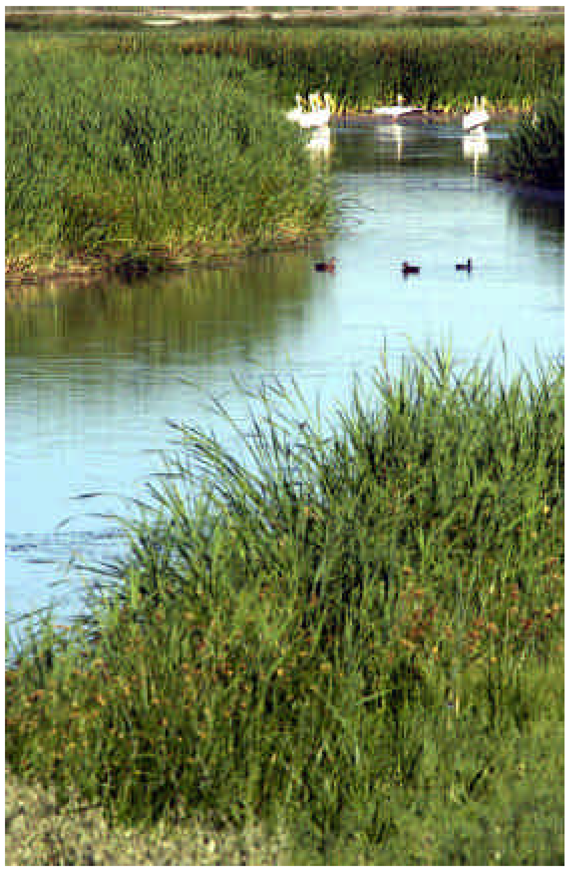
2004 Great Salt Lake Shorebird Productivity Report

Bear River Migratory Bird Refuge,
Farmington Bay Waterfowl Management Area,
Great Salt Lake Shorelands Preserve



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U.S. Fish & Wildlife Service

National Wildlife Refuge System

National Science Foundation
WHERE DISCOVERIES BEGIN

Utah Division of Wildlife Resources

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

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INTRODUCTION

PROJECT SUMMARY
Nest predation is the primary factor reducing the breeding success of many open-nesting birds (Ricklefs 1969, Martin 1992). High predation rates brought about by changes in land management practices and habitat fragmentation have caused fluctuations in bird populations (e.g. Svein 2004).

Because of widespread population declines, shorebird populations have become a national conservation concern (Oring et al. 2003a). For example, a 1995 summary indicated that more than half the shorebird species evaluated were declining (Brown et al. 2001). A reversal of these declines requires an understanding of the population dynamics (factors affecting productivity and survival) of shorebird species. Unfortunately, we currently lack a sound knowledge of many aspects of their basic biology. This knowledge is essential for the successful conservation and management of these populations.

This preliminary study was initiated to establish a baseline of nesting success for some of the most important breeding sites of shorebirds within the Greater Salt Lake Ecosystem, the Bear River Migratory Bird Refuge (BEAR), Farmington Bay Waterfowl Management Area (FARM) and the Nature Conservancy's Great Salt Lake Shorelands Preserve (SHORE).

This project is part of a longterm study that will allow: 1) identification of species' breeding habitat requirements, 2) assessment of current population health based on breeding productivity, and 3) projection of species vulnerability to habitat disturbance and land management.

BACKGROUND AND OBJECTIVES OF RESEARCH/PROJECT.
The Wasatch Front is defined as the five Utah counties concentrated between the valley of the Wasatch Mountains and the Great Salt Lake. The population of this region (1.3 million) contains slightly more than half the state's 2.2 million people. Because of the state's unique demographics; the youngest population in the country with the highest fertility rate and the second lowest death rate, population projections indicate that the Wasatch Front will contain 2.3 million people by the year 2030. This rapid growth and associated urbanization has created a number of ecological problems. One such problem is habitat fragmentation.

Habitat fragmentation occurs when large, continuous tracts of native vegetation are converted to other vegetation types or land uses so that only a few scattered fragments of original vegetation remain (Faaborg et al.1995). Fragmentation is a characteristic feature of most human dominated landscapes and is particularly evident along the Wasatch Front. Many studies have shown that habitat fragmentation can change the abundance and diversity of avian communities (Emlen 1974, Blair 1996). A number of mechanisms might underlie these changes. For example, fragmented habitats may have a higher proportion of nest predators or a different suite of predators relative to unfragmented sites (Haskell et al. 2001). This change in nest predator abundance and diversity may increase the rates of predation on eggs and young (Wilcove 1999, Cavitt and Martin 2002). For the past several decades considerable attention has been given to the effects of forest fragmentation on avian populations within North America because of widespread population declines (Cavitt and Martin 2002 and references therein). However, the effects of habitat fragmentation on wetland breeding species are largely unknown.

