DIET OVERLAP AMONG INVASIVE ROUND GOBY (*NEOGOBIUS MELANOSTOMUS)*, WHITE SUCKER (*CASTOSTOMUS COMMERSONI)*, AND YELLOW PERCH (*PERCA FLAVESCENS)* IN WESTERN LAKE HURON

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ABSTRACT

DIET OVERLAP AMONG INVASIVE ROUND GOBY (*NEOGOBIUS MELANOSTOMUS),* WHITE SUCKER (*CASTOSTOMUS COMMERSONI),* AND YELLOW PERCH (*PERCA FLAVESCENS)* IN WESTERN LAKE HURON

by Ashli B. Wilson

Round Goby (*Neogobius melanostomus*), native to the Black and Caspian Seas, invaded the Great Lakes in the 1990s. Round Goby have negatively impacted native species in the Great Lakes through predation and competition. Round Goby potentially compete with juvenile White Sucker (*Catostomus commersoni*) and Yellow Perch (*Perca flavescens*); both species have commercial, recreational, and ecological importance. The objective of this study was to compare the diets of Round Goby, White Sucker, and Yellow Perch in nearshore areas of western Lake Huron. Fish were collected at five sites in Lake Huron during May-September of 2012 for examination of the gut contents. Prey items in the diets were counted and identified to lowest possible taxon. Frequency of occurrence (%), proportion of prey by number, multivariate analysis of covariance (MANCOVA), canonical correspondence analysis, and Schoener's Index were used to quantify the diets and determine diet overlap. Round Goby, White Sucker, and Yellow Perch diets were dominated by Amphipoda, Chironomid larvae, and Cladocera. The diets varied based on site but not by species. Diets of Round Goby, White Sucker, and Yellow Perch diet had a high degree of diet overlap at each site but the prey items consumed by each species varied based on site.

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CHAPTER I

INTRODUCTION

Invasive species can negatively impact native species through competition (Mooney and Hobbs, 2000), resulting in reduced recruitment and higher mortality of native species (Marschner, 2003; Karlson et al., 2007). For example, the introduction of Alewife (*Alosa pseudoharengus*) into the Great Lakes resulted in early mortality of the native Lake Trout (*Salvelinus namaycush*) (Fisher et al., 1996; Madenjian et al., 2008; Brown et al., 2011), predation on native fish (Brandt et al., 1987; Krueger et al., 1995; Madenjian et al., 2008), and competition for prey (Crowder 1984). Similarly, the invasion of dreissenid mussels (*Dreissena polymorpha* and *D. rostriformis)* reduced fish recruitment and growth through physical and biotic changes to the ecosystem (Gopalan et al. 1998; MacIssac 1994; Nalepa et al., 2004). The Round Goby (*Neogobius melanostomus*), a more recent Great Lakes invader, has also negatively impacted the Great Lakes ecosystem.

Round Goby, native to the Black and Caspian Seas, was introduced to the Great Lakes in 1990 by shipping ballast water and established throughout the Great Lakes by 1995 (Roseman and Riley, 2009; Chotkowski and Marsden, 1999; Schaeffer et al., 2005). Round Goby prefer nearshore areas with rocky substrate (Schaffer et al., 2005; Ray and Corkum, 2001; Charlebois et al., 1997), although they are found in wetland and sandy habitats as well (Galarowicz, unpublished data; Ray and Corkum, 2001; Charlebois et al., 1997). Round Goby consume a wide breadth of prey such as aquatic arthropods, bivalves, Cladocera, and fish eggs and larvae (Cooper et al., 2009; Janssen and Jude, 2001; Schaffer et al., 2005), making them successful in the Great Lakes and increasing the chances of diet overlap with native species (Schaeffer et al.,

2005; French and Jude, 2001). Round Goby has altered Great Lakes food webs resulting in the decline of native species in local areas due to competition for food resources and habitat and predation on larval, juvenile, and adult fish of native species (Charlebois et al., 2001; Chotkowski and Marsden, 1999; Cooper et al., 2009; Janssen and Jude, 2001; Kipp and Ricciardi, 2012; Kipp et al., 2012). For example, Round Goby have negatively impacted Mottled Sculpin (*Cottus bairdi*) through competition for food at juvenile stages and for habitat in adult stages (Janssen and Jude, 2001; French and Jude, 2001). Further, Round Goby can negatively impact Smallmouth Bass recruitment through predation on the eggs (Steinhart et al., 2004).

Round Goby is a potential competitor with native species such as White Sucker (*Catostomus commersonii*) and Yellow Perch (*Perca flavescens*). White Sucker and Yellow Perch are ecologically and economically valuable Great Lakes species. White Sucker constitute more than half of the biomass in Lake Huron (Saint-Jacques et al., 2000; Simmons et al., 2012), and Yellow Perch is a valuable recreational and commercial species (Madenjian et al., 2002). In the Great Lakes, Round Goby, juvenile White Sucker, and juvenile Yellow Perch diets are variable but commonly consisting of Amphipoda, Chironomid, Cladocera, fish eggs, Isopoda, and larval fish (Creque and Czesny, 2012; Marschner 2003; Saint-Jacques et al., 2000; Schaeffer et al., 2005). White Sucker diets have not been quantified except for studies using small sample sizes (Saint-Jacques et al., 2000) and although diets of Round Goby and Yellow Perch have previously been documented in Lake Huron, the diets of Round Goby, White Sucker, and Yellow Perch need to be monitored due to the ongoing changes in the Lake Huron food web (Roseman and Riley, 2009).

Research on Lake Huron is vital because Lake Huron has undergone many changes (Staton et al., 2014) due to the invasion of dreissenid mussels and Round Goby; for example, the zooplankton assemblage has shifted from Cladocera to Copepod dominated assemblage (Roseman and Riley, 2009). Lake Huron also has experienced increased water clarity, more macrophytes, and decreased chlorophyll levels (Nalpea et al., 2003; Roseman and Riley, 2009). These changes in Lake Huron ultimately affect the fish species that feed on zooplankton and invertebrates (Nalepa et al., 2009).

