DIETARY ANALYSIS AND PHYSICAL CONDITION OF WATERFOWL AT GREAT SALT LAKE

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INTRODUCTION

The wetlands of Great Salt Lake (GSL) are uniquely situated within both the Central and Pacific Flyways. Consequently, the GSL provides critical resources for over 500,000 waterfowl each year (Manning and Paul 2003). These birds utilize the GSL and its associated wetlands for breeding, to acquire reserves during migration or as wintering habitat. Recent studies have suggested that an important wetland complex within the GSL ecosystem, Farmington Bay, has become hypereutrophic (e.g. Macarelli et al. 2003, Wurtsbaugh and Marcarelli 2006). It has been suggested that this eutrophication may lead to a reduction in the quality of food resources available for waterfowl (Macarelli et al. 2003, Wurtsbaugh and Marcarelli 2006). In order to evaluate the degree to which waterfowl may be affected, we examined the diets and body condition of waterfowl collected from the Farmington Bay Waterfowl Management Area and two reference sites.

OBJECTIVES

The objectives of this study were to:

1. Identify primary food items for common waterfowl.
2. Determine physical condition of waterfowl collected.

METHODS

Study Sites

Waterfowl were collected from plots within the following sites between the hours of 6am and 12pm.

Farmington Bay Waterfowl Management Area (FARM) is located west of Farmington, Utah and covers about 5,000 ha. The area 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. Waterfowl were collected from sites within Unit 1 (Figure 1). Collections took place on September 15th in 2009 and on May 27th, June 3rd, August 9th and 10th, and September 13th in 2010.

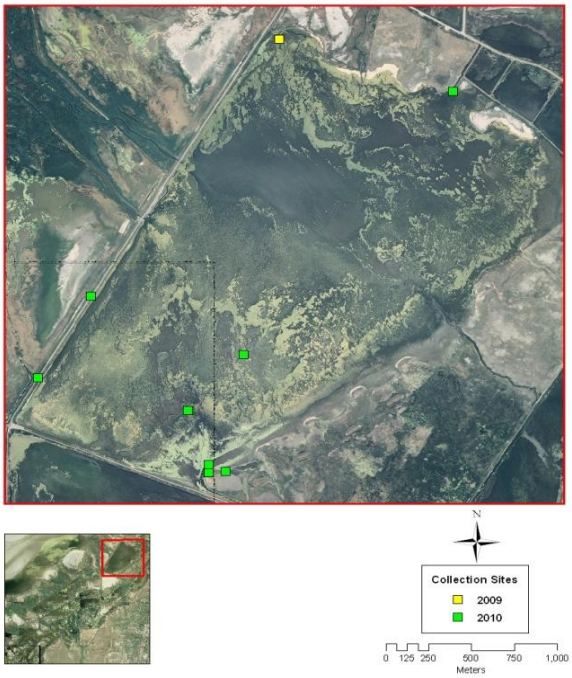

Figure 1. Collection sites at FARM.

Bear River Migratory Bird Refuge (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. Waterfowl were collected from the eastern and southern boundaries of Unit 4C (Figure 2). Collections were conducted on September 17th, 21st, 22nd, and 23rd in 2009 and on June 4th, 5th and September 13th in 2010.

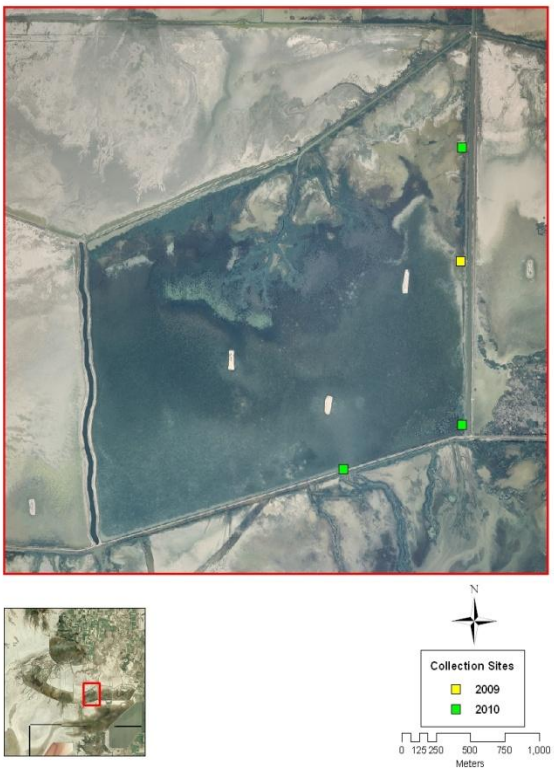

Figure 2. Collection sites at BEAR

Figure 3. Collection sites at PSGR

Public Shooting Grounds Waterfowl Management Area (PSGR) is located west of Corrine, Utah. The management area covers about 4,758 ha consisting of marsh, open water, mud flat and upland habitats. Waterfowl were collected mostly from the southern border of Pintail Lake (Figure 3). No waterfowl were collected from this site in 2009. In 2010, collections took place on June 10th and August 28th.

Species

This study focused on five species of waterfowl abundant at FARM, BEAR, and PSGR; Mallard (*Anas platyrhyncos*), Northern Pintail (*A. acuta*), Gadwall (*A. strepera*), Green-winged Teal (*A. crecca*), and Cinnamon Teal (*A. cyanoptera*).

The **Mallard** (MALL) is the most abundant waterfowl species and widely hunted in North America (Drilling et al. 2002) (Figure 4). It is considered a generalist and opportunistic feeder consuming aquatic invertebrates to cereal crops (Drilling et al. 2002). The adult breeding male has a bright green head, white neck ring, violet speculum and a characteristic tail-feather curl. The female is drab compared to the male, with a buff-colored head and a darker eye-stripe. She has patterns of dark brown upper-wing coverts with buffy edges, grayish primaries, and a distinctive speculum of blue to violet edged in black and white.

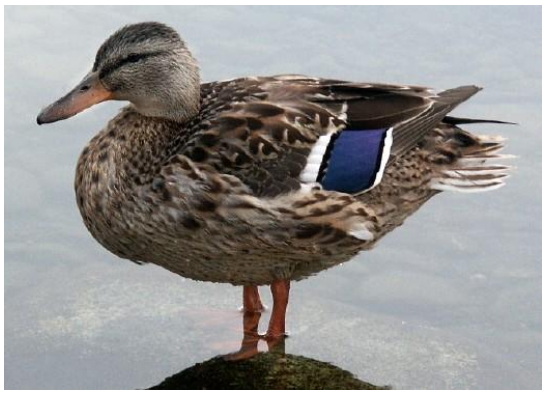

Figure 4. Female Mallard.

The **Northern Pintail** (NOPI) is a medium sized dabbling duck (Figure 5).It can be found either breeding or wintering through most of North America and year round at the wetlands surrounding the Great Salt Lake. NOPI are omnivorous consuming grains, marsh plant seeds, and aquatic invertebrates from shallow waters and flooded agricultural fields (Austin and Miller 1995). This species is easily differentiated from other dabblers by long slender neck and pointed tail. The male has a chocolate brown head with white neck and underparts and very long central tail feathers. Females are tan to brown with a dark bill.

Figure 5. Female Northern Pintail. Photo by Mike Lentz.

The **Gadwall** (GADW) is another medium sized dabbling duck that can be found year round at the wetlands of the Great Salt Lake (Fig 6). It forages shallow to deep wetlands for submerged aquatic vegetation, seeds, and aquatic invertebrates (Leschack et al. 1997). The breeding male GADW has a mottled grey plumage, black rump and undertail coverts, and white speculum. The female is mottled brown and also has a white speculum.

Figure 6. Female Gadwall.

The **Green-winged Teal** (GWTE) is the smallest dabbling duck in North America (Figure 7). GWTE migrate along all the major flyways and are consequently the second most abundant waterfowl species taken by hunters (Johnson 1995). GWTE are omnivorous and have been classified as an opportunistic feeder with a diet dependent on the food types available (Johnson 1995). Breeding males have a cinnamon head with a green crescent passing over the eye to a small crest at the back. Females are brown with a dark bill and white chin and belly.

Figure 7. Female Green-winged Teal. Photo by Mike Lentz.

The **Cinnamon Teal** (CITE) is a small dabbling duck (Figure 8). Unlike other dabblers it does not breed in the plains and is one of the least numerous ducks in North America. CITE are omnivorous, feeding primarily by dabbling in shallow water (Gammonley 2006). The breeding male is a dark chestnut color with a red eye and dark bill. The female is similar to other female ducks (cryptically colored) mostly brown and buff. Both male and female have bright blue upper wing coverts.

Figure 8. Female Cinnamon Teal.

GENERAL PROCEDURES

Dietary Analysis

Waterfowl were collected by shotgun after an observer had recorded between 5-15 minutes of active foraging within the study plot. Following the collection, birds were weighed to the nearest 0.01 g on a portable electronic balance and immediately dissected in the field. The mouth and pharynx were rinsed with 80% ethanol and the wash collected into plastic containers. The esophagus, proventriculus and ventriculus were then removed and preserved with 80% ethanol and dissected back at the lab. All carcasses were placed on ice and transported to the laboratory where they were frozen until necropsies could be preformed.

Food items were sorted and identified to family or the lowest taxonomic rank possible (Martin and Barkley 1961, Merritt and Cummins 1984, Voshell 2002). The volume that each food item represented within each organ was determined by displacement. Volumes under .05 mL were considered trace (T) amounts and not included in the analyses. Volumetric data of food samples are expressed in two different ways; as the mean of volumetric percentages (aggregate percentage), and percentages of the total volume (aggregate volume). The aggregate percentage method gives equal weight in the analysis to each bird, whereas the aggregate volume method gives equal weight to each unit of food consumed by any bird.

A literature search was performed to obtain the available values for the gross energy and important nutritional contents for each food item identified within the digestive tract.

Physical Condition

A field mass was obtained before dissection and preservation, followed with a thawed mass at the lab. Necropsies were performed for each individual collected. Thawed mass did not include the weight of the esophagus, proventriculus, and ventriculus. The total length of the bird was measured from the tip of the bill to the end of the tail feathers. An unflattened wing cord was measured from the bend of the manus to the tip of the longest primary feather. The total head length was measured from the back of the head to the end of the bill. Bill length was measured from the distal end of the nares to the tip of the bill. The tail was measured using a stop-end ruler and was slid between the center tail feathers until it reached the body. Tarsometatarsus length was measured from the last undivided scute on the tarsus to the middle of the digit joint. Internal measurements were obtained through dissection. The length of the large intestine, testicles/ovaries, and heart were measured. The mass of the right pectoral muscle, ceca, small and large intestine, liver, heart, kidneys, and abdominal fat were obtained. The liver and small intestines were also inspected for parasites. Parasites found in the dissection of the upper digestive tract were noted and preserved. All external measurements obtained in 2009 can be found in Appendix 1a and internal measurements can be found in Appendix 1b. Measurements obtained in 2010 are located in Appendix 1c and 1d.

A condition index was calculated by dividing the thawed mass by the wing chord for each waterfowl collected. When possible,

mean indices and standard errors were calculated.

RESULTS AND DISCUSSION

Dietary Analysis

In 2009, a total of nine waterfowl were collected for dietary analyses. On September 15, 2009 four waterfowl (3 CITE, 1 NOPI) were collected at FARM. From September 17-23, 2009 five waterfowl (2 MALL, 2 GWTE, and 1 NOPI) were collected at BEAR.

The diets of the waterfowl collected in 2009 contained greater than T amounts of ten food items (Table 1). Out of the nine waterfowl collected, two were found to only have T amounts of food items in their gut and therefore were not included in the analysis. We were unable to differentiate the seeds of Pondweed (*Potamogeton*); therefore items that may be drupelets of Sago Pondweed (*Stuckenia pectinata*) are classified under a generalized food item label, *Potamogeton* seeds. Pie charts summarizing aggregate volume of food items for each duck species collected from both study sites have been included in Appendix 2.

