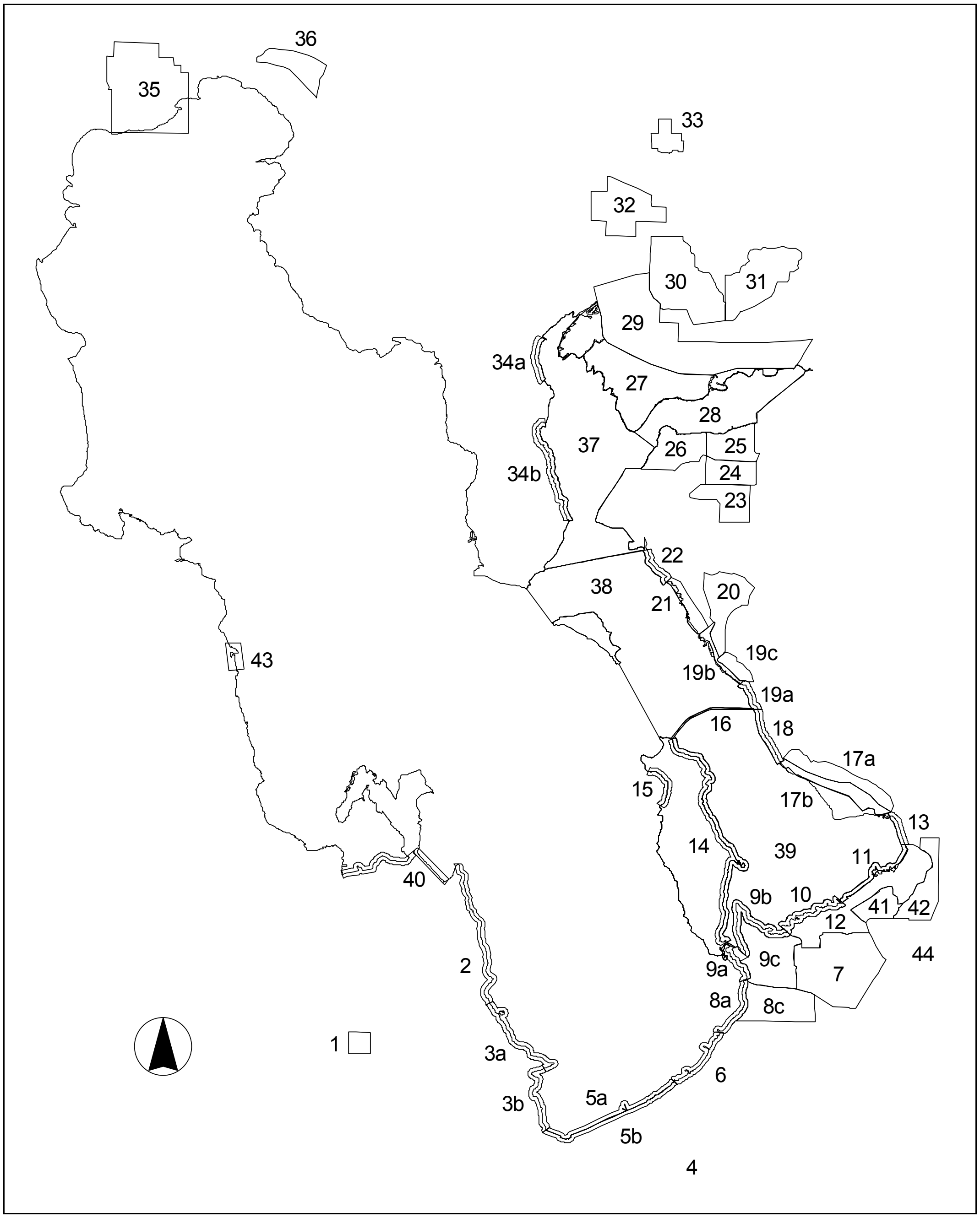
Because of the size of the GSL ecosystem, the original organizing group of the GSL Waterbird Survey decided to concentrate the survey efforts for the five-year study on the known areas of waterbird concentration within the GSL ecosystem. In general, this area included the GSL surface, shoreline, and associated wetlands, including the three major delta regions and nearby wetland complexes that drain into the GSL. Within this focus area, we identified sites to be surveyed in all the primary habitats, which included open water, shoreline, managed and unmanaged wetlands, and points of fresh/salt water interface (Figure 1). Most of the survey areas occurred near the east side, and north and south ends of the lake. There were a few survey areas that were placed on the west side and at the extreme north and south ends of the lake to cover more xeric environments. Of the four regions of the lake proper, only the North Arm (Gunnison Bay) was left unsurveyed.

Figure 1. Great Salt Lake Waterbird Survey areas classified by habitat type.



Actual survey sites included all the primary wetlands, and all of the shoreline on the east side of the lake from Stansbury Island on the south to and including the east side of Promontory Point on the north end (Figure 2, Table 2). Open water was surveyed at Farmington Bay, Bear River Bay, and Ogden Bay west to a georeferenced line between Antelope and Fremont islands. An estimated 73% of important wetlands, largely within duck clubs, was not covered by this effort because of limited access and man power.

Figure 2. Great Salt Lake Waterbird Survey areas. See Table 2 for names and specific descriptions.



Organizers of actual survey sites took into consideration land ownership, potential access, proximity to other survey areas, habitat type(s), the ability to recruit surveyors, specialized equipment needs and other logistical factors. The selection of actual survey routes and area sizes was largely predicated on the capacity to survey the area in four-hours or less. Survey areas were mapped and assigned a survey area name and number. Eventually, each survey was developed into a survey polygon and georeferenced for purposes of assessing relative avian population. Over the five-year study period, five new survey areas were included into the project.

Table 2. Summary of GSL Waterbird Survey areas.

Area Number	Area Name	Years Surveyed	Survey Technique*	Mode of Travel	Site Description
1	Timpie Springs WMA	1997-2001	TC	Driving	State managed wetland
2	Stansbury Island North	1999-2001	AR	Airplane	Private Shoreline
3a	Stansbury Island South- N	1997-2001	TC w/ PS	ATV/walking	Shoreline
3b	Stansbury Island South- S	1997-2001	TC w/ PS	ATV/walking	Shoreline
4	Interstate 80 South	Not surveyed			
5a	I-80 North-N	1997-2001	TC w/ PS (semi-circular plots)	Driving	Shoreline
5b	I-80 North- S	1997-2001	TC	Driving	Wetland-flooded area
6	Saltair	1997-2001	TC w/ PS	Walking	Shoreline
7	Associated Duck Club	1997-2001	TC	Driving/walking	Private duck club
8a	Kennecott- Lakeside	1997-2001	TC w/ PS	Walking	Shoreline
8c	Kennecott- ISSR	1997-2001	TC	Walking	Privately managed wetland
9a	Audubon Lakeside	1997-2001	TC w/ PS	ATV/walking	Shoreline
9b	Audubon North	1997-2001	TC w/ PS	ATV/walking	Shoreline
9c	Audubon Interior	2001	TC w/ AC	ATV/walking	Privately managed wetland
10	Crystal Lakeside	1997-2001	TC	Airboat	Marsh
11	Farmington Bay Lakeside	1997-2001	TC w/ PS	Driving	Shoreline
12	Farmington Bay WMA	1997-2001	TC w/ AC	Driving	State managed wetland
13	West Farmington	1997-2001	TC w/ PS	Walking	Shoreline
14	Antelope Island East	1997-2001	TC	Driving	Island shoreline
15	Antelope Island West	1997-2001	TC w/ PS	Walking	Island shoreline
16	Antelope Island Causeway	1997-2001	TC	Driving	Road to island
17a	West Kaysville- Interior	1997-2001	TC	Airboat	Marsh
17b	West Kaysville- Shore	1997-2001	TC w/ PS (1997), TC (1998-2001)	ATV/walking/airboat	Shoreline
18	West Layton	1997-2001	TC w/ PS	Walking	Shoreline
19a	Howard Slough WMA- Shore	1997-2001	TC w/ PS	Walking	Shoreline
19b	Howard Slough WMA- Dike	1997-2001	TC	Driving	Diked shoreline
19c	Howard Slough WMA- Pond	1997-2001	TC w/ AC (1997), TC (1998-2001)	Driving/walking	State managed wetland
20	Ogden Bay WMA	1997-2001	TC w/ AC	Driving	State managed wetland
21	Ogden Bay Lakeside	1997-2001	TC	Airboat	Marsh
22	Ogden Bay North	1998-2001	TC	Airboat	Shoreline
23	Rainbow	1998-2001	TC	Driving	Private duck club
24	South Harold Crane	1998-2001	TC	Driving	State managed wetland
25	Harold Crane WMA	1997-2001	TC w/ AC	Driving	State managed wetland
26	West Harold Crane Mud Bar	Not surveyed			
27	South Bear River	1997-2001	TC	Airboat	Federal managed wetland
28	Willard Spur	1997-2001	TC (1997), AR (1997-2001)	Airboat/airplane	Federal managed wetland
29	Bear River Refuge	1997-2001	TC	Driving	Federal managed wetland
30	Bear River Club	1997-2001	TC	Driving/walking	Private duck club
31	Chesapeake	Not surveyed			
32	Public Shooting Grounds WMA	1997-2001	TC w/ AC	Driving	State managed wetland
33	Salt Creek WMA	1997-2001	TC w/ AC	Driving	State managed wetland
34a	East Promontory- N	1997-2001	TC w/ PS	Walking	Shoreline
34b	East Promontory- S	1997-2001	TC	Driving	Shoreline
35	Locomotive Springs WMA	1997, 2001	TC w/ AC	Driving	State managed wetland
36	Salt Wells Flat WHA	1997-2001	TC w/ PS and AC	ATV/walking	Federal shoreline, wetland, and mudflat
37	Bear River Bay	1997-2001	AR	Airplane	Open water
38	Ogden Bay	1997-2001	AR	Airplane	Open water
39	Farmington Bay	1997-2001	AR	Airplane	Open water
40	Magcorp	1998-2001	AC	Driving	Two lakeside ponds
41	New State Duck Club	1999, 2001	TC	Motorized boat	Private duck club
42	East Farmington Bay	1999-2001	TC	Driving	Agricultural, urban, and industrial lands
43	Deardens Knoll	1999-2001	TC w/ PS	Driving	US Airforce/BLM public land
44	Jordan River	1999-2000	AR	Airplane	Private agricultural land

* Survey techniques: TC=Total count, TC w/ PS=Walking transect comprised of a total count combined with point sample(s), AC=Area count, AR=Aerial survey

Survey Protocol

Surveys were conducted every 10 days falling on or close to a designated target date (usually a Friday). The first survey season in 1997 started in late June and continued until mid-September with a total of 9 survey periods. Seasons in 1998-2001 had 17 survey periods from April through September. Four survey techniques were used based upon the area type. All data were collected in a format appropriate for analysis at the conclusion of the study.

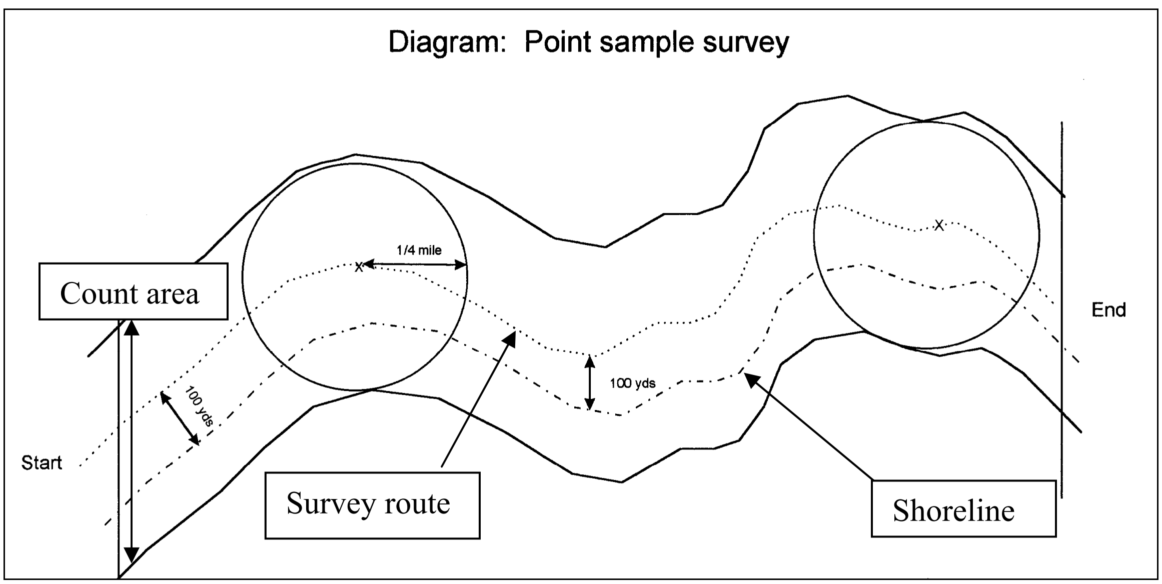
Total Count (TC)

In total count areas, all waterbirds seen and heard in the accessible areas of the site were recorded. The number of observers varied based on the survey area demands (e.g., numbers of birds, size of site). Often TC sites were not completely covered because of inaccessibility or the presence of dense, emergent vegetation that obstructed viewing. Most often, standardized travel routes were roadways on top of dikes, and in some areas transects were established. Many of these sites were located in State and Federal wildlife management areas or within the confines of private duck clubs or wildlife preserves.

Walking Transect and Point Sample (TC w/ PS)

Surveys along the shoreline of the lake were comprised of a walking transect with at least one point sample (Figure 3). Several shoreline areas were surveyed using all-terrain vehicles (ATV) due to their length.

Figure 3. Diagram of shoreline survey protocol. A typical route of a shoreline survey transect with a point sample parallels the shoreline at a distance of 100 yards. Point samples are centered on the survey route and encompass a circular area of ¼ mile radius.



Survey routes began at a designated starting point and followed the contours of the shore 100 yards from the waterline (distance estimated by sight). All waterbirds observed within 0.25 mile on either side of the transect line were recorded. Upon reaching a point sample location, the observer began a 10-minute count of all birds within a 0.25-mile radius circular plot. Habitat and behavioral observations were also collected at point sample locations. All birds recorded along the transect, and within the point samples, were treated as a total count; point counts were recorded separately.

All point sample locations were chosen in one of two random manners: numbers generated from a random numbers table determined the distance of random point count locations from the designated starting point of the transect; ten percent of all drainage points on the south, east, and north shorelines of the lake were also selected randomly for a point count. Due to the dynamic nature of GSL shorelines, it was determined that point samples should always be centered 100 yards from the shoreline through time. The protocol required that a surveyor move at right angles from the permanently placed sample marker as necessitated by the fluctuating shoreline. At times under these conditions, the point sample marker may be isolated some distance from the shoreline on land, or be surrounded by water during high lake periods. Many of the shoreline areas in the South Arm and Farmington Bay were mapped with Global Positioning System (GPS) equipment.

Area Count (AC)

One or more area counts were conducted at each of the large State waterfowl management areas (WMA) and the Federal wildlife habitat area (WHA). Survey sites were selected by the area managers based on their management needs. Counts were conducted along manmade impoundments or naturally occurring ponds with an identifiable boundary. The boundary enclosed a measured area from which bird density estimates could be derived. Habitat and behavioral observations were also collected during area counts. In addition to the area counts, birds observed in all other accessible portions of the WMA were recorded, completing a total count of the entire WMA.

Aerial Survey (AR)

Surveys were conducted from the air to count birds occupying open water in the large bays, and two areas with difficult access: Willard Spur and Stansbury Island, North. Each body of water (Farmington, Ogden and Bear River bays and the Willard Spur) was broken into 0.25-mile wide transects spaced one mile apart. Transects were positioned 0.5 miles from the 1997 shoreline (GSL elevation approximately 4201.10' ASL) to avoid overlap with shoreline surveys. In areas where shorelines were not surveyed (i.e., islands, remote areas, salt evaporation dikes), aerial surveys extended up to the shoreline. An in-plane, GPS was used to locate the predetermined start and finish points of transects. Georeferenced transects established in 1997 were used throughout the remainder of the five year survey period. To ensure plenty of light flights began around 7:30 am. According to the variety and abundance of waterbirds viewed below, speed of the plane varied but was typically in the range of 80-100 mph. Elevation varied, but the pilot and observers worked at maintaining an elevation of approximately 80-200 feet above the water surface. Two observers identified and counted waterbirds out to 0.125 miles on each side of the plane while noting observations on audiocassette recorders. At the Stansbury Island North site, the airplane followed the shoreline for the length of the transect, and waterbirds were identified and counted out to 0.125 miles on each side of the plane.

Transect counts from the three open water bays were extrapolated to the entire bay area in two ways: a general extrapolation was calculated by multiplying counts by four for each survey; a more seasonal specific extrapolation was achieved by calculating an average species density and multiplying it by the surface area of the bay specific to lake elevation at the time of the survey.

Surveyors

Because there was not enough professional staff to conduct the surveys, we recruited the assistance of citizen-scientists and avid birders from Audubon chapters, Friends of Great Salt Lake, universities, birding groups, duck clubs, allied State and Federal agencies, and the public at large. Eighty percent of the volunteers had birding and other natural resource field experience. Internal funds of the GSL Ecosystem Program supported three WMAs with a month each of technician time for each of the five years. In addition, the full-time staff from four WMAs carried out surveys on their respective sites or sites nearby. The Bear River Migratory Bird Refuge (MBR) biologists surveyed the 80,000 acre refuge. Other Utah Division of Wildlife Resources biologists from the Northern Region and the Salt Lake office, and biologists from the United States Fish and Wildlife Service (USFWS) and Bureau of Land Management (BLM) offices cooperated in surveying sites.

Often volunteers from other organizations brought field and bird identification skills to the study that were equal to, or exceeded some full-time professionals. There were some volunteers who had some or little skill in bird identification or in estimating large numbers of waterbirds. Often these people gained experience through on the job training, by acting as data scribes, and an extra pair of eyes for survey teams. Project managers organized teams, designating a leader. The team leader was selected based on past years experience, birding skill, and interest in the project or survey area. These people were critical in maintaining consistency in the data collection and in many cases were with the study for the entire five years. Team leaders were responsible for scheduling survey dates among the team and sending in the appropriate data forms.

Training was provided for participants prior to the start of the field season each year. A review of the study objectives and methods was discussed in a classroom session, and bird identification was practiced with a slide show presentation. Periodically, participants were asked to take a short bird identification quiz after the review to be used to ascertain skill levels. Data forms, return envelopes, survey protocol, area maps, and official letters of participation were distributed to each team. A second training session in the field focused on survey methodology for a point sample, distance estimation, bird identification, and flock size estimation.

During the field season, monthly newsletters were sent out to all participants with announcements, reminders, short data reports, and educational articles. The main objective for the newsletter was to maintain adherence to protocol standards, provide an efficient means of communication from the project coordinators to participants, as well as to create a sense of teamwork and community. As often as possible, articles were included that indicated how the Waterbird Survey (WBS) data were being used on the local and national levels. Participants were encouraged to send in descriptions of interesting survey experiences to share with the others.

Data Compilation

Weather information was collected by surveyors and from local climatological data reports from the National Oceanic and Atmospheric Administration. Lake elevation data measured by a gauge at Boat Harbor, South Arm was provided by Wallace Gwynn, Utah Geological Survey.

The project coordinators designed a data form suitable for all survey types. Participants recorded weather information and bird counts by species. Additionally, habitat evaluations, and species use and behavior data were recorded in survey sites that included point samples. Project coordinators encouraged team leaders to send in data forms at the end of every month. Data were then entered into a Paradox software database. Yearly Paradox data sets were sent to Jonathan Bart, United States Geological Survey (USGS), to be organized and transformed into Excel software tables that were more easily used by project data managers. The modified tables filled in missing data points by calculating an average of existing values on either side of a missed survey. Also, survey areas that were extremely incomplete were not included in lake-wide calculations (Appendix 2). Annual summary reports were written and distributed to all participants.

Data Analysis

Waterbird counts were examined by species for each area, as lake totals for each year of the survey, and a combined five-year summary. Five-year species means were calculated by first averaging counts from all years for each survey period. Next, an overall mean for each species was computed by averaging the 17 survey period means. The same process was applied to specific survey periods of interest for each species to arrive at a more accurate estimate of population size during periods of peak occurrence. For example, counts of Wilson's phalaropes from all survey sites were totaled for each survey period for each of the five years. Yearly totals for survey period 1 were averaged. This was repeated for the remaining 16 survey periods resulting in average numbers of phalaropes by survey period through the season. To calculate an overall average of Wilson's phalaropes, the 17 survey period means were averaged together. Also, selected periods of phalarope presence were averaged to get an estimate of the species' peak occurrence at GSL. Species distribution maps illustrate mean counts over survey periods when the species are present at Great Salt Lake. Means for suites of species were also calculated. Suites included unidentified groups that were not assigned to any species totals. For example, the DUCKSX suite includes all duck species and the "unidentified duck" (DUCK) category that cannot be assigned to any one species. Unidentified numbers are considerable in many cases and should not be overlooked. Peak numbers reported are the largest 5-year period mean for a particular species or suite.

An important consideration during the five-year survey was the fluctuation of lake elevation and its affect on habitat. For analytical purposes we determined to evaluate habitat changes and their subsequent species use for the years of lowest and highest lake elevation during the years of the study. The highest lake elevation year was 1999. Two years, 1997 and 2001, were both years of low lake elevation. The 2001 survey season was chosen to be the representative low lake year because the data set was more complete than that of 1997. To provide an assessment of the length of time individual bird populations occur within the ecosystem, bird use days were estimated from the data set. A bird day is defined as one bird spending 24 hours within the study area during the study period. These figures were computed by multiplying the mean number of birds by the number of survey days. For 1998-2001, the study period each year was 170 days, April through September. The field season was considerably shorter in 1997 and so the mean bird numbers was potentially inflated by as much as 25%. For a more accurate comparison of bird use days between years, data from 1997 were omitted.

Results

Great Salt Lake Climate and Elevation

Historical Perspective

The long-term (1847-2001) GSL mean elevation is 4200.4' ASL. These data were collected from the South Shore Boat Harbor. The range between record low and high lake elevations is 20.5'. The low occurred on November 1, 1963 at 4191.35' and the high on June 3, 1986 at 4211.85' (Table 3).

The rate of change in elevation varies with climatic patterns and especially with variation in periodic weather patterns. Hydrologic data indicate the lake will be equal to or exceed 4204' ASL ten percent of the time, and conversely, the lake will be equal to or less than 4193.5' ASL ten percent of the time (Austin 1980). This implies that the predicted change in GSL elevation will fall within a 10.5' pattern 80% of the time. From the same hydrology data set, which has 125 years of GSL elevation records modified by the 1980 rate of upstream water consumption, it is predicted that GSL will exceed 4210' ASL approximately once every 200 years (Austin 1980).

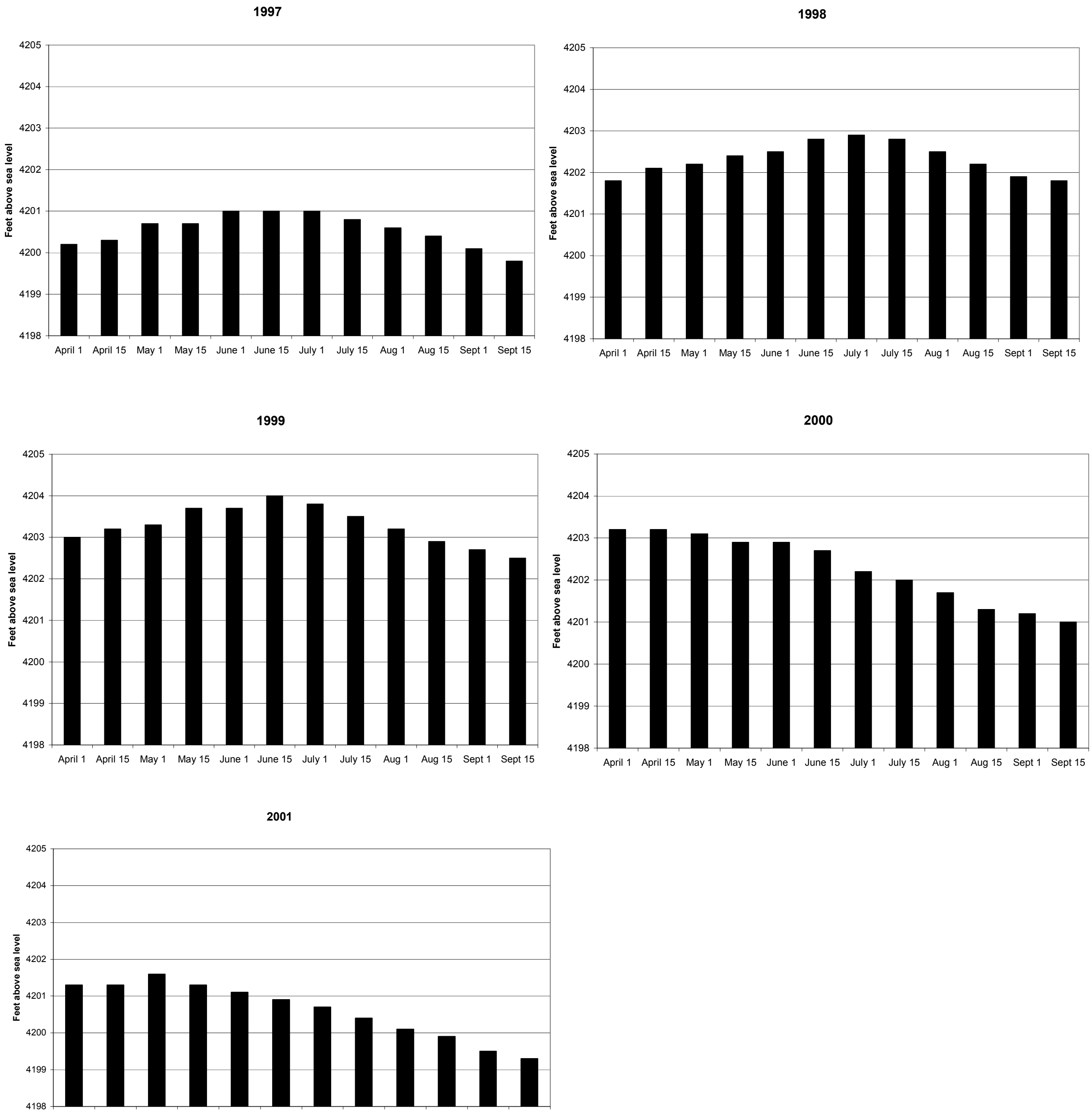
1997-2001

The GSL mean elevation was 4201.9' during the five-year study period. The range was 5.3' with a low lake elevation of 4199.3' and a high of 4204.6' occurring on June 15, 1999 and September 15, 2001 respectively. The most notable rate of change occurred between 1999 and 2001 at 5.3', and the greatest rate of change within one year was 2.4' in 2000 (Figure 4).

Table 3. Notable weather periods and lake elevations at Great Salt Lake.

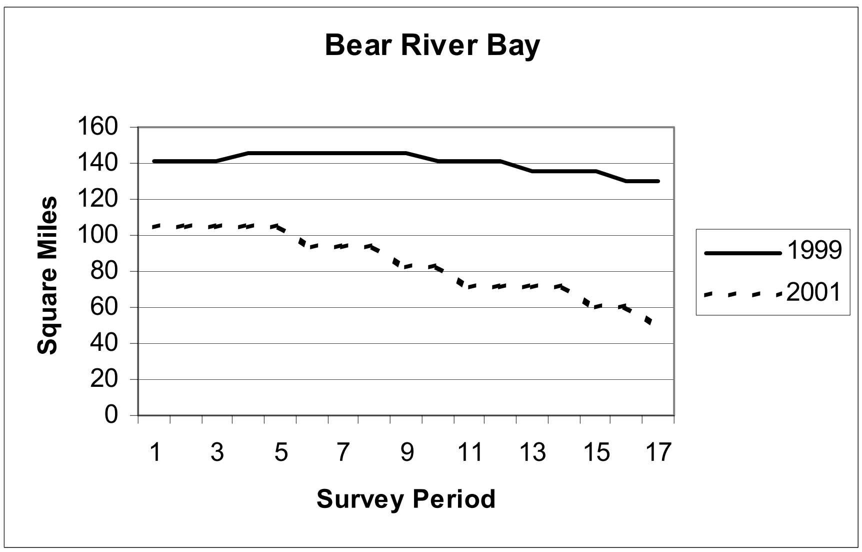
Time period	Average elevation	Std. Dev.	Range (feet)	Note
1847-2001	4200.4	4.5	20.5	154 years of elevation records.
1910-1930	4202.4	1.1	5.4	A 20-year weather cycle from 4201' to 4205' and back to 4200'.
1960-1990	4199.7	5.6	20.5	30 years that include the historic low (1963) and high (1987).
1982-1987	4208.1	3.2	11.8	Historic flood years with elevation ranging from 4200' to 4211.9'.
1997-2001	**4201.9**	**1.4**	**5.3**	**Waterbird Survey.**

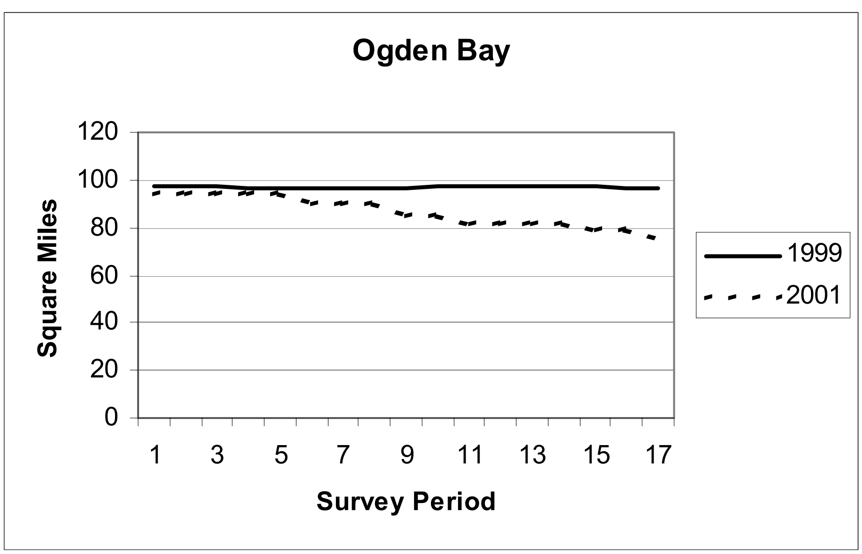
Figure 4. Great Salt Lake elevation at two-week intervals during the Waterbird Survey, 1997-2001.

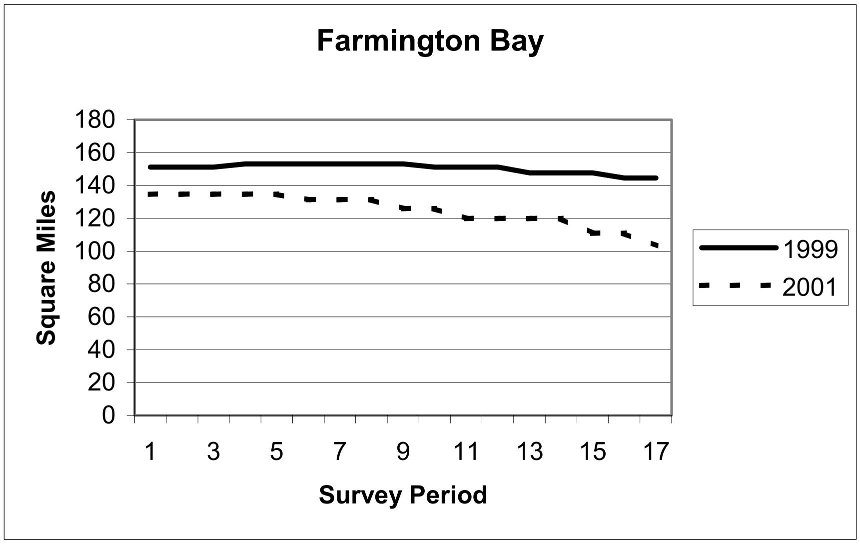


Fluctuations in the lake elevation throughout seasons and between years correlated directly with changes in the surface area of the open water bays (Figure 5). As the lake level dropped in 2001, the area size of all bays also decreased. As a result, the quantity and quality of available habitat for species that use open water spaces was variable through the duration of the study. Bear River Bay showed the greatest decrease in area size between the high and low lake years of 1999 and 2001. At the end of the survey season in 2001, the water surface area was approximately 80 square miles smaller than the same time during the high lake year of 1999.

Figure 5. Changes in bay area sizes with fluctuations in lake elevation. For three open water bays at Great Salt Lake (Bear River Bay, Ogden Bay, and Farmington Bay), each chart shows variation throughout the survey season (survey periods 1-17) and compares a year of high lake elevation (1999) to a year of low lake elevation (2001).



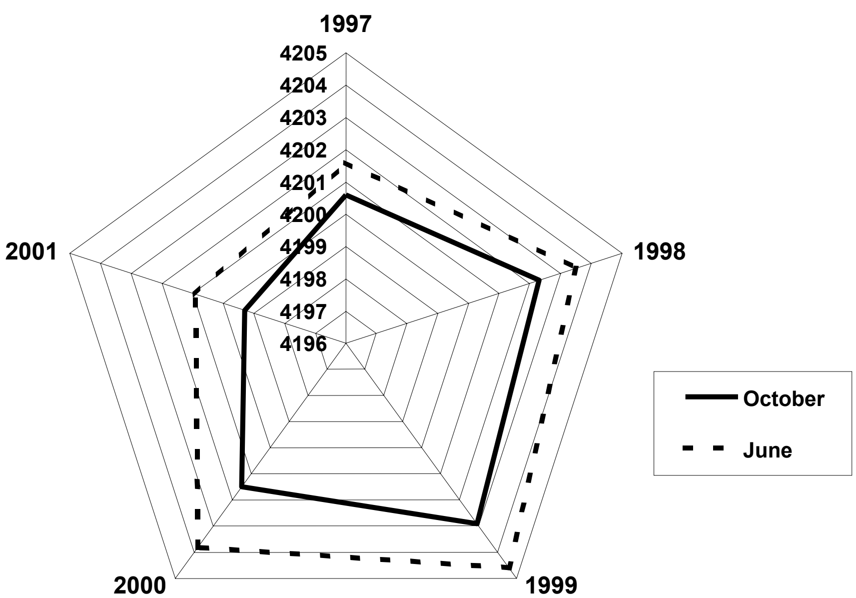




Within Season Changes

The changes of GSL elevation within survey seasons varied from 0.3 m (1 ft) in 1997 to 0.7 m (2.25 ft) in 2000 (Figure 6). These conditions reflect the vagrant conditions associated with the evaporation period of the annual lake cycle. The average seasonal change for the five-year study was 0.5 m (1.6 ft), which is inside the long-term trend of annual elevation change.

Figure 6. Comparison of GSL high (June) and low (October) elevations, 1997-2001. Lake elevation values are listed in the column (4196 – 4205) and represent feet above sea level.



The effects of wind on shoreline varied with shoreline type. Winds in excess of 30 mph were experienced each survey season. Where causeways were encountered by wind, the force often caused mixing on the leeward side of culverts. During strong winds, the Antelope Island State Park causeway culverts experienced focused, driving water on the windward side that ballooned through culverts often in excess of 1 km. These conditions were visible because of surface watercolor contrasts. Farmington Bay water is often less green or blue than the denser brines of Gilbert Bay. Vertical mixing of salinities at these culvert sites is unlikely due to the difference in brine densities.

Wind effect on low gradient mudflats and sandbars was noted to spread surface water over extensive areas, sometimes for several hundred meters. This phenomenon affected habitat and bird use in several ways. The substrate became moistened, and seemed to increase foraging activity in some cases (Appendix 3). At times invertebrate activity on wet shorelines also increased. Wind tides also drove masses of filamentous algae on to otherwise relatively sterile beaches (e.g., Ogden Bay North; Appendix 4). After these algal biomasses were stranded, they attracted brine flies, and subsequently, birds that foraged on the flies. This condition was noted most often later in the season, after filamentous algal blooms were well developed. Flies and birds used these same algae mats as they floated about the lake. Wind tides caused brine fly pupal chamber residue from hatches to windrow along the shoreline. These windrows offer a nutrient rich mix of algae and adult brine flies on which gulls and other shorebirds concentrate.

Wind also distributes organic and inorganic debris along the shoreline. Snowy plovers, stilts and avocets often nest next to wind placed debris. Western sandpipers also roost next to these debris at times in excess of 200 m from the current shoreline. Near shorelines on various islands and elevated bars, gulls use large isolated debris (logs, planks and uprooted brush). Water evacuated from beaches on the leeward side of wind events exposes wet mudflats used by foraging shorebirds and gulls. At other times wind tides inundate nests, causing egg loss or nest desertion.

Wind may or may not change the condition of large and small WMA impoundments. In general, the wind effect on managed sites is not as eventful because of their smaller size and emergent vegetation, which act as a buffer. Often, birds use managed sites for shelter during wind events.

Survey Coverage

Percent of GSL ecosystem covered by Waterbird Survey

For this report the GSL ecosystem is represented by the GSL and its associated delta-formed wetlands. When the lake is at its long-term historic elevation of 1,281 m (4202' ASL), the lake surface area is 3,885 km^2, and the associated emergent marshes and non-vegetated mud flats and salt flats encompass 2,065 km^2 (Fretwell et al. 1996). The GSL Waterbird Survey covered approximately 21% of the total area, and approximately 28% of important waterbird habitat (i.e., Gilbert, Ogden, Farmington and Bear River bays, Willard Spur and wetlands; see Table 4).

Table 4. Summary of area sizes of Great Salt Lake bays and wetlands, and the portions covered by the Waterbird Survey.

Area name	Area size (ha)	Portion surveyed (ha)	Percent coverage
Gilbert Bay	187,962	3,426	2
Ogden Bay*	21,148	21,148	100
Farmington Bay*	31,102	31,102	100
Bear River Bay/Willard Spur*	23,708	23,708	100
Total	**263,920**	**79,384**	**30**
North Arm	156,667	0	0
Willard Bay	3,821	0	0
MagCorp Pond 1N	13,857	376	3
Total	**174,345**	**376**	**0**
Total wetlands	**161,874**	**43,984**	**27**
Grand total	**600,140**	**123,744**	**21**

*One quarter of area surveyed via plane and results extrapolated for 100% coverage.

Coverage within survey areas

The GSL Waterbird Survey covered most of the known waterbird habitat (Figure 2). All of the shoreline from the Bear River Delta south to the Jordan River Delta and west to Stansbury Island was surveyed. Along that same section much of the lake's associated wetlands was included in survey areas, and a good proportion had survey coverage. Some wetlands known to have waterbird use that were not covered in this study are: Blue Creek complex south of Lampo Junction, Chesapeake Duck Club, Black Marsh, Reeder Overflow, the east extension of Ogden Bay WMA, Sulphur Creek, several clubs within the Associated Duck Clubs region, and ponds cut off from the south end of the lake by Interstate 80. These areas were not surveyed because of limited volunteer numbers or restricted access, but in the future should be investigated to determine the extent of waterbird use. Open water areas of Bear River, Ogden and Farmington Bays were surveyed by transects representing approximately ¼ of the total lake surface.

Data are missing at several levels of the Waterbird Survey, all of which have been accounted for in the data analyses. In 1997, the first seven survey periods were not surveyed because of unresolved logistical problems. The last survey period (17) was not part of the schedule in 1997, but was added to the following four years to include arriving waterfowl. For some analyses, only four years (1998-2001) of data were used to maintain consistency in comparisons. Five years of data were used for individual species, suites, and survey area comparisons.

On the north end of the lake, the managed wetland areas had some survey coverage, and the shoreline and open water were determined unsuitable for waterbird use because of the extreme saline conditions. A portion of the western shoreline south of the railroad causeway was covered by some survey efforts. The land on this side of the lake is used by the US Air Force munitions testing and has highly restricted access. Stansbury Bay has been converted into commercial evaporation ponds, but surveys were conducted between Lakepoint, Badger Island, and Stansbury Island from a dike road. This survey has been important in detecting the presence of large flocks of Wilson's and red-necked phalaropes on the west side of the lake.

Large wetland complexes were not surveyed in their entirety (Table 5). Coverage was limited for many reasons including: difficult access, limited viewing, and large area size. These complexes have been evaluated separately to describe survey coverage. The Waterbird Survey project managers met with site managers and/or survey participants to determine the approximate percent coverage of these areas. The size of the survey area, percent of appropriate waterbird habitat within the area, percent visibility, and the percent of the area actually surveyed were discussed. These coverage estimates were used in calculating densities of waterbird species in the respective area.

Between Year Changes in Survey Coverage

Survey coverage did alter between years, usually due to limited numbers of volunteers or restricted access at certain locations. Stansbury Island North (2) had restricted ground access, and was added to the aerial survey route in 1999 but was skipped every third period. Concurrently, the Farmington Bay lake portion coverage was reduced to the alternate flights when Stansbury Island North was not flown; this decision was made due to the low bird counts during parts of the survey season in this large area. Coverage continued through 2001. Audubon Interior (9c) had restricted access until the 2001 season. Locomotive Springs WMA (35) was surveyed in 1997 but not again until 2001 because of limited surveyors and the remote location. Magcorp (40; currently called US Magnesium Corporation of Salt Lake City) was added to the Waterbird Survey in 1998 and efforts continued through 2001. New State Duck Club (41) has limited access and difficult travel conditions. The area was added to the Survey in 1999 and covered by UDWR personnel. In 2000 the area was dropped because of limited UDWR staff, and in 2001, surveyed by a member of the duck club. East Farmington Bay (42) and Deardens Knoll (43) were added to the survey in 1999 and covered through 2001. Jordan River (44) was added to the aerial survey route in 1999 and counted every third period. The survey was dropped in 2001 because low lake elevation left this area dry and unused by waterbirds.

Survey coverage within years also had some variation. Most areas were surveyed on a regular basis; counts before and after the gap were averaged to fill in the missing point in cases where a survey period was missed. Occasionally, a survey area was not counted for multiple survey periods. These large gaps in coverage contribute to the conservative nature of these bird counts. For some analyses, incomplete data sets were not used.

Migration Chronology

The five year study of species use at the Great Salt Lake allows for a break out of five significant categories of use as birds move through the season (Table 6). These classifications are based on data displayed in the species count charts (see Species Accounts). These categories are departing and arriving winter residents (April and September), migrants to breeding grounds (April-May), local breeders (April-September), early migrants to wintering grounds (July-August), and later migrants to wintering grounds (August-September). Some species fit within more than one of the categories. A weighted line through the appropriate time periods shows species presence. Line designations are a subjective measurement of the portion of a species population known to be at Great Salt Lake at its peak time. Relative numbers of species by survey period are charted in the Species Accounts.

Table 5. Summary of survey coverage of large wetland complexes associated with GSL.

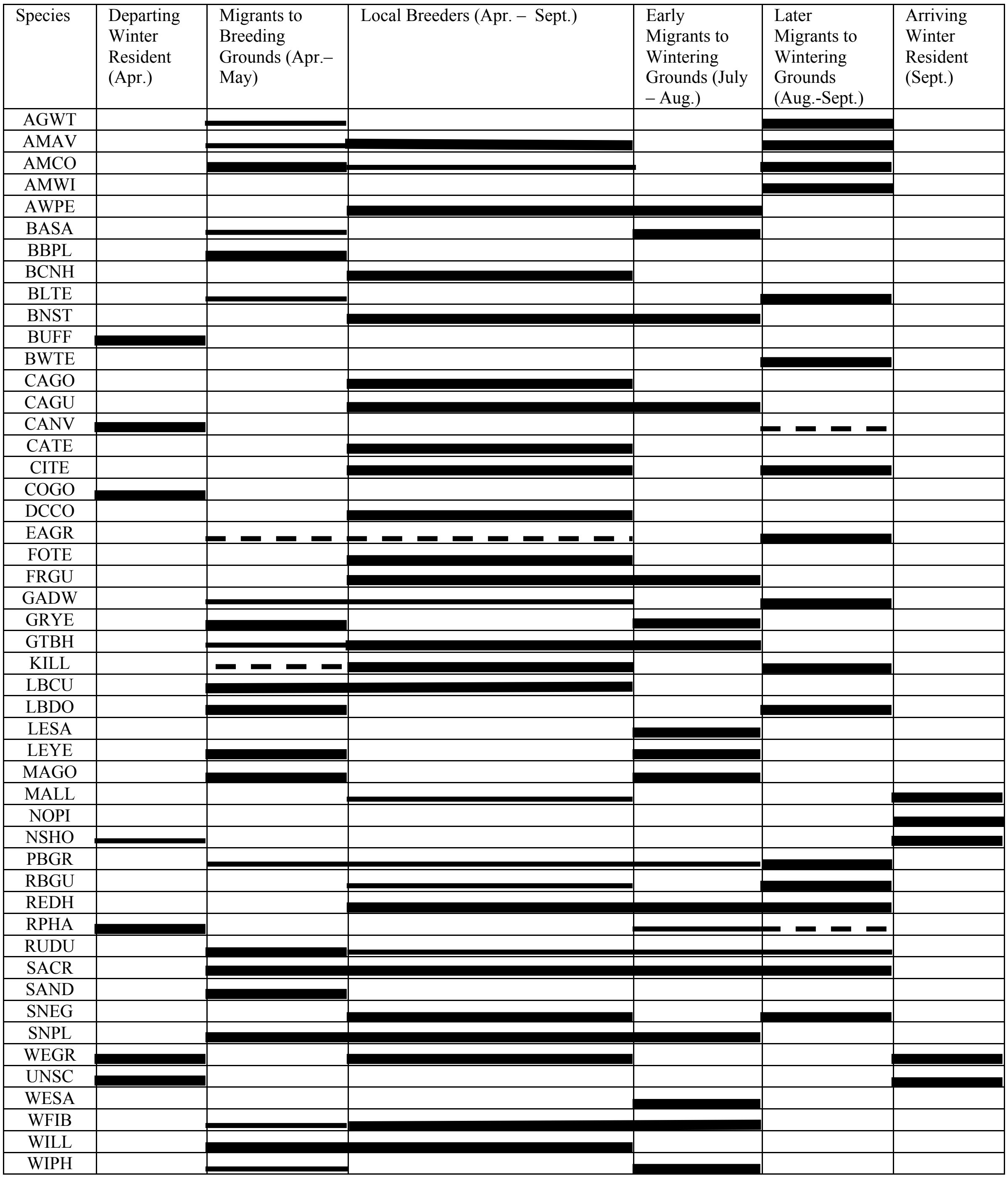
Name	**Area size (ha)**	**Percent covered by WBS**	**Percent good waterbird habitat**	**Comment**
Associated Duck Clubs	5910.5	15	90	Visibility is uninhibited, but in some cases viewing distances are too great for 100% detection.
Bear River Club	5183.8	40	95	Extensive open ponds, edge and emergent wetlands that support breeding populations of shorebirds and colonial nesting species.
Bear River Migratory Bird Refuge	10449.4	30	60	South Bear River (an adjacent 8272.3 ha survey area) has 80% good waterbird habitat and 50% was covered by WBS.
Farmington Bay WMA	4544.5	65	90	To get full coverage the best view would be from the air. It is difficult to travel on foot and in some places vegetation compromises great viewing distances.
Harold Crane WMA	5012.9	33	50	West Harold Crane mud bar was not surveyed. Areas not covered by survey could be accessed on foot. Some colonial nesting occurs in wetlands.
Howard Slough WMA	1263.9	85	95	Since 1997 the outer dikes have been washed out. The south impoundment has visibility difficulties because of large distances.
Locomotive Springs WMA	7607.9	4	17	Most mudflats were not surveyed. Other studies have observed snowy plovers in large numbers in these areas. Areas of emergents that are not viewed easily can be accessed on foot.
New State Duck Club	1200.2	50	100	
Ogden Bay WMA	2495.6	60	80	Areas not visible are likely not good for shorebirds. Near Unit 1 there is viewing difficulty near the grass island. Viewing could be enhanced from a boat for closer access.
Public Shooting Grounds WMA	3248.7	20	70	There is a large expanse of potholes that is not visible from the dike roads but would be visible from a plane.
Salt Creek WMA	863.4	35	55	Very few shorebirds. Tall vegetation is a barrier. Viewing could be enhanced from an observation tower.
Salt Wells Flat WHA	1659.8	40	40	Access is good and visibility could be improved from an observation tower. Mud is very soft and difficult to walk on, ATV needed for travel.
Timpie Springs WMA	556.7	80	90	

Table 6. Migration chronology of waterbirds at Great Salt Lake.

The majority of the Great Salt Lake (GSL) population is present.

Approximately half or more of the peak GSL population is present.

Less than half of the peak GSL population is present.



Breeding Species

This study did not directly assess the breeding status of waterbirds within the boundaries of the study area. However, counts did include breeding waterbird species as they occurred within each survey site. From this data set it is possible to assess potential breeding adults through the assumption that adults observed at known breeding periods are potential breeders. For this report, breeding period is defined as the period of time that encompasses pair bonding, nest building, and egg laying. These conditions can vary within and between species at the GSL. A conservative assessment was made to determine potential breeding adults by examining the five-year survey period means at a time when the species was present within the defined breeding period. For example, the optimum breeding period for American avocets was judged to fall between May 21 and July 10. At this time, the highest five-year survey period mean was greater than 63,000 potential breeding adults (Appendix 5). The survey period distribution of these 63,000 potential breeding avocets is displayed in Appendix 6. The projected breeding period was determined to be during survey periods 5-10 for this species. Similar examinations can be made for the most common, if not all potential breeding species at the GSL by examining the potential breeding data (Table 7) and comparing them to the Species Distribution by Survey Period (Appendix 6).

Table 7. Potential breeding population estimates of some waterbird species at GSL.

Species	Number of potential breeding adults
California gull	95,183
American avocet	63,806
Franklin's gull	30,652
White-faced ibis	28,626
Black-necked stilt	20,502
American white pelican	9,898
Forster's tern	1,586
Snowy egret	1,353
Snowy plover	541
Great blue heron	460
Black-crowned night heron	342
Cattle egret	53

Great Salt Lake Waterbird Species Accounts

The five-year data set was used to describe GSL ecosystem use by individual species with local population sizes according to survey period. It was then used to map their distribution around the lake. These data have been compared to global and North American population estimates where available. Our analytical approach has allowed us to identify peak periods of species presence, expressed by five-year means. Data are also available to identify the mean peak survey period, as well as the highest count recorded for one survey period during the five years. Mean occurrence by survey period are charted and mapped by survey area (Appendix 6).

Species Distribution By Survey Period

To accomplish our objective of identifying important waterbird use areas at GSL, georeferenced data have been mapped for individual species by survey period. Five-year means were plotted by survey area to show lake-wide distribution. Bird density by area information is provided in the Survey Area Descriptions (Appendix 4).

High and Low Lake Elevation Species Distribution (1999 and 2001)

Two years were compared to assess the distribution of individual species relative to high and low lake elevation scenarios. Species counts by survey area and survey period for the high lake year of 1999 and the low lake year of 2001 were mapped for comparison. The general trend of bird distribution follows the presence of water as lake elevation changes (Appendix 3).

Bird Use Days

A bird day is defined as one bird spending 24 hours within the study area during the study period. The GSL bird use day five-year mean was 86,752,258 (Table 8). Data from 1997 were only used in the five-year mean calculations of selected suites of species in Table 10. The 1997 data were omitted from the other tables to minimize variation in individual year means, because the survey season in 1997 had eight fewer survey periods than the other four years.

Bird use days are noticeably smaller in 1999. Bird use days by avocets and stilts were greatest in 2000 and 2001, and for dowitchers and waterfowl in 1998. The years 2000 and 2001 showed greater bird use days for gulls. Herons and egrets seemed to be more uniform in their use of the lake through 1998-2000, but diminished in 2001. The greatest year of peep sandpiper presence was 2000, while for phalaropes the highest use year was 2001 (Table 9).

An examination of the five-year mean bird use days by suite reflects the importance of the lake to avocets, phalaropes, waterfowl, and gulls--each present at GSL in the millions of bird days (Table 10).

Table 8. Mean bird use days at Great Salt Lake by year, 1998-2001.

Year	Mean Bird Use Days
1998	89,183,180
1999	77,469,285
2000	88,889,577
2001	85,349,660

Table 9. Annual bird use days at Great Salt Lake for selected suites of species.

	Bird Use Days by Suites						
Year	Avocets and Stilts	Dowitchers	Waterfowl	Gulls	Herons and Egrets	Small Sandpipers	Phalaropes
1998	8,815,020	1,669,340	38,070,840	16,164,400	227,635	1,434,150	4,630,780
1999	10,443,400	1,100,080	28,810,680	12,286,700	246,570	516,475	6,019,690
2000	15,776,080	792,975	23,412,310	19,671,630	238,620	3,198,305	9,135,470
2001	13,224,590	434,715	22,838,960	23,842,820	191,890	965,570	11,622,420

Table 10. Five-year mean bird use days at Great Salt Lake for selected suites of species.

Suite	Five-Year Mean Bird Use Days
Avocets and Stilts	14,696,844
Dowitchers	1,133,536
Waterfowl	32,563,640
Gulls	22,062,838
Herons and Egrets	262,739
Small Sandpipers	2,030,585
Phalaropes	7,044,632
All Waterbirds	86,752,258

Survey Area Descriptions

Each survey area is described and evaluated as to habitat type, accessibility, visibility, waterbird use, and actual survey coverage (Appendix 4). Five-year mean counts by species are displayed in a table for each area. These counts are the same values that are mapped by species in the Species Accounts. Species densities are also listed for each area. Calculated with ArcView software and georeferenced topographic maps, area sizes are a rough estimate. In general, shoreline areas had good visibility and virtually complete coverage. Large, wetland areas often were difficult to survey completely because of lack of surveyors, poor accessibility, or limited visibility. Species densities for these areas were figured with the area size actually surveyed, as estimated by the participants or area managers. This was done in an effort to make the density values more comparable between areas.

Habitat Use

All count data for the years representing high and low lake conditions (1999 and 2001, respectively) show patterns of abundance for the following suites of species (Appendix 3). Ducks and dowitchers that favor fresh water in association with emergent wetlands were more abundant in 1999. Gulls, avocets/stilts and small sandpipers were more abundant during the low lake year of 2001. These groups prefer exposed shoreline and mudflats for nesting and foraging. Phalaropes were also more abundant in 2001. Personal observations by the authors noted more abundant brine fly production during this low water year, which may have contributed to the larger numbers of phalaropes, gulls, and sandpipers. The survey year 2001 was also a better year for brine shrimp production than 1999. Counts at point samples did not always reflect these same patterns. Of 19 point samples, 74% had a greater ratio of species to habitat types in 1999 over the drier year of 2001 (Table 11 and Table 12).

Table 11. Comparison of species and habitat diversity at point samples in 1999 and 2001. The values listed are ratios of the number of species to number of habitat types.

Point	1999	2001
3a	2.3	1.7
3b	2.4	1.8
6.1	0.6	1.1
6.2	2.1	1.0
6.3	3.2	1.6
8a.1	4.0	3.7
8a.2	3.4	2.9
8a.3	4.5	5.8
9b	3.8	2.7
11.1	4.0	3.6
11.2	3.8	3.0
11.3	5.7	2.8
18.2	2.1	2.6
18.3	2.4	3.8
15.1	2.3	3.8
15.2	2.2	1.8
34a.1	3.8	1.1
34a.2	4.3	1.8
34a.3	4.1	2.0

Table 12. Comparison of waterbird density (birds/ha) by suite at point samples and corresponding shoreline areas. Point sample data were averaged through time and across samples. Data from the following shoreline areas were used to calculate mean birds per hectare for a point sample and the entire block of respective areas: 3a, 3b, 6, 8a, 9b, 11, 18, 34a.

Suite	Name	Mean density at a point sample	Mean density at GSL shoreline survey areas
1	Gulls	5.77	2.46
2	Terns	0.20	0.01
4	Dabbling ducks	0.94	0.19
5	Diving ducks	0.24	0.01
6	All ducks	7.07	0.20
7	Herons and egrets	0.08	0.00
8	Avocets and stilts	3.56	1.54
9	Small sandpipers	1.81	0.20
10	Dowitchers	0.30	0.00
11	Yellowlegs	0.07	0.00
13	Plovers	0.24	0.03
14	Phalaropes	1.29	0.41
15	Large sandpipers	0.13	0.02
16	Ibis	0.21	0.01
17	Pelicans	0.96	0.04
18	Eared grebes	1.62	0.14
19	Coots	0.90	0.05
20	Geese	0.73	0.05
21	Cormorants	0.09	0.00
22	Cranes	0.04	0.00
23	Medium sandpipers	0.49	0.01
24	Soras and rails	0.02	0.00
25	Other grebes	0.14	0.00
26	B.B. plovers and red knots	0.51	0.01
	All birds	27.42	5.40

Discussion

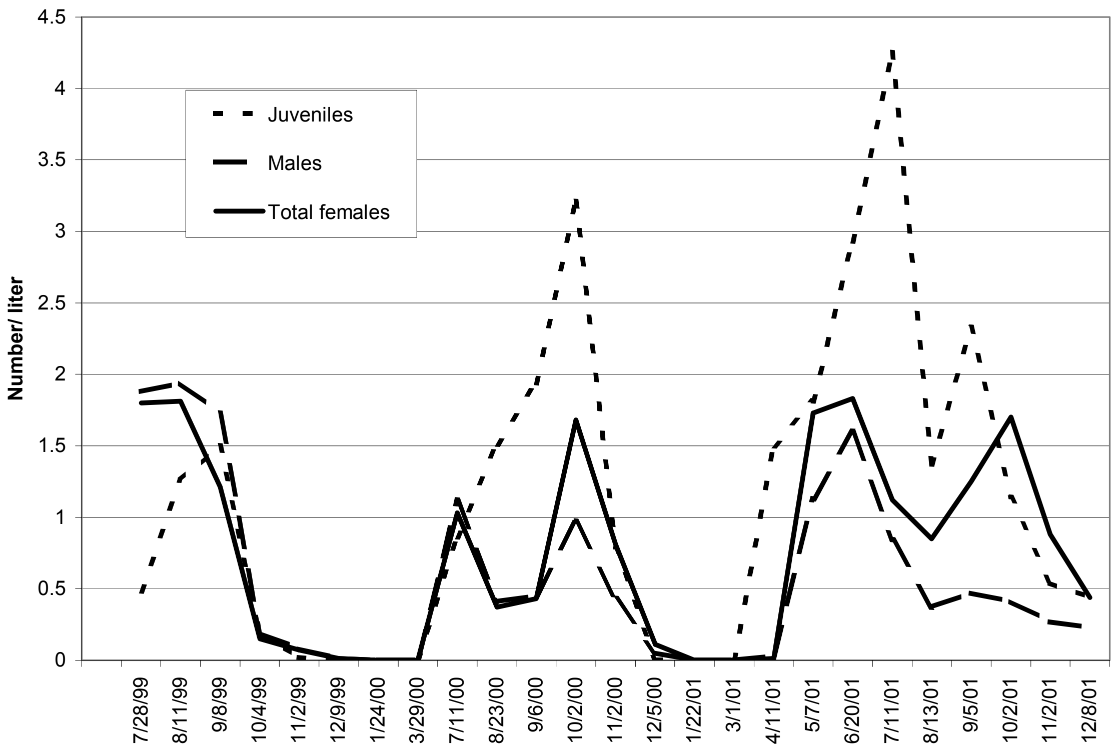
Habitat Changes with Lake Elevation Shift

It is important to consider the GSL elevation during the five-year study in context of historical lake elevation because of the known dramatic change in lake and shoreline habitats that occur due to the flat bottom nature of this playa lake. During the study period, the lake ranged within 25% of the 20.5' range known to occur over the 154-year lake elevation record period (Table 3). The five-year elevation pattern mimicked a period spanning 20 years, from 1910-1930. We consider the study period of 1997-2001 to be a reasonable representation of typical water level patterns, though condensed into a shorter time frame. The average GSL elevation data and its deviation from the average reflect the long-term tendency of the lake to return to an equilibrium around 4200' ASL (Arnow 1980). At the same time, a few inches of gain or loss of lake elevation can have an exceptional effect on GSL shoreline habitats. Shoreline fluctuation during the five-year study affected lake habitats in ways similar to those observed in the past. When the lake was at 4204.6' ASL, it flooded emergent vegetation stands in the same locations and reduced the shoreline playa reach between the water edge and uplands at other locations. Species that use flooded emergents for nesting colonized in several locations around the lake. At this lake elevation, some mud bars were covered, including some that were used by colonial nesters at other times. Land bridges between the mainland and small islands were covered by water, enhancing the attractiveness of the islands for colonial nesting species. Also, the distance between nearby uplands and water was shortened and water lapped at the feet of dikes and levies. In some cases, there was salt water intrusion into WMA ponds. Of note was the flooding of substantial bars that, at lower elevations, extrude for miles into parts of the lake. This was especially true in Farmington Bay where the bar south of the Great Salt Lake Shorelands Preserve was inundated, as well as the bar at the northwest end of the Jordan River Delta complex.

An antithetical condition occurred in 2001 and also to some degree in 1997 when the lake dropped below 4200'. The shorelines were dominated by extensive open mud bars, which in some cases isolated emergent wetlands from the salt water. The interface between salt water and fresh water wetlands and uplands was widened in many places by hundreds of meters. Colonial nesting species, especially gulls, occupied low relief mud bars and other islands. Nesters abandoned these nesting sites as land bridges became exposed and accessible to predators. Emergent wetlands were salt burned and set back to early serial stages, and mosaic patterns of new emergents were established. Distance increased between shoreline foraging habitat and other lake habitats like fresh water inflows.

Changes in lake volume affect lake limnology, as an artifact of lake elevation. During low lake periods, the decreased volume increases brine concentration and subsequently influences obligate halophytes and halophiles occurring at GSL. In general, lower brine concentrations foster greater species diversity, but may decrease productivity of individual species. High concentrations within a certain range (120-170 ppt) often generate lower species diversity, but large numbers of the species are present. These conditions occurred at GSL during the study period with excellent brine shrimp and brine fly populations during the years of 1997, 2000, and 2001; in these years, the Gilbert Bay portion of the South Arm was below 4202' ASL during mid-summer and early fall (Figure 7).

Figure 7. Brine shrimp numbers per liter in the South Arm, Great Salt Lake, 1999-2001.



In addition to lake elevation, there are other factors that affect lake limnology. Seasonal ambient and water temperatures are important, and nutrient recharge may affect lake production and species compositions of algae and invertebrates. A major breach in the Union Pacific railroad causeway near Lakeside, between Gunnison and Gilbert Bays was improved between the 2000 and 2001 survey years and allows better water flow exchange.

Changes in limnology in turn affect fisheries at GSL. During 1997, 1998, and 1999 a fishery occurred in the Bear River Bay/Willard Spur region. This fishery spanned from approximately two miles north of the Great Salt Lake Minerals Company (formerly IMC Kalium) culvert to the Bear River National Wildlife Refuge, and east in Willard Spur to the Willard Bay dike. Large numbers of several species of piscivorous birds consumed carp and gizzard shad during these years. In mid-summer 2000 and extending through 2001 this fishery was lost due to reduced flows from the Bear River and falling lake elevations that left mud flats and very shallow water as this region dried up.

Weather Variances

On several occasions during the mid 1970s, extreme wind events over the GSL drove Wilson's and red-necked phalaropes off the lake. On one occasion, large flocks of phalaropes were carried over the UDWR Northern Region office by wind from the southwest. As the wind subsided these flocks were observed returning west to the lake from the Ogden area. On another occasion a person brought several Wilson's phalaropes into the UDWR Northern Region office that had been found dead on Willard Peak. After an interview, it was learned that the phalaropes had been picked up by a southwest wind and carried to the Willard Basin where a severe rainstorm changed to hail at higher elevations. This storm had killed large numbers of the species in the Willard Basin area. With this information, D. Paul drove to the basin where he observed several hundred dead Wilson's phalaropes in an area of several square kilometers.

Although extreme conditions similar to this unique event were not recorded, there were episodes of high wind, cold periods (Spring 1999), and long, dry periods (July 2000-2001). Each of these conditions had an effect on habitat, bird distribution and surveyor capacity.

Evaluation of Methods

Most missing data points were sporadic, and filled in by taking an average of the numbers on either side of the gap. However, when two or more consecutive missed points occurred, the gaps were not filled. These holes in the data set do affect total counts at the all-lake level, but especially at the level of survey area. In large part the data reported are in the format of a five-year mean, and the missed counts are tempered by averaging. Comparisons between years are not as reliable because of missed surveys in areas. In some cases areas were not surveyed at all for a particular year. To make direct year-to-year comparisons, it is necessary to select areas that are similar in the extent of their coverage and then draw conclusions for those areas only, not from the entire GSL ecosystem. The Survey Area Descriptions section (Appendix 4) details the degree of coverage by survey area for the study period.

Detection rates were variable across survey areas. Most often shoreline areas were classified as having 100% detection. The wetland complex areas with tall, emergent vegetation, long viewing distances or access difficulties did not always have good detection rates. These situations were fairly consistent throughout the five years, and therefore the counts were constant in the portions of an area that had clear viewing. These counts are still valuable and may be able to indicate changes within an area. For this reason and others the project managers believe that the numbers reported in this document are sound, but conservative.

Several survey areas were not covered for the entire five-year study period. Some areas were surveyed intermittently while others were covered for the first or last years of the study (Table 2). Incomplete survey area data were rolled into an analysis of the years for which they were surveyed but excluded from any between year analyses.

Some survey sites are missing surveys from over the course of the five-year study. Most surveys missed were only intermittent with the surveys just before and after the missed survey period in place. In this circumstance, counts before and after the gap were averaged to estimate the missing data point.

Most survey forms were complete when turned in, especially for total count data. When information was missing, contacts with the survey team leader or surveyor were generally sufficient to make the data complete. The most incomplete or confusing data from the field crews pertained to point sample data. The survey form was not user-friendly, and the complexity of recording habitat type estimates by percent within the point and bird use within the types was the most difficult task requested of surveyors. Even so, with some effort on the part of the data manager, most of the sample point data was entered and used.

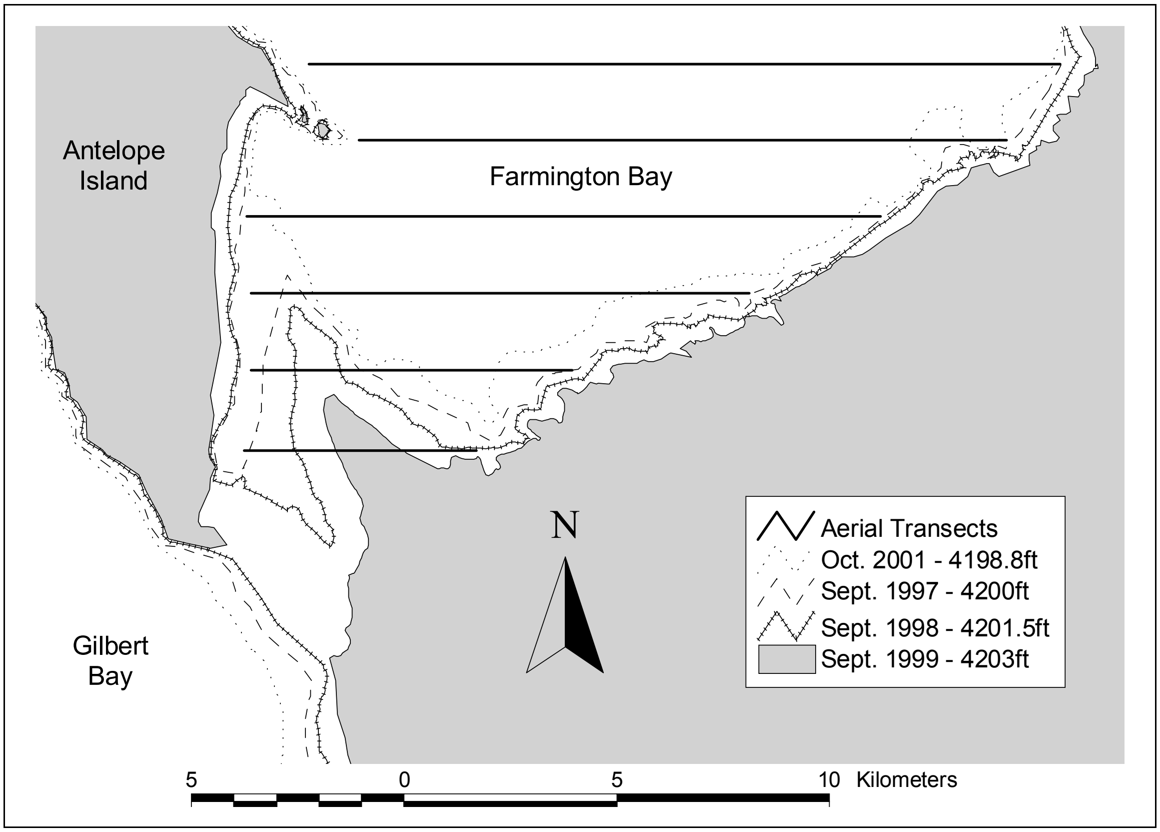
When GSL open water transects were developed in 1997, the GSL elevation was 4201.6' ASL (June 15, 1997). The transects for the open water in Farmington, Ogden, and Bear River bays were established so that the end points occurred one half mile off shoreline. Shoreline survey protocols required observers to count birds within a half-mile window, one-quarter mile on each side of the survey line, which paralleled the shoreline 91 meters (100 yards) from the water's edge. Thus, a surveyor counted birds out to 275 meters, or nearly ¼ mile, therefore reducing the bias of double counting birds observed in the aerial survey. However, because the shoreline fluctuated with changing lake elevations in neighboring survey areas there were potential overlaps between aerial and shoreline surveys. The 1997 aerial transect endpoints were used throughout the five years of study, but the potential overlaps occurred when the GSL elevation fell below 4201.6' ASL for two reasons. First, when the lake was down the aerial survey transect endpoints were within the adjacent shoreline survey areas as the surveyors on foot moved out with the GSL shoreline to maintain a 91 m travel lane from the water's edge. Second, when two sandbars extruded into the aerial transects, they dramatically re-configured the shoreline travel route (Figure 8). However, these overlap issues were addressed reducing the potential double count bias. The conflict with the dynamic shoreline was resolved in most cases through the aerial coverage. Bird counts were stopped short when the transect was within an estimated ½ mile of the shoreline. This was really only an issue in 2001 when the GSL was considerably lower than 4201' ASL, and in some late summer survey periods when the water level was down. Most of the extruding sandbar problems were resolved through communicating between aerial and ground surveyors.

As outlined in the Methods section of this report, a moving sample point was developed so that the inventory of birds using the shoreline was constant through the five-year study. This floating point occurred 91.44 m (100 yards) from the shoreline and at right angles between the original point sample marker and the GSL shoreline. This condition was largely achieved during the study. Exceptions occurred only if original point sample markers were lost during the winter or needed replacement. We used GPS references for replacement whenever possible, but the need to replace a marker was rare, because salt water retarded surface freezing during winter months.

We identified one set of circumstances that biased the comparison of bird use and habitat types at individual point sample sites. As surveyors moved out or back from point sample markers with shoreline fluctuations, they often moved into different habitat types or closer to or farther from specific habitats and landscape features. In some years, observers were hundreds of meters from the point sample marker of 1997. Therefore, perhaps the best comparison of data between years within point sample areas is for the data of birds directly associated with the actual shoreline.

The study managers did work to reduce bias from individual surveyor capacity to estimate distances accurately, especially at a quarter mile (440 yards or 402.3 m). We held an annual field day each spring for Waterbird Survey Team Members, and part of the training was spent helping surveyors develop distance estimation skills. Several tools were provided including the use of auxiliary posts placed at 440 yards on each side of a point sample marker to visually assess ½ mile diameter sampling areas. We know there will be variation by surveyor in estimating the boundaries of the sample point sites, however, the same surveyors made most of the counts throughout a season and from year to year. Therefore, bias should be consistent.

Figure 8. Aerial transects and GSL shoreline configuration at high and low lake elevations.



Data describing behavior of waterbird suites by habitat type were collected at point sample locations. Pre and post survey season meetings were held to assist survey team members in the use of the sample point and other survey protocols. This behavioral data was used mostly as an index to the reason for bird presence in this report. It was collected as a sample of one point in time (one observation / bird) and, therefore, is only a field note pertaining to habitat use within the point sample for each sample period.

From the five-year data set and other information and observations at the GSL, it is obvious that we have missed peak occurrence periods for some species of waterbirds. This is especially true for waterfowl and a few other species. Notably missing are: bufflehead, canvasback, common goldeneye, northern shoveler, northern pintail, mallard, redhead, western grebe, scaup, and larger numbers of eared grebes. There are some waterbird species that are present in large numbers outside of this study period. Tundra swan, snow goose, greater and lesser scaup, some sea ducks, common merganser, Bonaparte’s gull, and a few species of northern gulls are the majority of these birds missed by the survey. These are the primary components of frame bias associated with the data set. Beyond missing the peak period for some species, there were other species that occurred in large numbers at the lake, but often not within the survey areas. These include Wilson's phalaropes and red-necked phalaropes that occupy open regions of the GSL not in a survey area. Other species such as bitterns and rails were secretive and often not detected. Species like long-billed curlews and willets use uplands for nesting and part of their populations were not successfully surveyed.

The database that was established at the beginning of the Waterbird Survey was not an effective tool for several reasons. First, the format of the database underwent some changes between 1997 and 1998 especially within the point sample section, making data from 1997 difficult to use and incomparable with the other years. Second, the data entry system was not user friendly. The screen for actual data input was different from the screen to view all data, and as a result quality control during the data entry process was cumbersome. The database was quite complicated with different people responsible for entering data during each of the five years of study. Data querying and extraction from the database were also difficult, as data managers were not trained in the use of the program. Third, the Waterbird Survey data set was meant to be shared with others within and without the Utah Division of Wildlife Resources, but because the selected program is not universally used, requested data had to be transferred to a spreadsheet to make it functional, therefore, the tables of GSL Waterbird Survey data produced by Jonathan Bart USGS were utilized almost exclusively in the analysis of this data set.

The GSL Waterbird Survey data set is extensive, and the contents of this report only begin to answer a few of the many questions that may be addressed. This report does, however, provide good descriptions of bird use at GSL by species, by time period, and by survey area. Only basic statistical analyses have been completed to this point; a more sophisticated statistical analysis may be appropriate in drawing out additional detailed patterns of habitat selection and population fluctuations that may exist. Project managers have made great efforts to produce a database that is solid and broad in its reach of area, time and species coverage. This has been achieved and is a good foundation for further investigations of waterbird use of the Great Salt Lake ecosystem.

Survey Coverage

It was difficult to maintain consistent coverage over the five years, as we were dependent upon volunteer help. Also, natural barriers to optimal viewing compromised the quality of coverage in some areas. In a separate document, the greater Great Salt Lake area is evaluated as to the extent of appropriate shorebird habitat, detection rates around the lake are described, and suggestions are given for methods to provide for complete coverage. This document is titled "A Plan for Monitoring Shorebirds During the Non-breeding Season in Shorebird Monitoring Region Utah-BCR 9 (Great Basin)" and focuses on shorebird species. However, similar principles apply to other waterbird species and the evaluation could be expanded to include other species as needed (Manning et al. 2002). It is included as Appendix 7 at the end of this report.

Migration Chronology

A primary target of the five-year study was to capture the pulse of waterbirds as they move into, out of, and within the GSL ecosystem. We know from the high lake years of the 1980s that species move between systems in the intermountain region and beyond as local conditions change. The white-faced ibis is an example. In the mid

1980s, the GSL inundated much of the historical nest site habitat and subsequently ibises exploited improving water conditions elsewhere in the west. Oregon, Idaho, Nevada and northern Utah wetlands experienced expanding breeding populations of ibises. After the flood years and as habitat conditions improved for ibises they again colonized re-established emergent wetland vegetation sites at GSL. This study refines the current understanding of how waterbirds like white-faced ibises use the GSL ecosystem through the season.

In the evaluation of methods, frame bias was discussed for species that are on the margins of time pertaining to the study period. These species fit within six categories that we identified as periods of use in the migration chronology of waterbirds claiming some time and space at GSL (Table 6). These six periods are (1) April, departing winter residents; (2) April-May, migrants to breeding grounds; (3) April-September, local breeders; (4) July-August, early migrants to wintering grounds; (5) August-September, late migrants to wintering grounds; and (6) September, arriving winter residents. These categories are not mutually exclusive, and there are many species that fall into several of the descriptions. The degree to which species are present at GSL is well documented by this study. A good example of species presence through several periods is the American avocet. Avocets arrive from their wintering grounds on the west coast of Mexico in late March and by late April, approximately half of the peak GSL population is present and begin to pair up and establish nesting colonies. Some 60,000 to 100,000 breeding adults are present into April. Their young and arriving migratory individuals begin to flock and gorge on September brine flies. At the peak population size of 200,000 to 300,000 avocets depart GSL in late September and October.

For most departing winter residents (Migration Chronology Period 1), April is the end of their winter residency at the GSL. Winter residents return near the end of the survey season (September/October). The migrants to breeding grounds in Period 2 will stay at GSL to breed or travel farther north. Some individuals of these species associated with nesting at GSL (e.g., willets, move through the lake to nest at the northern extension of their range. Others still have many hundreds or thousands of miles to travel (e.g., long-billed dowitcher, black-bellied plover, greater yellowlegs, red-necked phalarope). There are at least 28 species that utilize the GSL ecosystem for breeding. There are some species that leave for their wintering grounds from the GSL in July and August. These include most of the peeps, many black-necked stilts, California gulls, Franklin's gulls, greater yellowlegs, lesser yellowlegs, marbled godwits, white-faced ibises, willets, and Wilson's phalaropes. Some of these species have been at the GSL though most of the survey periods, but others are just coming through from sites further north. This is also the case for species in the late migrants (August-September) category. In this group, there are many waterfowl species that are just arriving to GSL. Some continue on, while some stay until ice-up. Others, like the eared grebe, use GSL as a molt migration site. The ring-billed gull sometimes stay the winter, and other times passes through. The GSL breeding populations and their offspring are augmented by migratory populations of the same species in later survey periods. This seems to be true of avocets and pelicans for example.

The assessment of bird use days at GSL indicates that the greatest period of use begins halfway into the survey season and lasts through the remainder. Because of the numerical make up of occurrence, the waterfowl category is of great magnitude. It is suspected that bird use days remain strong well into the fall, beyond our periods of survey. Another important period of use is concurrent with summer and late fall halophile production of brine flies and shrimp.

The migration chronology data also demonstrate the dynamics of spring as birds move through the ecosystem. This is especially true for long-range migrants. Western sandpipers can occur in thousands at the lake in some survey sites, and dissipate before the next 10-day survey block. Red-necked phalaropes, Wilson's phalaropes, and eared grebes are similar in this regard, as they pass through to breeding grounds.

Species Distribution

Shorebirds

The distribution of shorebirds at GSL varied by species. There were even some changes in habitat type use by the same species during different times of the survey season, and some that keyed on the same geographic locations despite changes in lake elevation. The magnitude of occurrence of some long-range migrants seemed to change between spring arrival and fall passage. These observations are made by examining five-year averages by survey period for each survey area. There is some variation to these mean numbers if each survey year is examined separately. However, these variations in distribution are more contingent on survey site than survey period. For some years the habitat type is different for the same survey area as a consequence of lake elevation and transitory shoreline, or the availability of water to manage wetland complexes. At other times wetland managers adjusted water levels as part of a prescribed application.

Following are some highlights of shorebird presence on the lake through the survey season. These comments are based on data presented in Appendix 6. For details of occurrence by location see Survey Area Descriptions (Appendix 4).

American avocets and black-necked stilts both seem to use managed wetland complexes extensively from April-July. Starting in August a preponderance of avocets disperse to GSL shorelines and congregate in large numbers in Farmington Bay. This is true too for black-necked stilts, but they also use east Gilbert Bay and Bear River Bay in large numbers.

Long-billed dowitchers and greater and lesser yellowlegs prefer to use wetlands with pools and ponds bordered with emergent vegetation. In April, and May, and July through September, dowitchers are found in large numbers at Bear River MBR and Farmington Bay WMA complexes, and can also be found in small concentrations throughout GSL wetland complexes. The two yellowlegs species are often observed together from April into early May, and again in late June through September. The largest numbers occur in Farmington Bay WMA, Ogden Bay WMA, and Bear River MBR.

Marbled godwits occur at the lake in mid April, on their return to the prairies for breeding. In the spring, the largest numbers were recorded at Bear River MBR and Ogden Bay WMA. Late June through September, they are present in the tens of thousands within the Bear River Bay complex, especially in the Willard Spur.

From April through mid September, snowy plovers are found in numerous playas and shoreline reaches. Large numbers were located in the Locomotive Springs WMA and Salt Wells Flat WHA. They were also present in good numbers at Stansbury beach and along the South Shore, within the Inland Sea Shorebird Reserve, along the Audubon beach, and in the Harold Crane WMA complex.

Wilson's phalaropes appear at the lake in open water and associated wetlands during two concentration periods. First, in late April and early May they locate at Bear River MBR, east Gilbert Bay and Farmington Bay for a stop along their spring migration northward. Second, they return from breeding grounds in the intermountain west and prairies in June, build into July when they congregate in large flocks around Bear River MBR, the shorelines of the lake, and especially on open water reaches of GSL. Large flocks were counted in Gilbert Bay both in and out of Waterbird Survey areas, and also in Farmington Bay, and the largest flocks occurred around Carrington Island, along the Magcorp dike, and on the west shore.

Black-bellied plovers arrive in spring and again in late summer when they are observed in small flocks. The largest groups are consistently observed along the southern end of Antelope Island and the shoreline south of the Crystal Marsh and west of the Audubon properties. In some years, other sites of concentration are the Howard Slough shoreline and Ogden Bay WMA.

Least sandpipers are present in April and May and most commonly observed on the South Shore, Stansbury beach, the Inland Sea Shorebird Reserve, Farmington Bay WMA, and Bear River MBR. They return in August, locating again at the south end of the lake, Farmington Bay WMA, Inland Sea Shorebird Reserve and the Magcorp dike.

Western sandpipers arrive in late June and are seen though August. Some counts exceeded 150,000 individuals at Bear River MBR. Large numbers were also observed at Ogden Bay WMA, Farmington Bay WMA, the South Shore including Stansbury beach and the southeast shore of Antelope Island.

Sanderlings often occupy strips of sandy beach around the South Shore and along gravel dikes and causeway road structures including the Antelope Island State Park causeway, Magcorp dike, and dikes at Locomotive Springs. They are present at GSL April through May.

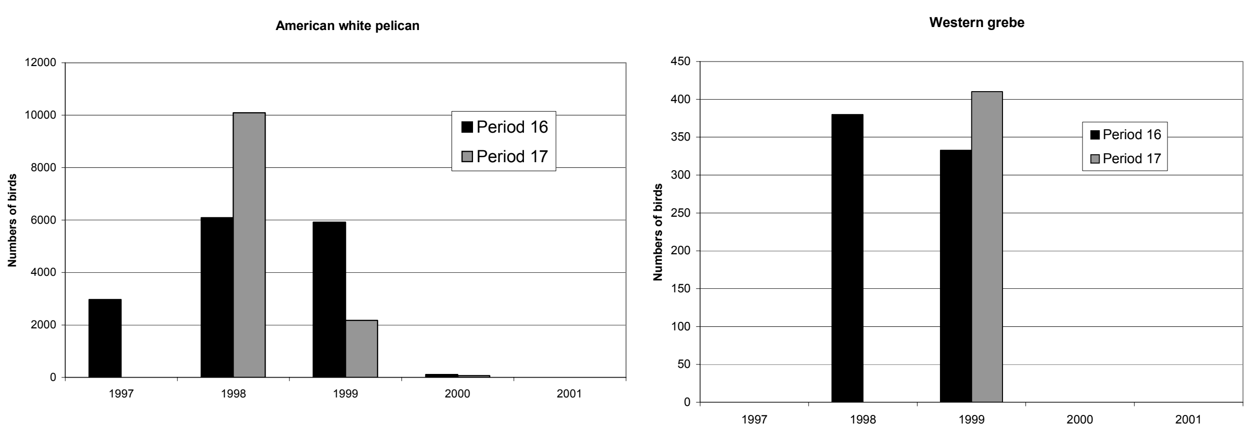
Colonial Waterbirds

Due to the close proximity of nesting colonies to some survey areas colonial waterbird distribution observations and population estimates within the ecosystem may be biased for some nesting species. In fact, several survey areas had colonies within their boundaries. This was true for California gulls, American avocets, black-crowned night herons, black-necked stilts, Caspian terns, eared grebes, Forster's terns, Franklin's gulls, western grebes, snowy egrets, and white-faced ibises. Some of these species do not always nest in dense colonies (e.g., American avocets and black-necked stilts), but most others do. The survey only required observers to report nesting activity during collection of point sample data. American white pelicans are an important species where no nesting activity took place in a survey area. The only nesting colony occurs on Gunnison Island, 35 miles from the nearest survey area.

Many waders are piscivorous species and were normally observed in parts of the ecosystem where fisheries occur. This was also the case for western grebes, Clark's grebes, double-crested cormorants, Forster's terns, Caspian terns, and black terns, all fish by diving into and under the water surface. These foraging conditions occurred at various locations around the lake and were largely associated with the three major river deltas of the Bear, Ogden/Weber, and Jordan. Occurrence was also noted at the mouths of smaller tributaries, canals and other artificial structures. Bear River Bay and Willard Spur portions of GSL held a fishery through the first three and a half survey seasons. The carp and gizzard shad fishery deteriorated with the hot, dry summer of 2000 continuing into 2001 when the Willard Spur was almost completely dry. Large carp carcasses were visible from the air in shallow water and on mudflats in the Bear River Bay region outside the D-line dike of Bear River MBR in mid summer 2000 and beyond. This affected fish-eating species distribution due to lack of a suitable fishery.

Observations of American white pelicans during the five-year study described how piscivorous species were influenced by variable conditions in GSL fisheries. Distributions of American white pelicans by survey period (Appendix 6) reflect specific site importance during an average year for pelicans. Areas of pelican concentration were the Bear River system and State WMAs on the east side of the lake. If the data are examined as annual means, counts of pelicans during late summer of 2000 and 2001 drop dramatically (Figure 9). These declines directly correlate with observed fishery loss in the Bear River system. Other fish eating waterbirds were also affected in a similar manner. However, the magnitude of effect depends on the species. Terns that forage on smaller fish, and grebes that dive, have some alternative fisheries in the area, such as Willard Bay Reservoir. Regardless, the quality of the fishery in the Bear River system has a profound affect on bird occurrence in the area.

Figure 9. Numbers of American white pelicans and western grebes at Willard Spur (28) during survey periods 16 and 17, 1997-2001. In 1997 survey work was not completed during period 17. No western grebes were recorded in the Willard Spur during survey periods 16 and 17 of 2000 and 2001 because the area was dry.



The California gull is an example of a ubiquitous, breeding, colonial species at the GSL, with a broad diet and exploitative foraging behavior. Five-year mean counts by survey period show this species' universal use of the GSL with some hot spots of occurrence near breeding colonies. These conditions are apparent in the months of June and July when the colonies are active with young (Appendix 6). In August and September, California gulls are found exploiting the large numbers of brine flies and brine shrimp in open water and shoreline areas.

White-faced ibises are a colonial species that establish colonies in emergent vegetation but spend much of their foraging in flood-irrigated agricultural lands feeding on earthworms and other invertebrates. Because the majority of their activity around the lake proper is associated with nesting, it is obvious where the nest sites occurred within wetland systems (see Appendix 6—White-faced Ibis Distribution by Survey Period, Periods 9 and 10).

Waterfowl

The distribution of waterfowl at GSL wetlands is well understood-data have been amassed for well over a half-century-and data from the five-year study show those same patterns (Appendix 6). Ducks occur in large numbers during April (survey periods 1 and 2) as they pass through the area en route to breeding grounds. Then they start to re-appear in late June when some molt migration takes place, and build in numbers through September when the largest numbers of all ducks materialize, especially at the managed systems, Bear River, and Farmington bays.

These are but a few examples of the distribution of different species across the GSL ecosystem through the 17 survey periods. Examination of individual Species Accounts (Appendix 5) and specific Survey Area Descriptions (Appendix 4) allows for a more detailed understanding of how each species uses the GSL landscape during the months of April through September. To better understand how lake elevation affects species distribution, see also Species Distribution at High and Low Lake Elevations (1999 and 2001, respectively) in Appendix 8.

Breeding Species

These data are taken from all-lake five-year means for survey period nine (end of June, beginning of July), and are assumed to be the peak breeding time (Table 7). However, Waterbird Survey areas did not cover all of the GSL breeding grounds, and some species have peak numbers later in the season. California gulls breed on many islands outside the GSL Waterbird Survey study area and therefore this potential breeding adult figure would underestimate their actual numbers. American white pelicans also breed outside the survey area but because of their use of fresh water fisheries within the survey area, the population estimate from survey data should be more realistic. The actual five-year average of American white pelicans from the Gunnison Island breeding adult survey is 13,338 for 1997-2001, a difference of 3,440 from the WBS estimate. If the high year (1999) is dropped the four-year average is 12,183 or a difference of 2,285. These estimates might also be useful in assessing the percentage of the breeding adult population that forages outside the survey area (i.e., American Falls Reservoir, Idaho).

Species Accounts

Data reported by species are valuable in drawing conclusions about GSL populations as they relate to populations of a larger geographical area. It is interesting to note what percentage of North American, or worldwide, populations are found at GSL. Equally important is a review of the scale of a particular population. All species do not occur at the same magnitude. For example, the estimated number of mallard ducks in North America is close to 7.5 million, and the high count recorded at GSL is137,468. The GSL population is 2% of the continental population. The highest count of marbled godwits at GSL during this study was 43,833, less than one-third the number of mallards. However, the estimated population size for marbled godwits in North America is 171,500, of which the GSL group represents 25%.

Three numbers for waterbird species present at GSL are reported in the Species Accounts: mean, peak and high count. All are useful in describing waterbird use of the GSL ecosystem. The mean is a stable and conservative figure that indicates likely population sizes during the respective time frame of presence for each species in any given year. The peak number is the highest count for one survey period. This is a mean over five years and is graphically displayed. The high count is the greatest number recorded in one survey during the study. This value may represent a time of optimal conditions at GSL for a particular species, or it may be an artifact of other circumstances that affect a species during other parts of its life cycle.

Bird Use Days

The bird use day calculation is useful in considering numbers of birds present at GSL in conjunction with their length of stay. A bird day is defined as one bird spending 24 hours within the study area during the study period. On average, between April and September (170 days) waterbirds spend 86,752,258 bird days at GSL. This number alone illustrates the importance of GSL and its allied wetlands to many waterbird species. This presence includes a range of activities: migratory stopovers, breeding cycles, molt migrations and a portion of year round residency. It is a way to combine observations of species that migrate through the area in large flock sizes (phalaropes) with species that spend much of the year at GSL (gulls), and species of which part of the population uses GSL habitats as a breeding site and part arrives later in the season to stage for fall migration (avocets).

Survey Area Descriptions

Not all survey areas contributed the same level of bird use to the total. Upon review of the Area Accounts it is possible to select areas that a related study could focus on to collect data that would provide very similar results to an all-lake survey, but require fewer resources to complete the task. One of the goals of this study was to develop a less intensive sampling plan that would maintain the same quality of information. This type of approach has been described in some detail in the document titled "A Plan for Monitoring Shorebirds During the Non-breeding Season in Shorebird Monitoring Region Utah-BCR 9 (Great Basin)", and can be found in Appendix 7 (Manning et al. 2002). In no way does this indicate that some of the outlined survey areas at GSL are not of importance to waterbirds. To date, the GSL ecosystem still has large tracts of contiguous wetland habitat, which varies with changes in lake elevation. This expanse of waterbird habitat is likely what attracts millions of migrating birds every year to feed on the abundant food source that inhabits these salt and fresh water systems. The whole is greater than the sum of its parts.

Identification of Important Sites

There were no sites surveyed that did not contribute to the waterbird population and ecology of the GSL. Some sites were seasonally important, some were important to specific species or suites of species, some were more important in specific years, and some sites changed values depending on lake elevation or drainage flow patterns. There were many sites that had relatively constant high value for a variety of species through the five-year study, such as Bear River MBR. Other areas that consistently had high numbers of birds were Ogden Bay and Farmington Bay WMAs and the Layton Wetlands (West Layton 17 a and b). Some survey areas with less diverse habitats and species richness are important because of the connectivity they provide to other habitats in the ecosystem. As the lake elevation rises and falls, and the state of emergent vegetation follows the type of available habitat changes. As a result the species present change, and total bird numbers can differ depending on the natural history of the species. North American population numbers are reported in the Species Accounts (Appendix 5). Therefore, total bird numbers are not the only way to judge the value of an area.

One tool that can be used to assess survey areas for important occurrences is the peak number category of Survey Area Descriptions (Appendix 4). For example, data from survey area 34b, East Promontory South, show a five-year mean number of Canada geese to be 1,897, and a peak number of 5,990. The data show high counts in the month of June. These geese appear at East Promontory South with their young in a molt migration and then they disperse. The ratio of peak to mean counts for Canada geese is 3.1 to 1, and for ring-billed gulls it is 1.1 to 1. High ratios seem to reflect high occurrence events or birds that are strongly migratory through the system. Birds that are breeders are more stable in numbers through time, and they generally appear to have smaller peak to mean ratios.

In summary, the best information for assessing areas of importance for waterbirds comes from the Survey Area Descriptions (Appendix 4). This information does not provide occurrence by date, but does provide some numeric values. The information by date is available in the GSL Waterbird Survey database that houses some nine million bird observations for each of the five years. For more detailed analysis, this database is the most comprehensive source for study information. Access to these data may be granted through the Great Salt Lake Ecosystem Program Manager.

Habitat Use

Generally, 1999 was wetter and cooler than 2001. Ducks were more prevalent in the wetter, high lake year, and gulls, phalaropes, recurvirostrids favored the drier, low lake year with its abundant macroinvertebrate halophiles. On a smaller scale, dowitchers favored wetter years with good stands of emergent vegetation surrounding open water, and peep sandpipers took advantage of dry year invertebrates and lots of mudflat habitat.

What we have learned about habitat change was perceived before the five-year study. We assumed that we would see significant variation in habitats and their use due to the terminal lake phenomenon that drives the GSL environments. This, we believed, would certainly be true as lake dynamics-affected shorelines. The 1980s high lake years provided a platform for this assumption as biologists and managers watched entire refuge systems go under water and then reappear as the lake receded. Bird populations reacted to these changes.

What was perhaps not as apparent or forecasted was exactly how individual species would react to change in their geographic and habitat use of the system. The temporal patterns were not well perceived either. This study has brought some of the answers to these questions into better focus and has allowed for a reaffirmation of lake dynamics (see Appendices 3 and 8). For example, Appendix 8 (avocets and stilts) shows avocet and stilt numbers at the end of the summer in 1999 (survey periods 13-17) were abundant in the Bear River MBR region. However in 2001 when that area dried up, avocets and stilts were absent from the MBR and moved to more favorable habitat at the peripheries of Farmington, Ogden, and Bear River Bays. Marbled godwit presence (as mapped in Appendix 8) shows a different response to the change in water level. In 1999, godwits were abundant at Bear River MBR during the mid and late summer survey periods. This is a typical pattern when water is present in the area providing appropriate habitat for godwits. During the last two survey periods of 2001, rather than shifting to another favorable place nearby, the area was dry and godwits left the GSL early.

The 2002 summer was even dryer than 2001. The lake continued to shrink with mid summer lake elevations at 4198' ASL. The landmass associated with south Farmington Bay migrated to Antelope Island near the Fielding Garr Ranch. The Willard Spur was dry again and certainly some bird populations adjusted accordingly. The most apparent habitat characteristic of the ecosystem is the dynamic condition that drives constant change in shorelines, serial stages in emergent vegetation, lake limnology, characteristics and location of colonial nesting substrate, and other habitat conditions.

Comparison of Other Great Salt Lake Surveys

William H. Behle conducted systematic colonial waterbird surveys in the 1930s and again in the 1940s with some follow up in the 1950s (Behle 1958). With the establishment of State and Federal wetland management projects (1930 to present), surveys have been conducted for waterbirds, primarily waterfowl. More recently, starting in 1980 surveys have been conducted at GSL for some migratory non-waterfowl species. The following is a list of key species suites and associate colonial nesting species for which five to 25 years of data are available: American white pelican, eared grebe, snowy plover, Wilson's phalarope, red-necked phalarope, white-faced ibis, California gull, Franklin's gull, black-crowned night-heron, snowy egret, and cattle egret. Of special interest are the survey data that overlap the GSL Waterbird Survey. Data comparisons are provided for five species: American white pelican, eared grebe, snowy plover, white-faced ibis and Wilson's phalarope.

American White Pelican

Each year since 1979 American white pelican breeding adult and projected fledgling data have been collected. These data are acquired by applying a photo survey protocol to the Gunnison Island breeding colony. The Gunnison colony is photographed from an airplane each May 20th, or the closest day to that date possible. Photographs are taken of each sub-colony from which count data are extrapolated to breeding adults. One nest-attending adult represents one pair.

There was a general downward trend in numbers of pelicans observed in the GSL Waterbird Survey through the five-year study. From a high of 85,000 to a low of 9,898; this trend generally reflects the collapse of the local non-game fishery associated with the drought conditions at the end of the study. Field surveyors often observed both fish mortality and loss of shallow water habitat during this time. The Bear River MBR operated at less than 27% of capacity during 2001 (Al Trout, personal communication), and the Willard Spur dried up completely. In 1999 cool, wet spring weather may have also been responsible for some declined use.

Gunnison Island breeding adult numbers have always shown considerable variability between years, but usually there are trends for different sets of years. An up and down cadence of year-to-year variation can be seen in the five-year data set. The year 2000 was interesting for pelican surveys, and illustrates the effect that changes in microclimate can have on the population. The spring of 2000 was ideal for the onset of breeding with reasonable moisture and lots of residual water from the wet 1999 year. However, conditions did not hold, and the summer turned dry and hot. When late summer arrived, the fishery habitats were poor, and pelican counts in August and September dropped as a result. The counts at Willard Spur for survey periods 16 and 17 in September 1999 were 5,921 and 2,176 respectively. During the same survey periods in 2000, the pelican counts at Willard Spur were 116 and 72 respectively. A dry winter, spring and summer followed with diminished numbers of pelicans in the 2001 count year (Figure 10 and Table 13). This figure also demonstrates a peculiar phenomenon; the breeding population of adults was higher than the Waterbird Survey count in 2001. From the conditions of the 1980s high lake years when WMAs were under a meter or two of water, we know that Gunnison Island breeding pelicans were making foraging sorties to American Falls Reservoir, Idaho and Utah Lake. With the numbers of Gunnison Island breeders higher than those at Waterbird Survey areas around the GSL ecosystem, there may have been some overflights of traditional fisheries from GSL to places beyond. For example, we know from satellite telemetry that pelicans fly from Pyramid Lake, Nevada to GSL in the course of a half-day (Fuller et al. 1998).

Figure 10. Graphical comparison of American white pelican data from the Waterbird Survey with the annual breeding population count at Gunnison Island using aerial photography.

Table 13. Comparison of American white pelican data from the Waterbird Survey with the annual breeding population count at Gunnison Island using aerial photography.

American White Pelicans	1997	1998	1999	2000	2001
Gunnison Island Survey[1]	12,516	14,014	11,702	17,958	12,010
Waterbird Survey period 5 count[2]	no count	1,756	3,224	3,785	1,457
Waterbird Survey peak count	85,834	68,187	51,114	20,404	9,898

[1]A photo survey of sub-colonies on Gunnison Island conducted in May of each year.
[2]Period 5 includes the date of the photo survey.

Snowy Plover

Peter Paton conducted an extensive ecological study of snowy plovers at GSL during the post-1980s high lake years and into the early 1990s (Paton 1994). This study followed Point Reyes Bird Observatory and the Utah Division of Wildlife Resources snowy plover inventories that suggested the snowy plover was prominent on the GSL landscape (Halpin and Paul 1989). Paton continued his snowy plover research in 1997 while under contract with the American Bird Conservatory. He carried out a replicate survey to those conducted in the early 1990s to see if the population had changed with any subsequent changes in the habitat. This survey overlapped the beginning year of the GSL Waterbird Survey. Paton's survey team assisted in collecting all waterbird data for the Waterbird Survey in conjunction with surveying snowy plovers at the Locomotive Springs WMA.

Over seven years of surveying snowy plovers, Paton's studies averaged 1121.8 plovers during peak periods. During the Waterbird Survey (1997-2001) peak counts for each year averaged 670.6. There were two exceptional count years in Paton's study, 1991 and 92. These were transition years when extensive flats occurred that had once been occupied by emergent wetlands but were barren of vegetation as the GSL receded increasing extensive snowy plover and other shorebird habitat. If these two high count years are eliminated from the Paton sample, the difference between averages of Paton's surveys and the Waterbird Survey is considerably less: 670 (Waterbird Survey) and 992 (Paton). The 1997 Paton and Waterbird Survey difference is very small, only nine percent, with numbers of 1,122 and 1,228 respectively (Table 14).

Beyond survey year differences, another influence in higher averages in the Paton sample is the conditions under which the information were collected. Paton et al developed a search gestalt only for snowy plovers. In contrast, Waterbird Survey volunteers were counting all waterbirds encountered. Under this system it becomes more difficult to pay the necessary attention to effectively search for the cryptic snowy plover. Given these conditions the peak counts are not out of line. Also, the survey routes for the Waterbird Survey stayed at 100 yard from the shoreline, and it is likely that in areas where the mudflats were extensive existing snowy plovers were too far from surveyors to be detected. The surveys in 1997 that overlapped may have been close in numbers because of the added emphasis on snowy plover detection by Paton's surveyors who were rolling up their plover observations into the Waterbird Survey.

Table 14. Comparison of snowy plover data from the Waterbird Survey with Peter Paton studies.

Snowy Plovers							
	Paton study						
Year	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1997**
Number of adults	478	845	769	1344	1501	1150	1122
		Waterbird Survey peak counts					
Year		**1997**	**1998**	**1999**	**2000**	**2001**	
Number of adults		1228	627	584	297	617	

Wilson's Phalarope

Wilson's phalaropes present a survey challenge due to their use patterns of the GSL ecosystem. Starting in June they occur at GSL in large numbers and numbers build until they peak in July (Appendix 5, Wilson's phalaropes). During this time, they aggregate into large flocks (tens to hundreds of thousands) that seem to develop patterns of occurrence that can change between years but remain somewhat constant within a year. These aggregations are usually birds standing on shorelines or in shallow water. During the day these large flocks break up into smaller foraging flocks (hundreds to thousands) that use the open water of GSL to forage brine shrimp and brine flies. They are often dynamic moving from one area of the lake to another. These conditions make surveying difficult from at least two perspectives. Sometimes the large flocks may be missed in aerial survey efforts to cover the 1,500 mi^2 lake and its vast associated shorelines. On the other hand small, mobile, open water foraging flocks are even more difficult to survey accurately because of their constant movements in and out of aerial survey transects. Wave action and cloud cover can exacerbate detection in open water environments.

Even so, there is a general trend shared by the two concurrent and independent surveys studying GSL Wilson's phalarope: the WBS and a one-day aerial survey (Figure 11 and Table 15). One exception to the similar counts found by both surveys is the 1999 annual aerial survey. Here, two possible conditions may have occurred: the aerial survey missed one or more large aggregate flocks, or it missed the peak of migration. The five-year mean peak from the Waterbird Survey occurs during the second week of July. The annual aerial survey occurred on or close to July 29th each year.

Phalaropes are dependent on the two major invertebrates that persist in the GSL when these birds are staging for migration to South America. Due to diluted brines at higher lake elevations and cool, wet weather 1998 and 1999 were years of low GSL macroinvertebrate production. Brine shrimp numbers were so low in Gilbert Bay that the brine shrimp harvest season was closed for that reach of the lake. The difference between the two surveys in 2001 is also interesting. During that year most of the Wilson's phalaropes were located on the west shore near Carrington Island, outside of most Waterbird Survey areas.

Figure 11. Graphical comparison of Wilson's phalarope data from the Waterbird Survey with the annual aerial, all-lake, population count.

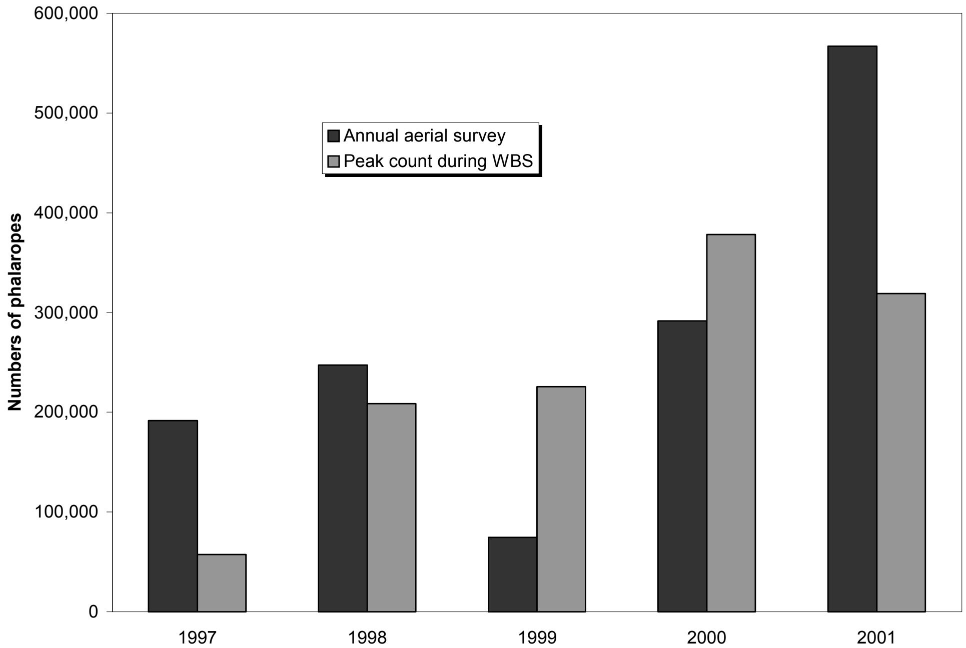


Table 15. Comparison of Wilson's phalarope data from the Waterbird Survey with the annual aerial, all-lake, population count.

Wilson's Phalaropes	**1997**	**1998**	**1999**	**2000**	**2001**
Annual aerial survey[1]	191,733	247,286	74,668	291,671	566,834
Waterbird Survey period 12 count[2]	57,328	17,431	81,478	25,021	242,344
Waterbird Survey peak count	57,328	208,461	225,488	378,292	318,974

[1]A one-day, all lake survey conducted in late July each year.
[2] Period 12 includes the date of the annual one-day survey.

Eared Grebe

For a number of years, an annual eared grebe survey has been conducted during the molting period in October. This is a stratified photo survey that has been developed in cooperation with Hubbs Sea World Research Institute and the Canadian Wildlife Service (Boyd and Jehl 1998). Survey areas are georeferenced, flown by a series of transects, and photographed at intervals. The mean number of birds counted per unit area is used to extrapolate to the GSL population size. A portion of the fall eared grebe population falls within the GSL Waterbird Survey boundaries of Ogden and Farmington Bays, with another small proportion inhabiting the Bear River Bay system. However, the majority of the fall population occurs outside the Waterbird Survey boundaries in open lake water between Antelope and Stansbury Islands, around the Carrington and Hat

Island complex, and extending up the west shore and north and west of Antelope and Fremont Islands. Because of this fact and the differences between survey techniques, comparisons between the two surveys are difficult (Figure 12 and Table 16). Also, the data from 1998 and 1999 reflect the absence of brine shrimp adults in the water column. This is important because when eared grebes are present at GSL, 99% of their diet is comprised of adult brine shrimp (UDWR unpublished data).

Figure 12. Graphical comparison of eared grebe data from the Waterbird Survey with the annual population estimate using aerial photography.

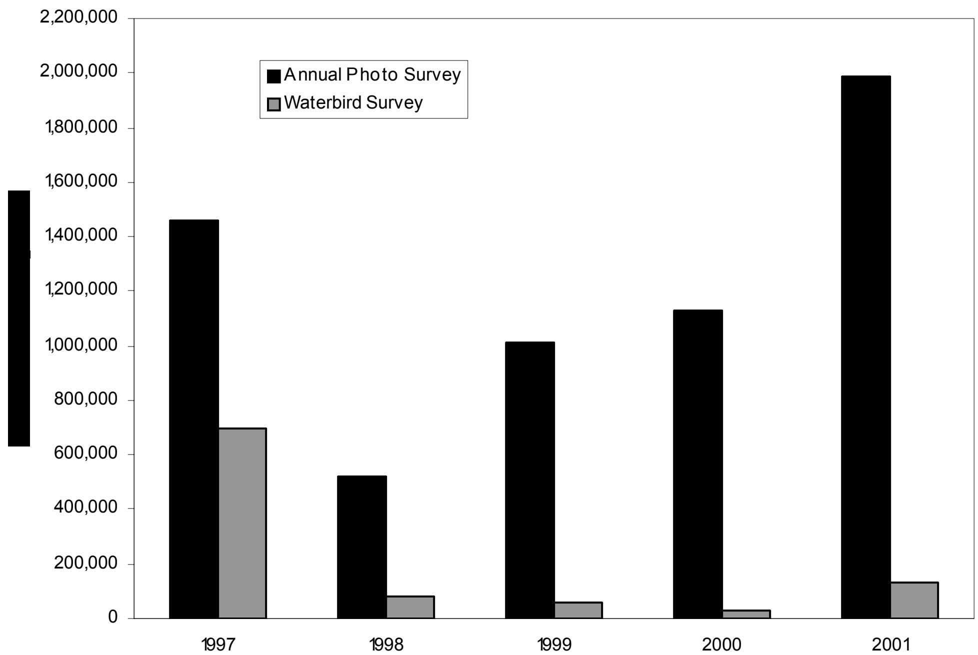


Table 16. Comparison of eared grebe data from the Waterbird Survey with the annual population estimate using aerial photography.

Eared Grebes	**1997**	**1998**	**1999**	**2000**	**2001**
Annual Photo Survey[1]	1,460,151	522,287	1,008,656	1,127,307	1,987,564
Waterbird Survey	698,793	80,541	60,499	28,893	130,473

[1]Adjusted estimate. Survey conducted in mid-October of each year.

White-faced Ibis

Concurrent with the Waterbird Survey, colonial waterbird surveys were conducted for known colonies of species using emergent wetlands (Paul et al 2000b). This included white-faced ibises that often nest in conjunction with several other species. Franklin's gulls, black-crowned night-herons, Forster's terns, snowy egrets, cattle egrets, and a few others were frequently located together. The target of the colonial waterbird survey was to assess the number of breeding adults in the colony. The comparative Waterbird Survey data for the same years are uniformly higher and should be, as they include non-breeding adults, sub-adults, and hatching year birds in the count. However, the trends are similar between the two data sets (Figure 13 and Table 17).

Figure 13. Graphical comparison of white-faced ibis data from the Waterbird Survey with the annual colonial waterbird breeding survey.

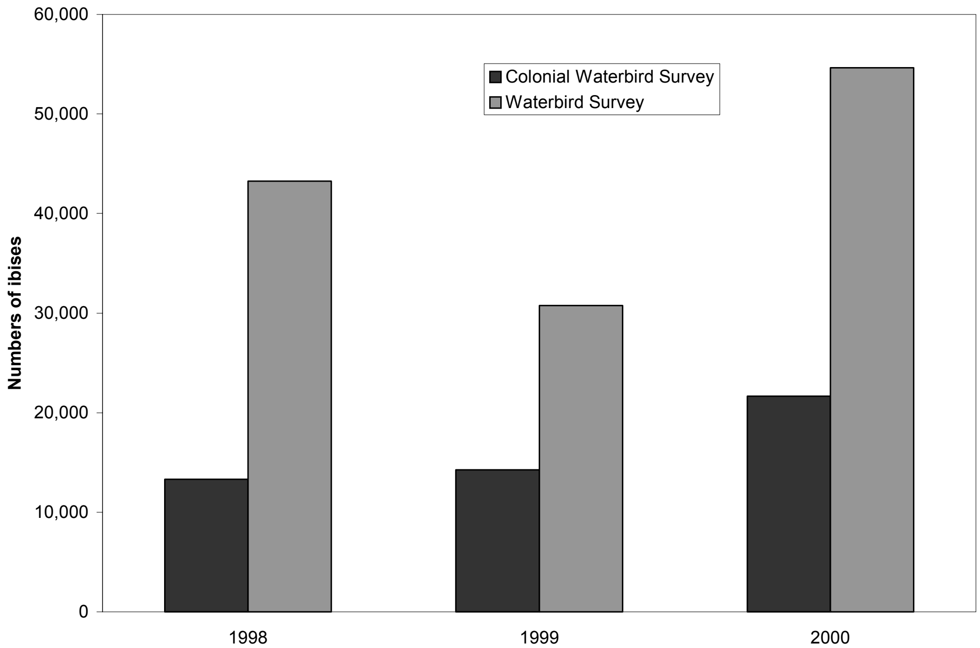


Table 17. Comparison of white-faced ibis data from the Waterbird Survey with the annual colonial waterbird breeding survey.

White-faced Ibises	1997	1998	1999	2000	2001
Colonial Waterbird Survey	no count	13,294	14,260	21,664	1,896
Waterbird Survey peak count	47,577	43,265	30,779	54,634	34,854

Management Implications

Implicit in the primary study objectives is the need to understand species habitat relationships for more effective management and stewardship. Many of the data analyses, if not all, were developed and executed to assist local resource managers in making wise and cogent decisions for a long term, sustainable GSL ecosystem. This study, basically a systematic inventory, and its database were used to gather and store data from which specific questions can be queried. Through some analyses, we have answered questions that will assist managers and decision makers as they seek to protect and conserve GSL resources. Some of these analyses follow.

Georeferenced Survey Areas

At the onset of the study, survey areas were delineated in discrete units with physical descriptions. These areas were placed into logical blocks that comprised similar resource areas (i.e., WMAs, stretches of shoreline, open water, islands, etc.). Later the database manger, with the assistance of Dave Mann and other UDWR GIS staff georeferenced each survey area. Then, survey areas where sampling was conducted were further refined to a percent of the area that was actually covered by survey effort. This process allowed for inter-area contrast through the application of population and species density comparisons (Appendix 4). Geographically referenced sites also allow resource managers to combine adjoining sites, or even similar habitat types that are not joined for evaluation. This can be either a quantitative or qualitative tool for comparative analyses on prioritizing conservation actions.

Survey Area Descriptions

Survey Area Descriptions may be the single most important source of information to evaluate on-the-ground bird presence in specific locations (Appendix 4). This is the density information by species. These data should be used with the knowledge that since it is an average of 77 surveys over five years, a five-year mean is a strong number with considerable comparative value. These years represent a good variation of wet and dry conditions, and reflect past times of lake fluctuation of five feet in elevation. On the other hand, the extreme situations are tempered in mean data, and therefore, it is of value to examine individual years and survey periods to get a clearer picture of what might happen under specific circumstances. There are times in a survey area when a species or suite is notably present, without an understanding of why that is the case.

Other information that may be of import to resource managers is species diversity. In this report, species diversity is defined as the number of species occurring in an area in high presence values. These individual area accounts will provide information on coverage by year and some comments on survey detection rates.

Species Accounts

This report presents Species Accounts for the majority of species identified during the Waterbird Survey (Appendix 5). Due to small data size or irregular occurrence, however, there are some species excluded. The information is presented in order to help resource managers grasp the importance of the GSL population compared to the North American and/or global populations where numbers were available. A graph of the mean five-year counts by survey period provides information on seasonal presence. Perhaps of greatest value in importance assessment for habitat use is in the species distribution plots georeferenced to a GSL map. This map reflects an over all area habitat use value of the five-year mean. This might be the answer to general questions like "which area(s) is most important for American white pelicans." The answer from the map is the Bear River Bay complex, and is true if you roll all survey periods into one mean; but without Gunnison Island (the breeding colony) for a substantial number of these pelicans using the Bear River system, this map would be altered significantly. To assist in the evaluation of areas important to species use at GSL, it will be important to inspect the specific Survey Area Descriptions (Appendix 4) and to consult the Species Distribution by Survey Period section (Appendix 6). These analyses and others in the report will help develop a more precise picture of bird use of the GSL.

