Reevaluating the Use of Acrylic Tubes for Collection of Largemouth Bass Stomach Contents[1]

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Abstract: Stomach contents of 434 largemouth bass (*Micropterus salmoides floridanus*) were collected with clear acrylic tubes. Sixty-four percent of the bass contained food. No significant differences ($P > 0.05$) in percent recovery of food items by weight occurred among 3 biologists for the 6 size groups studied. Greater than 80% recovery by weight of all food was obtained with acrylic tubes in 6 size groups of bass ranging from 100 to 590mm TL. Seven percent of bass that yielded no food when sampled with tubes actually contained food. Appropriate tube size was important in efficient food extraction. Largemouth bass >120 mm can be tubed easily and efficiently. Although considered an easy and efficient technique for largemouth bass >120 mm TL, limitations involving fish size, prey size, and incomplete recovery should be considered when interpreting food habit data obtained by acrylic tubes.

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Several techniques have been developed to remove piscivorous stomach contents without sacrificing the fish (Dubets 1954, Seaburg 1957, Jernejcic 1969, Forney 1974, and Van Den Avyle and Roussel 1980). Of these studies, we have found Van Den Avyle and Roussel's (1980) acrylic tube sampling to be the quickest and most efficient. However, having used this technique on largemouth bass for several years, we noticed differences in the methods and tube sizes used by individual biologists when sampling similar sized fish. The purpose of our study was to determine possible

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differences in the efficiency of food removal by field personnel, effects of fish size, and the size of tube used on the recovery of various types of food items.

Methods

Largemouth bass were captured by electrofishing during daylight hours from August through December 1989 in 9 central Florida lakes. Fish were placed in an aerated live-well after capture, usually for <30 minutes. With the techniques described by Forney (1974), Van Den Avyle and Roussel (1980), and Gilliland et al. (1981), largemouth bass stomach contents were removed with other clear acrylic tubes. For each fish, 1 of 3 biologists independently chose a wetted tube and inserted it through the esophagus into the stomach of the bass. Each fish was inverted (mouth down), and the tube was sealed with the thumb or palm of the hand to create a slight vacuum which sometimes aided in removal of food items. Food items collected with acrylic tubes were placed in glass jars numbered for individual fish and fixed in 10% formalin. Tube size was recorded for individual fish. After stomach contents were taken, bass were measured to the nearest millimeter in total length (TL), weighed (grams), individually tagged, and placed on ice to minimize post-capture digestion of any food remaining in the stomach. Occasionally, food items in large bass (≥500 mm) would not fit into our largest acrylic tube (44mm internal diameter). In cases where the caudal fins of prey fish were observed protruding from the esophagus, instruments such as pliers or hook removers were used to extract food items.

In the laboratory, largemouth bass were dissected and remaining stomach contents removed. All food items were identified, enumerated, and wet-weighed (mg). Food items preserved in formalin were blotted to remove excess liquid, identified, enumerated, and weighed (mg).

Six size groups of largemouth bass were used in the analysis: <150 mm, 150–199 mm, 200–299 mm, 300–399 mm, 400–499 mm, ≥500 mm (TL). Analysis of variance was used with the Kurskal-Wallis test to evaluate differences in the efficiency of food removed due to: 1) individual biologists, 2) size of fish, and 3) type of food ingested. All food items were analyzed as percent of total weight of stomach contents in each fish.

Results

Four hundred thirty-four largemouth bass were analyzed for food habits with acrylic tubes. One hundred sixty-eight of 434 bass (38.7%) were designated as empty in the field; however, 12 of the 168 (7.1%) contained food when dissected in the laboratory. All size groups had at least 1 fish in which this occurred. Five of the 12 were attributed to the tube size selected (a larger tube could have been used). Poor recovery from 5 other fish was related to the small weight (<17 mg) of food items present in each stomach (e.g. a few fish bones, small insects).

The remaining 278 largemouth bass contained food. Food items or parts of food items remained in 70 (25.2%) of those bass after we sampled with acrylic tubes. However, only 23 of the 70 (8% of the total) resulted in loss of qualitative data (i.e. missed or misidentified food items). Of these, 12 bass classified as empty in the field (all 3 biologists did this on 3 or more individual fish) contained food; 9 bass contained additional food items to those collected in the field; and 2 fish contained identifiable fish species that were identified as fish remains in the field. In addition, 4 largemouth bass contained items that were observed in the stomach, but did not come out with the tube due to the position of the prey in the stomach. However, these items were identified correctly in the field.