Aggregate volume calculations showed that plant items made up the majority of the diets at both sites in September 2009. At FARM, *Ruppia* drupelets (55%), *Potamogeton* seeds (37%) and *Schoenoplectus* achenes (8%) made up the entire diet. At BEAR, the genus *Potamogeton* made up 81% of the diet. Only 14% of the BEAR diet was comprised of animal items with the most prevalent being *Coenagrionidae* nymphs (11%). The only species of waterfowl collected from both study sites was the NOPI (FARM n = 1, BEAR n = 1). Diets of both the NOPI consisted of only three different plant taxa. *Potamogeton* seeds were found in both birds, making up 25% of the diet at FARM and 33% at BEAR (Appendix 2). The rest of the NOPI diet from FARM contained only *Ruppia* drupelets whereas the rest of the NOPI diet from BEAR contained only *Schoenoplectus* achenes.

The mean aggregate percent and volume of taxa collected for each species is presented in Appendix 3a. The mean aggregate percent and volume of taxa collected from each site is presented in Appendix 3b. Site calculations were made by analyzing all waterfowl of different ages and species collected from the site together. Each species, sex and age category may have different diet preferences. These factors will cause the mean aggregate percent and volume analysis by site to be biased towards the diet of the most commonly collected species, sex, and age.

In 2010, a total of 41 waterfowl were collected for dietary analysis. From May 27-September 13, 2010 26 birds (9 CITE, 6 GWTE, 5 GADW, 4 NOPI, and 2 MALL) were collected at FARM. From June 4-August 13, 2010 nine birds (5 NOPI, 2 GADW, and 2 CITE) were collected from BEAR. From June 10-August 28, 2010 six birds (5 GADW and 1 CITE) were collected from PSGR. Waterfowl were not collected from the BEAR and PSGR study sites after August. At BEAR the impoundment began to draw-down and waterfowl abandoned the site. At PSGR, our available collection dates conflicted with the preparation for the Ogden Youth Waterfowl Hunt.

Waterfowl collected in 2010 contained greater than T amounts of 22 food items

throughout their upper digestive tracts (Table 2). It is important to note that in our analysis of food items we were unable to differentiate between the leafy parts of *Ruppia* and *Stuckenia.* Therefore we refer to them together as their shared plant order, Alismatales. Out of the 41 waterfowl collected, six did not contain more than T amounts of any one food item resulting in them not being included in the analysis. The mean aggregate percent and volume of taxa collected for each species is presented in Appendix 4a. The mean aggregate percent and volume of taxa collected from each site is presented in Appendix 4b

Analysis of diet by site indicated that *Schoenoplectus* seeds and Alismatales were the only items observed from all three study sites. The largest percentages of the diets were comprised of Alismatales; FARM ~ 38%, PSGR, ~ 48%, and BEAR 98% (Table 2).

To compare the species' diets between FARM and at least one other study site, we split the data into two time frames, breeding (May-June) and staging/migrating (August-September). All results are presented in Appendix 5.

CITE were collected from all three study sites during the breeding time frame and showed varied results. At FARM, the three CITE's diets consisted of 96% animal food items most from the order Diptera. The diet of the single CITE from PSGR contained about 50% animal items and 50% plant items of which was mostly *Schoenoplectus* achenes. Two CITE from BEAR had diets of 100% plant items with *Ruppia* drupelets dominating the total mean volume with 54%. The only other comparison available for the breeding time frame was between GADW collected from FARM and PSGR. The three GADW from FARM had diets that consisted of a mean 91.6% aggregate volume of the family Chironomidae. The lone GADW from the PSGR site had a diet that was split 50/50 between Diptera parts and *Schoenoplectus* achenes.

During the staging/migrating time frame, only GADW and NOPI were collected from other sites besides FARM. The diets of the two GADW collected in September from FARM were composed of 100% Alismatales. The three GADW that were collected during August from PSGR had diets that consisted of 51% Alismatales. The other 49% was made up of animal items. Four NOPI from FARM had a diet which contained 79% *Ruppia* drupelets and only 7% Alismatales whereas the five NOPI from BEAR had a diet of 100% Alismatales.

In the absence of data to compare the September collected MALL, GWTE and CITE diets from FARM, we searched the literature on the recognized diets of these species. The diet of a MALL transitions from mostly animal foods in the breeding season to a preference for seeds outside the breeding season and finally to a majority of agricultural foods during migration when natural food availability is low (Drilling et al. 2002). The data we observed follows this information closely. We observed a diet consisting of 50% *Schoenoplectus* achenes and 50% Tipulidae larvae for the individual MALL collected from FARM in the breeding time frame. During the staging/migrating time period, we collected another single MALL whose diet consisted of just over 96% *Distichlis* lemmas.

The information presented on the diet of the GWTE describes the duck as having a

broad diet that is dependent on the food types available (Johnson 1995). The three GWTE collected during the breeding time frame had a diet consisting of Chironomidae larvae (94%) and achenes/seeds (6%). The composition of the GWTE diet changed in the autumn with Chironomidae larvae making up only 60% of the volume and *Schoenoplectus* achenes making up the rest.

The diets of the four CITE collected were dominated by the Chironomidae which made up 71.5% of the volume. Seeds made up a very small percentage of the volume which is opposite of the CITE diet described in the literature. Thorn and Zwank (1993) found that CITE migrating in the fall through central New Mexico consumed a higher proportion of plant foods than animal foods. Gammonley (1996) also cites studies from different regions, including the Great Salt Lake, showing CITE diets consisting of more seeds than animal matter post breeding season.

The degree to which the entire suite of waterfowl collected at each site overlapped in diets was determined by calculating the Renkonen index (Krebs 2009). This index is expressed as a percentage of dietary overlap. During the staging/migrating period in 2009 the diets of waterfowl collected at FARM and BEAR were 47.4% similar. During the 2010 staging/migrating period, waterfowl diets at PSGR and BEAR were more similar to each other (48.9%) than they were to FARM (FARM – BEAR = 22.4%; FARM – PSGR = 22.8%). Dietary overlap was much lower during the breeding period in 2010, but again waterfowl collected at PSGR and BEAR were more similar in diets (32.4%) than either were to FARM (FARM – BEAR = 11.4%; FARM – PSGR = 12.1%). A major cause for low similarity with FARM is the high proportion of Chironomids found within the waterfowl diets during both the breeding and staging/migrating periods at this location. In fact Chironomids were absent from waterfowl diets during breeding at PSGR and BEAR but larvae alone accounted for 76.7% of the aggregate volume at FARM. During staging/migrating, Chironomid adults were absent from waterfowl diets at BEAR and only made up 2.3% of the aggregate volume of diets at PSGR.

As part of our dietary analysis, we conducted a literature review on the gross energy and nutritional contents of the food items found in the diets and presented available values in Table 1 for 2009 and Table 2 for 2010. Values were obtained from multiple reports in different regions. When values for the same food item differed, we averaged the data and report the mean. Averages of *Potamogeton* and *Ruppia* leafy parts were made to achieve values listed for Alismatales. All values cited from Baldassarre and Bolen (2006) were obtained through additional literature.

The two most important food items for waterfowl during the breeding period at FARM were Chironomid larvae and *Schoenoplectus* achenes. Chironomids have very high protein content (51.5%) relative to *Schoenoplectus* (6.7%). Unfortunately, we were unable to find additional nutritional information for Chironomid larvae in the literature. *Schoenoplectus* was an important food item at both PSGR and BEAR. However, *Distichlis* (PSGR) and *Ruppia* (BEAR) also made up significant proportions of the diets. *Ruppia* druplets

are fairly similar in nutrient content to *Schoenoplectus;* providing relatively low protein and fat but high N.F.E. and crude fiber.

During the 2010 staging/migrating period *Distichlis* and Alismatales accounted for 76.1% of the volume of food items consumed by waterfowl at FARM. Alismatales contain 15.1% protein and 1.85% fat. Unfortunately we were unable to locate nutritional content of *Distichlis* since the diet of waterfowl collected at BEAR contained 100% Alismatales. Waterfowl at PSGR utilized both Alismatales (50.9%) and Ephemeroptera (40.5%). Ephemeroptera contain a higher percentage of both protein and fat than Alismatales.

Physical Condition

A central objective was to compare the physical condition of each species across sites and time periods (breeding, and staging/migrating). However, due to small sample sizes, we are unable to make species-specific comparisons (Table 4). Consequently, we pooled species collected and compared the condition index in a 2-way ANOVA with site and time period as factors. We found no significant difference in waterfowl condition between either site ($F = 0.122$; $df = 2$; $p = 0.886$) or period ($F = 0.688$; $df = 2$; $p = 0.415$).

FUTURE RESEARCH

Unfavorable site conditions reduced sample sizes and precluded important analyses. Consequently, we recommend a third field season to augment the sample. In addition, we suggest a nutritional analysis of food items commonly found in the diets of the waterfowl. This is particularly important given that waterfowl utilizing FARM seem to rely heavily on Chironomids during both the breeding and staging/migrating periods, whereas Chironmids at the other sites make up a much smaller contribution to their diet.

In addition, the literature search provided gross energy (GE) values for many of the items; however, these values are highly variable and depend on location. Furthermore, the values reported only represented GE, and not true metabolizable energy (TME) or other important nutritional information such as protein, fiber, and carbohydrate content. The nutritional information can be used with the abundance and availability of each food item to generate the importance of sites relative to the feeding ecology of waterfowl (Baldassarre and Bolen 2006). TME is important since it estimates the energy available to the birds unlike GE (Dugger et al. 2007) and because it can provide accurate assessments on habitat needs that may be underestimated using GE values (Baldassarre and Bolen 2006).

Table 1. Mean aggregate% and volume of food items recovered from the digestive tracts of dabbling ducks at FARM and BEAR, 2009 with gross energy and nutrient content values found in cited literature.

Food Items	FARM (n = 3)		BEAR (n = 4)		Gross Energy kcal/g	% Protein (Source)	% Crude Fat (Source)	% N.F.E. (Source)	% Crude Fiber (Source)
	Mean Aggregate % Volume	Mean Aggregate Volume	Mean Aggregate % Volume	Mean Aggregate Volume					
Ruppia Drupelets	55.0	25.0	-	-		7.8 (E)	2.9 (E)	51 (E)	35.2 (E)
Potamogeton Seeds	36.7	59.2	18.1	31.6	4.83+ (A)	8.7+ (A)		34.2+ (A)	51.4+ (A)
Schoenoplectus Achenes	8.3	15.8	3.2	35.4		6.7+ (E)	3.5+ (E)	47.0+ (E)	39.7+ (E)
Potamogeton Tuber	-	-	62.7	19.0	4.04 (F)				
Coenagrionidae Nymphs	-	-	11.0	3.3	5.63* (B)	58.3 - 61.3 (C)			
Unknown Plant Material	-	-	1.9	3.8					
Chironomidae Larvae	-	-	1.3	0.39	3.9 (D)	51.5(D)			
Chironomidae Adults	-	-	0.6	6.3	5.22+ (C)				
Corixidae	-	-	0.6	0.2	5.3 (D)	59.5 (D)		0.8 (A)	18.4 (A)
Odonata Nymphs	-	-	0.4	0.12	5.11 (A)	66.7 (A)		8.4 (A)	11.1 (A)

Sources: A = Reinecke and Owen Jr. 1980; B = Driver 1981; C = Driver et al. 1974; D = Anderson and Smith 1998; E = Baldassarre and Bolen 2006
* Average of figures given in source(s) for food item
+ Values from closely related taxa

Table 2. Mean aggregate % and aggregate volume, expressed in %, of food items recovered from dabbling ducks at FARM, PSGR and BEAR, during the breeding time frame of 2010 with energy and nutrient content of some food items found in literature.

