

MORTALITY, OSMOREGULATION, AND FAT DEPLETION
OF YOUNG-OF-THE-YEAR OF SOME SPECIES
OF FRESHWATER FISH IN WINTER CONDITIONS

by

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A THESIS

submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

College of Natural Resources

UNIVERSITY OF WISCONSIN
Stevens Point, Wisconsin

April 1977

ABSTRACT

To determine if mortality during winter was higher for smaller young-of-the-year, freshwater fish, eight experiments were conducted in lakes and hatchery ponds in which fish were measured in late fall and early spring. Over-winter increase in mean length of bluegill, Lepomis macrochirus, in one lake and largemouth bass, Micropterus salmoides, in another was attributed to higher mortality of smaller fish. Size-specific mortality was not detected in two other bluegill populations, one largemouth bass, one green sunfish, Lepomis cyanellus, one fathead minnow, Pimephales promelas, and one white crappie, Pomoxis annularis, population.

In laboratory experiments young-of-the-year green sunfish, largemouth bass, channel catfish, Ictalurus punctatus, brook trout, Salvelinus fontinalis, and yellow perch, Perca flavescens, were held for four months in simulated winter conditions (2-4°C, photoperiod of 9L:15D) in solutions of various osmotic strengths including 90% distilled water/10% tap water, tap water, 0.1, 0.2, 0.4, 0.5, 0.6, 0.85 and 1.0% NaCl. Mortalities occurred in 4 of the 6 experiments and often were greater in salt solutions, indicating that NaCl did not enhance survival. Larger fish tended to survive longer. Hematocrit was depressed below control levels for largemouth bass, brook trout, channel catfish, and yellow perch in all solutions at the end of experiments. All

species generally were able to regulate plasma osmotic concentration in all solutions except the highest NaCl concentrations where plasma osmolality was often significantly higher than control levels at the end of experiments. Plasma Na^+ and Cl^- concentrations usually were lower for experimental fish than control fish at the end of experiments, but they were frequently elevated in the highest salt concentrations. Fat content of survivors declined and water content increased for all species, but the losses and gains were not related to osmolality of solutions. Larger survivors tended to have more fat and less water. Low fat content probably was not a cause of mortality.

ACKNOWLEDGEMENTS

I extend thanks to Dr. Daniel W. Coble, my major professor, for his guidance throughout this study and his patient assistance in the preparation of this manuscript. I am grateful to Dr. Douglas Liesveld, Dr. Henry E. Boone, and Dr. Gerald Z. Jacobi, members of my graduate committee, for their assistance and review of this manuscript. I appreciate the help with analytical procedures provided by Dr. Liesveld and Dr. Boone. I thank Sherman Stairs, Manager of the Lake Mills (Wis.) National Fish Hatchery, for his assistance and cooperation throughout this study. The following provided valuable help in the field and laboratory: Mike Reif, Roman Jesien, Bruce Taubert, Gary Lutterbie, Bob Schmal, Tom Wilde, Bruce Hollander, Bob Kilcoyne, Dave Timm, and the personnel at the Environmental Task Force Laboratory.

I am indebted to the Wisconsin Cooperative Fishery Research Unit for financial support, equipment, and facilities that made this study possible.

I owe special thanks to my wife, Carrol, for typing this manuscript and for her continual support, patience and understanding during the past two and a half years.

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INTRODUCTION

Objectives of this study were: 1) to determine if mortality in winter of young-of-the-year of some freshwater fishes is greater for smaller individuals, 2) to determine if ionic and osmotic changes or imbalances in fish blood are associated with such mortality, and 3) to determine if relationships exist between depletion of stored fat, ionic or osmotic changes in blood, and mortality at cold temperatures.

Overwinter increase in mean length of young-of-the-year, which was not due to growth, has been observed for the walleye, Stizostedion vitreum, (Forney 1966; Chevalier 1973; Joy 1975); sander, Stizostedion lucioperca, (Negonovskaya 1972); brook trout, Salvelinus fontinalis, (Hunt 1969); Atlantic salmon, Salmo salar, (Lindroth 1965); largemouth bass, Micropterus salmoides, (Coble, Unpublished) (Appendix A); and bluegill, Lepomis macrochirus, (Chang 1971). The increase has been attributed to size-specific mortality caused by cannibalism (Forney 1966; Chevalier 1973) or depletion of fat reserves resulting in decreased ability to cope with cold-induced stresses (Reimers 1963; Hunt 1969; Svardson and Molin 1973).

Osmoregulation, the process by which fish maintain a specific dissolved solids-water balance between body fluids and the external medium, consumes energy (Potts 1954; Parry 1966; Parvatheswararao 1970; Nordlie and Leffler 1975;

Spaargaren 1975). If energy use appreciably exceeds energy gained from feeding in winter, fish must have sufficient energy stored, primarily in fat, to maintain osmotic balance. In addition cold temperatures may reduce iono-osmoregulatory efficiency by causing changes in the permeability of exchange membranes and the functioning of ion transport mechanisms (Wikgren 1953; Morris and Bull 1968; Davis and Simco 1976). Therefore the proportion of energy used for osmoregulation may be higher in cold than warm temperatures.

My hypotheses were, 1) that late hatching and small early hatching young-of-the-year of a species have low fat reserves at the start of winter, and that a disproportionate number may die during the winter due to the combined adverse effects of reduced osmotic efficiency and depletion of fat reserves, and 2) that survival could be increased and less energy required for osmoregulation if fish were held during winter in salt solutions approximately isosmotic with their blood.

Field studies were conducted in three lakes and three hatchery ponds from November 1975 to March-April 1976 to identify naturally occurring examples of size-specific winter mortality of young-of-the-year. Also six laboratory experiments with five species, simulating winter temperature and photoperiod, were conducted from July 1975 to December 1976 in an effort to relate iono-osmotic imbalance or fat reserve depletion or both to fingerling mortality.

METHODS AND MATERIALS

Description of Lakes and Hatchery Ponds

Overwinter mortality of young-of-the-year bluegill was investigated in Sunset and Meyers Lakes and of largemouth bass in Thomas Lake, all in Portage County, Wisconsin (Table 1).

Sunset Lake is a 25.5 hectare, clear, hardwater seepage lake with a maximum depth of 17 meters. The lake was chemically treated in 1954 and 1965 to remove stunted panfish populations. Species present in 1975-1976 included stocked rainbow trout, Salmo gairdneri; largemouth bass; bluegill; white sucker, Catostomus commersonii; cisco, Coregonus artedii; and several minnow species.

Meyers Lake is a 10.9 hectare, hardwater, seepage lake with a maximum depth of 3.4 meters. An intermittent outlet joins the lake to the Tomorrow River located approximately 400 m from the lake. The lake supported a dense summer growth of rooted aquatic vegetation and is susceptible to winterkill. The last winterkill occurred in 1969. Dissolved oxygen levels ranged from 2.0 ppm just below the ice to 0.2 ppm at the bottom in early March 1976. Northern pike, Esox lucius; largemouth bass; pumpkinseed, Lepomis gibbosus; green sunfish, Lepomis cyanellus; black bullheads, Ictalurus melas; yellow perch, Perca flavescens; and bluegill were present.

Thomas Lake is a 17.0 hectare, clear, hardwater seepage lake with a maximum depth of 9.5 m. The littoral zone is

covered by dense aquatic vegetation in summer. The lake was chemically treated in 1957 and 1960 for removal of stunted panfish. Stocked rainbow trout, largemouth bass, bluegill, pumpkinseed, white sucker, black bullhead, northern pike, assorted minnows and darters were present.

In addition overwinter mortality of young-of-the-year green sunfish, largemouth bass, bluegill, white crappie, Pomoxis annularis, and fathead minnow, Pimephales promelas, was investigated in three ponds at the Lake Mills National Fish Hatchery in Jefferson County, Wisconsin.

Each pond was rectangular, 0.2 hectare, with a maximum water depth of 1.2 m in the winter. The bottom of each pond was covered with a layer of rooted aquatic vegetation approximately 7.5 cm high. Source of water for the ponds was Rock Lake located about 800 m from the hatchery.

Water chemistry of the three lakes and ponds was similar (Appendix B). All had hard water and were low to moderate in fertility.

Lake Sampling

Fish were captured in late fall and early spring with a bag seine 15.3 m long, 1.6 m wide with 6-mm mesh for the seine and 3-mm for the bag. A maximum of four night- or daytime seine hauls were made perpendicular to the shore in each lake in each season. An attempt was made to seine in fall after the water temperature fell below 10°C and in spring before it rose to that temperature. McComish (1971) found that bluegill growth apparently ceases below 10°C.

TABLE 1. DATES, TIMES, AND TEMPERATURES OF LAKE AND HATCHERY SAMPLING.

<u>Species</u>	<u>Location</u>	<u>Fall 1975</u>			<u>Spring 1976</u>		
		<u>Date</u>	<u>Time</u>	<u>Water Temp. °C</u>	<u>Date</u>	<u>Time</u>	<u>Water Temp. °C</u>
Bluegill <u>Lepomis macrochirus</u>	Sunset Lake	16-XI-75	1700	8.5	13-IV-76	0900	7.2
Bluegill	Meyers Lake	4-X-72 ^a		16.5	18-IV-73		11.5
		17-XI-75	1730	6.7	6-IV-76	2000	10.5
					7-IV-76	1230	11.0
Largemouth Bass <u>Micropterus salmoides</u>	Thomas Lake	17-XI-75	2000	6.7	13-IV-76	1130	6.7
Green Sunfish <u>Lepomis cyanellus</u>	National Fish Hatchery	24-XI-75	0800	7.2	27-III-76	0800	6.7
Bluegill	Lake Mills,						
Fathead Minnow	Wisconsin						
<u>Pimephales promelas</u>							
White Crappie							
<u>Pomoxis annularis</u>							
Largemouth Bass							

^aCoble (Unpublished) (Appendix C)

All captured young-of-the-year of the experimental species were included in the sample, and total length was measured to the nearest millimeter. Scale samples were taken from a few individuals for confirmation of age. Fish were released after the final seine haul.

Hatchery Sampling

The young-of-the-year largemouth bass, bluegill, green sunfish, white crappie and fathead minnow were removed from hatchery ponds and placed in five indoor holding tanks several days before being measured in the fall.

Individuals captured in every third sweep of a dip net through each tank were measured (TL) to the nearest millimeter until a sample of 150 fish was measured. Then both fish that had been measured and those not measured were stocked in hatchery ponds.

Approximately 1,000 largemouth bass and 750 white crappie were put in separate 0.2 hectare ponds immediately after handling (Table 1). About 1,600 fathead minnow, 1,500 green sunfish and 4,000 bluegill were stocked together in a third 0.2 hectare pond the day after handling. The bluegill sample consisted of representatives from a June hatch and an August hatch; the latter outnumbered the June group by 5:1. Mean length of the June hatch group was 12.8 mm greater than the August group. Species were separated to minimize predation, and each pond contained only the experimental fish. Only naturally-occurring food was available.

The same procedure was followed for spring sampling except that sample sizes were increased to 200 fish when available.

Laboratory Experiments

Six experiments in which winter conditions were simulated were conducted at the University of Wisconsin-Stevens Point with green sunfish hatched at the University, channel catfish, Ictalurus punctatus, obtained from the Senecaville (Ohio) National Fish Hatchery; and largemouth bass, yellow perch and brook trout from the Lake Mills National Fish Hatchery (Table 2). Fish obtained from hatcheries were treated with malachite green and formalin upon arrival and were held for three weeks before experimentation in a 2190 liter, circular fiberglass tank receiving flowing water at $13^{\circ}\text{C} \pm 1$. Temperature was regulated with heaters and several air stones provided aeration.

In each experiment fish were held in three to five solutions ranging from 90% distilled/10% tap water to 1.0% NaCl for 100-120 days at simulated winter temperatures and photoperiods to determine if survival was related to salt concentration. Ten to fifty fish were netted from the holding tank and immediately transferred to bioassay jars (39 l) or glass aquaria (58 or 117 l) containing one of the solutions. Fish remaining in the holding tank were the control group. Temperature for control groups ranged from 13-26°C. Fish were not measured before the experiments. Fish remained in

TABLE 2. SUMMARY OF CONDITIONS OF SIX LABORATORY EXPERIMENTS (PHOTOPERIOD: CONTROLS 15L:9D; EXPERIMENTS 9L:15D).

Species and Experiment	Source and Age of Fish at Start	Length of Experiment	Solutions	Tanks	Density of Fish	Food	Temperature	Fat Sampling Periods	Blood Sampling Periods	Comments
Green Sunfish <u>Lepomis cyanellus</u> Experiment I	Hatched at the U.W. Stevens Point Fisheries Laboratory. 2.5 Months	15-VII-75 to 1-XII-75 (141 days); Dis-tilled Group 3-VIII-75 to 1-XII-75 (122 days)	90% Distill- ed/10% Tap, Tap, 0.1% NaCl, 0.5% NaCl, 1.0% NaCl, Control(Tap)	19 liter bioassay jars	1 fish/ 1.3 liter	Frozen brine shrimp; no feeding below 2°C.	Start:26°C Distilled Start:20°C 53 days at 4°C 75 days at 2°C ----- Control 26°C	None col- lected	None col- lected	
Largemouth Bass (I) <u>Micropterus salmoides</u> Experiment II	National Fish Hatchery, Lake Mills, Wis. 4 Months	5-X-75 to 31-I-76 (119 days)	90% Distill- ed/10% Tap, Tap, 0.1% NaCl, 0.5% NaCl, 1.0% NaCl, Control(Tap)	19 liter bioassay jars, 39 liter glass aquaria	1 fish/ 1.9 liter	Frozen brine shrimp& Gammarus Feeding discon- tinued 18-XI-75 (2°C) ----- Control: Gammarus once/day; Ewos ^a after 14-XI-75	Start:21°C 21 days at 4°C 78 days at 2°C ----- Control 14-21°C	Base sample 4-X-75 Each solution & control 31-I-76	Control & 5 so- lutions: 5-X-75 (21°C) 13-XI-75 (4°C) 5-XII-75 (2°C) 31-I-76 (2°C)	Fed once/2 days to 10°C; once/ week to 18-XI-75. No food from 19- XI-75 to 31-I-76
Largemouth Bass (II) Experiment III	National Fish Hatchery, Lake Mills, Wis. 9 Months	19-I-76 to 19-V-76 (120 days)	0.2% NaCl, 0.4% NaCl, 0.85% NaCl, Control(Tap)	19 liter bioassay jars	1 fish/ 1.6 liter	Ewos dry food once/day; discon- tinued 24-I-76 (10°C) ----- Control: Ewos once/day	Start:14°C 25 days at 4°C 82 days at 2°C ----- Control 14°-21°C	Base sample 24-I-76 Each solution & control 19-V-76	Control & 3 so- lutions: 19-I-76 (14°C) 24-II-76 (4°C) 17-III-76 (2°C) 19-V-76 (2°C)	

TABLE 2. CONTINUED.

