Productivity and Foraging Ecology of Two Co-existing Shorebirds Breeding at Great Salt Lake, Utah
2005 - 2006

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Report

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Cover Photo: Foraging Black-necked Stilt. Photo by Tom Grey.

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EXECUTIVE SUMMARY

Farmington Bay is a 260 km^2 embayment of the Great Salt Lake. Recent studies have suggested that this Bay is hypereutrophic and thus may negatively impact wildlife species dependent on it for foraging and reproduction (e.g. Macarelli et al. 2003, Wurtsbaugh and Marcarelli 2006). To examine the potential impacts on breeding shorebirds, we compared productivity of two abundant species of shorebirds using Farmington Bay Waterfowl Management Area, American Avocets (*Recurvirostra american*) and Black-necked Stilts (*Himantopus mexicanus*), to other breeding sites within the Great Salt Lake Ecosystem. In addition we examined the diet of birds within the Farmington Bay to those at other reference locations.

The results of this study suggest that American Avocet and Black-necked Stilt productivity, as measured by hatchability, number of young to nest-leaving and daily survival rate of nests, were among the highest reported for the entire Great Salt Lake Ecosystem. In fact, productivity is as high or higher than other published productivity data for these species. This high level of productivity is likely due to a successful predator control program implemented at FARM to reduce mammalian nest predators.

Dietary data indicated that the volume of food items recovered from American Avocet digestive tracts was dominated by Corixidae (23%), Hydrophilidae (5%), Chironomidae (33.7%), Ephydridae (6%) and seeds (15%). The digestive tracts of Black-necked Stilts were also dominated by the same taxa, Corixidae (30%), Hydrophilidae (7%), Chironomidae (17%), Ephydridae (5.6%), and seeds (4%). American Avocets were found to take invertebrates in proportion to their availability. However, Black-necked Stilts were more selective in their diet. The proportion of Corixidae recovered from Black-necked Stilt digestive tracts were much greater than would be predicted based on their availability within the foraging sites.

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 american*) and Black-necked Stilts (*Himantopus mexicanus*) 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). Despite the importance of the GSL to North American shorebird 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.

Breeding biology and dietary information is needed to estimate population health and predict the vulnerability of species to habitat alteration, but such information is lacking for most species. In addition, concern over water quality and eutrophication within the Farmington Bay at GSL has prompted questions related to the effects on bird populations. The most important effects of degradation in water quality for birds will likely occur through changes in food availability and or quality. In addition, heavy metal and other contaminants can also affect bird populations by reducing hatchability of eggs, increasing young mortality and the incidence of developmental deformities (Ohlendorf et al. 1989).

Unfortunately, detailed, direct dietary information coupled with productivity data is not available for shorebirds utilizing the GSL. Indirect inferences about diets, based on bill morphology, behavior or general food availability has been questioned in several empirical studies (Rotenberry 1980, Rosenberg et al. 1982). Because we lack clear understanding of the connections between foraging site-selection, food availability and diet, any assumptions made without empirical study are unfounded (Rosenberg and Cooper 1990). Shorebirds forage primarily on macroinvertebrates, so it is expected that these birds will respond negatively to reductions in water quality. Impacts that reduce the abundance and or quality of macroinvertebrates used may reduce shorebird abundance and/or impact their productivity. To ensure that water quality is sufficient to maintain healthy viable shorebird populations it is critical to have this data. This detailed knowledge will provide managers an assessment tool for ensuring water quality and the maintenance of Farmington Bay as an important breeding and foraging site for shorebirds and all waterbirds using the area.

Objectives

This project monitored the breeding productivity, foraging ecology and diets of American Avocets and Black-necked Stilts using a standardized sampling protocol. This methodology allows for 1) assessment of current population health based on breeding productivity, 2) identification of species' dietary requirements, and 3) projection of species vulnerability to habitat disturbance and changes in water quality.

METHODS

Species

Both the American Avocet and Black-necked Stilt were chosen as focal species for this study because 1) they are both abundant throughout the managed wetland complexes of the GSL during the breeding season, 2) productivity can be easily measured, and 3) they rely heavily on aquatic macroinvertebrates and thus are likely affected by changes in water quality.

The American Avocet 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 to 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 adult. Photo by Tom Grey.

Black-necked Stilts 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. 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).

Figure 2. Black-necked Stilt. Photo by TomGrey

<u>*Study Sites*</u>

A total of seven sites were used for this study (Figure 3). Four sites were monitored for breeding productivity. Dietary information was collected at all seven sites.

The first site, the <u>Bear River Migratory Bird Refuge</u> (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. Adults were collected at this site for dietary analysis during the late summer of 2005. Productivity data was collected during both the 2005 and 2006 breeding seasons. 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 throughout the breeding season.

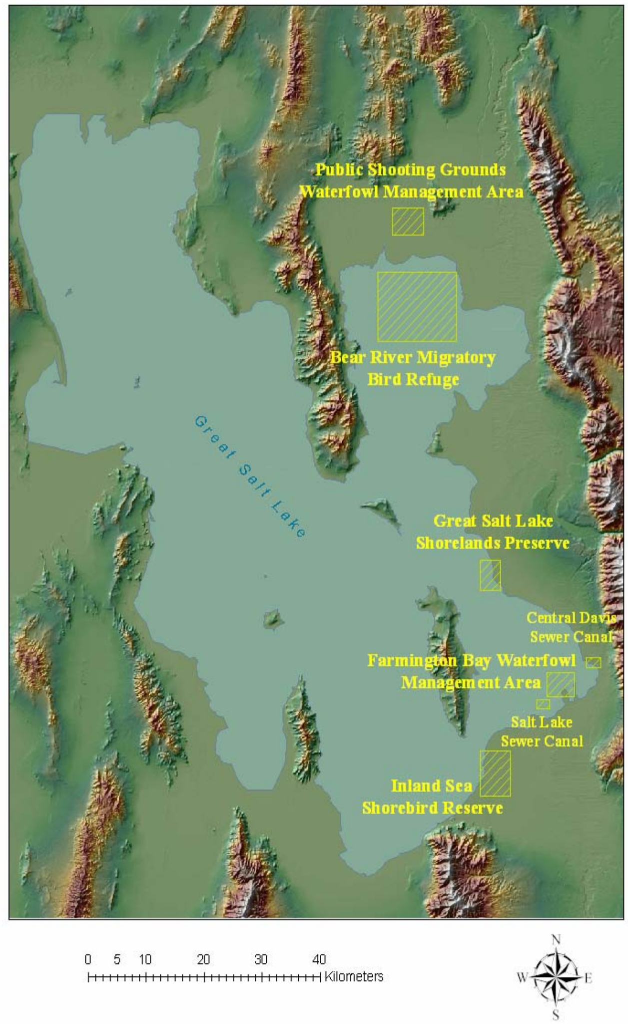


Figure 3. Study Sites used for dietary and productivity studies. See text for descriptions.

The <u>Great Salt Lake Shorelands Preserve</u> (SHORE) is 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. Adults were collected at this site for dietary analysis during the late summer of 2006 near the drainage canal for the North Davis County Sewage Treatment Plant (NDSC) and at three sites along Kays Creek (KACR). Productivity data were collected during the 2005 and 2006 breeding season.

<u>Farmington Bay Wildlife Management Area</u> (FARM) is located west of Farmington, Utah and covers about 5,000 ha. Farmington Bay is managed by the Utah Division of Wildlife Resources and hosts an array of impounded wetland habitats including fresh water ponds, marshes, expansive flats and open salt water. Productivity monitoring occurred west of the Turpin dike on the expansive mudflats and shallow emergent marshes. Both productivity data and adults were collected at this site during the 2005 and 2006 breeding season. This site has an active predator management program. Mammalian nest predators such as raccoon, skunk and fox are removed throughout the breeding season.

The Salt Lake Sewer Canal (SL CANAL) or Northwest Oil Drain, is located south of FARM and covers the area immediately surrounding the canal. The 9-mile canal is a major storm water and industrial wastewater discharge point for Salt Lake City's Water Reclamation Plant treated effluent. Sediment deposits containing hydrocarbons were found in certain segments of the canal in 1999. Local state and federal agencies addressed the problem and instituted a sediment removal remediation project which was completed in 2005. Because of this history and because large numbers of waterbirds use the canal and surrounding wetlands, this site was chosen to monitor breeding productivity and diet of shorebirds. Productivity data and adults were collected at this site during the 2005 and 2006 breeding season.

Public Shooting Grounds Waterfowl Management Area (PSGR) is located north of BEAR and 10.5 miles west of Corrine, UT. PSGR covers approximately 3200 ha of impounded wetlands, marshes, uplands, and open water. Adults were collected for dietary analysis during the 2006 breeding season at both Avocet Pond and Wigeon Lake.

Central Davis County Sewage Treatment Plant (CDSC) is located south of Kays Creek and north of FARM in Davis County. The treatment plant effluent is drained into the GSL through emergent marsh and playa. The terminus of this canal creates a shallow emergent marsh that is frequently used by both AMAV and BNST. Adults were collected for dietary analysis during the summer of 2006 at the terminus of the canal.

Inland Sea Shorebird Reserve (ISSR) – This study site is a 1485 ha of impounded wetlands and is managed by Kennecott Utah Copper. ISSR is located on the southeast corner of lake, west of the Salt Lake City International Airport. Water control structures are present. Adults and productivity data were collected during the 2006 breeding season.

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 2005 and 2006. Sites used only for collecting dietary data were visited a single time during the breeding season.

Productivity

Nests were located by either systematic searches of potential nesting sites or by observing the behavior of adults. 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 4). A unique nest identification number was written on each tag with permanent marker.

Because shorebirds lay only 1 egg/day, the laying date of 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.

Figure 4. American Avocet nest illustrating nest marker used to uniquely identify nests.

The status of extant nests was determined by visitations every 3-4 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 ~1-5mm 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 (> 5mm in size), and yolk within the nest material.

For each nest we recorded the following information - date of clutch initiation, maximum number of eggs, clutch size, date of hatching, number of eggs hatched, number of young produced, and nest fate. From this data I was 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.

Dietary Analysis

AMAV and BNST were randomly collected by shotgun after 15min. of active foraging. Following the collection, birds were dissected in the field. The mouth and pharynx were rinsed with 80% ethanol and the wash collected into plastic containers. In addition, the esophagus, proventriculus and ventriculus were removed and preserved with 80% ethanol. Birds were collected throughout the breeding season (May through August) to examine seasonal variation in diet.

Food items were sorted and identified to family and order (Merritt and Cummins 1984, Voshell 2002). Invertebrates were counted and volumes determined for each taxa. Data from samples were summarized as aggregate % volume.

Foraging Behavior

During the 2005 breeding season, we conducted foraging observations during a 5 minute sampling period prior to collecting adults. Observations of each individual were made with 7x35 binoculars. During the feeding observation, we recorded the amount of time each bird spent within the following foraging microhabitats: vegetated mudflat, unvegetated mudflat, shallow emergent wetland, mid-depth emergent wetland, or shallow submergent wetland. In addition, we recorded the frequency of each feeding method used. We classified feeding methods after Davis and Smith (2001) as:

- Pecking - < ¼ bill length penetrating substrate
- Probing - > ¼ bill lengths penetrating substrate
- Plunging – head submerged below water surface
- Scything - bill slightly open, moved from side to side
- Filtering – bill opens and closes rapidly while moving over mud

Feeding method diversity was calculated for each individual using the reciprocal of Simpson's index (Krebs 1998):

$$B = 1 / \sum p^2 i$$

where B = Feeding method diversity
pi = the proportion of ith feeding method of a given individual

The microhabitat of the foraging area was delineating by the point the bird was first detected foraging to the point where it was collected. A transect was established within this foraging sampling area (FSA) and water depths recorded at random points along the length. In addition each FSA was classified according to habitat (vegetated mudflat, unvegetated mudflat, shallow emergent wetland, mid-depth emergent wetland, or shallow submergent wetland). Although we were able to collect behavioral data on some of the birds collected, it was often difficult relocating the same individual prior to collection.

