

2009

Breeding Productivity of Shorebirds and Colonial Waterbirds at Bear River Migratory Bird Refuge, Utah 2009 Annual Report



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12/31/2009

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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.

For the past seven years the Avian Ecology Laboratory has monitored the breeding productivity of shorebirds at the Bear River Migratory Bird Refuge. This information is critical for estimating population health and predicting the vulnerability of species to habitat alteration. This information is also important for assessing the effects of land management activities, including predator removal programs.

Objectives

This project monitored the breeding productivity of American Avocet, Black-necked Stilt, Snowy Plover, Long-billed Curlew (*Numenius americanus*), White-faced Ibis, Franklin's Gull (*Larus pipixcan*), California Gull, and Great Blue Heron (*Ardea herodias*) 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 – July 26, 2009. 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 (AMAV), Black-necked Stilt (BNST), Snowy Plover (SNPL) and Long-billed Curlew (LBCU). In addition, this study examined productivity of four colonial waterbird species, White-faced Ibis (WFIB), Franklin's Gull (FRGU), California Gull (CAGU), and Great Blue Heron (GBHE). A small number of Black-crowned Night-Heron (*Nycticorax nycticorax*, BCNH), and Snowy Egret (*Egretta thula*, SNEG) nests were also monitored as they were encountered within the WFIB colony.

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. 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).

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

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.



The WFIB is a medium sized wading bird with long legs and a long decurved bill (Figure 5). 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 (Ryder and Manry 1994).



The FRGU is a small, black hooded gull with a bold partial white eye-ring (Figure 6). 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).



The CAGU is a medium-sized white-headed gull with black and red spots on the lower mandible (Figure 7). 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).



The GBHE is the largest North American heron, and one of the most adaptable wading birds on the continent (Figure 8). 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).



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.

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 9). 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 was found and monitored during 2009. Surprisingly a small number of GBHE nests were also monitored along this dike (Figure 10). 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.



WFIB and FRGU

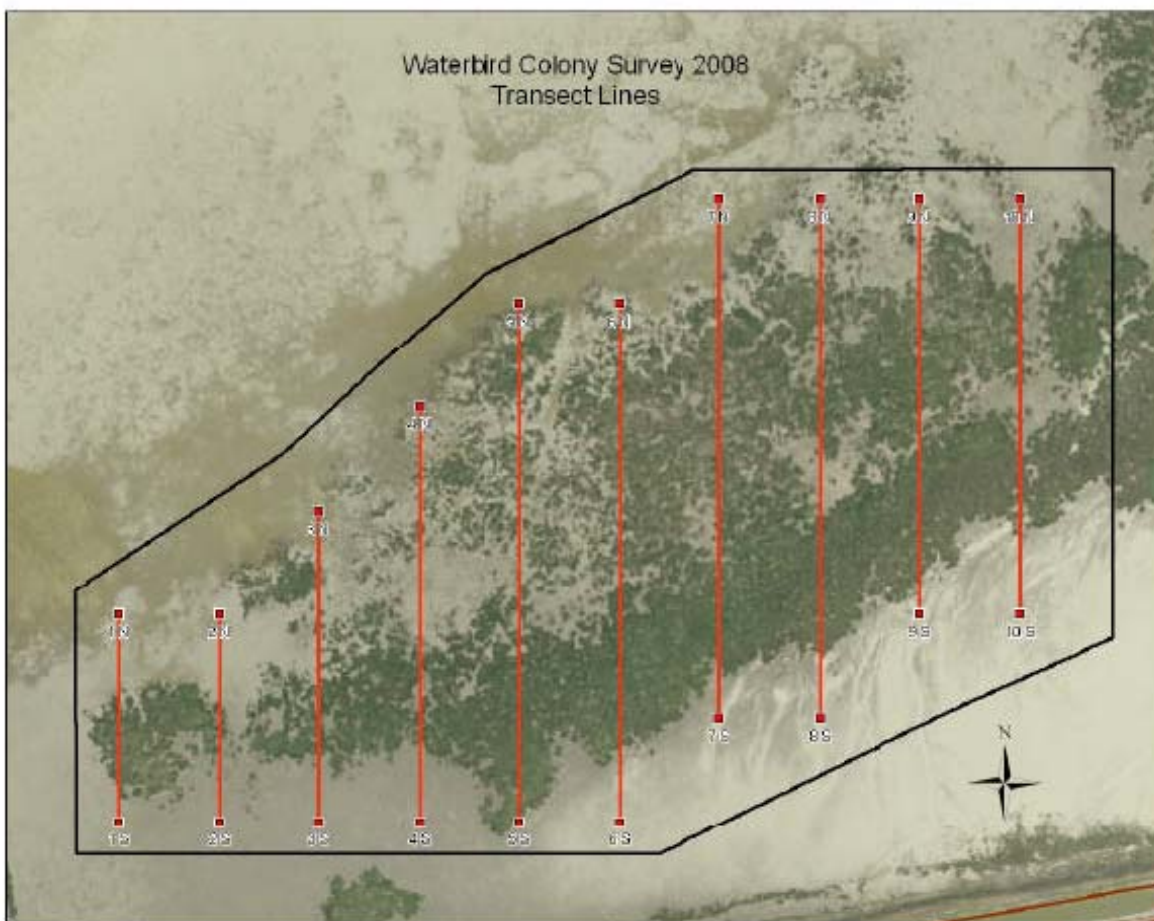
A colony of WFIB and FRGU was monitored within unit 1C in accordance to the procedure established in 2008. Ten transects (oriented in a north-south direction) were established 100 m apart. In an attempt to minimize disturbance, nest monitoring began only after incubation had commenced in the colony.

