Dietary Review for Aquatic Birds Utilizing Willard Spur, Great Salt Lake

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Introduction

The Great Salt Lake Ecosystem (GSL) is a site of hemispheric importance for millions of migratory birds. Understanding the diet of birds that rely on the GSL provides important information on their energetic requirements, as well as how these species utilize the habitat within and around this critical site. Here we summarize the current dietary information available for the suite of species that can be found utilizing the Willard Spur (Figure 1). These species were selected based on survey data from the Utah Division of Wildlife Resources, Great Salt Lake Waterbird Surveys (Paul and Manning 2002). All species recorded from this survey within the Willard Spur were included in this review.

The Willard Spur is located within Bear River Bay, directly south of the Bear River Migratory Bird Refuge. Several different habitat types occur within the spur. Salt-water habitat forms a large component of the spur. Eared Grebes, phalaropes, gulls as well as several species of ducks consume brine shrimp and brine flies that occur within this habitat. Piscivores, such as pelicans, grebes and cormorants are found in freshwater habitats that occur near inflows from streams and rivers such as the Bear River. Shorelines, playas and beaches make up a key component of the habitat of the spur because these areas have high concentrations of brine flies, and other prey that for many birds forms the bulk of their diet during spring and summer months. Wetlands, marshes and riparian areas occur primarily within the nearby Bear River Migratory Bird Refuge and private land. These areas provide much of the invertebrate and vertebrate forage and nesting sites for birds such as White-faced Ibis, Sandhill Cranes, swans, gulls, and waterfowl.

We compiled dietary information from primary literature and focused on quantitative studies when available. Initial literature searches concentrated on information specific for the GSL and Willard Spur. We then reviewed literature for quantitative studies from other regions within each species distribution. Literature was archived using Zotero. When available we note the seasons, number of individuals examined and methodology (ex. observational, stomach, proventriculus, ventriculus, aggregate percent biomass). We also include anecdotal evidence of prey items.

We include two tables that demonstrate gaps in our knowledge of the diet of these birds. First, we tabulated the presence or absence of diet studies for the GSL (Table 1). Second we show the general diet of these birds (Table 2).

Only a small number (15 of 52) of the species included here have had dietary studies on the GSL published. Of these fifteen only one, the California Gull, has been studied in all four seasons. The largest seasonal gap in our knowledge occurs during the spring, with only two studies. Breeding season includes seven studies while the winter and fall each have five. Insects form the largest component of the diet (n=44), while other invertebrates (n=36), plants (n=29) and fish (n=23) form the next highest prey categories. Only ten species include vertebrates in their diet. At least eleven species consume brine flies, while a minimum of eight species prey on brine fly larvae and brine shrimp.

Species Accounts

Pied-billed Grebe *Podiymbus podiceps*

Dietary data unavailable for the Great Salt Lake.

Diverse diet based on availability, includes insects, bugs (Hemiptera), fishes and crustaceans (Muller and Storer 1999). Wetmore (1924) published the only quantitative analyses of this species. He examined the stomach contents of 174 individuals. These were comprised of mostly beetles (33%), fish (20%) and bugs (21%).

Clark's Grebe *Aechmophorus clarkii*

Dietary data unavailable for the Great Salt Lake.

Little dietary data exists for this species due to recent split from *A. occidentalis*. Morphology, habitat, and natural history similarities of these two species suggests that their diet is similar. Diet is primarily fish with some insects and polychaete worms (Storer and Nuechterlein 1992).

Western Grebe *Aechmophorus occidentalis*

Dietary data unavailable for the Great Salt Lake.

The Western Grebe is known to have a diverse fish diet with approximately 80% taken during breeding season and 80-100% in general (Storer and Nuechterlein 1992, Lawrence 1950, Wetmore 1924). This species will consume crustaceans, insects, and polychaetes (Storer and Nuechterlein 1992).

Eared Grebe *Podiceps nigricollis*

Paul (1996) examined the stomach contents from birds collected from August to November 1996 on the Great Salt Lake: 7 August (n=8: recently arrived migrants, six had only a trace of shrimp and corixids, two earlier migrants contained entirely shrimp); 23 August (n=9: four full of shrimp and eggs, five mostly empty with a trace of flies in two); 5 September (n=3: all three appeared ill, two parasitized and one appeared to have cancer. One bird contained only flies, another all shrimp and the third 95% fly and 5% shrimp); 9 September (n=6: all shrimp); 20 September (n=8: all shrimp); 23 October (n=8: 100% shrimp); 12 November (n=7: six contained >90% shrimp while one contained equal portions of corixids and shrimp, stomachs of these birds were large but decreasing suggesting that food was running out); and 21 November (n=5: only corixids, 6-9 g).

On the Great Salt Lake during September 17 of 30 esophagi contained food (5 only adult brine, 2 only brine flies and 10 both), while 16 of 30 birds (esophagi) collected during November had eaten only adult brine shrimp (Conover and Vest 2009).

Caudell and Conover (2006) observed brine flies, larvae, corixids, white and red brine shrimp with and without eggs, and brine shrimp cysts from birds collected from June though September.

During April and May on Mono Lake, Nevada eared grebes consumed mostly (~100%; determined from gizzards) brine flies, pupae, and larvae, switching to mostly brine shrimp later in the year (July-October) with a small amount of dance flies (Diptera: Empididae) consumed during the month of July (Jehl 1988).

Wetmore (1924) summarized the diet determined from stomachs (n=27) from birds collected throughout the western United States throughout the years except for August, January and February (# of occurrances): Annulata (*Nereis* sp,, 1), Amphipoda (*Grammarus* sp. 1), Schizopoda (*Neomysis* sp., 1), unidentified crustaceans (2), Zygoptera (unidentified, 1), Anisoptera (Libellulid nymph, 1 and unid. nymph, 1), Orthoptera (unid. grasshopper, 1), Heteroptera (unid. Reduviidae, 1; *Belostoma* sp., 1; *Notonecta* sp., 1 and unid. Corixidae, 11), Phyrganoidea (unid. caddisfly larvae, 2), Lepidoptera (Pyralid caterpillars, 2; unid. caterpillar, 1 and unid. pupae, 1), Coleoptera (*Bembidium* sp., 2; *Amara* sp., 2; unid. carabid larvae, 1; unid. Carabidae, 4; *Haliplus cribrarius*, 1; *H. longulus,* 1; *H.* sp., 2; *Peltodytes callosus*, 1; unid. Haliplidae, 1; *Coelambus inaequalis*, 1; *C. patruelis*, 1; *Deronectes griseostriatus*, 1; *Rhantus binotatus*, 1; *Colymbetes* sp., 1; *Acilius* sp., 1; unid. dytiscid larvae, 4; unid. Dytiscidae, 2; *Gyrinus* sp., 1; *Helophorus* sp., 2; *Tropisternus* sp., 1; *Berosus striatus*, 2; *B.* sp., 2; *Philhydrus hamiltoni*, 1; *P.* sp., 1; unid. hydrophilid larvae,1; unid. Hydrophilidae,

1; *Philonthus fusiformis*, 1; unid. Staphylinidae; *Monocrepidius vespertinus*, *M.* sp., 1; *Myochrous longulus*, 1; *M. squamosus*, 2; *Dabrotica* sp., 1; *Hyperodes* sp., 2; unid. Curculionidae, 1and *Sphenophorus* sp., 1), Diptera (unid. stratiomyid larvae, 1; unid. dipterous larvae, 1 and unid. Diptera, 1), Hymenoptera (Ichneumonidae, 1 and Ants, 1), Chilopoda (unid. centipede, 1), Aradeida (unid. spiders, 2), Acarida (unid. aquatic mite, 1), Mollusca (*Planorbis* sp., 1), Pisces (unid. Cottidae, 1 and unid. fishes, 4) and Amphibia (frog,1).

American White Pelican *Pelecanus erythrorhynchus*

At Bear River Refuge, Cottam and Williams (1939) examined four stomachs and found minnows and carp. At Hat Island, Behle's (1958) examination of food piles of regurgitated fish by young birds in May 1932 revealed silverside minnows (66% by volume), carp (20%), chub minnows (10%) and suckers (4%). Current dietary information on the Gunnison Island population is being collected by the Utah Division of Wildlife Resources (pers. com. Jim Parrish, DWR).

Other dietary studies within the Great Basin provide more specific information on pelican diet. Eighteen stomachs examined at the Fallon area in Nevada by Alcorn (1943) over three years recovered six species of fish: yellow perch (*Perca flavescens*: 0.6% volume, 0.75" length), chub (*Siphateles obesus*: 1.1%, 4.0"), catfish (*Ameiurus nebulosus/melas*: 7.8%, 2.5-13.0"), largemouth bass (*Huro salmoides*: 13.4%, 2.0-4.0"), carp (*Cyprinus carpio*: 17.8%, 3.5-21.0"), and Sacramento perch (*Archoplites interruptus*: 59.2%, 1.0-7.0"). Also in Nevada but examined from regurgitated fish at nesting sites Alcorn (1943) found Cui-ui suckers (*Chasmistes cujus*: ~21"), carp (*Cyprinus carpio*: ~8"), and chubs (*Siphateles obesus*: no measurement). At Pyramid Lake, Nevada Knopf and Kennedy (1981) examined fish regurgitated by young and found mostly carp (*Cyprinus carpio*: 58.6%) and tui chub (*Gila bicolor*: 39.5%), while white crappie (*Pomoxis annularis*), Tahoe sucker (*Catostomus tahoensis*), Sacramento perch (*Archoplites interruptus*) and brown bullhead (*Ictalurus nebulosus*) comprised the rest of the fish taxa. Finally, analysis of boli found 24 species of prey items with the principle taxa comprised of carp, white suckers, tiger salamanders, crayfish and Iowa Darters in order of index of relative importance (IRI: Findholt and Anderson 1995).

Double-crested Cormorant *Phalacrocorax auritus*

Dietary data unavailable for the Great Salt Lake.

Double-crested Cormorant is primarily piscivorous, including game fish. Usually taking fish between 3-40 cm but averages below 15 cm (Hatch and Weseloh 1999). This species will occasionally eat insects and amphibians (Palmer 1962). Bent (1922) reported predation on a snake. The entire diet (regurgitated by young) of this species at Pyramid Lake, Nevada was comprised of Tui Chubs, measuring between 131-220mm (Knopf and Kennedy 1981)

Great Blue Heron *Ardea herodias*

On Gunnison Island, Great Salt Lake, Utah ten pellets from nests contained ground squirrel (76%), field mice (21%), carp (1.0%), miscellaneous insects (1%) and plants fibers from aquatic and marsh taxa (1%: Cottam and Williams 1939). At nearby Bear River six stomachs examined by Cottam and Williams (1939) contained (by volume) suckers (Castostomidae: 33.3%), minnows (Cyprinidae: 25.8%), plant fibers mostly from *Potamogeton* and *Scirpus* (22.5%), carp (16.7%), and diving beetles (1.7%). This species also has been observed taking muskrats (*Ondatra zibethicus*) on two separate occasions at the Bear River Migratory Bird Refuge, north of Willard Spur (Cavitt pers. obs.)