PROCEDURES AND METHODS.

STUDY SITES

This preliminary study was conducted from late April to late July of 2004. Study plots were located and monitored in each of three sites bordering the eastern shore of the Great Salt Lake. The first site, the Bear River Migratory Bird Refuge (BEAR), is located 15 miles west of Brigham City, Utah. The refuge covers nearly 30,000 hectares and is comprised of marshes, uplands, and open water. The plots monitored during this study are located in Units 2B, 2C, 3E, 10 and the dikes surrounding 3E, 4B, and O-line dike.

The second site is the Great Salt Lake Shorelands Preserve (SHORE), a 1600 ha Nature Conservancy Site located south of the Antelope Island causeway. SHORE does not contain water control structures and thus water levels fluctuate depending on annual precipitation. This site consists of uplands, marshes, and mudflats.

The third site, Farmington Bay Wildlife Management Area (FARM), west of Farmington, Utah covers about 5,000 hectares. Farmington Bay is managed by the Utah Division of Wildlife Resources and hosts an array of wetland habitats including fresh water ponds, marshes, expansive flats and open salt water.

Each site was characterized with the most recent Digital Orthophoto Quads (DOQs) available from State of Utah. The photos for BEAR represent data from 1993, FARM from 1997 and SHORE from 1997. ESRI ArcMap v8.3 was used to create a 10km buffer around the midpoint of each study site (Figure 1). This area was chosen because 10km corresponds to a typical maximum raccoon home range (Zeveloff 2002). The DOQs were analyzed at a scale of 1:7500 and "urban" areas within the 10km buffer region were manually selected. In this study, "urban" is defined as buildings; this did not include all impacted land, such as agricultural fields.

GENERAL PROCEDURES

Study plots were located and monitored throughout the breeding season. Each plot was searched twice weekly for the presence of shorebird nests. Because flagging or other visible markers can increase the risk of predation (Picozzi 1975), nest locations were determined by GPS, plotted on aerial photographs of the study site and the precise location described using compass bearings and distance estimates (paces) from obvious landmarks. Small plastic plant tags were also used to uniquely identify nests in areas where nests were aggregated. These plant tags were pushed into the ground so that only the top 15mm was visible. Nests were checked every three to four days to determine nest status (Martin and Geupel 1993). To minimize the probability of nest predators locating nests, 1) nests were checked from as great a distance as possible, 2) adults and nests were disturbed as little as possible and different routes were taken within each site to avoid making trails, and 3) visits to nests were quick, minimizing the amount of time spent at the nest. Nests were classified as failed if they disappeared prior to the expected date of hatching and the eggshell evidence was consistent with a failed nest (see Mabee 1997 for techniques used to classify the fates of shorebird nests).

The daily survival rate (DSR) of nests and their associated standard errors were estimated using the Mayfield (1961, 1975) method as modified by Johnson (1979) and Hensler and Nichols (1981). We calculated the DSR for nests of each species as one minus the total number of failures divided by the total number of days nests were observed. Mayfield (Mayfield 1961, 1975) and apparent estimates of nesting success are also provided.

The population density of Snowy Plover (*Charadrius alexandrinus,* SNPL) within each study site was determined by the variable distance point count method (Ralph et al. 1992) with points spaced 400 m apart. Data were collected by counting the number of individuals and estimating their distance to the observer throughout a 5-minute observation period at each point. Counts were made during the 2004 breeding season in May, June and July. Population densities were derived using the computer program Distance v.4.1 (Thomas et al. 2003).

The potential for SNPL populations to serve as either breeding sources or sinks (Pulliam 1988, Temple and Carey 1988) were calculated following Trine (1998) where;

Source-sink threshold = (2 x adult mortality) / (1 - juvenile mortality).

When observed productivity is above this threshold, the population is a potential source. However, when population productivity falls below this threshold, the population is a likely sink. Because adult and juvenile mortality rates are largely unkown for many species, I used a range of estimates in the calculations and assumed that juvenile survival is 0.5 of adult survival (Temple and Carey 1988, Thompson 1993). Annual productivity per breeding pair (*P)* was estimated after Pinkowski (1979); where

P = (number fledged per successful nest) x (% nest success) x (number of nests per year).

Because adult and juvenile mortality is currently unknown for American Avocets (*Recurvirostra americana* AMAV), and Black-necked Stilts (*Himantopus mexicanus*, BNST), I am unable to calculate the potential source-sink threshold for these species.

The primary species of study for this report are AMAV, BNST, Killdeer (*Charadrius vociferous*, KILL), and SNPL.