Nearshore Great Lakes habitats are used by nearly all fish species at some point as nurseries, shelter, migratory pathways, or temporary feeding (Edsall and Charlton, 1997). Because Round Goby survive in high abundances in nearshore areas (Schaeffer et al., 2005), there is increased likelihood for competition among native species. White Sucker are associated with benthic habitats, and juvenile Yellow Perch are often found in Great Lakes nearshore areas (Michigan Department of Natural Resources; Creque and Czensy, 2012). Further, White Sucker and Yellow Perch spawn during the spring (April-May) in nearshore areas (Whiteside et al., 1985; McManamay et al., 2012), resulting in high abundances of juvenile White Sucker and juvenile Yellow Perch, increasing the likelihood for competition.

The objective of this study was to compare the diets of Round Goby, White Sucker, and Yellow Perch in nearshore areas of western Lake Huron in 2012. Comparisons were made among different sites over the sampling period. We predicted that the diets of Round Goby, White Sucker, and Yellow Perch will overlap, indicating the potential for competition to occur.

CHAPTER II

METHODS

Fish at five sites (Alpena, Au Gres, Harbor Beach, Port Austin and Tawas) along the western Lake Huron, Michigan, United States, shoreline were sampled between 21 May 2012 and 5 September 2012 (Galarowicz, unpublished data) (Figure 1). Fish were sampled weekly at each site at nighttime with a 46 m beach seine (15.24m bunt with 9.53mm mesh and 12.7mm wings) following Hintz (1994). Round Goby (n=584), White Sucker (n=105), and Yellow Perch (n=404) were anesthetized in MS-222 and preserved in 5% formalin, transported to the laboratory for processing, and transferred to 70% ethanol to ensure safety when handling. Total length (TL; nearest mm) of each fish was measured. The entire digestive tract was removed by making an incision from the anus to the operculum. Yellow Perch were not collected at the Alpena site.

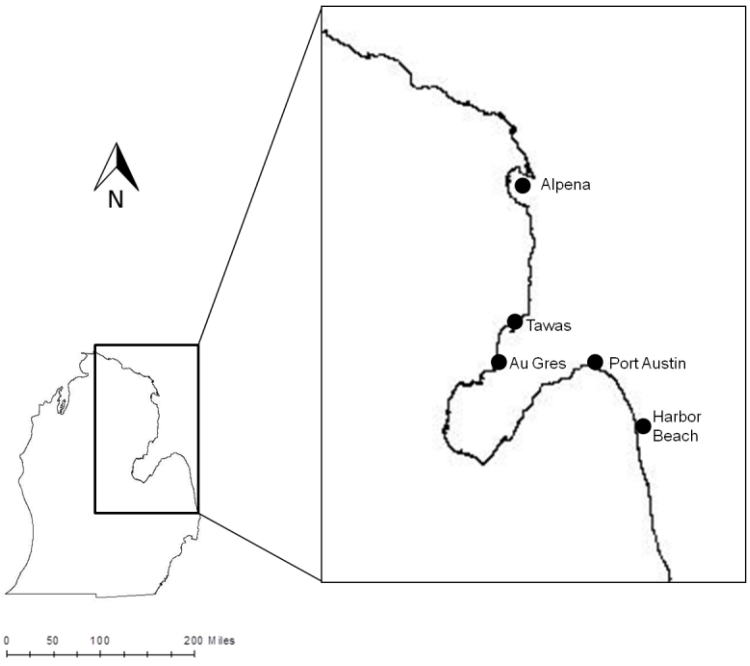


Figure 1. Location of sampling sites in western Lake Huron, Michigan. Sites were sampled from 21 May-5 September, 2012.

The digestive tract contents were examined with a Nikon SMZ800 compound microscope, and photos of prey were taken using Image-Pro PLUS 5.1 (Media Cybernetics®) software. Prey were enumerated and identified to the lowest possible taxon, typically order. The number of fish with empty stomachs were counted. The percentage of empty stomachs per species ranged from 0 to 52% at the different sites (Figure 2).

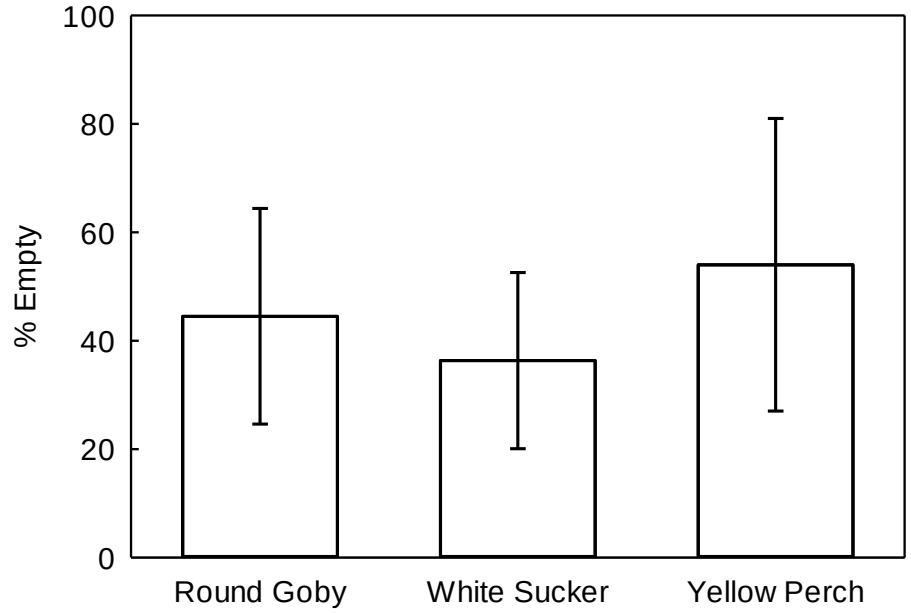


Figure 2. Mean (±SE) percent empty stomachs of Round Goby, White Sucker, and Yellow Perch dissected by site. Fish were collected at five nearshore sites in western Lake Huron (see Figure 1).

