Diet Overlap Between Saugeye and Largemouth Bass in Thunderbird Reservoir, Oklahoma[1]

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Abstract: Walleye (*Stizostedion vitreum vitreum*) × sauger (*S. canadense*) hybrids (saugeye) and largemouth bass (*Micropterus salmoides*) ≥350 mm total length were sampled in 1988 and 1989 to determine food habits and diet overlap. Shad (*Dorosoma* spp.) were the most important prey of both largemouth bass and saugeye. Both predators were opportunistic, eating a variety of prey items. Although diet overlap was high, competition for food was not apparent and would not be likely to occur unless forage became limited.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 44:98–104

Saugeye have become a popular sport fish and an important component of fisheries management programs in Ohio, Tennessee, and Oklahoma in the past 10 years (Johnson 1981, Humphreys et al. 1984, Leeds and Summers 1987). Fast growth rates and excellent food quality have made saugeye a desirable addition to many sport fisheries.

A previous study in Oklahoma indicated that age–0 saugeye (≤300 mm) preyed heavily on inland silversides (*Menidia beryllina* Leeds and Summers 1987). Studies in Ohio and Tennessee found that age–0 saugeye ate shad (Johnson 1981, Humphreys et al. 1984). Little information is available concerning the diet of larger saugeye. Lynch et al. (1982) studied food habits and growth of saugeye in Ohio ponds for 3 years. Fish >400 mm total length (TL) consumed the predominant prey species in the pond including fathead minnows (*Pimephales promelas*), golden shiners (*Notemigonus chrysoleucas*), bluegill (*Lepomis macrochirus*), and green sunfish (*L. cyanellus*). Johnson et al. (1988) studied saugeye up to age 3 and >555 mm TL and found that the diet was composed primarily of gizzard shad (*D. cepedianum*). Our

[1]Contribution No. 215 of the Oklahoma Fishery Research Laboratory, a cooperative unit of the Oklahoma Department of Wildlife Conservation and University of Oklahoma Biological survey.

study was designed to determine food habits of large (>350 mm TL) saugeye and to evaluate their dietary interactions with largemouth bass in a reservoir environment.

Funding for this project was provided under Oklahoma Federal Aid in Sport Fish Restoration project F–37-R. Appreciation is extended to Jeff Boxrucker, Troy Hatfield, and other Oklahoma Fishery Research Laboratory personnel for field assistance.

Methods

Lake Thunderbird (2,456 ha) was constructed in 1965 to serve as a municipal water supply reservoir for several central Oklahoma communities (Boxrucker 1990). Lake Thunderbird contains a variety of fish species including largemouth bass, white bass (*Morone chrysops*), catfishes (*Ictalurus* spp. and *Pylodictus olivaris*), and white crappie (*Pomoxis annularis*, Summers 1984, Boxrucker 1990). The forage base is composed primarily of gizzard shad, inland silversides, and sunfishes (*Lepomis spp.* Summers 1984). Threadfin shad (*D. petenense*) have been stocked annually since 1985 (Boxrucker 1990).

One hundred each of largemouth bass and saugeye ≥350 mm TL were collected in spring, summer, and fall 1988 and 1989. Fish were collected by electrofishing with pulsed-DC current from a boat-mounted Smith-Root GPP unit.

All saugeye and largemouth bass were measured (mm TL), weighed (g), stomach contents were evacuated from each fish with clear plastic tubes (modified from Gilliland et al. 1981), and fish were then released. Stomach contents were preserved in 10% formalin for later analysis.

All food items were counted and identified to lowest possible taxa. Food items categorized as fish were measured, when possible, for total length and body depth. Volumes of prey items were determined by water displacement.