No significant differences ($P > 0.05$) existed between 3 biologists in relative recovery of food contents (% by weight) for any of 6 size groups studied (Table 1) or between size groups for individual biologists. However, differences in tube size selected by different biologists for similar size fish were apparent (Table 2). Of the 11 tube sizes, biologist No. 3 sampled significantly smaller ($P < 0.05$) largemouth bass with 6 tube sizes than biologist No. 1, while biologist No. 2 sampled significantly smaller bass with 1 tube size than biologist No. 1. Biologist No. 2 and No. 3 sampled similar size fish with all tube sizes. Although these differences occurred, we believe this had relatively little effects on food recovery rates in this study.

Greater than 80% recovery by weight of all food in the field was obtained for all size groups (Table 1). A declining trend of the percent of bass in which all food weight was recovered with tubes was observed with increasing fish size for bass >200 mm TL. The diet of all size groups of largemouth bass was dominated in weight (>88%) by fish (Table 3). Recovery of fish with acrylic tubes varied from 65.0% to 98.8% by weight for the various size groups. No significant differences ($P > 0.05$) were observed between recovery of various other food groups (e.g. insects, crustaceans) due to the low percent (by weight) of these groups in the diet of largemouth bass we studied.

Discussion

Van Den Avyle and Roussel (1980) reported 100% food removal with acrylic tubes from largemouth bass ($N = 40$) and spotted bass (*Micropterus punctulatus*, $N = 63$) and >98% from smallmouth bass (*M. dolomieui*, $N = 57$). Gilliland et al. (1981) reported 100% food removal for largemouth bass ($N = 5$) and striped bass (*Morone saxatilis*; $N = 4$), 90% for white bass (*Morone chrysops*; $N = 48$) and 95% for the striped bass × white bass hybrid ($N = 82$).

In our study, although food recovery rates were >80% by weight for all largemouth bass size groups, acrylic tubes did not yield near 100% accuracy as reported in the above studies for a much larger sample size ($N = 278$).

Van Den Avyle and Roussel (1980) sampled bass at night and used a light directed down the tube to visually examine stomach contents. We relied totally on sunlight which may not provide as much light as is needed to detect all stomach contents. This may partially account for differences in recovery rates.

While Van Den Avyle and Roussel (1980) generally used the maximum tube diameter that could fit through the esophagus, they only studied bass >200 mm TL.

Table 1. Mean percent recovery by weight of food items excised from largemouth bass by 3 biologists.

	<150mm TL	150–199mm TL	200–299mm TL	300–399mm TL	400–499mm TL	>500 mm TL	Total mm TL
Biologist No. 1							
N	14	14	26	19	6	3	82
% 100% recovery	78.6	85.7	73.1	68.4	66.7	33.3	73.2
Mean % recovery	82.3	91.8	95.7	88.0	97.8	65.1	90.0
SE	9.9	7.1	2.2	7.2	1.4	32.6	3.0
Range	0–100	0–100	46.1–100	0–100	92.0–100	0–100	0–100
Biologist No. 2							
N	12	10	29	22	12	11	96
% 100% recovery	41.7	90.0	82.8	77.3	75.0	36.3	70.8
Mean % recovery	64.2	97.8	95.9	89.2	91.5	79.7	88.2
SE	13.2	2.2	3.4	6.3	8.3	12.0	3.1
Range	0–100	78.3–100	0–100	0–100	0–100	0–100	0–100
Biologist No. 3							
N	13	19	25	26	14	3	100
% 100% recovery	84.6	84.2	92.0	84.0	42.9	100	80.0
Mean % recovery	92.7	93.5	99.2	90.7	83.1	100	92.8
SE	5.3	5.3	0.6	5.3	9.6	—	2.3
Range	36.3–100	0–100	86.5–100	0–100	0–100	100	0–100
Total							
N	39	43	80	67	32	17	278
% 100% recovery	69.2	86.0	82.5	76.1	59.4	47.1	74.8
Mean % recovery	80.2	94.0	96.8	89.4	89.0	80.7	90.5
SE	5.8	3.3	1.4	3.5	5.2	9.4	1.6
Range	0–100	0–100	0–100	0–100	0–100	0–100	0–100

Table 2. Comparison of mean length total (mm) of largemouth bass sampled with 11 tube sizes by 3 biologists. Values with same letter(s) not significantly different ($P > 0.05$) within same tube size.