Food Items	FARM (n = 9)		PSGR (n = 2)		BEAR (n = 2)		Gross Energy kcal/g (Source)	% Protein (Source)	% Crude Fat (Source)	% N.F.E. (Source)	% Crude Fiber (Source)
	Mean Aggregate %	Mean Aggregate Volume	Mean Aggregate %	Mean Aggregate Volume	Mean Aggregate %	Mean Aggregate Volume					
Chironomidae Larvae	61.0	76.7	-	-	-	-	3.9 (F)	51.5(F)			
Chironomidae Adults	11.1	2.8	-	-	-	-	5.22+ (C)				
Alismatales	11.1	0.7	-	-	-	-	3.67^ (D,E)	15.1^ (D,E)	1.85^^ (D,G)	50.4^^ (D,G)	27.9^ (D,E)
Tipulidae Larvae	5.6	1.4	-	-	-	-	5.36 (B)	43.8 (B)			
Corixidae	0.5	2.8	-	-	-	-	5.3 (F)	59.5 (F)		0.8 (A)	18.4 (A)
Schoenoplectus Achenes	8.5	10.7	41.7	32.4	30.0	42.9		6.7+ (G)	3.5+ (G)	47.0+ (G)	39.7+ (G)
Diptera Parts	1.2	1.4	33.3	24.32	-	-					
Chironomidae Pupae	0.5	2.8	-	-	-	-	5.34+ (C)				
Potamogeton Seeds	0.5	0.7	-	-	10.0	14.3	4.83+ (A)	8.7+ (A)		34.2+ (A)	51.4+ (A)
Distichlis Lemmas	-	-	8.3	27.0	-	-					
Coleoptera	-	-	8.3	8.11	-	-	6.29 (A)	45.6 (A)		5.2 (A)	19.5 (A)
Gastropoda	-	-	8.3	8.11	-	-		9.4 (G)	0.6 (G)	0.0 (G)	2.2 (G)
Ruppia Drupelets	-	-	-	-	50.0	28.6		7.8 (G)	2.9 (G)	51 (G)	35.2 (G)
Unkown Seed 18	-	-	-	-	10.0	14.3					

Sources: A = Reinecke and Owen Jr. 1980; B = Driver 1981; C = Driver et al. 1974; D = Sugden 1973; E = Paulus 1982; F = Anderson and Smith 1998; G = Baldassarre and Bolen 2006.

^ Mean value for leafy parts of Ruppia and Potamogeton

^^Mean value for leafy parts of Potamogeton from two sources

+ Values from closely related tax

Table 3. Mean aggregate % and aggregate volume, expressed in %, of food items recovered from dabbling ducks at FARM, PSGR and BEAR, during the staging/migrating time frame of 2010 with energy and nutrient content of some food items found in literature.

Food Items	FARM (n = 13)		PSGR (n = 3)		BEAR (n = 5)		Gross Energy kcal/g (Source)	% Protein (Source)	% Crude Fat (Source)	% N.F.E. (Source)	% Crude Fiber (Source)
	Mean Aggregate %	Mean Aggregate Volume	Mean Aggregate %	Mean Aggregate Volume	Mean Aggregate %	Mean Aggregate Volume					
Alismatales	33.0	22.4	20.7	50.9	100.0	100.0	3.67^ (D,E)	15.1^ (D,E)	1.85^^ (D,G)	50.4^^ (D,G)	27.9^ (D,E)
Chironomidae Larvae	21.0	12.8	-	-	-	-	3.9 (F)	51.5 (F)			
Schoenoplectus Achenes	16.5	1.6	-	-	-	-		6.7+ (G)	3.5+ (G)	47.0+ (G)	39.7+ (G)
Ruppia Drupelets	16.2	1.9	-	-	-	-		7.8 (G)	2.9 (G)	51 (G)	35.2 (G)
Distichlis Lemmas	7.4	53.7	-	-	-	-					
Ephemeroptera Nymphs	1.1	0.2	69.5	40.5	-	-	5.02+ (A)	51.2+ (A)		16.2+ (A)	4.9+ (A)
Amphipoda	1.1	0.2	0.2	0.6	-	-	3.85*+ (B,D)	47.0+ (D)	5.9+ (D)	16.5+ (D)	8.4+ (D)
Chironomidae Pupae	1.2	3.0	-	-	-	-	5.34+ (C)				
Planorbidae	0.5	1.2	-	-	-	-	1.02 (A)	12.2 (A)		0.9 (A)	12.5 (A)
Potamogeton Seeds	0.4	0.7	-	-	-	-	4.83+ (A)	8.7+ (A)		34.2+ (A)	51.4+ (A)
Lemnacae	0.4	0.7	-	-	-	-	4.1* (A,D)	31.25* (A,D)	4.2 (D)	45.95* (A,D)	7.2* (A,D)
Diptera Parts	0.3	0.7	-	-	-	-					
Pulmonata	0.1	0.9	-	-	-	-					
Coenagrionidae Nymphs	-	-	4.3	4.6	-	-	5.63* (B)	58.3 - 61.3 (C)			
Chironomidae Adults	-	-	3.4	2.3	-	-	5.22+ (C)				
Corixidae	-	-	1.7	0.6	-	-	5.3 (F)	59.5 (F)		0.8 (A)	18.4 (A)
Trichoptera Larvae	-	-	0.2	0.6	-	-	5.03 (A)	45.7 (A)		33.8 (A)	8.8 (A)

Sources: A = Reinecke and Owen Jr. 1980; B = Driver 1981; C = Driver et al. 1974; D = Sugden 1973; E = Paulus 1982; F = Anderson and Smith 1998; G = Baldassarre and Bolen 2006.

* Represents mean of values given within the source(s)

^ Mean value for leafy parts of Ruppia and Potamogeton

^^Mean value for leafy parts of Potamogeton from two sources

+ Values from closely related tax

Table 4. Mean condition index (thawed mass/wing chord) and standard error for waterfowl collected during the staging/migrating time frame in 2009 from FARM and BEAR.

Species	FARM	BEAR
CITE	2.22 ± .18 n = 3	
GWTE		1.38 ± .17 n = 2
NOPI	3.21 n = 1	2.35 n = 1
MALL		4.2 ± .05 n = 2

Table 5. Mean condition index (thawed mass/wing chord) and standard error for waterfowl collected in 2010 from all study sites.

Species	Collection Time Frame	Age	FARM	PSGR	BEAR
CITE	Breeding	Adult Juvenile	1.81 ± .02 (n = 3)	1.96 (n = 1)	1.81 (n = 1) 1.91 (n = 1)
	Staging/ Migrating	Adult Juvenile	2.34 ± .06 (n = 5) 2.08 (n = 1)		
GWTE	Breeding	Adult	1.83 ± .04 (n = 3)		
	Staging/ Migrating	Adult	1.79 ± .05 (n = 3)		
GADW	Breeding	Adult	2.63 ± 0.10 (n = 3)	2.52 (n = 1)	2.94 ± 0.05 (n = 2)
	Staging/ Migrating	Adult Juvenile	2.98 ± .02 (n = 2)	2.69 (n = 1) 5.53 ± .21 (n = 3)	
NOPI	Staging/ Migrating	Adult Juvenile	3.31 ± 0.09 (n = 4)		2.75 (n = 1) 4.33 ± .19 (n = 4)
MALL	Breeding Staging/ Migrating	Adult Adult	3.61 (n = 1) 4.42 (n = 1)		

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Appendix 1a External physical measurements of waterfowl collected from FARM and BEAR in 2009

Site	plot	Date	Species	Bird ID	Sex	field mass g	thawed mass g	total length mm	wing cord mm	total head mm	bill mm	tail mm	tarsometatarsus mm
FARM	UNIT 1	9/15/2009	CITE	915-2-KJS-09	F	301.8	288	380	154	86.95	33.94	62	36.95
FARM	UNIT 1	9/15/2009	CITE	915-3-KJS-09	F	482.6	468	410	182	87.73	33.29	70	33.3
FARM	UNIT 1	9/15/2009	CITE	915-1-KJS-09	M	358.3	343	341	178	93.37	35.46	49	38.75
FARM	UNIT 1	9/13/2009	NOPI	913-4-KJS-09	M	886	850	570	265	112.9	43.22	108	49.01
BEAR	4C	9/21/2009	GWTE	921-1-KJS-09	M	245	212	284	185	79.46	29.61	51	28.88
BEAR	4C	9/23/2009	GWTE	923-1-KJS-09	F	310	287	287	177	70.65	28.88	51	30.26
BEAR	4C	9/17/2009	MALL	917-1-KJS-09	F	1215.5	1150	537	279	109.07	38.93	71	42.62
BEAR	4C	9/21/2009	MALL	921-2-KJS-09	F	1190	1115	455	261	113.57	39.69	78	44.9
BEAR	4C	9/22/2009	NOPI	922-1-KJS-09	M	785	729	424	310	102.74	37.57	110	43.8

Appendix 1b Internal measurements for waterfowl collected from FARM and BEAR in 2009

Site	plot	Date	Species	Bird ID	Sex	pec. muscle mass g	sm. intestine mass g	sm. intestine parasites	seca mass	lg. intestine mass g	lg. intestine length mm	Testicles / ovaries	liver mass g	liver parasites	heart mass g	heart length mm	kidney mass g	abdominal Fat g
FARM	UNIT 1	9/15/2009	CITE	915-2-KJS-09	F	31.16	19.41	YES	0.49	0.97	54.3	10.25	15.49	NO	4.41	28.5	3.59	0.8
FARM	UNIT 1	9/15/2009	CITE	915-3-KJS-09	F	31.88	24.67	NO	0.87	0.51	31.79	20.17	10.16	NO	3.99	28.29	2.3	14.9
FARM	UNIT 1	9/15/2009	CITE	915-1-KJS-09	M	27	24.13	NO	0.66	0.84	55.83	9.15	11.2	NO	3.99	26.81	3.77	0.41
FARM	UNIT 1	9/13/2009	NOPI	913-4-KJS-09	M	73.2	25.7	NO	1.8	1.7	61.15	15.96	16.1	NO	8.6	35.94	5.7	8.4
BEAR	4C	9/21/2009	GWTE	921-1-KJS-09	M	21.36	9.5	NO	0.73	0.5	43.72	L4.95 R4.39	6.37	NO	2.7	24.06	1.58	2.1
BEAR	4C	9/23/2009	GWTE	923-1-KJS-09	F	25.01	10.52	NO	0.93	0.46	33.96	12.62	4.86	NO	3.88	27.46	1.28	3.5
BEAR	4C	9/17/2009	MALL	917-1-KJS-09	F	80.4	53.5	NO	3.9	2	81.22	NOT FOUND	42	NO	7	34.12	6.2	13.1
BEAR	4C	9/21/2009	MALL	921-2-KJS-09	F	87.97	60.67	NO	3.08	3.69	69.58	20.1	29.94	NO	12.24	36.21	5.8	8.57
BEAR	4C	9/22/2009	NOPI	922-1-KJS-09	M	57.8	20.5	NO	1.92	1.19	48.92	L13.52 R15.12	20.64	NO	10.52	40.21	6.56	-

Appendix 1c External measurements of physical characteristics for waterfowl collected in 2010