Species and Experiment	Source and Age of Fish at Start	Length of Experiment	Solutions	Tanks	Density of Fish	Food	Temperature	Fat Sampling Periods	Blood Sampling Periods	Comments
Channel Catfish <u>Ictalurus punctatus</u> Experiment IV	National Fish Hatchery, Senecaville, Ohio. 9 Months	12-III-76 to 9-VII-76 (120 days)	90% Distilled/10% Tap, Tap, 0.2% NaCl, 0.4% NaCl, 0.85% NaCl, Control(Tap)	19 liter bioassay jars, 39 liter glass aquaria	1 fish/1.6 liter	Ewos dry food once/day; Discontinued 16-III-76 (10°C) Control: Ewos once/day	Start:14°C 23 days at 4°C 87 days at 2°C ----- Control 13°-18°C	Base sample 16-III-76 Each solution & control 9-VII-76	Control & 5 solutions 12-III-76 (13°C) 6-V-76 (2°C) 9-VII-76 (2°C)	Fungal related mortalities in Tap, 0.2% NaCl, 0.4% NaCl.
Brook Trout <u>Salvelinus fontinalis</u> Experiment V	National Fish Hatchery, Lake Mills, Wis. 4.5 Months	12-III-76 to 9-VII-76 (120 days)	90% Distilled/10% Tap, Tap, 0.2% NaCl, 0.4% NaCl, 0.85% NaCl, Control(Tap)	58 & 117 liter glass aquaria	1 fish/39 liters	Trout pellets once/day; Discontinued 16-III-76 (Below 10°C) Control: Trout pellets twice/day.	Start:13°C 23 days at 4°C 87 days at 2°C ----- Control 13°C	Base sample 16-III-76 Each solution & control 9-VII-76	Control & 5 solutions 12-III-76 (13°C) 13-IV-76 (4°C) 6-V-76 (2°C) 9-VII-76 (2°C)	
Yellow Perch <u>Perca flavescens</u> Experiment VI	National Fish Hatchery, Lake Mills, Wis. 5 Months	1-IX-76 to 5-XII-76 (96 days)	90% Distilled/10% Tap, Tap, 0.2% NaCl, 0.4% NaCl, 0.6% NaCl, Control(Tap)	58 & 117 liter glass aquaria	1 fish/13 liters	Assorted live invertebrates, ^b frozen brine shrimp. Discontinued 1-IX-76 (5.5°C) Control: Invert. & pellets twice/day.	Start:5.5°C 9 days at 4°C 86 days at 2°C ----- Control 18°C	Base samples 1-IX-76 Each solution & control 5-XII-76	Control, 90% Tap, 0.2%, 0.4% 18-VIII-76 (18°C) Control, 0.6% 25-VIII-76 (13°C) Control & 5 solutions 10-IX-76 (4°C) 2-X-76 (2°C) 5-XII-76 (2°C)	Discrepancies between time of start & initial fat & blood samples due to extension of acclimation period in 0.6% NaCl.

^a Dry particulate fish food manufactured in Sweden.

^b Assorted aquatic insects, Gammarus, Daphnia.

the solutions at a constant temperature of 13-26°C (depending on species) for a one week acclimation period during which unhealthy fish were removed and replaced.

Water temperature was then decreased 1°C/day until 4°C was reached, and photoperiod was reduced gradually from 15L:9D to 9L:15D. After approximately three weeks, water temperature was reduced to 2°C over a two day period where it remained until the conclusion of each experiment.

Feeding was usually discontinued at temperatures below 10°C. Approximately one-third of the solution was siphoned off the bottom of each jar or aquarium and replaced with a solution of the same salt concentration and temperature every other day while food was still offered. Thereafter jars and tanks were cleaned once per week. Salt solutions were made by mixing preweighed amounts of commercial grade NaCl with chlorine-free tap water (Table 3). Bioassay jars and glass aquaria were aerated with plastic filters containing activated charcoal and filter floss.

TABLE 3. CHEMICAL COMPOSITION OF THE TAP WATER, VALUES IN PPM UNLESS OTHERWISE NOTED.

pH	Cond mmhos	Alk	Total Ca ⁺⁺ Hard	Hard	D.O.	Cl ⁻	Na ⁺	Ortho P	Total P	NH ₄ N	NO-NO ₂ N
7.7	330	140	178	108	3.0	11.5	14.0	.005	.009	.14	.25

Fish were checked at least twice daily. Dead fish were removed, measured to the nearest millimeter and some were weighed to the nearest thousandths of a gram and frozen at -20°C for later determination of total body fat and water content. Also I attempted to collect blood samples from fish that appeared to be near death during Experiments II-VI.

Blood Sampling and Analysis

Fish from all solutions in Experiments II-VI were killed periodically for blood and fat analysis. Five to 10 fish from each solution including the control group were killed for blood analysis at the start of the experiment, after fish were at 4°C and 2°C for at least three weeks, and at the end of the experiment (2°C). Fish of different lengths were removed from their solution and measured to the nearest millimeter without anesthesia. Then the caudal peduncle was severed and the free-flowing blood was collected in heparinized micro-hematocrit tubes 75 mm long with an outside diameter of 1.47 mm and an inside diameter of 0.56 mm. Removal of fish to completion of blood collection required 30-45 seconds. Tubes were sealed with a clay sealer and centrifuged for four minutes at 10,500 rpm on an Adams Autocrit Centrifuge. Hematocrit was measured to the nearest one-half percent. The section of tube containing red cells was discarded and the plasma was sealed in the remainder of the tube and stored at -12°C for later determination of

osmolality, and sodium and chloride ion concentrations. Fish were not fed 24 hours before they were killed, which occurred between 8-12 A.M.

Plasma from largemouth bass, channel catfish and brook trout was not pooled. Plasma from two or three yellow perch was pooled after determination of hematocrit to provide enough plasma in a sample for determination of osmolality, sodium and chloride ion concentrations.

To measure osmolality I used the procedure of Ramsay and Brown (1955). Several droplets of thawed plasma were drawn from the hematocrit tube in which plasma was stored into a drawn-out capillary tube, which was then sealed with clay. The droplets were frozen with dry ice and the capillary tube was immersed in a subzero alcohol bath to which heat was then applied. The difference between 0°C and the temperature at which the last ice crystal in a droplet of plasma neither grew nor shrank was the freezing point depression of the plasma. This figure was converted to osmolality units with the formula,

$$\frac{-1.86^{\circ}\text{C}}{1000 \text{ mosm/l}} = \frac{p}{X \text{ mosm/l}},$$

where -1.86 = the freezing point depression of a 1 molal solution, p = the freezing point depression of the plasma, and X = the osmolality of the plasma.

To determine the concentration of Na^+ and Cl^- , five microliter samples of plasma were diluted with 2 ml of deionized-distilled water. A Perkins-Elmer Flame Photometer

was used to measure the sodium ion concentration of the diluted samples. I used the method of Shales and Shales (1941) to determine chloride ion concentrations. The mercuric nitrate titrant (Sigma Chloride Reagent Kit #830) was delivered from a Syringe Micro-Buret (Model SD-2, Micro-metric Instrument Co.). Insufficient Plasma precluded duplicate determinations on all samples.

Body Fat and Water Analysis

In Experiment II, 25 largemouth bass (controls) representing fish from all solutions and of various lengths were killed by a blow to the head the day before temperature decrease, frozen, and stored in water in plastic bags at -20°C for later determination of total body fat and water. For Experiments III-VI a sample of 15 to 40 fish (controls) of various lengths from all solutions were removed after the water temperature reached 10°C or less, when feeding was discontinued, weighed and frozen for later analysis. Fat and water content also was determined for 15 to 20 fish from each solution and the control group at the end of each of the five experiments. Fish were measured to the nearest millimeter, weighed to the nearest thousandths of a gram on an analytical balance, placed in plastic bags and stored frozen at -20°C for one to four months before analysis.

After storage, individual fish were placed in aluminum planchets and oven-dried for 96 hours at 70°C . Fish weighing four grams or less (wet weight) were dried intact while

larger fish were cut in two or more pieces before drying. After drying, the planchets containing fish were cooled in a dessicator for at least two hours. Dry weight was then determined with an analytical balance and percent total body water was calculated as $\frac{\text{wet weight} - \text{dry weight}}{\text{wet weight}} \times 100$.

Dried fish larger than 0.2 g were ground in a Thomas Wiley Mill with a 2 mm screen. Fat was extracted from duplicate subsamples of 0.05 g to 0.2 g with Freon 11 (Monofluorotrichloromethane) for one hour (Korn and Macedo 1973). Dried fish less than 0.2 g were cut in small pieces and not ground before fat extraction. I modified the extraction procedure because my samples were small (0.05-0.2 g). Anhydrous sodium sulfate was reduced from 80 g to 40 g per sample and Freon 11 was reduced from 100 ml to 50 ml per sample. I found through previous testing that these reductions did not affect the results of extraction.

RESULTS AND DISCUSSION

Field Studies: Size-Specific Mortality

Changes in mean length from fall to spring were significant for the three lake and two of the five hatchery populations, but I believe the Sunset Lake bluegill and the Thomas Lake largemouth bass were the only groups in which significant increases in mean length were due to higher mortality of smaller fish (Figures 1, 2, and 3; Table 4). The mean length increase of 3.95 mm for the bluegill was highly significant ($t = 10.7470$, $p < 0.01$) and appeared to result from the loss of 30-32 mm individuals and a substantial reduction in the number of 33-39 mm individuals between fall and spring (Figure 1). The increase in bass mean length of 6.75 mm was also significant ($t = -4.7076$, $p < 0.01$), but it apparently resulted not only from a loss or reduction of the small individuals, but also from the appearance of more fish 70-90 mm long in the spring sample (Figure 2).

No annuli were present on scales taken from the three lake groups in spring, which indicated that growth had not yet resumed.

The increase in mean length of 1.78 mm for the Meyers Lake bluegill was relatively small yet significant ($t = -3.0790$, $p < 0.01$) (Figure 3). I do not believe the difference was the result of size-specific mortality because: 1) length distributions were nearly identical fall and spring,

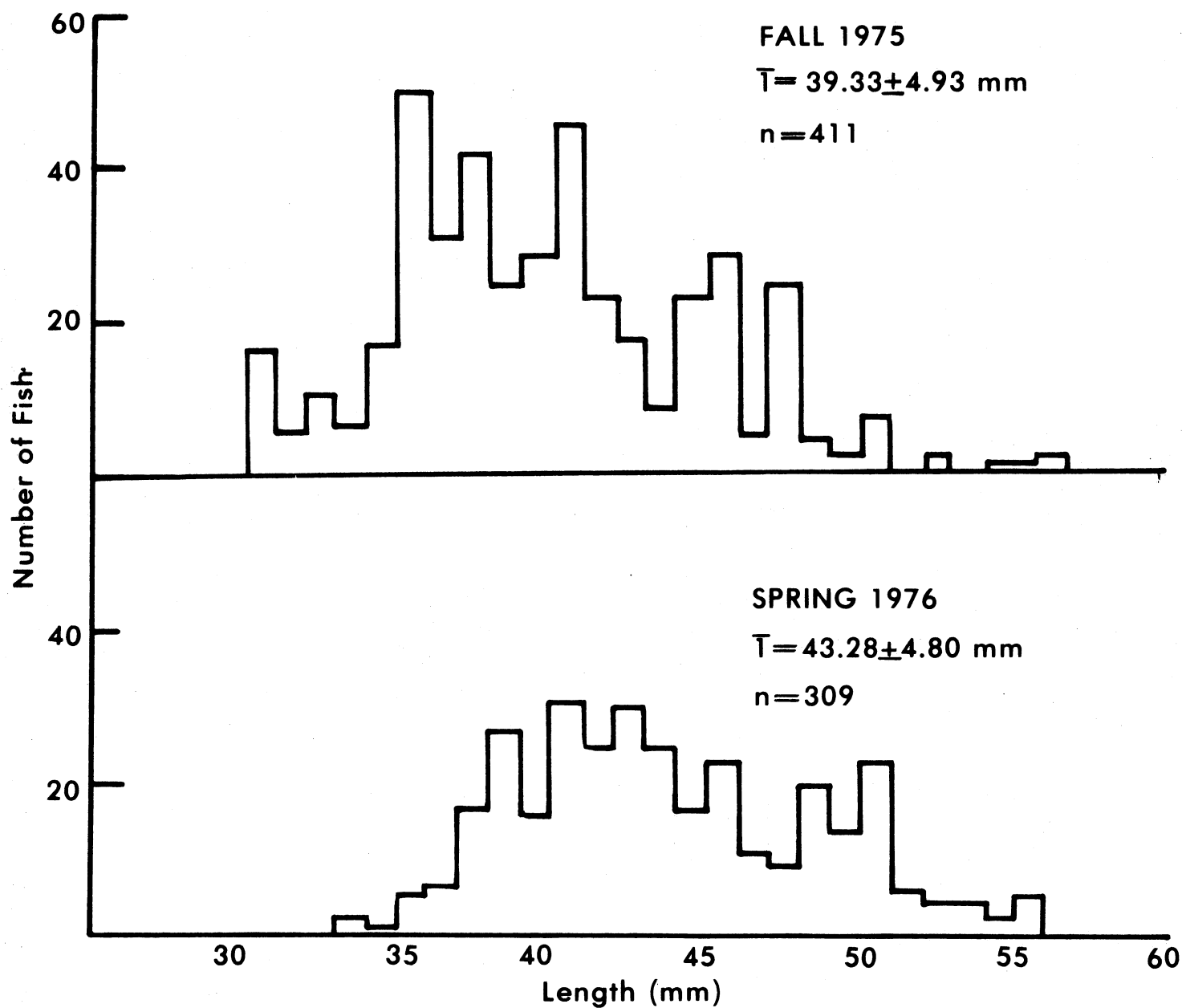


FIGURE 1. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM SUNSET LAKE SEINED 16-XI-75 AND 13-IV-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = -10.7470$; $p < 0.01$; $df = 718$).

