Post-mortem Weight Gain in Largemouth Bass

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Abstract: Largemouth bass (*Micropterus salmoides*) held at 10.7 and 26.7 C in insulated fiberglass tanks were treated with rotenone and inspected daily to determine days-to-surfacing and change in body weight. Fish held at 10.7 C surfaced in 3–12 days, whereas fish held at 26.7 C surfaced within 24 hours. Fish at each temperature gained weight after death. Analysis of weight gain in fish held at 10.7 C produced no significant relationship between weight-gain and period of submergence for fish submerged 7 or more days. Weight gain was an exponential function of total length in fish held at 10.7 C and a logarithmic function of total length in fish held at 26.7 C.

Proc. Annu. Conf. Southeast Assoc. Fish and Wildl. Agencies 44:20–26

Lake Fork Reservoir, located in northeast Texas, is the premier trophy largemouth bass lake in the state. As of September 1990, the state record largemouth bass and 7 of the top 10 and 32 of the top 50 largest largemouth bass have come from this reservoir. In both 1989 and 1990, fishermen found several dead trophy-sized largemouth bass (7.0–9.3 kg) floating in Lake Fork Reservoir. These fish, when weighed at time of discovery, were near, or in excess of, the current species state-record weight. Although it is common knowledge among fisheries biologists that fish gain weight after death (Grinstead et al. 1976) or after preservation for storage (Anderson and Gutreuter 1983), the question of weight change in such fish is often asked of fishery biologists by anglers in Texas.

The scientific literature provides little insight into the nature of post-mortem weight change. Parker (1970) found that time-to-surfacing of dead fishes was affected by temperature. Fish at low temperatures took much longer to surface and some never surfaced at all. Fish at high temperatures surfaced in as little as 12 hours. The purpose of our study was to quantify post-mortem weight change and time-to-surfacing of largemouth bass at winter and summer temperatures characteristic

of Lake Fork Reservoir. We were interested in understanding 3 relationships: 1) temperature and period of submergence (POS), 2) total length (TL) and weight gain (WG), and 3) temperature and WG.

Methods

Seven largemouth bass were collected by electrofishing in April 1989 and acclimated for 2 weeks at 10.7 C in a 1,893-liter insulated fiberglass tank prior to their treatment with liquid rotenone. Water temperature was chosen to duplicate winter temperature at Lake Fork Reservoir and was maintained by recirculating test water through a thermostatically controlled cooling unit. In January 1990, an additional 30 largemouth bass were similarly collected, acclimated, and treated with rotenone. Data from these 37 fish were pooled.

Twenty-nine largemouth bass were collected by electrofishing in the summer of 1989 and held at 26.7 C for 1 day in a 1,893-liter insulated fiberglass tank prior to rotenone application. This temperature was the ambient summer surface temperature at Lake Fork Reservoir at time of collection and was considered to represent normal summer surface temperatures.

Rotenone treatment was conducted in a separate 83.7-liter tub. Prior to rotenone treatment, each fish was weighed, measured, and implanted with an individually coded Passive Integrated Transponder tag (PIT tag—Biosonics, Inc., Seattle, Wash.). Initial weight was that of the fish at the time of tag implantation. Dead fish were placed back into the insulated fiberglass tank for testing.

The tank was examined at 0800 hours each day after rotenone application. In the first treatment of largemouth bass held at 10.7 C, each fish was weighed at 0800 hours of each day post-treatment until the fish surfaced. In the second low temperature trial, fish were weighed only at 24 hours for comparison to fish held at 26.7 C and then again at time of surfacing. The decision to weigh fish only at 24 hours and at time of surfacing in the second low temperature trial was made because results of the first low temperature trial suggested the majority of WG in these fish took place within the first few days of submergence. At time of surfacing, fish were removed, identified by transponder number, dried, and weighed.

WG was calculated by subtraction of the initial weight from the 24 hour weight (WG_{24}) and final weight (WG_{Final}) of each fish. The relationship of TL and temperature to the dependent variable WG was analyzed through multiple regression with main effects TL and temperature and their interaction term. Relationships between variables TL and POS to dependent variable WG was analyzed with multiple regression with TL and POS as main effects and their interaction. Simple linear models were used to determine the relationship between TL and WG at both temperatures and between TL and POS at 10.7 C.

