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# Breeding Productivity of Shorebirds, Waterfowl, and Colonial Waterbirds at Bear River Migratory Bird Refuge, Utah 2010 Annual Report

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## 2010 Report

# Background

## Context

The Great Salt Lake (GSL) is well known as one of North America's most important inland shorebird sites. At least 22 species of shorebirds utilize the GSL during migration and another eight species nest in habitats associated with the lake. The breeding populations of American Avocets (*Recurvirostra americana*), Black-necked Stilts (*Himantopus mexicanus*), and Snowy Plover (*Charadrius alexandrinus*) are among the highest in North America (Aldrich and Paul 2002). Consequently, the GSL is recognized as a site of hemispheric importance within the Western Hemisphere Shorebird Reserve Network (Andres et al. 2006). In addition the GSL is also one of the most important breeding and migratory sites for waterbirds within the western hemisphere. The world's largest breeding populations of White-faced Ibis (*Plegadis chihi*) and California Gulls (*Larus californicus*) occur within the GSL ecosystem (Paul and Manning 2002). Despite the importance of the GSL to North American aquatic bird populations, little effort has focused on determining the factors that support healthy, self-sustaining populations. This knowledge is essential for the successful conservation and management of these populations.

## Objectives

This project monitored the breeding productivity of a suite of common nesting species at the BRMBR to augment a long-term study of their population health. This suite includes; American Avocet (AMAV), Black-necked Stilt (BNST), Snowy Plover (SNPL), Long-billed Curlew (*Numenius americanus*, LBCU), White-faced Ibis (WFIB), Franklin's Gull (*Larus pipixcan*, FRGU), California Gull (CAGU), Great Blue Heron (*Ardea herodias*, GBHE), Black-crowned Night Heron (*Nycticorax nycticorax*, BCNH), Northern Shoveler (*Anas clypeata*, NOSH), Mallard (*Anas platyrhynchos*, MALL), Gadwall (*Anas strepera*, GADW), and Cinnamon Teal (*Anas cyanoptera*, CITE) using a standardized sampling protocol. This methodology allows for 1) assessment of current population health based on breeding productivity, and 2) projection of species vulnerability.

# Methods

## Study Site

This study was conducted at the Bear River Migratory Bird Refuge (BEAR). BEAR is located 15 miles west of Brigham City, Utah. The refuge covers nearly 30,000 ha and consists of impounded wetlands, marshes, uplands, and open water. Productivity data was collected from April 22 – August 4, 2010. This site has an active predator management program. Mammalian nest predators such as raccoon (*Procyon lotor*), skunk (*Mephitis mephitis*) and fox (*Vulpes vulpes*) are removed.

## Species

This study focused on four species of shorebirds breeding at Bear River Migratory Bird Refuge (BEAR), American Avocet, Black-necked Stilt, Snowy Plover, and Long-billed Curlew. A small number of Killdeer (*Charadrius vociferus,* KILL) nests were also monitored as they were encountered within the study plots. In addition, this study examined productivity of four colonial waterbird species, California Gull, Great Blue Heron, White-faced Ibis, Franklin's Gull, and Black-crowned Night-Heron. A small number of Snowy Egret (*Egretta thula*, SNEG) nests were also monitored as they were encountered within the WFIB colony. Lastly, this study focused on four species of waterfowl breeding at BEAR including Northern Shoveler, Mallard, Gadwall, and Cinnamon Teal. A small number of Lesser Canada Goose (*Branta canadensis parvipes*, LCGO) nests were also monitored as they were encountered.

The AMAV is a semi-colonial shorebird with a distinctive appearance (Figure 1). This species has a long recurved bill, bluish legs, and a black-and-white chevron pattern on its back (Figure 1). Breeding adults have a rusty to salmon colored head and neck which is replaced by white to light gray plumage during the pre-basic molt. AMAV are common summer residents of the GSL. Local breeders arrive in middle to late March with first eggs laid in April. Pairs select nest sites in areas with little or no vegetation, thus providing an unobstructed view by the attending adult (Cavitt 2005). Consequently nests are frequently located in shallow emergent wetlands, vegetated mudflats, sparsely vegetated islands or along dikes. The modal clutch size of AMAV is 4 eggs and incubation commences following laying of the penultimate egg (Cavitt 2004, 2005). Both sexes alternate incubation for 23 days. Young are precocial and remain in the nest for only 24 hr. after hatching. At nest-leaving, adults lead young to brooding/nursery sites which contain shallow water and dense vegetation for cover (Cavitt 2005).

**Figure 1.** American Avocet

BNSTs (Figure 2) are a loosely colonial shorebird that can be found breeding throughout western North America. Its black and white patterning and long reddish colored

**Figure 2.** Black-necked Stilt

legs readily distinguish this bird from any other (Figure 2). BNSTs are also a common summer resident within the GSL. Adults begin arriving in early April with first eggs laid in late April to early May. There is some overlap in nest site selection with AMAV, but BNST tend to select sites with slightly taller and denser vegetation. Both shallow emergent wetlands and vegetated mudflats are used frequently for nesting. Modal clutch size is 4 eggs and incubation commences following laying of the penultimate egg. Both sexes alternate incubation for 23 days. Young are precocial and remain in the nest for only 24 hr. after hatching. At nest-leaving, adults lead young to brooding/nursery sites, which contain shallow water and dense vegetation for cover (Cavitt 2005).