The pelican example brings to light the observation that breeding populations in the area sometimes influence the Waterbird Survey data for specific areas, regions and populations of the lake. Breeding populations were not accounted for in this study. The only time breeding populations are considered is in some of the narrative of specific Survey Area Descriptions. Yet, colonial nesting populations and loosely associated nesters (i.e., American avocets were frequently associated with survey areas and routes) did influence counts in many areas. There was no attempt to avoid them; they were counted uniformly across the landscape along with non-breeding populations.

Species Distribution by Survey Period

Information important during different periods of the survey season is available here. This information represents a five-year mean for each survey period (1-17). These temporal data are important to evaluating seasonal use of each species. Cinnamon teal distributions through time is prominent in the Bear River Bay during the early to mid survey periods (April-July), and becomes equally or more important in the Ogden and Farmington Bay WMAs at the end of the season (August-September).

The vast majority of marbled godwits are located in the Bear River Bay system through both the spring and late summer use periods. Managers considering the GSL's role in godwit conservation need to pay close attention to the Bear River MBR and the Willard Spur systems. Why birds occur at certain times in specific places is a question not answered for most species in this study.

Migration Chronology

This report provides a migration chronology similar to the information on presence status in Birds of Utah (Behle and Perry 1975), but refined for GSL (Table 6). Habitat managers and biologists are often requested to provide recommended windows of time for development or potential disturbance activities. These "best time, worst time" requests are difficult without systematically collected temporal data. Therefore, this migration chronology should assist resource mangers in designing best-case scenarios.

Shoreline Conservation

The numerous shoreline survey area data sets confirm the critical role that GSL shorelines habitats play for a variety of species for most phylogenetic groups in the GSL ecosystem. Several of the analyses provided in the report can assist in the understanding of shoreline habitat characteristics and values.

Point sample data are the only information describing habitat use by waterbirds in the study. These data are summarized for the high lake study year, 1999, and the low lake year, 2001, only. Mean bird counts are compared by suite, habitat type, and year. Charts compare mean bird counts for all habitat types combined for 1999 and 2001. Due to the dynamic condition of the shoreline, which is an important value and phenomenon in lake avian ecology, this information should be used to predict bird use at different elevations and for developing shoreline management strategies. The data collected in this study makes clear the critical role shoreline fluctuations play in bird and wetland succession. For this reason, shorelines should be allowed to expand and contract through their full range with minimal anthropogenic developments.

When point samples were established at GSL in 1997, certain randomly selected points were put in place to compare with bird use data collected from non-drainage points. The comparison between these two point sample types is difficult because we do not have good flow rates at drainage points. Some were established where irrigation returns enter the GSL; flow regimes are difficult to measure at these sites due to the intermittent flows associated with agriculture water systems. In some cases drainages were discontinued altogether, and the drainage point sample became a non-drainage point in terms of presence of water and bird use.

Managed Wetlands

Until this study, there had not been an effort to collect coordinated data between wetland managers (State, Federal and non-profit). With this study, wetland managers will be able to determine which species and for which time of year their management areas are important. The data will also make coordinated conservation actions between management areas a more viable possibility. These data provide some information on species values by area that can assist managers in developing management practices that best suit their areas and intrinsic habitat values.

In addition to total count data, most State managers incorporated area counts into their sampling program during the study. These area counts were conducted in defined sites, bounded by dikes or other borders, that have or could be georeferenced to compute density data for comparison. The area counts assess the area in the same way that occurred in point samples. Area counts were suggested as a tool for managers to use in assessing treatment values to the area. These could include controlled burns, drawdowns and flooding, and chemical treatments. The study allowed the managers to choose area count sites within their sampling scheme. This approach was developed for managers to use as a tool and not as an element to be analyzed in this report. Data were provided annually to managers for their use. The use of this technique can be applied in time and is suggested as a possible evaluation tool for future treatments.

The data sets for managed areas are among the richest in species composition and numbers of birds that occurred in the five-year study. The individual and collective data sets for emergent vegetation survey areas, the species accounts, and chronological bird data are some useful tools to consider for managers.

The Great Salt Lake

Bird use of the GSL is substantial but varies by area, time of year, and lake elevation. The three open lake regions of the GSL that were surveyed, Farmington Bay, Ogden Bay, and Bear River Bay, each offer significant avian values. Managers can assess the values by examining the individual Survey Area Descriptions (Appendix 4).

Managers should carefully consider shoreline associations of each of these lake regions. Lake elevation should also be considered when evaluating annual data. Most of the data are represented as a five-year mean, but there is a sample of high and low lake elevation, 1999 and 2001 respectively, in the Appendix 8. There is also a high and low lake year data set for GSL shoreline use as described through point sample data (Appendix 3).

Important to the Farmington Bay region is the occurrence of large sandbars in the south part of the bay between the mainland and the southeastern portion of Antelope Island and south of the Great Salt Lake Shorelands Preserve. These formations are two of the most dynamic features at GSL. Carefully consider bird data in this area by lake elevation. An interesting pattern of bird use occurs at different lake elevations in the Layton Wetland complex as well.

Within the study area, East Gilbert Bay is the primary producer of brine shrimp and is an extension of the main Gilbert Bay where the vast majority of brine shrimp are produced. This area is also affected by lake elevation, but not in the same way as Farmington Bay. Here, WMA dikes at Howard Slough and Ogden Bay are submerged when GSL is above 4202' ASL. Managers should pay attention to lake elevation and brine shrimp and fly production when evaluating bird data in this area. These is no current brine fly monitoring at GSL, but the Great Salt Lake Ecosystem Program files have good brine shrimp harvest and density data since 1996. Great Salt Lake elevation records generally correlate to brine densities, and these data are available through Utah Geologic Survey, Utah Department of Natural Resources.

The Bear River Bay region is an intermittent fishery and the associated waterbird presence is profoundly influenced by the fishery condition. The most extensive wetlands occurring outside management areas occur here. When there are low flows in the Bear River and the GSL is at 4200' ASL or below, the fishery in the Bear River Bay and Willard Spur is dysfunctional. When flows are average or greater and elevations are at 4202' ASL or higher, there is a consequential fishery and piscivorous bird presence in the area. The difference can be tens of thousands of birds. During the dry climate condition, much of the outlying emergent wetlands are dry. During wet cycles robust emergent waterbird colonies are present; some colonies are the largest in western North America. These are especially important to white-faced ibises and Franklin's gulls. Here again five-year mean data are of value but particular attention should be paid to individual year records measured against Bear River flows and lake elevation.

Habitat and Population Modeling

Some modeling of habitat and potential species presence exists using the database and this report. Because this study was an ecosystem based systematic survey that covered all prominent habitats, modeling is a real possibility. This survey can be used to refine the model that is currently in place to assess brine shrimp harvest impacts on avian resources.

Conservation Planning

This data set and subsequent report provide a foundation of biological and habitat information for conservation planning within the ecosystem. The surveys took place over several years and during five feet of vertical lake elevation change, and provide a reasonable picture of how the lake is used by waterbirds under a variety conditions, and through much of recorded lake elevation history. However, it is important to remember that extreme events did not occur during this survey. Extreme events (i.e., historic lows and highs) can have dramatic effects on wildlife populations and their habitats.

This information will also be useful in evaluating existing plans such as the Utah Department of Natural Resource's GSL Comprehensive Management Plan, regional and national shorebird and waterbird plans, and Intermountain West Joint Venture Focus Area plans. The draft GSL Shorebird Plan will perhaps benefit the most from this data set as it validates assumptions and offers new information. The GSL Waterbird Survey Report will be helpful in defending the 23-21-5 designation authorized by the Utah state legislature that allows for wildlife management primacy in several sections of State land within Farmington, Bear River, Gilbert and Gunnison Bays.

The information collected in this study is already being utilized with the Western Shorebird Survey. This survey is a subset of data being collected to monitor national and continental shorebird populations. Utah was one of the first states to come on line in the Western Shorebird Survey with survey sites, surveyors and data sets already in place. This web-based approach to data collection is unique in the western shorebird monitoring community.

This study with its impressive bird numbers and demonstrative species value should be used to emphasize the importance of the system to communities and their leaders. Bird use days, peak populations and the strength of the five-year mean data are selling points from Syracuse, Utah to Washington D.C. These data validate the anecdotal observations and less robust data sets by describing in more detail, with greater accuracy and more reliable data, the value of the GSL in the Western Hemisphere setting. This story should be told.

Recommendations

The data reported in this document are valuable to many entities around GSL and other organizations nationwide, and have been already shared with such groups while the study was ongoing. But because of the importance of this data set to so many, we recommend that it be updated on a regular basis. Population trends are most accurate when many years of data are available. As the GSL is a dynamic system, long-term data collection is even more important, to blend lake flooding and receding cycles into larger scale population trends (Table 18).

Now that a baseline inventory of waterbird species around GSL has been completed, it is recommended that future efforts reduce the scale of study and focus on areas of high waterbird use as outlined in the document, "A Plan for Monitoring Shorebirds During the Non-breeding Season in Shorebird Monitoring Region Utah-BCR 9 (Great Basin)" (Manning et al 2002). Intensive survey work at the species level would also be valuable for those species that may not have been well detected through the Waterbird Survey protocol. For example, snowy plovers are small and cryptic, and are not located near the shoreline all of the time. Because Waterbird surveyors stayed 100 yards from the shoreline they may have missed plovers distributed on an expansive mudflat. A more concentrated area search at all appropriate habitat types would yield a more accurate number of snowy plovers at GSL. The same applies for other species.

If a similar inventory using volunteer help is planned, we make the following recommendations. To minimize the variation in skill levels between surveyors, provide ample training for volunteers. This is best achieved in small groups, ideally at the survey team level, and at the particular site where volunteers will be doing their surveys. Keep the protocol as simple as possible. The point sample section of the data form used in this study was too complicated, and data that were not recorded properly could not be used. Survey routes should be limited to that which can be covered in 2 hours. The Waterbird Survey had many dedicated volunteers who gave much of their time over five years to contribute to this effort. It is easier to have consistent volunteers when their travel and survey time is kept to a manageable amount.

Develop a schedule for waterbird surveys through time. This process should consider the monitoring protocols set for the through the North American Waterfowl Management Plan, National Shorebird Plan, Continental Waterbird Plan, and consider any actions recommended by Partners In Flight. The coordination of this effort should be an element of the Utah All Bird Committee and the Utah All Bird Plan.

The Western Shorebird Survey is already in place, and Utah is organized and cooperating in the 2002 season. This commitment should be considered in developing survey schedules. (Complete by February 2003.)

The GSL shorebird planning effort should be revisited using the GSL Waterbird Survey five-year data set as a conservation and implementation tool. This plan should be completed with the involvement of the primary land managers associated with the GSL shoreline and water bodies as proposed in the draft plan. (Complete by April 2004.)

Community based data collection and data use were sub-objectives of the Waterbird Survey, and given this element, the database should be provided to cooperators for their use in conservation actions. It is recommended that electronic copies of the database be provided to the sponsoring institutions of Waterbird Survey team members. In addition, this report should be made available in hard copy to each Waterbird Survey team member, each sponsoring institution, and the organizations listed in the Acknowledgements. This report should be for sale in hard copy format in the Utah state of Utah Department of Natural Resources bookstore. We also recommend that this report be produced in an interactive format on CD-ROM and made available through the bookstore and at the Northern and Central UDWR regional offices. This format should also be put on the UDWR website through the Great Salt Lake Ecosystem Program link.

The Paradox database should be appropriately archived in three or more locations to help insure its preservation through time. Copies should be housed in the Aquatic Section, GSLEP, the Wildlife Section, Habitat section, non-game bird coordinator's office, and the waterfowl management coordinator's office.

Table 18. Recommendations for further waterbird study at GSL and volunteer participation.

For continued study of waterbirds at Great Salt Lake:

- Continue to monitor migratory bird populations at GSL.
- Some species may require specialized survey methods (e.g., snowy plovers).
- Develop a schedule for survey work through time, coordinating monitoring protocols describe in bird management plans.
- Make data available to local and national managers, conservation planners and research biologists.

For volunteer participation in survey work:

- Provide ample training for volunteers.
- Keep survey protocol simple.
- Survey routes should be limited to that which can be covered in two hours.

Acknowledgements

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Table 19. Great Salt Lake Waterbird Survey participants. This list is unfortunately not all-inclusive. There are several people not on this list that gave time and effort to contribute to this study and our records did not capture their names.

Albanese, Gene	Halliday, Karen	Neptune, Dawn
Anderson, Kathy	Harvey, Adrienne	Neville, Ann
Annand, Elizabeth	Hatch, Jolene	Norvell, Russell
Armantrout, Hank	Hayness, Michelle	O'Brien, Deedee
Bachman, Val	Henry, Adonia	O'Connell, Ann
Ballard, Leanna	Hill, Melissa	Oliver, George
Bates, Steve	Hillard, Ryan	Orton, Kay
Beeny, Lance	Hooker, Lori	Packer, Nate
Beeny, Tara	Howe, Frank	Parrish, Jim
Berger, Randy	Hudman, Chris	Paul, Don S.
Beyer, Senta	Huntington, Bob	Pearce, Ann
Birdsey, Paul	Jancart, Susan	Pearce, Maunsel
Bloch, Yvonne	Jochum-Natt, Stephanie	Perschon, Clay
Brown, Chris	Johnson, Bruce	Peterson, Cheryl
Bruner, Sue	Johnson, Richard	Peterson, Joel

Bryner, Yae
Butler-Curl, Jaimi
Cady, Candace
Caldes, Clair
Carpenter, Gordon
Case, Bill
Catchelin, Adrienne
Chase, Dan
Chelminski, Michael
Christiansen, Lynn
Ciak, Penny
Clapier, Dave
Clark, Alan
Cline, Chris
Collins, Dennis
Currie, Vera
Darnall, Nathan
Davidson, Jenny
Davidson, Mark
DeFreitas, Patrick
Dewey, Lindsey
Dick, Ann
Dolling, Justin
Douglass, Phil
Evans, James
Ewing, Louise
Fletcher, Bonnie
Flory, Joel
Ford, Henry
Freeman, Terry
Frokjer, Chris
Gardiner, Kirk
Goodell, John
Gray, Bill
Gray, Sylvia
Hall, Chauncey
Hall, Emily
Johnston, Dan
Johnston, Laura
Jorgensen, Ray
Kadesch, Margot
Kearl, Debbi
Kearl, Rick
Kelly, Patrick
Klein, Kimberly
Koch, Brandee
Kramer, Pam
Kremer, Shelly
Larsen, Elizabeth
Laurila, Pamela
LeBer, Jeanne
LeBlanc, Cecile
Lee, Dave
Light, Avis
Light, Jim
Lindsey, Karen
Loeffel, Leslie
Low, Blair
Luft, John
Magasich, Phil
Manes, Sam
Manning, Ann
Marden, Brad
Markin, Melanie
Martinson, Wayne
Martz, Maxine
Melcher, Jaye
Merola, Paul
Mills, Mike
Natt, Mark
Neff, Darcie
Neill, John
Nelson, Marie
Reed, Rick
Roletto, Jan
Roundy, Steve
Roy, Vickie
Rudman, Jill
Ryburn, June
Saenz, Joe
Saffle, Sue
Sherman, Kevin
Slaughter, Danielle
Smith, Bill
Smith, Harold
Smith, Margaret
Sorensen, Ella
Stafford, Cindy
Stauffer, Jim
Sterner, Shannon
Stroup, Yvonne
Swartzfager, Marsha
Szczypinsky, Mark
Torres, Maria
Torrey, Jack
Trimmer, Edie
Tripp, Tom
Tropea, Kim
Warchol, Glen
Warrick, Curtis
Watson, Alan
Watts, Ardean
Welty, Todd
Werner, Ron
White, Mel
Wood, Mike
Wyss, Larene
York, Elaine
Zuby, Kris

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Appendix 1: Species List

The following is a summary of the species included in the Great Salt Lake Waterbird Survey. Common names are listed along with the associated Latin name and four letter codes used by the American Ornithologists Union and this report. As indicated in the following table, the six letter codes are unique to this report and represent a particular suite of species. Species with limited survey records are not listed below.

Suite	Code	Common Name	Latin Name
25	CLGR	Clark's grebe	*Aechmophorus clarkii*
18	EAGR	Eared grebe	*Podiceps nigricollis*
25	GREB	Unidentified grebe	
25	PBGR	Pied-billed grebe	*Podilymbus podiceps*
25	WCGR	Western or Clark's grebe	
25	WECLGR	CLGR + WCGR + WEGR	
25	WEGR	Western grebe	*Aechmophorus occidentalis*
17	AWPE	American white pelican	*Pelecanus erythrorhynchos*
21	DCCO	Double-crested cormorant	*Phalacrocorax auritus*
7	BCNH	Black-crowned night heron	*Nycticorax nycticorax*
7	CAEG	Cattle egret	*Bubulcus ibis*
7	GREG	Great egret	*Casmerodius albus*
7	GTBH	Great blue heron	*Ardea herodias*
7	HEREGR	CAEG + GREG + GTBH + SNEG	
7	SNEG	Snowy egret	*Egretta thula*
16	WFIB	White-faced ibis	*Plegadis chihi*
4, 6	AGWT	Green-winged teal	*Anas crecca*
4, 6	AMWI	American wigeon	*Anas americana*
5, 6	BAGO	Barrow's goldeneye	*Bucephala islandica*
5, 6	BUFF	Bufflehead	*Bucephala albeola*
4, 6	BWTE	Blue-winged teal	*Anas discors*
20	CAGO	Canada goose	*Branta canadensis*
5, 6	CANV	Canvasback	*Aythya valisineria*
4, 6	CITE	Cinnamon teal	*Anas cyanoptera*
5, 6	COGO	Common goldeneye	*Bucephala clangula*
5, 6	COME	Common merganser	*Mergus merganser*
6	DUCK	Unidentified duck	
6	DUCKSX	AGWT + AMWI + BAGO + BUFF + BWTE + CANV + CITE + COGO + DUCK + GADW + GOLD + GRSC + LESC + MALL + NOPI + NSHO + REDH + RNDU + RUDU + SCAU + TEAL + UNSC + WODU	
4, 6	GADW	Gadwall	*Anas strepera*
5, 6	GOLD	Unidentified goldeneye	
5, 6	GRSC	Greater scaup	*Aythya marila*
5, 6	LESC	Lesser scaup	*Aythya affinis*
4, 6	MALL	Mallard	*Anas platyrhynchos*
5, 6	MERG	Unidentified merganser	
4, 6	NOPI	Northern pintail	*Anas acuta*
4, 6	NSHO	Northern shoveler	*Anas clypeata*
5, 6	RBME	Red-breasted merganser	*Mergus serrator*
5, 6	REDH	Redhead	*Aythya americana*
5, 6	RNDU	Ring-necked duck	*Aythya collaris*
5, 6	RUDU	Ruddy duck	*Oxyura jamaicensis*
5, 6	SCAU	Unidentified scaup	
20	SNGO	Snow goose	*Chen caerulescens*
4, 6	TEAL	Unidentified teal	
20	TUSW	Tundra swan	*Cygnus columbianus*
5, 6	UNSC	Unidentified scaup	
4, 6	WODU	Wood duck	*Aix sponsa*

Suite	Code	Common Name	Latin Name
19	AMCO	American coot	*Fulica americana*
22	SACR	Sandhill crane	*Grus canadensis*
24	SORA	Sora	*Porzana carolina*
24	VIRA	Virginia rail	*Rallus limicola*
8	AMAV	American avocet	*Recurvirostra americana*
8	AVOSTI	AMAV + BNST	
9	BASA	Baird's sandpiper	*Calidris bairdii*
26	BBPL	Black-bellied plover	*Pluvialis squatarola*
8	BNST	Black-necked stilt	*Himantopus mexicanus*
23	COSN	Common snipe	*Gallinago gallinago*
10	DOWI	Unidentified dowitcher	
10	DOWITC	LBDO + DOWI	
11	GRYE	Greater yellowlegs	*Tringa melanoleuca*
13	KILL	Killdeer	*Charadrius vociferus*
15	LBCU	Long-billed curlew	*Numenius americanus*
10	LBDO	Long-billed dowitcher	*Limnodromus scolopaceus*
9	LESA	Least sandpiper	*Calidris minutilla*
11	LEYE	Lesser yellowlegs	*Tringa flavipes*
15	MAGO	Marbled godwit	*Limosa fedoa*
9	PEEP	Unidentified peep sandpiper	
9	PEEPSX	BASA + LESA + SESA + WESA + PEEP	
14	PHAL	Unidentified phalarope	
14	PHALAR	PHAL + RNPH + RPHA + WIPH	
26	REKN	Red knot	*Calidris canutus*
14	RNPH	Red-necked phalarope alt.	*Phalaropus lobatus*
14	RPHA	Red-necked phalarope	*Phalaropus lobatus*
23	SAND	Sanderling	*Calidris alba*
13	SEPL	Semipalmated plover	*Charadrius semipalmatus*
9	SESA	Semipalmated sandpiper	*Calidrius pusilla*
13	SNPL	Snowy plover	*Charadrius alexandrinus*
23	SPSA	Spotted sandpiper	*Actitis macularia*
23	STLS	Stilt sandpiper	*Calidris himantopus*
11	UNYE	Unidentified yellowlegs	
9	WESA	Western sandpiper	*Calidris mauri*
15	WHIM	Whimbrel	*Numenius phaeopus*
15	WILL	Willet	*Catoptrophorus semipalmatus*
14	WIPH	Wilson's phalarope	*Phalaropus tricolor*
11	YELLOW	GRYE + LEYE + UNYE	
2	BLTE	Black tern	*Chlidonias niger*
1	BOGU	Bonaparte's gull	*Larus philadelphia*
1	CAGU	California gull	*Larus californicus*
2	CATE	Caspian tern	*Sterna caspia*
2	FOTE	Forster's tern	*Sterna forsteri*
1	FRGU	Franklin's gull	*Larus pipixcan*
1	GULLSX	BOGU + CAGU + FRGU + RBGU + UNGU	
1	RBGU	Ring-billed gull	*Larus delawarensis*
1	UNGU	Unidentified gull	
2	UNTE	Unidentified tern	

Appendix 2:

Documentation for GSL Waterbird Survey Analyses

Jonathan Bart, USGS, Boise

Ann Manning, GSL Waterbird Survey, Salt Lake City

April 2000

These notes summarize the approach we took in analyzing the 1997-1999 waterbird survey data during the April 3-5, 2000 meeting in Boise.

Basic Data Tables

Workbook GSLBdNames.xls contains the species, species groups, and codes.

Workbook "Data.xls" contains data used for the analyses. It has the following worksheets, each of which was saved using TruBasic as a separate file with the same name and a "csv" extension for analyses.

Species (just the codes; sorted with groups first, then species by total number recorded)

Areas (Table 1)
1 Area Number (sequential numbers for the transects, 1 to 54)
2 Area code
3 Name
4 Expansion factor (4 for the Bays; 1 otherwise)

Dates
1 Area number (not codes)
2 Year
3 Julian date (Table 2)
4 Assigned Period *
5 Error *
6 Real Period *

* Assigned Period is the period number assigned for the survey, chosen to maximize the number of different periods with a survey. Real Period is the 10-day interval that the survey was actually in. If the survey was run during the intended interval then error is 0 and Real Period = Assigned Period. Otherwise, error is the number of days outside of the interval and Real Period is the period that the survey was run in.

Points (Table 3)
1 Area number
2 Year
3 Point number
4 Point type (1=Random; 2=Drainage)

Counts
1 Area number (not codes)
2 Year
3 Julian date
4 Point number (0=not a point count)
5 Species code
6 Number recorded

Notes:

1. In 1999, during periods 3,4, and 5, results reported for Area 5A actually covered 5A and 5B. We handled this by adding rows in the Dates file for these 3 periods. Thus the Dates file contains records saying area 5B was run but Counts does not include any records from area 5B during these periods. Tallies of the number of surveys, from Dates, and of the number of birds from Counts are correct, but comparisons of 5A vs. 5B must exclude periods 3-5 in 1999.

2. Program Change.dat modifies the Dates file. It changes area codes to area numbers, extracts year from date, changes mm/dd to Julian date, and adds "period." Period is the nominal period-the period the survey date actually falls in. Alternate period is our suggested designation for cases in which no survey occurs within a period but surveys occur in the surrounding periods, one of them within a few days of the period lacking a survey. "Error in alt. period" is the number of days by which the survey is outside the alternate period. The Alternate Periods are added manually in Excel. Error in alt. period is added by program AddPer.2. Program Change.cts modifies the Counts files. It changes area codes to area numbers, extracts year from date, and changes mm/dd to Julian date.

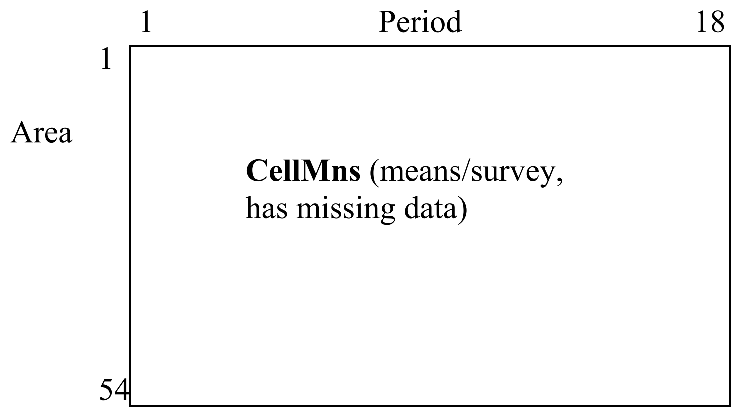
Calculation of Means per Survey

Most of the analyses were done with program Analysis.cts (Figure 1). It uses a "species list" which includes all of the groups identified by Don Paul and all single species for which more than 10 individuals were recorded 1997-1999 (about 85 species). It first reads the Dates file into an array. It then prepares a data table for each species (and species group) either in a specified year or for all years. For a given species, it reads each record in Counts and determines whether the year and species should be included in the analysis. If so, it records the number counted. The program, thus, gets the number of counts, and the number of birds counted for every transect and period. It then calculates means per transect-period and optionally stores this data in a file, CellMns.

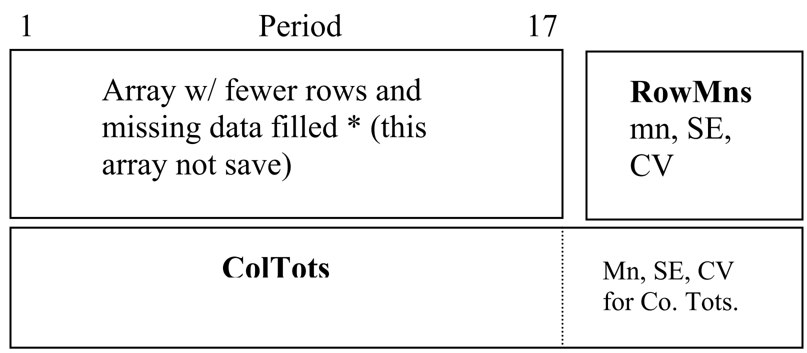
For analyses of restricted areas, the program eliminates rows and/or periods that are not to be included and then calculates row means, SEs, and CVs and column totals. It also calculates the mean of the column totals and the SE and CV of this mean. These results are stored in the file RowMns and ColTots.

Figure 1. Arrays used in program Analysis.cts to calculated means/survey for each area-period (CellMns) area for all periods (RowMns) and for selected areas (those with largely complete data) within each period (ColTots). Grand means, SEs, and CVs are contained within the array ColTots.

1. For a species or group of species, Analysis.cts first calculated the means/survey for each area and period.



2. Next it extracted areas with largely complete data, excluded period 18 (surveys later than period 17), and filled in missing data (taking the average of immediately adjacent means). It then calculated and saved **RowMns** and **ColTots** (which includes the grand mean and its SE and CV).



* Areas excluded due to missing data: 10, 11, 14, 19, 19A, 29B, 34B, 35, 36, 36A, 36B, 39, 40, 43, 44.

Points Analysis

These analyses were carried out with program Analysis.pts. Analysis.pts stores Dates and Points and then uses these to build the array NPts(p,[R,D]) which has the number of random and drainage points surveyed in each period. The program then reads through counts. When it finds a point count it looks in Points to see if the record is useful for this analysis and, if it is, gets the period from Dates. The program prints out the means/survey for random and drainage points and the differences. These are regarded as a random (systematic) sample from which the grand mean, and its SE and CV, are calculated.

The Points spreadsheet was constructed from Manning's list of point types for each year with the following modifications. We excluded pt. 2 at Area 5a (I-80, North-N) because, according to the list, results from pt. 1 and pt. 2 were to be added and treated as a single point. By excluding pt. 2, we kept the sample size for this area correct. 1999 was assumed to be like 1998 except that we excluded W. Layton point 1 (it was done a few times early but then not again) and E Promontory-N because the types were not clear (according to Manning).

In constructing NPts, the program reads thru Dates and looks for a match in Points. When no match is found, it does not add anything to Points. Thus, excluding these records from Points results in them being excluded from the sample sizes even though they occur in Dates. Similarly, in reading thru Counts, when a point record is found we look for it in Points. If it isn't found, then no birds are added so the record is excluded. The one needed change is that records for point 2 at Area 5a DO need to be included. This was handled by changing the point number to 1.

Analyses to Address the Questions Don Paul Posed

Paul and Manning prepared a list of questions to be addressed. Our work on each is summarized below.

III.2. Bird Use Days

We used ColTots grand mean and its SE to calculate bird use days for each group (using 170 days in the study period). Eighty percent CIs are the estimated bird use days +/- 1.28 * SE.

We did all years; estimates for 1999 only and for other species can be added using the ColTots worksheet.

III.3. Grand total bird numbers by period

We summed the ColTots across species (using only the species groups) to get number present in each period.

III.4. All lake suite totals by period

We used the entries from ColTots for 1997-1999 and 1999 only.

III.5&6. Shoreline activity and habitat analysis by area groups

Manning's additional notes indicated that for these two tasks we should prepare a table with species (avocets/stilts, gulls, SNPL, peeps) as rows and periods as columns and that the cell entries should be means/survey for each of the areas. We did not do Howard Slough because there was too much missing data from this area. We did do the other five areas, and we did 1999 and 1997-1999 for each one. The output was called TaskIII.6. We obtained the reduced arrays using program Analysis.1 and modifying the Shrink subroutine so that it only extracted which ever rows from CellMns that we wanted. We also nullified the statements to print row means.

We did not yet address the question "What habitat is there?"

III.7. Comparison of bird numbers and species richness at random and drainage point samples.

Analysis.pts was used to calculate the means/survey for random and drainage points and the difference. Manning is analyzing these results.

III.8. How well do point samples predict bird numbers and species in the associated survey area?

Manning has the means per random point and transect. She will address this issue by converting both to densities. Subsequent analysis can be carried out in the same was as to address question 7 above.

Table 1. Areas

Number	Code	Name	ExpFact
1	1	TIMPIE SPRINGS WMA	1
2	2	STANSBURY ISLAND NO.	1
3	3A	STANSBURY SOUTH- N	1
4	3B	STANSBURY SOUTH- S	1
5	5A	I 80 NORTH- N	1
6	5B	I-80 NORTH- S	1
7	6	SALTAIR	1
8	7	ASSOCIATED DUCK CLUB	1
9	8A	KENNECOTT- GOGGIN	1
10	8B	KENNECOTT- LEE CREEK	1
11	8C	KENNECOTT- ISSR	1
12	9A	AUDUBON LAKESIDE- S	1
13	9B	AUDUBON NORTH	1

Number	Code	Name	ExpFact
14	10	CRYSTAL LAKESIDE	1
15	11	FARM BAY LAKESIDE	1
16	12	FARMINGTON BAY WMA	1
17	13	WEST FARMINGTON	1
18	14	ANTELOPE ISLAND EAST	1
19	15	ANTELOPE ISLAND WEST	1
20	16	ANT ISLAND CAUSEWAY	1
21	17A	WEST KAYSVILLE	1
22	17B	WEST KAYSVILLE	1
23	18	WEST LAYTON	1
24	19	H SLOUGH WMA- D & P	1
25	19A	H SLOUGH WMA- BEACH	1
26	19B	H SLOUGH WMA- DIKE	1
27	19C	H SLOUGH WMA- POND	1
28	20	OGDEN BAY WMA	1
29	21	OGDEN BAY LAKESIDE	1
30	22	OGDEN BAY NORTH	1
31	23	RAINBOW	1
32	24	SOUTH H CRANE WMA	1
33	25	HAROLD CRANE WMA	1
34	27	SOUTH BEAR RIVER	1
35	28	WILLARD SPUR	1
36	29A	BEAR RIVER REFUGE	1
37	29B	BEAR RIVER REFUGE RD	1
38	30	BEAR RIVER CLUB	1
39	32	PUB SHOOT GRNDS WMA	1
40	33	SALT CREEK WMA	1
41	34A	EAST PROMONTORY- N	1
42	34B	EAST PROMONTORY- S	1
43	35	LOCOMOTIVE SPGS WMA	1
44	36	SALT WELLS FLAT WHA	1
45	36A	SALT WELLS- SHORE	1
46	36B	SALT WELLS FLAT WHA	1
47	37	BEAR RIVER BAY	4
48	38	OGDEN BAY	4
49	39	FARMINGTON BAY	4
50	40	MAGCORP	1
51	41	NEW STATE DUCK CLUB	1
52	42	EAST FARMINGTON BAY	1
53	43	DEARDENS KNOLL	1
54	44	JORDAN RIVER	1

Table 2. Julian Dates

Mth	Day	JDay	Mth	Day	JDay	Mth	Day	JDay	Mth	Day	JDay	Mth	Day	JDay	Mth	Day	JDay
Jan	1	1	Mar	1	60	May	1	121	Jul	1	182	Sep	1	244	Nov	1	305
	2	2		2	61		2	122		2	183		2	245		2	306
	3	3		3	62		3	123		3	184		3	246		3	307
	4	4		4	63		4	124		4	185		4	247		4	308
	5	5		5	64		5	125		5	186		5	248		5	309
	6	6		6	65		6	126		6	187		6	249		6	310
	7	7		7	66		7	127		7	188		7	250		7	311
	8	8		8	67		8	128		8	189		8	251		8	312
	9	9		9	68		9	129		9	190		9	252		9	313
	10	10		10	69		10	130		10	191		10	253		10	314
	11	11		11	70		11	131		11	192		11	254		11	315
	12	12		12	71		12	132		12	193		12	255		12	316
	13	13		13	72		13	133		13	194		13	256		13	317
	14	14		14	73		14	134		14	195		14	257		14	318
	15	15		15	74		15	135		15	196		15	258		15	319
	16	16		16	75		16	136		16	197		16	259		16	320
	17	17		17	76		17	137		17	198		17	260		17	321
	18	18		18	77		18	138		18	199		18	261		18	322
	19	19		19	78		19	139		19	200		19	262		19	323
	20	20		20	79		20	140		20	201		20	263		20	324
	21	21		21	80		21	141		21	202		21	264		21	325
	22	22		22	81		22	142		22	203		22	265		22	326
	23	23		23	82		23	143		23	204		23	266		23	327
	24	24		24	83		24	144		24	205		24	267		24	328
	25	25		25	84		25	145		25	206		25	268		25	329
	26	26		26	85		26	146		26	207		26	269		26	330
	27	27		27	86		27	147		27	208		27	270		27	331
	28	28		28	87		28	148		28	209		28	271		28	332
	29	29		29	88		29	149		29	210		29	272		29	333
	30	30		30	89		30	150		30	211		30	273		30	334
	31	31		31	90		31	151		31	212						
Feb	1	32	Apr	1	91	Jun	1	152	Aug	1	213	Oct	1	274	Dec	1	335
	2	33		2	92		2	153		2	214		2	275		2	336
	3	34		3	93		3	154		3	215		3	276		3	337
	4	35		4	94		4	155		4	216		4	277		4	338
	5	36		5	95		5	156		5	217		5	278		5	339
	6	37		6	96		6	157		6	218		6	279		6	340
	7	38		7	97		7	158		7	219		7	280		7	341
	8	39		8	98		8	159		8	220		8	281		8	342
	9	40		9	99		9	160		9	221		9	282		9	343
	10	41		10	100		10	161		10	222		10	283		10	344
	11	42		11	101		11	162		11	223		11	284		11	345
	12	43		12	102		12	163		12	224		12	285		12	346
	13	44		13	103		13	164		13	225		13	286		13	347
	14	45		14	104		14	165		14	226		14	287		14	348
	15	46		15	105		15	166		15	227		15	288		15	349
	16	47		16	106		16	167		16	228		16	289		16	350
	17	48		17	107		17	168		17	229		17	290		17	351
	18	49		18	108		18	169		18	230		18	291		18	352
	19	50		19	109		19	170		19	231		19	292		19	353
	20	51		20	110		20	171		20	232		20	293		20	354
	21	52		21	111		21	172		21	233		21	294		21	355
	22	53		22	112		22	173		22	234		22	295		22	356
	23	54		23	113		23	174		23	235		23	296		23	357
	24	55		24	114		24	175		24	236		24	297		24	358
	25	56		25	115		25	176		25	237		25	298		25	359
	26	57		26	116		26	177		26	238		26	299		26	360
	27	58		27	117		27	178		27	239		27	300		27	361
	28	59		28	118		28	179		28	240		28	301		28	362
				29	119		29	180		29	241		29	302		29	363
				30	120		30	181		30	242		30	303		30	364
										31	243		31	304		31	365

Table 3. Points at random and drainage locations surveyed in 1997-99.

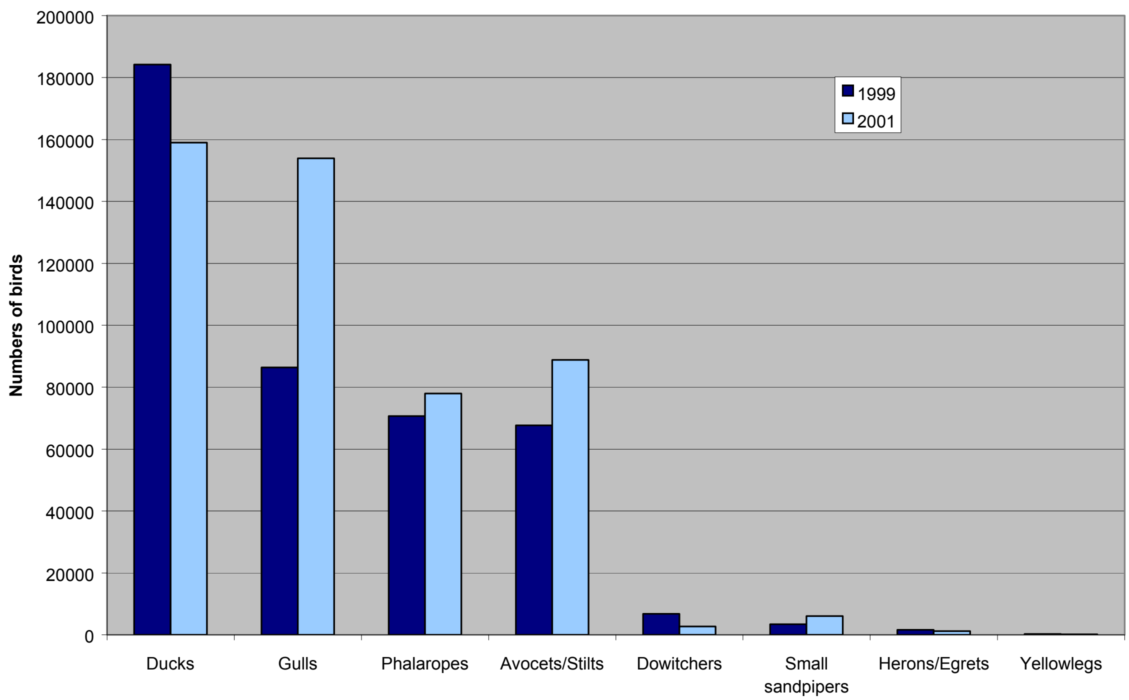
Area			1997		1998		1999	
No.	Code	Name	R	D	R	D	R	D
3	3a	Stansbury South-N	1		1		1	
4	3b	Stansbury South-S	1		1		1	
5	5a	I-80 North-N	1,2*		1,2*		1,2*	
7	6	Saltair	1,3	2	1,3	2	1,3	2
9	8a	Kennecott-Goggin	2	1	2	1	2	1
10	8b	Kennecott-Lee Creek	1		1		1	
12	9a	Audubon Lakeside-S	1		1		1	
13	9b	Audubon North	1		1		1	
15	11	Farm Bay Lakeside	2	1,3	1,2,3		1,2,3	
17	13	West Farmington	1	2,3	1	2,3	1	2,3
19	15	Antelope Island West	1,2		1,2		1,2	
22	17b	West Kaysville	1,2,3	4				
23	18	West Layton	2	1,3	2	1,3	2	3
25	19a	Howard Slough Beach	2	1	1,2		1,2	
45	34a	East Promontory-N	2	1,3	2	1,3		
		Total	19	12	19	8	18	5

* Results from points 1 and 2 added and treated as a single point.

Appendix 3: Habitat Use

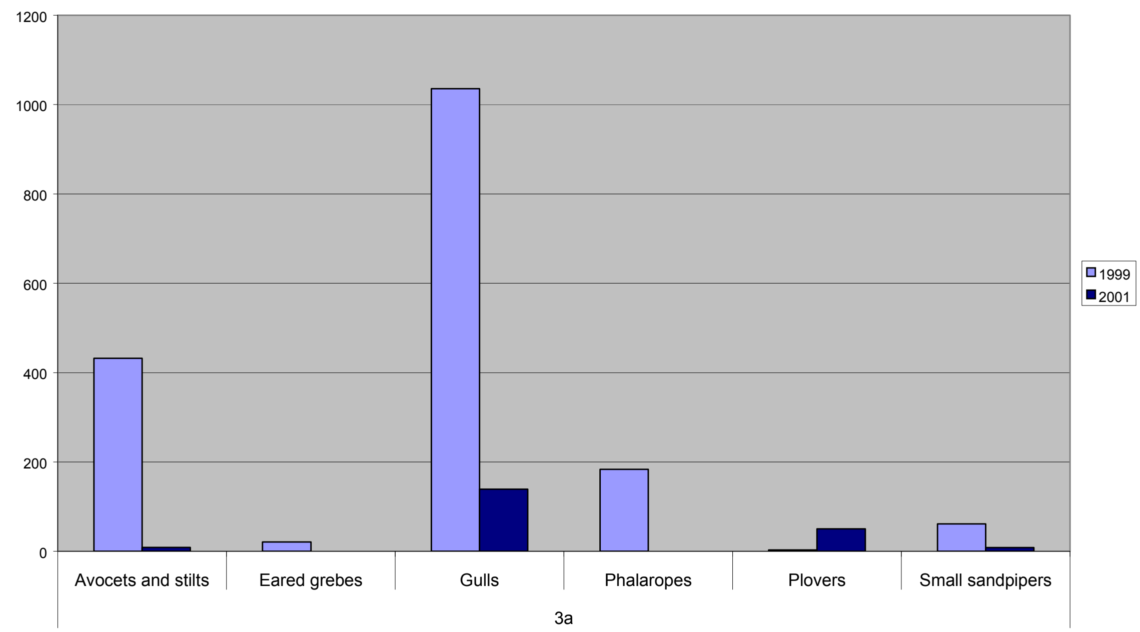
The following tables and charts display data collected from selected point samples as part of the protocol for areas classified as "total count with point sample." To illustrate varying conditions related to different lake elevations, only data from 1999 and 2001 are included here. During the time frame of this study, the lake elevation reached its highest point in 1999. In both 1997 and 2001, lake elevations were similarly low, but data were better collected in the latter year and, therefore, are included in this appendix. The tables show mean bird counts by suite, habitat type, and year, and the charts compare mean-bird counts for all combined habitat types for 1999 and 2001.

Comparison of numbers of birds at Great Salt Lake by suite in wet and dry years (1999 and 2001 respectively).



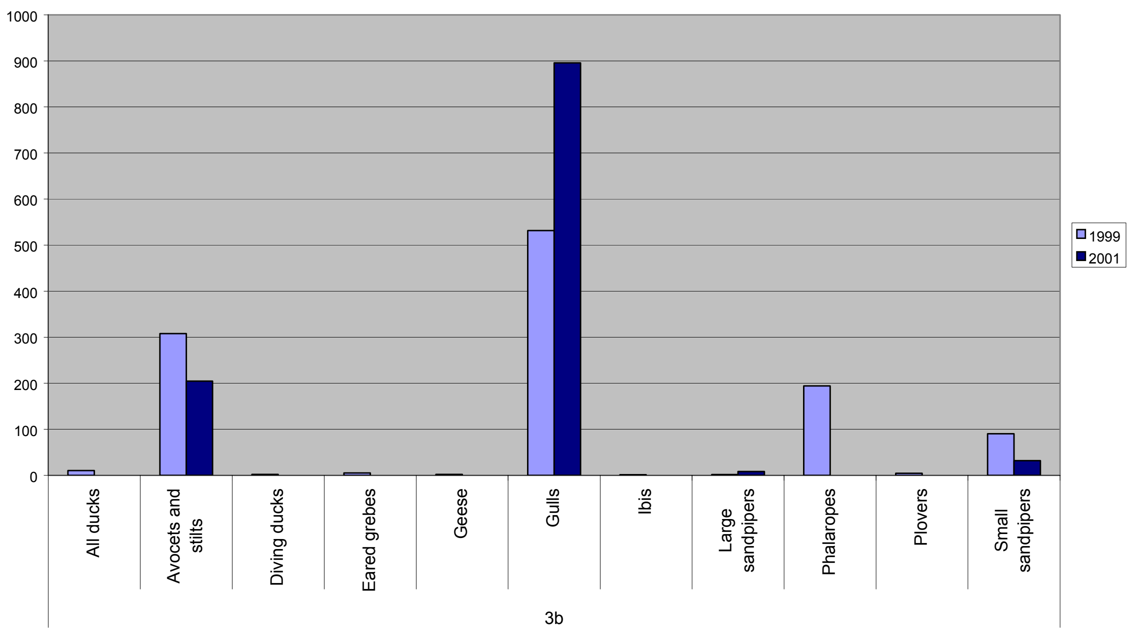
Area 3a (Stansbury Island South- N), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **3a** during surveys in **1999**	0.0	0.0	0.0	14.3	45.7	0.0	0.0	0.0	0.0	0.0	0.0	40.0
Mean percent of habitat type at point **3a** during surveys in **2001**	0.0	0.0	0.0	48.2	14.6	0.0	0.0	0.0	0.0	0.0	0.0	37.1
1999 mean counts/survey												
Gulls				29.2	518.5							487.6
Avocets and stilts					25.0							406.9
Small sandpipers					11.9							49.6
Plovers					3.0							
Phalaropes												183.5
Eared grebes												21.0
2001 mean counts/survey												
Gulls					23.2							115.9
Avocets and stilts												8.8
Small sandpipers					8.7							
Plovers				28.1	21.9							



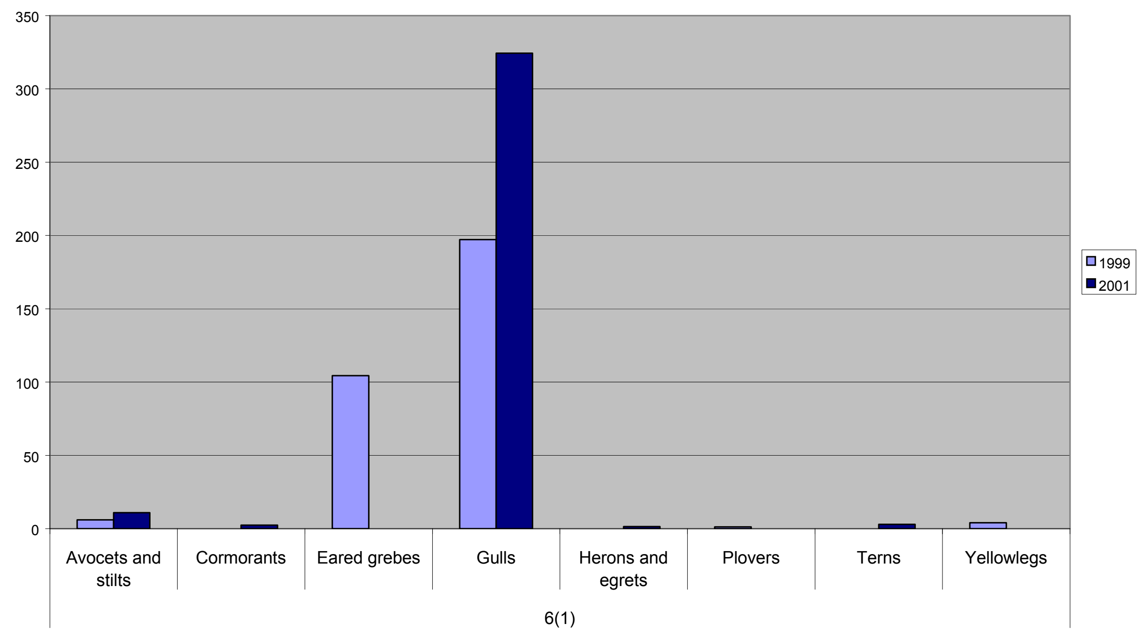
Area 3b (Stansbury Island South- S), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **3b** during surveys in **1999**	0.0	0.9	0.0	14.1	39.7	0.9	0.0	6.2	0.0	0.0	0.3	37.9
Mean percent of habitat type at point **3b** during surveys in **2001**	0.0	0.0	0.0	53.8	7.8	2.2	0.0	0.0	0.0	0.0	0.0	36.3
1999 mean counts/survey												
Gulls				0.9	353.2	9.5		49.9				118.2
Diving ducks												2.0
All ducks												10.0
Avocets and stilts					5.0			3.1				299.6
Small sandpipers					42.3							47.7
Plovers				0.7	2.4			0.7			0.3	
Phalaropes					22.7							171.5
Large sandpipers					1.2						0.3	0.2
Ibis					1.0							
Eared grebes												5.0
Geese					2.0							
2001 mean counts/survey												
Gulls				11.4	151.0							733.3
Avocets and stilts				0.2	15.2							189.4
Small sandpipers					10.0							21.7
Large sandpipers				2.8	3.3							2.0



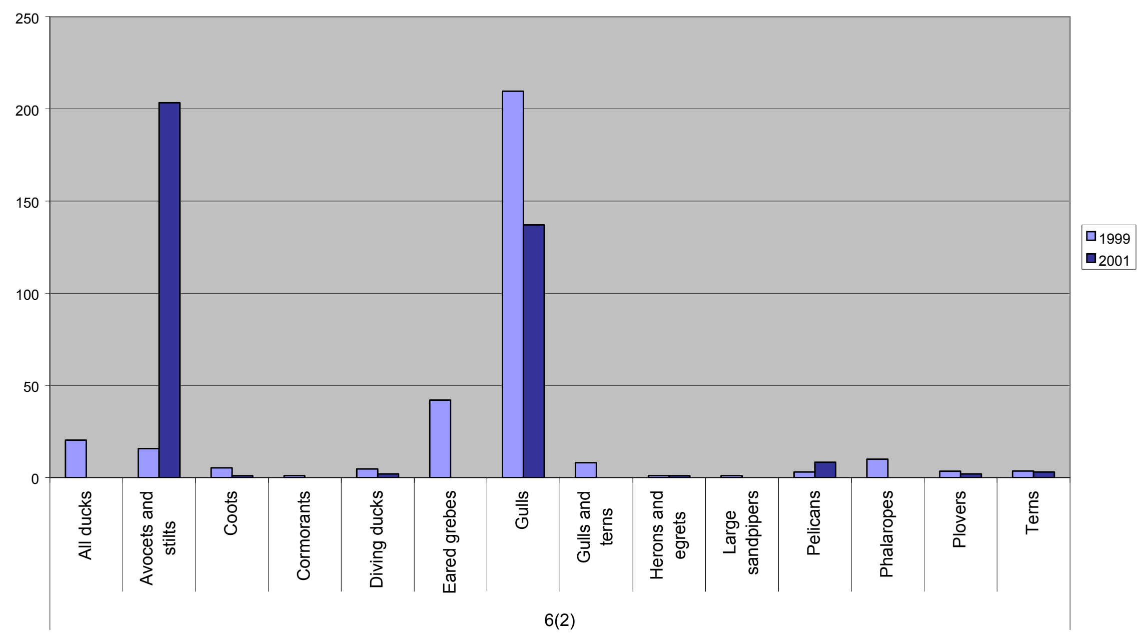
Area 6 (Saltair), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **6-1** during surveys in **1999**	2.1	3.2	0.0	2.4	6.8	12.1	19.4	0.3	4.1	8.8	0.0	40.9
Mean percent of habitat type at point **6-1** during surveys in **2001**	0.0	0.0	0.0	0.7	6.7	15.3	25.0	0.3	10.0	0.0	0.0	42.0
1999 mean counts/survey												
Gulls		1.325			13.69	71.76	10.75					99.7
Avocets and stilts		1.6			4							0.4
Yellowlegs					4							
Plovers							1.2					
Eared grebes												104.4
2001 mean counts/survey												
Gulls					19.3	177.6	20.7					106.8
Terns						1.8						1.2
Herons and egrets						1.0			0.5			
Avocets and stilts												11.0
Cormorants						2.5						



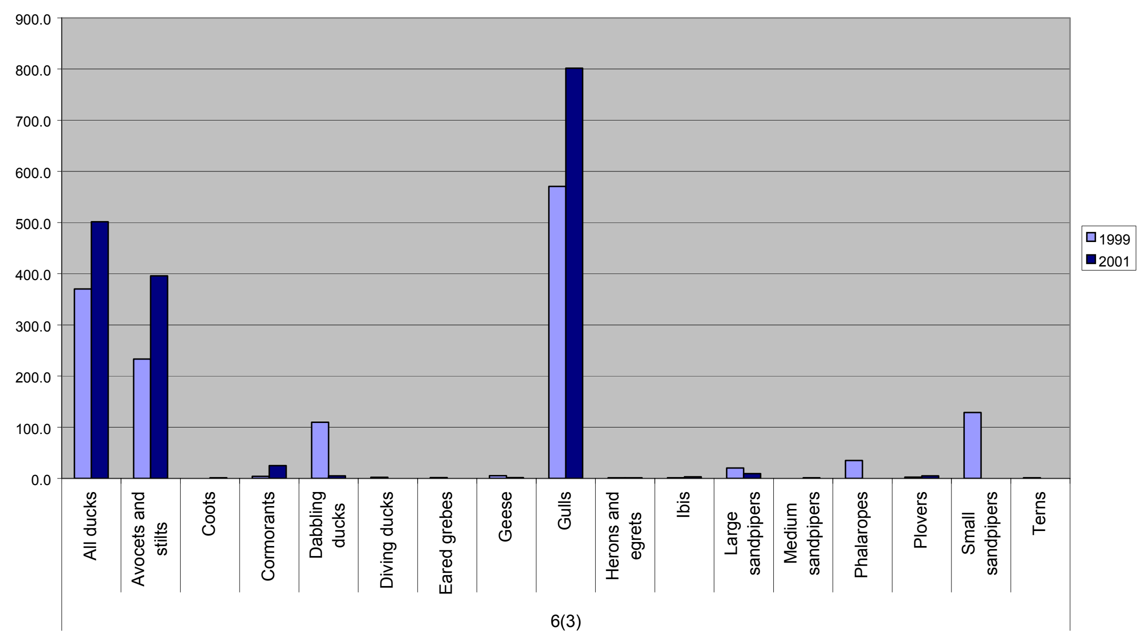
Area 6 (Saltair), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **6-2** during surveys in **1999**	6.6	3.1	0.0	3.4	10.0	5.6	14.1	0.0	2.5	13.4	0.6	40.6
Mean percent of habitat type at point **6-2** during surveys in **2001**	6.0	0.0	0.0	7.9	8.5	0.7	20.9	0.3	9.9	4.3	0.3	41.2
1999 mean counts/survey												
Gulls	0.1				13.3					0.5		195.8
Terns	0.2				1.8		0.2			1.3		
Gulls and terns					4.0					3.0		1.0
Diving ducks					1.6					3.1		
All ducks					13.2					2.7		4.4
Herons and egrets					0.3					0.7		
Avocets and stilts				0.5	5.3					6.1		3.8
Plovers	0.6				1.6	1.0	0.2					
Phalaropes										10.0		
Large sandpipers					1.0							
Pelicans					1.5					1.5		
Eared grebes										0.6		41.4
Coots										5.3		
Cormorants										1.0		
2001 mean counts/survey												
Gulls					81.7							55.5
Terns												3.0
Diving ducks												2.0
Herons and egrets	0.5									0.5		
Avocets and stilts					88.7							114.6
Plovers					2.0							
Pelicans												8.3
Coots											1.0	



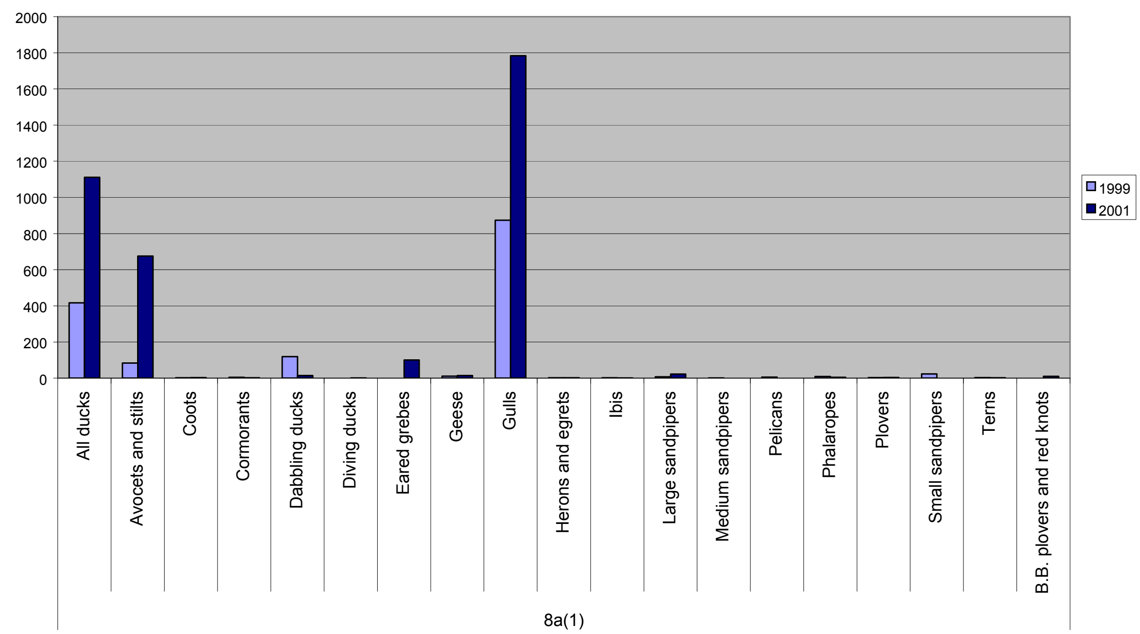
Area 6 (Saltair), Point 3

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **6-3** during surveys in **1999**	6.6	3.1	0.0	3.4	10.0	5.6	14.1	0.0	2.5	13.4	0.6	40.6
Mean percent of habitat type at point **6-3** during surveys in **2001**	6.0	0.0	0.0	7.9	8.5	0.7	20.9	0.3	9.9	4.3	0.3	41.2
1999 mean counts/survey												
Gulls	0.3			0.3	172.6						261.3	136.6
Terns					1.0							
Dabbling ducks											75.6	34.0
Diving ducks											2.0	
All ducks											190.0	180.3
Herons and egrets	0.5									0.5		
Avocets and stilts					71.8						137.6	23.9
Small sandpipers					78.4						6.5	43.9
Plovers	0.1			0.3	2.1							
Phalaropes											35.0	
Large sandpipers					2.8						17.2	
Ibis											1.0	
Eared grebes										0.8	0.5	0.3
Geese										2.6	2.8	
Cormorants											4.0	
2001 mean counts/survey												
Gulls				19.5	317.4						407.0	58.1
Dabbling ducks										2.6	2.2	
All ducks					120.0						381.7	
Herons and egrets										1.0		
Avocets and stilts					84.2						298.7	12.7
Plovers				0.3	4.7							
Large sandpipers										3.0	6.0	
Ibis										3.0		
Coots										1.0		
Geese					0.5						1.0	
Cormorants												25.0
Medium sandpipers					0.5					0.5		



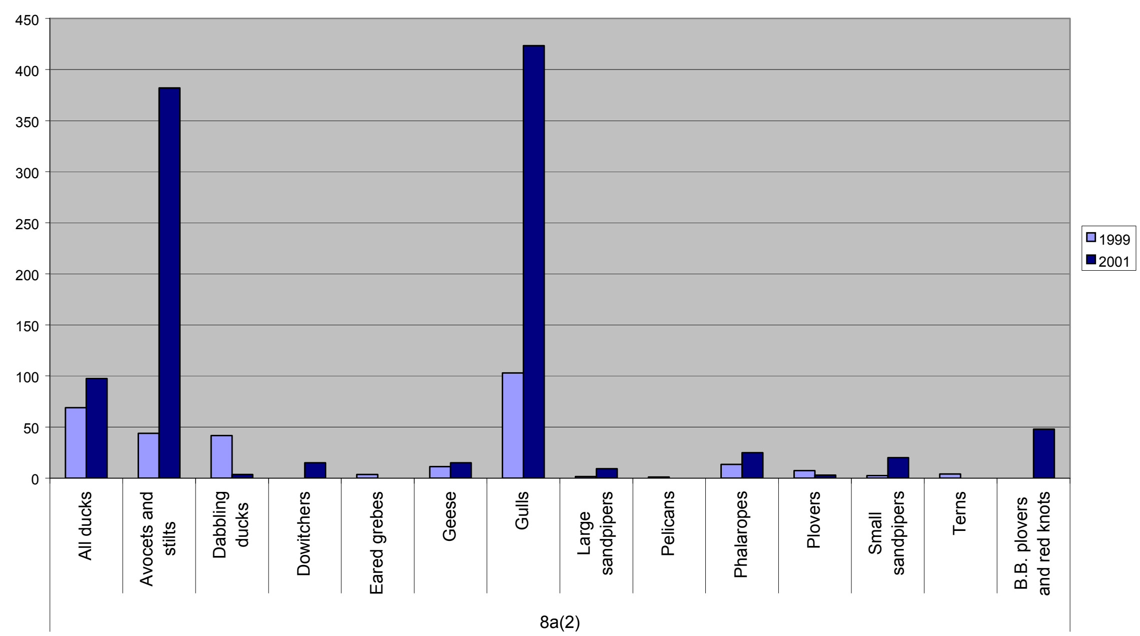
Area 8a (Kennecott- Lakeside), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **8a1** during surveys in **1999**	6.9	3.9	0.6	8.4	9.3	0.0	32.5	4.9	0.0	0.0	26.4	6.5
Mean percent of habitat type at point **8a1** during surveys in **2001**	5.6	0.4	0.0	62.6	14.5	0.0	0.2	0.1	0.5	0.0	13.8	1.8
1999 mean counts/survey												
Gulls					180.1						692.5	1.0
Terns					3.0							
Dabbling ducks		0.4		0.4	11.4						106.7	
All ducks					22.2						394.7	
Herons and egrets	0.5						0.2				1.0	
Avocets and stilts		0.0			18.9						62.7	2.0
Small sandpipers					5.3						17.3	
Plovers				0.3	2.3		0.2					
Phalaropes				4.5							4.0	
Large Sandpipers				0.2	1.7		0.2	0.2			5.0	
Ibis					1.0			0.5				
Pelicans					0.7						5.2	
Coots					2.0							
Geese					1.9						8.5	0.4
Cormorants	0.1				0.2						4.8	
Medium sandpipers					1.0							
2001 mean counts/survey												
Gulls				344.8	508.2						896.1	35.3
Terns	2.0											
Dabbling ducks	0.5			0.7	2.2						8.8	1.7
Diving ducks											1.0	
All ducks					29.0						1067.9	14.8
Herons and egrets	0.2				0.4						1.0	
Avocets and stilts		0.2			66.3						549.8	58.9
Plovers				1.0	2.5							
Phalaropes											5.0	
Large Sandpipers					0.8			0.2			20.2	0.5
Ibis											1.0	
Eared grebes											100.0	
Coots											2.5	
Geese	0.2			3.5			0.3				10.4	
Cormorants	0.5			0.3							0.8	
Black-bellied plovers and red knots					10.0							



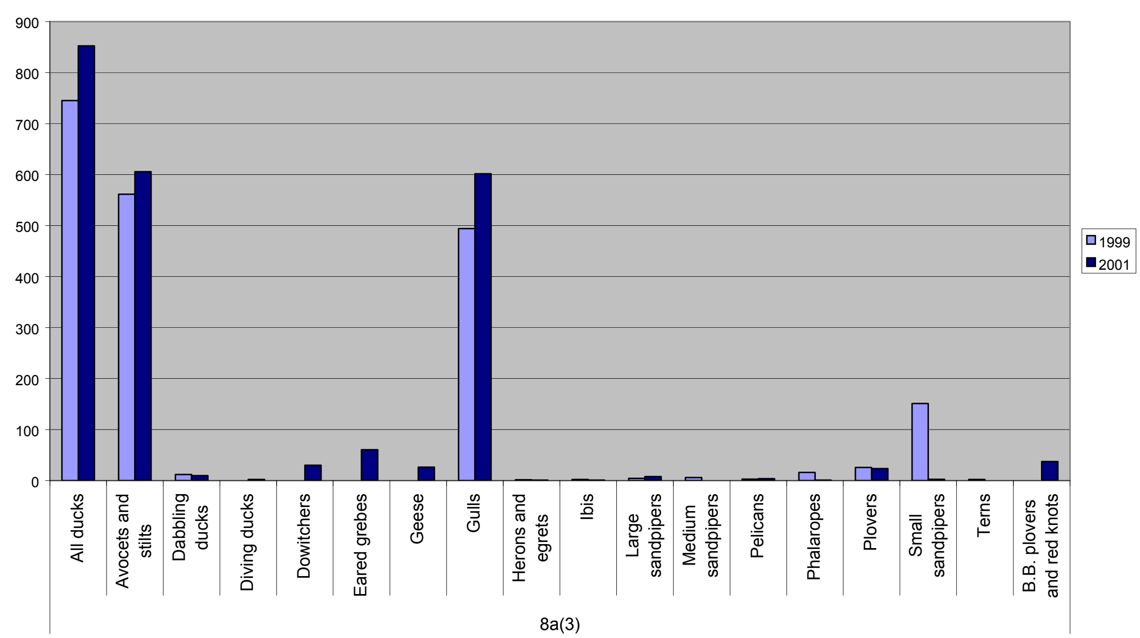
Area 8a (Kennecott- Lakeside), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **8a2** during surveys in **1999**	0.0	7.5	0.0	2.5	7.1	0.0	50.3	0.7	0.0	0.0	1.8	30.1
Mean percent of habitat type at point **8a2** during surveys in **2001**	0.0	0.0	0.0	46.8	14.3	18.8	6.3	0.8	0.0	0.0	0.6	12.4
1999 mean counts/survey												
Gulls					2.7							100.2
Terns												4.0
Dabbling ducks		0.3			26.8		0.9					13.7
All ducks												69.0
Avocets and stilts		5.7			1.4						0.3	36.6
Small sandpipers					2.0						0.5	
Plovers		0.5			7.0							
Phalaropes												13.5
Large sandpipers					0.8		0.2	0.2				0.4
Pelicans												1.0
Eared grebes												3.5
Geese							11.3					
2001 mean counts/survey												
Gulls				1.0	200.0	96.2					6.4	119.8
Dabbling ducks												3.5
All ducks												97.4
Avocets and stilts					11.9	3.8					29.2	337.0
Small sandpipers						20.0						
Dowitchers					15.0							
Plovers						3.0						
Phalaropes												25.0
Large sandpipers					0.6	0.4						8.1
Geese												15.0
Black-bellied plovers and red knots												48.0



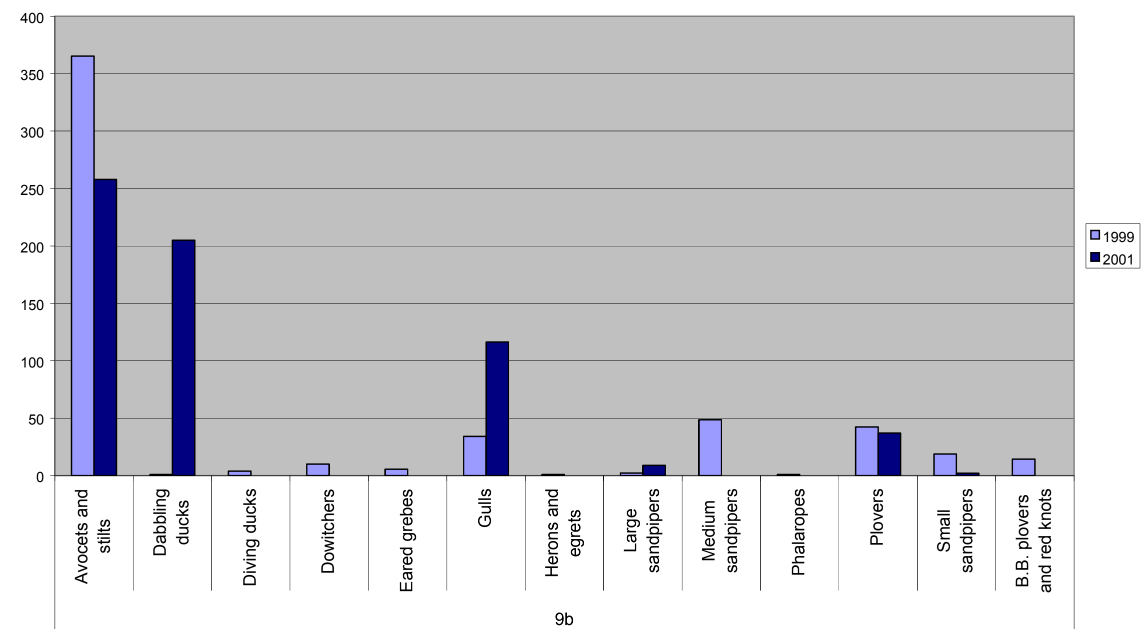
Area 8a (Kennecott- Lakeside), Point 3

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **8a3** during surveys in **1999**				35.8	22.4		7.6			1.4	4.6	28.8
Mean percent of habitat type at point **8a3** during surveys in **2001**				69.8	15.4						0.9	13.9
1999 mean counts/survey												
Gulls				5.6	59.2					31.4	92.3	305.5
Terns					2.0							
Dabbling ducks											1.4	10.6
All ducks											140.4	604.6
Herons and egrets										0.5	1.0	
Avocets and stilts					49.0					30.5	143.7	338.4
Small sandpipers				1.8	149.4							
Plovers				14.2	11.7							
Phalaropes					9.8						3.3	3.0
Large sandpipers					2.0					1.5	0.2	0.7
Ibis										2.0		
Pelicans					3.0							
Medium sandpipers					6.0							
2001 mean counts/survey												
Gulls				12.8	308.2						34.1	246.4
Dabbling ducks				0.1	4.3							5.3
Diving ducks												2.0
All ducks												852.3
Herons and egrets												1.0
Avocets and stilts					268.8						23.1	313.8
Small sandpipers					1.3							1.0
Dowitchers					20.7							9.3
Plovers				19.9	3.2							0.1
Phalaropes												1.0
Large sandpipers				0.7	6.7							0.5
Ibis					1.0							
Pelicans											4.0	
Eared grebes												60.5
Geese				24								2
Black-bellied plovers and red knots												37



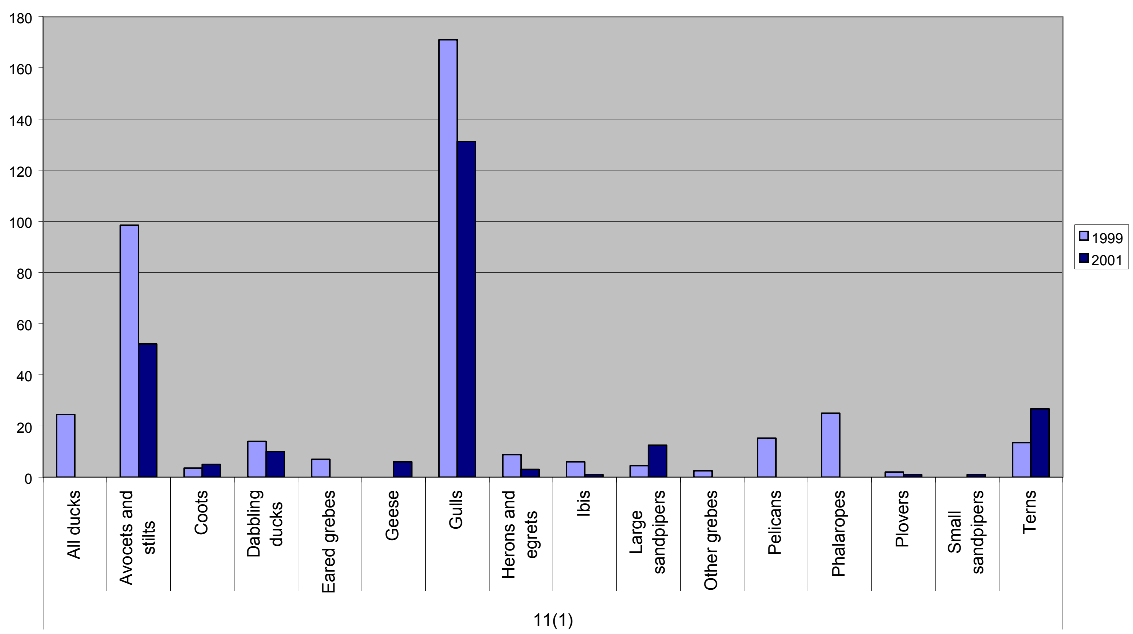
Area 9b (Audubon Lakeside), Point 1

	Habitat types										
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **9b** during surveys in **1999**				38.6	15.0		4.6	18.2				24.3
Mean percent of habitat type at point **9b** during surveys in **2001**				59.4	27.6							12.9
1999 mean counts/survey												
Gulls					22.6							11.6
Dabbling ducks												1.0
Diving ducks												4.0
Herons and egrets								1.0				
Avocets and stilts					2.5							362.8
Small sandpipers					14.9							3.9
Dowitchers								10.0				
Plovers				4.1	5.0			33.2				
Phalaropes												1.0
Large sandpipers					1.0		0.5					0.8
Eared grebes												5.5
Medium sandpipers					48.5							
Black-bellied plovers and red knots				3.0	8.3							3.0
2001 mean counts/survey												
Gulls					100.3							15.9
Dabbling ducks												205.0
Avocets and stilts					9.6							248.3
Small sandpipers					1.0							1.0
Plovers				27.8	9.4							
Large sandpipers					9.0							



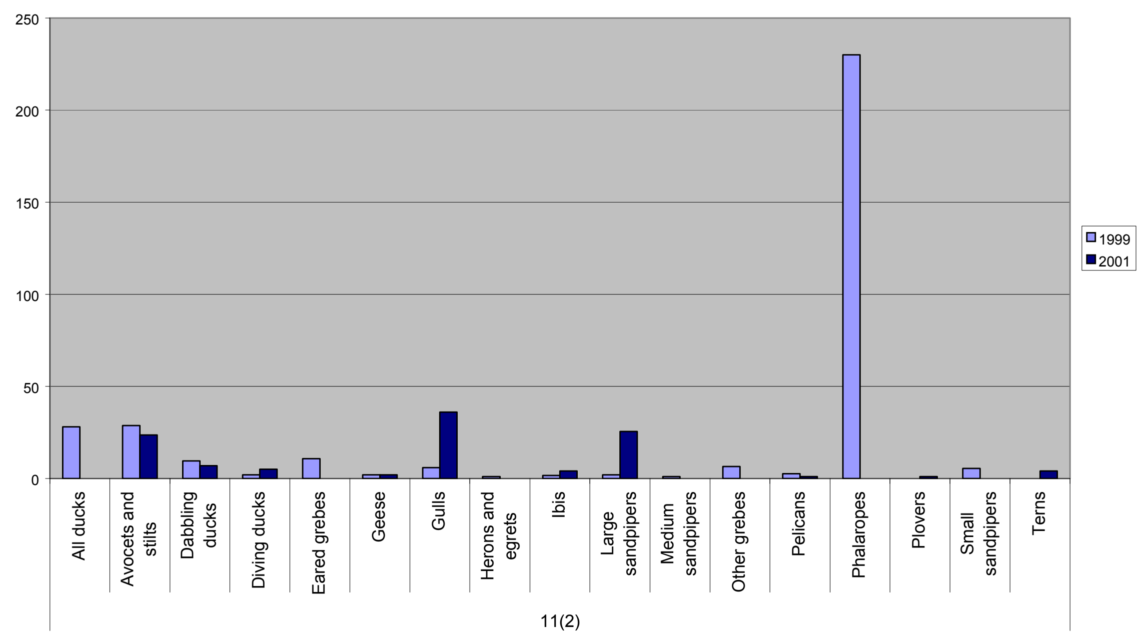
Area 11 (Farmington Lakeside), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **11-1** during surveys in **1999**	0.0	0.0	0.0	0.8	1.4	0.1	0.0	0.0	0.0	0.0	93.8	3.8
Mean percent of habitat type at point **11-1** during surveys in **2001**	0.0	0.0	0.0	52.8	10.0	0.0	0.0	0.0	0.0	7.0	23.1	1.4
1999 mean counts/survey												
Gulls				46.7	97.4						26.9	
Terns				12.5							1.0	
Dabbling ducks											14.0	
All ducks											24.5	
Herons and egrets				3.0	4.9						1.0	
Avocets and stilts				11.8	56.8						30.0	
Plovers						2.0						
Phalaropes											25.0	
Large sandpipers				2.0							2.5	
Ibis											6.0	
Pelicans				7.0							8.2	
Eared grebes											7.0	
Coots											3.5	
Other grebes											2.5	
2001 mean counts/survey												
Gulls				84.8	36.6					0.2	9.5	
Terns				1.3						23.0	2.3	
Dabbling ducks										8.3	1.8	
Herons and egrets				3.0								
Avocets and stilts				0.4	1.8					10.6	37.3	2.0
Small sandpipers											1.0	
Plovers										1.0		
Large sandpipers					0.3						12.3	
Ibis										1.0		
Coots											5.0	
Geese											6.0	



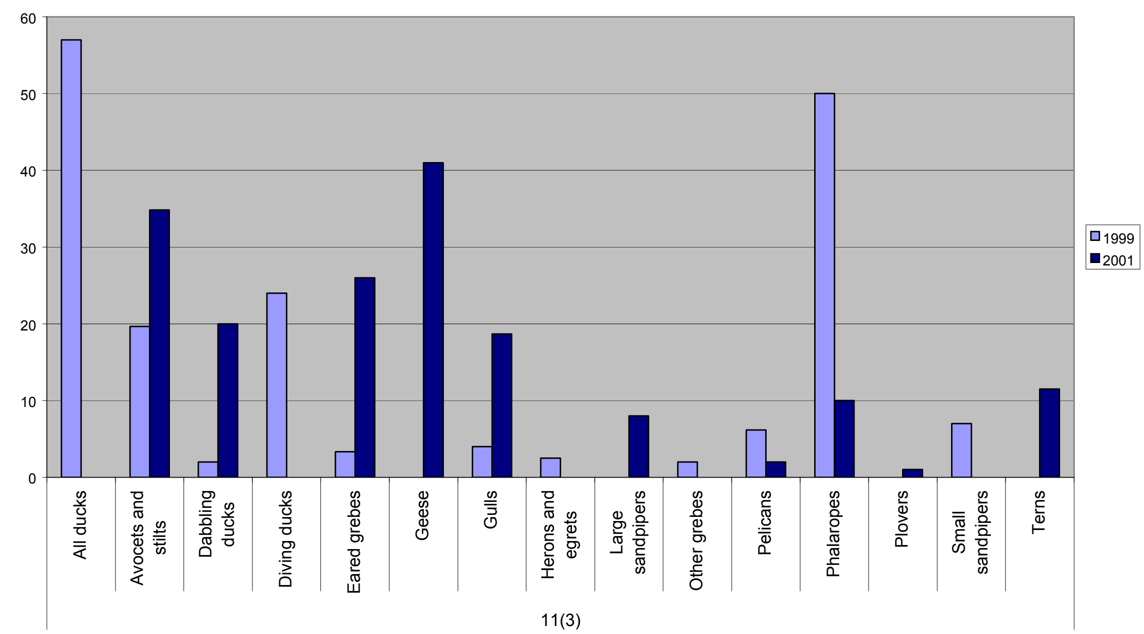
Area 11 (Farmington Lakeside), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **11-2** during surveys in **1999**	0.0	0.4	0.0	0.0	0.1	0.5	0.0	0.0	0.0	0.0	95.2	3.8
Mean percent of habitat type at point **11-2** during surveys in **2001**	0.0	0.0	0.0	31.5	3.7	0.0	0.0	0.0	0.0	0.0	50.7	14.0
1999 mean counts/survey												
Gulls											5.8	
Dabbling ducks											9.5	
Diving ducks											2.0	
All ducks											28.0	
Herons and egrets											1.0	
Avocets and stilts						10.0					18.8	
Small sandpipers						4.5					1.0	
Phalaropes											230.0	
Large sandpipers						2.0						
Ibis		0.6				0.1					1.0	
Pelicans											2.6	
Eared grebes											10.8	
Geese											2.0	
Medium sandpipers											1.0	
Other grebes											6.5	
2001 mean counts/survey												
Gulls				2.2	6.2						2.3	25.4
Terns											4.0	
Dabbling ducks												7.0
Diving ducks											5.0	
Avocets and stilts					0.4						19.8	3.4
Plovers				1.0								
Large sandpipers												25.5
Ibis				4.0								
Pelicans											1.0	
Geese											2.0	



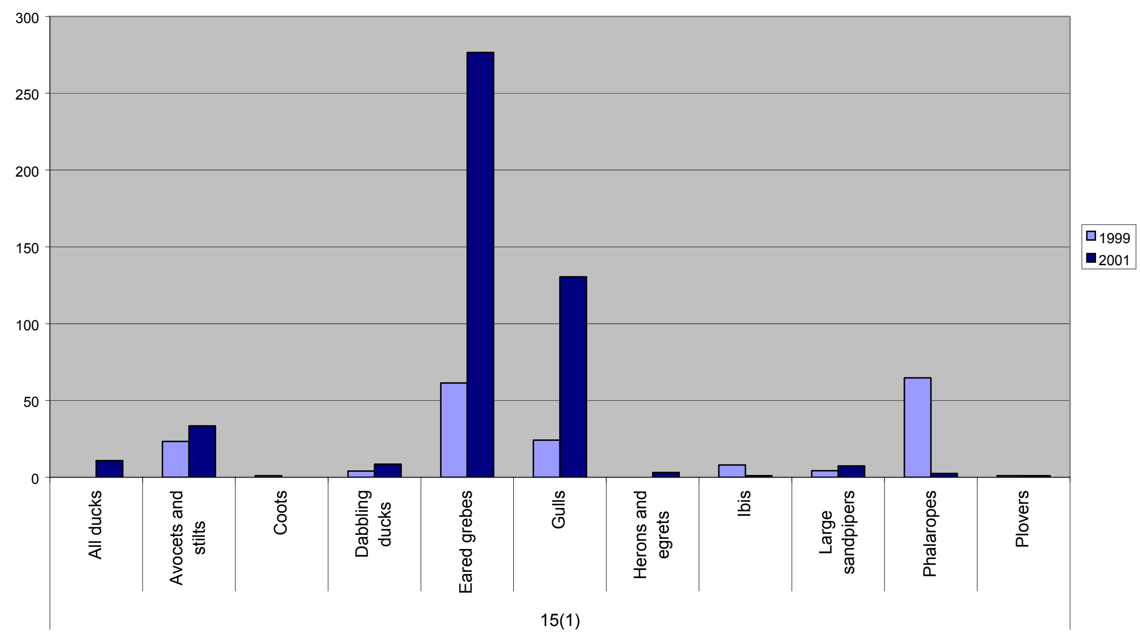
Area 11 (Farmington Lakeside), Point 3

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **11-3** during surveys in **1999**	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	90.8	3.8
Mean percent of habitat type at point **11-3** during surveys in **2001**	0.0	0.0	0.0	29.9	2.1	0.0	0.0	0.0	0.0	0.3	52.1	15.7
1999 mean counts/survey												
Gulls											2.6	1.4
Dabbling ducks											2.0	
Diving ducks											24.0	
All ducks											57.0	
Herons and egrets											2.5	
Avocets and stilts						12.3					7.3	
Small sandpipers						5.5					1.5	
Phalaropes											50.0	
Pelicans											5.5	0.7
Eared grebes											2.3	1.0
Other grebes											2.0	
2001 mean counts/survey												
Gulls				1.0	5.1						6.0	6.6
Terns											11.5	
Dabbling ducks										16.3	3.8	
Avocets and stilts				3.6							6.0	25.3
Plovers				1.0								
Phalaropes												10.0
Large sandpipers											8.0	
Pelicans											1.5	0.5
Eared grebes											26.0	
Geese											41.0	



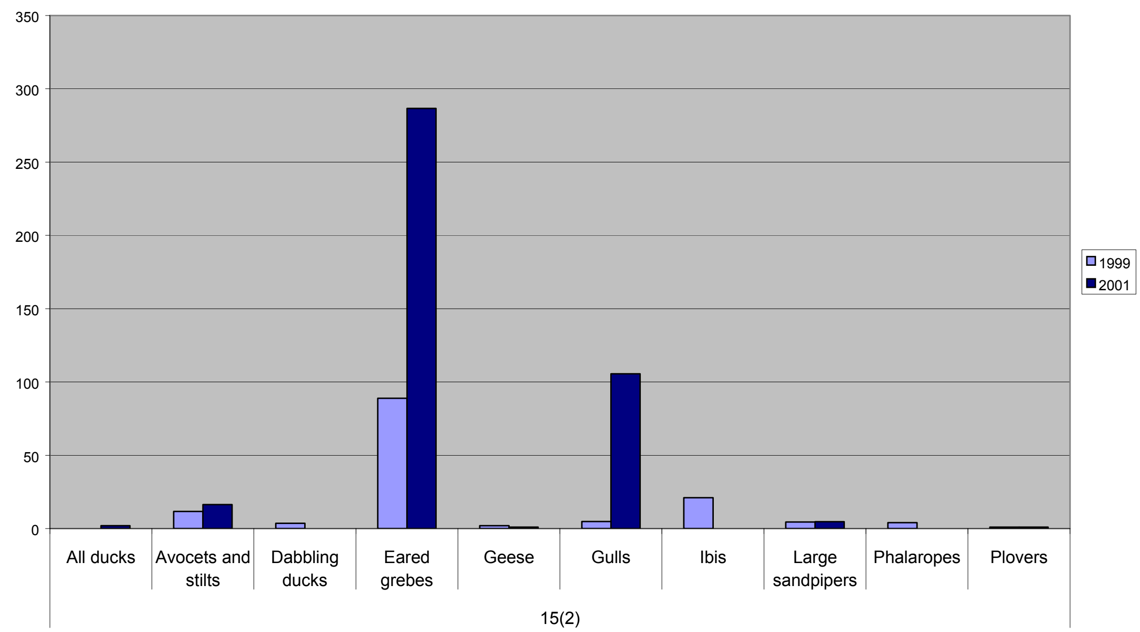
Area 15 (Antelope Island West), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **15-1** during surveys in **1999**	0.0	25.1	0.0	0.0	11.2	0.0	7.5	0.0	0.0	0.9	23.4	31.9
Mean percent of habitat type at point **15-1** during surveys in **2001**	0.0	30.4	0.0	0.0	40.9	0.0	4.9	0.0	0.0	0.0	7.9	15.9
1999 mean counts/survey												
Gulls					24.1							
Dabbling ducks		1.0			0.7						0.3	2.0
Avocets and stilts		4.0			10.2					0.1	8.5	0.5
Plovers					1.0							
Phalaropes					16.1						33.5	15.1
Large Sandpipers		1.5			2.4							0.3
Ibis		8.0										
Eared grebes												61.4
Coots											1.0	
2001 mean counts/survey												
Gulls					60.7						1.8	68.0
Dabbling ducks											6.9	1.6
All ducks					2.3						7.4	1.2
Herons and egrets												3.0
Avocets and stilts					13.0		0.4				11.5	8.5
Plovers					1.0							
Phalaropes											0.5	2.0
Large Sandpipers					3.7		2.1				1.1	0.5
Ibis											1.0	
Eared grebes												276.6



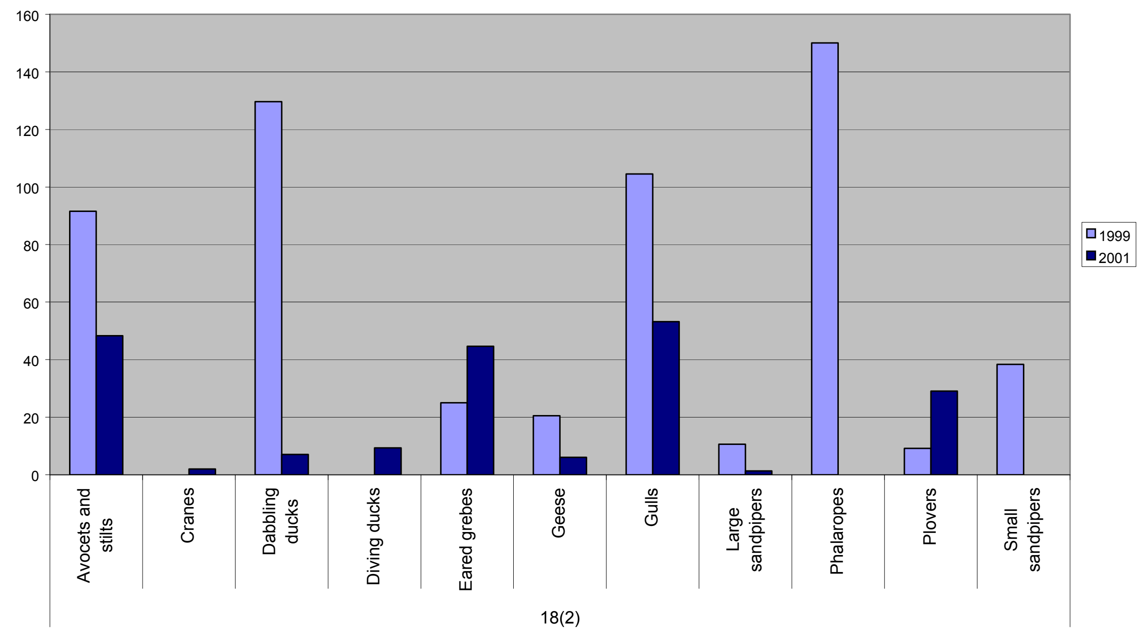
Area 15 (Antelope Island West), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **15-2** during surveys in **1999**	0.0	28.0	0.0	0.0	14.3	0.0	8.0	0.0	0.0	0.0	2.0	47.7
Mean percent of habitat type at point **15-2** during surveys in **2001**	0.0	34.0	0.0	0.0	41.6	0.0	9.8	0.0	0.0	0.0	0.9	13.6
1999 mean counts/survey												
Gulls					3.7							1.2
Dabbling ducks		3.0										0.7
Avocets and stilts		0.8			9.1						0.5	1.2
Plovers					1.0							
Phalaropes					0.2						3.8	
Large sandpipers		2.3			0.9						0.1	1.2
Ibis												21.0
Eared grebes												89.0
Geese					2.0							
2001 mean counts/survey												
Gulls					53.4						1.8	50.3
All ducks					1.0							1.0
Avocets and stilts					4.7						0.8	11.0
Plovers		1.0										
Large sandpipers		0.2			2.9						0.4	1.2
Eared grebes												286.7
Geese											0.5	0.5



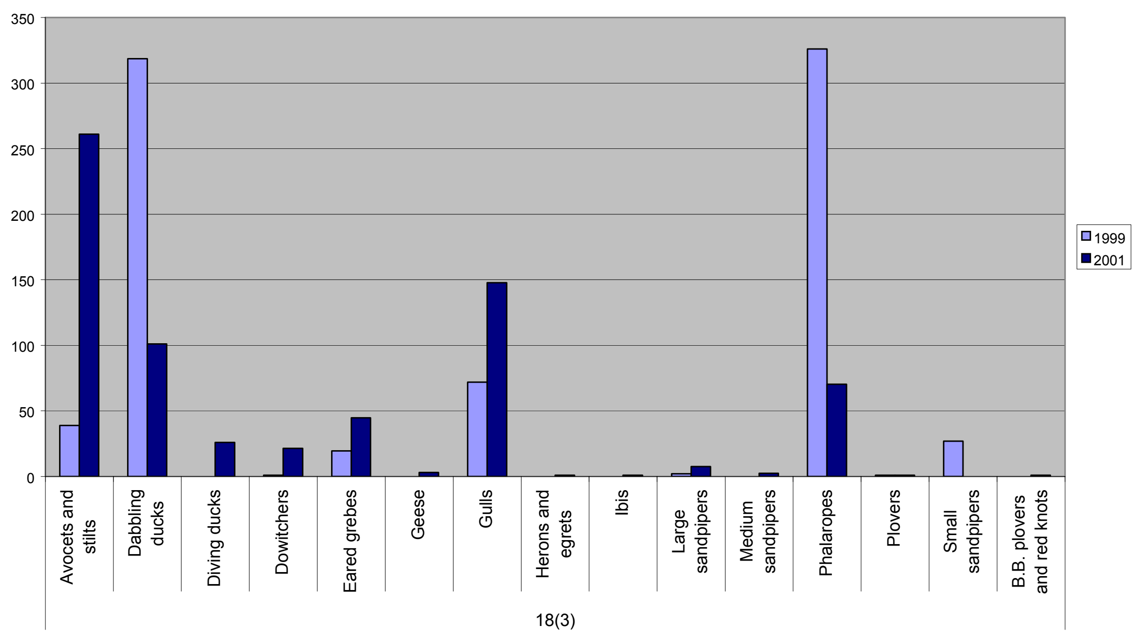
Area 18 (West Layton), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **18-2** during surveys in **1999**	0.5	0.0	0.0	23.1	10.4	0.0	0.0	13.5	0.0	0.3	1.3	50.9
Mean percent of habitat type at point **18-2** during surveys in **2001**	0.0	0.0	0.0	38.5	18.5	0.0	0.0	15.0	5.0	0.0	0.0	23.0
1999 mean counts/survey												
Gulls					18.7							85.8
Dabbling ducks					3.3							126.3
Avocets and stilts					18.5						0.2	72.9
Small sandpipers				10.4	27.9							
Plovers				7.6	1.5			0.0				
Phalaropes												150.0
Large sandpipers					10.6							
Eared grebes												25.0
Geese				11.8								8.8
2001 mean counts/survey												
Gulls					12.3							40.8
Dabbling ducks												7.0
Diving ducks												9.3
Avocets and stilts					5.4							42.9
Plovers				26.6	1.6							0.9
Large sandpipers					0.7							0.7
Eared grebes												44.7
Geese								0.7	5.3			
Cranes									2.0			



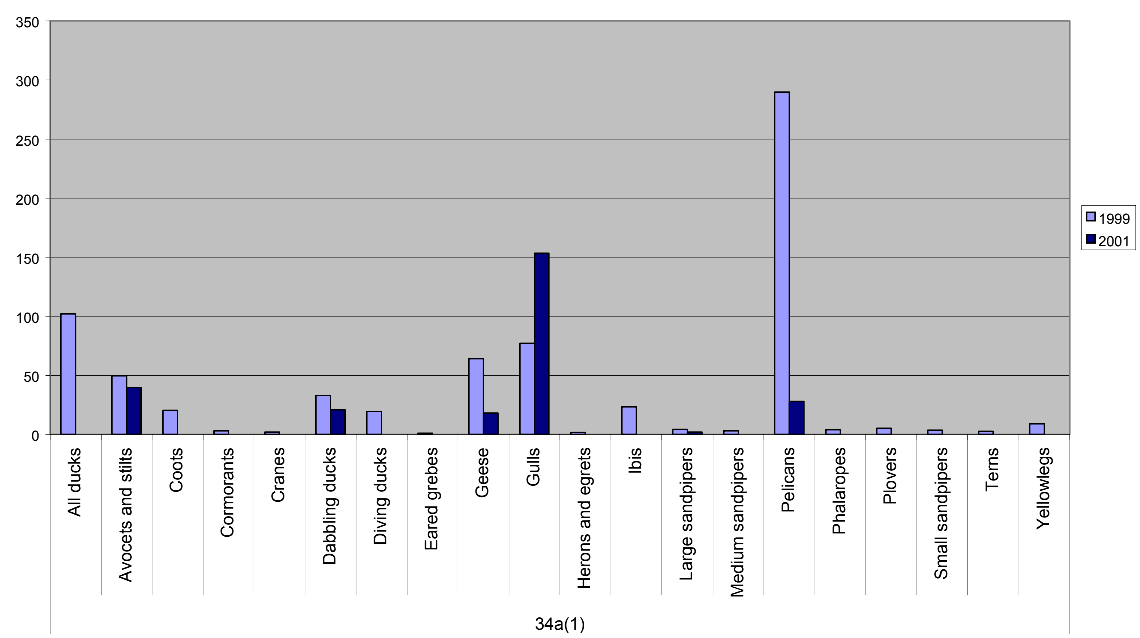
Area 18 (West Layton), Point 3

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **18-3** during surveys in **1999**	0.0	0.0	0.0	19.0	17.2	1.1	12.9	5.0	0.0	0.0	0.3	44.4
Mean percent of habitat type at point **18-3** during surveys in **2001**	4.0	0.0	0.0	34.5	13.8	0.0	35.0	0.0	0.0	0.0	1.0	11.7
1999 mean counts/survey												
Gulls					15.0	0.1					8.6	48.2
Dabbling ducks					0.2						32.1	286.3
Avocets and stilts					1.4	0.5		0.2				36.8
Small sandpipers				26.5	0.5							
Dowitchers					1.0							
Plovers				1.0								
Phalaropes					40.8							285.2
Large sandpipers					0.3			0.7				1.0
Eared grebes												19.5
2001 mean counts/survey												
Gulls					51.5						17.2	79.0
Dabbling ducks					0.1						0.3	100.8
Diving ducks												26.0
Herons and egrets											0.5	0.5
Avocets and stilts					15.4						1.4	244.3
Dowitchers					1.5							20.0
Plovers					0.5						0.5	
Phalaropes												70.3
Large sandpipers	1.4				5.6						0.4	0.3
Ibis	1.0											
Eared grebes												44.7
Geese							2.7					0.3
Medium sandpipers					2.5							
Black-bellied plovers and red knots					1.0							



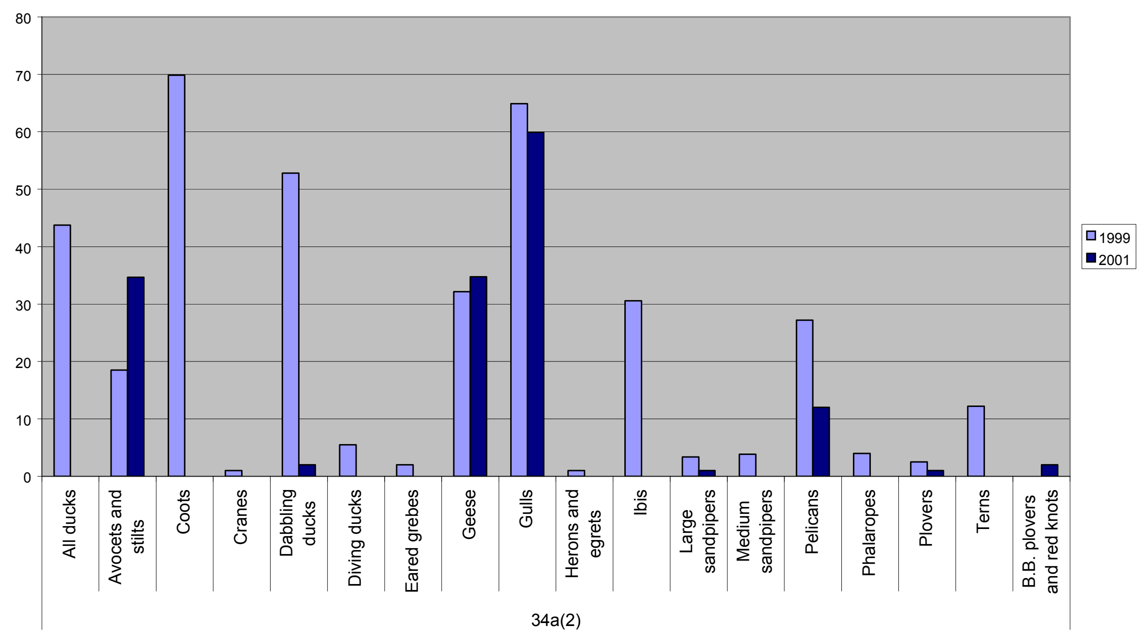
Area 34a (East Promontory- N), Point 1

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **34a-1** during surveys in **1999**	23.1	0.0	0.0	11.7	14.6	3.2	6.6	6.6	2.5	0.0	0.9	30.8
Mean percent of habitat type at point **34a-1** during surveys in **2001**	4.1	0.0	0.0	57.9	12.6	1.0	0.0	3.9	0.7	0.0	0.0	19.8
1999 mean counts/survey												
Gulls	1.1			4.2	16.4	0.9		1.4				53.2
Terns	0.3			2.0	0.3							
Dabbling ducks	10.8					12.2						10.0
Diving ducks						15.0						4.3
All ducks					2.4	39.0						60.7
Herons and egrets	0.2					1.5						
Avocets and stilts	1.5				10.8	0.9						36.4
Small sandpipers	0.5				3.0							
Yellowlegs					9.0							
Plovers				0.2	4.8			0.2				
Phalaropes												4.0
Large sandpipers	0.8			0.3	2.3	0.1		0.7				0.1
Ibis	7.2			0.4	12.3			0.5				2.9
Pelicans					18.5	195.0					3.3	73.0
Eared grebes												1.0
Coots						1.4						18.9
Geese	1.9				1.1	37.6		0.4				23.1
Cormorants						3.0						
Cranes	2.0											
Medium sandpipers												3.0
2001 mean counts/survey												
Gulls					94.0	39.8						19.6
Dabbling ducks	1.1											20.0
Avocets and stilts					13.6							26.1
Large sandpipers	1.5							0.5				
Pelicans	12.4											15.6
Geese	12.5				2.0							3.5



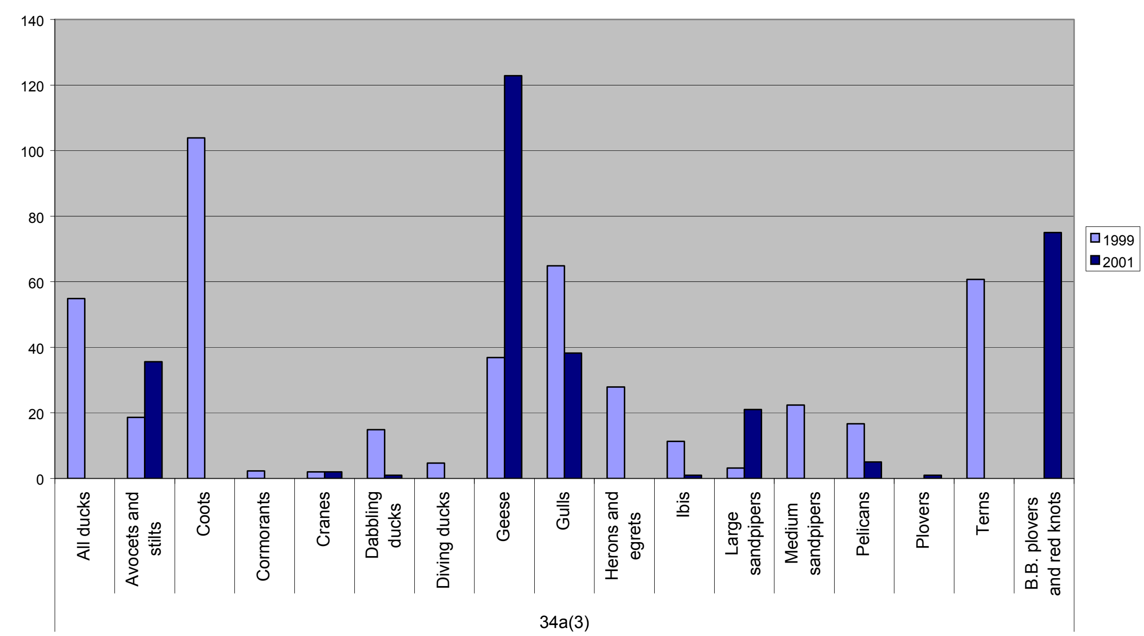
Area 34a (East Promontory- N), Point 2

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **34a-2** during surveys in **1999**	22.0	0.0	0.0	16.5	14.7	0.7	3.7	3.0	0.0	0.0	0.0	39.0
Mean percent of habitat type at point **34a-2** during surveys in **2001**	1.0	0.0	0.0	45.6	17.6	0.0	0.0	2.0	0.0	0.0	0.0	33.9
1999 mean counts/survey												
Gulls	0.3			6.7	30.8	4.3						22.9
Terns				0.8	0.6							10.8
Dabbling ducks					3.4							49.4
Diving ducks					1.6							3.9
All ducks												43.8
Herons and egrets												1.0
Avocets and stilts	0.6			0.2	4.1			0.1				13.6
Plovers				2.5								
Phalaropes					3.5							0.5
Large sandpipers	1.0			0.1	1.9							0.4
Ibis	10.4				4.3							15.9
Pelicans						3.4						23.8
Eared grebes												2.0
Coots												69.9
Geese				5.7	7.2							19.3
Cranes	1.0											
Medium sandpipers												3.8
2001 mean counts/survey												
Gulls				0.3	52.1							7.5
Dabbling ducks												2.0
Avocets and stilts					8.3							26.4
Plovers					1.0							
Large sandpipers								1.0				
Pelicans												12.0
Geese												34.8
Black-bellied plovers and red knots					2.0							



Area 34a (East Promontory- N), Point 3

	Habitat types											
	Emergent vegetation, discharge	Emergent vegetation, marsh	Emergent vegetation, riverine	Mud, dry	Mud, wet	Other, rocks	Other, uplands	Playa, short	Playa, tall	Water, fresh	Water, mixed	Water, salt
Mean percent of habitat type at point **34a-3** during surveys in **1999**	30.6			3.2	7.9	1.1	21.4	0.7			1.7	33.4
Mean percent of habitat type at point **34a-3** during surveys in **2001**	10.0			49.9	11.4		2.6	2.4			0.9	22.6
1999 mean counts/survey												
Gulls	0.3			2.5	32.7						4.3	25.0
Terns				11.0	41.4	8.4						
Dabbling ducks	0.4				0.6			3.5				10.4
Diving ducks												4.7
All ducks					39.8	1.7					1.1	12.3
Herons and egrets	10.7			0.1	15.2	0.0		1.1			0.3	0.4
Avocets and stilts	0.5			6.8	7.1							4.2
Large sandpipers	0.5				1.8	0.2	0.3	0.2				0.2
Ibis	3.6				1.3						0.2	6.2
Pelicans	0.8					4.1						11.8
Coots					0.2							103.6
Geese												36.8
Cormorants						1.3						1.0
Cranes					1.0		1.0					
Medium sandpipers											0.0	22.4
2001 mean counts/survey												
Gulls	5.6				25.2							7.4
Dabbling ducks	1.0											
Avocets and stilts	11.8				4.3						13.5	6.0
Plovers				0.3			0.7					
Large sandpipers	11.6				8.4						0.7	0.3
Ibis	1.0											
Pelicans							3.0					2.0
Geese	3.3				4.3							115.3
Cranes	0.7			0.7			0.7					
Black-bellied plovers and red knots											75.0	



Appendix 4: Survey Area Descriptions

The following accounts detail by mean, peak and density (birds per hectare) each survey area for habitat type, the number of seasons it was surveyed, visibility quality, and numbers of birds. Some of the larger wetland complex areas were not completely covered by survey effort, and therefore density figures were calculated by the area size (hectares) actually surveyed rather than the total area outlined by survey boundaries. These areas are identified with an asterisk (*) after the area name or number.

At times, surveyors were not able to identify birds to the species level and instead recorded counts at the suite level (see Appendix 1 for suite designations). In some cases those counts were large numbers (i.e., flocks of waterfowl viewed at great distance). Suite counts are not included in the following Survey Area Descriptions and, therefore, the data presented may be regarded as conservative.

*1 Timpie Springs WMA**

Description: This small, UDWR managed, wetland complex is surveyed from a vehicle on dike roads. The area was treated as a total count, recording all birds within the peripheral and internal dike systems.
Primary Habitat: Fresh Water; Salt Marsh
Area Size (ha): 556.7
Estimated Area Covered by Survey (ha): 445.5
Years Surveyed: 5
Detection Rates: Visibility is generally unobstructed. Some corners of the ponds are difficult to see. Vegetation beyond ponds can flood and subsequently be used by waterbirds. Viewing birds in these areas can be difficult.

Species	Mean	Peak	Birds/ha
AGWT	6.4	83.0	0.0
AMAV	87.2	237.8	0.2
AMCO	211.9	1232.8	0.5
AMWI	6.0	30.0	0.0
AWPE	5.3	6.3	0.0
BASA	0.3	1.6	0.0
BBPL	0.0	1.3	0.0
BCNH	3.1	9.3	0.0
BLTE	0.0	0.0	0.0
BNST	25.7	153.5	0.1
BUFF	0.6	1.7	0.0
BWTE	1.7	6.0	0.0
CAEG	0.0	0.0	0.0
CAGO	17.6	61.2	0.0
CAGU	112.5	619.0	0.3
CANV	0.1	4.0	0.0
CATE	1.2	10.0	0.0
CITE	1.5	46.3	0.0
CLGR	0.0	0.3	0.0
COGO	0.4	0.8	0.0
DCCO	0.3	1.8	0.0
EAGR	0.2	26.0	0.0
FOTE	4.5	13.8	0.0
FRGU	0.0	2.0	0.0
GADW	18.3	90.6	0.0
GRYE	2.3	23.8	0.0
GTBH	3.7	7.8	0.0
KILL	1.9	6.4	0.0
LBCU	0.1	1.4	0.0
LBDO	0.3	2.3	0.0
LESA	1.1	6.0	0.0
LESC	6.3	14.7	0.0
LEYE	0.9	8.2	0.0
MAGO	0.4	1.0	0.0
MALL	40.2	83.0	0.1
NOPI	103.1	261.5	0.2
NSHO	6.9	30.0	0.0
PBGR	0.5	1.0	0.0
RBGU	0.5	59.5	0.0
REDH	10.8	28.4	0.0
RPHA	10.6	41.0	0.0
RUDU	1.8	2.8	0.0
SACR	0.2	1.0	0.0
SAND	12.0	50.0	0.0
SNEG	1.6	4.0	0.0
SNPL	1.1	4.3	0.0
SPSA	1.2	3.3	0.0
WEGR	0.1	0.5	0.0
WESA	0.2	1.0	0.0
WFIB	13.7	21.8	0.0
WILL	9.0	13.6	0.0
WIPH	5.5	48.0	0.0

2 Stansbury Island North

Description: Facing east, this narrow, privately owned, shoreline runs from the north tip of Stansbury Island to the pumping station gate at the south end. Because land access was denied the survey was not completed in 1997 or 1998. In 1999, the shoreline stretch was included as an aerial survey alternating with the Farmington Bay aerial survey every third period.

Primary Habitat: Rocky Shorelines and Levees; Great Salt Lake Islands

Area Size (ha): 785.6

Estimated Area Covered by Survey (ha): 785.6

Years Surveyed: 3

Detection Rates: Visibility is not obstructed, but rapid travel by airplane can make counting and identification difficult. However, because total numbers were always generally low in this area, it is likely counts are reliable.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.0	0.0	GTBH	0.0	0.0	0.0
AMAV	669.7	2082.5	0.9	KILL	0.0	0.0	0.0
AMCO	0.0	0.0	0.0	LBCU	0.0	0.0	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.0	0.0	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	0.0	0.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.0	0.0	0.0
BLTE	0.0	0.0	0.0	MALL	0.0	0.0	0.0
BNST	0.0	4.7	0.0	NOPI	0.0	0.0	0.0
BUFF	0.0	0.0	0.0	NSHO	0.0	0.0	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	3.9	11.7	0.0
CAGO	0.2	1.3	0.0	REDH	0.0	0.0	0.0
CAGU	1261.3	2535.7	1.6	RPHA	0.0	0.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	0.1	0.3	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.0	0.0	0.0
DCCO	0.0	0.3	0.0	SPSA	0.0	0.0	0.0
EAGR	85.2	206.7	0.1	WEGR	0.0	0.0	0.0
FOTE	0.0	0.3	0.0	WESA	0.0	0.0	0.0
FRGU	1.3	7.3	0.0	WFIB	0.0	0.0	0.0
GADW	0.0	0.0	0.0	WILL	0.8	4.0	0.0
GRYE	0.0	0.0	0.0	WIPH	0.0	3.3	0.0

3 Stansbury Island South

Description: The stretch of mudflat between the pumping station on the south end of Stansbury Island to the railroad is a shoreline survey that has been divided into two sections by the secondary canal (3a = north section, 3b = south section). Each section has a randomly selected point sample and is managed by UDWR.

Primary Habitat: Saltwater Shorelines, Beaches and Playas

Area Size (ha): 3a = 1003.5; 3b = 722.3

Estimated Area Covered by Survey (ha): 3a = 1003.5; 3b = 722.3

Years Surveyed: 5

Detection Rates: Visibility is good, though at certain times mud consistencies may prohibit access to the shoreline by some distance, making detection and identification of small sandpipers and plovers difficult.

3a

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.0	0.0	GTBH	0.0	0.2	0.0
AMAV	4062.9	8039.8	4.0	KILL	0.1	1.0	0.0
AMCO	0.0	0.0	0.0	LBCU	1.2	10.6	0.0
AMWI	0.0	0.0	0.0	LBDO	28.4	170.2	0.0
AWPE	0.0	0.0	0.0	LESA	229.6	1290.0	0.2
BASA	53.2	217.8	0.1	LESC	0.0	0.0	0.0
BBPL	2.7	12.0	0.0	LEYE	0.3	5.4	0.0
BCNH	0.0	0.0	0.0	MAGO	1.3	7.6	0.0
BLTE	0.0	0.0	0.0	MALL	0.0	0.0	0.0
BNST	0.0	1.0	0.0	NOPI	0.0	0.0	0.0
BUFF	0.0	0.0	0.0	NSHO	0.0	0.5	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.1	2.3	0.0	RBGU	2.8	14.0	0.0
CAGO	0.0	0.0	0.0	REDH	0.0	0.0	0.0
CAGU	2868.7	12430.4	2.9	RPHA	0.0	0.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	0.0	0.6	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	72.8	132.0	0.1
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	170.5	846.5	0.2	WEGR	0.0	0.0	0.0
FOTE	0.0	0.0	0.0	WESA	1182.2	2821.4	1.2
FRGU	884.5	2343.8	0.9	WFIB	0.0	4.0	0.0
GADW	0.0	0.0	0.0	WILL	0.4	2.0	0.0
GRYE	0.0	0.0	0.0	WIPH	385.4	2280.4	0.4

3b

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.0	0.0	GTBH	0.0	0.4	0.0
AMAV	1166.9	1930.8	1.6	KILL	0.5	2.5	0.0
AMCO	0.0	0.0	0.0	LBCU	0.8	4.0	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.1	0.4	0.0	LESA	0.0	1.0	0.0
BASA	0.7	4.0	0.0	LESC	0.0	0.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.0	2.0	0.0
BLTE	0.0	0.0	0.0	MALL	0.0	0.8	0.0
BNST	1.1	3.0	0.0	NOPI	0.0	0.0	0.0
BUFF	0.0	0.0	0.0	NSHO	0.0	0.0	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	0.0	0.0
CAGO	0.0	0.5	0.0	REDH	0.0	0.0	0.0
CAGU	992.6	2448.8	1.4	RPHA	0.0	0.0	0.0
CANV	0.0	0.5	0.0	RUDU	0.0	0.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	0.0	13.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	38.3	96.2	0.1
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	0.0	13.3	0.0	WEGR	0.0	0.0	0.0
FOTE	0.0	0.0	0.0	WESA	176.0	693.4	0.2
FRGU	2067.8	4181.8	2.9	WFIB	0.0	0.5	0.0
GADW	0.0	0.4	0.0	WILL	3.1	11.8	0.0
GRYE	0.0	0.0	0.0	WIPH	56.3	827.4	0.1

4 Interstate 80 South

Description: These unsurveyed ponds reside south of Interstate 80, cut off from south end of lake by the railroad dike and Interstate 80.
Years Surveyed: 0
Detection Rates: Visibility is probably very good in this area.