Results

Temperature and Period of Submergence

Time-to-Surfacing of the 37 fish tested at 10.7 C ranged from 3 to 12 days (Table 1). We found no significant relationship between TL and POS at 10.7 C when data were pooled. However, it should be noted that 2 fish in the first low temperature

Table 1. Summarization of length and weight gain data from fish held at 10.7 C. Fish marked by an asterisk were treated in the first trial, the remaining fish were treated in the second trial. Mean percent of final weight gain within 24 hours of death was 66.0%.

	Wt (gm)			Wt Gain (gm)				
Total length (mm)	Initial	24 hours	Final	24 hour	% of Final at 24 hours	Final	Days to surface	% Wt gain
88	75.7	83.2	85.7	7.5	75.0	10.0	7	13.2
90	72.9	81.1	82.8	8.2	82.8	9.9	7	13.6
131	183.8	197.1	204.4	13.3	64.6	20.6	7	11.2
178	60.6	68.0	69.9	7.4	79.6	9.3	8	15.3
210	108.8	121.1	122.5	12.3	89.8	13.7	7	12.6
290*	298.7	307.0	338.3	8.3	21.0	39.6	10	13.3
312	402.3	426.5	435.8	24.2	72.2	33.5	8	8.3
322	460.0	485.3	503.4	25.3	58.3	43.4	8	9.4
337	506.4	536.9	562.8	30.5	54.1	56.4	9	11.1
352	687.3	721.6	740.5	34.3	64.5	53.2	11	7.7
364	703.0	738.6	758.0	35.6	64.7	55.0	9	7.8
374	817.5	861.0	882.6	43.5	66.8	65.1	9	8.0
375	847.4	882.8	914.0	35.4	53.2	66.6	10	7.9
377	697.4	733.1	764.2	35.7	53.4	66.8	9	9.6
380	825.1	859.0	895.6	33.9	48.1	70.5	10	8.5
384	783.4	864.1	854.0	80.7	114.3	70.6	10	9.0
392*	922.7	974.9	1050.6	52.2	40.8	127.9	10	13.9
398	1024.4	1079.2	1108.7	54.8	65.0	84.3	9	8.2
405	1221.5	1273.7	1300.1	52.2	66.4	78.6	8	6.4
411	1194.4	1244.5	1292.1	50.1	51.3	97.7	10	8.2
414	1041.0	1085.6	1115.4	44.6	59.9	74.4	11	7.1
420	1208.9	1277.0	1299.6	68.1	75.1	90.7	10	7.5
427	929.3	1040.0	1080.2	110.7	73.4	150.9	12	16.2
428	1295.9	1350.9	1370.3	55.0	73.9	74.4	10	5.7
434	1491.3	1570.3	1587.9	79.0	81.8	96.6	10	6.5
437	1270.9	1352.0	1364.3	81.1	86.8	93.4	7	7.3
437	1192.4	1225.3	1277.4	32.9	38.7	85.0	11	7.1
445	1425.3	1480.7	1516.5	55.4	60.7	91.2	8	6.4
451*	1768.6	1895.4	1926.9	126.8	80.1	158.3	3	9.0
458	1604.3	1676.2	1713.1	71.9	66.1	108.8	10	6.8
458*	1309.3	1382.5	1390.3	73.2	90.4	81.0	3	6.2
465	1643.0	1693.0	1754.0	50.0	45.0	111.0	10	6.8
471	1309.2	1375.8	1405.2	66.6	69.4	96.0	11	7.3
490	1991.4	2077.8	2105.7	86.4	75.6	114.3	7	5.7
499*	2383.5	2502.0	2608.2	118.5	52.7	224.7	9	9.4
511*	2351.1	2532.5	2651.7	181.4	60.3	300.6	12	12.8
515*	2724.2	2853.2	2924.2	129.0	64.5	200.0	9	7.3

Table 2. Summarization of length-weight gain data for fish held at 26.7 C. Percent weight gain is percentage of the weight gained at emergence (within 24 hours of death).