Invertebrate availability

After each shorebird observation/collection, invertebrates were collected from the mudflat, benthos and water column within each foraging area. Two invertebrate samples were collected at each FSA using D-frame net (Figure 5). The net was lowered so that the frame lay flat on the bottom. It was then quickly moved forward for a distance of 1m and then back again. The net was lifted up to the surface and the contents poured into a collecting bucket. The sample was washed through a 0.5mm sieve and the contents labeled and preserved with 80% ethanol. Invertebrates were sorted and identified to order and family using Merritt and Cummins (1984) and Voshell (2002). Invertebrates were counted and volumes determined for each taxa.

Figure 5. Sweep sample technique.

Statistical analyses

Tests of significance were set at $\alpha = 0.05$. Parametric analyses were used unless transformations were unable to correct for deviations in normality or heterogeneous variances.

I 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). Variation in DSR between sites was compared using the program CONTRAST (Sauer and Williams 1989). The program is based on establishing variance-covariance matrices that contrast two or more DSR and then comparing their differences with a chi-square distribution.

RESULTS

Productivity

A total of 239 nests were located and monitored at BEAR, 647 at FARM, 27 at SL CANAL and 6 at SHORE during the 2005 breeding season. During the 2006 breeding season, 327 nests were monitored at BEAR, 935 at FARM, 19 at SL CANAL, 198 at ISSR, and 120 at SHORE. Distribution of nests at each site for the 2006 breeding season are in Appendix 1.

Nest Fate – The most common source of nest failure for both species at all sites was nest predation. Nest predation accounted for 67 - 90% of all nest failures (Figure 6). Other sources of nest failure included flooding, 0 – 12%, and nest abandonments, 0 – 17%.

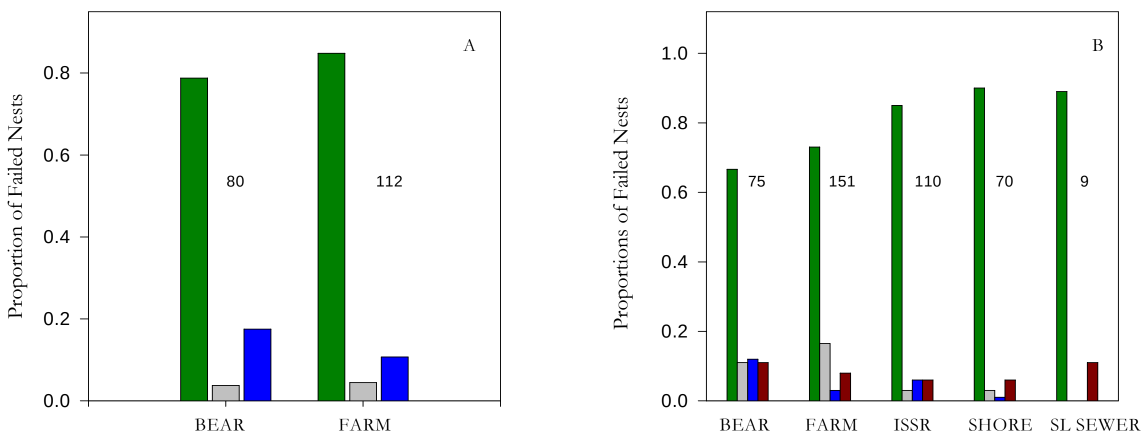


Figure 6. Proportion of failed nests during the 2005 (A) and 2006 (B) breeding seasons attributed to predation (green bars), flooding (blue), abandonment (gray) and unknown failures (red). The total numbers of failed nests are reported next to bars for each site. See text for site abbreviations.

Clutch Size, Number of Young to Nest-leaving, and Hatchability – The modal clutch size of both AMAV and BNST was 4 eggs. Measures of productivity are listed in Table 1. by species, site and year.

In 2005, 54.4% of all AMAV eggs laid at FARM produced young to nest-leaving. This compares to 75% at BEAR, 44% at SL CANAL, and 0 % at SHORE. For BNST 96% of eggs laid produced young to nest-leaving at FARM, 77% at BEAR, 0 % at SHORE, and 77% at SL CANAL. However, there were no significant differences in hatchability between sites for AMAV ($H = 1.2$, $df = 2$, $P = 0.550$) or for BNST ($U = 979.5$, $df = 1$, $P = 1.0$)

In 2006, 72% of all AMAV eggs laid at FARM produced young to nest-leaving. This compares to 65% at BEAR, 51% at SL SEWER, 24% at ISSR and 20% at SHORE. For BNST 82% of eggs laid produced young to nest-leaving at FARM, 77% at BEAR, 75% at SHORE, and 18% at ISSR. However, there were no significant differences in AMAV hatchability between sites ($H = 5.175$, $df = 3$, $P = 0.159$). BNST hatchability was significantly higher at FARM relative to BEAR ($H = 4.6$, $df = 1$, $P = 0.03$; Table 1).

Table 1. Measures of productivity for each site, year and species. Mean clutch size, hatchability and number of young produced to nest leaving (± standard error) for successful nests.

Site	Year	Species	Total Eggs Laid (total nests)	Clutch Size (n)	Hatchability (n)	Total Young Produced (average # eggs hatched / nest)	# Young Leaving/Nest (n)
BEAR	2005	AMAV	715 (311)	3.92 ± 0.67 (143)	0.96 ± 0.10 (143)	536 (1.7)	3.75 ± 0.72 (143)
		BNST	94 (29)	3.9 ± 0.57 (10)	0.98 ± 0.06 (10)	38 (1.3)	3.8 ± 0.42 (10)
	2006	AMAV	924 (302)	3.92 ± 0.52 (171)	0.94 ± 0.15 (151)	596 (1.97)	3.68 ± (162)
		BNST	84 (23)	4 ± 0 (18)	0.91 ± 0.15 (18)	65 (2.8)	3.61 ± (18)
FARM	2005	AMAV	1681 (481)	3.86 ± 0.51 (247)	0.96 ± 0.13 (247)	914 (1.9)	3.75 ± 0.57 (247)
		BNST	769 (411)	3.87 ± 0.48 (201)	0.97 ± 0.11 (201)	737 (1.79)	3.76 ± 0.62 (201)
	2006	AMAV	2146 (641)	3.93 ± 0.30 (413)	0.93 ± 0.15 (369)	1538 (2.4)	3.55 ± (435)
		BNST	1123 (313)	3.97 ± 0.21 (232)	0.96 ± 0.12 (221)	916 (2.9)	3.77 ± (243)
ISSR	2006	AMAV	507 (158)	3.9 ± .037 (42)	0.98 ± 0.08 (29)	122 (0.77)	3.59 ± (34)
		BNST	22 (8)	4 ± 0 (3)	-	4 (0.5)	4 ± 0 (1)
SHORE	2005	AMAV	18 (6)	4.0 ± 0.0 (3)	-		-
		BNST	-	-	-		-
	2006	AMAV	295 (106)	3.88 ± 0.33 (25)	0.89 ± 0.16 (14)	60 (0.57)	3.53 ± (17)
		BNST	20 (7)	4 ± 0 (4)	0.94 ± 0.13 (4)	15 (2.14)	3.75 ± (4)
SL CANAL	2005	AMAV	36 (11)	3.6 ± 0.70 (10)	1 ± 0.0 (5)	16 (1.45)	3.2 ± 0.84 (5)
		BNST	61 (16)	3.81 ± 0.54 (16)	0.98 ± 0.07 (13)	47 (2.9)	3.62 ± 0.65 (13)
	2006	AMAV	61 (19)	3.71 ± 0.76 (7)	1 ± 0 (8)	31 (1.63)	3.88 ± (8)
		BNST	-	-	-	-	-

Nest Success - Sites differed in DSR during both the 2005 and 2006 breeding season. In 2005, AMAV DSR was significantly higher at BEAR, FARM and SL CANAL relative to SHORE (X^2 = 10.47, df = 3, P = 0.015). There were no differences between sites for BNST nest DSR (X^2 =3.46, df = 2, P = 0.20; Table x). In 2006, AMAV nest DSRs differed between study sites (X^2 = 149.71, df = 4, P = 0.0001). Both FARM and BEAR had the highest DSR relative to the other sites (Table 2). However, the DSR of BNST nests did not significantly differ between sites (X^2 = 7.11, df = 3, P = 0.07; Table 2).

Table 2. Nest daily survival rate (DSR ± SE) of each species by site and year. DSRs with the same letter are not significantly different (P > 0.05; statistical comparisons are made within each column). Mayfield estimates of nesting success are located below each DSR.

Site	AMAV 2005 DSR ± SE Nesting Success	BNST 2005 DSR ± SE Nesting Success	AMAV 2006 DSR ± SE Nesting Success	BNST 2006 DSR ± SE Nesting Success
BEAR	0.97 ± 0.004 a 0.45	0.97 ± 0.13 a 0.45	0.98 ± 0.002 a 0.56	0.99 ± 0.004 a 0.76
FARM	0.98 ± 0.002 a 0.56	0.98 ± 0.002 a 0.56	0.98 ± 0.001 a 0.56	0.99 ± 0.001 a 0.76
ISSR	--	--	0.90 ± 0.009 b 0.06	0.83 ± 0.06 a 0.01
SL CANAL	0.95 ± 0.02 a,b 0.25	--	0.92 ± 0.02 b 0.11	--
SHORE	0.85 ± 0.06 b 0.01	--	0.88 ± 0.01 b 0.03	0.98 ± 0.01 a 0.56

Diet and Aquatic Invertebrate Availability

A total of 34 AMAV and 46 BNST were collected for dietary analyses. On September 12, 2006 the CDSC was visited and eight birds (3 AMAV, 5 BNST) were collected. However, many of the birds congregating near the CDSC were suffering from an outbreak of avian botulism. Several thousand shorebirds and waterfowl were found dead in the area during collection. Because we are unsure how this disease could affect foraging behavior and diet selection, birds collected at CDSC are not included in the remaining analyses.

A total of 16 different taxa were identified within the digestive tracts of AMAV and BNST (Table 3). The most important aquatic invertebrates consumed by AMAV and BNST were Corixidae and Chironomidae. In fact, 63% of AMAV diet was made up of just three invertebrate taxa, Chironomidae, Corixidae, and Ephydridae (Table 3). BNST diet was slightly more varied, but 65% of the food material recovered consisted of four taxa, Corixidae, Chironomidae, Hydrophilidae, and miscellaneous Coleoptera parts (Table 3). Seeds made up 15% of the volume of food items collected from AMAV digestive tracts but only 4% of BNST. A small percentage of the material recovered (5 – 7%) included very small or shredded objects that could not be identified (Table 3). A summary of the aggregate % volume of each species by site and year are found in Appendix 2. A complete listing of the volume of taxa collected from each bird is presented in Appendix 3 and 4.