5 Interstate 80 North

Description: This area includes ponds between Interstate 80 and the railroad dike (5b) and a 'shoreline like' count along the railroad dike from Burmester to Black Rock (5a). The ponds were surveyed as a total count. The 'shoreline' was surveyed from the tracks counting out ¼ mile into the lake and included 2 randomly selected, semicircle point samples with ¼ mile radius cut off at the railroad. The access road is owned by Union Pacific Railroad.
Primary Habitat: Fresh Water; Rocky Shorelines and Levees
Area Size (ha): 5a = 697.1; 5b = 658.2
Estimated Area Covered by Survey (ha): 5a = 697.1; 5b = 559.5
Years Surveyed: 5
Detection Rates: Visibility is good for 5a. Viewing distances at the ponds of 5b made some waterfowl identification difficult even with a spotting scope.

5a

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.1	0.7	0.0	GTBH	0.8	3.3	0.0
AMAV	624.8	1729.2	0.9	KILL	42.3	568.8	0.1
AMCO	0.1	69.5	0.0	LBCU	0.0	1.4	0.0
AMWI	0.0	0.2	0.0	LBDO	0.0	0.0	0.0
AWPE	0.0	0.4	0.0	LESA	0.0	1.0	0.0
BASA	0.0	0.0	0.0	LESC	0.1	0.3	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.3	0.0	MAGO	0.0	1.0	0.0
BLTE	0.0	0.0	0.0	MALL	0.1	13.0	0.0
BNST	9.4	38.0	0.0	NOPI	0.0	0.7	0.0
BUFF	0.0	0.0	0.0	NSHO	0.3	1.4	0.0
BWTE	0.0	4.2	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.3	0.0	RBGU	316.8	1455.0	0.5
CAGO	1.5	11.3	0.0	REDH	0.0	0.0	0.0
CAGU	12312.2	17710.3	17.7	RPHA	0.0	0.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.1	1.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	2.1	8.3	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.3	1.7	0.0	SNPL	0.3	1.8	0.0
DCCO	0.0	0.0	0.0	SPSA	1.1	2.3	0.0
EAGR	2105.8	7063.8	3.0	WEGR	0.2	2.5	0.0
FOTE	0.2	1.8	0.0	WESA	0.0	5.8	0.0
FRGU	2302.4	6650.8	3.3	WFIB	0.8	4.6	0.0
GADW	0.0	5.3	0.0	WILL	16.3	23.4	0.0
GRYE	0.0	0.0	0.0	WIPH	5.3	18.6	0.0

5b*

Species	Mean	Peak	Birds/ha
AGWT	3.3	15.3	0.0
AMAV	127.6	395.8	0.2
AMCO	37.4	150.3	0.1
AMWI	5.9	21.8	0.0
AWPE	95.5	141.3	0.2
BASA	0.0	0.0	0.0
BBPL	0.0	0.0	0.0
BCNH	0.2	2.0	0.0
BLTE	0.0	0.4	0.0
BNST	55.9	234.0	0.1
BUFF	0.0	0.0	0.0
BWTE	0.0	0.0	0.0
CAEG	0.0	0.0	0.0
CAGO	55.2	101.3	0.1
CAGU	9039.6	18914.8	16.2
CANV	1.5	23.6	0.0
CATE	0.5	4.3	0.0
CITE	2.0	5.4	0.0
CLGR	0.0	0.3	0.0
COGO	0.0	0.0	0.0
DCCO	3.2	11.3	0.0
EAGR	0.7	249.3	0.0
FOTE	21.3	300.0	0.0
FRGU	1744.0	4705.0	3.1
GADW	29.3	100.5	0.1
GRYE	0.8	4.4	0.0

Species	Mean	Peak	Birds/ha
GTBH	1.8	3.7	0.0
KILL	2.8	17.3	0.0
LBCU	0.0	0.8	0.0
LBDO	0.1	0.8	0.0
LESA	0.0	0.0	0.0
LESC	0.0	0.0	0.0
LEYE	0.1	1.2	0.0
MAGO	0.4	2.6	0.0
MALL	112.1	172.6	0.2
NOPI	140.2	467.2	0.3
NSHO	8.1	36.0	0.0
PBGR	0.7	1.4	0.0
RBGU	6.2	30.0	0.0
REDH	38.3	233.3	0.1
RPHA	0.0	2.3	0.0
RUDU	0.5	2.3	0.0
SACR	0.0	0.0	0.0
SAND	1.0	5.0	0.0
SNEG	12.8	35.2	0.0
SNPL	0.5	2.6	0.0
SPSA	0.4	0.8	0.0
WEGR	11.3	27.0	0.0
WESA	1.2	4.8	0.0
WFIB	20.5	67.3	0.0
WILL	5.4	18.2	0.0
WIPH	17.4	61.2	0.0

6 Saltair

Description: A shoreline survey from Black Rock to the old Saltair railroad grade. Three point samples are included with the two outside points being randomly selected, and the middle point located at the drainage east of the boat harbor. The area has public access.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface

Area Size (ha): 737.9

Estimated Area Covered by Survey (ha): 737.9

Years Surveyed: 5

Detection Rates: Some emergent vegetation and structures associated with the marina and resort inhibit visibility.

Species	Mean	Peak	Birds/ha
AGWT	112.5	247.5	0.2
AMAV	1733.8	3613.0	2.3
AMCO	31.1	60.8	0.0
AMWI	0.0	0.0	0.0
AWPE	0.8	11.0	0.0
BASA	0.0	8.8	0.0
BBPL	10.9	50.8	0.0
BCNH	0.2	1.0	0.0
BLTE	0.0	0.0	0.0
BNST	91.5	163.8	0.1
BUFF	0.0	0.0	0.0
BWTE	0.4	1.8	0.0
CAEG	0.0	0.0	0.0
CAGO	2.9	12.3	0.0
CAGU	1884.5	6967.3	2.6
CANV	0.0	0.0	0.0
CATE	0.9	2.0	0.0
CITE	0.4	2.2	0.0
CLGR	0.1	0.5	0.0
COGO	0.0	0.0	0.0
DCCO	3.4	10.0	0.0
EAGR	206.7	1033.3	0.3
FOTE	6.0	13.3	0.0
FRGU	34.4	178.6	0.0
GADW	0.2	2.0	0.0
GRYE	1.2	7.3	0.0
GTBH	0.7	3.3	0.0
KILL	12.3	27.0	0.0
LBCU	0.0	0.3	0.0
LBDO	0.6	3.6	0.0
LESA	1.2	3.3	0.0
LESC	0.8	1.5	0.0
LEYE	0.5	8.3	0.0
MAGO	0.3	1.6	0.0
MALL	24.2	45.0	0.0
NOPI	0.6	2.7	0.0
NSHO	0.9	43.5	0.0
PBGR	0.9	2.0	0.0
RBGU	4.1	12.2	0.0
REDH	10.7	65.5	0.0
RPHA	0.2	0.8	0.0
RUDU	10.1	21.3	0.0
SACR	0.0	0.0	0.0
SAND	8.0	40.0	0.0
SNEG	11.6	18.8	0.0
SNPL	5.3	15.8	0.0
SPSA	0.7	1.5	0.0
WEGR	0.2	1.0	0.0
WESA	26.4	78.0	0.0
WFIB	5.1	10.2	0.0
WILL	7.9	22.4	0.0
WIPH	3.1	12.6	0.0

*7 Associated Duck Club**

Description: This survey area includes all accessible Ambassador Duck Club and Harrison Duck Club properties, and any other property where access is obtained within the Associated Duck Club area.

Primary Habitat: Fresh Water; Lakeside Uplands; Freshwater Wetlands

Area Size (ha): 5910.5

Estimated Area Covered by Survey (ha): 886.6

Years Surveyed: 5

Detection Rates: This area is large and not completely covered by the survey route. Emergent vegetation obstructs visibility in some places.

Species	Mean	Peak	Birds/ha
AGWT	1417.6	3056.0	1.6
AMAV	657.9	1702.3	0.7
AMCO	615.0	1963.4	0.7
AMWI	966.0	4337.8	1.1
AWPE	263.1	410.2	0.3
BASA	0.0	0.0	0.0
BBPL	28.2	114.8	0.0
BCNH	8.9	25.8	0.0
BLTE	9.4	28.5	0.0
BNST	162.4	432.5	0.2
BUFF	2.1	6.3	0.0
BWTE	5.6	23.2	0.0
CAEG	1.3	7.3	0.0
CAGO	206.1	358.8	0.2
CAGU	51.8	148.8	0.1
CANV	1.8	4.0	0.0
CATE	3.6	25.8	0.0
CITE	70.6	119.6	0.1
CLGR	1.5	4.8	0.0
COGO	0.1	0.3	0.0
DCCO	10.8	26.6	0.0
EAGR	0.3	24.0	0.0
FOTE	23.3	58.8	0.0
FRGU	43.2	188.3	0.0
GADW	460.0	1475.8	0.5
GRYE	1.1	7.0	0.0

Species	Mean	Peak	Birds/ha
GTBH	26.4	71.3	0.0
KILL	17.3	56.3	0.0
LBCU	16.2	21.8	0.0
LBDO	22.5	184.5	0.0
LESA	1.0	5.0	0.0
LESC	155.6	467.8	0.2
LEYE	4.6	24.5	0.0
MAGO	3.4	75.3	0.0
MALL	821.5	1706.0	0.9
NOPI	1045.3	2204.3	1.2
NSHO	60.9	203.6	0.1
PBGR	4.2	8.4	0.0
RBGU	10.8	26.5	0.0
REDH	9.4	167.5	0.0
RPHA	17.3	67.5	0.0
RUDU	65.3	144.3	0.1
SACR	1.0	2.8	0.0
SAND	0.0	0.0	0.0
SNEG	69.5	124.0	0.1
SNPL	0.7	2.5	0.0
SPSA	1.0	2.6	0.0
WEGR	2.6	10.0	0.0
WESA	0.3	11.3	0.0
WFIB	487.1	706.2	0.5
WILL	4.9	139.5	0.0
WIPH	3.4	67.5	0.0

8 Kennecott

Description: This survey includes the section of shoreline between the old Saltair railroad grade and the Goggin Drain, with two randomly selected point samples and one drainage point sample at the Goggin Drain (8a). In addition a total count survey covers all ponds on the Kennecott Inland Sea Shorebird Reserve (8c). Two independent teams surveyed area 8a. The raw data is separated accordingly in the database (areas 8a and 8b), but for simplicity the data is combined and named area 8a throughout this report.
Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface
Area Size (ha): 8a = 580.3; 8c = 2763.2
Estimated Area Covered by Survey (ha): 8a = 580.3; 8c = 1105.3
Years Surveyed: 5
Detection Rates: Visibility is good for all of the shoreline section except at the Goggin Drain where emergent vegetation blocks a good view of the entire point sample. In 1999, surveyors from the adjacent survey area (9a) began recording half of the point sample that could be seen from the other side of the drain, but the numbers were not kept separately from the rest of the survey at 9a and, therefore, not added in to the Goggin point sample.

8a

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	36.6	217.4	0.1	GTBH	1.2	4.2	0.0
AMAV	3952.0	5556.2	6.8	KILL	1.7	5.2	0.0
AMCO	3.2	16.4	0.0	LBCU	0.8	5.0	0.0
AMWI	0.0	2.4	0.0	LBDO	0.8	16.4	0.0
AWPE	0.1	3.2	0.0	LESA	0.3	3.0	0.0
BASA	7.3	38.6	0.0	LESC	0.0	0.8	0.0
BBPL	96.1	267.6	0.2	LEYE	0.2	2.0	0.0
BCNH	0.2	0.6	0.0	MAGO	5.4	25.4	0.0
BLTE	0.0	0.0	0.0	MALL	4.7	25.8	0.0
BNST	66.8	252.4	0.1	NOPI	37.2	97.2	0.1
BUFF	0.0	0.0	0.0	NSHO	110.7	184.8	0.2
BWTE	3.6	18.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.1	0.4	0.0
CAGO	22.5	46.8	0.0	REDH	2.1	14.4	0.0
CAGU	3677.5	13363.8	6.3	RPHA	2.8	10.8	0.0
CANV	0.1	1.2	0.0	RUDU	0.2	0.8	0.0
CATE	0.1	0.6	0.0	SACR	0.0	0.0	0.0
CITE	1.5	7.8	0.0	SAND	17.0	59.8	0.0
CLGR	0.0	0.0	0.0	SNEG	0.4	2.6	0.0
COGO	0.0	0.2	0.0	SNPL	45.1	132.0	0.1
DCCO	1.9	7.0	0.0	SPSA	0.5	1.6	0.0
EAGR	55.8	190.0	0.1	WEGR	35.5	602.8	0.1
FOTE	0.3	3.4	0.0	WESA	476.9	879.8	0.8
FRGU	578.7	2000.6	1.0	WFIB	11.2	37.4	0.0
GADW	51.4	202.8	0.1	WILL	39.9	86.2	0.1
GRYE	0.4	3.0	0.0	WIPH	8.4	39.6	0.0

8c*

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	62.2	133.2	0.1	GTBH	2.3	5.8	0.0
AMAV	1251.6	2678.2	1.1	KILL	26.0	69.8	0.0
AMCO	2.5	32.8	0.0	LBCU	8.1	12.5	0.0
AMWI	1.5	19.8	0.0	LBDO	3.2	63.3	0.0
AWPE	1.4	11.8	0.0	LESA	0.0	3.3	0.0
BASA	0.1	0.4	0.0	LESC	2.0	10.0	0.0
BBPL	36.0	104.5	0.0	LEYE	0.4	2.0	0.0
BCNH	0.2	1.0	0.0	MAGO	0.3	45.0	0.0
BLTE	0.0	0.0	0.0	MALL	53.6	127.4	0.0
BNST	126.0	305.3	0.1	NOPI	43.6	87.0	0.0
BUFF	0.8	3.8	0.0	NSHO	119.0	462.0	0.1
BWTE	5.1	12.8	0.0	PBGR	0.2	1.2	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	0.0	0.0
CAGO	188.4	481.6	0.2	REDH	2.9	29.3	0.0
CAGU	57.9	137.0	0.1	RPHA	89.6	315.5	0.1
CANV	0.0	0.0	0.0	RUDU	0.5	1.0	0.0
CATE	0.2	0.8	0.0	SACR	0.0	0.4	0.0
CITE	35.6	89.6	0.0	SAND	0.4	7.6	0.0
CLGR	0.0	0.4	0.0	SNEG	3.9	9.0	0.0
COGO	0.3	1.5	0.0	SNPL	8.8	41.2	0.0
DCCO	0.4	4.0	0.0	SPSA	0.7	1.8	0.0
EAGR	1.3	233.3	0.0	WEGR	0.1	0.5	0.0
FOTE	0.5	3.5	0.0	WESA	60.8	136.0	0.1
FRGU	15.6	51.8	0.0	WFIB	205.2	290.6	0.2
GADW	33.4	121.3	0.0	WILL	22.9	76.5	0.0
GRYE	1.6	20.5	0.0	WIPH	9.5	253.3	0.0

9 Audubon

Description: The Audubon site includes a shoreline survey from the Goggin Drain to the first major drainage of the Crystal Unit of Farmington Bay WMA, divided in two pieces by the old Antelope Island causeway. The southern portion (9a) was traveled by foot and included a randomly selected point sample. The northern portion (9b) was traveled by ATV and included a randomly selected point sample. The inland portion (9c) of the Audubon property includes several playas and a pond fed by canal water. An ephemeral pond called "Church Pond" was surveyed as an area count. Access is through Kennecott Inland Sea Shorebird Reserve and National Audubon Society private property.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface

Area Size (ha): 9a = 435.6; 9b = 1092.4; 9c = 3164.6

Estimated Area Covered by Survey (ha): 9a = 435.6; 9b = 1092.4; 9c = 791.2

Years Surveyed: 5 (except 9c surveyed only in 2001)

Detection Rates: Visibility is good along the shoreline, although at some times mud consistencies prohibit travel at 100 yards from the water. Species identification may be difficult if viewing distances are too great.

9a

Species	Mean	Peak	Birds/ha
AGWT	15.2	76.0	0.0
AMAV	547.6	1424.5	1.3
AMCO	0.1	2.7	0.0
AMWI	0.0	0.0	0.0
AWPE	0.0	1.2	0.0
BASA	0.0	3.3	0.0
BBPL	61.4	164.3	0.1
BCNH	0.2	3.0	0.0
BLTE	0.0	0.0	0.0
BNST	6.0	37.8	0.0
BUFF	0.0	0.0	0.0
BWTE	0.0	0.5	0.0
CAEG	0.0	0.3	0.0
CAGO	7.2	39.8	0.0
CAGU	608.7	1376.3	1.4
CANV	0.0	0.0	0.0
CATE	0.1	1.0	0.0
CITE	0.4	4.0	0.0
CLGR	0.0	0.0	0.0
COGO	0.0	0.0	0.0
DCCO	1.4	5.3	0.0
EAGR	0.0	62.5	0.0
FOTE	0.0	0.0	0.0
FRGU	30.7	220.0	0.1
GADW	3.4	11.0	0.0
GRYE	0.0	0.3	0.0
GTBH	0.3	1.0	0.0
KILL	0.9	2.3	0.0
LBCU	3.0	9.3	0.0
LBDO	0.1	0.8	0.0
LESA	0.0	1.7	0.0
LESC	0.0	0.0	0.0
LEYE	0.0	0.3	0.0
MAGO	0.0	3.5	0.0
MALL	0.1	2.8	0.0
NOPI	0.0	2.0	0.0
NSHO	20.0	100.0	0.0
PBGR	0.0	0.0	0.0
RBGU	16.6	81.3	0.0
REDH	0.0	0.0	0.0
RPHA	0.0	0.0	0.0
RUDU	0.0	0.0	0.0
SACR	0.0	0.8	0.0
SAND	17.4	53.0	0.0
SNEG	0.1	0.5	0.0
SNPL	0.1	0.5	0.0
SPSA	0.0	0.3	0.0
WEGR	0.0	0.0	0.0
WESA	3.1	16.7	0.0
WFIB	0.5	15.0	0.0
WILL	6.1	19.0	0.0
WIPH	14.8	65.0	0.0

9b

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.7	0.0	GTBH	0.3	1.8	0.0
AMAV	2253.3	7579.8	2.1	KILL	0.2	1.0	0.0
AMCO	0.0	0.0	0.0	LBCU	1.1	3.0	0.0
AMWI	0.5	2.4	0.0	LBDO	0.0	12.3	0.0
AWPE	0.0	24.0	0.0	LESA	1.3	7.8	0.0
BASA	8.8	48.0	0.0	LESC	0.0	0.0	0.0
BBPL	107.0	291.7	0.1	LEYE	0.1	1.4	0.0
BCNH	0.0	0.0	0.0	MAGO	0.4	4.7	0.0
BLTE	0.2	1.0	0.0	MALL	0.1	1.0	0.0
BNST	131.3	581.0	0.1	NOPI	1.5	4.6	0.0
BUFF	0.0	0.0	0.0	NSHO	170.5	306.8	0.2
BWTE	0.0	4.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	146.0	511.5	0.1
CAGO	1.7	22.0	0.0	REDH	3.7	19.8	0.0
CAGU	304.8	1267.0	0.3	RPHA	4.6	18.3	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.2	0.6	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	262.3	695.0	0.2
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	34.3	97.2	0.0
DCCO	0.1	1.0	0.0	SPSA	0.0	0.3	0.0
EAGR	92.8	375.8	0.1	WEGR	0.0	0.0	0.0
FOTE	1.2	18.2	0.0	WESA	233.1	1217.5	0.2
FRGU	78.1	148.0	0.1	WFIB	0.1	0.7	0.0
GADW	4.1	20.0	0.0	WILL	9.4	35.0	0.0
GRYE	0.0	0.2	0.0	WIPH	37.1	177.5	0.0

10 Crystal Lakeside

Description: The Crystal Lakeside site includes area from the southernmost major drainage on the Crystal Unit of Farmington Bay WMA to the southwest elbow of the Turpin dike. This survey is a total count done from an airboat via a public access boat ramp in Farmington Bay WMA.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Freshwater Wetlands

Area Size (ha): 786.1

Estimated Area Covered by Survey (ha): 786.1

Years Surveyed: 5

Detection Rates: Emergent vegetation may obscure visibility in some areas.

Species	Mean	Peak	Birds/ha
AGWT	44.9	145.5	0.1
AMAV	2340.5	3922.0	3.0
AMCO	43.1	348.0	0.1
AMWI	0.6	5.7	0.0
AWPE	136.1	363.8	0.2
BASA	0.0	8.0	0.0
BBPL	209.4	400.3	0.3
BCNH	12.5	90.8	0.0
BLTE	51.1	229.4	0.1
BNST	713.2	2197.8	0.9
BUFF	0.0	0.0	0.0
BWTE	3.3	6.4	0.0
CAEG	0.0	0.0	0.0
CAGO	75.1	493.5	0.1
CAGU	125.1	405.3	0.2
CANV	0.0	0.0	0.0
CATE	0.9	7.0	0.0
CITE	0.1	4.7	0.0
CLGR	0.0	0.3	0.0
COGO	0.0	0.0	0.0
DCCO	7.4	44.4	0.0
EAGR	30.3	362.5	0.0
FOTE	29.8	103.0	0.0
FRGU	622.0	1511.8	0.8
GADW	1.7	79.7	0.0
GRYE	9.6	150.0	0.0
GTBH	3.4	13.0	0.0
KILL	0.0	0.7	0.0
LBCU	0.6	3.0	0.0
LBDO	4.5	14.7	0.0
LESA	0.0	8.0	0.0
LESC	0.0	0.0	0.0
LEYE	0.4	4.2	0.0
MAGO	1.5	31.0	0.0
MALL	21.2	83.8	0.0
NOPI	11.2	78.3	0.0
NSHO	1102.6	2818.0	1.4
PBGR	0.5	1.6	0.0
RBGU	393.8	595.5	0.5
REDH	9.7	55.0	0.0
RPHA	0.0	0.0	0.0
RUDU	0.4	15.0	0.0
SACR	0.0	0.0	0.0
SAND	0.0	1.5	0.0
SNEG	3.1	48.8	0.0
SNPL	0.1	1.2	0.0
SPSA	0.1	0.3	0.0
WEGR	0.1	1.3	0.0
WESA	524.9	2767.7	0.7
WFIB	61.6	128.7	0.1
WILL	35.3	131.3	0.0
WIPH	854.7	3140.4	1.1

11 Farmington Bay Lakeside

Description: This is a 'shoreline' survey done from a WMA dike road. The stretch includes lakeside area from the southwest elbow of the Turpin dike to the Egg Island observation point, one randomly selected point sample and two drainage point samples. The point samples are semi-circles of ¼ mile radius and cut off by the dike. There is public access on UDWR managed site.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface

Area Size (ha): 522.2

Estimated Area Covered by Survey (ha): 522.2

Years Surveyed: 5

Detection Rates: Visibility is clear.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	1.0	0.0	GTBH	1.6	8.2	0.0
AMAV	170.1	418.6	0.3	KILL	0.5	2.0	0.0
AMCO	23.2	94.3	0.0	LBCU	0.0	1.0	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	21.8	87.0	0.0	LESA	0.0	5.0	0.0
BASA	0.0	0.0	0.0	LESC	0.0	3.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.5	2.0	0.0	MAGO	2.0	11.0	0.0
BLTE	1.8	10.0	0.0	MALL	0.1	2.5	0.0
BNST	160.1	373.8	0.3	NOPI	0.4	1.8	0.0
BUFF	0.0	0.0	0.0	NSHO	376.7	638.4	0.7
BWTE	0.0	1.8	0.0	PBGR	0.1	0.4	0.0
CAEG	0.0	0.2	0.0	RBGU	38.1	178.6	0.1
CAGO	6.9	20.4	0.0	REDH	0.2	4.5	0.0
CAGU	154.9	404.6	0.3	RPHA	0.0	0.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.8	29.0	0.0
CATE	0.9	4.5	0.0	SACR	0.0	0.0	0.0
CITE	0.0	8.5	0.0	SAND	0.0	1.6	0.0
CLGR	0.0	0.0	0.0	SNEG	8.2	37.6	0.0
COGO	0.0	0.0	0.0	SNPL	0.6	10.0	0.0
DCCO	1.4	10.6	0.0	SPSA	0.0	0.0	0.0
EAGR	65.3	436.4	0.1	WEGR	4.7	15.8	0.0
FOTE	5.0	22.0	0.0	WESA	1.1	3.8	0.0
FRGU	76.4	188.3	0.1	WFIB	19.2	57.0	0.0
GADW	0.2	5.8	0.0	WILL	4.8	44.0	0.0
GRYE	0.0	0.0	0.0	WIPH	3348.0	20086.0	6.4

*12 Farmington Bay WMA**

Description: The area is a total count of all Farmington Bay WMA impoundments including Turpin.
Primary Habitat: Freshwater Wetlands; Freshwater Shorelines
Area Size (ha): 4544.5
Estimated Area Covered by Survey (ha): 2953.9
Years Surveyed: 5
Detection Rates: Visibility rates vary as a result of emergent vegetation and large viewing distances in some Units.

Species	Mean	Peak	Birds/ha
AGWT	11279.6	16184.3	3.8
AMAV	9354.3	13292.8	3.2
AMCO	6841.1	14827.0	2.3
AMWI	1410.0	2624.3	0.5
AWPE	554.7	960.0	0.2
BASA	0.0	0.0	0.0
BBPL	5.8	16.8	0.0
BCNH	30.4	89.3	0.0
BLTE	94.0	236.8	0.0
BNST	1854.1	2691.0	0.6
BUFF	39.7	159.0	0.0
BWTE	0.0	19.0	0.0
CAEG	1.9	7.8	0.0
CAGO	507.1	733.4	0.2
CAGU	3328.2	5385.0	1.1
CANV	36.0	148.3	0.0
CATE	1.1	4.5	0.0
CITE	2581.4	4624.8	0.9
CLGR	2.1	20.2	0.0
COGO	0.0	0.0	0.0
DCCO	73.3	131.8	0.0
EAGR	194.5	2732.4	0.1
FOTE	72.1	191.3	0.0
FRGU	789.0	1195.8	0.3
GADW	4084.4	8275.8	1.4
GRYE	0.8	7.8	0.0
GTBH	51.6	94.6	0.0
KILL	5.8	18.2	0.0
LBCU	0.0	0.3	0.0
LBDO	1666.1	3336.8	0.6
LESA	18.5	86.0	0.0
LESC	1349.0	3706.0	0.5
LEYE	15.6	233.0	0.0
MAGO	0.7	125.8	0.0
MALL	3033.8	3987.8	1.0
NOPI	12162.3	16981.3	4.1
NSHO	9359.5	12682.0	3.2
PBGR	33.2	56.8	0.0
RBGU	110.4	216.8	0.0
REDH	1054.7	1779.6	0.4
RPHA	1213.3	2640.8	0.4
RUDU	7004.0	14152.3	2.4
SACR	1.1	2.5	0.0
SAND	0.0	0.0	0.0
SNEG	138.3	192.0	0.0
SNPL	0.0	0.0	0.0
SPSA	2.9	8.2	0.0
WEGR	21.4	146.7	0.0
WESA	884.8	2611.6	0.3
WFIB	862.4	1193.6	0.3
WILL	6.7	26.5	0.0
WIPH	1633.1	5623.0	0.6

13 West Farmington

Description: The shoreline is surveyed from the Egg Island Observation point to the drainage due west of the north end of the Davis County Sewer Plant. It includes one randomly placed point sample and two drainage point samples. Access is public from Farmington Bay WMA.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface

Area Size (ha): 305.6

Estimated Area Covered by Survey (ha): 305.6

Years Surveyed: 5 (Many periods were not surveyed in 2001.)

Detection Rates: Visibility is good.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.3	122.3	0.0	GTBH	2.0	6.5	0.0
AMAV	641.4	1926.0	2.1	KILL	7.0	55.0	0.0
AMCO	8.1	704.5	0.0	LBCU	0.0	3.5	0.0
AMWI	0.0	54.3	0.0	LBDO	0.0	2.0	0.0
AWPE	12.1	38.0	0.0	LESA	3.6	21.8	0.0
BASA	0.0	0.0	0.0	LESC	2.0	8.0	0.0
BBPL	9.4	44.0	0.0	LEYE	0.3	3.3	0.0
BCNH	0.5	2.7	0.0	MAGO	0.4	2.3	0.0
BLTE	0.0	0.0	0.0	MALL	5.0	21.7	0.0
BNST	183.8	419.0	0.6	NOPI	41.7	201.3	0.1
BUFF	1.7	6.0	0.0	NSHO	426.6	1237.0	1.4
BWTE	0.0	0.3	0.0	PBGR	0.0	1.0	0.0
CAEG	1.7	11.3	0.0	RBGU	156.0	566.7	0.5
CAGO	31.1	95.7	0.1	REDH	1.3	12.5	0.0
CAGU	662.5	2169.3	2.2	RPHA	229.8	2275.0	0.8
CANV	0.0	0.3	0.0	RUDU	5.0	76.0	0.0
CATE	1.2	17.8	0.0	SACR	0.2	1.0	0.0
CITE	4.7	23.3	0.0	SAND	0.0	0.0	0.0
CLGR	0.6	3.0	0.0	SNEG	3.2	15.5	0.0
COGO	0.1	1.3	0.0	SNPL	0.2	1.5	0.0
DCCO	23.0	76.5	0.1	SPSA	0.3	1.3	0.0
EAGR	56.2	591.5	0.2	WEGR	1.4	7.0	0.0
FOTE	4.4	28.8	0.0	WESA	1.0	5.3	0.0
FRGU	1037.0	3385.7	3.4	WFIB	34.9	117.8	0.1
GADW	68.3	194.3	0.2	WILL	10.6	25.0	0.0
GRYE	1.9	16.7	0.0	WIPH	2.5	179.7	0.0

14 Antelope Island East

Description: The east side of Antelope Island State Park from the triangle intersection at the north causeway to the mainland gate at the south causeway is a total count.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Salt Marsh; Rocky Shorelines and Levees; Great Salt Lake Islands

Area Size (ha): 2417.1

Estimated Area Covered by Survey (ha): 2417.1

Years Surveyed: 5

Detection Rates: The survey is conducted from the east side road, and in some places the viewing distance can compromise identification. Vegetation and land configuration also block viewing in many places.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	9.0	38.8	0.0	GTBH	0.4	2.0	0.0
AMAV	3078.9	8774.5	1.3	KILL	2.8	7.3	0.0
AMCO	0.1	0.7	0.0	LBCU	1.2	4.0	0.0
AMWI	0.0	2.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.0	7.5	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	1.3	5.0	0.0
BBPL	8.3	20.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.2	0.8	0.0
BLTE	0.0	0.0	0.0	MALL	60.1	180.3	0.0
BNST	127.6	667.8	0.1	NOPI	5.2	21.5	0.0
BUFF	3.3	9.3	0.0	NSHO	120.0	461.2	0.0
BWTE	0.2	1.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	51.0	0.0
CAGO	43.9	141.6	0.0	REDH	0.0	17.7	0.0
CAGU	855.6	3023.2	0.4	RPHA	0.0	62.5	0.0
CANV	0.3	1.3	0.0	RUDU	0.0	0.2	0.0
CATE	0.0	0.5	0.0	SACR	0.0	0.0	0.0
CITE	0.0	1.3	0.0	SAND	15.1	74.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.0	0.3	0.0
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	1238.1	1786.8	0.5	WEGR	0.5	6.0	0.0
FOTE	0.0	0.0	0.0	WESA	0.6	50.3	0.0
FRGU	676.7	1717.0	0.3	WFIB	0.0	5.0	0.0
GADW	37.6	188.0	0.0	WILL	11.7	57.5	0.0
GRYE	0.1	1.7	0.0	WIPH	54.9	166.0	0.0

15 Antelope Island West

Description: The shoreline in White Rock Bay from Buffalo Point to Elephant head is surveyed with two randomly placed point samples. Access is in Antelope Island State Park.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Salt Marsh; Great Salt Lake Islands

Area Size (ha): 440.6

Estimated Area Covered by Survey (ha): 440.6

Years Surveyed: 5

Detection Rates: Tall emergent vegetation blocks viewing in some places.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	1.3	0	GTBH	0.1	1.0	0.0
AMAV	111.6	227.0	0.3	KILL	2.9	7.0	0.0
AMCO	0.0	0.7	0.0	LBCU	5.6	10.5	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.0	6.3	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	0.0	0.0	0.0
BBPL	0.1	0.3	0.0	LEYE	0.0	0.3	0.0
BCNH	0.0	0.0	0.0	MAGO	0.0	1.3	0.0
BLTE	0.0	0.0	0.0	MALL	0.4	13.3	0.0
BNST	20.2	49.8	0.0	NOPI	0.0	1.0	0.0
BUFF	0.0	0.0	0.0	NSHO	0.2	3.3	0.0
BWTE	0.0	0.7	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	44.8	0.0
CAGO	1.4	8.5	0.0	REDH	0.1	0.4	0.0
CAGU	407.4	875.6	0.9	RPHA	1.8	7.0	0.0
CANV	0.2	0.8	0.0	RUDU	0.8	4.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	3.3	0.0	SAND	0.0	60.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.1	0.8	0.0
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	794.4	1133.0	1.8	WEGR	0.7	11.3	0.0
FOTE	0.0	0.0	0.0	WESA	0.0	0.2	0.0
FRGU	20.3	89.0	0.0	WFIB	1.2	10.8	0.0
GADW	0.9	15.0	0.0	WILL	30.7	68.7	0.1
GRYE	0.0	0.0	0.0	WIPH	83.5	259.0	0.2

16 Antelope Island Causeway

Description: The north and south sides of the north causeway, from where the water first occurs against the causeway by the entrance station to the three-way intersection on the Island, are a total count. Only birds directly associated with the causeway are recorded. Public access is on a Davis County road.

Primary Habitat: Rocky Shorelines and Levees; Salt Water

Area Size (ha): 120.4

Estimated Area Covered by Survey (ha): 120.4

Years Surveyed: 5

Detection Rates: Visibility is good for most of the route. In some places, large rocks may obscure birds. It is possible to see the entire area on foot.

Species	Mean	Peak	Birds/ha
AGWT	0.1	0.3	0.0
AMAV	51.5	147.8	0.4
AMCO	0.3	2.0	0.0
AMWI	0.0	0.0	0.0
AWPE	2.8	13.8	0.0
BASA	0.1	0.6	0.0
BBPL	0.2	0.8	0.0
BCNH	0.0	0.0	0.0
BLTE	0.0	0.0	0.0
BNST	123.0	382.4	1.0
BUFF	0.0	0.0	0.0
BWTE	0.0	0.0	0.0
CAEG	0.0	0.0	0.0
CAGO	0.6	8.4	0.0
CAGU	719.7	1955.3	6.0
CANV	0.0	0.0	0.0
CATE	0.2	2.8	0.0
CITE	0.0	0.0	0.0
CLGR	0.8	14.3	0.0
COGO	0.0	0.3	0.0
DCCO	0.0	0.0	0.0
EAGR	344.5	662.8	2.9
FOTE	0.0	0.0	0.0
FRGU	140.4	431.8	1.2
GADW	0.0	0.0	0.0
GRYE	4.5	75.8	0.0
GTBH	0.0	0.3	0.0
KILL	2.4	12.7	0.0
LBCU	0.0	0.0	0.0
LBDO	0.1	0.4	0.0
LESA	0.0	0.5	0.0
LESC	9.9	45.0	0.1
LEYE	0.0	0.4	0.0
MAGO	0.0	1.3	0.0
MALL	0.1	0.3	0.0
NOPI	0.0	0.0	0.0
NSHO	59.1	183.5	0.5
PBGR	0.0	0.3	0.0
RBGU	1022.1	1199.6	8.5
REDH	0.1	0.3	0.0
RPHA	71.1	125.3	0.6
RUDU	0.0	2.3	0.0
SACR	0.0	0.0	0.0
SAND	59.4	247.5	0.5
SNEG	0.2	1.3	0.0
SNPL	0.1	1.0	0.0
SPSA	0.1	0.8	0.0
WEGR	0.1	1.6	0.0
WESA	0.0	8.5	0.0
WFIB	1.1	5.0	0.0
WILL	12.8	29.2	0.1
WIPH	182.0	1017.0	1.5

17 West Kaysville

Description: This area has two sections: the interior wetlands (17a) where we did a total count; and mudflat (17b) where we did a shoreline survey. Both areas are between the drainage due west of the north end of the Davis County Sewer Plant and the peregrine hack tower. This area is the Great Salt Lake Shorelands Preserve owned by The Nature Conservancy. Surveys were conducted from an airboat. In 1997, three point samples were designated as part of survey 17b, but the increased lake elevation in 1998 prohibited access to these points, and the area was treated as a total count for the duration of this project.

Primary Habitat: Saltwater-Freshwater Interface; Freshwater Wetlands; Saltwater Shorelines, Beaches and Playas

Area Size (ha): 17a = 1770.7; 17b = 1331.8

Estimated Area Covered by Survey (ha): 17a = 1770.7; 17b = 1331.8

Years Surveyed: 5

Detection Rates: Visibility is good along the shoreline section. However, the interior wetlands have much vegetation that can obstruct viewing.

17a

Species	Mean	Peak	Birds/ha
AGWT	56.2	92.6	0.0
AMAV	1264.7	3482.0	0.7
AMCO	56.8	1817.3	0.0
AMWI	2.8	12.5	0.0
AWPE	5.0	18.8	0.0
BASA	0.0	0.0	0.0
BBPL	4.2	20.7	0.0
BCNH	4.6	13.3	0.0
BLTE	0.0	4.5	0.0
BNST	1218.9	3621.4	0.7
BUFF	1.4	3.3	0.0
BWTE	0.6	2.8	0.0
CAEG	3.1	13.6	0.0
CAGO	49.3	260.2	0.0
CAGU	115.6	458.2	0.1
CANV	0.4	2.0	0.0
CATE	0.2	1.0	0.0
CITE	22.9	128.8	0.0
CLGR	0.0	0.0	0.0
COGO	0.0	0.0	0.0
DCCO	0.4	1.3	0.0
EAGR	76.4	1177.0	0.0
FOTE	10.8	42.0	0.0
FRGU	358.9	795.2	0.2
GADW	9.6	29.0	0.0
GRYE	0.0	0.3	0.0
GTBH	1.9	4.2	0.0
KILL	0.0	0.4	0.0
LBCU	0.1	0.7	0.0
LBDO	239.4	357.4	0.1
LESA	0.0	0.0	0.0
LESC	4.1	15.7	0.0
LEYE	0.3	2.3	0.0
MAGO	1.2	5.4	0.0
MALL	332.0	1625.6	0.2
NOPI	63.6	224.2	0.0
NSHO	1272.8	2981.3	0.7
PBGR	0.0	0.0	0.0
RBGU	49.0	194.8	0.0
REDH	21.9	91.0	0.0
RPHA	141.3	557.0	0.1
RUDU	24.0	49.4	0.0
SACR	0.2	1.0	0.0
SAND	0.0	0.0	0.0
SNEG	13.8	57.3	0.0
SNPL	0.0	0.0	0.0
SPSA	0.0	0.3	0.0
WEGR	0.0	0.0	0.0
WESA	14.5	90.2	0.0
WFIB	471.4	935.3	0.3
WILL	15.6	30.2	0.0
WIPH	2981.5	5434.2	1.7

17b

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	91.6	353.6	0.1	GTBH	2.2	6.0	0.0
AMAV	7313.6	14827.8	5.5	KILL	0.4	3.8	0.0
AMCO	64.5	545.7	0.0	LBCU	0.1	0.4	0.0
AMWI	0.0	0.0	0.0	LBDO	86.4	322.5	0.1
AWPE	2.7	35.6	0.0	LESA	0.0	0.0	0.0
BASA	0.2	5.0	0.0	LESC	37.3	148.0	0.0
BBPL	96.3	185.7	0.1	LEYE	0.1	0.6	0.0
BCNH	2.6	8.5	0.0	MAGO	3.1	8.5	0.0
BLTE	9.7	35.2	0.0	MALL	98.0	461.6	0.1
BNST	3194.6	6087.0	2.4	NOPI	20.0	238.3	0.0
BUFF	1.0	3.7	0.0	NSHO	422.2	707.7	0.3
BWTE	0.6	2.8	0.0	PBGR	0.0	0.0	0.0
CAEG	6.6	23.8	0.0	RBGU	12.4	43.0	0.0
CAGO	18.8	65.0	0.0	REDH	13.3	62.8	0.0
CAGU	517.1	1844.6	0.4	RPHA	34.8	137.7	0.0
CANV	0.3	1.3	0.0	RUDU	5.5	61.5	0.0
CATE	0.8	6.0	0.0	SACR	0.6	6.2	0.0
CITE	29.0	131.8	0.0	SAND	0.7	3.3	0.0
CLGR	0.2	2.8	0.0	SNEG	10.0	29.4	0.0
COGO	0.0	0.0	0.0	SNPL	0.8	4.0	0.0
DCCO	1.1	5.3	0.0	SPSA	0.0	0.0	0.0
EAGR	83.2	1603.7	0.1	WEGR	0.1	1.0	0.0
FOTE	20.3	56.8	0.0	WESA	309.5	979.2	0.2
FRGU	1295.5	2355.8	1.0	WFIB	923.4	1699.2	0.7
GADW	5.6	42.0	0.0	WILL	49.1	124.0	0.0
GRYE	0.0	0.5	0.0	WIPH	432.6	1132.0	0.3

18 West Layton

Description: The West Layton area is the shoreline between the peregrine hack tower at the Layton Preserve and the northern Antelope Island causeway. Three point samples were designated in this survey, one randomly selected and two at drainage points. Access is by permission of The Nature Conservancy.

Primary Habitat: Saltwater-Freshwater Interface; Saltwater Shorelines, Beaches and Playas

Area Size (ha): 525.9

Estimated Area Covered by Survey (ha): 525.9

Years Surveyed: 5

Detection Rates: The shoreline viewing is clear. In some years, access through the southern end was difficult because of extremely soft mud consistencies, so counts were not complete.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	492.8	2463.8	0.9	GTBH	0.2	1.3	0.0
AMAV	1217.9	3419.3	2.3	KILL	1.9	11.3	0.0
AMCO	0.5	53.7	0.0	LBCU	0.7	1.3	0.0
AMWI	0.6	9.5	0.0	LBDO	0.2	16.7	0.0
AWPE	0.0	8.8	0.0	LESA	2.4	13.5	0.0
BASA	0.0	0.0	0.0	LESC	13.0	24.7	0.0
BBPL	35.2	141.0	0.1	LEYE	0.0	0.3	0.0
BCNH	0.0	0.5	0.0	MAGO	0.6	3.8	0.0
BLTE	0.0	0.0	0.0	MALL	55.3	135.5	0.1
BNST	88.5	327.8	0.2	NOPI	6.0	24.7	0.0
BUFF	0.2	0.8	0.0	NSHO	1065.4	3284.5	2.0
BWTE	0.0	2.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.1	1.5	0.0	RBGU	150.9	284.8	0.3
CAGO	43.6	159.5	0.1	REDH	0.5	5.7	0.0
CAGU	182.2	634.0	0.3	RPHA	0.8	59.7	0.0
CANV	0.0	2.0	0.0	RUDU	0.0	14.0	0.0
CATE	0.0	0.5	0.0	SACR	0.4	2.3	0.0
CITE	14.4	22.5	0.0	SAND	0.1	0.3	0.0
CLGR	0.0	0.3	0.0	SNEG	0.2	1.3	0.0
COGO	0.0	0.0	0.0	SNPL	12.9	66.7	0.0
DCCO	0.1	0.8	0.0	SPSA	0.3	0.8	0.0
EAGR	101.4	180.0	0.2	WEGR	0.0	0.3	0.0
FOTE	0.4	2.7	0.0	WESA	9.3	23.3	0.0
FRGU	772.2	1708.8	1.5	WFIB	27.9	48.8	0.1
GADW	115.0	367.5	0.2	WILL	39.6	84.0	0.1
GRYE	0.2	1.5	0.0	WIPH	358.4	1770.8	0.7

19 Howard Slough WMA

Description: Howard Slough WMA consists of three sections: shoreline, dike, and ponds. The shoreline section (19a) extends between the northern Antelope Island causeway and the southernmost Howard Slough WMA dike. It includes two point samples. In 1997, one point was designated in a drainage and the other randomly selected. During the following four years both points were classified as randomly selected. The dike section (19b) is a total count survey of a section of Great Salt Lake shoreline west of the WMA dikes. It is bounded between the north end of 19a and the south fork of the Weber River on the Ogden Bay WMA. The pond section (19c) is an area count and consists of the drivable impoundments in Howard Slough WMA. This section was included as part of the Ogden Bay WMA survey in 1997.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Saltwater-Freshwater Interface

Area Size (ha): 19a = 300.4; 19b = 394.2; 19c = 569.3

Estimated Area Covered by Survey (ha): 19a = 300.4; 19b = 335.1; 19c = 483.9

Years Surveyed: 5

Detection Rates: Restricted access on the mudflat beach and on the WMA dikes makes viewing distances greater. Due to extreme distances, bird identification and counts may be compromised.

19a

Species	Mean	Peak	Birds/ha
AGWT	39.3	139.0	0.1
AMAV	1661.3	4476.0	5.5
AMCO	3.4	25.7	0.0
AMWI	0.0	2.3	0.0
AWPE	2.3	29.0	0.0
BASA	0.0	0.0	0.0
BBPL	122.5	435.0	0.4
BCNH	0.3	1.3	0.0
BLTE	0.2	1.0	0.0
BNST	183.4	445.5	0.6
BUFF	0.2	0.7	0.0
BWTE	1.9	5.8	0.0
CAEG	0.0	0.3	0.0
CAGO	60.2	177.6	0.2
CAGU	441.7	2434.7	1.5
CANV	0.3	1.3	0.0
CATE	0.0	0.7	0.0
CITE	27.3	98.5	0.1
CLGR	0.0	0.0	0.0
COGO	0.0	0.0	0.0
DCCO	0.6	5.0	0.0
EAGR	119.3	1541.7	0.4
FOTE	0.3	3.0	0.0
FRGU	6621.2	21437.3	22.0
GADW	11.3	48.0	0.0
GRYE	0.3	2.0	0.0
GTBH	1.0	3.3	0.0
KILL	2.0	15.0	0.0
LBCU	0.7	4.0	0.0
LBDO	0.2	52.0	0.0
LESA	0.0	2.8	0.0
LESC	4.5	16.8	0.0
LEYE	0.1	1.8	0.0
MAGO	0.5	2.3	0.0
MALL	0.3	4.0	0.0
NOPI	61.3	143.0	0.2
NSHO	568.4	1051.3	1.9
PBGR	0.0	0.7	0.0
RBGU	957.9	1114.4	3.2
REDH	0.3	16.8	0.0
RPHA	0.0	0.0	0.0
RUDU	4.7	19.8	0.0
SACR	0.4	2.0	0.0
SAND	0.0	82.0	0.0
SNEG	0.4	2.4	0.0
SNPL	0.0	0.0	0.0
SPSA	0.0	0.2	0.0
WEGR	0.0	0.3	0.0
WESA	8.1	43.7	0.0
WFIB	47.5	131.8	0.2
WILL	45.3	119.7	0.1
WIPH	296.3	1500.0	1.0

19b*

Species	Mean	Peak	Birds/ha
AGWT	111.0	367.8	0.3
AMAV	1867.5	5299.3	5.6
AMCO	1.8	159.5	0.0
AMWI	0.3	2.8	0.0
AWPE	46.4	117.8	0.1
BASA	0.1	41.7	0.0
BBPL	26.7	100.3	0.1
BCNH	0.5	4.5	0.0
BLTE	0.0	0.0	0.0
BNST	185.8	561.0	0.6
BUFF	0.0	0.0	0.0
BWTE	4.5	19.3	0.0
CAEG	0.0	0.0	0.0
CAGO	89.4	280.0	0.3
CAGU	1641.3	4517.8	4.9
CANV	0.6	2.0	0.0
CATE	0.5	1.8	0.0
CITE	18.2	57.5	0.1
CLGR	0.0	0.0	0.0
COGO	0.4	1.0	0.0
DCCO	5.4	23.0	0.0
EAGR	296.5	1289.0	0.9
FOTE	2.4	10.0	0.0
FRGU	4227.3	8740.0	12.6
GADW	5.0	32.7	0.0
GRYE	0.0	0.3	0.0

Species	Mean	Peak	Birds/ha
GTBH	1.6	5.3	0.0
KILL	0.9	6.8	0.0
LBCU	1.0	2.0	0.0
LBDO	0.3	31.3	0.0
LESA	0.0	0.5	0.0
LESC	33.0	106.0	0.1
LEYE	0.2	1.4	0.0
MAGO	0.7	4.0	0.0
MALL	40.8	163.3	0.1
NOPI	41.9	130.8	0.1
NSHO	460.0	1489.3	1.4
PBGR	96.0	480.0	0.3
RBGU	1675.5	3404.3	5.0
REDH	4.2	141.4	0.0
RPHA	17.6	54.0	0.1
RUDU	3.8	26.8	0.0
SACR	0.5	4.5	0.0
SAND	0.7	2.3	0.0
SNEG	0.7	2.7	0.0
SNPL	0.3	2.6	0.0
SPSA	0.4	1.8	0.0
WEGR	0.2	1.0	0.0
WESA	0.0	1.8	0.0
WFIB	55.7	117.2	0.2
WILL	45.1	125.2	0.1
WIPH	808.7	2878.0	2.4

19c*

Species	Mean	Peak	Birds/ha
AGWT	811.5	1521.8	1.7
AMAV	718.7	1536.6	1.5
AMCO	371.7	1308.4	0.8
AMWI	111.2	524.4	0.2
AWPE	47.6	186.0	0.1
BASA	0.0	1.7	0.0
BBPL	12.1	57.0	0.0
BCNH	6.2	10.6	0.0
BLTE	0.2	2.5	0.0
BNST	167.0	320.2	0.3
BUFF	2.2	8.3	0.0
BWTE	2.5	23.3	0.0
CAEG	1.7	10.2	0.0
CAGO	99.1	160.4	0.2
CAGU	400.6	1225.8	0.8
CANV	0.3	21.0	0.0
CATE	0.4	2.4	0.0
CITE	550.2	924.6	1.1
CLGR	0.3	2.0	0.0
COGO	1.1	5.0	0.0
DCCO	9.0	29.7	0.0
EAGR	11.3	513.8	0.0
FOTE	8.2	24.3	0.0
FRGU	440.0	1443.5	0.9
GADW	403.5	1262.8	0.8
GRYE	2.8	14.2	0.0
GTBH	11.6	21.4	0.0
KILL	3.8	8.8	0.0
LBCU	3.9	9.3	0.0
LBDO	61.7	129.6	0.1
LESA	0.6	44.0	0.0
LESC	552.8	987.0	1.1
LEYE	2.4	13.8	0.0
MAGO	2.2	85.5	0.0
MALL	308.1	682.0	0.6
NOPI	876.8	2819.0	1.8
NSHO	1139.2	4253.2	2.4
PBGR	15.7	26.2	0.0
RBGU	285.9	438.2	0.6
REDH	71.3	313.3	0.1
RPHA	0.1	237.5	0.0
RUDU	159.6	941.5	0.3
SACR	5.6	17.0	0.0
SAND	0.0	0.0	0.0
SNEG	12.9	30.8	0.0
SNPL	0.1	1.0	0.0
SPSA	1.3	2.5	0.0
WEGR	3.4	11.0	0.0
WESA	1.4	8.6	0.0
WFIB	226.6	345.0	0.5
WILL	11.4	37.2	0.0
WIPH	280.1	1000.6	0.6

*20 Ogden Bay WMA**

Description: This area includes all of the impoundments and drivable interior dikes of the Ogden Bay WMA. It is a total count survey.

Primary Habitat: Freshwater Wetlands; Riparian Systems; Fresh Water

Area Size (ha): 2495.6

Estimated Area Covered by Survey (ha): 1497.4

Years Surveyed: 5

Detection Rates: Emergent vegetation obstructs viewing in several areas.

Species	Mean	Peak	Birds/ha
AGWT	20305.3	33272.2	13.6
AMAV	1872.0	4416.4	1.3
AMCO	3935.7	12066.8	2.6
AMWI	1840.3	4374.5	1.2
AWPE	125.7	282.6	0.1
BASA	7.6	35.2	0.0
BBPL	61.3	286.0	0.0
BCNH	26.1	43.6	0.0
BLTE	1.4	64.3	0.0
BNST	1276.0	1930.8	0.9
BUFF	17.5	64.8	0.0
BWTE	0.0	28.4	0.0
CAEG	3.8	27.2	0.0
CAGO	478.6	1159.4	0.3
CAGU	2752.0	6005.6	1.8
CANV	278.6	756.3	0.2
CATE	0.2	0.8	0.0
CITE	4218.3	7643.4	2.8
CLGR	6.2	16.8	0.0
COGO	1.1	5.0	0.0
DCCO	47.4	71.0	0.0
EAGR	9.6	3183.8	0.0
FOTE	74.9	515.4	0.1
FRGU	2344.8	4896.4	1.6
GADW	8025.7	20811.3	5.4
GRYE	40.9	162.6	0.0
GTBH	52.6	80.0	0.0
KILL	11.5	31.5	0.0
LBCU	2.4	6.3	0.0
LBDO	232.1	2250.8	0.2
LESA	12.0	71.0	0.0
LESC	693.1	2025.5	0.5
LEYE	56.1	475.8	0.0
MAGO	93.5	1031.5	0.1
MALL	5086.5	7048.8	3.4
NOPI	11559.5	21550.2	7.7
NSHO	5188.7	10083.2	3.5
PBGR	27.7	35.2	0.0
RBGU	915.5	1703.8	0.6
REDH	438.4	1154.6	0.3
RPHA	321.1	1061.3	0.2
RUDU	961.2	2132.5	0.6
SACR	11.1	25.2	0.0
SAND	9.3	19.0	0.0
SNEG	79.8	122.6	0.1
SNPL	0.1	1.8	0.0
SPSA	5.3	14.2	0.0
WEGR	26.2	67.0	0.0
WESA	62.7	360.0	0.0
WFIB	1636.6	2156.4	1.1
WILL	126.5	185.2	0.1
WIPH	3838.7	5821.0	2.6

*21 Ogden Bay Lakeside**

Description: This area is surveyed by airboat as a total count and includes the Pintail Flats portion of Ogden Bay WMA between the north and south forks of the Weber River.
Primary Habitat: Saltwater-Freshwater Interface; Freshwater Wetlands
Area Size (ha): 811.4
Estimated Area Covered by Survey (ha): 649.1
Years Surveyed: 5
Detection Rates: The easternmost part of the area is covered with emergent vegetation and not all birds are detectable. The noise of the airboat flushes many birds, but it is likely that many hide in the vegetation. Further west visibility is good, but it can be difficult to separate flocks for counting when the airboat causes birds to flush, blending in with other groups farther down the route. Also, flock sizes can be very large and the viewing perspective from the airboat when birds are clumped on the ground isn't as favorable as an aerial view might be. Accordingly, counts may be skewed.

Species	Mean	Peak	Birds/ha
AGWT	969.8	2058.2	1.5
AMAV	4858.5	11414.0	7.5
AMCO	5.4	165.0	0.0
AMWI	52.5	142.0	0.1
AWPE	6.8	68.0	0.0
BASA	1.4	5.8	0.0
BBPL	82.2	239.0	0.1
BCNH	2.1	7.0	0.0
BLTE	2.1	8.4	0.0
BNST	758.2	1996.4	1.2
BUFF	0.0	0.0	0.0
BWTE	0.4	3.8	0.0
CAEG	0.9	6.0	0.0
CAGO	13.1	41.0	0.0
CAGU	3057.9	9416.2	4.7
CANV	0.0	0.0	0.0
CATE	0.7	7.6	0.0
CITE	32.2	250.3	0.0
CLGR	0.0	0.0	0.0
COGO	0.1	0.3	0.0
DCCO	4.8	12.2	0.0
EAGR	4.4	338.5	0.0
FOTE	18.2	55.0	0.0
FRGU	4834.9	11203.2	7.4
GADW	20.4	199.5	0.0
GRYE	0.5	4.4	0.0
GTBH	2.8	6.8	0.0
KILL	0.6	6.3	0.0
LBCU	10.8	86.5	0.0
LBDO	37.2	1554.8	0.1
LESA	8.2	123.3	0.0
LESC	1.5	7.3	0.0
LEYE	0.9	8.8	0.0
MAGO	4.9	114.0	0.0
MALL	27.9	215.8	0.0
NOPI	132.8	1200.5	0.2
NSHO	1023.8	3083.4	1.6
PBGR	0.0	0.0	0.0
RBGU	507.3	883.8	0.8
REDH	9.5	104.8	0.0
RPHA	1010.6	4016.8	1.6
RUDU	2.7	12.0	0.0
SACR	0.5	2.0	0.0
SAND	451.0	2093.8	0.7
SNEG	20.3	43.0	0.0
SNPL	0.4	6.4	0.0
SPSA	0.2	1.0	0.0
WEGR	0.1	0.8	0.0
WESA	985.9	5739.0	1.5
WFIB	224.2	651.0	0.3
WILL	254.1	396.5	0.4
WIPH	32876.9	69469.4	50.7

22 Ogden Bay North

Description: This is a shoreline piece from the north fork of the Weber River to the railroad tracks surveyed from an airboat. Counts do not include gulls, etc., that are directly associated with Landing Rocks. The area has public access.

Primary Habitat: Saltwater Shorelines, Beaches and Playas

Area Size (ha): 389.4

Estimated Area Covered by Survey (ha): 389.4

Years Surveyed: 4

Detection Rates: Visibility is clear. The mudflat is only viewed from the airboat. Often snowy plovers and small sandpipers are viewed along the water edge. However, the more inland parts of the mudflat are not searched so snowy plover numbers are likely very conservative. Also, it can be difficult to separate flocks for counting when the airboat causes birds to flush and blend with others farther down the route.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	2.3	11.5	0.0	GTBH	0.6	2.5	0.0
AMAV	830.0	1630.8	2.1	KILL	0.1	1.5	0.0
AMCO	0.0	1.3	0.0	LBCU	0.1	0.7	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.7	0.0
AWPE	3.2	18.8	0.0	LESA	1.3	12.5	0.0
BASA	0.3	1.8	0.0	LESC	0.3	1.3	0.0
BBPL	9.2	37.8	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.8	0.0	MAGO	1.3	14.3	0.0
BLTE	0.0	0.0	0.0	MALL	0.0	0.0	0.0
BNST	114.3	360.5	0.3	NOPI	16.4	79.3	0.0
BUFF	0.0	0.0	0.0	NSHO	2.3	8.8	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	110.1	336.3	0.3
CAGO	0.4	4.5	0.0	REDH	0.8	25.0	0.0
CAGU	1131.9	5203.8	2.9	RPHA	0.0	0.3	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.1	1.3	0.0	SACR	0.0	0.5	0.0
CITE	0.0	0.0	0.0	SAND	7.4	28.5	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	4.9	31.8	0.0
DCCO	1.6	4.5	0.0	SPSA	0.0	0.0	0.0
EAGR	0.0	153.3	0.0	WEGR	0.0	0.0	0.0
FOTE	18.7	300.0	0.0	WESA	2.1	60.8	0.0
FRGU	2097.3	4816.7	5.4	WFIB	0.0	0.0	0.0
GADW	1.0	5.0	0.0	WILL	23.0	43.0	0.1
GRYE	0.0	0.0	0.0	WIPH	9353.3	43837.5	24.0

23 Rainbow
24 South Harold Crane
25 Harold Crane WMA

Description: These three areas are adjacent to one another and have been typically surveyed as one route. All are managed by UDWR. The Rainbow site includes the George East Duck Club and Rainbow pond and is a total count survey from existing roads. South Harold Crane is also a total count within the gravel road through the UDWR gate on the east, the GSL Minerals Company canal on the north and west, and the railroad tracks on the south. Harold Crane WMA is a total count from all drivable interior dikes within the WMA.
Primary Habitat: Freshwater Wetlands; Lakeside Uplands
Area Size (ha): 23 = 1799.7; 24 = 1439.8; 25 = 1773.4
Estimated Area Covered by Survey (ha): 23 = 593.9; 24 = 475.1; 25 = 585.2
Years Surveyed: 4 (area 25 surveyed all 5 years)
Detection Rates: Some ponds are obstructed from view by tall emergent vegetation. By leaving the dike roads, all ponds could be accessed on foot for better viewing.

23*

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	618.2	1261.7	1.0	GTBH	8.6	14.5	0.0
AMAV	239.7	580.0	0.4	KILL	3.3	9.0	0.0
AMCO	128.1	261.7	0.2	LBCU	3.9	6.0	0.0
AMWI	57.4	110.7	0.1	LBDO	38.2	100.0	0.1
AWPE	13.0	67.5	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	0.6	2.7	0.0
BBPL	0.0	0.0	0.0	LEYE	2.0	21.3	0.0
BCNH	2.6	8.0	0.0	MAGO	1.7	18.8	0.0
BLTE	0.0	0.0	0.0	MALL	400.1	558.3	0.7
BNST	87.4	202.8	0.1	NOPI	455.7	615.5	0.8
BUFF	0.0	0.0	0.0	NSHO	254.2	616.0	0.4
BWTE	0.0	6.0	0.0	PBGR	0.1	0.5	0.0
CAEG	0.4	1.5	0.0	RBGU	1.9	68.8	0.0
CAGO	117.4	287.8	0.2	REDH	19.9	62.3	0.0
CAGU	229.5	1021.7	0.4	RPHA	0.0	1.3	0.0
CANV	0.5	2.0	0.0	RUDU	7.0	16.3	0.0
CATE	0.4	4.3	0.0	SACR	2.7	9.0	0.0
CITE	74.9	127.3	0.1	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	24.1	81.3	0.0
COGO	0.0	0.0	0.0	SNPL	0.3	2.5	0.0
DCCO	0.6	2.0	0.0	SPSA	0.0	0.0	0.0
EAGR	0.0	4.8	0.0	WEGR	0.6	4.0	0.0
FOTE	8.2	23.3	0.0	WESA	0.0	0.0	0.0
FRGU	38.0	96.3	0.1	WFIB	478.8	720.5	0.8
GADW	116.5	172.5	0.2	WILL	3.3	12.3	0.0
GRYE	0.0	0.0	0.0	WIPH	12.3	40.3	0.0

24*

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	960.2	1612.0	2.0	GTBH	6.7	12.5	0.0
AMAV	3029.9	4524.3	6.4	KILL	2.1	5.0	0.0
AMCO	254.2	1556.3	0.5	LBCU	2.5	5.3	0.0
AMWI	100.5	171.3	0.2	LBDO	105.6	304.5	0.2
AWPE	22.5	33.5	0.0	LESA	0.1	0.8	0.0
BASA	0.0	0.3	0.0	LESC	5.7	136.3	0.0
BBPL	0.6	1.3	0.0	LEYE	4.1	33.8	0.0
BCNH	3.3	10.5	0.0	MAGO	49.9	129.5	0.1
BLTE	0.0	0.0	0.0	MALL	683.1	1348.5	1.4
BNST	349.7	709.5	0.7	NOPI	544.9	909.5	1.1
BUFF	0.0	0.0	0.0	NSHO	297.5	612.5	0.6
BWTE	0.0	1.0	0.0	PBGR	0.2	0.5	0.0
CAEG	0.1	1.5	0.0	RBGU	19.7	57.0	0.0
CAGO	142.6	360.0	0.3	REDH	56.6	95.0	0.1
CAGU	127.9	211.7	0.3	RPHA	0.0	0.0	0.0
CANV	0.3	2.0	0.0	RUDU	2.3	21.5	0.0
CATE	0.3	3.0	0.0	SACR	9.3	24.5	0.0
CITE	234.1	393.8	0.5	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	16.7	46.5	0.0
COGO	0.0	0.0	0.0	SNPL	0.7	1.8	0.0
DCCO	3.6	16.0	0.0	SPSA	0.0	0.0	0.0
EAGR	0.6	38.0	0.0	WEGR	0.5	2.5	0.0
FOTE	17.9	43.3	0.0	WESA	0.0	0.0	0.0
FRGU	60.9	100.3	0.1	WFIB	392.2	577.8	0.8
GADW	231.6	431.5	0.5	WILL	4.3	10.5	0.0
GRYE	0.2	3.8	0.0	WIPH	32.4	66.7	0.1

25*

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	2802.3	4406.6	4.8	GTBH	32.1	53.0	0.1
AMAV	1670.9	3088.0	2.9	KILL	5.7	10.8	0.0
AMCO	925.0	1514.6	1.6	LBCU	1.0	35.0	0.0
AMWI	369.1	1141.0	0.6	LBDO	1156.7	1797.6	2.0
AWPE	250.0	895.4	0.4	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	98.9	271.3	0.2
BBPL	9.9	47.5	0.0	LEYE	16.9	49.0	0.0
BCNH	35.7	72.0	0.1	MAGO	217.1	895.0	0.4
BLTE	0.2	34.8	0.0	MALL	2507.4	3354.4	4.3
BNST	803.5	1391.8	1.4	NOPI	2472.0	3927.2	4.2
BUFF	0.0	0.0	0.0	NSHO	1092.8	1570.4	1.9
BWTE	0.0	1.7	0.0	PBGR	1.0	2.8	0.0
CAEG	0.4	4.0	0.0	RBGU	27.4	37.8	0.0
CAGO	548.4	1419.8	0.9	REDH	342.6	586.8	0.6
CAGU	315.4	731.0	0.5	RPHA	0.0	1.2	0.0
CANV	8.5	40.3	0.0	RUDU	161.2	312.5	0.3
CATE	5.6	18.3	0.0	SACR	5.1	18.6	0.0
CITE	671.3	846.2	1.1	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	64.0	103.8	0.1
COGO	0.0	0.0	0.0	SNPL	0.5	2.3	0.0
DCCO	27.3	71.4	0.0	SPSA	0.0	0.5	0.0
EAGR	7.1	266.5	0.0	WEGR	10.6	30.4	0.0
FOTE	77.3	167.3	0.1	WESA	0.0	0.0	0.0
FRGU	328.8	809.6	0.6	WFIB	1520.2	2147.0	2.6
GADW	691.2	1205.6	1.2	WILL	7.9	13.2	0.0
GRYE	2.2	11.0	0.0	WIPH	314.4	676.2	0.5

26 West Harold Crane Mud Bar

Description: West Harold Crane Mud Bar is mainly mudflat with some vegetation to the south and along its eastern border with Harold Crane WMA. Bear River Bay and Willard Spur lie to the west and north, respectively. In periods of low lake levels the area dries up reducing bird use in this area.
Primary Habitat: Freshwater Wetlands; Freshwater Shorelines
Area Size (ha): 2169.2
Years Surveyed: 0
Detection Rates: Visibility is probably very good in this area.

*27 South Bear River**

Description: South Bear River is a large wetland complex south of the D-line dike in the Bear River Migratory Bird Refuge. The area is managed by USFWS.
Primary Habitat: Freshwater Wetlands; Freshwater Shorelines
Area Size (ha): 8272.3
Estimated Area Covered by Survey (ha): 4136.1
Years Surveyed: 5
Detection Rates: Due to emergent vegetation and viewing distances, visibility is considerably limited.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	29678.9	39723.3	7.2	GTBH	37.7	65.0	0.0
AMAV	11289.8	18975.3	2.7	KILL	2.7	14.5	0.0
AMCO	6192.9	11937.2	1.5	LBCU	0.0	0.3	0.0
AMWI	489.6	860.0	0.1	LBDO	5086.4	8245.0	1.2
AWPE	6524.9	8197.8	1.6	LESA	0.0	0.0	0.0
BASA	1.6	4.8	0.0	LESC	162.2	545.5	0.0
BBPL	15.5	74.8	0.0	LEYE	0.0	0.0	0.0
BCNH	12.7	60.0	0.0	MAGO	4547.9	6918.4	1.1
BLTE	127.2	383.8	0.0	MALL	12683.3	36119.3	3.1
BNST	2466.1	7536.6	0.6	NOPI	10417.7	15209.5	2.5
BUFF	49.5	245.8	0.0	NSHO	9266.1	11870.0	2.2
BWTE	0.3	51.0	0.0	PBGR	0.6	7.3	0.0
CAEG	2.0	13.8	0.0	RBGU	18.4	92.0	0.0
CAGO	198.5	407.0	0.0	REDH	97.1	564.0	0.0
CAGU	1059.4	3186.0	0.3	RPHA	0.1	0.3	0.0
CANV	130.9	480.5	0.0	RUDU	481.0	1168.0	0.1
CATE	9.9	37.5	0.0	SACR	0.6	1.7	0.0
CITE	976.7	1797.3	0.2	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	98.9	204.3	0.0
COGO	6.8	32.3	0.0	SNPL	0.0	0.0	0.0
DCCO	97.6	253.8	0.0	SPSA	0.3	0.8	0.0
EAGR	31.8	4055.0	0.0	WEGR	206.0	1541.5	0.0
FOTE	79.4	217.8	0.0	WESA	4952.5	14004.0	1.2
FRGU	2327.4	9575.7	0.6	WFIB	4799.1	8120.2	1.2
GADW	13547.7	37483.7	3.3	WILL	10.7	42.8	0.0
GRYE	5.6	26.3	0.0	WIPH	1237.0	5572.5	0.3

28 Willard Spur

Description: This area is bounded by emergent marsh or sandbar fringe on the north, the Willard Bay reservoir dike on the east, the North Harold Crane dike and emergent marsh on the south, and a line from the northwest corner of GSL Minerals Company north to the mud bar spit on the west. It is surveyed from an airplane in four transects running in an east-west orientation. In 1997, this area was surveyed on the ground by airboat. The area is managed by USFWS.

Primary Habitat: Freshwater Wetlands; Fresh Water; Freshwater Shorelines

Area Size (ha): 6590.3

Estimated Area Covered by Survey (ha): 6590.3

Years Surveyed: 5

Detection Rates: Because this area is rich in numbers and diversity of species, it is difficult to count and identify birds while flying at speeds of 80+ mph. It is also very difficult to see small birds. Survey accuracy in this important area is not good. An observer counts out 1/8 mile on either side of the plane. Four transects were surveyed and data were extrapolated to reflect total coverage. Due to high variability in habitat types within each transect, this extrapolation is not a good technique. The true birds/ha is most likely much greater that the data listed here.

Species	Mean	Peak	Birds/ha
AGWT	2538.4	5099.0	0.4
AMAV	2032.8	3547.0	0.3
AMCO	1773.4	3995.6	0.3
AMWI	54.4	468.0	0.0
AWPE	2877.8	3938.2	0.4
BASA	0.0	10.0	0.0
BBPL	0.0	0.0	0.0
BCNH	5.3	21.3	0.0
BLTE	3.5	34.3	0.0
BNST	528.6	1038.8	0.1
BUFF	9.3	43.7	0.0
BWTE	0.0	1.0	0.0
CAEG	5.0	41.5	0.0
CAGO	174.0	533.8	0.0
CAGU	316.5	541.8	0.0
CANV	87.3	369.3	0.0
CATE	8.5	23.0	0.0
CITE	81.3	290.0	0.0
CLGR	0.0	0.0	0.0
COGO	3.3	16.3	0.0
DCCO	51.5	110.6	0.0
EAGR	64.1	1285.0	0.0
FOTE	168.4	337.8	0.0
FRGU	300.5	2305.3	0.0
GADW	522.3	737.0	0.1
GRYE	0.2	4.0	0.0
GTBH	18.9	57.8	0.0
KILL	0.0	0.0	0.0
LBCU	0.0	0.0	0.0
LBDO	1994.5	4382.4	0.3
LESA	0.0	0.0	0.0
LESC	11.1	19.3	0.0
LEYE	0.0	0.0	0.0
MAGO	1269.9	1560.2	0.2
MALL	469.5	1161.4	0.1
NOPI	2733.2	3753.6	0.4
NSHO	1349.5	2377.8	0.2
PBGR	0.0	0.2	0.0
RBGU	164.2	287.4	0.0
REDH	458.1	1391.8	0.1
RPHA	0.0	10.0	0.0
RUDU	773.7	1493.3	0.1
SACR	0.2	1.0	0.0
SAND	0.2	1.0	0.0
SNEG	187.5	368.4	0.0
SNPL	0.0	0.0	0.0
SPSA	0.0	0.0	0.0
WEGR	167.2	266.0	0.0
WESA	2.0	12.0	0.0
WFIB	1762.3	3592.5	0.3
WILL	9.0	33.3	0.0
WIPH	1151.4	4210.3	0.2

29 *Bear River Refuge**

Description: The area includes all impounded units and any appropriate habitat with established dike units, within the Bear River Bird Refuge. The area is managed by USFWS.

Primary Habitat: Freshwater Wetlands; Fresh Water

Area Size (ha): 10449.4

Estimated Area Covered by Survey (ha): 3134.8

Years Surveyed: 5

Detection Rates: Due to emergent vegetation and viewing distances, visibility is considerably limited.

Species	Mean	Peak	Birds/ha
AGWT	32951.2	52584.7	10.5
AMAV	13626.0	23240.0	4.3
AMCO	7560.4	10778.7	2.4
AMWI	2148.6	2929.0	0.7
AWPE	2119.2	3902.0	0.7
BASA	5.2	18.0	0.0
BBPL	17.7	53.3	0.0
BCNH	11.8	33.8	0.0
BLTE	122.6	263.0	0.0
BNST	8351.8	14582.4	2.7
BUFF	18.4	80.8	0.0
BWTE	0.0	4.0	0.0
CAEG	0.5	4.8	0.0
CAGO	788.5	2874.3	0.3
CAGU	1330.3	3569.0	0.4
CANV	26.9	119.3	0.0
CATE	9.3	78.2	0.0
CITE	3609.1	5145.6	1.2
CLGR	1.3	20.8	0.0
COGO	3.8	10.0	0.0
DCCO	215.6	372.2	0.1
EAGR	3.7	3932.0	0.0
FOTE	70.3	201.0	0.0
FRGU	2806.7	9903.2	0.9
GADW	9960.1	13450.0	3.2
GRYE	15.7	121.3	0.0

Species	Mean	Peak	Birds/ha
GTBH	40.7	81.6	0.0
KILL	5.0	14.3	0.0
LBCU	0.1	1.0	0.0
LBDO	1087.8	5580.3	0.3
LESA	0.7	4.0	0.0
LESC	304.7	1271.0	0.1
LEYE	5.5	62.4	0.0
MAGO	8866.7	16956.5	2.8
MALL	12256.8	18838.0	3.9
NOPI	14614.8	18840.0	4.7
NSHO	12630.1	16674.2	4.0
PBGR	12.0	25.0	0.0
RBGU	22.3	868.8	0.0
REDH	643.9	1647.5	0.2
RPHA	0.7	1600.0	0.0
RUDU	1116.0	2130.5	0.4
SACR	0.5	2.0	0.0
SAND	0.0	0.0	0.0
SNEG	155.1	312.8	0.0
SNPL	0.0	0.8	0.0
SPSA	2.4	7.6	0.0
WEGR	101.2	253.8	0.0
WESA	11597.8	52396.0	3.7
WFIB	8396.1	16006.8	2.7
WILL	16.0	60.5	0.0
WIPH	5590.0	26541.8	1.8

*30 Bear River Club**

Description: Bear River Club is a total count survey including the area north of the Bear River access road, west of the road connecting Goose Island, and east of Public Shooting Grounds WMA. This area is private property.
Primary Habitat: Freshwater Wetlands; Freshwater Shorelines; Lakeside Uplands
Area Size (ha): 5183.8
Estimated Area Covered by Survey (ha): 2073.5
Years Surveyed: 5
Detection Rates: It is likely that emergent vegetation inhibits visibility in some places.

Species	Mean	Peak	Birds/ha
AGWT	2.0	399.0	0.0
AMAV	490.3	958.6	0.2
AMCO	92.9	354.4	0.0
AMWI	12.4	62.0	0.0
AWPE	74.5	129.4	0.0
BASA	0.1	4.3	0.0
BBPL	0.0	0.0	0.0
BCNH	4.9	9.0	0.0
BLTE	0.3	2.0	0.0
BNST	152.0	314.4	0.1
BUFF	3.1	9.0	0.0
BWTE	0.2	8.4	0.0
CAEG	6.3	21.2	0.0
CAGO	270.9	896.6	0.1
CAGU	38.1	117.3	0.0
CANV	1.7	14.4	0.0
CATE	1.4	10.5	0.0
CITE	18.0	122.0	0.0
CLGR	0.3	1.8	0.0
COGO	0.0	0.2	0.0
DCCO	5.5	22.0	0.0
EAGR	3.1	132.5	0.0
FOTE	12.4	41.6	0.0
FRGU	81.6	214.6	0.0
GADW	26.7	313.5	0.0
GRYE	5.5	49.0	0.0
GTBH	7.9	14.8	0.0
KILL	5.9	12.3	0.0
LBCU	0.5	1.5	0.0
LBDO	89.8	272.8	0.0
LESA	0.1	4.3	0.0
LESC	25.3	67.3	0.0
LEYE	7.9	31.0	0.0
MAGO	24.8	68.4	0.0
MALL	14.7	60.0	0.0
NOPI	90.3	498.2	0.0
NSHO	79.6	330.3	0.0
PBGR	4.9	8.3	0.0
RBGU	54.4	107.2	0.0
REDH	1.2	48.0	0.0
RPHA	2.6	10.3	0.0
RUDU	7.2	18.8	0.0
SACR	17.9	68.0	0.0
SAND	0.0	0.0	0.0
SNEG	59.3	313.8	0.0
SNPL	0.3	2.2	0.0
SPSA	0.1	0.4	0.0
WEGR	1.5	7.0	0.0
WESA	0.1	5.0	0.0
WFIB	457.1	1378.8	0.2
WILL	3.5	9.8	0.0
WIPH	5.4	47.3	0.0

31 Chesapeake

Description: The area is east of the road from Goose Island North, and west and north of the Bear River. It is private property.
Primary Habitat: Freshwater Wetland; Riparian Systems; Lakeside Upland
Area Size (ha): 3731.8
Years Surveyed: 0
Detection Rates: Unknown.

*32 Public Shooting Grounds WMA**

Description: The area includes all accessible sites within the Public Shooting Grounds WMA with emphasis on the impoundments. An area count is included. It is managed by UDWR.
Primary Habitat: Freshwater Wetlands; Fresh Water
Area Size (ha): 3248.7
Estimated Area Covered by Survey (ha): 649.7
Years Surveyed: 5
Detection Rates: Detection rate for shorebirds is 100%--mostly avocets and stilts. There is a large expanse of potholes that is not visible from the dike roads and probably hides waterfowl and other waterbirds.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	6205.1	12126.3	9.6	GTBH	18.4	33.3	0.0
AMAV	271.4	873.7	0.4	KILL	2.3	6.3	0.0
AMCO	1731.4	5912.0	2.7	LBCU	0.1	2.0	0.0
AMWI	2111.1	5511.5	3.2	LBDO	1.0	43.0	0.0
AWPE	194.4	261.5	0.3	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	76.5	227.3	0.1
BBPL	0.0	0.0	0.0	LEYE	7.5	47.5	0.0
BCNH	8.7	18.3	0.0	MAGO	0.0	2.2	0.0
BLTE	0.2	0.8	0.0	MALL	2128.7	4032.3	3.3
BNST	407.4	942.8	0.6	NOPI	18732.7	36420.5	28.8
BUFF	17.5	71.0	0.0	NSHO	951.5	2578.5	1.5
BWTE	1.5	7.5	0.0	PBGR	18.4	25.3	0.0
CAEG	0.0	0.0	0.0	RBGU	84.2	146.3	0.1
CAGO	312.0	723.0	0.5	REDH	66.8	254.0	0.1
CAGU	99.9	339.8	0.2	RPHA	0.0	0.0	0.0
CANV	12.3	31.5	0.0	RUDU	84.3	215.0	0.1
CATE	0.2	1.3	0.0	SACR	4.8	11.3	0.0
CITE	759.9	1450.0	1.2	SAND	0.0	0.0	0.0
CLGR	12.1	30.3	0.0	SNEG	69.2	119.0	0.1
COGO	0.0	0.0	0.0	SNPL	0.0	0.0	0.0
DCCO	10.0	32.5	0.0	SPSA	0.0	0.8	0.0
EAGR	0.6	119.3	0.0	WEGR	42.4	65.3	0.1
FOTE	57.0	165.0	0.1	WESA	0.4	1.0	0.0
FRGU	121.0	212.0	0.2	WFIB	534.3	849.0	0.8
GADW	1144.7	1840.8	1.8	WILL	7.9	10.7	0.0
GRYE	7.3	35.6	0.0	WIPH	33.3	120.7	0.1

*33 Salt Creek WMA**

Description: The area includes all accessible sites within the Salt Creek WMA with emphasis on the impoundments. An area count is included. This site is managed by UDWR.

Primary Habitat: Freshwater Wetlands; Lakeside Uplands

Area Size (ha): 863.4

Estimated Area Covered by Survey (ha): 302.2

Years Surveyed: 5

Detection Rates: Detection rate for larger shorebirds is 99% (dowitchers, stilts, avocets). Tall vegetation is a barrier however. Of total WMA, 35% is surveyed, but 55% is good waterbird habitat.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	2343.6	3818.8	7.8	GTBH	9.0	22.0	0.0
AMAV	502.1	927.2	1.7	KILL	4.9	19.2	0.0
AMCO	245.3	960.3	0.8	LBCU	1.1	4.0	0.0
AMWI	222.0	567.5	0.7	LBDO	7.8	278.0	0.0
AWPE	92.2	187.4	0.3	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	16.3	37.0	0.1
BBPL	0.0	0.0	0.0	LEYE	9.2	55.5	0.0
BCNH	5.1	15.8	0.0	MAGO	0.9	63.0	0.0
BLTE	0.2	1.0	0.0	MALL	950.1	1373.4	3.1
BNST	284.7	577.0	0.9	NOPI	4977.9	7238.0	16.5
BUFF	4.1	11.7	0.0	NSHO	463.7	714.8	1.5
BWTE	173.4	867.0	0.6	PBGR	3.6	9.5	0.0
CAEG	0.1	0.8	0.0	RBGU	24.6	52.0	0.1
CAGO	301.3	819.8	1.0	REDH	40.2	116.8	0.1
CAGU	146.4	499.0	0.5	RPHA	7.3	16.7	0.0
CANV	3.0	42.3	0.0	RUDU	29.1	167.8	0.1
CATE	0.0	0.8	0.0	SACR	24.2	66.8	0.1
CITE	445.2	689.3	1.5	SAND	0.0	0.6	0.0
CLGR	1.1	4.5	0.0	SNEG	32.0	43.0	0.1
COGO	0.0	0.0	0.0	SNPL	0.0	0.0	0.0
DCCO	9.4	27.5	0.0	SPSA	0.7	3.8	0.0
EAGR	0.7	31.7	0.0	WEGR	6.0	14.8	0.0
FOTE	6.0	20.8	0.0	WESA	3.6	6.8	0.0
FRGU	26.2	125.0	0.1	WFIB	664.0	1304.2	2.2
GADW	437.1	633.8	1.4	WILL	6.3	13.5	0.0
GRYE	8.3	32.4	0.0	WIPH	61.3	242.8	0.2

34 East Promontory

Description: The eastern shore of the Promontory peninsula is surveyed between the UDWR waterfowl hunter access road and Pokes Point where the GSL Minerals Company dike access road still exists. The area is surveyed in two parts divided by the Booth Valley Hill. The northern part (34a) has three point samples, two of them located in drainages (access to shoreline through private property); the southern part (34b) is surveyed from the road (public access) that parallels the shoreline.

Primary Habitat: Freshwater Shorelines; Freshwater Wetlands

Area Size (ha): 34a = 425.8; 34b = 1062.1

Estimated Area Covered by Survey (ha): 34a = 425.8; 34b = 1062.1

Years Surveyed: 5

Detection Rates: It is not possible to see around Booth Valley Hill, and the north side of Booth Bay is too far from the road for accurate species identification and counting. A few other spots along the driving portion of the survey are difficult to see and may hide small numbers of birds.

34a

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	1080.1	3881.3	2.5	GTBH	2.7	11.8	0.0
AMAV	181.4	427.8	0.4	KILL	3.1	13.0	0.0
AMCO	233.0	833.0	0.5	LBCU	17.0	30.3	0.0
AMWI	611.5	1900.8	1.4	LBDO	0.0	0.0	0.0
AWPE	330.5	946.0	0.8	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	4.6	11.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.3	1.0	0.0	MAGO	0.0	5.3	0.0
BLTE	0.0	0.0	0.0	MALL	45.0	180.4	0.1
BNST	6.4	25.2	0.0	NOPI	237.4	722.8	0.6
BUFF	0.1	0.5	0.0	NSHO	654.5	1647.2	1.5
BWTE	0.0	0.5	0.0	PBGR	0.1	0.3	0.0
CAEG	0.6	5.0	0.0	RBGU	203.1	675.3	0.5
CAGO	254.5	682.3	0.6	REDH	1.5	152.5	0.0
CAGU	170.3	343.0	0.4	RPHA	0.5	2.0	0.0
CANV	0.2	0.7	0.0	RUDU	16.0	30.0	0.0
CATE	8.9	38.3	0.0	SACR	1.8	3.3	0.0
CITE	8.8	30.3	0.0	SAND	0.0	0.0	0.0
CLGR	1.9	8.7	0.0	SNEG	8.1	25.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.2	1.3	0.0
DCCO	1.4	7.3	0.0	SPSA	0.0	0.0	0.0
EAGR	0.2	19.7	0.0	WEGR	13.6	77.7	0.0
FOTE	9.3	42.8	0.0	WESA	0.2	1.2	0.0
FRGU	97.4	216.5	0.2	WFIB	53.5	284.8	0.1
GADW	195.6	673.8	0.5	WILL	18.5	51.8	0.0
GRYE	0.7	8.7	0.0	WIPH	0.1	18.0	0.0

34b

Species	Mean	Peak	Birds/ha
AGWT	184.2	430.8	0.2
AMAV	998.6	4122.4	0.9
AMCO	243.5	1293.2	0.2
AMWI	232.0	645.5	0.2
AWPE	31.9	208.3	0.0
BASA	0.0	0.0	0.0
BBPL	0.0	0.0	0.0
BCNH	0.0	0.0	0.0
BLTE	0.0	0.0	0.0
BNST	6.7	33.0	0.0
BUFF	0.3	1.3	0.0
BWTE	0.0	8.0	0.0
CAEG	0.0	0.8	0.0
CAGO	1897.4	5990.0	1.8
CAGU	2072.1	8236.5	2.0
CANV	0.3	1.7	0.0
CATE	4.4	37.0	0.0
CITE	56.7	181.4	0.1
CLGR	0.3	2.0	0.0
COGO	4.1	7.7	0.0
DCCO	0.3	2.8	0.0
EAGR	165.1	561.8	0.2
FOTE	2.6	21.0	0.0
FRGU	980.1	2911.5	0.9
GADW	17.3	56.0	0.0
GRYE	0.0	0.0	0.0

Species	Mean	Peak	Birds/ha
GTBH	1.0	7.0	0.0
KILL	2.3	8.5	0.0
LBCU	11.5	44.5	0.0
LBDO	0.0	0.2	0.0
LESA	0.0	0.0	0.0
LESC	57.7	67.5	0.1
LEYE	0.1	0.5	0.0
MAGO	0.0	3.0	0.0
MALL	16.7	29.8	0.0
NOPI	80.7	325.0	0.1
NSHO	232.8	771.0	0.2
PBGR	0.0	2.0	0.0
RBGU	176.0	209.6	0.2
REDH	266.3	649.3	0.3
RPHA	0.0	0.0	0.0
RUDU	84.4	467.6	0.1
SACR	0.2	1.0	0.0
SAND	0.0	0.0	0.0
SNEG	4.1	17.5	0.0
SNPL	0.0	0.0	0.0
SPSA	0.2	1.0	0.0
WEGR	4.3	30.3	0.0
WESA	0.0	0.0	0.0
WFIB	66.5	172.7	0.1
WILL	7.5	44.5	0.0
WIPH	0.0	80.8	0.0

*35 Locomotive Springs WMA**

Description: The survey area includes all established management units and outflow areas that are a part of Locomotive Springs WMA. It is managed by UDWR.

Primary Habitat: Freshwater Wetlands; Saltwater Shorelines, Beaches and Playas; Salt Marsh

Area Size (ha): 7607.9

Estimated Area Covered by Survey (ha): 304.3

Years Surveyed: 2

Detection Rates: Approximately 80% of this area has good visibility. Some marshy areas are inaccessible, and some large ponds are difficult to see across from the dike. Of 20,000 acres, 4% was covered by survey, and 17% is good waterbird habitat. The mudflat is where snowy plovers have been observed in large numbers in other studies, but were not surveyed here.

Species	Mean	Peak	Birds/ha
AGWT	114.0	437.0	0.4
AMAV	20.2	343.0	0.1
AMCO	9.2	755.0	0.0
AMWI	15.4	560.0	0.1
AWPE	5.4	129.0	0.0
BASA	1.8	11.0	0.0
BBPL	7.0	29.0	0.0
BCNH	4.4	21.0	0.0
BLTE	0.5	3.0	0.0
BNST	13.1	193.0	0.0
BUFF	7.8	22.0	0.0
BWTE	2.7	22.0	0.0
CAEG	0.0	0.5	0.0
CAGO	10.7	90.0	0.0
CAGU	33.3	133.0	0.1
CANV	23.6	530.5	0.1
CATE	2.2	8.0	0.0
CITE	27.5	314.0	0.1
CLGR	0.0	0.0	0.0
COGO	0.0	0.0	0.0
DCCO	6.0	35.0	0.0
EAGR	0.6	4.0	0.0
FOTE	10.8	42.0	0.0
FRGU	0.3	48.0	0.0
GADW	24.6	262.0	0.1
GRYE	3.9	11.0	0.0
GTBH	8.9	12.5	0.0
KILL	15.2	73.0	0.1
LBCU	15.8	55.0	0.1
LBDO	5.8	188.0	0.0
LESA	0.0	0.0	0.0
LESC	36.0	120.0	0.1
LEYE	4.9	23.5	0.0
MAGO	3.5	17.5	0.0
MALL	194.5	260.0	0.6
NOPI	217.3	366.0	0.7
NSHO	27.1	169.0	0.1
PBGR	2.0	6.0	0.0
RBGU	4.5	16.0	0.0
REDH	156.1	927.5	0.5
RPHA	14.3	48.0	0.0
RUDU	8.2	21.0	0.0
SACR	0.7	4.0	0.0
SAND	0.2	46.5	0.0
SNEG	1.6	4.0	0.0
SNPL	59.5	130.0	0.2
SPSA	1.5	4.5	0.0
WEGR	0.5	3.0	0.0
WESA	62.1	120.0	0.2
WFIB	54.8	110.5	0.2
WILL	76.3	170.0	0.3
WIPH	117.4	272.0	0.4

*36 Salt Wells Flat WHA**

Description: The survey area includes all established management units and outflow areas that are a part of Salt Wells Flat WHA. Managed by BLM.
Primary Habitat: Salt Marsh; Saltwater Shorelines, Beaches and Playas
Area Size (ha): 1659.8
Estimated Area Covered by Survey (ha): 663.9
Years Surveyed: 5
Detection Rates: Visibility on the open mud flats is 100%. At the ponds tall, emergent vegetation blocked visibility—could only see 65%. Access is good and visibility could be increased from an observation tower. Mud is very soft so it is difficult to walk out into the area.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	6.0	35.5	0.0	GTBH	1.2	4.0	0.0
AMAV	16.1	318.0	0.0	KILL	9.5	20.0	0.0
AMCO	0.0	13.5	0.0	LBCU	10.7	19.8	0.0
AMWI	0.5	4.0	0.0	LBDO	1.7	151.0	0.0
AWPE	0.2	9.5	0.0	LESA	0.4	2.0	0.0
BASA	1.2	25.0	0.0	LESC	1.8	4.0	0.0
BBPL	0.2	0.5	0.0	LEYE	0.9	8.0	0.0
BCNH	0.1	1.0	0.0	MAGO	0.0	2.0	0.0
BLTE	0.0	6.0	0.0	MALL	4.2	67.0	0.0
BNST	8.0	98.0	0.0	NOPI	6.9	62.8	0.0
BUFF	0.5	1.5	0.0	NSHO	1.6	327.0	0.0
BWTE	1.4	35.0	0.0	PBGR	0.0	0.3	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	10.0	0.0
CAGO	5.4	18.0	0.0	REDH	1.5	14.5	0.0
CAGU	164.8	1715.3	0.2	RPHA	0.0	49.0	0.0
CANV	0.6	3.0	0.0	RUDU	0.6	3.0	0.0
CATE	0.0	0.5	0.0	SACR	0.3	2.0	0.0
CITE	5.6	60.0	0.0	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.2	0.7	0.0
COGO	0.8	4.0	0.0	SNPL	72.2	140.3	0.1
DCCO	0.0	0.0	0.0	SPSA	0.1	0.5	0.0
EAGR	0.3	1.0	0.0	WEGR	0.0	0.0	0.0
FOTE	0.0	0.0	0.0	WESA	24.3	73.0	0.0
FRGU	0.4	31.5	0.0	WFIB	17.4	106.0	0.0
GADW	10.5	38.0	0.0	WILL	34.5	92.5	0.1
GRYE	1.7	12.0	0.0	WIPH	21.8	119.5	0.0

37 Bear River Bay

Description: Bear River Bay in an open water area between the railroad causeway on the south and Bear River NWR on the north. It was surveyed from an airplane in east-west running transects spaced one mile apart. Observers counted birds on both sides of the plane out to 1/8 mile. To extrapolate to the whole area, transect counts were multiplied by four. Public access.

Primary Habitat: Fresh Water; Freshwater Wetlands

Area Size (ha): 16467.3

Estimated Area Covered by Survey (ha): 16467.3

Years Surveyed: 5

Detection Rates: It is difficult to count and identify birds while flying at speeds of 80+ mph. It is also very difficult to see small birds. Survey accuracy in this area is not good.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	3029.8	7492.8	0.2	GTBH	13.2	83.2	0.0
AMAV	2628.8	5318.4	0.2	KILL	0.0	0.0	0.0
AMCO	2325.8	5819.2	0.1	LBCU	0.0	2.0	0.0
AMWI	125.7	268.0	0.0	LBDO	2248.5	12535.0	0.1
AWPE	11465.8	26230.4	0.7	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	212.3	744.0	0.0
BBPL	9.3	46.7	0.0	LEYE	0.0	0.0	0.0
BCNH	4.4	42.4	0.0	MAGO	16.6	323.2	0.0
BLTE	1.3	6.4	0.0	MALL	373.4	935.0	0.0
BNST	890.2	4986.4	0.1	NOPI	6211.9	17669.6	0.4
BUFF	6.9	32.0	0.0	NSHO	2937.8	6927.2	0.2
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	803.2	1556.0	0.0
CAGO	2355.8	8499.2	0.1	REDH	3032.9	7720.8	0.2
CAGU	8340.1	13740.0	0.5	RPHA	8.3	1027.0	0.0
CANV	8.3	26.7	0.0	RUDU	653.2	1038.7	0.0
CATE	29.8	118.4	0.0	SACR	0.1	1.6	0.0
CITE	59.6	236.8	0.0	SAND	1.3	6.7	0.0
CLGR	0.0	0.0	0.0	SNEG	54.3	110.4	0.0
COGO	365.3	1798.7	0.0	SNPL	0.0	0.0	0.0
DCCO	130.6	302.4	0.0	SPSA	0.1	0.8	0.0
EAGR	1342.0	3213.3	0.1	WEGR	804.7	3024.0	0.0
FOTE	62.4	257.0	0.0	WESA	0.0	0.0	0.0
FRGU	1412.7	3752.8	0.1	WFIB	787.1	2121.6	0.0
GADW	413.0	1580.0	0.0	WILL	1.9	6.7	0.0
GRYE	0.0	0.0	0.0	WIPH	6945.6	33638.4	0.4

38 Ogden Bay

Description: We surveyed the open water area of the bay between Antelope Island State Park causeway to the south and the railroad causeway to the north. WBS areas bound Ogden Bay to the east (areas 19, 20, 21, and 22); and lines connecting Promontory Point, Fremont Island, and Antelope Island bound this area to the west. The survey was done from an airplane in east-west running transects spaced one mile apart. Observers counted birds on both sides of the plane out to 1/8 mile. To extrapolate to the whole area, transect counts were multiplied by four. This area provides public access.

Primary Habitat: Salt Water

Area Size (ha): 20679.6

Estimated Area Covered by Survey (ha): 20679.6

Years Surveyed: 5

Detection Rates: It is difficult to count and identify birds while flying at speeds of 80+ mph. It is also very difficult to see small birds. Survey accuracy in this important area is not good. An observer counts out 1/8 mile on either side of the plane.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.2	0.8	0.0	GTBH	2.0	10.7	0.0
AMAV	475.6	1949.6	0.0	KILL	0.0	0.0	0.0
AMCO	0.8	10.0	0.0	LBCU	0.0	1.0	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	13.4	64.0	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	62.1	169.3	0.0
BBPL	0.3	1.3	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.9	9.0	0.0
BLTE	0.4	1.6	0.0	MALL	0.2	0.8	0.0
BNST	32.1	240.0	0.0	NOPI	121.5	573.0	0.0
BUFF	0.3	1.3	0.0	NSHO	681.6	1964.0	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	551.4	1418.4	0.0
CAGO	636.8	8019.2	0.0	REDH	13.5	98.4	0.0
CAGU	14645.4	56801.6	0.7	RPHA	309.7	794.7	0.0
CANV	0.0	0.0	0.0	RUDU	14.7	68.0	0.0
CATE	0.1	1.0	0.0	SACR	0.0	0.0	0.0
CITE	0.5	4.0	0.0	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	1.3	12.0	0.0
COGO	2.1	10.7	0.0	SNPL	0.0	0.0	0.0
DCCO	0.8	13.0	0.0	SPSA	0.0	0.0	0.0
EAGR	85164.2	149604.0	4.1	WEGR	10.1	131.0	0.0
FOTE	1.1	5.0	0.0	WESA	0.0	0.0	0.0
FRGU	3714.3	8890.4	0.2	WFIB	21.7	100.0	0.0
GADW	0.3	21.3	0.0	WILL	0.2	6.7	0.0
GRYE	0.0	0.0	0.0	WIPH	17084.8	26650.4	0.8

39 Farmington Bay

Description: We surveyed the open water area of the bay between the old Antelope Island causeway on the south and the new Antelope Island State Park causeway on the north. The survey was done from an airplane in east-west running transects spaced one mile apart. Observers counted birds on both sides of the plane out to 1/8 mile. To extrapolate to the whole area, transect counts were multiplied by four. The area has public access.

Primary Habitat: Salt Water; Saltwater-Freshwater Interface

Area Size (ha): 28719.6

Estimated Area Covered by Survey (ha): 28719.6

Years Surveyed: 5

Detection Rates: It is difficult to count and identify birds while flying at speeds of 80+ mph. It is also very difficult to see small birds. Survey accuracy in this important area is not good. An observer counts out 1/8 mile on either side of the plane. During 1999-2001 this area was surveyed only every 3rd period, alternating with Stansbury Island North.

Species	Mean	Peak	Birds/ha
AGWT	37.5	173.6	0.0
AMAV	12441.4	51606.0	0.4
AMCO	12.9	80.0	0.0
AMWI	13.5	50.0	0.0
AWPE	22.0	100.0	0.0
BASA	0.0	0.0	0.0
BBPL	0.0	50.0	0.0
BCNH	0.0	0.0	0.0
BLTE	3.9	23.2	0.0
BNST	1033.1	4023.2	0.0
BUFF	0.0	0.0	0.0
BWTE	0.0	0.0	0.0
CAEG	0.0	0.0	0.0
CAGO	48.4	200.0	0.0
CAGU	5927.2	37620.0	0.2
CANV	0.0	0.0	0.0
CATE	1.8	24.0	0.0
CITE	0.8	4.0	0.0
CLGR	0.0	0.0	0.0
COGO	1.8	5.3	0.0
DCCO	6.4	56.0	0.0
EAGR	10168.5	16476.0	0.4
FOTE	11.2	57.3	0.0
FRGU	9679.7	30230.0	0.3
GADW	22.0	41.3	0.0
GRYE	0.0	0.0	0.0
GTBH	1.5	9.3	0.0
KILL	0.0	0.0	0.0
LBCU	0.0	0.0	0.0
LBDO	0.0	0.0	0.0
LESA	0.0	0.0	0.0
LESC	15.1	45.3	0.0
LEYE	0.0	0.0	0.0
MAGO	4.3	26.0	0.0
MALL	179.7	377.6	0.0
NOPI	513.6	2178.7	0.0
NSHO	17278.7	34049.3	0.6
PBGR	0.0	0.0	0.0
RBGU	1248.4	2754.0	0.0
REDH	171.7	769.6	0.0
RPHA	268.4	805.3	0.0
RUDU	2.7	3054.7	0.0
SACR	0.0	0.0	0.0
SAND	0.0	0.0	0.0
SNEG	1.4	8.0	0.0
SNPL	0.0	0.0	0.0
SPSA	0.0	0.0	0.0
WEGR	4.8	24.0	0.0
WESA	0.0	0.0	0.0
WFIB	80.7	220.0	0.0
WILL	0.0	5.3	0.0
WIPH	1231.0	10481.6	0.0

40 Magcorp

Description: This area runs along the Magcorp (currently called US Magnesium Corporation of Salt Lake City) dike road from the west GSL shoreline to Badger and Stansbury Islands. Pond 1N designates Magcorp's solar pond "1 North." It is the first pond to receive brine from the GSL and has approximately twice the salinity of the lake. The survey was conducted by driving the 11-mile length of the dike (western margin to Stansbury Island) and counting birds on the south side to the distance where species may be identified. Pond 0 designates the GSL immediately north of the Magcorp dike and is the source of water drawn into Magcorp's solar ponds. Birds are counted on the north side along the length of the dike. There is no public access.

Primary Habitat: Rocky Shorelines and Levees; Saltwater Shorelines, Beaches and Playas

Area Size (ha): 752.0

Estimated Area Covered by Survey (ha): 752.0

Years Surveyed: 4

Detection Rates: Visibility is generally good.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.4	1.8	0.0	GTBH	0.2	1.3	0.0
AMAV	2323.5	8908.0	3.1	KILL	0.4	3.0	0.0
AMCO	0.0	0.0	0.0	LBCU	1.8	7.3	0.0
AMWI	0.0	0.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.0	0.0	0.0	LESA	285.4	1180.8	0.4
BASA	0.0	14.3	0.0	LESC	0.9	2.3	0.0
BBPL	0.1	0.7	0.0	LEYE	0.0	0.0	0.0
BCNH	0.1	0.8	0.0	MAGO	0.0	7.7	0.0
BLTE	0.0	0.0	0.0	MALL	0.8	4.0	0.0
BNST	0.7	6.0	0.0	NOPI	0.0	0.0	0.0
BUFF	0.0	0.0	0.0	NSHO	0.0	0.0	0.0
BWTE	0.0	6.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	0.0	0.0
CAGO	0.1	2.5	0.0	REDH	0.0	0.0	0.0
CAGU	2437.4	8174.0	3.2	RPHA	1258.9	2400.7	1.7
CANV	0.0	0.0	0.0	RUDU	0.8	2.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.5	2.7	0.0	SAND	12.9	50.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.0	0.7	0.0
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	376.6	1353.3	0.5	WEGR	1.3	10.0	0.0
FOTE	0.0	0.0	0.0	WESA	311.5	1078.0	0.4
FRGU	92.9	821.0	0.1	WFIB	1.0	5.0	0.0
GADW	0.7	4.7	0.0	WILL	0.1	3.3	0.0
GRYE	0.2	3.0	0.0	WIPH	36082.1	119789.0	48.0

*41 New State Duck Club**

Description: The area is within property boundaries of New State Inc., bounded by the outer dike on the north, the east channel, Margetts dike on the south and the Salt Lake City sewage canal on the west. A total count was made during travel on the canals, and at ponds along the route.

Primary Habitat: Freshwater Wetlands

Area Size (ha): 1200.2

Estimated Area Covered by Survey (ha): 600.1

Years Surveyed: 2

Detection Rates: Visibility is not good. There is much emergent vegetation obstructing vision and some ponds are very large with difficult viewing distances. Counts from this area are very conservative.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	3419.0	8985.0	5.7	GTBH	16.5	39.0	0.0
AMAV	380.6	1236.0	0.6	KILL	4.4	40.0	0.0
AMCO	1490.7	3988.0	2.5	LBCU	0.0	0.0	0.0
AMWI	107.2	415.0	0.2	LBDO	157.9	485.0	0.3
AWPE	100.7	325.0	0.2	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	163.7	560.0	0.3
BBPL	0.1	18.5	0.0	LEYE	0.1	2.0	0.0
BCNH	7.7	32.0	0.0	MAGO	0.0	11.5	0.0
BLTE	0.0	0.0	0.0	MALL	2489.1	5579.5	4.1
BNST	84.7	197.0	0.1	NOPI	910.7	2115.0	1.5
BUFF	1.6	5.0	0.0	NSHO	2944.8	7830.0	4.9
BWTE	1.0	8.0	0.0	PBGR	10.9	19.5	0.0
CAEG	0.0	0.0	0.0	RBGU	4.2	21.0	0.0
CAGO	100.0	323.0	0.2	REDH	299.7	1290.5	0.5
CAGU	132.1	421.0	0.2	RPHA	302.0	1204.0	0.5
CANV	12.7	26.0	0.0	RUDU	873.8	2150.0	1.5
CATE	0.2	2.0	0.0	SACR	1.2	9.0	0.0
CITE	2151.7	5402.0	3.6	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	72.6	131.5	0.1
COGO	0.2	1.0	0.0	SNPL	0.0	0.0	0.0
DCCO	17.5	53.0	0.0	SPSA	0.0	0.0	0.0
EAGR	0.9	613.5	0.0	WEGR	6.4	33.0	0.0
FOTE	12.1	33.0	0.0	WESA	17.5	51.0	0.0
FRGU	27.2	831.5	0.0	WFIB	198.8	297.0	0.3
GADW	5454.7	17207.0	9.1	WILL	10.8	50.0	0.0
GRYE	7.5	78.5	0.0	WIPH	8.3	516.5	0.0

42 East Farmington Bay

Description: In this survey area we conducted a total count of all waterbird use areas visible from the following route. Travel south from Glover Lane and 650 West to dead end, return back to Glover Lane and Pipeline Road, and travel south along the Pipeline Road to Parrish Lane. This road parallels the railroad tracks on the west side. At Parrish Lane, travel east to 1250 West, then turn north and continue on to dead end pond. Return back to Pipeline Road and travel south to Porter Lane. Turn west at the landfill (some of this section will be residential and for travel purposes only). We surveyed upland drainages here, but not the large pond to the west and north. We turned west at 1600 North and continued along South Canal Road, bordering the South Bountiful Landfill to the large pond. The pond and associated wetlands were counted, and we returned back to the1600 North and 1100 West intersection and traveled north on 1100 West to 1200 North. Wetlands near the road leading west to the sewer plant were surveyed and we returned back to 1100 West and 1200 North and traveled south on 1100 West to 500 South, and then west to New State Duck Club road. We turned north at the gate on to berm to dead end while counting both sides of the berm road. There is public access.

Primary Habitat: Lakeside Uplands; Freshwater Wetlands

Area Size (ha): 2035.6

Estimated Area Covered by Survey (ha): 2035.6

Years Surveyed: 3

Detection Rates: Visibility is obstructed in some areas.

Species	Mean	Peak	Birds/ha
AGWT	3.0	7.3	0.0
AMAV	10.0	107.0	0.0
AMCO	0.1	64.5	0.0
AMWI	0.0	2.7	0.0
AWPE	30.2	109.7	0.0
BASA	0.0	0.0	0.0
BBPL	0.9	3.0	0.0
BCNH	0.1	0.5	0.0
BLTE	0.0	0.0	0.0
BNST	4.4	20.0	0.0
BUFF	0.0	0.0	0.0
BWTE	0.0	4.5	0.0
CAEG	1.6	17.7	0.0
CAGO	64.9	195.7	0.0
CAGU	129.4	496.0	0.1
CANV	7.8	27.0	0.0
CATE	0.1	1.7	0.0
CITE	3.0	46.0	0.0
CLGR	0.0	0.3	0.0
COGO	0.1	0.7	0.0
DCCO	1.4	4.5	0.0
EAGR	0.2	25.3	0.0
FOTE	2.6	9.7	0.0
FRGU	0.6	34.0	0.0
GADW	0.0	12.5	0.0
GRYE	0.6	5.0	0.0
GTBH	4.9	57.0	0.0
KILL	8.0	25.7	0.0
LBCU	0.1	0.7	0.0
LBDO	3.5	24.3	0.0
LESA	0.8	31.7	0.0
LESC	8.3	30.0	0.0
LEYE	0.7	6.7	0.0
MAGO	0.0	1.0	0.0
MALL	8.6	41.5	0.0
NOPI	1.6	9.3	0.0
NSHO	0.0	40.5	0.0
PBGR	0.2	1.0	0.0
RBGU	0.0	0.0	0.0
REDH	0.0	15.0	0.0
RPHA	0.0	0.7	0.0
RUDU	0.5	2.0	0.0
SACR	0.9	4.0	0.0
SAND	0.0	0.0	0.0
SNEG	5.8	54.5	0.0
SNPL	1.0	10.3	0.0
SPSA	0.0	0.7	0.0
WEGR	1.1	2.7	0.0
WESA	0.3	7.0	0.0
WFIB	33.6	619.3	0.0
WILL	0.9	4.0	0.0
WIPH	0.0	550.0	0.0

43 Deardens Knoll

Description: Three points were identified on the western shore, south of the railroad dike. In 1999, some bird counts outside of the points were included. In 2000 and 2001 only the point samples were surveyed. As most of the shoreline between points was unsuitable for waterbirds, these points were grouped together and regarded as a total count as viewed from three vantage points. Access is restricted through US Air Force property.

Primary Habitat: Saltwater Shorelines, Beaches and Playas; Salt Water

Area Size (ha): 475.6

Estimated Area Covered by Survey (ha): 475.6

Years Surveyed: 3

Detection Rates: Several places along the transect it is necessary to drive around rock outcrops that prevent visibility of the water, but viewing is good at the point samples.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.0	0.0	GTBH	0.0	0.7	0.0
AMAV	835.7	2621.0	1.8	KILL	0.2	1.0	0.0
AMCO	0.0	0.0	0.0	LBCU	0.2	1.0	0.0
AMWI	0.0	0.0	0.0	LBDO	0.1	0.5	0.0
AWPE	0.4	1.0	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	0.0	0.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.0	0.0	0.0
BLTE	0.0	0.0	0.0	MALL	0.0	0.0	0.0
BNST	0.8	3.7	0.0	NOPI	0.1	0.7	0.0
BUFF	0.0	0.0	0.0	NSHO	0.0	0.0	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.0	0.0	0.0	RBGU	0.0	1.0	0.0
CAGO	0.0	0.0	0.0	REDH	0.0	0.0	0.0
CAGU	453.4	1331.0	1.0	RPHA	0.0	1500.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	0.0	0.0	0.0	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.0	0.3	0.0
COGO	0.0	0.0	0.0	SNPL	0.0	0.3	0.0
DCCO	0.0	0.0	0.0	SPSA	0.0	1.0	0.0
EAGR	916.7	3333.3	1.9	WEGR	0.0	0.0	0.0
FOTE	0.0	0.0	0.0	WESA	45.0	270.0	0.1
FRGU	4.7	28.3	0.0	WFIB	0.0	0.0	0.0
GADW	0.0	0.0	0.0	WILL	1.0	5.0	0.0
GRYE	0.0	0.0	0.0	WIPH	1796.9	3600.0	3.8

44 Jordan River

Description: This area consists of agricultural land that can be flooded and used by waterbirds when lake elevations are high. Since the property is private, access is restricted. It was surveyed by transect from an airplane.

Primary Habitat: Lakeside Uplands

Area Size (ha): 290.7

Estimated Area Covered by Survey (ha): 230.7

Years Surveyed: 2

Detection Rates: It is difficult to count and identify birds while flying at speeds of 80+ mph. It is also very difficult to see small birds. Survey accuracy is moderate, as there are few birds. An observer counts out 1/8 mile on either side of the plane. This area was surveyed only every 3rd period, alternating with Stansbury Island North.

Species	Mean	Peak	Birds/ha	Species	Mean	Peak	Birds/ha
AGWT	0.0	0.0	0.0	GTBH	0.0	0.0	0.0
AMAV	1.0	5.0	0.0	KILL	0.0	0.0	0.0
AMCO	30.8	145.0	0.1	LBCU	0.0	0.0	0.0
AMWI	3.1	25.0	0.0	LBDO	0.0	0.0	0.0
AWPE	0.6	3.0	0.0	LESA	0.0	0.0	0.0
BASA	0.0	0.0	0.0	LESC	0.0	0.0	0.0
BBPL	0.0	0.0	0.0	LEYE	0.0	0.0	0.0
BCNH	0.0	0.0	0.0	MAGO	0.0	0.0	0.0
BLTE	0.0	0.0	0.0	MALL	5.3	31.0	0.0
BNST	0.0	0.0	0.0	NOPI	0.1	1.0	0.0
BUFF	0.0	0.0	0.0	NSHO	2.5	20.0	0.0
BWTE	0.0	0.0	0.0	PBGR	0.0	0.0	0.0
CAEG	0.8	5.0	0.0	RBGU	0.0	0.0	0.0
CAGO	25.5	74.0	0.1	REDH	0.9	7.0	0.0
CAGU	1.0	4.0	0.0	RPHA	0.0	0.0	0.0
CANV	0.0	0.0	0.0	RUDU	0.0	0.0	0.0
CATE	0.0	0.0	0.0	SACR	0.0	0.0	0.0
CITE	1.0	7.0	0.0	SAND	0.0	0.0	0.0
CLGR	0.0	0.0	0.0	SNEG	0.8	4.0	0.0
COGO	0.0	0.0	0.0	SNPL	0.0	0.0	0.0
DCCO	0.0	0.0	0.0	SPSA	0.0	0.0	0.0
EAGR	3.8	30.0	0.0	WEGR	0.3	1.0	0.0
FOTE	0.0	0.0	0.0	WESA	0.0	0.0	0.0
FRGU	0.4	2.0	0.0	WFIB	7.1	43.0	0.0
GADW	2.3	15.0	0.0	WILL	0.1	1.0	0.0
GRYE	0.0	0.0	0.0	WIPH	0.0	0.0	0.0

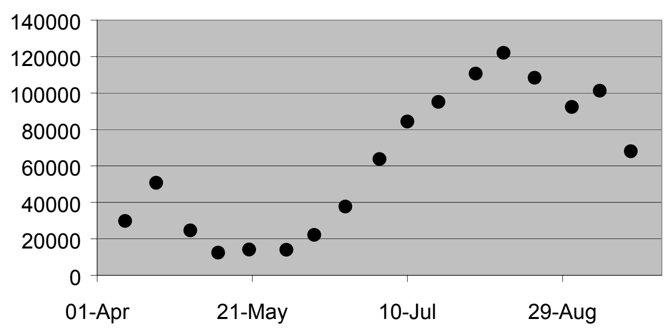
Appendix 5: Species Accounts

Each species account includes data collected from the Five-Year Waterbird Survey, and in many cases, population estimates on a broader scale from outside sources (br = breeding adults; Morrison et al. 2001; Wilkens et al. 2000; NAWCP Appendix 4; Jehl 2001). Means for each survey period are calculated over five years (1997-2001) and displayed in each chart. The mean number reported in the table for GSL is an average of survey period means for selected months during which the species is present in abundance. The peak number reported is the largest of the survey period means. The high count is the largest count at GSL at any time throughout the five-year study. The year of the high count is noted. The abundance status is taken from a Utah birds checklist (Bromley and Webb 1995) and is included as a description of species occurrence (C = common, seen frequently in habitat; FC = fairly common, small numbers or not always seen; U = uncommon, seldom seen but not a surprise; R = rare, always a surprise but not out of normal range; O = occasional, out of usual range and/or habitat). The map for each species reflects the distribution of the mean number across waterbird survey areas as data were reported. Areas not shaded represent a count of zero.