Site	plot	Date	Species	Bird ID	Sex	Age	field mass g	thawed mass g	total length mm	wing cord mm	total head mm	bill mm	tail mm	tarsometatarsus mm
FARM	UNIT 1	5/27/2010	CITE	MSL-01-10	M	Adult	354	327	335	180	90.64	37.74	70	39.71
FARM	UNIT 1	5/27/2010	CITE	MSL-02-10	M	Adult	356	317	315	179	97.38	37.9	69	30.08
FARM	UNIT 1	5/27/2010	GADW	MSL-03-10	M	Adult	876	630	389	249	97.52	36.5	74	42.8
FARM	UNIT 1	5/27/2010	CITE	MSL-04-10	M	Adult	-	360	354	195	92.88	38.1	62	34.49
FARM	UNIT 1	5/27/2010	GWTE	MSL-05-10	M	Adult	-	322	325	179	83.78	30.5	66	31.46
FARM	UNIT 1	6/3/2010	GWTE	MSL-06-10	M	Adult	347	344	337	179	83.53	29.79	63	34.22
FARM	UNIT 1	6/3/2010	GWTE	MSL-07-10	M	Adult	355	308	222[A]	175	80.33	29.15	61	30.24
FARM	UNIT 1	6/3/2010	GADW	MSL-08-10	M	Adult	-	791	510	276	101.6	37.47	84	47.26
FARM	UNIT 1	6/3/2010	GADW	MSL-09-10	M	Adult	-	666	476	268	95.86	34.21	84	40.6
FARM	UNIT 1	6/3/2010	MALL	MSL-10-10	M	Adult	-	1051	555	291	115.49	42.97	93	47.6
FARM	UNIT 1	8/10/2010	NOPI	MSL-13-10	M	Adult	1062	973	565	274	116.5	41.58	92	49.06
FARM	UNIT 1	8/10/2010	NOPI	MSL-14-10	M	-	-	906	231	282	109	41.17	13	48.83
FARM	UNIT 1	8/10/2010	CITE	MSL-15-10	M	Adult	453	438	392	175	87.05	32.87	65	28.83
FARM	UNIT 1	8/10/2010	GWTE	MSL-16-10	M	Adult	356	337	329	190	81.83	30.62	65	35.15
FARM	UNIT 1	8/10/2010	GWTE	MSL-17-10	M	Adult	333	278.3	340	160	79.78	29.71	65	32.28
FARM	UNIT 1	8/10/2010	GWTE	MSL-18-10	M	Adult	-	343	352	185	75.1	26.85	67	30.5
FARM	UNIT 1	8/10/2010	CITE	MSL-19-10	M	Juvenile	400	389	359	187	91.44	36.35	68	36.28
FARM	UNIT 1	8/10/2010	CITE	MSL-20-10	M	Adult	-	445	386	190	92	36	70	34.2
FARM	UNIT 1	8/10/2010	NOPI	MSL-21-10	F	Adult	883	827	467	242	91.73	35.94	86	49.24
FARM	UNIT 1	9/13/2010	CITE	MSL-30-10	M	Adult	427	407	373	193	88.11	37	66	36.13
FARM	UNIT 1	9/13/2010	CITE	MSL-31-10	M	Adult	456	435	325	190	86.91	33.38	65	36.85
FARM	UNIT 1	9/13/2010	CITE	MSL-32-10	M	Adult	507	481	362	197	87.2	33.23	74	35.27
FARM	UNIT 1	9/13/2010	NOPI	MSL-33-10	M	Adult	852	781	564	255	106.64	38.57	102	50.02
FARM	UNIT 1	9/13/2010	GADW	MSL-34-10	F	Juvenile	829	755	450	255	93.26	33.78	73	38.4
FARM	UNIT 1	9/13/2010	GADW	MSL-35-10	U	Juvenile	902	809	480	270	97.8	35.24	41	41.81
FARM	UNIT 1	9/13/2010	MALL	MSL-36-10	M	Adult	1394	1287	536	291	115.57	42.26	92	46.9

Site	plot	Date	Species	Bird ID	Sex	Age	field mass g	thawed mass g	total length mm	wing cord mm	total head mm	bill mm	tail mm	tarsometatarsus mm
PSGR	Pintail	6/10/2010	CITE	MSL-11-10	M	Adult	388	371	370	189	88.46	34.95	77	37.85
PSGR	Pintail	6/10/2010	GADW	MSL-12-10	M	Adult	-	697	443	277	95.37	35.6	88	41.67
PSGR	Pintail	8/28/2010	GADW	EP-001-10	M	Juvenile	483	427	367	80	79.73	25.88	52	39.88
PSGR	Pintail	8/28/2010	GADW	EP-002-10	F	Juvenile	423	381	353	63	80	26.46	48	42.2
PSGR	Pintail	8/28/2010	GADW	EP-003-10	F	Juvenile	534	469	410	90	81.32	25.55	52	40.5
PSGR	Pintail	8/28/2010	GADW	EP-004-10	F	Adult	679	644	375	239	90.88	33.25	82	46.57
BEAR	4C	6/4/2010	GADW	060410-01-KJS	F	Adult	772	732	44	256	95.48	33.49	85	42
BEAR	4C	6/5/2010	CITE	060510-01-KJS	M	Adult	343	336	385	186	92	34.32	71	37
BEAR	4C	6/5/2010	GADW	060510-02-KJS	M	Adult	862	813	506	270	95.99	34.16	82	46.61
BEAR	4C	6/5/2010	CITE	060510-03-KJS	M	Juvenile	378	355	410	186	89	36	72	38.3
BEAR	4C	8/13/2010	NOPI	081310-01-KJS	F	Adult	680	625	460	227	89.72	31.87	98	47
BEAR	4C	8/13/2010	NOPI	081310-02-KJS	M	Juvenile	620	557.2	428	131	86.03	30.03	71	46
BEAR	4C	8/13/2010	NOPI	081310-03-KJS	F	Juvenile	600	536.6	443[B]	142	84	31	65	38
BEAR	4C	8/13/2010	NOPI	081310-04-KJS	M	Juvenile	595	527	414	110	82.34	27.61	58	39.83
BEAR	4C	8/13/2010	NOPI	081310-05-KJS	M	Juvenile	550	491	398	109	83.57	28.28	60	43.62

[B] Vertebrae severed at neck, reported total body length may be longer than actual body length.

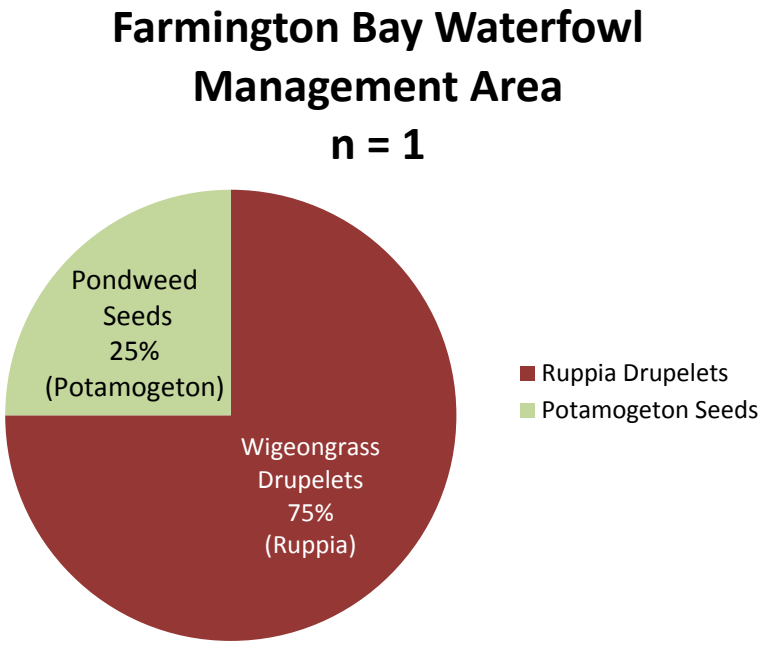
[A] Length doesn't include neck and head due to decapitation.

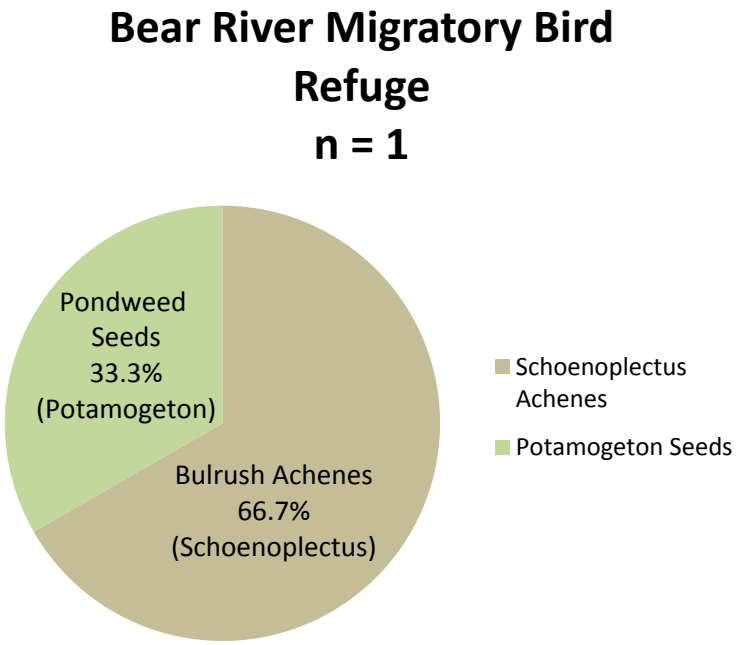
Appendix 1d Internal measurements for waterfowl collected in 2010

Site	plot	Date	Species	Bird ID	Sex	Age	pec. muscle mass g	sm. intestine mass g	sm. intestine parasites	seca mass	lg. intestine mass g	lg. intestine length mm	Testicles / ovaries	liver mass g	liver parasites	heart mass g	heart length mm	kidney mass g	abdominal Fat g
FARM	UNIT 1	5/27/2010	CITE	MSL-01-10	M	Adult	37	17.1	YES	0.23	0.31	28.12	R 20.85/ L28.05	15.05	NONE	4.51	25.85	2.74	NONE
FARM	UNIT 1	5/27/2010	CITE	MSL-02-10	M	Adult	27.65	12.28	NONE	0.34	0.3	31.5	R 17.42	19.95	NONE	4.48	34.69	2.56	NONE
FARM	UNIT 1	5/27/2010	GADW	MSL-03-10	M	Adult	66.87	25.7	NONE	1.35	1.88	65.6	R 25.9 /L26.8	25.75	NONE	7.44	32.9	6.96	8.66
FARM	UNIT 1	5/27/2010	CITE	MSL-04-10	M	Adult	37.8	21.44	YES	0.49	0.67	39.01	R14.36 /L15.93	10.39	NONE	7.44	26.06	3.11	NONE
FARM	UNIT 1	5/27/2010	GWTE	MSL-05-10	M	Adult	33.97	17.46	YES	0.43	0.77	40.58	R32 /L27.73	10.9	NONE	4.42	26.6	3.42	1.12
FARM	UNIT 1	6/3/2010	GWTE	MSL-06-10	M	Adult	31.31	16.51	NONE	0.53	1.18	58.08	R26.89/ L29.51	7.98	NONE	4.95	27.3	3.67	1.16
FARM	UNIT 1	6/3/2010	GWTE	MSL-07-10	M	Adult	30.26	9.81	NONE	0.49	0.43	33.61	R30. /L31.33	7.38	NONE	3.55	25.33	2.65	1.08
FARM	UNIT 1	6/3/2010	GADW	MSL-08-10	M	Adult	83.1	25.1	NONE	1.7	2.1	92.28	R18.97/L 25.06	15.1	NONE	9.4	37.23	9.4	3.8
FARM	UNIT 1	6/3/2010	GADW	MSL-09-10	M	Adult	80.86	22.62	NONE	0.8	0.89	60.79	R25.45 /L39.51	14.08	NONE	12.39	39.09	4.3	3.6
FARM	UNIT 1	6/3/2010	MALL	MSL-10-10	M	Adult	120.66	35.12	YES	1.4	1.51	52.45	R53.76 /L44.73	18.8	NONE	11.34	41.78	7.74	NONE
FARM	UNIT 1	8/10/2010	NOPI	MSL-13-10	M	Adult	98.75	52	NONE	2.79	2.42	70.5	R 9.66/L 11.24	34.84	NONE	10.81	42.26	10.63	6.24
FARM	UNIT 1	8/10/2010	NOPI	MSL-14-10	M	-	-	39.14	NONE	2.1	2.15	67	R 17.13 /L 19.68	18.63	NONE	9.72	36.4	6.23	9.42
FARM	UNIT 1	8/10/2010	CITE	MSL-15-10	M	Adult	-	-	-	-	-	-	-	-	-	-	-	-	-
FARM	UNIT 1	8/10/2010	GWTE	MSL-16-10	M	Adult	34.51	13.72	NONE	0.62	-	41.5	R8.78 /L7.26	5.17	NONE	4.97	31.71	3.11	1.25
FARM	UNIT 1	8/10/2010	GWTE	MSL-17-10	M	Adult	29.4	12.8	NONE	0.8	0.9	48.96	-	-	-	-	27.66	3.4	NONE
FARM	UNIT 1	8/10/2010	GWTE	MSL-18-10	M	Adult	-	-	-	-	-	-	R 6.98/L 6.45	-	-	-	-	-	-
FARM	UNIT 1	8/10/2010	CITE	MSL-19-10	M	Juvenile	35.52	18.98	NONE	0.74	0.63	42.31	R 7.3 /L 7.99	11.56	NONE	4.36	27.62	4.18	0.59
FARM	UNIT 1	8/10/2010	CITE	MSL-20-10	M	Adult	-	-	-	-	-	-	R 6.44 /L 7.16	-	-	-	-	-	-
FARM	UNIT 1	8/10/2010	NOPI	MSL-21-10	F	Adult	66.56	37.35	NONE	2.8	1.89	59.23	10.43	18.87	NONE	8.88	30.02	6.12	9.33
FARM	UNIT 1	9/13/2010	CITE	MSL-30-10	M	Adult	35.03	15.8	NONE	1.66	0.92	46.62	R 6047 /L 7.85	11.6	NONE	4.45	25.71	4.78	1.32
FARM	UNIT 1	9/13/2010	CITE	MSL-31-10	M	Adult	34.99	27.42	YES	1.34	0.98	55.91	R5.25 L6.48	13.46	NONE	4.48	29.4	4.96	9.98
FARM	UNIT 1	9/13/2010	CITE	MSL-32-10	M	Adult	41.37	28.34	YES	1.08	0.81	48.18	R8.73 /L9.36	14.2	NONE	4.87	28.71	4.77	15.56
FARM	UNIT 1	9/13/2010	NOPI	MSL-33-10	M	Adult	75.85	42.18	YES	3.54	2.23	60.77	R 5.63 /L6.46	15.8	NONE	8.88	32.88	6.63	NONE
FARM	UNIT 1	9/13/2010	GADW	MSL-34-10	F	Juvenile	87.3	90.1	NONE	3.4	5.4	87.21	18.55	17.2	NONE	7.4	32.97	12.6	NONE
FARM	UNIT 1	9/13/2010	GADW	MSL-35-10	U	Juvenile	70.5	110.23	YES	5.89	6.36	108.11	NOT FOUND	78.23	NONE	4.46	34.25	8	NONE
FARM	UNIT 1	9/13/2010	MALL	MSL-36-10	M	Adult	131.01	56.72	NONE	4.04	2.41	66.51	R 8.05	19.5	NONE	11.85	39.22	7.77	18.85