In general this species is an opportunistic forager on vertebrates and invertebrates (Vennesland and Butler 2011). Diet likely driven by local abundance of prey types (Butler 1991). For example voles made up to 40% of food items given to nestlings in Idaho (Collazo 1979).

Snowy Egret *Egretta thula*

Dietary data unavailable for the Great Salt Lake.

Primarily consumes fish and some crustaceans (Parsons and Master 2000). Data from interior populations is lacking. Tends to focus on a few species in a given habitat despite utilizing a large repertoire of foraging behaviors. Nestlings and adults consume primarily fish during the breeding season (see Parsons and Master 2000).

Cattle Egret *Bubulcus ibis*

Dietary data unavailable for the Great Salt Lake.

Summer diet (May-July) of nestlings determined by examining regurgitated boluses (n=50) weres similar across four localities in Florida (Lake Alice, L. Griffin, L Okeechobe, and Tampa Bay; Jenni 1973). For example, at Lake Griffin 18 taxonomic categories were identified and are as follows (no. of items, followed be percent of total volume): invertebrates (Orthoptera [Locustidae: 367, 31.4; Gryllidae: 303, 17.5; Tettigonidae: 165, 7.6; Tettigidae: 12, 0.7; Gryllotalpidae: 2, 0.4]; Odonata [Zygoptera: 1, 0.3; Anisoptera: 3, 0.1]; Isoptera: trace; Dermaptera: 2, 0.1; Coleoptera [Elateridae: 11, 0.1; unident. 7, 0.4; Curculionidae: 1, trace]; Diptera: 7, 0.4; Arachnids: 31, 1.7) and vertebrates (amphibians [*Bufo terrestris*: 26, 15.5; *Acris gryllis*: 34, 4.0; *Rana pipiens*: 6, 18.5; *Hyla* spp.: 1, 0.2]).

Also during summer in north-central Florida, an examination of 410 stomachs revealed an impressive diversity of taxa consumed by this species (Fogarty and Hetrick 1973).

Opportunistic generalist primarily takes insects flushed by grazing mammals (Telfair and Raymond 2006). Diet changes with seasons and availability and includes insects, primarily grasshoppers, Arachnids, amphibians and Noctuidae moths (Telfair and Raymond 2006). Examination of 20 undigested chick-boluses in Texas contained mostly fishes (58.9%), Decapods (39.1%), Odonata (1.7%) and Hemiptera (0.2%: Telfair 1981). A diverse diet was observed in egrets (n=115) during brooding on Lake Okeechobee, Florida with fish (91.4%) comprising the bulk, but also included leopard or pigfrog adults and tadpoles (1.3%), grass shrimp (5.0%), and crayfish (1.0%), Anisoptera nymph and adult (0.6%), Zygoptera (Odonata: 0.2%) and giant waterbeetle (0.3%). The top five items in this study were mosquito fish (29.10%), sailfin molly (28.8%), least killifish (8.1%), bluefin killifish (7.6%) and grass shrimp (Smith 1997).

Black-crowned Night-Heron *Nycticorax nycticorax*

Dietary data unavailable for the Great Salt Lake.

Highly variable generalist and will shift to available food sources (Hothem *et al.* 2010). For example, an individual was observed catching adult Cliff Swallows (*Petrochelidon pyrrhonota*) as they tended nests located on the underside of a bridge at the Bear River Migratory Bird Refuge (Cavitt pers. obs.). Diet can be all fish, all mammals or all insects or some combination (Henny et al. 2002). Predation on the young of other colonial nesting birds is not uncommon (Hothem et al. 2010).

White-faced Ibis *Plegadis chihi*

Dietary data unavailable for the Great Salt Lake.

In Louisiana ibis consumed crayfish, insects, snails, small bivalves, earthworms, small fish and frogs (Flickinger and Meeker mentioned in Belknap 1957)

Analysis of stomachs (n=88) from birds in Argentina across seasons, between sexes and versus aquatic and terrestrial prey was done by Soave et al. (2006: all percentages below were estimated from graphs). A total of 2731 items were recovered with an average of 31 per stomach, consisting primarily of animal matter. By volume and frequency of occurrence these fell into four broad taxonomic categories: Gastropoda (76%, 74%), Insecta (14%, 80%), Crustacea (8%, 40%) and other (2%, 21%). Seasonal changes in diet were most notable in insects with autumn and winter comprising less 5% of the total volume down from roughly 22% during spring and summer. Crustaceans made up about 17% and 25% of the volume for spring and autumn respectively, whereas Gastropods formed the bulk of the diet throughout the year with spring being the lowest (~60%) and winter (~90%) being the highest. More significant changes across the seasons are seen when considering prey numbers (by percentage). Spring was relatively balanced with insects (20%), crustaceans (45%), gastropods (30%) and others (5%), while

summer, autumn and winter experienced greater differences. These are: insect (45%, <2%, 55%, <2%), crustaceans (45%, <2%, 75%, 5%), gastropods (28%, 55%, 20%, <2%), and other (5%, <2%, 20%, <2%) for summer, autumn and winter respectively. Volume and frequency between the sexes are (male versus female): gastropods (80% vs. 62% and 82% vs. 59%), insects (12% vs. 21% and 73% vs. 91%), crustaceans (7% vs. 12% and 44% vs. 34%) and other (1% vs. 5% and 14% vs. 31%). Finally, comparisons of aquatic and terrestrial prey items between the sexes were noted. Both sexes consumed more terrestrial prey (63% males, 64% females) than aquatic items. See appendix in Soave et al. (2006) for a complete list of prey items.

Earthworms (Oligochaeta: Lumbricidae) were the primary (68% by volume) food item found in the esophagi of sixteen birds collected from irrigation fields in Nevada, with larvae from two families of insects, *Libellulidae* (15%) and *Tabanidae* (12%) comprising the bulk of the other taxa consumed (Bray and Klebenow 1988).

Canada Goose *Branta canadensis*

No diet data for the Great Salt Lake.

Will consume most types of residential (lawn) grasses (Conover 1991). Food items found during the examination of esophagi, proventriculus and gizzards from birds (n=33) collected during the spring, but prior to migration, in Minnesota yielded the following (by percent): corn (52), bluegrass (36), unidentifiable roots (27), spike rush (15), green plant remains (12), bulrush tubers (12), millet seeds (6), cereal grains (3), duckweed (3), snails (3) and no food present (9 McLandress and Raveling 1981)

Mallard *Anas platyrhynchos*

During breeding season 2010 (n=1) at Farmington Bay consumes equal portions of cranefly (Diptera: Tipulidae) larvae and bulrush achenes. Fall staging diet (2010; n=1) at Farmington Bay was 97% saltgrass Lemma, remaining 3% consisted of *Pulmonata, Potamogeton* seeds and *Ruppia* drupelets (Wilson *et al.* 2010). No further data on other seasons at Farmington Bay or the Great Salt Lake Ecosystem in general.

In Colorado during the breeding season: 37% *Scirpus spp* seeds, 19% *Eleocharis spp* seeds, 6% *Chenopodiaceae spp* seeds, 4% other seeds, 3% vegetable matter, 18% Chironomidae larva, 3% Coleoptera, 3% Gastropoda, 6% other inverts (Gammonley and Laubhan 2002).

Food from 306 birds from Chippewa National Forest during August through September contained 44 species of plants, fourteen made up 90% of the total volume (Stoudt 1944). The top fourteen plant species were (% volume): *Zizania aquatica* (35.5), *Potamogeton strictifolius* (22.8), *Sparganium chlorocarpum* (11.1), *Scirpus validus* (4.0), *Potamogeton natans* (3.4), *P. richardsonii* (2.3), *Naias flexilis* (2.0), *Ceratophyllum demersum* (2.0), *P. pectinatus* (1.5), *Carex* spp. (1.4), *P. zosteriformis* (1.3), *Carex pseudo-cyperus* (1.0), *Scirpus acutus* (1.0), *Sparganium eurycarpum* (0.9), and *Polgonum lapathifolium* (0.9).

Plant and animals were recovered from breeding males (n=39), nonlaying females (n=41), and laying females (n=37) in wetlands from south-central Dakota (Swanson et al. 1985).

Proportion of animal and plant was nearly identical between males and nonlaying females (males: 37.6 and 62.4; females: 37.0 and 63.0). Laying females consumed more animal matter (71.9%) than plants (28.1%). Animal matter for males was comprised of Gastropoda (6.3%: Lymnaeidae [4.1%] and Planorbidae [2.2%]), Insecta (16.8%: Coleoptera [0.5%], Diptera [10.0%], Odonata [0.9%] and Trichoptera [5.3%], and Crustacea (11.3%: Anostraca [0.4%], Cladocera [2.9%], Conchostraca [6.3%] and Amphipoda [1.7%]). Animal matter for nonlaying females was Gastropoda (4.5%: Lymnaeidae [0.1%] and Planorbidae [2.5%]) and Insecta (22.6%: Coleoptera [2.5%], Diptera [12.6%], Lepidoptera [1.5%], Odonata [0.2%] and Trichoptera [5.7%]), and Crustacea (7.5%: Anostraca [2.6%], and Conchostracea [4.4%]).

Laying females consumed the following Gastropoda (16.4%: Lymnaeidae [11.4%] and Planorbidae [2.8%]), Insecta (27.1%: Coleoptera [4.8%], Diptera [6.0%], Lepidoptera [2.8%], Odonata [4.5%] and

Trichoptera [8.7%], Crustacea (12.9%: Anostraca [4.2%], Cladocera [2.6%], Conchostraca [5.7%] and Amphipoda [0.4%]) and Oligochaeta (11.8%).
Percentage of seeds consumed by males, nonlaying and laying females respectively was: *Chenopodium* spp. (0.7, 2.3, n/a), *Ambrosia* spp. (1.6, 2.6, 2.9), *Helianthus annuus* (0.9, n/a, 2.4), *Carex* spp. (1.8, 0.4, n/a), *Scirpus* spp. (6.3, 0.2, 0.1), *Avena fatua* (2.4, n/a, n/a), *Echinochloa crusgalli* (18.3, 22.8, 5.9), *Glyceria* spp. (n/a, 3.1, n/a), *Hordeum vulgare* (n/a, 2.4, 0.2), *Phalaris arundinacea* (n/a, n/a 0.2), *Setaria* spp. (1.8, 5.3, 1.0), *Tritticum aestivum* (5.1, 11.0, 7.7), *Zea mays* (2.2, 2.2, n/a), *Polygonum* spp. (10.1, 1.1, 0.3), *Rumex* spp. (2.6,1.0, 0.4), *Potamogeton* spp. (n/a, 2.4, n/a). Vegetation comprised 6.0, 4.5, and 3.3 of diet for males, nonlaying and laying females respectively, whereas roots and tubers made up 4.1, 3.9 and 2.8 percent of the diet of these three categories.