The percent frequency of occurrence (%) and proportion of prey by number were calculated for Round Goby, White Sucker, and Yellow Perch for each sampling date at each site. Proportion of prey by number was arcsine transformed to achieve normality. The proportion of prey by number was compared among species and site with total length as a covariate using multivariate analysis of covariance (MANCOVA).

The proportion of prey by number was also used to determine which prey items accounted for the similarities in the diets of Round Goby, White Sucker, and Yellow Perch first using non-metric multidimensional scaling (NMDS); this approach was not viable because stress levels was not equal or less than 20% (Kruskal 1964). Canonical correspondence analyses (CCA; CANOCO 4.02) were then used to examine patterns in proportion of prey by number in the diets. A CCA was first used to test the importance of site of the variation in diet. A second CCA then examined differences among the three species while constraining the data set by site. Prey items that composed less than 3% of all of the diets were excluded from the analyses. The two axes that explained the most variation were examined using an ordination plot.

Schoener's Indices (*SI*) for each site were also calculated to determine diet overlap between Round Goby and White Sucker, Round Goby and Yellow Perch, and White Sucker and Yellow Perch using:

$$SI = 1 - 0.5 \left(\sum \left| P_{xi} - P_{yi} \right|\right)$$

where P_{xi} is the proportion of i^{th} prey item for species x and P_{yi} is the proportion of the i^{th} prey item species y (Schoener 1970). Schoener's index indicates diet overlap, and a *SI* value greater than 0.6 indicates competition for prey items (Wallace 1981).

CHAPTER III

RESULTS

Diets of Round Goby, White Sucker, and Yellow Perch were primarily Amphipoda, Chironomid larvae, and Cladocera (Appendix A). Fish eggs, Isopoda, and larval fish were also found in the stomachs of Round Goby, White Sucker, and Yellow Perch (Appendix A). Both Round Goby and White Sucker ate Hemiptera, while *Dreissena* spp. and *Pisidium* spp. were only consumed by Round Goby (Appendix A).

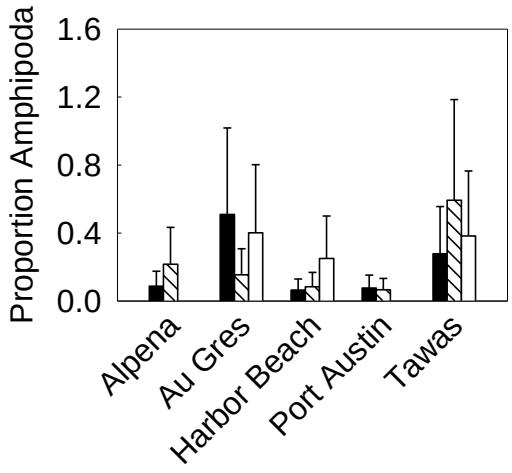
The overall proportion of prey by number differed among species and site (MANCOVA Wilks $\lambda = 0.44$; Species: $F=1.94$, $P<0.0001$; Site: $F=9.21$, $P<0.0001$; Species x Site: $F=1.25$, $P<0.0001$). The proportion of prey by number of Amphipoda, Chironomid larvae, Cladocera, fish eggs, and Isopoda did not differ among Round Goby, White Sucker, and Yellow Perch (Figure 3, Table 1); the proportion of prey by number of Hemiptera did not differ between Round Goby and White Sucker. More larval fish were consumed by White Sucker than Round Goby and Yellow Perch (Figure 3, Table 1).

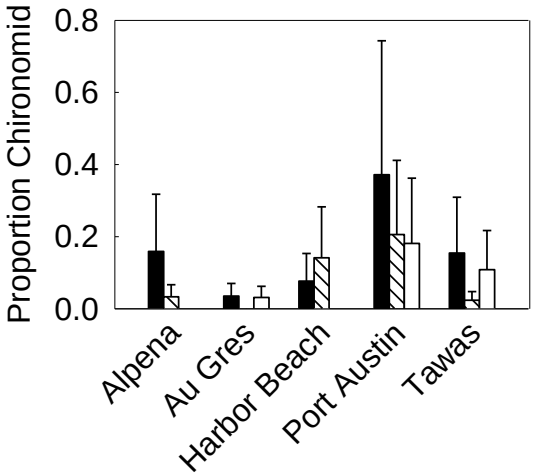
The proportion of Amphipoda, Chironomid larvae, Cladocera, fish eggs, Hemiptera, larval fish, and *Pisidium* spp. by number differed among sites (Figure 3, Table 1). More Amphipoda were consumed at the Tawas and Au Gres sites than at other sites; Yellow Perch did not consume Amphipoda at the Alpena and Port Austin sites, but was consumed in Au Gres, Harbor Beach, and Tawas (Figure 3, Table 1). Amphipoda were consumed by Round Goby and White Sucker at each site (Figure 3, Table 1). Chironomid larvae were predominately consumed by Round Goby, White Sucker, and Yellow Perch in Port Austin (Figure 3, Table 1). Cladocera were only consumed at Port Austin and Tawas. In Port Austin, Cladocera were consumed by

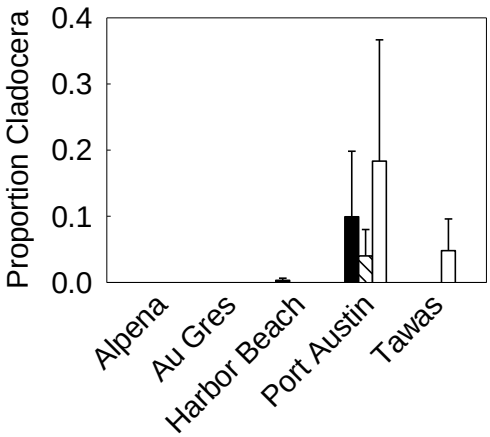
Round Goby, White Sucker, and Yellow Perch and Yellow Perch were the only species to consume Cladocera in Tawas (Figure 3, Table 1). Round Goby consumed Cladocera in low proportions in Harbor Beach (Figure 3, Table 1).