Food habits were characterized by calculating % empty stomachs, frequency of occurrence, % by number, % by volume, prey length to predator length ratio, and a diet overlap index (α, Wallace 1981):

$$\alpha = 1 - 0.5(\Sigma\ |p_{xi} - p_{yi}|),$$

where p_{xi} = proportion of food category i in the diet of species x, p_{yi} = proportion of food category i in the diet of species y, and N = the number of food categories

Overlap indices range from 0, or no overlap, to 1, or complete overlap. Food habits were analyzed by food item, size groups of predator, season, and year. Analysis of variance was used to test for differences among mean percent volume for each food category, by species of each length group, by season, and between years.

Results

Foods were grouped into 4 categories: 1) gizzard and unidentified shad (threadfin shad were found in only 2 fish over the course of the study), 2) white crappie,

3) other fish including sunfish, silversides, etc., 4) other prey including crayfish and insects. No significant differences in diet composition were found for saugeye among length groups, by season, or between years. For largemouth bass there were no significant differences between years but there was a difference among seasons ($P = 0.0001$) due to higher consumption of crappie during the spring (Table 1).

Stomach contents from 616 largemouth bass and 612 saugeye ≥350 mm were included in the data set. At least 100 individuals of each species were sampled in all seasons except fall 1989 when only 65 saugeye were collected. The percentage of empty stomachs encountered averaged 58% of largemouth bass and 36% for saugeye. Percent empty stomachs in largemouth bass was relatively constant each season both years (range = 48%–68%). Saugeye empty stomach percentage varied considerably between seasons, ranging from 19% to 61%, with lowest values in the fall of each year.

Shad were the most commonly eaten prey item of largemouth bass (71% by

Table 1. Percent volume of prey items in the diet of largemouth bass (LMB) and saugeye (SE) ≥350 mm from Lake Thunderbird by length group seasonally and annually for 1988 and 1989.

Length group (mm)	Prey item	Spring % vol.		Summer % vol.		Fall % vol.		Annual % vol.	
		LMB	SE	LMB	SE	LMB	SE	LMB	SE
350–374	Shad	92		57	13	64	57	71	38
	Crappie			3	6				3
	Other fish[a]	8		34	71	25	43	22	56
	Other[b]			6	10	10		6	4
375–449	Shad	43	82	79	74	81	50	66	67
	Crappie	36		16	19	2		18	7
	Other fish	20	18	4	6	17	50	15	26
	Other	1		1				1	
449–524	Shad	74	85	75	80	67	72	73	79
	Crappie	14	8	4	13		8	9	10
	Other fish	12	7	21	7	29	19	17	11
	Other					4		1	
525–599	Shad	70	76	100	30	100	90	86	72
	Crappie	30	19		60		9	14	24
	Other fish	1	5		10				5
	Other								
600–674	Shad		74		26		85		70
	Crappie	100	22		74		11	100	27
	Other fish		3				4		3
	Other								
All lengths combined									
	Shad	62	77	77	42	83	76	71	70
	Crappie	24	18	9	48	9	1	21	13
	Other fish	13	6	13	9	8	20	7	15
	Other	1		1			3		1

[a]Includes sunfish spp., silversides, unidentified fish remains, etc.
[b]Includes crayfish, insects, and debris.

volume for all lengths combined annually, Table 1). Other fish, primarily sunfish, ranked second (21% by volume, Table 1). White crappie were also important prey of largemouth bass >375 mm TL in spring (14% to 36% by volume, Table 1). Crayfish were found only in the diets of largemouth bass but were not an important prey item.

Shad were also the most important prey item for saugeye (70% by volume for all lengths combined annually, Table 1). Other fish (primarily silversides) comprised a substantial part of the diet of 350–374 mm TL saugeye. A change in food preferences from silversides to shad occurred in saugeye 375–449 mm TL. White crappie were important to the largest 2 size groups of saugeye during summer with percent volumes of 60% and 74%, respectively (Table 1).