The SNPL (Figure 3) is a small shorebird found breeding along the Pacific and Gulf coasts and within the western interior of North America (Figure 3). This species is fairly cryptic in coloration as the pale brown upper parts and white under parts match the colors found on the beaches, sparsely vegetated mudflats and salt-evaporation ponds where this species commonly nests. Arrival in Utah begins in early April with first nests initiated in mid to late April

**Figure 3.** Snowy Plover

(Behle and Perry 1975, Paton 1995). The modal clutch size is 3 eggs, which are incubated for approximately 27 days. Both parents alternate incubation duties but females will often desert the brood shortly after hatching to begin another nest (Page et al. 1995). Following hatching, the young remain in the nest for only a few hours. The young are able to feed themselves after hatching but are brooded by parents for several days.

**Figure 4.** Long-billed Curlew

The LBCU is the largest North American shorebird, and yet it is perhaps one of the least studied (Figure 4). This species measures 500 – 600 mm in length but its most impressive feature is a very long decurved bill ranging 113-219 mm (Dugger and Dugger 2002). LBCU have a buffy brown to cinnamon body coloration and

the head is heavily streaked with dark brown to black. This species breeds within the western Great Plains, Great Basin and mountain valleys of the US and southwestern Canada (Dugger and Dugger 2002). The intermountain west is perhaps the most important area in North America for breeding populations (Brown et al. 2001). LBCUs generally nest in mixed-grass and short-grass communities. Breeding birds at GSL seem to arrive paired and are on territories by mid April. Nest construction begins within several days of pairing. Modal clutch size is 4 eggs. Both adults alternate incubation for approximately 27 days. Young leave the nest within a few hours of hatching but are brooded by parents for several days.

**Figure 5.** California Gull

The CAGU is a medium-sized white-headed gull with black and red spots on the lower mandible (Figure 5). This species measures approximately 540 mm in length. Breeding locations are scattered throughout the interior of North America and along the west coast. Birds often return to colony sites three to seven weeks before first eggs are laid. Information on pair formation is lacking and may occur during preceding wintering and migration periods, or immediately after arrival at colony site (Winkler 1996). Nest building usually occurs about a week before eggs are laid. Modal clutch size ranges from 2-3 eggs. Both adults alternate incubation for approximately 24 days. No quantitative information is available, but brooding behavior is rarely seen after chicks reach a few days in age. Chicks remain in the nest for first three days, crouching motionless if disturbed. After three days in age chicks will wander short distances from the nest (Winkler 1996).

**Figure 6.** Great Blue Heron

The GBHE is the largest North American heron, and one of the most adaptable wading birds on the continent (Figure 6). This species stands around 160 cm tall and ranges from 97 - 137 cm in length. GBHE most commonly nest colonially in trees but have been reported nesting singly and on the ground in areas isolated from predators including Islands (Butler 1992). Data is lacking on pair formation and arrival times to Utah. First eggs observed in Idaho are usually laid in the third week of March (Collazo 1981). Nests can be constructed in as little as 3 days or take as long as 2 weeks, new material is added continuously throughout the breeding season. Modal clutch size ranges from 3-4 eggs. Both adults alternate incubation for approximately 27 days. Young are brooded by both adults for 3 to 4 weeks. Brood reduction seems to be affected more by prey size than chick hunger. Nestlings fed mostly large prey items are reported to be less aggressive toward nest mates than those fed primarily small prey items (Butler 1992).

**Figure 7.** White-faced Ibis

The WFIB is a medium sized wading bird with long legs and a long decurved bill (Figure 7). This species measures 460 – 560 mm in length. The head, neck, upper back, wing coverts, and undersides are a dark chestnut-maroon with a metallic green and bronze sheen. WFIB breeds within the marshes of the western United States, and throughout the Great Basin (Ryder and Manry 1994). Within the Great Basin, WFIB are a "category 2 candidate" for listing as a Threatened or Endangered species by U. S. Fish and Wildlife Service. Birds arrive at GSL in early April, and begin forming pairs and selecting nest sites. Nest construction can be rapid, beginning as little as two days before the first egg is laid. Modal clutch size ranges from 3-4 eggs. Both adults alternate incubation for 21-22 days. Young are brooded by both adults for up to two weeks, and will remain in the nest for 10-12 days. Young in the nest are prone to disturbance and display variable responses based on age. Young less than 5 days old will try to hide in the nest, 5 – 8 days old young will scramble out of the nest, while young 10 days old will stand in a threatening position (Ryde and Manry 1994).

**Figure 8.** Franklin's Gull

The FRGU is a small, black hooded gull with a bold partial white eye-ring (Figure 8). This species measures 320 – 360 mm in length and has a pigeon-like appearance with rounded head and body, short tail, and buoyant flight (Burger and Gochfeld 1994). FRGU are found breeding in the interior of North America in colonies of various sizes. Colony sites typically change from year to year due to fluctuating water levels and or disturbance. This expression of low site fidelity is unusual for gulls (Burger and Gochfeld 1994). Drought and large-scale drainage projects over the years have threatened FRGU habitat, thus the large wetlands created by many protected wildlife refuges have become very important breeding sites for FRGU (Burger and Gochfeld 1994). Breeding birds arrive in mid-April with pairing taking place shortly after arrival, but before colony location. Nest building begins during territory establishment and requires continuous maintenance throughout the nesting cycle. Modal clutch size ranges from 2-3 eggs. Both adults alternate incubation for 23-26 days. Young can swim after 3 days and are brooded by both adults for approximately ten days. When disturbed chicks will crouch at the edge of nest or hide in vegetation close to the nest and remain motionless (Burger and Gochfeld 1994).