In general, diet during the fall consists of pondweed, bulrush, wildmillet, spikerush, muskgrass, corn, alga, with sorghum, wildmillet, pondweed, bulrush, spikerush, muskgrass, corn, alga is consumed in the winter (Martin et al. 1951).

Overall mallard's have a diverse diet that is largely driven by hydrology and the seasons (Drilling et al. 2002).

Northern Pintail *Anas acuta*

One bird collected in September at Farmington Bay had eaten mostly *Ruppia* drupelets (75%) and *Potamogeton* seeds (25%). During the same period but at the Bear River Migratory Bird Refuge one bird had consumed mostly bulrush achenes (66.7%) as well as *Potamogeton* seeds (33.3%, Wilson *et al.* 2010). In another year (2010) four birds collected during staging/migrating period consumed 79.3% *Ruppia* drupelets with the remaining diet consisting of *Alismatales*, amphipods, ephemenoptera nymphs, bulrush achenes, Lemnaceae. Five birds from Bear River examined during the same period had consumed entirely wigeongrass (*Alismatales*: Wilson *et al.* 2010).

Euliss and Harris (1987) examined the diet of birds (n=262) feeding on four pond types between October and February in California. These birds fed mostly on plant seeds (72.3%) and animal matter (27.7%), however diet changed (shifted to most available food types) from mostly plants in October 82%-99% to half or 80% animal in February (swamp timothy [*Heleochloa shoenoides*] caryopses, chironomid midge larvae and common barnyardgrass [*Echinochloa crusgalli*] caryopses formed > 50% of diet).

Euliss *et al*. (1991) examined the diet of pintails wintering in California. Birds examined during March (n=24) consumed mostly midges (75%: 10% other animal, 8% other plants, 7% Alkali weed seeds). Seven birds collected in September consumed 40% widgeongrass nutlets, 40% midges, 15% water boatmen and 5% other. Birds from October (n=4) consumed mostly 75% widgeongrass nutlets, 25% peppergrass seeds, whereas five birds collected in January consumed 40% widgeongrass nutlets, 35% fog weed Seeds, 15% bed brome caryopses, 10% peppergrass seeds. Finally in February (n=17) birds consumed 65% widgeongrass, 12% midges, 9% water boatmen, 8% water boatmen eggs and 6% other plants (Euliss *et al.* 1991).

Krapa (1974) studied the diet of breeding pintails in North Dakota feeding in shallow, nontilled wetlands. Fourteen males had consumed mostly plants (70%: top three most common were-13.5% *Suaeda depressa* seed, 7.1% *Phalaris arundinacea* caryopses, 7% *Triticum aestivum* "wheat" caryopses) and 30% animal (20.5% *Diptera* flies and larvae). Examination of females (n=29) revealed a similar diet composed of 20.8% plant material, (top three most common were-2.5% sloughgrass caryopses [*Beckmannia syzigachne*], 2.4% Corn and 2.5% unidentified) and 79.2% animal (with the top three taxa being 28% *Diptera* flies and larvae, 22.5% snails, 11% fairy shrimp *Anostraca*). Birds (n=21) breeding in on shallow tilled wetlands consumed a larger percent of plants. For example males (n=7) diet consisted almost entirely of plants (99%: 55% barnyard grass *Echinochloa crusgalli*, 15% foxtail *Setaria glauca*, 14% wheat *Tricticum aestivum* among others) and 1% animal, mostly snails. Females (n=14) also consumed a large percent of plants (83.5%: with the top three most consumed being 71% barnyard grass, 8.5% foxtail and 1.3% wheat) and 16.6% animal taxa (the top three were 8.4% *Diptera*, 2.8% fairy shrimp and 2.3% water beetles). Hens feeding in fields (n=10) also mostly consumed plants (83.8%: top three were 68.4% wheat, 10% barley and 5.2% oats) and 16.2% animal (top3-7.3% snails, 3.9%

caddisflies larvae, 2.3% water beetles). Finally renesting hens (n=11) consumed a much lower amount of plants (16.1%: top three were 11% barnyard grass, 1.8 ragweed and 1.3% wheat) and 84% animal (top three were 40.7% diptera, 20.3% snails and 8.3% damselflies).

Krapu (1974) studied the feeding of females during breeding in the Drift Prairie and Missouri Coteau region of east central North Dakota.

Gadwall *Anas strepera*

Breeding birds at Farmington Bay, Great Salt Lake consumed midge larvae (58%), midge adults (33%) and *Alismatales* (8%) while at PSGR the diet was equal parts bulrush achenes and Dipterans. During the fall at Farmington Bay the diet was entirely *Alismatales*, while at PSGR roughly half (51%) was *Alismatales* with mayfly larvae (40%) and Coenagrionidae nymphs, adults, Corixidae and amphipods (Wilson *et al*. 2010).

Widgeongrass, muskgrass, eelgrass *Zostera*, pondweed, and *Najas* (Stewart 1962).

Outside of Great Salt Lake 42% vegetation, 13% *Scirpus* spp seeds, 4% *Eleocharis* spp seeds, 2% other seeds, 22% Chironomidae larva, 14% Crustacea, 2% Coleoptera, (Gammonley and Laubhan 2002).

American Widgeon *Anas americana*

Dietary data unavailable for the Great Salt Lake.

Will eat plants brought up by diving ducks (Stewart 1962). Also eelgrass and muskgrass (Bellrose 1980).

Northern Shoveler *Anas clypeata*

On the Great Salt Lake during winter months Northern Shoveler's consumed 52% Artemia cysts (52%), Artemia adult (20%), Ephydridae larvae (8%), Corixidae adults (5%) and larvae (3%: Vest and Conover 2011).

In general, about one-quarter of diet consist of ostracods, copepods, crustaceans, insects such as aquatic beetles, water boatmen, caddisfly larvae, naiads of Odonata, and small mollusks, (Martin et al 1951). Martin et al (1951) found duckweed (Lemnaceae) and vegetative parts of pondweeds (*Potamogeton*), wigeongrass (*Ruppia), bulrushes* formed most of the plant diet.

During the spring Northern Shoveler's will eat spike rush (*Eleocharis,* Keith 1961). During the month of March (Euliss *et al.* 1991) examined seventeen birds and found Copepods (83%), Rotifers (5%) and other animals.

Thirteen birds examined during the month of September fed mostly on water boatmen (70%), midges (18%), clover fern sporocarps (6%), widgeongrass nutlets (6%). During October Thirteen additional birds contained water boatmen (82%), midges (8%), widgeongrass nutlets (6%), with the remaining consisting of other plants (Euliss *et al.* 1991).

The winter diet observed by (Euliss *et al.* 1991) was as follows: November (n=13) water boatmen (84%), other plants (13%), alkali weed seeds (13%); December (n=11), water boatmen (75%), fescue caryopses (17%), other animals (3%) and other plants (1%); January (n= 30), water boatmen (42%), rotifers (45%), copepods (5%), other plants (4%), other animal (2%); and February (n=8), rotifers (60%), waterboatmen (28%) and midges (12%).

Blue-winged Teal *Anas discors*

Dietary data unavailable for the Great Salt Lake.

Euhliss *et al.* (1991) studied the diet of teals at evaporating ponds in California over several months. In May (n=#) 34.2% of the total dry volume was composed of plants (the top three most common were *Sparganium* seeds 10.8%, *Eleocharis* seeds 6.3%, *Carex* seeds 6.3%) and 65.8% animal (three most common were Gastropoda 42.8%, Diptera*/Chironomus* 14.9% and Amphipoda 6.1%). During the month of June 32.4% plant (with *Carex* seeds 11.4%, *Sparganium* seeds 7.3%, *Hippuris vulgaris* seeds 5.4% being the most common) and 67.6% animal (47.9% Gastropoda, 10.9% Trichoptera, 7.8% Amphipoda). In July 18.8% of the diet was plants (7.2% *Carex* seeds, 4.1% *Scirpus*, 3.8% *Eleocharis* seeds) and 81.2% animal (61.5% Hirudinea, 18.8% Gastropoda, 0.9% Diptera/*Chironomus)*.

The diet was similar during fall months. In August 69.8% plants (18.5% *Carex* seeds, 12.4% *Nuphar variegatums* seeds, 10.9% *Scirpus* seeds,) and 30.2% animal (26.7% Gastropoda, 2.1% Amphipoda, 1.4% Hirudinea). While in September 83.3% plant (51% *Nuphar variegatum* seeds, 10.3% *Scirpus* seeds, 7% *Carex* seeds) and 15.6% animal (15.6% Gastropoda, 0.1% Amphipoda).

In general insects, mollusk, crustaceans (Johnsgard 1975).

Cinnamon Teal *Anas cyanoptera*

Data for the Great Salt Lake comes from Wilson *et al.* (2010).
At Farmington Bay (n=4) during breeding season: 59% midge larvae, 19% *Alismatales*, 12% Chironomidae pupae, remaining comprised of Dipterans, *Ruppia, Potamogeton* seeds, Corixidae. At Bear River (n =2): 55% *Ruppia* drupelets, 32% bulrush achenes, 10.8% *Potamogeton* seeds, remaining items was comprised of *Alismatales*. PSGR (n=1): 16.7% Bulrush Achenes, 16.7 Diptera, 16.7 Coleoptera, 16.7 , Ruppia Druplets, and 16.7% Gastopoda.
At Farmington Bay in September (n=3), 33.3% of the diet consisted of *Schoenoplectus* achenes and 66.7% *Potamogeton* seeds. At Farmington Bay (n =3) during fall staging 86% of the diet was composed of Chironomidae larvae, with the remaining comprised of Corixidae, Diptera, *Schoenoplectus* achenes and Chironomidae pupae.

In Northern Arizona during the spring females (n=52) consumed 68% animal (35.8% *Diptera*, 15.5% Gastropoda, 5.5% Hemiptera, 4% Coleoptera, 1.7% Ephemroptera, 1.6% Amphipoda, 1.1% Cladocera, 0.9% Ostracoda, 0.8% Oligochaeta, 0.5% Arachnida, 0.5% Odonata, 0.4% Trichoptera, trace of Copepoda) and 31.7% Plant (includes: *Carex, Echinochloa, Eleocharis, Glyceria, Polygonum, Potamogeton, Scirpus* and unidentified material), whereas males (n=34) consumed 52.5% animal matter (32.6% *Diptera*, 8.4% Gastropoda, 3.5% Coleoptera, 3% Hemiptera, 2.1% Odonata, 2% Cladocera, 0.6% Ephemeroptera), 43.6% seeds and 3.9% plant material (Gammonley 1995).

At New Mexico's Bosque del Apache NWR, females, (n=28: looked at four habitat types, diet varies slightly between habitats) animal diet 37.6% to 74.9% (top five most common items were: Chironomids, Cladocera, Gastropoda, Diptera, Ostracoda) and plant (smartweeds, hardstem bulrush, sunflower, alkali bulrush, three-square bulrush, flatsedge *Cyperus strigosus*, sprangletop, saltgrass, (Thorn and Zwank 1993).