Total length (mm)	Initial weight (gm)	Final weight (gm)	% Wt gain
130	25.0	27.8	11.2
159	58.0	65.0	12.1
159	44.0	44.0	0.0
159	45.9	50.4	9.8
165	48.8	56.5	15.8
165	35.9	38.9	8.4
197	89.0	100.1	12.5
200	99.9	109.0	9.1
210	113.7	119.9	5.5
229	154.9	166.8	7.7
235	162.9	175.8	7.9
245	190.4	208.8	9.7
254	226.2	271.2	19.9
254	227.0	240.8	6.1
267	258.2	278.3	7.8
270	243.8	267.3	9.6
298	406.0	430.4	6.0
305	350.0	372.9	6.5
305	375.9	399.8	6.4
305	397.0	415.2	4.6
324	532.0	555.4	4.4
327	418.0	473.3	13.2
340	563.0	575.7	2.3
359	595.6	631.3	6.0
406	1154.0	1191.9	3.3
410	1009.1	1031.9	2.3
438	1312.0	1363.3	3.9
454	1358.0	1400.5	3.1
521	2135.0	2188.1	2.5

trial surfaced within 3 days of death, a period of time that was quite less than the other fish in this experiment. Analysis of fish from the second trial alone did yield a significant relationship between TL and POS ($r^2 = 0.33$). In the second low temperature trial, larger fish took longer to surface. All 29 fish held at 26.7 C had surfaced within 24 hours of rotenone treatment (Table 2).

Temperature, Total Length, and Weight Gain

All fish held at 10.7 and 26.7 C gained weight after death (Tables 1, 2). Analysis of the relationship between WG as a function of TL and temperature yielded a significant interaction between these variables at the 2 temperature levels.

The linear relationship between TL and WG for fish held at 26.7 C was best fit by the model:

$$1.\ \text{Log WG}_{\text{Final}} = -3.6 + 1.98\ \text{Log TL}\ (p < 0.01; r^2 = 0.85).$$

The relationship between 24-hour and final WG with TL for fish held at 10.7 C was best described by the exponential models (respectively):

2. $WG_{24} = 3.145\,(10^{(0.003\,TL)})$ $(p < 0.01; r^2 = 0.83)$
3. $WG_{Final} = 4.637\,(10^{(0.1003\,TL)})$ $(p < 0.01; r^2 = 0.88)$.

Exponents of equations (2) and (3) are equal for any given TL, suggesting that mean WG_{24} should be about 67% of WG_{Final}. This is consistent with the finding (Table 1) that the mean WG_{24} was 66% of the WG_{Final} for fish held at 10.7 C.

A plot of predicted WG from each equation against total length (Fig. 1) indicated a consistent rate of WG with length at 26.7 C and an increasing rate of WG with length at 10.7 C. Fish held at 26.7 C gained less weight than fish held at 10.7 C for 24 hours. The greatest WG was in fish held at 10.7 C until surfacing.

We found no significant relationship between the POS and WG_{Final} in the low temperature trial. In effect, WG in those fish which were held at 10.7 C may have reached an asymptote within a short period of time after death. This is consistent with results of the daily weighing of fish in the first low temperature trial (Table 3) in which approximately 79% of WG_{Final} had occurred within the first 6–7 days of submergence.

Discussion

Largemouth bass begin to gain weight shortly after death. The gain is rapid, with 66%–67% of total individual WG occurring within the first 24 hours. WG of