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).



Results and Discussion

Nesting Chronology

Shorebirds

AMAV and BNST

A total of 583 AMAV, and 13 BNST nests were located and monitored at BEAR during the 2009 breeding season. The first AMAV nest monitored for this project was initiated on April 20, whereas the first BNST nest monitored was initiated on May 26. During the 2009 breeding season the average date of nest initiation was May 5 for AMAV and June 3 for BNST. The last young left AMAV nests July 3 and BNST left on July 14.

LBCU

A total of 11 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 10.

SNPL

A total of 15 SNPL nests were located at BEAR. The first SNPL nests monitored for this study was initiated on June 6. During the 2009 breeding season the average date of nest initiation was June 17 for SNPL. The last SNPL young left its nest on July 22.

Colonial Waterbirds

CAGU and GBHE

A total of 141 CAGU, and 11 GBHE nests were located and monitored between the two plots described above. The initial visit to the colonies took place on May 20. Because several nests already had young during this visit, we did not calculate nest initiation dates for either CAGU

or GBHE. The last young left both CAGU and GBHE nest on July 3.

WFIB and FRGU

A total of 189 WFIB, 48 FRGU, 2 BCNH, and 2 SNEG nests were located and monitored in Unit 1C at BEAR during the 2009 breeding season. The first visit to the WFIB and FRGU colony took place on May 26. Nest monitoring methods did not allow for us to calculate nest initiation dates for these four species. The last WFIB young left its nest on July 22 and the last FRGU young left on July 11. The last BCNH young left its nest on May 26 and the last SNEG young left its nest on May 29.

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. Seventy percent of all AMAV and BNST eggs laid produced young to nest leaving. This is nearly triple the values for 2008 which were thirty percent for AMAV and twenty-five percent for BNST.

The hatchability rate for both AMAV and BNST at BEAR are 0.94. The DSR for all AMAV and BNST nests are found in Table 2. Management units differed in DSR during the 2009 breeding season. AMAV nests located on the 3E islands as well as BNST nests in Unit 8 had the highest DSR for 2009. AMAV nests located in Unit 8 had the lowest DSR. Table 3 lists the DSR and nesting success estimates for each management unit. The Mayfield nesting success estimate for both AMAV and BNST seems to have recovered from the last few years (Figure 12).

Table 1. Measures of shorebird productivity at BEAR during 2009. Mean clutch size, hatchability and number of young produced to nest leaving (\pm standard error) for successful nests.