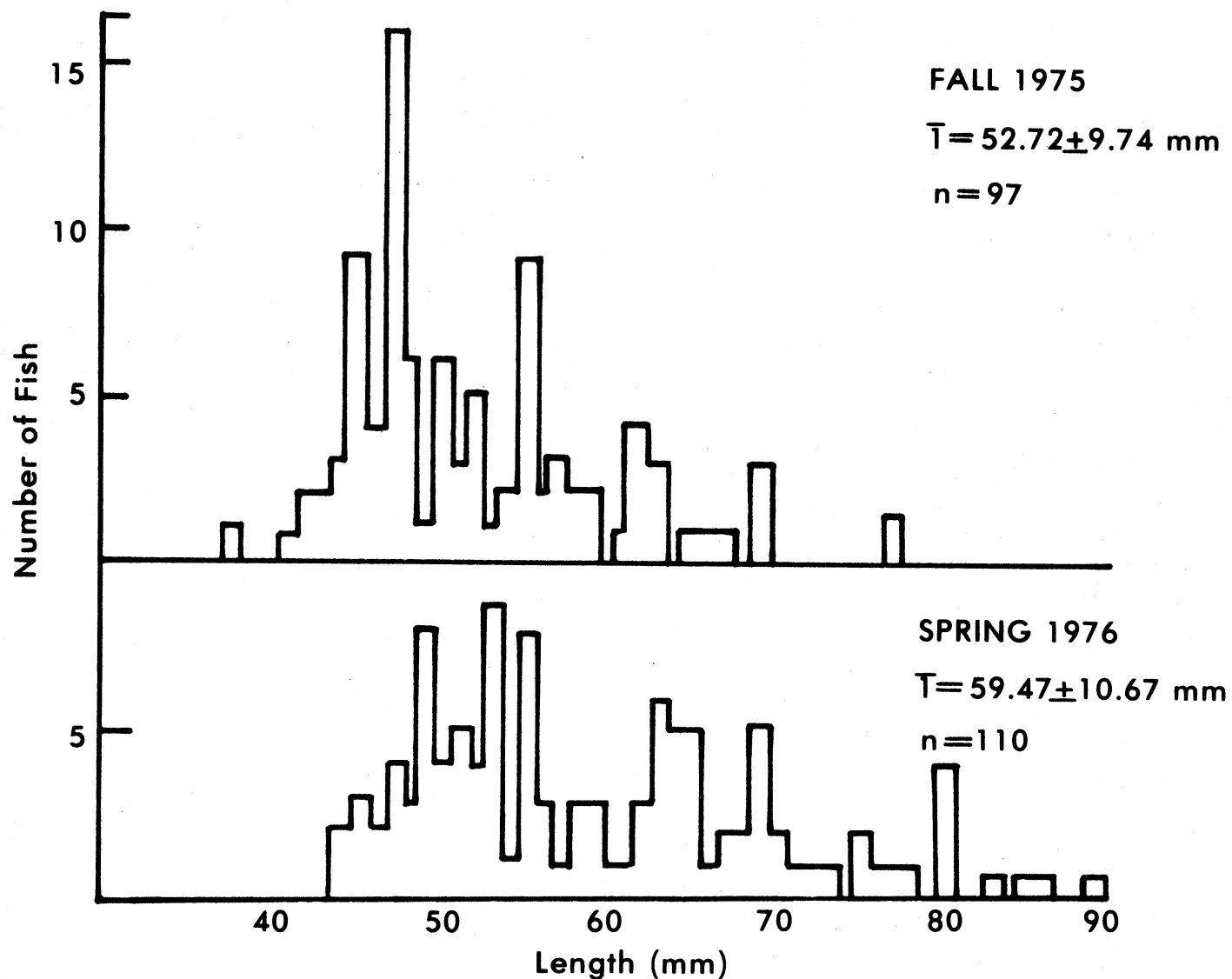


FIGURE 2. LENGTH FREQUENCY DISTRIBUTIONS OF LARGEMOUTH BASS FROM THOMAS LAKE SEINED 17-XI-75 AND 13-IV-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = -4.7076$; $p < 0.01$; $df = 205$).

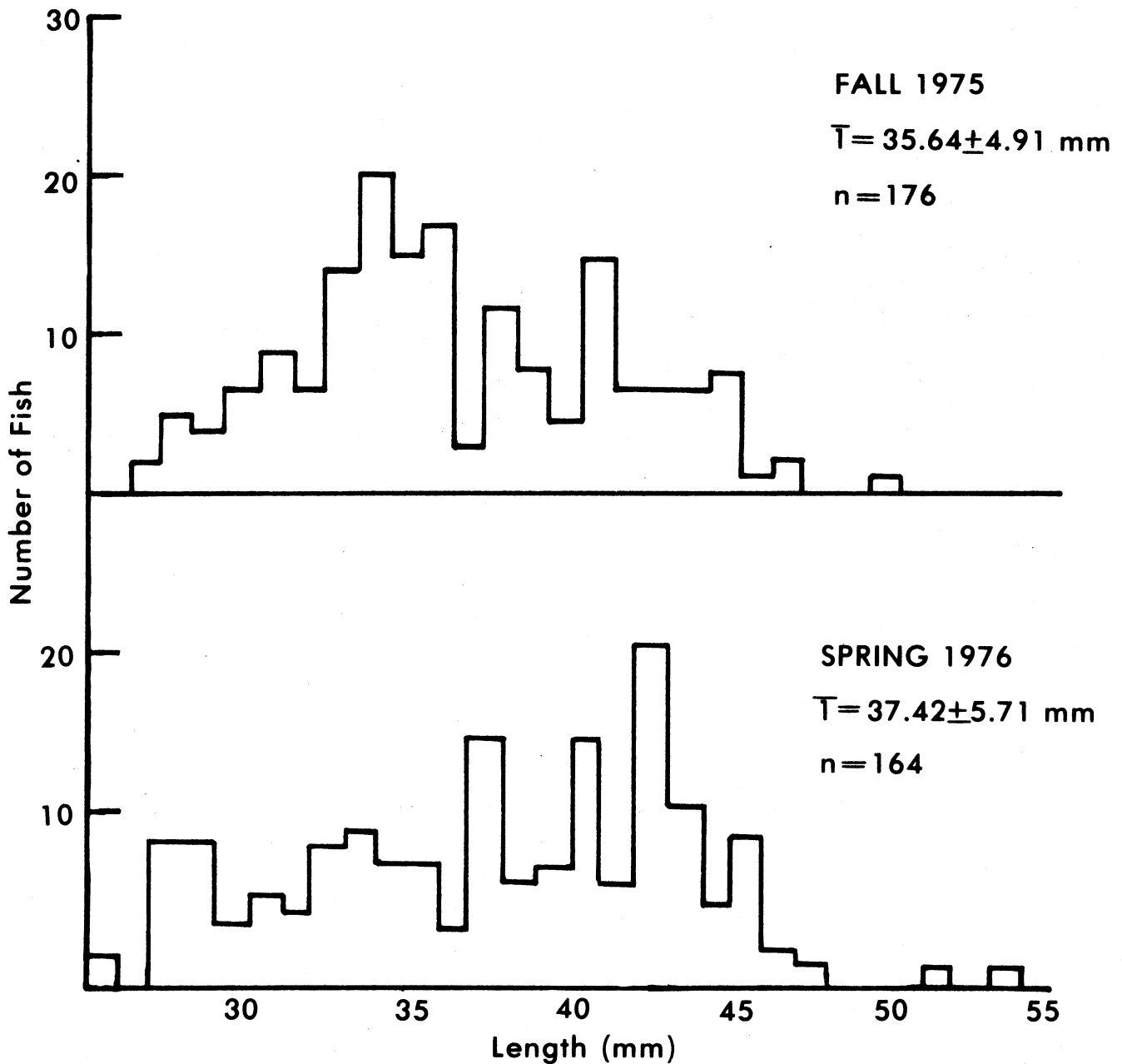


FIGURE 3. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM MEYERS LAKE SEINED 17-XI-75 AND 6, 7-IV-76 (MEAN $\pm$ SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = -3.0790$; $p < 0.01$; $df = 338$).

TABLE 4. OVERWINTER MEAN LENGTH CHANGES AND SAMPLE SIZES OF MEYERS LAKE BLUEGILL (1972-1973) AND HATCHERY SPECIES (t-test; *p < 0.05, **p < 0.01).

		<u>Meyers Lake Bluegill^a</u>		<u>Fathead Minnow</u>	<u>White Crappie</u>	<u>Green Sunfish</u>	<u>Largemouth Bass</u>	<u>Bluegill^b</u>	
								<u>< 30 mm</u>	<u>> 30 mm</u>
$\bar{X}$	Fall	43.03	Fall	48.02	49.22	37.90	81.37	24.98	37.80
SD	1972	9.13	1975	5.01	3.21	5.94	5.90	2.28	3.93
N		56		152	159	156	162	105	51
Range		33-65		40-65	41-57	30-73	60-110	17-30	32-50

								<u>< 30 mm</u>	<u>> 30 mm</u>
$\bar{X}$	Spring	41.73	Spring	47.84	49.69	39.17	79.00 **	25.89	40.13 **
SD	1973	6.69	1976	4.56	3.65	7.26	5.49	2.05	4.01
N		67		216	84	213	204	89	128
Range		33-64		39-63	40-60	28-77	60-98	10-30	32-47

^a Coble, Unpublished (Appendix C).

^b Lake Mills bluegill were treated as two groups, those less than 30 mm and those greater than 30 mm.

as they were for all species held in hatchery ponds, and the greatest difference was a reduction overwinter of the number of medium size, rather than the smallest, bluegill, 2) small differences between means of large sample sizes may be statistically but not necessarily biologically significant, and 3) there was no significant difference in mean length for young-of-the-year bluegill sampled by Coble (Appendix C) in October 1972 and April 1973 in Meyers Lake (Table 4).

In the hatchery ponds, there was no significant change in mean length overwinter for fathead minnow, green sunfish, and white crappie (Table 4). For white crappie there were only 84 survivors out of approximately 750 fish stocked. I believe the changes in mean length for largemouth bass and for the larger group of bluegill in the hatchery pond were not biologically significant even though they were statistically significant. For largemouth bass, the change was a decrease which is in contrast to the results of Thomas Lake bass (Figure 2) and the results of Coble (Appendix A). For bluegill, the change occurred only in the larger group. If my hypothesis is correct that smaller fish are at a greater disadvantage, a significant change in mean length overwinter should have been more evident in the smaller group of bluegill than in the larger.

I conclude from the information available to me (Table 5), including that in the next section, that size-specific fingerling mortality, in winter, in which mortality is higher among smaller fish, is probably not a widespread phenomenon

TABLE 5. SUMMARY OF EVIDENCE FOR AND AGAINST SIZE-SPECIFIC MORTALITY OF YOUNG-OF-THE-YEAR OF SEVERAL SPECIES DURING WINTER.

Species	Location	Mortality Size- Specific	Evidence	Source
Bluegill	Sunset Lake, Portage County, Wisconsin	Yes	Significant overwinter increase in mean length of 3.95 mm was result of absence or reduction in number of smallest fish in spring sample.	Present study
Bluegill	Missouri Pond	Yes	Significant overwinter increase in mean length of 4 mm was found.	Chang 1971
Largemouth Bass	Thomas Lake, Portage County, Wisconsin	Yes	Significant overwinter mean length increase of 6.75 mm was found.	Present study
Largemouth Bass	Cages in Missouri Ponds	Yes	Overwinter survival for two consecutive years was greatest for longer and heavier fish.	Coble, Unpublished (Appendix)
Walleye	Oneida Lake, New York	Yes	Overwinter increases in mean length of 11-20 mm were found and attributed to cannibalism.	Forney 1966
Walleye	Oneida Lake, New York	Yes	Overwinter increase in mean length of 16 mm was found and attributed to size-selective cannibalism.	Chevalier 1973
Walleye	Big Eau Pleine Reservoir, Wisconsin	Yes	Overwinter increase in mean length of 19 mm was found but spring sample consisted of only eight fish.	Joy 1975
Sander	Lake Pskov- Chudskoye, USSR	Yes	Overwinter increase in average size of young-of-the-year was found but was not due to growth.	Negonovskaya 1972

TABLE 5. CONTINUED.

Species	Location	Mortality Size- Specific	Evidence	Source
Sander	Lakes Vombsjon, Hjalmaren, Malaren, Ivosjon, Vanern, Sweden	Yes	Good first summer growth was related to high survival during the first winter.	Svårdson and Molin 1973
Brook Trout	Lawrence Creek, Marquette County, Wisconsin	Yes	Greater mean length in fall was positively correlated with greater overwinter survival.	Hunt 1969
Atlantic Salmon	Bergeforsen Salmon Rearing Station, Sweden	Yes and No	Mortality was greatest for small fish within year classes but not between year classes.	Lindroth 1965
Bluegill	National Fish Hatchery, Lake Mills, Wisconsin	No	No significant change in mean length of < 30 mm group was found. Significant mean length increase of 2.33 mm for > 30 mm may have been a function of larger spring sample size.	Present study
Bluegill	Meyers Lake, Portage County, Wisconsin	No	Overwinter mean length increase of 1.78 mm was significant. Greatest change in length frequency was reduction in number of intermediate-length fish; no change in overall length representation occurred.	Present study
Bluegill	Meyers Lake, Portage County, Wisconsin	No	Overwinter decrease in mean length of 1.30 mm was not significant.	Coble, Unpublished (Appendix)
Bluegill	Missouri Pond	No	Overwinter decrease in mean length of 1 mm was not significant.	Chang 1971

TABLE 5. CONTINUED.

Species	Location	Mortality Size- Specific	Evidence	Source
Largemouth Bass	National Fish Hatchery, Lake Mills, Wisconsin	No	Significant decrease in mean length was found but there was no change in overall length representation.	Present study
Largemouth Bass	Missouri Pond	No	No change overwinter in mean length occurred the first year of study and overwinter increase in mean length of 1 mm the second year was not significant.	Chang 1971
Green Sunfish	National Fish Hatchery, Lake Mills, Wisconsin	No	No significant change in mean length.	Present study
White Crappie	National Fish Hatchery, Lake Mills, Wisconsin	No	No significant change in mean length.	Present study
Fathead Minnow	National Fish Hatchery, Lake Mills, Wisconsin	No	No significant change in mean length.	Present study
Walleye	Clear Lake, Iowa	No	Negative relationship was found between year class abundance and growth for all ages.	Carlander and Whitney 1961
Walleye	Black Lake, New York	No	Negative relationship was found between year class abundance and growth for all ages.	LeTendre and Schneider 1969
Walleye	Lake Winnebago, Wisconsin	No	No relationship was found between rapid growth during first summer and survival during first winter.	Priegel 1970

for bluegill and largemouth bass. Such mortality was observed in only 5 of 12 investigations (Table 5). Such mortality may be more important for walleye and sander, for it has been detected in 5 of 8 investigations (Table 5). Assessment of its importance for salmonids, cyprinids, and centrarchids other than bluegill and largemouth bass is precluded by the small number of investigations. Lindroth (1965) concluded that mortality of young-of-the-year fish during the winter is related to more than just absolute length.

Snieszko (1958), Bennett (1970), and others believed that most fish mortalities occur in early spring because physical condition of fish is low and susceptibility to diseases and parasites is high. There is a possibility that mortality of the small young-of-the-year is higher at this time than in winter, as I hypothesized. This would be difficult to assess, however, because growth may occur and complicate results if sampling were delayed a few weeks after ice-out.

Laboratory: Mortality

Patterns of mortality during the experiments did not support the hypothesis that hypoosmotic salt solutions approaching the concentration of fish blood would reduce mortality of age 0 fish in cold temperatures. Fish died in 4 of the 6 experiments and generally mortality was greater in the salt solutions (Table 6). The 1.0% NaCl solution was

TABLE 6. PERCENT MORTALITY IN VARIOUS SOLUTIONS FOR FIVE SPECIES DURING SIX EXPERIMENTS IN WHICH FISH WERE HELD FOR 9 TO 53 DAYS AT 4°C FOLLOWED BY 75 TO 87 DAYS AT 2°C. PERCENT MORTALITY (NUMBER ORIGINALLY STOCKED).