MESOPREDATOR ABUNDANCE
In an attempt to monitor the relative abundance of potential nest predators within BEAR and FARM, scent station transects (n = 3) were established and monitored during two weeklong survey periods (early June and mid-July). Each transect was 5km in length and consisted of 10 track stations located at 0.5 km intervals along dikes. Each station consisted of 57cm diameter plastic container (garbage can lid), which was prepared with sifted lime. A fatty acid scent tablet was placed in the center of the station and replaced as needed during survey periods (Figure 2). Stations were checked daily during the survey period.

HABITAT CHARACTERISTICS OF AVOCET AND STILT BROODING SITES
The purpose of this study was to determine the components of the habitat that parents select as brooding sites. Both AMAV and BNST parents lead young to brooding sites within 24h after hatching.

This study was conducted at BEAR and FARM where we selected a total of 17 plots (10 at BEAR and 7 at FARM). Each plot consisted of a "use site" (site utilized by parents and young) and a randomly selected "non-use site". Each non-use site was located 50 meters from the use site and contained no young or adults. Adults and young were located and counted using a vehicle as a blind. At each use site, the numbers of young and adults of each species were counted within a 50 m radius.

Vegetation analysis

We recorded several aspects of vegetation at each use and non-use site. The percent ground cover was measured by placing a stake in the ground with rope (5 m length) extending out in the four cardinal directions. In each quadrant, percent ground cover was estimated for three categories: water, bare ground, and vegetation. Vegetation was further divided into three sub-categories: *Scirpus sp*., *Salicornia sp*., and "other". The "other" category included grasses, sedges, mustards, and aquatic vegetation. Visual obstruction by vegetation and vegetation density were also estimated at each site. To determine the visual obstruction by vegetation at each site, we used a pole marked in 10 cm segments. The pole was placed in each of the quadrants and the number of segments obstructed by vegetation was recorded by standing 4 m from the pole and 1 m above the ground (Martin et al. 1997). Vegetation density was estimated by placing a second pole which had been marked in 5 cm increments in each quadrant. The number of contacts by herbaceous vegetation at each segment was recorded (Martin et al. 1997).

Statistical Analysis

A multivariate ANOVA was used to determine if the habitat characteristics of the two study areas differed and to determine any difference between the use and non-use sites. In addition, a stepwise multiple regression analysis was used to select habitat variables important for brood site selection. For all statistical analyses, the a level was set at $P = 0.05$.

PRELIMINARY RESULTS

SITE CHARACTERIZATION

The percent urban landcover classification for each of the three study sites is shown in Figure 3 below. BEAR had the lowest score followed by FARM and then SHORE. This data will be supplemented as more recent DOQs become available.

SPECIES RESULTS

American Avocet

Nesting sites for AMAV included islands, dikes and mudflats. AMAV typically congregate in breeding colonies ranging from a few pairs to several hundred pairs. The largest colony observed in this study was located on an island in Unit 4B at BEAR. We estimated that the colony had at least 200 nesting pairs. This colony was not monitored because an adjacent colony of Califonia Gulls (*Larus californicus,* CAGU) attempted to depredate AMAV nests when approached by the field crew. Colonies monitored on the 3E islands ranged in size from 2 - 37 nesting pairs. Preliminary results for these colonies suggest that daily survival rate tended to increase with increasing colony size, although not significantly ($r = 0.32$, $P = 0.16$).

First nests at BEAR were initiated on April 7 on the Unit 3E islands. First nests of AMAV at FARM were initiated on April 27 near the Headquarters area. The last successful nests were initiated on June 28 and 29 at BEAR and FARM respectively. The young left both nests on July 17.

A total of 465 AMAV nests were monitored for this study[1]. The nesting success at each site and plot are located in Table 1. We were unable to locate a breeding colony of AMAV at SHORE during this field season.

Predation was the major cause of nest failure for American Avocets within all plots at the BEAR and FARM sites. Flooding of nests accounted for another important source of nest failure and typically occurred as water was diverted into units over short periods of time. During gradual increases in water levels, AMAV typically were able to incorporate additional nesting material into nests thereby elevating the eggs above the water and avoiding nest failure. The proportion of nests lost to each fate is depicted in Figure 4. Nests built on islands or along the edges of dikes were the most vulnerable to flooding events.

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[1] Nest records from FARM are still being analyzed and thus the data for this site is not complete.

Table 1. 2004 nesting success of American Avocets by site and plot.

Site	Plot	Mayfield Nesting Success Estimate	Apparent Nesting Success	# Nests observed
BEAR				
	3E Islands	0.358	0.493	152
	4B Dike	0.409	0.563	96
	10	0.484	0.671	73
	O-Line Dike	0.095	0.273	33
TOTAL BEAR		**0.362**	**0.525**	**354**
FARM				
	Headquarters	0.01	0.05	20
	Marsh A	0.680	0.820	11
	Marsh B	0.438	0.60	5
	Marsh C	0.810	0.867	75
	Marsh D	-	-	-
	Marsh E	-	-	-
	Marsh F	-	-	-
	Marsh G	-	-	-
Total FARM		**0.571**	**0.703**	**111**

Black-necked Stilt

Black-necked Stilts prefer nesting in areas very similar to AMAV, however preferred nesting sites tend to have more emergent vegetation. In addition, BNST are more territorial in their nesting behavior and thus nests are more widely scattered.

