Diet analysis of predator fish in Otsego Lake prior and subsequent to walleye (*Sander vitreus*) stocking, 2005

Tom Somerville[1]

INTRODUCTION

Otsego Lake (42˚ 41'N-70˚'W) is the headwaters of the glacially-created Susquehanna River Valley within the northern Appalachian Plateau. Harman et al. (1997) classified the lake as oligo-mesotrophic prior to the unauthorized introduction of alewife (*Alosa pseudoharengus*) in 1986 (Foster 1989). This introduction affected the lake, causing the limnology to turn toward a more eutrophic system (Harman et al. 2002). Alewives are effective planktivores and have created a shift in zooplankton populations from larger *Daphnia* to the smaller *Bosmina* (Warner 1999). With the decrease in large zooplankton, algae populations have increased causing the transparency of the lake to decrease. Increased algae levels cause depressed hypolimnetic oxygen concentrations during summer stratification. Algae decomposing in the hypolimnetic zone consume dissolved oxygen within that strata. Competition with alewife for food can be blamed for the decrease of the Otsego bass (*Coregonus clupeaforms*) and cisco (*C. artedii*) (Linhart 1999).

Otsego Lake has been stocked with walleye since 2000 at a targeted rate of 80,000 per year. The intention for research during summer 2005 was to stock 40,000 pond fingerlings at sites on the east shore during the daytime and 40,000 at sites on the west shore during night time in order to evaluate differences in short term survival rates of the walleye. This would complement work done in 2004 (Cheever 2005). However, this year, only 40,000 walleye were stocked due to complications with an outside supplier. This first batch of fish was all stocked during the day, frustrating the research objectives.

Continued research by the Biological Field Station has investigated alewife abundance (Brooking and Cornwell 2005), as well as trophic changes (Albright 2005) that might be related to declining alewife populations resulting from walleye predation.

Alewife use shallow waters in the littoral zone to spawn from late May to August (Smith 1985). The stocking of walleye has been timed to correlate with the spawning alewife. Introduced walleye are expected to feed upon the alewife fry allowing for optimal walleye growth. Stocked walleye must survive heavy predation as they are stocked; this is generally considered the most important variable determining the success of stocked fish (Clapp et al. 1995).

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[1] Robert C. MacWaters Internship in Aquatic Sciences, summer 2005. Present affiliation: Department of Fisheries and Wildlife Technology, SUNY Agricultural and Technical College.

Walleye were stocked two times during the summer of 2005. The first stocking, June 24th, was comprised of pond fingerlings that averaged 41.5 mm in length. Those stocked on June 28th also averaged 41.5mm, however there was a larger number of fish over 50mm. Hoyle and Keast (1987) indicate that bass can consume slender bodied prey (i.e., Walleye) up to 50% of the bass total length, with 35% of their total length being optimal. These models suggest that stocked walleye could be vulnerable to predators as small as 100mm and very vulnerable to fish 150mm.

The goal of this study is to determine the survival rates of stocked walleye and to identify specific predators by examining stomach contents of seined predatory fish prior to and after stocking. A comparison of stocking time was also done using previously collected data (Cheever 2005) to determine if survival is higher during the day or night stocking.

METHODS

This study took place during June 2005. Six sample sites were chosen for predator data collection. The three sites on the west shore included Brookwood Point, Three mile Point, Five Mile Point, and the three sites on the east side included Point Judith, Point Florence, and Gravely Point (Figure 1). These sites were chosen for their accessibility, ease of seining, and for having similar bathymetrics. Pre-stocking seining was conducted between June 9th and 20th, with each site being seined an average of 3 times. This work was conducted to characterize the fish community and predation habits prior to the addition of walleye. Additionally, this work provided the opportunity to train the seining team so that work would proceed effectively following the walleye stocking.

Stocking on the east side of the lake took place on 24 June and 28 June. The first day stocking included Gravely Point and Point Florence. Point Judith was stocked on the later date. A total of 40,000 fish were released evenly at these three sites. Walleye fingerlings tend to be littoral fish and therefore were not expected to cross the deep basin of Otsego Lake, so any walleye collected at a particular site was assumed to have been stocked in that immediate vicinity.