Species	Solutions				
	<u>90% Distilled</u>	<u>Tap</u>	<u>0.1% NaCl</u>	<u>0.5% NaCl</u>	<u>1.0% NaCl</u>
Green Sunfish	9.1 (44)	0.0 (45)	2.3 (44)	0.0 (45)	78.6 (42)
Largemouth Bass (I)	4.4 (46)	4.6 (44)	2.3 (44)	23.3 (43)	92.9 (42)
	<u>90% Distilled</u>	<u>Tap</u>	<u>0.2% NaCl</u>	<u>0.4% NaCl</u>	<u>0.85% NaCl</u>
	---	---	0.0 (30)	0.0 (31)	0.0 (34)
Largemouth Bass (II)	---	---	0.0 (30)	0.0 (31)	0.0 (34)
Brook Trout	0.0 (38)	0.0 (38)	0.0 (44)	0.0 (44)	0.0 (42)
Channel Catfish	0.0	79.6 (34)	58.1 (31)	17.2 (29)	34.2 (38)
Percent of Catfish that died in each solution that were infected with fungus before death:	0.0	87.5	77.8	20.0	0.0
	<u>90% Distilled</u>	<u>Tap</u>	<u>0.2% NaCl</u>	<u>0.4% NaCl</u>	<u>0.6% NaCl</u>
	37.3 (75)	55.0 (80)	75.3 (77)	73.0 (100)	82.4 (51)
Yellow Perch	37.3 (75)	55.0 (80)	75.3 (77)	73.0 (100)	82.4 (51)

hyperosmotic to the blood of green sunfish and largemouth bass (I) as was the 0.85% NaCl solution to channel catfish (Tables 7 and 9), and in these solutions mortalities were some of the highest of any solutions. These mortalities may have resulted from dehydration or acid-base changes in blood (Black 1951).

Mortalities occurred in hypoosmotic solutions and were sometimes higher in the salt solutions than in distilled and tap water, which indicated possible intolerance even to low and intermediate salt solutions. Salt concentrations were changed for the largemouth bass (II), brook trout and channel catfish experiments, and only the channel catfish incurred mortalities, although the majority of those that died were infected with fungus before death. In the perch experiment,

TABLE 7. OSMOLALITY, SODIUM, AND CHLORIDE ION CONCENTRATIONS OF NINE EXPERIMENTAL SOLUTIONS.

<u>Solution</u>	<u>Osmolality (mosm/l)</u>	<u>Sodium (meq/l)</u>	<u>Chloride (meq/l)</u>
90% Distilled/10% Tap	16.1	0.6	Undetectable
Tap Water	21.5	0.6	Undetectable
0.1% NaCl	37.6	15.7	23.1
0.2% NaCl	80.6	34.9	45.5
0.4% NaCl	172.0	61.1	88.5
0.5% NaCl	215.1	92.6	105.0
0.6% NaCl	241.9	108.3	126.0
0.85% NaCl	322.5	155.5	178.0
1.0% NaCl	360.6	183.4	198.0

TABLE 8. LEAST SQUARES REGRESSIONS AND CORRELATION COEFFICIENTS FOR SURVIVAL TIME VS. LENGTH OF FISH FOR GROUPS IN WHICH MORTALITY EXCEEDED 5%. (Y = SURVIVAL TIME (DAYS), X = LENGTH OF FISH; *p < 0.05, **p < 0.01).

<u>Species</u>	<u>Solutions</u>	<u>Regression</u>	<u>r</u>
Green Sunfish	90% Dist.	y = 39.6167+1.5447X	0.4733
Green Sunfish	1.0% NaCl	y = -0.3047+3.3182X	0.5353**
Largemouth Bass (I)	0.5% NaCl	y = -126.5818+3.6182X	0.4843
Largemouth Bass (I)	1.0% NaCl	y = -50.4218+1.9711X	0.5328**
Channel Catfish	Tap	y = 40.8515-0.0860X	-0.0346
Channel Catfish	0.2% NaCl	y = 16.3968+0.4139X	0.1212
Channel Catfish	0.4% NaCl	y = -185.2540+5.0847X	0.9145**
Channel Catfish	0.85% NaCl	y = 75.1769+0.2278X	0.1375
Yellow Perch	90% Dist.	y = -15.8838+1.5402X	0.1849
Yellow Perch	Tap	y = -76.4842+2.8005X	0.4895**
Yellow Perch	0.2% NaCl	y = -74.4387+2.7202X	0.4305**
Yellow Perch	0.4% NaCl	y = -34.0022+1.7372X	0.3118**
Yellow Perch	0.6% NaCl	y = -15.8020+1.0542X	0.1741

the highest salt concentration was decreased to 0.6% and, for this species, mortalities occurred in all solutions and increased with increasing salt concentration.

Larger fish tended to survive longer although the majority of correlations between survival time in days and length of fish were weak to moderate and were significant in 6 of 13 cases (Table 8).

My results agree with those of Coble (Unpublished; Appendix A), who found that mortality of age 0 large-mouth bass was greater in hypoosmotic salt solutions than in tap water during winter, and Stanley and Colby (1971) who found that increased salinity did not increase survival of alewife, Alosa pseudoharengus, in cold water.

Results of this study are not in accord with those of several authors. Death of fresh- and saltwater fish due to low temperature-induced ionic-osmotic imbalances was reported for brook trout (Phillips et al. 1964), California killifish, Fundulus parvipinnis (Doudoroff 1945), alewife, in fresh water (Graham 1956; Stanley 1969; Stanley and Colby 1971), and Tilapia mossambica (Allanson et al. 1971). Furthermore, Doudoroff (1945), Phillips et al. (1964), Podoliak (1965) and Allanson et al. (1971) found that the addition of NaCl aided fish in reestablishing ionic-osmotic balance disrupted by cold temperatures.

Laboratory: Hematocrit

Hematocrit usually decreased with the decrease in water temperature and apparently was neither a cause of mortality nor a function of salt concentration (Table 9). The decrease appeared to be a general response to drop in temperature or food deprivation or both since it occurred in all solutions. Hematocrit decreased significantly and was below control values at the end of both largemouth bass experiments and the channel catfish and the brook trout experiments (Table 9).

TABLE 9. MEAN HEMATOCRIT AND OSMOLALITY OF EXPERIMENTAL GROUPS ACCORDING TO SPECIES, SOLUTION AND TEMPERATURE.

Species		Hematocrit (%)				Osmolality (mosm/l)				
		Start	4°C ^a	2°C	End(2°C)	Start	4°C ^a	2°C	End(2°C)	
Largemouth Bass (I)	Control (14-21°C)	$\bar{X}$	38.9	30.0	24.4	36.4	301.1	311.8	307.5	308.6
		SD(n)	3.1(5)	2.2(5)	3.9(5)	3.0(5)	10.1(5)	6.6(5)	11.7(5)	6.1(5)
	90% Distilled(a.c)	$\bar{X}$	36.3	16.6	20.4	25.4 **	296.8	301.1	293.7	305.4
		SD(n)	2.2(5)	3.2(5)	6.4(5)	5.0(5)	7.0(5)	12.6(5)	9.6(5)	7.0(5)
	Tap	$\bar{X}$	36.4	11.3	22.4	23.0 **	308.6	290.3	290.3	308.6
		SD(n)	6.9(5)	2.2(5)	6.4(5)	4.1(5)	3.1(5)	11.6(4)	10.1(5)	11.8(5)
	0.1% NaCl (c)	$\bar{X}$	38.9	16.8	18.6	19.3 **	307.5	317.2	332.3	322.6 *
		SD(n)	2.6(5)	3.4(5)	2.5(5)	2.6(5)	13.9(5)	11.6(4)	10.3(5)	10.1(5)
	0.5% NaCl (a)	$\bar{X}$	36.6	20.3	18.8	26.0 **	300.0	327.9	332.3	365.6 **
		SD(n)	1.3(5)	4.5(3)	1.8(5)	4.6(5)	9.6(5)	19.3(3)	12.8(5)	19.4(5)
	1.0% NaCl (c)	$\bar{X}$	31.2	18.8	25.9	20.0 **	322.6	344.1	359.1	397.9 **
		SD(n)	4.3(5)	1.3(4)	2.6(5)	6.3(3)	15.2(5)	9.8(4)	8.0(5)	19.4(3)
Largemouth Bass (II)	Control (14-21°C)	$\bar{X}$	35.7	41.3	32.8	35.6	332.3	315.1	314.0	316.1
		SD(n)	1.9(5)	6.9(5)	4.5(5)	6.7(5)	8.0(5)	11.2(5)	15.5(5)	4.5(5)
	0.2% NaCl	$\bar{X}$	40.9	27.0	24.9	20.9 **	324.8	322.6	318.3	336.6 **
		SD(n)	8.0(5)	3.7(5)	2.9(5)	3.2(5)	20.7(5)	3.8(5)	5.9(5)	6.1(5)
	0.4% NaCl	$\bar{X}$	45.0	26.9	26.5	19.7 **	339.8	314.0	338.7	341.9 **
		SD(n)	5.6(5)	4.3(5)	3.3(5)	1.6(5)	13.9(5)	4.8(5)	5.4(5)	6.2(5)
0.85% NaCl (a)	$\bar{X}$	32.7	22.6	25.2	21.1 **	347.3	321.5	373.1	318.3	
	SD(n)	6.6(5)	2.5(5)	3.1(5)	2.9(5)	19.2	14.9(5)	8.1(5)	49.3(5)	
Channel Catfish	Control (13-18°C)	$\bar{X}$	19.0	---	16.5	16.1	268.8	---	252.7	240.9
		SD(n)	2.0(5)	---	2.1(5)	1.7(5)	6.6(5)	---	11.4(5)	16.7(5)
	90% Distilled (a)	$\bar{X}$	15.9	---	7.7	4.4 **	235.5	---	202.1	273.1 *
		SD(n)	4.8(5)	---	1.4(5)	0.7(5)	8.8(5)	---	7.3(5)	16.3(5)
	Tap (a)	$\bar{X}$	14.4	---	9.9	4.7 **	270.9	---	214.0	279.6 *
		SD(n)	2.8(5)	---	2.3(5)	1.0(5)	11.8(5)	---	8.0(5)	28.2(5)
	0.2% NaCl (a)	$\bar{X}$	15.9	---	10.1	4.6 **	276.3	---	222.6	272.1 *
		SD(n)	3.2(5)	---	1.3(5)	0.6(5)	17.3(5)	---	8.2(5)	16.4(5)
	0.4% NaCl (a)	$\bar{X}$	15.2	---	8.6	4.9 **	269.9	---	255.9	280.7 *
		SD(n)	1.8(5)	---	2.2(5)	1.0(5)	12.2(5)	---	21.7(5)	27.3(5)
	0.85% NaCl (d)	$\bar{X}$	19.6	---	9.2	4.9 **	305.4	---	275.3	271.0 *
		SD(n)	2.4(5)	---	0.9(5)	0.8(5)	7.0(5)	---	31.2(5)	23.6(5)

TABLE 9. CONTINUED.

	Species		Hematocrit (%)				Osmolality (mosm/l)			
			Start	4°C	2°C	End (2°C)	Start	4°C	2°C	End (2°C)
Brook Trout	Control (13°C)	X	36.8	37.3	34.5	34.5	337.6	322.6	338.7	318.3
		SD(n)	5.2(5)	3.6(5)	4.3(5)	3.6(5)	11.6(5)	15.7(5)	11.4(5)	4.5(5)
	90% Distilled (a)	X	35.2	27.2	23.5	23.3 **	347.3	332.2	337.6	323.7
		SD(n)	3.8(5)	3.3(5)	2.5(5)	4.0(5)	14.5(5)	15.9(5)	10.4(5)	13.9(5)
	Tap (a,c)	X	32.9	24.1	27.5	19.6 **	352.7	342.1	343.0	333.3 *
		SD(n)	3.2(5)	3.9(5)	2.6(5)	5.4(5)	24.5(5)	12.7(5)	10.3(5)	13.7(5)
	0.2% NaCl (a)	X	34.3	26.6	24.8	15.2 **	349.5	340.9	338.7	355.9 **
		SD(n)	2.8(5)	2.0(5)	2.0(5)	2.5(5)	16.4(5)	11.1(5)	10.8(5)	13.9(5)
	0.4% NaCl (a)	X	33.6	23.5	24.4	14.1 **	333.2	341.9	357.9	338.7
		SD(n)	3.3(5)	1.2(5)	1.6(5)	2.3(5)	16.2(5)	6.2(5)	7.8(5)	22.5(5)
Yellow Perch	0.85% NaCl (a)	X	32.4	27.1	27.0	17.1 **	326.9	348.4	358.1	373.1 **
		SD(n)	3.1(5)	1.9(5)	3.7(5)	2.2(5)	19.6(5)	10.3(5)	11.2(5)	8.1(5)
	Control (18°C)	X	41.5	31.5	33.3	27.2	298.9	279.6	281.2	325.8
		SD(n)	7.2(6)	1.9(6)	2.8(6)	2.4(5)	20.6(5)	21.2(5)	9.0(5)	12.4(5)
	90% Distilled (a)	X	34.3	28.6	31.3	24.4	320.4	195.7	218.3	324.7
		SD(n)	2.3(6)	1.7(5)	3.1(6)	4.9(8)	53.4(5)	8.1(5)	15.5(5)	14.5(5)
	Tap (b)	X	32.2	24.6	30.0	22.1	350.5	207.5	225.8	325.8
		SD(n)	3.3(6)	3.1(5)	2.1(5)	4.2(8)	37.0(5)	15.5(5)	14.7(5)	15.0(5)
	0.2% NaCl	X	36.5	28.0	22.7	25.6	346.2	209.7	237.6	332.3
		SD(n)	3.7(6)	2.3(6)	5.2(6)	6.5(7)	15.0(5)	5.4(5)	21.3(5)	16.3(5)
Yellow Perch	0.4% NaCl	X	30.8	32.1	31.2	18.4 **	332.3	194.7	234.4	304.3 *
		SD(n)	3.4(6)	1.8(7)	5.4(5)	1.9(7)	21.3(5)	7.0(5)	23.0(5)	9.8(5)
	0.6% NaCl	X	32.3	36.5	30.5	23.2	304.3	222.6	224.7	361.6 **
		SD(n)	5.4(6)	6.3(6)	3.8(6)	6.7(5)	36.2(5)	15.5(5)	35.7(5)	11.9(4)

^a Blood samples were not collected from Channel Catfish at 4°C because of the fungus infection.

Experimental group differed from control during experiment

- (a) Paired t, Hematocrit $p < 0.05$
 (b) " " " $p < 0.01$
 (c) " " Osmolality $p < 0.05$
 (d) " " " $p < 0.01$

Experimental group differed from control at end

- * t-test, $p < 0.05$
 ** " " $p < 0.01$

The mean difference at the end of the four experiments ranged from 37.5% for largemouth bass (I) to 71% for channel catfish. Yellow perch hematocrit varied, increasing or decreasing with lower water temperature, and was slightly lower than control values at the end of the experiment.