Diet overlap values equalled or exceeded 0.5 among all size groups of bass and saugeye for all seasons, with 93% of the overlap values ≥0.8 (Table 2). The lowest overlap values (α = 0.5 in fall, Table 2) were in part the result of small sample sizes of largemouth bass from 525–599 mm TL. Overlap values ≤0.8 were generated in all seasonal matrices for the largest size group of largemouth bass (525–599 mm; Table 2). Most of the total overlap values (α = 1.0) were observed when comparing saugeye that were 1 to 3 size groups larger than largemouth bass. In the annual overlap matrix, the only values <1.0 were found when comparing the smallest size

Table 2. Seasonal and annual diet overlap values for all size groups of largemouth bass (LMB) and saugeye (SE) ≥350 mm from Lake Thunderbird for 1988 and 1989.

		LMB size group (mm)			
Saugeye size group (mm)		350–374	375–449	450–524	525–599
Spring	350–374	0.9	1.0	1.0	0.7
	375–449	1.0	0.9	1.0	0.8
	450–524	0.9	1.0	1.0	0.8
	450–524	0.9	1.0	1.0	0.8
	525–599	0.9	1.0	1.0	0.7
	600–674	0.9	1.0	1.0	0.8
Summer	350–374	0.9	0.9	0.9	0.8
	375–449	0.8	0.9	0.8	0.8
	450–524	0.9	1.0	1.0	0.8
	525–599	0.9	1.0	1.0	0.8
	600–674	0.9	0.9	0.9	0.8
Fall	350–374	0.9	0.9	0.9	0.5
	375–449	0.9	1.0	1.0	0.5
	450–524	0.9	0.9	0.9	0.5
	525–599	0.9	1.0	1.0	0.5
	600–674	0.9	1.0	1.0	0.5
Annual	350–374	0.9	0.9	0.9	0.9
	375–449	1.0	1.0	1.0	0.9
	450–524	1.0	1.0	1.0	0.9
	525–599	1.0	1.0	1.0	0.9
	600–674	1.0	1.0	1.0	0.9

Table 3. Mean prey length and largest prey item by length group for largemouth bass (LMB) and saugeye (SE) ≥350 mm from Lake Thunderbird for 1988 and 1989.

	LMB			SE		
Length group (mm)	*N* w/prey measured	Mean length (mm)	Largest length (mm)	*N* w/prey measured	Mean length (mm)	Largest length (mm)
350–374	6	116	191	8	85	105
375–449	27	137	180	16	97	159
450–524	25	130	235	12	146	184
525–599	4	156	196	40	141	173
600–674	[a]			14	153	191

[a]No LMB in this size group collected.

group of saugeye (350–374 mm) to all sizes of largemouth bass and the largest size group of largemouth bass (525–599 mm) to all sizes of saugeye (Table 2).

Mean prey lengths of largemouth bass ranged from 116 mm to 156 mm and of saugeye from 85 mm to 153 mm (Table 3). A significant linear relationship indicated that saugeye ate prey approximately 25% of their body length (r^2 = 0.42, P = 0.0001; Fig. 1). However, no relationship was found between prey length and largemouth bass length.