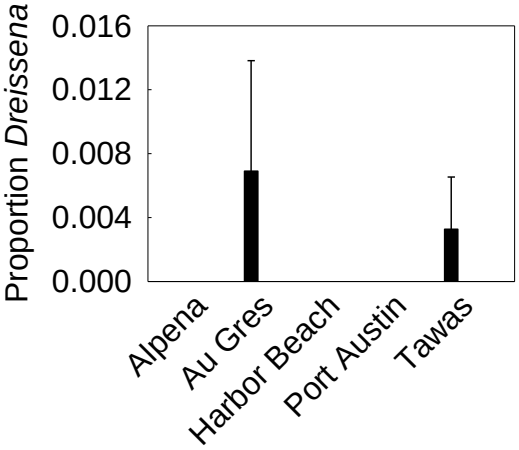
Fish eggs and Isopoda were only found in the diets of Round Goby, White Sucker, and Yellow Perch in Alpena, Au Gres, Harbor Beach, and Tawas with proportions varying based on site and not species (Figure 3, Table 1). Hemiptera were consumed by Round Goby and White Sucker in Tawas in similar proportions. Round Goby in Au Gres and Tawas consumed *Dreissena* spp. and *Pisidium* spp. were consumed by Round Goby in Harbor Beach, Port Austin, and Tawas, with higher proportion by number occurring in Harbor Beach (Figure 3).

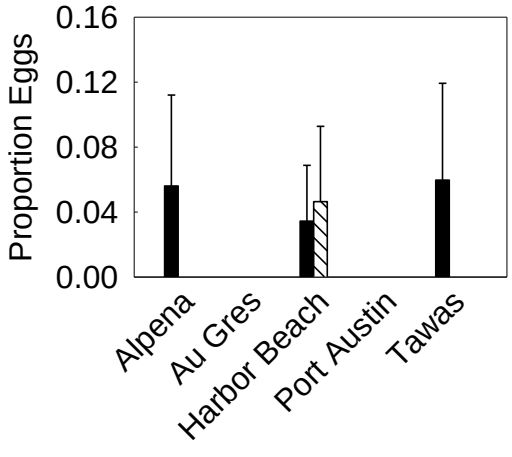
Proportion of prey by number was also used in canonical component analysis to determine the variation site and species accounts for in the diets. The first CCA determined significant influence of the sites on the variation in the diets ($P<0.001$). Axis 1 explained 84.2% of the variation in the diets, while Axis 2 accounted for 13.0% of the variation. Variation in the proportion of diet by number varied among the three species ($P<0.0001$), determined by the second CCA constrained by site. Axis 1 explained 1.1% of the variation in the diet, while Axis 2 accounted for 45.2% of the variation (Figure 4, Table 2).

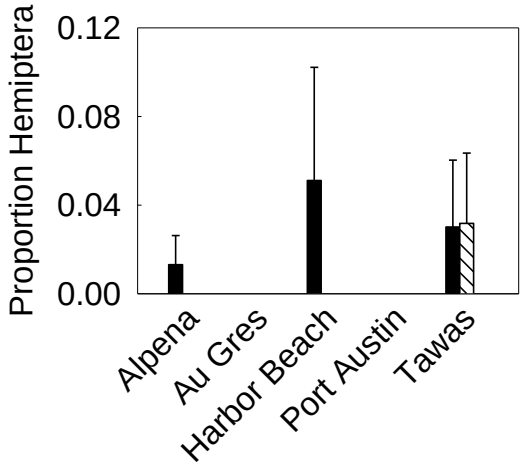

Proportion Amphipoda
1.6
1.2
0.8
0.4
0.0
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas


Proportion Chironomid
0.8
0.6
0.4
0.2
0.0
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas


Proportion Cladocera
0.4
0.3
0.2
0.1
0.0
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas


Proportion Dreissena
0.016
0.012
0.008
0.004
0.000
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas


Proportion Eggs
0.16
0.12
0.08
0.04
0.00
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas


Proportion Hemiptera
0.12
0.08
0.04
0.00
Alpena
Au Gres
Harbor Beach
Port Austin
Tawas