These results paralleled those of several studies. Houston and DeWilde (1969) related the decrease in brook trout hematocrit to the decreased blood O_2 carrying capacity required in cold water. Kristoffersson et al. (1972) and Ince and Thorpe (1976) interpreted the drop in hematocrit in fasted Northern pike held at 9-16°C as a response to lack of food.

Conversely, Larsson and Lewander (1973) found no significant change in hematocrit in starved European eel, Anguilla anguilla, held at 9°C in sea water for 145 days. Grabowski (1973) found no significant change in hematocrit of steelhead, Salmo gairdneri, held at temperatures fluctuating between 8-18°C. Guernsey and Poluhowich (1975) believed increased salinity resulted in decreased hematocrit in the American eel, Anguilla rostrata.

Sano (1960) and Denton and Yousef (1975) attributed monthly changes in hematocrit not to temperature alone but to seasonal changes in metabolism. Normandeau (1962) suggested that changes in hematocrit for sub-yearling brook trout may be due to stage of maturity.

Laboratory: Plasma Osmolality

All species generally were able to regulate plasma osmotic concentration in cold temperatures without the aid of hypo- or isosmotic salt solutions (Table 9). Fewer major changes in osmolality occurred during experiments in the non-salt solutions than in those containing NaCl. In the non-salt solutions usually there were only small differences in osmolality between control and experimental groups at the end of experiments, except for channel catfish. However, for this species osmolality of the control fish steadily decreased during the experiment.

Plasma osmolality was highest at the end of experiments in the highest salt concentrations. Elevated osmolalities resulted in some cases from steady increases during experiments and also after initial decreases in osmolality.

Some of my results agree with those of Allanson et al. (1971), who found plasma osmolality of Tilapia mossambica decreased in fresh water and increased in salt water at near lethal low temperatures, and Privol'nev (1970), who concluded that blood osmotic concentration increases when freshwater fish are exposed to even a slight increase in salinity. Privol'nev felt that these fish are "defenseless" against increases in external salinity.

The decrease followed by an increase in osmolality, that I noted in some groups, may have been an example of inefficient osmotic regulation at temperatures near 0°C found by Doudoroff (1945) for California killifish and Umminger (1969,

1971, 1971a) for mummichog, Fundulus heteroclitus; gulf killifish, Fundulus grandis; and brown bullhead, Ictalurus nebulosus.

However, the lack of a general trend of increased osmolality in my experiments contradicts Umminger's (1969) conclusion that plasma or serum osmolality usually increases with a reduction in temperature. Shterman (1960) and Houston et al. (1970) also found increased osmolality in fingerling and adult carp, Cyprinus carpio, respectively, when water temperature was reduced. Furthermore, the occurrence of some changes in plasma osmolality in my experiments and the general trend noted by Umminger (1969) in his review are in contrast to the lack of change found by Byrne et al. (1972) for Atlantic salmon held at temperatures of 3-14°C and salinities of 0‰ to 30‰.

Laboratory: Plasma Sodium and Chloride

All species apparently had some difficulty regulating Na^+ and Cl^- in cold temperatures. The general pattern was decreased plasma ion concentration for experimental fish compared to controls at the end of experiments, except for significant increases that frequently occurred in fish in the highest salt concentrations (Table 10). In the fresh water and lower salt concentrations, plasma concentration of these ions frequently decreased and then increased. The presence of salt apparently did not enhance the ability to regulate, and in high concentrations of 0.85% or more,

TABLE 10. MEAN SODIUM AND CHLORIDE ION CONCENTRATIONS OF EXPERIMENTAL GROUPS ACCORDING TO SPECIES, SOLUTION AND TEMPERATURE.

			Sodium (meq/l)				Chloride (meq/l)			
			Start	4°C ^a	2°C	End(2°C)	Start	4°C ^a	2°C	End(2°C)
Largemouth Bass (I)	Control (14-21°C)	$\bar{X}$	---	---	---	---	91.2	103.5	100.0	116.4
		SD(n)					8.0(5)	6.2(4)	15.1(5)	4.3(5)
	90% Distilled	$\bar{X}$	---	---	---	---	95.0	79.6	84.4	78.4 **
		SD(n)					6.8(5)	8.3(5)	5.9(5)	7.5(5)
	Tap	$\bar{X}$	---	---	---	---	98.8	82.5	81.2	97.0 **
		SD(n)					9.7(5)	5.2(4)	10.0(5)	9.1(5)
	0.1% NaCl (c)	$\bar{X}$	---	---	---	---	89.2	92.5	97.0	108.1
		SD(n)					13.0(5)	16.6(4)	10.5(5)	11.5(5)
	0.5% NaCl	$\bar{X}$	---	---	---	---	106.0	118.0	99.6	108.8
		SD(n)					7.1(5)	11.4(3)	9.6(5)	20.5(5)
Largemouth Bass (II)	1.0% NaCl	$\bar{X}$	---	---	---	---	112.4	104.7	144.0	139.7 **
		SD(n)					19.4(5)	13.8(3)	6.3(5)	17.6(3)
	Control (14-21°C)	$\bar{X}$	136.9	137.3	142.5	133.1	126.6	122.8	117.8	113.6
		SD(n)	9.4(5)	15.3(5)	10.5(5)	6.9(5)	9.6(5)	3.4(5)	3.5(5)	8.7(5)
	0.2% NaCl	$\bar{X}$	150.6	138.4	135.9	141.0	110.2	112.4	111.6	124.6
		SD(n)	13.4(4)	16.1(4)	14.2(5)	3.3(4)	9.4(5)	7.8(5)	4.6(5)	9.9(5)
	0.4% NaCl	$\bar{X}$	131.5	150.9	147.6	138.0 *	125.8	109.2	119.6	135.0
		SD(n)	18.0(4)	8.4(5)	5.4(4)	4.5(4)	13.3(5)	4.0(5)	13.0(5)	15.3(5)
	0.85% NaCl	$\bar{X}$	141.9	152.7	156.8	124.5	130.4	119.8	135.0	108.6
		SD(n)	16.1(4)	6.6(5)	2.2(4)	21.1(4)	22.1(5)	19.2(5)	7.3(5)	31.0(5)
Channel Catfish	Control (13-18°C)	$\bar{X}$	132.1	---	132.1	127.2	115.8	---	119.6	115.2
		SD(n)	3.6(5)		17.3(5)	4.0(5)	6.5(5)		8.2(5)	10.1(5)
	90% Distilled (b)	$\bar{X}$	125.4	---	126.2	119.1	127.6	---	118.2	108.8
		SD(n)	11.3(5)		5.3(4)	9.7(5)	2.7(5)		3.9(5)	13.0(5)
	Tap (a)	$\bar{X}$	127.5	---	113.9	115.3 *	129.8	---	103.6	120.8
		SD(n)	11.0(5)		6.6(5)	10.0(5)	5.0(5)		6.7(5)	8.4(5)
	0.2% NaCl	$\bar{X}$	135.9	---	127.1	125.8	129.8	---	119.8	116.8
		SD(n)	8.9(5)		5.3(4)	10.2(5)	5.8(5)		14.3(5)	4.6(5)
	0.4% NaCl (c)	$\bar{X}$	137.6	---	129.6	123.0	125.4	---	124.6	128.2
		SD(n)	4.8(5)		9.9(5)	11.2(5)	14.3		14.8(5)	10.8(5)
	0.85% NaCl (ac)	$\bar{X}$	144.6	---	155.9	157.2 **	132.8	---	147.8	139.0 *
		SD(n)	13.8(5)		9.0(4)	11.1(5)	8.8(5)		20.2(5)	19.5(5)

TABLE 10. CONTINUED.

		Sodium (meq/l)				Chloride (meq/l)				
		Start	4°C	2°C	End (2°C)	Start	4°C	2°C	End (2°C)	
Brook Trout	Control (13°C)	$\bar{X}$	139.1	133.8	135.2	141.8	120.0	120.2	128.8	131.8
		SD(n)	12.5(5)	15.0(5)	14.2(5)	13.3(5)	9.2(5)	5.3(5)	7.5(5)	6.6(5)
	90% Distilled	$\bar{X}$	147.8	112.8	138.7	137.7	126.6	114.6	119.0	133.8
		SD(n)	6.6(5)	4.7(5)	25.2(5)	11.2(5)	6.1(5)	14.5(5)	23.0(5)	3.6(5)
	Tap (a)	$\bar{X}$	125.8	114.9	132.8	134.1	122.6	118.4	132.2	126.4
		SD(n)	8.9(5)	12.1(5)	18.6(5)	10.4(4)	12.9(5)	8.4(5)	7.3(5)	18.1(5)
	0.2% NaCl (d)	$\bar{X}$	137.3	118.8	133.2	127.1	130.6	125.6	137.8	138.7
		SD(n)	11.6(5)	6.2(5)	10.0(4)	7.2(4)	6.0(5)	14.2(5)	4.4(4)	3.7(5)
0.4% NaCl	$\bar{X}$	136.9	127.5	132.0	126.8	125.4	118.8	148.8	126.4	
	SD(n)	6.8(5)	15.3(4)	20.8(5)	7.7(5)	9.0(5)	18.3(5)	12.4(5)	24.3(5)	
0.85% NaCl	$\bar{X}$	132.2	139.7	141.5	162.0	131.4	140.0	131.8	161.8 **	
	SD(n)	14.1(4)	7.1(4)	15.7(4)	22.8(4)	16.3(5)	13.4(5)	11.0(5)	2.7(5)	
Yellow Perch	Control (18°C)	$\bar{X}$	118.9	140.5	139.0	134.2	106.4	---	---	109.2
		SD(n)	23.3(5)	9.3(5)	19.2(5)	4.2(5)	5.5(5)	---	---	3.5(5)
	90% Distilled	$\bar{X}$	126.5	115.6	97.8	116.7 **	114.0	---	---	100.0 *
		SD(n)	22.6(5)	13.7(5)	13.2(5)	6.5(5)	6.6(5)	---	---	3.7(5)
	Tap	$\bar{X}$	132.8	114.2	118.4	124.4 *	110.4	---	---	89.2 **
		SD(n)	17.4(5)	5.3(5)	10.0(5)	5.9(5)	2.1(5)	---	---	8.5(5)
	0.2% NaCl	$\bar{X}$	132.8	106.2	109.0	124.4 *	124.8	---	---	89.2 **
		SD(n)	8.1(5)	12.3(5)	8.1(5)	5.4(5)	9.2(5)	---	---	4.0(5)
	0.4% NaCl (a)	$\bar{X}$	114.2	125.4	127.5	120.2	123.2	---	---	100.6
		SD(n)	16.1(5)	2.6(5)	19.7(5)	12.1(5)	7.1(5)	---	---	7.2(5)
0.6% NaCl	$\bar{X}$	138.4	123.0	125.1	136.3	128.8	---	---	112.0	
	SD(n)	24.4(5)	16.1(5)	19.5(5)	12.4(4)	14.7(5)	---	---	14.7(4)	

^a Blood samples were not collected from Channel Catfish at 4°C because of the fungus infection.

Experimental group differed from control during experiment

(a)	Paired t, Sodium	p < 0.05
(b)	" " "	p < 0.01
(c)	" " Chloride	p < 0.05
(d)	" " "	p < 0.01

Experimental group differed from control at end

*	t-test,	p < 0.05
**	" "	p < 0.01

sometimes disrupted regulation. The high concentrations were hyperionic to all control groups (Tables 7 and 10).

Those groups that had elevated plasma osmolality also frequently had increased Na^+ and Cl^- concentrations.

There was no apparent relationship between changes in plasma ion concentration and mortality. Sometimes the greatest differences in plasma ion concentration between experimental and control solutions occurred in the solutions where mortality was relatively low. Also, concentrations increased and decreased sometimes significantly in groups that did not suffer mortalities.

My results agree in part with those of studies reviewed by Umminger (1969) and studies of the lamprey, Petromyzon fluviatilis, and carp (Wikgren 1953); goldfish, Carassius auratus, (Meyer et al. 1956; Heinicke and Houston 1965; Prosser et al. 1970); rainbow trout (Reaves et al. 1968); and northern pike (Kristoffersson et al. 1972), in which Na^+ and Cl^- usually decreased in blood of freshwater fish held in cold water. Prosser et al. (1970) viewed the decrease of blood Na^+ and Cl^- in cold-acclimated goldfish as an adaptive mechanism directed at reduction of osmotic work through a decrease in the osmotic gradient. The pattern of initial decrease followed by increase in ion concentration that I found in some groups was also found by Reaves et al. (1968) and Kristoffersson et al. (1972). They attributed the pattern to acclimation and reestablishment of equilibrium ion concentrations.

The correspondences that I found between increases in plasma osmolality and Na^+ and Cl^- concentrations were similar to results found for several species of freshwater fish (Gordon 1963; Byrne et al. 1972; Davis and Simco 1976).

Laboratory: Body Fat and Water Content

The pattern of fat depletion during the experiments did not support the hypothesis that less energy would be used if fish were held in salt solutions of osmotic concentrations close to that of fish blood. Fat content of survivors declined 5.4% to 41.0%, usually significantly, and water content increased 0.6% to 4.7%, usually significantly, for all species (Tables 11 and 12). Fat loss or water gain was not related to osmolality of solutions. The least squares regression, which was not significant, for the relation between osmolality and fat loss was:

$$y = 29.4902 - 0.0410X, \quad r = -0.3026,$$

where X = osmolality of solution and y = percent fat lost. The least squares regression, which also was not significant, for the relation between osmolality and water gain was:

$$y = 2.6603 + 0.0001X, \quad r = 0.0094,$$

where X = osmolality of solution and y = percent water gained.