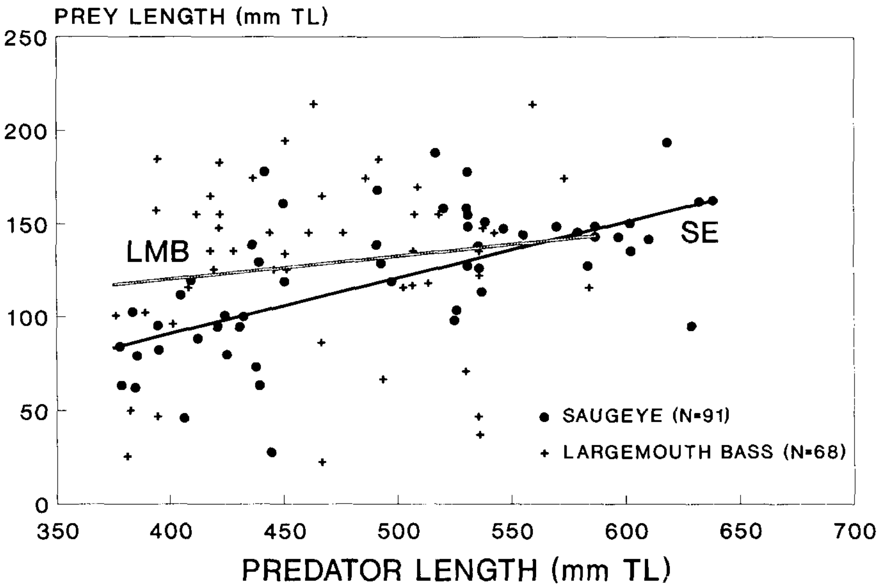

Figure 1. The relationships between predator and prey lengths for saugeye (SE) and largemouth bass (LMB) from Lake Thunderbird in 1988 and 1989.

Discussion

Saugeye and largemouth bass in Lake Thunderbird were opportunistic predators. Largemouth bass ate predominantly shad, followed by white crappie, sunfish, crayfish, silversides, and a variety of other prey. Saugeye ≤374 mm ate inland silversides, similar to results reported by Leeds and Summers (1987). Larger saugeye preyed primarily on shad, as reported by Johnson et al. (1988), but also ate white crappie, sunfish, insects, minnows, and assorted other prey.

The importance of white crappie in the diet of large saugeye during summer appeared to be a function of their tendency to eat a certain size prey in relation to their body length (Fig. 1). Results of standardized survey sampling on Lake Thunderbird indicated that the spring gizzard shad population was composed chiefly of adults from 140 to 200 mm TL, and summer shoreline seining indicated age–0 shad were 20 mm to 60 mm in length (Summers 1984). Allowing for growth, adult shad averaged >180 mm TL by summer, thereby leaving a gap in the shad population size structure from 60 mm to 180 mm. Many stunted white crappie exist in Lake Thunderbird in the 160-mm to 180-mm size range (Boxrucker 1990) that may have filled this gap and served as alternative prey for large saugeye.

Zaret and Rand (1971) considered diet overlap values ≥0.6 as significant. At this level, 93% of the overlap values among saugeye and largemouth bass were significant (Table 2). Diet overlap was very high because both saugeye and largemouth bass preyed predominantly on gizzard shad. Inland silversides, present in Lake Thunderbird in large numbers (Summers 1984), generally inhabit shallow, sandy beach areas where saugeye and largemouth bass ≥375 mm in length were seldom collected. Shad are present in Lake Thunderbird in large numbers, in a wide range of sizes, in most seasons, and in all habitat types (Summers 1984), which probably accounts for their abundance in saugeye and largemouth bass stomachs.

At the sizes reached in 5 growing seasons (675 mm), Oklahoma saugeye ate relatively large gizzard shad (mean length of 153 mm; Table 3). The predator length-prey length ratio of 0.25 generated for Lake Thunderbird saugeye was similar to that reported in Ohio (0.30, Johnson et al. 1988).

Saugeye have provided an outstanding fishery in Lake Thunderbird as a put-grow-take introduction with no apparent harmful impacts on the existing largemouth bass population. However, high diet overlap suggests that competition could occur if forage became limited. In Lake Thunderbird, the bulk of the shad population is gizzard shad. Threadfin shad die out most years due to winterkill. In systems where large segments of the forage base would be subject to severe die offs, competition would probably be a likely occurrence until the forage population(s) were able to recover. If the entire forage base was subject to severe mortality events on a regular basis (such as annual winterkill) then competition would probably limit the ability of fishery managers to provide an expanded sport fishery through the introduction of saugeye.

The decision to stock saugeye in other systems should be based on criteria such as the status of present predator population(s), the strength and diversity of the forage base, and the acceptance by the angling public of new sport species. Reservoirs with low density predator populations but with an abundant and diverse forage base (e.g., silversides, shad, and stunted crappie) may be candidates for saugeye introductions. If several years of sampling data are available, trends in predator relative weights (Wr) and forage abundance could be used to determine if the prey base is sufficient to support additional predators.

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