In Colorado during the summer 19% of the diet consisted of *Scirpus* seeds, 16% *Eleocharis* seeds, 2% Chenopodiaceae, 18% Chironomidae larva, 5% Ephydridae larva, 3% Stratiomydae larva, 2% other inverts, 13% Gastropods, 7% Coleoptera, 2% Ephemeroptera, and <1% Hemiptera, (Gammonley and Laubhan 2002).

Also at Bosque del Apache NWR but during the fall immature birds (n=15) from three habitat types, consumed plants from 81.3% to 91.3% (top plants: wild millet, smartweeds, hardstem bulrush, alkali bulrush, three-squared bulrush and *Potamogeton*) and animal materials from 8.8-18.7% (top animals: Gastropoda, Odonata-Coenagrionidae: Thorn and Zwank 1993).

Green-winged Teal *Anas carolinensis*

One bird collected in September contained 75% *Schoenoplectus* achenes and 25% Chironomid midges (Wilson *et al.* 2010). Three breeding specimens at Farmington Bay contained 94% midge larvae, 4% *Schoenoplectus* achenes and 2% *Potamogeton* seeds, whereas three birds collected later during the staging period consumed 60% midge larvae and 40% bulrush achenes (Wilson *et al*. 2010).

During the winter on the Great Salt Lake teals were found to have consumed 80% *Artemia* cysts, 11% Ephydridae larvae and 2% adult Corixidae (Vest and Conover 2011).

In general bulrush, smartweed, bristlegrass, ragweed, sedge and plant seeds (Johnsgard 1975, Martin *et al.* 1951).

Lesser Scaup *Aythya affinis*

Dietary data unavailable for the Great Salt Lake.

In general 91% animal-breeding, 94% animal-fall, 64% animal-winter (Rogers and Korschgen 1966).

An exhaustive study by Dirschl (1969) examined birds over several months on the Saskatchewan River Delta. In May, 9.1% plant (top three by dry weight are 5.2% *Ceratophyllum* seeds, 2.8% *Myriophyllum* seeds, 0.6% *Scirpus* seeds) and 90.9% animal (top3- 66% Amphipoda, 12.7% Pelecypoda/Sphaeriidae, 12% Hirundinea). During June 4.7% plant (less than 2% for *Scirpus, Myriophyllum and Potamogeton seeds)* and 95.3% animal (with the top three being Amphipoda (67.4%), Hirundinea (18.3%) and Pelecypoda (5.6%)). In July 4.9% plant material (three most common, less than 2% *Sparganium, Scirpus and Potamogeton* seeds*)* and 95.1% animal (three most common were 49% Hirudinae, 20.6% Amphipoda, 11.5% Pelecypoda/Sphaeriidae). While in August the diet was mostly plant (65.1%: with the top tree most common items being *Nupher variegatum* seeds (39.2%), *Sparganium* seeds (12.2%), and *Scirupus* seeds (6.3%)), with animals making up 34.9% of the diet (Gastropoda 11.1%, Amphipoda 8.7% and Pisces/Cyprinidae 8.7%). Later during September the plant portion was even larger at 94.1% (*Nuper variegatums* seeds 85.6%, *Sparganium* seeds 2.9% and *Myriophyllum* 2.2%). Finally, in October the diet switch to mostly animal matter (93.3%: Amphipoda 85%, Trichoptera 4.5% and Hirundinae 3.5%) with only 6.7% of the total dry weight being plant matter (*Potamogeton* seeds 3.3%, *Scirpus* seeds 2.2% and *Lemna* 0.8%).

Breeding bulrush, wigeongrass, pondweed, muskgrass, watermilfoil, smartweed; amphipods (Rogers and Korschagen 1966, Munro 1941).

Examination of esophagi and proventriculus of birds (n=32) from Lake Erie and Lake St. Clair during the spring and fall had the following items (percent aggregate volume): Lake Erie (n=27: Mollusca (zebra mussels, 98.6; *Amnicola walkeri*, 0.2; *Physella integra*, 0.9; Sphaeriidae, <0.1), Isopoda (*Caecidotea*, sp., 0.2) and Annelida (0.1)); Lake St. Clair (n=5: Mollusca (zebra mussels, 54.4; *Amnicola walkeri*, 2.6; *Pleurocera acuta*, 20.2; *Physella integra*, 1.0; *Valvata* sp., 0.8; *Gyraulus* sp., 1.2; Sphaeriidae, 1.2; *Ferrissia parallela*, 0.1), *Hyalella/Gammarus* spp., 14.4, *Caecidotea* sp. (Isopoda, 3.0), Diptera (1.3) and fish (<0.1: Custer and Custer 1996).

Esophagi and proventriculus of birds (n=14) collected during the fall and winter in southwestern South Carolina contained mostly animal matter (89.3%) consisting of Pelecypoda (*Corbicula fluminea*, 50.3% and *Anodonta umbecillis*, 14.0%), Gastropoda (*Helisoma* spp., 13.3% and *Physella heterostropha*, 6.6%), Diptera (*Chironomidae*, 3.6%) and Odonata (Anisoptera nymphs, 1.5%). Plants made up 10.7% of the volume collected from these birds with *Eleocharis* sp. Comprising only trace amounts and an unknown plant comprising the rest of the volume (Hoppe *et al.* 1986).

Canvasback *Aythya valisineria*

Dietary data unavailable for the Great Salt Lake.

In general diet is influenced by season, age and local prey availability (Mowbray 2002).

Stomachs from 130 males collected during postreproductive molts (from early preflightless to staging) contained between 96 to 100% dry aggregate mass plant material, with *Potamogeton pectinatus* forming 80 to 99.9% of the total. Total animal matter (mostly Chironomidae) formed 5.4% during the first stage, 6.7% dry mass in the second late preflightless stage, 1.2% and 1.1% in flightless and postflightless stages, respectively (Thompson and Drobney 1997). Austin et al (1990) found little diet difference between the sexes during the breeding season in Manitoba, with both plant and animal matter consumed. Prelaying diet at Mono Lake was over 90% plant material with females shifting to more invertebrates (78%) during egg laying (Noyes and Jarvis 1985). During fall and spring migrations plant material comprised nearly 100% of the diet of birds in the upper Midwest (Lovvorn 1990, Korschegen *et al.* 1988).

The most exhaustive study on the diet of canvasbacks was conducted during the spring and summer in southwestern Manitoba (Bartonek and Hickey 1969). The esophageal contents (by aggregate percent volume), of juvenile (n=86), adult females (16) and adult males (13) was determined. These are (juvenile, female and male respectively): *Zannichellia* nutlets (8, n/a, n/a), *Chara* oögonia (2, trace, n/a), *Potamogeton* tubers (1, 7, 95), other seeds and vegetative parts (trace, trace, 2), total plant material (13, 8,

98), Trichoptera larvae and cases (59, 10, n/a), Gastropoda (18, 66, n/a), Tendipedidae larvae and pupae (8, 2, 2), Ephemeroptera nymphs (1, 13, n/a), miscellaneous aquatic Insecta (1, trace, n/a), other aquatic invertebrates (trace, n/a, n/a). Total animal material was 87%, 92% and 2%. This same study examined the esophagus-proventriculus-gizzard contents of juveniles (120), adult females (23) and males (19). The contents were (by aggregate percent volume): *Potamogeton* tubers and winter buds (3, 13, 81), nutlets (2, 6, 4), *Zannichellia* nutlets (4, n/a, n/a), *Chara* oögonia and vegetative parts (4, 2, n/a), *Scirpus* achenes (3, 4, 3), *Ceratophyllum* nutlets (3, trace, trace), *Carex* achenes and perigynia (1, trace, 2), *Myriophyllum* nutlets (trace, 1, 1), *Chenepodium* utricles (trace, trace, 5), varies seeds and vegetation (1, 1, trace) and total plant material (21, 27, 96). Total animal material was (79, 73, 4) and consisted of Trichoptera larvae and cases (61, 24, 1), Gastropoda (10, 33, n/a), Tendipedidae larvae and pupae (4, 5, 3), Odonata nymphs (1, trace, n/a), Ephemeroptera nymphs (1, 8, n/a) other aquatic invertebrates (1, 1, trace), and unidentified animal matter (79, 73, 4).

Esophageal and esophagus-proventriculus-gizzard contents were also examined from birds collected during the hunting season (late September to early October) in southwestern Manitoba (Bartonek &and Hickey 1969). These birds were not separated by sexes as in the summer analysis. Esophagea contents were as follows (n=7: percent aggregate volume): *Potamogeton* tubers (71), *Chara* vegetation (5), *Myriophyllum* nutlets (1), other vegetative parts and seeds (1). Total esophageal plant content was 78%, whereas animal content was comprised of Ephemeroptera nymphs (18), Zygoptera nymphs (3) and other aquatic invertebrates (1). The esophagus-proventriculus-gizzard contents from thirteen birds was: *Potamogeton* tubers and winter buds (51), nutlets (20), *Scirpus* achenes (4), *Chara* vegetative (4), *Myriophyllum* nutlets and vegetation (1), various seeds (1) and unidentified plant parts (5). Fourteen percent of the total volume was comprised of animals: Ephemeroptera nymphs (12), Zygoptera nymphs (1) and miscellaneous aquatic invertebrates (1).

Redhead *Anthya americana*

Dietary data unavailable for the Great Salt Lake.

During the breeding season in the Prairie Pothole Region, North Dakota Redhead's consume both invertebrates and plants (Woodin and Swanson 1989). Stomach contents from 59 adult Redheads reveal a diet composed of 60% macro-invertebrates and 1% micro-invertebrates, with Diptera forming the largest component of animal prey. Plant matter made up 39% of the diet. Proportions of major food types were similar in females across prelaying, laying and postlaying periods (males were not broken-down by periods). The following plant genera were consumed: propagules from shallow marsh habitat - *Alisma, Beckmania, Echinochloa, Eleocharis* and *Glyceria*, from deep marsh habitat, *Scirpus*; vegetation - Algae ssp., *Chara, Lemna,* Potamogeton and Zannichellia (Woodin and Swanson 1989).

At Ruby Lake, Nevada nine males consumed 65% vegetable matter, 16% seeds and 19% animal, with tule bulrush, muskgrass, *Trichoptera* larvae, and largemouth bass eggs forming the bulk. The diet of ducklings (n=27) differed from adults with 47% of their diet composed of animal, mostly waterboatmen, and muskgrass forming the bulk plant items (Jarvis and Noyes 1986).

The diet of females was also studied at Ruby Lake, Nevada (Noyes and Jarvis 1985). Three-fourths of the diet of pre-laying breeding females (n=13) was comprised of muskgrass (*Characeae*), whereas midge and caddisfly larvae and mayfly nymphs made up the majority of animal matter. During egg-laying females consumed a larger portion of animal matter (77%) with large-mouth bass eggs and dragonfly nymphs forming the largest component of the diet. Portions of animal and plant matter were roughly equal during incubations, but switched to nearly 100% plant during brooding.