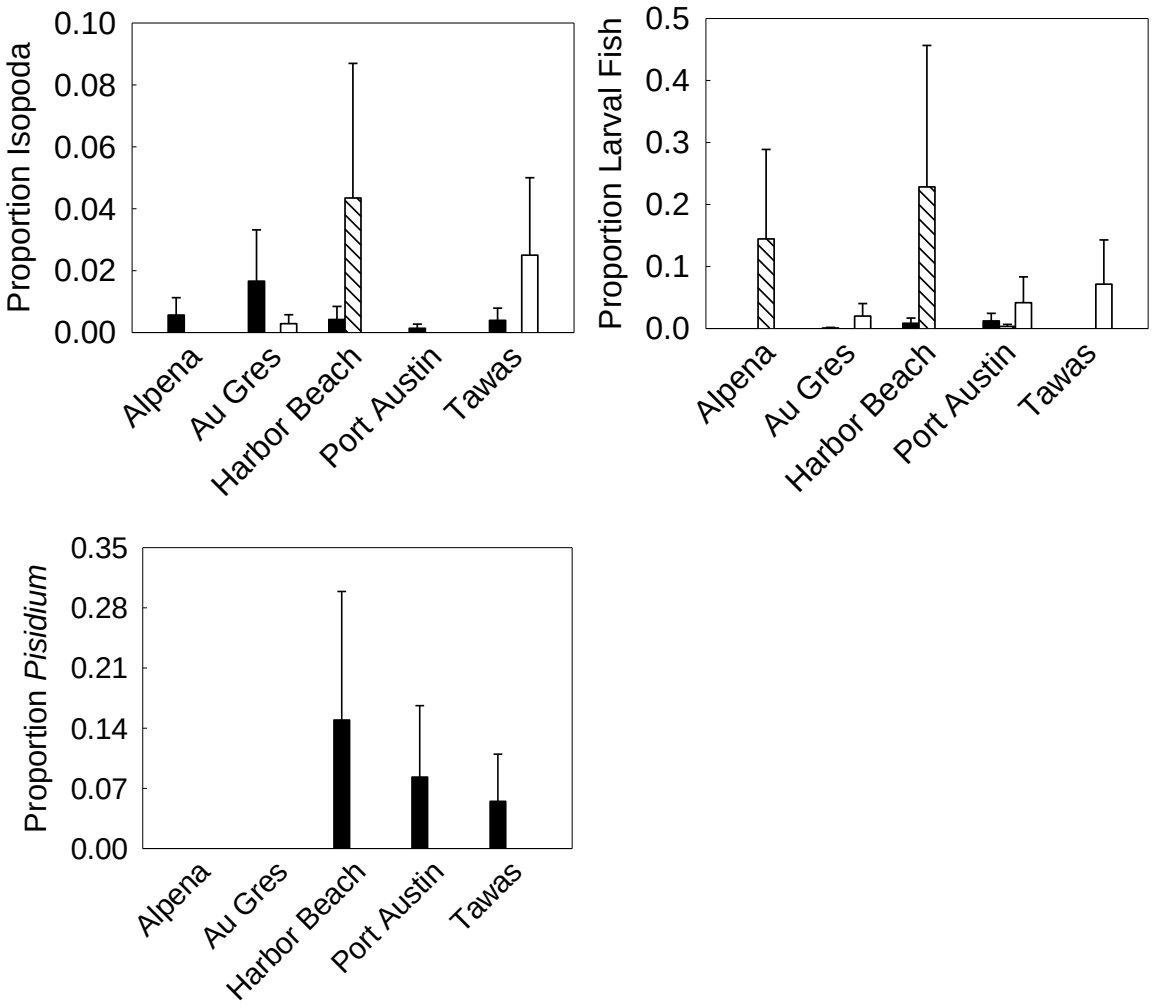


Figure 3. Proportion of prey by number for Round Goby (black bars), White Sucker (hatched bars), and Yellow Perch (white bars) with standard error (±SE) for each sampling site in Western Lake Huron. See Figure 1 for site locations.

Table 1. Mulivariate analysis of covariance (MANCOVA) examining difference in proportion of prey by number among species and sites with total length as a covariate. Proportion of prey by number were arc-sin transformed for analysis. Significant P values are highlighted in bold.

Prey	Parameter	Species	Site	Species•Site	TL
Amphipoda	df	2	4	7	78
	F	1.64	77.18	3.01	1.26
	P	0.20	**0.0001**	**0.004**	0.08
Chironomid	df	2	4	7	78
	F	2.83	45.92	1.92	1.50
	P	0.06	**0.0001**	0.06	**0.008**
Cladocera	df	2	4	7	78
	F	2.99	44.55	8.33	0.83
	P	0.05	**0.0001**	**0.0001**	0.83
Dreissena	df	2	4	7	78
	F	2.31	0.36	0.18	1.47
	P	0.10	0.83	0.99	**0.01**
Fish eggs	df	2	4	7	78
	F	2.26	7.52	1.47	0.60
	P	0.11	**0.0001**	0.18	0.10
Hemiptera	df	2	4	7	78
	F	1.70	7.97	1.58	0.59
	P	0.18	**0.0001**	0.14	0.10
Isopoda	df	2	4	7	78
	F	0.35	0.67	1.20	0.95
	P	0.70	0.61	0.30	0.60
Larval fish	df	2	4	7	78
	F	34.33	12.01	17.41	2.24
	P	**0.0001**	**0.0001**	**0.0001**	**0.0001**
Pisidium	df	2	4	7	78
	F	8.95	20.77	4.05	0.61
	P	**0.0002**	**0.0001**	**0.0003**	0.10