Nest initiation for BNST occurred later relative to AMAV. First nests at BEAR began on April 13 and May 6 at FARM. The last successful nest at BEAR was initiated on June 20 with young leaving the nest on July 14. The last successful nest at FARM was initiated on June 24 and its young left the nest on July 16.

A total of 163 nests were monitored for this study[2]. At BEAR nesting success varied by nest plot. The nesting success at each site and plot are located in Table 2. We were unable to locate breeding BNST at SHORE during this field season.

[2] Nest records are still being analyzed for FARM and thus data for this site is not complete.

Table 2. 2004 nesting success of Black-necked Stilts by site and plot.

Site	Plot	Mayfield Nesting Success Estimate	Apparent Nesting Success	# Nests observed
BEAR				
	2C	0.160	0.286	7
	3E Islands	0.320	0.429	42
	4B Dikes	0.416	0.52	25
	10	0.319	0.5	8
	O-Line Dike	0.043	0	2
TOTAL BEAR		**0.323**	**0.440**	**84**
FARM				
	Marsh A	0.328	0.50	30
	Marsh B	0.490	0.667	3
	Marsh C	0.713	0.783	46
	Marsh D	-	-	-
	Marsh E	-	-	-
	Marsh F	-	-	-
	Marsh G	-	-	-
TOTAL FARM		**0.557**	**0.671**	**79**

Similarly to results obtained for AMAV, nest predation was the most important source of nest failure for BNST at BEAR. The proportion of nests lost to each fate is depicted in Figure 5.

Killdeer
Killdeer nests were primarily located incidentally to searching for SNPL nests. The majority of these nests occurred along the O-line dike at BEAR. Mayfield nesting success for these nests was 0.405 (apparent = 0.555, N = 9).

Snowy Plover
A total of 52 nests were located and monitored (e.g. Figure 6) during the 2004 breeding season (31- BEAR, 17- SHORE, 4-FARM). Nest initiation dates ranged from early May through mid July each year.

Nesting success varied according to site with the highest nesting success reported for FARM and BEAR and the lowest reported for SHORE (Table 3).

Table 3. 2004 nesting success of Snowy Plover by site.

	Apparent Nesting Success	**Mayfield**	**Number of Nests**
BEAR	.645	.504	31
FARM	.75	.618	4
SHORE	.412	.139	17

Productivity for SNPL was estimated as follows BEAR 3.02, FARM 3.7, and SHORE 0.83. Using survival analysis, Paton (1994) estimated annual adult survival to be 0.578-0.880 and annual juvenile survival at 0.385. The source-sink threshold calculated for SNPL using survival rates estimated by Paton (1994) range from 2.19 - 0.623. In other words, each pair within these populations would need to rear between 2.19 – 0.623 young per year for replacement to occur. According to these calculations, SNPL breeding within both BEAR and FARM are serving as source populations, but those breeding within SHORE would only be considered a source if annual adult survival is at its maximal estimate (0.880).

Population density (individuals/km^2) was estimated for each site during the 2004 breeding season by point counts- BEAR 11.2, FARM 4.6, and SHORE 4.0. The higher estimate reported for BEAR is due to large flocks (up to 100 individuals) counted on two consecutive periods. Flocks of this size were not counted in either FARM or SHORE during the survey period. Population density estimates did not include birds associated with dikes and only can be extrapolated to suitable mudflat habitats.

MESOPREDATOR ABUNDANCE

BEAR began a predator control program in 2002. During the 2004 breeding season, a total of 39 raccoons (*Procyon lotor*), 53 skunks (*Mephitis mephitis*), and 9 red fox (*Vulpes vulpes*) were removed. FARM implemented an intensive predator control program during the 2004 breeding season and successfully removed 143 raccoons, 90 skunks , and 12 red fox.

The two most abundant mammals visiting scent stations were raccoons and striped skunks. Visits were also made by various species of small mammals and a single record of a badger (*Taxidea taxus*). There were no significant differences between sites in either raccoon or skunk abundance during the first survey period (raccoon - G = 0.65, df = 1, P>0.05; skunk - G = 2.26, df = 1, P> 0.05). However, significantly more raccoon visits occurred at the FARM site during the second survey relative to BEAR (G= 6.43, df = 1, P< 0.05). This same pattern, higher visitation at FARM relative to BEAR, occurred for skunks during the second survey period as well (G= 20.67, df = 1, P< 0.01). The visitation rates for each species and site is found in Figure 7.