Walleye were dropped evenly along a 15-20' contour at each location. A handheld depth finder was used to ensure accuracy. The Biological Field Station barge, including a 350 gallon holding tank and aerator, was used to transport fingerlings to their point of release. Fish were stocked at 11:00 AM. Sampling occurred three hours following, beginning at 2:00 PM.

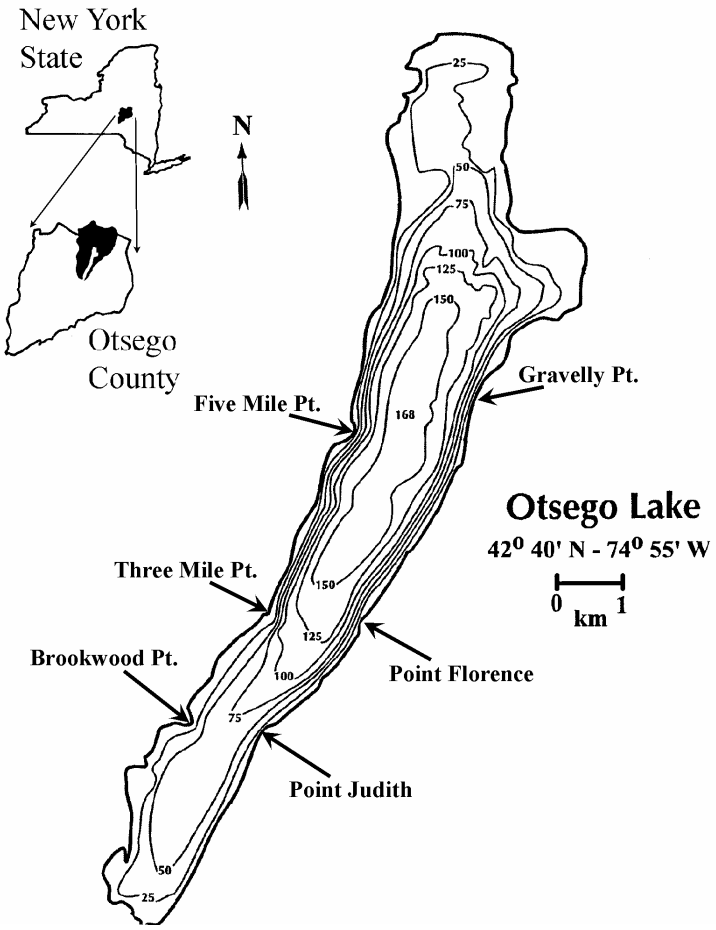

Figure 1. Bathymetric map of Otsego Lake showing sites of walleye stocking sites and seining locations.

The collection of fish followed methodologies outlined in Nelson et al. (1983). A 200' haul seine was used for fish collection. Fish caught were designated into three categories; predator, prey and others. Predators included individuals of the following species which exceeded 100mm: largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), yellow perch (*Perca flavescens*), chain pickerel (*Esox niger*) and rock bass (*Ambloplites rupestris*). Prey included bluntnose minnows (*Pimephales notatus*) tessellated darters (*Etheostoma olmstedi*), and any other fish under 100mm in length. "Other" fish included sunfish over 100mm, recently stocked brown trout (*Salmo trutta*) (mean size = 98mm) and carp (*Cyprinus carpio*). Predators were weighed and measured while all other fish were just measured. All bait fish were counted. Stomach contents were taken from all predators over 100mm using pulsed gastric lavage as described by Lagler et al. (1962) and Foster (1977). Stomach contents were collected in Whirl-Pacs®, labeled, preserved in 70% ethanol and refrigerated.