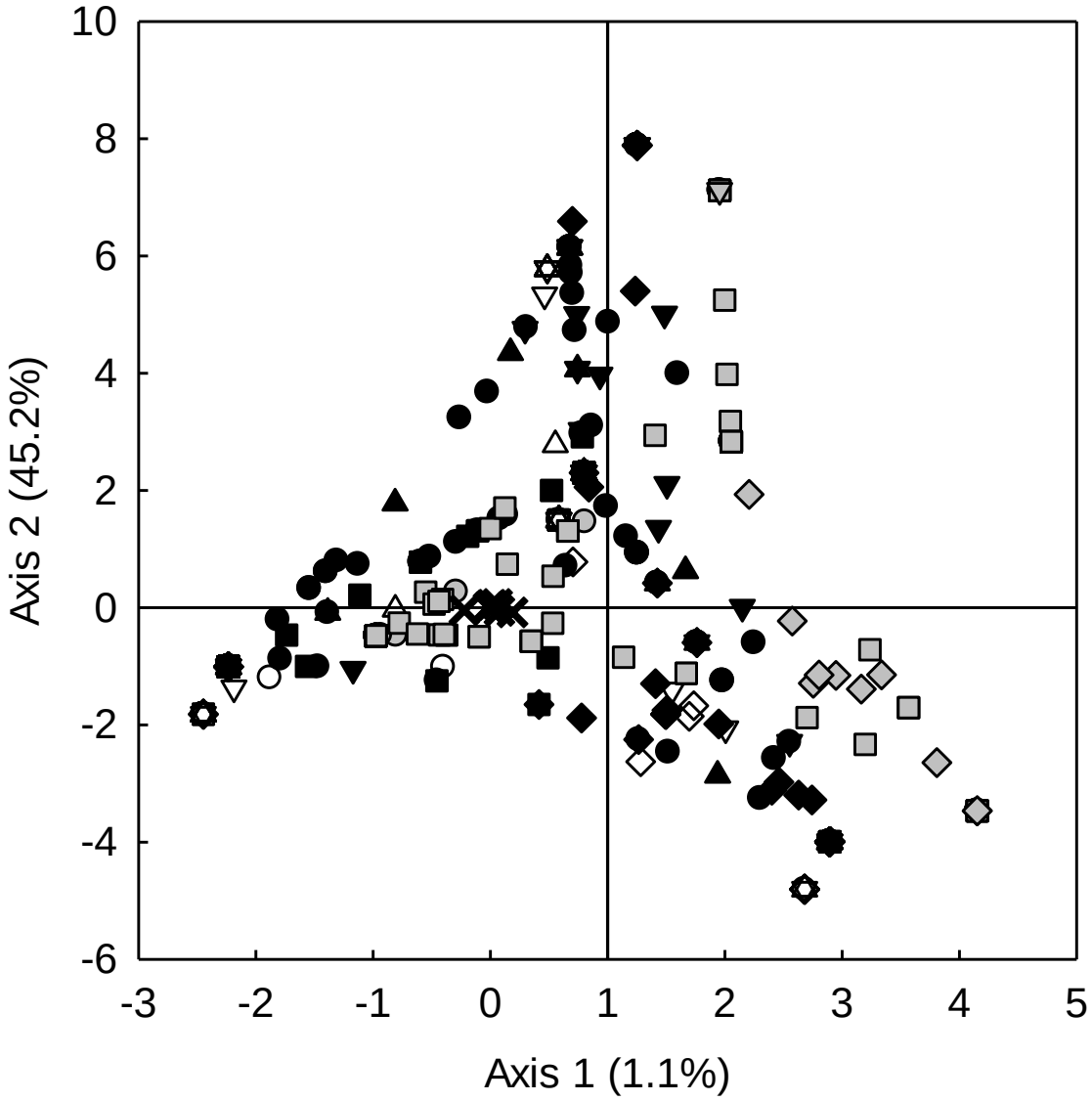


Figure 4. Canonical correspondence analysis (CCA) of proportion in diet by number for Round Goby (black symbols), White Sucker (white symbols), and Yellow Perch (grey symbols) at the Alpena (▲),Tawas (●), Au Gres (■), Harbor Beach (♦), and Port Austin (▼) sites. Ordinations of the prey species are represented by the X's. See Figure 1 for site locations.

Table 2. Canoncial Component Analysis examining the contribution of each prey item to the similarities of the diets of Round Goby, White Sucker, and Yellow Perch.

Prey	Axis 1	Axis 2
Amphipoda	-0.22	-0.03
Chironomid	0.19	-0.07
Cladocera	0.08	-0.04
Dreissena	-0.008	0.013
Fish eggs	0.015	0.055
Hemiptera	0.008	0.053
Isopoda	-0.012	0.020
Larval fish	0.017	0.06
Pisidium	0.061	0.076

Schoener's Indices at all sites between Round Goby and White Sucker, Round Goby and Yellow Perch, and White Sucker and Yellow Perch were greater than 0.60, indicating diet overlap (Figure 5). Schoener's Indices were highest at the Tawas site: Round Goby and White Sucker = 0.97, Round Goby and Yellow Perch = 0.98, and White Sucker and Yellow Perch = 0.99.

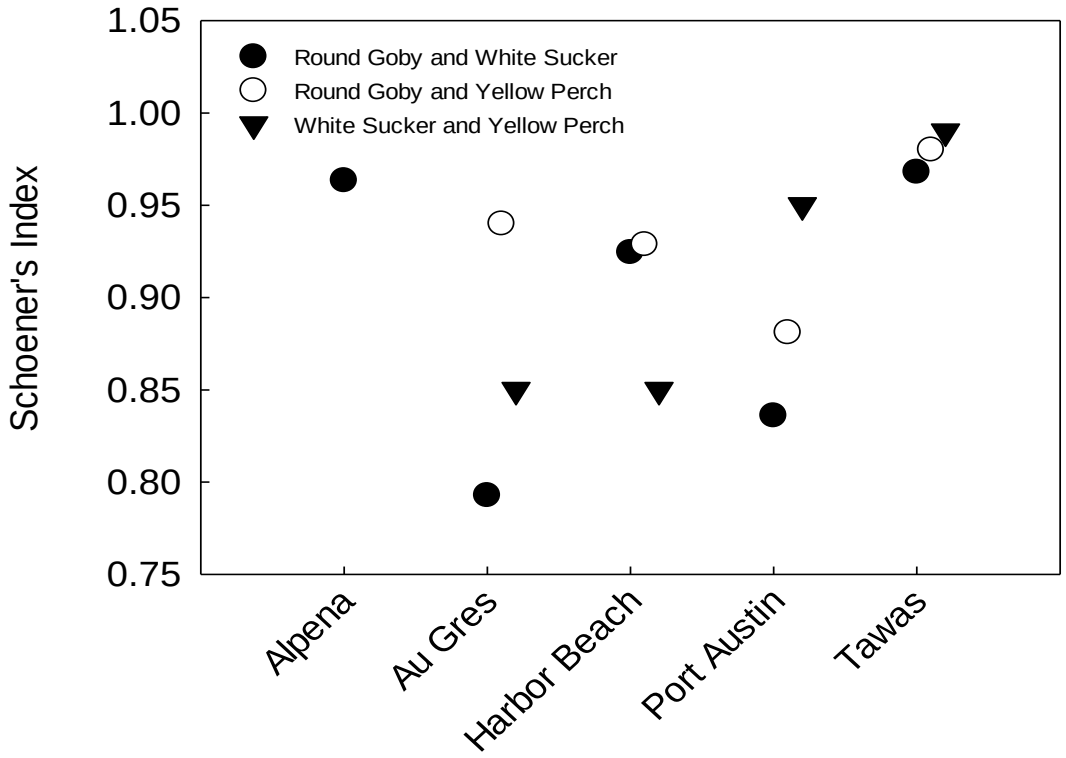


Figure 5. Schoener's Indices between Round Goby and White Sucker (black circles), Round Goby and Yellow Perch (open circles), and White Sucker and Yellow Perch (triangles) at each sampling site. Values greater than 0.6 indicate diet overlap. See Figure 1 for site locations.