HABITAT CHARACTERISTICS OF AVOCET AND STILT BROODING SITES

We found no significant difference between BEAR and FARM for any habitat variable or number of young counted at plots ($F_{20,11}$=1.174, P > 0.05). Thus, we pooled the data from both study areas together for remaining analyses. There was also no statistically significant difference between use and non-use sites ($F_{20,11}$=0.989, P > 0.05). Although not significant, there was a trend for *Salicornia sp.* to occur more often in brooding sites relative to non-use sites (P = 0.09). The stepwise regression model identified three variables that were important for predicting BNST brooding sites ($F_{3,16}$=6.659, P < 0.05, r^2=0.606). This model suggests that BNST lead young to sites with vegetation providing high visual obstruction (vegetation height - 0.9 – 1.5m) and extensive water cover (between 90 – 100%). The preferred density of the vegetation selected was low with 0-5 contacts at 5 cm from the ground. Analyses are still being conducted to examine the habitat selection for AMAV.

DISCUSSION

These results provide an indication of the reproductive success of shorebirds breeding within the Great Salt Lake Ecosystem.

Nesting success estimates for all shorebirds monitored have increased on both BEAR and FARM relative to the 2003 breeding season (Cavitt 2003). This increase may be due to the success of the predator removal programs currently in place at each site. However, the overall nesting success of AMAV and BNST breeding at BEAR is lower compared to those breeding at FARM. The differences between these sites are somewhat surprising considering the intensive predator removal program in place at BEAR. Several explanations may account for these differences. First, on April 28, 2004, 23 nests located on the unit 3E islands failed due flooding when water levels were increased. Although this was an important source of nest failure flooding alone can not completely account for the observed differences between sites. An additional explanation may be due differences in nest site selection at BEAR relative to FARM. A large number of nests at BEAR were located on dikes and islands whereas at FARM the majority of nests were located within shallow emergent marshes and vegetated mudflats. Nests located on dikes may be more easily located by potential nest predators. Island nests typically have higher nesting success, however the islands located in Unit 3E at BEAR became accessible to terrestrial predators early in the breeding season as water levels receded. A second explanation may be that nest predation by CAGU may be much higher at BEAR than at FARM. The number of CAGU observed using BEAR is much higher than observed at FARM. In addition an active breeding colony of CAGU was observed using an island near nests monitored in Unit 3E and along the 4B dike. This hypothesis is currently being tested by comparing the percentage of nests lost to avian versus mammalian predators at each site.

Snowy Plover nesting success estimates were very similar between BEAR and FARM (Table 3) despite the fact that the birds monitored used different nest substrates at each location. SNPL nests monitored at BEAR were found on dikes, but at SHORE and FARM they were located on mudflats. SNPL nests monitored at FARM were actually within 10 – 20m of AMAV colonies and thus may have also benefited from the nest defense behavior of avocets.

Both the predator removal data and the scent station data suggest that mesopredator populations are greater at FARM relative to BEAR. Both sites have implemented a predator management plan, however BEAR has been removing predators for the last several years whereas FARM has just started a consistent effort. This difference in effort over the last several years may account for the greater activity of mesopredators detected at FARM during the second survey period. Because FARM has a higher urban classification score (see Figure 3), mesopredator populations may be at a higher density. This could require increased efforts in predator removal.

The brood habitat selection study suggests that BNST prefer flooded sites, relatively high vegetation but with low vegetation density. These attributes provide necessary food, and cover yet still provide sufficient mobility for young. Data are still being analyzed to examine the habitat selection by AMAV. It is interesting that we were unable to detect a difference between use and non-use sites. The close proximity of use to non-use sites (~50m) likely resulted in field assistants sampling within a utilized area. Methodologies in subsequent field seasons will take this into account and hopefully reduce this bias.