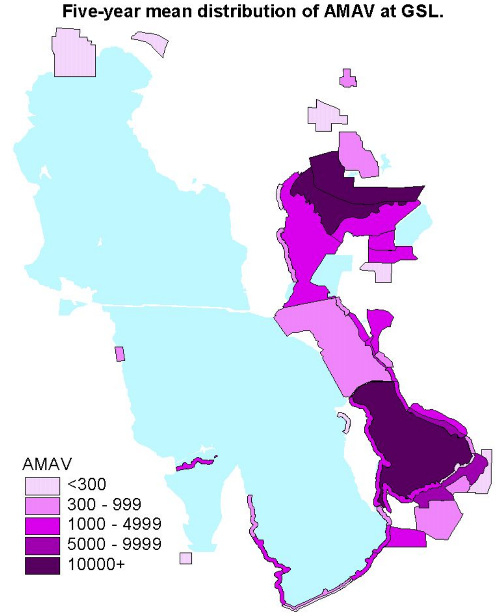
American Avocet

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Sep	Peak 10-Aug	High Count 1997	Abundance Status
AMAV	450,000	450,000	94,006	122,083	204,878	C

Mean number of AMAV at GSL by survey period.



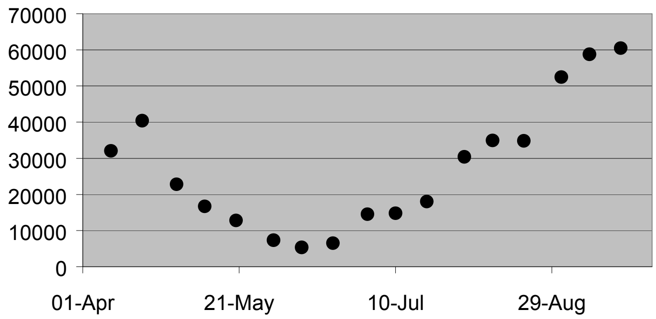
Five-year mean distribution of AMAV at GSL.



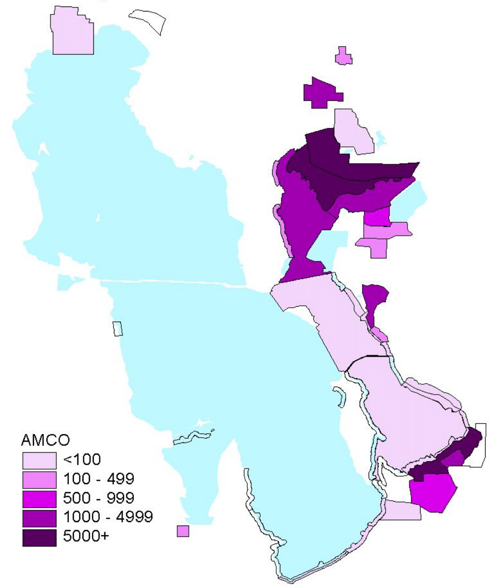
American Coot

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Sep	Peak 20-Sep	High Count 1998	Abundance Status
AMCO	NA	1,625,949	35,464	60,481	109,260	C

Mean number of AMCO at GSL by survey period.



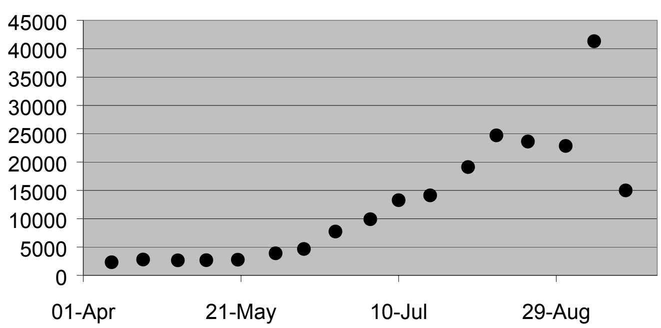
Five-year mean distribution of AMCO at GSL.



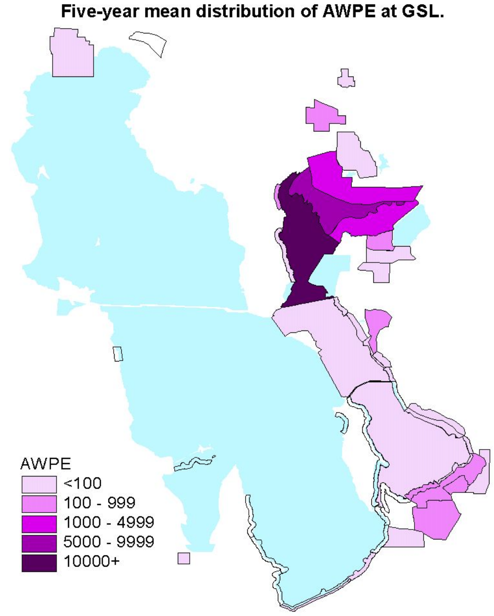
American White Pelican

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 10-Sep	High Count 1997	Abundance Status
AWPE	NA	>120,000 br	25,480	41,318	85,834	C

Mean number of AWPE at GSL by survey period.



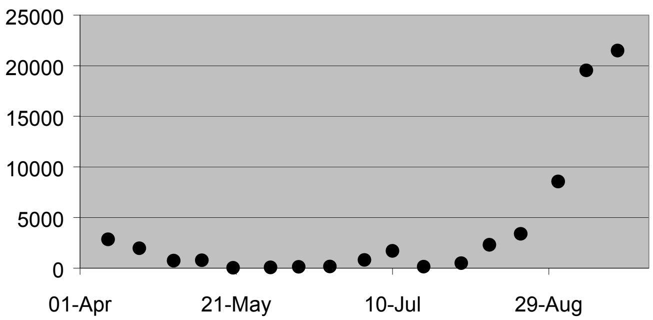
Five-year mean distribution of AWPE at GSL.



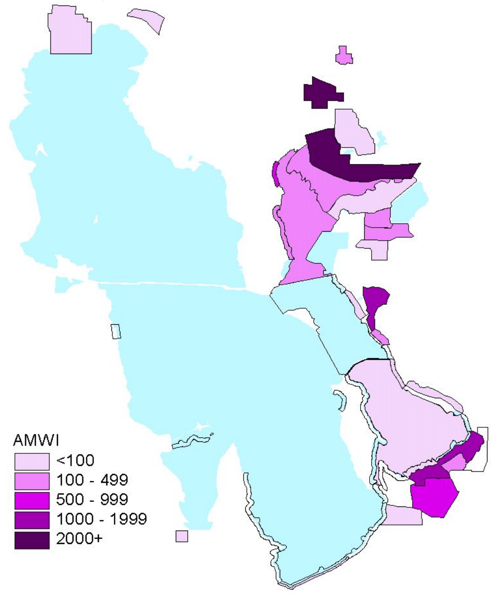
American Wigeon

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Sep	High Count 1998	Abundance Status
AMWI	NA	2,647,200	11,055	21,493	30,184	C

Mean number of AMWI at GSL by survey period.



Five-year mean distribution of AMWI at GSL.

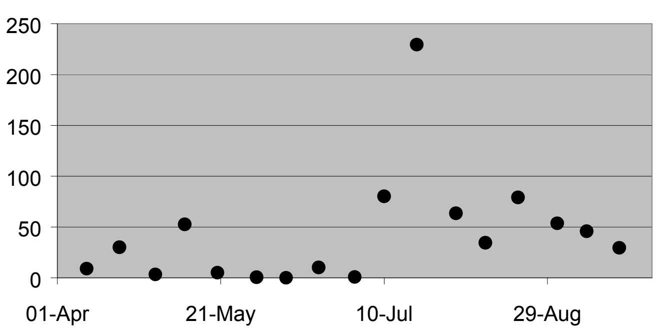


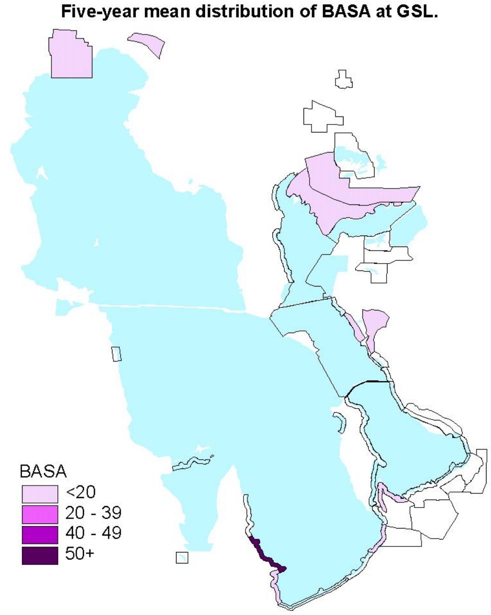
Baird's Sandpiper

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Aug	Peak 20-Jul	High Count 1997	Abundance Status
BASA	300,000	300,000	90	229	1,130	FC

Five-year mean distribution of BASA at GSL.

Mean number of BASA at GSL by survey period.

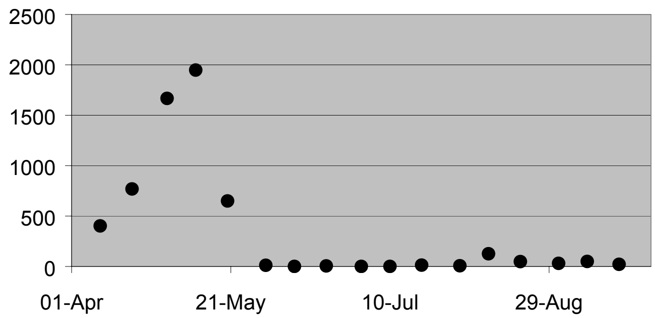




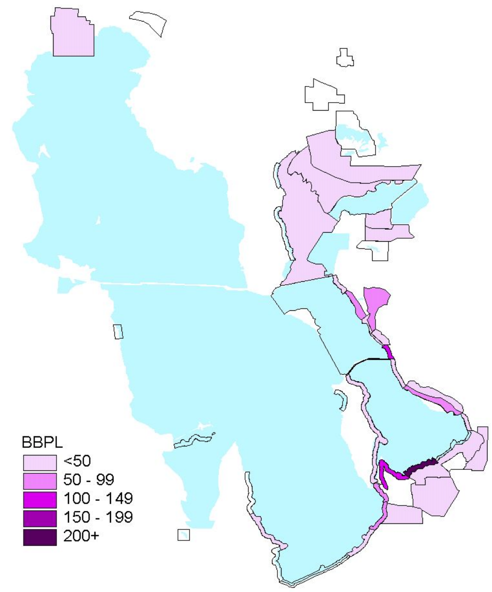
Black-bellied Plover

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-May	Peak 10-May	High Count 2001	Abundance Status
BBPL	498,000	200,000	1,086	1,948	3,383	FC

Mean number of BBPL at GSL by survey period.



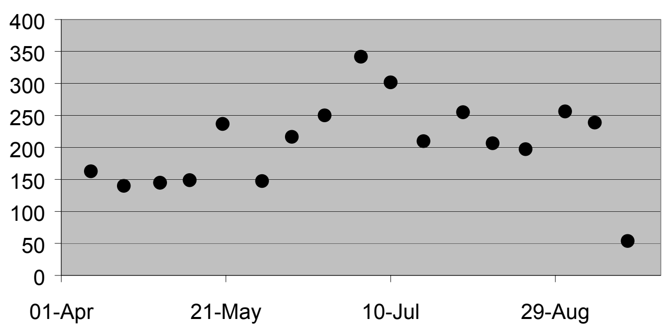
Five-year mean distribution of BBPL at GSL.



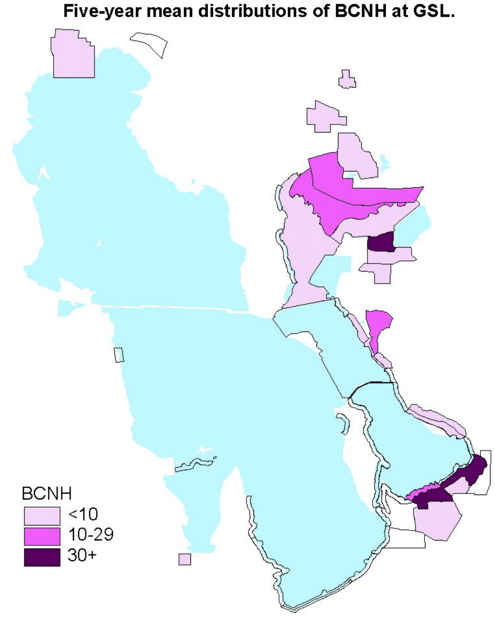
Black-crowned Night Heron

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 01-Jul	High Count 1997	Abundance Status
BCNH	NA	>50,000 br	206	342	419	C

Mean number of BCNH at GSL by survey period.



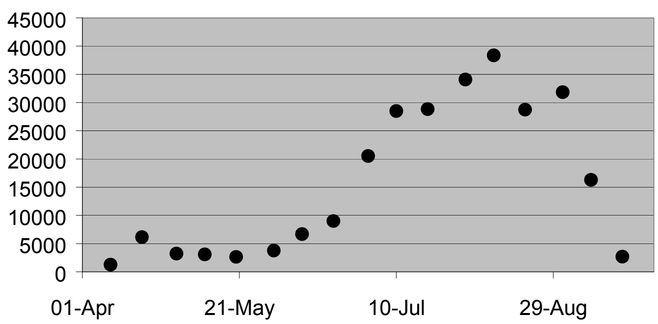
Five-year mean distributions of BCNH at GSL.



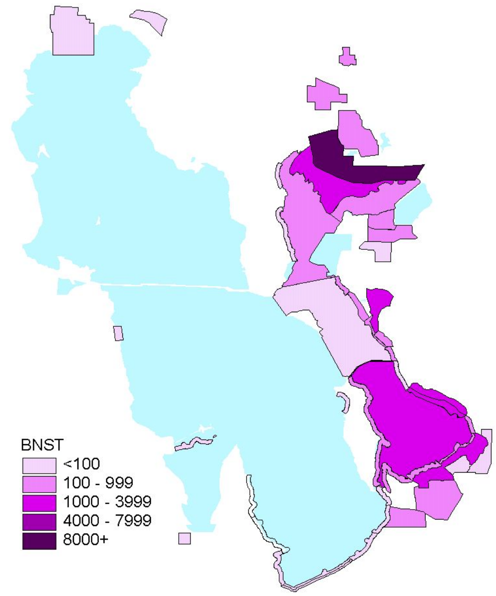
Black-necked Stilt

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Jul-Sep	10-Aug	1997	Status
BNST	850,000+	150,000	25,522	38,353	56,883	C

Mean number of BNST at GSL by survey period.



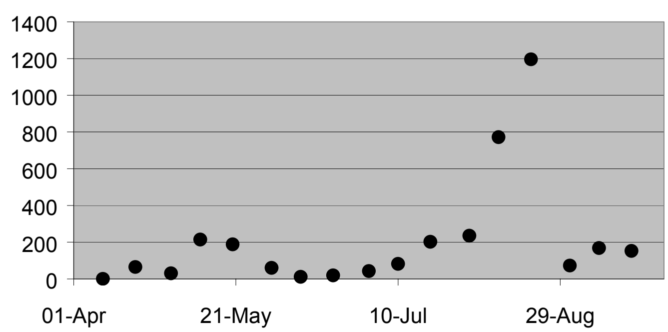
Five-year mean distribution of BNST at GSL.



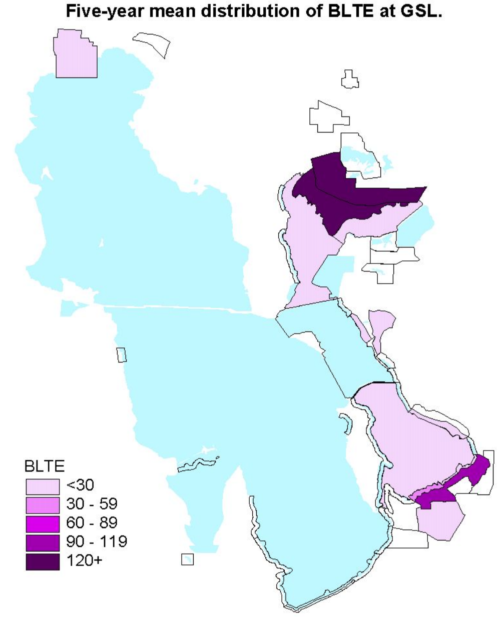
Black Tern

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Jul-Aug	20-Aug	2000	Status
BLTE	NA	100,000-500,000 br	426	1,195	1,504	FC

Mean number of BLTE at GSL by survey period.



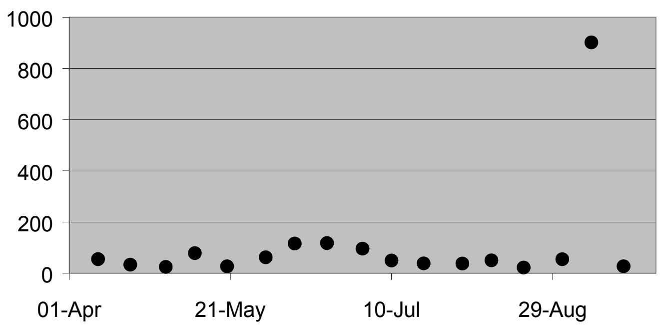
Five-year mean distribution of BLTE at GSL.



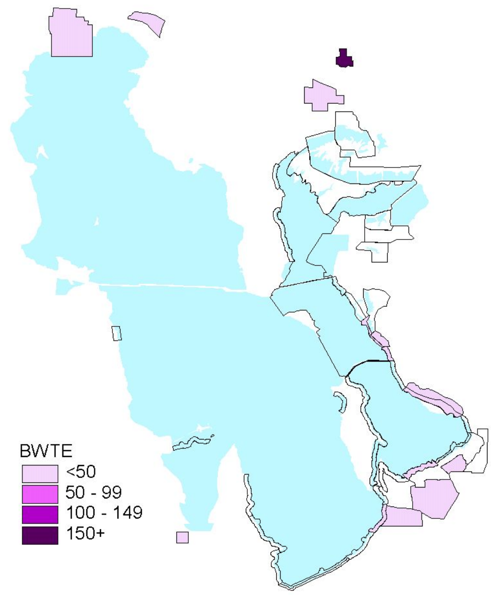
Blue-winged Teal

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Aug-Sep	10-Sep	1997	Status
BWTE	4,881,900	4,399,700	211	901	3,518	FC

Mean number of BWTE at GSL by survey period.



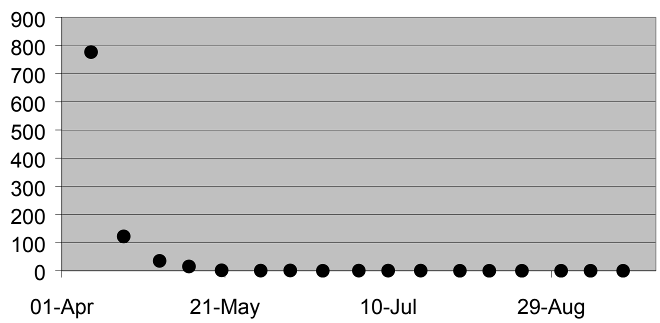
Five-year mean distribution of BWTE at GSL.



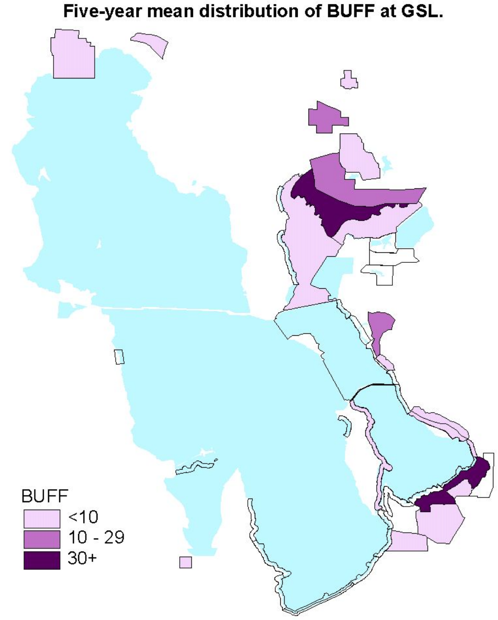
Bufflehead

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Apr-May	10-Apr	1998	Status
BUFF	8,864,000	679,955	190	776	1,229	C

Mean number of BUFF at GSL by survey period.



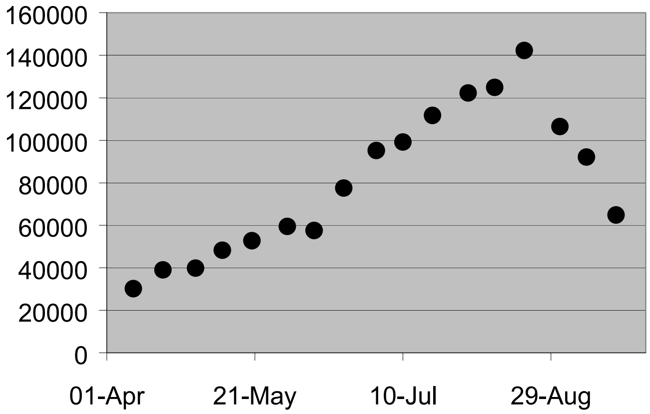
Five-year mean distribution of BUFF at GSL.



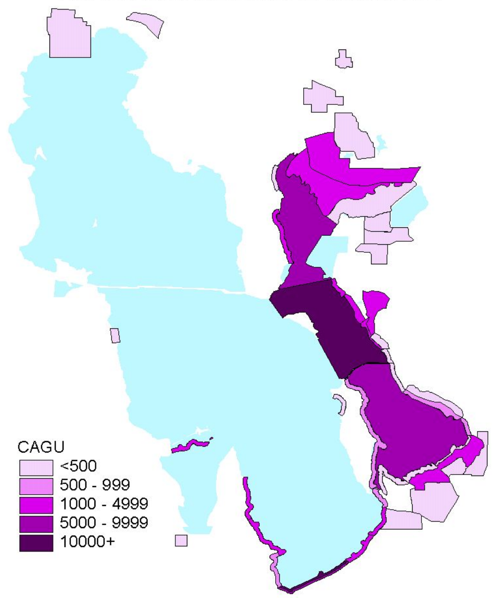
California Gull

Code	Population estimates: Global	Population estimates: North America	Great Salt Lake: Mean Apr-Sep	Great Salt Lake: Peak 20-Aug	Great Salt Lake: High Count 1997	Great Salt Lake: Abundance Status
CAGU	NA	>414,000 br	80,193	142,240	276,560	C

Mean number of CAGU by survey period.



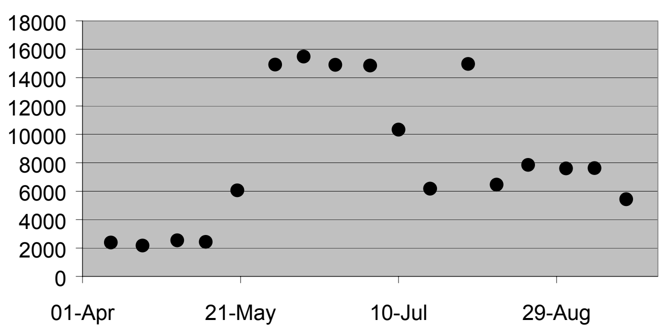
Five-year mean distribution of CAGU at GSL.



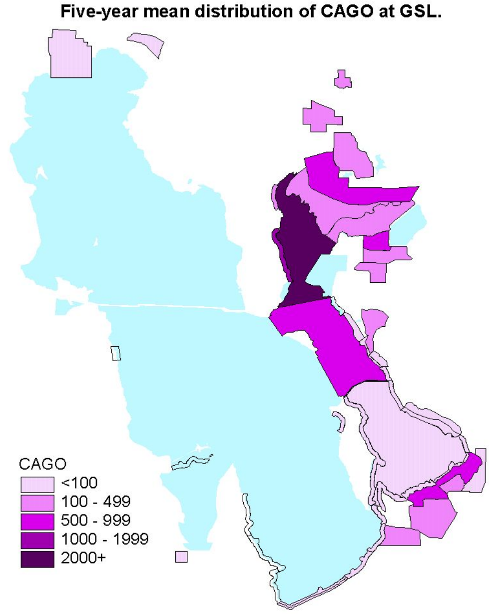
Canada Goose

Code	Population estimates: Global	Population estimates: North America	Great Salt Lake: Mean May-Sep	Great Salt Lake: Peak 10-Jun	Great Salt Lake: High Count 1998	Great Salt Lake: Abundance Status
CAGO	4,479,300	4,479,300	10,201	15,477	46,498	C

Mean number of CAGO at GSL by survey period.



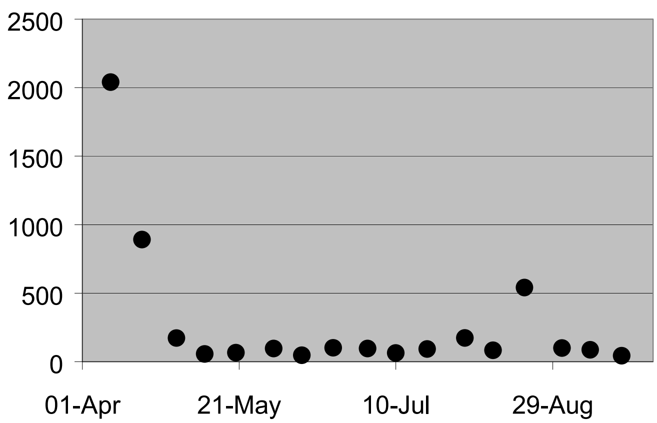
Five-year mean distribution of CAGO at GSL.



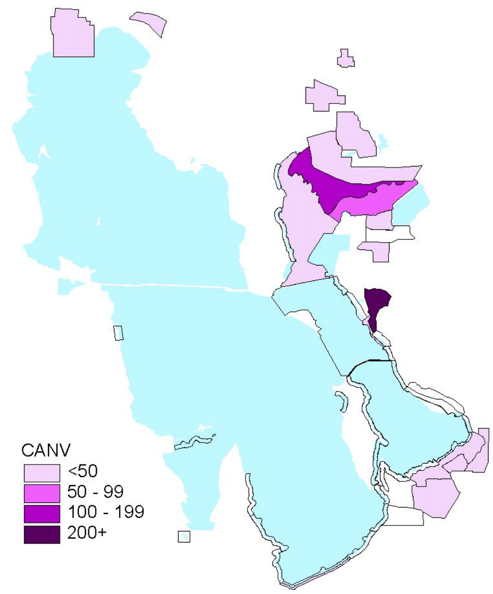
Canvasback

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-May	Peak 10-Apr	High Count 2001	Abundance Status
CANV	619,700	559,900	645	2,040	3,130	FC

Mean number of CANV at GSL by survey period.



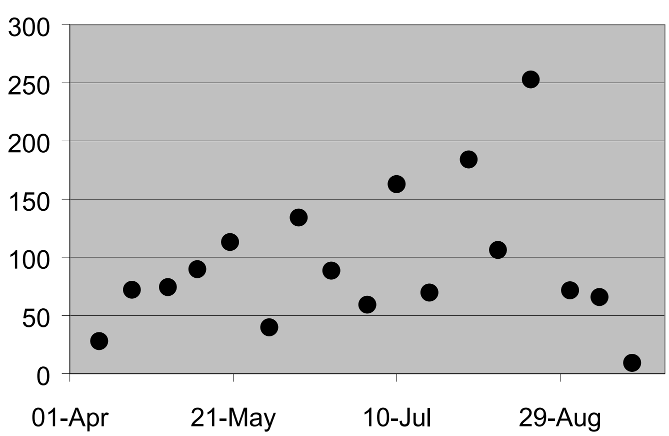
Five-year mean distribution of CANV at GSL.



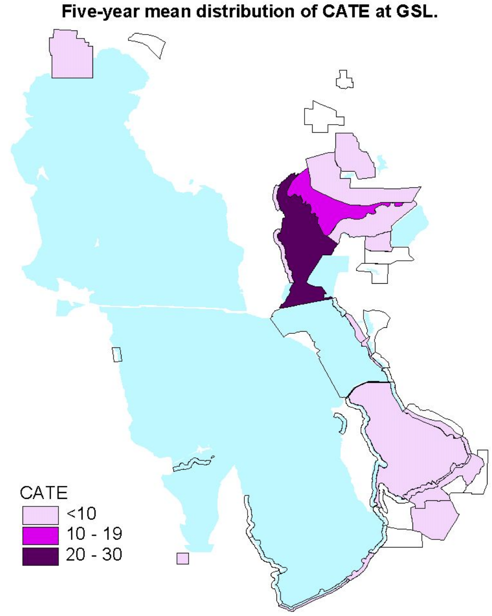
Caspian Tern

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 20-Aug	High Count 1997	Abundance Status
CATE	NA	66,000-70,000 br	95	253	459	FC

Mean number of CATE at GSL by survey period.



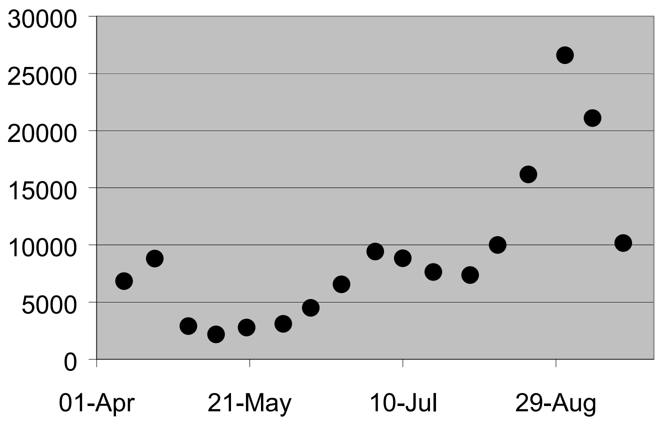
Five-year mean distribution of CATE at GSL.



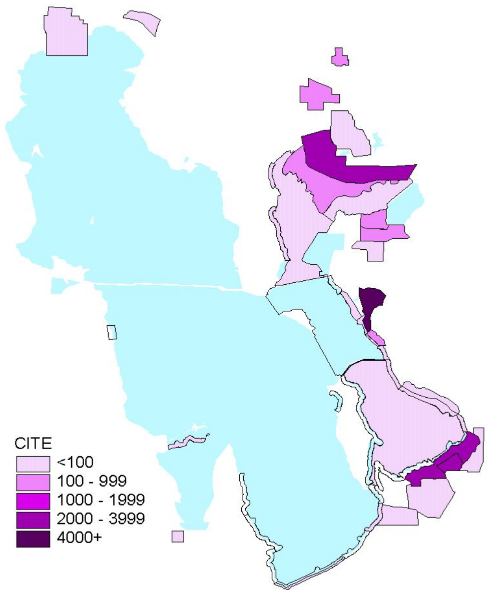
Cinnamon Teal

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Aug-Sep	01-Sep	1997	Status
CITE	NA	NA	16,795	26,586	39,845	C

Mean number of CITE at GSL by survey period.



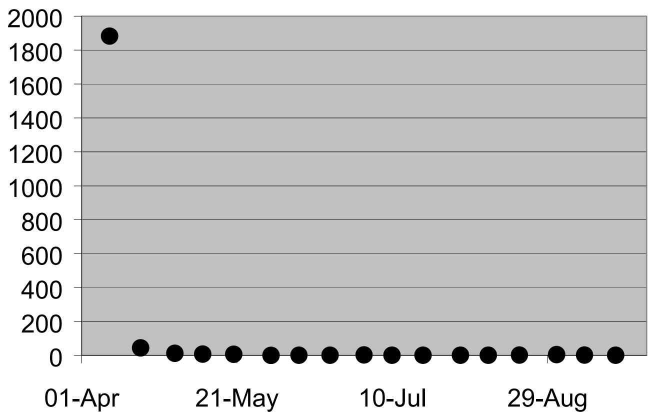
Five-year mean distribution of CITE at GSL.



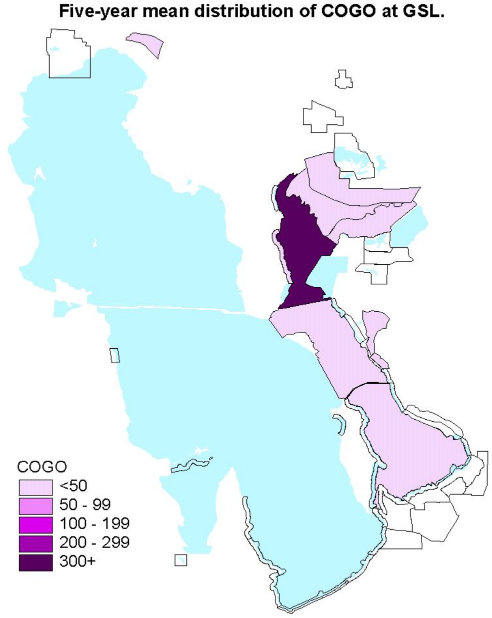
Common Goldeneye

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Apr-May	10-Apr	2001	Status
COGO	1,170,000	750,000	390	1,882	5,451	C

Mean number of COGO at GSL by survey period.



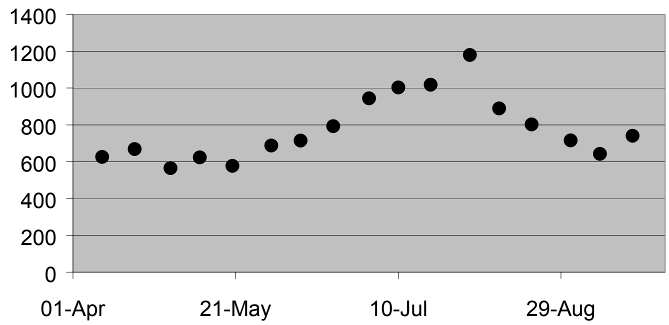
Five-year mean distribution of COGO at GSL.



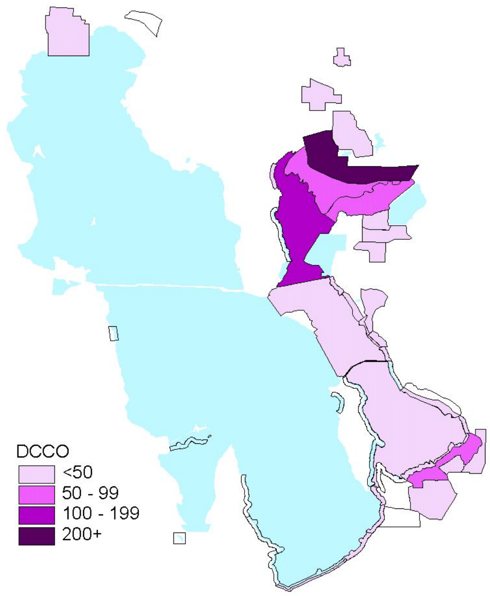
Double-crested Cormorant

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Apr-Sep	01-Aug	1999	Status
DCCO	>1,500,000 br	>1,500,000 br	776	1,179	2,060	C

Mean number of DCCO at GSL by survey period.



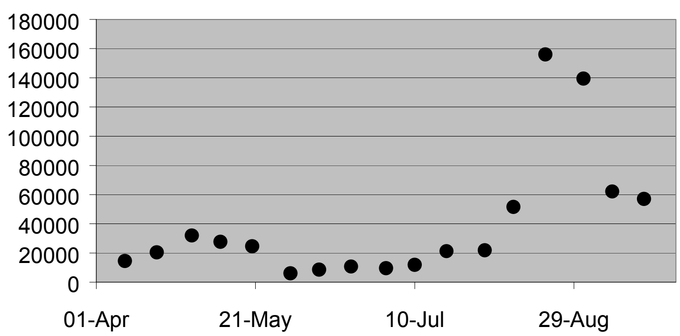
Five-year mean distribution of DCCO at GSL.



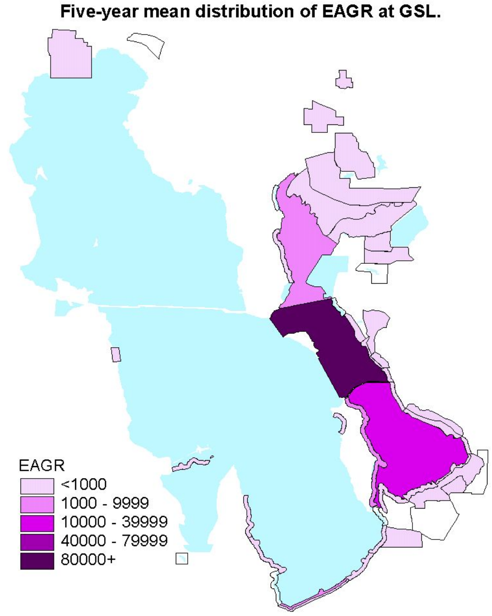
Eared Grebe

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Aug-Sep	20-Aug	1997	Status
EAGR	~4,000,000	3,700,000	93,221	156,036	698,793	C

Mean number of EAGR at GSL by survey period.



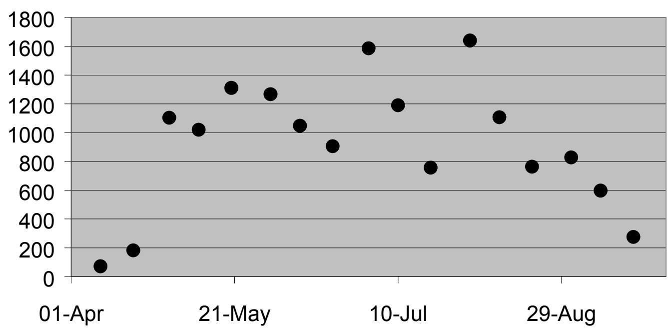
Five-year mean distribution of EAGR at GSL.



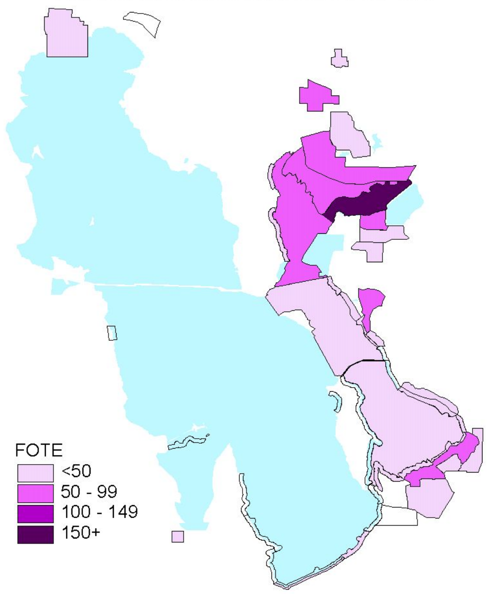
Forster's Tern

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 01-Aug	High Count 2001	Abundance Status
FOTE	40,000	40,000	921	1,639	3,462	C

Mean number of FOTE at GSL by survey period.



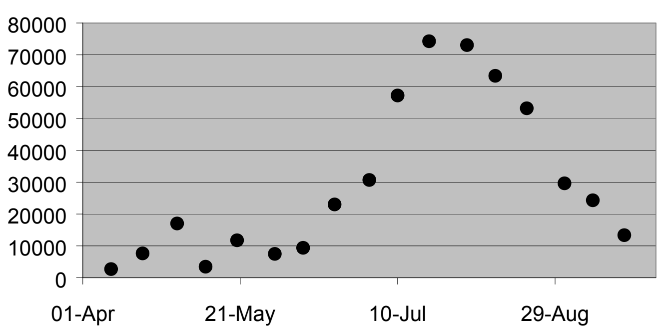
Five-year mean distribution of FOTE at GSL.



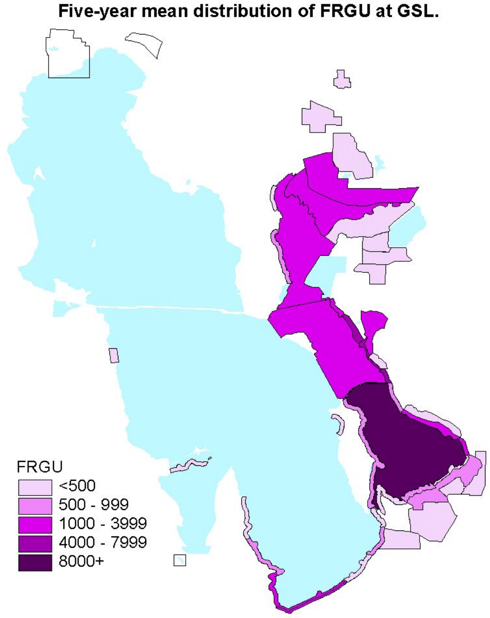
Franklin's Gull

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Sep	Peak 20-Jul	High Count 2001	Abundance Status
FRGU	NA	315,608-990,864 br	46,550	74,254	86,620	C

Mean number of FRGU at GSL by survey period.



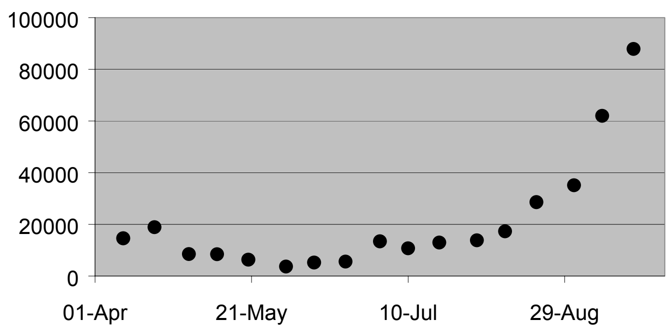
Five-year mean distribution of FRGU at GSL.



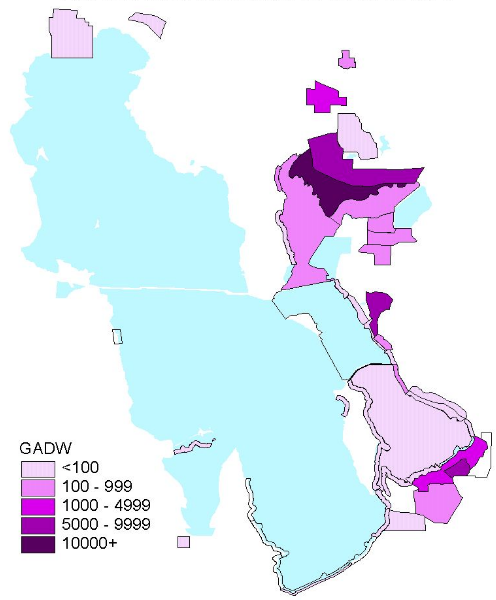
Gadwall

Code	Population estimates: Global	North America	Great Salt Lake: Mean Aug-Sep	Peak 20-Sep	High Count 1998	Abundance Status
GADW	2,795,200	2,385,200	46,185	87,892	159,759	C

Mean number of GADW at GSL by survey period.



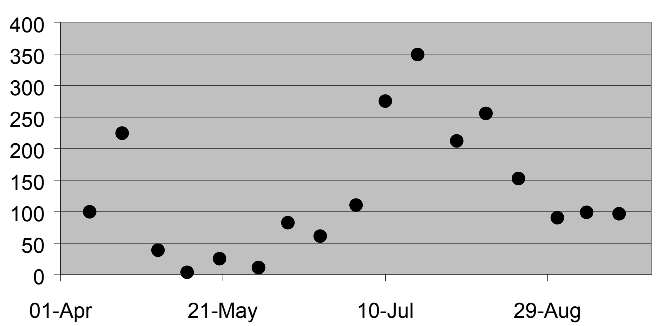
Five-year mean distribution of GADW at GSL.



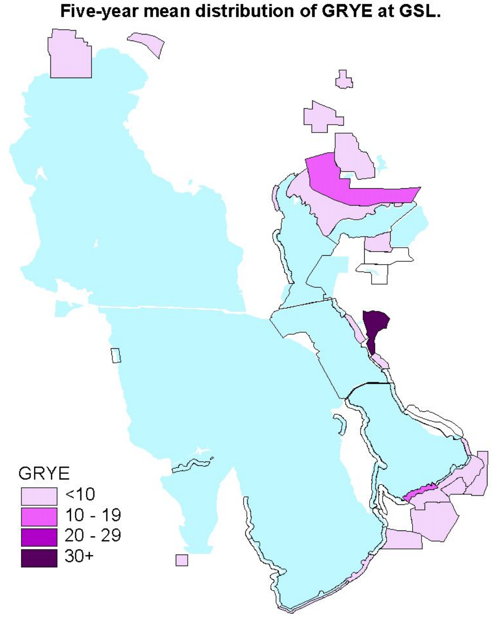
Greater Yellowlegs

Code	Population estimates: Global	North America	Great Salt Lake: Mean Apr-Sep	Peak 20-Jul	High Count 2000	Abundance Status
GRYE	100,000	100,000	129	349	555	C

Mean number of GRYE at GSL by survey period.



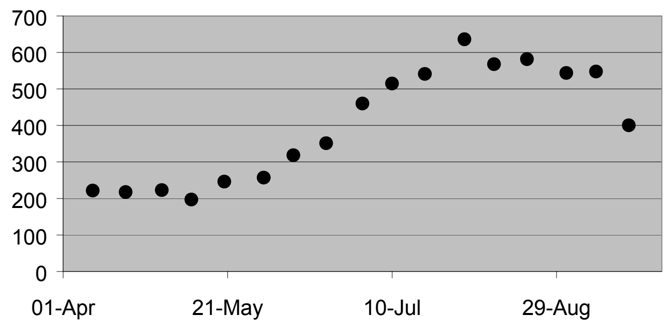
Five-year mean distribution of GRYE at GSL.



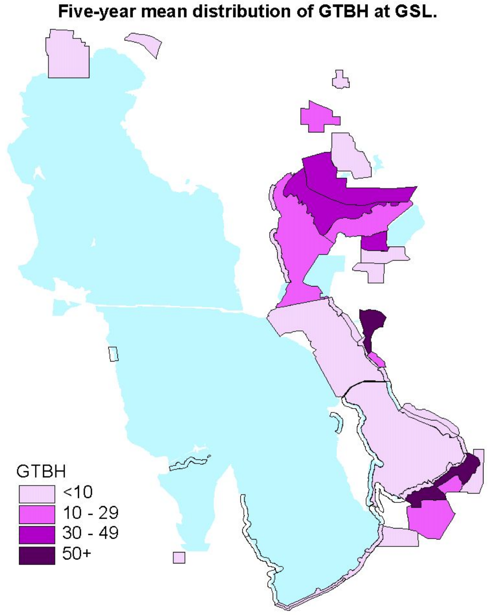
Great Blue Heron

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 01-Aug	High Count 1997	Abundance Status
GTBH	NA	83,000 br	401	636	797	C

Mean number of GTBH at GSL by survey period.



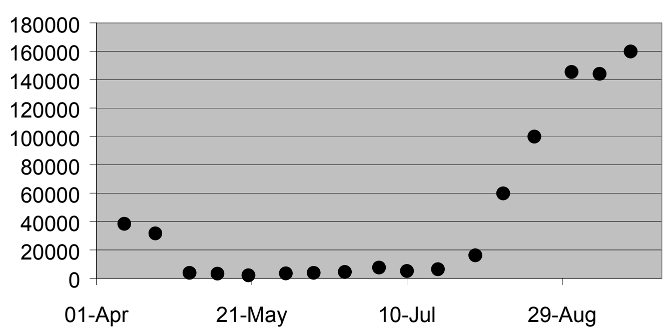
Five-year mean distribution of GTBH at GSL.



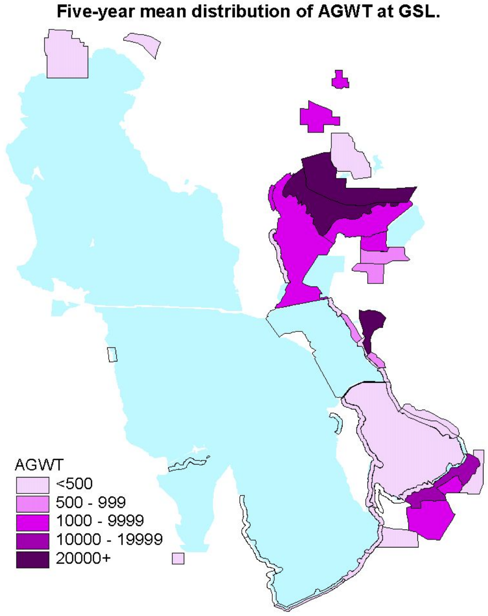
Green-winged Teal

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Sep	High Count 1999	Abundance Status
AGWT	5,446,400	2,136,400	121,804	159,829	211,683	C

Mean number of AGWT at GSL by survey period.



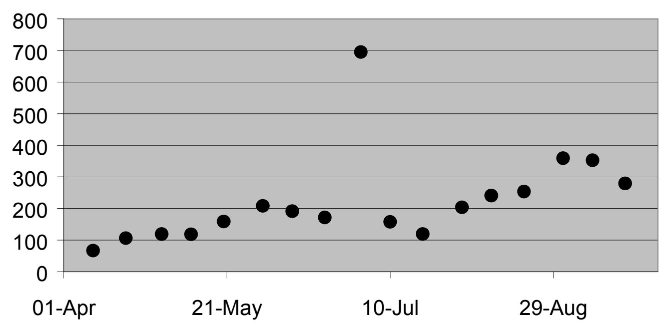
Five-year mean distribution of AGWT at GSL.



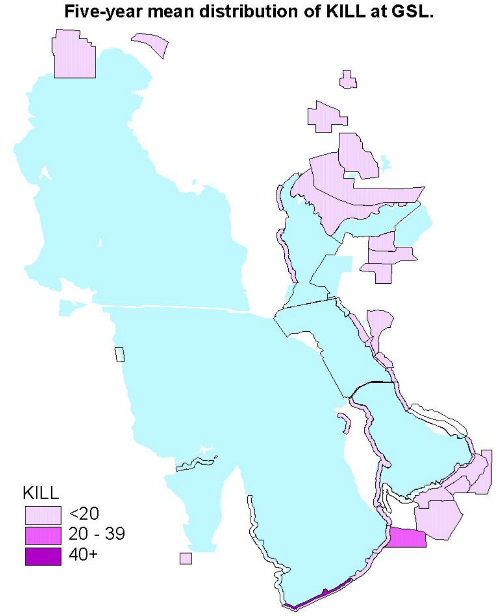
Killdeer

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Apr-Sep	01-Jul	1997	Status
KILL	1,000,000	1,000,000	224	695	3,020	C

Mean number of KILL at GSL by survey period.



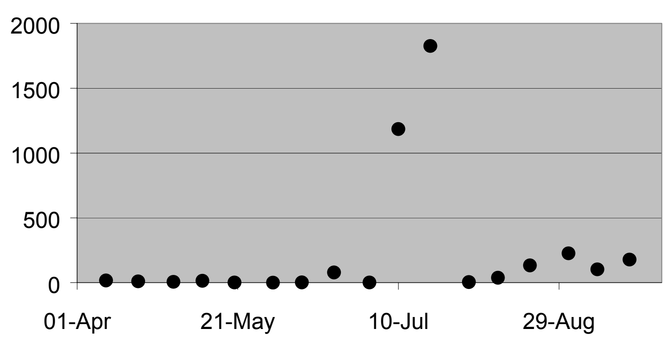
Five-year mean distribution of KILL at GSL.



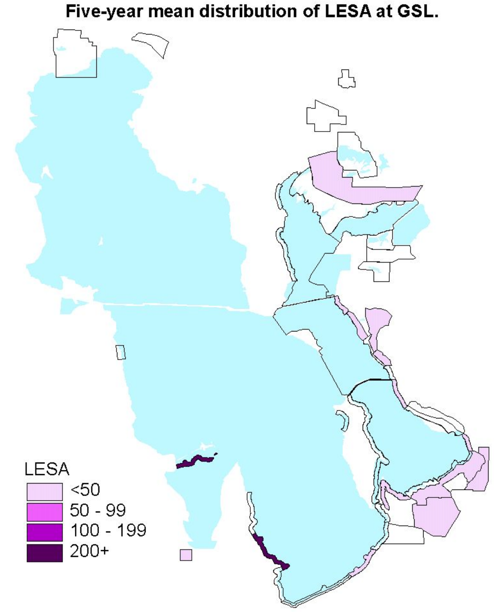
Least Sandpiper

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Jul-Aug	20-Jul	1998	Status
LESA	600,000	600,000	569	1,826	8,041	C

Mean number of LESA at GSL by survey period.



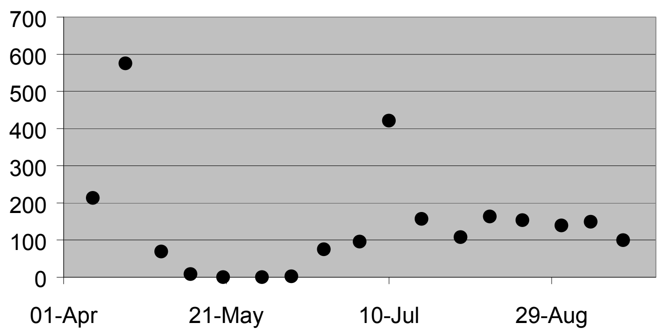
Five-year mean distribution of LESA at GSL.



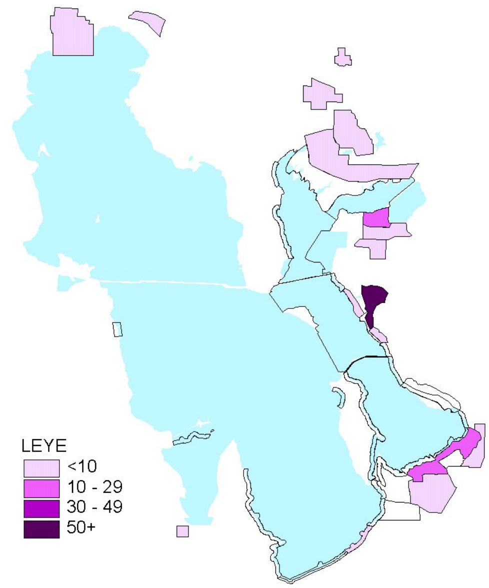
Lesser Yellowlegs

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 20-Apr	High Count 2000	Abundance Status
LEYE	500,000	500,000	143	576	1,832	C

Mean number of LEYE at GSL by survey period.



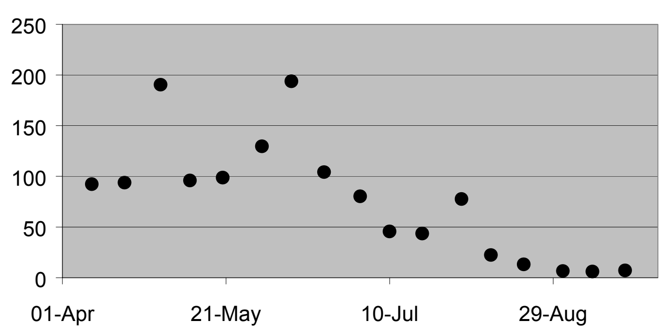
Five-year mean distribution of LEYE at GSL.



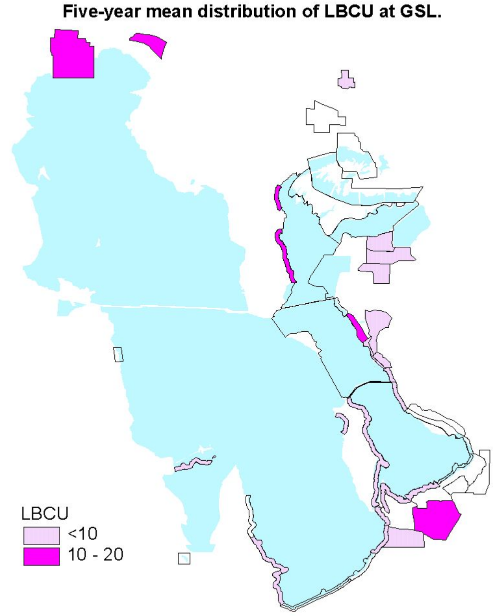
Long-billed Curlew

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Jun	Peak 10-Jun	High Count 2001	Abundance Status
LBCU	20,000	20,000	125	194	409	FC

Mean number of LBCU at GSL by survey period.



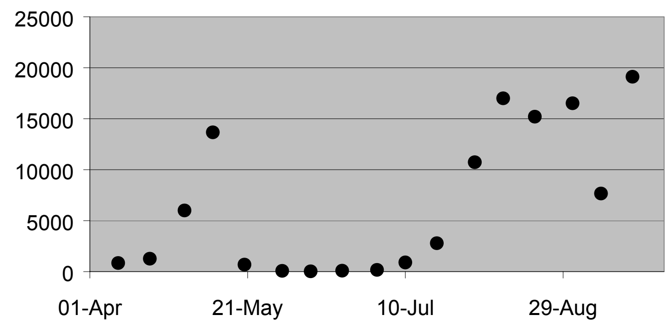
Five-year mean distribution of LBCU at GSL.



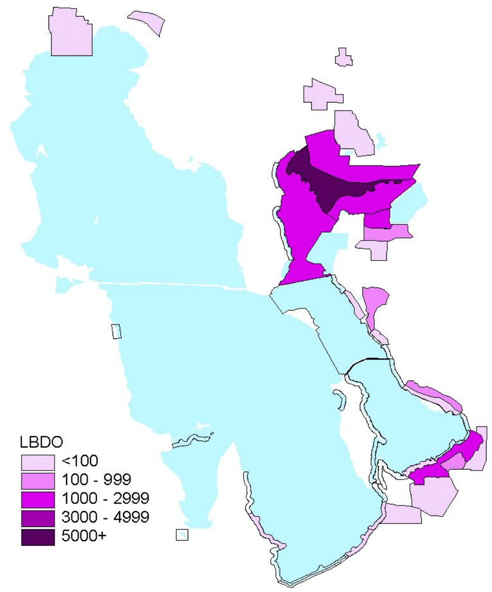
Long-billed Dowitcher

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Sep	High Count 1998	Abundance Status
LBDO	500,000	500,000	14,370	19,113	58,880	C

Mean number of LBDO at GSL by survey period.



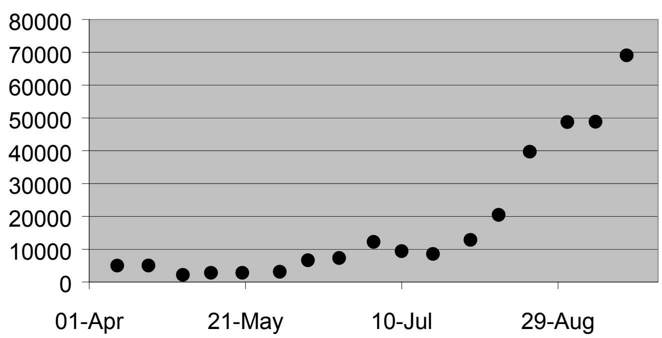
Five-year mean distribution of LBDO at GSL.



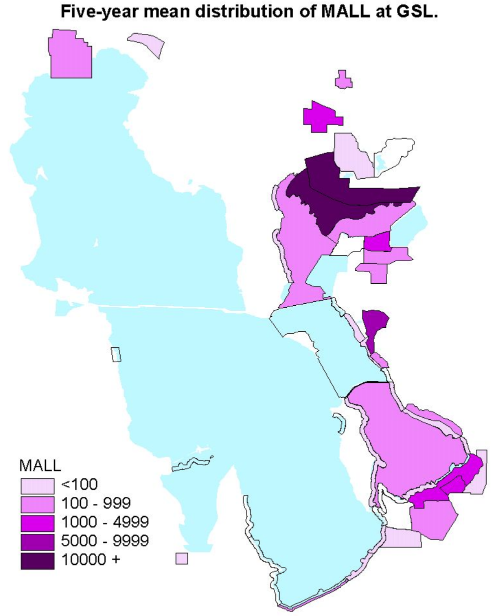
Mallard

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Sep	High Count 1998	Abundance Status
MALL	16,482,600	7,494,300	45,352	69,066	137,468	C

Mean number of MALL at GSL by survey period.



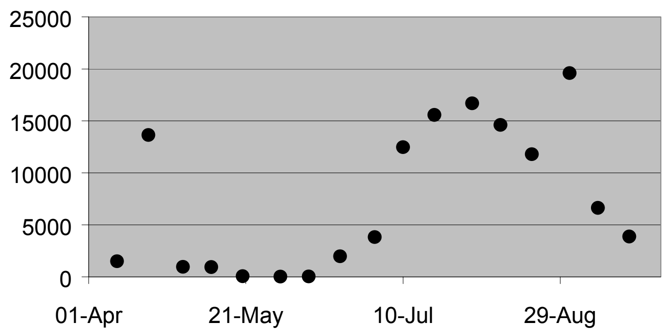
Five-year mean distribution of MALL at GSL.



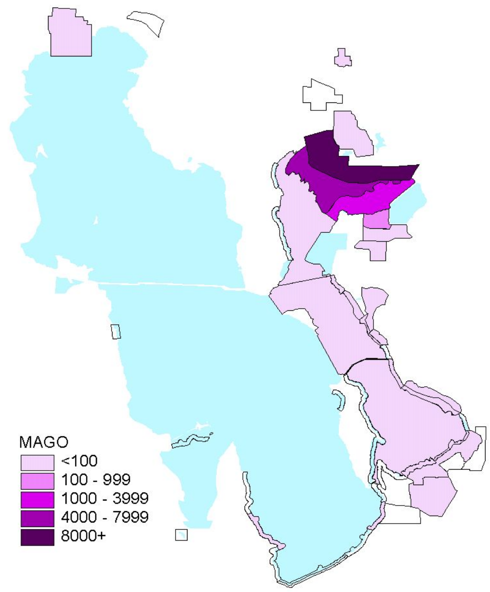
Marbled Godwit

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Aug	Peak 01-Sep	High Count 2000	Abundance Status
MAGO	171,500	171,500	15,125	19,599	43,833	FC

Mean number of MAGO at GSL by survey period.



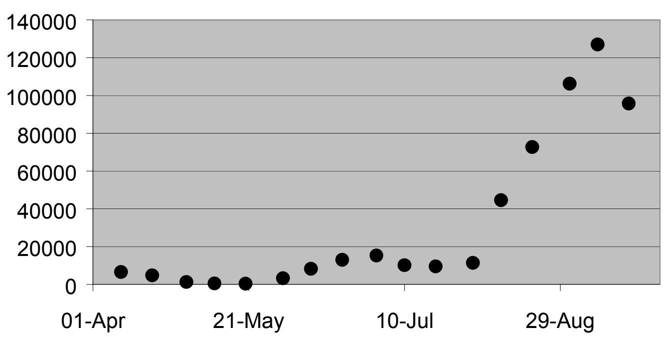
Five-year mean distribution of MAGO at GSL.



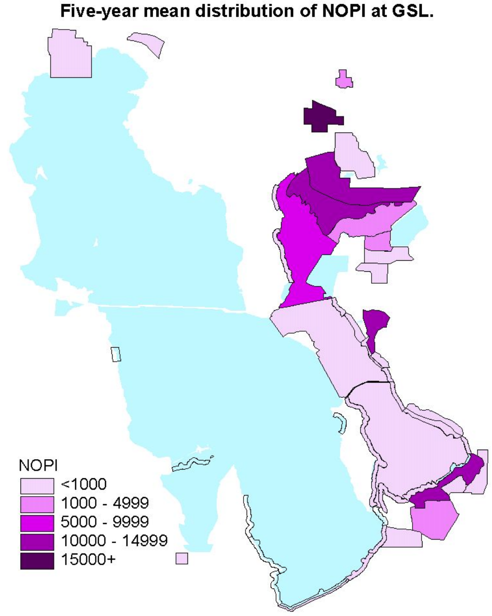
Northern Pintail

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 10-Sep	High Count 1998	Abundance Status
NOPI	4,484,800	2,524,800	89,198	126,940	181,189	C

Mean number of NOPI at GSL by survey period.



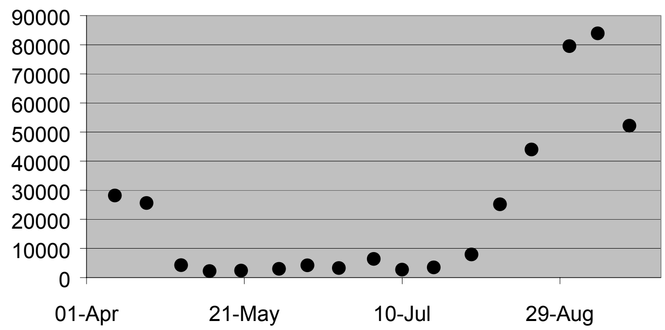
Five-year mean distribution of NOPI at GSL.



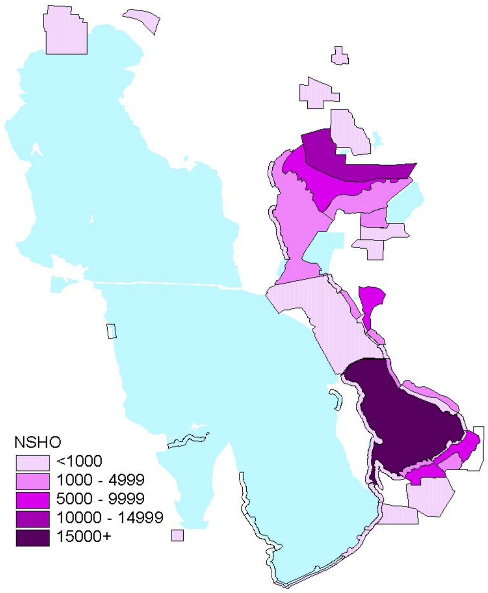
Northern Shoveler

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 10-Sep	High Count 1997	Abundance Status
NSHO	3,533,400	2,041,100	56,950	83,894	162,540	C

Mean number of NSHO at GSL by survey period.



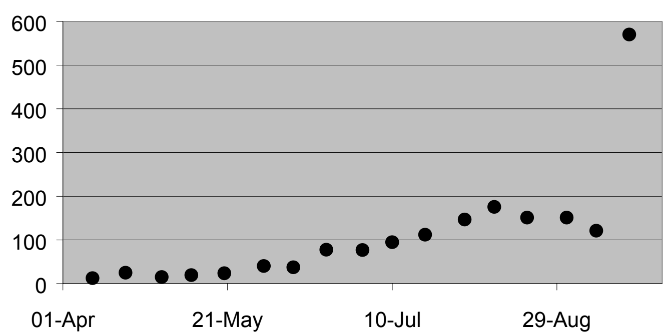
Five-year mean distribution of NSHO at GSL.



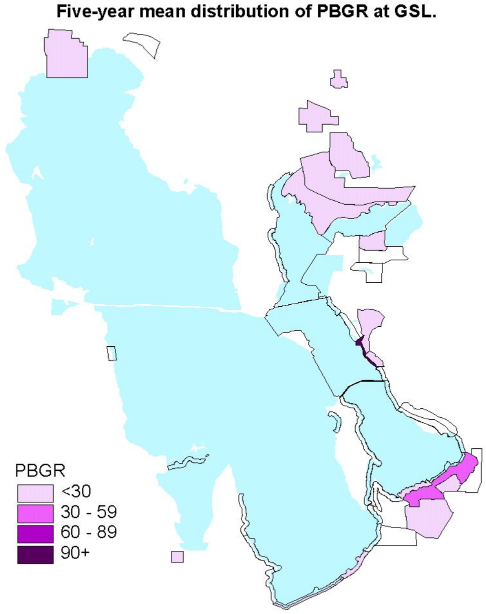
Pied-billed Grebe

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Sep	High Count 1999	Abundance Status
PBGR	100,000	25,000-40,000	234	570	2,000	C

Mean number of PBGR at GSL by survey period.



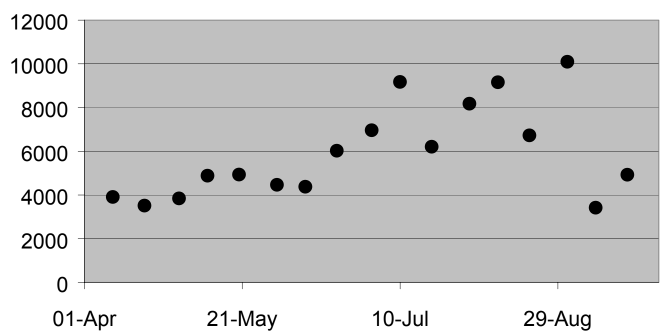
Five-year mean distribution of PBGR at GSL.



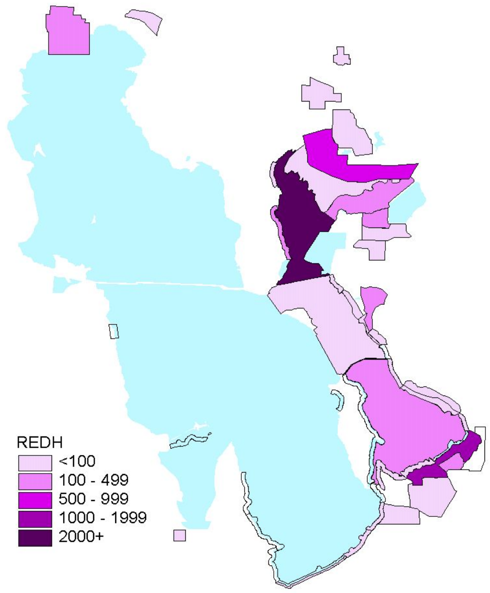
Redhead

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Sep	Peak 01-Sep	High Count 1999	Abundance Status
REDH	691,400	691,400	7,202	10,088	34,616	C

Mean number of REDH at GSL by survey period.



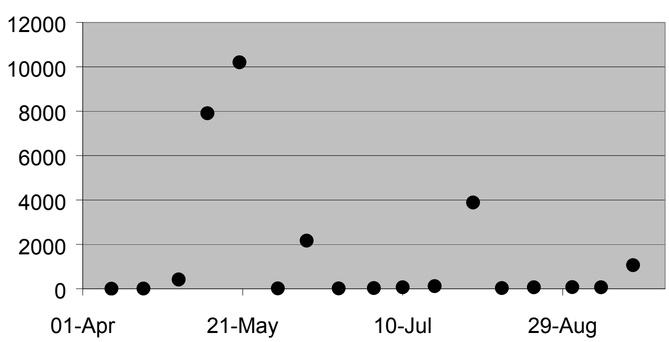
Five-year mean distribution of REDH at GSL.



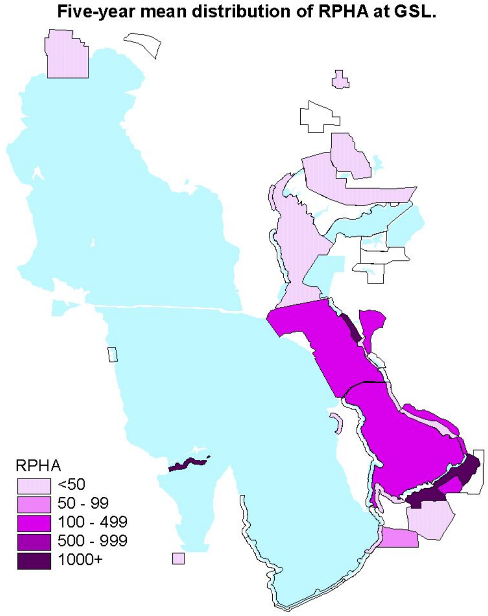
Red-necked Phalarope

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean May-Jun	Peak 20-May	High Count 1999	Abundance Status
RPHA	4,000,000	2,500,000	5,071	10,199	22,447	C

Mean number of RPHA at GSL by survey period.



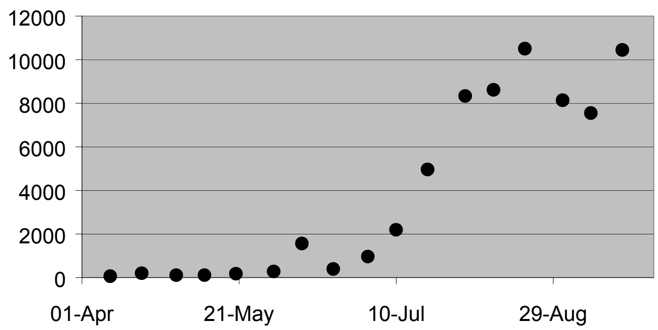
Five-year mean distribution of RPHA at GSL.



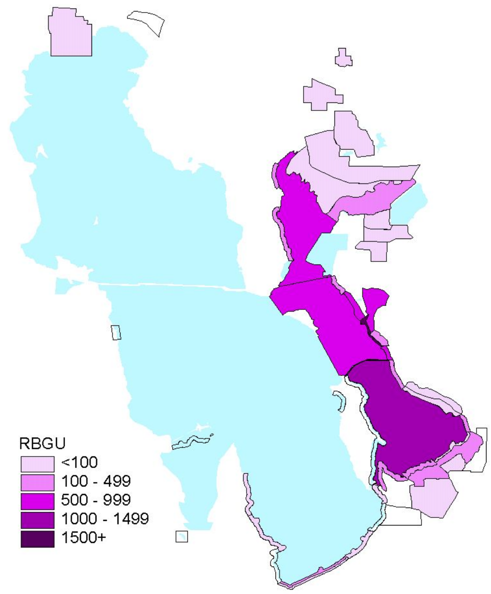
Ring-billed Gull

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Aug-Sep	Peak 20-Aug	High Count 1998	Abundance Status
RBGU	3,500,000	~1,700,000 br	9,048	10,504	24,728	C

Mean number of RBGU at GSL by survey period.



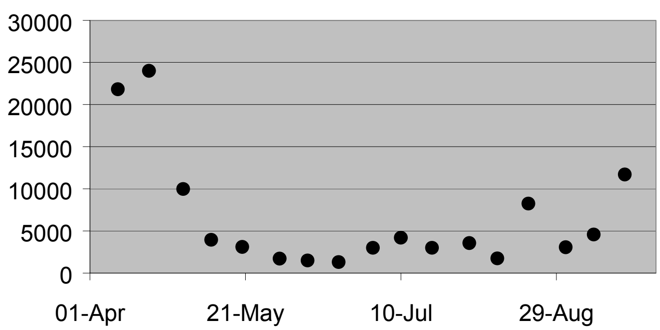
Five-year mean distribution of RBGU at GSL.



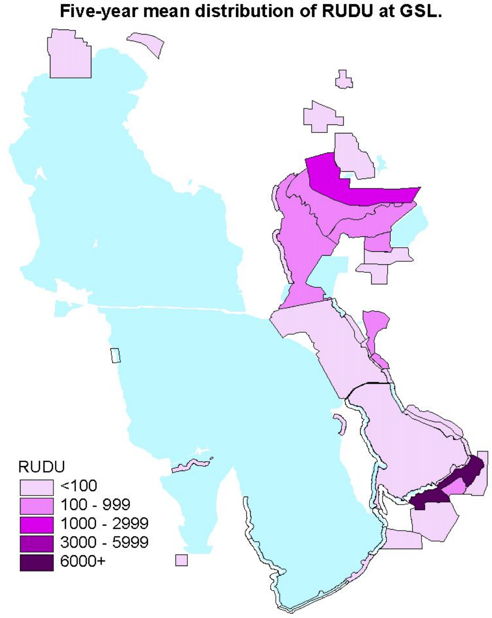
Ruddy Duck

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-May	Peak 20-Apr	High Count 2001	Abundance Status
RUDU	690,000	409,783	12,565	24,005	26,034	C

Mean number of RUDU at GSL by survey period.



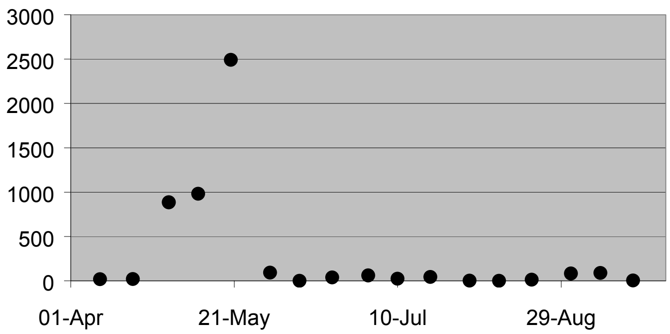
Five-year mean distribution of RUDU at GSL.



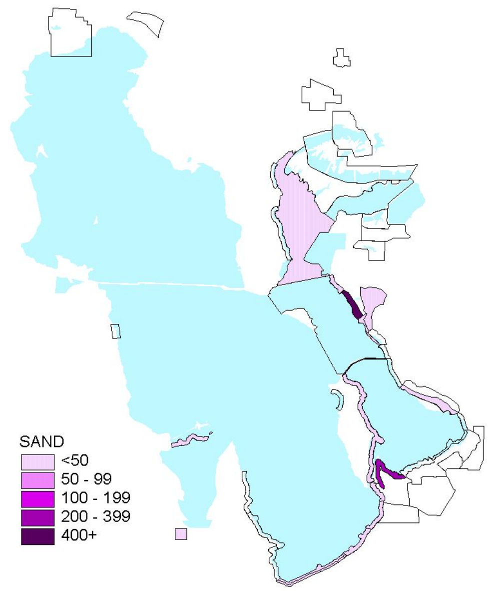
Sanderling

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-May	Peak 20-May	High Count 2001	Abundance Status
SAND	643,000	300,000	878	2,491	8,477	FC

Mean number of SAND at GSL by survey period.



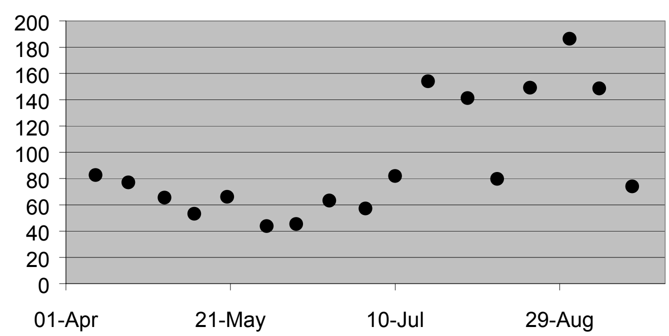
Five-year mean distribution of SAND at GSL.



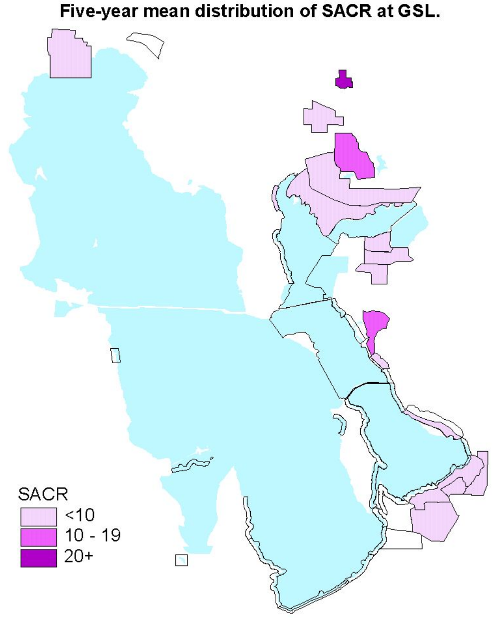
Sandhill Crane

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 01-Sep	High Count 1999	Abundance Status
SACR	526,000	526,000	92	187	326	FC

Mean number of SACR by survey period.



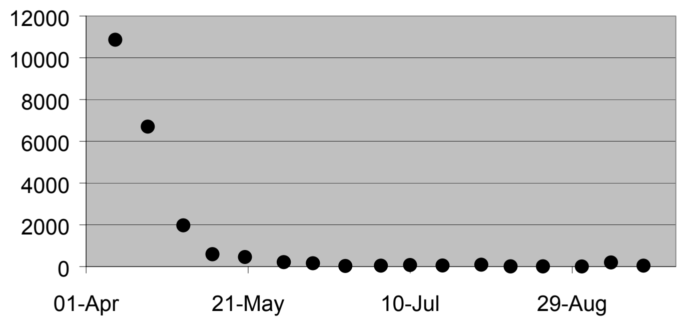
Five-year mean distribution of SACR at GSL.



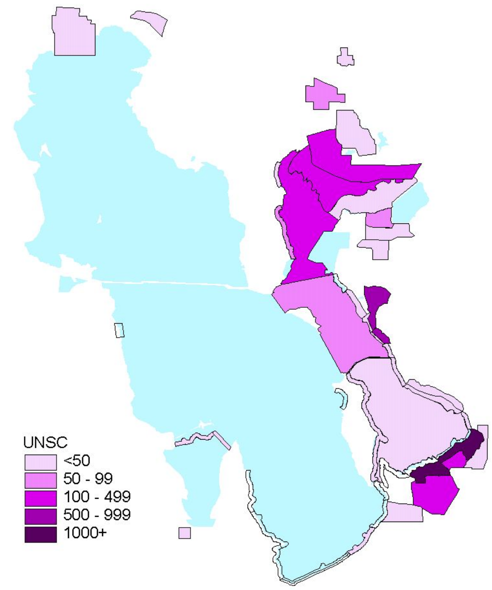
Scaup

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Apr-May	10-Apr	2001	Status
UNSC	NA	5,383,500	4,115	10,864	12,813	C

Mean number of UNSC at GSL by survey period.



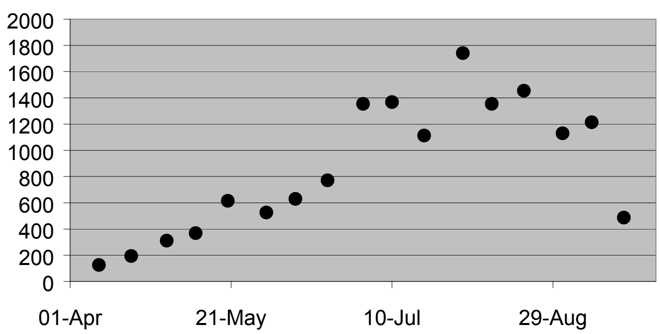
Five-year mean distribution of UNSC at GSL.



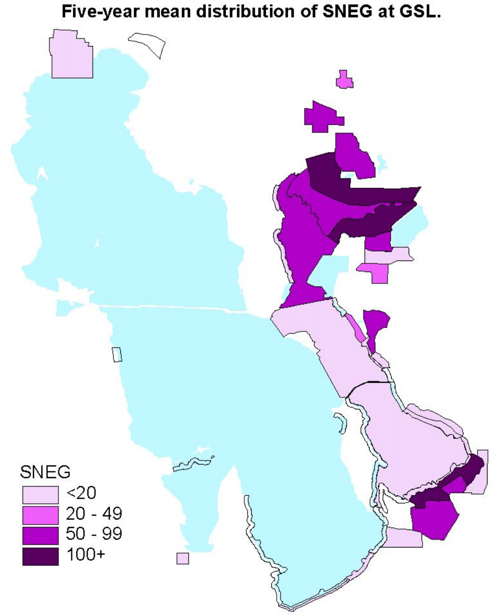
Snowy Egret

	Population estimates		Great Salt Lake			
		North	Mean	Peak	High Count	Abundance
Code	Global	America	Jul-Sep	01-Aug	2000	Status
SNEG	NA	>40,000	1,246	1,741	2,585	C

Mean number of SNEG at GSL by survey period.



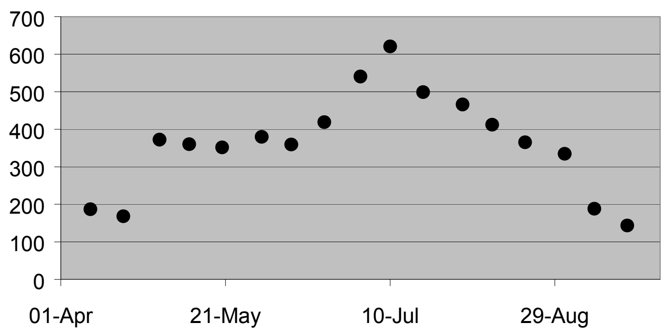
Five-year mean distribution of SNEG at GSL.



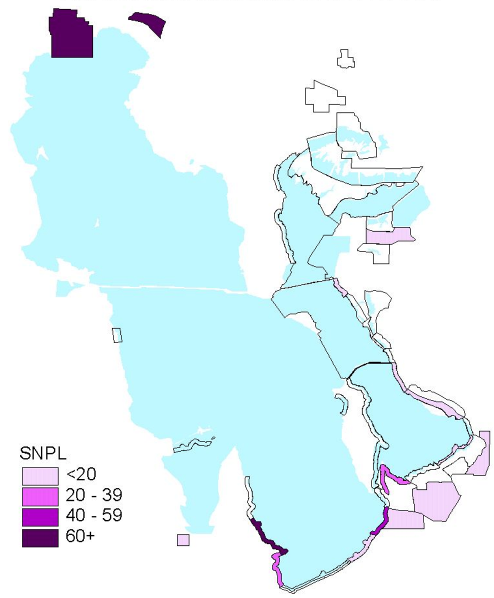
Snowy Plover

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 10-Jul	High Count 1997	Abundance Status
SNPL	586,000	16,000	363	621	1,228	U

Mean number of SNPL at GSL by survey period.



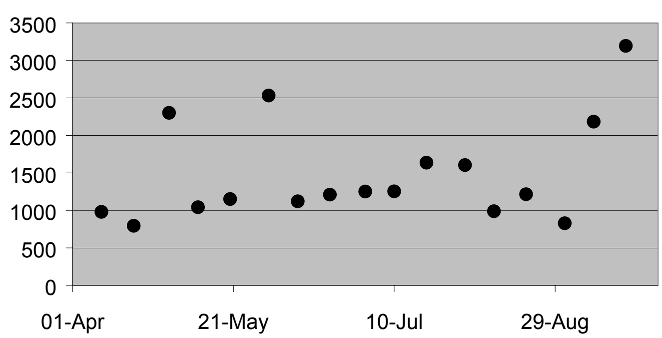
Five-year mean distribution of SNPL at GSL.



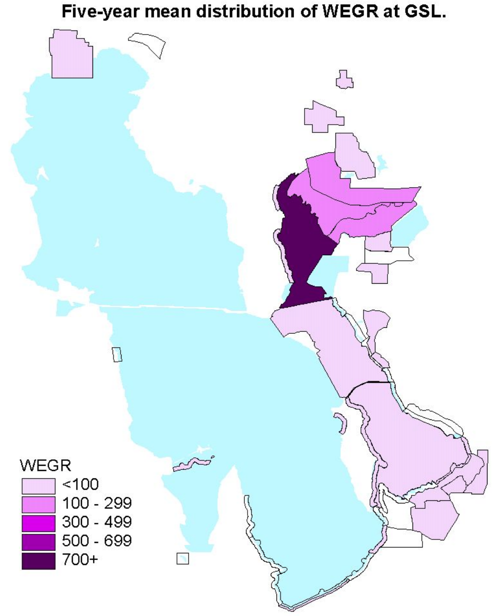
Western Grebe

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Apr-Sep	Peak 20-Sep	High Count 1998	Abundance Status
WEGR	>120,000	110,000	1,487	3,193	7,552	C

Mean number of WEGR at GSL by survey period.



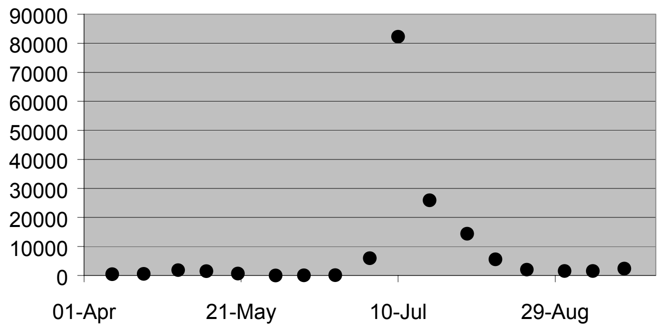
Five-year mean distribution of WEGR at GSL.



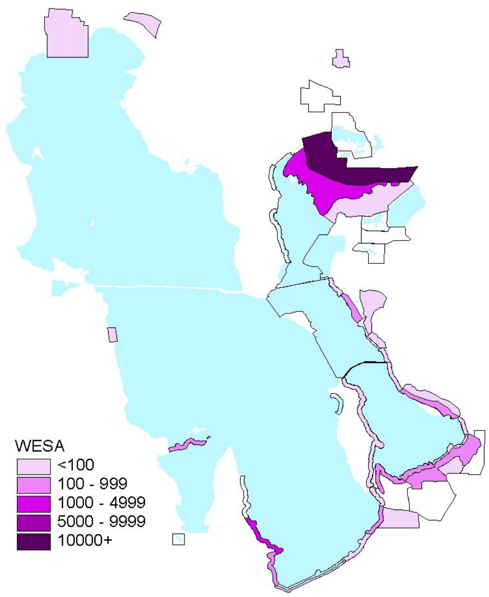
Western Sandpiper

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Aug	Peak 10-Jul	High Count 2000	Abundance Status
WESA	3,500,000	3,500,000	21,938	82,254	194,536	C

Mean number of WESA at GSL by survey period.



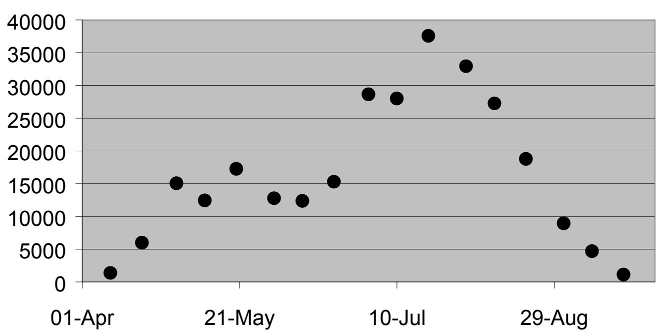
Five-year mean distribution of WESA at GSL.



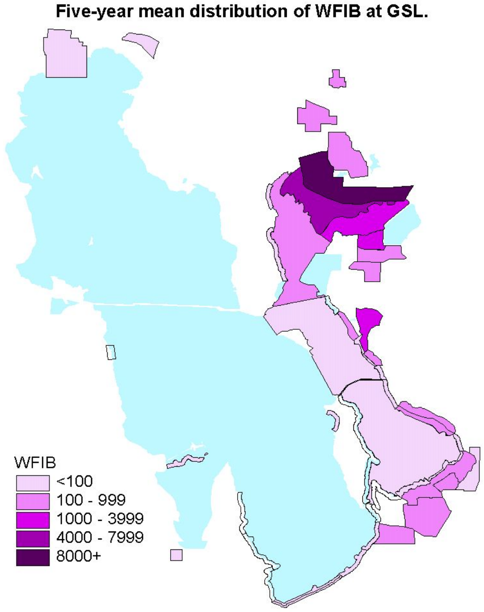
White-faced Ibis

	Population estimates		Great Salt Lake			
Code	Global	North America	Mean Jul-Aug	Peak 20-Jul	High Count 2000	Abundance Status
WFIB	NA	>100,000 br	25,576	37,568	54,908	C

Mean number of WFIB at GSL by survey period.



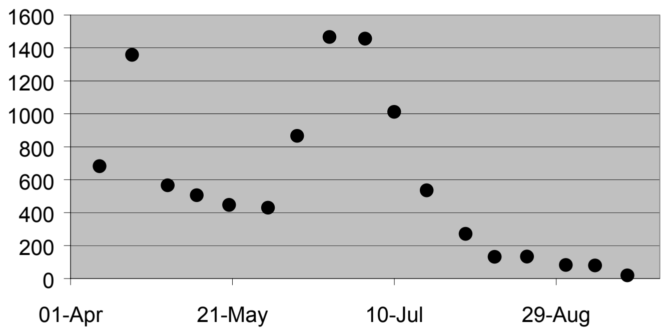
Five-year mean distribution of WFIB at GSL.



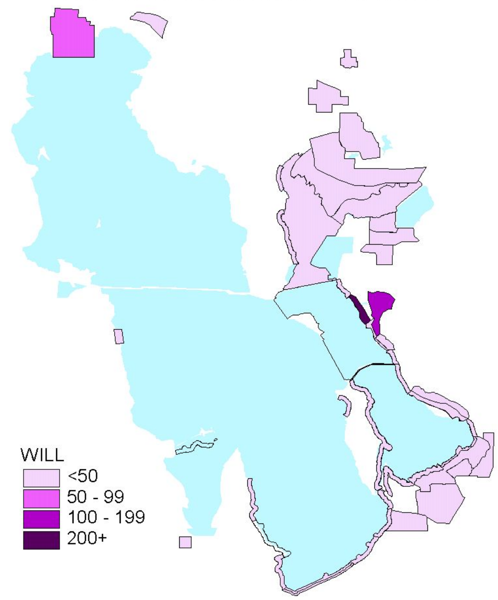
Willet

Code	Population estimates Global	North America	Great Salt Lake Mean Jun-Jul	Peak 20-Jun	High Count 2001	Abundance Status
WILL	250,000	250,000	1,067	1,466	2,289	C

Mean number of WILL at GSL by survey period.



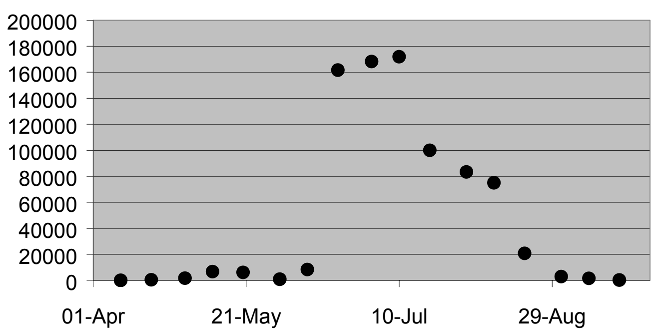
Five-year mean distribution of WILL at GSL.



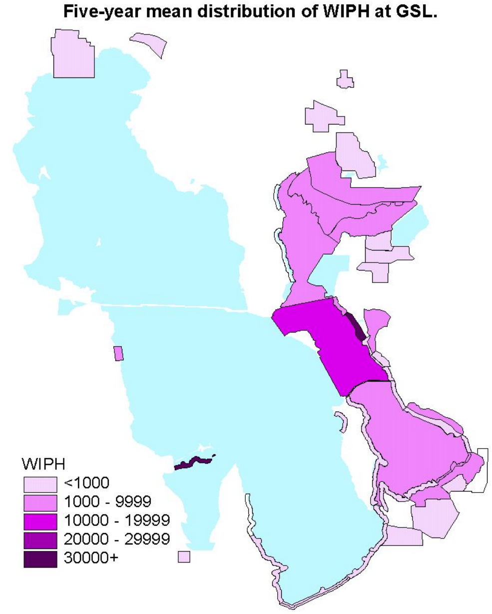
Wilson's Phalarope

Code	Population estimates Global	North America	Great Salt Lake Mean Jun-Aug	Peak 10-Jul	High Count 2000	Abundance Status
WIPH	1,500,000	1,500,000	126,629	171,876	354,729	C

Mean number of WIPH at GSL by survey period.



Five-year mean distribution of WIPH at GSL.

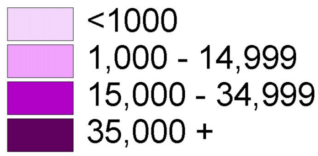


Appendix 6: Species Distribution by Survey Period

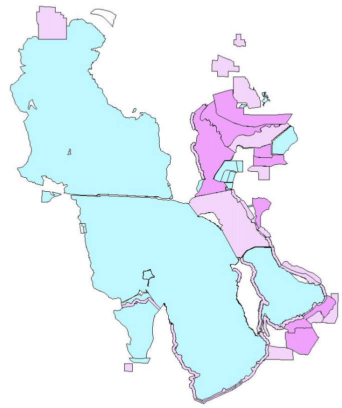
This group of maps shows how species are distributed around GSL by survey period for an average year. These data are comparable with the five-year mean numbers listed in the Species Accounts (Appendix 5) and the Survey Area Descriptions (Appendix 4). It should be noted that areas are various in size. Therefore, of two areas of differing size but with similar numbers of birds, the smaller area represents a greater density of that particular species.

American avocet distribution by survey period.

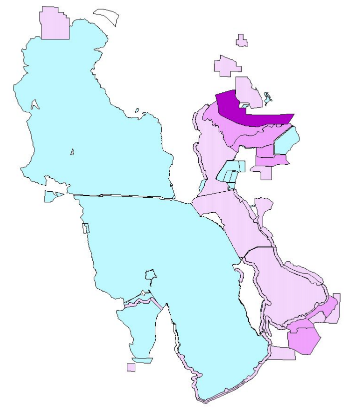
Numbers of AMAV



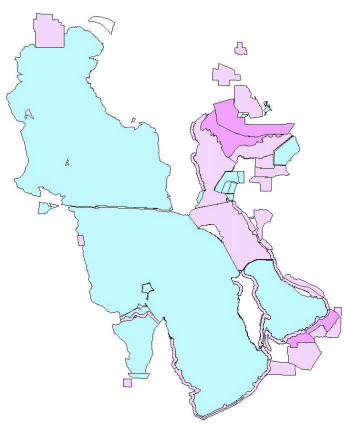
Period 1: April 6-15



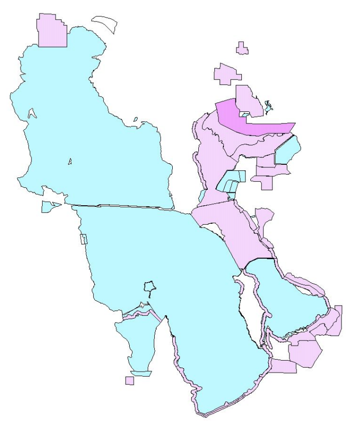
Period 2: April 16-25



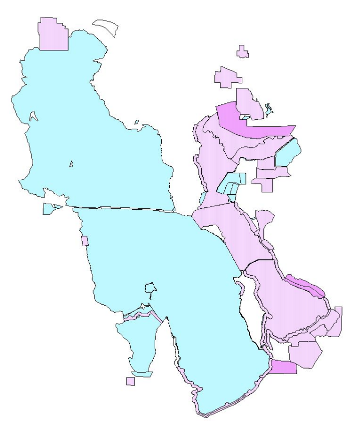
Period 3: April 26-May 5



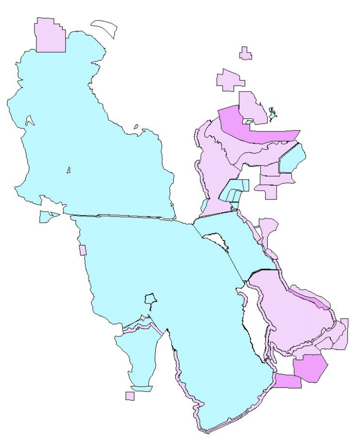
Period 4: May 6-15



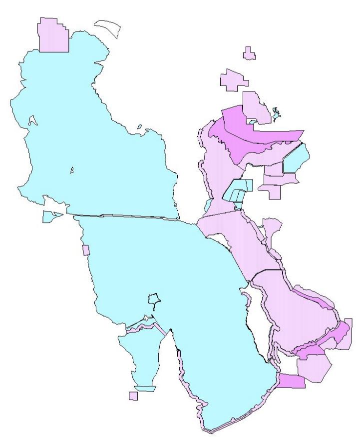
Period 5: May 16-25



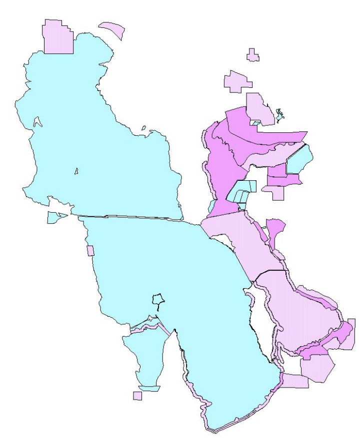
Period 6: May 26-June 4



Period 7: June 5-14

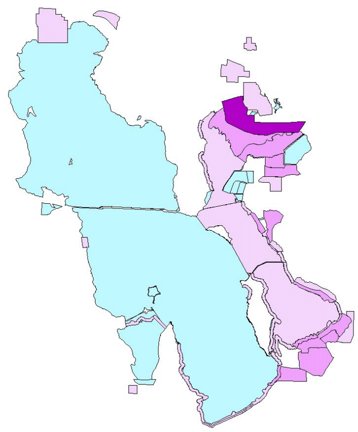


Period 8: June 15-24

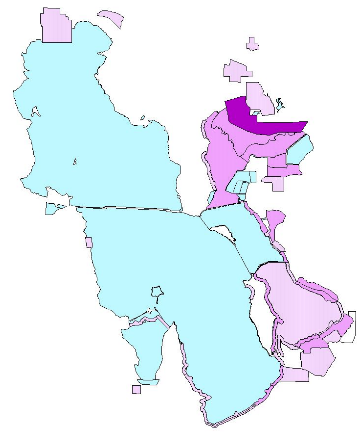


American avocet distribution by survey period.

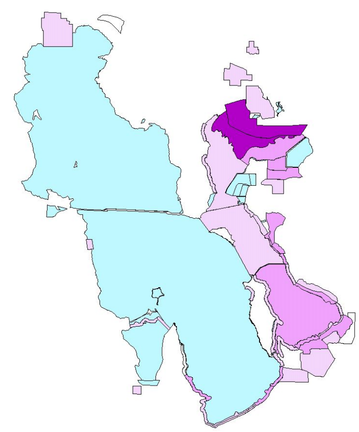
Period 9: June 25-July 4



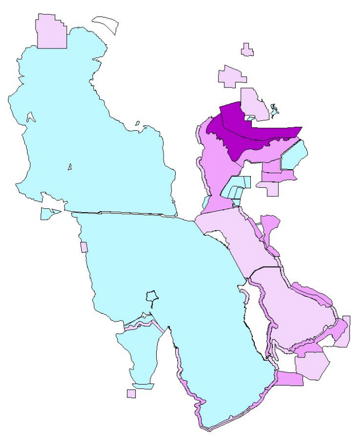
Period 10: July 5-14



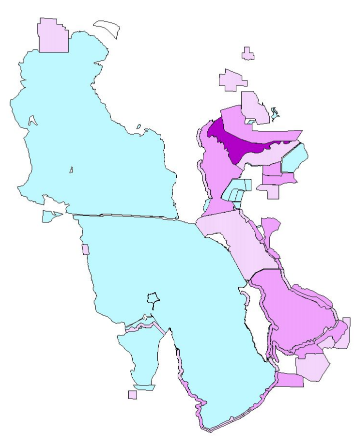
Period 11: July 15-24



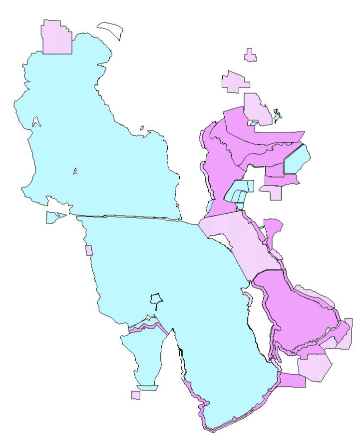
Period 12: July 25-Aug 3



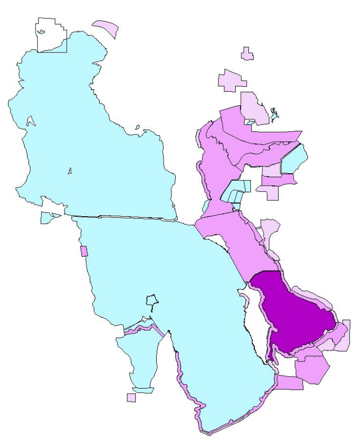
Period 13: Aug 4-13



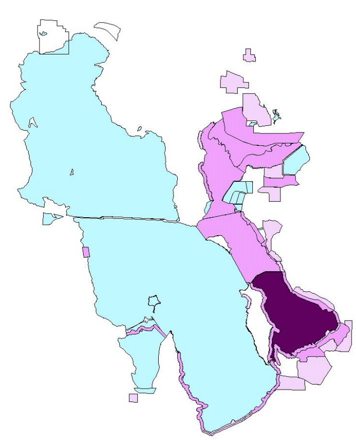
Period 14: Aug 14-23



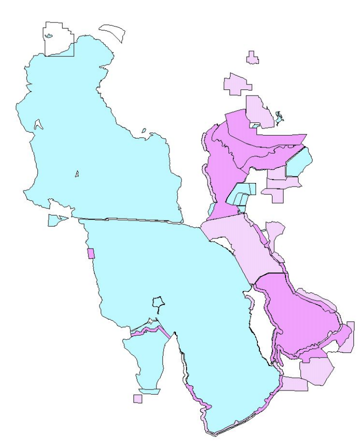
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

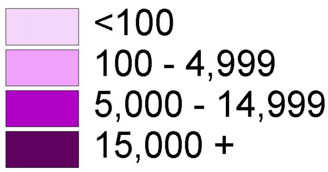


Period 17: Sep 13-22

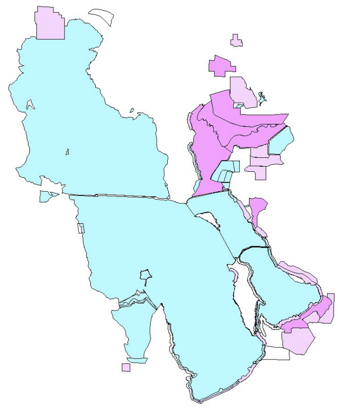


American white pelican distribution by survey period.

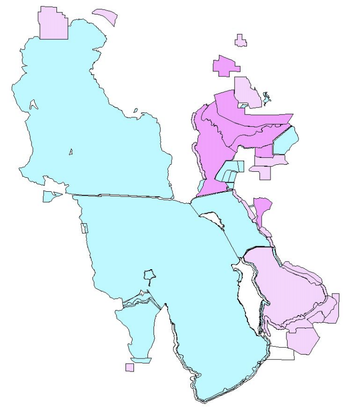
Numbers of AWPE



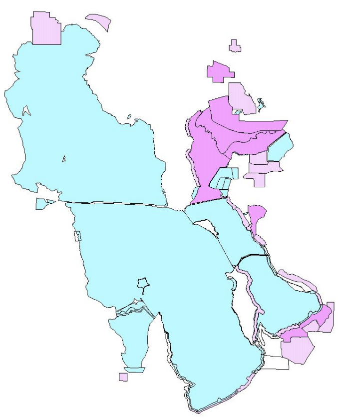
Period 1: April 6-15



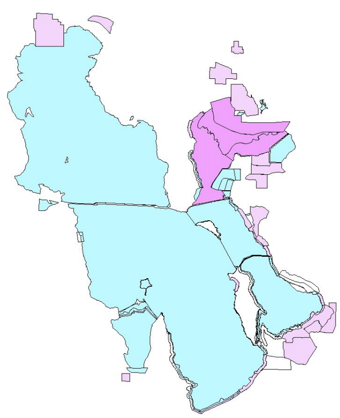
Period 2: April 16-25



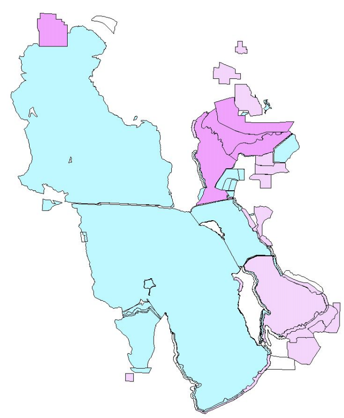
Period 3: April 26-May 5



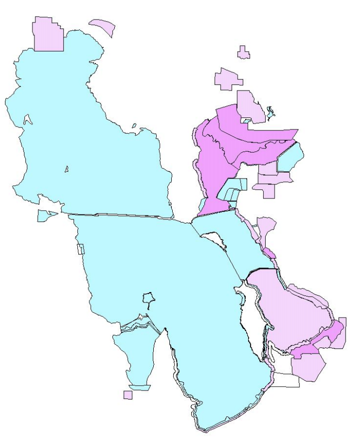
Period 4: May 6-15



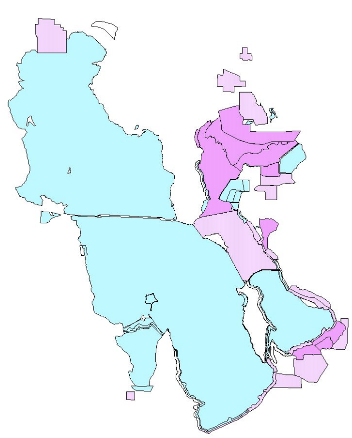
Period 5: May 16-25



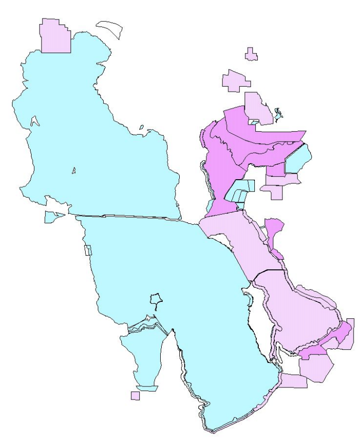
Period 6: May 26-June 4



Period 7: June 5-14

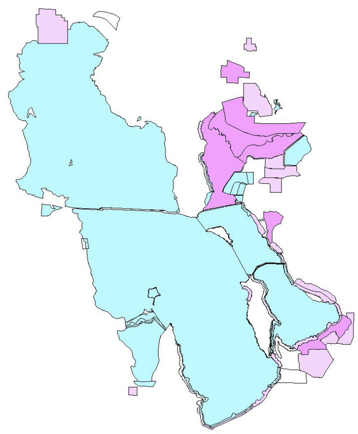


Period 8: June 15-24

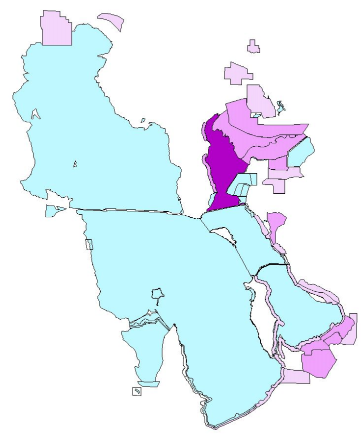


American white pelican distribution by survey period.

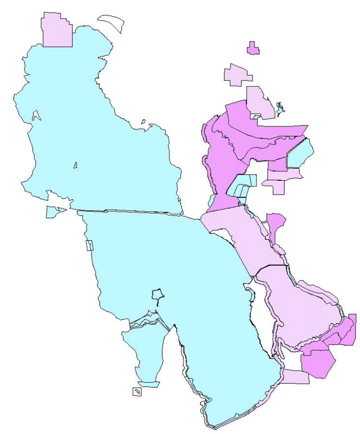
Period 9: June 25-July 4



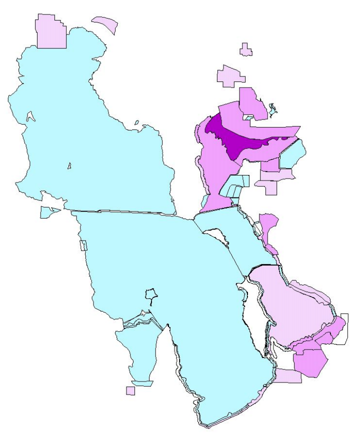
Period 10: July 5-14



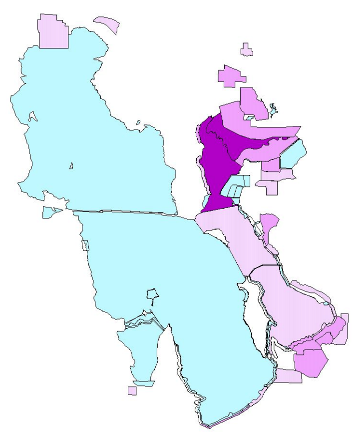
Period 11: July 15-24



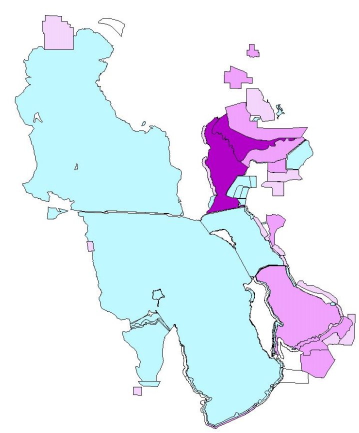
Period 12: July 25-Aug 3



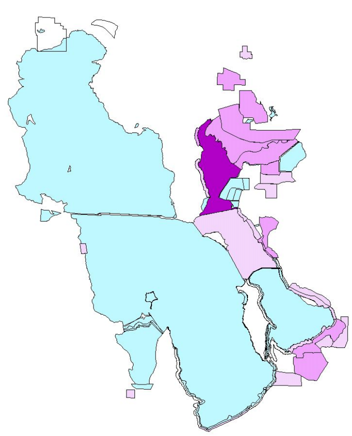
Period 13: Aug 4-13



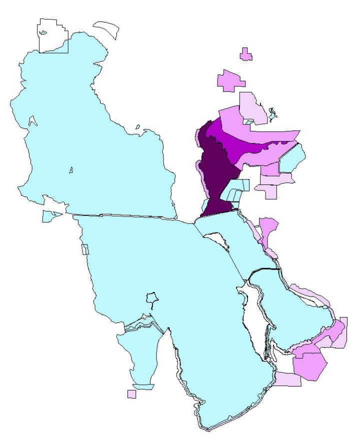
Period 14: Aug 14-23



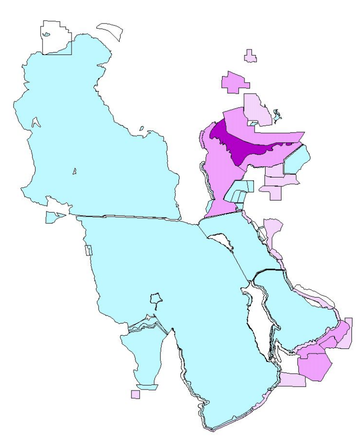
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12



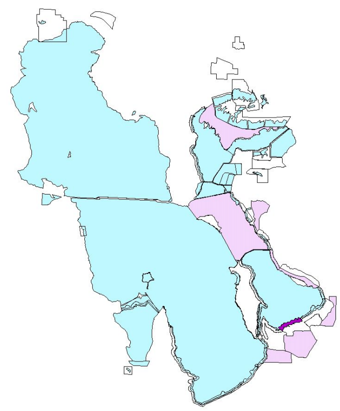
Period 17: Sep 13-22



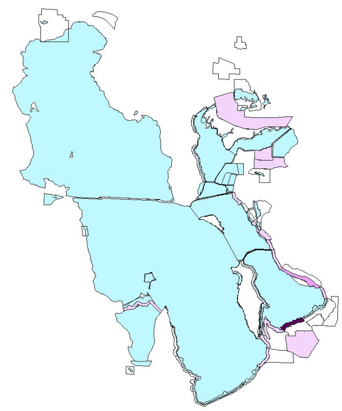
Black-bellied plover distribution by survey period. Because black-bellied plovers are at GSL in notable numbers during spring migration, only survey periods 1-5 are shown here.