**Figure 9.** Northern Shoveler


**Figure 10.** Mallard

The NOSH is a medium-sized dabbling duck (Figure 9). All adult plumages are characterized by a large blue patch on the forewing. The blue patch is a muted blue-gray in female and juvenile NOSH; in adult males, it is bright light-blue with a marked strip at the trailing edge. When selecting a nest site, NOSH prefers short vegetation cover. Of 37 nests in Utah, 65% were found in saltgrass (*Distichlis spicata*; Williams and Marshall 1938). Pairs fly together in search of nest sites, but the female ultimately selects the nest site by probing and pecking at vegetation while they walk; the male is generally inactive (Poston 1974). The modal clutch size of NOSH is 8-12 eggs, and female does all incubation. Young are precocial and leave the nest shortly after hatching. The female leads her young from the nest to suitable brood-rearing habitat.

The MALL is the most familiar and widely distributed of the dabbling ducks (Figure 10). The adult breeding male has a conspicuous dark-green head, white neck ring, violet speculum and a characteristic black tail-curl. The female is drab compared to the male, with a buff-colored head and a darker eye-stripe. She has patterns of dark brown upper-wing coverts with buffy edges, grayish primaries, and a distinctive speculum of blue to violet edged in black and white. MALL usually nests on ground in upland areas near water. The nest is placed under overhanging cover or in dense vegetation for maximum concealment. Although usually an upland nester, MALL is more likely than other dabbling ducks to nest in wetlands or over water. Cover vegetation at overwater and wetland nest sites includes reedgrass, bulrush, cat-tail, slough sedge and grass (Krapu et al. 1979b). The modal clutch size for MALL is 10-12 eggs. The average incubation period is 28 days, and incubation is performed by the female only. Young are precocial and gradually become more mobile and steady within 24 h of hatching (Bjarvall 1968). Young usually depart the nest on the morning after hatching.


**Figure 11.** Gadwall

The GADW is another medium sized dabbling duck that can be found frequently at the wetlands of the Great Salt Lake (Figure 11). The breeding male GADW has a mottled grey plumage, black rump and undertail coverts, and

white speculum. The female is mottled brown and also has a white speculum. The GADW nests in fields and meadows, and on islands and dikes in marshes. Nest site selection depends on location (i.e., island versus mainland), availability, density and height of vegetation, and water conditions (e.g., drought). Nests are typically founds in dense brush, forbs, and/or grasses in dry areas. The modal clutch size for GADW is 8-12 eggs. Incubation last about 26 days, and is performed by the female only. Young are precocial and depart the nest 24-36 h after hatching. The female leads the young from nest to brood-rearing habitat, where ducklings feed on a diet of invertebrates.


**Figure 12.** Cinnamon Teal

The CITE is a small dabbling duck, and is one of the least numerous ducks in North America (Figure 12). The breeding male is a dark chestnut color with a red eye and dark bill. The female is similar to other female ducks (cryptically colored) mostly brown and buff. Both male and female have bright blue upper wing coverts. CITE uses freshwater (including highly alkaline) wetlands of various sizes, including large marsh systems, natural basins, reservoirs, sluggish streams, ditches, and stock ponds. CITE prefers to nest near water in low, dense perennial vegetation such as Baltic rush, saltgrass, western wheatgrass, and various forbs; however, when upland cover is lacking or degraded, CITE will nest adjacent to or over water in dense bulrushes, cattails, and sedges (Williams and Marshall 1938). The modal clutch size for CITE is 8-12 eggs. Incubation lasts 21-25 days, and is performed by the female only. Young are precocial, and highly mobile. They leave the nest within 24 h of hatching where they follow the female to the nearest source o f water.

## General Procedures

Each study site utilized for breeding productivity consists of replicated plots that were visited every three to four days from late April until early August 2009.

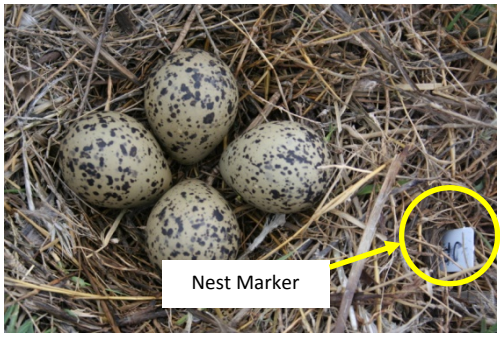


**Figure 13.** Shorebird nest showing marking technique

## Productivity

### Shorebirds

Nests were located by either systematic searches of potential nesting sites or by observing the behavior of adults. Systematic searches for LBCU nests utilized two ATVs dragging a 25 meter section of 2.5 centimeter diameter rope. We recorded the location of each nest with a Magellan Explorist 100 Global Positioning System (GPS) unit. To facilitate relocating nests in dense colonies, each nest was marked with a 10cm wooden tag, placed in the ground at the edge of the nest so only the top 3-4cm was visible (Figure 13). A unique nest identification number was written on each tag with permanent marker.

Because shorebirds lay only 1 egg/day, the laying date of the first eggs (clutch initiation date) was determined by back dating when nests were found prior to clutch completion.

Clutch size was only assigned for a nesting attempt when the same number of eggs was recorded on two consecutive visits and there was evidence that incubation had commenced (i.e. adult behavior and egg temperature). Clutch initiation dates were also estimated for nests located after clutch completion and in which young successfully hatched. The incubation stages of nests found with complete clutches were estimated by egg floatation, which allowed for the prediction of hatching date. The status of extant nests was determined by visitations every three to four days until either eggs hatched or the nest failed.