CHAPTER IV

DISCUSSION

Round Goby, White Sucker, and Yellow Perch diets overlapped but diet composition differed at each site in the Lake Huron. This spatial variation in diet composition can be attributed to differences in the invertebrate communities due to different habitat, abiotic and biotic factors, (MacKenzie et al., 2004) and adaptability of species' use of resources (Huss et al., 2014). Previously, Round Goby diets varied among different locations in Lake Huron, which was attributed to differences in the invertebrate community among sites (Bunnell et al., 2012). A high degree of spatial overlap can increase the amount of diet overlap of different species (Creque and Czensy, 2012). The variation in diets based on site suggests that Round Goby, White Sucker, and Yellow Perch are opportunistic (Creque and Czensy, 2012; Marschner 2003; Saint-Jacques et al., 2000) and feed on the most abundant and easily accessible prey. Resources are unevenly distributed (Huss et al., 2008), which contributes to the variation of Round Goby, White Sucker, and Yellow Perch diets at different sites. The most abundant prey items have to be recognized as a resource and deemed profitable for species to use (Huss et al., 2008).

Similarly, the diet overlap of Round Goby, White Sucker, and Yellow Perch could indicate competition for food resources. Amphipoda, Chironomid larvae, and Cladocera were important prey items for Round Goby, White Sucker, and Yellow Perch. These prey species are common invertebrate species found in the nearshore areas in the Great Lakes and are important prey items for fish and bird species (Ali et al., 1995; MacNeil et al., 1997). In Lake Huron, Amphipoda and Cladocera populations decreased after the 1980s due in part to *Dreissena* spp. (Bunnell et al., 2012; Napela et al., 2007; Napela et al., 2009), decrease in phosphorus levels

(Nalepa et al., 2007), and increases in *Bythotrephes* (Bunnell et al., 2012). Reduced levels in Amphipoda and Cladocera may result in competition for these species.

Round Goby and juvenile Yellow Perch prefer rocky substrates with macrophytes (Duncan et al., 2011). In rocky areas, diets of Round Goby, White Sucker and Yellow Perch could include more macroinverterbrates (DeVanna et al., 2011) including Amphipoda, Chironomids, Cladocera, and Isopoda due to increased *Dreissena* spp. pseudofeces (DeVanna et al., 2011). In sandy substrates, *Dreissena* spp. clusters protect the invertebrate species and decrease the amount of foraging by fish species on benthic invertebrates (DeVanna et al., 2011), which could have occurred in this diet analysis.

Dreissena spp. and *Pisidium* spp. were not found in high abundances in Round Goby, White Sucker, and Yellow Perch diets. Round Goby were the only species to consume *Dreissena* spp. and *Pisidium* spp. in this diet analysis. *Dreissena* spp. can be found in rocky and sandy habitats; *Dreissena bugensis* are found in high abundances in shallow and sandy substrates (Berkman et al., 2000). Round Goby may control *Dreissena* spp. populations in the Great Lakes (Djuricich and Janssen 2001) since both are native to the Black and Caspian Seas; however, Round Goby were not found to consume *Dreissena* spp. in high abundances in this analysis. White Sucker and Yellow Perch may not recognize *Dreissena* spp. as a food source since it was introduced to the Great Lakes and White Sucker and Yellow Perch may lack the ability to crush the shells of *Dreissena* spp.

The nearshore areas in Lake Huron have changed drastically over the past 20 years due to invasive species including Round Goby and *Dreissena* spp. (Riley et al., 2008; Riccardi and MacIssac, 2000). Previously, Round Goby were not present in the Great Lakes and

Catostomidae and Yellow Perch abundances increased in the nearshore area from 1971 compared to 2012 (Galarowicz, unpublished data). Increased abundances of species can reduced prey availability (Svanbäck and Bolnick, 2007) and increase competition for the shared food resources (Rahmana and Verdegem, 2010). Since the populations of Round Goby, White Sucker, and Yellow Perch have increased in the nearshore area, there is more pressure on the populations of shared prey items which can decrease the available prey which increases the likelihood for opportunistic feeding and competition. As Round Goby, White Sucker, and Yellow Perch grow the diet overlap with each other and Round Goby could be reduced due to ontogenetic diet shifts. Each species would utilize different prey groups become more specialized in the prey selection.

These findings show the importance of continued monitoring of the impact invasive species have on native species. Continued monitoring is needed to understand the changes in the food web caused by invasive species. Future research should continue to focus on quantifying diets and sampling of the invertebrate community to determine the selective foraging of these species. Understanding the invertebrate community population and diets of native species is vital because of the impact food resources availability on native species.

APPENDIX A

FREQUENCY OF OCCURRENCE OF DIET ITEMS CONSUMED BY ROUND GOBY, WHITE SUCKER, AND YELLOW PERCH AT EACH SAMPLING SITE AND DATE IN 2012. NUMBER SAMPLED (N) AND MEAN (SE) TOTAL LENGTH (TL;MM). SEE FIGURE1 FOR SITE LOCATIONS.