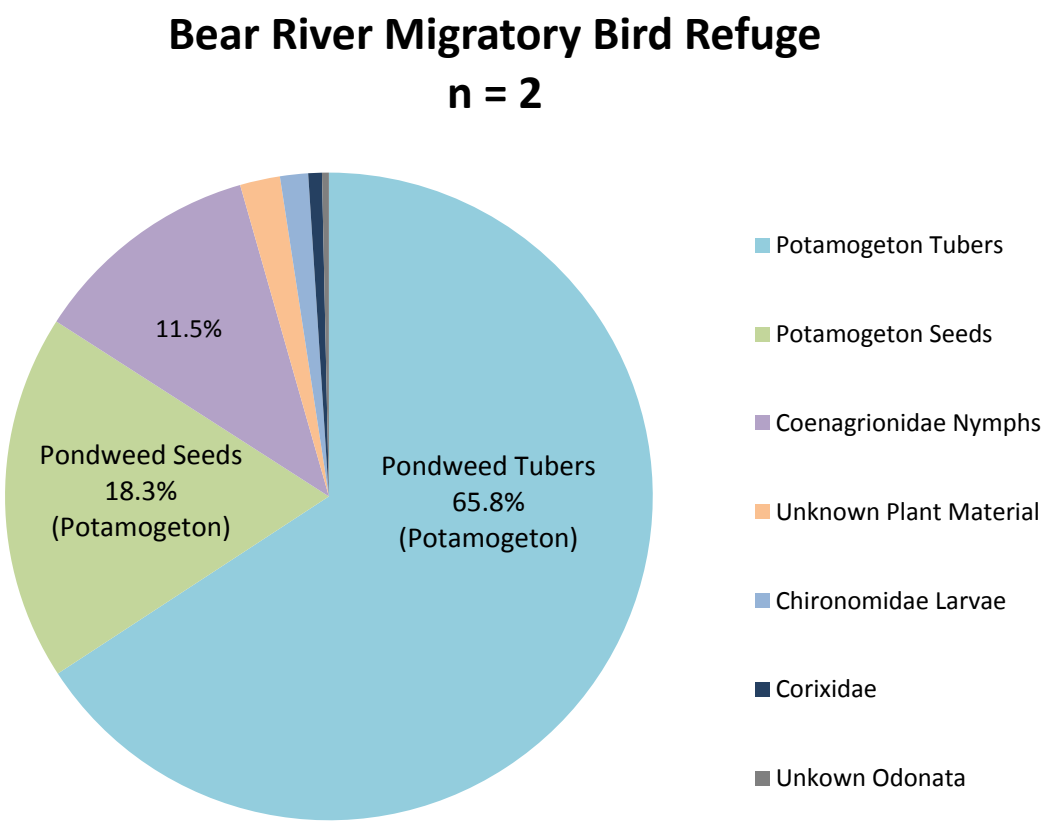
Site	plot	Date	Species	Bird ID	Sex	Age	pec. muscle mass g	sm. intestine mass g	sm. intestine parasites	seca mass	lg. intestine mass g	lg. intestine length mm	Testicles / ovaries	liver mass g	liver parasites	heart mass g	heart length mm	kidney mass g	abdominal Fat g
PSGR	Pintail	6/10/2010	CITE	MSL-11-10	M	Adult	39.39	19.36	YES	0.67	0.93	35	R 18.88 /L21.44	9.72	NONE	4.52	26.52	5.17	2.09
PSGR	Pintail	6/10/2010	GADW	MSL-12-10	M	Adult	93.94	38.71	NONE	2.52	1.8	66.02	R30.2 /L35.	17.12	NONE	11.01	37.05	5.99	0.32
PSGR	Pintail	8/28/2010	GADW	EP-001-10	M	Juvenile	6.42	39.49	NONE	3.11	2.74	69	R 5.53 /L 4.99	20.74	NONE	3.31	23.74	5.1	NONE
PSGR	Pintail	8/28/2010	GADW	EP-002-10	F	Juvenile	4.66	25.5	NONE	3.06	3.23	85	11.08	19.49	NONE	3.48	24.78	5.51	NONE
PSGR	Pintail	8/28/2010	GADW	EP-003-10	F	Juvenile	10.49	55.47	YES	5.35	4.14	84.12	13.12	20.66	NONE	4.29	28.51	9.07	NONE
PSGR	Pintail	8/28/2010	GADW	EP-004-10	F	Adult	53.7	34.28	NONE	2.25	2.84	74	17.81	19.38	NONE	7.36	34.8	6.61	0.43
BEAR	4C	6/4/2010	GADW	060410-01-KJS	F	Adult	60.11	32.47	NONE	1.63	1.69	62.68	33.75	28.28	NONE	10.76	40.02	8.35	1.92
BEAR	4C	6/5/2010	CITE	060510-01-KJS	M	Adult	47.86	19.27	NONE	0.62	0.93	55	R 15.7 / L18.55	8.86	NONE	6.37	29	4.51	NONE
BEAR	4C	6/5/2010	GADW	060510-02-KJS	M	Adult	66.47	-	-	-	-	-	R 22.05 /L22.85	12.42	NONE	10.1	50.1	4.34	NONE
BEAR	4C	6/5/2010	CITE	060510-03-KJS	M	Juvenile	27.68	10.56	NONE	0.56	0.63	47	R 18.35 / L 18.35	3.94	NONE	5	32	2.56	NONE
BEAR	4C	8/13/2010	NOPI	081310-01-KJS	F	Adult	60.4	58.2	NONE	21.8	22.3	83	10	29.8	NONE	23.8	32	22.4	NONE
BEAR	4C	8/13/2010	NOPI	081310-02-KJS	M	Juvenile	11.14	52.95	NONE	3.28	3.23	130	R 6.44 /L 6.58	16.11	NONE	4.67	23.76	5.32	NONE
BEAR	4C	8/13/2010	NOPI	081310-03-KJS	F	Juvenile	19.11	19.42	NONE	0.86	0.39	36	12	8.7	NONE	4	29	4.82	NONE
BEAR	4C	8/13/2010	NOPI	081310-04-KJS	M	Juvenile	7.14	77.88	NONE	1.64	4.92	145	R 6.58 / L 8.18	13.86	NONE	3.91	27.81	4.47	NONE
BEAR	4C	8/13/2010	NOPI	081310-05-KJS	M	Juvenile	6.81	50.78	NONE	2.6	4.04	110	R 4.57 /L 7.19	12.27	NONE	3.19	23.45	4.18	NONE