Table 3. Mean aggregate % volume of food items recovered from the digestive tracts of American Avocets and Black-necked Stilts.

Taxa	AMAV N = 31	BNST N = 41
	Mean Aggregate % Volume	Mean Aggregate % Volume
Gastropoda	0.4	1.6
Odonata	0.2	5
Hemiptera		
Corixidae	23.2	30
Coleoptera		
Carabidae	3	0.6
Dytiscidae	0	2
Hydrophilidae	4.7	7.5
Coleoptera Parts	3	10.5
Trichoptera		
Limnephilidae	0.1	0
Diptera		
Culicidae	0.8	0.5
Ceratopogonidae	0	0.2
Chironomidae	33.7	17.2
Stratiomyidae	0	0.01
Syrphidae	0	3.6
Ephydridae	6.1	5.6
Muscidae	1.4	3.3
Misc. Diptera	0	2.6
Hymenoptera		
Braconidae	0.9	0.01
Seeds	15.2	4.2
Unidentifiable Parts	7	5.2

Because Corixidae, Hydrophilidae, Chironomidae, Ephydridae, and seeds made up the largest proportion of food items in the diet of both AMAV and BNST, I focused on these taxa in site comparisons. There were no significant effects of year on the aggregate volume of food items consumed (P > 0.1), so data collected from 2005 and 2006 were pooled.

For AMAV, the aggregate proportional volume of Corixidae was significantly higher at ISSR relative to all other sites ($F_{5,21}$=4.03, P = 0.01; Figure 7). The aggregate proportional volume of Chironomidae and Ephydridae recovered from AMAV digestive tracts also differed between sites (Chironomidae - H =11.29, df = 5, P = 0.046, Figure 8a; Ephydridae - H =11.60, df = 5, P = 0.041; Figure 8b). Chironomidae made up a greater proportional volume of food items at FARM and BEAR relative to KACR (Figure 8A). The aggregate proportional volume of Ephydridae was significantly greater at SL CANAL relative to all other sites but not different from NDSC (Figure 8B). There were no significant differences between sites in the aggregate proportional volume of Hydrophilidae (H =10.3, df = 5, P = 0.067) or seeds (H =9.36, df = 5, P = 0.10) recovered from AMAV digestive tracts.

The aggregate proportional volume of Chironomidae was significantly higher in BNST collected at SL CANAL relative to KACR (H =18.9, df = 5, P = 0.002). There were no significant differences between sites in the

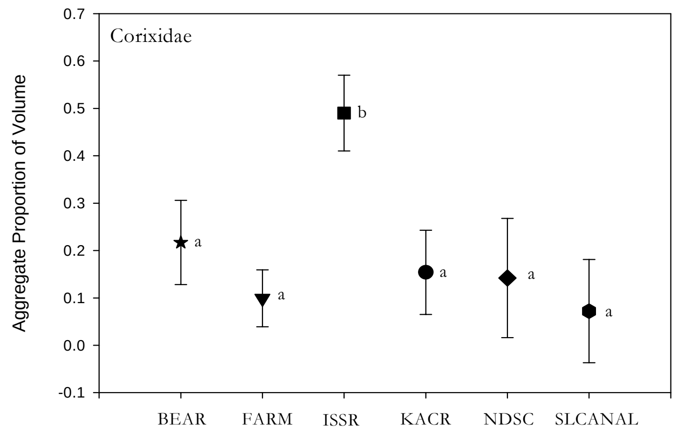


Figure 7. Mean Corixidae aggregate proportional volume (± SE) recovered from digestive tracts of AMAV at each site. Means with the same letter are not significantly different (P < 0.02).

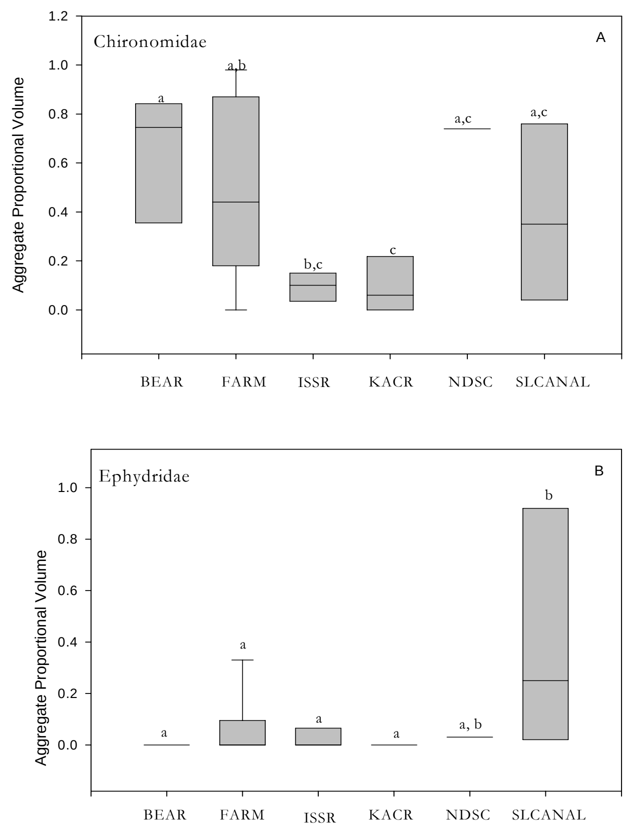


Figure 8. Median Chironomidae (A) and Ephydridae (B) aggregate proportional volume (upper, lower quartiles) recovered from digestive tracts of AMAV at each site. Medians with the same letter are not significantly different (P < 0.05).

aggregate proportional volume of Corixidae (H =10.3, df = 5, P = 0.067), Hydrophilidae (H =9.32, df = 5, P = 0.097) , Ephydridae (H =10.3, df = 5, P = 0.067) or seeds (H =5.06, df = 5, P = 0.41) recovered from BNST digestive tracts.

There was a significant difference between sites in the proportion of Chironomidae recovered from sweep samples ($F_{8, 31}$ = 2.5, P = 0.04) but no significant year affect (Figure 9). Chironomidae were significantly more abundant in samples collected at SL CANAL and at the NDSC relative to other sites (Figure 9). There were no significant year or site differences in the availability of Corixidae ($F_{8, 31}$ = 1.6, P = 0.19).

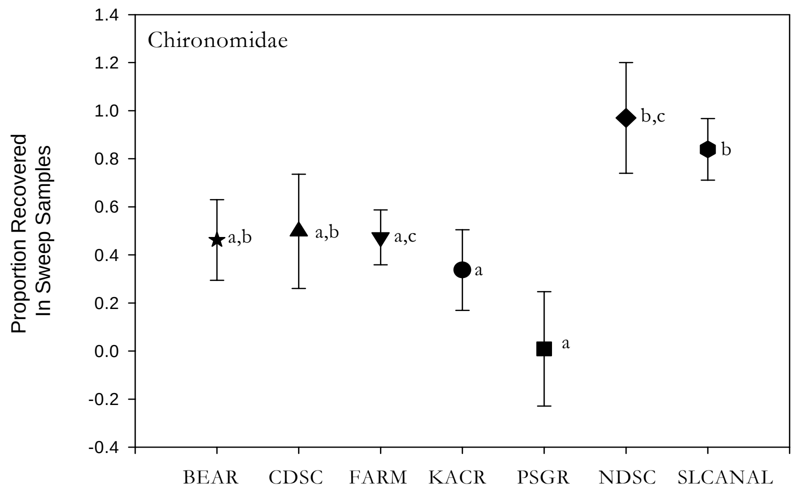


Figure 9. Mean proportion (± SE) of chironomidae recovered from sweep samples at each site. Means with the same letter are not significantly different (P < 0.05).

The proportion of Chironomidae consumed by AMAV did not differ from the proportion available within sweep samples ($F_{1, 54}$ = 0.308, P = 0.581). Likewise, there were no differences in the proportion of Corixidae consumed relative to the proportion available within sweep samples ($F_{1, 62}$ = 0.232, P = 0.632). However, BNST digestive tracts had fewer Chironomidae than would be expected if they were consuming invertebrates based on availability ($F_{1, 65}$ = 14.77, P = 0.001). There was a significant year by sample (diet and sweep sample) interaction term when comparing BNST consumption of Corixidae ($F_{1, 69}$ = 6.1, P = 0.02). In 2005, BNST consumed more Corixidae than would be expected based on availability but not in 2006.

Foraging Behavior

There were significant differences in the feeding methods utilized by each species. BNST utilized "pecking" more frequently ($F_{1,88}$ = 23.45, P = 0.001), whereas AMAV engaged in "plunging" ($F_{1,88}$ = 9.04, P = 0.003) and "scything" more frequently ($F_{1,88}$ = 8.43, P = 0.005; Figure 10). There was no difference between species in the frequency of "probing" ($F_{1,88}$ = 0.45, P = 0.505). As a result, feeding method diversity was significantly greater for AMAV relative to BNST (t = 2.4, df = 1, 90, P = 0.018; Figure 11).

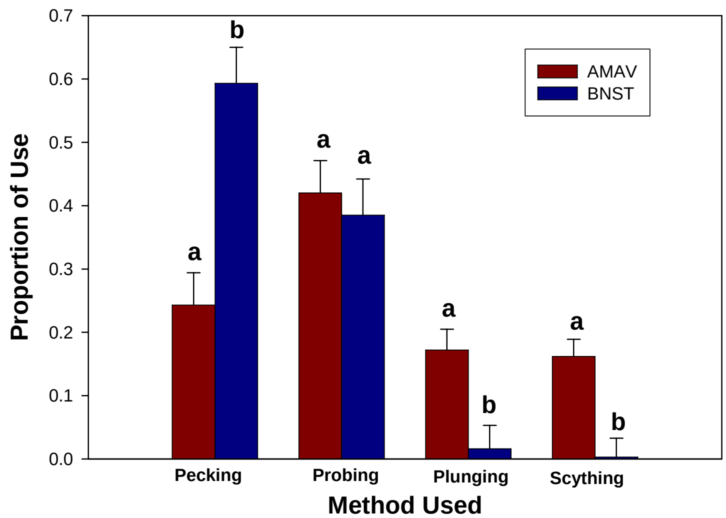


Figure 10. Foraging method utilized by AMAV and BNST.

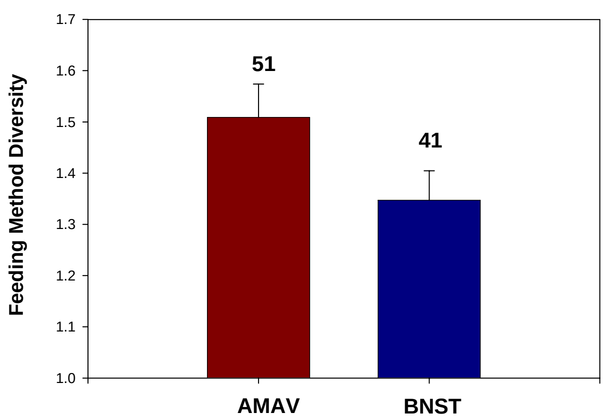


Figure 11. Feeding method diversity of AMAV and BNST.

DISCUSSION

The results of this study suggest that all measures of AMAV and BNST breeding productivity are high at FARM. Hatchability rates at FARM are among the highest found within the GSL ecosystem and daily survival rates of nests at FARM and BEAR are significantly higher than all other sites studied.