Numbers of BBPL

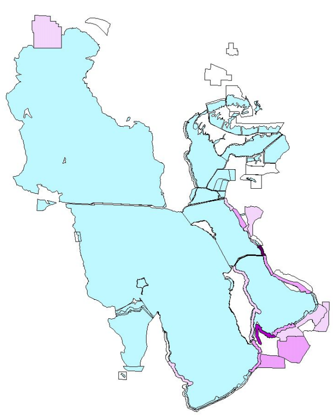
Period 1: April 6-15



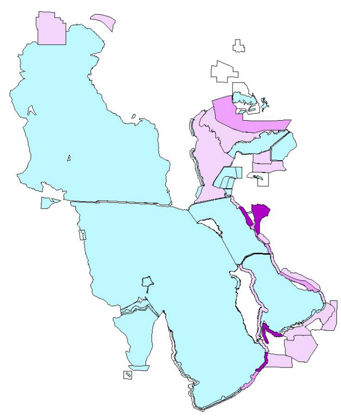
Period 2: April 16-25



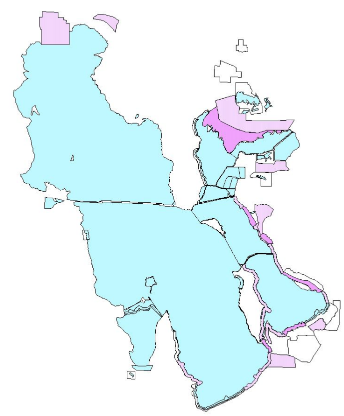
Period 3: April 26-May 5



Period 4: May 6-15

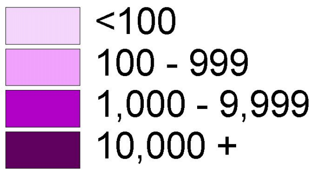


Period 5: May 16-25

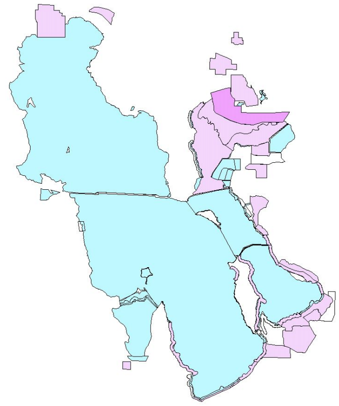


Black-necked stilt distribution by survey period.

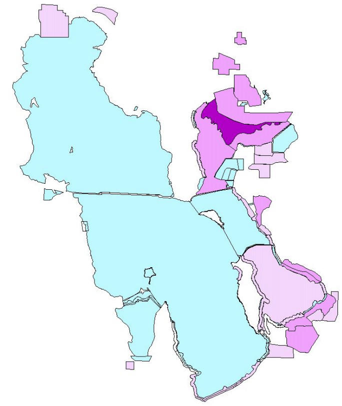
Numbers of BNST



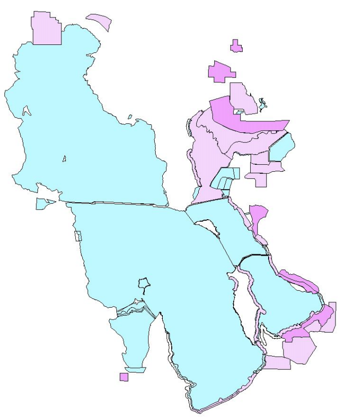
Period 1: April 6-15



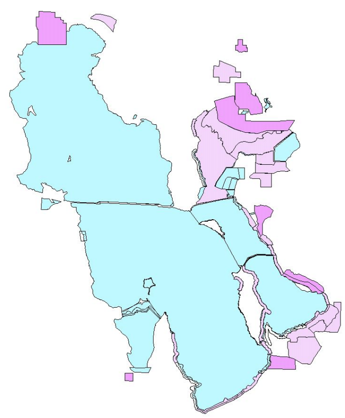
Period 2: April 16-25



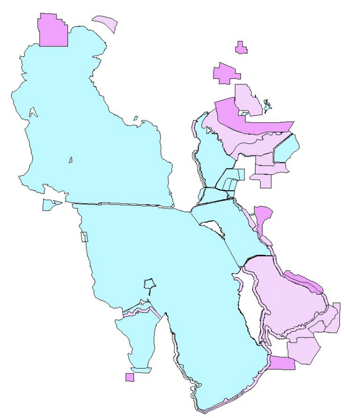
Period 3: April 26-May 5



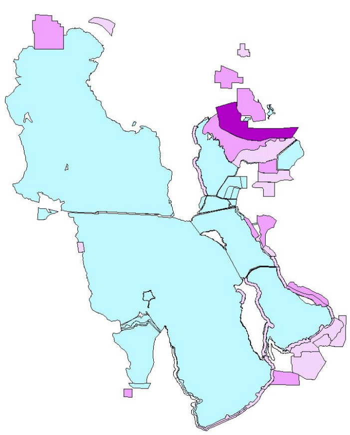
Period 4: May 6-15



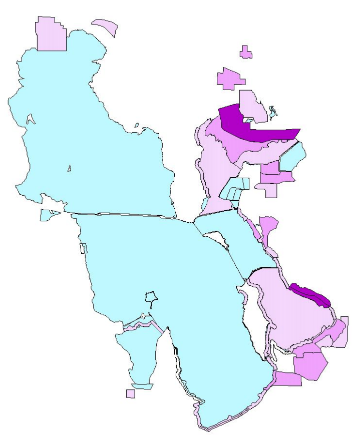
Period 5: May 16-25



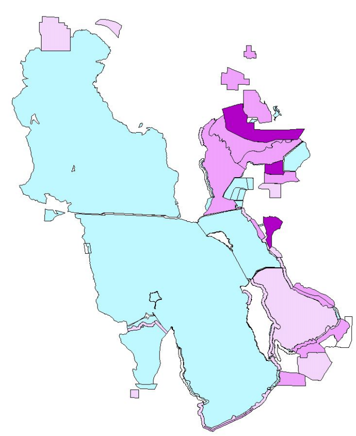
Period 6: May 26-June 4



Period 7: June 5-14

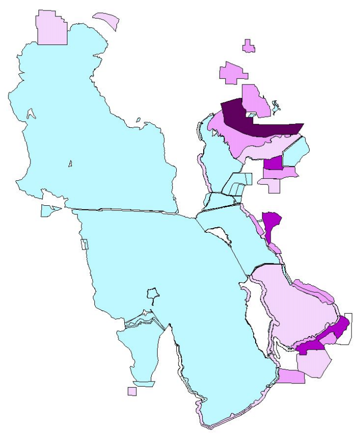


Period 8: June 15-24

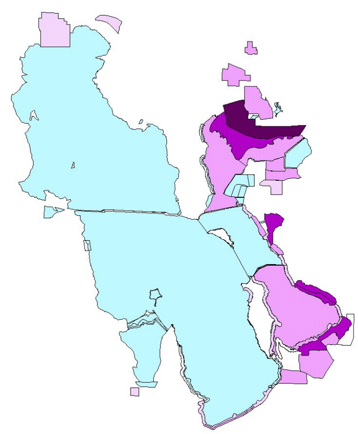


Black-necked stilt distribution by survey period.

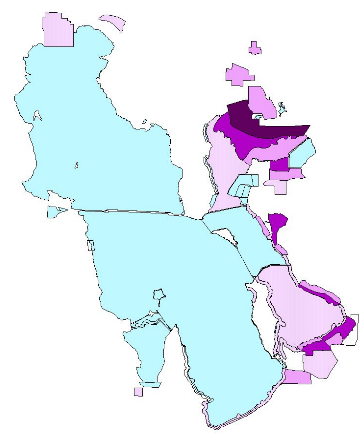
Period 9: June 25-July 4



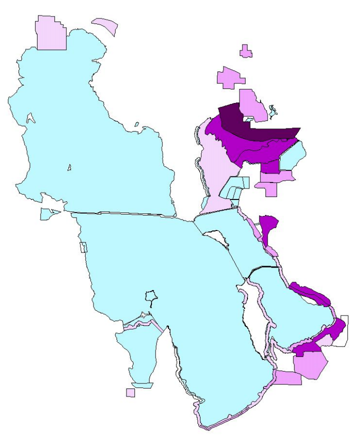
Period 10: July 5-14



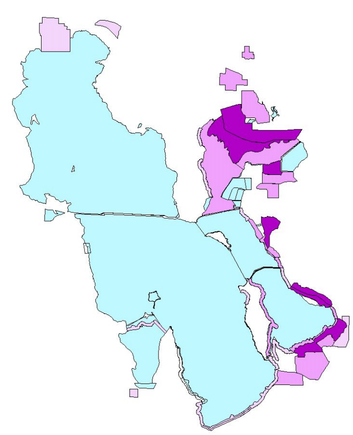
Period 11: July 15-24



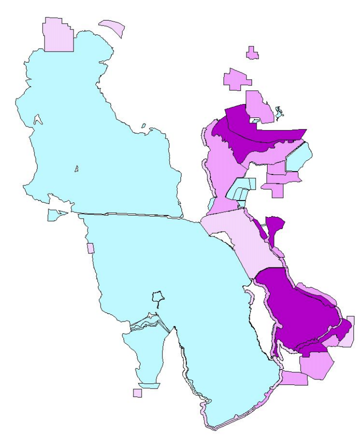
Period 12: July 25-Aug 3



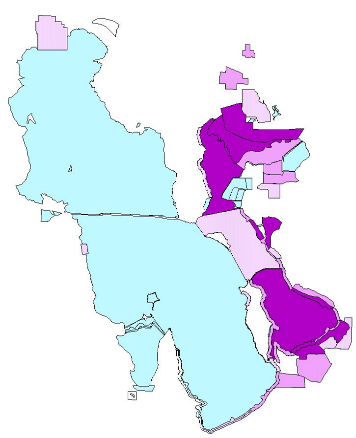
Period 13: Aug 4-13



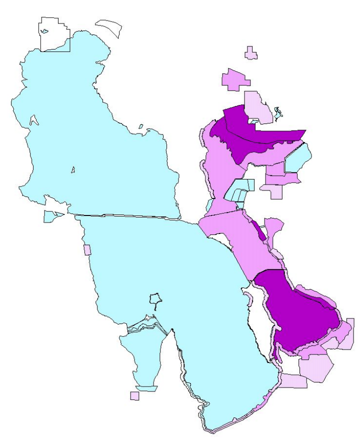
Period 14: Aug 14-23



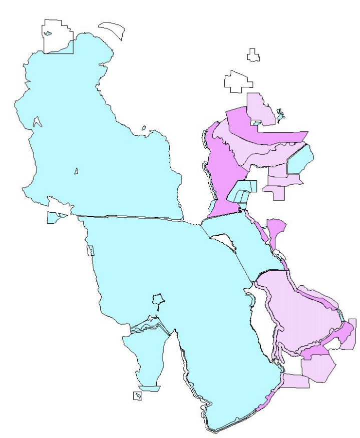
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

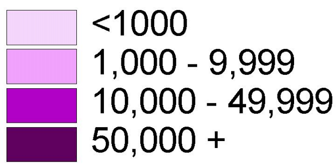


Period 17: Sep 13-22

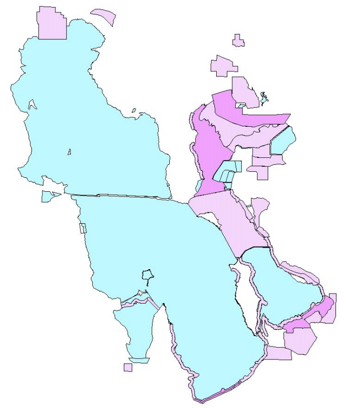


California gull distribution by survey period.

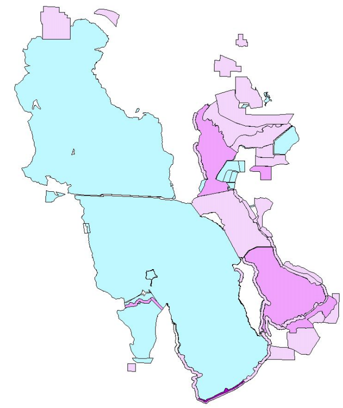
Numbers of CAGU



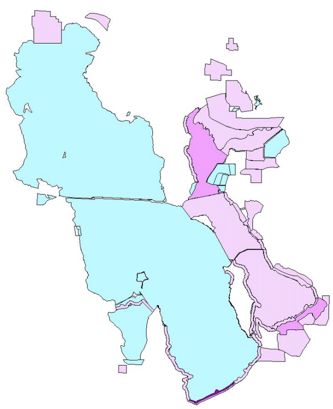
Period 1: April 6-15



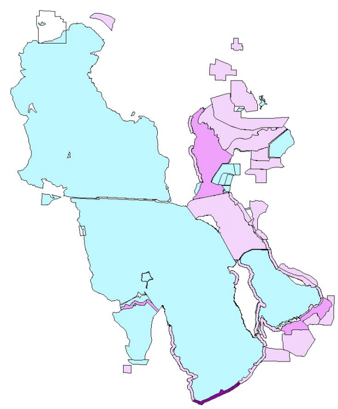
Period 2: April 16-25



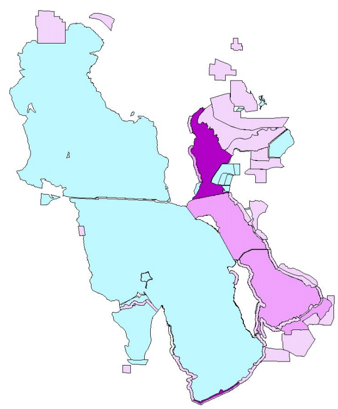
Period 3: April 26-May 5



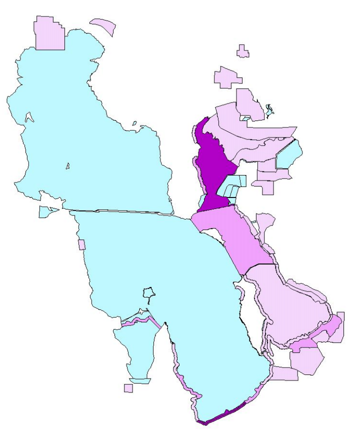
Period 4: May 6-15



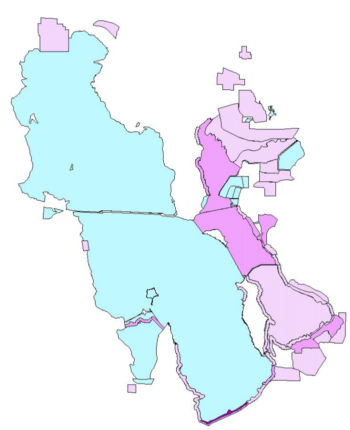
Period 5: May 16-25



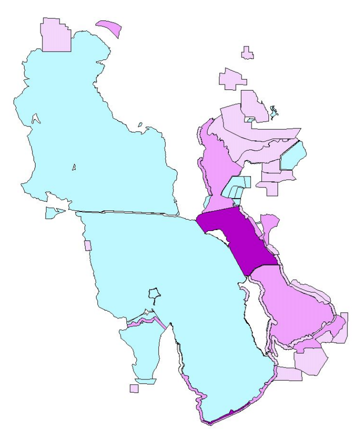
Period 6: May 26-June 4



Period 7: June 5-14

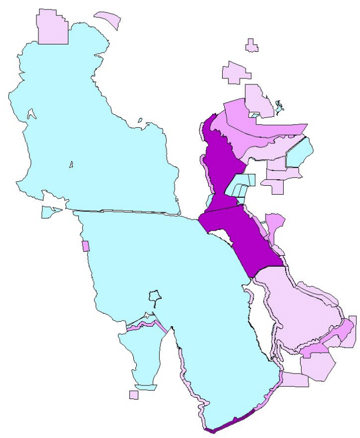


Period 8: June 15-24

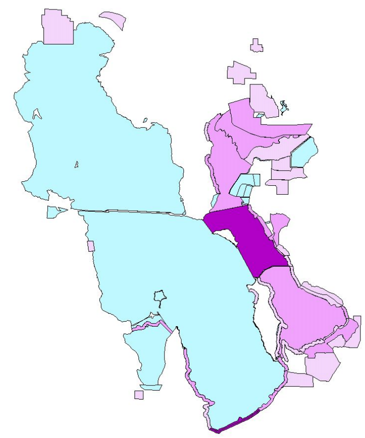


California gull distribution by survey period.

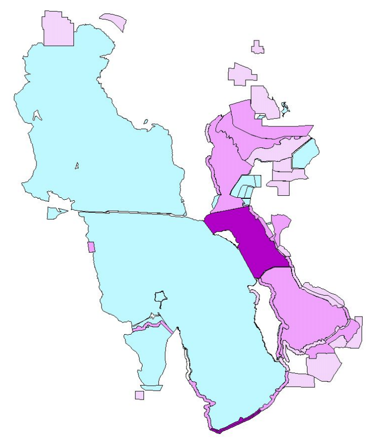
Period 9: June 25-July 4



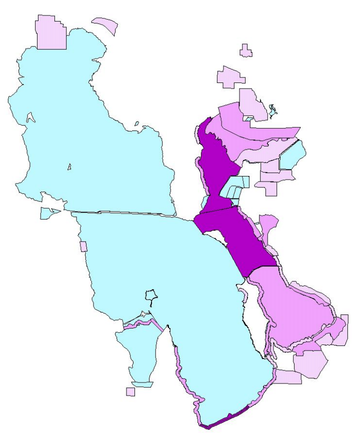
Period 10: July 5-14



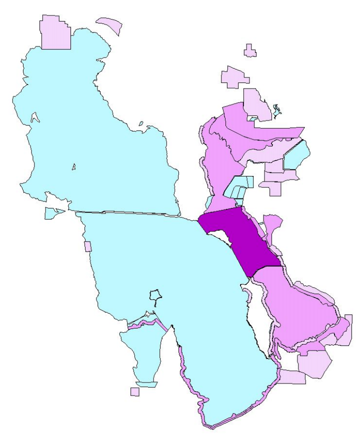
Period 11: July 15-24



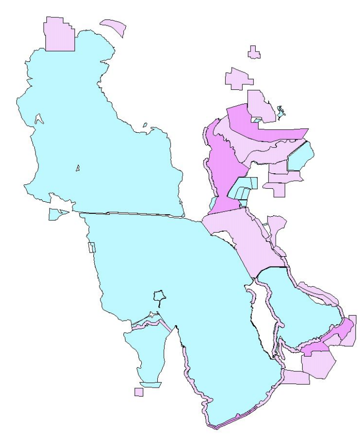
Period 12: July 25-Aug 3



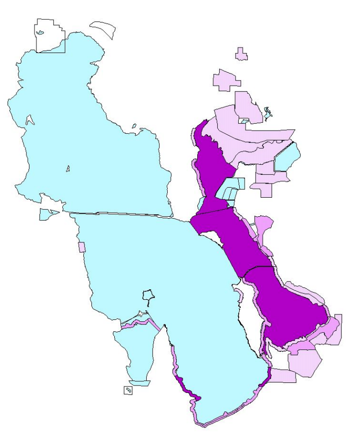
Period 13: Aug 4-13



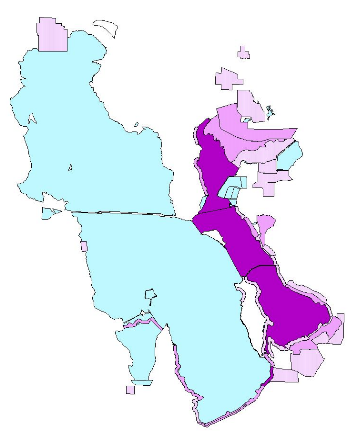
Period 14: Aug 14-23



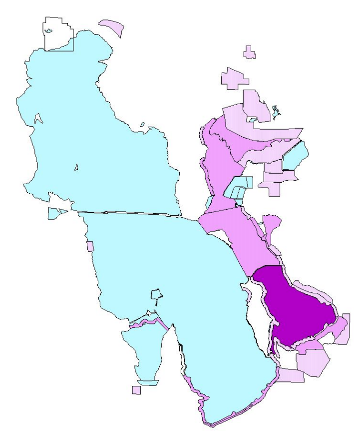
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

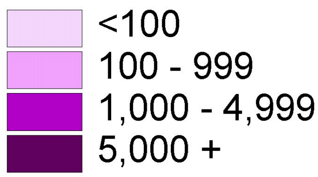


Period 17: Sep 13-22

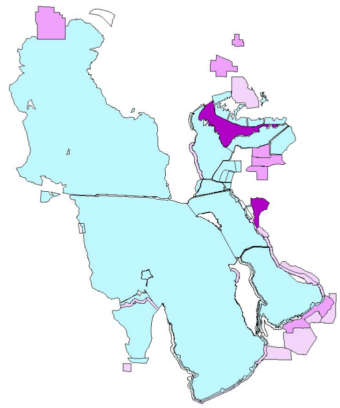


Cinnamon teal distribution by survey period.

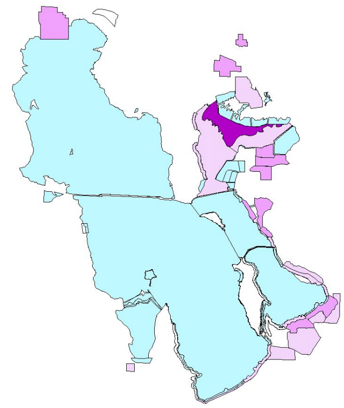
Numbers of CITE



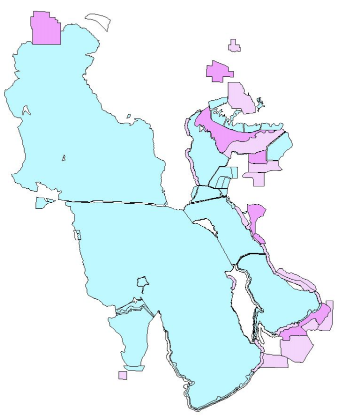
Period 1: April 6-15



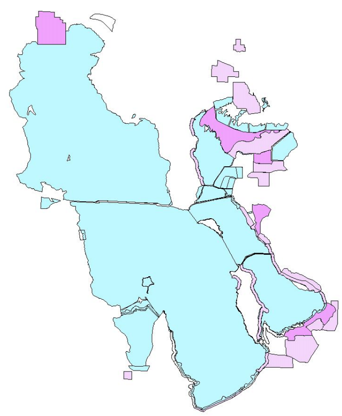
Period 2: April 16-25



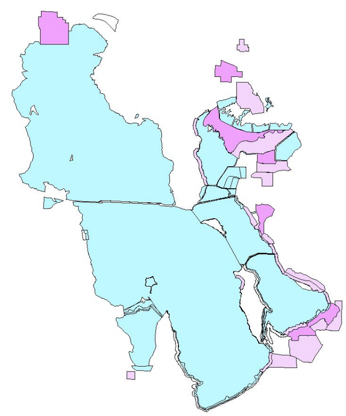
Period 3: April 26-May 5



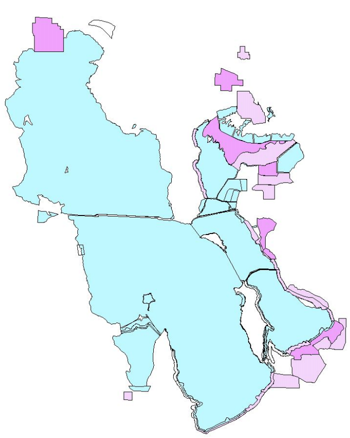
Period 4: May 6-15



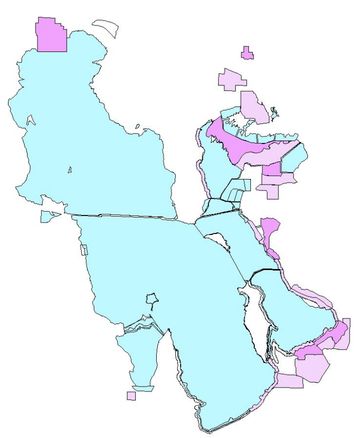
Period 5: May 16-25



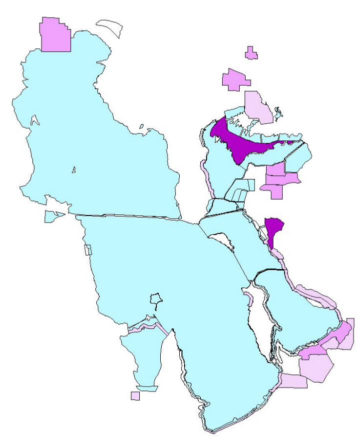
Period 6: May 26-June 4



Period 7: June 5-14

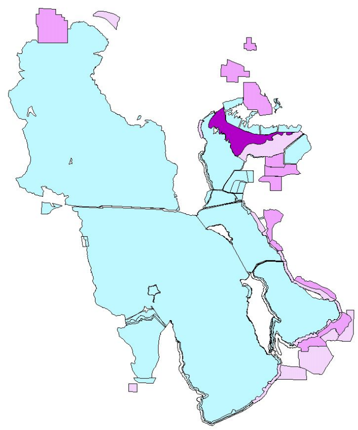


Period 8: June 15-24

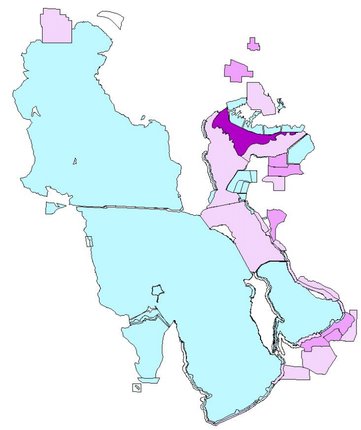


Cinnamon teal distribution by survey period.

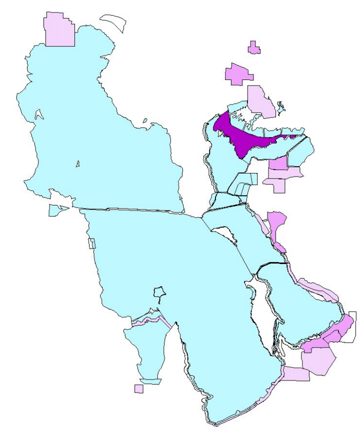
Period 9: June 25-July 4



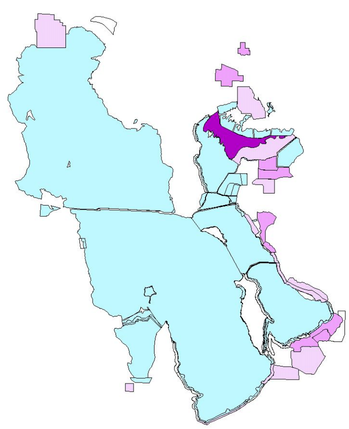
Period 10: July 5-14



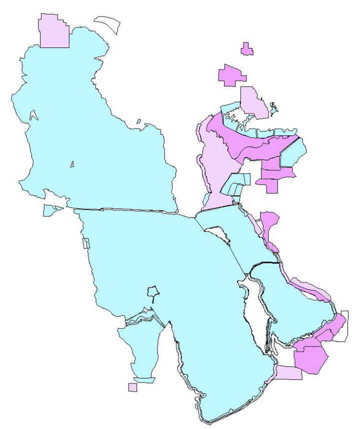
Period 11: July 15-24



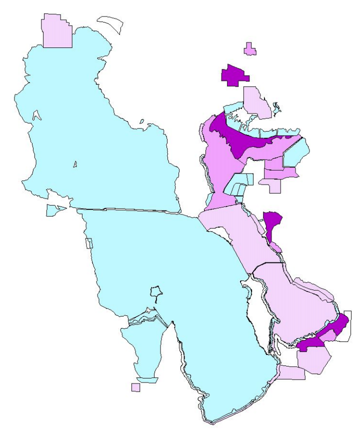
Period 12: July 25-Aug 3



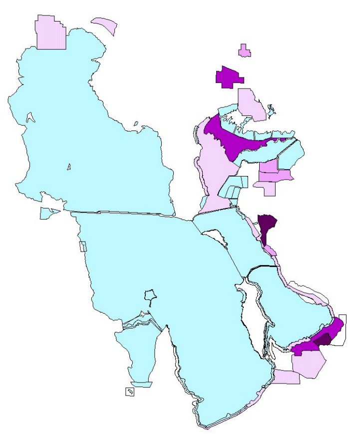
Period 13: Aug 4-13



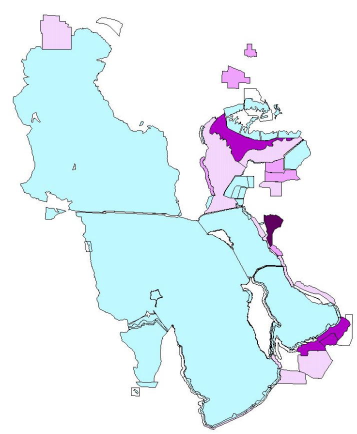
Period 14: Aug 14-23



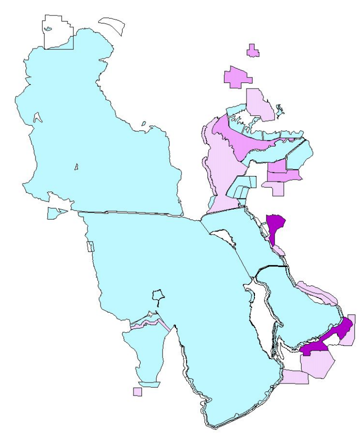
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

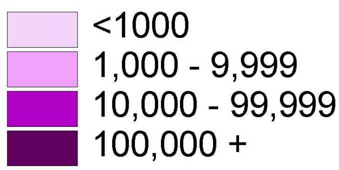


Period 17: Sep 13-22

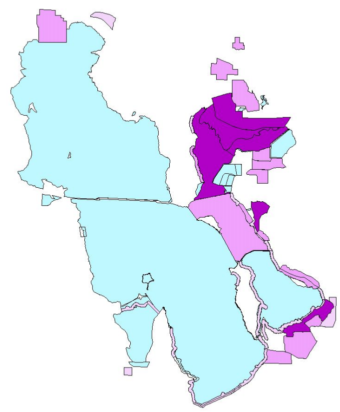


Duck distribution by survey period.

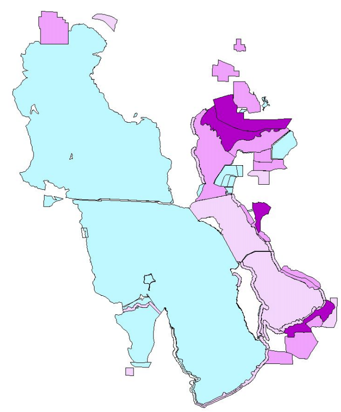
Numbers of Ducks



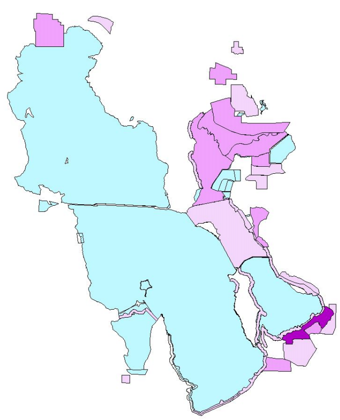
Period 1: April 6-15



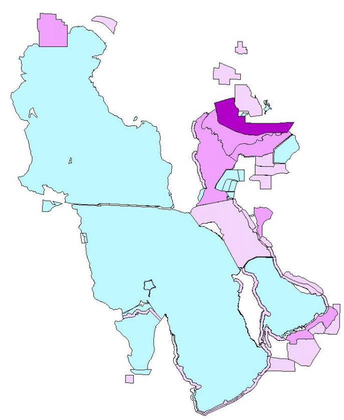
Period 2: April 16-25



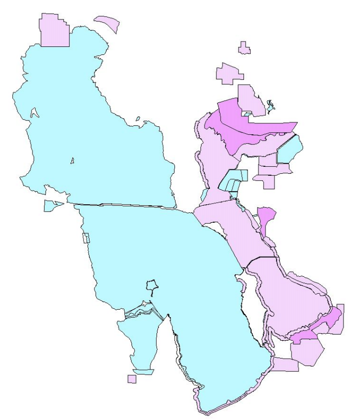
Period 3: April 26-May 5



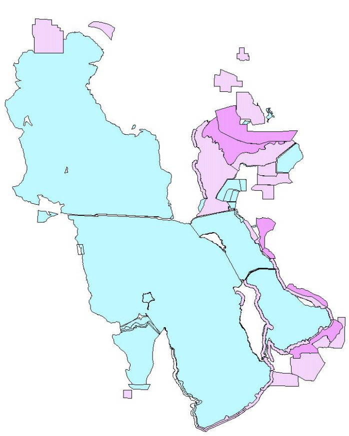
Period 4: May 6-15



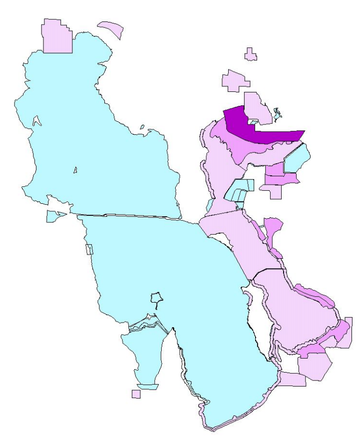
Period 5: May 16-25



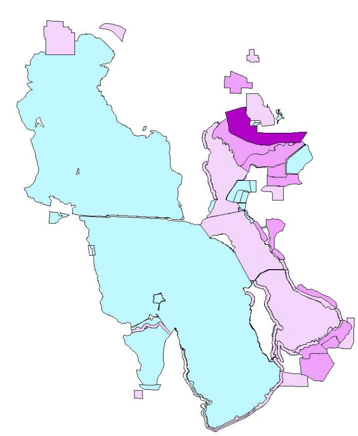
Period 6: May 26-June 4



Period 7: June 5-14

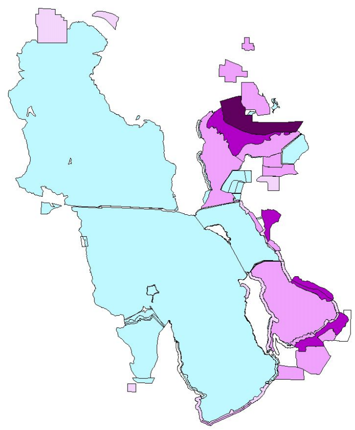


Period 8: June 15-24

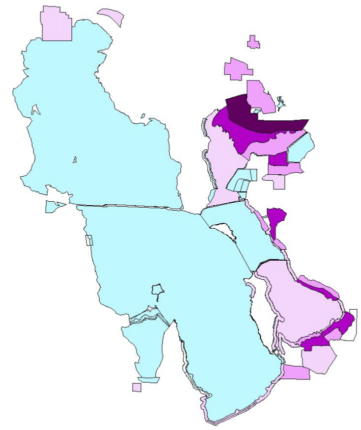


Duck distribution by survey period.

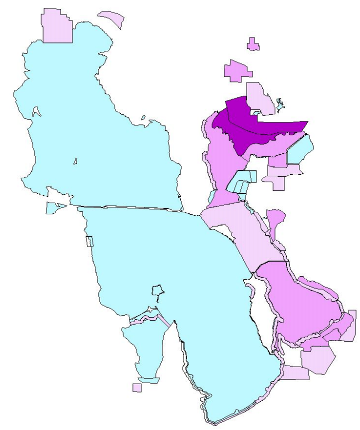
Period 9: June 25-July 4



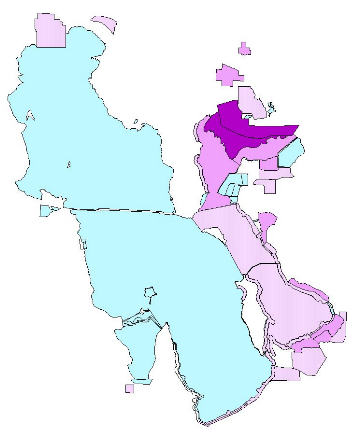
Period 10: July 5-14



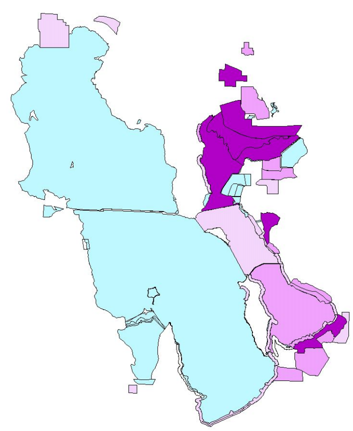
Period 11: July 15-24



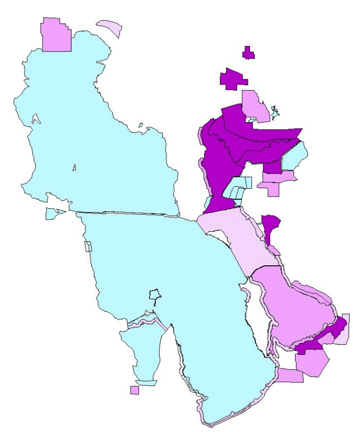
Period 12: July 25-Aug 3



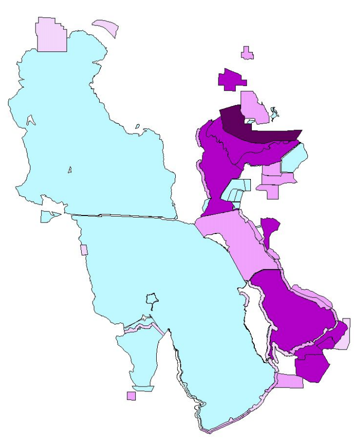
Period 13: Aug 4-13



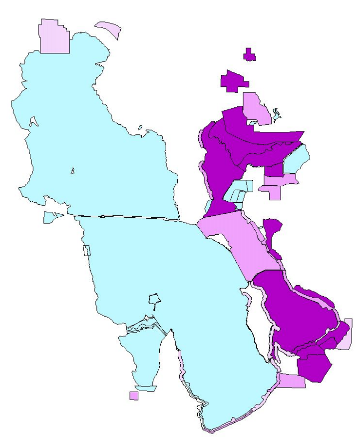
Period 14: Aug 14-23



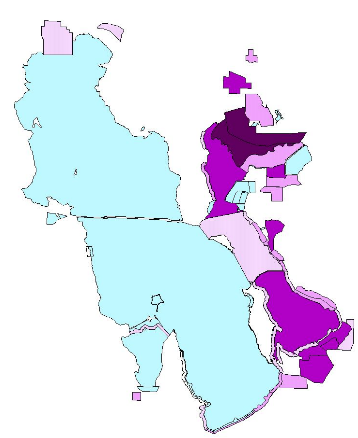
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

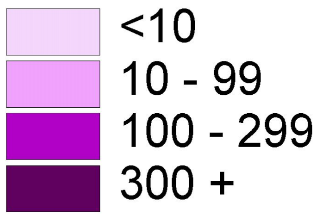


Period 17: Sep 13-22

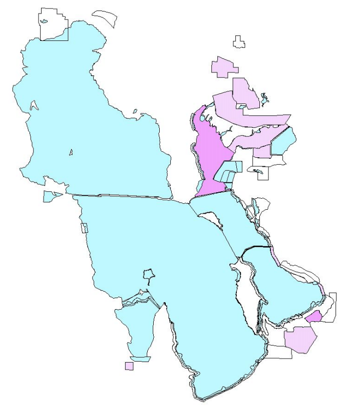


Forster's tern distribution by survey period.

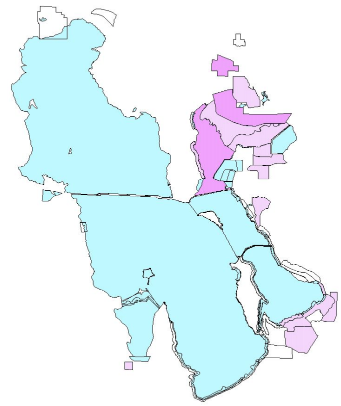
Numbers of FOTE



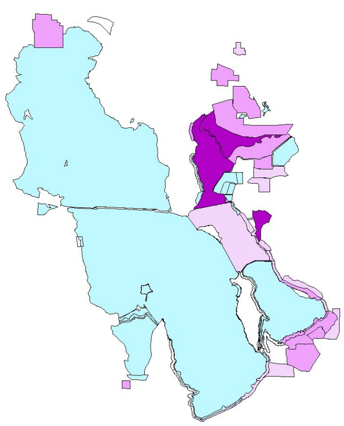
Period 1: April 6-15



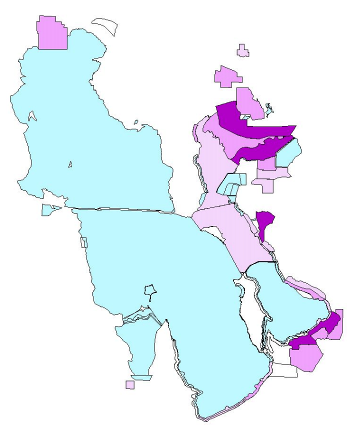
Period 2: April 16-25



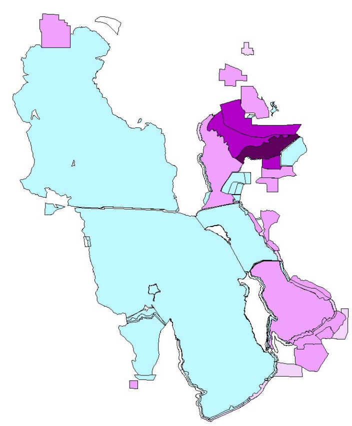
Period 3: April 26-May 5



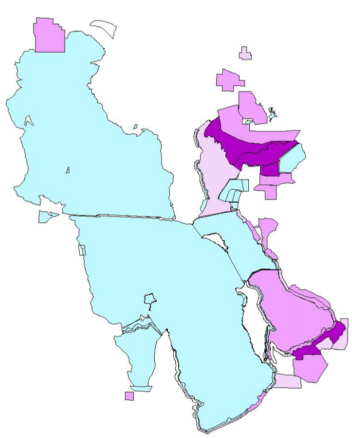
Period 4: May 6-15



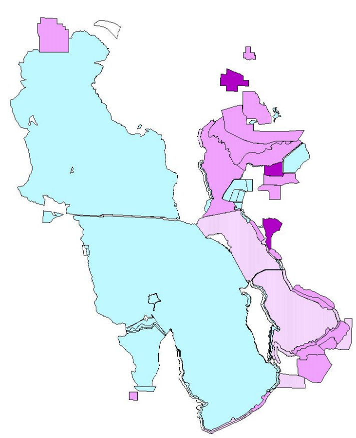
Period 5: May 16-25



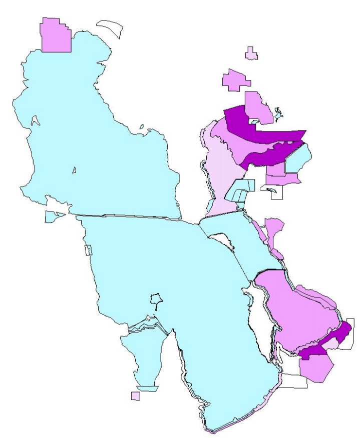
Period 6: May 26-June 4



Period 7: June 5-14

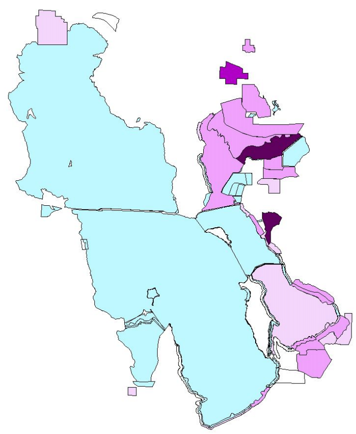


Period 8: June 15-24

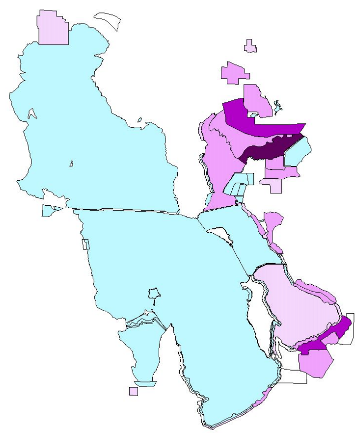


Forster’s tern distribution by survey period.

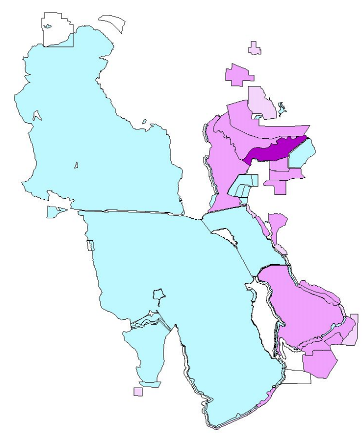
Period 9: June 25-July 4



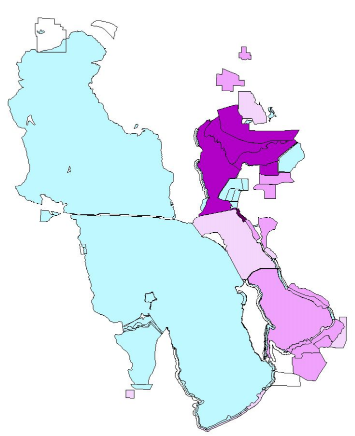
Period 10: July 5-14



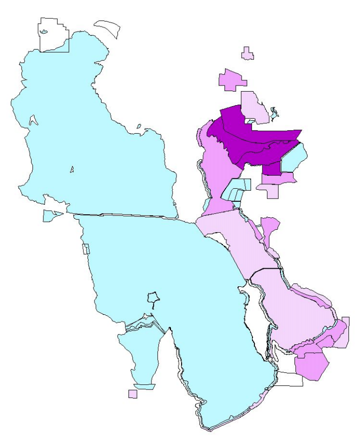
Period 11: July 15-24



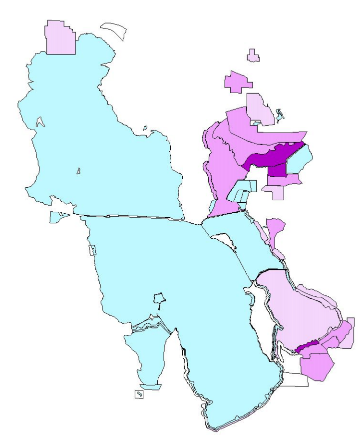
Period 12: July 25-Aug 3



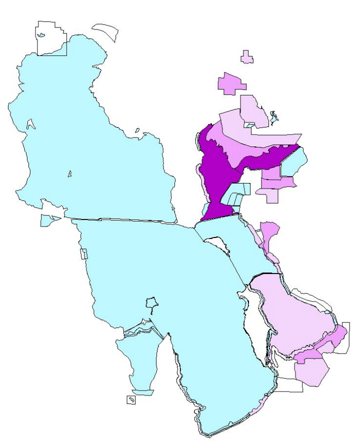
Period 13: Aug 4-13



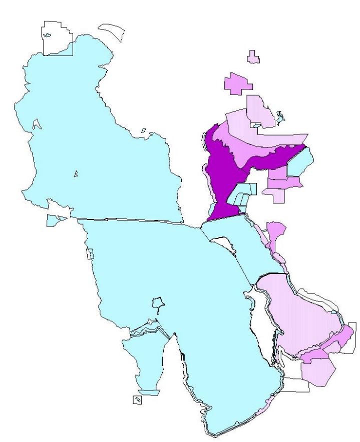
Period 14: Aug 14-23



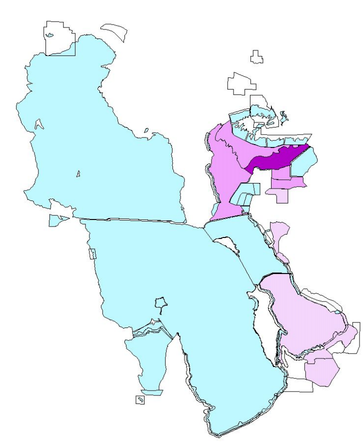
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

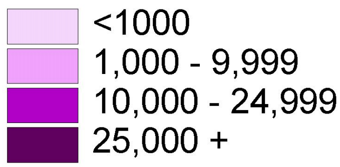


Period 17: Sep 13-22

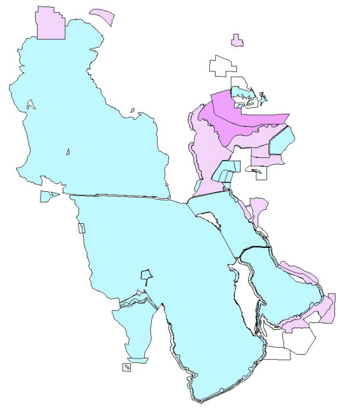


Franklin’s gull distribution by survey period.

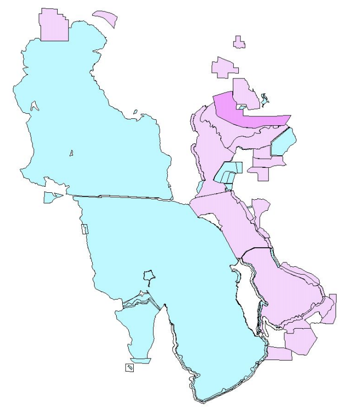
Numbers of FRGU



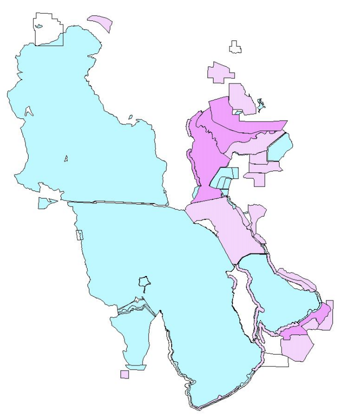
Period 1: April 6-15



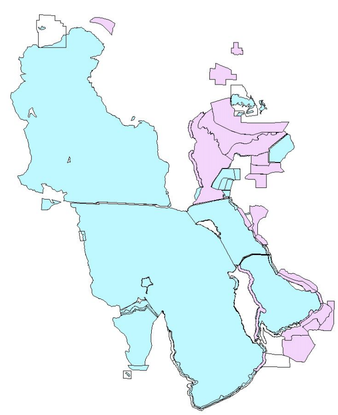
Period 2: April 16-25



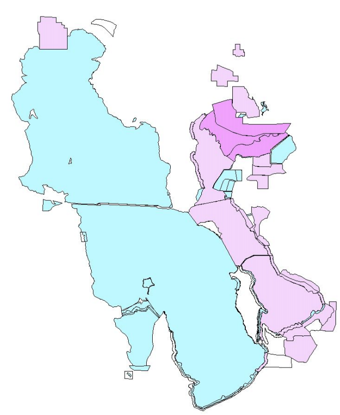
Period 3: April 26-May 5



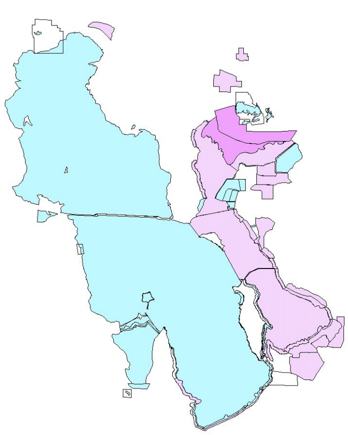
Period 4: May 6-15



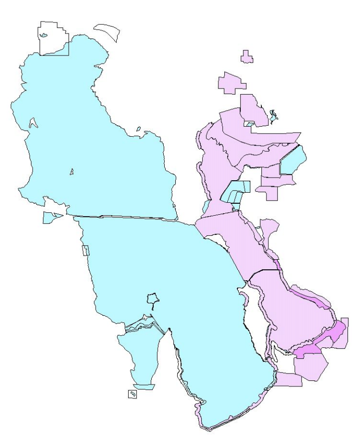
Period 5: May 16-25



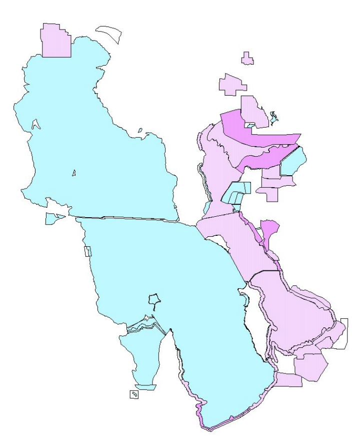
Period 6: May 26-June 4



Period 7: June 5-14

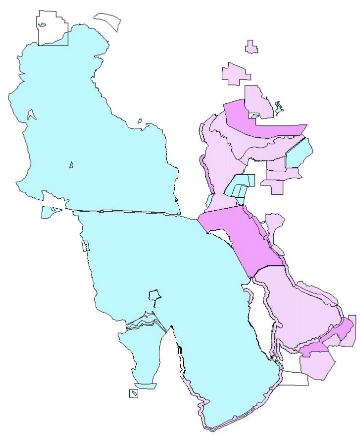


Period 8: June 15-24

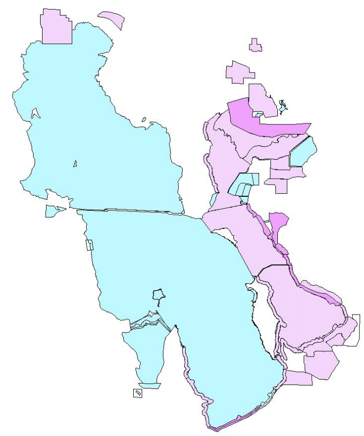


Franklin's gull distribution by survey period.

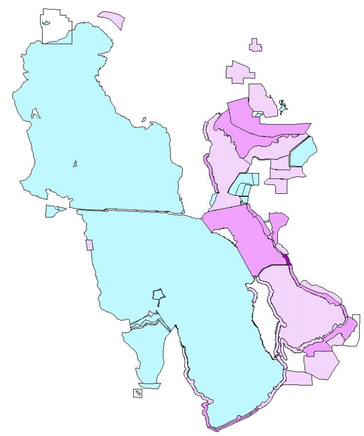
Period 9: June 25-July 4



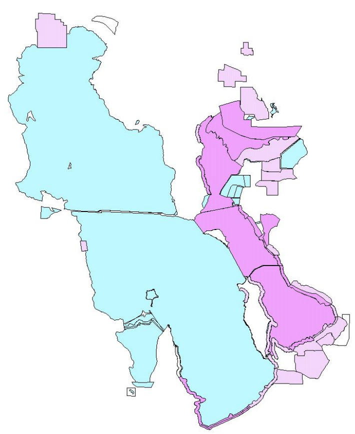
Period 10: July 5-14



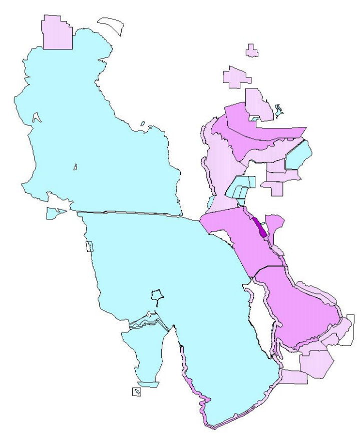
Period 11: July 15-24



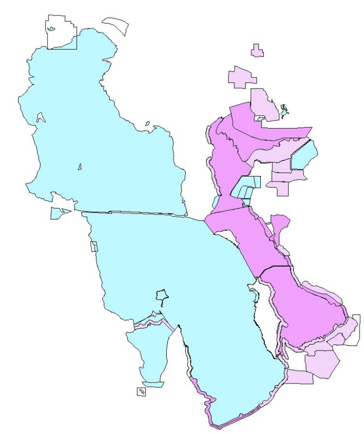
Period 12: July 25-Aug 3



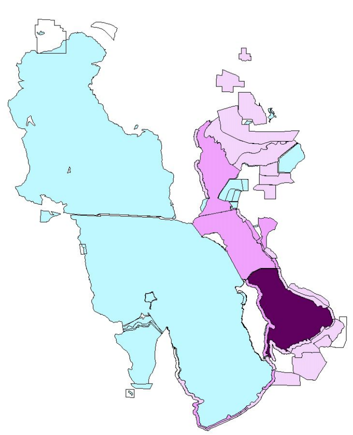
Period 13: Aug 4-13



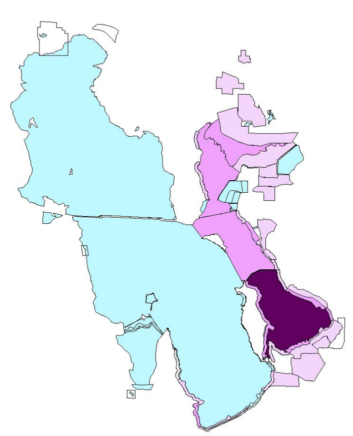
Period 14: Aug 14-23



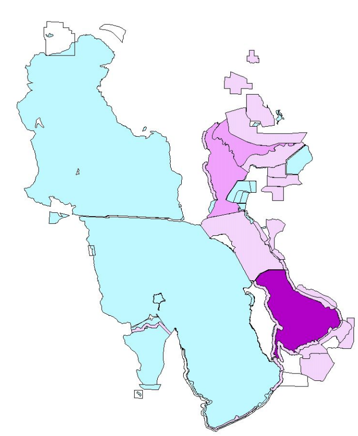
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

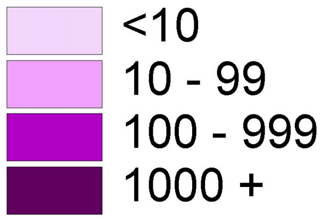


Period 17: Sep 13-22

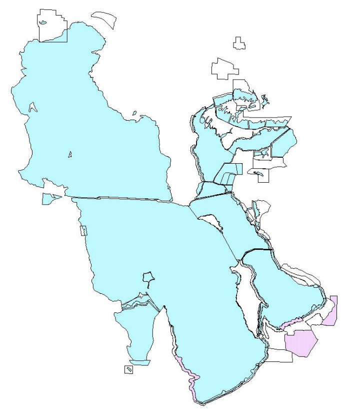


Least sandpiper distribution by survey period.

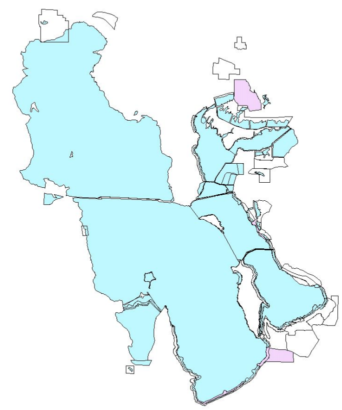
Numbers of LESA



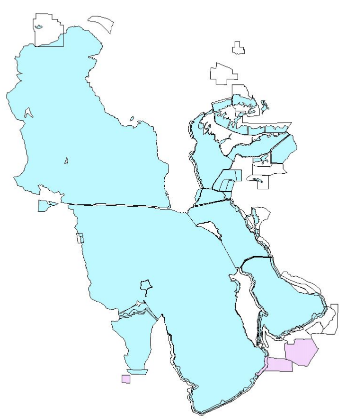
Period 1: April 6-15



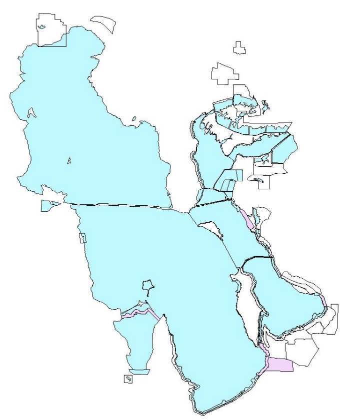
Period 2: April 16-25



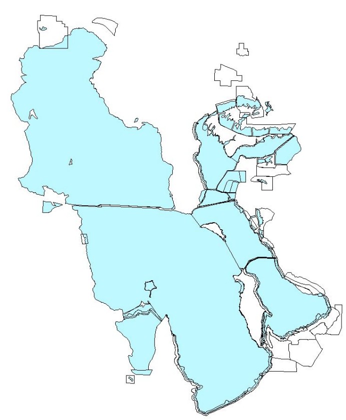
Period 3: April 26-May 5



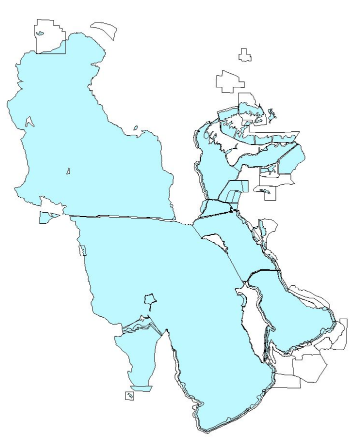
Period 4: May 6-15



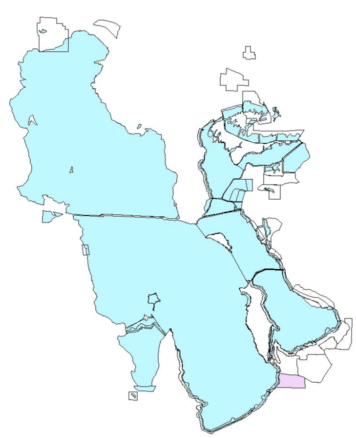
Period 5: May 16-25



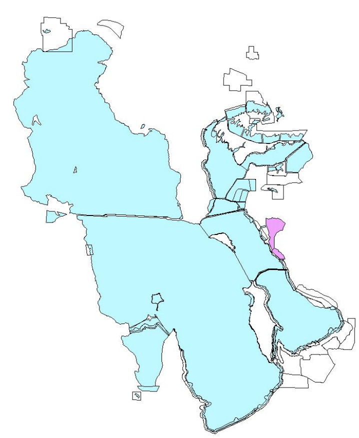
Period 6: May 26-June 4



Period 7: June 5-14

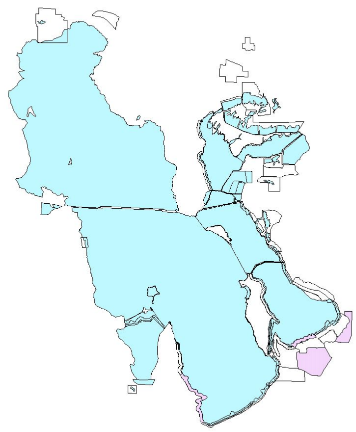


Period 8: June 15-24

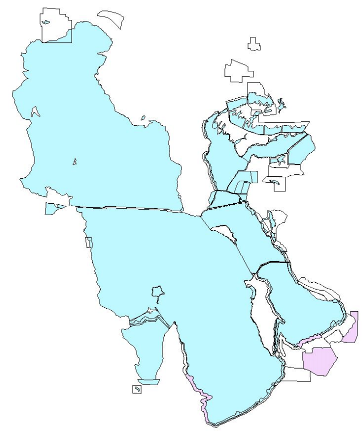


Least sandpiper distribution by survey period.

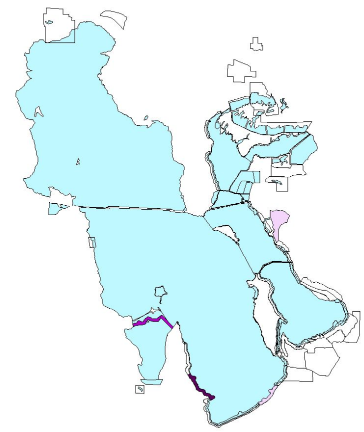
Period 9: June 25-July 4



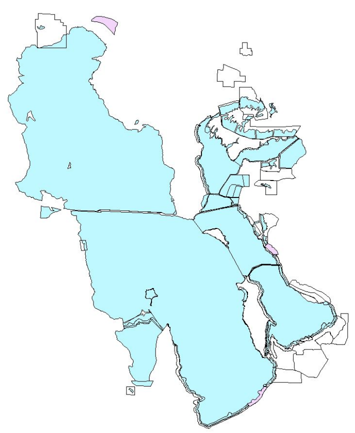
Period 10: July 5-14



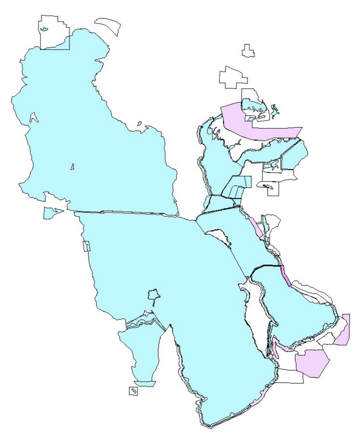
Period 11: July 15-24



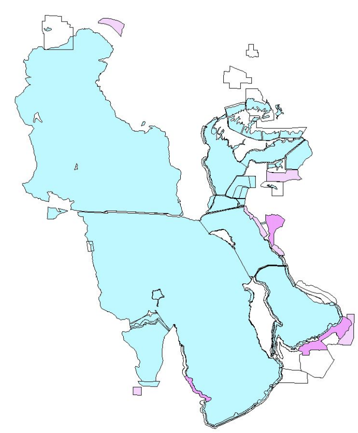
Period 12: July 25-Aug 3



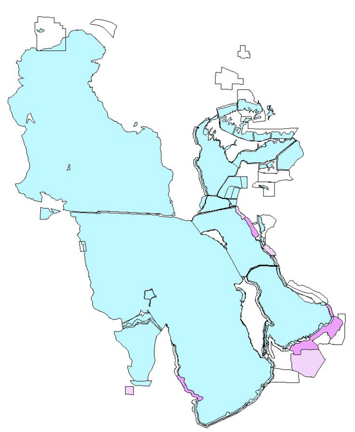
Period 13: Aug 4-13



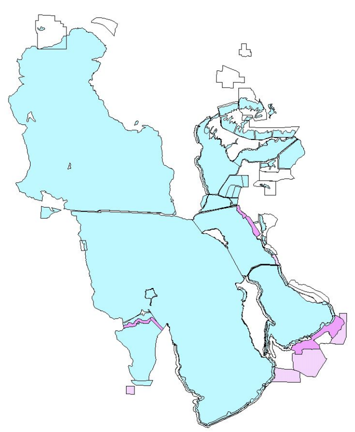
Period 14: Aug 14-23



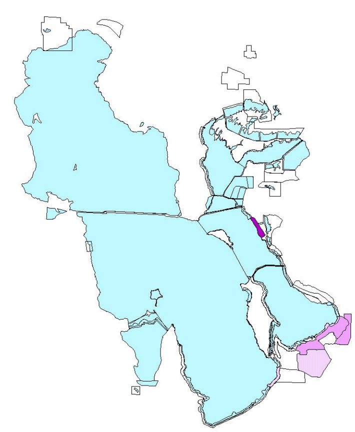
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

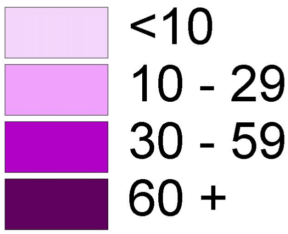


Period 17: Sep 13-22

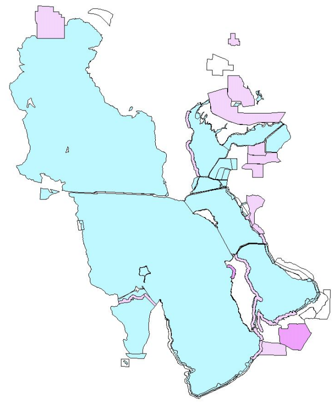


Long-billed curlew distribution by survey period.

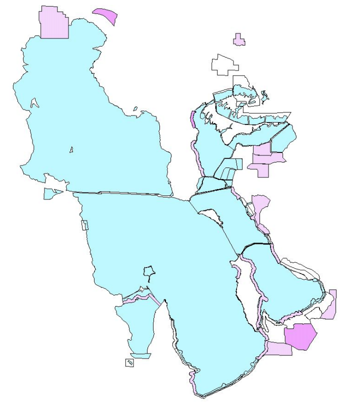
Numbers of LBCU



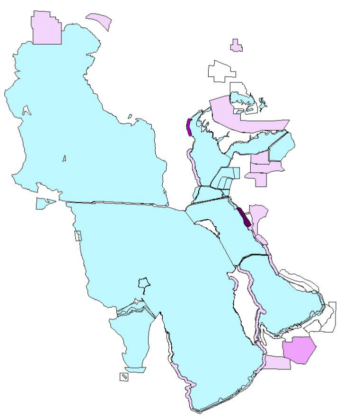
Period 1: April 6-15



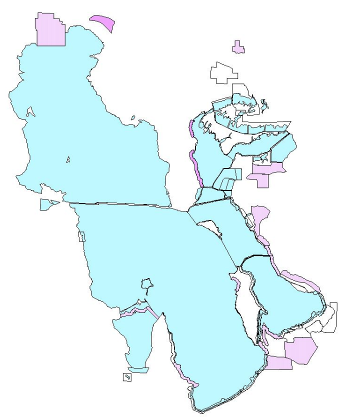
Period 2: April 16-25



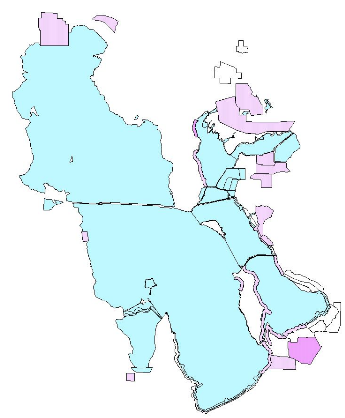
Period 3: April 26-May 5



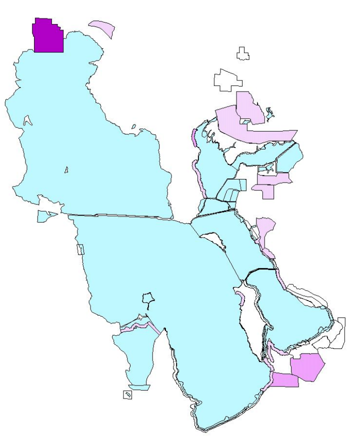
Period 4: May 6-15



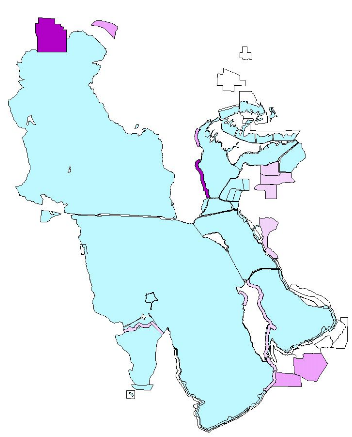
Period 5: May 16-25



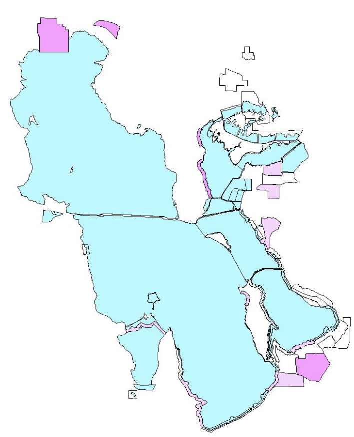
Period 6: May 26-June 4



Period 7: June 5-14

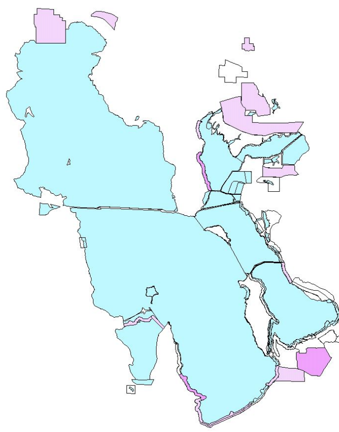


Period 8: June 15-24

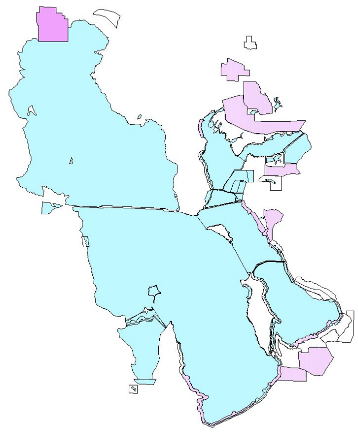


Long-billed curlew distribution by survey period.

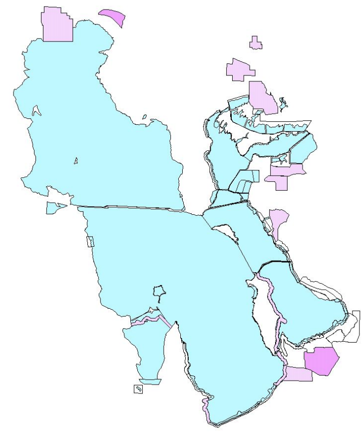
Period 9: June 25-July 4



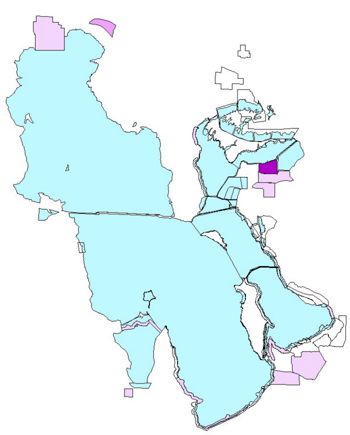
Period 10: July 5-14



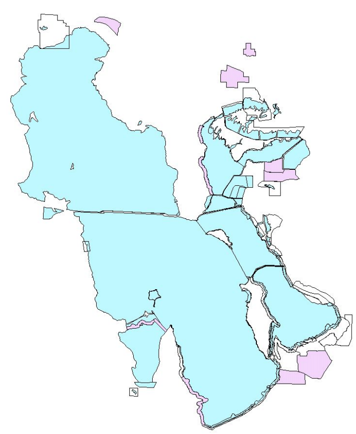
Period 11: July 15-24



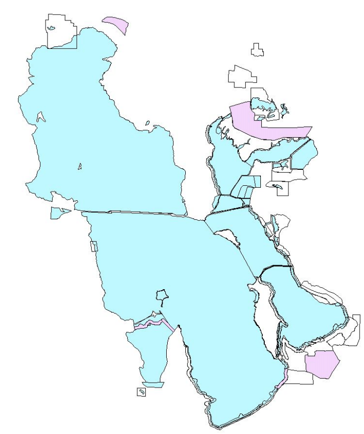
Period 12: July 25-Aug 3



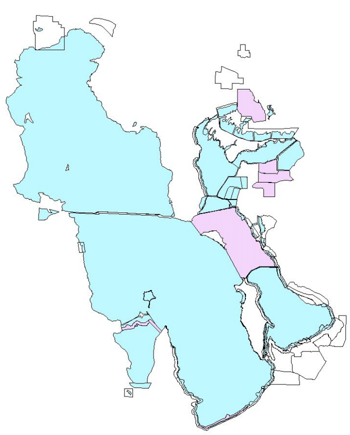
Period 13: Aug 4-13



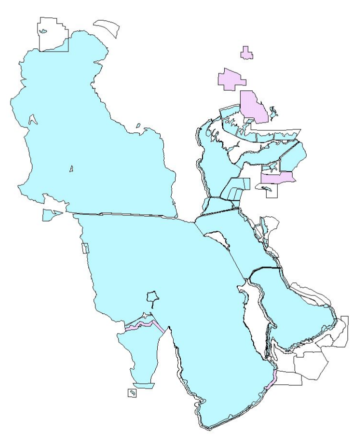
Period 14: Aug 14-23



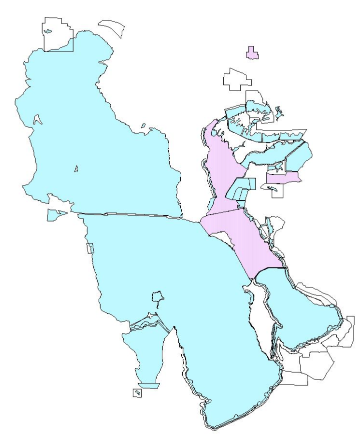
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

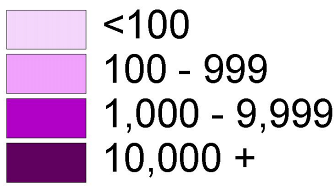


Period 17: Sep 13-22

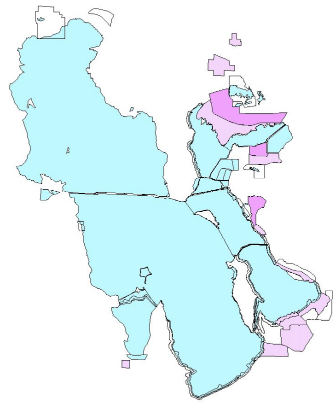


Long-billed dowitcher distribution by survey period.

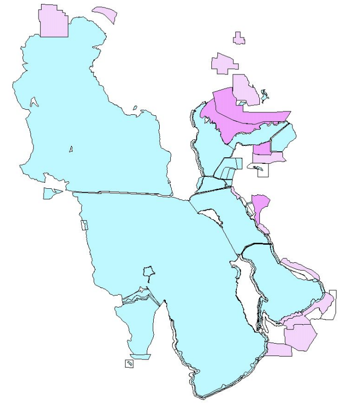
Numbers of LBDO



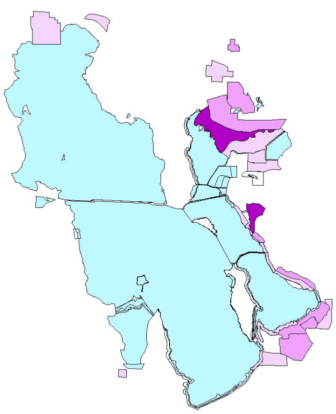
Period 1: April 6-15



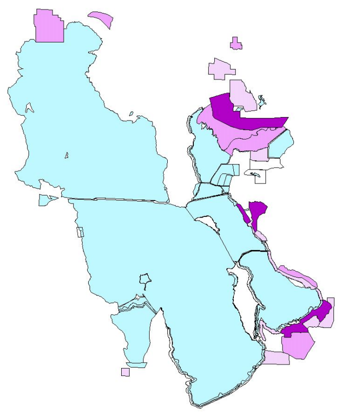
Period 2: April 16-25



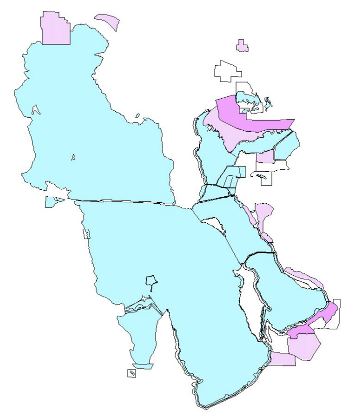
Period 3: April 26-May 5



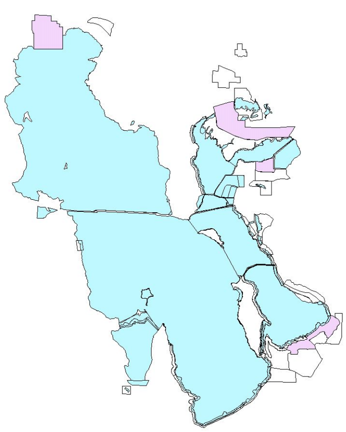
Period 4: May 6-15



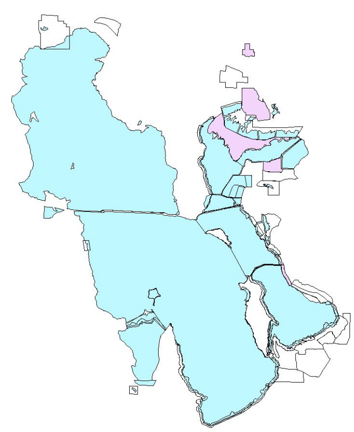
Period 5: May 16-25



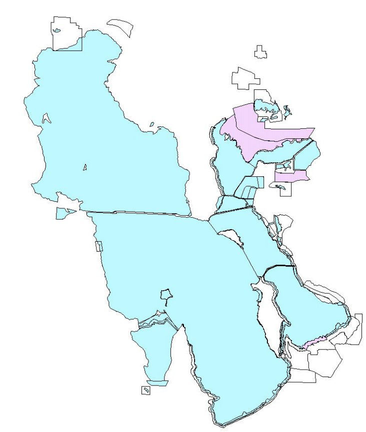
Period 6: May 26-June 4



Period 7: June 5-14

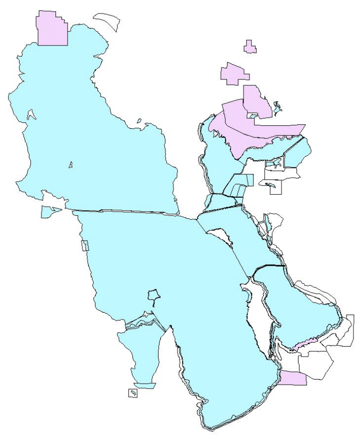


Period 8: June 15-24

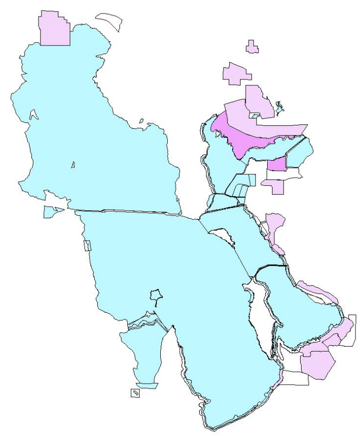


Long-billed dowitcher distribution by survey period.

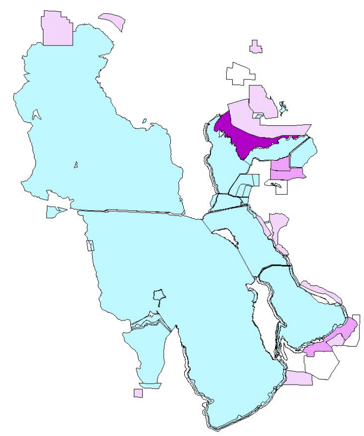
Period 9: June 25-July 4



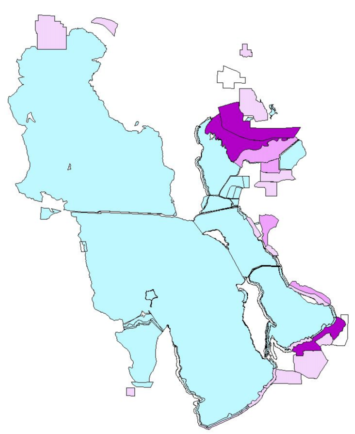
Period 10: July 5-14



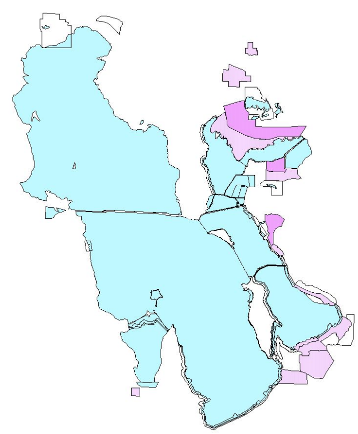
Period 11: July 15-24



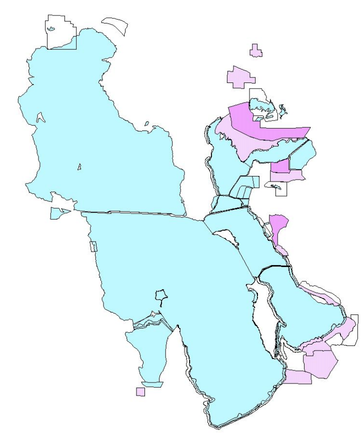
Period 12: July 25-Aug 3



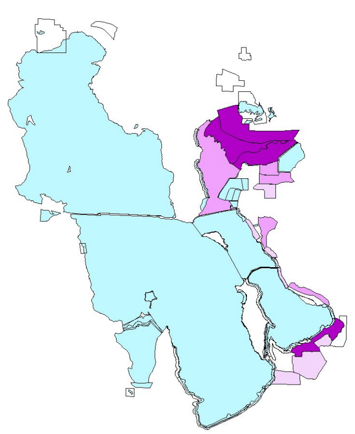
Period 13: Aug 4-13



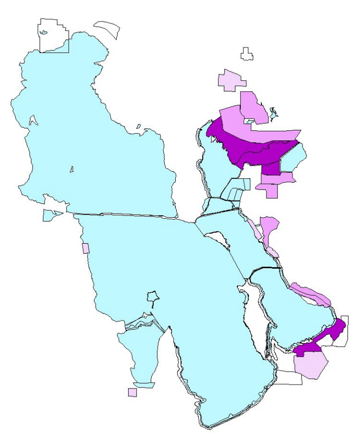
Period 14: Aug 14-23



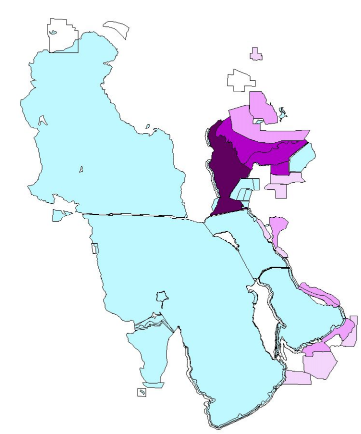
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

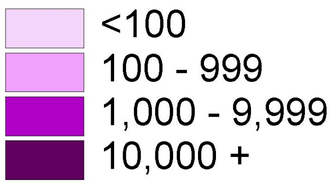


Period 17: Sep 13-22

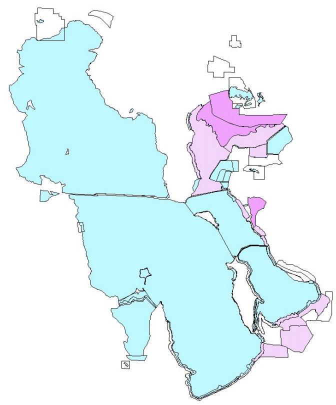


Marbled godwit distribution by survey period.

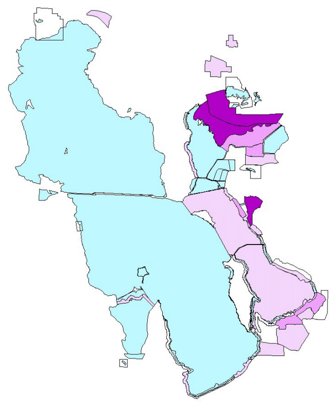
Numbers of MAGO



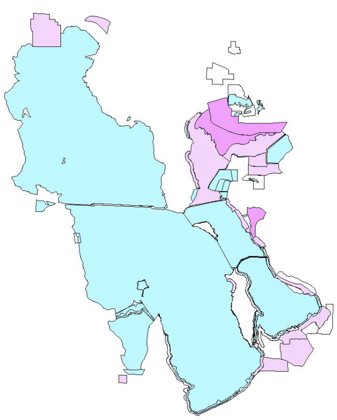
Period 1: April 6-15



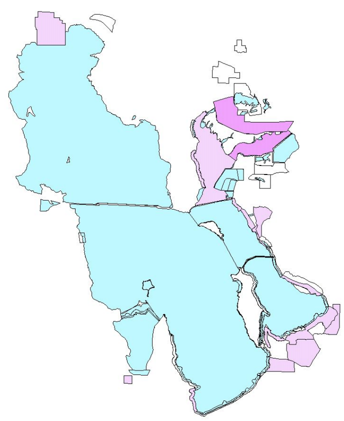
Period 2: April 16-25



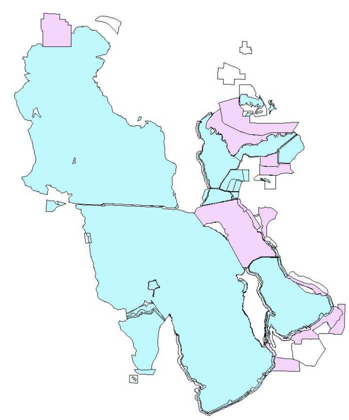
Period 3: April 26-May 5



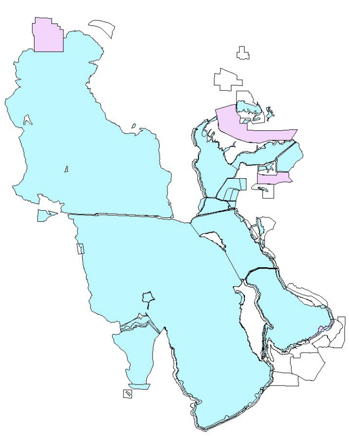
Period 4: May 6-15



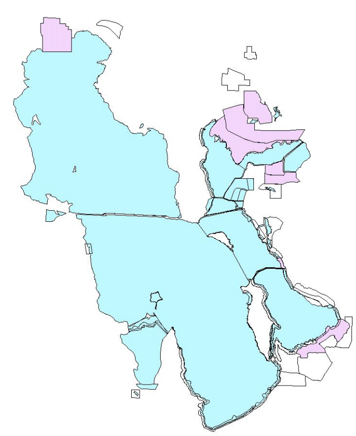
Period 5: May 16-25



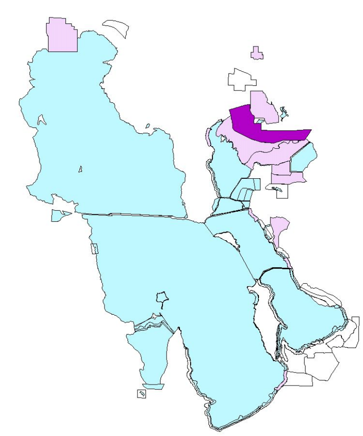
Period 6: May 26-June 4



Period 7: June 5-14

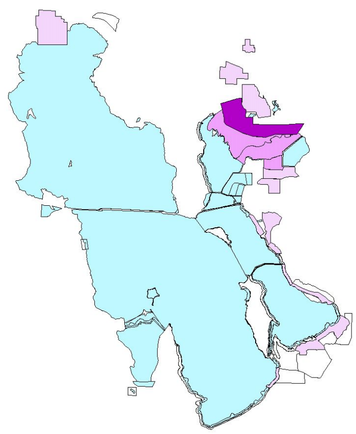


Period 8: June 15-24

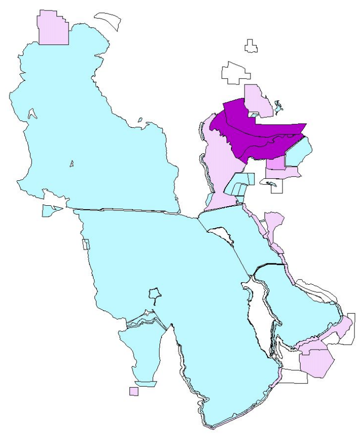


Marbled godwit distribution by survey period.

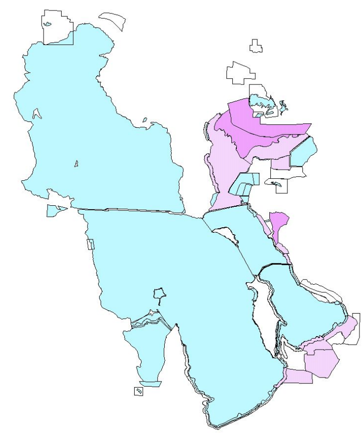
Period 9: June 25-July 4



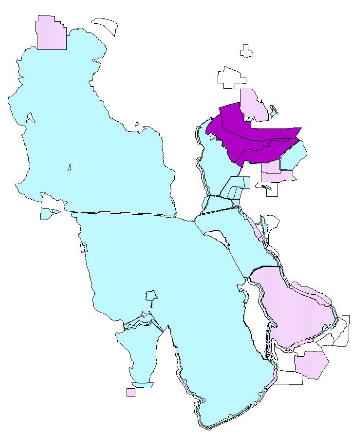
Period 10: July 5-14



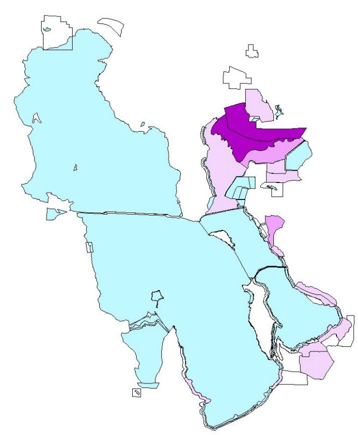
Period 11: July 15-24



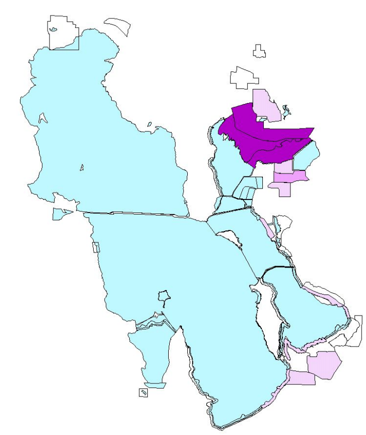
Period 12: July 25-Aug 3



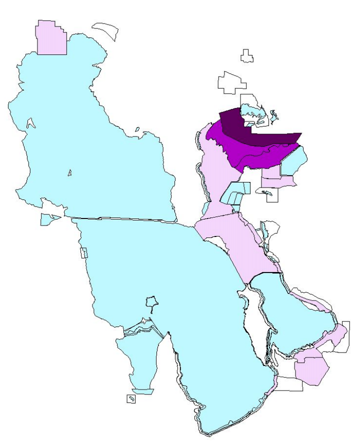
Period 13: Aug 4-13



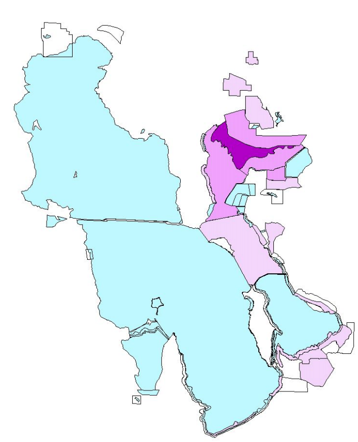
Period 14: Aug 14-23



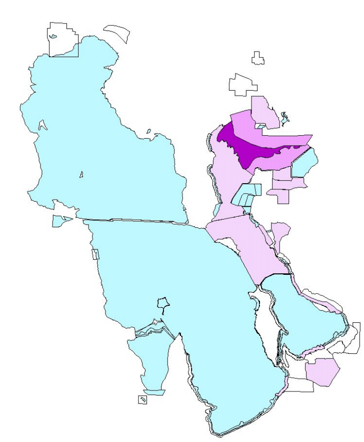
Period 15: Aug 24-Sep 2



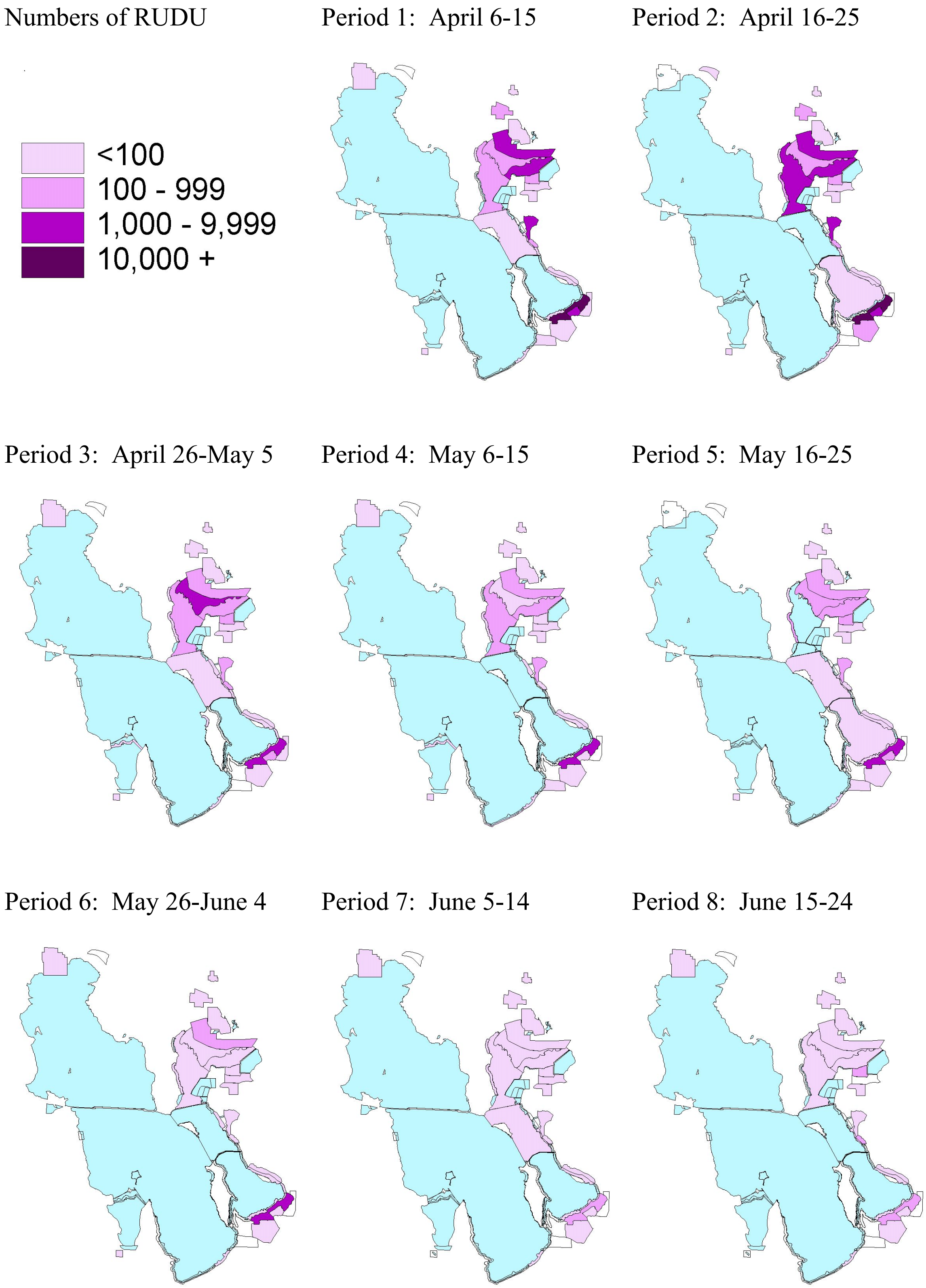
Period 16: Sep 3-12



Period 17: Sep 13-22

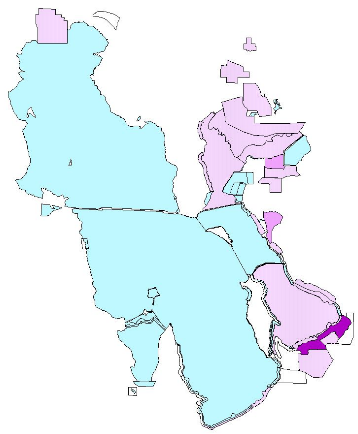


Ruddy duck distribution by survey period.

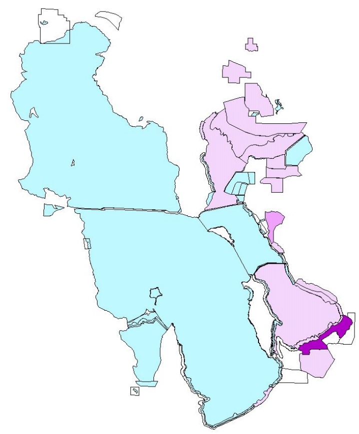


Ruddy duck distribution by survey period.

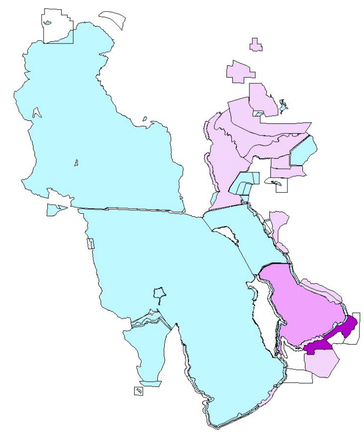
Period 9: June 25-July 4



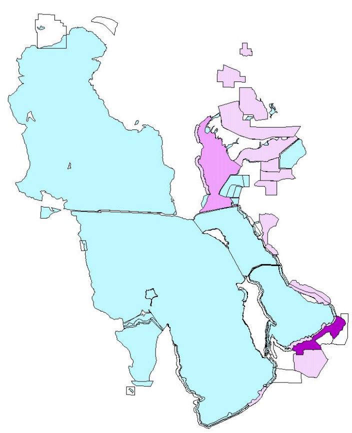
Period 10: July 5-14



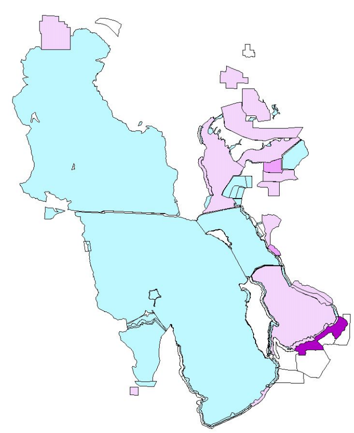
Period 11: July 15-24



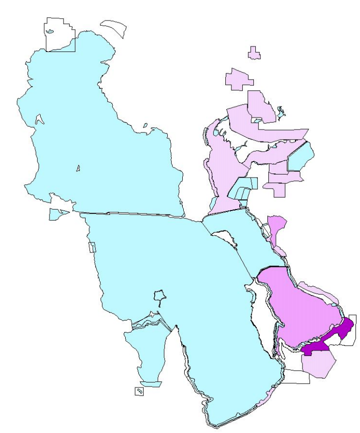
Period 12: July 25-Aug 3



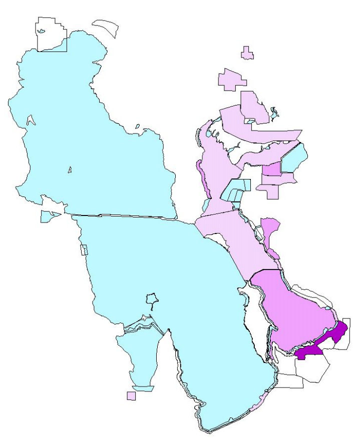
Period 13: Aug 4-13



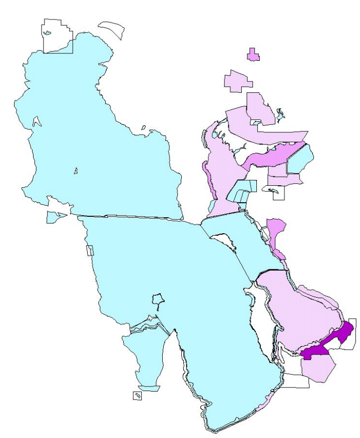
Period 14: Aug 14-23



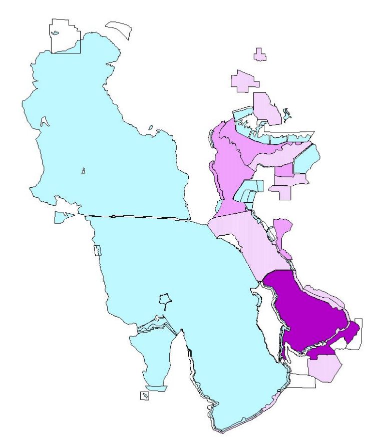
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

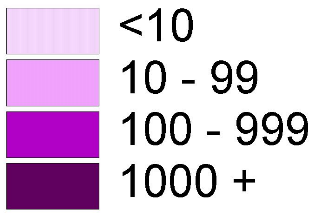


Period 17: Sep 13-22

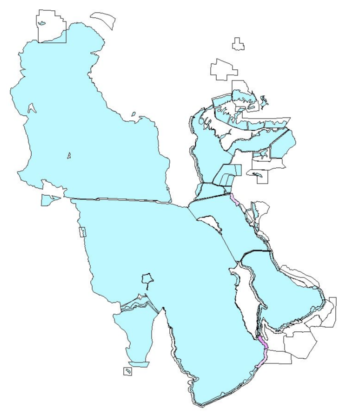


Sanderling distribution by survey period. Because sanderlings are at GSL in notable numbers during spring migration, only survey periods 1-5 are shown here.

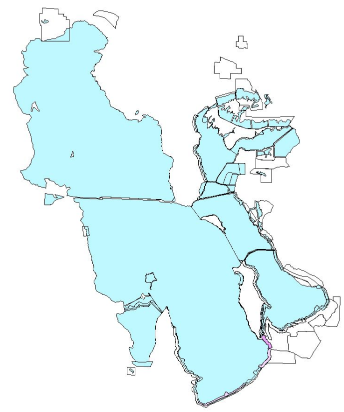
Numbers of SAND



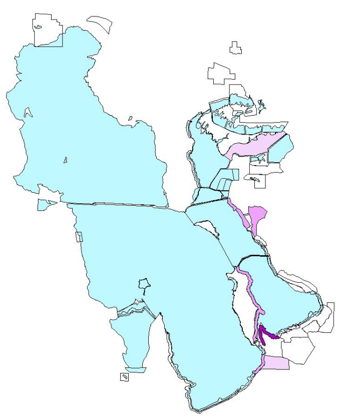
Period 1: April 6-15



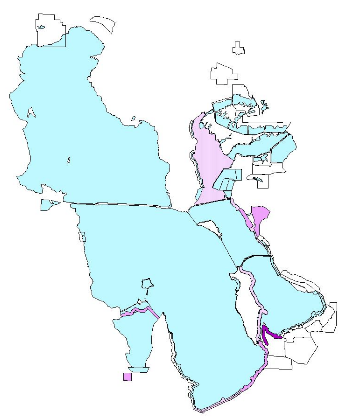
Period 2: April 16-25



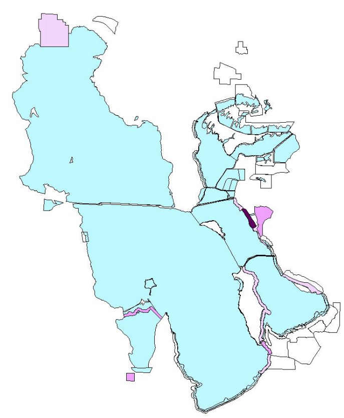
Period 3: April 26-May 5



Period 4: May 6-15

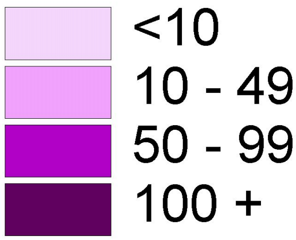


Period 5: May 16-25

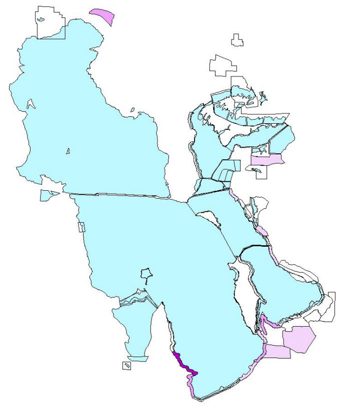


Snowy plover distribution by survey period.

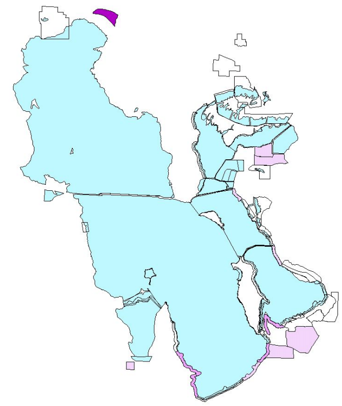
Numbers of SNPL



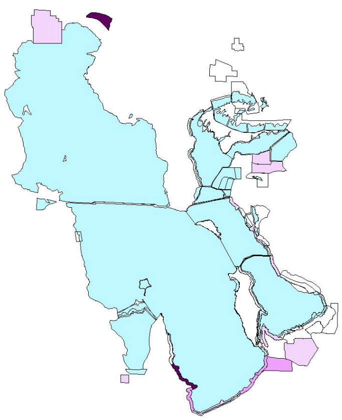
Period 1: April 6-15



Period 2: April 16-25



Period 3: April 26-May 5



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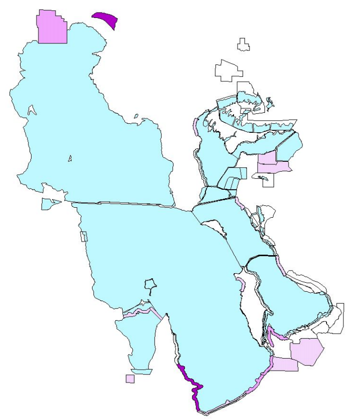

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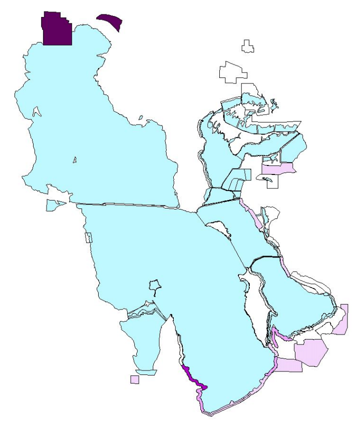

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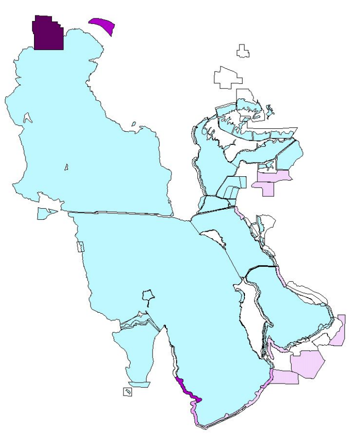

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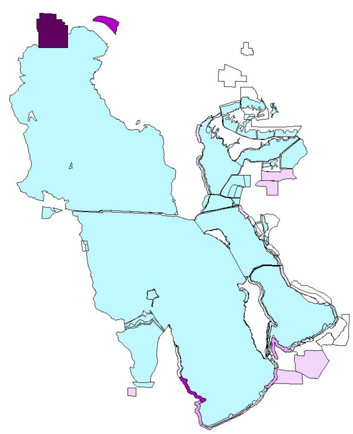
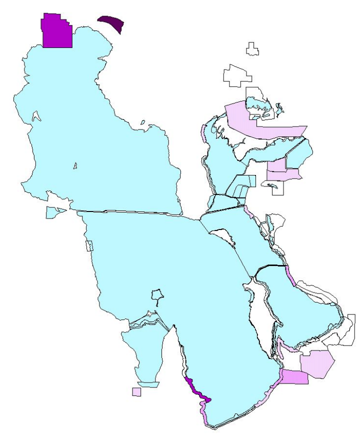
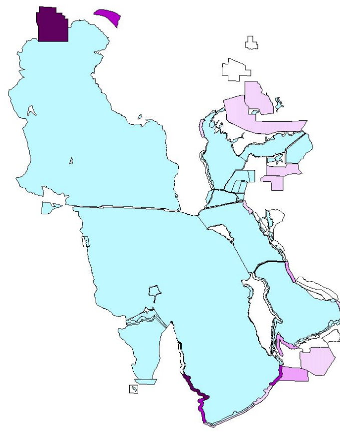


Period 8: June 15-24

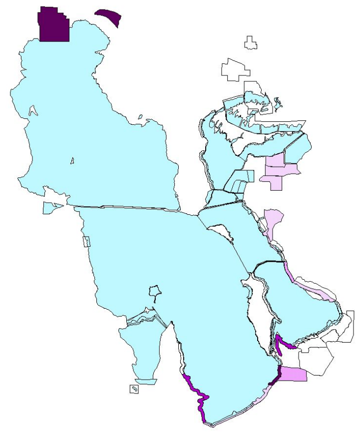


Snowy plover distribution by survey period.

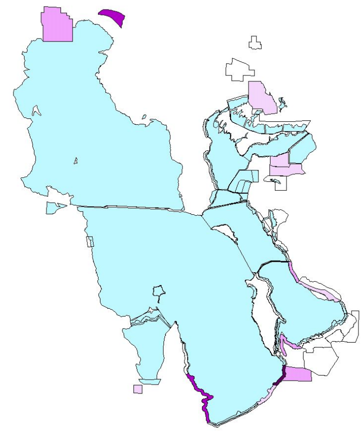
Period 9: June 25-July 4



Period 10: July 5-14



Period 11: July 15-24



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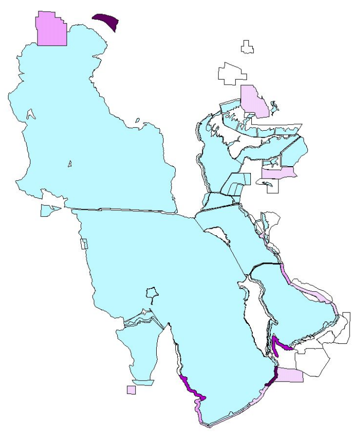
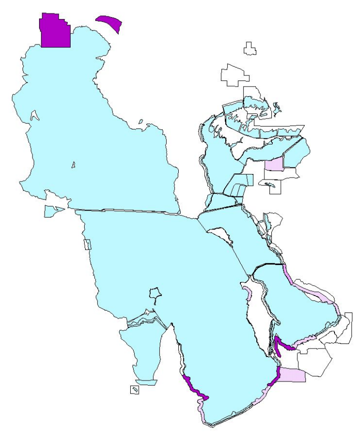


Period 13: Aug 4-13



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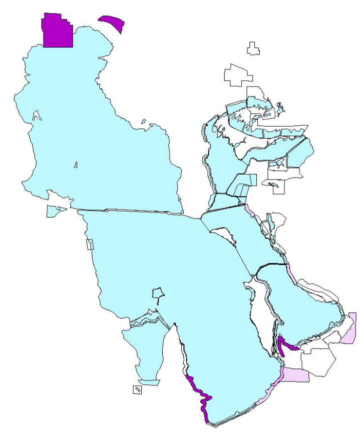
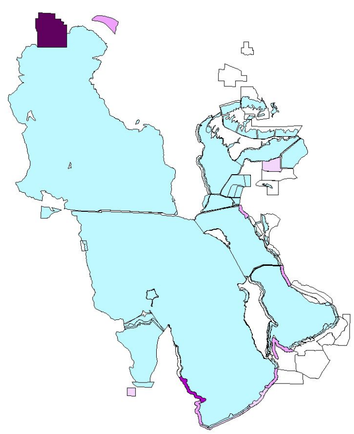
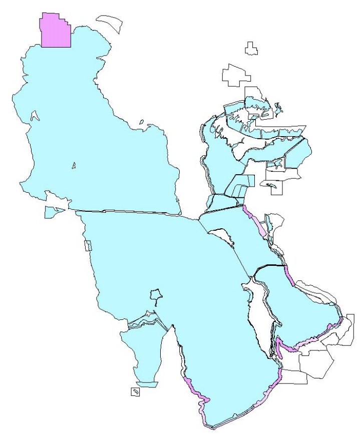


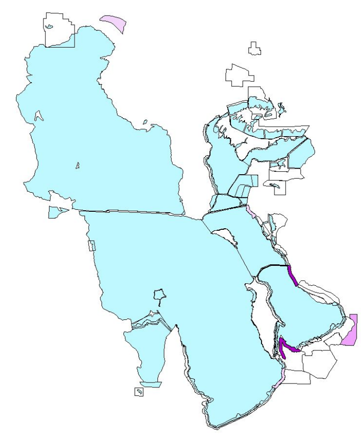
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

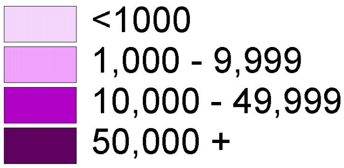


Period 17: Sep 13-22

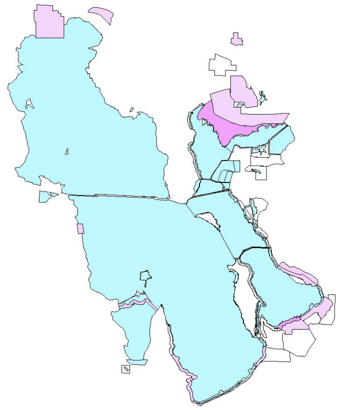


Western sandpiper distribution by survey period. The survey periods shown are times of western sandpiper presence at GSL.