Nests were defined as successful if at least one young hatched and survived to nest leaving. Nests were presumed successful if eggs disappeared near the expected date of hatching and there was evidence of a successful hatching. This evidence included the presence of young, the presence of eggshell tops and bottoms near the nest, egg shell fragments ~1-5 mm in size and detached egg membrane within the nest lining (Mabee 1997, Mabee et al. 2006). A failed nest was classified as depredated if all eggs disappeared prior to the expected date of nest-leaving and there was no basis for weather or flood induced mortality. Further evidence of egg depredation included eggshell pieces in the nest (>5 mm in size), and yolk within the nest material.

For each nest we recorded the following information – date of clutch initiation (i.e. nest initiation), maximum number of eggs, clutch size, date of hatching, number of eggs hatched, number of young produced and nest fate. From this data we were able to calculate hatchability, daily nest survival rate and nesting success. Hatchability of eggs is defined as the proportion of eggs present at hatching time that produce young (Koenig 1982). Consequently, eggs taken by nest predators or those flooded are not included in the calculation.

## Colonial Waterbirds

### CAGU AND GBHE

An island colony of CAGU was located during a survey of the 5B unit in 2008. Another colony nesting along the west dike of Unit 4C (Figure 14) was located in 2009. A small number of GBHE nests were also monitored along this dike (Figure 14). The nests found within the colony located in 5B, and the colony located along the west dike of Unit 4C were monitored during 2010. In order to minimize disturbance to these colonies, 10 cm wooden tags were labeled with unique nest identification numbers prior to entering the colonies. To facilitate relocating nests, the pre-labeled tags were placed in the ground as described above. In an attempt to minimize the time spent in the colonies, UTM's of nests were not recorded and visitations were only made once per week. Nests were visited until the young were mobile and left the nest or the nest failed. Nest fates and measures of productivity for each nest were determined following the procedures described above.

Only nestlings in the 4C colony were captured by hand and banded. Each nestling was banded with a numbered aluminum U.S. Fish and Wildlife Service leg band.


**Figure 14.** Gull Colony along dike of unit 4C

### WFIB and FRGU

A colony of WFIB and FRGU was monitored within unit 1C and Unit 3K (Figure 15) in accordance to the procedure established in 2008. Ten transects (oriented in a north-south direction) were established 100 m apart. In an attempt to minimize disturbance, nest monitoring began only after incubation had commenced in the colony.

Only nests located within 1 m of transects were monitored. We recorded the location of each nest as outlined above. To facilitate relocating nests along transects the 10 cm wooden tags were placed on the east side of the nest. Visitations were made every seven days to determine the status of extant nests. Nests were visited until young successfully left the nest or the nest failed. Nest fates and measures of productivity for each nest were determined following the procedures described above.

## Analyses

We examined nesting success by estimating daily survival rates (DSR) and their associated standard errors according to Mayfield's (1961, 1975) method as modified by Johnson (1979) and Hensler and Nichols (1986).