At FARM the average number of eggs hatched per nest ranged from 1.9 – 2.4 for AMAV and 1.8 – 2.9 for BNST. In comparison, the average number of AMAV eggs hatched per nest at BEAR ranged from 1.7 – 1.97 and 1.3 – 2.8 for BNST. These data are higher than reported in other similar studies. For example, Robinson et al. (1997) report a range of 0 – 1.48 AMAV eggs hatched per nest on study sites in California and Nevada. At these same sites, only 1.2 – 2.2 BNST eggs hatched per nest (Robinson et al. 1999).

Hatchability of BNST eggs at BEAR during the 1980's was 0.95 for 24 nests (Sordahl 1996). In central Oregon, AMAV hatchability was only 0.9 for 59 nests monitored (Gibson 1971). In contrast, Ohlendorf et al. (1989) reported hatchability rates of .876 for BNST breeding at Kesterson Reservoir, a selenium contaminated site in California. BNST breeding at this site had high rates of embryo mortality and deformity attributable to the contamination. On average the hatchability for uncontaminated populations of aquatic birds averages ~ 0.91 (Ohlendorf 1989). The rates of hatchability found for AMAV and BNST at FARM during this study were greater (AMAV = 0.93 – 0.96; BNST = 0.96 – 0.97) and suggest egg viability is not a factor affecting breeding productivity at FARM.

The high rates of productivity at FARM and BEAR are partly due to the predator management program employed at these sites. Nest predation is the most important source of egg loss for all species at each site. This is a typical pattern seen for most breeding bird populations (e.g. Cavitt and Martin 2002). Nesting success was found to be highly variable, and two sites (SHORE and ISSR) had only 1% nesting success. In contrast, nesting success ranged from 45 – 76% at BEAR and 56 – 76% at FARM. Data from sites in California and Nevada where predators are not managed suggest much lower nesting success rates for both AMAV, 0 – 51% (Robinson et al. 1997) and BNST, 38 – 67% (Robinson et al. 1999). Consequently, AMAV and BNST at FARM and BEAR are able to successfully produce a large number of young each year.

The most important food items consumed by AMAV and BNST were Chironomidae and Corixidae. At FARM Chironomidae made up ~ 50% of the volume of food items recovered from the digestive tracts of AMAV and ~30 % of BNST. In comparison, Corixidae accounted for ~ 10% of AMAV diet at FARM and ~22% of BNST. Many other aquatic invertebrates were recovered but large volumes of Chironomidae and Corixidae were consistently recovered from the digestive tracts at the majority of sites monitored for this study.

Dietary information obtained by this study suggests that AMAV select food items in proportion to their availability within their foraging sites, whereas BNST are more selective in their diet. Chironomidae were consumed by BNST less frequently than would be expected based on their availability, but Corixidae made up a greater than expected proportion of the diet. This dietary information corresponds with the foraging behavior observed. BNST spent significantly more time "pecking" food items off the surface of the water whereas AMAV penetrated deeper into the foraging substrate by using a "plunging" behavior as well as sweeping motions (scything) to acquire food items. It may be that BNST are attracted to prey movement and thus select moving food items and not necessarily the most abundant. Corixidae are very active swimmers and thus would attract the attention of a visually oriented predator. However, Chironomidae larvae are generally benthic organisms and thus are not actively swimming through the water column. Chrionomidae would be more likely captured with broad sweeping motions that skim through the benthos.

In conclusion, the results of this research suggest that all measures of breeding productivity at FARM included in this report are either comparable or higher than at reference sites throughout the GSL. Furthermore, breeding productivity at FARM is also equivalent or greater than published data available for other breeding locations throughout North America. Dietary data suggest that AMAV are highly adaptable to local food resources and generally consume their major prey items in proportion to their availability. BNST may be more selective and tended to favor more active prey.

PRIORITIES FOR FUTURE RESEARCH

It is important to note that productivity in this study only included the period from egg laying to the departure of young (i.e. the brood) from the nest. However, the time from nest-leaving to independence is likely to be a critical factor influencing breeding productivity of these species. Parents of both species lead young from the nest to brooding areas. These areas can be near the nest site but may be up to 1km away (Sordahl 1996). Parents continue to defend the brood but young forage and feed themselves. Unfortunately, we know very little about the selection of these brooding sites and the factors influencing brood survival following nest-leaving (Sordahl 1996, Robinson et al. 1997). Furthermore, food availability in these brooding areas and its relationship to young-feeding has never been studied. This information is critical to accurately project the vulnerability of these species to habitat alteration and the potential degradation of water quality.

ACKNOWLEDGEMENTS

Many thanks to the staff and managers of Bear River Migratory Bird Refuge, Farmington Bay Waterfowl Management Area, Inland Sea Shorebird Reserve, and The Nature Conservancy of Utah for their support and access to study sites. Thanks also to Theron Miller, Utah Division of Water Quality, for many stimulating conversations and suggestions. A debt of gratitude is owed to the many students who endured the rigors of field research at Great Salt Lake including, Chris Bryan, Jen Cary, Jannette Dickinson, Christian Edwards, Matt Fisher, Karla Krause, Aaron Layton, Andy McFadden, Kyle Stone, Nicole Snow, Kate Ennenga, Mike Gamble, Trina Nixon, Trey Parker, Lindsay Anderson, Amber Freeland, Nate Cooney, Sunee Buck, Shane Pearson, Josh Shepard and Brian Oney. Special thanks to Christian Edwards, Kyle Stone, Rich Emerson, and Karla Krause for assistance with data entry and analyses.

LITERATURE CITED

Aldrich, T. W., and D. S. Paul. 2002. Avian ecology of Great Salt Lake. Great Salt Lake: an overview of change. Utah Department of Natural Resources.

Andres, B., R. Clay, and C. Duncan. 2006. Shorebird species of conservation concern in the western hemisphere. Western Hemisphere Shorebird Reserve Network.

Cavitt, J.F. 2004. 2003 Shorebird Productivity Report. Report to US Fish and Wildlife Service, Bear River Migratory Bird Refuge, Brigham City, UT.

Cavitt, J.F. 2005. 2004 Shorebird Productivity Report. Report to US Fish and Wildlife Service, Bear River Migratory Bird Refuge, Brigham City, UT.

Cavitt, J. F., and T. E. Martin. 2002. The effects of forest fragmentation on brood parasitism and nest predation in eastern and western landscapes. Studies in Avian Biology 25:73-80.

Gibson, F. 1971. The breeding biology of the American Avocet (*Recurvirostra americana*) in central Oregon. Condor 73:444-454.

Hensler G. L., and J. D. Nichols. 1981. The Mayfield method of estimating nesting success: a model, estimators and simulation results. Wilson Bulletin 93:42-53.

Johnson D. H. 1979. Estimating nesting success: the Mayfield method and an alternative. Auk 96:651-661.

Krebs, C. J. 1998. Ecological methodology. Addison Wesley Educational, Menlo Park, CA.

Mabee, T. J. 1997. Using eggshell evidence to determine nest fate of shorebirds. Wilson Bulletin 109:307-313.

Mabee, T. J., A. M. Wildman, and C. B. Johnson. 2006. Using egg flotation and eggshell evidence to determine age and fate of Artic shorebird nests. Journal of Field Ornithology 77(2):163-172.

Marcarelli AM, Wurtsbaugh WA, Albrecht B, Archer E, Bassett J, Beckstrand M, Hadley M, Kling J, Lester O, MacKinnon P and Ting T-h. 2003. Is Farmington Bay healthy? Continuing studies of water quality in the Great Salt Lake. Friends of Great Salt Lake Newsletter 9(2): 6-7, 14.

Mayfield H. 1961. Nesting success calculated from exposure. Wilson Bulletin 73:255-261.

Mayfiled H. 1975. Suggestions for calculating nest success. Wilson Bulletin 87:456-466.

Merritt, R. W., and K. W. Cummins. 1996. An introduction to the aquatic insects of North America. Kendall/Hunt Pub. Co., Dubuque, IA.

Ohlendorf, H., R. Hothem, and D. Welsh. 1989. Nest success, and hatchability of aquatic birds at selenium contaminated Keterson resivor. Condor 91:787-796.

Robinson, J. A., L. W. Oring, J. P. Skorupa, and R. Boettcher. 1997. American Avocet (*Recurvirostra american*). The Birds of North America 275.

Robinson, J. A., J. M. Reed, J. P. Skorupa, and L. W. Oring. 1999. Black-necked Stilt (Himantopus mexicanus). The Birds of North America 449.

Rosenberg, K., and R. Cooper. 1990. Approaches to avian diet analysis. Studies in Avian Biology 13:80-90.

Rosenberg, K., D. Ohmart, and B. Anderson. 1982. Community organization of riparian birds: response to annual resource peak. Auk 99:260-274.

Rotenberry, J. 1980. Dietary relationships among shrub-steppe passerine birds. Ecological Monographs 50:93-110.

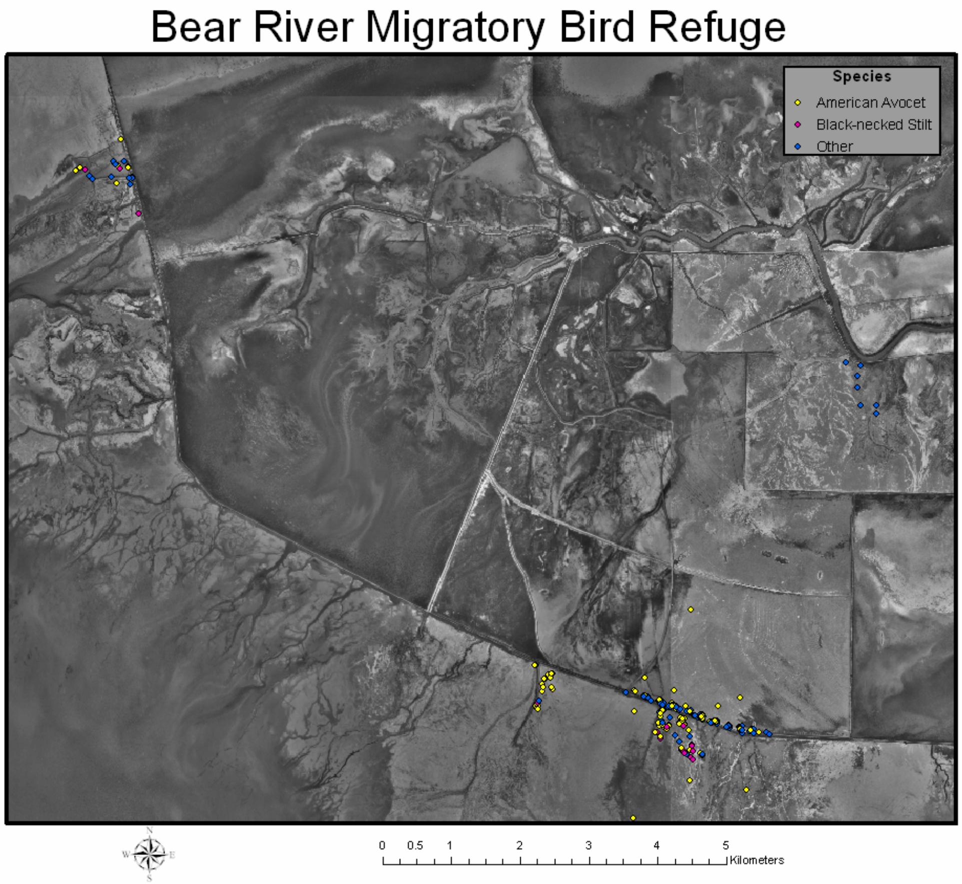
Sauer, J. R.., and B. K. Williams. 1989. Generalized procedures for testing hypotheses about survival or recovery rates. Journal of Wildlife Management 53:137-142.