Appendix 2a NOPI collected September 2009

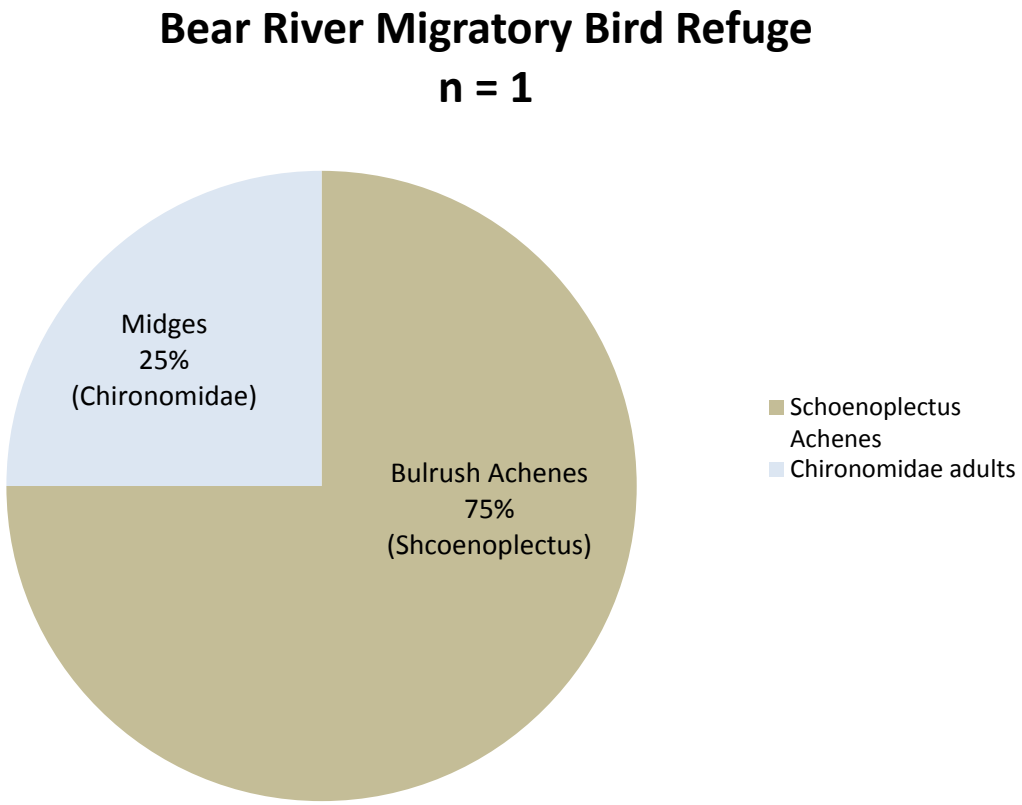




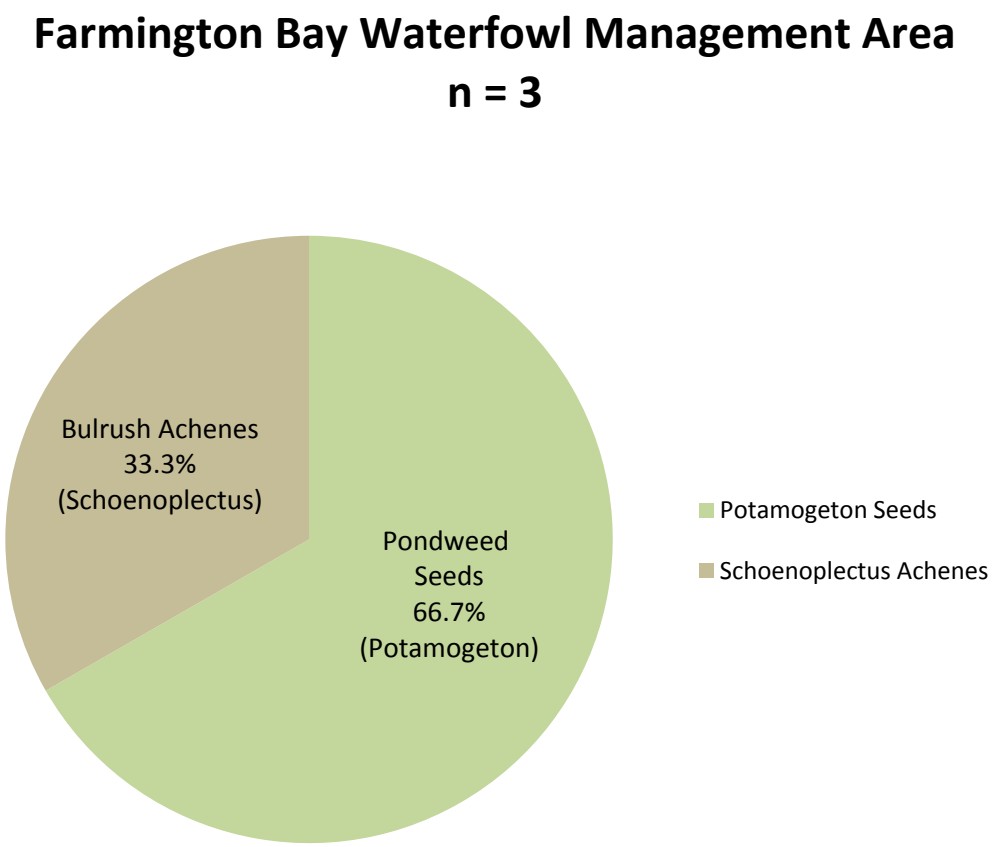
Appendix 2b MALL collected in September 2009



Appendix 2c GWTE collected in September 2009



Appendix 2d CITE collected in September 2009



Appendix 3a Mean aggregate percent and volume calculations by species for 2009.

Species	Bird ID	n	Site			Chironimidae Larvae	Chironimidae Adults	Corixidae	Unk Odonata	Coenagrionidae Nymphs	Schoenoplectus Achenes	Stuckenia Drupelets	Potamogeton Tubers	Ruppia Drupelets	Unk Plant Material	Sum
CITE	915-1-KJS-09 915-3-KJS-09	2	FARM	Agg %	Mouth						0	0				0
					Esoph						0	0				0
					Provent						0	0				0
					Vent						0.25	0.75				1
					All						0.25	0.75				1
				Agg Vol	Mouth						0	0				0
					Esoph						0	0				0
					Provent						0	0				0
					Vent						0.3333	0.6667				1
					All						0.3333	0.6667				1
MALL	917-1-KJS-09 921-2-KJS-09	2	BEAR	Agg %	Mouth	0		0	0	0		0	0		0	0
					Esoph	0.0179		0.0090	0.0045	0.1525		0.0000	0.8161435		0	1
					Provent	0		0		0		0.6667	0.33333333		0	1
					Vent					0		0.82105263	0.1		0.07894737	1
					All	0.0078		0.0039	0.0020	0.0667		0.4642	0.38039216		0.075	1
				Agg Vol	Mouth	0									0	0
					Esoph	0.0179		0.0090	0.0045	0.1525		0	0.8161		0	1
					Provent	0		0	0	0		0.4286	0.5714		0	1
					Vent	0		0	0	0		0.8276	0.0690		0.1034	1
					All	0.0136		0.0068	0.0034	0.1153		0.1831	0.6576		0.0203	1
GWTE	921-1-KJS-09	1	BEAR	Agg %	Mouth		0				0					0
					Esoph		0				0					0
					Provent		1				0					1
					Vent		0				1					1
					All		0.25				0.75					1
				Agg Vol	Mouth		0				0					0
					Esoph		0				0					0
					Provent		1				0					1
					Vent		0				1					1
					All		0.25				0.75					1

Species	Bird ID	n	Site			Chironimidae Larvae	Chironimidae Adults	Corixidae	Unk Odonata	Coenagrionidae Nymphs	Schoenoplectus Achenes	Stuckenia Drupelets	Potamogeton Tubers	Ruppia Drupelets	Unk Plant Material	Sum
NOPI	915-4-KJS-09	1	FARM	Agg %	Mouth							0		0		0
					Esoph							0		0		0
					Provent							0		0		0
					Vent							0.25		0.75		1
					All							0.25		0.75		1
				Agg Vol	Mouth							0		0		0
					Esoph							0		0		0
					Provent							0		0		0
					Vent							0.25		0.75		1
					All							0.25		0.75		1
NOPI	922-1-KJS-09	1	BEAR	Agg %	Mouth						0	0				0
					Esoph						0	0				0
					Provent						0	0				0
					Vent						0.6667	0.3333				1
					All						0.6667	0.3333				1
				Agg Vol	Mouth						0	0				0
					Esoph						0	0				0
					Provent						0	0				0
					Vent						0.6667	0.3333				1
					All						0.6667	0.3333				1

Appendix 3b Mean aggregate percent and volume calculations by species for 2010.

Species	Bird ID	n	Site			Diptera	Chironomidae Larvae	Chironomidae Pupae	Chironomidae Adults	Tipulidae Larvae	Trichoptera Larvae	Ephemeroptera Nymphs	Coenagrionidae Adults	Coenagrionidae Nymphs	Corixidae	Coleoptera	Gastropoda	Pulmonata	Planorbid Snail	Amphipoda	Schoenoplectus Achenes	Potamogeton Seeds	Ruppia Drupelets	Distichlis Lemmas	Unk Seed 18	Lemnaceae	Alismatales	Sum
CITE		6	FARM	Agg %	Mouth	0	0	0							0				0		0	0	0				0	0
					Esoph	0.0141	0.8727	0.0754							0.0190				0.0188		0	0	0				0	1
	MSL-02-10				Provent	0	0.9524	0.0476							0				0		0	0	0				0	1
	MSL-04-10				Vent	0.0222	0.537	0							0				0.0556		0.0519	0.0079	0.1667				0.1587	1
	MSL-19-10				All	0.0237	0.5624	0.0344							0.0077				0.0103		0.0282	0.0079	0.1667				0.1587	1
	MSL-20-10			Agg Vol	Mouth	0		0							0													0
	MSL-30-10				Esoph	0.1111		0.5926							0.1481				0.1481									1
	MSL-31-10				Provent	0		1.0000							0													1
					Vent	0.0690		0							0				0.0345		0.1379	0.0345	0.0345				0.6897	1
					All	0.0877		0.2982							0.0702				0.0877		0.0702	0.0175	0.0175				0.3509	1
CITE	MSL-11-10	1	PSGR	Agg %	Mouth	0										0	0				0			0				0
					Esoph	0										0	0				0			0				0
					Provent	0										0	0				0			0				0
					Vent	0.1667										0.1667	0.1667				0.3333			0.1667				1
					All	0.1667										0.1667	0.1667				0.3333			0.1667				1
				Agg Vol	Mouth	0										0	0				0			0				0
					Esoph	0										0	0				0			0				0
					Provent	0										0	0				0			0				0
					Vent	0.1667										0.1667	0.1667				0.3333			0.1667				1
					All	0.1667										0.1667	0.1667				0.3333			0.1667				1
CITE		2	BEAR	Agg %	Mouth																0	0	0		0			0
					Esoph																0	0	0		0			0
					Provent																0	0	0		0			0
					Vent																0.3	0.1	0.5		0.1			1
	060510-01-KJS				All																0.3	0.1	0.5		0.1			1
	060510-03-KJS			Agg Vol	Mouth																0	0	0		0			0
					Esoph																0	0	0		0			0
					Provent																0	0	0		0			0
					Vent																0.3243	0.1081	0.5405		0.0270			1
					All																0.3243	0.1081	0.5405		0.0270			1

Species	Bird ID	n	Site			Diptera	Chironomidae Larvae	Chironomidae Pupae	Chironomidae Adults	Tipulidae Larvae	Trichoptera Larvae	Ephemeroptera Nymphs	Coenagrionidae Adults	Coenagrionidae Nymphs	Corixidae	Coleoptera	Gastropoda	Pulmonata	Planorbid Snail	Amphipoda	Schoenoplectus Achenes	Potamogeton Seeds	Ruppia Drupelets	Distichlis Lemmas	Unk Seed 18	Lemnaceae	Alismatales	Sum
GADW		5	FARM	Agg %	Mouth		0		0																		0	0
					Esoph		0		0																		1	1
	MSL-03-10				Provent		0.25		0.25																		0.5	1
	MSL-08-10				Vent		0.2		0.2																		0.6	1
	MSL-09-10				All		0.2		0.2																		0.6	1
	MSL-34-10			Agg Vol	Mouth		0		0																		0	0
	MSL-35-10				Esoph		0		0																		1	1
					Provent		0.0175		0.0351																		0.9474	1
					Vent		0.3529		0.1176																		0.5294	1
					All		0.0814		0.0465																		0.8721	1
GADW		4	PSGR	Agg %	Mouth	0					0	0	0	0	0					0	0						0	0
					Esoph	0					0	0.65	0.025	0.05	0.0125					0.0125	0						0.25	1
					Provent	0					0	0.7630	0.0370	0.0095	0					0	0						0.1905	1
	EP-001-10				Vent	0.125					0.0078	0.3734	0	0.1	0.05					0	0.125						0.2188	1
	EP-002-10				All	0.125					0.0018	0.5214	0.0253	0.0323	0.0126					0.0018	0.125						0.1549	1
	EP-003-10			Agg Vol	Mouth	0					0	0	0	0	0					0	0						0	0
	EP-005-10				Esoph	0					0	0.3333	0.0476	0.0952	0.0238					0.0238	0						0.4762	1
					Provent	0					0	0.5217	0.0217	0.0217	0					0	0						0.4348	1
					Vent	0.0455					0.0227	0.1818	0	0.0455	0.0227					0	0.0455						0.6364	1
					All	0.0112					0.0056	0.3933	0.0225	0.0449	0.0112					0.0056	0.0112						0.4944	1
GWTE		6	FARM	Agg %	Mouth		0														0	0						0
					Esoph		1.0000														0	0						1
	MSL-05-10				Provent		1														0	0						1
	MSL-06-10				Vent		0.48														0.48	0.0400						1
	MSL-07-10				All		0.6429														0.3492	0.0079						1
	MSL-16-10			Agg Vol	Mouth		0														0	0						0
	MSL-17-10				Esoph		1														0	0						1
	MSL-18-10				Provent		1														0	0						1
					Vent		0.55														0.4	0.05						1
					All		0.8615														0.1231	0.0154						1

Species	Bird ID	n	Site			Diptera	Chironomidae Larvae	Chironomidae Pupae	Chironomidae Adults	Tipulidae Larvae	Trichoptera Larvae	Ephemeroptera Nymphs	Coenagrionidae Adults	Coenagrionidae Nymphs	Corixidae	Coleoptera	Gastropoda	Pulmonata	Planorbid Snail	Amphipoda	Schoenoplectus Achenes	Potamogeton Seeds	Ruppia Drupelets	Distichlis Lemmas	Unk Seed 18	Lemnaceae	Alismatales	Sum
NOPI		4	FARM	Agg %	Mouth							0								0	0		0			0	0	0
					Esoph							0								0	0		0			1	0	1
					Provent							0								0	0		0.5			0	0.5	1
	MSL-13-10				Vent							0.0556								0.0556	0.0556		0.7222			0	0.1111	1
	MSL-14-10				All							0.0357								0.0357	0.0357		0.5238			0.0357	0.3333	1
	MSL-21-10			Agg Vol	Mouth							0								0	0		0			0	0	0
	MSL-33-10				Esoph							0								0	0		0			1	0	1
					Provent							0								0	0		0.6667			0	0.3333	1
					Vent							0.04								0.04	0.04		0.84			0	0.04	1
					All							0.0345								0.0345	0.0345		0.7931			0.0345	0.0690	1
NOPI		5	BEAR	Agg %	Mouth																						0	0
					Esoph																						1	1
					Provent																						1	1
	081310-01-KJS				Vent																						1	1
	081310-02-KJS				All																						1	1
	081310-03-KJS			Agg Vol	Mouth																						0	0
	081310-04-KJS				Esoph																						1	1
	081310-05-KJS				Provent																						1	1
					Vent																						1	1
					All																						1	1
MALL		2	FARM	Agg %	Mouth					0								0			0	0	0	0				0
					Esoph					0								0.0196			0	0	0	0.9804				1
					Provent					0								0			0	0	0.125	0.8750				1
					Vent					0.25								0			0.25	0.0556	0	0.4444				1
	MSL-10-10				All					0.25								0.0084			0.2500	0.0042	0.0042	0.4832				1
	MSL-36-10			Agg Vol	Mouth					0								0				0	0	0				0
					Esoph					0								0.0196				0	0	0.9804				1
					Provent					0								0				0	0.125	0.875				1
					Vent					0.1								0				0.1	0	0.8				1
					All					0.0083								0.0167				0.0083	0.0083	0.9583				1