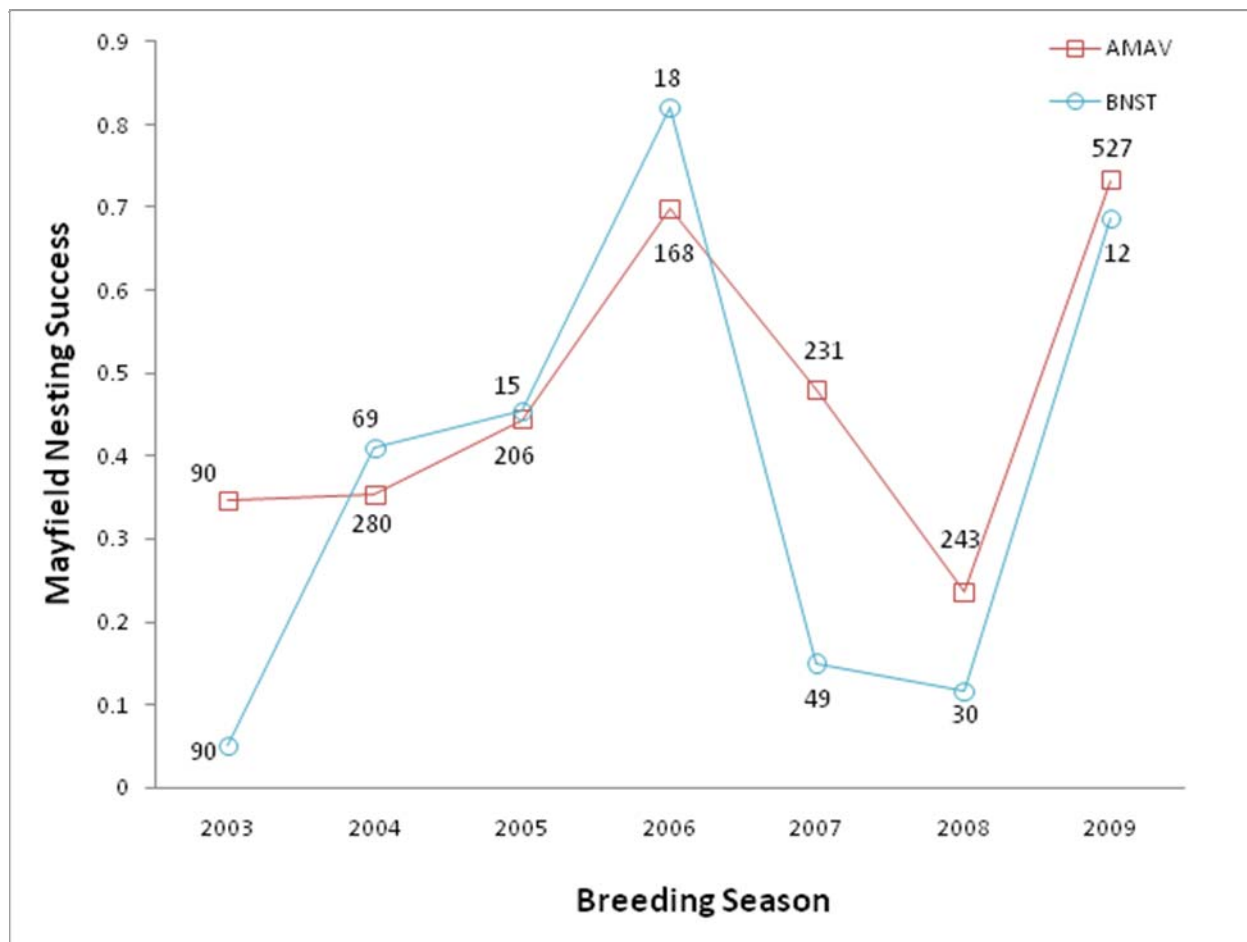
Year	Species	Total Eggs Laid (total nests)	Clutch Size (n)	Hatchability (n)	Total Young Produced (average # eggs hatched/nest)	# Young Leaving/Successful Nest (n)
2009	AMAV	2247 (583)	3.9 \pm 0.55 (439)	0.94 \pm 0.13 (392)	1605 (2.75)	3.66 \pm 0.76 (439)
	BNST	47 (13)	3.9 \pm 0.32 (10)	0.94 \pm 0.11 (9)	33 (2.54)	3.67 \pm 0.5 (9)
	LBCU	42 (11)	3.91 \pm 0.3 (11)	0.98 \pm 0.07 (11)	42 (3.82)	3.82 \pm 0.4 (11)
	SNPL	45 (15)	3 \pm 0 (13)	0.94 \pm 0.14 (6)	20 (1.33)	2.86 \pm 0.38 (7)

Table 2. Nest daily survival rate (DSR \pm standard error) of AMAV, BNST, LBCU, and SNPL for the 2009 breeding season. Mayfield estimates and apparent nesting success are located below each DSR.