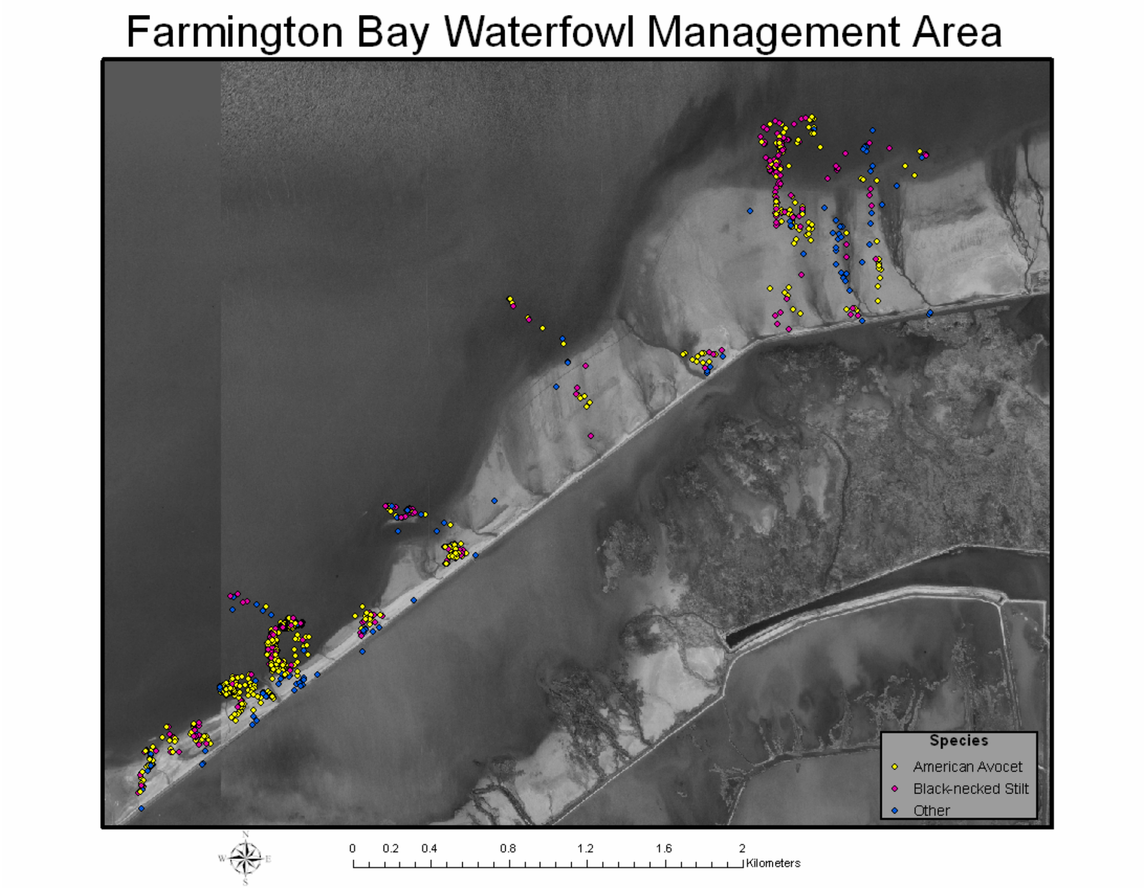
Sordahl, T. A. 1996. Breeding biology of the American Avocet and Black-necked Stilt in northern Utah. Southwest. Nat. 41:348-354.

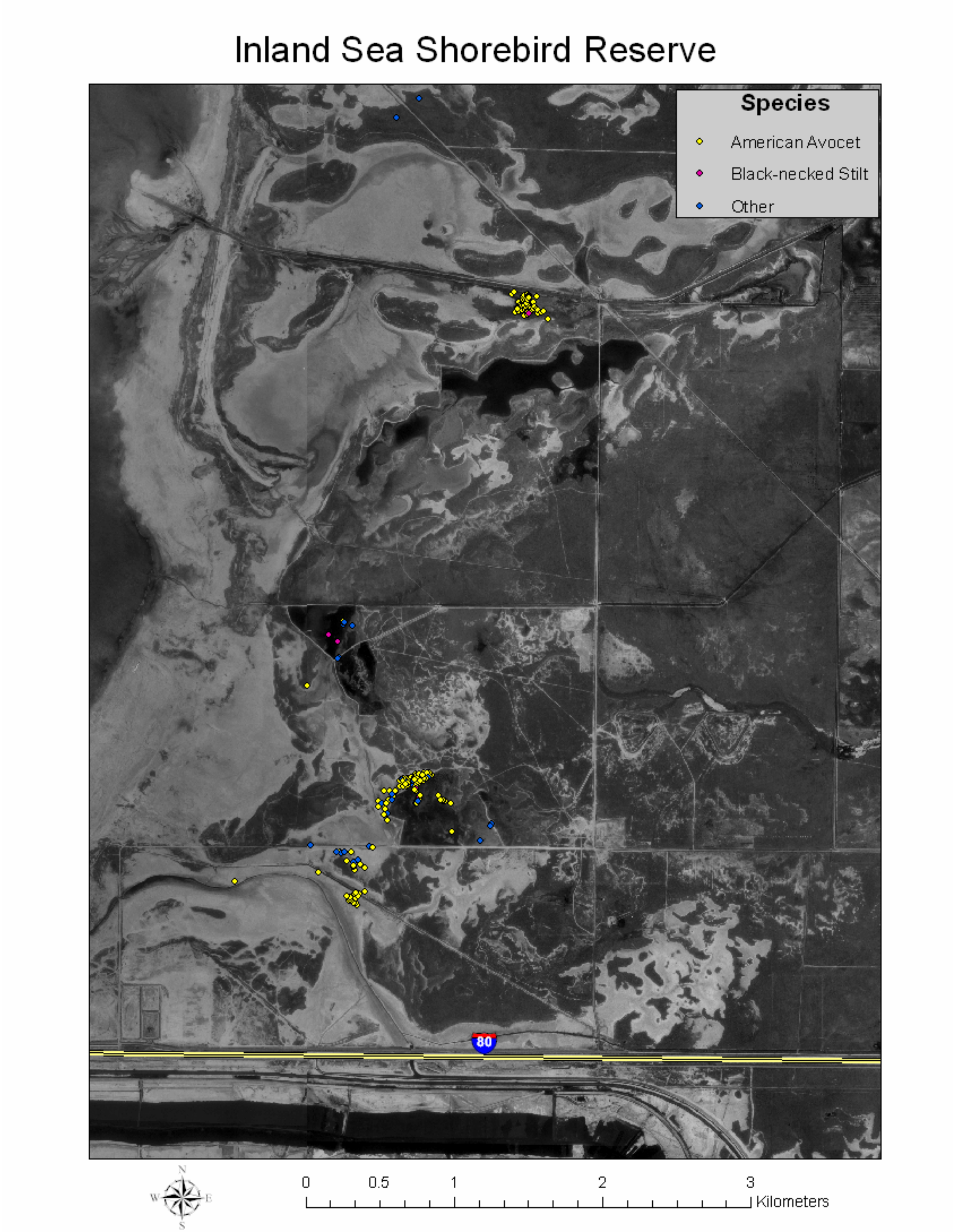
Voshell Jr., J. R. 2002. A guide to common freshwater invertebrates of North America. The McDonald ad Woodward Pub. Co., Blacksburg, VA.

Wurtsbaugh WA and Marcarelli AM. 2006. Eutrophication in Farmington Bay, Great Salt Lake, Utah 2005 Annual Report. Report to the Central Davis Sewer Improvement District. Kaysville, UT.

Appendix 1. Distribution of nests at each study site for the 2006 breeding season.



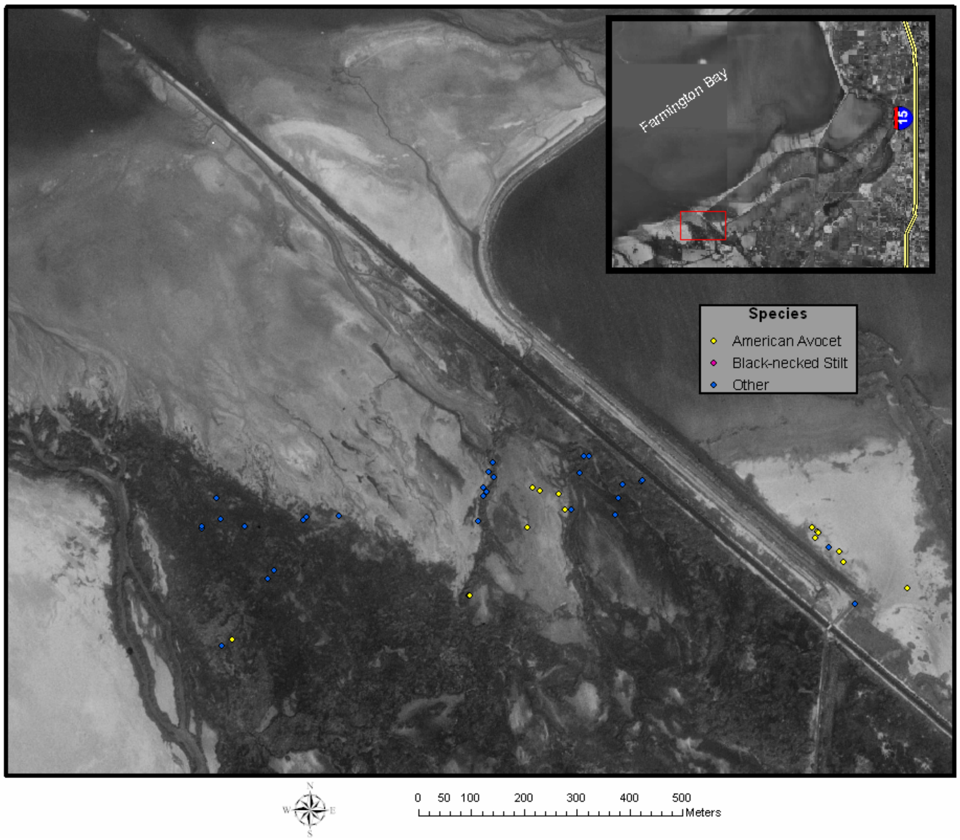

Farmington Bay Waterfowl Management Area
Species
American Avocet
Black-necked Stilt
Other
0 0.2 0.4 0.8 1.2 1.6 2
Kilometers