Numbers of WESA



Period 9: June 25-July 4



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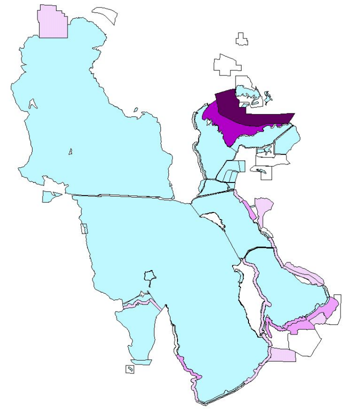
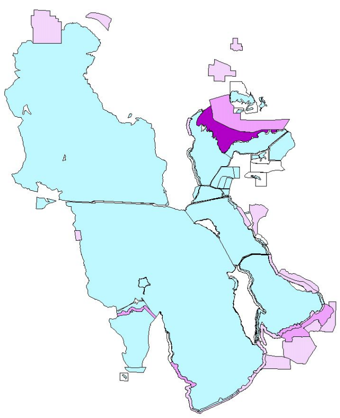
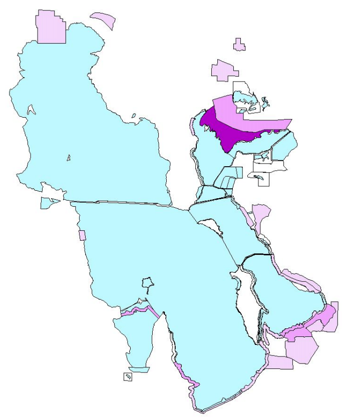


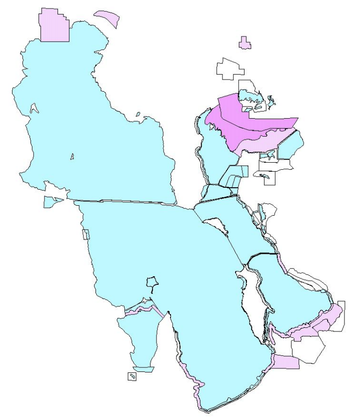
Period 11: July 15-24



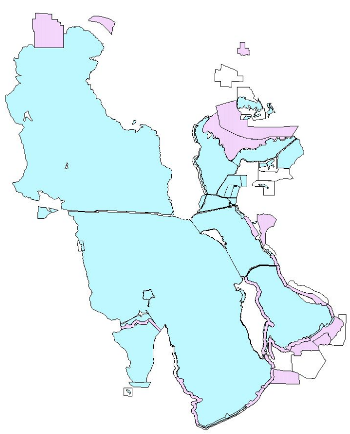
Period 12: July 25-Aug 3



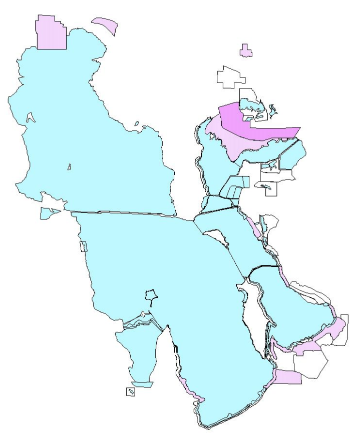
Period 13: Aug 4-13



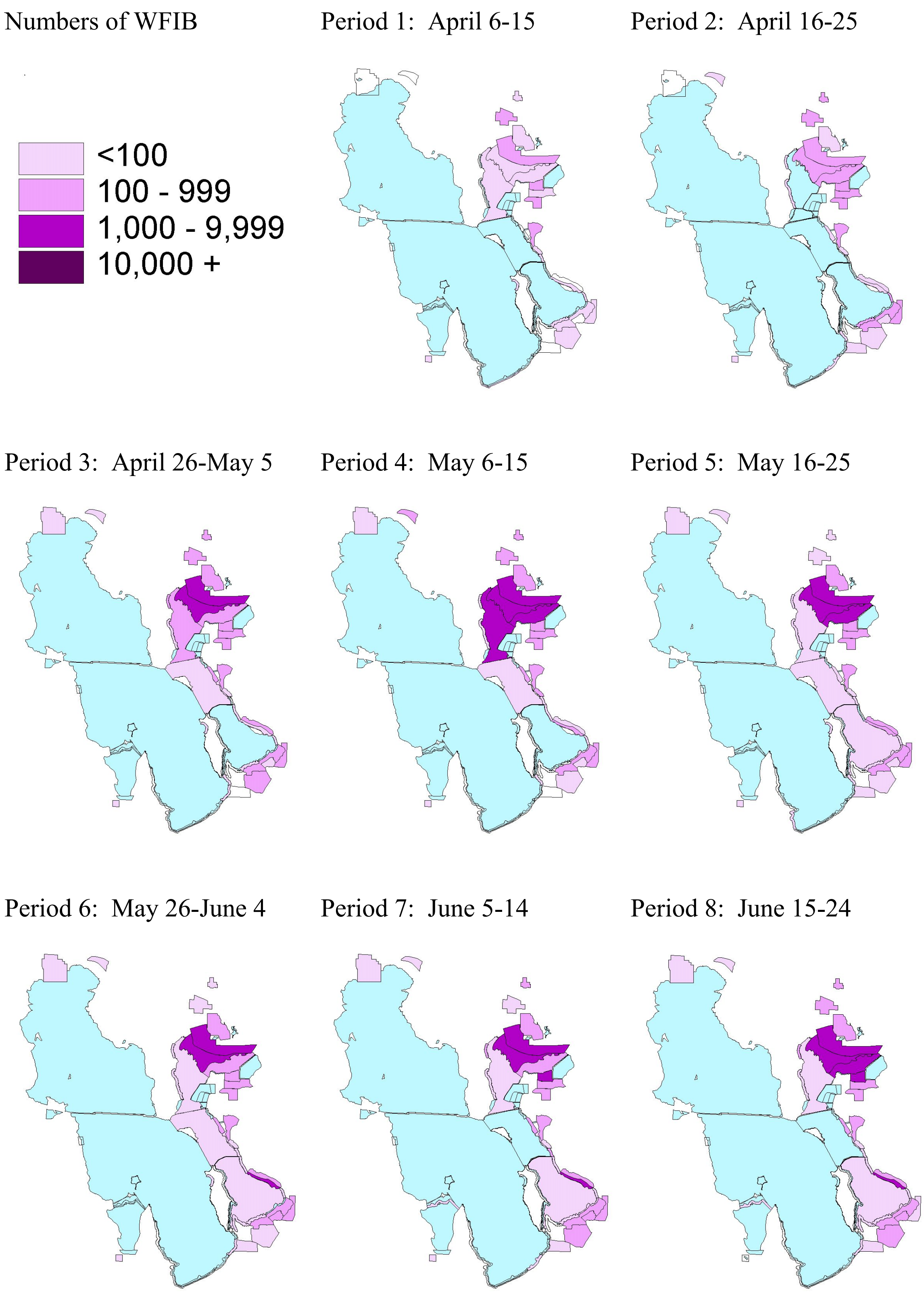
Period 14: Aug 14-23



Period 15: Aug 24-Sep 2

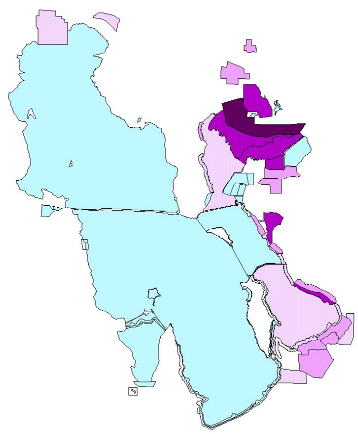


White-faced ibis distribution by survey period.

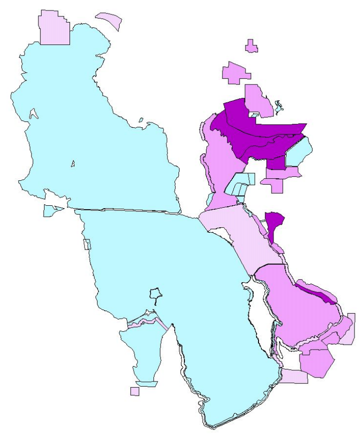


White-faced ibis distribution by survey period.

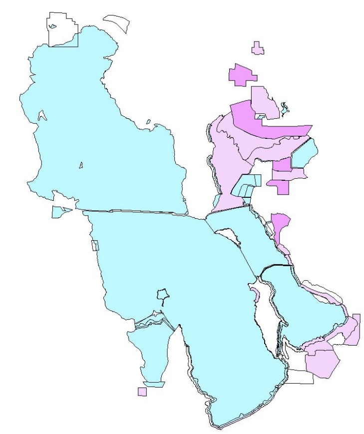
Period 9: June 25-July 4



Period 10: July 5-14



Period 11: July 15-24



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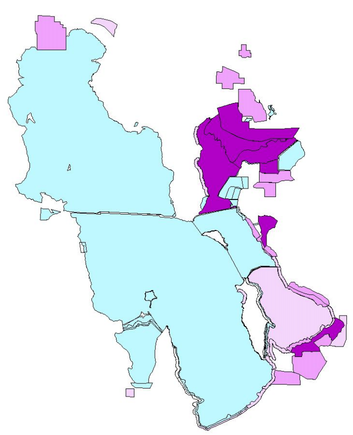
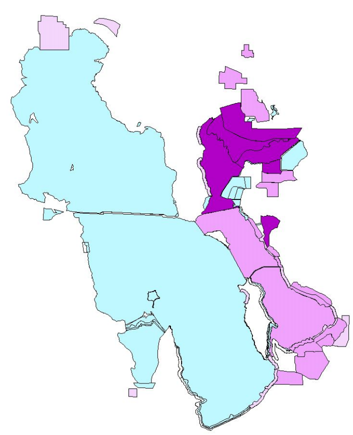
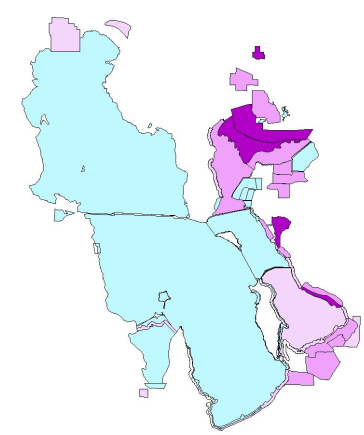


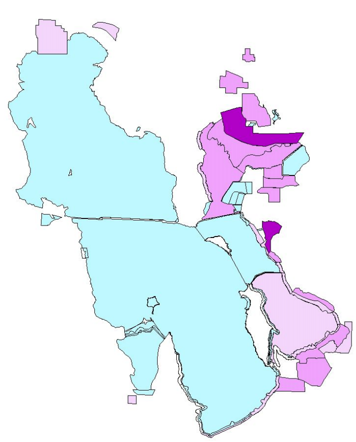
Period 13: Aug 4-13



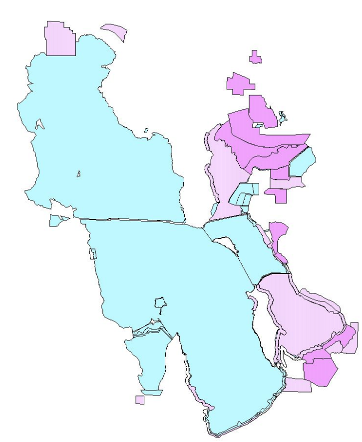
Period 14: Aug 14-23



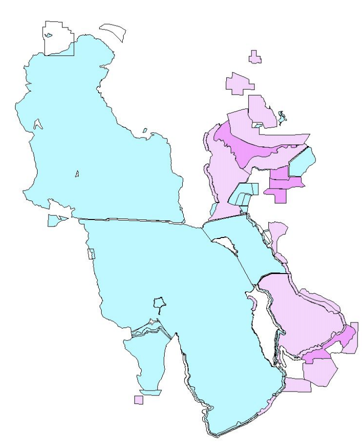
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

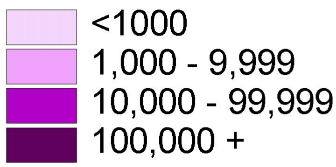


Period 17: Sep 13-22

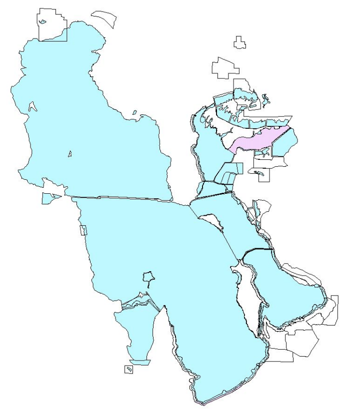


Wilson's phalarope distribution by survey period.

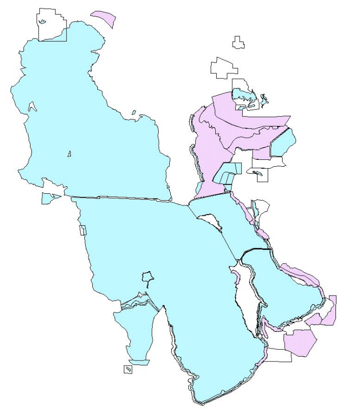
Numbers of WIPH



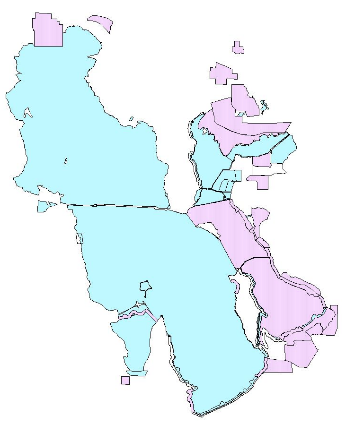
Period 1: April 6-15



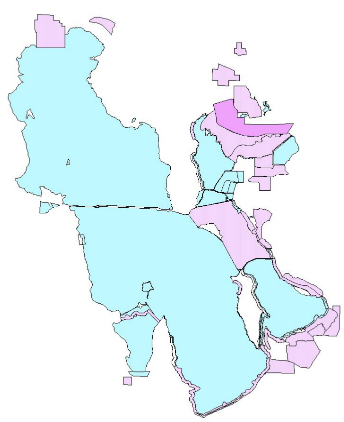
Period 2: April 16-25



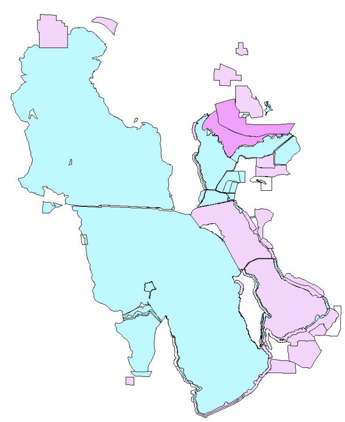
Period 3: April 26-May 5



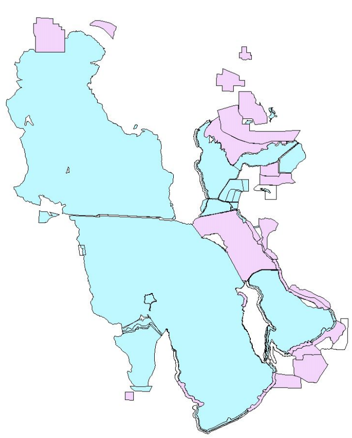
Period 4: May 6-15



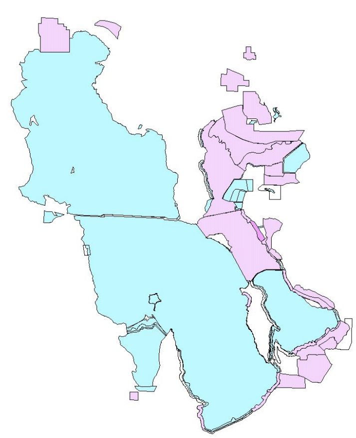
Period 5: May 16-25



Period 6: May 26-June 4



Period 7: June 5-14



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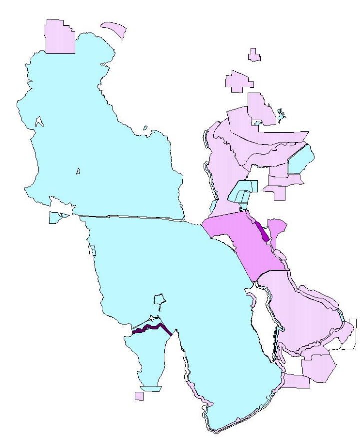
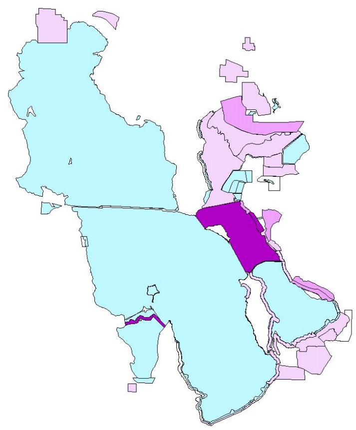
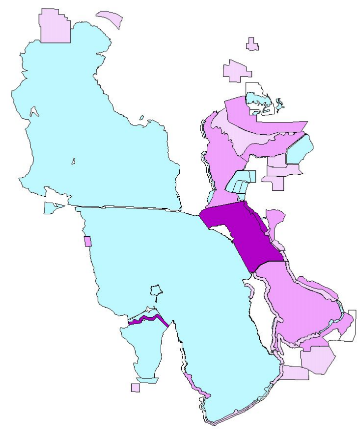


Wilson's phalarope distribution by survey period.

Period 9: June 25-July 4



Period 10: July 5-14



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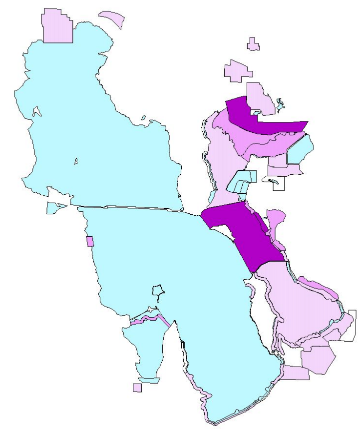
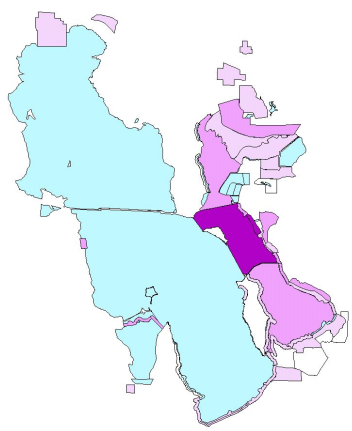
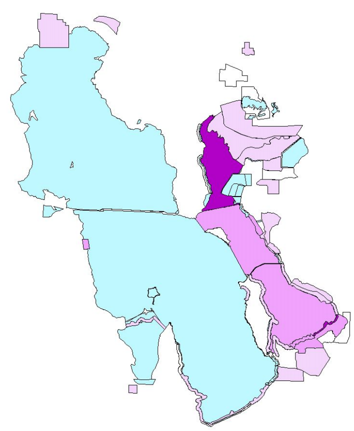


Period 12: July 25-Aug 3



Period 13: Aug 4-13



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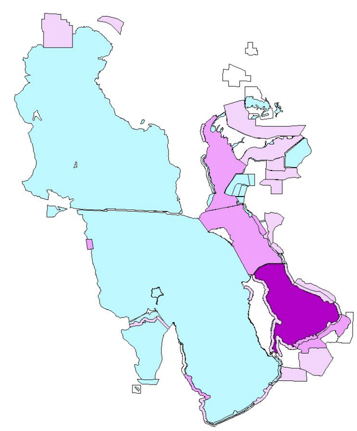
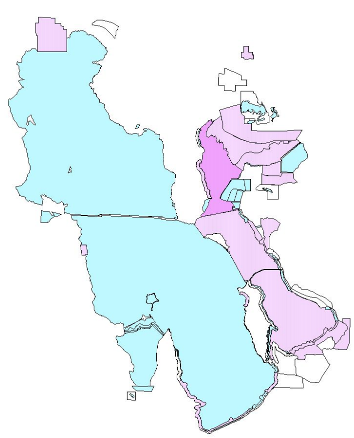
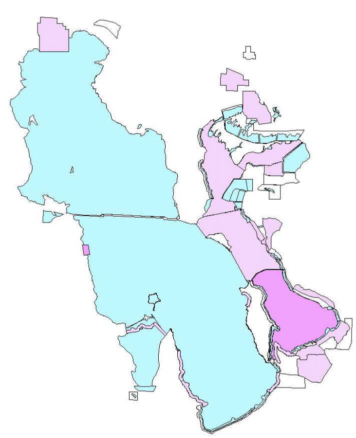


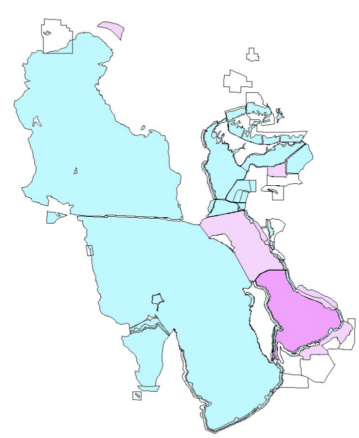
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12

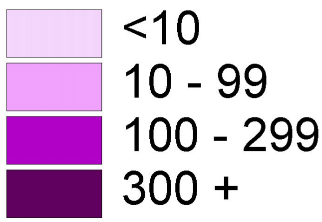


Period 17: Sep 13-22

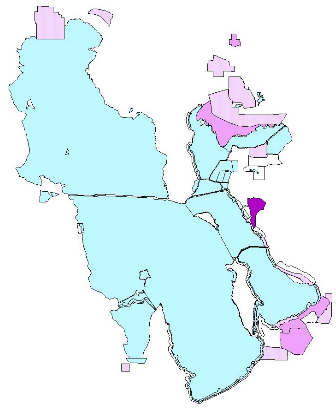


Yellowlegs distribution by survey period.

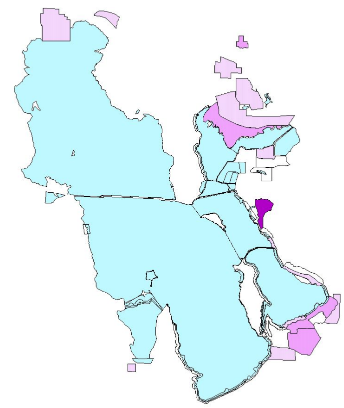
Numbers of YELLOW



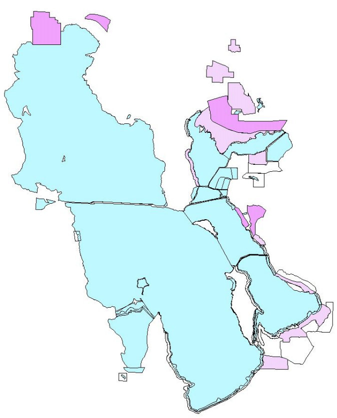
Period 1: April 6-15



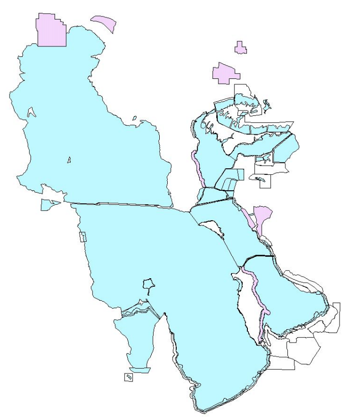
Period 2: April 16-25



Period 3: April 26-May 5



Period 4: May 6-15



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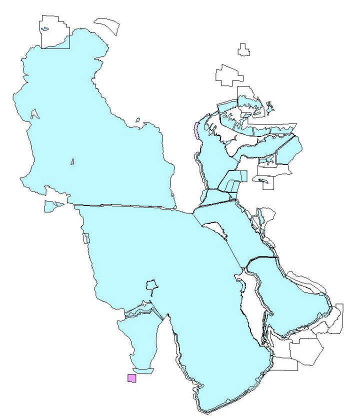
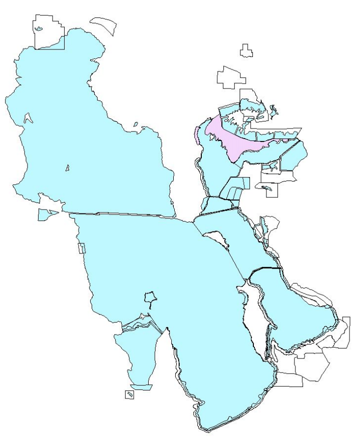
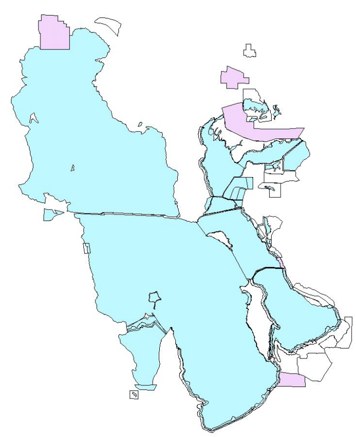


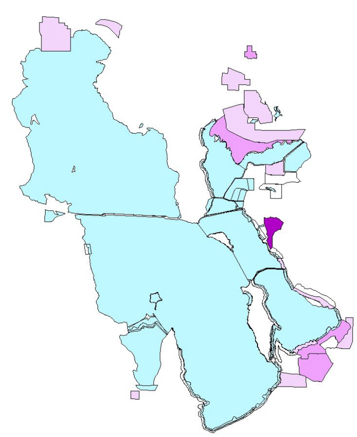
Period 6: May 26-June 4



Period 7: June 5-14

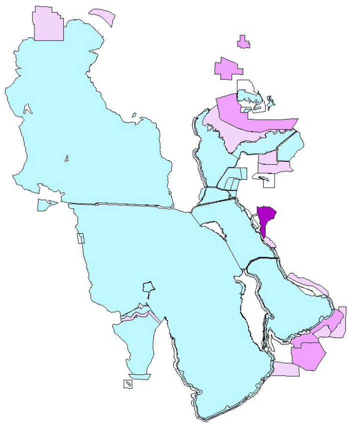


Period 8: June 15-24

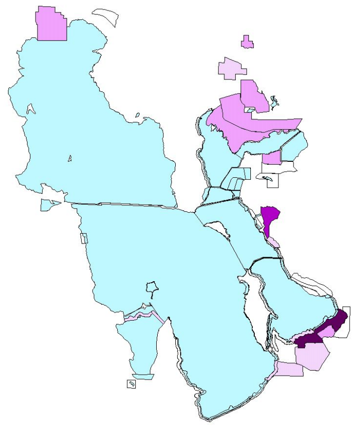


Yellowlegs distribution by survey period.

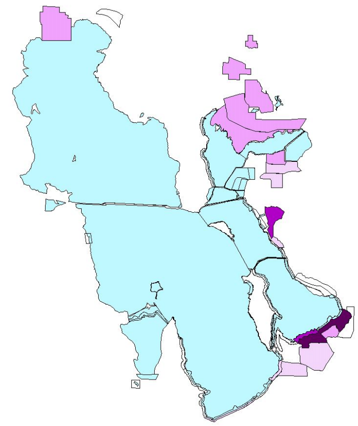
Period 9: June 25-July 4



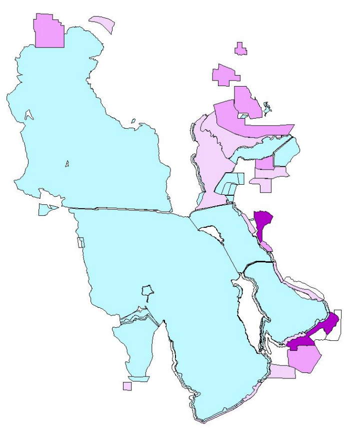
Period 10: July 5-14



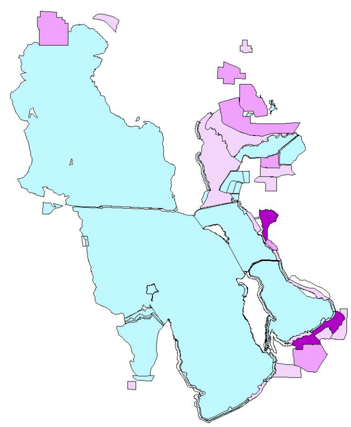
Period 11: July 15-24



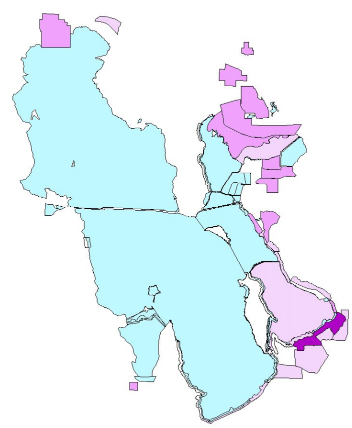
Period 12: July 25-Aug 3



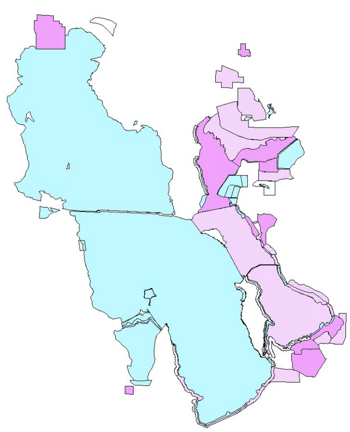
Period 13: Aug 4-13



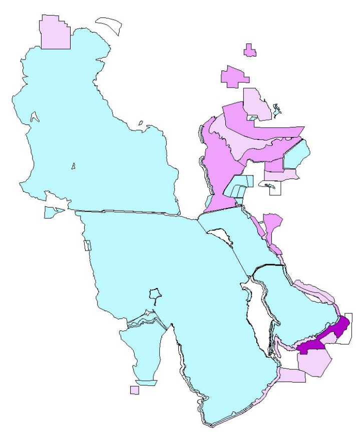
Period 14: Aug 14-23



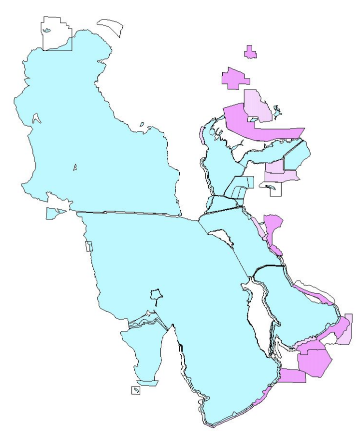
Period 15: Aug 24-Sep 2



Period 16: Sep 3-12



Period 17: Sep 13-22



Appendix 7:

A Plan for Monitoring Shorebirds During the Non-breeding Season in Region Utah – BCR9 (Great Basin)

Ann Manning, Catherine Wightman and Jon Bart

Version 0.2

March 2002

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Summary

This monitoring plan is designed to provide good estimates of the average number of shorebirds present in Utah's Great Basin region during the non-breeding season. These estimates will be used by Utah Division of Wildlife Resources (UDWR) to analyze trends in populations of individual species of shorebirds. Most of this document focuses on sampling plans for obtaining average estimates of shorebirds using ground surveys. A few species (i.e., American Avocets, Black-necked Stilts, Wilson's Phalaropes and Red-necked Phalaropes) are difficult to survey accurately from the ground and separate surveys are discussed for these exceptions at the end of the document. To facilitate planning, Bird Conservation Region-Great Basin (BCR9) in Utah has been divided into nine domains. Each domain is divided into one or more strata, which are the sampling units for these surveys. Habitat in each stratum is classified based on the amount of shorebird use. Unless casual observation suggests shorebirds are using these areas in moderate numbers, habitat of little to no shorebird use (Type 3 habitat) will not be surveyed. Areas with moderate use are classified as Type 2 habitat. Periodic, flexible surveys are recommended for these areas, primarily to verify that only a small proportion of the population uses these areas. More detailed and comprehensive surveys are recommended for habitat with substantial shorebird use (Type 1 habitat). Data collected from these surveys will be used in the trend analyses of shorebird populations. Out of 51 strata, 20 include some Type 1 habitat. Of these, 10 strata require additional information or a pilot study before survey recommendations can be made. In the other 10 strata, complete counts of shorebirds are possible in all Type 1 habitat.

This plan is a collaborative effort among local, regional, and national biologists. Local biologists have been particularly important by providing habitat information and survey recommendations. Implementation of this monitoring plan relies on their continued support and involvement.

Introduction

Shorebird Monitoring Region "Utah – BCR9 (Great Basin)," includes western Utah west of Interstate Routes 80 and 15 (Figure 14). The most important shorebird area in this region, and one of the most important in the western United States, is the Great Salt Lake–the fourth largest terminal lake in the world. The Great Salt Lake (GSL) is an aggregation of ecosystems each driven by different concentrations of brine as a result of anthropogenic activities and structures on and around the lake. The north, east, and south sides of the lake are the most modified and receive the most avian use. Human population density is also greatest along these edges. More than 23 species of shorebirds use the GSL ecosystem during migration stopovers, and for some it is a breeding ground. In mid-summer an abundant food source of brine flies and brine shrimp attracts the continent's largest staging concentrations of Wilson's phalaropes and significant numbers of red-necked phalaropes. The largest breeding and migratory populations of snowy plovers are typically found on mudflats in the summer months. American avocets and black-necked stilts also stage in large numbers, and a portion of them breed at the Great Salt Lake. The delta-formed wetlands also attract tens of thousands of long-billed dowitchers, marbled godwits, and western and least sandpipers during migration in spring and late summer. Other notable sites in the Region include Fish Springs NWR and Utah Lake.

The monitoring plan for the northern portion of this Region was designed using the knowledge gained during the Great Salt Lake Waterbird Survey (WBS; Appendix A). Three separate surveys are suggested: (1) ground-based counts for all species; (2) aerial surveys for avocets and black-necked stilts; (3) a survey for phalaropes using methods still to be determined. Separate counts of avocets, stilts, and phalaropes are needed because these species often occur in extremely large numbers (individual flocks with tens of thousands of birds) which are difficult to count accurately from the ground and are present too far from land to be counted accurately by ground-based surveyors. In many areas, however, especially the Wildlife Management Areas (WMAs), it may be possible to count avocets and stilts accurately from the ground. If so, since counts will be made here anyway for other species, ground counts may be a more cost-effective method for surveying avocets and stilts in these areas than covering these areas by the aerial survey. This issue will need attention as the sampling plan is developed. In this draft, however, we assume that avocets and stilts will be counted on ground counts and that aerial surveys will not cover selected areas that are well enough covered from the ground. Phalaropes are less likely to be covered to any significant extent on the ground-based counts because they are much more abundant in the open water portions of the GSL. Most of this document is focused on the ground surveys, but are included at the end of the report short sections suggesting needed development work on the other two surveys.

Delineation of Strata and Survey Areas Within Strata

The monitoring plan was designed to provide good estimates of the average number of shorebirds present during the "study period" for each "focal species." Final selection of the study period should not be made until several investigations, identified in this document, have been carried out and monitoring plans for other groups have been developed. We have carried out a preliminary analysis, however, and suspect that the study period will be July and August (Appendix B). We use this period below, while acknowledging that it may be changed before the final plan is adopted. The focal species include species that occur in the study area during the study period in high enough numbers that trends in the mean number of them present might be important in making management decisions at the regional, national, or international level. Trends for some additional species may be important at the local (e.g., a Wildlife Management Area) level, but we assume that local biologists would develop monitoring efforts for such species. We would be willing to provide advice for such efforts, however. Our tentative list of focal species for this planning region is given in Table 20.

We use the "shorebird-day" as a unit of measurement. A shorebird-day is one shorebird spending 24 hours within the study area during the study period. The value of this unit derives from the fact that the mean number of shorebirds present in the study area during the study period (the quantity we are trying to monitor) equals the total number of shorebird-days during the study period divided by the number of days in the study period. In deciding which areas to focus survey efforts on, we use rules based on the fraction of the shorebird-days that occur within different portions of the study area. This approach is explained in the next paragraph.

Table 20. Important shorebird species in Utah – BCR9

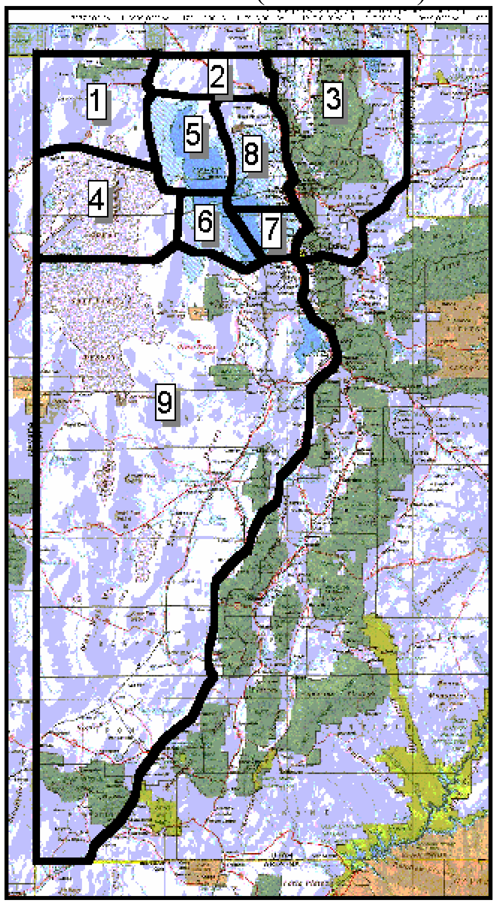
CODE	SPECIES	CONSERVATION VALUE[1]
AMAV	American Avocet[2]	5
AMGL	American Golden Plover	1
BASA	Baird's Sandpiper	1
BBPL	Black-bellied Plover	2
BNST	Black-necked Stilt[2]	5
COSN	Common Snipe	3
GRYE	Greater Yellowlegs	3
KILL	Killdeer	3
LESA	Least Sandpiper	4
LEYE	Lesser Yellowlegs	2
LBCU	Long-billed Curlew	5
LBDO	Long-billed Dowitcher	5
MAGO	Marbled Godwit	4
RNPH	Red-necked Phalarope[2]	4
SAND	Sanderling	1
SNPL	Snowy Plover	5
SOSA	Solitary Sandpiper	2
WESA	Western Sandpiper	4
WHIM	Whimbrel	1
WILL	Willet	4
WIPH	Wilson's Phalarope[2]	5

[1]U.S. Shorebird Conservation Plan - Intermountain West Region
5=critically important, 4=very important, 3=important, 2=slightly important, 1=unimportant

[2]Important shorebird species in the region that are not adequately monitored by ground surveys and are, therefore, not considered focal species in the ground survey section of this report

The Region has been divided into 9 "domains" (Figure 14). All areas within each domain were assigned to one of the following types: Type 1 – shorebirds present during the study period in substantial numbers; Type 2 – shorebirds present but in small numbers; Type 3 – virtually no shorebirds present during the study period. The goal in assigning habitat types was that >75% of the shorebird-days for each focal species in the region would occur in Type 1 strata; <20% of the shorebird-days in the region would occur in type 2 strata, and <5% of the shorebird-days in the region would occur in Type 3 areas. A sample of plots in Type 1 habitat will be surveyed each year using a detailed protocol that provides an estimate of the mean number of shorebirds present in the surveyed areas during the study period. Type 2 habitat will be surveyed every few years, using more flexible methods, to verify the assumption that <20% of the shorebird-days for each focal species occur in these areas. Type 3 habitat will not be surveyed regularly but bird watchers and biologists will be notified that we consider these areas virtually devoid of the focal shorebirds during the study period, and they will be asked to contact us if they find evidence that this assumption is wrong.

Figure 14. Utah-BCR9 (Great Basin) Domains



Delineated areas were defined by starting with shorebird concentration areas. When these areas were distinct and isolated from other areas (e.g., a Wildlife Management Area), they became "domains" (groups of strata). The borders between domains were chosen to follow a readily recognizable feature such as a road or river. Domains were defined for larger, continuous areas, such as the shore of the Great Salt Lake, by identifying portions of the area that would probably be surveyed using similar methods or that were in a single ownership. Sizes of domains were made small enough so that all the strata within each one could be displayed clearly on one-page maps.

Domains were then sub-divided into strata in such a way that a single sampling plan would be appropriate for all Type 1 habitat in each stratum. The sampling plan might be simple, such as "cover the entire stratum" or "cover a systematic sample of plots," or it might be more complex involving, for example, a two-stage process of rapid surveys of a large sample of plots and intensive surveys on a sub-set of these plots. The guiding principle, however, was that a single sampling plan be applicable to all Type 1 habitat. For example, if part of an area needed to be covered by aerial surveys and photography, and the rest could be covered by ground surveys, then the two areas would be placed in different strata since the sample selection and estimation methods would be quite different.

Development of Survey Protocols

A short description of each stratum was prepared reporting the species and approximate numbers present during the study period and discussing possible survey approaches. The most important part of these descriptions was the discussion of difficulties likely to be encountered in obtaining an accurate count. These descriptions included discussion of potential sampling plans but did not present a detailed operational plan. Detailed plans specifying the sample size, sample selection method, and field survey methods, will be prepared after special studies identified in this document have been completed and plans for monitoring other waterbirds have been developed. Many of the needed special studies, however, may require surveys to investigate the extent of problems in getting accurate counts and ways of solving these problems. Thus, surveys should probably be conducted in the near future in selected areas.

The description of each stratum contained two other sections intended to help us develop the survey methods and evaluate reliability of collected data. The first section was "Measurement Error and Measurement Bias:" Measurement error means not counting all the birds present in a plot at the time of the survey. Measurement bias is a long-term trend in the degree of measurement error. Measurement error does not necessarily cause serious problems because the proportion of birds detected might be constant through time so that the trend estimate would be accurate. However, any time detections rate are well below 100% (e.g., <80%), then it is possible that a long-term trend might occur in the detection rate (e.g., it might fall from 80% to 50%) thus generating spurious trends in the mean number of birds present in the stratum. We use the phrase "measurement error" rather than detection rate because in some cases (e.g., aerial surveys) the number recorded might exceed the number present. Measurement error – the ratio of number recorded to number present – is thus a more general term.

If measurement error was considered potentially serious (defined as an estimate that is not within 20% of the true number present at the time of the survey) then a discussion was provided of ways to minimize the error. Frequently, this discussion identified special studies that will need to be carried out before a final survey plan is adopted. If it seemed unlikely that substantial measurement error could be avoided, a discussion was also provided of the potential for measurement bias and of ways to determine whether this problem occurs during the coming years.

The second section for each stratum was a discussion of the potential for "selection bias." At the level of the stratum, selection bias arises when some parts of the stratum cannot be surveyed, usually due to access problems. Non-surveyable areas raise two problems. Some estimate of the mean number of birds present in these areas must be made so that results from different strata can be combined. This estimate does not need to be highly accurate. Methods for making these estimates for each non-surveyable area were discussed. The second problem is that any long-term trend in the fraction of birds within the stratum that are in the non-surveyable areas generates a spurious trend in the numbers present. For example, if initially half the birds are in non-surveyable areas but these areas gradually become unsuitable so the shorebirds move to the surveyable areas, then an increase will occur in the numbers recorded even if the number of birds actually present in the stratum shows no trend. Whenever non-surveyable areas existed in a stratum, and were thought to contain substantial numbers of birds – or might do so in the future – the potential for selection bias, and ways to remove it, were discussed. Special studies were often identified in these discussions.

The potential for selection bias was also discussed at the regionwide level. Some entire strata might be in the non-surveyable category, which introduces potential for bias not discussed within the individual stratum sections. Furthermore, while there might be substantial potential for selection bias in some strata, it might be felt that spurious negative and positive trends would approximately balance each other at the regional level.

The next section provides an overview of survey recommendations and the pilot studies that are needed before a comprehensive plan can be described. Pilot studies are prioritized and cost estimates are included. A discussion of the accuracy of the proposed surveys is also reported. In the concluding sections of this report, we describe ground, aerial photography, and phalarope surveys in detail.

Recommendations and Pilot Studies

A summary of each stratum and proposed sampling plan can be found in Table 21. This table also identifies where pilot studies are needed. There are 10 strata with Type 1 habitat that require pilot studies or additional information. These are prioritized below; however, the order in which they are implemented may change according to funding and time constraints.

The highest priority pilot study is to classify all habitat by type and identify survey constraints for Bear River Migratory Bird Refuge (stratum 8.102). This pilot study needs to include estimates of accuracy and potential errors. The sampling plan for Bear River Migratory Bird Refuge (MBR) will likely involve the use of random or stratified plots; therefore, selection bias will need to be evaluated.

The second highest priority pilot study is to classify all habitat by type and identify survey constraints for Utah Lake (strata 9.104, 9.105 and 9.106). This is of secondary importance to Bear River MBR because it is likely that all Type 1 habitat, once identified, can be surveyed completely. This would eliminate the need for a detailed sampling plan.

The next highest priority is developing wetland survey protocols for the West Kaysville (7.109) and Farmington Bay WMA (7.110) strata. It is likely that all Type 1 habitat cannot be surveyed accurately in these strata and, therefore, sampling plans are needed.

For Ogden Bay (8.105) and Harold Crane WMA (8.107) strata, pilot studies are needed to assess whether all Type 1 habitat is visible and can be surveyed completely. If it is determined that all Type 1 habitat cannot be surveyed completely, then sampling plans are needed.

Table 21. Summary of Utah – BCR9 strata by habitat type and area, plus recommended survey methods and time required to conduct surveys.

STRATUM	NAME	AREA (km^2)				HABITAT	SURVEY METHODS	TIME REQUIRED
		TYPE 1	TYPE 2	TYPE 3	TOTAL			
1.101	Northwest	0	0	6957	6957	dry desert and mountains	NONE	NONE
2.101	Northcentral	0	0	3381	3381	pinyon-juniper and sagebrush	NONE	NONE
3.101	Cutler Marsh	0	?	?	1562	mountains and river valleys	occasional aerial surveys of Type 2 habitat	N/A
3.102	Wasatch Range	0	0	11675	11675	mountains	NONE	NONE
3.103	Neponset Reservoir	0	8	480	488	reservoir and uplands	occasional ground surveys of Neponset Reservoir	?
4.101	Northern Utah – Southwest	0	0	8357	8357	salt desert	NONE	NONE
5.101	Locomotive Springs WMA	61	0	295	356	marsh, mudflats, uplands and open water	census marsh and mudflats by foot	4 hrs
5.102	Salt Wells Flat WHA	47	15	93	155	mudflats, ponds, uplands and open water	census mudflats by ATV, occasional surveys of ponds by foot	4 hrs
5.103	Northwest Great Salt Lake	0	0	1645	1645	shoreline, uplands and open water	NONE	NONE
5.104	West of Promontory Mtns.	0	0	1924	1924	shoreline, uplands and open water	NONE	NONE
6.101	Westcentral Great Salt Lake	0	120	2130	2250	shoreline, uplands and open water	occasional ground surveys of shoreline	3 hrs
6.102	Stansbury Bay	14	0	837	851	evaporation ponds and shoreline	census shoreline from dike road	3 hrs
6.103	Stansbury North	0	40	63	103	shoreline, uplands and open water	occasional aerial surveys of shoreline	N/A
6.104	Stansbury South	26	95	0	121	shoreline and mudflats	census shoreline by ATV, occasional foot surveys of Type 2	3 hrs
6.105	Interstate 80 North	0	22	83	105	shoreline, ponds and open water	periodic driving surveys of shoreline, pilot study required to assess complete coverage of Type 2 habitat	3 hrs
7.101	Antelope Island West	0	66	362	428	rocky shoreline and open water	occasional ground survey of shoreline	3 hrs
7.102	Antelope Island Causeway	0	64	0	64	causeway and shoreline	occasional driving survey of causeway	1-2 hrs
7.103	Antelope Island Northeast	0	23	117	140	shoreline, uplands and open water	occasional aerial surveys of shoreline	N/A
7.104	West Layton	0	5	34	39	shoreline and wetlands	occasional aerial surveys of shoreline	N/A

STRATUM	NAME	AREA (km^2)				HABITAT	SURVEY METHODS	TIME REQUIRED
		TYPE 1	TYPE 2	TYPE 3	TOTAL			
7.105	Antelope Island Southeast	?	?	?	58	shoreline and mudflats	simultaneous counts from both sides of stratum, ATV if helpful	5 hrs
7.106	Crystal Lakeside	12	?	?	54	shoreline and open water	pilot study to assess accuracy of airboat surveys of shoreline	2-3 hrs
7.107	Farmington Bay Lakeside	0	5	82	87	shoreline and open water	occasional aerial surveys of shoreline	N/A
7.108	West Farmington	0	?	?	12	shoreline and uplands	occasional aerial surveys of shoreline	N/A
7.109	West Kaysville	?	?	?	208	shoreline, wetlands, and open water	census shoreline by foot, pilot study need for wetlands	4 hrs
7.110	Farmington Bay WMA	27.5	0.5	71	99	wetlands and uplands	pilot study for wetlands needed	4 hrs
7.111	Saltair	11	0	23	34	shoreline and open water	census shoreline from vehicle and by foot	2-3 hrs
7.112	Kennecott	?	?	?	37	shoreline, wetlands, open water and shallow ponds	census shoreline and wetlands by foot	3 hrs
7.113	Associated Duck Clubs	0	?	?	207	wetlands and uplands	census wetlands by foot and boat	8-10 hrs
8.101	Salt Creek	0	?	?	1122	wetlands and uplands	occasional aerial surveys of wetlands	N/A
8.102	Bear River NWR	?	?	?	291	wetlands and shallow ponds	pilot study needed to classify habitats and develop sampling plan	8-10 hrs
8.103	Bear River Bay	82	?	?	663	wetlands or dry depending on water level	census of Willard Spur by airboat, occasional aerial surveys for rest	4 hrs
8.104	Ogden Bay North	0	7	39	46	shoreline and open water	occasional foot or ATV surveys of shoreline	2 hrs
8.105	Ogden Bay	22	3	244	269	wetlands, open water and uplands	pilot study needed to determine whether all Type 1 habitat is visible	5 hrs
8.106	Howard Slough WMA	4	4	180	188	wetlands, open water and uplands	ground surveys of drawn down pond, occasional aerial surveys for rest	4 hrs
8.107	Harold Crane WMA	33	6	240	279	wetlands, open water and uplands	pilot study needed to assess feasibility of censusing all Type 1 habitat	4 hrs
9.101	Blue Lakes	?	?	611	670	marshes and salt desert	pilot study needed to assess habitat type and ability to census marsh	?
9.102	Great Salt Lake Desert	0	0	13298	13298	salt desert	NONE	NONE
9.103	Oquirrh Mountains	0	0	7834	7834	mountains and sagebrush	NONE	NONE
9.104	North Utah Lake	?	?	?	185	playa, marsh, shoreline and open water	pilot study needed to assess habitat type and ability to census all Type 1	?
9.105	Central Utah Lake	?	?	?	721	playa, marsh, shoreline, mountain and open water	pilot study needed to assess habitat type and ability to census all Type 1	?

STRATUM	NAME	AREA (km^2)				HABITAT	SURVEY METHODS	TIME REQUIRED
		TYPE 1	TYPE 2	TYPE 3	TOTAL			
9.106	Utah Lake Wetland Preserve	?	?	?	213	playa, marsh, shoreline and open water	pilot study needed to assess habitat type and ability to census all Type 1	?
9.107	Eastern Juab County	0	0	6268	6268	dry desert and mountains	NONE	NONE
9.108	Fish Springs NWR	91?	0	0	91	marshes and small ponds	pilot study or more info needed to assess detection rates on vehicle surveys	?
9.109	Big Spring Complex	0	0	7330	7330	dry desert and mountains	NONE	NONE
9.110	Sevier River	0	1	4422	4423	dry desert and mountains	occasional ground census of Topaz Slough and Sevier River in wet years	NONE
9.111	Clear Lake WMA	0	31	0	31	marshes	occasional ground census	?
9.112	Central Utah	0	10	7052	7062	dry desert and mountains	occasional ground census of Minersville Reservoir	?
9.113	Sevier and Escalante Deserts	0	0	18248	18248	dry desert and mountains	NONE	NONE
9.114	Parowan Valley	0	0	1478	1478	dry desert and mountains	NONE	NONE
9.115	Cedar City	0	7	139	146	wetlands or dry depending on water level and upland	occasional ground census of Quichapa Lake in spring and fall	?
9.116	Southwestern Utah	0	0	6173	6173	mountains	NONE	NONE

A pilot study is also necessary to assess the accuracy of airboat surveys of the shoreline in the Crystal Lakeside stratum (7.106). Additionally, habitat type and ability to census the marsh at Blue Lake (stratum 9.101) needs to be evaluated. Pilot studies at these two strata are of lower priority because they cover relatively small areas (e.g., 12-km^2 of Type 1 habitat in stratum 7.106).

Finally, the occasional aerial surveys that are recommended for surveying for all focal species in much of the Type 2 habitat need to be evaluated for accuracy and cost-effectiveness. An alternative method may be necessary if accuracy is low. Similarly, a pilot study may be needed to evaluate survey methods for the Type 2 habitat in the Interstate 80 North stratum (6.105). Sampling protocols for Type 2 habitats are lower priority than all surveys in Type 1 habitat.

Cost estimates of implementing these pilot studies will be added.

Accuracy of the Proposed Surveys

Precision

In strata where all Type 1 habitat can be accurately sampled, precision of these surveys should be relatively high. It is important for the proportion of shorebirds counted to the actual number present to be relatively constant. Observers need to evaluate constantly their ability to cover Type 1 habitat, as a change in the amount of Type 1 habitat covered could decrease precision in numbers counted. This may be an important consideration in the proposed surveys because water levels fluctuate among years and may impede access to certain areas.

More complex sampling plans for some of the strata have yet to be developed. The precision of the surveys will depend on the sampling plan.

Bias

For many strata in this region, all type 1 habitat is surveyed. Therefore, there is no potential for bias associated with selected survey areas. More complex sampling plans for some of the strata have yet to be developed. However, bias associated with these sampling plans needs to be evaluated.

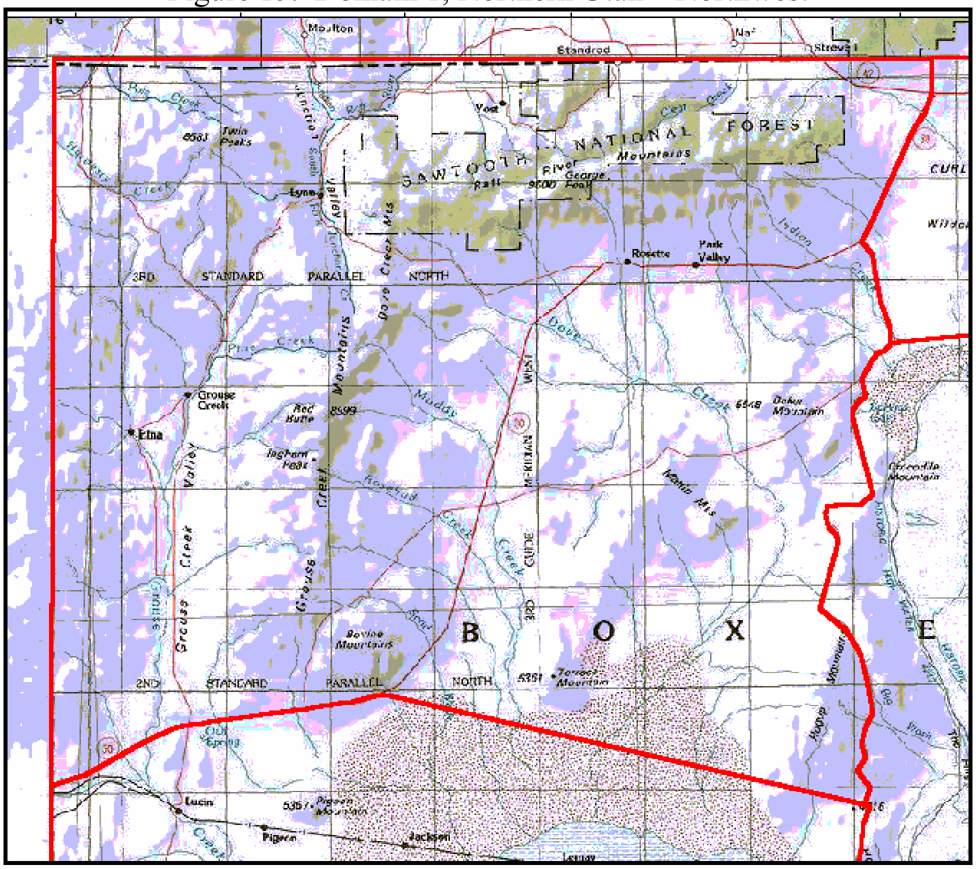
In very wet years, the availability and location of suitable habitat for shorebirds may change substantially in western Utah. This is an important consideration in designing shorebird surveys for this region. Occasional surveys of dry basins (e.g., Sevier Lake) and other Type 3 habitats are recommended in years of very high precipitation to detect possible shifts in habitat suitability, and thus, use by shorebirds. These periodic surveys would reduce regional selection bias caused by the movement of birds from a surveyed area to an unsurveyed area. If these movements went undetected, trend analysis might indicate a population change, even if there is no change in numbers of shorebirds in the region.

Ground Surveys

This section describes each stratum in the study area providing the information described above. Strata are grouped into nine domains for convenience. A separate map is provided for each domain.

Domain 1. Northern Utah – Northwest

Figure 15. Domain 1, Northern Utah – Northwest



Description: Domain 1 is bordered on the west and north sides by the Utah State border. The southern border is State Rt. 30 on the west side and a straight line from the bend in Rt. 30 to the southeast corner of the Domain, which is in the uplands of the Hogup Mountains. The east border lies along small roads. The domain includes a single stratum (1.101).

Land Ownership: This domain consists of public and private lands.

Classification: The entire domain is Type 3.

Survey Method: None needed unless casual observations suggest a change in shorebird use.

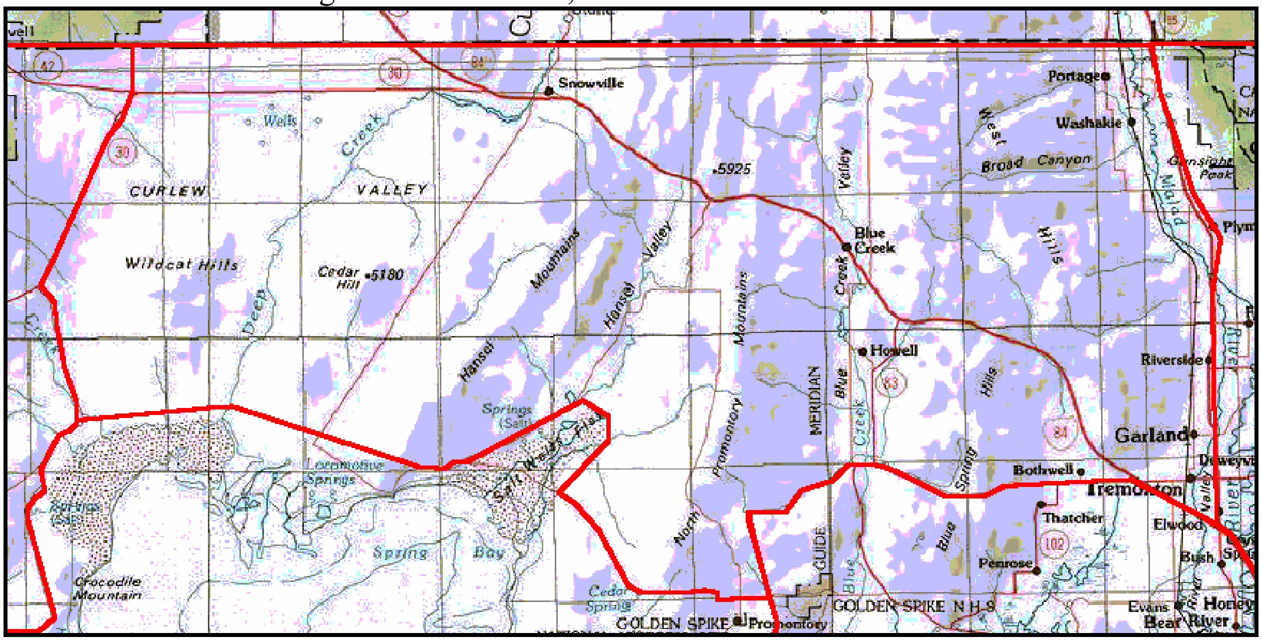
Measurement Error and Measurement Bias: None.

Selection Bias: None.

Pilot Studies Needed: None.

Domain 2. Northern Utah – Northcentral

Figure 16. Domain 2, Northern Utah – Northcentral



***Description*:** Domain 2 includes the area between the north end of the Great Salt Lake and the northern Utah border. The western border is State Rt. 30 and a small road from a bend in Rt. 30 to Kelton. The southern border is small roads, lying completely north of the Locomotive Springs WMA, and SR 83 on the east side except that the border skirts Salt Wells Flat WHA (Wildlife Habitat Area), which is in Domain 5. The southeast corner of the domain is the intersection of SR 83 and I-15. The eastern border is I-15. The domain includes a single stratum (2.101).

***Land Ownership*:** This domain consists of public and private lands.

***Classification*:** The entire domain is Type 3 habitat.

***Survey Method*:** None needed unless casual observations suggest a change in shorebird use.

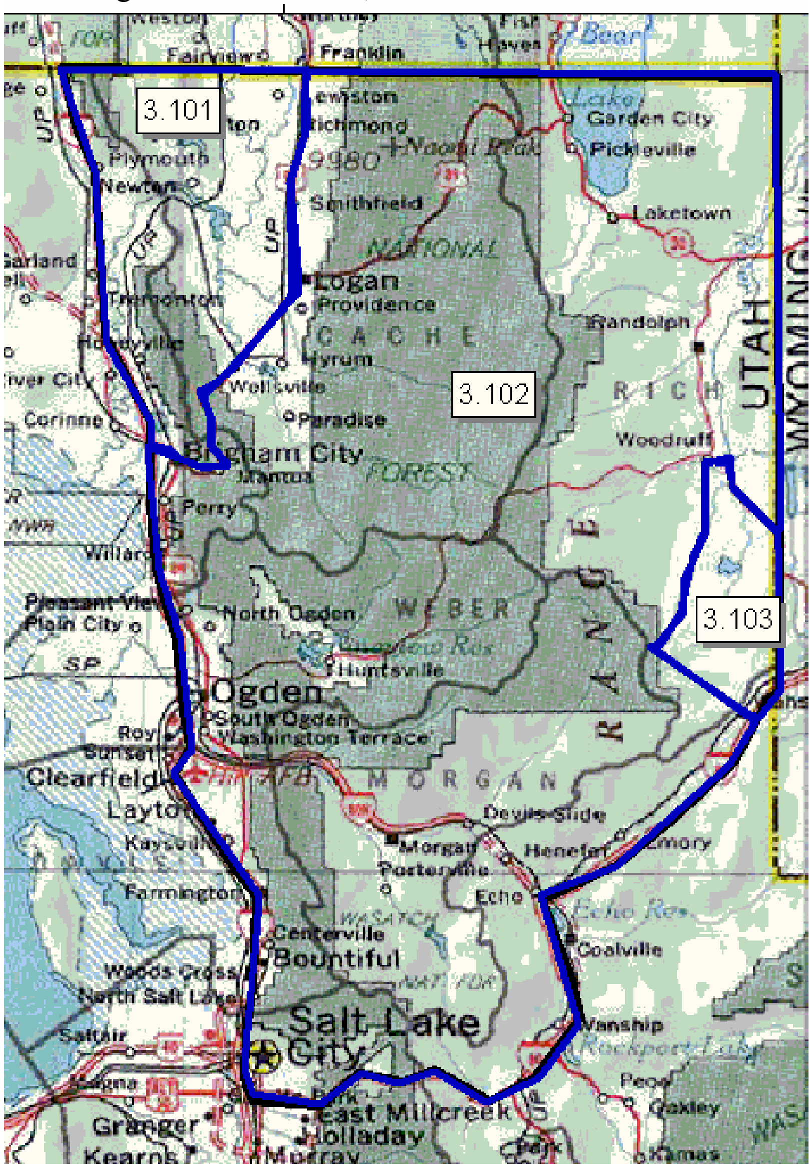
***Measurement Error and Measurement Bias*:** None.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Domain 3. Northern Utah – Northeast

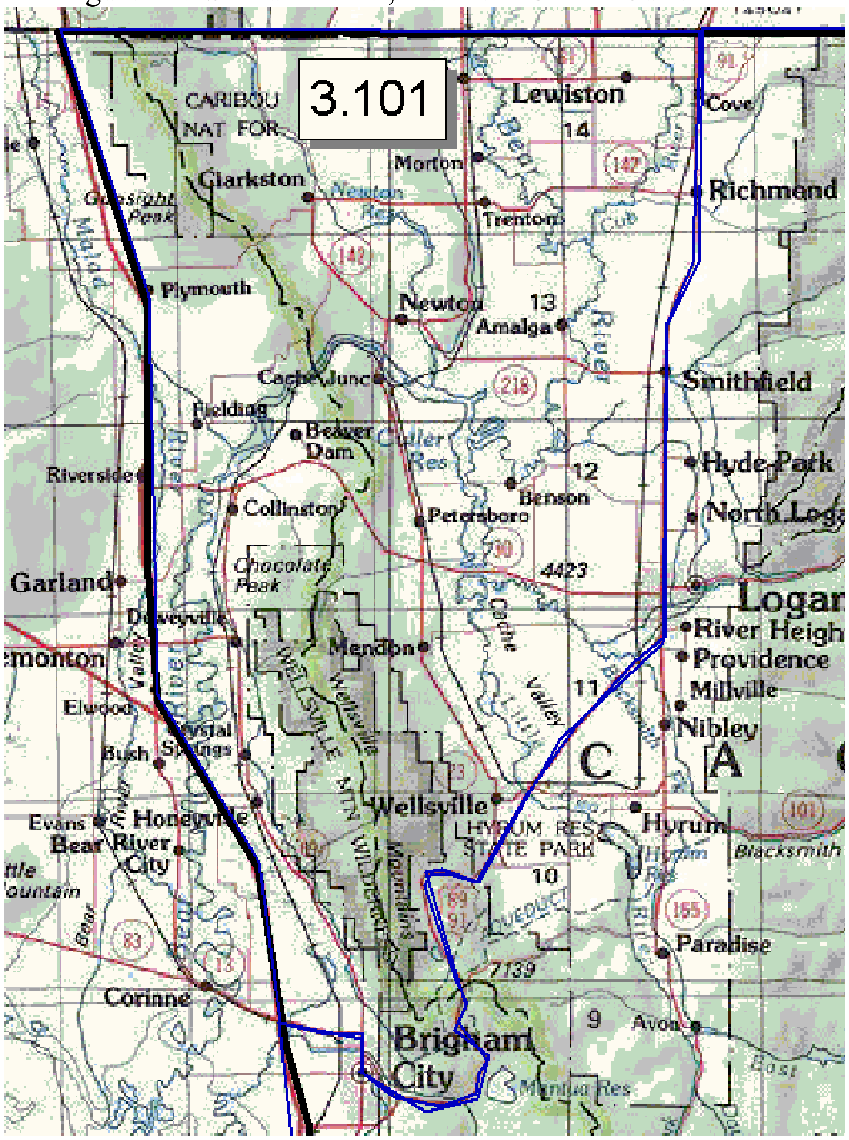
Figure 17. Domain 3, Northern Utah – Northeast



***Description*:** The northern and eastern boundaries of this domain are the Utah State border. The southeastern border is I-80; the western border is I-15. There are 3 strata in this domain.

Stratum 3.101. Northern Utah – Cutler Marsh

Figure 18. Stratum 3.101, Northern Utah – Cutler Marsh



***Description*:** This stratum is bordered by Idaho to the north and I-15 to the west. To the east and south, it is bordered by State highway 91 to Brigham City and highway 83 to I-15. It is primarily mountain and river valley habitat.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** The Bear River Portions of Cache Valley, including Cutler Marsh and Bear River Oxbow, are Type 2 habitat. The rest of the stratum is Type 3.

***Survey Method*:** Occasional aerial survey to confirm low numbers of shorebirds in the Type 2 portions of this stratum.

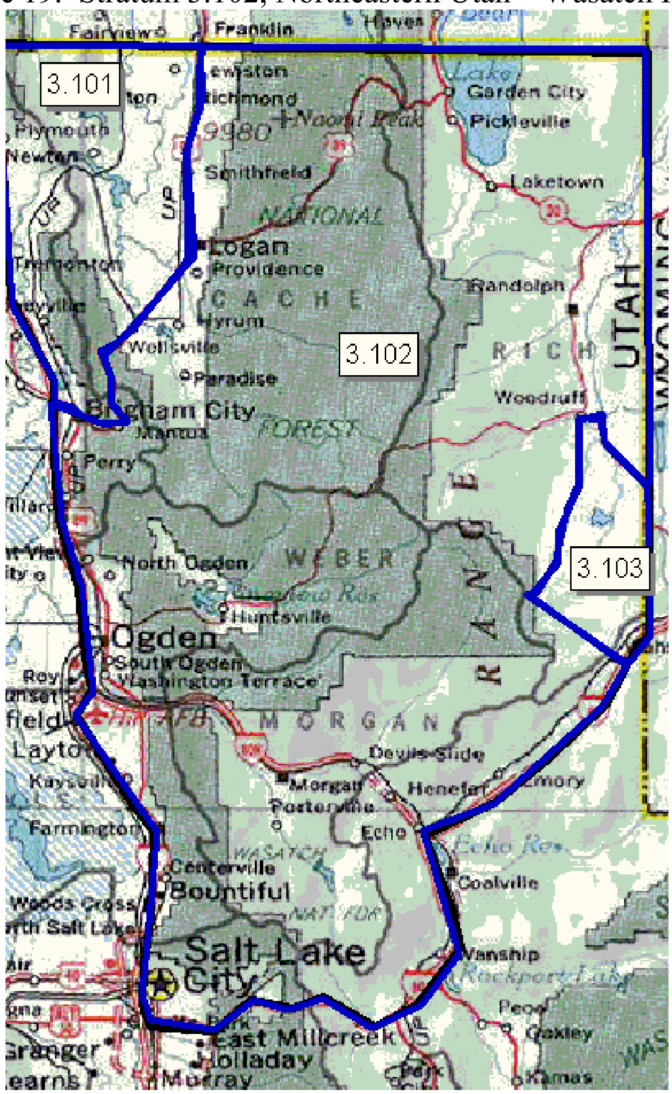
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 3.102. Northeastern Utah – Wasatch Range

Figure 19. Stratum 3.102, Northeastern Utah – Wasatch Range



***Description*:** This stratum is bordered to the west by I-15, highway 83 and highway 91. To the north is the Idaho border and to the east is the Wyoming border to highway 16. The stratum boundary follows Hwy 16 to Woodruff, then turns south and follows the Saleratus River to the Wasatch Range. The border then cuts southeast to the town of Wahsatch. The southern boundary of this stratum is I-80. The habitat is primarily mountains.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** Entire stratum is type 3 habitat.

***Survey Method*:** None needed unless casual observations suggest a change in shorebird use.

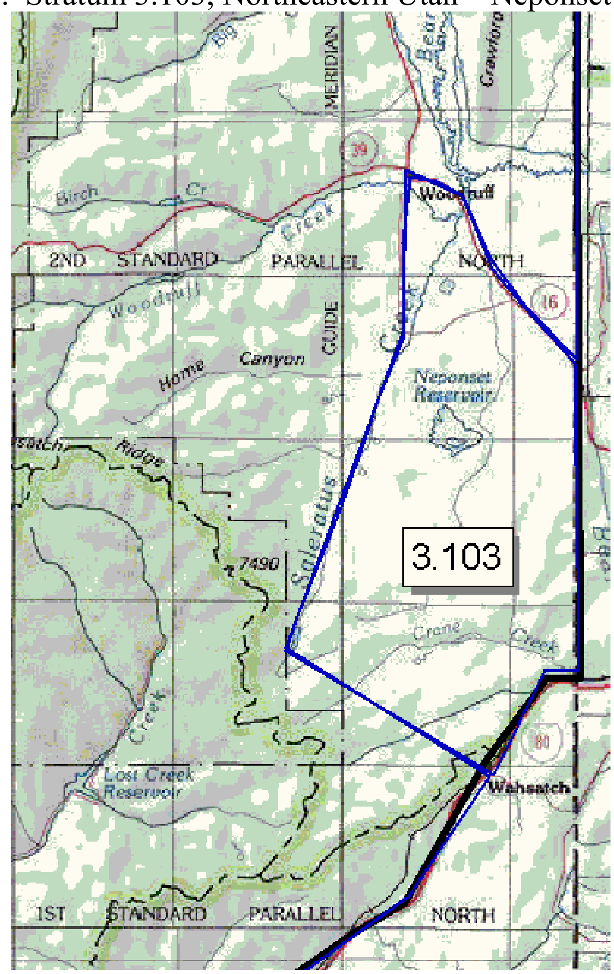
***Measurement Error and Measurement Bias*:** None.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 3.103. Northeastern Utah – Neponset Reservoir

Figure 20. Stratum 3.103, Northeastern Utah – Neponset Reservoir



***Description*:** The northern border of this stratum is highway 16 to Woodruff. At Woodruff, the border turns south to Saleratus Creek, which it follows to the Wasatch Range. From the Wasatch

Range the border run SE to the town of Wahsatch. The southeastern border is I-80 and the eastern border is Wyoming. Neponset Reservoir is primarily surrounded by uplands.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** Neponset Reservoir is Type 2 habitat. The rest of stratum is Type 3.

***Survey Method*:** Occasional ground surveys to confirm low numbers of focal shorebirds at Neponset Reservoir.

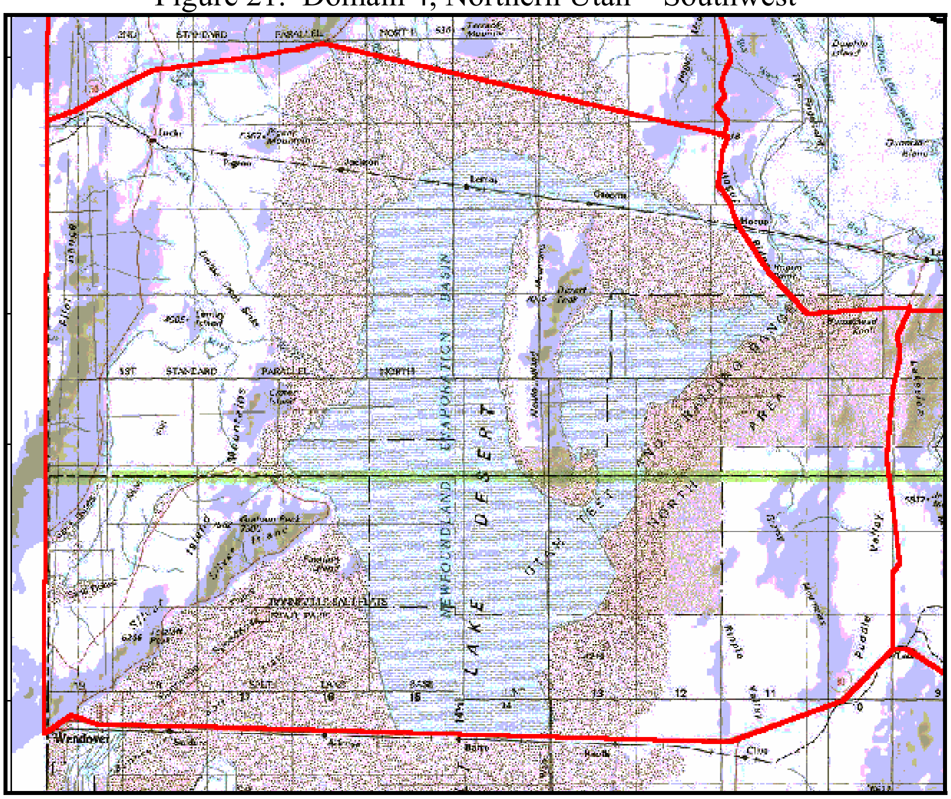
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Domain 4. Northern Utah – Southwest

Figure 21. Domain 4, Northern Utah – Southwest



***Description*:** The western border of domain 4 is the Utah border. The northern border is SR 30 in the west and a straight line from the bend in Rt. 30 to the southeast corner of the Domain, which is in the uplands of the Hogup Mountains. The southern border is I-80. The evaporation basin is dry, but it could fill after a major weather event like the flood years of the 80s.

***Land Ownership*:** This domain consists of public and private lands.

***Classification*:** The entire domain is classified as Type 3. However, if a major weather event causes the basin to fill, the area should be surveyed for shorebird use.

***Survey Method*:** None needed unless casual observations suggest a change in shorebird use.

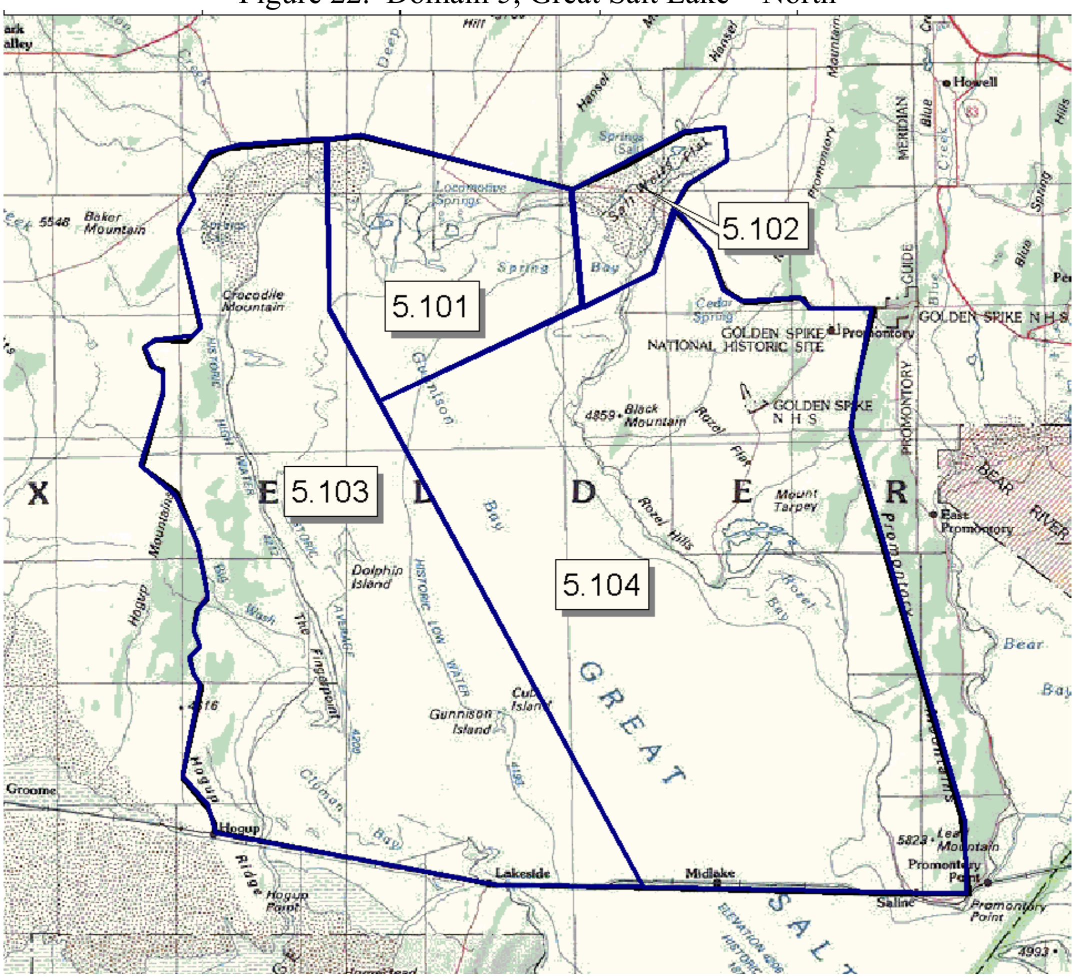
***Measurement Error and Measurement Bias*:** None.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Domain 5. Great Salt Lake – North

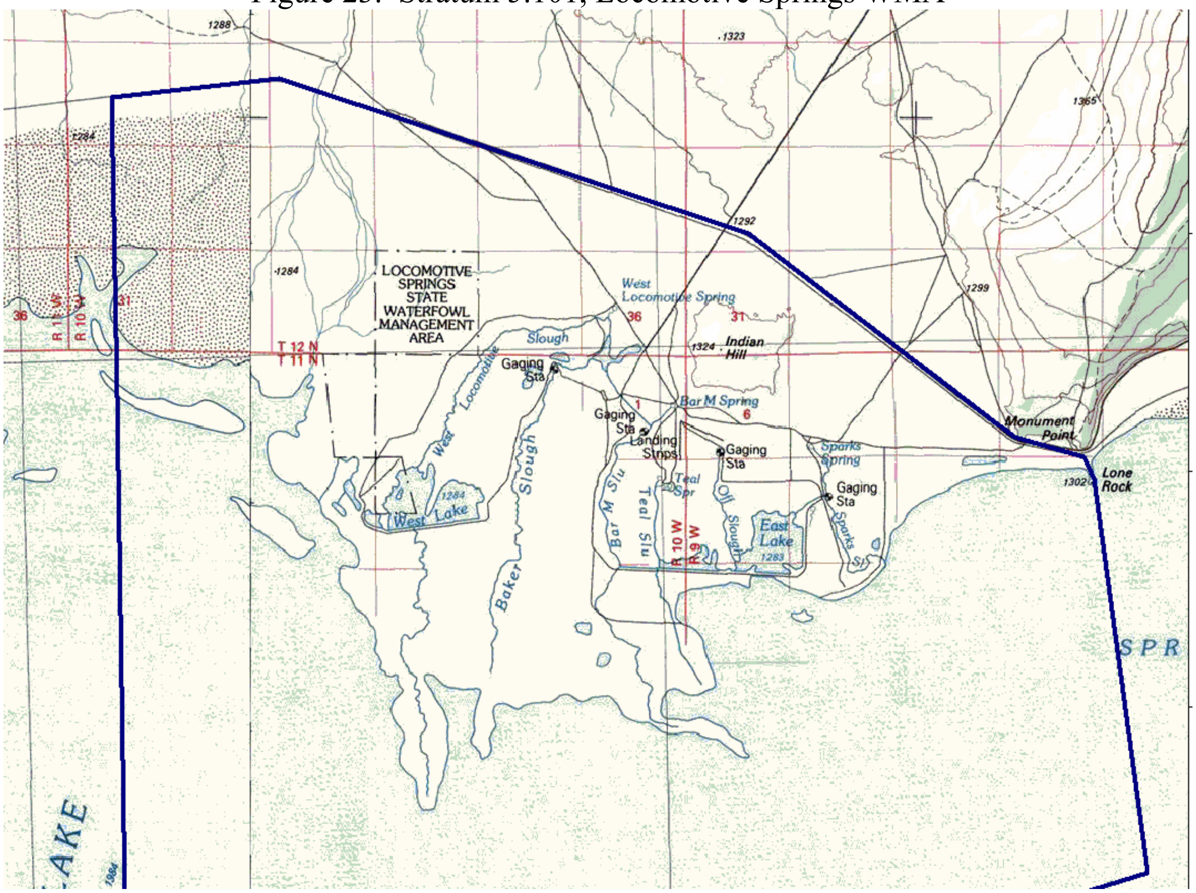
Figure 22. Domain 5, Great Salt Lake – North



***Description*:** Domain 5 is the northern arm of the Great Salt Lake. The western border is a small road from SR 30 in the north to the Hogup station on the causeway. The north border is a line through upland areas from SR 30 the Locomotive Springs area and then a small road from there to I-15. The eastern border is I-15. The southern border is the causeway. The domain includes all of the Locomotive Spring WMA and Salt Wells Flat WHA. The domain has been divided into 4 strata.

Stratum 5.101. Locomotive Springs WMA

Figure 23. Stratum 5.101, Locomotive Springs WMA



***Description*:** Stratum 5.101 includes the Locomotive Springs WMA and surrounding land from Monument Point on the east to the mouth of Deep Creek on the west, and from deep, open water on the south to upland areas (unsuitable for shorebirds) on the north.

Locomotive Springs WMA was surveyed on the Great Salt Lake Waterbird Survey (area 35). The mean numbers/survey (>10) recorded in July and August, for the more common species, were WIPH–50, WESA – 49, SNPL – 41, BNST – 21, KILL – 20, AMAV – 16, LBDO – 14, WILL – 10, and SAND – 8. Breeding SNPL have been documented in Locomotive Springs. Of the 20,000 acre WMA, 17% is good waterbird habitat, and 25% of this was covered in the WBS. This stratum can be covered easily on foot and visibility is good.

***Land Ownership*:** The WMA is administered by the Utah Division of Wildlife Resources (UDWR).

***Classification*:** When water is available, Locomotive Springs WMA is Type 1 habitat. The rest of the stratum is Type 3.

***Survey Methods*:** Census of all Type 1 habitat, including mudflats, by foot surveys.

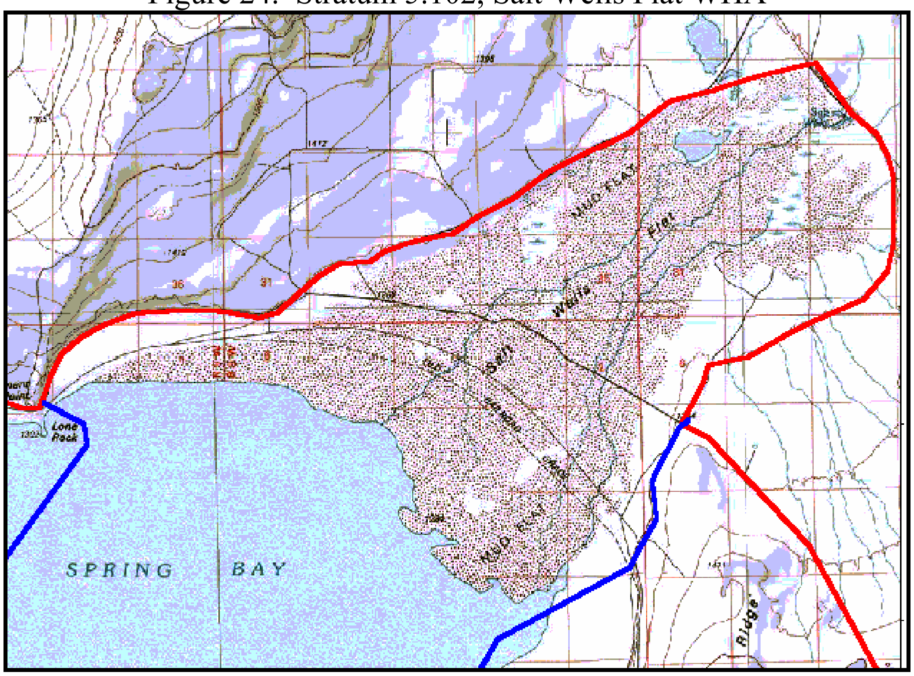
***Measurement Error and Measurement Bias*:** Minimal. All Type 1 habitat surveyed.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 5.102. Salt Wells Flat WHA

Figure 24. Stratum 5.102, Salt Wells Flat WHA



***Description*:** This stratum is a large complex of impounded water with islands of emergent vegetation. The survey area includes all established management units and outflow areas that are a part of Salt Wells Flat WHA. High shorebirds numbers occur in this area in spring when water is available. An ATV is needed for travel.

Salt Wells Flat WHA was surveyed on the Great Salt Lake Waterbird Survey (areas 36, 36A, and 36B). The mean numbers recorded in July and August, for the more common species, were SNPL – 369, BASA – 257, AMAV – 58, BNST – 27, WESA – 24, WIPH – 23, WILL – 20, KILL – 15, and LBDO – 13. All suitable habitat was surveyed (40% of total area). Visibility on the open mud flats was 100%, but approximately 65% at the ponds because tall, emergent vegetation blocked views. Access is good but an observation tower could increase visibility. Mud is often soft making it difficult to walk on flats.

Land Ownership: Salt Wells Flat WHA is managed by the Bureau of Land Management (BLM).

Classification: The mud flats are Type 1, the drainages are Type 2 habitat, and the rest of the stratum is Type 3 habitat.

Survey Methods. Conduct complete counts of mud flats using ATVs, plus occasional ground surveys of ponds and drainages.

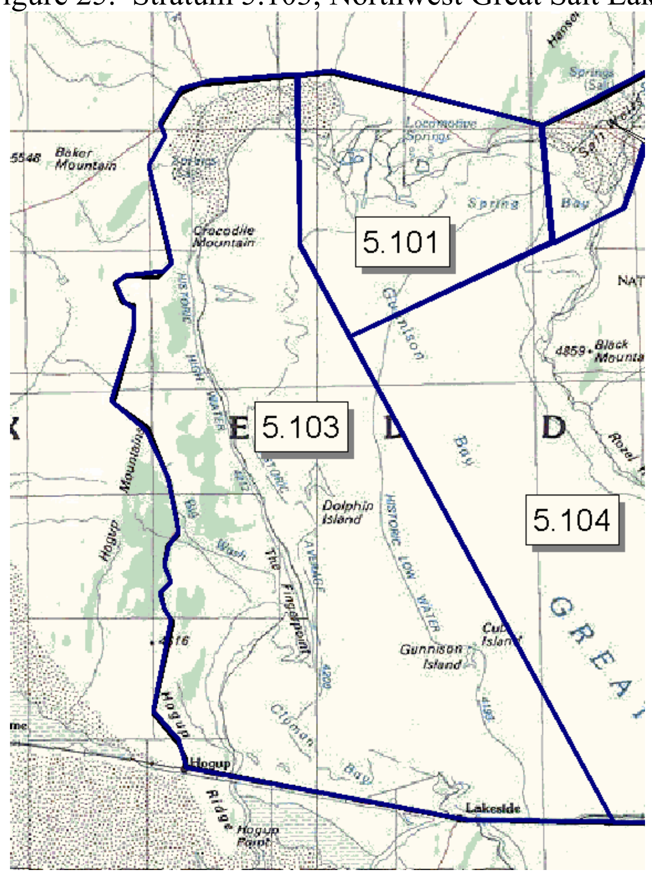
Measurement Error and Measurement Bias: Minimal. All Type 1 habitat surveyed.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 5.103. Northwest Great Salt Lake

Figure 25. Stratum 5.103, Northwest Great Salt Lake



Description: This stratum covers the western side of the Great Salt Lake within Domain 5. It was not surveyed during the Great Salt Lake Waterbird Survey. SNPLs breed in small numbers around the seep, but there are few shorebirds present during migration.

***Land Ownership*:** This stratum is mostly public land.

***Classification*:** Entire stratum is Type 3 habitat.

***Survey Method*:** None needed unless casual observations suggest a change in shorebird use.

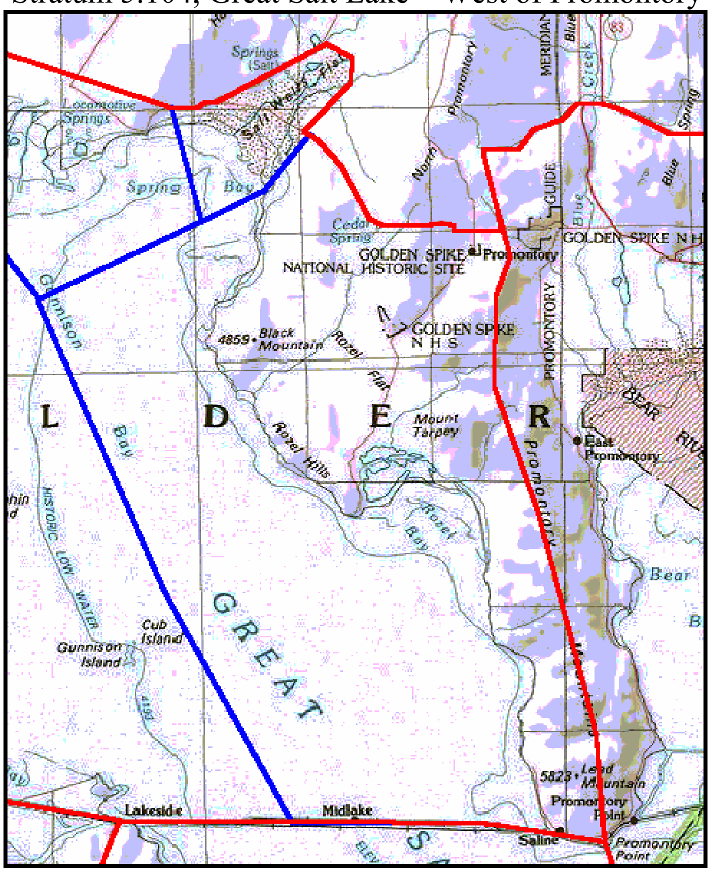
***Measurement Error and Measurement Bias*:** None.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 5.104. Great Salt Lake – West of Promontory Mountains

Figure 26. Stratum 5.104, Great Salt Lake – West of Promontory Mountains



***Description*:** This stratum covers the eastern side of the Great Salt Lake within Domain 5. It was not surveyed during the Great Salt Lake Waterbird Survey. There is a spring driven wetland at Rozel Bay that shorebirds use in moderate numbers.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** The area around Rozel Bay is Type 2 habitat, and the rest of the stratum is Type 3.

***Survey Method*:** None needed unless casual observations suggest a change in shorebird use.

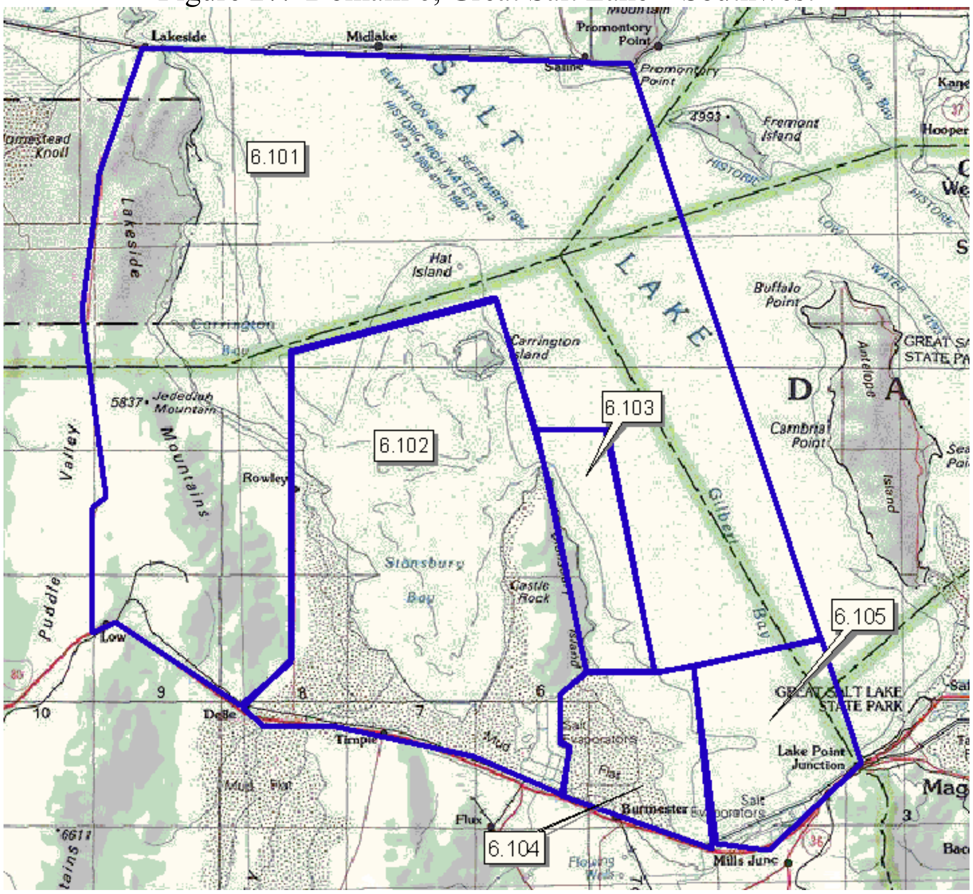
***Measurement Error and Measurement Bias*:** None.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Domain 6. Great Salt Lake – Southwest

Figure 27. Domain 6, Great Salt Lake – Southwest



***Description*:** This domain consists of 5 strata that together cover the southwestern portion of the Great Salt Lake.

Stratum 6.101. Great Salt Lake – Westcentral

***Description*:** This stratum covers the west central portion of the Great Salt Lake from the causeway south to the western-most point of Carrington Bay. It includes the uplands in the Lakeside Mountains west to the small road that forms the domain border. It also includes a substantial portion of open lake where none of the shorebird species covered in the ground surveys (excluding avocets and black-necked stilts) occur.

This stratum was covered in the Great Salt Lake Waterbird Survey (area 43). Among the focal species for this survey, only WESAs were recorded regularly (mean of 83 during July and August). Hundreds to thousands of AMAV, BNST, and WIPH were also recorded. This area was surveyed from the ground from 3 viewpoints. The shoreline is not visible along the whole route so counts were made from good viewing vantage points. The surveyors thought they were able to see most of the birds.

Land Ownership: The U.S. Air Force manages most of this stratum. Access is permitted only with military escort. Hat Island is owned by the State of Utah.

Classification: The stratum is all Type 3 habitat except for the narrow shoreline zone, which is Type 2 habitat.

Survey Method: Occasional ground surveys of shoreline to confirm low numbers of focal species.

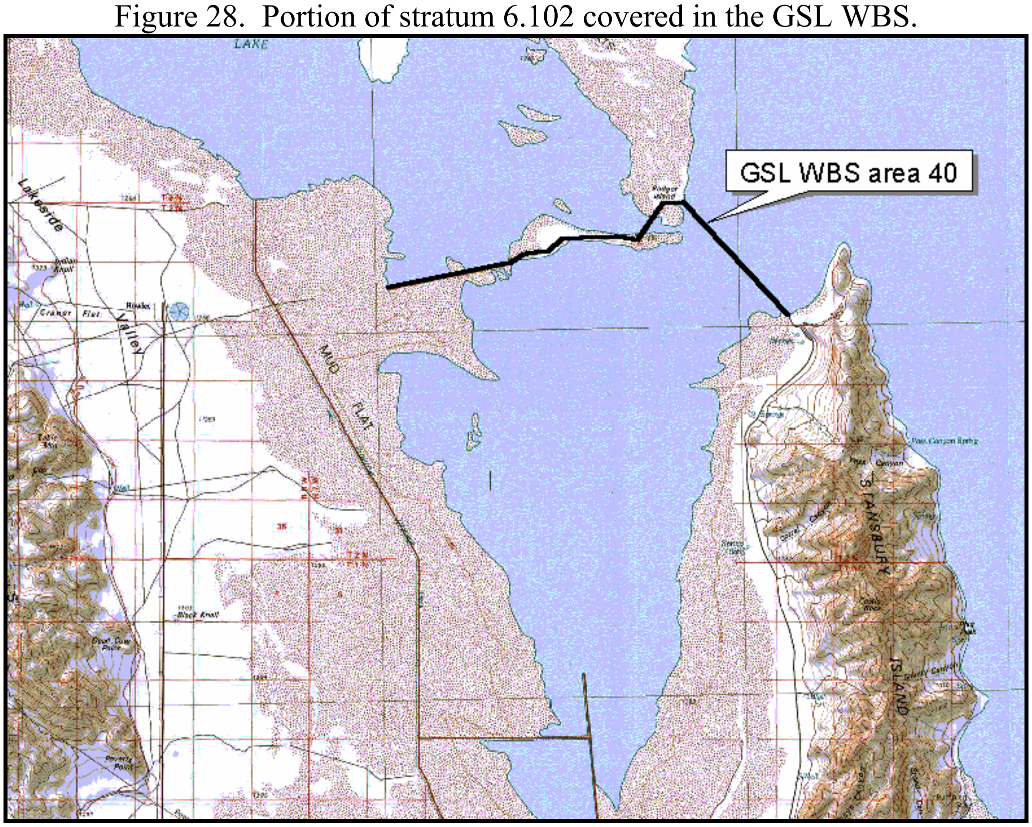
Measurement Error and Measurement Bias: Minimal if detection rates are high.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 6.102. Great Salt Lake – Stansbury Bay

Figure 28. Portion of stratum 6.102 covered in the GSL WBS.



Description: This stratum consists primarily of solar evaporation ponds, with some shallow water near a dike road. This latter portion was covered in the Great Salt Lake Waterbird Survey (area 40, Figure 28) by an observer in vehicle who counted birds on both sides of the road. An employee of the industry conducted these surveys. Mean numbers recorded in July and August were WESA – 357, PEEP – 606, and LESA – 146 as well as thousands of AMAV and WIPH. Detection rates were high. The evaporation ponds are not used by shorebirds.

***Land Ownership*:** Everything to the south of the dike road is now primarily solar evaporation ponds that are privately owned. The area north of the dike road is managed by the State of Utah.

***Classification*:** This stratum is Type 3 habitat except for the shallow water on either side of the dike road, which is Type1.

***Survey Method*:** Ground surveys from the dike road are adequate to census Type 1 habitat.

***Measurement Error and Measurement Bias*:** Minimal. All Type 1 habitat was surveyed.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 6.103. Great Salt Lake – Stansbury North

***Description*:** This stratum covers the shoreline on the east side of the Stansbury Mountains from the north tip of the island to the pump station at their south end. Access to this area was refused during the GSL WBS but it was covered by air. A few hundred AMAVs were recorded but virtually no other shorebirds.

***Land Ownership*:** Some of the shoreline in this stratum belongs to the BLM. However, access is through private land, which was denied.

***Classification*:** The shoreline is Type 2 habitat. The remainder of the stratum is Type 3.

***Survey Method*:** Occasional aerial survey to confirm the absence of birds in this Stratum.

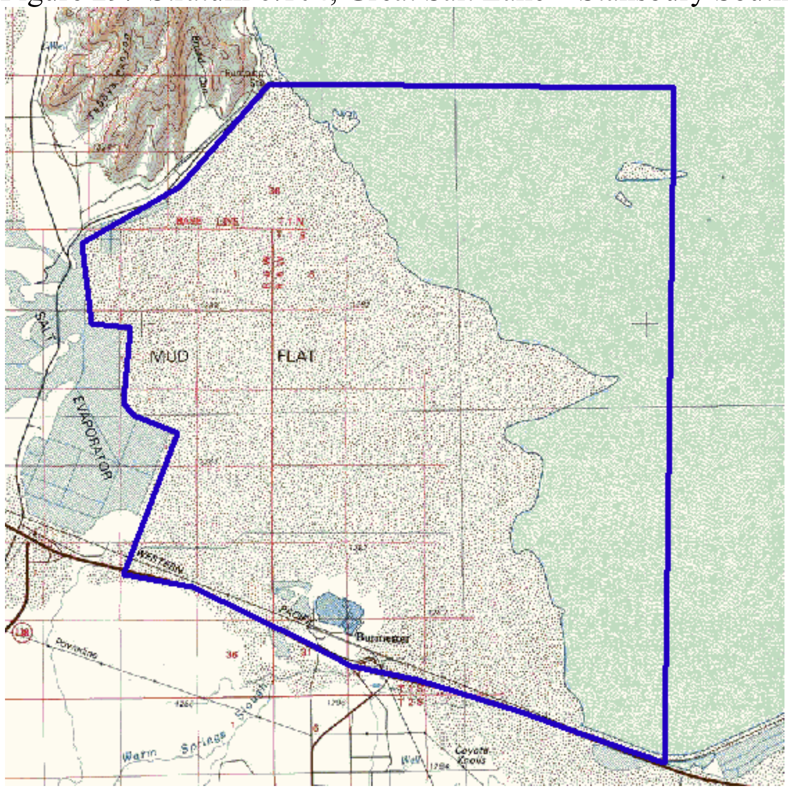
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 6.104. Great Salt Lake – Stansbury South

Figure 29. Stratum 6.104, Great Salt Lake – Stansbury South



***Description*:** The north boundary of this stratum is an east-west line extending through the pump station at the south edge of the Stansbury Mountains. The west boundary runs along the Salt Evaporation Ponds to I-80. I-80 forms the south border, which extends east to directly south of the southernmost point of the Great Salt Lake (between ponds to the south and north sides of I-80). The east border is a north-south line extending north from the southeastern corner of the stratum.

The shoreline of this stratum was surveyed in the GSL WBS (area 3). Significant numbers of the focal shorebirds were recorded including (means for July and August) WESA 1767, PEEP 970, LESA 306, SNPL 150, BASA 68, and LBDO 38. Most, or all, suitable habitat for the focal shorebirds is along the shoreline but birds sometimes roost well up on the beach so these areas should be checked occasionally to confirm that few birds are present.

Visibility along the shoreline is good, although at times soft mud prevents close approach to the shore making identification of small shorebirds difficult. The survey is conducted on an ATV.

***Land Ownership*:** The land in this stratum is managed by the BLM and the State of Utah.

***Classification*:** The shoreline is Type 1 habitat and the rest of the stratum is Type 2.

Survey Method**:** Ground census of shoreline habitat using ATV or airboat with occasional ground surveys of Type 2 habitat.

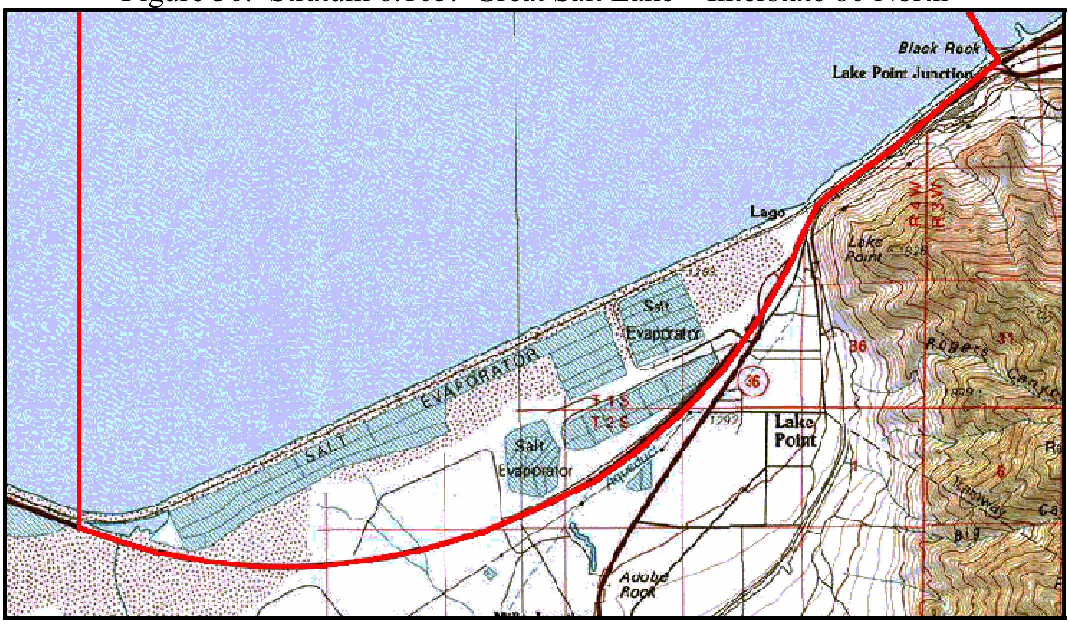
Measurement Error and Measurement Bias**:** Minimal. All Type 1 habitat is surveyed.

Selection Bias**:** None.

Pilot Studies Needed**:** None.

Stratum 6.105. Great Salt Lake – Interstate 80 North

Figure 30. Stratum 6.105. Great Salt Lake – Interstate 80 North



Description**:** The southwest corner of this stratum is just west of the small pond west of the Salt Evaporator. From that point, the boundary follows I-80 east to Black Rock. The north boundary is well out into the Great Salt Lake (Figure 27).

The area was surveyed on the GSL WBS with separate counts being made for the shoreline (area 5a) and the area between the railroad and I-80 (area 5b). Neither area had many shorebirds (WESA 107, KILL 22). Most of the WESAs were in the ponds; most of the KILLs were along the shore. Visibility was reported as moderate or poor for the ponds due to long viewing distances. On the north side, all shoreline was visible. However, looking to the south, some areas of the shoreline habitat are too far away to accurately identify shorebirds.

Land Ownership**:** Access to this stratum is through the Union Pacific Railroad. The area between the railroad and I-80 is privately owned.

Classification**:** The shoreline and ponds are Type 2 habitat. The remainder of the stratum is Type 3.

***Survey Methods*:** Periodic driving surveys along the railroad will cover most of the shoreline. If appropriate for Type 2 habitat sampling, a pilot study is needed to determine how to survey the shoreline areas with long viewing distances and how to survey the ponds.

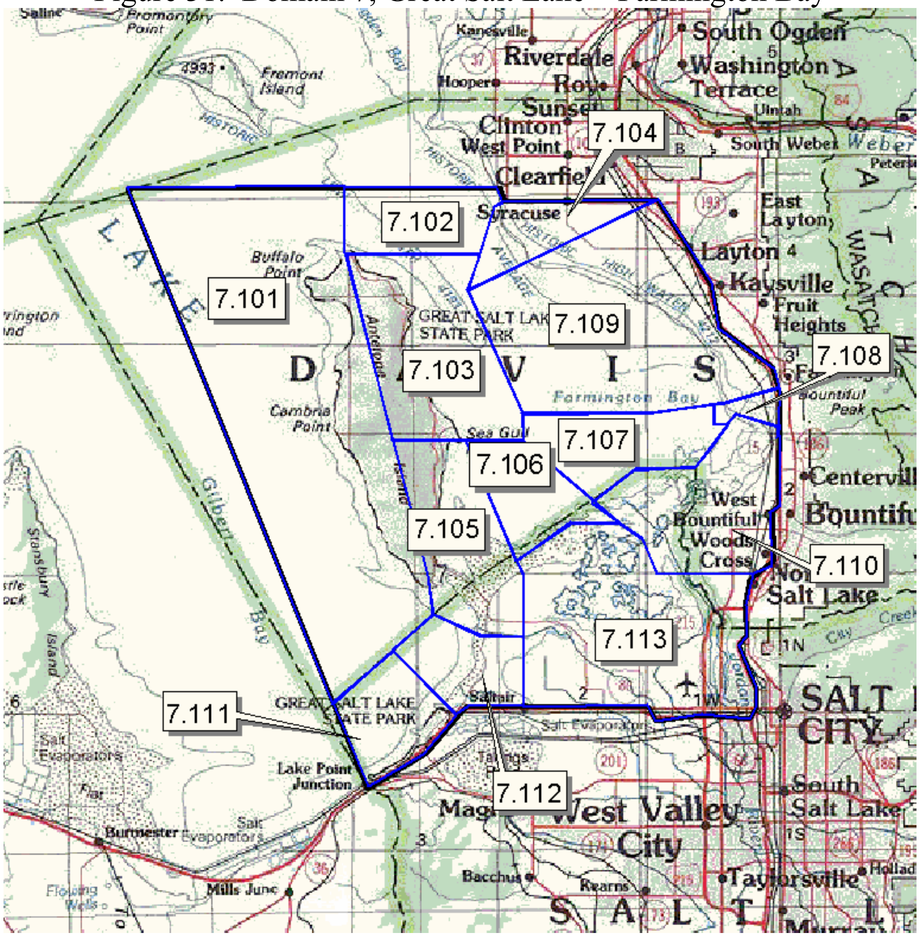
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None needed unless Type 2 habitat sampling requires complete coverage. In which case a pilot study is needed to determine the best method for surveying the southern shoreline and ponds.

Domain 7. Great Salt Lake – Farmington Bay

Figure 31. Domain 7, Great Salt Lake – Farmington Bay



***Description*:** Domain 7 includes Farmington Bay and surrounding area east to I-15, south to I-80, west to Gilbert Bay (including Antelope Island), and north to Ogden Bay. Important shorebird areas in this domain include the Farmington Bay shoreline including the Antelope Island Causeway, Farmington Bay WMA, private duck clubs, and the southeast shore of Gilbert Bay. There are thirteen strata in this domain.

Stratum 7.101. Great Salt Lake – Antelope Island West

***Description*:** This stratum covers the west side of Antelope Island from its northern tip to its southern tip and some open water of the Great Salt Lake. A small portion of this stratum (near the road from the Antelope Island State Park) was surveyed as part of the GSL WBS. The only means >10 for the focal shorebirds were for SAND (16) suggesting that this stratum has minimal numbers. No other data were gathered, but the majority of the west side is rocky with little beach and is unsuitable for shorebirds. Larger shorebirds, such as avocets or stilts, are also absent from the west side observations.

***Land Ownership*:** Managed by Antelope Island State Park.

***Classification*:** The shoreline is Type 2 habitat and the rest of the stratum is Type 3.

***Survey Methods*:** Occasional ground surveys of the shoreline.

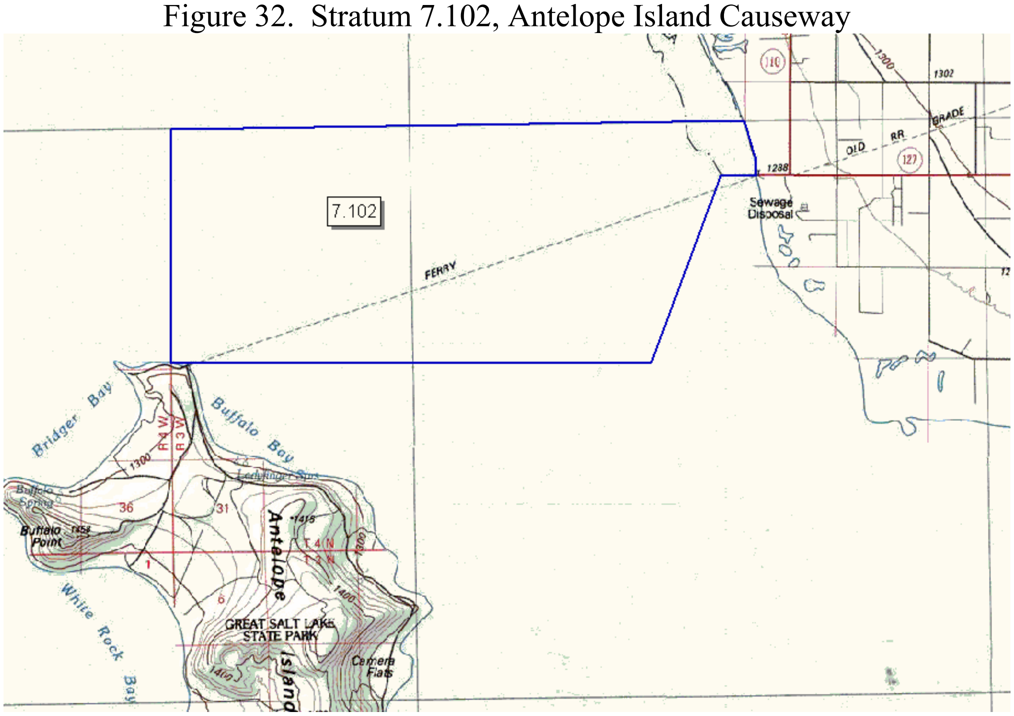
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.102. Great Salt Lake – Antelope Island Causeway

Figure 32. Stratum 7.102, Antelope Island Causeway



***Description*:** This stratum lies along the Causeway extending well out into open water (farther than the focal shorebirds would occur). The area was surveyed in the GSL WBS (area 16) but none of the focal birds were recorded in appreciable numbers. It is possible that appreciable numbers of birds were missed because the observer usually drove the causeway without stopping to cover portions of the shore not visible due to rocks.

***Land Ownership*:** Managed by Antelope Island State Park. The access road belongs to Davis County.

***Classification*:** This stratum is Type 2 habitat.

Survey Methods: Driving the causeway and stopping anytime the shore is not visible will provide essentially complete coverage.

Measurement Error and Measurement Bias: Minimal.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 7.103. Great Salt Lake – Antelope Island Northeast

Description: This stratum includes the northeast shore of Antelope Island from the northern tip to the tip of Sea Gull Point. This area was surveyed in the GSL WBS (area 14) from the road. Distances were often too great to detect small shorebirds. Mean survey counts for the focal shorebirds were all <10.

Land Ownership: Managed by Antelope Island State Park.

Classification: The shoreline is Type 2 habitat; the rest of the stratum is Type 3.

Survey Methods: We used occasional aerial surveys to document low numbers of focal shorebirds along the shoreline, although if deemed necessary the area could be covered more thoroughly on the ground.

Measurement Error and Measurement Bias: Minimal.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 7.104. Great Salt Lake – West Layton

Description: The Antelope Causeway and SR 127 border this stratum to the north and I-15 borders it to the east. The line is perpendicular from I-15 and passes though the peregrine hacking tower on the Layton Preserve; it has open water to the west. Suitable shorebird habitat includes the shoreline and a small area of wetland. The stratum was surveyed in the GSL WBS (area 18) but the only means >10 for the focal shorebirds were WESA 14 and WILL 15. The Miller ponds were not included in the GSL WBS but could be accessed and viewed easily. Visibility on the GSL WBS was good but in some cases that soft mud in the south prevented complete counts. Detection rate for the shoreline was approximately 95%. If observers walk into the ponds for viewing, there is an estimated 85% detection for the wetlands.

Land Ownership: Land in this stratum is publicly and privately owned.