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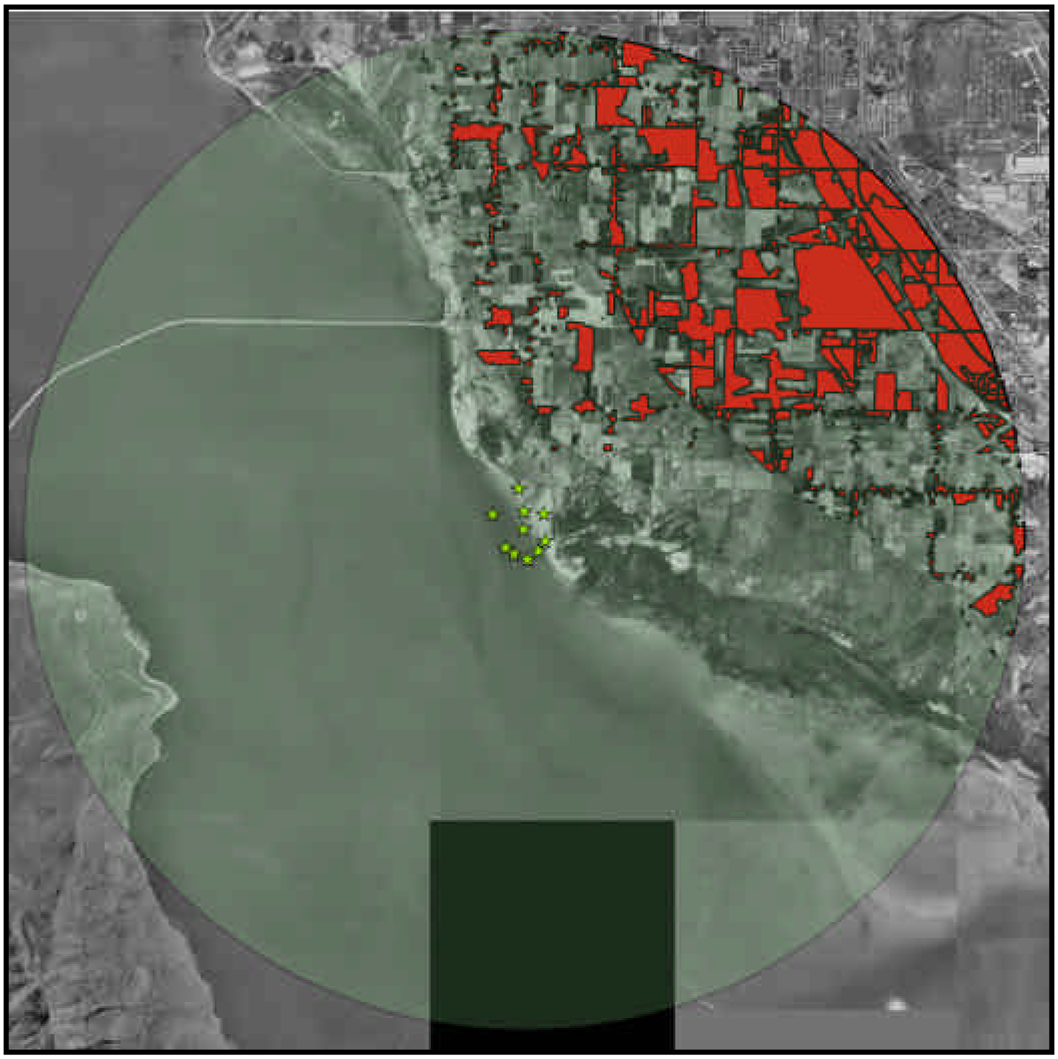

Figure 1. Example of urban landcover classification at 10km radius (green shaded circle) at the Shorelands Preserve near Layton, UT. Red corresponds to areas classified as urban and green stars represent point count stations, black box indicates data missing from aerial image source.

Figure 2. Scent station along dike at Bear River Migratory Bird Refuge.

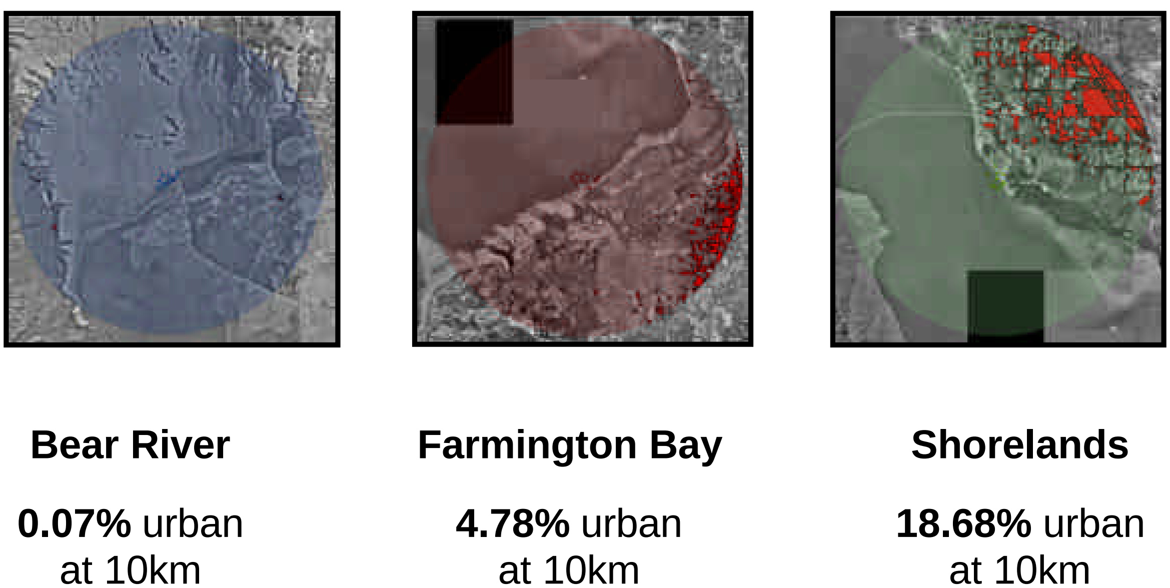

Figure 3. The % urban landcover classification at 10km radius for each of the three study site locations (see text for detailed description).