Tube diameter (mm)		Biologist No. 1 Fish length				Biologist No. 2 Fish length				Biologist No. 3 Fish length			
Outside	Inside	*N*	$\bar{x}$	Min.	Max.	*N*	$\bar{x}$	Min.	Max.	*N*	$\bar{x}$	Min.	Max.
6	3	7	103	97	107								
9	6	11	144a	118	169	11	129ab	112	146	9	126b	116	134
12	9	10	184a	159	218	7	184a	160	203	13	174a	140	201
16	12	14	248a	196	283	9	225ab	194	240	8	213b	186	234
19	16	18	274a	251	307	15	258ab	232	280	18	245b	210	262
22	18	18	311a	252	350	43	287b	257	336	35	284b	250	325
25	19	8	351a	334	391	26	336ab	281	396	22	323b	301	376
32	25	11	397a	353	443	24	414a	335	514	16	384a	338	409
38	32	11	476a	428	536	7	465ab	410	537	11	429b	390	466
45	37	4	540a	510	587	14	556a	500	627	5	515a	463	573
50	44					7	597a	577	656	5	581a	566	596

Table 3. Composition and percent field recovery of largemouth bass stomach contents with acrylic tubes.

	Crustacea	Fish	Insect
<150 mm			
Sample size (*N*)	7	26	18
All items recovered (%)	85.7	76.9	83.3
% Recovery by weight	98.3	65.0	90.4
% Diet makeup	6.2	88.5	5.1
150–199 mm			
Sample size (*N*)	16	33	16
All items recovered (%)	100	90.9	81.3
% Recovery by weight	100	98.3	91.7
% Diet makeup	8.3	89.1	2.1
200–299 mm			
Sample size (*N*)	16	72	3
All items recovered (%)	93.8	81.9	100
% Recovery by weight	99.0	98.4	100
% Diet makeup	8.2	89.9	0.1
300–399 mm			
Sample size (*N*)	2	61	8
All items recovered (%)	100	75.4	87.5
% Recovery by weight	100	91.3	83.8
% Diet makeup	0.8	96.2	0.8
400–499 mm			
Sample size (*N*)	3	29	1
All items recovered (%)	66.7	69.0	100
% Recovery by weight	69.3	98.8	100
% Diet makeup	2.0	96.5	0.0
>500 mm			
Sample size (*N*)	1	14	1
All items recovered (%)	100	42.9	0
% Recovery by weight	100	96.0	0
% Diet makeup	0.2	98.4	0.0

Our study indicated that the diet of largemouth bass <200 mm can be efficiently determined with smaller tubes. We recommend using caution when inserting tubes in bass <200 mm TL, as internal injuries may result (pers. observ.), increasing the chance of mortality that this technique serves to alleviate.

Poor percent recovery of food items for 45% of the bass >400 mm TL (*N* = 22) was frequently due to: 1) fish bones remaining after extracting large food items; or 2) the presence of small food items or small content weights present in stomachs. We recommend that a tube of maximum diameter for esophagus size be used first; if small contents are encountered, additional use of a smaller diameter tube may help contents to remain in the tube. Also, by partially filling the tube with water while it is in the bass, a flushing mechanism is created for recovery of small food items. Although only 1 large fish (>575mm TL) in this study had large food items in its stomachs, past experience has shown that our maximum diameter tube (44mm internal diameter) failed to recover large food items (e.g. centrarchids, catostomids).

Under these circumstances, a larger diameter tube may be necessary, but hook removers or pliers will extract large prey fish relatively easily.

In conclusion, we believe that when using the acrylic tube technique, no significant differences in percent recovery by weight should occur among field personnel if our recommendations are followed. Appropriate tube size is paramount to the successful collection of the majority of food items. Extra time and care should be used when collecting stomach contents with acrylic tubes for largemouth bass <200 mm TL and >400 mm TL. We feel that acrylic tubes are an important tool, but limitations due to fish size, prey size, and incomplete recovery must be considered.

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