					Frequency of occurrence (%)		
Site	Species	Date	n	TL (mm)	Amphipoda	Chironomid	Cladocera
Alpena	Round Goby	30-Jul	14	42.43 (3.09)	25	0	0
		27-Aug	75	57.93 (1.2)	18	33	8
	White Sucker	30-Jul	4	83.00 (2.55)	33	33	0
		20-Aug	26	87.92 (1.72)	33	0	0
Au Gres	Round Goby	26-Jun	64	51.73 (0.97)	81	11	2
		7-Aug	38	50.24 (1.84)	60	0	43
		21-Aug	38	59.24 (1.41)	55	0	27
		28-Aug	41	58.59 (1.37)	62	9	9
	White Sucker	26-Jun	10	52.80 (1.70)	33	0	0
		28-Jul	3	101.00 (4.50)	0	0	0
	Yellow Perch	26-Jun	49	36.57 (1.84)	81	10	0
		7-Aug	100	74.82 (0.73)	68	2	33
		21-Aug	100	77.62 (0.79)	93	13	0
		28-Aug	99	71.66 (0.84)	48	48	14
Harbor Beach	Round Goby	20-Jun	6	46.33 (1.50)	0	40	0
		27-Jun	26	54.73 (1.90)	8	33	8
		15-Aug	47	53.55 (1.77)	24	19	10
	White Sucker	27-Jun	2	107.00 (16.26)	50	0	0

		15-Aug	21	74.76 (1.84)	8	31	0
	Yellow Perch	20-Jun	4	85.25 (4.61)	100	0	0
Port Austin	Round Goby	27-Jun	32	54.97 (1.36)	10	48	19
		15-Aug	50	57.00 (1.39)	15	61	20
	White Sucker	27-Jun	4	65.75 (13.56)	0	0	0
		15-Aug	26	105.96 (0.72)	14	50	14
	Yellow Perch	1-Aug	2	64.50 (3.18)	0	50	100
		15-Aug	9	83.11 (7.49)	0	25	50
		28-Aug	13	59.62 (0.98)	0	83	67
Tawas	Round Goby	26-Jun	53	47.34 (0.97)	38	38	28
		31-Jul	23	48.48 (2.84)	6	39	39
		7-Aug	65	51.45 (1.51)	43	25	37
		14-Aug	4	65.00 (1.50)	100	0	25
		21-Aug	3	66.00 (2.45)	67	0	0
		28-Aug	5	70.40 (4.44)	100	0	0
	White Sucker	26-Jun	1	58.00 (-)	100	0	100
		31-Jul	3	77.00 (4.50)	33	0	33
		14-Aug	2	89.00 (0.71)	100	0	0
		28-Aug	3	107.00 (3.30)	67	33	33
	Yellow Perch	26-Jun	4	89.50 (2.61)	100	0	0
		31-Jul	2	61.00 (0.71)	0	0	100
		7-Aug	13	64.31 (0.99)	60	40	0
		14-Aug	9	77.33 (6.48)	44	11	0

Site	Species	Date	Frequency of occurrence (%)		
			Dreissena spp.	Fish eggs	Hemiptera
Alpena	Round Goby	30-Jul	0	25	0
		27-Aug	0	12	4
	White Sucker	30-Jul	0	0	0
		20-Aug	0	0	0
Au Gres	Round Goby	26-Jun	0	0	0
		7-Aug	0	0	0
		21-Aug	6	0	0
		28-Aug	0	0	0
	White Sucker	26-Jun	0	0	0
		28-Jul	0	0	0
	Yellow Perch	26-Jun	0	0	0
		7-Aug	0	5	0
		21-Aug	0	0	0
		28-Aug	0	0	0
Harbor Beach	Round Goby	20-Jun	0	0	0
		27-Jun	0	0	8
		15-Aug	0	19	19
	White Sucker	27-Jun	0	0	0
		15-Aug	0	15	0
	Yellow Perch	20-Jun	0	0	0
Port Austin	Round Goby	27-Jun	0	0	0
		15-Aug	0	0	0
	White Sucker	27-Jun	0	0	0
		15-Aug	0	0	0
	Yellow Perch	1-Aug	0	0	0
		15-Aug	0	0	0
		28-Aug	0	0	0

Tawas	Round Goby	26-Jun	0	8	5
		31-Jul	6	6	6
		7-Aug	0	10	5
		14-Aug	0	25	0
		21-Aug	0	33	0
		28-Aug	0	0	20
	White Sucker	26-Jun	0	0	0
		31-Jul	0	0	0
		14-Aug	0	0	0
		28-Aug	0	0	33
	Yellow Perch	26-Jun	0	0	0
		31-Jul	0	0	0
		7-Aug	0	0	0
		14-Aug	0	0	0

Site	Species	Date	Frequency of occurrence (%)		
			Isopoda	Larval fish	*Pisidium* spp.
Alpena	Round Goby	30-Jul	0	0	0
		27-Aug	2	0	0
	White Sucker	30-Jul	0	0	0
		20-Aug	0	28	0
Au Gres	Round Goby	26-Jun	4	0	0
		7-Aug	0	3	0
		21-Aug	3	0	0
		28-Aug	0	0	0
	White Sucker	26-Jun	0	0	0
		28-Jul	0	0	0
	Yellow Perch	26-Jun	0	0	0
		7-Aug	0	3	0
		21-Aug	0	7	0
		28-Aug	5	5	0
Harbor Beach	Round Goby	20-Jun	0	0	60
		27-Jun	8	0	92
		15-Aug	0	5	10
	White Sucker	27-Jun	0	50	0
		15-Aug	8	38	0
	Yellow Perch	20-Jun	0	0	0
Port Austin	Round Goby	27-Jun	5	0	38
		15-Aug	0	2	0
	White Sucker	27-Jun	0	0	0
		15-Aug	0	7	0
	Yellow Perch	1-Aug	0	0	0
		15-Aug	0	25	0
		28-Aug	0	0	0
Tawas	Round Goby	26-Jun	0	0	15
		31-Jul	0	0	6
		7-Aug	2	0	19
		14-Aug	0	0	0
		21-Aug	0	0	0
		28-Aug	0	0	0
	White Sucker	26-Jun	0	0	0
		31-Jul	0	0	0
		14-Aug	0	0	0
		28-Aug	0	0	0

Yellow Perch	26-Jun	0	0	0
	31-Jul	50	0	0
	7-Aug	0	0	0
	14-Aug	11	22	0

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