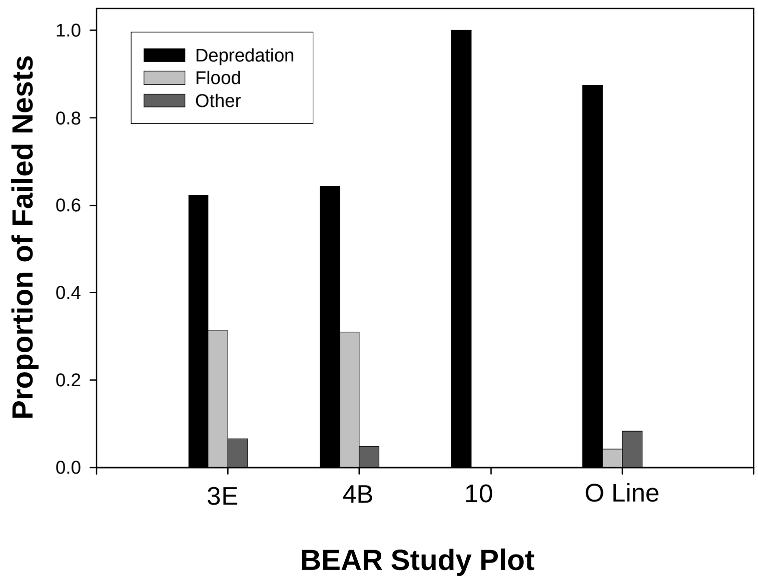

Figure 4. Type of nest failure by study plot for American Avocets breeding at Bear River Migratory Bird Refuge.

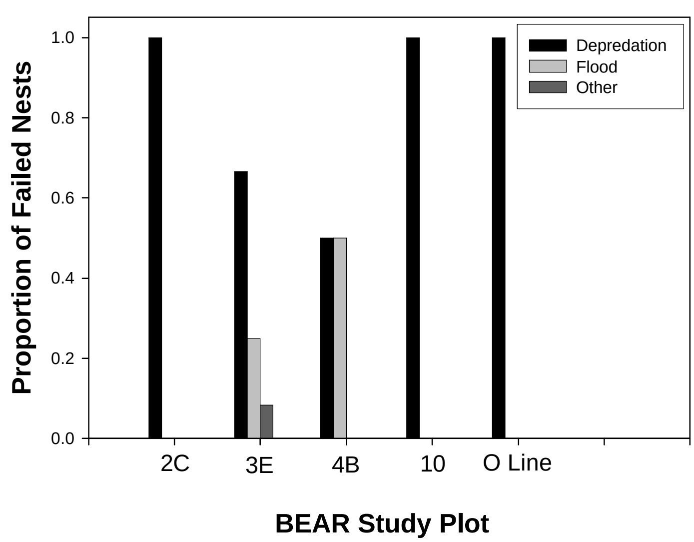

Figure 5. Type of nest failure by study plot for Black-necked Stilts breeding at Bear River Migratory Bird Refuge.