Stomach contents from 15 postbreeding males from southwestern Manitoba were examined by Bergman (1973). In this study 96% of the diet was comprised of plants, with *Potamogeton pectinatus, Chara* and *Ruppia* forming the majority of taxa eaten. *Corixidae*, *Chironomidae* were the most consumed animal taxa. Similar results from Manitoba from males (n=98) and females (n=25) were obtained by Bailey and Titman (1984), with plant foods comprising 92-99% of the diet of both sexes. Fennelleaf pondweed and tule bulrush achnes formed the majority of items consumed by both sexes.

Will consume Zebra mussels during migration (Custer and Custer 1996). Smith (1979) reports *Chara spp., Potamogeton fresii, Zea mays*, wheat, wild celery and *Najas spp.*, were eaten during fall months at Long Point Ontario.

Coastal populations during winter rely on shoalgrass, but will also consume a variety of gastropod species (ex. Michot and Nault 1993). Wintering inland populations consume *Potamogeton* and *Elodea* species of plants (Thompson et al. 1988).

An exhaustive study examined esophageal and esophageal-proventriculus-gizzard contents from juveniles, adult females and males during spring and summer in southwestern Manitobal (Bartonek and Hickey 1969). Esophageal contents from juveniles (n=37), adult females (n =6), and adult males (n =6) was as follows (percent aggregate volume, juveniles, females and males respectively): *Chara* oögonia (16, n/a, n/a) and vegetation (2, n/a, na/a), *Scholochloa* grains (17, trace, trace), *Chlorophyceae* (8, n/a, trace), *Ranunculus* achenes (5, n/a, n/a), *Scirpus* achenes (3, 4, trace), *Potamogeton* winter buds (3, 15, 12), *Lemna* vegetative (2, trace, trace), miscellaneous seeds (1, trace, 2). Total plant material was 57%, 19%, and 14%. Animal matter was comprised of Trichoptera larvae and cases (18, 80, 62), Gastropoda (11, n/a, n/a), Cladocera adults and ephippia (7, n/a, n/a), Tendipedidae larvae and pupae (1, trace, 22), invetebrate eggs (5, n/a, n/a) and miscellaneous aquatic invertebrates (1, trace, 2). Diet contents from esophagus-proventriculus-gizzards (juveniles, n=59; adult females, n=10, adult males, n=14) was as follows: *Chara* oögonia (11, n/a, n/a) and vegetation parts (1, n/a, n/a), *Potamogeton* winter buds (7, 19, 50) and nutlets (3, 1, trace), *Scolochloa* grains (7, 2, 9), *Scirpus* achenes (6, 5, 2), *Ranunculus* achenes (5, n/a, trace), Chlorophyceae (5, trace, trace), various seeds and vegetative parts (2, trace, 2). The total plant material was 46%, 27% and 64%. Animal matter was composed of Trichoptera larvae and cases (36, 72, 33), Cladocera adults and ephippia (5, n/a, n/a), Gastropoda (4, trace, n/a), Tendipedidae larvae and pupae (1, 1, 3), Corixidae adults and nymphs (1, trace, n/a), invertebrate eggs (5, n/a, n/a) and miscellaneous aquatic vertebrates (trace, trace, trace).

Esophageal contents from birds (n=5) collected from late September to early October in southwestern Montana contained 99% *Chara* vegetation and a trace of *Hordeum* grain (Bartonek and Hickey 1969). *Chara* vegetation made up the largest percent (96) of the total volume, as well as *Potamogeton* vegetation and nutlets (1), various seeds (2) and unidentified plant material (1), recovered from the esophagus-proventriculus-gizzard of sixteen birds collected during the same period (Bartonek and Hickey 1969).

Common Goldeneye *Bucephala clangula*

In the winter esophagi were examined (n=355: aggregate percent biomass) from birds collected on the South Arm of the Great Salt Lake, brine fly larvae (67.6%), *Artemia* cysts (3.9%) and Hemiptera-Corixidae (8.1%) formed the bulk of the diet (Vest and Conover 2011).

Outside of the Great Salt Lake region breeding cladocerans, gastropod mollusks, larva of Trichoptera and Tendipedidae, (Bartonek and Hickey 1969).

Predominately consumes animals on breeding grounds, mostly Odonata nymphs and the larvae of caddisflies (Eadie *et al.* 1995). Salmon eggs and fish made up to 66% of the diet of birds in British Columbia during the winter (Munro 1939).

In general diet varies depending on season and if birds are foraging in salt or freshwater habitats (Eadie *et al.* 1995). Cottam (1939) examined the contents of the stomachs of 395 birds throughout the year and found that crustaceans formed the bulk of prey items (32%) while insects and mollusks made up 28% and 10% respectively, seeds and plants made up 26% of the total volume.

Bufflehead *Bucephala albeola*

Dietary data unavailable for the Great Salt Lake.

In general mollusks, fish eggs, fish, snails, insects, seeds and vegetable matter (Wiemeyer 1967).

Examination of esophagus and proventriculus of fifteen birds from Lake Erie during the spring and fall had the following items (percent aggregate volume): *Hyalella/Grammarus* spp. (Amphipoda, 46.6), zebra mussels (23.5), *Caecidotea* sp. (Isopoda, 8.8), *Polygonum* sp. Seeds (6.7), wildcerely

winterbuds (6.1), *Hydropsyche* sp. (Trichoptera, 4.8), *Enallagma* sp. (3.6), crustaceans (1.1), *Amnicola walkeri* (Mollusca, 0.6) and Trichoptera adults (<0.1: Custer and Custer 1996).

Diet of females (upper digestive tracts [eosophagus and proventriculus) over five periods of the breeding season in central British Columbia was examined by Thompson and Ankney (2002).

Ruddy Duck *Oxyura jamaicensis*

Dietary data unavailable for the Great Salt Lake.

In general submerged plants, *Macoma spp* of bivalves, small *Mya and Mulinia clams*, gastropods *Acteocina*, amphipods, ostracod crustraceans (Stewart 1962). Also pondweeds (30%), sedges (18%), muskgrass (4%), wildcelerey (2%), smartweed (2%), animal (22%), midges (15%), mollusk (3%), crustaceans (3%: Cottam 1939).

Thirteen birds collected during the fall and winter in South Carolina had the following items in their esophagi and proventriculus: animal (58.9%: Diptera (Chironomidae, 57% and Culicidae, 0.7%), Odonata (Anisoptera nymphs, 0.8%), Gastropoda (*Helisoma* spp., 0.4%) and Coleoptera (Dytiscidae, trace) and plant (41.1%: *Eleocharis* sp., 15.4%; unknown veg., 11.9%; unknown seeds, 7.7%; and *Nymphaea odorata*, 6.1%: Hoppe *et al.* 1986).

Euliss *et al.* (1991) studied the diet of this species in California over several months. In March (n=32) the diet was composed of midges (80%), brine flies (15%) and plants (5%).
During September (n=20), the diet consisted of water boatmen (58%), Midges (26%) widgeongrass nutlets (7%), other animal (5%) and plants (4%). In October (n=22) waterboatmen 55%, midges (24%) and other plants (21%). During the month of November (n=25), water boatmen (50%), midges (28%), brine flies (10%), filaree (8%) and other plants (4%). In December (n=31), midges (55%), water boatmen (45%). During January (n=31), water boatmen (50%), midges (40%), wigeongrass nutlets (5%) and 5% other plants. Finally in February (n=26), midges (75%), water boatmen (13%), 8% other plants and 4% filaree (Euliss *et al. 1991*).

American Coot *Fulica americana*

Dietary data unavailable for the Great Salt Lake.

Nesting coots in southeastern Washington consumed (via proventriculus and gizzard; % frequency, juvenile [n=48] and adults [n=95] respectively): filamentous algae (18.2, 22.5), *Chara* (1.6, 4.5), *Potamogeton* (22.5, 21.2), *P. pectinatus* (19.5, 16.7), *Scirpus* (0.2, 0.4), *Lemna* (0.5, 0.5), *Typha latifolia* (0.6, 0.5), *Ranunculus aquatilis* (0.2, 2.9), *Myriophyllum* (14.0, 17.0), undetermined plant taxa (2.2, 2.7) and invertebrates (20.5, 11.1: Fitzner *et al.* 1980).

Sandhill Crane *Grus canadensis*

Dietary data unavailable for the Great Salt Lake.

Omnivore will consume grains from cultivated fields, small mammals, berries, tubers and insects, with little differences between seasons (Tacha *et al*. 1992, Tacha *et al*. 1985, Iverson et al 1982).

Black-bellied Plover *Pluvialis squaterola*

Dietary data unavailable for the Great Salt Lake.

One breeding bird from the Northwest Territories had feed primarily on flies (Hanset et al. 1956, cited in BNA account: Paulson 1995). Twenty-three breeding individuals from Wrangel Island, Alaska had consumed caterpillars, beetles, caddisfly larvae, flies, and amphipods (Glutz von Blotzheim et al. 1975, cited in Paulson 1995).

Nonbreeding birds consume bloodworms, gastropods, polychaetes, and bivalves (Paulson 1995, Recher 1966).

Snowy Plover *Charadrius nivosus*

Dietary data unavailable for the Great Salt Lake other data mostly foraging observations.

Ephydra, beetles, moths and caterpillars were consumed in evaporating ponds in San Francisco Bay (Feeney and Maffei 1991; cited in Tuckier and Powell 1999). Individuals on Mono Lake consumed *Artemia monica*, several taxa of flies, including *Mosillus, Ephydra, Thinophilus,* and *Lamproscatella*, beetles, and Hemiptera (Swarth 1983). Observed foraging on burrowing beetles and *Ephydra* in Oklahoma (Grover and Knopf 1982).

Breeding birds on the California coast mostly consumed Coleoptera, with species of Staphylinidae (rove beetles) and tiger beetles (Cicindelidae) forming the majority of stomach contents. Other taxa were Dipterans, mostly Ephydridae, Dolichopodidae and Anthomyiidae, and Hymenopter and Hemiptera (Tucker and Powell 1999).

Killdeer *Charadrius vociferus*

Dietary data unavailable for the Great Salt Lake.

Breeding birds in South Dakota consumed almost entirely animals (99%: 77% beetles, 14 aquatic arthropods, 5% crickets: Baldwin 1971). While breeding birds in Colorado had a slightly more diverse diet (46% Coleoptera, 17% Chiromidae larva, 9% Stratiomydiae larva, 5% Ephydridae, 4% Gastropods, 5% other inverts, >1% seeds, 1% Hemiptera, Total dipterans=43%, Gammonley and Laubhan 2002).

Thirty of the thirty-five birds during the fall of 2007 contained ≥ 1 food item. Of these, 100% (n=30) contained invertebrates and 16.7% (n=5) contained plant seeds. Nematoda (round worms) were the most common item found, occurring in 66.7% (n=20) of birds (Stafford *et al*. 2008).