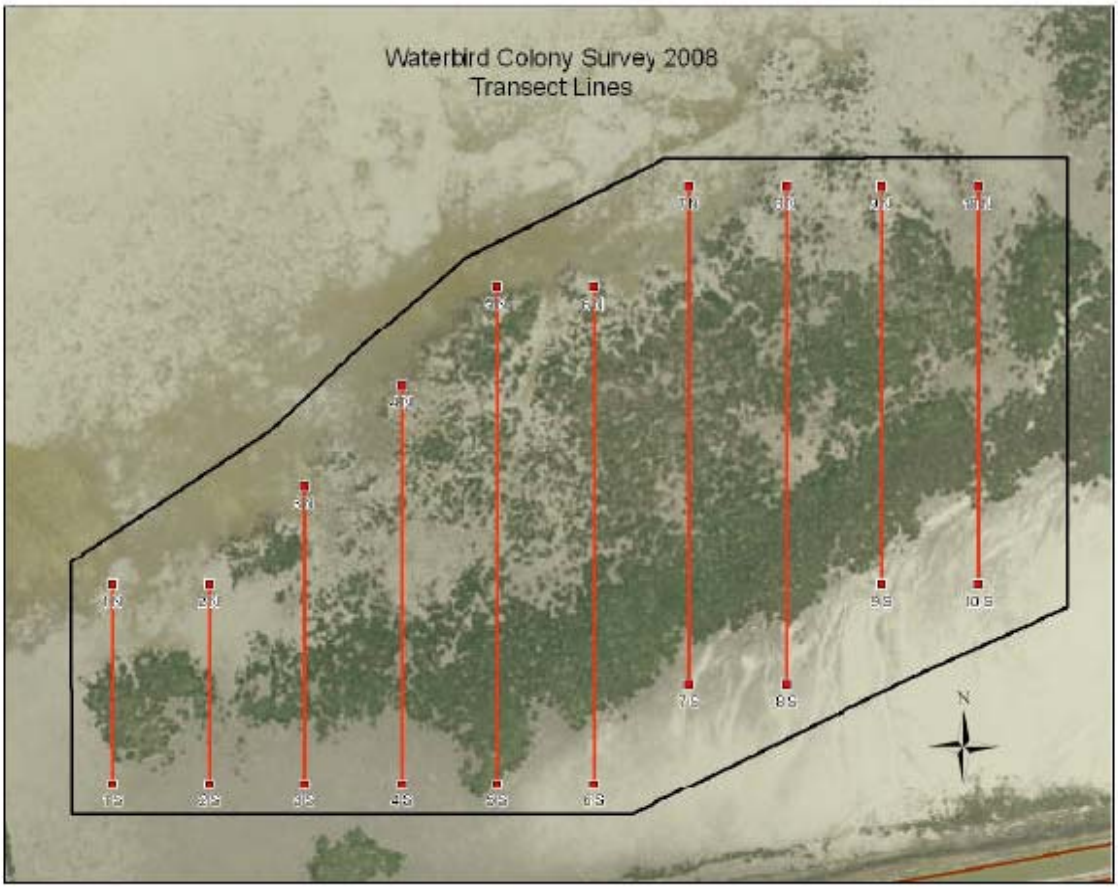


**Figure 15.** White-faced Ibis and Franklin's gull colony transects

# Results and Discussion

## Nesting Chronology

### Shorebirds

#### AMAV and BNST

A total of 510 AMAV, and 5 BNST nests were located and monitored at BEAR during the 2010 breeding season. The first AMAV nest monitored for this project was initiated on April 5, whereas the first BNST nest monitored was initiated on April 24. During the 2010 breeding season the average date of nest initiation was May 1 for AMAV and May 4 for BNST. The last young left AMAV nests on June 30 and BNST left on June 15.

#### LBCU

A total of 2 LBCU nests were located at BEAR. The first LBCU nest monitored for this study was initiated on April 15. Other nests monitored were initiated between April 18 and May 10. The last young left LBCU nest on June 5.

#### SNPL and KILL

A total of 20 SNPL nests and 6 KILL nests were located and monitored at BEAR. The first nest monitored for this study was initiated on April 29 for both SNPL and KILL. During the 2010 breeding season, the average date of nest initiation was June 6 for SNPL and May 19 for KILL. The last SNPL young left its nest on July 31, and the last KILL young left on July 1.

### Colonial Waterbirds

#### CAGU and GBHE

A total of 54 CAGU, and 13 GBHE nests were located and monitored between Unit 1C and Unit 3K. The first CAGU nest monitored for this study was initiated on April 18, and the first GBHE nest monitored was initiated on April 22. The average date of nest initiation for both the CAGU and GBHE was May 5. The last young left the GBHE nests on June 9 and CAGU nests on June 12.

#### WFIB and FRGU

A total of 130 WFIB, 59 FRGU, 20 BCNH, and 1 SNEG nests were located and monitored in Unit 1C and Unit 3K at BEAR during the 2010 breeding season. The first visit to Unit 3K took place on June 4 and the first visit to Unit 1C took place on June 11. Nest monitoring methods did not allow for us to calculate nest initiation dates for these four species. The last WFIB young, FRGU young, and BCNH young left its nest on July 7. The last SNEG young left its nest on July 3.

### Waterfowl

A total of 3 NOSH nests were located and monitored at BEAR during the 2010 breeding season. The first NOSH nest monitored for this project was initiated on June 2. During the 2010 breeding season the average date of nest initiation was June 2. The last NOSH young left its nest on July 5.

Six MALL nests were located and monitored at BEAR during the 2010 breeding season. The first MALL nest monitored for this project was initiated on April 18. During the 2010 breeding season, the average date of nest initiation was April 28. The last MALL young left its nest on June 19.

A total of 14 GADW nests were located and monitored at BEAR during the 2010 breeding season. The first GADW nest monitored for this project was initiated on April 15. During the 2010 breeding season, the average date of nest initiation was May 12. The last GADW young left its nest on July 1.

A total of 25 CITE nests were located and monitored at BEAR during the 2010 breeding season. The first CITE nest monitored for this

project was initiated on April 25. During the 2010 breeding season, the average date of nest initiation was May 21. The last CITE young left its nest on July 8.

A total of 4 LCGO nests were located and monitored at BEAR during the 2010 breeding season. The first LCGO nest monitored for this project was initiated on March 30. During the 2010 breeding season, the average date of nest initiation was April 9. The last LCGO young left its nest on June 1.

# Productivity

## Shorebirds

### AMAV and BNST

The modal clutch size for both AMAV and BNST nests was 4 eggs. Measures of productivity are listed in Table 1 by species. Only 10% of all AMAV produced young to nest-leaving whereas 60% of all BNST eggs did. The most important cause of nest failure for AMAV was predation resulting in 67% of all nests monitored failing (see Figure 16).

The hatchability rate for AMAV was 0.93 and 1.00 for BNST. Hatchability is an important indicator of potential contamination. On average, the hatchability for uncontaminated populations of aquatic birds has been suggested to be above 0.91 (range from 0.906-0.938; Jehl 1971, Koenig 1982, and Ohlendorf et al. 1989).

The DSR for all AMAV and BNST nests are found in Table 2. The majority of AMAV and BNST nests monitored for this study were located on the 3E islands. The Mayfield nesting success estimate for AMAV in 2010 is much lower than previous years. For BNST, the Mayfield nesting success estimate in 2010 has remained similar to 2009's estimate (Figure 17). Predation was very high on the 3E islands. Raccoons were observed near these areas on several occasions and refuge personnel were notified. Unfortunately control measures were not successful in reducing predation at this site.

### LBCU

The modal clutch size was 4 for LBCU. Measures of productivity for LBCU are listed in Table 1. Due to the limited sample size for LBCU, measures of productivity listed in Table 1 may not be an accurate depiction for this species. Of the 8 eggs laid at BEAR in 2010, 8 hatched. All nests found at BEAR during the 2010 breeding season were successful. The DSR for all LBCU nests is found in Table 2.