Stomach contents were examined at a later date. Contents were described in two ways; frequency of occurrence and percent composition. Frequency of occurrence is the proportion of fish that contained one or more of a given food type (Bowen 1996). The percent composition is the number of items of a given food type expressed as a percentage of the total items counted of all food types (Bowen 1996). The Strauss index (1979) was used to describe prey selection by predators in this study and is represented by the formula:

$$SI=r_i-p_i$$

SI is the expression of the Strauss index from 1 to -1, r_i is the relative abundance of prey type in the predator diet and p_i is the relative abundance of that fish in the environment (Bowen 1996). A Strauss index of 1 indicates perfect selection for a prey item and an index of -1 indicates perfect selection against (Bowen 1996).

RESULTS AND DISCUSSION

Tables 1 through 3 show the frequency of occurrence (FOO) and percent composition (PN) of various prey items encountered in game fish stomachs for the east shore pre-stocking, west shore pre-stocking, and east shore post-stocking, respectively. Walleye fingerlings prior to the anticipated night stocking became unavailable due to near 100% mortality during their removal from the rearing ponds. Therefore, no stocking occurred on the sites at the west side. Because of this, stocking data from 2004 (Cheever 2005) were used for comparing predation and predator selection between day vs. night stocking Figure 4). Stocking on the east shore was done during the day in 2005, whereas it was conducted at night in 2004 (Cheever 2005). Pre-stocking prey results show that the most common items were crustaceans (mostly crayfish) and insects. The east shore predators preyed on more cyprinids during the pre-stock survey than west shore predators. Following stocking, walleye were the most commonly consumed prey, with crustaceans being selected equally. Walleye were also found to be the most common prey fish in the community (i.e., pi) during the post-stocking seining.

Table 5 shows the Strauss index for top predators in the environment. Prey fish considered here were those fish of species previously defined and being under 100 mm. Total numbers used were pooled data collected across sites during all post-stocking seining. Yellow perch, largemouth bass, and rock bass all selected against walleye during the day (that is, their proportion in predator stomachs was less than that in the environment). Smallmouth bass were the only predator to positively select for walleye during the day. According to Cheever (2005), rock bass and chain pickerel were the only predators to select for walleye during the night. Yellow perch, largemouth bass, chain pickerel and smallmouth bass selected for walleye during the day in the 2004 study (Cheever 2005).

Despite a frequency of occurrence of 88.9 for walleye by smallmouth bass, the Strauss index indicates that they only slightly selected for walleye. That is because the total number of walleye captured during seining (1114) is so much higher than the

number of walleye in stomachs (100). Therefore, the Strauss index leads us to believe that walleye are not a prey selected for by smallmouth bass, despite the fact that such predation was high. Yellow perch and rock bass also selected against stocked walleye fingerlings according to the Strauss index (Table 5).

PREDATORS- EAST SIDE PRE-STOCKING

	Rockbass N=5		Yellow perch N=14		Largemouth bass N=5		Smallmouth bass N=7		Chain pickerel N=4	
PREY	FOO	PN	FOO	PN	FOO	PN	FOO	PN	FOO	PN
Walleye	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprinids	0.0	0.0	7.1	0.9	16.7	14.3	42.9	54.6	0.0	0.0
Alewife	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tesselated darter	0.0	0.0	7.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Brown trout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue gill	0.0	0.0	0.0	0.0	16.7	14.3	0.0	0.0	0.0	0.0
Crustacea	80.0	83.3	57.1	83.9	50.0	42.9	57.1	18.2	0.0	0.0
Ephemeroptera	0.0	0.0	21.4	2.3	0.0	0.0	14.3	4.6	0.0	0.0
Odonata	20.0	16.7	35.7	7.8	0.0	0.0	0.0	0.0	0.0	0.0
Diptera	0.0	0.0	21.4	3.2	16.7	28.6	14.3	13.6	0.0	0.0
Hemiptera	0.0	0.0	7.1	1.4	0.0	0.0	14.3	4.6	0.0	0.0
Orthoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Empty	20.0	NA	0.0	NA	0.0	NA	14.3	NA	100.0	NA

Table 1. Frequency of occurrence (FOO) and percent composition (PN) for game fish collected from the east side prior to stocking, June 2005.