American Avocet *Recurvirostra americana*

Breeding birds on the Great Salt Lake were found to have a diet that consisted of 33.7% Chironomidae, 23% Corixidae, 15% seeds, Ephydridae, 5% Hydrophilidae (Cavitt 2006a). Avocets feed exclusively on adult brine flies during breeding season at Mono Lake, Nevada (Mahoney and Jehl 1985). Prey items from the analyses of mouth, esophagus and proventriculus as well as the entire digestive tract (mouth, espophagus, proventriculus and the ventriculus) from adult males and females were conducted by Cavitt (2006b) and Cavitt and Stone (2007). Contents from the mouth, esophagus and proventriculus from birds collected on Antelope Island (n=5), Ogden Bay (n=5) and Saltair (n=5: respectively) found the following items (by percent aggregate volume): brine flies (100, 20, 36), midges (0, 66, 40), miscellaneous Hemiptera (0, <20, <20), Corixidae (0, <5, <5), Muscidae (0, 0, ~10) and Braconidae (0, 0, <5). Analysis of the entire digestive tracts (n= recovered a more diverse diet: brine flies (65, 18, 30), seeds (34, 6 [includes other plant material], 0), midges (0, 52, 34), water boatmen (0, 16, ~5), Coleoptera (0, ~5, ~12), Hemiptera (0, 0, ~10), miscellaneous dipterans (0, ~6, <6), and Braconidae (0, 0, 11).

In Colorado during the breeding season stomachs from 52 breeding birds were comprised of 52% Chiromidae larva, 17% Coleoptera, 6% Gastropods, 5% Hemiptera, 5% other inverts, 4% seeds, 4% Ephydra larva (Gammonley and Laubhan 2002). Plant seeds, most notably *Scirpus*, made up less than 4% of the total diet of birds in Colorado (Gammonley and Laubhan 2002).

Migrating avocets (n=9) in California mostly relied on Ostracods (24%) and two Amphipods *Gemma gemma* (52%) and *Neanthes succinea* (16%: Recher 1966). Nine wintering birds in the high plains of Texas consumed Chironomids (70%), seeds (19%) and adult butterflies (10%: Baldassarre and Fischer 1984).

In general avocets obtain invertebrates from shallow pools, but will also take terrestrial invertebrates (Robinson et al 1997).

Prefers small prey items between 0.1-10.0 mm 81% of time during the spring and 91% of the time during the fall (Davis and Smith 2001).

Black-necked Stilt *Himantopus mexicanus*

During the spring on the Great Salt Lake, stilts consumed Corixidae (30%), Chironomidae (17%), Hydrophilidae (7%), Ephydridae (5.6%), and seeds (4%: Cavitt 2006a). Analysis of the diet of birds breeding at Ogden Bay was conducted by Cavitt (2006b). Examination of the mouth, esophagus and proventriculus from five birds (males=4, females=1) found (by percent aggregate volume): miscellaneous

Coleoptera fragments (50), water boatmen (30) and 20% brine flies. Analysis of dietary items from the entire digestive tract (including the ventriculus) recovered a more diverse diet; miscellaneous Coleoptera fragments (30), Odonata parts (26), water boatmen (13), Muscidae (12), brine flies (9), Hemiptera (<9) and Chrionomidae (<2).

In general there are few studies on this species. Feeds primarily on brine shrimp and flies, and other insects while foraging on saline bodies of water (Hamilton 1975). Wetmore (1925) examined eighty birds foraging in non-saline wetlands and found stilt's feed primarily on Hemiptera and beetles, with flies, snails, caddisflies and fish making up less 20% of the diet.

Greater Yellowlegs *Tringa melanoleuca*

Dietary data unavailable for the Great Salt Lake, little data elsewhere.

Two stomachs of migrating birds in Illinois in the month of October contained 88% Anisoptera and 12% Cyprinidae, whereas one individual in November had mostly Dystiscidae (50%), Physidae (bladder snails: 25%) and Stratiomyidae (soldier flies: 10%; Brooks 1967).

In general diet (summarized from BNA account and references therein) consists of Odonata naiads, Hemiptera, fish, diving beetles and larvae, snails, soldier fly among others (Elphick and Tibbitts 1998).

Lesser Yellowlegs *Tringa flavipes*

Dietary data unavailable for the Great Salt Lake.

Four individuals (stomachs) collected during September in Illinois contained Chironomids (35%), Dytiscidae (23%), Corixidae (20%), Hydrophilidae (6%) and Physidae (4%: Brooks 1967). In the same study birds collected during October (n=5) contained a large volume of Corixidae (59%), Dystiscidae (17%), Anisoptera (10%), Corixidae (8%), with Hydrophilidae, Coenagrionidae, and miscellaneous insects making up 6% of the total diet.

A majority of fall birds (37 of 40) contained ≥ 1 food item. Invertebrate foods occurred in 100% (n=37) of individuals, whereas plant seeds occurred in 40.5% (n=15). The most common food consumed by Lesser Yellowlegs were invertebrates (primarily unidentifiable parts, e.g., heads, legs) which were present in 51.4% (n=19) of birds (Stafford *et al*. 2008).

Spotted Sandpiper *Actitis macularius*

Dietary data unavailable for the Great Salt Lake.

Diet consists primarily of aquatic invertebrates (Oring *et al.* 1997). Midges and mayflies form the bulk of the diet in Minnesota (Lank *et al.* 1985, Maxson and Oring 1980, Rubbelke 1976).

Long-billed Curlew *Numenius americanus*

Dietary data unavailable for the Great Salt Lake.

Opportunistic carnivore taking mostly invertebrates, but also known to consume bird eggs and nestlings among others items during breeding season (Dugger and Dugger. 2002, Goater and Bush 1986, Sadler and Maher 1976). Crab and ghost shrimp when not breeding (Leeman *et al.* 2001).

Marbled Godwit *Limiosa fedoa*

Dietary data unavailable for the Great Salt Lake.

Recher (1966) examined gizzards from nine birds along the central coast of California over several years (fall to spring). He found the following five prey items (by percent composition): Amphipods (*Neanthes succinea* [76.0] and *Gemma gemma* [6.2]), Ostracods (*Ilyanassa obsolete*, >0.25"[8.7] and <0.25 [2.5]; and *Mya arenaria* and *Macoma inconspicua* [combined = 6.6]). Ramer *et al.* (1991) examined diet in California in fall (n=6; stomachs), winter (n=9) and spring (n=9; by percent occurance and fall, winter and spring respectively): polychaeta (83, 33, 0), *Capitella capitata* (33, 44, 0), *Gemma gemma* (33, 33, 11), Spionidae (67, 44, 0), *Macoma* spp. (17, 44, 44), Bivalvia (17, 33, 22), Algae (likely eaten by accident: 50, 33, 67), *Boccardia hamata* (17, 6, 0), *Protothaca staminea* (17, 11, 22), *Macoma nasuta* (0,

44, 0), *Hemigrapsus* spp. (17, 22, 0), *H. oregonensis* (0, 11, 44), *Pachygrapsus crassipes* (0, 11, 0), crab fragments (17, 0, 22), and eggs 0, 0, 22).

Willet *Tringa semipalmata*

No diet data for the Great Salt Lake and no quantitative studies have been undertaken.

The following is a summary list of items eaten by this species (Lowther *et al*. 2001; and references therein): Coleoptera (Hydrophilidae: *Tropisternus*, *Berosus*, *Enochrus*), diving beetles (Dystiscidae), Curculionidae, spiders, Cypriniformes, shorecrab (*Hemigrapsus*), cirratulid sandworms, brachyuran crabs, *Macoma* and *Pachyrapsus* clams and crabs, Polycheates, Caenogastropoda, *Gemma gemma* and *Protothaca staminea* clames, mussels (*Mytilus*), amphipods, fiddler crabs and mole crabs.

Sanderling *Calidris alba*

Dietary data unavailable for the Great Salt Lake.

No know data during breeding season.

Spring diet during migration was examined at Delaware Bay (Tsipoura and Burger 1999: gut samples via flushing): (May 1996, n=7); horseshoe crab eggs (~51% [estimated from graph]), worms (~25%), detritus (~20%) and sand (~4%) and (May 1997, n=8); detritus (~55%), worms (~38%) and horseshoe crab eggs (~7%).

Stomach contents (n=72) from sanderlings on Roquant Island, Chile during the winter by Sallaberry *et al.* (1996) recovered the following items (frequency out of 801 occurrances): Crustacea (*Cancer setosus*, 68.33; *Exirolana hirsuticauda*, 1.0; *Lepidopa chilensis*, 1.0 and *Emerita analoga*, 0.75), Annelida (*Perinareis vallata*, 16.83; *Scolelepis squamata*, 2.24 and *Malacoceros glutaeus*, 0.75), Mollusca (*Littorina araucana*, 1.74; *Mulinia edulis*, 1.74; *Semimytilus algosus*, 1.62; *Nassarisus gayi*, 0.86 and *Aulacomya ater*, 0.62) and Insecta (Coleoptera unid., 1.49; Carabidae, 0.75 and Ligacidae, 0.25).

A study on Belgian beaches (Vanermen *et al.* 2009) during the winter months recorded successful foraging observations (n=1182). The majority of identifiable (unidentifiable, n=698) prey items were polycheates (n=263), followed by bivalves (unidentified, n=85; *Enis* sp., n=66; *Donax vittatus*, n=27; and *Mytilus edulis*, n=1), crustaceans (n=17), and anemones (n=7). Another winter study, also using observations in Cádiz Bay, Spain, observed 750 foraging attempts, of these 59 were successful (or observable?): unidentifiable (n=42), Cerastoderma (Bivalvia, n=8), polychaetes (n=4), Prosobranchs (Bivalvia, n=4), and Scrobicularia (Bivalvia, n=1: Perez-Hurtado *et al.* 1997). A study in Argentina in the province of Buenos Aires examined pellets (n=34) and droppings (n=105) to investigate the winter (Petracci 2002). This study observed the following prey items (frequency of occurance; droppings and pellets respectively): Coleoptera (mostly *Hydrophylidae*, *Curculionidae* and *Staphylinidae* [44, 73]), Mollusca (*Brachydontes rodriguezi* [28,67] and *Corbula* sp. [10, 39]), Diptera (22, 3), unrecognized items (20,0), Crustacea (*Corophium* sp. [15, 0]), Perciformes (1, 0), Polychaetes (*Nereidae* [1, 0]), and Hymenoptera (0, 1).

Western Sandpiper *Calidris mauri*

Dietary data unavailable for the Great Salt Lake.

Baldassarre and Fischer (1984) found Chironomidae (67%), adult Coleoptera (13%), adult Diptera (2%) and seeds (18%) in 18 stomachs collected in September on a playa lake in Hart, Texas. Chironomids occurred in all 18 stomachs while Coleopterans, Dipterans and seeds were found in 73%, 9% and 64% of stomachs respectively.

Holmes (1972) examined the stomach contents of both adult and immature Western Sandpipers on the Kolomak River in the Yukon Delta over three summers. The following tables have been recreated from Holmes (1972).