### SNPL and KILL

The modal clutch size was 3 for SNPL and 4 for KILL. Measures of productivity are listed in Table 1. In 2010, 77% of the SNPL eggs laid produced young to nest-leaving, while 44% of the KILL eggs laid produced young to nest-leaving. The DSR for all SNPL and KILL nests is found in Table 2. SNPL productivity at Bear was very high this year in comparison to other sites monitored (Table 3). All SNPL and Killdeer nests were located on dikes, which suggests that predators have been effectively controlled within these areas.

**Table 1. Measures of shorebird productivity at BEAR during 2010. Mean clutch size, hatchability and number young produced to nest leaving (± standard error) for successful nests.**

| Year | Species | Total Eggs Laid (total nests) | Clutch Size (n) | Hatchability (n) | Total Young Produced (average # eggs hatched/nest) | # Young Leaving/Successful Nest (n) |
|---|---|---|---|---|---|---|
| 2010 | AMAV | 1483 (510) | 3.65 ± 1.05 (218) | 0.93 ± 0.22 (38) | 145 (0.28) | 3.15 ± 0.20 (46) |
| | BNST | 20 (5) | 4.00 ± 0 (5) | 1.00 (3) | 12 (2.40) | 4.00 ± 0 (3) |
| | LBCU | 8 (2) | 4.00 ± 0 (2) | 1.00 (2) | 8 (4) | 4.00 ± 0 (2) |
| | SNPL | 56 (20) | 2.80 ± 0 .11 (20) | 0.97 ± 0.02 (15) | 43 (2.15) | 2.90 ± 0.09 (15) |
| | KILL | 18 (6) | 4.00 ± 0 (1) | 1.00 (2) | 8 (1.33) | 4.00 ± 0 (2) |

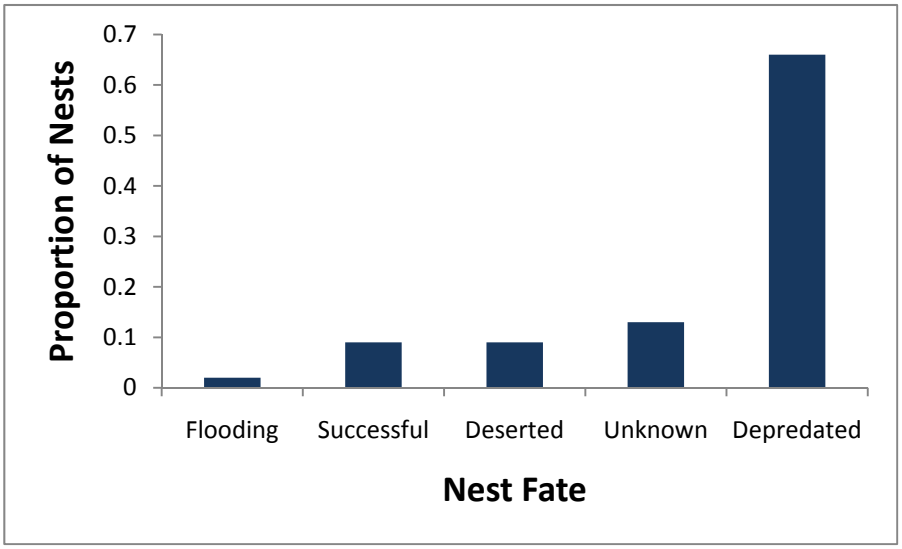


**Figure 16. Proportion of AMAV nests at BEAR in 2010 and associated nest fates.**

**Table 2. Nest daily survival rate (DSR ± standard error) of AMAV, BNST, LBCU, SNPL, and KILL for the 2010 breeding season. Mayfield estimates and apparent nesting success are located below each DSR.**

| | AMAV (n) | BNST (n) | LBCU (n) | SNPL (n) | KILL (n) |
|---|---|---|---|---|---|
| DSR | 0.92 ± 0.004 (484) | 0.98 ± 0.013 (5) | 1.00 ± 0 (2) | 0.99 ± 7.67 (20) | 0.89 ± 0.06 (5) |
| Mayfield | 0.10 (484) | 0.61 (5) | 1 (2) | 0.73 (20) | 0.03 (5) |
| Apparent | 0.09 (510) | 0.60 (5) | 1 (2) | 0.75 (20) | 0.33 (6) |

**Table 3. Measures of Snowy Plover breeding productivity at each study site (sample size utilized are given within parentheses). See text for site abbreviations.**

| Breeding Variable | Site | | |
|---|---|---|---|
| | BEAR | SALT | SHOR |
| Total Nests Monitored | 20 | 24 | 65 |
| Julian Day of 1st Nest Initiation | 119 (April 29, 2010) | 121 (May 1, 2010) | 117 (April 27, 2010) |
| Julian Day of Last Successful Nest Leaving | 212 (July 31, 2010) | 226 (August 14, 2010) | 223 (August 11, 2010) |
| Total Eggs Laid | 55 | 65 | 182 |
| Mean Clutch Size (± SE) | 2.94 ± 0.06 (18) | 2.78 ± 0.09 (23) | 2.86 ± .05 (63) |
| Mean Hatchability (± SE) | 0.98 ± 0.02 (15) | 0.97 ± 0.03 (11) | 0.93 ± 0.03 (36) |
| Mean # Young Produced / Successful Nest (± SE) | 2.87 ± 0.09 (15) | 2.73 ± 0.14 (11) | 2.61 ± 0.10 (36) |
| Total Young Produced | 43 | 30 | 94 |
| Mayfield Estimate of Nesting Success | 0.62 | 0.34 | 0.36 |
| Apparent Nesting Success | 0.75 | 0.46 | 0.57 |