Appendix 4a Mean aggregate percent and volume calculations by site for 2009

Site	Bird ID	n			Chironimidae Larvae	Chironimidae Adults	Corixidae	Unk Odonata	Coenagrionidae Nymphs	Schoenoplectus Achenes	Potamogeton Seeds	Potamogeton Tuber	Ruppia Drupelets	Unk Plant Material	Sum
Farm		3	Agg %	Mouth	0	0	0	0	0	0	0	0		0	0
				Esoph	0	0	0	0	0	0	0	0	0	0	0
				Provent	0	0	0	0	0	0	0	0	0	0	0
	915-1-KJS-09			Vent	0	0	0	0	0	0.1579	0.5921	0	0.25	0	1
	915-3-KJS-09			All	0	0	0	0	0	0.1579	0.5921	0	0.25	0	1
	915-4-KJS-09		Agg Vol	Mouth	0	0	0	0	0	0	0	0	0	0	0
				Esoph	0	0	0	0	0	0	0	0	0	0	0
				Provent	0	0	0	0	0	0	0	0	0	0	0
				Vent	0	0	0	0	0	0.0826	0.3670	0	0.5505	0	1
				All	0	0	0	0	0	0.0826	0.3670	0	0.5505	0	1
Bear		4	Agg %	Mouth	0	0	0	0	0	0	0	0	0	0	0
				Esoph	0.0179	0	0.0090	0.0054	0.1523	0	0	0.8154	0	0	1
				Provent	0	0.3333333	0	0	0	0	0.4375	0.2222	0	0	1
	917-1-KJS-09			Vent	0	0	0	0	0	0.4167	0.4919	0.05	0	0.0395	1
	921-1-KJS-09			All	0.0039	0.0625	0.0020	0.0012	0.0333	0.3542	0.3160	0.1900	0	0.0375	1
	921-2-KJS-09		Agg Vol	Mouth	0	0	0	0	0	0	0	0	0	0	0
	922-1-KJS-09			Esoph	0.0179	0	0.0090	0.0054	0.1523	0	0	0.8154	0	0	1
				Provent	0	0.125	0	0	0	0	0.375	0.5	0	0	1
				Vent	0	0	0	0	0	0.1429	0.7143	0.0571	0	0.0857	1
				All	0.0129	0.0065	0.0065	0.0039	0.1100	0.0323	0.1811	0.6274	0	0.0194	1

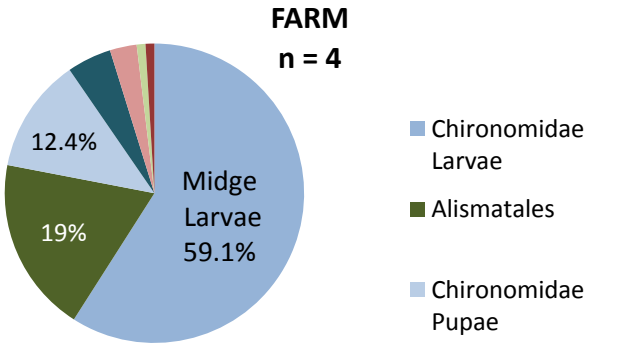
Appendix 4b Mean aggregate percent and volume calculations by site for 2010

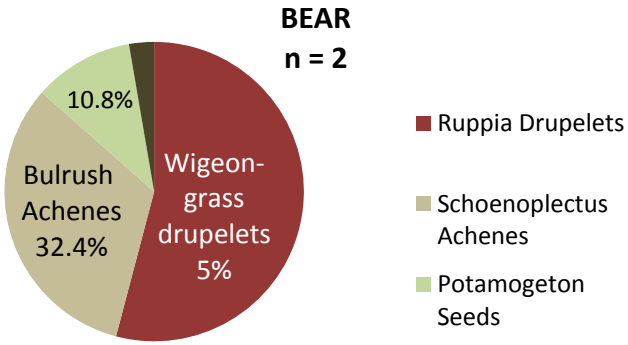
Site	Bird ID	n			Diptera	Chironomidae Larvae	Chironomidae Pupae	Chironomidae Adults	Tipulidae Larvae	Trichoptera Larvae	Ephemeroptera Nymphs	Coenagrionidae Adults	Coenagrionidae Nymphs	Corixidae	Coleoptera	Gastropoda	Pulmonata	Planorbid Snail	Amphipoda	Schoenoplectus Achenes	Potamogeton Seeds	Ruppia Drupelets	Distichlis Lemmas	Unk Seed 18	Lemnaceae	Alismatales	Sum
FARM		23																									
	MSL-02-10																										
	MSL-03-10																										
	MSL-04-10																										
	MSL-05-10																										
	MSL-06-10																										
	MSL-07-10																										
	MSL-08-10		Agg %	Mouth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MSL-09-10			Esoph	0.0042254	0.6618	0.0226	0	0	0	0	0	0	0.0057	0	0	0.0020	0.0056	0	0	0	0	0.0980	0	0.1000	0.1000	1
	MSL-10-10			Provent	0	0.5275	0.0110	0.0769	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0865	0.0673	0	0	0.2308	1
	MSL-13-10			Vent	0.0063492	0.3153	0	0.0476	0.0238	0	0.0079	0	0	0	0	0	0	0.016	0.008	0.1608	0.0171	0.1508	0.0423	0	0	0.2041	1
	MSL-14-10			All	0.006187	0.3579	0.0090	0.0435	0.0217	0	0.0062	0	0	0.0020	0	0	0.0007	0.003	0.006	0.1264	0.0045	0.1349	0.0420	0	0.0062	0.2298	1
	MSL-16-10		Agg Vol	Mouth		0	0	0	0		0			0			0	0	0	0	0	0	0		0	0	0
	MSL-17-10			Esoph		0.3594	0.1691	0	0		0			0.0423			0.0423	0.0423	0	0	0	0	0.2073		0.0106	0.1268	1
	MSL-18-10			Provent		0.1304	0.0109	0.0217	0		0			0			0	0	0	0	0	0.0489	0.1902		0	0.5978	1
	MSL-19-10			Vent		0.1560	0	0.0183	0.0183		0.0092			0			0	0.0092	0.0092	0.1193	0.0367	0.2018	0.1468		0	0.2752	1
	MSL-20-10			All		0.2464	0.0665	0.0156	0.0007		0.0039			0.0156			0.0156	0.0196	0.0039	0.0508	0.0085	0.1	0.0750		0.0039	0.3794	1
	MSL-21-10																										
	MSL-30-10																										
	MSL-31-10																										
	MSL-33-10																										
	MSL-34-10																										
	MSL-35-10																										
	MSL-36-10																										

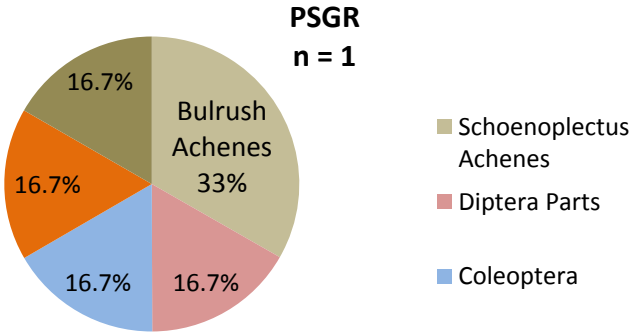
Site	Bird ID	n			Diptera	Chironomidae Larvae	Chironomidae Pupae	Chironomidae Adults	Tipulidae Larvae	Trichoptera Larvae	Ephemeroptera Nymphs	Coenagrionidae Adults	Coenagrionidae Nymphs	Corixidae	Coleoptera	Gastropoda	Pulmonata	Planorbid Snail	Amphipoda	Schoenoplectus Achenes	Potamogeton Seeds	Ruppia Drupelets	Distichlis Lemmas	Unk Seed 18	Lemnaceae	Alismatales	Sum
PSGR		5	Agg %	Mouth	0					0	0	0	0	0	0	0			0	0			0			0	0
				Esoph	0					0	0.6500	0.0250	0.0500	0.0125	0	0			0.0125	0			0			0.2500	1
	MSL-11-10			Provent	0					0	0.7630	0.0370	0.0095	0	0	0			0	0			0			0.1905	1
	MSL-12-10			Vent	0.1333					0.0063	0.2988	0.0000	0.0800	0.0400	0.0333	0.0333			0	0.1667			0.0333			0.1750	1
	EP-001-10			All	0.1333					0.0014	0.4171	0.0202	0.0258	0.0101	0.0333	0.0333			0.0014	0.1667			0.0333			0.1239	1
	EP-002-10		Agg Vol	Mouth	0					0	0	0	0	0	0	0			0	0			0			0	0
	EP-003-10			Esoph	0					0	0.3333	0.0476	0.0952	0.0238	0	0			0.0238	0			0			0.4762	1
				Provent	0					0	0.5217	0.0217	0.0217	0	0	0			0	0			0			0.4348	1
				Vent	0.0600					0.0200	0.1600	0	0.0400	0.0200	0.0200	0.0200			0	0.0800			0.0200			0.5600	1
				All	0.0163					0.0054	0.3804	0.0217	0.0435	0.0109	0.0054	0.0054			0.0054	0.0217			0.0054			0.4783	1
BEAR		7	Agg %	Mouth																0	0	0		0		0	0
				Esoph																0	0	0		0		1.0000	1
	060510-01-KJS			Provent																0	0	0		0		1.0000	1
	060510-03-KJS			Vent																0.0857	0.0286	0.1429		0.0286		0.7143	1
	081310-01-KJS			All																0.0857	0.0286	0.1429		0.0286		0.7143	1
	081310-02-KJS		Agg Vol	Mouth																0	0	0		0		0	0
	081310-03-KJS			Esoph																0	0	0		0		1.0000	1
	081310-04-KJS			Provent																0	0	0		0		1.0000	1
	081310-05-KJS			Vent																0.0201	0.0067	0.0134		0.0067		0.9530	1
				All																0.0077	0.0026	0.0051		0.0026		0.9820	1