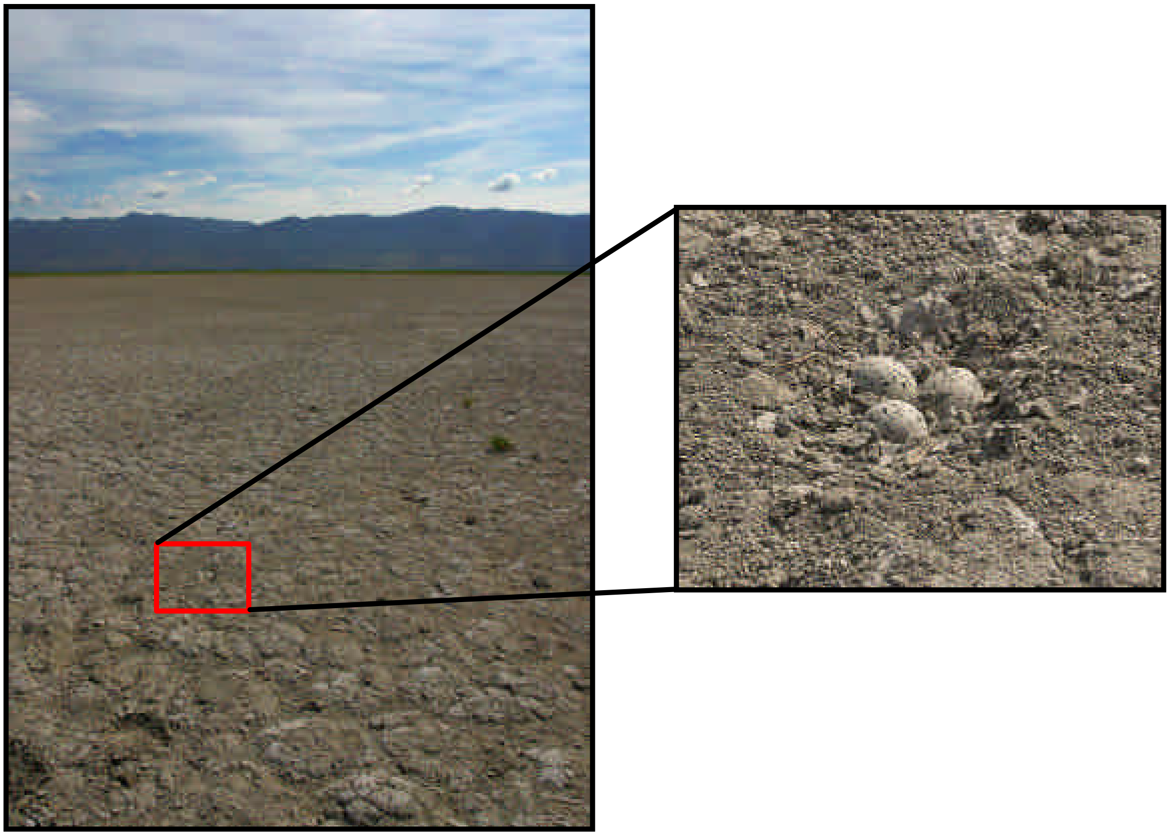

Figure 6. Typical nest site of Snowy Plover on mudflat at Great Salt Lake Shorelands Preserve.

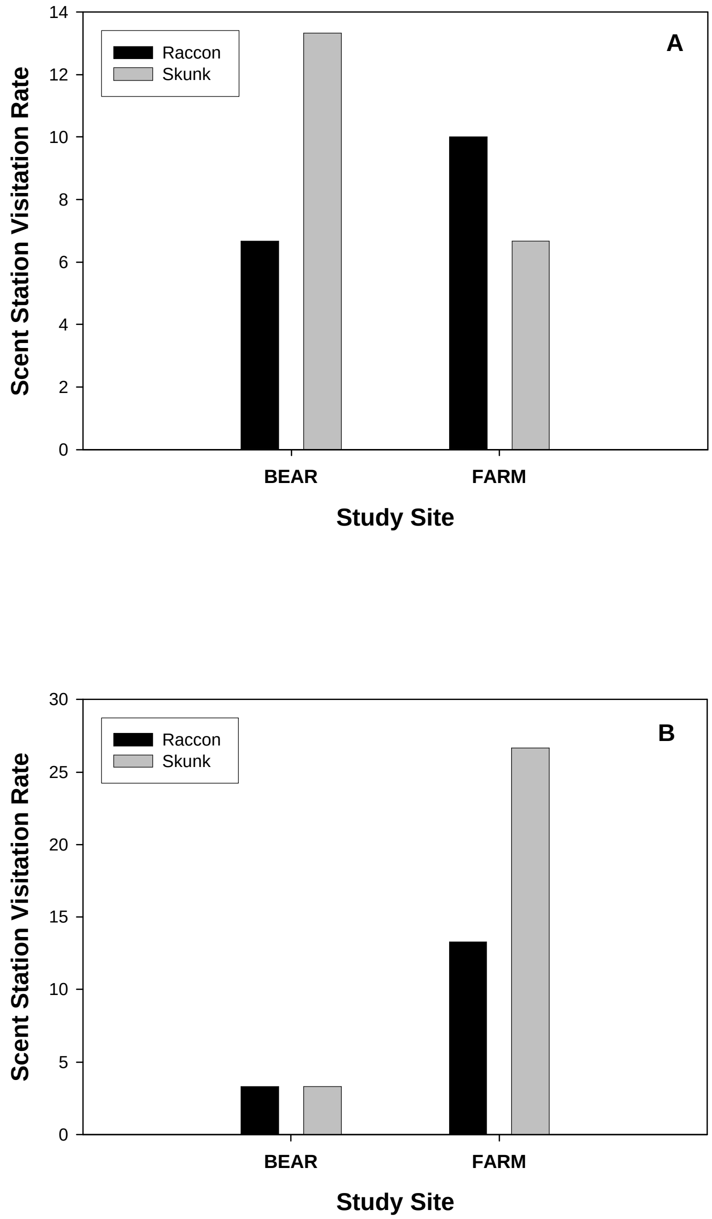

Figure 7. Visitation rate of Raccoon and Striped Skunks to scent stations during the first (A) and second (B) survey periods.