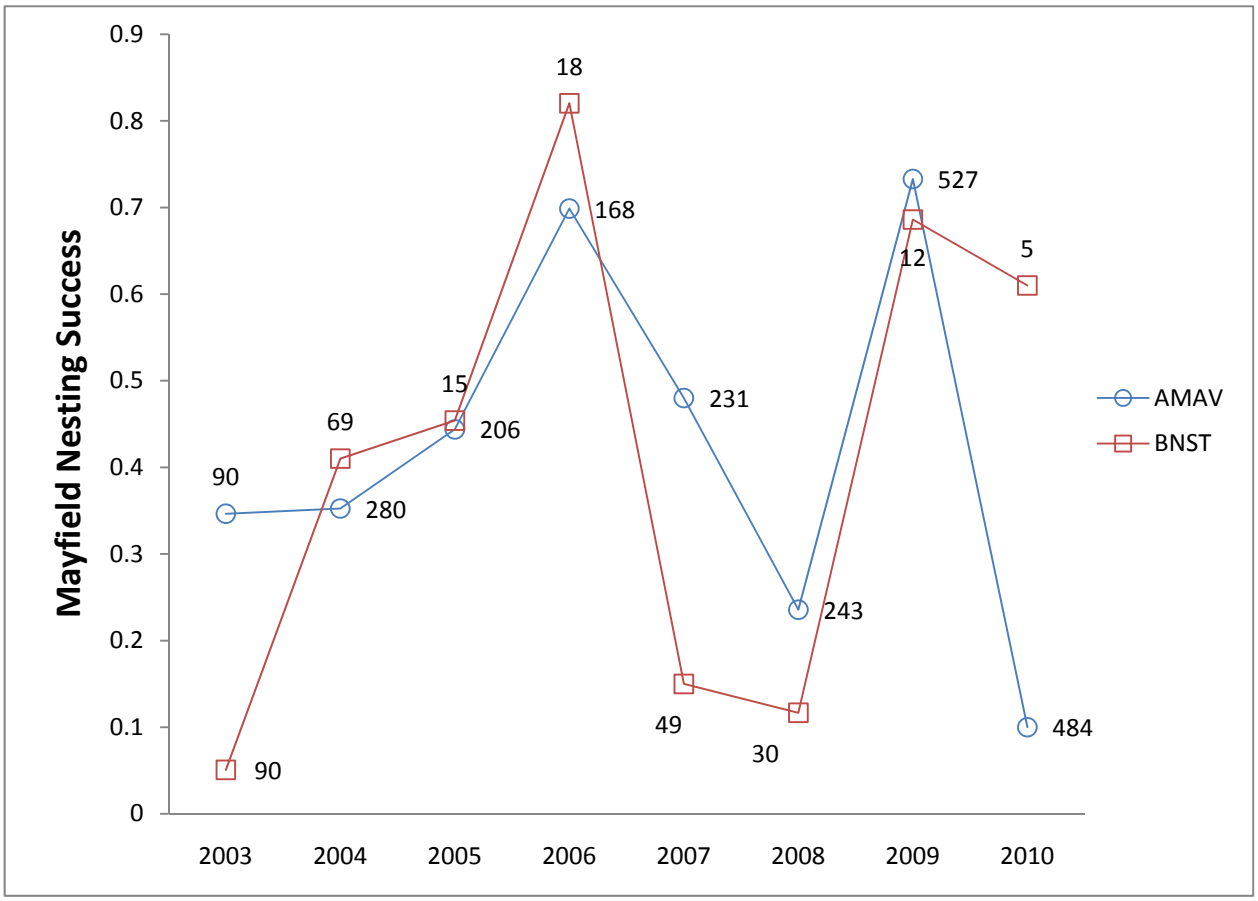


**Figure 17.** Nesting success at BRMBR across years.

## Colonial Waterbirds

### CAGU and GBHE

The modal clutch size was 2 for CAGU. Measures of productivity for the two CAGU colonies combined are listed in Table 4. In 2010, 50% of all CAGU eggs laid in selected nests within colonies produced young to nest-leaving. The DSR for all CAGU for 2010 is found in Table 5.

### WFIB and FRGU

The modal clutch size was 3 for WFIB and FRGU. Measures of productivity for this colony are listed in Table 4 by species. In 2010, 60% of the eggs from selected WFIB nests along transects produced young to nest-leaving. Capen (1978) reports WFIB nesting success as 55.8% for six colonies on the Bear River Club marsh in 1973 and 1974. Our estimate of apparent nesting success is very similar at 62%. For FRGU, only 15% of the eggs from selected nests along transects produced young to nest-leaving. The DSR for all WFIB and FRGU nests are found in Table 5. It is unclear why FRGU within WFIB colonies would have lower success. This is currently under review and will be a focus during the 2011 nesting season.

### BCNH, GBHE, and SNEG

The modal clutch size for BCNH and SNEG was 4. The modal clutch size for GBHE was 3. Measures of productivity are listed in Table 4 by species. In 2010, 34% percent of all BCNH eggs laid within the colony produced young to nest-

leaving. Fifty-four percent of all GBHE eggs laid within the colony produced young to nest-leaving. Due to the limited sample size for SNEG, measures of productivity listed in Table 4 may not be an accurate depiction for this species. The DSR for all BCNH, GBHE, and SNEG nests is found in Table 5.