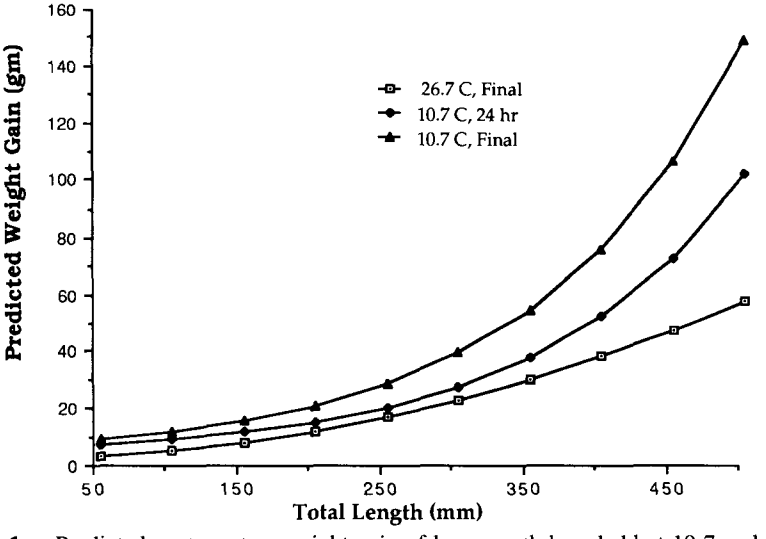

Figure 1. Predicted post-mortem weight gain of largemouth bass held at 10.7 and 26.7 C. All fish held at 26.7 C surfaced within 24 hours of death.

Table 3. Initial weight and weight at 24-hour intervals after death for first trial of fish held at 10.7 C. Fish marked with an asterisk emerged on the third day post-treatment.

Total length (mm)	Initial weight (gm)	Days post-treatment weight (gm)							
		1	2	3	4	5	6	7	8
290	298.7	307.0	316.6	320.1	326.9	324.7	331.3	335.9	342.2
392	922.7	974.9	991.5	1004.8	996.1	1017.2	1025.6	1032.2	1042.3
451*	1768.6	1868.6	1895.4						
458*	1309.3	1382.5	1381.3						
499	2383.5	2502.0	2489.2	2523.7	2513.7	2530.1	2529.5	2540.7	2568.2
511	2351.1	2532.5	2557.3	2557.3	2548.2	2578.9	2597.3	2590.7	2640.6
515	2724.2	2853.2	2843.9	2849.6	2849.2	2863.2	2890.5	2909.1	2940.0
Mean % of final wt gain		56	63	62	63	70	79	79	98

individual fish is affected by body surface area and water temperature, which in turn influences the rate of decomposition and therefore the period of submergence. Quite simply, the longer a largemouth bass is submerged, the more weight it gains. However, WG at 10.7 C is minimal after 6–7 days of submergence because by that time the fish may well have absorbed enough water to become isotonic with the surrounding medium.

The physical mechanism behind post-mortem WG would appear to be the same, regardless of temperature, if integument permeability is not affected by temperature: when osmoregulation stops, water continues to diffuse into the body across the integument, and weight increases.

We hypothesize that the different temperature to WG relationships are directly related to the period of submergence and surface area of the fish in contact with the water. Fish held at 26.7 C surfaced within 24 hours and were therefore totally exposed to the surrounding water for a shorter period of time when compared to fish held at 10.7 C. After surfacing, the area of integument in contact with the water would decrease by as much as 50%, water inflow would decrease sharply with concomitant dehydration of exposed tissues. In retrospect, monitoring of WG during the 26.7 C trial for the entire 24 hours may have provided insight into weight gain in fish which surfaced soon after death and remained at the surface until the following morning.

These results support the contention of Grinstead et al. (1976) that weights of fish collected on the day after rotenone treatment should not be considered valid and suggest fish which have been dead only a short period of time can gain a substantial amount of weight. The relative WG is most pronounced in small fish which tend to constitute a large percentage of the total number and weight captured and have a relatively large surface to volume ratio.

Findings of this study should also be important to investigators who use other sampling techniques that result in the collection of dead fishes. Gill and/or trammel nets are often fished overnight. Entrapped fish often die and may be submerged for

time periods approaching 24 hours. If the osmoregulatory process observed for largemouth bass is the same for all species of fish, then weight gain would begin soon after death. Weight gain would continue until the affected fish were removed from the water for measurement. Recorded weights from these fish would be erroneous, and the degree of error would depend upon the length of submergence.

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