Appendix 5a CITE collected in 2010

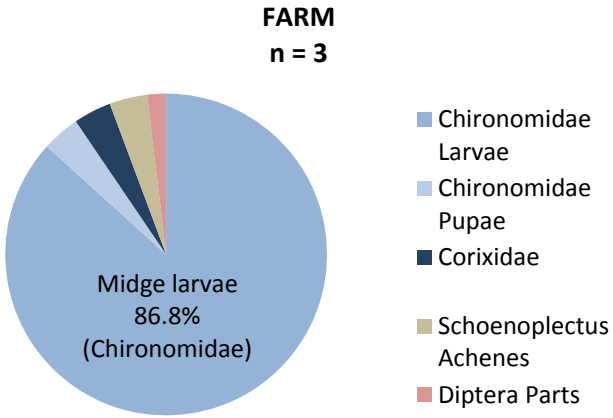
Breeding Time Frame





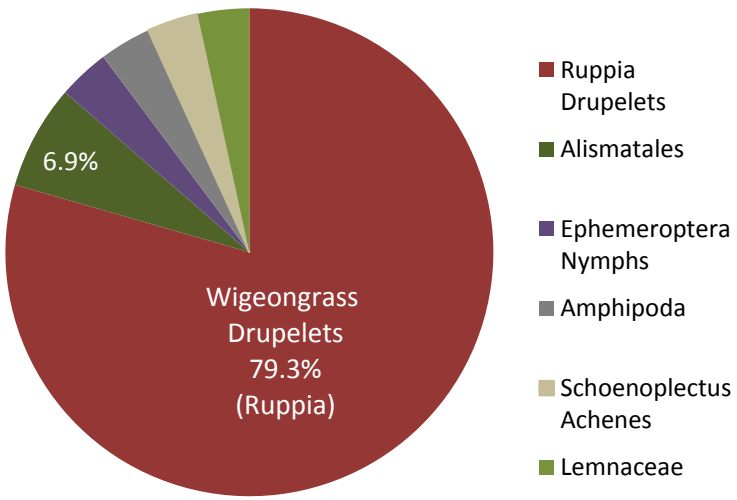


Staging/Migrating Time Frame

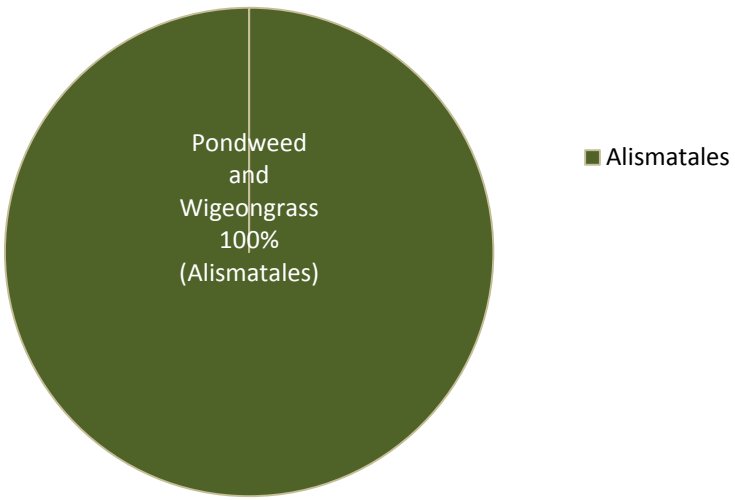


Appendix 5b NOPI collected in 2010 during the staging/migrating time frame

FARM
n = 4



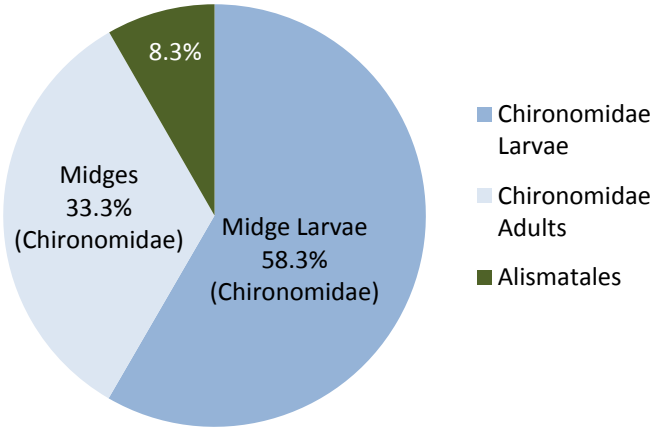
BEAR
n = 5



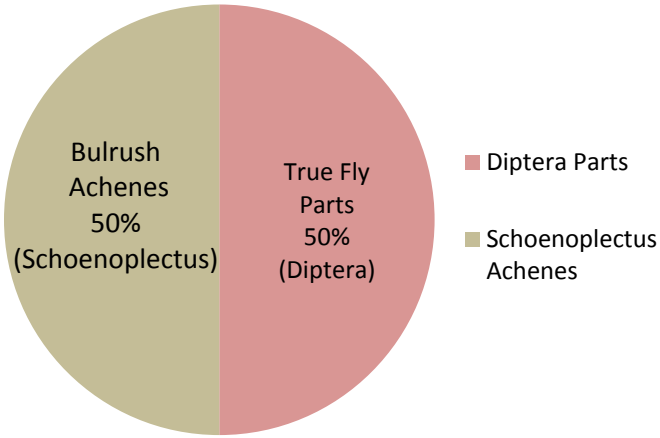
Appendix 5c GADW collected in 2010

Breeding Time Frame

FARM
n = 3

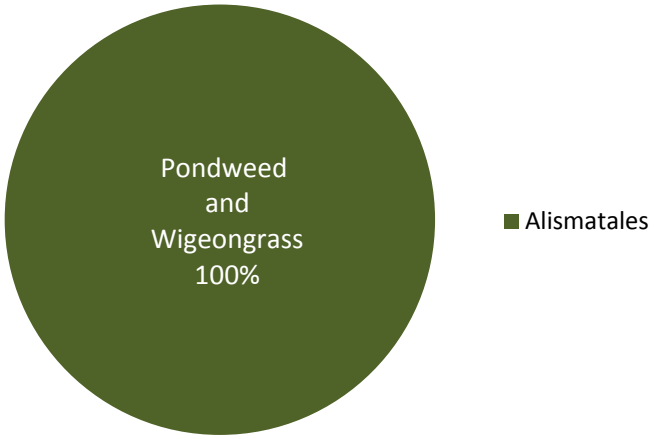


PSGR
n = 1

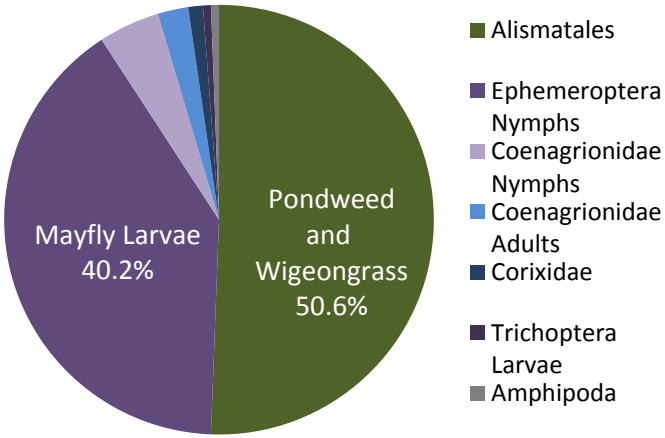


Staging/Migrating Time Frame

FARM
n = 2

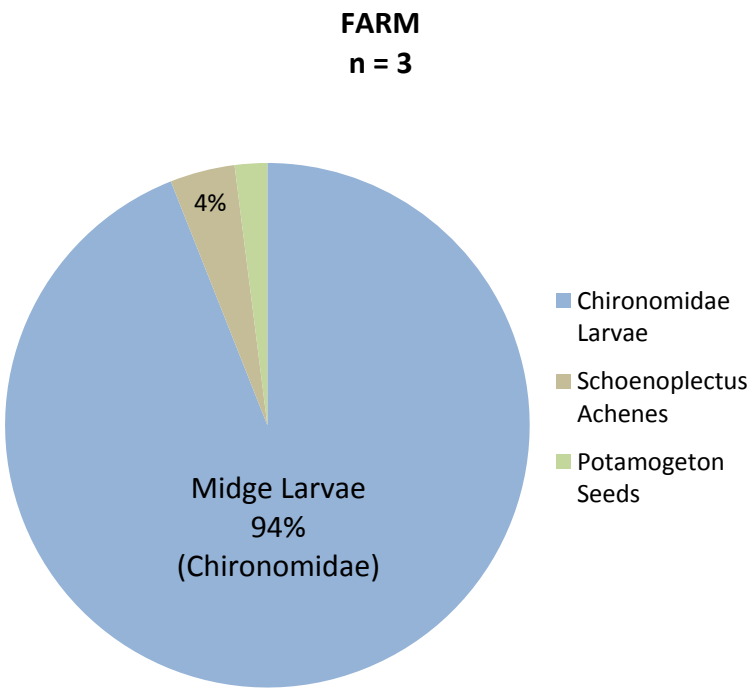


PSGR
n = 3

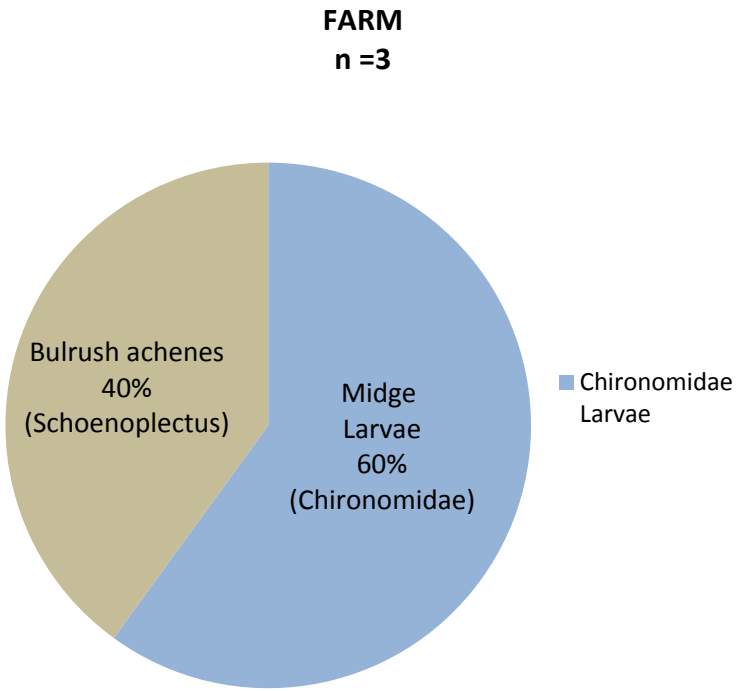


Appendix 5d GWTE collected in 2010

Breeding Time Frame



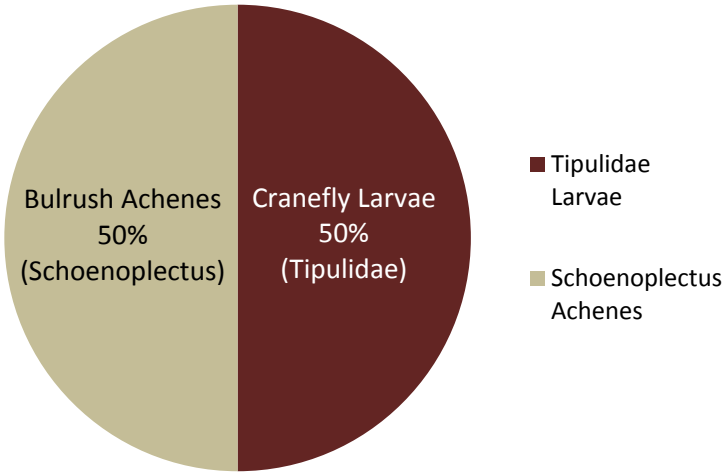
Staging/Migrating Time Frame

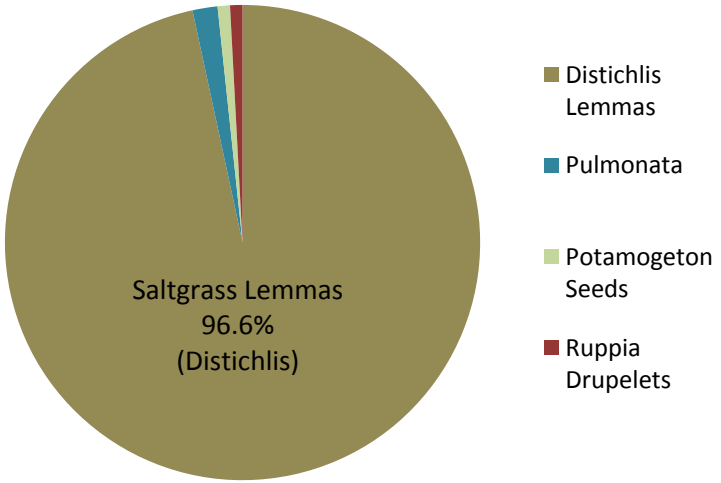


Appendix 5e MALL collected in 2010

Breeding Time Frame

FARM
n = 1



Staging/Migrating Time Frame

FARM
n = 1