PREDATORS- WEST SIDE PRE-STOCKING

	Rockbass N=6		Yellow perch N=8		Largemouth bass N=2		Smallmouth bass N=14		Chain pickerel N=1	
PREY	FOO	PN	FOO	PN	FOO	PN	FOO	PN	FOO	PN
Walleye	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyprinids	16.7	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alewife	16.7	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tesselated darter	0.0	0.0	0.0	0.0	0.0	0.0	14.3	12.5	100.0	100.0
Brown trout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blue gill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crustacea	83.3	50.0	25.0	3.3	0.0	0.0	42.9	20.0	0.0	0.0
Ephemeroptera	16.7	33.3	37.5	6.5	50.0	100.0	14.3	10.0	0.0	0.0
Odonata	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diptera	0.0	0.0	62.5	7.6	0.0	0.0	28.6	32.5	0.0	0.0
Hemiptera	0.0	0.0	25.0	83.7	0.0	0.0	28.6	25.0	0.0	0.0
Orthoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Empty	16.7	NA	25.0	NA	50.0	NA	14.3	NA	0.0	NA

Table 2. Frequency of occurrence (FOO) and percent composition (PN) for game fish collected from the west side prior to stocking, June 2005.

PREDATORS EAST SIDE POST-STOCKING DAY (2005)

	Rockbass		Yellow perch		Largemouth bass		Smallmouth bass		Chain pickerel	
	1		27		9		9		0	
PREY	FOO	PN	FOO	PN	FOO	PN	FOO	PN	FOO	PN
Walleye	100.0	60.0	74.1	78.7	22.2	29.2	88.9	96.2	0.0	0.0
Cyprinids	100.0	20.0	7.4	2.4	33.3	16.7	0.0	0.0	0.0	0.0
Alewife	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tesselated darter	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown trout	0.0	0.0	0.0	0.0	11.1	4.2	0.0	0.0	0.0	0.0
Blue gill	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crustacea	100.0	20.0	18.5	3.9	22.2	8.4	22.2	3.8	0.0	0.0
Ephemeroptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Odonata	0.0	0.0	18.5	3.9	0.0	0.0	0.0	0.0	0.0	0.0
Diptera	0.0	0.0	14.8	10.2	22.2	41.7	0.0	0.0	0.0	0.0
Hemiptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Empty	0.0	NA	3.7	NA	11.1	NA	0.0	NA	0.0	NA

Table 3. Frequency of occurrence (FOO) and percent composition (PN) for game fish collected from the east side after day stocking, June 2005.

PREDATORS EAST SIDE POST-STOCKING NIGHT (2004)

	Rockbass		Yellow perch		Largemouth bass		Smallmouth bass		Chain pickerel	
PREY	FOO	PN	FOO	PN	FOO	PN	FOO	PN	FOO	PN
Walleye	50.0	64.6	31.3	47.8	57.1	61.6	25.0	13.3	50.0	68.4
Cyprinids	8.3	1.2	12.5	8.7	28.6	16.7	50.0	46.7	12.5	5.3
Alewife	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	10.5
Largemouth Bass	33.3	4.9	0.0	0.0	14.3	0.0	50.0	26.6	25.0	10.5
Smallmouth bass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rockbass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Yellow Perch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tesselated darter	0.0	0.0	6.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0
Brown Bullhead	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Brown trout	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crustacea	75.0	11.0	31.3	15.2	28.6	11.1	0.0	0.0	12.5	5.3
Ephemeroptera	41.7	11.0	18.8	15.2	0.0	0.0	0.0	0.0	0.0	0.0
Odonata	8.3	1.2	0.0	0.0	0.0	0.0	25.0	6.7	0.0	0.0
Diptera	16.7	6.1	12.5	6.5	14.3	5.6	0.0	0.0	0.0	0.0
Hemiptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Orthoptera	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Empty	8.3	NA	25.0	NA	14.3	NA	25.0	NA	25.0	NA

Table 4. Frequency of occurrence (FOO) and percent composition (PN) for gamefish collected from the east sites after night time stocking, June 2004 (Cheever 2005).