Fat loss may have been related to mortality for yellow perch. The yellow perch experiment was the only one in which substantial mortality occurred that was not related to

TABLE 11. PERCENT FAT (DRY WEIGHT) BY SPECIES AND SOLUTION AT START AND CONCLUSION OF FIVE EXPERIMENTS AND SIGNIFICANCE OF FAT LOSS BY SPECIES. MEAN $\pm$ SD (n).
(t-test; *p<0.05, **p<0.01)

Species	Start	Conclusion									
		90% Dist. 10% Tap	Tap	0.1%	0.2%	0.4%	0.5%	0.6%	0.85%	1.0%	Control
Large-mouth Bass (I)	8.10+ 2.37(25)	4.77+ ** 1.50(13)	4.95+ ** 2.58(13)	3.81+ ** 1.73(15)	--	--	5.57+ ** 1.09(14)	--	--	--	11.83+ 1.10(15)
Large-mouth Bass (II)	15.48+ 2.78(16)	--	--	--	12.45+ ** 2.54(13)	14.54+ 1.94(15)	--	--	13.34+ * 2.53(14)	--	15.83+ 2.57(15)
Channel Catfish	22.59+ 5.52(16)	19.05+ 4.29(12)	22.12+ 3.47(9)	--	21.83+ 6.91(12)	21.64+ 5.36(12)	--	--	22.50+ 3.37(15)	--	23.98+ 4.43(10)
Brook Trout	17.27+ 3.00(15)	13.86+ * 3.57(12)	11.54+ ** 3.19(12)	--	13.24+ ** 1.94(11)	12.32+ ** 3.44(12)	--	--	12.19+ ** 3.12(12)	--	16.44+ 2.75(9)
Yellow Perch	6.50+ 3.28(39)	4.20+ * 0.40(16)	3.90+ ** 0.37(14)	--	4.03+ * 0.53(10)	4.28+ * 1.12(12)	--	4.40+ 0.75(9)	--	--	10.61+ 1.54(12)

TABLE 12. PERCENT TOTAL BODY WATER BY SPECIES AND SOLUTION AT START AND CONCLUSION OF FIVE EXPERIMENTS AND SIGNIFICANCE OF WATER GAIN BY SPECIES. MEAN $\pm$ SD (n).
(t-test; *p < 0.05, **p < 0.01)

Species	Start	Conclusion									
		90% Dist. 10% Tap	Tap	0.1%	0.2%	0.4%	0.5%	0.6%	0.85%	1.0%	Control
Large-mouth Bass (I)	78.66+ 1.15(25)	81.79*** 0.63(13)	80.73*** 0.86(13)	81.22*** 0.81(15)	--	--	81.34*** 0.56(14)	--	--	--	75.61+ 0.36(15)
Large-mouth Bass (II)	75.51+ 1.08(16)	--	--	--	80.14*** 1.53(13)	77.95*** 1.23(15)	--	--	78.92*** 2.44(14)	--	76.59+ 1.25(15)
Channel Catfish	77.67+ 2.51(16)	81.09*** 2.32(12)	79.90+ * 1.48(9)	--	78.82+ 3.52(12)	79.10+ 1.95(12)	--	--	77.90+ 1.84(15)	--	78.54+ 2.84(10)
Brook Trout	79.83+ 1.45(15)	82.98*** 1.62(12)	82.94*** 1.35(12)	--	81.55*** 1.63(11)	82.00*** 1.23(12)	--	--	81.69*** 0.84(12)	--	77.42+ 0.85(9)
Yellow Perch	83.29+ 1.29(39)	82.70+ 1.21(16)	83.40+ 1.27(14)	--	84.75*** 1.09(10)	83.79+ 1.22(12)	--	84.28+ * 1.25(9)	--	--	75.87+ 1.25(12)

fungus or hyperosmotic solutions. In that experiment fat content of survivors was always higher than that of perch that died, and the difference was significant in 3 of the 5 solutions (Table 13). The dead perch had more than 3% fat. I do not know if the fat content of perch had reached a critically low level. Newsome and Le Duc (1975) found a relation between winter mortality of mature female perch and a fat content of about 2.0%. However, since percent mortality in my experiment increased with increased salinity, inability to tolerate salt was probably a more important cause of mortality than minimum fat content.

TABLE 13. PERCENT BODY FAT (DRY WEIGHT) OF YELLOW PERCH THAT DIED AND THAT SURVIVED. MEAN $\pm$ SD (n) (t-test; *p<0.05; **<0.01).

<u>Solution</u>	<u>Percent Fat</u>	
	<u>Dead</u>	<u>Survivors</u>
90% Distilled *	3.74 $\pm$ 0.61 $\overline{}$ (20)	4.21 $\pm$ 0.40 $\overline{}$ (15)
Tap	3.54 $\pm$ 0.85 $\overline{}$ (26)	3.90 $\pm$ 0.37 $\overline{}$ (14)
0.2% NaCl **	3.33 $\pm$ 0.64 $\overline{}$ (25)	4.03 $\pm$ 0.53 $\overline{}$ (11)
0.4% NaCl	3.82 $\pm$ 1.26 $\overline{}$ (26)	4.28 $\pm$ 1.12 $\overline{}$ (12)
0.6% NaCl **	3.28 $\pm$ 0.79 $\overline{}$ (17)	4.40 $\pm$ 0.75 $\overline{}$ (9)

There was a trend toward higher fat content in larger fish that survived for all species, but the relation between length of fish and fat content was seldom significant (Table 14). The trend was reversed for water content, and the relation between length of fish and water content was frequently significant (Table 15).

TABLE 14. LEAST SQUARES REGRESSIONS AND CORRELATION COEFFICIENTS OF % FAT (DRY WEIGHT) VS. LENGTH OF SURVIVOR
(y = PERCENT FAT, X = LENGTH OF SURVIVOR; *p < 0.05).

Largemouth Bass I

Base Sample	y = -3.3737+0.1807X,	r = 0.3971*
90%	y = -13.3018+0.2977X,	r = 0.6091*
Tap	y = -10.6833+0.2508X,	r = 0.4576
0.1% NaCl	y = 0.4003+0.0560X,	r = 0.1492
0.5% NaCl	y = 2.8560+0.0440X,	r = 0.1562
End Control	y = 9.7849+0.0302X,	r = 0.1201

Largemouth Bass II

Base Sample	y = 9.8252+0.0796X,	r = 0.1667
Pooled Survivors	y = 8.2575+0.0763X,	r = 0.2437
End Control	y = 3.6909+0.1557X,	r = 0.4282

Channel Catfish

Base Sample	y = 5.0714+0.2714X,	r = 0.3975
Pooled Survivors	y = 10.0244+0.1832X,	r = 0.3177*
End Control	y = 9.3459+0.2031X,	r = 0.4388

Brook Trout

Base Sample	y = 13.8233+0.0445X,	r = 0.1172
Pooled Survivors	y = 1.1600+0.1506,	r = 0.4735*
End Control	y = 15.0510+0.0108X,	r = 0.0608

Yellow Perch

Base Sample	y = 4.2022+0.0511X,	r = 0.0736
Pooled Survivors	y = 3.8953+0.0053X,	r = 0.0333
End Control	y = 3.8683+0.0795X,	r = 0.5206

TABLE 15. LEAST SQUARES REGRESSIONS AND CORRELATION COEFFICIENTS OF % TOTAL BODY WATER VS. LENGTH OF SURVIVORS. (y = PERCENT TOTAL BODY WATER, X = LENGTH OF SURVIVOR; *p<0.05, **p<0.01).

Largemouth Bass I

Base Sample	y = 85.5634-0.1088X,	r = -0.4929*
90% Dist.	y = 84.4542-0.0447X,	r = -0.2402
Tap	y = 86.5488-0.5073X,	r = -0.5073
0.1% NaCl	y = 83.4674-0.0366X,	r = -0.2083
0.5% NaCl	y = 85.6099-0.0692X,	r = -0.4754
End Control	y = 77.2117-0.0235X,	r = -0.2886

Largemouth Bass II

Base Sample	y = 81.2426-0.0808X,	r = -0.4363
Pooled Survivors	y = 87.5423-0.1255X,	r = -0.4232**
End Control	y = 85.7412-0.1173X,	r = -0.6611**

Channel Catfish

Base Sample	y = 87.8905-0.1596X,	r = -0.5138*
90% Dist.	y = 83.1614-0.0589X,	r = -0.0907
Tap	y = 86.0666-0.0947X,	r = -0.0947
0.2% NaCl	y = 98.2735-0.3092X,	r = -0.4933
0.4% NaCl	y = 87.8449-0.1380X,	r = -0.7149*
0.85% NaCl	y = 88.3519-0.1792X,	r = -0.7567**
End Control	y = 89.3737-0.1513X,	r = -0.5092

Brook Trout

Base Sample	y = 90.6366-0.1393 ,	r = -0.7732**
90% Dist.	y = 92.3724-0.1227 ,	r = -0.6402*
Tap	y = 90.0429-0.0985 ,	r = -0.7948**
0.2% NaCl	y = 90.9979-0.1202 ,	r = -0.7881**
0.4% NaCl	y = 87.8145-0.0754 ,	r = -0.6463*
0.85% NaCl	y = 85.6609-0.0519 ,	r = -0.5492
End Control	y = 83.4073-0.0458 ,	r = -0.8471**

Yellow Perch

Base Sample	y = 87.0798-0.0840 ,	r = -0.3063
Pooled Survivors	y = 86.5255-0.0599 ,	r = -0.1801
End Control	y = 84.5163-0.1019 ,	r = -0.8213**

My results concur with those of studies reviewed by Love (1970) and studies by Meyer et al. (1956) and Stanley (1969), who found that increases in body water frequently were associated with decreases in fat content.

My results did not support the results of several other studies, which indicated that osmotic workload, and consequently energy required, is decreased if a fish is maintained in a solution roughly equivalent in osmotic concentration with its blood (Shell 1961; Rao 1968; Farmer and Beamish 1969; Parvatheswararao 1970; Byrne et al. 1972; Kristoffersson 1972).

My results were consistent with the belief of Gordon (1963) that different salinities would not require more or less osmotic work, but rather a simple change in gill membrane permeability.

Wikgren (1953) concluded from a review of several studies that the amount of energy needed for active ion absorption is a small fraction of total metabolism. Perhaps gross fat depletion was not an adequately sensitive measure for detection of differences in energy expenditure in the various solutions.

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APPENDIX A

Overwinter Mortality of Captive Young-of-the-Year Largemouth Bass

INTRODUCTION

Small young-of-the-year freshwater fish may undergo greater overwinter mortality than larger fingerlings due to depletion of energy reserves stored in fat. Some fraction of the energy used is required for osmoregulation. This fraction may be critical to survival of the small fish. Survival may be increased, and less work and energy required for osmoregulation if fish are held in salt solutions approximately isosmotic with fish blood.

To test this hypothesis of size-specific mortality and its possible relation to osmoregulation, a series of experiments were conducted by D. W. Coble at the Little Dixie Research Ponds and the University of Missouri during the winters of 1967-1968 and 1968-1969. The experimental fish were young-of-the-year largemouth bass, Micropterus salmoides, obtained from the Fareport and Guttenburg (Iowa) National Fish Hatcheries.

METHODS AND MATERIALS

Experiment I

Fish were anesthetized with amyl alcohol, measured to 0.5 mm (total length), and separated into four length groups - 52.5, 55.0, 57.5, 60.0 mm. Approximately 100 fish in each length group were weighed to 0.01 g and divided equally into four weight groups (Table 1).

Each of the 16 groups was placed in a compartment in one of four wire cages, 2.5 m X 0.6 m X 0.9 m, partially submerged in Little Dixie Pond No. 12 on November 20-22, 1967. Each cage was divided into four compartments, 0.6 m X 0.6 m X 0.9 m, and was covered with $\frac{1}{4}$ inch hardware cloth and lined with bobbinet (1 mm mesh opening). Depth of water in compartments ranged from 0.6-0.8 m.

Water temperature was determined with a hand-held thermometer or a minimum-maximum thermometer and at time of stocking was 7.8°C. During December, January, and February water temperature was measured about every 6 days. Minimum temperature averaged 2.9°C $\pm$ 0.1 and the maximum averaged 5.6°C $\pm$ 0.2. During March water temperature gradually rose. Fish were fed chironomid larvae once each month from November, 1967 to April, 1968.

Cages were removed on April 2, 1968, and live and dead fish were counted, measured and weighed. Water temperature was 10.5°C.

Experiment II

Hatchery-reared largemouth bass were separated into 16 groups of 25 fish, based on total length and placed in the same cages, described above, in Pond No. 12 on October 16 and 17, 1968 (Table 2). Pond temperature was 17.5°C.

A second group of hatchery bass was weighed to 0.01 g, separated by weight into eight groups of 24 or 25 fish/group, and stocked in two cages in Pond No. 12 on October 31, 1968 (Table 2). Pond temperature was 13°C.

A third group of hatchery bass was weighed to 0.01 g, separated into eight groups of 24 or 25 fish and put in two cages in Pond No. 12 on November 13, 1968 (Table 2). Pond temperature was 5°C.

Surface temperature was measured every 10 to 15 days and ranged from 1°C to 6°C during December to April. Fish were fed chironomid larvae once each month.

Cages were removed April 9 and 10, 1969, and live and dead fish were counted, measured, and some groups were weighed. Surface temperature was 14°C.

Experiment III

Eight plastic waste baskets were placed in each of two fiberglass tanks containing about 400 liters of water. Two baskets in each tank contained 200 l of tapwater, 0.2125%, 0.425% or 0.85% NaCl solution. Each basket was aerated with an airstone and supplied with shelters made of short lengths of steel pipe. The tanks were outdoors at the University of

Missouri and were covered with plastic to prevent dilution of salt solutions.

Largemouth bass were measured, weighed, and divided into 16 groups, with 10 bass of various lengths in each group. One group was placed in each basket in Tank 1 on November 5, 1968, and in Tank 2 on November 18, 1968.

Fifteen liters of solution were removed 5-7 times each week from each basket and replaced with fresh solution of the same temperature. Daily water temperature in baskets ranged from 1°C to 6°C from December through March. Fish were fed chironomid larvae or minnows once each month.

Baskets were checked daily for dead fish, which were removed and measured. Through December 20, dead fish were replaced in solutions with live fish. Thereafter no replacements were made.

The experiment in Tank 1 was terminated February 5, 1969, and in Tank 2 on March 19, 1969, when all live and dead fish were removed, counted, and measured.

RESULTS AND DISCUSSION

Survival during the two pond experiments was generally greatest for the longer and heavier bass (Tables 1 and 2). In Experiment I the 55 mm group had the lowest survival (67.3%) and the largest group, 60 mm, had the highest survival (85.0%), and for all 16 groups combined there was a significant positive relationship at the 5% level between percent survival and initial mean weight. The least squares regression was:

$$y = 33.5085 + 9.6747X, \quad r = 0.5387,$$

where y = percent survival and X = initial mean weight.

Survival in Experiment II was greatest (80-100%) for the 71-72 mm groups, lowest (0-8%) for the 55-63 mm groups, and moderate for the 61-62 mm (0-72%) and 71 mm (58%) groups. For this experiment the relationship between length and percent survival was significant at the 1% level. The least squares regression was:

$$y = -347.0510 + 5.8472X, \quad r = 0.7821$$

where y = percent survival and X = length.

Mean percent weight loss ranged from 1.5% to 27.4% and was greatest for the largest bass in both pond experiments (Tables 1 and 2).

Although the reason for the larger weight loss among larger fish is not known, the results of the pond experiments support the hypothesis that overwinter mortality is

TABLE 1. PRE- AND POST WINTER LENGTHS, WEIGHTS, OVERWINTER PERCENT WET WEIGHT LOSS AND SURVIVAL OF LARGE-MOUTH BASS, NOVEMBER, 1967 - APRIL, 1968, IN LITTLE DIXIE POND NO. 12 (MEAN $\pm$ SD).