**Table 4. Measures of Colonial Waterbird productivity at BEAR during 2010. Mean clutch size, hatchability and number young produced to nest leaving (± standard error) for successful nests.**

| Year | Species | Total Eggs Laid (total nests) | Clutch Size (n) | Hatchability (n) | Total Young Produced (average # eggs hatched/nest) | # Young Leaving/Successful Nest (n) |
|---|---|---|---|---|---|---|
| 2010 | CAGU | 120 (54) | 2.15 ± 0.19 (13) | 0.93 ± 0.19 (23) | 60 (1.11) | 2.22 ± 0.14 (28) |
| | GBHE | 46 (13) | 3.00 ± 0 (4) | 0.89 ± 0.05 (9) | 25 (1.92) | 2.78 ± 0.28 (9) |
| | WFIB | 430 (130) | 3.34 ± 0.11 (20) | 0.87 ± 0.03 (15) | 258 (1.98) | 3.35 ± 0.12 (80) |
| | FRGU | 135 (59) | 2.50 ± 0.12 (18) | 0.92 ± 0.26 (13) | 21 (0.36) | 2.69 ± 0 (13) |
| | BCNH | 67 (20) | 3.20 ± 0.20 (5) | 0.90 ± 0.77 (7) | 23 (1.15) | 2.50 ± 0.50 (2) |
| | SNEG | 5 (1) | 5.00 ± 0 (1) | 1.00 ± 0 (1) | 5 (5) | 5.00 ± 0 (1) |

**Table 5. Nest daily survival rate (DSR ± standard error) of CAGU, GBHE, WFIB, FRGU, and BCNH for the 2010 breeding season. Mayfield estimates and apparent nesting success are located below each DSR.**

| | CAGU | GBHE | WFIB | FRGU | BCNH |
|---|---|---|---|---|---|
| DSR | 0.99 ± 0.003 (31) | 0.98 ± 2.97 (11) | 0.97 ± 1.56 (101) | 0.95 ± 9.00 (21) | 0.96 ± 3.91 (10) |
| Mayfield | 0.84 (31) | 0.53 (11) | 0.51 (101) | 0.25 (21) | 0.31 (10) |
| Apparent | 0.52 (54) | 0.69 (13) | 0.62 (130) | 0.22 (59) | 0.10 (20) |

## Waterfowl

The modal clutch size was 9 for NOSH. Measures of productivity are listed in Table 6 by species. Due to the limited sample size for NOSH, measures of productivity listed in Table 6 may not be an accurate depiction for this species. The DSR for NOSH nests is found in Table 7.

The modal clutch size was 13 for MALL. Measures of productivity are listed in Table 6 by species. In 2010, 64% of MALL eggs laid produced young to nest-leaving. The DSR for MALL nests is found in Table 7.

The modal clutch size was 9 for GADW. Measures of productivity are listed in Table 6 by species. In 2010, 30% of GADW eggs laid

produced young to nest-leaving. The DSR for GADW nests is found in Table 7.

The modal clutch size was 9 for CITE. Measures of productivity are listed in Table 6 by species. In 2010, 38% of CITE eggs laid produced young to nest-leaving. The DSR for CITE nests is found in Table 7.

The modal clutch size was 7 for LCGO. Measures of productivity are listed in Table 6 by species. Due to the limited sample size for LCGO, measures of productivity listed in Table 6 may not be an accurate depiction for this species. The DSR for LCGO nests is found in Table 7.

**Table 6. Measures of waterfowl productivity at BEAR during 2010. Mean clutch size, hatchability and number young produced to nest leaving (± standard error) for successful nests.**

| Year | Species | Total Eggs Laid (total nests) | Clutch Size (n) | Hatchability (n) | Total Young Produced (average # eggs hatched/nest) | # Young Leaving/Successful Nest (n) |
|---|---|---|---|---|---|---|
| 2010 | NOSH | 24 (3) | 9.00 ± 0 (2) | 0.75 ± 0 (1) | 6 (2.00) | 6.00 ± 0 (1) |
| | MALL | 66 (6) | 12.80 ± 0 (5) | 0.85 ± 0.14 (4) | 42 (7.00) | 10.50 ± 2.5 (4) |
| | GADW | 109 (14) | 8.25 ± 0.47 (4) | 0.96 ± 0.04 (3) | 33 (2.36) | 8.25 ± 0.48 (4) |
| | CITE | 188 (25) | 10.25 ± 0.55 (12) | 0.85 ± 0.06 (8) | 72 (2.88) | 9.00 ± 0.88 (8) |
| | LCGO | 23 (4) | 7.00 ± 0 (1) | 0.85 ± 0.14 (2) | 17 (4.25) | 5.66 ± 0.33 (3) |

**Table 7. Nest daily survival rate (DSR ± standard error) of NOSH, MALL, GADW, CITE, and LCGO for the 2010 breeding season. Mayfield estimates and apparent nesting success are located below each DSR.**

| | NOSH | MALL | GADW | CITE | LCGO |
|---|---|---|---|---|---|
| DSR | 0.95 ± 0.03 (3) | 0.98 ± 9.75 (6) | 0.95 ± 0.02 (12) | 0.99 ± 1.05 (25) | 0.98 ± 0.02 (4) |
| Mayfield | 0.31 (3) | 0.53 (6) | 0.28 (12) | 0.69 (25) | 0.53 (4) |
| Apparent | 0.33 (3) | 0.66 (6) | 0.29 (14) | 0.32 (25) | 0.75 (4) |

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