Will consume small prey items between 0.1-5.0 mm, 73% of the time during the spring, with the next largest size category (5.1-10 mm) 26% of the time. Similar preference for size of prey is seen during

the fall with the smallest sizes consumed 64% of the time and the next largest at 32% (Davis and Smith 2001).

Least Sandpiper *Calidris minutilla*

Dietary data unavailable for the Great Salt Lake.

Least Sandpiper's (n=94) in the Playa Lakes Region of Texas during the spring fed largely on animals (87.8%), with Dipterans (83.7%), mostly Chironimids (62.7) forming the bulk of the diet. Beetles (Coleoptera, 16.7%) also made up a large portion of the animal taxa consumed (Davis and Smith 1998). Plants eaten during the spring were primarily amaranths (3.5%) and *Panicum* (1.9%).

Three stomachs examined during July in Illinois contained mostly Stratiomyidae (Diptera: 43%), with Hydrophilidae (scavenger beetles: 17%), Dystiscidae (diving beetles: 15%), Chironomidae (11%) and Halipidae (crawling water beetles: 10%) with Corixidae and miscellaneous insects forming comprising the rest of the diet (Brooks 1967)

Stafford et al. (2008) examined the stomach contents of 37 Least Sandpipers collected in the Illinois River during the fall of 2007. Seeds were observed in 16 of these birds, while Dipterans (flies and mosquitoes) occurred in over half (n=21).

Davis and Smith (1998) also examined the diet of Least Sandpipers in the fall, but in the Playa Lakes Region of Texas. Examination of 95 individuals showed that animal matter was preferred over plants 70% to 25% respectively. Coleopterans made up the majority of animal prey 46.7%, while Chironomids made up 11.3%, and Odonata comprised 3.5%. All other animal taxa were less than 2.5% each. For plants, seeds of *Panicum* (10%), *Amaranthus* (5.7%), *Polygonum* (5.4%), *Scirpus* (1.1%) and *Eleocharis* (0.8%) were eaten (Davis and Smith 1998). Baldassarre and Fischer (1984) also found that a large component of this species diet in the High Plains of Texas were Chironomids.

Small prey preferred (0.1-5.0 mm) in the spring 54% of the time, with the next largest (5.1-10.0 mm) consumed 38%, while during the fall these two size categories were consumed 63% and 35% respectively (Davis and Smith 2001).

Baird's Sandpiper *Calidris bairdii*

Dietary data unavailable for the Great Salt Lake.

Baird's Sandpiper's feed almost exclusively on insects, primarily tipulid larvae, Diptera (including Chironomidae), *Heleidae*, Coleoptera and larvae of Lepidoptera (Holmes and Pitelka 1968**,** Baldassarre and Fischer 1984). Holmes and Pitelka (1968) observed a decline in the consumption of larvae and an increase in adult prey over the summer months.

Spring migrants in the pothole regions of North Dakota were examined by Eldridge *et al.* (2009). This study examined esophagi of 81 birds and found that 89% (aggregate precent frequency) of the diet consisted of insects (Diptera 77.1% [Chironomidae, 73%; Heleidae, 16.4%; Ephydridae, 7.6%; Anthomyiidae, 9.4% and Cyclorrhapha, 2.7%]; Hemiptera, 3.5% and Coleoptera, 2.5%), Arthropoda (99.6% [Crustacea, 17.0%, Eubranchiopoda, 9.7%, Copeopoda, 1.3%, Amphipoda, 5.4%), Gastropoda, 0.4 and Arachnida (1.3%). The aggregate percentage frequency of Diptera larva, pupa and adults from 29 esophagi was 78.2%, 19.4% and 2.4% respectively.

Long-billed Dowitcher *Limnodromus scolopaceus*

Dietary data unavailable for the Great Salt Lake.

Very little data exist for breeding birds in the Western Hemisphere (Takekawa and Warnock 2000). Chironomids are the main food item in Alaska and the Chukotka Peninsula, Russia (Connors 1984, Dement'ev and Gladkov 1969, Bent 1927).

Davis and Smith (1998) examined the diet of dowitchers during the spring and fall in the Playa Lake Region of Texas. Insects, primarily Chironomidae (61.1%: also major food item in Baldassarre and Fischer [1984]), annelids (23.8%) and coleopteran (5.3%) formed the bulk of the spring diet from 94 individuals examined. Seeds such as *Polygonum*, *Amaranthus*, and *Panicum* made up the majority of the 4.7% of the vegetable matter. Of the 75 individuals examined during the fall Coleopterans (26.4%),

gastropods from Planorbidae (21.7%) and Chironomids (16.6%) formed the major animal taxa consumed. Seed, mostly *Polygonum* (5.5%), and *Panicum* (2.9%) comprised the vegetative diet component (Davis and Smith 1998).

Prefers food items 5.1-10.0 mm half the time and items between 0.1-5.0 mm and 10.1-15.0 mm 12 and 24 percent, respectively, during the spring, with the two smallest categories consumed 94% of the time in the fall season (Davis and Smith 2001).

Wilson's Phalarope *Phalaropus tricolor*

Breeding birds on the Great Salt Lake and Mono Lake, California feed almost exclusively on brine flies or shrimp (Mahoney and Jehl 1985; Jehl 1988). Birds, especially nestlings, nesting in freshwater areas of the Great Salt Lake may feed on other taxa (Cavitt pers. obs.). In general diet depends on sex and age of bird. For example, on both the Great Salt Lake and Mono Lake young feed exclusively on brine flies, while adult males consumed relatively more brine flies than brine shrimp compared to females.

In Colorado, breeding phalarope's consumed mostly Dipterans (26% Chiromidae larva, 6% Stratiomyidae larva, 2% Certopogonidae, 0.4% Ephydridae larva), and Coleopterans (37%), while Crustacea (8%), Gastropoda (6%), Hemiptera (9%), and seeds 1% were also eaten (Gammonley and Laubhan 2002).

Dipterans, Hemiptera (Heteroptera: "water striders") and Coleopterans formed the bulk of the diet in fall migrants in west Texas (Baldassarre and Fischer, 1984).

Red-necked Phalarope *Phalaropus lobatus*

Paul and Jehl (unpublished data cited in Aldrich and Paul, 2002) examined the stomach contents of 16 adults and juveniles (male and female) from the Great Salt Lake from late July to early October. The diet of these birds consisted entirely of brine flies, pupae and larvae.

Contents (proventriculi and ventriculi combined) from ten birds collected off Point Reyes California contained (number of stomachs and % volume) the following items: fish eggs (8, 39), *Eupahausia pacifiea* (5, 28), cirriped cypris (6, 4), insect parts (4, 2.2) and several other taxomic groups all less than 0.8% volume (Briggs *et al.* 1984).

On Lake Abert in southern Oregon during the fall, migrating birds (n=91; stomach contents) feed on the following items (percent aggregate weight): *Ephydra hians* (adults, 10.1; larvae, 55.3; pupae without case, 23.8), *Hydrophorus plumbeus* (adult, 0.1; larvae, 8.8), other dipterans (adult, 0.9; larvae or pupae, 0.1), Coleoptera (*Hyallela azteca*, 0.3), *Artemia* sp. (adult, 0.4; juvenile, 0.1; cyst, 0) and *Scirpus* seeds (0.4: Boula 1986).

A controlled foraging study on Mono Lake suggest that this species is an obligatory brine fly specialist and is physiologically unable to meet daily energetic requirements when forced to rely on brine shrimp (Rubega and Inouye 1994).

Feed almost exclusively on brine flies at Mono Lake during fall migration (Jehl 1986).

Franklin's Gull *Leucophaeus pipixcan*

Dietary data unavailable for the Great Salt Lake.

Generalist consuming plant, garbage and animal matter, including mammals, with insect forming the majority of prey items (Burger and Gochfeld 2009; and references therein).
Analyses of 108 stomach contents from Montana specimens showed mostly insects including (Coleoptera, Hemiptera and Diptera) and some vegetable matter in more than half of the stomachs (Rothweiler 1960).

Ring-billed Gull *Larus delawarensis*

Dietary data unavailable for the Great Salt Lake.

Like most gull species, the Ring-billed Gull is an opportunistic omnivore and will take terrestrial, aquatic and aerial invertebrates (Diploda, Coleoptera, Odonata among others) as well as migrating salmon

smolt, grain, vegetable matter, small mammals and human garbage (Pollet et al. 2012; and references therein). A study of western populations recorded 43% arthropods, 26% grain and 8% earthworms (Baird 1976). In the Lower Columbia River (Island #18) of Washington State 38 adult foregut and regurgitation samples contained anthropogenic material (63.6%), as well as annelids (11.4%) and insects (25.0%: Collis *et al.* 2002).

California Gull *Larus californicus*

Sixty-three percent of the diet of Great Salt Lake California Gulls was comprised of insects (*Ephydra* spp.: 46.5%; Carabidae: 15%; Noctuidae: 1.0%; grasshoppers and Hymenopterans: 0.67%), as well as angleworms (Lumbricidae: 15.83%), carrion (8.33%) varies vegetable debris (8.33%), fish (including carp and minnows: 4.17%), and undetermined bone fragments (0.17: Cottam and Williams 1939). Greenhalgh (1952) examined stomach contents of 529 California Gulls from the GSL throughout the year. Fifty-three percent of the volume of these stomachs was comprised of Orthopterans, 13% was carrion or trash, 9% Odonata, 5% cherries, 4% birds or eggs and 3% Homopterans. Birds at the Antelope Island colony consumed brine shrimp and some human garbage during egg laying period (Conover and Vest 2009b). Thirty out of thirty-five breeding birds examined by Conover *et al.* (2009) contained only a single (ex. 100%) prey item in their stomachs, usually brine shrimp (n=37), brine larvae (n=3), corixids (n=2), midge larvae (n=4), bread (n=5), carp (n=1), bread (n=5), a hotdog (n=1), a couple of bird legs (n=1) and damsel fly larvae (n=1). Throughout Utah California Gulls consume large quantities of farm pest including orthopterans, cutworms, white grubs, Mormon crickets and mice (Knowleton 1941).

Young (1952) observed young birds at Mono Lake, Nevada eating brine fly larvae and pupae, with some fish remains and possibly brine shrimp.

This species has been observed on many occasions at GSL taking the eggs and young of Snowy Plover, American Avocet and Black-necked Stilts (Cavitt pers. obs.).

In general the diet of California Gull's is diverse and opportunistic and can be driven by local abundance of prey items (Winkler 1996). In the Lower Columbia River (Little Memaloosa Island) anthropogenic items (56.1%), salmonids (14.9%), and annelids (12.3%) formed the bulk of the diet as determined from adult foreguts and chick regurgitation while non-salmonid fishes (5.4%), unidentified fish (4.0%), mollusks (3.7%), insect (2.8%), crustaceans (0.8%), fish eggs (trace) and non-fish vertebrates (trace) making up the rest (Collis *et al.* 2002: n=31).

Black Tern *Chlidonia niger*

Dietary data unavailable for the Great Salt Lake.