Group and Date Stocked		Fall		Spring		% Weight Loss	% Survival
	N	lg (mm)	$\bar{W} \pm (SD)$ (g)	N	lg (mm)	$\bar{W} \pm (SD)$ (g)	
IV 22-XI-67	25	52.5	1.41 $\pm$ 0.06	8	52.5	1.28 $\pm$ 0.09	9.2
	25	52.5	1.54 $\pm$ 0.02	21	55.0	1.23 $\pm$ 0.11	20.1
	25	52.5	1.62 $\pm$ 0.03	19	55.0	1.31 $\pm$ 0.10	19.1
	25	52.5	1.76 $\pm$ 0.07	24	52.5	1.47 $\pm$ 0.11	16.5
			1.58 $\pm$ 0.15			1.32 $\pm$ 0.10	16.2 $\pm$ 4.9
II 20-XI-67	25	55.0	1.64 $\pm$ 0.08	11	55.0	1.42 $\pm$ 0.10	13.4
	25	55.0	1.79 $\pm$ 0.02	22	55.0	1.52 $\pm$ 0.10	15.1
	25	55.0	1.89 $\pm$ 0.02	17	55.0	1.59 $\pm$ 0.07	15.9
	26	55.0	2.01 $\pm$ 0.06	18	57.5	1.65 $\pm$ 0.09	17.9
			1.83 $\pm$ 0.16			1.55 $\pm$ 0.10	15.6 $\pm$ 1.9
III 22-XI-67	23	57.5	1.85 $\pm$ 0.08	9	57.5	1.54 $\pm$ 0.10	16.8
	23	57.5	2.00 $\pm$ 0.09	18	57.5	1.64 $\pm$ 0.09	18.0
	23	57.5	2.08 $\pm$ 0.03	21	57.5	1.72 $\pm$ 0.09	17.3
	23	57.5	2.24 $\pm$ 0.09	22	57.5	1.88 $\pm$ 0.12	16.1
			2.04 $\pm$ 0.16			1.69 $\pm$ 0.14	17.8 $\pm$ 1.6
I 20-XI-67	25	60.0	2.14 $\pm$ 0.09	21	60.5	1.76 $\pm$ 0.13	30.4
	25	60.0	2.30 $\pm$ 0.01	20	60.0	1.95 $\pm$ 0.11	15.2
	25	60.0	2.41 $\pm$ 0.04	20	60.0	1.99 $\pm$ 0.12	17.4
	25	60.0	2.56 $\pm$ 0.50	24	60.0	2.07 $\pm$ 0.10	19.1
			2.35 $\pm$ 0.18			1.94 $\pm$ 0.13	20.5 $\pm$ 6.8

TABLE 2. PRE- AND POST WINTER LENGTHS, WEIGHTS, OVERWINTER PERCENT WET WEIGHT LOSS AND SURVIVAL OF LARGE-MOUTH BASS NOVEMBER, 1968 - APRIL, 1969, IN LITTLE DIXIE POND NO. 12 (MEAN $\pm$ SD).

Date Stocked	Fall			Spring		% Weight Loss	% Survival
	N	lg (mm)	$\bar{W} \pm (g)$	N	$\bar{W} \pm (g)$		
16-X-68	25	55.6 $\pm$ 0.5	---	1	---	---	4.0
	25	57.6 $\pm$ 0.5	---	2	---	---	8.0
	25	59.0 $\pm$ 0.0	---	1	---	---	4.0
	25	60.0 $\pm$ 0.0	---	0	---	---	0.0
	25	61.0 $\pm$ 0.0	---	0	---	---	0.0
	25	62.0 $\pm$ 0.0	---	0	---	---	0.0
	25	63.0 $\pm$ 0.0	---	2	---	---	8.0
17-X-68	25	64.0 $\pm$ 0.0	---	2	---	---	8.0
	25	65.0 $\pm$ 0.0	---	0	---	---	0.0
	25	68.1 $\pm$ 0.9	---	4	---	---	16.0
	25	70.8 $\pm$ 0.9	---	15	---	---	58.0
	25	73.8 $\pm$ 0.8	---	5	---	---	20.0
31-X-68 1-XI-68	25	61-62	1.81 $\pm$ 0.04	0	---	---	0.0
	25	"	1.90 $\pm$ 0.02	1	1.87 $\pm$ 0.0	1.5	4.0
	25	"	1.94 $\pm$ 0.04	0	---	---	0.0
	25	"	2.00 $\pm$ 0.00	0	---	---	0.0
	25	"	2.04 $\pm$ 0.02	2	1.72 $\pm$ 0.13	15.7	8.0
	25	"	2.10 $\pm$ 0.01	2	1.75 $\pm$ 0.23	16.7	8.0
	24	"	2.18 $\pm$ 0.03	2	1.88 $\pm$ 0.06	13.8	8.3
	25	"	2.39 $\pm$ 0.14	18	1.87 $\pm$ 0.15	21.8	72.0
13-XI-68	25	71-72	4.10 $\pm$ 0.20	22	3.18 $\pm$ 0.21	22.4	88.0
	25	"	4.40 $\pm$ 0.04	24	3.35 $\pm$ 0.17	23.9	96.0
	50 ^a	"	4.60 $\pm$ 0.09	47	3.42 $\pm$ 0.19	25.7	94.0
	25	"	4.80 $\pm$ 0.04	20	3.59 $\pm$ 0.12	25.2	80.0
	25	"	4.59 $\pm$ 0.02	24	3.53 $\pm$ 0.17	23.1	96.0
	25	"	4.94 $\pm$ 0.05	24	3.74 $\pm$ 0.23	24.3	96.0
	24	"	5.29 $\pm$ 0.23	24	3.84 $\pm$ 0.18	27.4	100.0

a - One bobbinet panel shifted during the winter and allowed bass from two adjacent compartments to mingle.

greater for smaller young-of-the-year largemouth bass.

Survival in Experiment III was highest for the fish in tapwater and lowest for fish in 0.85% NaCl (Table 3). For numbers of fish that died in each solution pooled for both tanks, survival of bass in tapwater was not significantly different from that in 0.2125% NaCl ($X^2 = 1.3165$, $df = 1$) but was significantly higher for fish in 0.425% NaCl ($X^2 = 28.3749$, $df = 1$, $p < 0.01$) and 0.85% NaCl ($X^2 = 37.2807$, $df = 1$, $p < 0.01$).

Rust from the steel pipe shelters may have influenced the results of the experiments. The water became rust colored especially in the higher salt solutions. Several dead fish were found to have a coating of rust on the gills, but it was not determined if the rust was deposited on the gills before death. Also some mortality in the salt solutions may have been caused by periodic freezing of the solutions which may have increased the salt concentration of the unfrozen portions. Hyperosmotic solutions can cause dehydration and extreme pH changes in the blood of freshwater fish (Black 1951).

Results of the third experiment did not indicate that low concentrations of NaCl enhance survival of young-of-the-year largemouth bass in winter, and, depending on the severity of the variables mentioned above, may even have reduced survival.

TABLE 3. SUMMARY OF STOCKING AND MORTALITY DATA FROM OSMOREGULATION EXPERIMENT, NOVEMBER, 1968 - MARCH, 1969.

		(1)	(2)	(3)	(4)	(5)
		Number Originally Stocked	Number Died, and Replaced	Total Stocked (1 & 2)	Number Died, Not Replaced	Total Mortalities (2 & 4)
<u>Solution</u>						
Tank 1 Stocked 5-XI-68	Tapwater	20	17	37	10	27
	0.2125% NaCl	20	10	30	11	21
	0.425% NaCl	20	18	38	9	27
	0.85% NaCl	20	20	40	15	35
Tank 2 Stocked 18-XI-68	Tapwater	20	1	21	7	8
	0.2125% NaCl	20	6	26	11	17
	0.425% NaCl	20	9	29	19	28
	0.85% NaCl	20	8	28	20	28

APPENDIX B. WATER CHEMISTRY OF SUNSET, THOMAS, AND MEYERS LAKES AND THE LAKE MILLS (WIS.)
HATCHERY PONDS. ALL VALUES IN PPM UNLESS OTHERWISE INDICATED.

LOCATION	DATE	DEPTH m	TEMP °C	pH	COND Mmhos	ALK	TOTAL HARD- NESS	Ca ⁺⁺ HARD- NESS	D.O.	C.O.D.	B.O.D.	ORTHO P	TOTAL P	NH ₄ N	NO ₃ -NO ₂ N	TOTAL N
Sunset ^a Lake	26-VI-74	8.6	9.5	8.8	280	150	150	84	14.0	22.56	1.1	0.006	0.026	--	--	0.21
Thomas ^a Lake	18-VII-75	10.0	10.0	7.2	291	142	162	98	--	39.2	5.3	0.065	0.188	.27	.11	2.73
Meyers ^a Lake	22-VII-74	2.5	23.0	8.5	265	176	164	86	8.5	35.6	--	0.006	0.041	--	0.04	0.67
Lake ^b Mills Ponds	6-VIII-74	Top	--	8.5	--	181	212	95	10.3	--	--	0.0	0.0	0.20	0.0	--

^a Lake water analyzed by personnel at the Environmental Task Force Laboratory, University of Wisconsin, Stevens Point, Wisconsin.

^b Pond water analyzed by Howard Jackson.

APPENDIX C1. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM SUNSET LAKE SEINED 16-XI-75 AND 13-IV-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = -10.7470$, $p < 0.01$, $df = 718$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
30	15		
31	5		
32	9		
33	6	33	2
34	16	34	1
35	50	35	5
36	30	36	6
37	41	37	16
38	24	38	26
39	28	39	15
40	45	40	30
41	22	41	24
42	17	42	29
43	8	43	24
44	23	44	16
45	28	45	22
46	5	46	10
47	24	47	9
48	4	48	19
49	2	49	13
50	7	50	22
		51	5
52	2	52	4
		53	4
54	1	54	2
<u>55</u>	<u>2</u>	<u>55</u>	<u>5</u>
39.33 ± 4.93 411		43.28 ± 4.80 309	

APPENDIX C2. LENGTH FREQUENCY DISTRIBUTIONS OF
LARGEMOUTH BASS FROM THOMAS LAKE
SEINED 17-XI-75 AND 13-IV-76 (MEAN +
SD). DIFFERENCE BETWEEN MEAN LENGTHS
OF SAMPLES WAS SIGNIFICANT ($t = -4.7076$,
 $p < 0.01$, $df = 205$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
38	1		
41	1		
42	2		
43	2		
44	3	44	2
45	9	45	3
46	4	46	2
47	16	47	4
48	6	48	3
49	1	49	8
50	6	50	4
51	3	51	5
52	5	52	4
53	1	53	9
54	2	54	1
55	9	55	8
56	2	56	3
57	3	57	1
58	2	58	3
59	2	59	3
		60	1
61	1	61	1
62	4	62	3
63	3	63	6
		64	5
65	1	65	5
		66	1
67	1	67	2
		68	2
69	3	69	5
70	1	70	2
		71	1
		72	1
		73	1
		75	2
		76	1
77	2	77	1
		78	1
		80	4
		83	1
		85	1
		86	1
		90	1
<u>108</u>	<u>1</u>		
52.72 $\pm$ 9.74	97	59.47 $\pm$ 10.67	110

APPENDIX C3. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM MEYERS LAKE SEINED BY D. W. COBLE 4-X-72 AND 18-IV-73 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS NOT SIGNIFICANT ($t = 0.9020$, $df = 121$).

<u>FALL 1972</u>		<u>SPRING 1973</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
26	1		
28	1		
32	1	32	1
33	3	33	1
34	3		
35	1	35	8
36	1	36	5
37	5	37	9
38	6	38	3
39	4	39	3
40	5	40	10
		41	1
42	3	42	4
43	4	43	2
44	1	44	1
		45	2
		46	1
48	1	48	1
		49	3
		50	2
		51	4
52	3		
53	2	53	3
54	2	54	1
55	3	55	1
56	1		
58	1		
59	2		
61	1		
		64	1
<u>65</u>	<u>1</u>		
43.03 $\pm$ 9.13	56	41.73 $\pm$ 6.69	67

APPENDIX C4. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM MEYERS LAKE SEINED 17-XI-75 AND 6, 7-IV-76 (MEAN $\pm$ SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = -3.0790$, $p < 0.01$, $df = 338$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
26	2	25	1
27	5	27	8
28	4	28	8
29	7	29	3
30	9	30	5
31	7	31	4
32	14	32	8
33	20	33	9
34	15	34	7
35	17	35	7
36	3	36	3
37	12	37	15
38	8	38	6
39	5	39	7
40	15	40	15
41	7	41	7
42	7	42	21
43	7	43	11
44	8	44	5
45	1	45	9
46	2	46	2
		47	1
<u>49</u>	<u>1</u>		
		51	1
		<u>53</u>	<u>1</u>
35.64 $\pm$ 4.91	176	37.42 $\pm$ 5.71	164

APPENDIX C5. LENGTH FREQUENCY DISTRIBUTIONS OF FATHEAD MINNOW FROM LAKE MILLS HATCHERY MEASURED 24-XI-75 AND 27-III-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS NOT SIGNIFICANT ($t = 0.3569$, $df = 366$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
40	2	39	2
41	4	40	4
42	15	41	6
43	9	42	7
44	4	43	15
45	18	44	18
46	13	45	21
47	14	46	20
48	14	47	25
49	4	48	16
50	18	49	7
51	9	50	18
52	9	51	18
53	2	52	9
54	1	53	4
55	3	54	7
56	2	55	7
57	2	56	3
58	1	57	1
59	2	58	3
61	2	59	1
62	2	61	1
63	1	62	2
65	1	63	1
			<u>1</u>
48.02 ± 5.01	152	47.84 ± 4.56	216

APPENDIX C6. LENGTH FREQUENCY DISTRIBUTIONS OF WHITE CRAPPIE FROM LAKE MILLS HATCHERY MEASURED 24-XI-75 AND 27-III-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS NOT SIGNIFICANT ($t = -1.030$, $df = 241$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
41	3	40	1
44	1	44	3
45	10	45	2
46	13	46	1
47	32	47	16
48	15	48	12
49	14	49	13
50	22	50	12
51	10	51	5
52	15	52	6
53	7	53	1
54	4	54	2
55	7	55	2
56	3	56	2
<u>57</u>	<u>3</u>	57	2
		58	1
		59	1
		<u>60</u>	<u>2</u>
49.22 ± 3.21	159	49.69 ± 3.65	84

APPENDIX C7. LENGTH FREQUENCY DISTRIBUTIONS OF GREEN SUNFISH FROM LAKE MILLS HATCHERY MEASURED 24-XI-75 AND 27-III-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS NOT SIGNIFICANT ($t = -1.7849$, $df = 367$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
		28	2
30	1	31	1
31	1	32	3
32	3	33	5
33	5	34	21
34	10	35	32
35	32	36	29
36	29	37	27
37	28	38	27
38	12	39	6
39	5	40	12
40	8	41	4
41	1	42	4
42	3	43	2
43	1	44	6
44	3	45	4
46	4	46	4
47	3	47	4
48	2	48	3
		49	2
		50	3
51	1	54	2
56	1	56	1
		57	1
		58	1
		59	2
65	1	67	1
		68	1
		70	1
72	1		
<u>73</u>	<u>1</u>	74	1
		<u>77</u>	<u>1</u>
37.90 ± 5.94	156	39.17 ± 7.26	213

APPENDIX C8. LENGTH FREQUENCY DISTRIBUTIONS OF LARGE-MOUTH BASS FROM LAKE MILLS HATCHERY MEASURED 24-XI-75 AND 27-III-76 (MEAN + SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES WAS SIGNIFICANT ($t = 3.9575$, $p < 0.01$, $df = 364$).