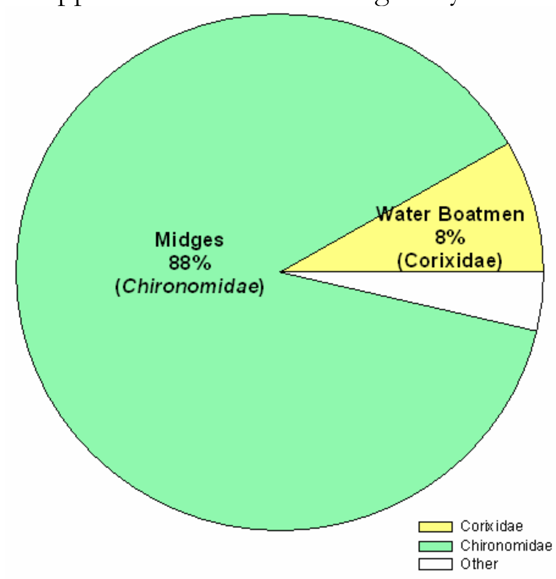
Inland Sea Shorebird Reserve
Species
American Avocet
Black-necked Stilt
Other
80
N
S
W
E
0
0.5
1
2
3
Kilometers


Great Salt Lake Shorelands Preserve
Davis County Causeway
(Antelope Dr)
Species
American Avocet
Black-necked Stilt
Other
N
W
E
S
0
0.2
0.4
0.8
1.2
1.6
2
Kilometers

Salt Lake Sewer Canal



Appendix 2a Bear River Migratory Bird Refuge



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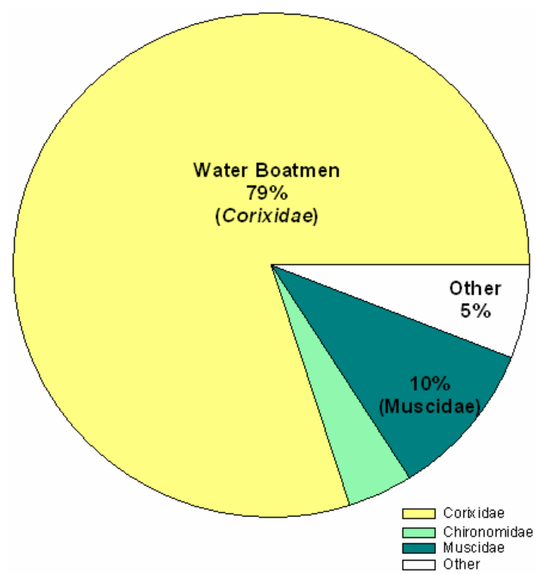
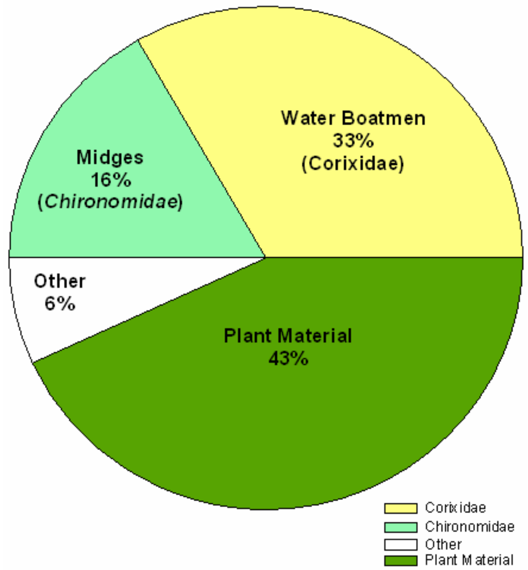


BNST

2005

Appendix 2b Central Davis Sewer Canal



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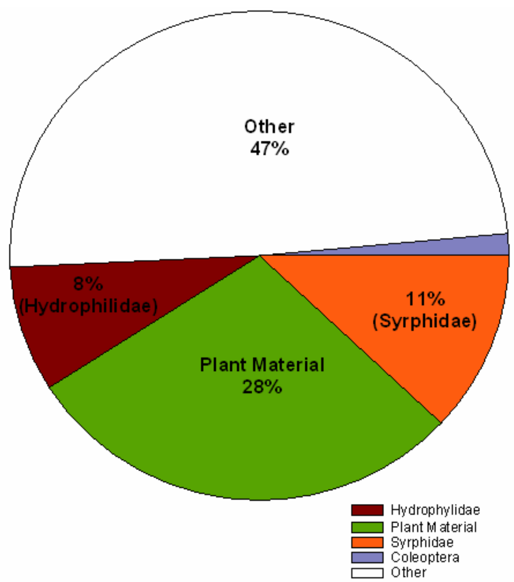
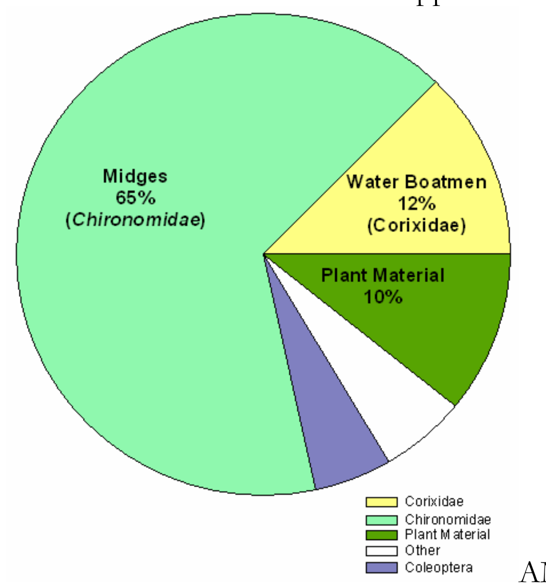


BNST

2006

Appendix 2c Farmington Bay Waterfowl Management Area



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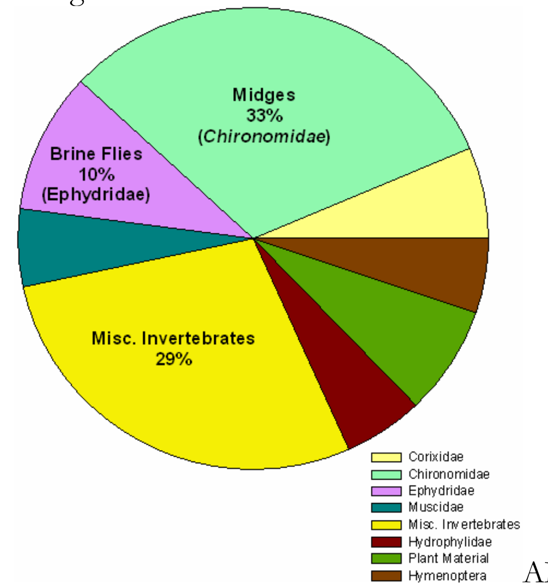

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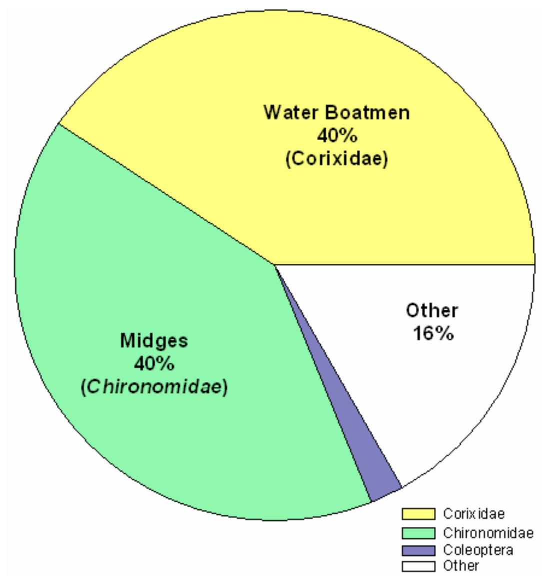
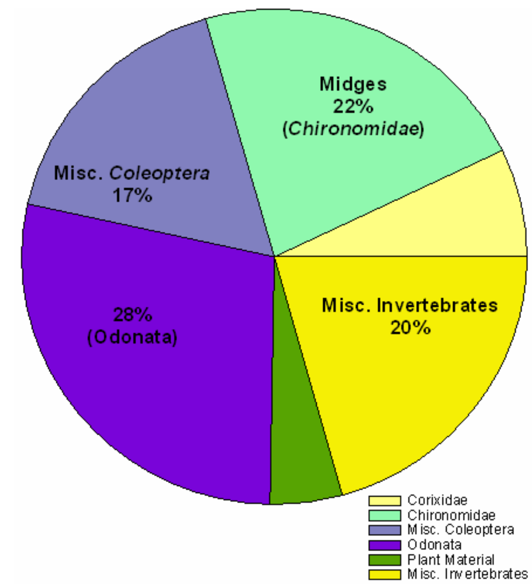


BNST

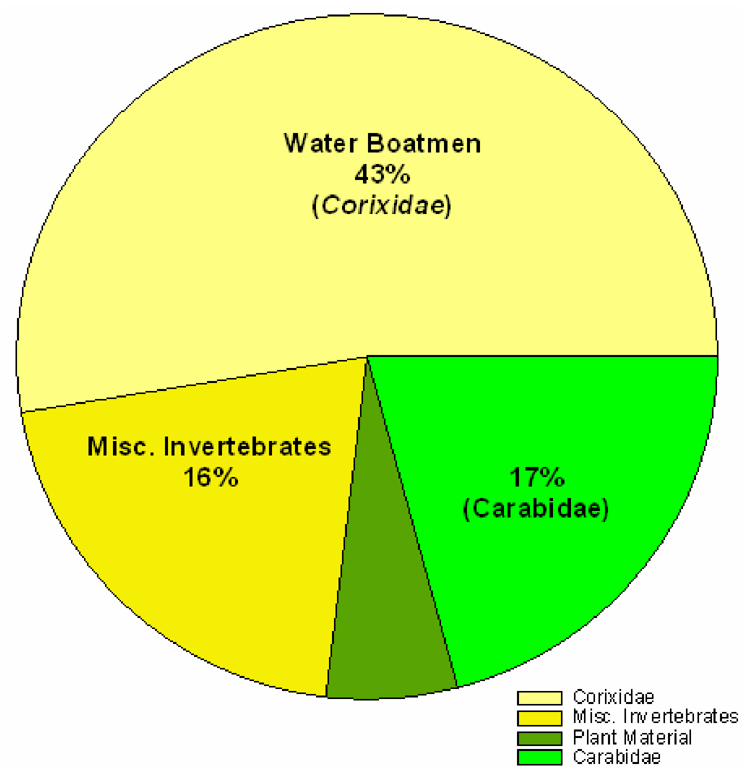
2005



BNST

2006

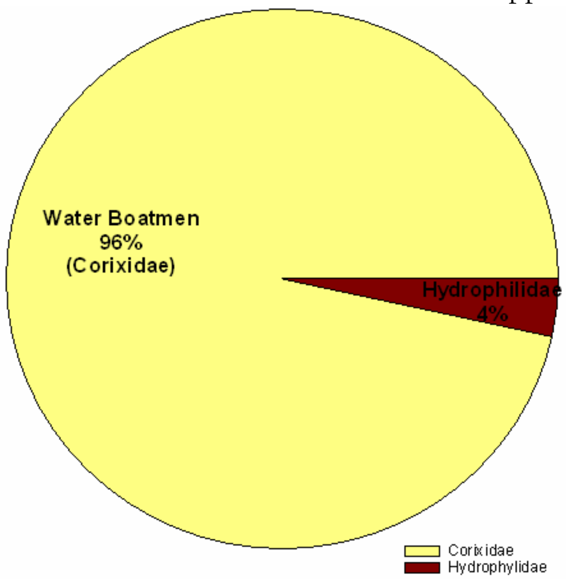
Appendix 2d Inland Sea Shorebird Reserve