Few quantitative studies of this species have been undertaken. Most data comes from studies of chick feeding. In these studies, fish, Odonata and mayflies were the main food items delivered to young (Heath *et al.* 2009; and references therein).

Diet changes seasonally with polychaetes forming the primary fall food item, but occur in the diet throughout the year. Crabs and bivalves are consumed during the spring, while Bivalvia species are the principle food item during winter months (Recher 1966, Gratto-Trevor 2000: and references therein).

Caspian Tern *Hydroprogne caspia*

Dietary data unavailable for the Great Salt Lake.

Mostly fish with some insects (Diptera and Coleoptera), mollusca and crayfish consumed (Cuthbert and Wires 1999). Smelt (*Osmerus mordax*) and alewife (*Alosa pseudoharengus*) form a large part of interior (breeding) populations (Ewins *et al.* 1994, Ludwig 1965), whereas Pacific coast breeding individuals consume jacksmelt, shiner perch and sculpin (Gill 1976).

Collis *et al.* (2002) examined 448 diet samples (foregut, bill load and chick regurgitations) and 1448 bill load observations of birds at a Rice Island colony in Washington state and nine identifiable taxa. These are (with percent by volume): Salmonids (*Oncorhynchus* spp.: 77.1%), Cyprinidae (peamouth and pikeminnow: 9%), Clupeidae (herring and shad: 7.0%), other (2.0%), Osmeridae (smelt: 1.7%), Cottidae (sculpin: 1.3%), Embiotocidae (surfperch: 1.0%), Pacific Sand Lance (0.4%), suckers (0.4%) and

Sticklebacks (Gasterosteidae: 0.1%). At Three Mile Canyon, Washington 86 samples (diet samples [n=26] and bill-load observations [n=60]) revealed mostly salmonids (*Oncorhynchus* spp.: 80.6%), bass (*Micropterus* spp.: 12.5%), other (3.8%), suckers (1.9%) and yellow perch (1.2%: Collis *et al.* [2002]). Shugart et al. (1979) found alewives (*Alosa pseudoharengus*: 57%) and smelt (*Osmerus mordax*: 34%) mostly between 5 to 15 cm in length in Lake Michigan. Another analysis by Shugart *et al.* (1979) in both Lake Michigan and Huron recovered alewives (78%) and smelt (16%).

Forster's Tern *Sterna forsteri*

Dietary data unavailable for the Great Salt Lake.

This species is considered an obligate piscivore. Mostly anecdotal data on diet which includes small fish usually less than 10cm in length (Mcnicholl *et al.* 2001). Stomach contents from 15 birds collected in July at Monterey County, California contained shiner perch, anchovy and a goby species (Baltz *et al.* 1979). Perch (*Perca flavescens*) formed the bulk of fish presented during courtship feeding and given to chicks in Minnesota (Fraser 1997).

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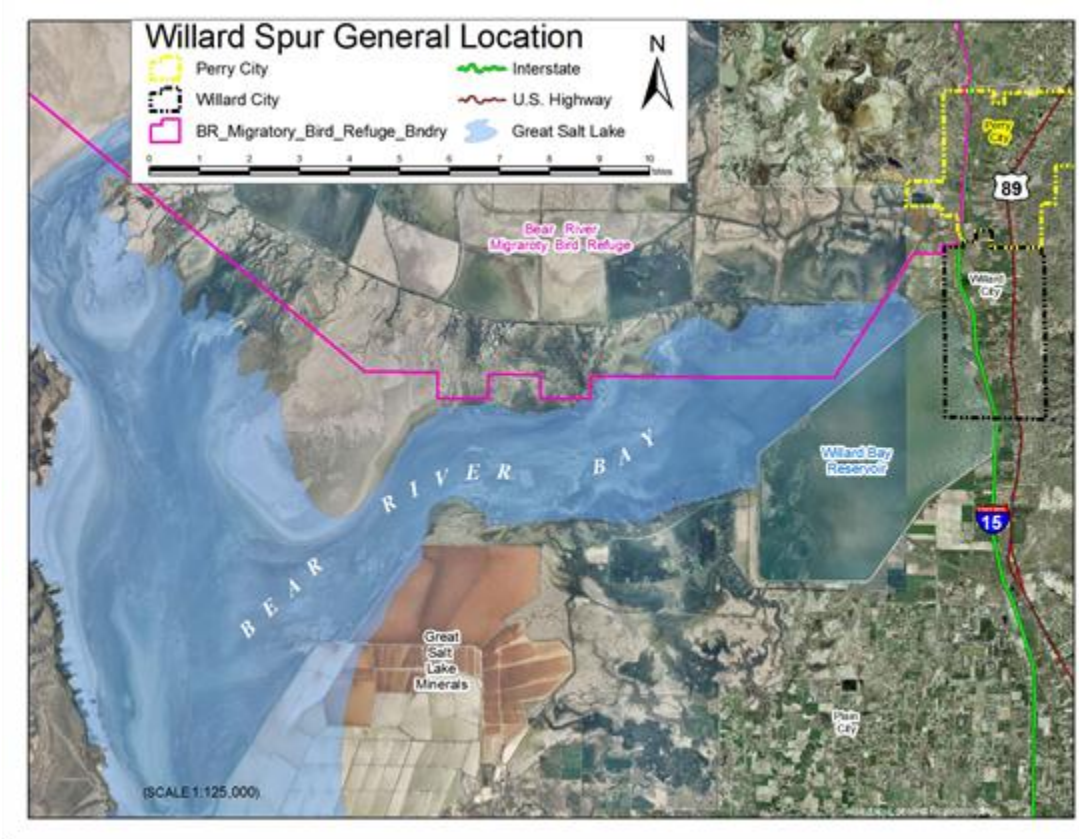

Figure 1. Willard Spur, Great Salt Lake

Table 1. Presence (+) and absence (-) of diet studies for birds of the Great Salt Lake. Seasons were left blank for studies that did not indicate time of the year.

Species	GSL	spring	breeding	fall/staging	winter
Pied-billed Grebe	-	-	-	-	-
Clark's Grebe	-	-	-	-	-
Western Grebe	-	-	-	-	-
Eared Grebe	+	-	-	+	-
American White Pelican	+	-	-	-	-
Double-crested Cormorant	-	-	-	-	-
Great Blue Heron	+	-	-	-	-
Snowy Egret	-	-	-	-	-
Cattle Egret	-	-	-	-	-
Black-crowned Night-Heron	-	-	-	-	-
White-faced Ibis	-	-	-	-	-
Canada Goose	-	-	-	-	-
Gadwall	+	-	+	-	+
American Widgeon	-	-	-	-	-
Mallard	+	-	+	+	-
Northern Shoveler	+	-	-	-	+
Redhead	-	-	-	-	-
Lesser Scaup	-	-	-	-	-
Green-winged Teal	+	-	+	-	+
Blue-winged Teal	+	-	-	-	-
Cinnamon Teal	+	-	+	+	-
Canvasback	-	-	-	-	-
Northern Pintail	+	-	-	+	-
Bufflehead	-	-	-	-	-
Common Goldeneye	+	-	-	-	+
Ruddy Duck	-	-	-	-	-
American Coot	-	-	-	-	-
Sandhill Crane	-	-	-	-	-
Black-bellied Plover	-	-	-	-	-
Snowy Plover	-	-	-	-	-
Killdeer	-	-	-	-	-
American Avocet	+	-	+	-	-
Black-necked Stilt	+	+	-	-	-
Greater Yellowlegs	-	-	-	-	-
Lesser Yellowlegs	-	-	-	-	-
Spotted Sandpiper	-	-	-	-	-
Willet	-	-	-	-	-
Long-billed Dowitcher	-	-	-	-	-
Long-billed Curlew	-	-	-	-	-
Marbled Godwit	-	-	-	-	-
Sanderling	-	-	-	-	-
Western Sandpiper	-	-	-	-	-
Least Sandpiper	-	-	-	-	-
Baird's Sandpiper	-	-	-	-	-
Wilson's Phalarope	+	-	+	-	-
Red-necked Phalarope	-	-	-	-	-
Franklin's Gull	-	-	-	-	-

Species	GSL	spring	breeding	fall/staging	winter
Ring-billed Gull	-	-	-	-	-
California Gull	+	+	+	+	+
Caspian Tern	-	-	-	-	-
Forster's Tern	-	-	-	-	-
Black Tern	-	-	-	-	-
Total	15	2	7	5	5

Table 2. General diet of birds utilizing Willard Spur.[1]

Species	Plant	Animal-Vertebrates	Animal-Invertebrates	Fish	Insect	Brine Fly Adult	Brine Fly Larvae	Brine Shrimp
Pied-billed Grebe			+	+	+			
Clark's Grebe				+	+			
Western Grebe			+	+	+			
Eared Grebe					+	+	+	+
American White Pelican		+	+	+				
Double-crested Cormorant		+		+	+			
Great Blue Heron	+	+	+	+				
Snowy Egret			+	+				
Cattle Egret		+	+		+			
Black-crowned Night-Heron		+	+	+	+			
White-faced Ibis		+	+	+	+			
Canada Goose	+							
Gadwall	+				+			
American Widgeon	+							
Mallard	+		+		+			
Northern Shoveler	+		+		+	+	+	+
Redhead	+		+	eggs	+	?	?	?
Lesser Scaup	+		+	+	+			
Green-winged Teal	+					+	?	+
Blue-winged Teal	+		+		+			
Cinnamon Teal	+		+		+	+	+	
Canvasback	+		+		+	?	?	
Northern Pintail	+		+		+			
Bufflehead	+		+	+	+			
Common Goldeneye	+		+	+	+	?	+	+
Ruddy Duck	+		+		+	+	?	
American Coot	+							
Sandhill Crane	+	+	+		+			
Black-bellied Plover			+		+			
Snowy Plover				+	+	+		
Killdeer	+				+	+		
American Avocet	+		+		+	+	+	
Black-necked Stilt			+	+	+	+	?	+
Greater Yellowlegs			+	+	+			
Lesser Yellowlegs	+				+			
Spotted Sandpiper			+		+			
Willet			+		+			
Long-billed Dowitcher	+		+		+			
Long-billed Curlew			+		+			
Marbled Godwit			+	+	+			
Sanderling			+		+			
Western Sandpiper	+				+			
Least Sandpiper	+				+			

[1] A + indicates that published literature supports the food item as part of the diet. A ? indicates it is suspected as part of the diet.

Species	Plant	Animal-Vertebrates	Animal-Invertebrates	Fish	Insect	Brine Fly Adult	Brine Fly Larvae	Brine Shrimp
Baird's Sandpiper					+	+	?	
Wilson's Phalarope	+		+		+	?	+	+
Red-necked Phalarope	+			eggs	+	+	+	+
Franklin's Gull	+	+	+		+	?	+	+
Ring-billed Gull	+	+	+	+	+	?	?	?
California Gull	+	+	+	+	+			
Caspian Tern			+	+	+			
Forster's Tern				+				
Black Tern			+	+	+			