	AMAV (n)	BNST (n)	LBCU (n)	SNPL (n)
DSR	0.99 \pm 0.001 (527)	0.99 \pm 0.008 (12)	1 \pm 0 (11)	0.96 \pm 0.016 (14)
Mayfield	0.73 (527)	0.69 (12)	1 (11)	0.28 (14)
Apparent	0.75 (583)	0.69 (13)	1 (11)	0.47 (15)

Table 3. Daily survival (\pm standard error) and nesting success by management unit for 2009.

Plot		AMAV	BNST	LBCU
3E Islands	DSR	0.99 \pm 0.0009	-	-
	Mayfield	0.84	-	-
	Apparent	0.81	-	-
	# of Nests	462	-	-
Unit 8	DSR	0.94 \pm 0.008	0.99 \pm 0.008	-
	Mayfield	0.20	0.69	-
	Apparent	0.33	0.69	-
	# of Nests	65	12	-
Unit 5A	DSR	-	-	1 \pm 0
	Mayfield	-	-	1
	Apparent	-	-	1
	# of Nests	-	-	11



LBCU

The modal clutch size was 4 for LBCU. Measures of productivity for LBCU are listed in Table 1. Of the 43 eggs laid at BEAR in 2009 42 hatched. All nests found at BEAR during the 2009 breeding season were successful. DSR for all LBCU nests is found in Table 2.

SNPL

The modal clutch size was 3 for SNPL. Measures of productivity are listed in Table 1. In 2009, 44% of the SNPL eggs laid produced young to nest-leaving. DSR for all SNPL nests is found in Table 2.

Colonial Waterbirds CAGU and GBHE

The modal clutch size was 2 for CAGU and 3 for GBHE. Measures of productivity for the two CAGU colonies combined and those for GBHE are listed in Table 4 by species. In 2009, 89% of all CAGU eggs laid in selected nests within colonies produced young to nest-leaving. Sixty percent of all GBHE eggs laid within the colony produced young to nest-leaving. The DSR for all CAGU and GBHE nests for 2009 is found in Table 5.

WFIB and FRGU

The modal clutch size was 3 for WFIB and FRGU. The modal clutch size for BCNH and SNEG was 4. Measures of productivity for this colony are listed in Table 4 by species. Due to the limited sample size for BCNH and SNEG, measures of productivity listed in Table 4 may not be an accurate depiction for these species within the colony. In 2009 only fifty percent 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 52%. For FRGU 34% 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.

Table 4. Measures of colonial waterbird productivity at BEAR during 2009. Mean clutch size, hatchability and number young produced to nest leaving (\pm 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)
2009	CAGU	249 (141)	2.46 \pm 0.72 (24)	0.98 \pm 0.1 (24)	222 (1.57)	2.29 \pm 0.8 (97)
	GBHE	28 (11)	3.33 \pm 0.58 (3)	0.8 \pm 0.17 (3)	17 (1.54)	2.43 \pm 1.13 (7)
	WFIB	564 (189)	3.02 \pm 0.66 (166)	0.99 \pm 0.04 (90)	286 (1.51)	2.92 \pm 0.65 (98)
	FRGU	123 (48)	2.59 \pm 0.61 (32)	1 \pm 0 (4)	43 (0.89)	2.53 \pm 0.8 (17)
	BCNH	7 (2)	3 \pm 0 (1)	-	3 (1.5)	3 \pm 0 (1)
	SNEG	8 (2)	4 \pm 0 (2)	1 \pm 0 (2)	8 (4)	4 \pm 0 (2)

Table 5. Nest daily survival rate (DSR \pm standard error) of CAGU, GBHE, WFIB, and FRGU for the 2009 breeding season. Mayfield estimates and apparent nesting success are located below each DSR.

	CAGU	GBHE	WFIB	FRGU
DSR	0.99 \pm 0.002 (103)	0.97 \pm 0.012 (11)	0.99 \pm 0.0008 (101)	0.97 \pm 0.01 (21)
Mayfield	0.88 (103)	0.46 (11)	0.96 (101)	0.49 (21)
Apparent	0.69 (141)	0.63 (11)	0.52 (189)	0.35 (48)

Acknowledgements

This research would not have been possible without the cooperation and assistance of Bridget Olsen, and the rest of the staff from Bear River Migratory Bird Refuge. A debt of gratitude is owed to the many students who endured the rigors of field research at Great Salt lake including, Lindsay Cole, Lucas Hall, Kristen Gurr, Ed Parker, Valerie Frokjer, Mike Cranney, Haylie Cox, Jake Johnson, Renee Linford, and Dallin Syphus.

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