AMAV

2006

Appendix 2e Kay's Creek North



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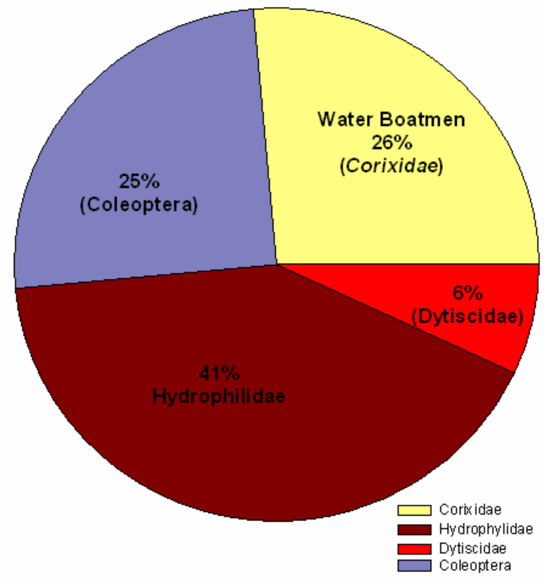
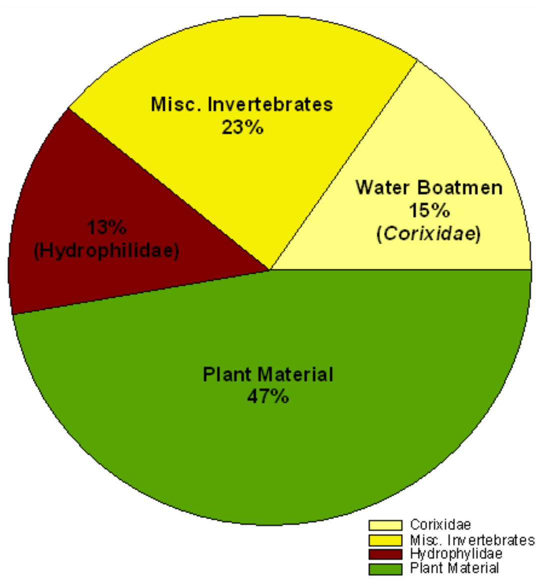


BNST

2006

Appendix 2f Kay's Creek South



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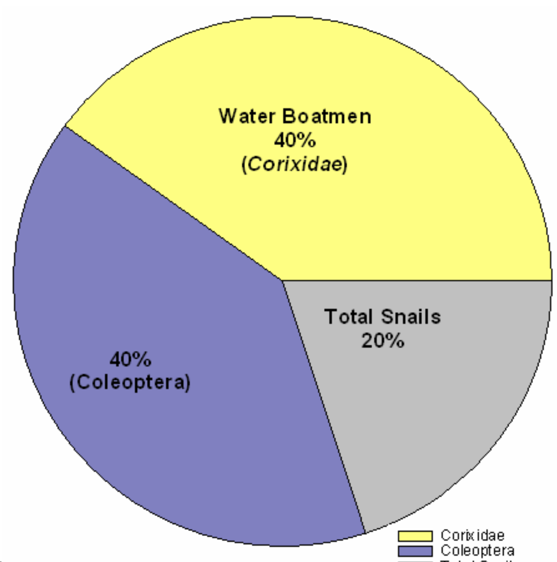
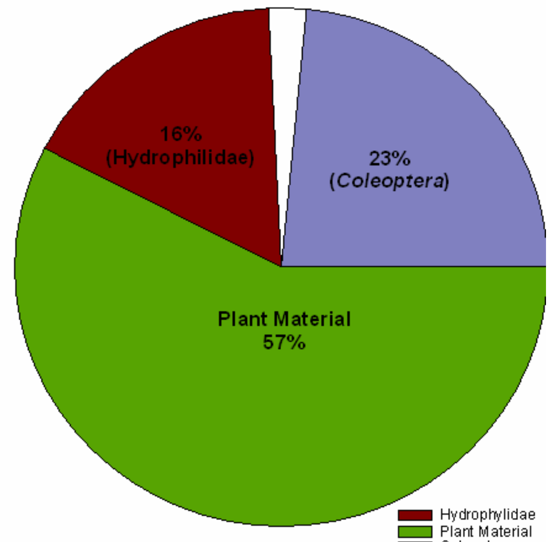


BNST

2006

Appendix 2g Kay's Creek West



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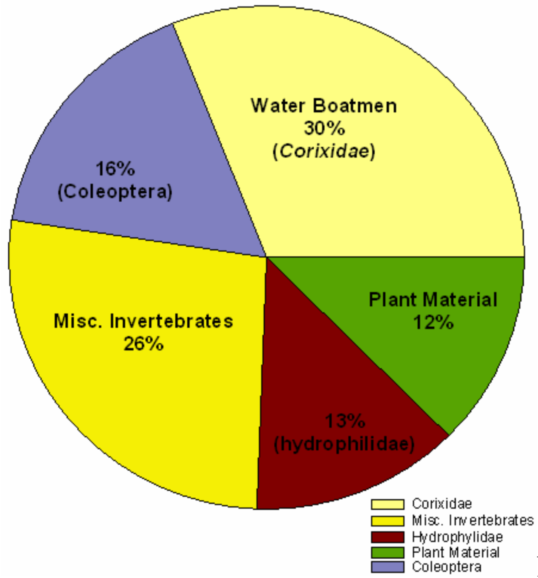
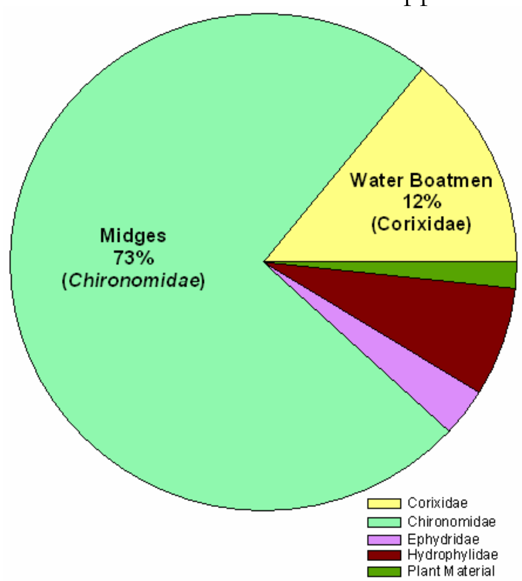


BNST

2006

Appendix 2h North Davis Sewer Canal



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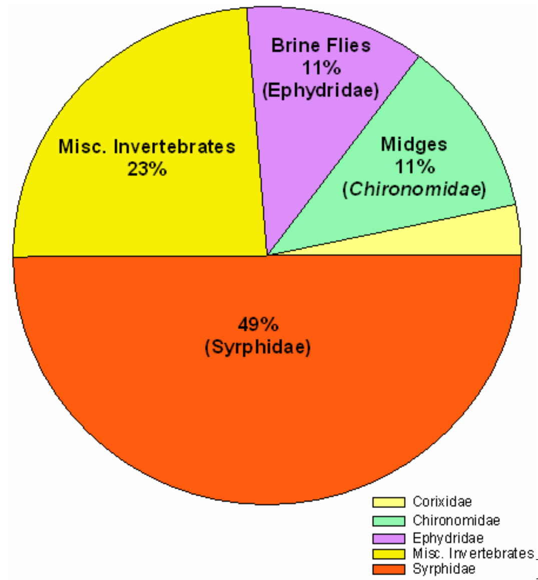
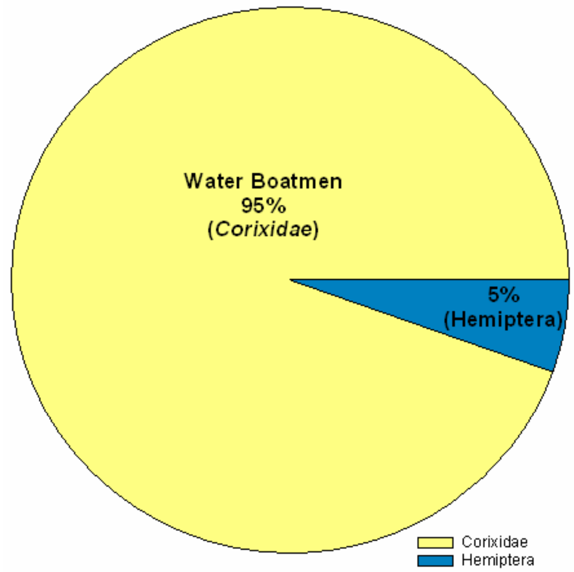


BNST

2006

Appendix 2i Public Shooting Grounds



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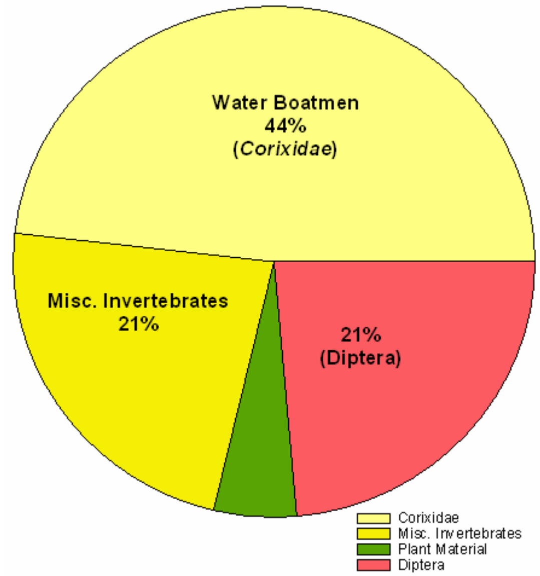
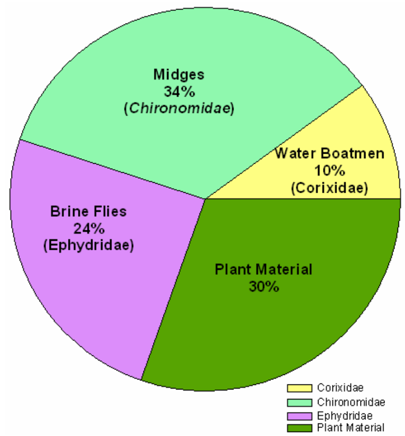
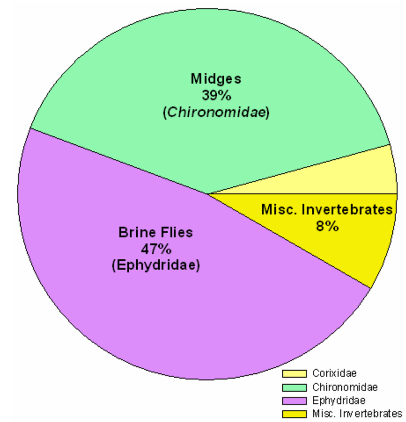


BNST

2006

Appendix 2j Salt Lake Sewer Canal





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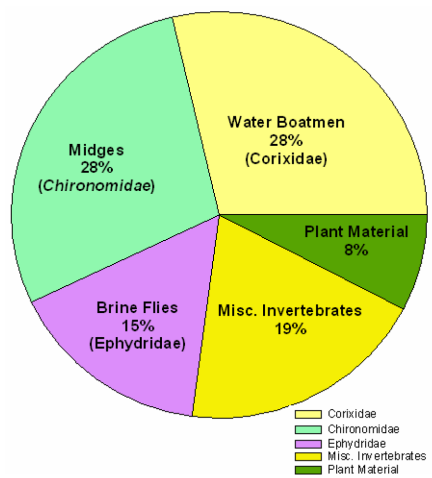

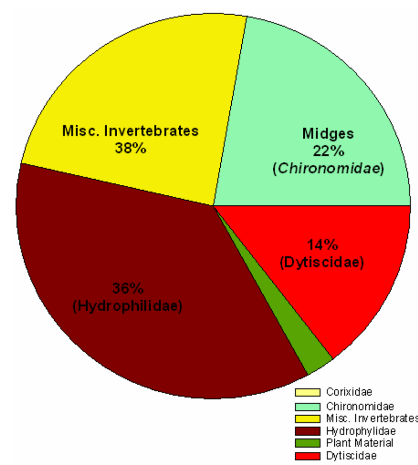

BNST

BNST

2005

2006

Appendix 3. Volume (cm^3) of material removed from the digestive tract of each bird collected in 2005. The bird ID # contains the date of collection (first and second digits – month, third and fourth digits – day, fifth and sixth digits – bird number).