***Classification*:** The shoreline is Type 2 habitat and the rest of the stratum is Type 3.

***Survey Methods*:** We conducted occasional aerial surveys to document low numbers of focal species on the shoreline. If deemed necessary an airboat might provide better complete coverage.

***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.105. Great Salt Lake – Antelope Island Southeast

***Description*:** In this stratum, the southern border along the shore is the Goggin Drain; the eastern border is the west end of the Crystal Unit of the Farmington Bay WMA. The western border follows Antelope Island North to Sea Gull Point. This stratum was covered by the GSL WBS (areas 9a, 9b, and the southern end of 14). After the survey, it was decided to combine these areas. The means >10 for focal shorebirds were WESA 278, SNPL 74, PEEP 60, and BASA 12. The extent of suitable shorebird habitat between the shore of the mainland and Antelope Island varied substantially. Although soft mud was sometimes a problem, birds could usually be surveyed completely from one or both sides of the stratum.

***Land Ownership*:** This area is managed by the Antelope Island State Park and the State of Utah.

***Classification*:** The entire stratum is Type 1 habitat, although in any given year some areas will be unsuitable for shorebirds.

***Survey Methods*:** Surveyors counting simultaneously from both sides would provide complete coverage. An ATV may permit closer approach when mud is soft.

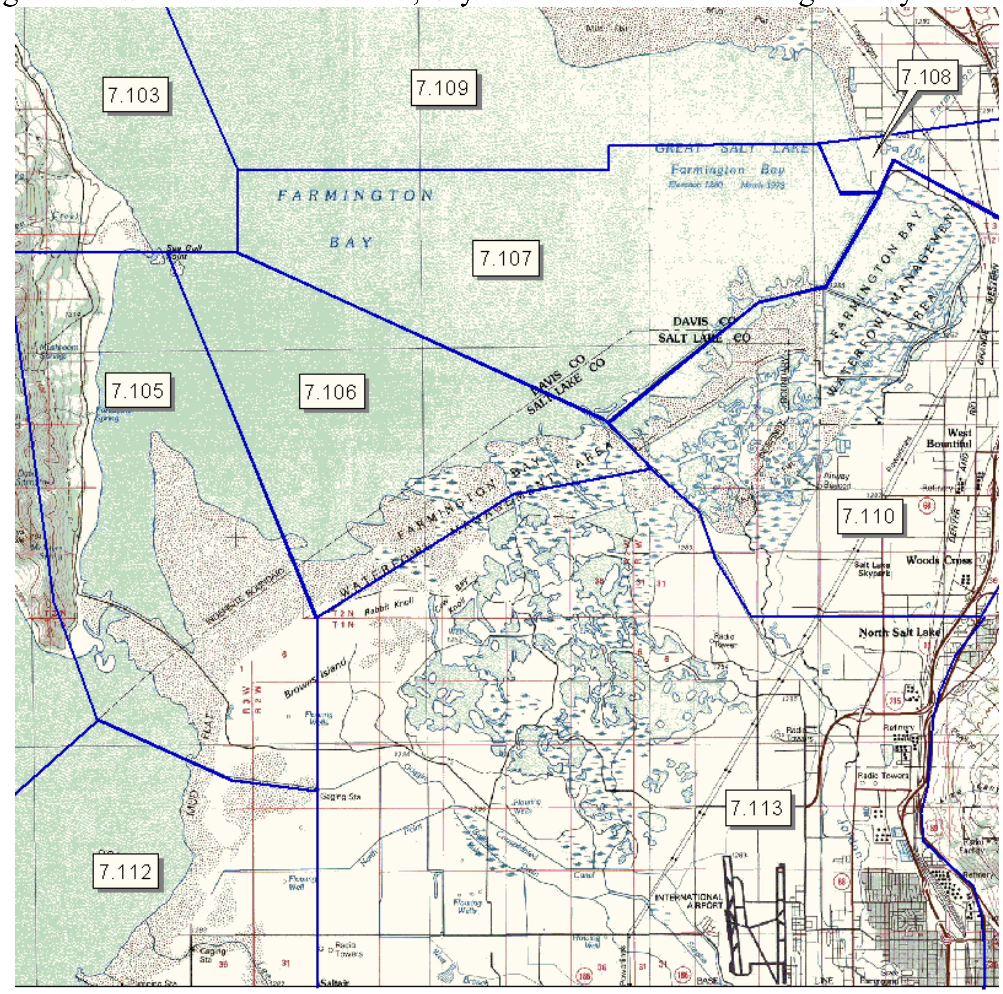
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.106. Great Lake Salt – Crystal Lakeside

Figure 33. Strata 7.106 and 7.107, Crystal Lakeside and Farmington Bay Lakeside



***Description*:** This stratum includes the shoreline from the southernmost major drainage on the Crystal Unit of Farmington Bay WMA to the southwest elbow of the Turpin dike. The Farmington Bay WMA is immediately inland, so this stratum does not include any unsuitable uplands. It was surveyed as area 10 in the GSL WBS. Mean survey counts >10 for focal shorebirds were WESA 465, PEEP 121, GRYE 23, and BBPL 24. This survey was a total count conducted from an airboat.

***Land Ownership*:** The Utah Division of Wildlife Resources manages the Wildlife Management Area. There are also privately owned duck clubs and agricultural areas in this stratum.

***Classification*:** The shoreline is Type 1 habitat and the rest of the stratum is Type 3.

***Survey Methods*:** Uncertain. Pilot study or more information needed.

***Measurement Error and Measurement Bias*:** Uncertain.

***Selection Bias*:** Uncertain.

***Pilot Studies Needed*:** The airboat worked fairly well, though some concerns were expressed about the completeness of counts. More work is needed to evaluate the airboat surveys.

Stratum 7.107. Great Salt Lake – Farmington Bay Lakeside

***Description*:** The shoreline and associated narrow beach form the southeast side (the Farmington Bay WMA lies immediately inland) of this stratum. The shoreline extends from the southwest elbow of the Turpin dike to the Egg Island observation point. It was surveyed as area 10 in the GSL WBS. The only mean for focal shorebird >10 was for WILL (11). Visibility was good.

***Land Ownership*:** The State of Utah manages most of this stratum.

***Classification*:** The entire stratum is Type 2.

***Survey Methods*:** Occasional aerial surveys to confirm low numbers of focal species in the stratum.

***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.108. Great Salt Lake – West Farmington

***Description*:** This stratum includes the shoreline from the Egg Island Observation point to the drainage due west of the north end of the Davis County Sewer Plant. It was surveyed in the GSL WBS (area 13). None of the mean survey counts for focal species were >10.

***Land Ownership*:** This stratum consists of public (state and county) and private lands.

***Classification*:** The shoreline is Type 2 habitat. The remainder of the stratum is Type 3.

***Survey Methods*:** Occasional aerial or airboat survey to confirm low numbers of focal species.

***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.109. Great Salt Lake – West Kaysville

***Description*:** This stratum extends from the drainage ditch due west of the north end of the Davis County Sewer Plant to the peregrine hack tower on The Nature Conservancy property. It includes the wetlands between the shoreline and I-15. It was covered as areas 17a (interior wetlands) and 17b (shoreline) in the GSL WBS. Mean survey counts in July and August for interior wetlands were: WESA 22, PEEP 130, LESA 14, WILL 22; and for the shoreline were: WESA 474, LESA 224, WILL 23. Visibility was good along the shoreline but not on the wetlands due to vegetation and lack of access.

***Land Ownership*:** Primarily owned by Davis County, The Nature Conservancy, and the State of Utah.

***Classification*:** The shoreline and wetlands are Type 1. The uplands are Type 2 habitat.

***Survey Methods*:** Walking survey is effective for the shoreline; methods to be determined for the wetlands. Depending on the lake elevation the shoreline/mud toe may be better accessed by airboat.

***Measurement Error and Measurement Bias*:** Minimal for the shoreline; uncertain for the wetlands.

***Selection Bias*:** NA for the shoreline; uncertain for the wetlands.

***Pilot Studies Needed*:** Survey methods need to be developed for the wetlands.

Stratum 7.110. Farmington Bay WMA

***Description*:** This stratum includes the Farmington Bay WMA and surrounding areas. It was surveyed in the GSL WBS (area 12). Mean survey counts for focal species >10 were: LBDO 1516, WESA 975, UNYE 197, PEEP 25, LESA 25. Surveys were made from the dikes. Visibility is often poor due to long distances and tall vegetation. Substantial areas in the eastern part of the WMA were not surveyed but probably do not have many birds.

***Land Ownership*:** The WMA is administered by UDWR.

***Classification*:** The wetlands are Type 1 habitat, and the rest of the stratum is Type 3.

***Survey Methods*:** A better "interior wetlands" survey method needs to be developed.

***Measurement Error and Measurement Bias*:** Uncertain.

***Selection Bias*:** Uncertain.

***Pilot Studies Needed*:** Develop an interior wetlands survey for this area.

Stratum 7.111. Great Salt Lake – Saltair

***Description*:** The shoreline in stratum 7.111 extends from Black Rock to the old Saltair railroad grade. It was surveyed as area 6 in the GSL WBS. Mean survey counts for focal shorebirds >10 were: PEEP – 41, WESA – 23, KILL – 17.

***Land Ownership*:** This area is primarily public with some private lands. Both require administrative access at times.

***Classification*:** The shoreline is Type 1 habitat, and the rest of the stratum is Type 3.

***Survey Methods*:** Survey from road with occasional walking needed for complete coverage.

***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.112. Great Salt Lake – Kennecott

***Description*:** This stratum includes the shoreline between the old Saltair railroad grade and the Goggin Drain and all ponds on the Kennecott Inland Sea Shorebird Reserve. It was surveyed as areas 8A (shoreline) and 8C (interior wetlands) in the GSL WBS. Mean survey counts >10 for focal shorebirds for the shoreline were: WESA 99, PEEP 12 and for the interior wetlands were: WESA 530, PEEP 54, SNPL 83, WILL 12.

***Land Ownership*:** This stratum consists of public (state) and private lands.

***Classification*:** The shoreline and interior wetlands are Type 1 habitat. The rest of the stratum is Type 2 habitat.

***Survey Methods*:** Survey shoreline and wetlands by foot.

***Measurement Error and Measurement Bias*:** Minimal. All Type 1 habitat was surveyed.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 7.113. Associated Duck Clubs

***Description*:** This area includes all Ambassador Duck Club and Harrison Duck Club properties, and any other property where access is obtained within the Associated Duck Club area. Approximately 90% of this stratum is appropriate waterbird habitat, as there is some ephemeral, upland playa.

The Ambassador and Harrison Duck Clubs were surveyed in the GSL WBS (area 7), which covered 15% of the area. Mean survey counts for focal species (>10) were: PEEP – 41, WESA – 23, KILL – 17. It is possible to cover the entire area and access is good. Permission from the various duck clubs is necessary, and observers may need to use a boat to navigate the North Point Duck Club.

When the lake elevation is low and water isn't coming into the ponds, tall vegetation (e.g., *Phragmites*) takes over. Some of the clubs get rid of it and manage for the shorter wetland vegetation. Visibility was uninhibited for most of the surveyed area, though in some cases (large ponds) viewing distances were too great to have 100% detectability. It would be possible to walk around ponds to get better views. In areas with tall vegetation, one could probably see into the ponds from an observation platform.

AMAV and BNST are well distributed throughout the surveyed portion of this stratum. There is no known area with good habitat for PEEP. When the lake elevation was higher there were more SNPL. WESA are usually near the large western pond.

***Land Ownership*:** The entire stratum is managed by the Associated Duck Clubs.

***Classification*:** There are some scattered Type 2 areas but the rest of the stratum is Type 3.

***Survey Methods*:** Census periodically with ground and boat surveys to confirm low numbers of focal species.

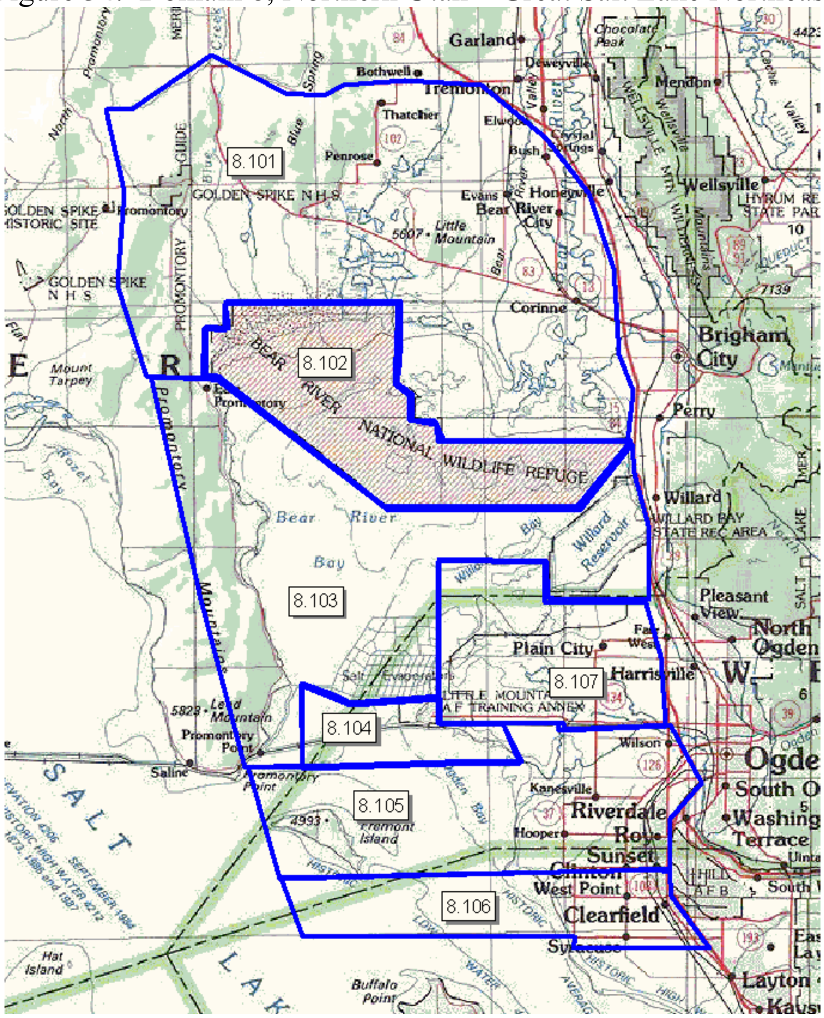
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Domain 8. Great Salt Lake Northeast

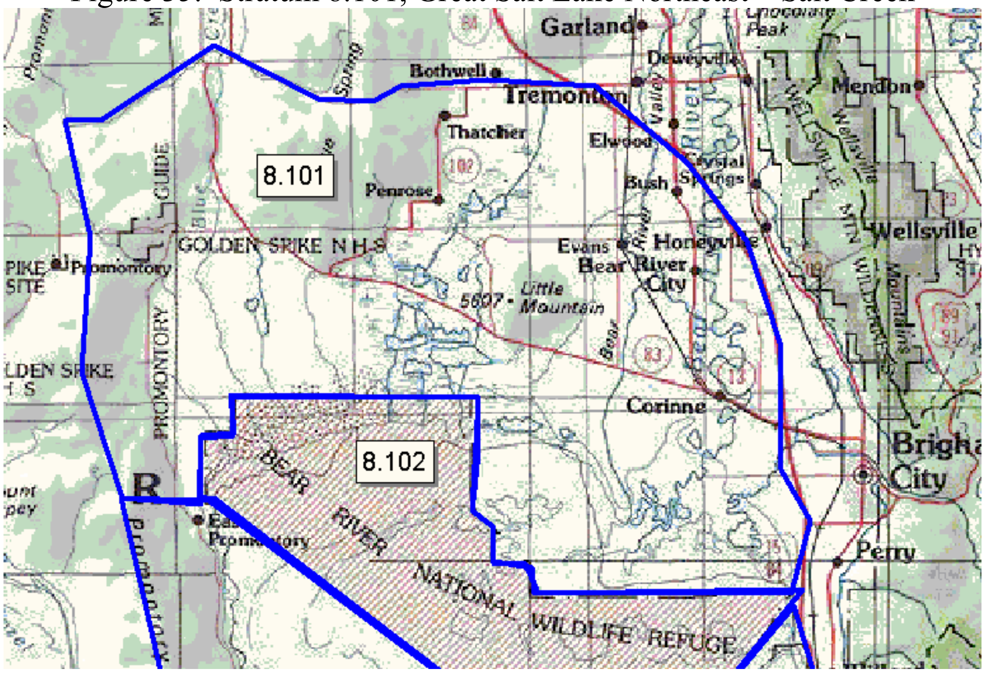
Figure 34. Domain 8, Northern Utah – Great Salt Lake Northeast



Description: Domain 8 includes the Bear River and Ogden Bay areas of Great Salt Lake. Important shorebird areas in this domain are the Bear River NWR, and the Harold Crane and Ogden Bay Wildlife Management Areas. There are seven strata in this domain.

Stratum 8.101. Great Salt Lake Northeast – Salt Creek

Figure 35. Stratum 8.101, Great Salt Lake Northeast – Salt Creek



***Description*:** This stratum includes Public Shooting Grounds WMA, Salt Creek WMA, Bear River Duck Club, Chesapeake Duck Club, Sulphur Creek, and the Reeder Overflow. Fifty–five percent of the Salt Creek WMA is good waterbird habitat, but tall vegetation reduced GSL WBS survey coverage to only 35% of the WMA (area 33). Mean survey counts (>10) for focal species were WIPH – 18, LBDO – 14, KILL – 10, and GRYE – 12. There were also hundreds of AMAV and BNST. Detection rate for the larger shorebirds is estimated at 99%; however, tall vegetation reduces detection of smaller shorebirds. An observation tower might increase detection in these areas. The 12,000 acre Public Shooting Grounds WMA also has 70% good waterbird habitat, but only 20% was covered in GSL survey (area 32). Mean survey counts (>10) for focal species were WIPH – 17 and GRYE – 17. There were also hundreds of AMAV and BNST. There is a large expanse of potholes that is not visible from the dike roads, but would be visible from a plane. Chesapeake, Sulphur and Reeder have not been included in previous survey efforts.

***Land Ownership*:** The WMAs are managed by UDWR. The rest of the stratum is privately owned.

***Classification*:** The WMAs, Duck Clubs and associated wetlands, and flood irrigated pastures are Type 2 habitat. The rest of the stratum is Type 3.

***Survey Methods*:** Occasional aerial surveys to verify absence of substantial numbers of focal species.

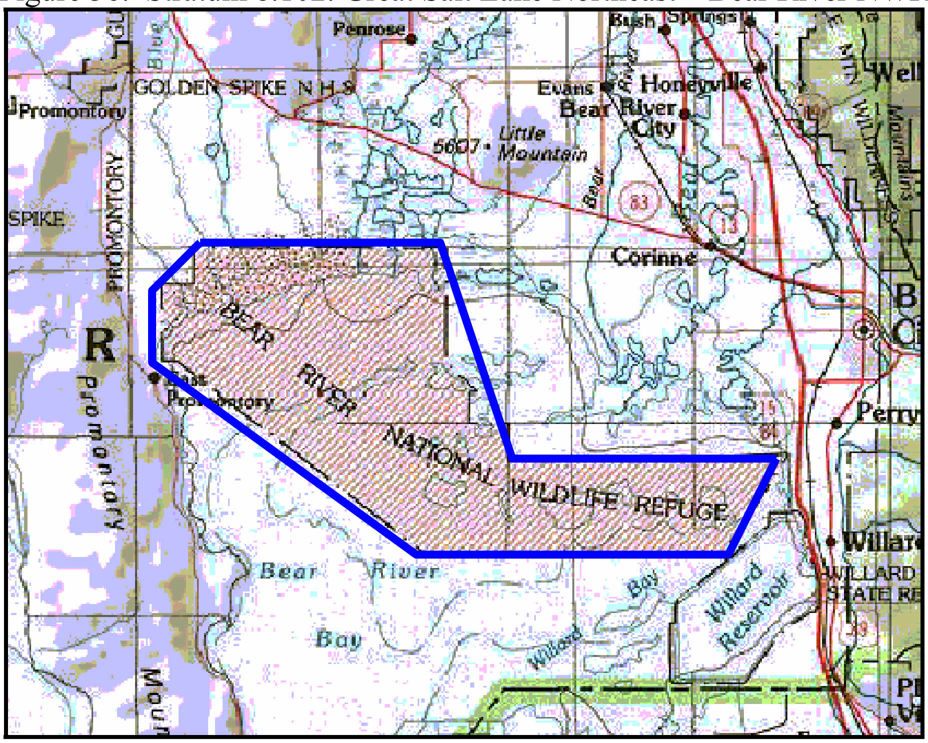
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 8.102. Great Salt Lake Northeast – Bear River NWR

Figure 36. Stratum 8.102. Great Salt Lake Northeast – Bear River NWR



***Description*:** Bear River National Wildlife Refuge (NWR) is a large, important area for shorebirds; however, the habitat changes dramatically due to management regimes and flood events that remove vegetation. Visibility is often low, and access to all areas of the refuge is questionable.

This area was surveyed on the GSL Waterbird Survey (areas 29a and 29b). Area 29b was along the refuge road and had low numbers (<10) of focal species. Mean survey counts (>10) for focal species for areas 27 and 29a were WIPH – 3684, WESA – 4619, LBDO – 3510, MAGO – 4938, GRYE – 11, and LEYE – 12. Tens of thousands of AMAV and thousands of BNST were also counted.

***Land Ownership*:** The NWR is administered by the U.S. Fish and Wildlife Service.

***Classification*:** Much of the refuge is Type 1 habitat, although there may be areas of Type 2 or 3 habitat. More work is needed to identify all Type 1 habitat.

Survey Method**:** A pilot study is needed.

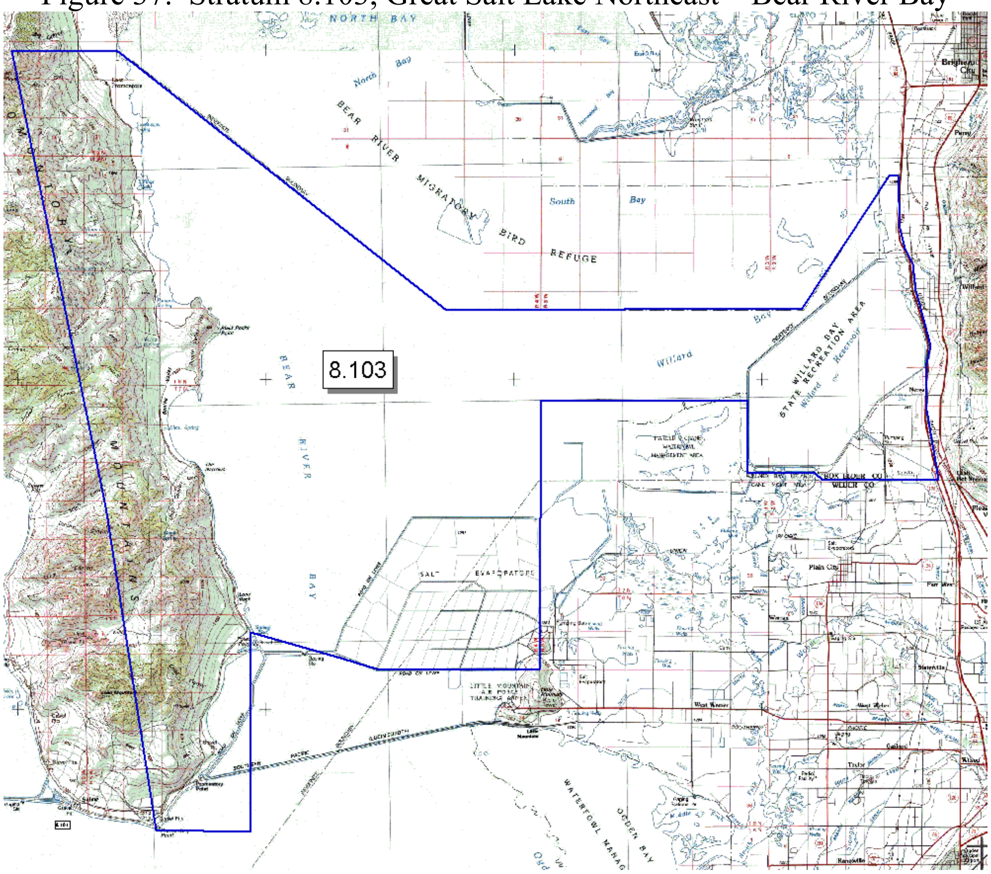
Measurement Error and Measurement Bias**:** Unknown.

Selection Bias**:** Unknown.

Pilot Studies Needed**:** A pilot study is needed to classify all areas by habitat Type and to assess whether there are areas of inaccessible Type 1 habitat. If all Type 1 habitat cannot be surveyed, then a sampling plan will be needed where a small, random sample of the inaccessible Type 1 habitat is surveyed each year.

Stratum 8.103. Great Salt Lake Northeast – Bear River Bay

Figure 37. Stratum 8.103, Great Salt Lake Northeast – Bear River Bay



Description**:** This stratum is sandwiched between the Harold Crane WMA on the south and the Bear River Migratory Bird Refuge D-line dike to the north. This area can be dry or wetlands, depending on the lake level and the amount of fresh water inflow into Bear River Bay and the Willard Spur.

Bear River Bay (area 37), Willard Spur (area 28), and South Bear River (area 27) were surveyed on the GSL Waterbird Survey. Mean survey counts (>10) for the Bear River Bay were

WIPH – 8215, LBDO – 212, MAGO – 22, PEEP – 1428, and PHAL – 63. Mean survey counts (>10) for Willard Spur were WIPH – 965, LBDO – 2373, MAGO – 1398, and PEEP – 231. There were also thousands of AMAV and BNST on both surveys. These areas were surveyed by transects from the air. The count data were extrapolated to cover the whole area; therefore, the entire stratum was not covered completely. Detection rates were relatively low because of fast travel speeds of the aircraft and some shorebirds hide in the vegetation.

***Land Ownership*:** This area consists of state and private lands.

***Classification*:** The Willard Spur area north and east of the evaporation ponds is Type 1 habitat. West of the evaporation ponds is Type 2 habitat

***Survey Methods*:** Surveys of the Willard Spur by airboat will provide complete coverage. Occasional aerial surveys for the rest of the stratum are adequate to confirm the absence of substantial numbers of focal species.

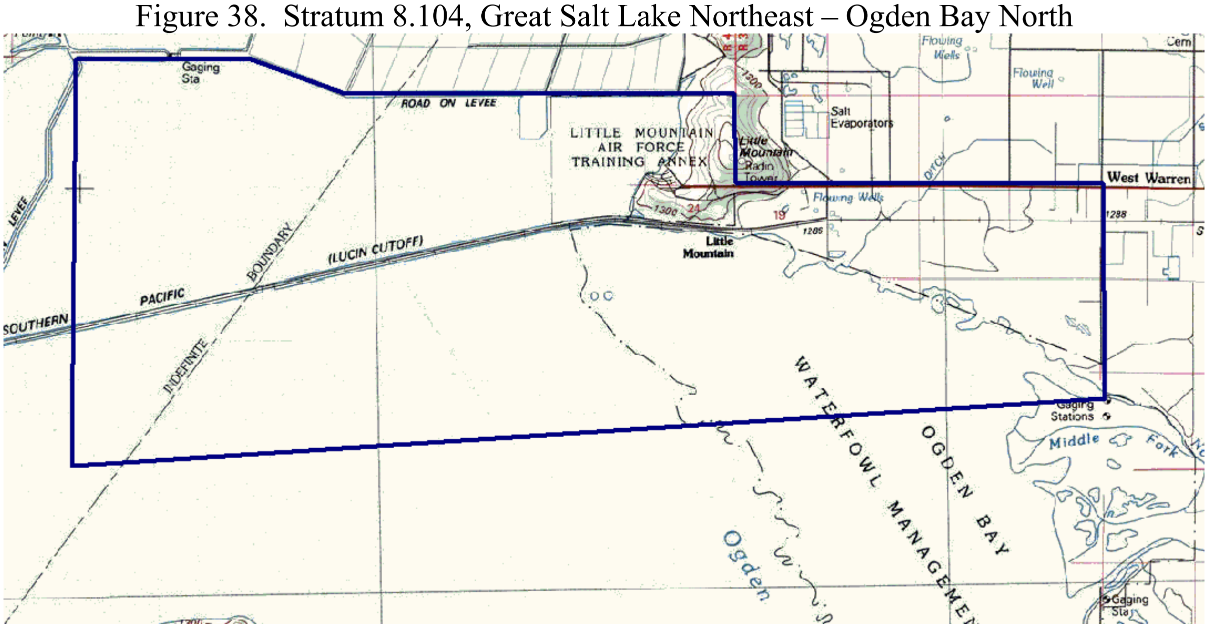
***Measurement Error and Measurement Bias*:** Minimal. All Type 1 habitat sampled.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 8.104. Great Salt Lake Northeast – Ogden Bay North

Figure 38. Stratum 8.104, Great Salt Lake Northeast – Ogden Bay North



***Description*:** This stratum is a shoreline piece from the north fork of the Weber River to the railroad tracks. It was surveyed in the GSL Waterbird Surveys by airboat (area 22). Mean survey counts (>10) for focal species were WIPH – 857 and WILL – 17. There were also hundreds of AMAV and BNST. Counts do not include gulls and other birds directly associated with Landing Rocks. Public access is good.

***Land Ownership*:** The state, the military, and private landowners own the land in this stratum. The state leases some of their land.

***Classification*:** The shoreline is Type 2 habitat and the rest of the stratum is Type 3.

***Survey Methods*:** An occasional foot or ATV survey is needed to confirm low numbers of focal species.

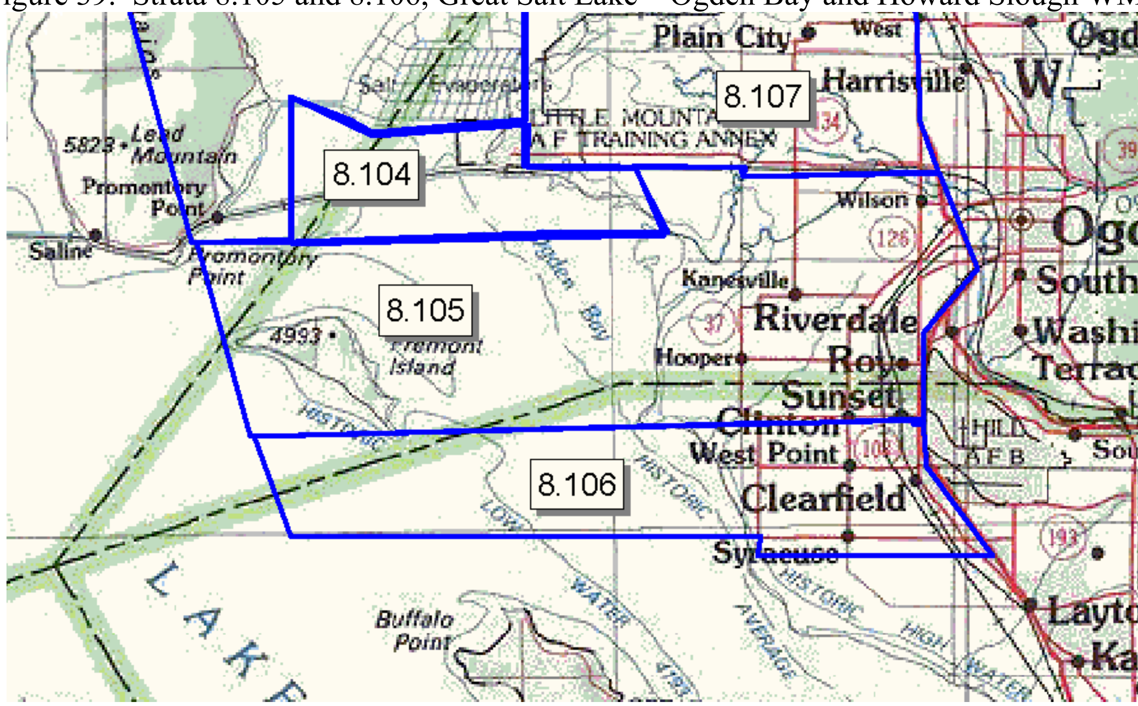
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 8.105. Great Salt Lake – Ogden Bay

Figure 39. Strata 8.105 and 8.106, Great Salt Lake – Ogden Bay and Howard Slough WMA



***Description*:** This area is a large complex of impounded water and emergent vegetation. It includes all of the impoundments and drivable interior dikes of the Ogden Bay WMA. Since 1997, all vegetation in Unit 3 has been dead. Stands of alkali bulrush are growing on the outside of Unit 1. Unit 3 dike is breached. This stratum is 16,700 acres, and 100% of area was surveyed in the GSL Waterbird Surveys. Eighty percent of the WMA is good waterbird habitat, but only 60% was visible. In good areas detection rates were 90+%. The WMA was subdivided into

Type 1, 2 and 3 on a map. The non–visible areas had tall vegetation and deep water; therefore, they may not be as good for shorebirds as the visible areas. Near Unit 1 there is viewing difficulty near the grass island. A spotting scope or boat might provide better viewing in this area.

This was area 20 on the GSL Waterbird Survey. Mean survey counts (>10) were WESA – 83, WIPH – 2313, LBDO – 131, MAGO – 13, PEEP –109, LESA – 16, WILL – 48, KILL – 13, GRYE – 69, LEYE – 32, and thousands of AMAV and BNST.

***Land Ownership*:** The WMA is managed by UDWR. The rest of the stratum is privately owned.

***Classification*:** 60% of the WMA is Type 1 habitat for shorebirds. Three km^2 of the WMA is Type 2 habitat. The rest of the stratum is Type 3.

***Survey method*:** A pilot study is needed to determine whether all Type 1 habitat is visible.

***Measurement Error and Measurement Bias*:** Uncertain.

***Selection Bias*:** Uncertain.

***Pilot Study Needed*:** Need to verify shorebird use in the areas not visible in GSL Waterbird Surveys and to assess the effectiveness of spotting scopes or boats for increasing visibility.

Stratum 8.106. Great Salt Lake Northeast – Howard Slough WMA

***Description*:** The shoreline section extends between the Antelope Island North causeway and the WMA dike. The WMA includes the area on the lakeside of the dikes from the north end of the shoreline section to the south fork of the Weber River on the Ogden Bay, and the drivable impoundments in Howard Slough WMA. This area has a shoreline portion and large complexes of impounded water and emergent vegetation. The WMA covers 3,197 acres, of which 85% was covered by survey. Ninety–five percent of the WMA is good waterbird habitat. The outer dikes were washed out in 1997. Salt water was then able to reach the marsh vegetation. The high salinity of the water killed the plants, which resulted in increased visibility. However, due to the breach in the dike, travel was impossible. Observations had to be made at either end of the impoundment. The increased distances made visibility and identification more difficult, especially seeing PEEPs. The secondary ponds can be good for shorebirds. One pond is drawn down each year on a rotating basis.

This area was surveyed on the Great Salt Lake Waterbird Survey (areas 19a, 19b, and 19c). The only focal species that had mean survey counts >10 were LBDO – 22 and WIPH – 17. Thousands of AMAV and hundreds of BNST were also counted.

***Land Ownership*:** The WMA is managed by UDWR.

***Classification*:** The draw down pond is Type 1 habitat; otherwise the water is too deep and secondary ponds are Type 3. There are other areas of Type 1, 2, and 3 habitat in the WMA and these have been subdivided on a map. The rest of the stratum is Type 3 habitat.

***Survey method*:** Ground surveys of draw down pond and occasional aerial surveys of the rest of the stratum.

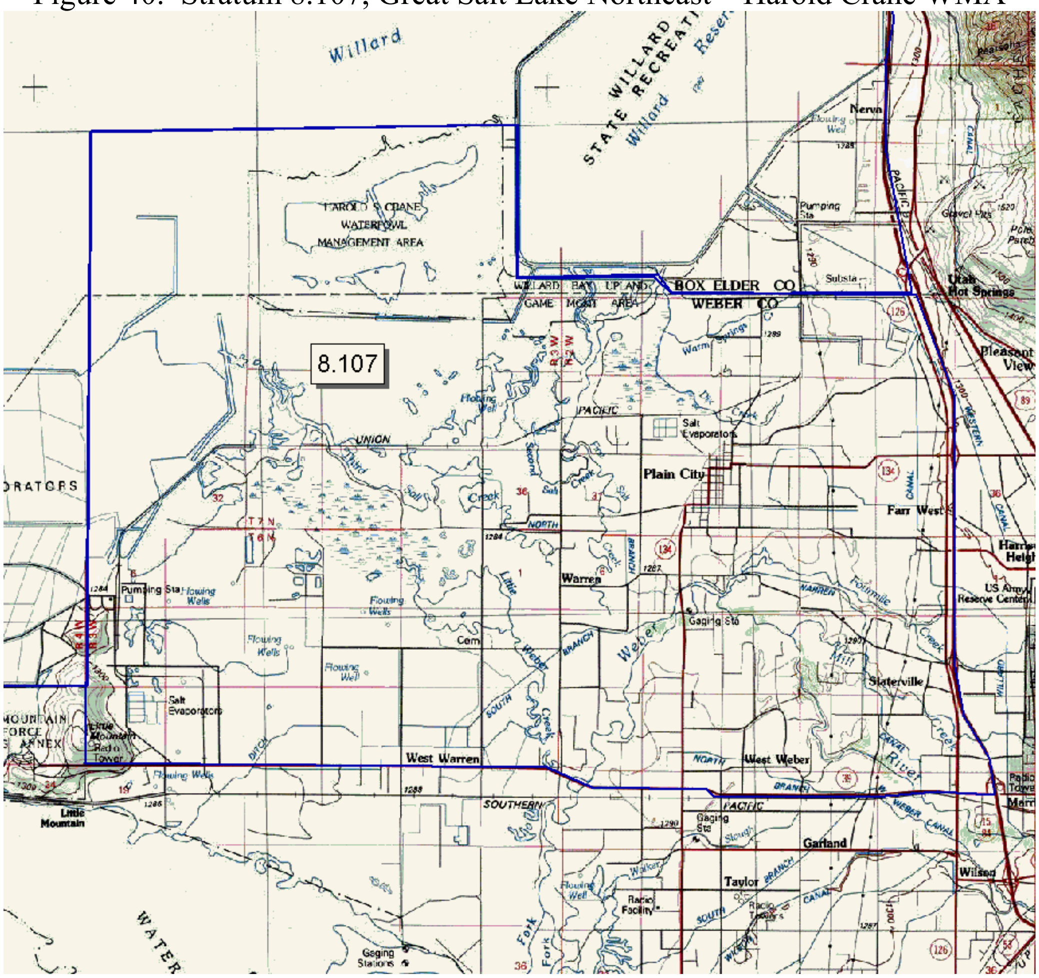
***Measurement Error and Measurement Bias*:** Minimal because all Type 1 habitat surveyed.

***Selection Bias*:** None.

***Pilot Study Needed*:** None.

Stratum 8.107. Great Salt Lake Northeast – Harold Crane WMA

Figure 40. Stratum 8.107, Great Salt Lake Northeast – Harold Crane WMA



***Description*:** This stratum includes the Harold Crane WMA, South Harold Crane and Rainbow areas. It is a large complex of impounded water and emergent vegetation and covers 11,430 acres. Fifty percent of the stratum is good waterbird habitat. Some of the waterbird habitat is on private land. Approximately one–third of the strata (4,000 acres) has good visibility. The three areas are adjacent to one another and have been surveyed as one route. The Rainbow site includes the George East Duck club and Rainbow pond and is a total count survey from existing roads. The South Harold Crane survey is a total count within the gravel road through the UDWR gate on the east, the GSL Minerals Company canal on the north and west, and the railroad tracks on the south. The Harold Crane WMA survey is a total count from all drivable interior dikes within the WMA.

The Harold Crane WMA includes areas 23, 24, and 25 of the GSL Waterbird Survey. Mean survey counts (>10) of focal species were WIPH – 104, LBDO – 297, MAGO – 111, and LEYE – 14. Thousands of AMAV and hundreds of BNST were also counted. Some good peep areas were missed by the WBS survey. Areas not covered in the WBS are accessible by foot. The southwest corner is privately owned and may have good peep use.

Land Ownership**:** The entire stratum is managed by UDWR.

Classification**:** Approximately 50% of the WMA areas are Type 1 habitat and approximately 10% are Type 2 habitat. The rest of the stratum is Type 3 habitat.

Survey Methods**:** Uncertain. A pilot study is needed.

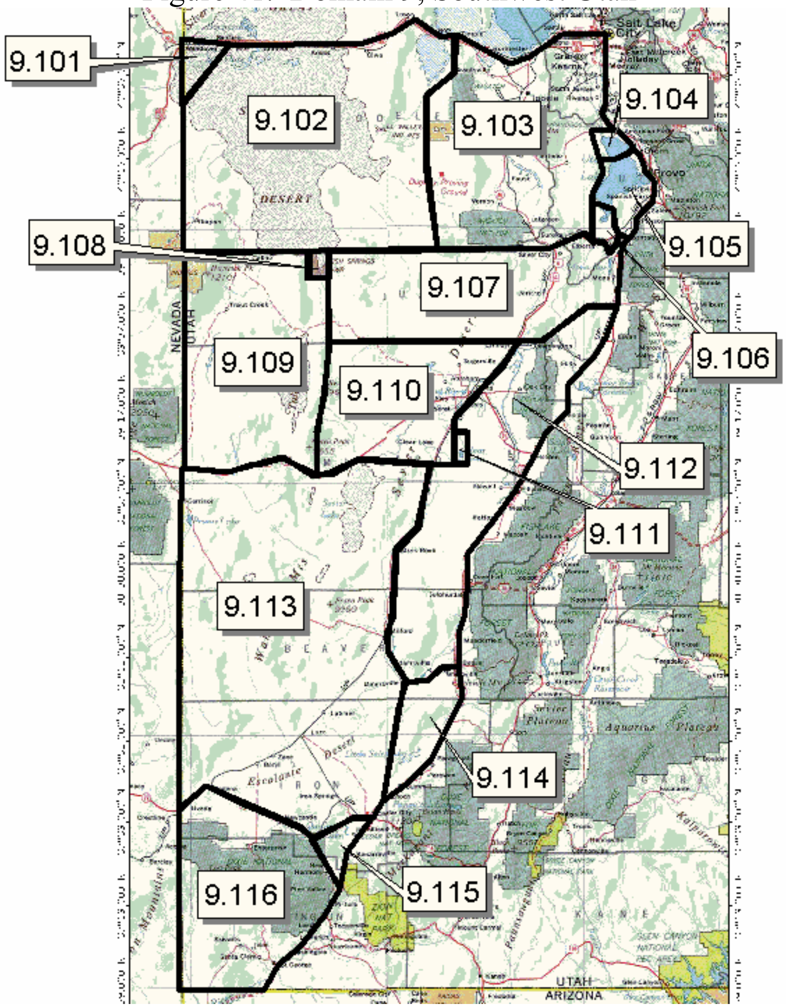
Measurement Error and Measurement Bias**:** Uncertain.

Selection Bias**:** Uncertain.

Pilot Studies Needed**:** A study is needed to assess whether all Type 1 habitat can be surveyed completely.

Domain 9. Southwest Utah

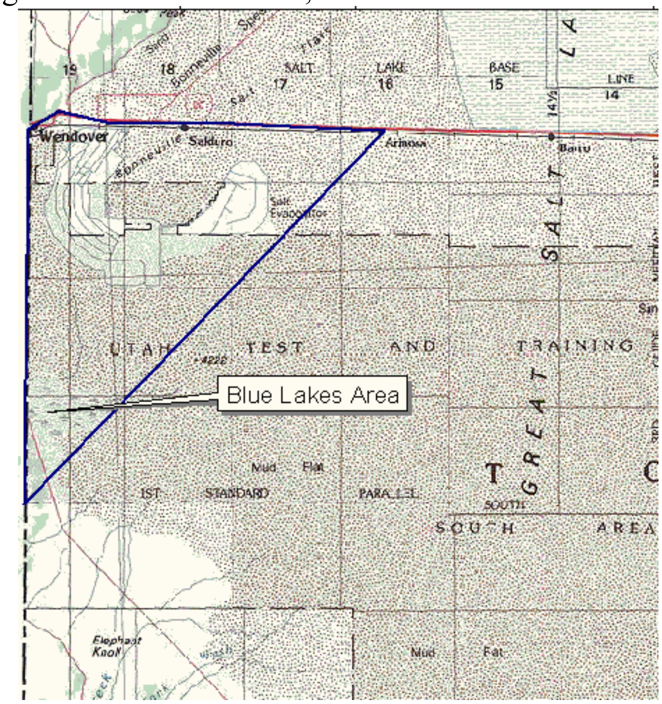
Figure 41. Domain 9, Southwest Utah



Description**:** Domain 9 is bordered by Nevada to the west, I-80 to the north, I-15 to the east and Arizona to the south. Much of the domain is dry desert habitat unsuitable for shorebirds, although there are small wetland areas interspersed throughout the domain. Fish Springs NWR and Utah Lakes are two important shorebird areas. There are sixteen strata in Domain 9.

Stratum 9.101. Southwest Utah – Blue Lakes

Figure 42. Stratum 9.101, Southwest Utah – Blue Lakes



Description: This stratum is bordered to the west by Nevada, to the north by I-80 and the town of Wendover. The Great Salt Desert is to the east and south. Much of the land is actively used Military land, and the southwestern tip of the stratum is the Military Boundary. The northeastern tip is the location of Arinosa. Blue Lake and the surrounding ponds and marshes are the only areas suitable for shorebirds in this stratum. The *Birding Utah* guide lists SEPL, MOUP, BNST, AMAV, GRYE, LEYE, and WILL in this area. There is a good observation point of the marsh area from a 10' tall rock on the west side of Blue Lake.

Land Ownership: The Blue Lake area is managed by the BLM. The rest of the stratum is primarily military land.

Classification: Blue Lakes and surrounding marshes are Type 1 or 2 habitat. The rest of the stratum is type 3.

Survey Method: A pilot study is needed to determine survey method and habitat type.

Measurement Error and Measurement Bias: Uncertain.

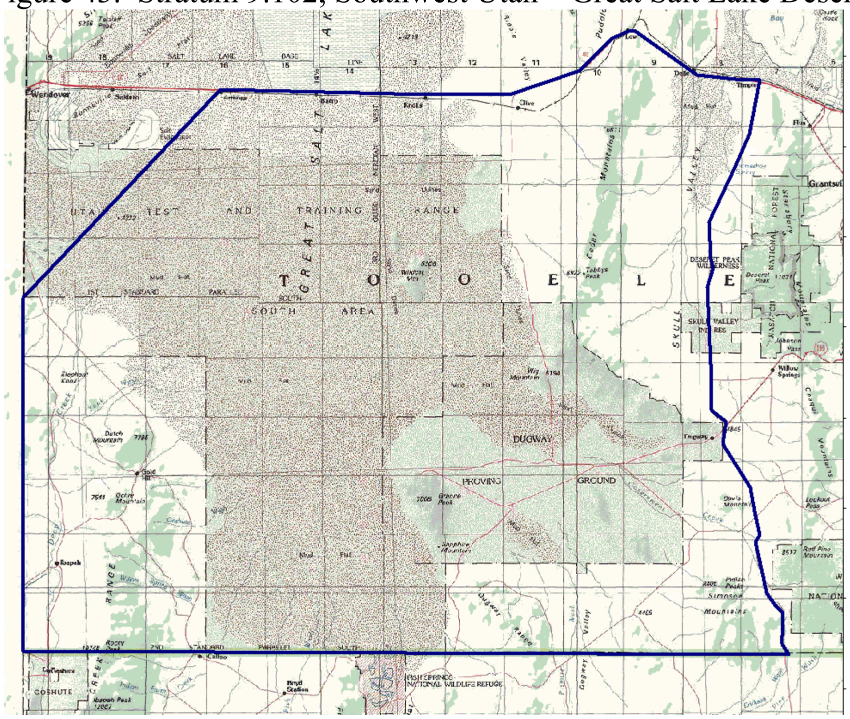
Selection Bias: Uncertain.

Local Contact: BLM, Salt Lake Field Office, Curtis Warick 801-977-4332 or Nate Packer 801-997-4351.

Pilot Studies Needed: This area is small and a complete survey may be feasible. A pilot study is necessary to assess the accuracy of a shorebird census and to confirm habitat type.

Stratum 9.102. Southwest Utah – Great Salt Lake Desert

Figure 43. Stratum 9.102, Southwest Utah – Great Salt Lake Desert



Description: The entire stratum is a dry, salt basin and is unsuitable for shorebirds. It includes the Cedar Mountains, Skull Valley, and Dugway Proving Grounds. The southern border for this stratum is the southern border of Tooele County. Fish Springs NWR and Goshute Indian Reservation are not included in this stratum.

Land Ownership: This stratum consists of public and private lands.

Classification: All habitat is Type 3 for shorebirds.

Survey Method: None needed unless casual observation suggests a change in shorebird use.

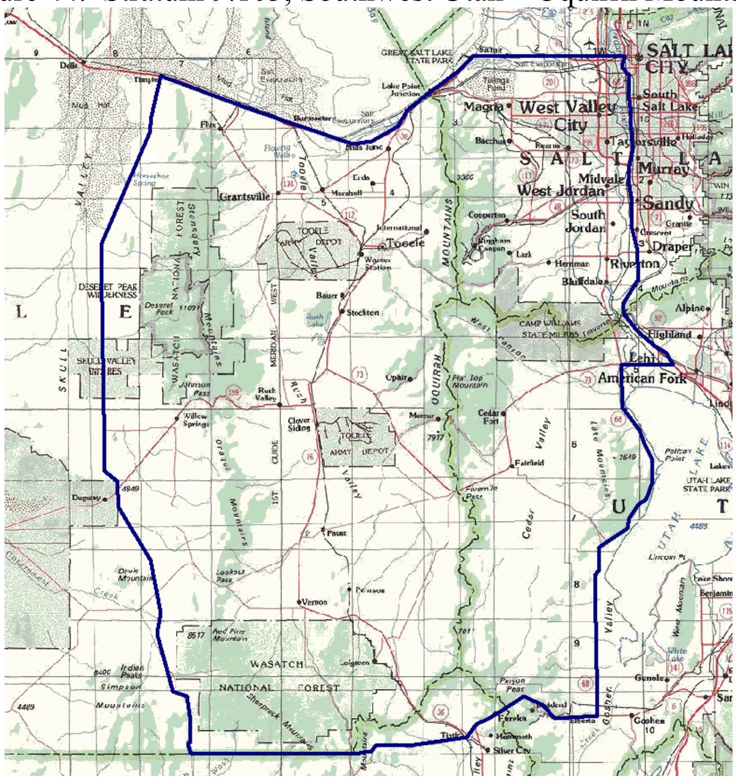
Measurement Error and Measurement Bias: Minimal.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 9.103. Southwest Utah – Oquirrh Mountains

Figure 44. Stratum 9.103, Southwest Utah – Oquirrh Mountains



***Description*:** County road that runs through Skull Valley from Timpie to Dugway is the western border of this stratum. The eastern border is State Highway 68, just west of Utah Lake. The southern border is the southern edge of Sheeprock Mountains in the Wasatch National Forest to Tintic and Highway 6 to State Highway 68. This stratum is unsuitable for shorebirds.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** Entire stratum is Type 3 habitat.

***Survey Method*:** None needed unless casual observation suggests a change in shorebird use.

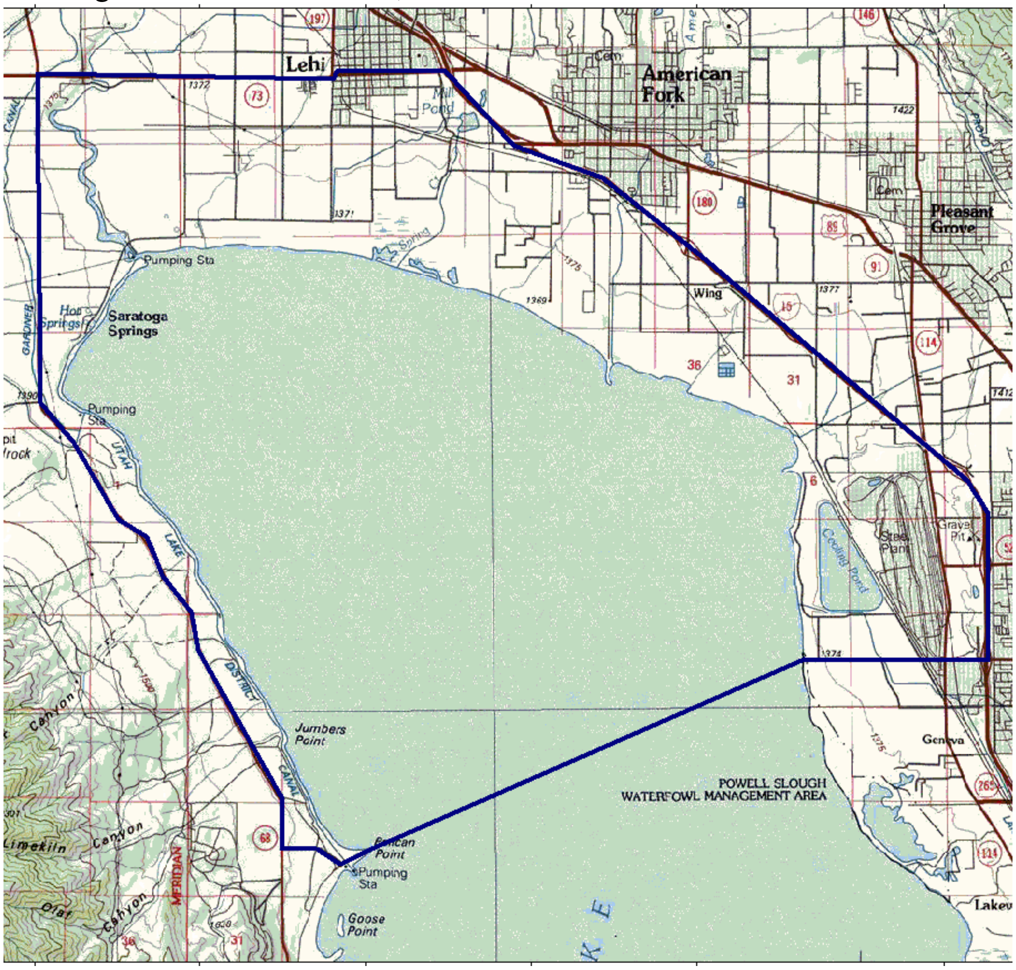
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 9.104. Southwest Utah – North Shore Utah Lake

Figure 45. Stratum 9.104, Southwest Utah – North Shore Utah Lake



***Description*:** This stratum is bordered to the west by state Highway 68, to the north by Highway 73, and to the east by I-15. The southern boundary runs south of the cooling ponds and across the lake to Pelican Point. The habitat is primarily playa, marsh, shoreline, and open water. Good numbers of shorebirds are found in the wetlands near the mouth of the Jordan River and Spring Creek. The shoreline sees moderate use by shorebirds when the lake level is lower, which is usually in the late summer and fall. Visibility is also better during fall migration, as shorebirds congregate on the open mudflats. Early morning surveys are recommended to decrease the glare from the sun, which can decrease visibility. Access to viewing areas is good.

***Land Ownership*:** Much of the land in this stratum is private or managed by the Bureau of Reclamation.

***Classification*:** Casual observations suggest the wetlands near the mouth of the Jordan River and Spring Creek are Type 1 habitat and the remaining shoreline is Type 2 habitat. The rest of the stratum is Type 3.

***Survey Methods*:** A pilot study is needed.

***Measurement Error and Measurement Bias*:** Uncertain.

***Selection Bias*:** Uncertain.

***Local Contact*:** David Lee, UDWR, 801- 538-4751 or Russ Lawerence, UDWR, 801-510-7062.

***Pilot Studies Needed*:** A pilot study is needed to confirm habitat classifications and to assess whether all Type 1 habitat can be surveyed accurately.

Stratum 9.105. Southwest Utah – Central Utah Lake

Figure 46. Stratum 9.105, Southwest Utah – Central Utah Lake

***Description*:** This stratum is bordered to the west by state Highway 68. At the Goshen Valley, the stratum border crosses the lake to the West Mountains and turns south to Highways 141 and 6. The southern border is Highway 6 to Santaquin and the eastern border is I-15. The habitat consists of playa, marsh, shoreline, mountain and open water. Good numbers of shorebirds are found in Powell Slough WMA, Provo Bay and Benjamin Slough. The shoreline sees moderate use by shorebirds when the lake level is lower, which is usually in the late summer and fall. Visibility is also better during fall migration, as shorebirds congregate on the open mudflats. Early morning surveys are recommended to decrease the glare from the sun, which can decrease visibility. Access to viewing areas is good.

Land Ownership**:** Much of the land in this stratum is private or managed by the Bureau of Reclamation. The Benjamin Slough area is being considered for preserve status.

Classification**:** Casual observations suggest the wetlands of Powell Slough WMA, Provo Bay and Benjamin Slough are Type 1 habitat and the remaining shoreline is Type 2 habitat. The rest of the stratum is Type 3.

Survey Methods**:** A pilot study is needed.

Measurement Error and Measurement Bias**:** Uncertain.

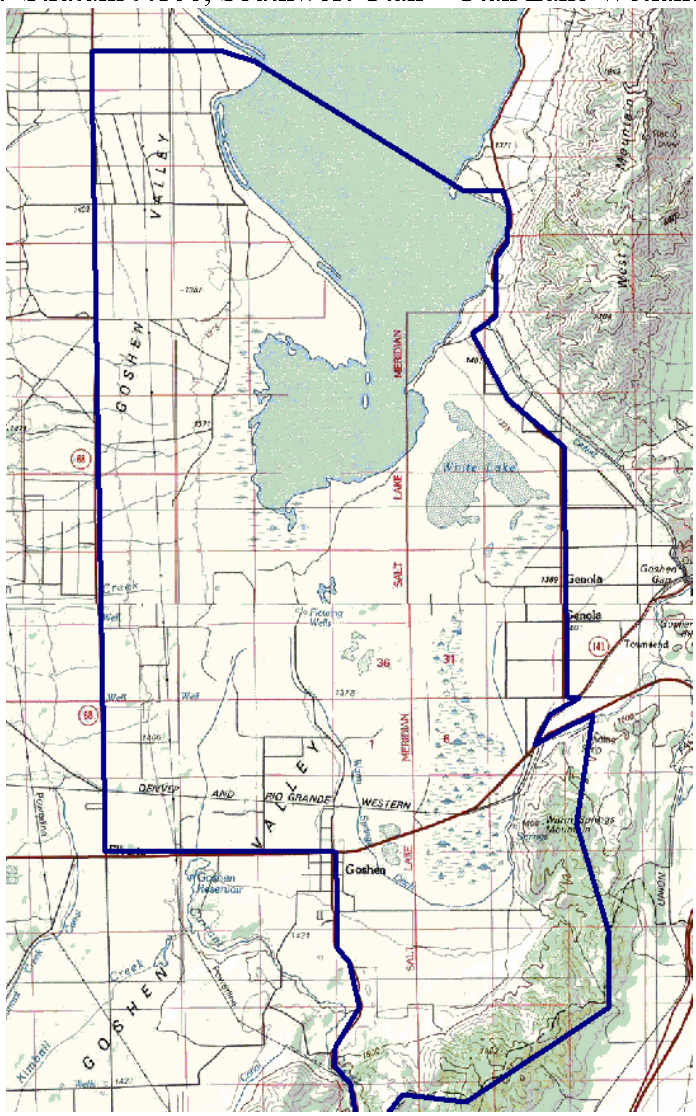
Selection Bias**:** Uncertain.

Local Contact**:** David Lee, UDWR, 801- 538-4751 or Russ Lawerence, UDWR, 801-510-7062.

Pilot Studies Needed**:** A pilot study is needed to confirm habitat classifications and to assess whether all Type 1 habitat can be surveyed accurately.

Stratum 9.106. Southwest Utah – Utah Lake Wetland Preserve

Figure 47. Stratum 9.106, Southwest Utah – Utah Lake Wetland Preserve



***Description*:** This stratum consists of the Utah Lake Wetlands Preserve and the surrounding Goshen Valley. It includes the Warm Springs WMA. The southern border is Highway 6 to Goshen and the Long Ridge Mountains. The habitat is primarily playa, marsh, shoreline and open water. Warm Springs WMA is primarily tall emergent marsh used by large waders and rails. Good numbers of shorebirds are found in the wetlands near White Lake and the southern tip of Utah Lake. The shoreline sees moderate use by shorebirds when the lake level is lower, which usually occurs in the fall. Visibility is also better in the fall, as shorebirds congregate on the open mudflats. Early morning surveys are recommended to decrease the glare from the sun, which can decrease visibility.

***Land Ownership*:** The Utah Lake Wetland Preserve and Warm Springs WMA are managed by the Utah Division of Wildlife Resources. The remainder of this stratum is managed by the BLM, the Bureau of Reclamation, or privately owned.

***Classification*:** Casual observations suggest the wetlands near White Lake and the southern tip of Utah Lake are Type 1 habitat. The remaining shoreline and Warm Spring WMA is Type 2. The rest of the stratum is Type 3.

***Survey Methods*:** A pilot study is needed.

***Measurement Error and Measurement Bias*:** Uncertain.

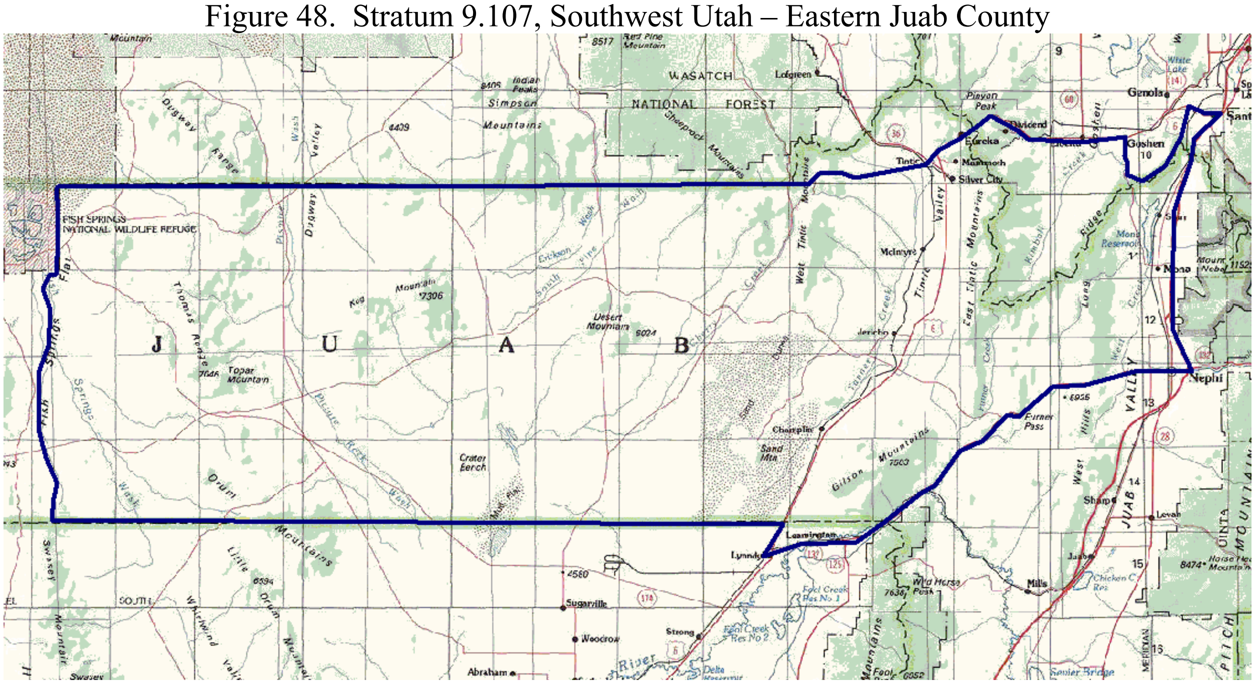
***Selection Bias*:** Uncertain.

***Local Contact*:** David Lee, UDWR, 801- 538-4751 or Russ Lawerence, UDWR, 801-510-7062.

***Pilot Studies Needed*:** A pilot study is needed to confirm habitat classifications and to assess whether all Type 1 habitat can be surveyed accurately.

Stratum 9.107. Southwest Utah – Eastern Juab County

Figure 48. Stratum 9.107, Southwest Utah – Eastern Juab County



***Description*:** This stratum is west of I-15, north of Highway 132, and east of Fish Springs Mountains. It includes Fish Spring Flats, but does not include Fish Springs NWR. This area is primarily dry desert and is unsuitable for shorebird.

***Land Ownership*:** This stratum consists of public and private lands.

Classification: The entire stratum is Type 3 habitat.

Survey Method: None needed unless casual observation suggests a change in shorebird use.

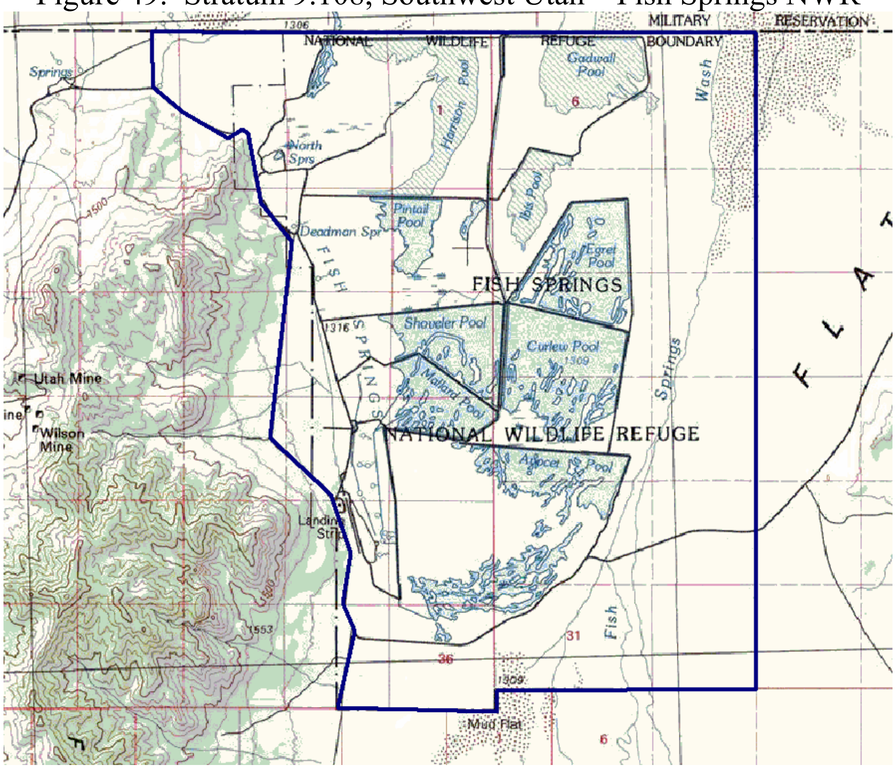
Measurement Error and Measurement Bias: Minimal.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 9.108. Southwest Utah – Fish Springs NWR

Figure 49. Stratum 9.108, Southwest Utah – Fish Springs NWR



Description: This stratum is comprised of the National Wildlife Refuge only. This area is marsh and small pond habitat. Beginning in early 1990s, refuge staff conducted bi-monthly surveys throughout the year. Surveys are conducted from the driving tour roads throughout the refuge. The surveys cover most of the refuge. More information is needed on detection rates. Surveys indicate 10,000-14,000 shorebird visits each year. *Birding Utah* guide reports SNPL, LBCU, GRYE (spring), WILL, SPSA, and WIPH.

Peak spring migration is between March 15 and 30 April. Fall migration peaks between late July and early September.

***Land Ownership*:** The NWR is managed by the U.S. Fish and Wildlife Service.

***Classification*:** The entire stratum is probably Type 1 habitat, although additional information from the Refuge Staff is needed.

***Survey Method*:** Unless detection rates are low, driving surveys of the refuge should provide complete coverage.

***Measurement Error and Measurement Bias*:** Uncertain.

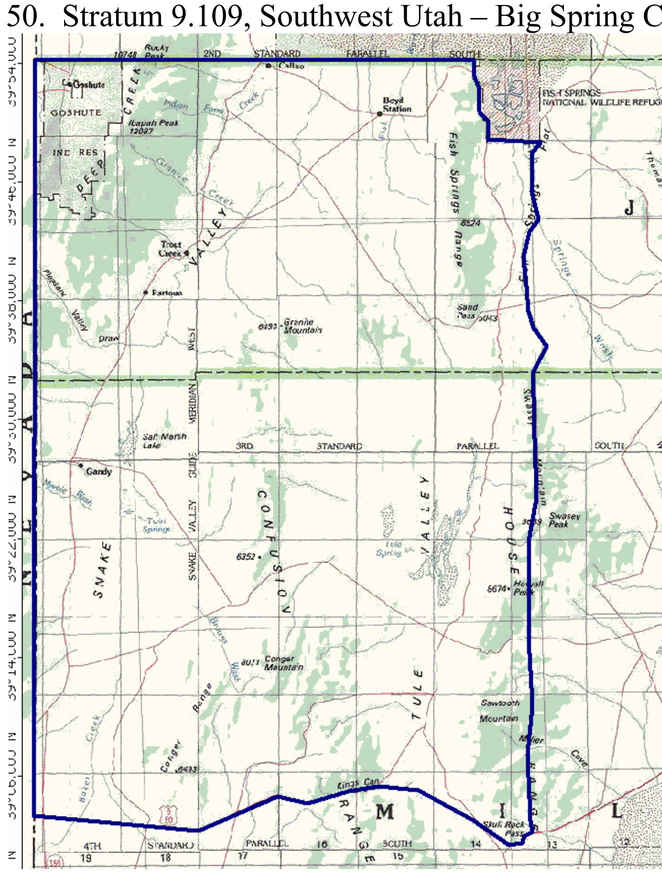
***Selection Bias*:** Uncertain.

***Local Contact*:** Jay Banta, Refuge Manager, 435-831-5353, ext. 2223.

***Pilot Studies Needed*:** A pilot study, or more information is needed to assess detection rates of vehicle surveys.

Stratum 9.109. Southwest Utah – Big Spring Complex

Figure 50. Stratum 9.109, Southwest Utah – Big Spring Complex



***Description*:** Stratum 9.108 is bordered to the south by Highway 50 and to the east by the House Range. This area is primarily dry desert. Salt Marsh Lake and Tule Springs are small wetlands with little shorebird use; however, they may support larger numbers in very wet years.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** This stratum is classified as Type 3.

***Survey Method*:** None needed unless casual observation indicates a shift in shorebird use.

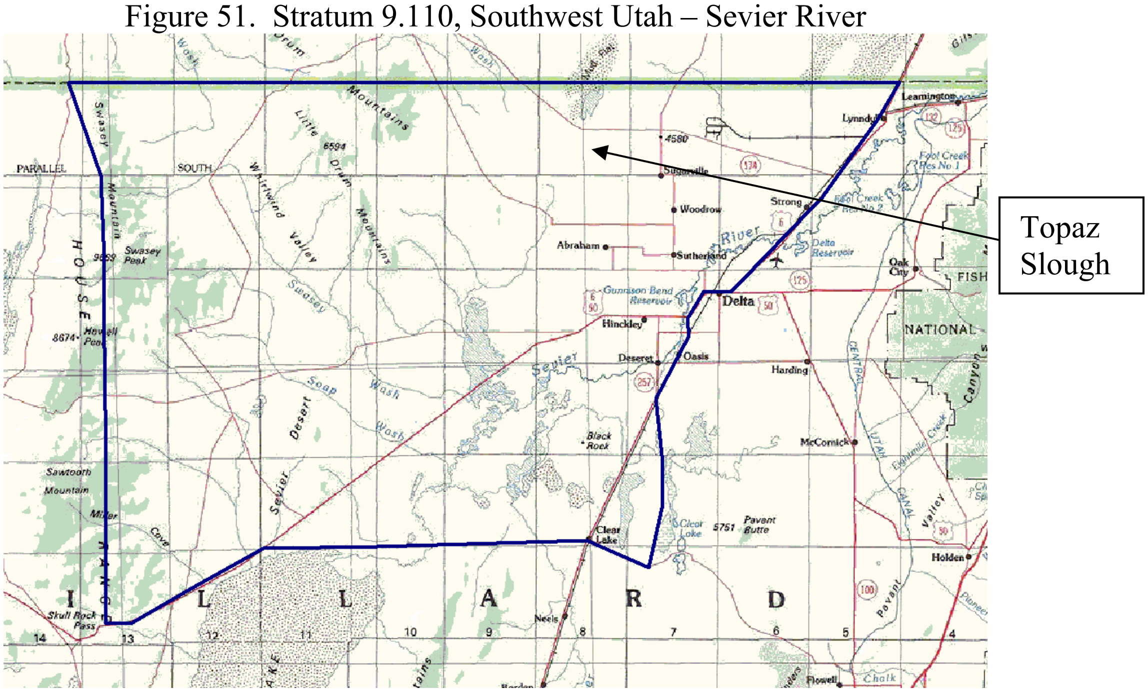
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 9.110. Southwest Utah – Sevier River

Figure 51. Stratum 9.110, Southwest Utah – Sevier River



***Description*:** Stratum 9.110 is bordered to the west by House Range to the south by highway 50 and the town of Clear Lake. Highway 6 and Clear Lake WMA border this stratum to the east. Gunnison Bend Reservoir is deep, with little wading area, and therefore does not support much shorebird use. Topaz Slough is a small wetland (1 km^2) that supports 100s of AMAV and BNST. Highest numbers are found during fall migration, when there may be up to 300-500 BNST. The area around the Sevier River in the northeast portion of the stratum is good shorebird habitat in wet years. The rest of this stratum is dry desert habitat.

***Land Ownership*:** This stratum consists of public and private lands.

***Classification*:** Topaz Slough is Type 2 habitat, and the rest of the stratum is Type 3, although the Sevier River area may be Type 2 in wet years.

***Survey Method*:** Occasional ground surveys to confirm low numbers of focal species at Topaz Slough and the Sevier River in wet years.

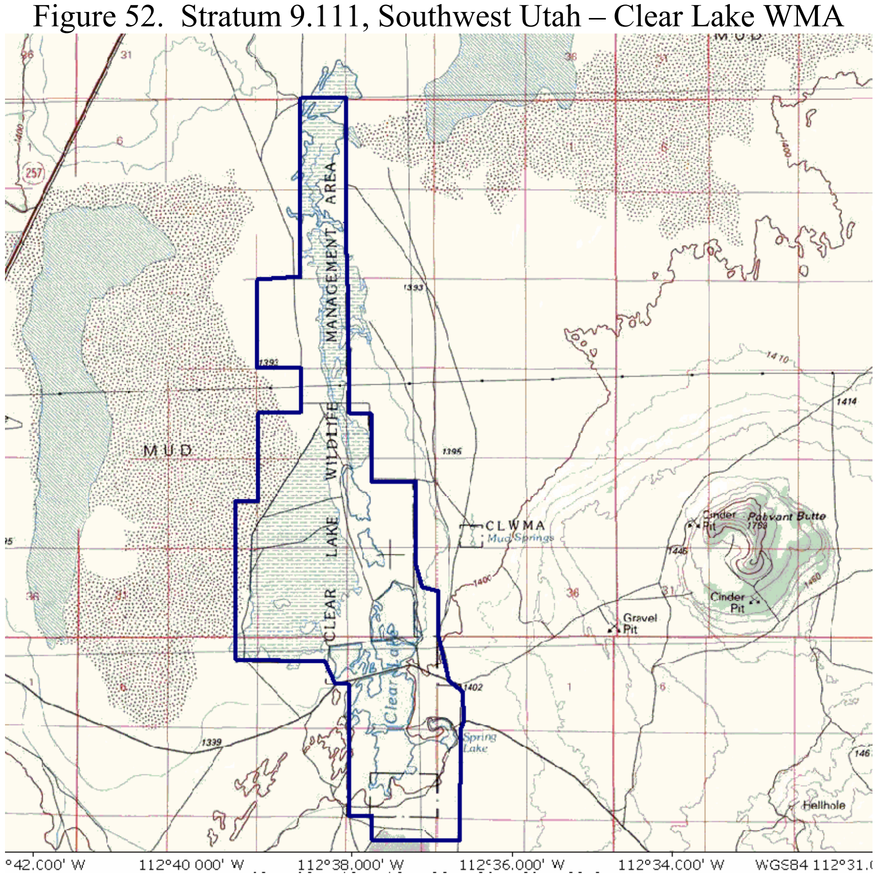
***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Stratum 9.111. Southwest Utah – Clear Lake WMA

Figure 52. Stratum 9.111, Southwest Utah – Clear Lake WMA



***Description*:** The UDWR conducts quarterly censuses of all non-game birds in this WMA. Shorebird use is moderate. Approximate averages of shorebird numbers on surveys are BNST – 4000, AMAV – 1000, and LEYE <20. Fall migration is a little later than the GSL area, averaging between late August and late September.

***Land Ownership*:** The WMA is managed by UDWR.

***Classification*:** This stratum is Type 2 habitat.

***Survey Method*:** Continue existing ground surveys of entire Management Area.

***Measurement Error and Measurement Bias*:** Minimal. Complete counts were made.

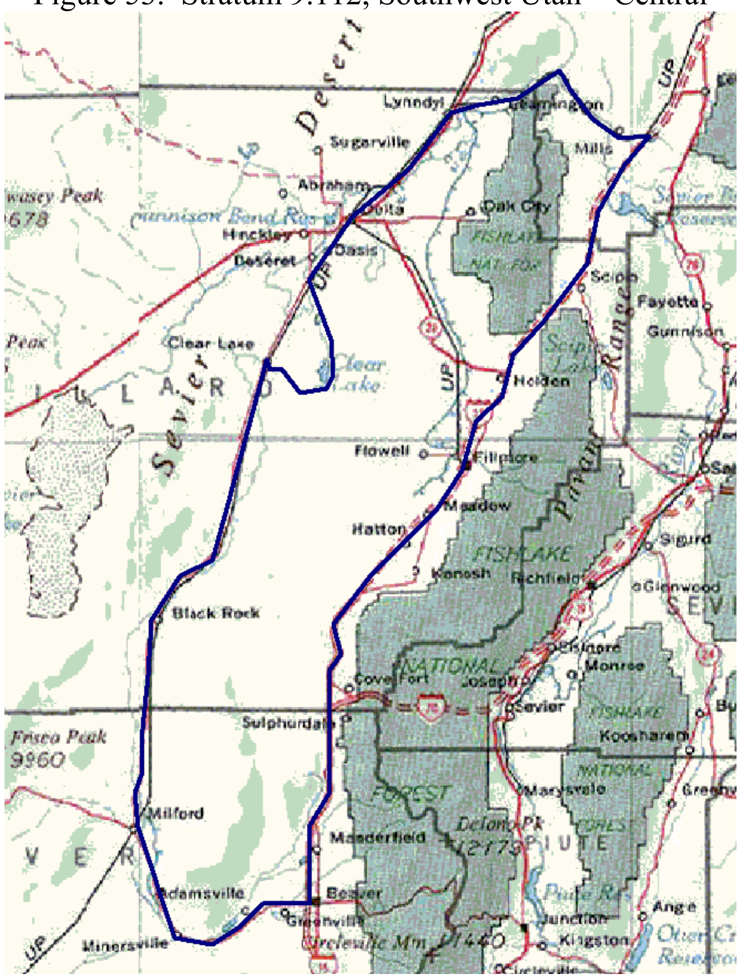
***Selection Bias*:** None. The entire stratum was surveyed.

***Local Contact*:** Lynn Zubeck, UDWR, 435-864-3200.

***Pilot Studies Needed*:** None.

Stratum 9.112. Southwest Utah – Central

Figure 53. Stratum 9.112, Southwest Utah – Central



***Description*:** This stratum is east of Highway 6, west of I-70, north of Highway 21 and south of Highway 132, with the exception of Clear Lake WMA. At Minersville reservoir, there is sagebrush along the shoreline and high fluctuations in the water level may result in few wading birds. Birder Steve Summers of Cedar City reports moderate numbers of shorebirds at Minersville reservoir in August and September. Means/record (>10) are KILL – 24, AMAV – 20, WILL – 10, WESA – 31, LESA – 12, BASA – 11, and RHPH – 10. These numbers may be biased, as counts were not standardized and there are no data regarding visits when no individuals of a species were seen. Regardless, these data suggest moderate use of Minersville Reservoir by shorebirds. The rest of the stratum is unsuitable for shorebirds.

***Land Ownership*:** Minersville Reservoir is managed by the Utah Division of Parks and Recreation. The rest of the stratum is a mix of public and private land.

***Classification*:** Minersville Reservoir is Type 2 habitat. The remainder of stratum is Type 3.

***Survey Method*:** Occasional ground surveys of Minersville Reservoir to confirm low numbers of shorebirds.

***Measurement Error and Measurement Bias*:** Minimal.

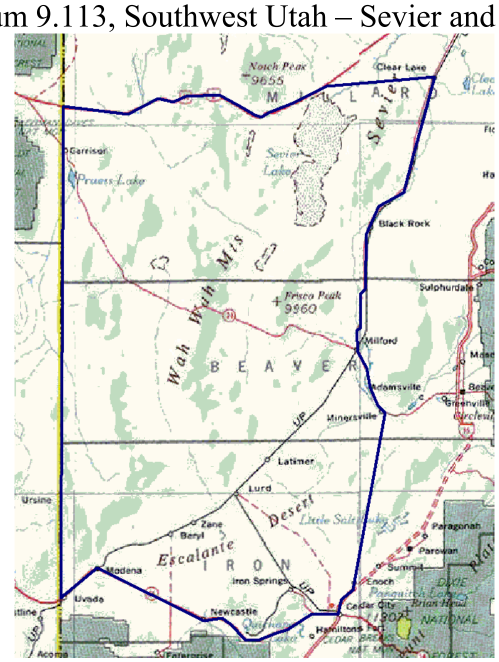
***Selection Bias*:** None.

***Local Contact*:** For Minersville Reservoir, Norm Forbush, Park Manager, 801-586-4497.

***Pilot Studies Needed*:** None.

Stratum 9.113. Southwest Utah – Sevier and Escalante Deserts

Figure 54. Stratum 9.113, Southwest Utah – Sevier and Escalante Deserts



Description: The eastern border of this stratum is Highway 30, the southern border is Highway 56 and the northern border is Highway 6 to Clear Lake. The entire stratum is dry desert and is unsuitable for shorebirds, although Sevier Dry Lake could become suitable in very wet years.

Land Ownership: This stratum consists of public and private lands.

Classification: Entire stratum is Type 3 habitat.

Survey Method: None needed unless casual observation suggests a change in shorebird use.

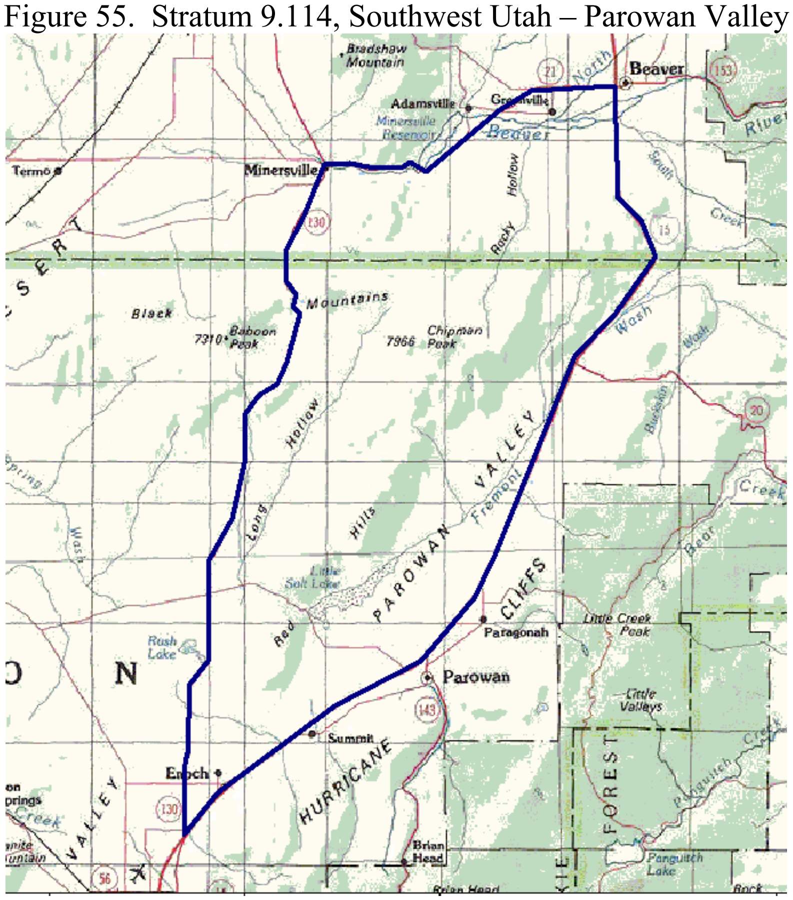
Measurement Error and Measurement Bias: None.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 9.114. Southwest Utah – Parowan Valley

Figure 55. Stratum 9.114, Southwest Utah – Parowan Valley



Description: This stratum is located between highway 130 and 21 and I-15. Most of stratum is unsuitable for shorebirds. Little Salt Lake is a playa lake that may have some water in spring, but is dry the rest of the year. Shorebirds on migration can be found in small numbers at variable locations throughout the stratum, such as the Parowan sewage ponds. The number of shorebirds, however, is too low to warrant surveys.

Land Ownership**:** This stratum consists of public and private lands.

Classification**:** This stratum is Type 3 habitat.

Survey Method**:** None needed unless casual observation indicates a change in shorebird use.

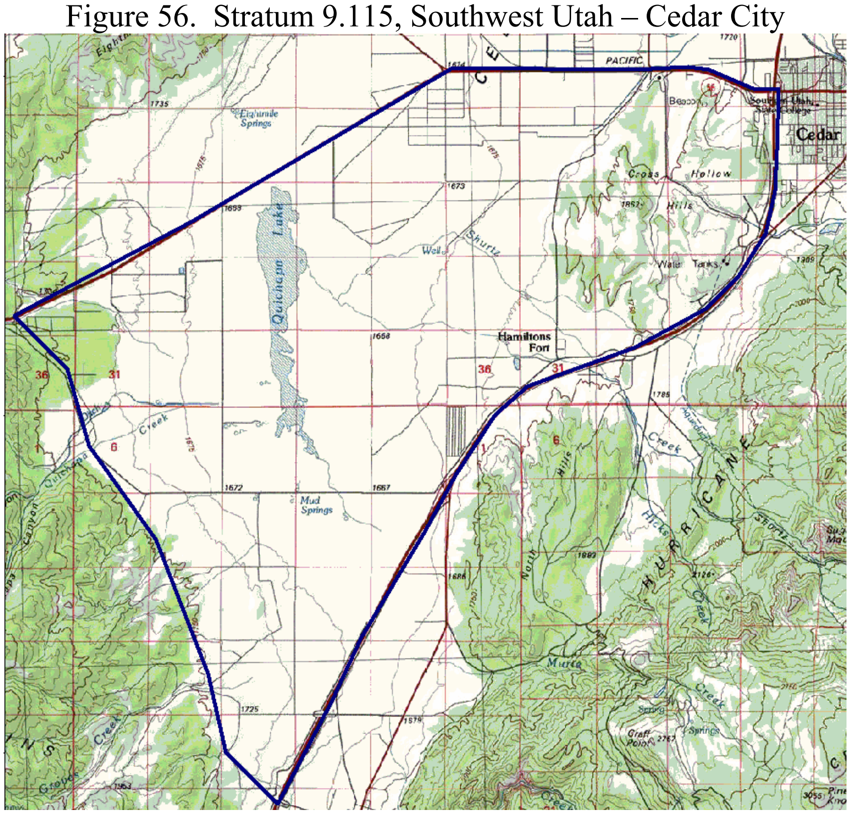
Measurement Error and Measurement Bias**:** None.

Selection Bias**:** None.

Pilot Studies Needed**:** None.

Stratum 9.115. Southwest Utah – Cedar City

Figure 56. Stratum 9.115, Southwest Utah – Cedar City



Description**:** This stratum is located between Cedar City, highway 56 and the Harmony Mountains. Because the lake often fills in spring, but is usually dry the remainder of the year, shorebird use at Quichapa Lake is variable. When Quichapa Lake is wet, it has moderate shorebird use. Birder Steve Summers of Cedar City reports the following means/record (>10) in

April and May at Quichapa Lake: AMAV – 378, BNST – 600, LESA – 33, MAGO – 26, RNPH – 250, WESA – 22, WILL – 15, and WIPH – 14. In August and September, he reports means/record (>10) of AMAV – 31, BNST – 376, LESA – 18, LBDO – 11, RNPH – 200, and WESA –20. These numbers may be biased, as counts were not standardized and there are no data regarding visits when no shorebirds were seen. These data, however, suggest moderate use of Quichapa Lake by shorebirds. The remainder of the stratum has little shorebird use.

Land Ownership: This stratum consists of public and private lands.

Classification: Quichapa Lake is Type 2 habitat and the rest of the stratum is Type 3.

Survey Method: Occasional ground surveys of Quichapa Lake in spring and fall to confirm low numbers of focal species. Surveys need to be conducted during wet years.

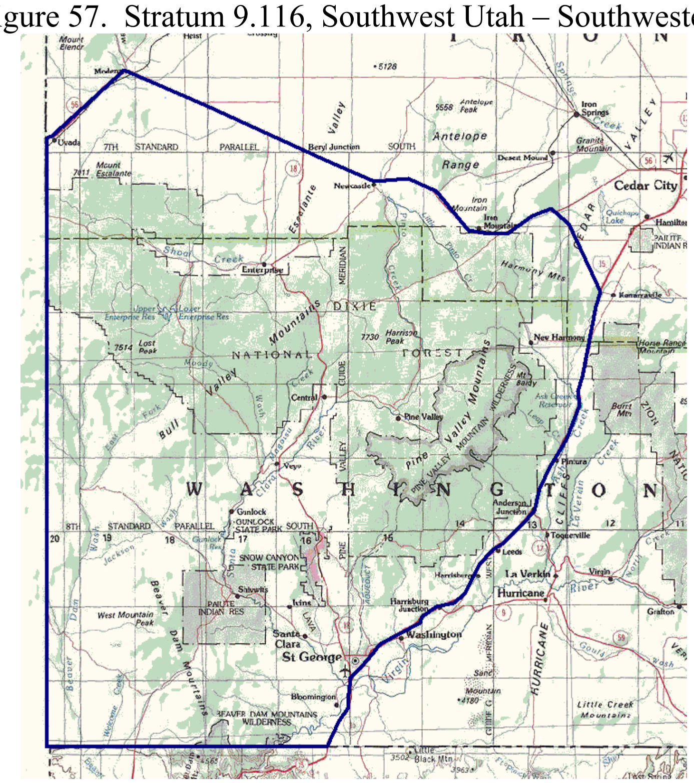
Measurement Error and Measurement Bias: Minimal.

Selection Bias: None.

Pilot Studies Needed: None.

Stratum 9.116. Southwest Utah – Southwestern

Figure 57. Stratum 9.116, Southwest Utah – Southwestern



***Description*:** This stratum lies between Highway 56, I-15 and the Utah borders. Most of this stratum is high elevation and does not support shorebirds. Enterprise Reservoir is >6000' and is ice free late in the spring, although it does have good potential shoreline habitat. *Birding Utah* guide reports WILL, SPSA, and WESA in this area. Casual observations, however, suggest low numbers of shorebirds. Gunlock Reservoir is a lower than Enterprise, but does not have much shoreline habitat when the reservoir is full.

***Land Ownership*:** Gunlock Reservoir is managed by the Utah Division of Parks and Recreation. Enterprise Reservoir is managed by the Dixie National Forest. The rest of the stratum is a mix of private and public lands.

***Classification*:** The stratum is all Type 3 habitat.

***Survey Method*:** None needed unless casual observation indicates a shift in shorebird use.

***Measurement Error and Measurement Bias*:** Minimal.

***Selection Bias*:** None.

***Pilot Studies Needed*:** None.

Appendix A: The Great Salt Lake Waterbird Survey

The distribution and abundance of shorebirds in the Great Salt Lake area (Figure 58) is well known as a result of an extensive waterbird survey carried out during 1997-2001. Surveys were conducted on more than 50 plots (Figure 59 and Table 22) once every 10 days from early April to late September.

Figure 58. Major shorebird locations in the Great Salt Lake area.

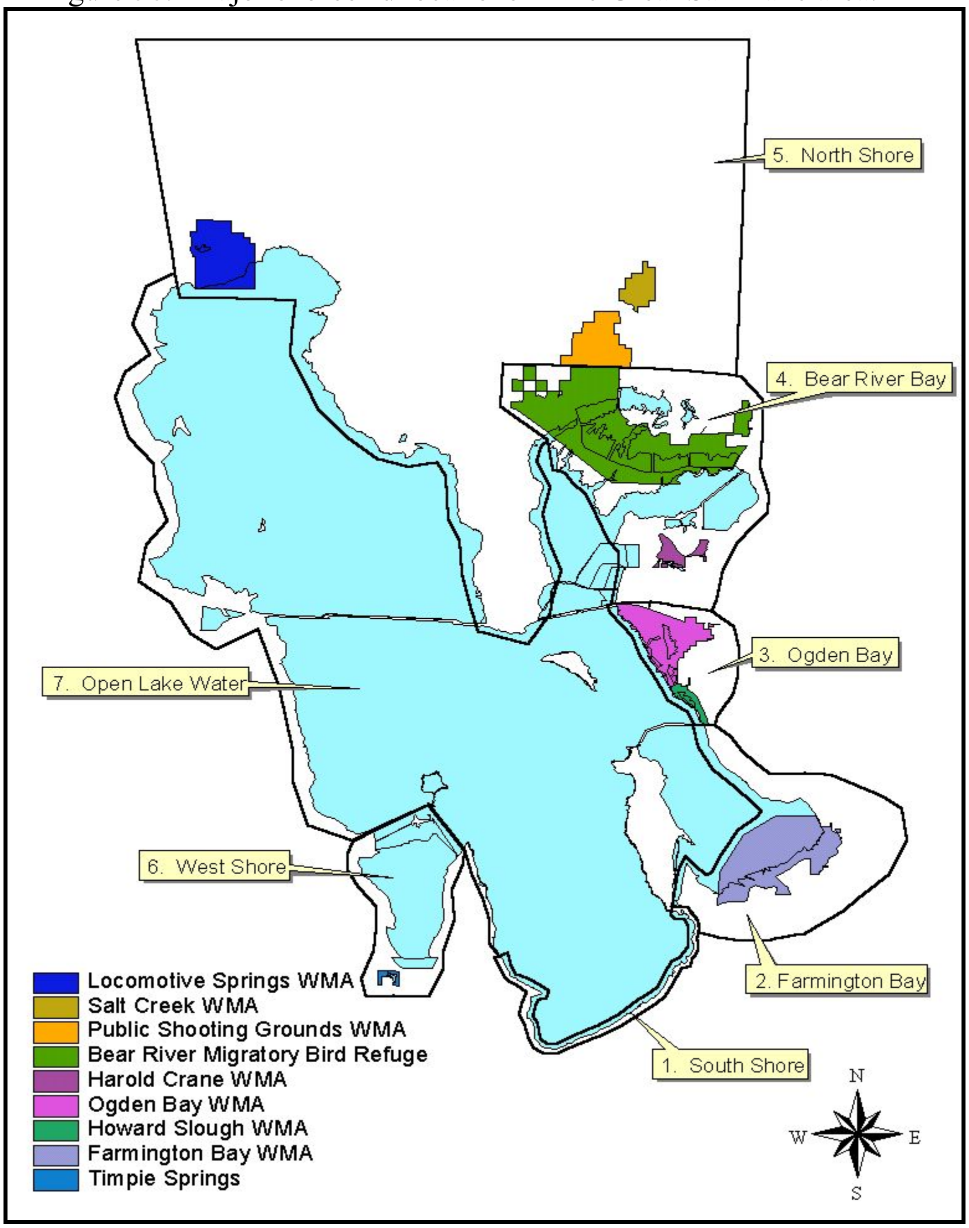


Figure 59. Survey sites in the Great Salt Lake Waterbird Survey (see Table 22 for names and descriptions).

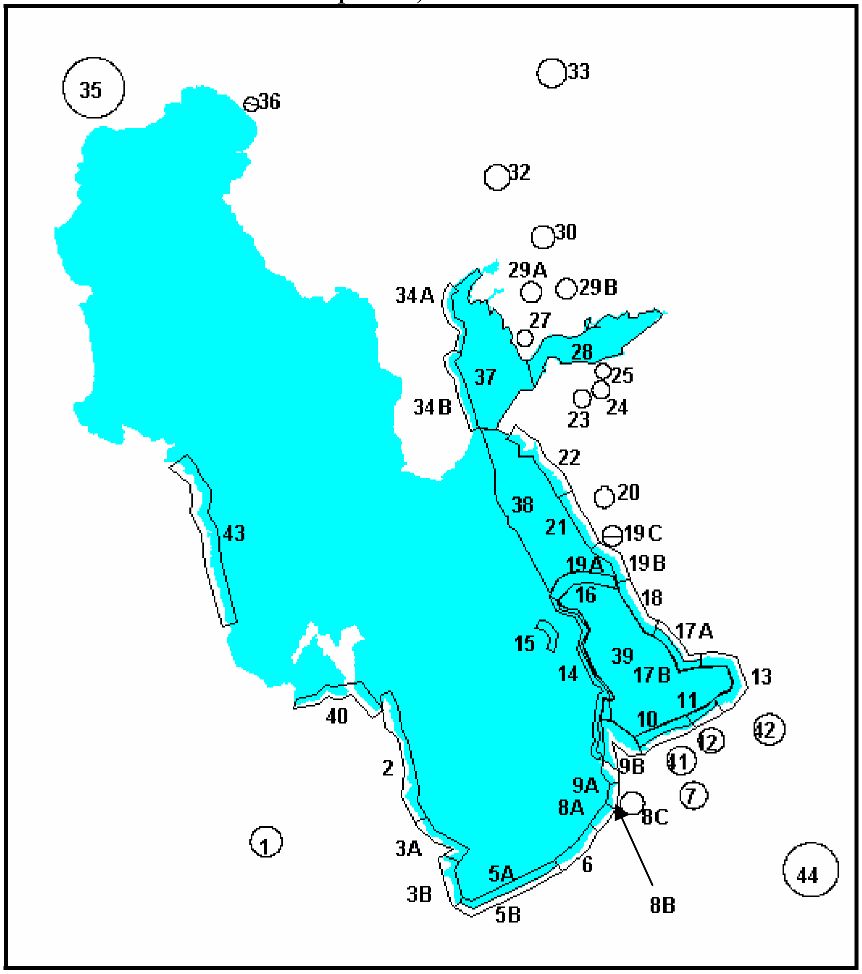


Table 22. Description of survey sites in the Great Salt Lake Waterbird Survey.

WBS-ID	Name	Description	Mean Number of Shorebirds per Survey
1	Timpie Springs WMA	State managed wetland	363
2	Stansbury Island North	Private Shoreline	91
3A	Stansbury South- N	Shoreline	8731
3B	Stansbury South- S	Shoreline	2210
5A	I-80 North- N	Shoreline	857
5B	I-80 North- S	Wetland-flooded area	284
6	Saltair	Shoreline	1301
7	Associated Duck Club	Private duck club	1035
8A	Kennecott- Goggin	Shoreline	1771
8B	Kennecott- Lee Creek	Shoreline	4460
8C	Kennecott- ISSR	Privately managed wetland	1582
9A	Audubon Lakeside- S	Shoreline	541
9B	Audubon North	Shoreline	1351
9C	Audubon Interior	Privately managed wetland	Insufficient Data

WBS-ID	Name	Description	Mean Number of Shorebirds per Survey
10	Crystal Lakeside	Marsh	6665
11	Farmington Bay Lakeside	Shoreline	6973
12	Farmington Bay WMA	State managed wetland	7969
13	West Farmington	Shoreline	436
14	Antelope Island East	Island shoreline	1959
15	Antelope Island West	Island shoreline	387
16	Antelope Island Causeway	Road to island	80
17A	West Kaysville- Interior	Marsh	4757
17B	West Kaysville- Shore	Shoreline	4220
18	West Layton	Shoreline	1422
19A	Howard Slough WMA- Beach	Shoreline	1608
19B	Howard Slough WMA- Dike	Diked shoreline	4013
19C	Howard Slough WMA- Pond	State managed wetland	1466
20	Ogden Bay WMA	State managed wetland	8691
21	Ogden Bay Lakeside	Marsh	23136
22	Ogden Bay North	Shoreline	1696
23	Rainbow	Private duck club	389
24	South Harold Crane WMA	State managed wetland	5609
25	Harold Crane WMA	State managed wetland	6254
27	South Bear River	Federal managed wetland	36256
28	Willard Spur	Federal managed wetland	4744
29A	Bear River Refuge	Federal managed wetland	51157
29B	Bear River Refuge Road	Federal managed wetland	452
30	Bear River Club	Private duck club	649
32	Public Shooting Grounds WMA	State managed wetland	772
33	Salt Creek WMA	State managed wetland	1609
34A	East Promontory- N	Shoreline	258
34B	East Promontory- S	Shoreline	245
35	Locomotive Springs WMA	State managed wetland	294
36A	Salt Wells Flat WHA- Shore	Federal shoreline	59
36B	Salt Wells Flat WHA	Federal managed wetland	290
37	Bear River Bay	Open water	5995
38	Ogden Bay	Open water	12937
39	Farmington Bay	Open water	2830
40	Magcorp	Two lakeside ponds	42535
41	New State Duck Club	Private duck club	1581
42	East Farmington Bay	Agricultural, urban, and industrial lands	17
43	Deardens Knoll	US Air Force/BLM public land	8402
44	Jordan River	Private agricultural land	Insufficient Data

The Great Salt Lake Waterbird Survey provides an excellent basis for deciding which area should be covered in the permanent shorebird survey. Means numbers recorded per survey during July and August were calculated for all of the survey areas together (Table 23) and for each of the survey areas. Maps depicting the area-specific means were then prepared for all shorebirds for which the mean number recorded per sample survey (all areas) exceeded 50 (Figure 60) and the maps were scrutinized to identify concentration areas.

Most areas had a substantial number of shorebirds. The average number of shorebirds per survey, during July and August, exceed 200 for all but seven of the 55 survey areas and the average was 1000 or more in 33 of the areas. The eastern shore and associated wetlands were particularly important for the most abundant species but the south and southwest shores were also important for some species. For example, western sandpipers and willets were found along the entire shore, snowy plovers were particularly abundant on the south shore, and both yellowlegs were frequently found away from the lake in the smaller, more isolated wetlands. It thus seems necessary to cover the entire area surveyed in the Great Salt Lake Waterbird Survey.

Table 23. Mean number of shorebirds recorded per survey in July and August during 1997-2001 on the Great Salt Lake Waterbird Survey.

AMAV	WIPH	BNST	WESA	LBDO	MAGO	PEEP	PHAL	SNPL
109,301	79,847	33,353	15,923	12,722	11,702	4,274	4,115	762
LESA	WILL	BASA	KILL	UNYE	RNPH	GRYE	LEYE	BBPL
522	372	367	266	235	234	211	190	54
LBCU	SAND	SPSA	SEPL	SESA	REKN	WHIM	COSN	
41	36	27	20	4	3	1	1	

Figure 60. Mean number of shorebirds recorded during July and August 1997-2001 on the Great Salt Lake Waterbird Survey.

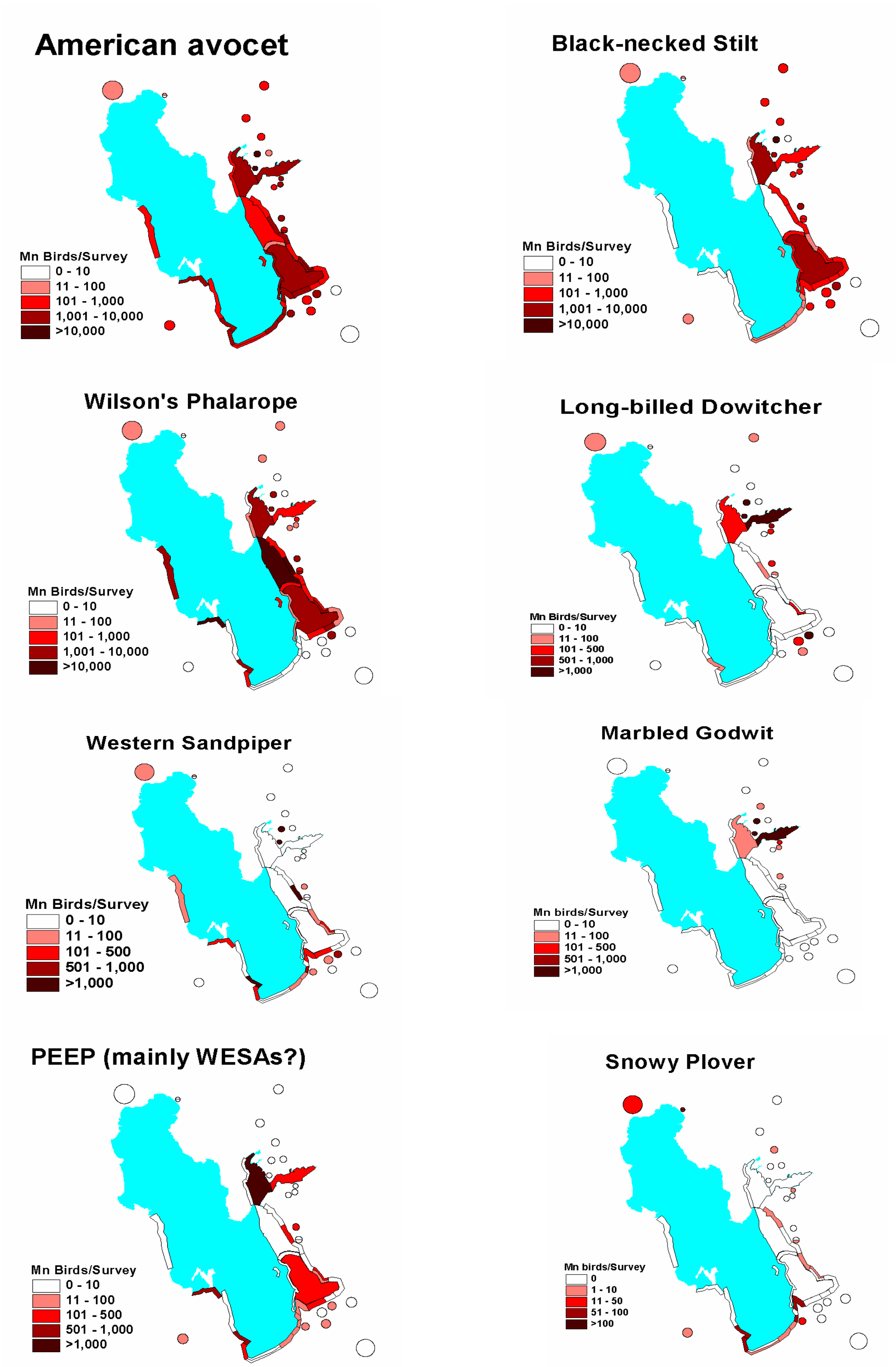
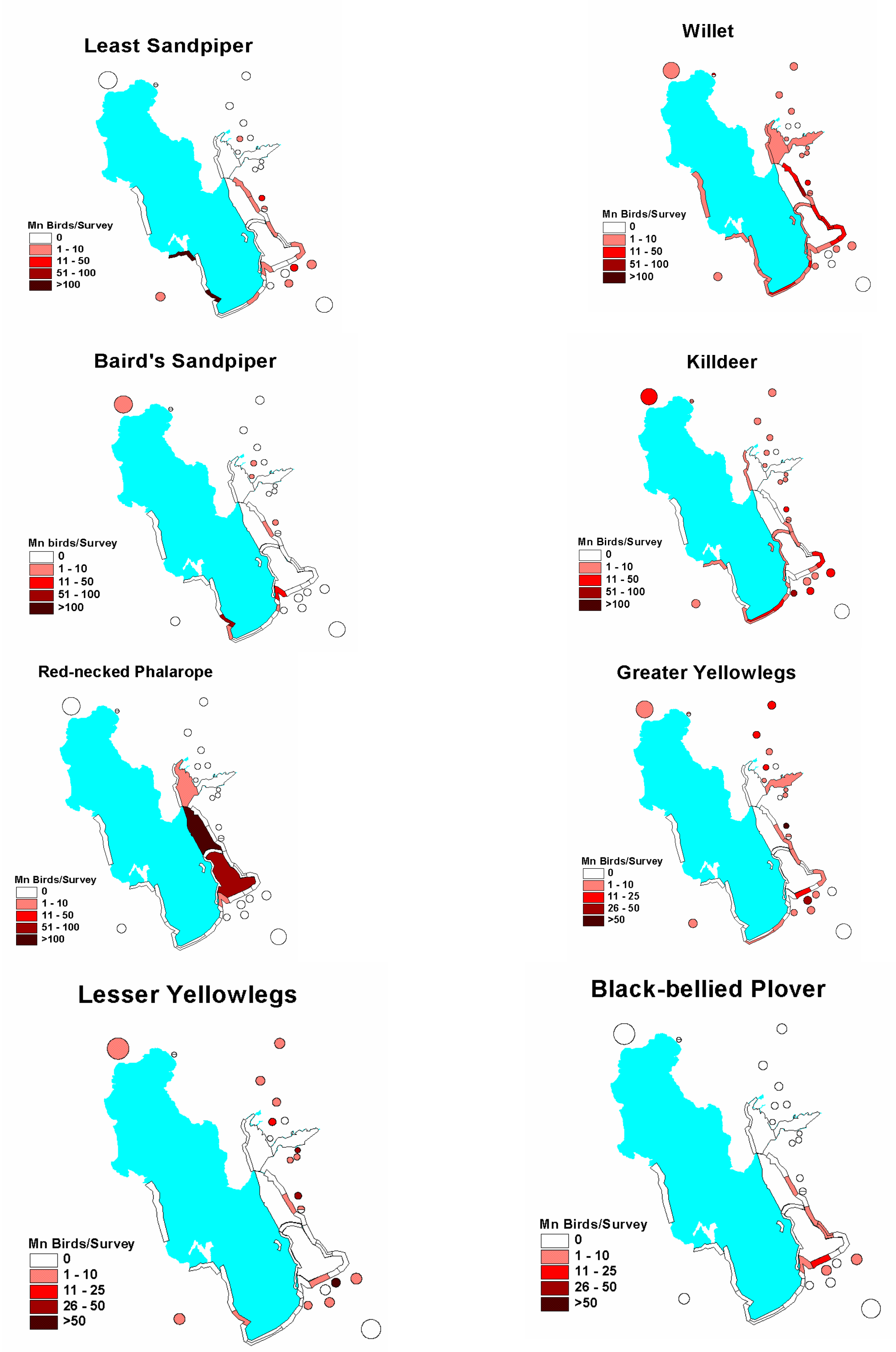


Figure 60 (cont'd). Mean number of shorebirds recorded during July and August 1997-2001 on the Great Salt Lake Waterbird Survey.

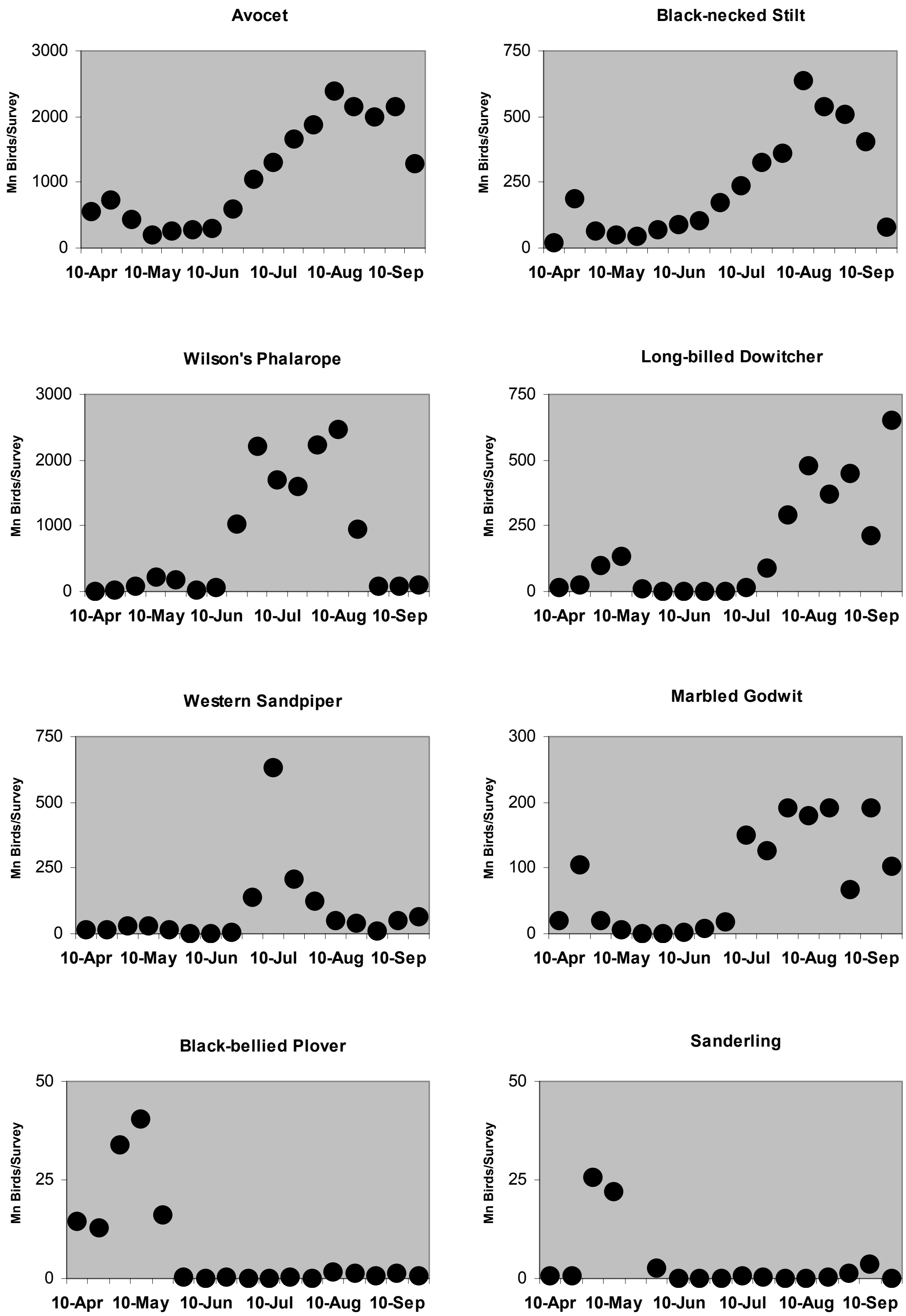


Appendix B: Timing of Surveys

Results from the surveys were analyzed to determine when shorebirds are present in greatest numbers. We excluded data from 1997 because surveys that year did not begin until early July and we also excluded 8 areas with uneven coverage. The results (Figure 61) showed that Wilson's phalaropes occur in large numbers in July and August; American avocets, black-necked stilts, and long-billed dowitchers occur in large numbers during August and September; and that relatively small numbers of black-bellied plovers and marbled godwits occur during spring. Several other species were recorded but not in significant numbers to affect the decision about when surveys should be conducted.

The trend data suggest that the survey should be held in July and August. The specific dates can be chosen after other work is completed but for the analysis of which areas should have highest priority, this report uses the Great Salt Lake Waterbird Survey periods 10-15 which correspond approximately to 1 July-31 August. This analysis should suffice for surveys anytime during the late summer and fall. If a decision is made to conduct spring surveys too, then a new analysis might be appropriate to decide which areas to survey because few avocets, stilts, phalaropes, and dowitchers are present in the spring and species that are present then (e.g., plovers, sanderlings) may well occur primarily in other areas.

Figure 61. Mean number of shorebirds recorded per survey during the Great Salt Lake Waterbird Survey, 1998-2001.