PREDATOR	PREY	#NETTED		#CONSUMED		SI NIGHT	SI DAY
		2004 (Night)	2005 (Day)	2004	2005	2004	2005
YP	**WE**	**312**	**1114**	**22**	**100**	**-0.164**	**-0.084**
2004- n=27	ALE	0	0	0	0	0.000	0.000
2005-n=27	TD	19	18	2	0	0.003	0.000
	SMB	2	3	0	0	-0.004	0.000
	LMB	75	4	0	0	-0.147	0.000
	BNM	15	128	0	0	-0.029	0.000
	BT	86	6	0	0	-0.169	0.000
	CYP	0	4	4	1	0.082	0.021
	EMP	NA	NA	4	1		
	TOTALS	509	1277	32	102		
RB	**WE**	**312**	**1114**	**53**	**3**	**0.026**	**-0.271**
2004- n=17	ALE	0	0	0	0	0.000	0.000
2005- n=1	TD	19	18	0	0	-0.037	0.000
	SMB	2	3	0	0	-0.004	0.000
	LMB	75	4	4	0	-0.099	0.000
	BNM	15	128	0	1	-0.029	0.100
	BT	86	6	1	0	-0.157	0.000
	CYP	0	4	0	0	0.000	0.000
	EMP	NA	NA	1	0		
	TOTALS	509	1278	59	4		
LMB	**WE**	**312**	**1114**	**11**	**7**	**-0.034**	**-0.579**
2004- n=16	ALE	0	0	0	0	0.000	0.000
2005- n=9	TD	19	18	0	0	-0.013	0.000
	SMB	2	3	0	0	-0.003	0.000
	LMB	75	4	1	0	0.049	0.000
	BNM	15	128	0	1	0.000	0.067
	BT	86	6	0	1	-0.603	0.037
	CYP	0	4	3	3	0.126	0.164
	EMP	NA	NA	1	1		
	TOTALS	509	1278	16	13		
SMB	**WE**	**312**	**1114**	**2**	**51**	**-0.508**	**0.091**
2004- n=18	ALE	0	0	0	0	0.000	0.000
2005- n=9	TD	19	18	0	0	-0.013	0.000
	SMB	2	3	0	0	-0.003	0.000
	LMB	75	4	8	0	0.418	0.000
	BNM	15	128	0	0	0.000	0.000
	BT	86	6	0	0	-0.603	0.000
	CYP	0	4	7	0	0.337	0.000
	EMP	NA	NA	1	1		
	TOTALS	509	1278	18	52		
CP	**WE**	**312**	**1114**	**13**	**0**	**0.006**	**0.000**
2004- n=10	ALE	0	0	2	0	0.095	0.000
2005- n=0	TD	19	18	0	0	-0.037	0.000
	SMB	2	3	0	0	-0.004	0.000
	LMB	75	4	2	0	-0.052	0.000
	BNM	15	128	0	0	-0.029	0.000
	BT	86	6	0	0	-0.169	0.000
	CYP	0	4	1	0	0.048	0.000
	EMP	NA	NA	2	0		
	TOTALS	509	1278	20	0		

Table 5. Strauss index for game fish for prey items following day walleye stocking and night stocking (WE = walleye, ALE = alewife, TD = tessellated darter, SMB = smallmouth bass, LMB = largemouth bass, BNM = blunt nose minnow, BT = brown trout, CYP = "other" cyprinids, EMP = empty). Data from east side stocking at night in 2004 from Cheever (2005).

CONCLUSIONS

Conservation agencies spend countless time and money on stocking public waters for environmental health and recreational enjoyment. Understanding survival rates of stocked walleye is important for these agencies so that cost benefit can be maximized. This research suggests that walleye fingerlings stocked during the day are selected for by only smallmouth bass. Stocked fingerlings are disoriented when they enter the water and pose an easy target for gamefish. Stocking walleye at night likely increases their chances of survival. Most predators in Otsego Lake are visual hunters, not designed to feed at night. If stocked fingerlings are able to survive the initial few hours, their long term survival will likely be better.

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