Bird ID #	Species	Location	Bithyniidae	Planorbidae	Odonata	Corixidae	Coleoptera Parts	Chironomidae	Ephydridae	Muscidae	Seeds	Other	Sum(cm^3)
0809-05	AMAV	FARM	0	0	0	0.09	0.27	0.6	0	0	0.1	0	1.06
0809-06	AMAV	FARM	0	0	0	0	0	0.12	0	0	0.01	0	0.13
0809-07	AMAV	FARM	0	0	0	0	0	0.89	0	0	0.2	0	1.09
0809-08	AMAV	FARM	0	0	0	0.18	0	0.18	0	0	0.04	0.01	0.41
0810-03	AMAV	BEAR	0	0	0	0.09	0	0.5	0	0	0.04	0	0.63
0810-04	AMAV	BEAR	0	0	0	0.15	0.04	0.67	0	0	0.1	0	0.96
0810-05	AMAV	BEAR	0	0	0	0.2	0	0.1	0	0	0	0.12	0.42
0810-06	AMAV	BEAR	0	0	0	0.23	0	2.1	0	0	0.1	0.02	2.45
0826-01	AMAV	SLCANAL	0	0	0	0.09	0	0.31	0.22	0	0.27	0	0.89
0809-01	BNST	FARM	0	0	0	0	0	0.02	0	0	0	0	0.02
0809-02	BNST	FARM	0	0	0.05	0.02	0	0.09	0	0	0	0	0.16
0809-03	BNST	FARM	0.02	0.08	0	0.18	0.03	0.02	0	0	0	0	0.33
0809-04	BNST	FARM	0	0	0	0.1	0	0	0	0	0	0	0.1
0810-01	BNST	BEAR	0	0	0	0.24	0	0	0	0	0	0.06	0.3
0810-02	BNST	BEAR	0	0	0	0.38	0.1	0	0	0	0	0.02	0.5
0810-07	BNST	BEAR	0	0	0	0.18	0	0.06	0	0	0	0	0.24
0810-08	BNST	BEAR	0	0	0	0.05	0	0	0	0.05	0	0.01	0.11
0817-01	BNST	SLCANAL	0	0	0	0.06	0.2	0.2	0	1.23	0	0	1.69
0817-02	BNST	SLCANAL	0	0	0	0	0	0.2	1.31	0	0	0.13	1.64
0817-03	BNST	SLCANAL	0	0	0	0	0.18	0.01	0	0	0.18	0.02	0.39
0817-04	BNST	SLCANAL	0	0	0	0	0	0.05	0.87	0	0	0.01	0.93
0825-01	BNST	SLCANAL	0	0	0	0	0	0.2	0.01	0	0.01	0	0.22
0825-02	BNST	SLCANAL	0	0	0	0	0.02	0.26	0	0	0.03	0	0.31
0825-03	BNST	SLCANAL	0	0	0	0.62	0	0.01	0	0	0	0	0.63
0826-02	BNST	SLCANAL	0	0	0	0.34	0	0.04	0	0	0.08	0	0.46
0826-04	BNST	SLCANAL	0	0	0	0.28	0	0.08	0	0	0	0.04	0.4
0826-05	BNST	SLCANAL	0	0	0	0.13	0	0.1	0	0	0	0.04	0.27
0830-01	BNST	SLCANAL	0	0	0	0	0.32	0.49	0	0	0.08	0	0.89

Appendix 4. Volume (cm3) of material removed from the digestive tract of each bird collected in 2006. The bird ID # contains the date of collection (first and second digits – month, third and fourth digits – day, fifth and sixth digits – year, seventh and eighth – bird number).

Bird ID #	Species	Sex	Location	Gastropoda	Odonata	Corixidae	Carabidae	Dytiscidae	Hydrophilidae	Coleoptera parts	Limnephilidae	Culicidae	Ceratopogonidae	Chironomidae	Stratiomyidae	Syrphidae	Ephydridae	Muscidae	Misc. Diptera	Braconidae	Shells	Eggshell	Seeds	Other	Sum Contents
091206-01	AMAV	U	CDSC	0	0	0.01	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0.02
091206-02	AMAV	U	CDSC	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.02
091206-03	AMAV	U	CDSC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.27	0.07	0.34
091206-04	BNST	U	CDSC	0.02	0	0	0	0	0.04	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.05	0.14
091206-05	BNST	U	CDSC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0.01	0.06
091206-06	BNST	U	CDSC	0	0	0	0	0	0.02	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.03	0.02	0.17
091206-07	BNST	U	CDSC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0.08
091206-08	BNST	U	CDSC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0.09	0.12
06706-06	AMAV	F	FARM	0	0	0	0	0	0.02	0	0	0	0	0.01	0	0	0	0.02	0	0.03	0	0	0.08	0.04	0.2
06706-08	AMAV	M	FARM	0	0	0.01	0	0	0	0	0	0	0	0.01	0	0	0.01	0	0	0	0	0	0	0	0.03
06706-11	AMAV	M	FARM	0	0	0	0	0	0.03	0	0	0	0	0.05	0	0	0.03	0.03	0	0.02	0	0	0	0	0.16
06706-13	AMAV	M	FARM	0.05	0	0.03	0	0	0.02	0	0	0.02	0	7.95	0	0	0	0	0	0	0	0.01	0.03	0	8.11
06706-15	AMAV	M	FARM	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0.03	0.04
06706-09	BNST	M	FARM	0.03	0	0	0	0	0	0	0	0	0	0.64	0	0	0	0	0	0	0	0	0	0.32	0.99
06706-07	BNST	M	FARM	0	0.59	0	0	0.02	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.02	0	0.65
06706-10	BNST	M	FARM	0	0.05	0	0	0	0.02	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0.01	0.1
06706-12	BNST	F	FARM	0	0	0.06	0	0.01	0	0.01	0	0	0	0.08	0	0	0	0	0	0	0	0	0	0.01	0.17
06706-14	BNST	M	FARM	0	0	0	0	0	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.05
052406-01	AMAV	F	ISSR	0	0	0.09	0	0	0	0	0	0	0	0.01	0	0	0.02	0	0	0	0	0.05	0.02	0.01	0.2
052406-02	AMAV	M	ISSR	0	0	0.22	0	0	0	0	0.01	0	0	0.03	0	0	0	0	0	0	0	0	0.02	0.02	0.3

052406-03	AMAV	M	ISSR	0	0	0.06	0.27	0	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.38
052406-05	AMAV	F	ISSR	0	0	0.1	0.03	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0.04	0	0.01	0.2
052406-04	AMAV	M	ISSR	0	0	0.04	0	0	0	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0.01	0.05	0.12
071206-01	AMAV	M	KACR-N	0	0	0.28	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.29
071206-02	BNST	M	KACR-N	0	0	0.04	0	0.02	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09
071206-03	BNST	M	KACR-N	0	0	0.04	0	0.03	1.78	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.95
071206-04	BNST	F	KACR-N	0	0	0.02	0	0.04	0.75	0.19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
071206-05	BNST	F	KACR-N	0	0	0.04	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07
071906-08	AMAV	M	KACR-S	0	0	0.01	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.04
071906-07	AMAV	M	KACR-S	0	0	0.02	0	0	0.03	0	0	0	0	0.02	0	0	0	0	0	0	0	0	0.1	0	0.17
071906-09	AMAV	M	KACR-S	0	0	0	0	0	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0.05
071906-06	AMAV	F	KACR-S	0	0	0.02	0	0	0.01	0	0	0	0	0.02	0	0	0	0.01	0	0	0	0	0.02	0	0.08
071906-10	BNST	M	KACR-S	0.01	0	0.02	0	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.05
072606-02	AMAV	F	KACR-W	0	0	0	0	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.18	0.01	0.22
072606-01	AMAV	F	KACR-W	0	0	0	0	0	0.03	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0.09
072606-05	BNST	F	KACR-W	0	0	0.03	0	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.02	0.07
072606-03	BNST	F	KACR-W	0	0	0.04	0	0.01	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.08
072606-04	BNST	F	KACR-W	0	0	0	0.01	0	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0.04
071306-05	AMAV	F	PSGR	0	0.03	0.52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.55
071306-03	BNST	F	PSGR	0	0.02	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.12
071306-04	BNST	F	PSGR	0	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0.02	0	0	0	0.08
071306-02	BNST	M	PSGR	0.01	0	0.09	0	0.02	0.02	0	0	0	0.02	0	0	0	0	0	0.05	0	0.02	0	0.03	0.01	0.27
071306-01	BNST	M	PSGR	0.01	0.03	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0.04	0	0	0	0.01	0.01	0.13

051806-02	AMAV		SLCANAL	**0**	**0**	**0.04**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.07**	**0**	**0**	**1.69**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0.02**	**1.83**
051806-1	AMAV	F	SLCANAL	**0.18**	**0.01**	**0.11**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.29**	**0**	**0**	**0.03**	**0.02**	**0**	**0**	**0.02**	**0**	**0**	**0.05**	**1.71**
051806-3	BNST	M	SLCANAL	**0**	**0**	**0**	**0**	**0.06**	**0.03**	**0**	**0**	**0**	**0**	**0.13**	**0**	**0**	**0.04**	**0.02**	**0.02**	**0**	**0**	**0**	**0.02**	**0.09**	**0.41**
051806-4	BNST	M	SLCANAL	**0**	**0**	**0**	**0**	**0.17**	**0.77**	**0**	**0**	**0**	**0**	**0.15**	**0**	**0**	**0.07**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**1.17**
062806-1	AMAV	M	NDSC	**0**	**0**	**0.04**	**0**	**0**	**0.02**	**0**	**0**	**0**	**0**	**0.09**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.16**
062806-2	AMAV	M	NDSC	**0**	**0**	**0.02**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0**	**0.54**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.02**	**0**	**0.59**
062806-5	BNST	F	NDSC	**0**	**0**	**0**	**0**	**0**	**0**	**0.03**	**0**	**0**	**0**	**0**	**0**	**0.26**	**0**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0.03**	**0.33**
062806-4	BNST	M	NDSC	**0**	**0**	**0.02**	**0**	**0**	**0**	**0.05**	**0**	**0**	**0**	**0**	**0**	**0.22**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.02**	**0.31**
062806-3	BNST	F	NDSC	**0**	**0**	**0.01**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0.1**	**0.02**	**0**	**0.01**	**0**	**0**	**0**	**0.05**	**0.29**