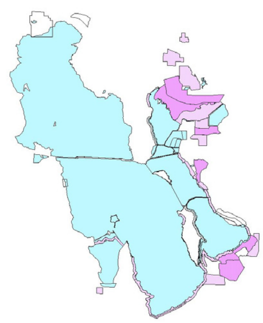
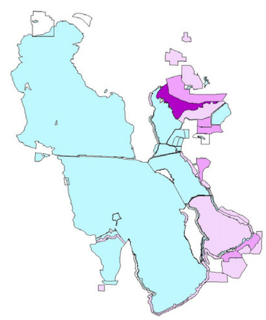
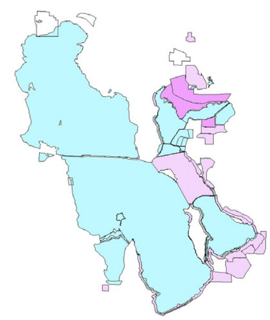
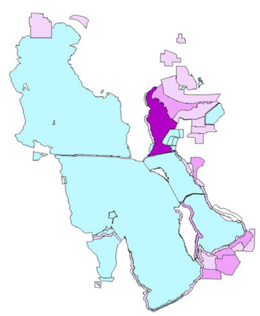
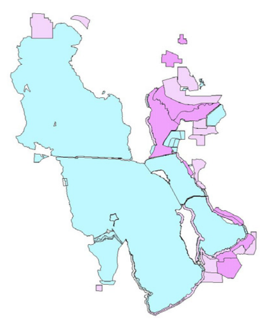
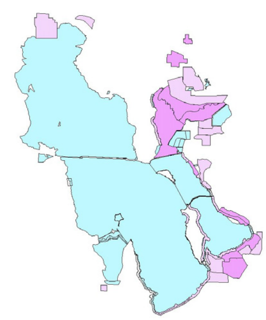
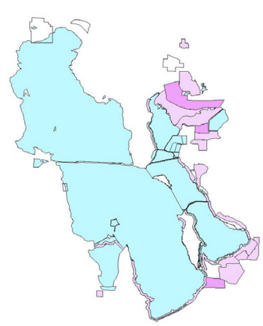
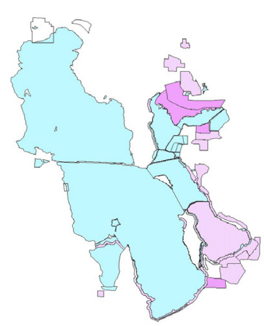
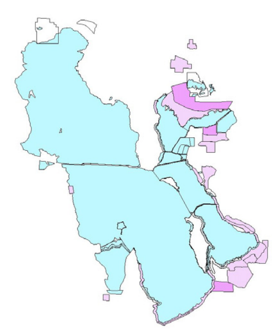
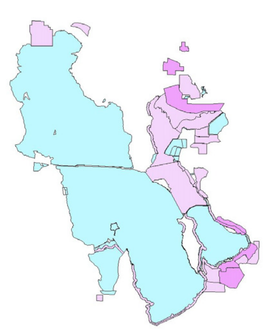
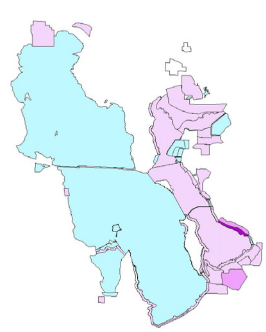
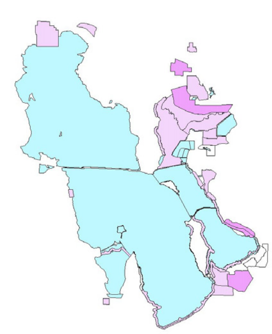
Appendix 8: Species Distribution at High and Low Lake Elevations

This group of maps is the distribution of species by survey period during a high lake elevation year (1999) and a low lake elevation year (2001). These maps are arranged to contrast species use of the available habitat under two very different sets of conditions. Because these maps represent one point in time rather than a mean, missed surveys for a particular area and survey period show the same as a count of zero.

Comparison of the distribution of **avocets and stilts** in high (1999) and low (2001) lake conditions.

Number of avocets and stilts.

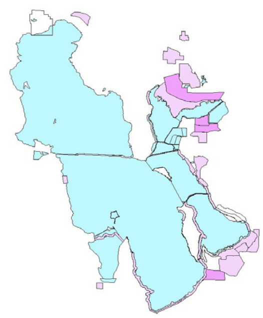
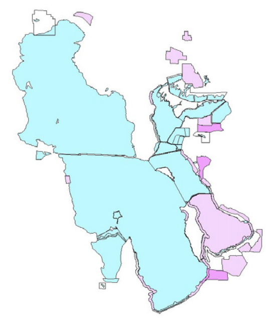
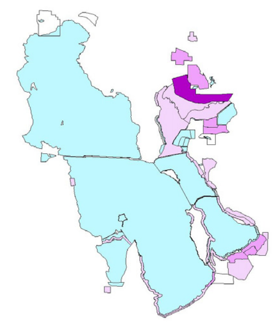
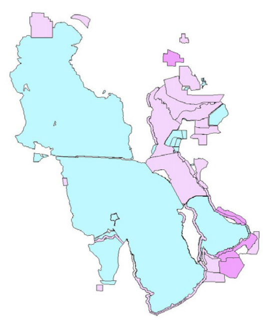
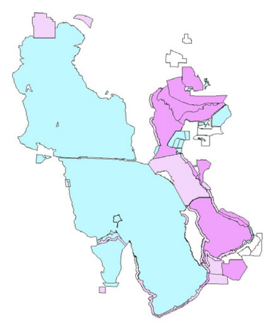
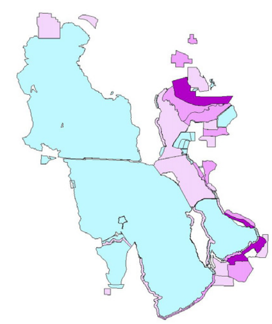
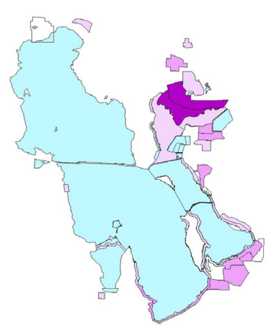
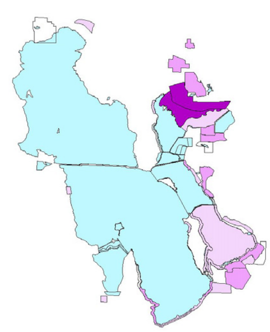
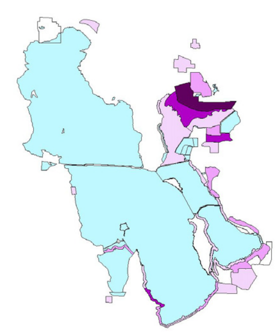
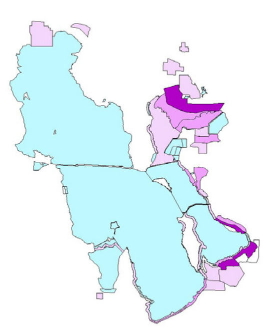
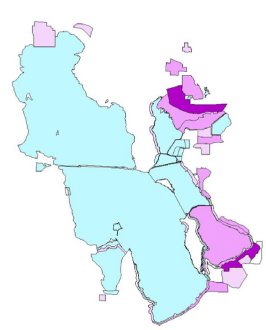
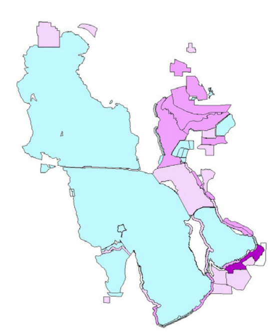
<1000
1,000 - 9,999
10,000 - 49,999
50,000 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **avocets and stilts** in high (1999) and low (2001) lake conditions.

Number of avocets and stilts.

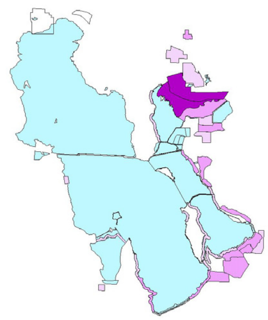
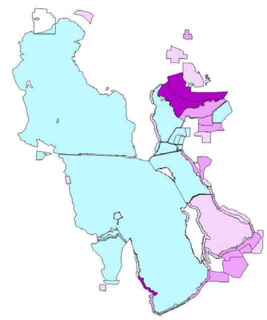
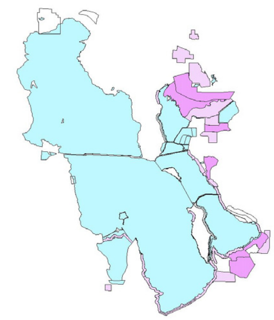
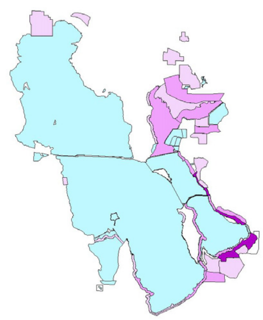
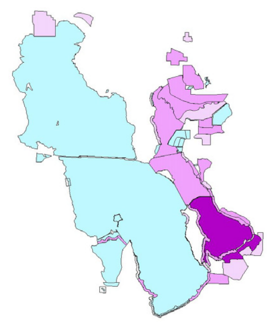
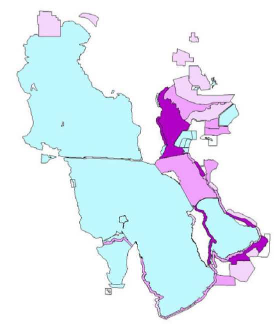
- <1000
- 1,000 - 9,999
- 10,000 - 49,999
- 50,000 +

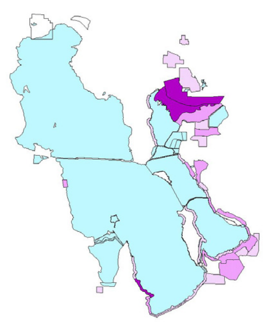
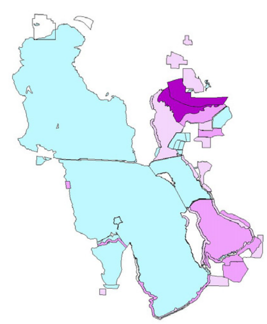
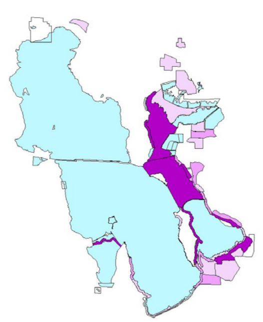
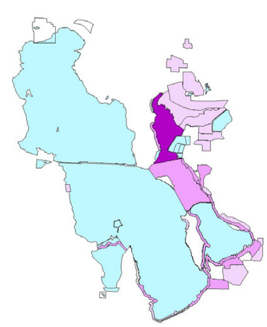
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **avocets and stilts** in high (1999) and low (2001) lake conditions.

Number of avocets and stilts.

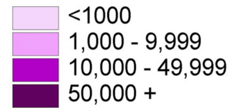
- <1000
- 1,000 - 9,999
- 10,000 - 49,999
- 50,000 +

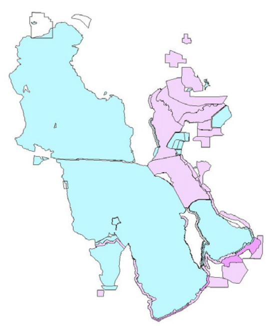
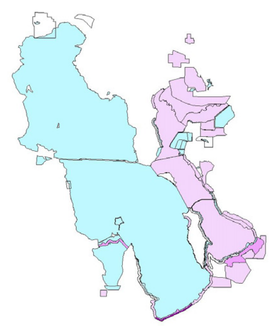
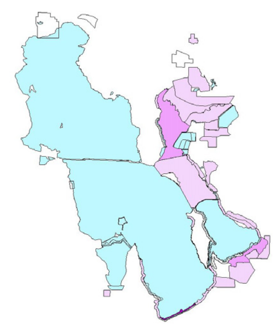
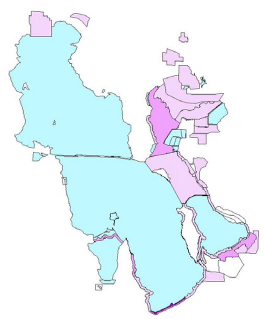
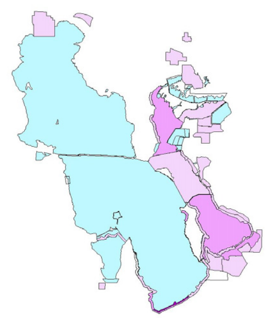
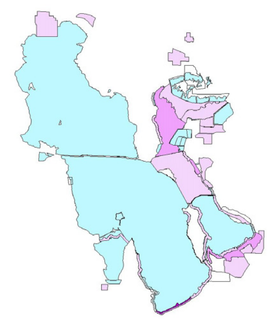
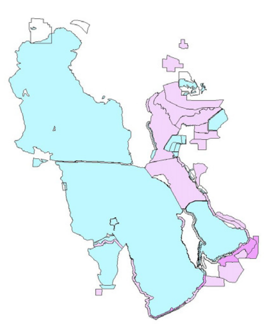
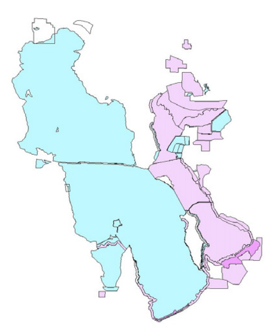
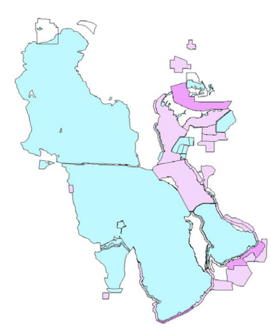
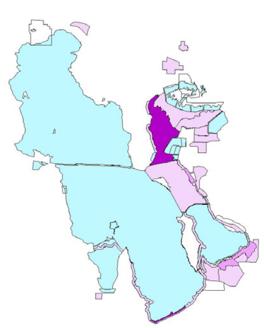
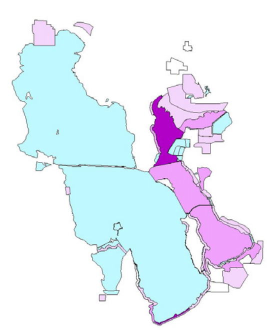
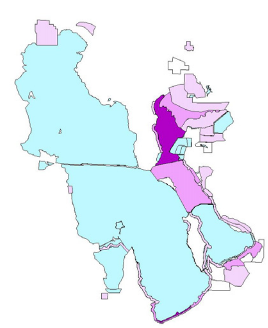
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **California gulls** in high (1999) and low (2001) lake conditions.

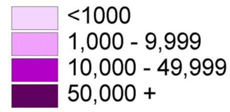
Number of California gulls.

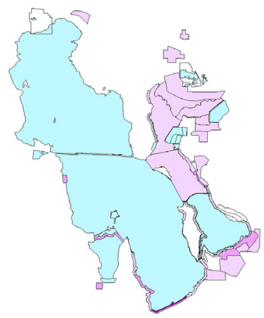
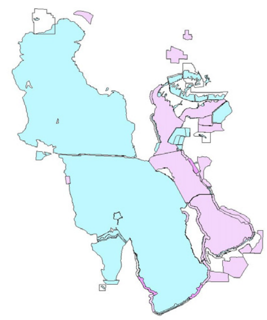
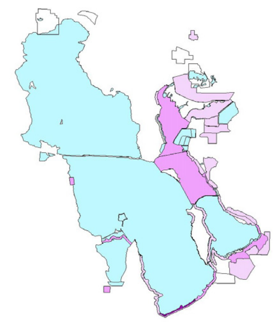
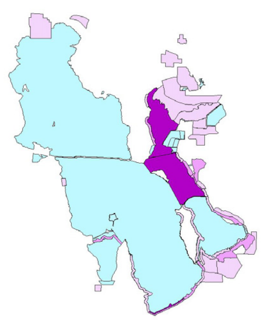
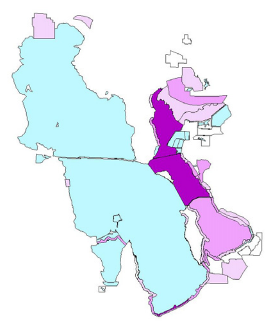
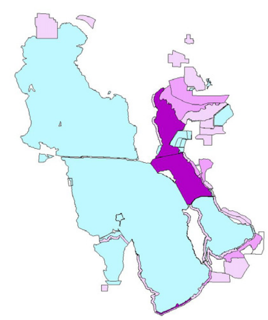
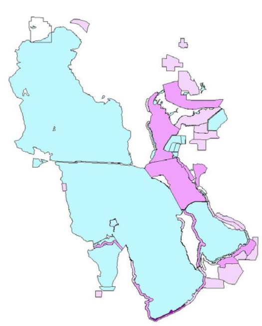
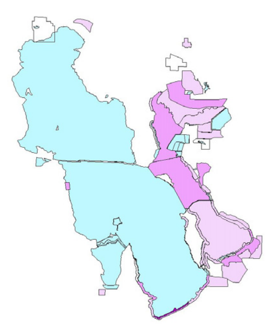
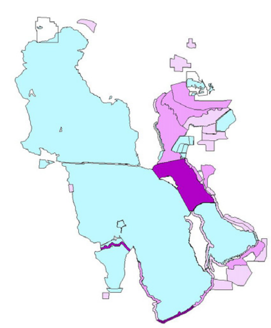
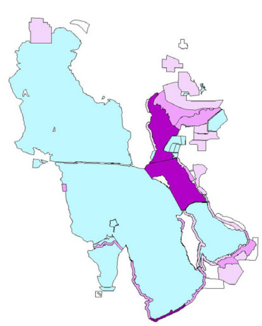
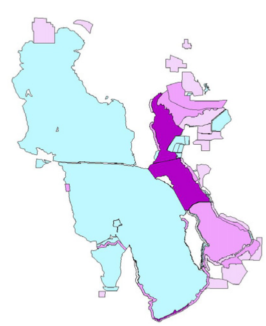
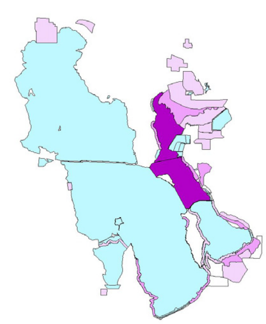


Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **California gulls** in high (1999) and low (2001) lake conditions.

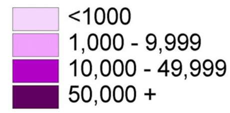
Number of California gulls.

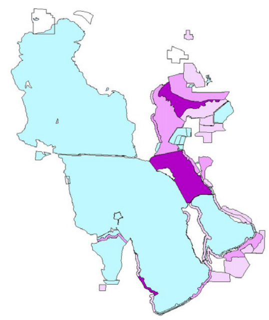
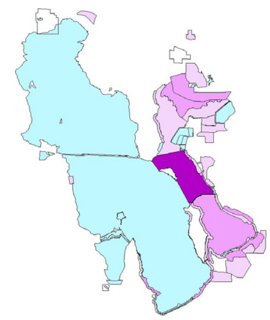
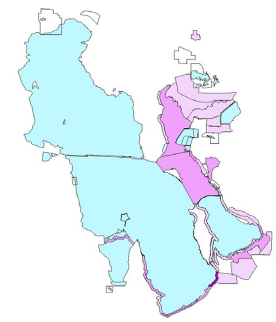
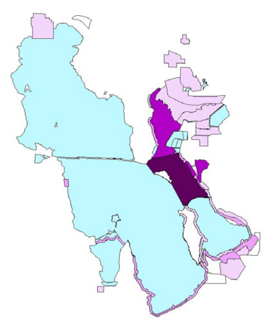
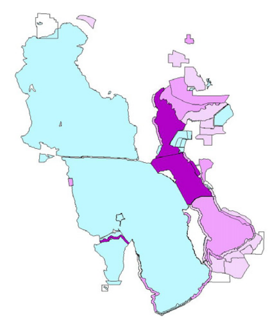
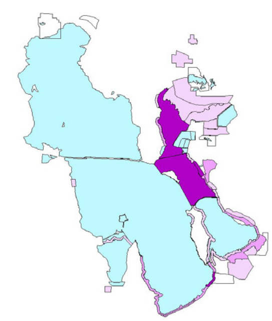


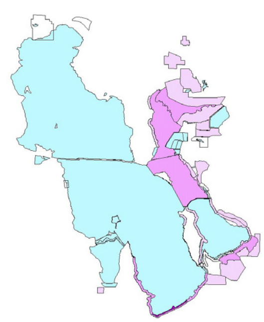
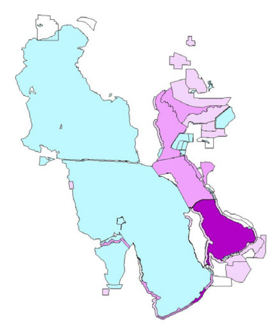
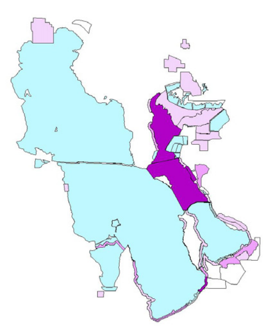
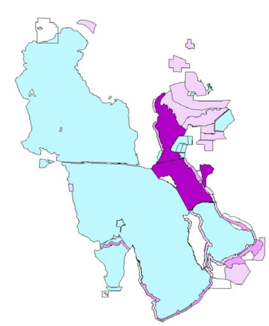
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **California gulls** in high (1999) and low (2001) lake conditions.

Number of California gulls.



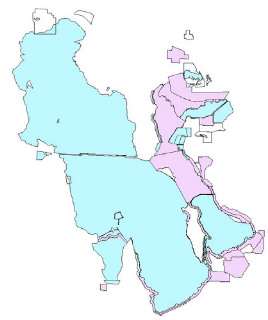
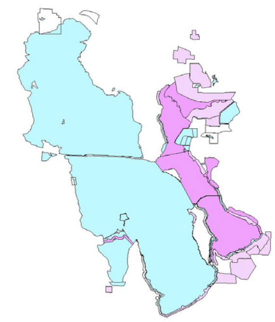
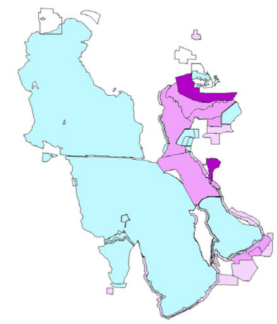
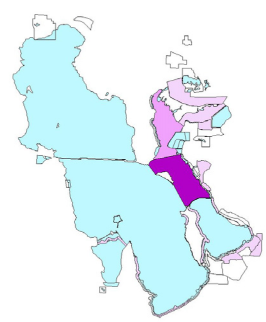
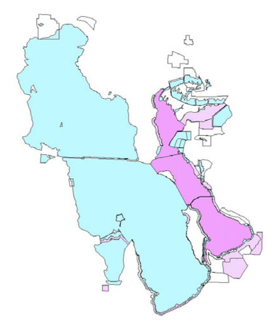
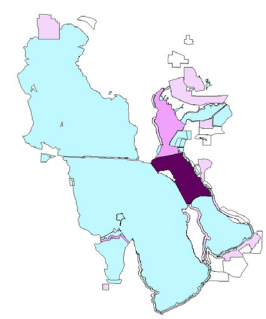
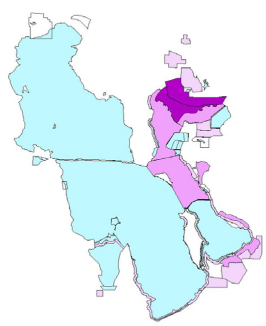
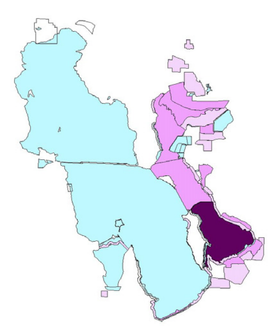
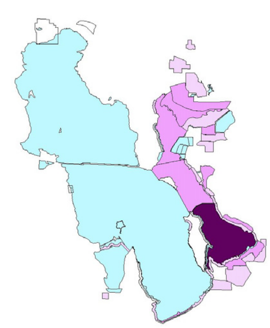
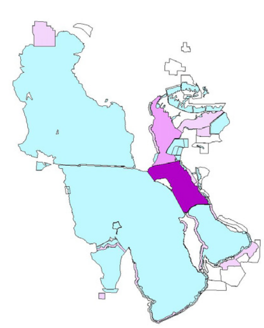
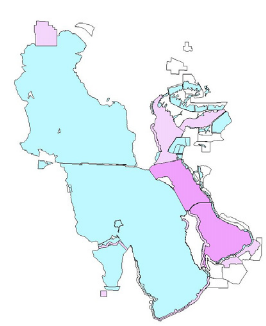
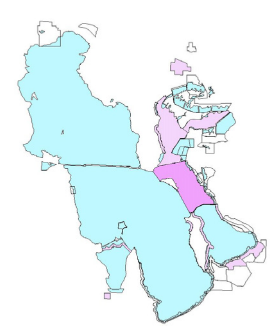
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **eared grebes** in high (1999) and low (2001) lake conditions.

Number of eared grebes.

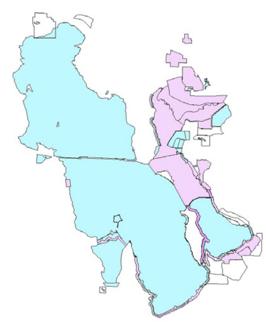
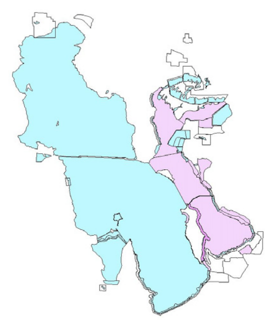
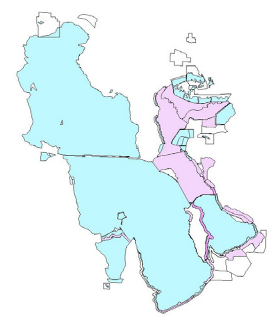
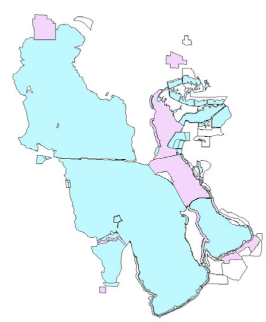
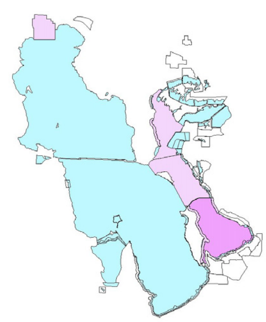
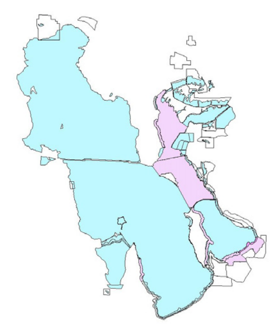
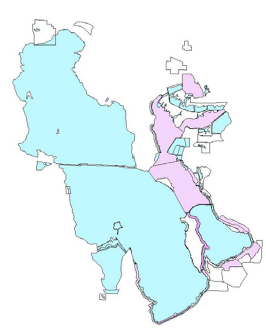
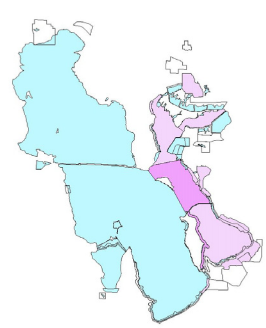
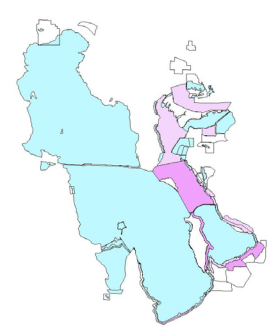
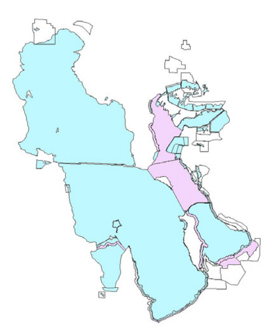
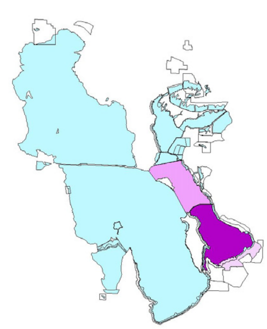
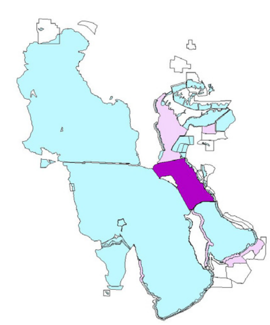
- <1000
- 1,000 - 9,999
- 10,000 - 24,999
- 25,000 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **eared grebes** in high (1999) and low (2001) lake conditions.

Number of eared grebes.

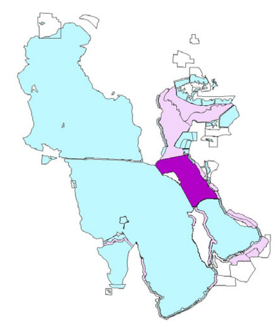
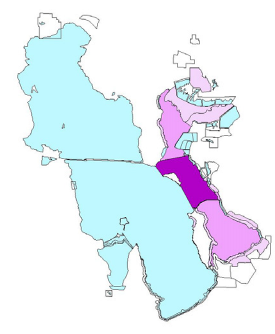
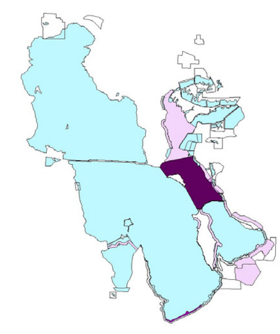
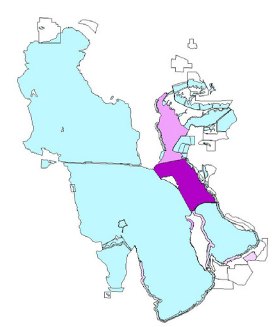
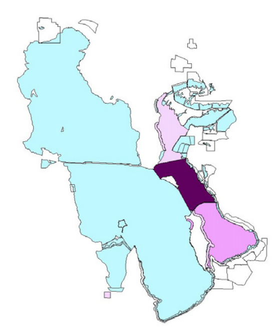
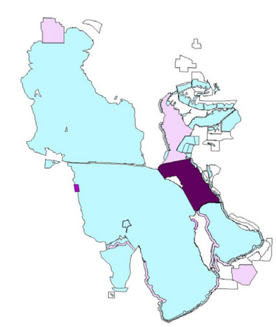
<1000
1,000 - 9,999
10,000 - 24,999
25,000 +

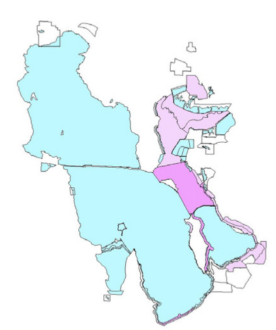
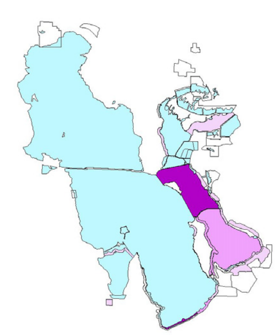
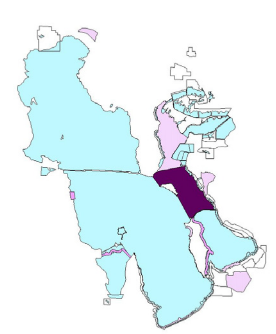
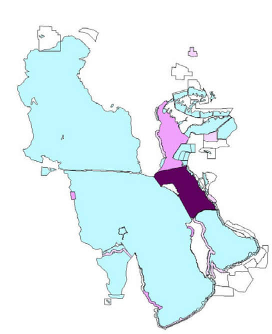
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **eared grebes** in high (1999) and low (2001) lake conditions.

Number of eared grebes.

<1000
1,000 - 9,999
10,000 - 24,999
25,000 +

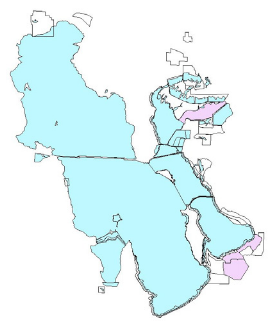
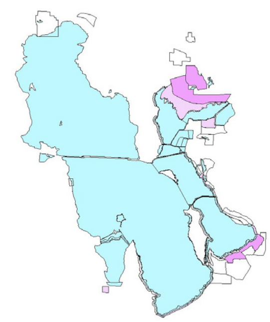
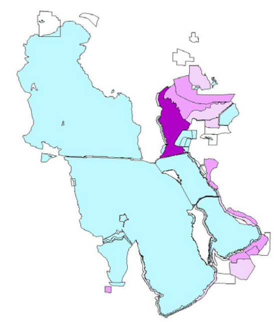
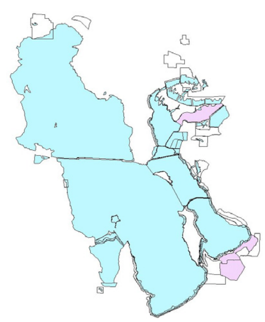
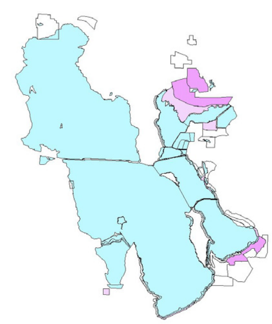
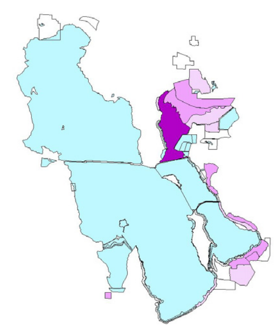
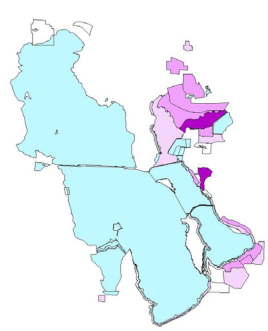
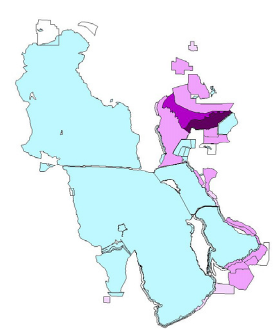
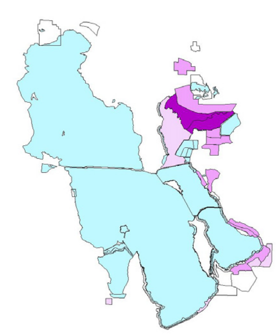
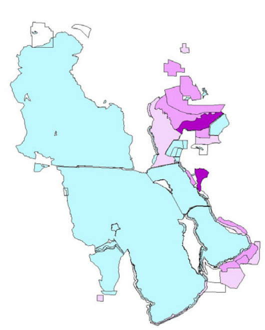
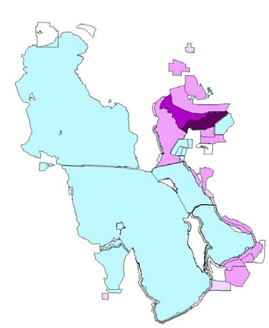
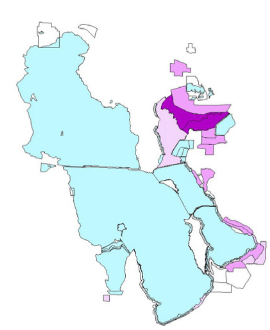
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **Forster's terns** in high (1999) and low (2001) lake conditions.

Number of Forster's terns.

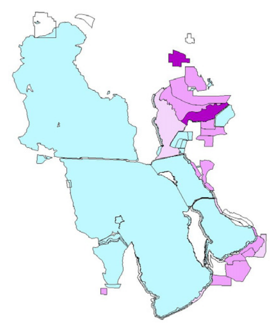
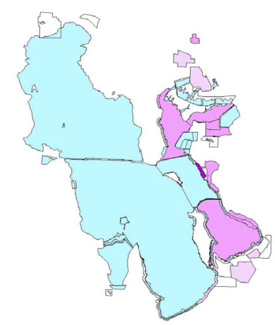
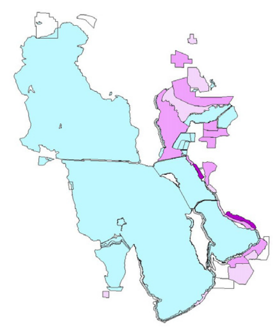
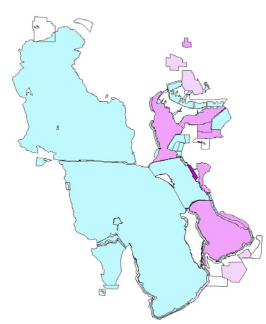
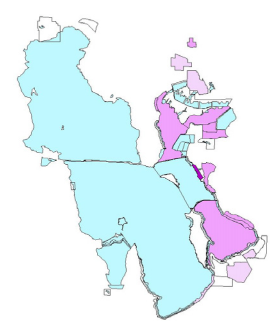
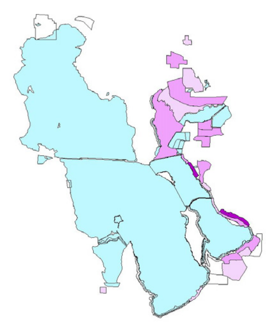
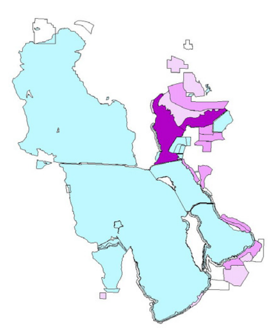
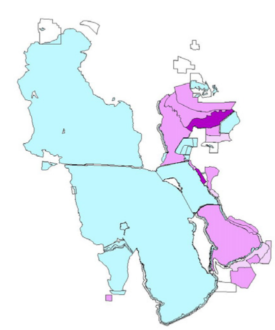
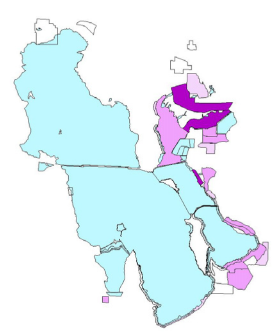
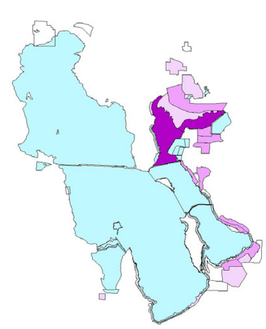
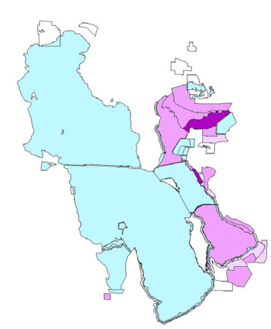
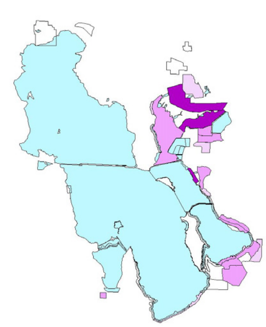
<10
10 - 99
100 - 299
300 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **Forster's terns** in high (1999) and low (2001) lake conditions.

Number of Forster's terns.

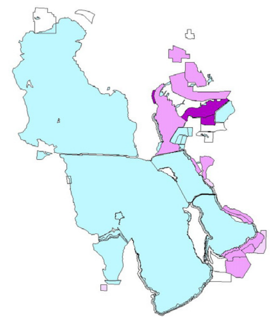
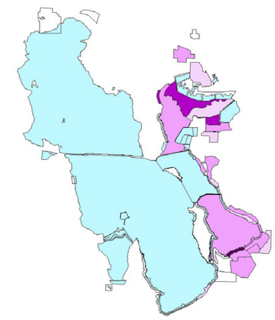
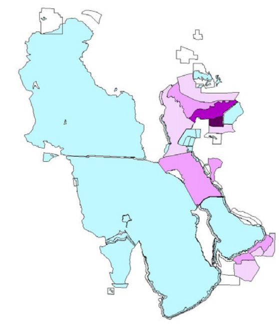
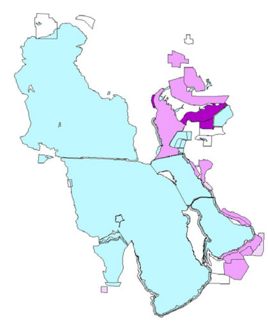
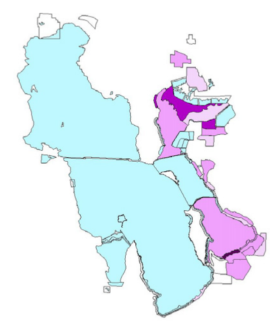
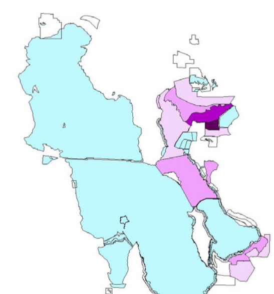
<10
10 - 99
100 - 299
300 +

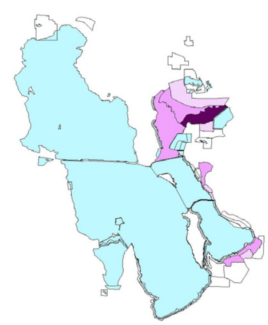
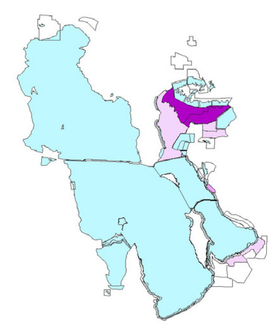
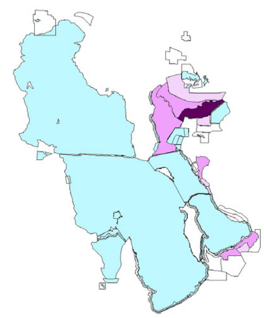
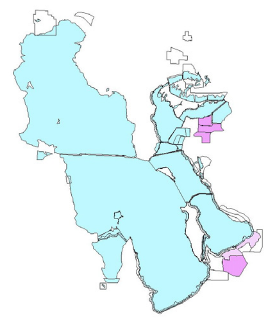
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **Forster's terns** in high (1999) and low (2001) lake conditions.

Number of Forster's terns.

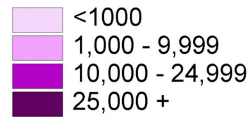
<10
10 - 99
100 - 299
300 +

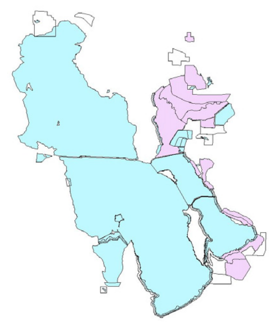
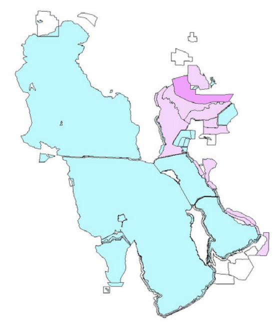
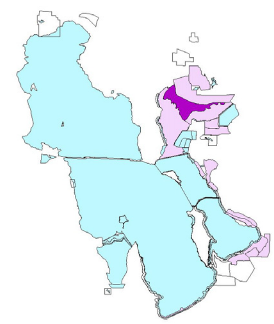
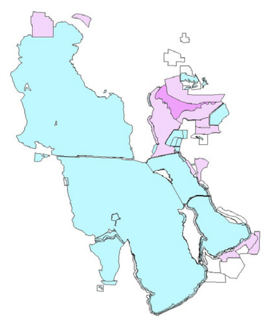
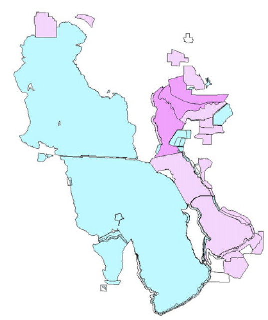
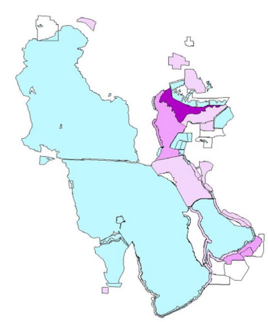
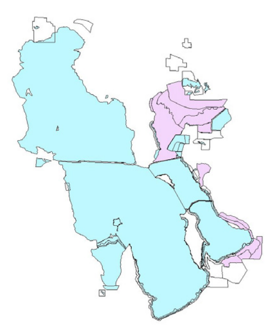
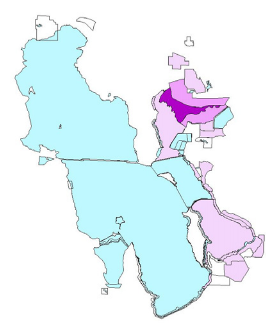
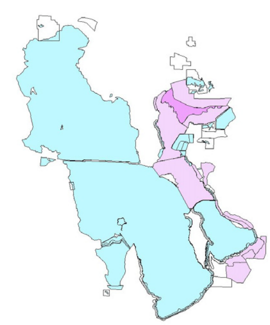
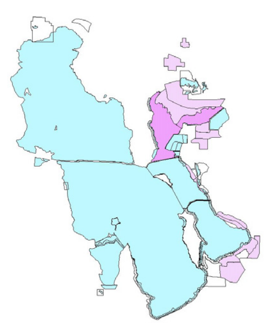
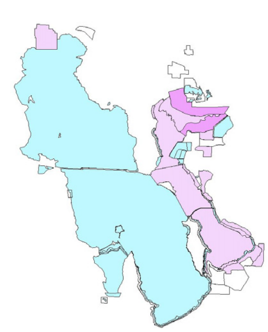
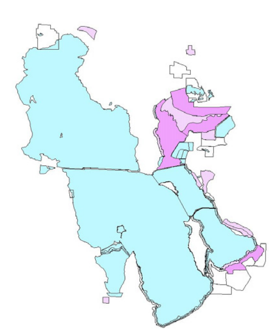
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **Franklin's gulls** in high (1999) and low (2001) lake conditions.

Number of Franklin's gulls.

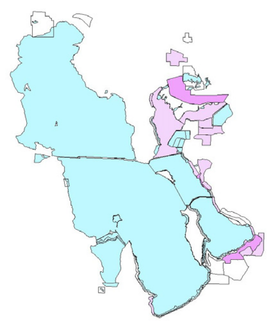
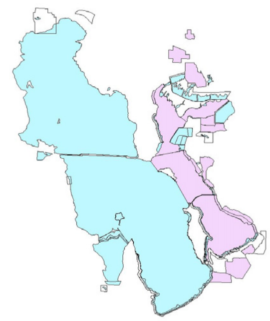
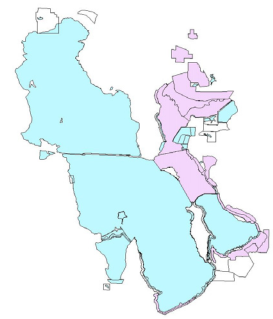
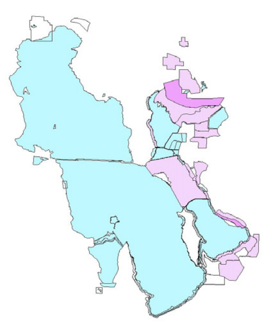
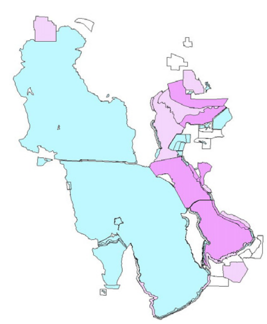
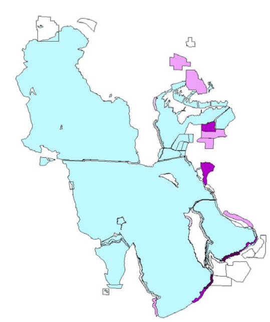
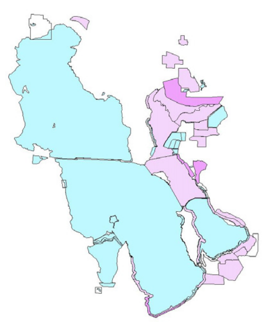
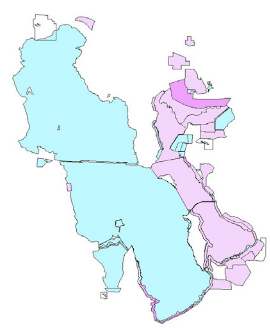
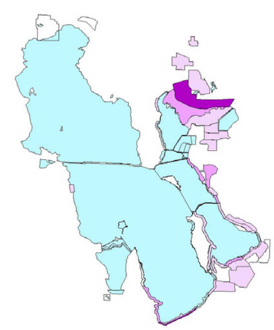
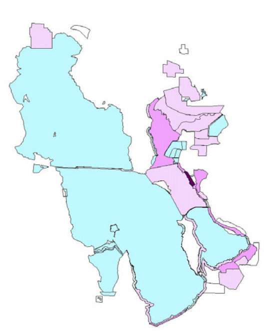
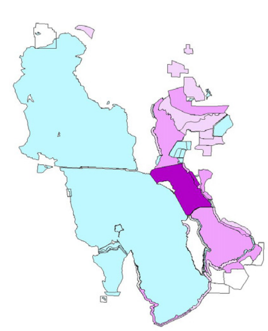
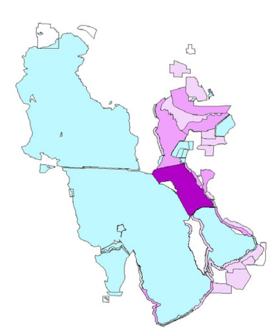


Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **Franklin's gulls** in high (1999) and low (2001) lake conditions.

Number of Franklin's gulls.

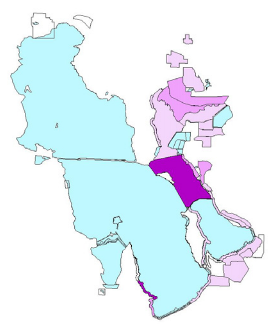
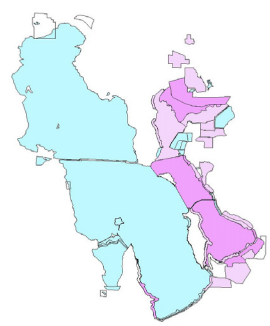
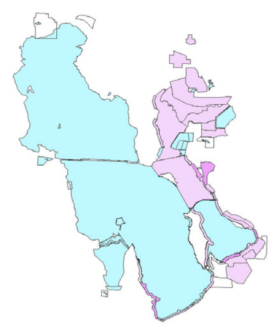
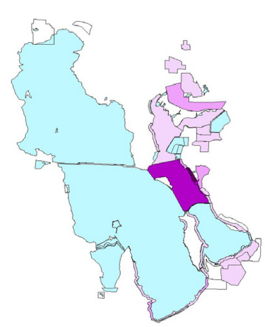
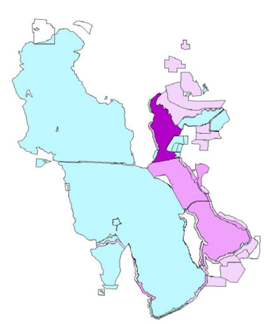
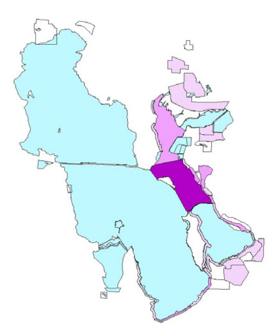
- <1000
- 1,000 - 9,999
- 10,000 - 24,999
- 25,000 +

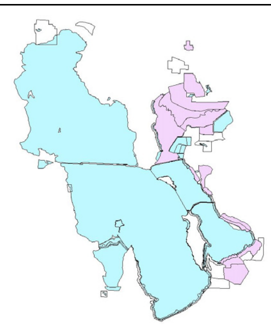
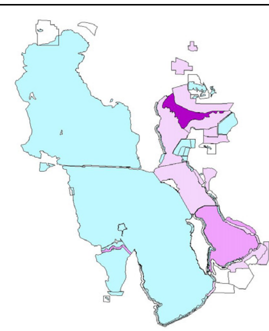
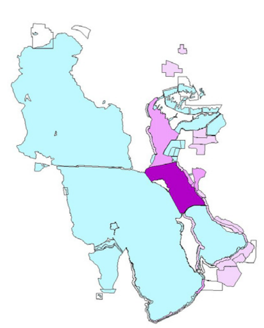
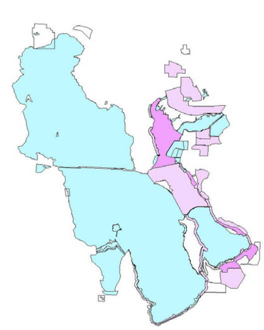
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **Franklin's gulls** in high (1999) and low (2001) lake conditions.

Number of Franklin's gulls.

<1000
1,000 - 9,999
10,000 - 24,999
25,000 +

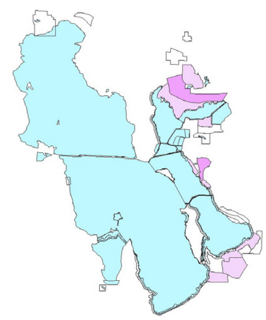
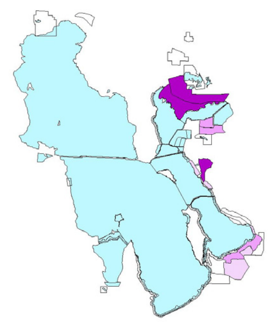
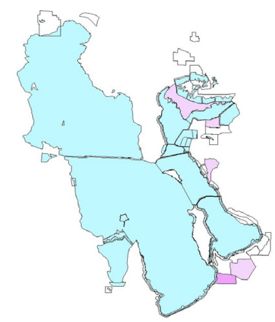
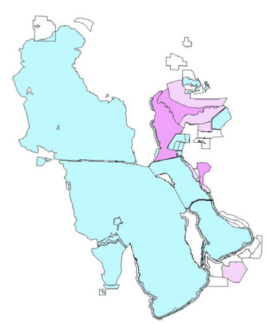
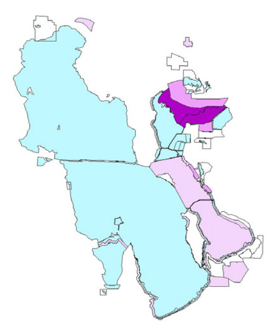
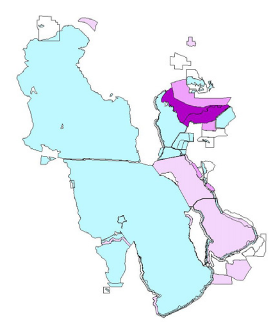
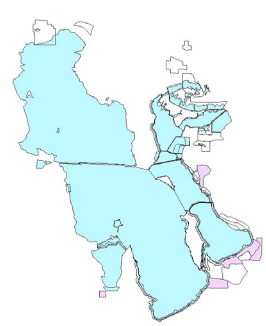
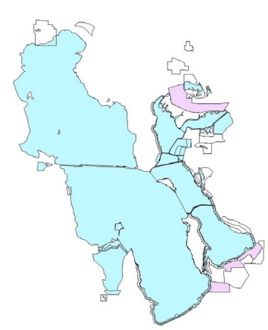
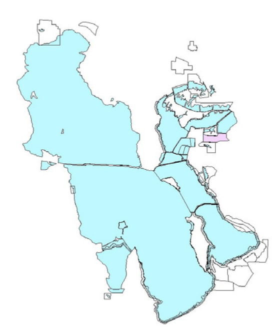
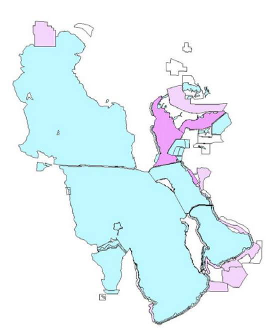
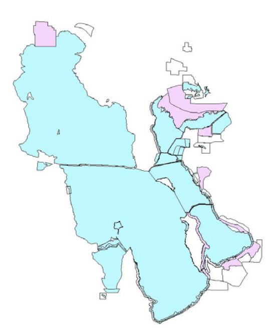
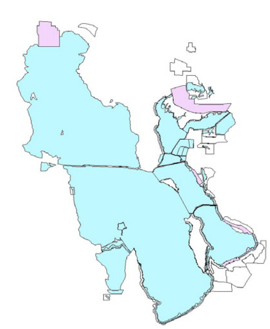
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **marbled godwits** in high (1999) and low (2001) lake conditions.

Number of marbled godwits.

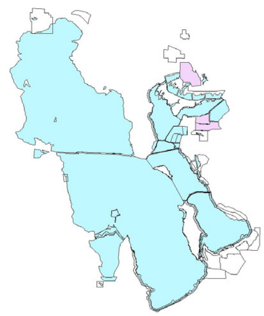
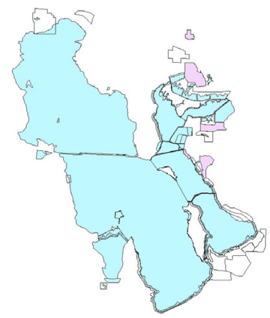
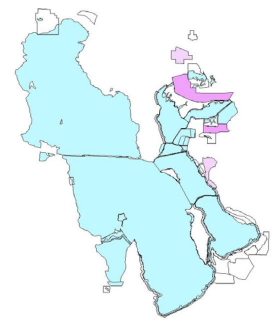
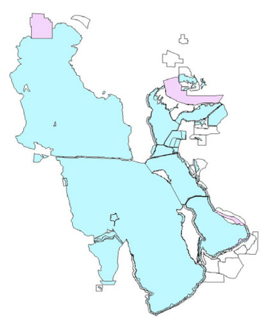
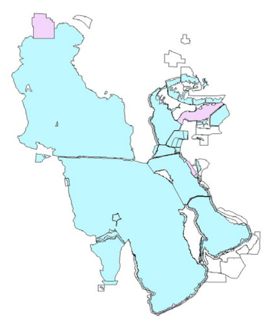
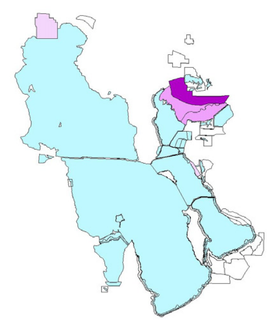
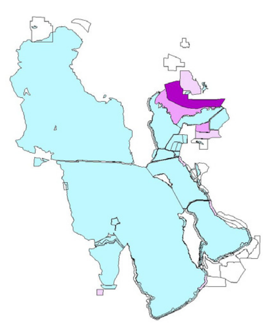
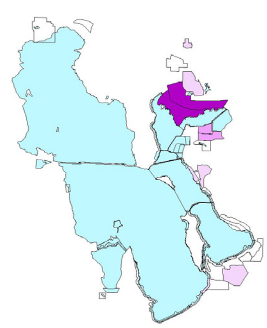
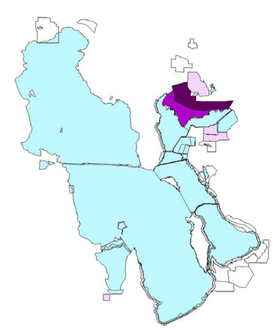
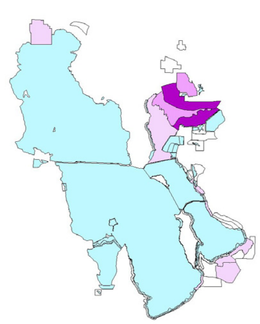
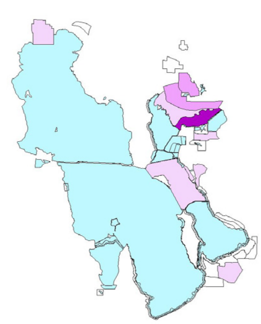
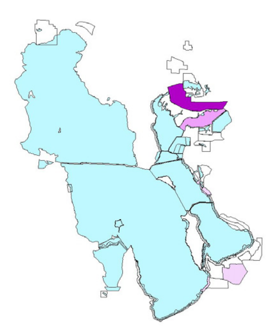
<100
100 - 999
1,000 - 9,999
10,000 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **marbled godwits** in high (1999) and low (2001) lake conditions.

Number of marbled godwits.

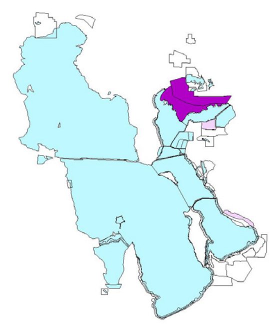
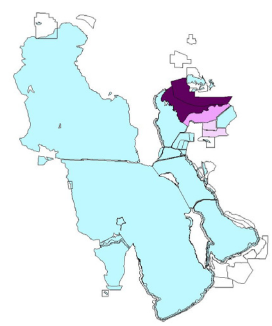
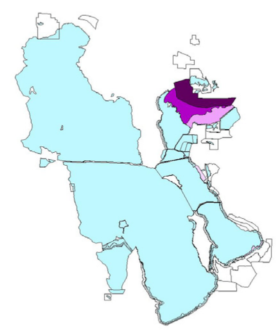
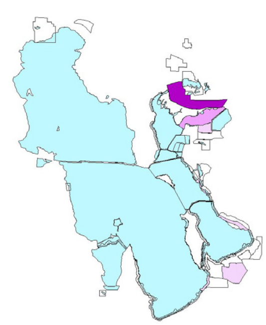
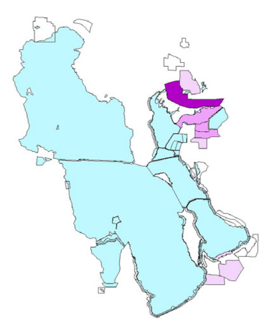
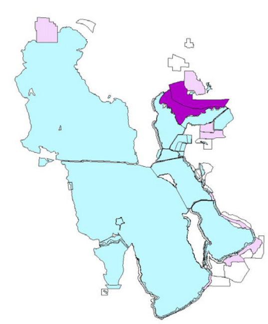
<100
100 - 999
1,000 - 9,999
10,000 +

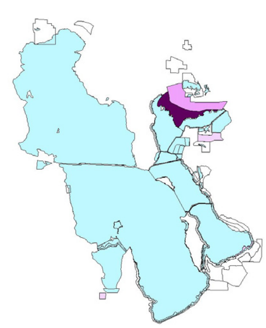
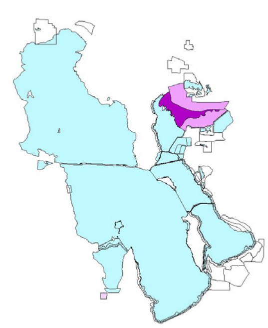
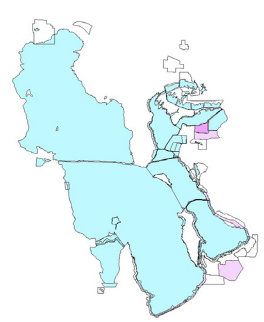
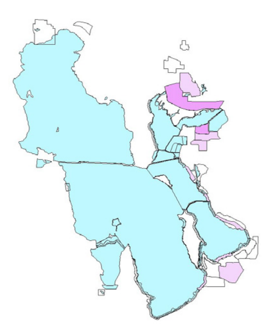
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **marbled godwits** in high (1999) and low (2001) lake conditions.

Number of marbled godwits.

<100
100 - 999
1,000 - 9,999
10,000 +

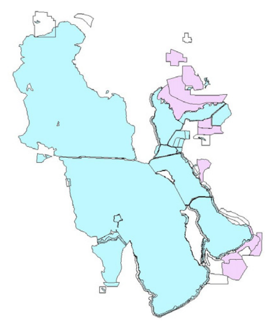
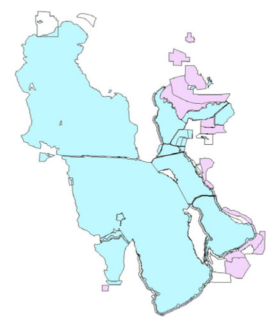
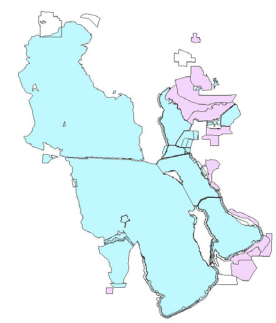
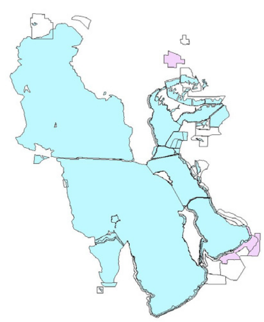
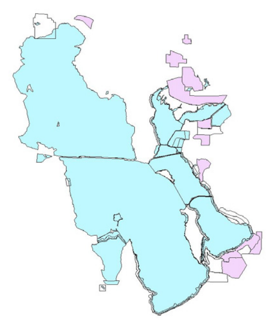
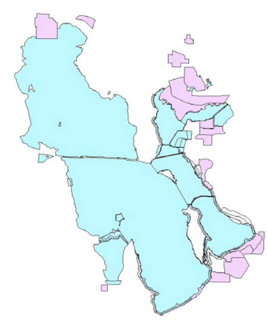
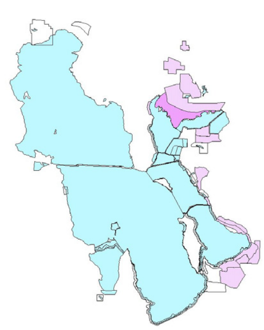
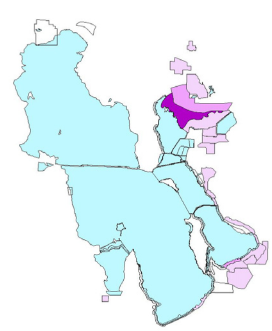
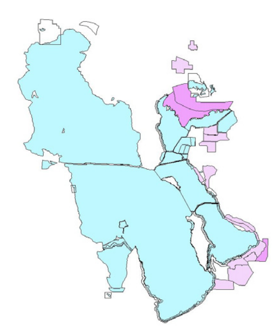
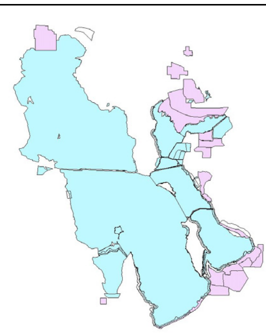
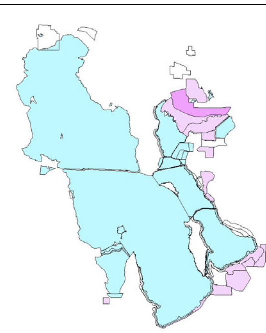
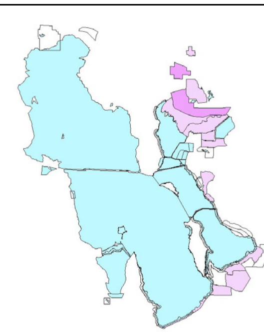
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **snowy egrets** in high (1999) and low (2001) lake conditions.

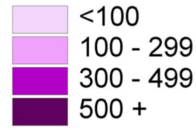
Number of snowy egrets.

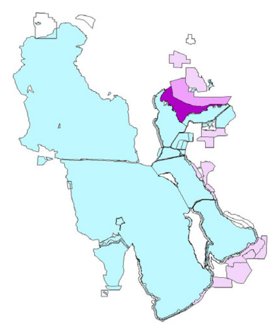
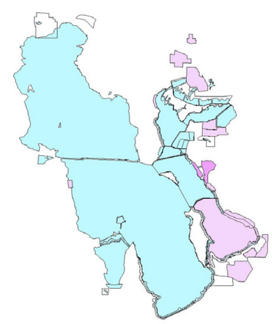
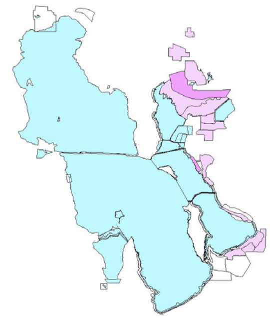
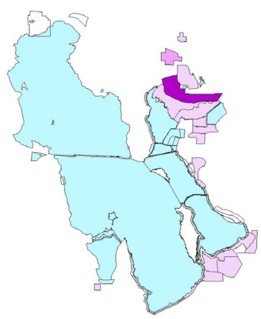
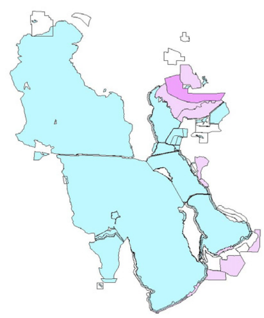
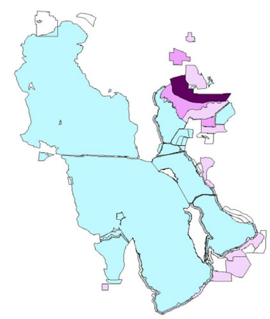
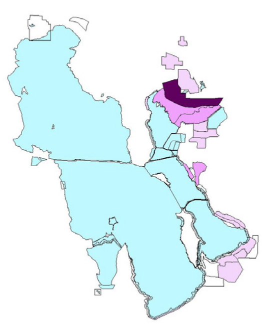
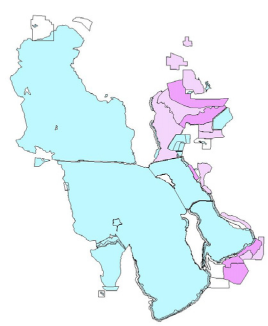
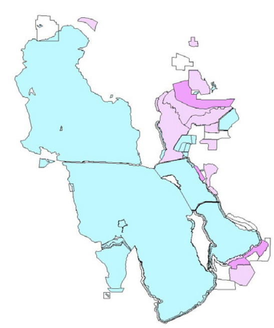
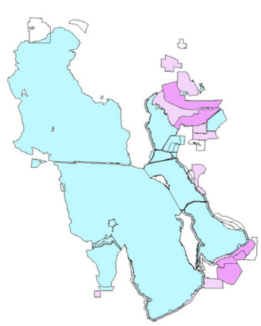
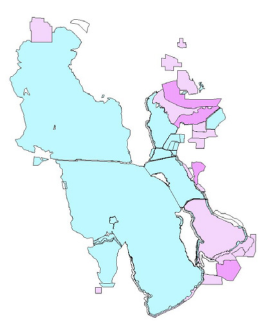
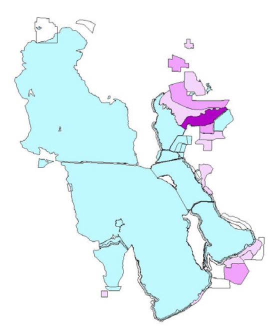
- <100
- 100 - 299
- 300 - 499
- 500 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **snowy egrets** in high (1999) and low (2001) lake conditions.

Number of snowy egrets.

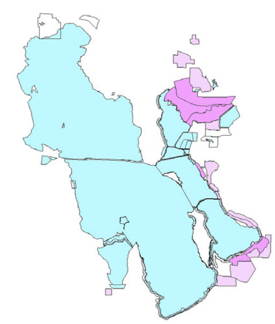
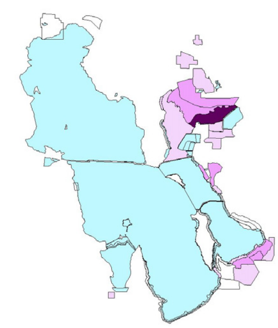
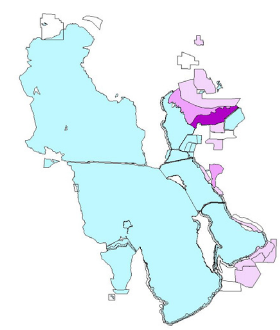
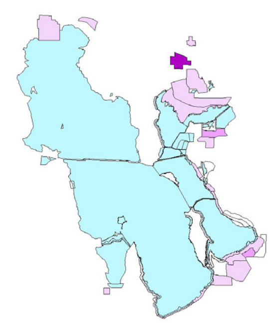
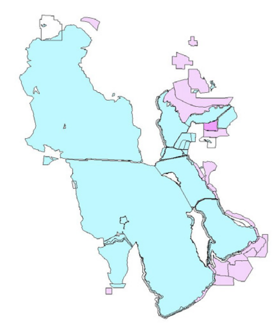
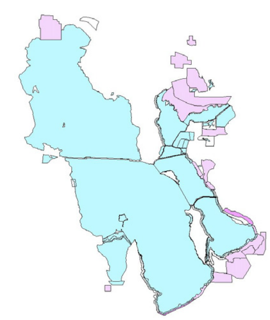


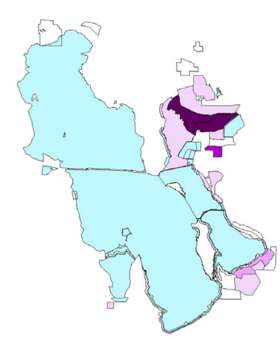
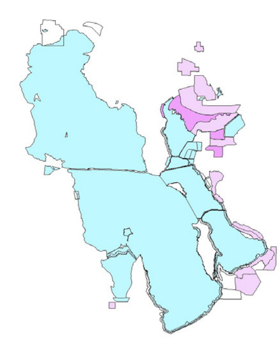
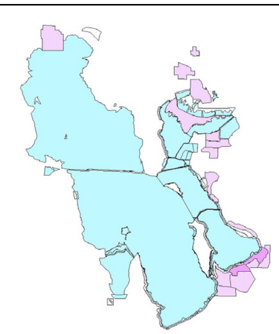
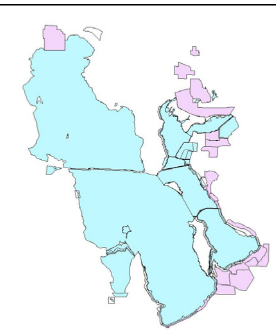
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **snowy egrets** in high (1999) and low (2001) lake conditions.

Number of snowy egrets.

<100
100 - 299
300 - 499
500 +

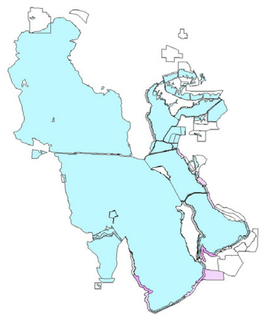
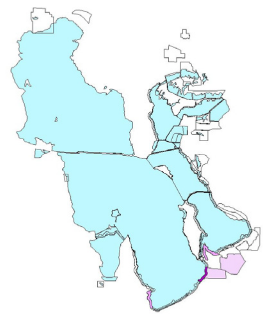
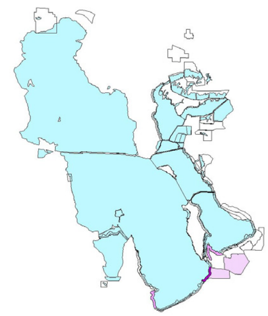
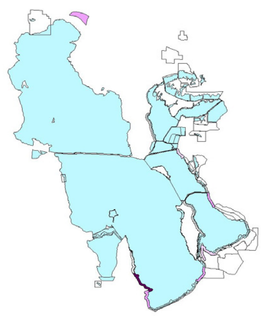
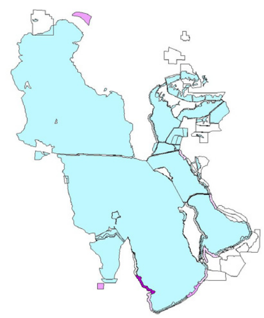
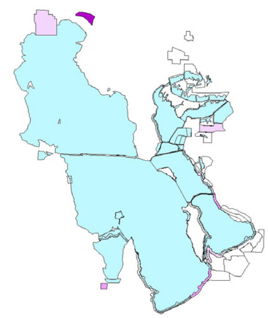
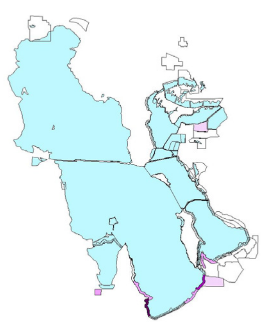
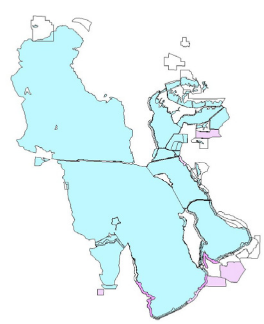
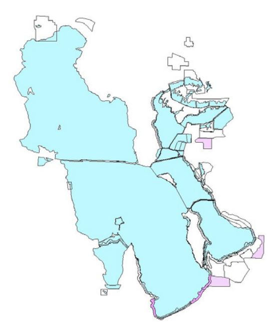
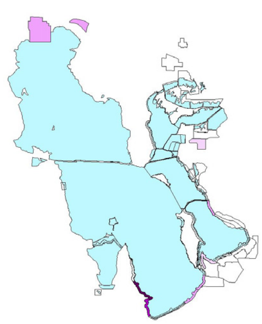
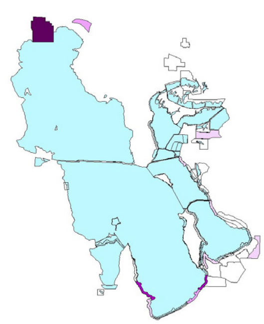
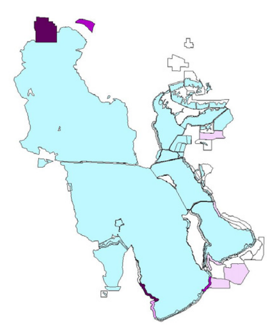
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **snowy plovers** in high (1999) and low (2001) lake conditions.

Number of snowy plovers. (Locomotive Springs was not surveyed in 1999.)

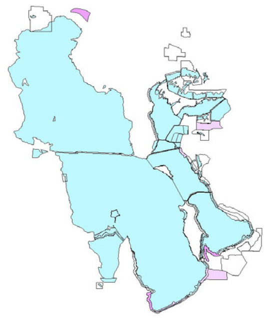
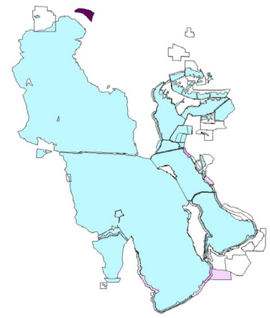
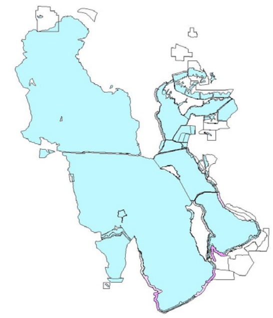
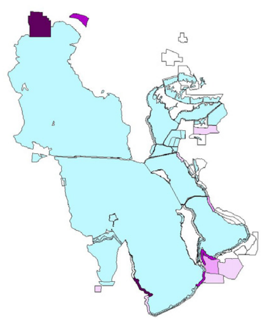
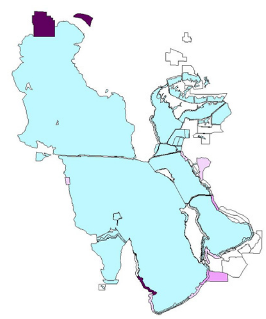
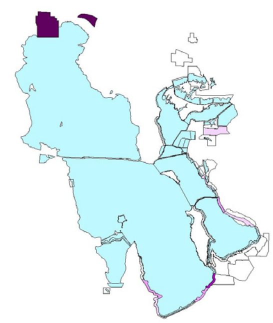
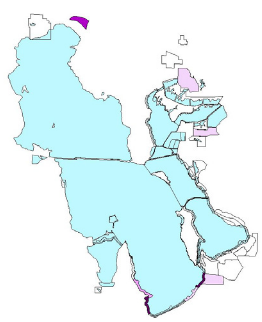
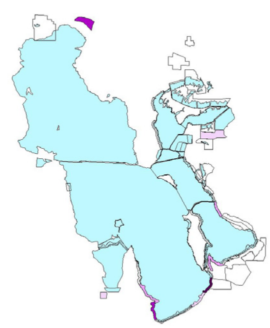
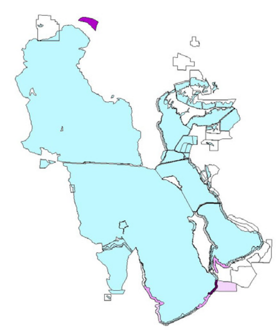
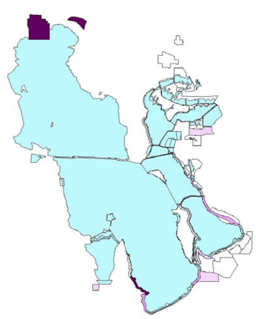
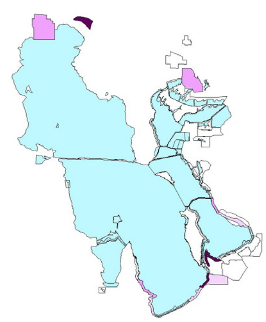
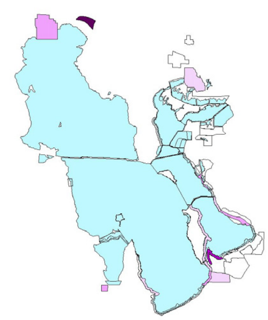
<10
10 - 49
50 - 99
100 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **snowy plovers** in high (1999) and low (2001) lake conditions.

Number of snowy plovers. (Locomotive Springs was not surveyed in 1999.)

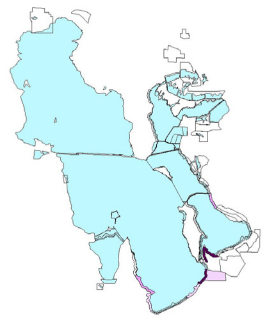
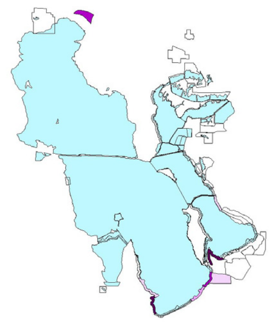
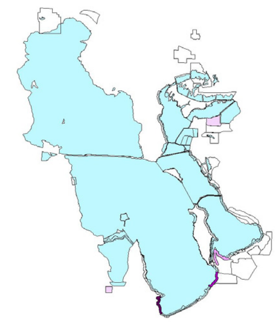
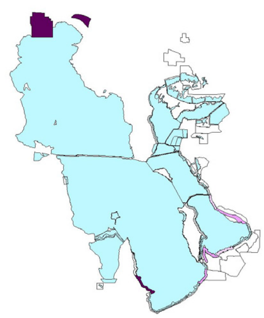
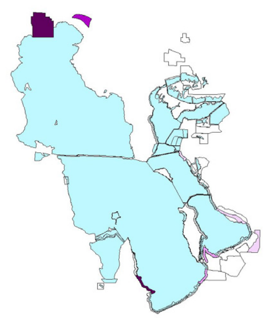
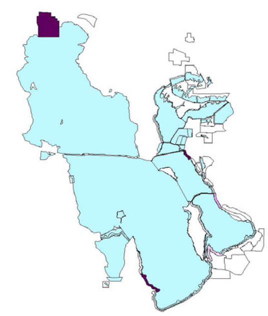
<10
10 - 49
50 - 99
100 +

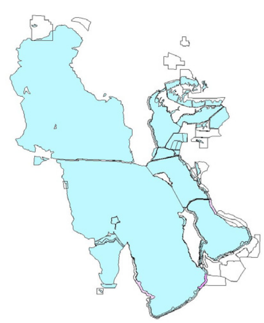
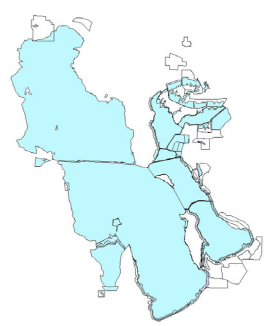
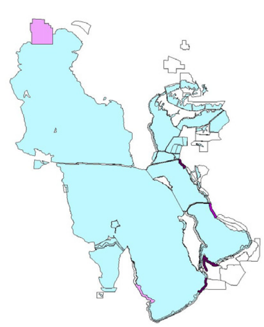
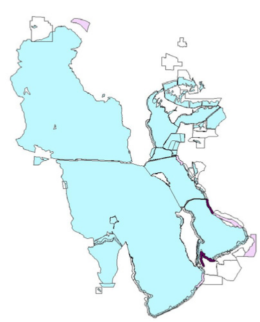
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **snowy plovers** in high (1999) and low (2001) lake conditions.

Number of snowy plovers. (Locomotive Springs was not surveyed in 1999.)

<10
10 - 49
50 - 99
100 +

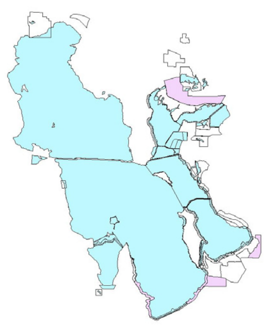
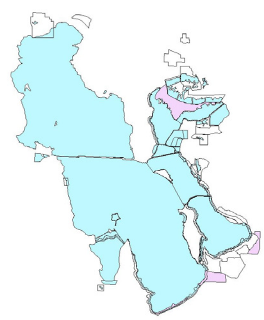
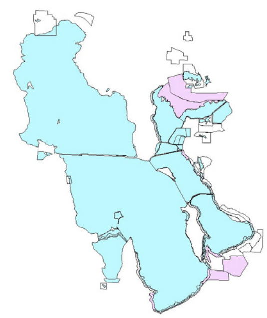
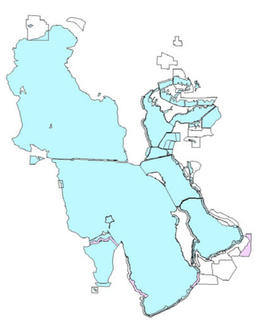
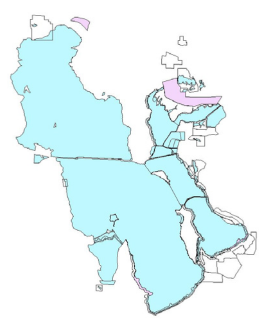
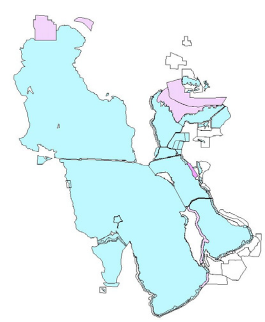
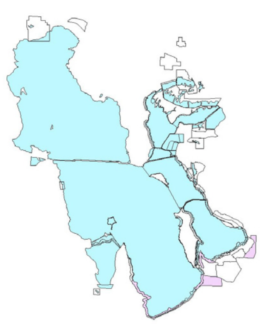
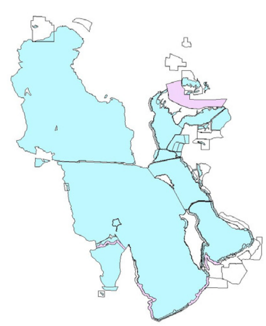
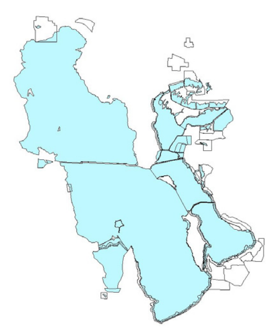
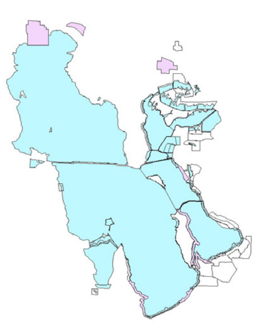
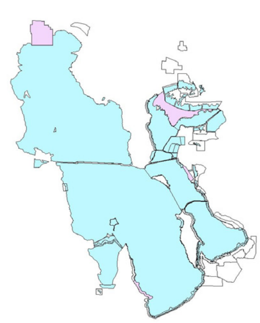
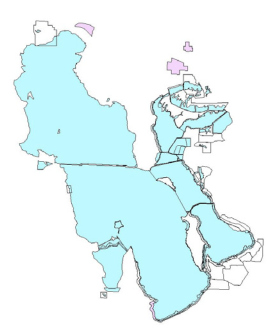
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **western sandpipers** in high (1999) and low (2001) lake conditions.

Number of western sandpipers.

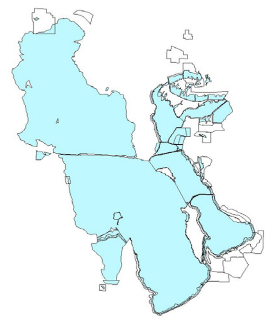
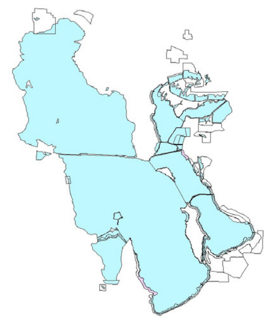
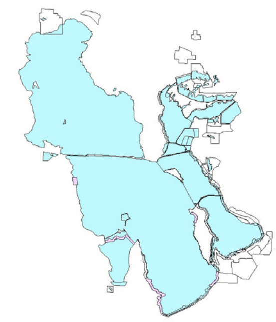
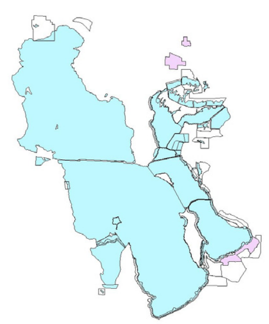
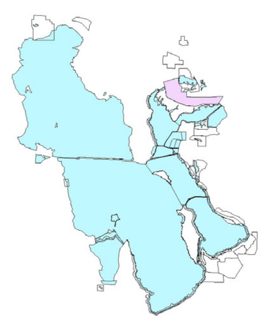
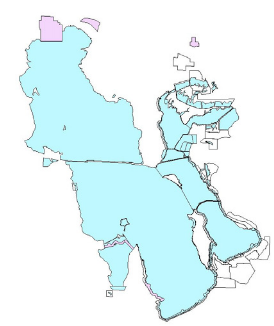
<1000
1,000 - 9,999
10,000 - 49,999
50,000 +

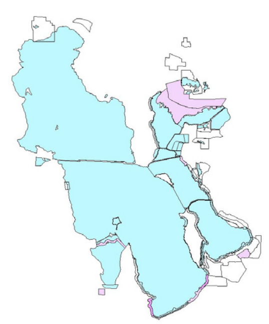
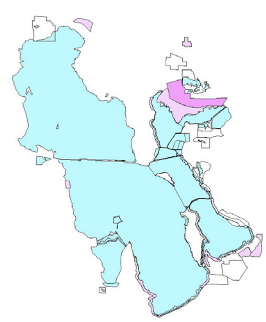
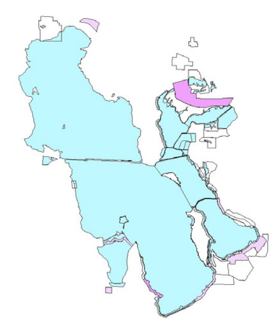
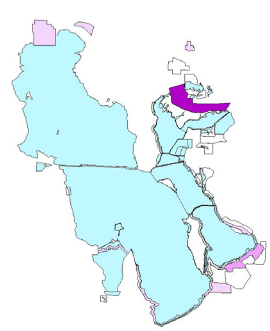
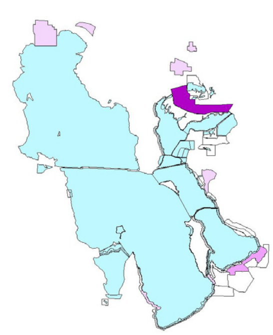
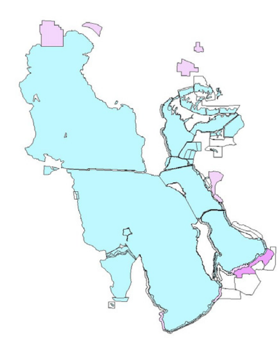
Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **western sandpipers** in high (1999) and low (2001) lake conditions.

Number of western sandpipers.

- <1000
- 1,000 - 9,999
- 10,000 - 49,999
- 50,000 +

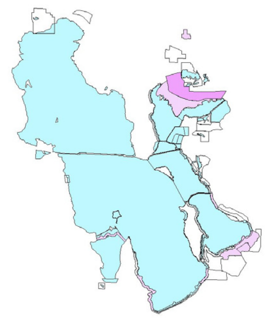
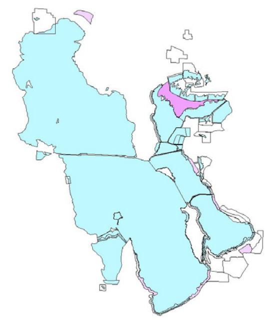
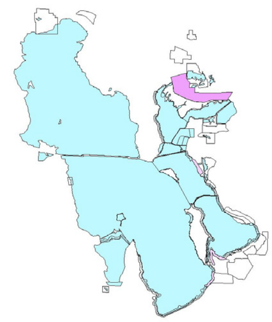
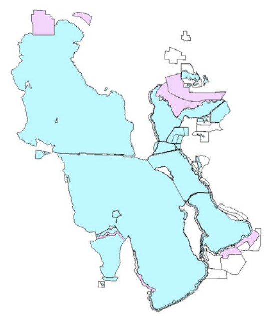
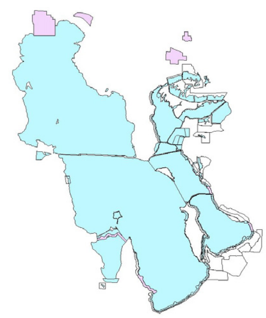
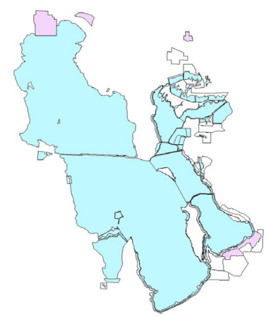
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			

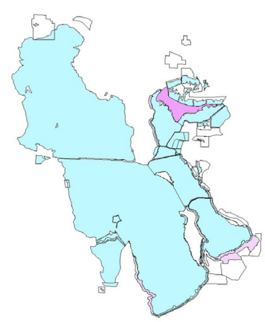
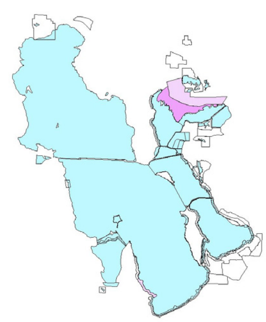
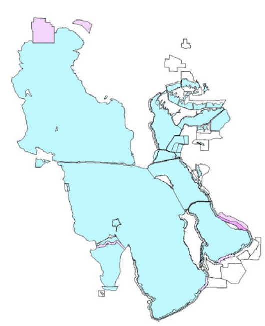
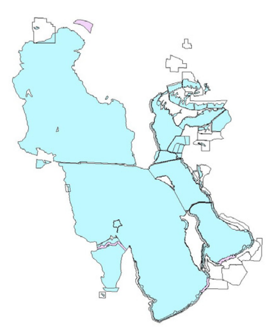
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **western sandpipers** in high (1999) and low (2001) lake conditions.

Number of western sandpipers.

- <1000
- 1,000 - 9,999
- 10,000 - 49,999
- 50,000 +

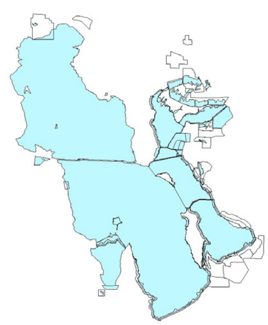
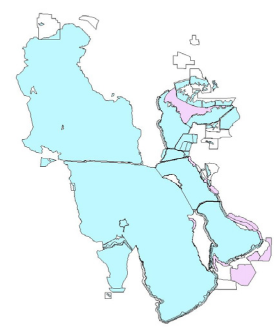
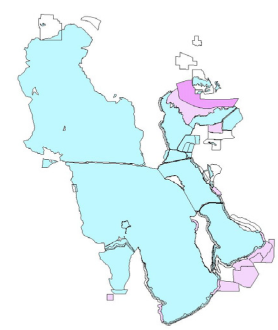
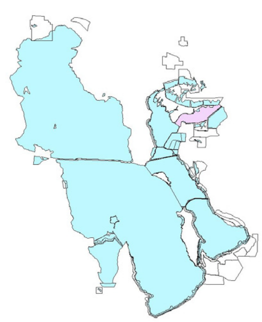
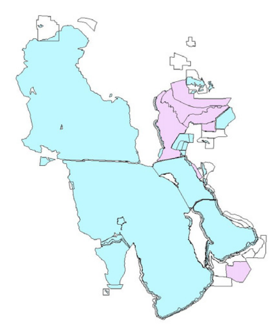
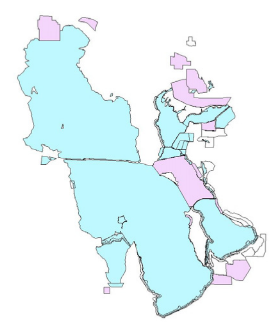
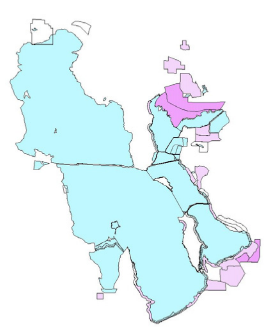
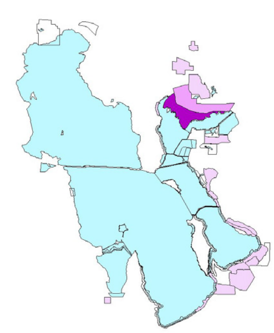
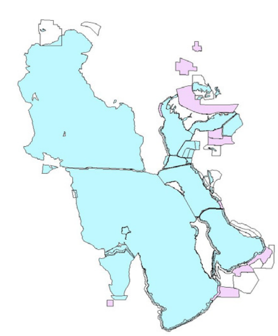
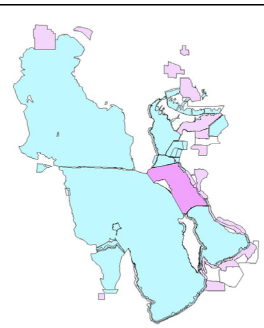
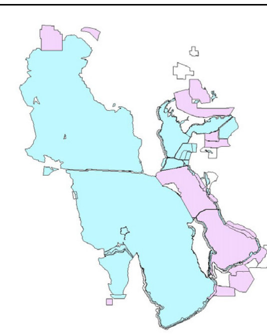
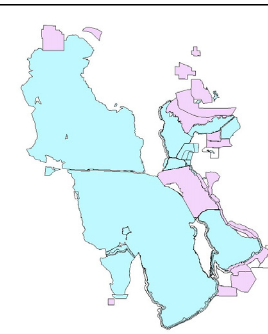
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **white-faced ibis** in high (1999) and low (2001) lake conditions.

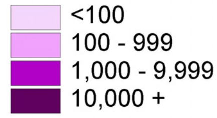
Number of white-faced ibis.

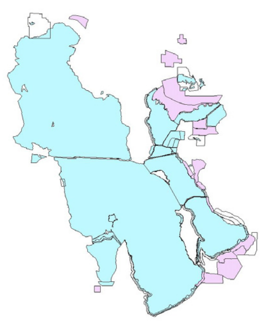
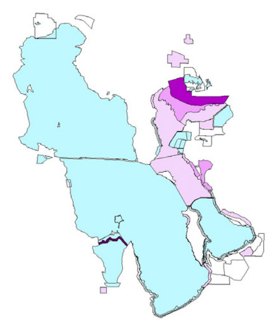
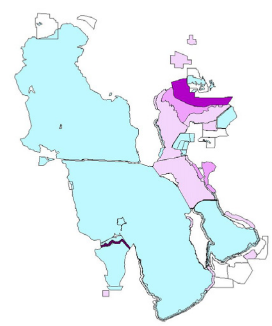
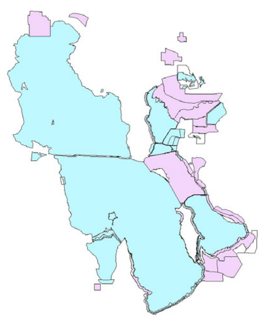
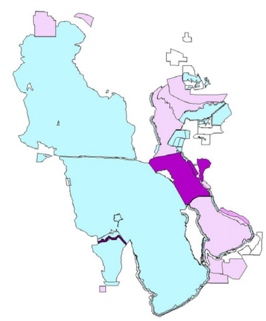
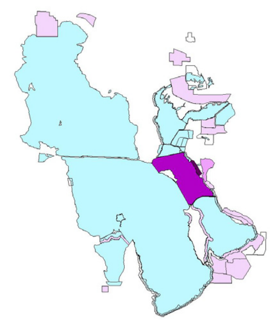
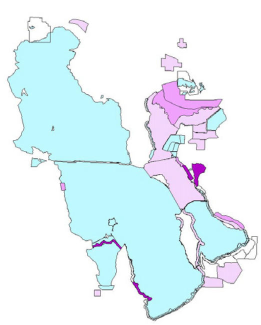
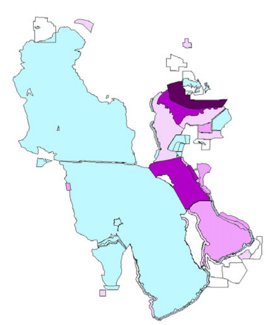
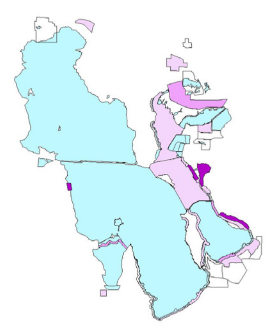
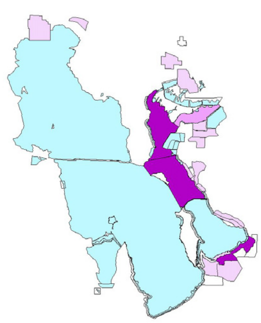
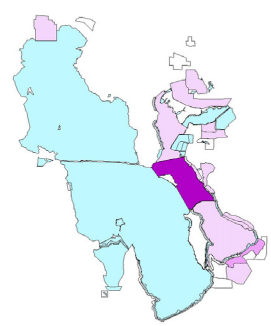
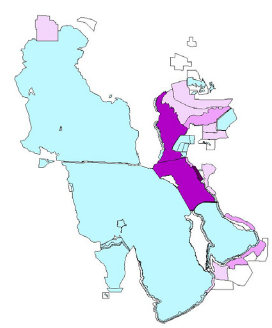
<100
100 - 999
1,000 - 9,999
10,000 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **white-faced ibis** in high (1999) and low (2001) lake conditions.

Number of white-faced ibis.

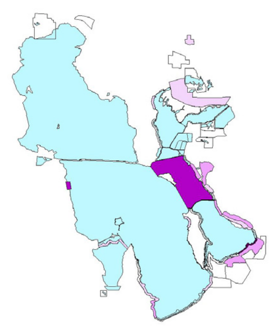
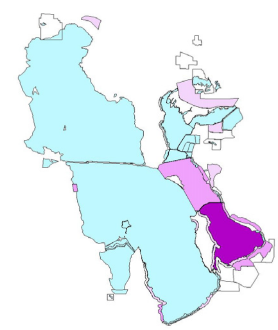
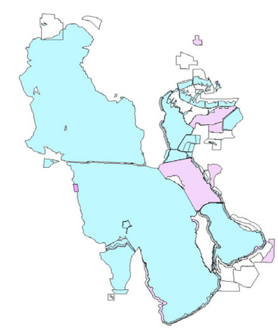
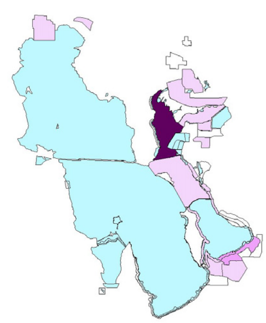
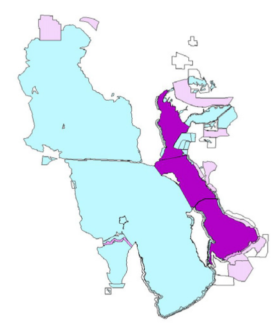
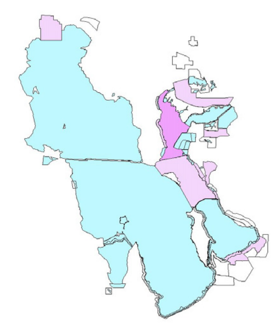


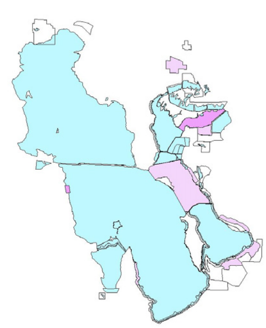
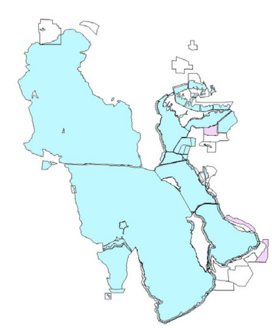
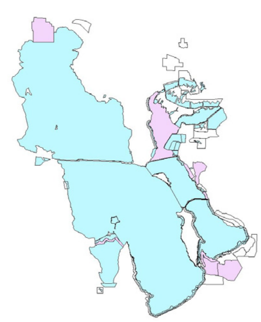
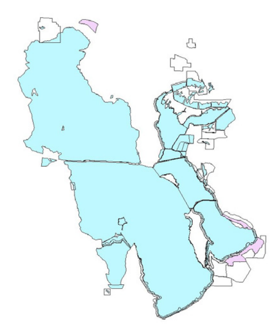
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **white-faced ibis** in high (1999) and low (2001) lake conditions.

Number of white-faced ibis.

<100
100 - 999
1,000 - 9,999
10,000 +

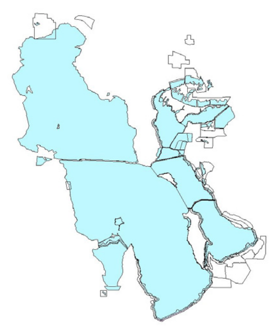
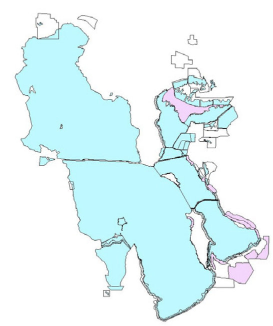
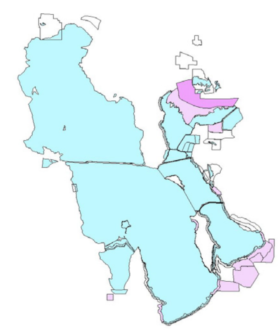
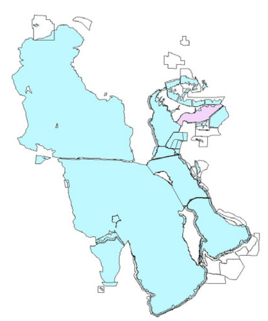
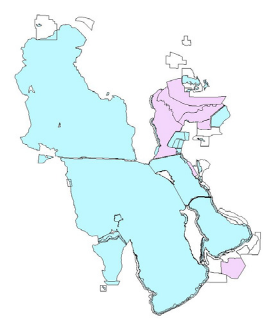
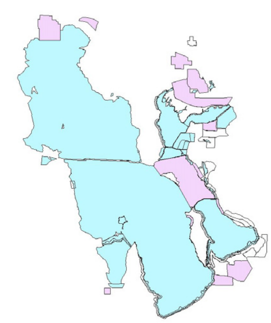
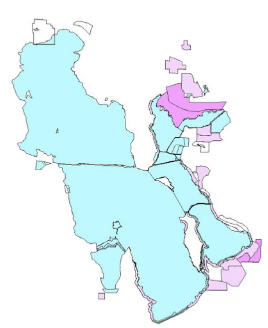
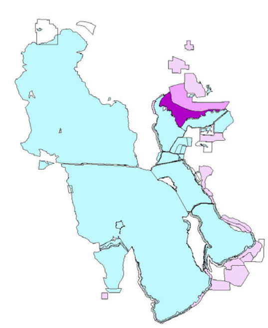
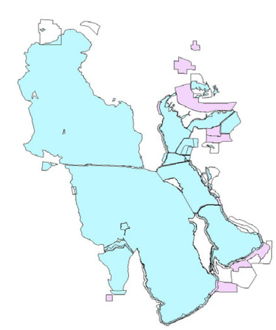
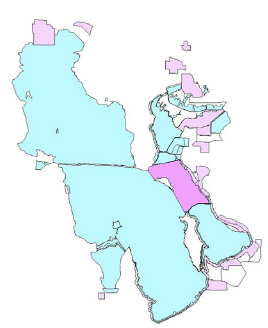
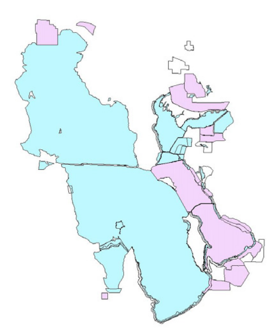
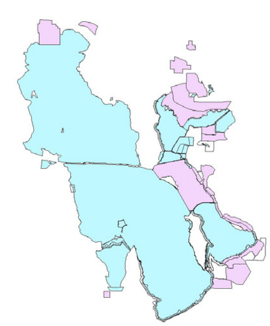
Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001		

Comparison of the distribution of **Wilson's phalaropes** in high (1999) and low (2001) lake conditions.

Number of Wilson's phalaropes.

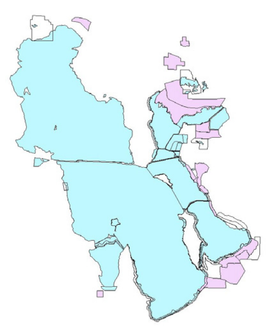
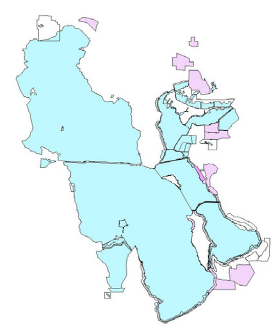
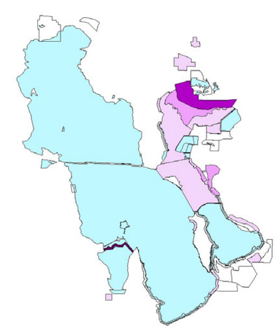
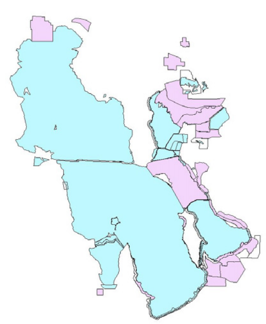
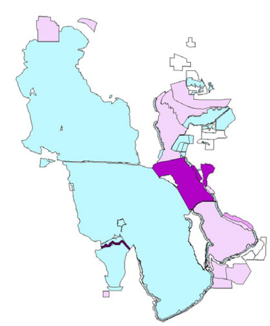
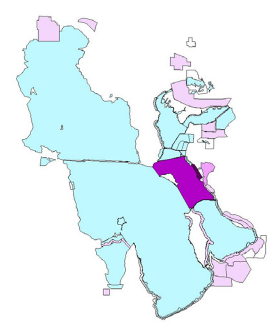
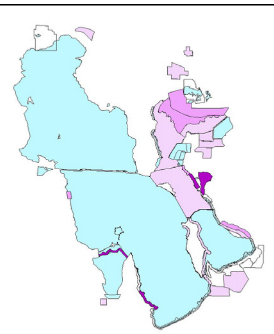
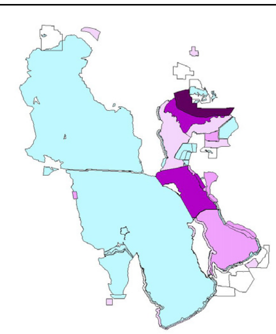
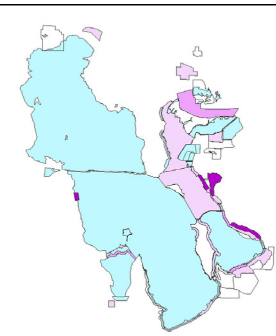
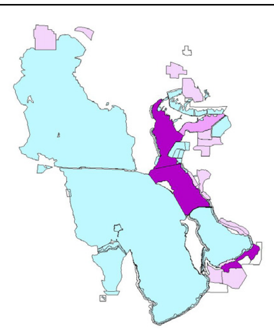
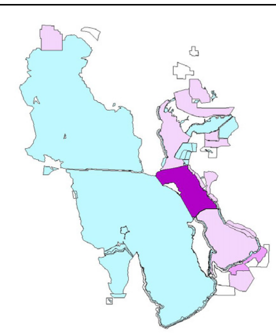
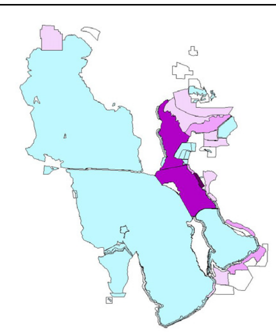
- <1000
- 1,000 - 9,999
- 10,000 - 99,999
- 100,000 +

Year	Period 1: April 6-15	Period 2: April 16-25	Period 3: April 26-May 5
1999			
2001			
Year	Period 4: May 6-15	Period 5: May 16-25	Period 6: May 26-June 4
1999			
2001			

Continued…Comparison of the distribution of **Wilson's phalaropes** in high (1999) and low (2001) lake conditions.

Number of Wilson's phalaropes.

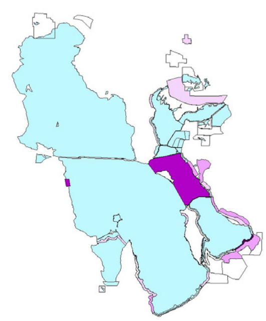
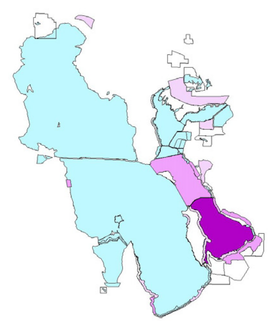
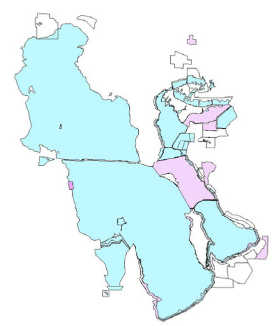
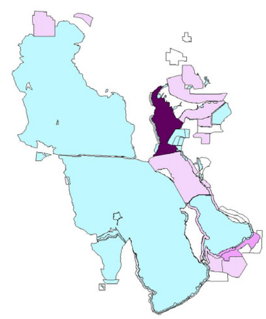
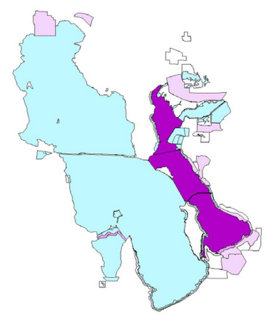
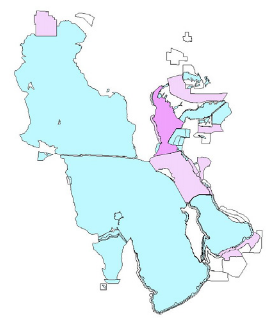
<1000
1,000 - 9,999
10,000 - 99,999
100,000 +

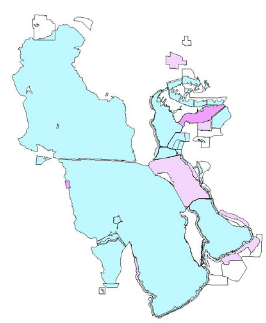
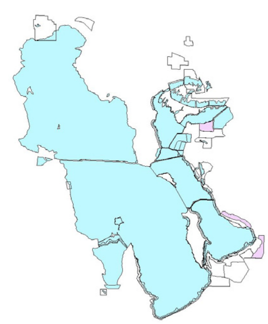
Year	Period 7: June 5-14	Period 8: June 15-24	Period 9: June 25-July 4
1999			
2001			
Year	Period 10: July 5-14	Period 11: July 15-24	Period 12: July 25-Aug 3
1999			
2001			

Continued…Comparison of the distribution of **Wilson's phalaropes** in high (1999) and low (2001) lake conditions.

Number of Wilson's phalaropes.

- <1000
- 1,000 - 9,999
- 10,000 - 99,999
- 100,000 +

Year	Period 13: Aug 4-13	Period 14: Aug 14-23	Period 15: Aug 24-Sep 2
1999			
2001			

Year	Period 16: Sep 3-12	Period 17: Sep 13-22
1999		
2001