<u>FALL 1975</u>		<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>	<u>Length</u>	<u>n</u>
60	1	60	1
		62	2
		65	1
		66	1
67	1	67	1
		68	1
		69	2
		70	4
71	2	71	3
72	5	72	4
73	2	73	2
74	3	74	14
75	3	75	11
76	7	76	9
77	12	77	20
78	8	78	12
79	9	79	19
80	23	80	20
81	9	81	12
82	16	82	19
83	15	83	6
84	11	84	20
85	9	85	5
86	4	86	3
87	5		
88	4	88	2
89	2		
90	3	90	6
91	3	91	2
		92	1
93	1		
97	1		
		<u>98</u>	<u>1</u>
100	1		
102	1		
<u>110</u>	<u>1</u>		
81.37 ± 5.90	162	79.00 ± 5.49	204

APPENDIX C9. LENGTH FREQUENCY DISTRIBUTIONS OF BLUEGILL FROM LAKE MILLS HATCHERY MEASURED 24-XI-75 AND 27-III-76 (MEAN $\pm$ SD). DIFFERENCE BETWEEN MEAN LENGTHS OF SAMPLES OF FISH < 30 mm WAS NOT SIGNIFICANT ($t = -1.7123$, $df = 192$), BUT WAS SIGNIFICANT FOR FISH > 30 mm ($t = -3.5091$, $p < 0.01$, $df = 177$).

<u>FALL 1975</u>		<u>< 30 mm</u>	<u>SPRING 1976</u>	
<u>Length</u>	<u>n</u>		<u>Length</u>	<u>n</u>
17	1		17	1
20	2			
21	2		21	2
22	10		22	1
23	9		23	6
24	13		24	15
25	30		25	21
26	14		26	15
27	12		27	13
28	6		28	11
29	1		29	2
<u>30</u>	<u>5</u>		<u>30</u>	<u>2</u>
24.98 $\pm$ 2.28	105		25.52 $\pm$ 2.05	89
		<u>> 30 mm</u>		
32	3		32	1
33	5		33	2
34	6		34	3
35	4		35	11
36	1		36	9
37	5		37	11
38	6		38	10
39	2		39	9
40	5		40	16
41	7		41	12
42	3		42	14
43	1		43	5
			44	6
45	2		45	6
			46	5
			47	3
			48	2
<u>50</u>	<u>1</u>		50	1
			51	1
			<u>53</u>	<u>1</u>
37.80 $\pm$ 3.93	51		40.13 $\pm$ 4.01	128

APPENDIX D1. LENGTH AND SURVIVAL TIME OF GREEN SUNFISH
THAT DIED IN 90% DISTILLED/10% TAP WATER
DURING A 122 DAY EXPERIMENT.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>
24	66	41	74 123
24		41	
25		42	
26		43	
26		43	
26		44	
26		45	
27		50	
28			
29			
30			
30			
30			
30			
30			
30			
31			
31			
32			
32			
33			
33			
34			
34			
35	121		
35			
35			
35			
37			
37			
38			
39			
39			
39			
40			
40			

APPENDIX D2. LENGTH AND SURVIVAL TIME OF GREEN SUNFISH
THAT DIED IN TAP WATER DURING A 122 DAY
EXPERIMENT.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>
23		37	
26		37	
26		37	
27		37	
28		38	
28		39	
28		40	
29		41	
29		41	
30		42	
30		45	
30			
30			
31			
32			
32			
32			
32			
33			
33			
33			
34			
34			
34			
34			
34			
34			
35			
35			
35			
36			
36			
36			
36			

APPENDIX D3. LENGTH AND SURVIVAL TIME OF GREEN SUNFISH
THAT DIED IN 0.1% NaCl DURING A 122 DAY
EXPERIMENT.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>
23		37	
25		37	
25		38	
25		38	
26		38	34
28		39	
28		40	
29		42	
29			
29			
29			
29			
30			
31			
31			
32			
32			
32			
32			
33			
34			
34			
34			
34			
34			
35			
35			
35			
35			
35			
35			
35			
35			
36			

APPENDIX D4. LENGTH AND SURVIVAL TIME OF GREEN SUNFISH
THAT DIED IN 0.5% NaCl DURING A 122 DAY
EXPERIMENT.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>
24		38	
25		39	
26		40	
26		40	
27		40	
27		41	
28		43	
28		44	
28			
28			
28			
29			
29			
29			
29			
30			
30			
31			
32			
32			
33			
34			
34			
34			
34			
34			
35			
35			
35			
36			
36			
36			
37			
37			
37			
37			

APPENDIX D5. LENGTH AND SURVIVAL TIME OF GREEN SUNFISH
THAT DIED IN 1.0% NaCl DURING A 122 DAY
EXPERIMENT.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>
25	82	37	118
25	98	37	125
25	40	38	
27	82	38	130
27	101	39	130
28	84	39	127
28	96		
29	94		
29	137		
30	124		
30	88		
31	95		
31	137		
31	110		
31			
31			
31			
32	34		
32	137		
33			
34	88		
34	106		
34			
35			
35			
35	86		
35	134		
35	125		
35	137		
36	95		
36	129		
37			
37	95		
37	129		
37	127		
37	129		

APPENDIX E1. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF LARGemouth BASS (I) FROM ALL SOLUTIONS, SACRIFICED THE DAY BEFORE TEMPERATURE WAS DECREASED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
51	1582	305	80.7	3.8	0.7
56	1707	329	80.7	5.8	1.1
56	2219	499	77.5	11.3	2.5
57	1525	310	79.7	6.1	1.2
58	2103	439	79.1	5.9	1.2
59	2193	469	78.6	8.7	1.9
60	2104	466	77.9	9.6	2.1
61	2413	512	78.8	6.4	1.4
61	2100	403	80.8	5.4	1.0
62	2408	485	79.9	6.0	1.2
64	2685	601	77.6	11.4	2.6
65	2724	607	77.7	9.4	2.1
65	2676	583	78.2	8.2	1.8
65	3002	667	77.8	10.4	2.3
65	3021	686	77.3	11.1	2.5
66	2530	516	79.6	5.6	1.1
66	2914	643	77.9	8.6	1.9
67	3092	660	78.7	7.5	1.6
67	2913	617	78.8	6.1	1.3
67	3016	608	79.8	5.6	1.1
68	3174	723	77.2	9.9	2.3
69	3674	775	78.9	12.1	2.6
70	3760	877	76.7	11.5	2.7
71	3690	811	78.0	7.7	1.7
<u>71</u>	<u>3482</u>	<u>750</u>	<u>78.5</u>	<u>8.3</u>	<u>1.8</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	63.48	2668	574	78.66	8.10	1.75
SD	5.21	638	155	1.15	2.37	.60
n	25					

APPENDIX E2. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (I) IN 90% DISTILLED/10% TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
55	--	2086	358	82.8	1.5	0.3
56						
57	--	2823	524	81.4	6.2	1.2
57	--	2183	405	81.5	3.3	0.6
57						
57						
58	--	2245	411	81.7	3.3	0.6
59						
59						
59						
59						
60						
60						
60						
60						
60						
60						
60	54	--	--	--	--	--
60	--	2233	382	82.9	6.0	1.0
60						
61	37	--	--	--	--	--
61						
61	--	2122	400	81.2	3.3	0.6
61	--	2543	461	81.9	5.8	1.1
62	--	2107	364	82.7	4.7	0.8
62						
62						
63						
63						
63	--	2692	487	81.9	5.9	1.1
63	--	3075	574	81.3	5.1	1.0
64	--	3320	616	81.5	6.6	1.2
64	--	3200	607	81.0	5.4	1.0
64	--	2793	519	81.4	4.9	0.9
64						
64						
65						
66						
67	--	3342	620	--	--	--
71	--	4254	790	--	--	--
72						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	60.69	2571	470	81.79	4.77	0.88
SD	3.07	444	92	0.63	1.50	0.28
n	13					

APPENDIX E3. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (I) IN TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
50	84	--	--	--	--	--
53						
55						
56	--	2045	338	--	--	--
56	--	1922	362	81.2	3.9	0.7
56	--	1602	296	--	--	--
57	--	1842	356	80.7	1.4	0.3
57	--	2294	467	79.6	9.7	2.0
57						
57						
57						
58						
58						
58						
59						
59						
59	--	2182	389	82.2	1.8	0.3
60	--	2459	452	81.6	2.3	0.4
60						
60	--	2553	480	81.2	2.4	0.5
61	--	2622	504	80.8	6.1	1.2
61						
62	108	--	--	--	--	--
62						
62						
62	--	2928	545	--	--	--
63	--	3002	560	81.4	5.3	1.0
63						
65						
65						
66	--	3109	598	80.8	6.1	1.2
66	--	3227	627	80.6	4.5	0.9
66	--	3051	588	80.7	5.1	1.0
67						
68						
69						
69						
69	--	3981	815	79.5	7.7	1.6
70	--	4237	882	79.2	8.0	1.7
72						
72						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	62.31	2806	545	80.73	4.95	0.99
SD	4.70	729	161	0.86	2.58	0.55
n	13					

APPENDIX E4. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (I) IN 0.1% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
54						
54						
54	--	1502	282	81.2	1.2	0.2
54	--	1932	343	82.3	4.3	0.8
55						
57						
57	53	--	--	--	--	--
57	--	1796	324	82.0	2.7	0.5
58	--	2516	500	80.1	6.6	1.3
58						
58						
59						
59						
59	--	2160	389	82.0	3.6	0.7
60	--	2751	529	80.8	4.9	0.9
60	--	2301	434	81.1	3.2	0.6
60						
60						
60						
61						
61	--	2378	428	82.0	3.7	0.7
62	--	2482	462	81.4	0.9	0.2
62						
62						
62						
63						
64	--	3214	648	79.8	5.9	1.2
64	--	3467	661	80.9	5.5	1.1
64						
65						
65						
65						
66	--	3504	697	80.1	4.9	1.0
66	--	3102	595	80.8	3.3	0.6
67	--	3195	587	81.6	1.4	0.3
67						
67						
68						
69	--	3807	654	82.2	5.0	0.9

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	60.85	2674	502	81.22	3.81	0.73
SD	4.24	687	135	0.81	1.73	0.34
n	15					

APPENDIX E5. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (I) IN 0.5% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
54	53	--	--	--	--	--
55						
56	97	--	--	--	--	--
56	--	1769	328	81.5	3.9	0.7
57						
57	53	--	--	--	--	--
57						
57						
58						
58	--	1961	367	81.3	5.8	1.1
59	--	2376	444	81.3	8.1	1.5
59						
60						
60						
60	78	--	--	--	--	--
60	109	--	--	--	--	--
60	114	2131	397	81.4	9.9	1.8
60	101	2194	316	85.6	2.9	0.4
60	--	2004	360	82.0	5.7	1.0
60	--	2592	483	81.4	4.6	0.9
60	--	2340	415	82.3	4.8	0.9
60	--	3149	600	81.0	4.9	0.9
60	--	2754	505	81.7	4.7	0.9
61	--	2807	523	81.4	6.8	1.3
61						
62						
62						
62	92	--	--	--	--	--
62	112	--	--	--	--	--
63						
63						
63						
63						
63	--	2671	496	81.4	5.7	1.1
64	--	2255	443	80.4	5.8	1.1
64						
64	78	2100	397	81.1	4.6	0.9
65						
65						
65						
65	--	3382	628	81.4	6.1	1.1
66						
67						
68						
69	--	3424	634	81.5	4.7	0.9
69	--	<u>3581</u>	<u>714</u>	<u>80.1</u>	<u>6.4</u>	<u>1.3</u>

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	61.71	2648	496	81.34	5.57	1.05
SD	3.85	574	115	0.56	1.09	2.1
n	14					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	61.33	2142	370	82.70	5.80	1.03
SD	2.31	48	47	2.52	3.65	0.71
n	3					

APPENDIX E6. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (I) IN 1.0% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight DW and wet weight, WW) OF SELECTED FISH THAT DIED.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
55	64	1315	284	78.4	4.7	1.1
56	58	--	--	--	--	--
56	69	1452	262	82.0	2.1	0.4
57	72	2191	370	--	--	--
58	53	--	--	--	--	--
58	44	--	--	--	--	--
58	92	--	--	--	--	--
58	85	1902	366	80.8	9.2	1.8
59	55	1758	316	82.0	2.2	0.4
59	73	--	--	--	--	--
59	71	--	--	--	--	--
60	88	--	--	--	--	--
60	50	--	--	--	--	--
60	54	--	--	--	--	--
60	54	1900	338	82.2	4.7	0.8
60	55	2004	387	--	--	--
61	67	2004	389	--	--	--
61	85	2420	431	--	--	--
61	75	2031	406	80.0	4.8	1.0
61	56	--	--	--	--	--
62	79	2086	405	80.6	1.3	0.3
62	69	1905	364	80.9	2.7	0.5
63	45	--	--	--	--	--
63	89	--	--	--	--	--
63	64	--	--	--	--	--
63	69	--	--	--	--	--
63	69	--	--	--	--	--
64	66	--	--	--	--	--
64	68	--	--	--	--	--
64	85	2744	525	79.4	5.3	1.0
65	63	2051	422	81.3	3.9	0.8
65	112	--	--	--	--	--
65	70	--	--	--	--	--
65	--	--	--	--	--	--
66	--	--	--	--	--	--
66	66	--	--	--	--	--
67	88	3091	577	80.9	7.9	1.5
68	112	--	--	--	--	--
69	64	--	--	--	--	--
69	--	--	--	--	--	--
70	106	4114	807	80.4	9.8	1.9
75	85	4433	932	79.0	9.4	2.0
78	114	4875	973	80.0	6.5	1.3

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	63.71	2547	498	80.56	5.32	1.06
SD	6.79	1146	238	1.14	2.86	0.58
n	14					

APPENDIX E7. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CONTROL LARGEMOUTH BASS (I), SACRIFICED THE DAY THE EXPERIMENT ENDED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
63	3387	821	75.8	10.3	2.5
63	3870	940	75.7	13.4	3.3
64	4052	1009	75.1	12.4	3.1
64	3613	882	75.6	11.3	2.8
64	3895	937	75.9	10.9	2.6
64	3945	959	75.7	12.4	3.0
66	4059	986	75.7	12.3	3.0
67	4566	1076	76.4	10.6	2.5
68	4683	1169	75.0	10.9	2.7
68	4652	1130	75.7	10.7	2.6
70	6045	1469	75.7	12.7	3.1
71	4332	1053	75.7	13.9	3.4
73	5337	1300	75.6	12.9	3.1
75	5646	1380	75.6	11.5	2.8
<u>76</u>	<u>6216</u>	<u>1552</u>	<u>75.0</u>	<u>11.3</u>	<u>2.8</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	67.73	4553	1111	75.61	11.83	2.89
SD	4.38	882	221	0.36	1.10	.28
n	15					

APPENDIX F1. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF LARGEMOUTH BASS (II) FROM ALL SOLUTIONS, SACRIFICED THE DAY FEEDING WAS DISCONTINUED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
65	3556	826	76.8	17.6	4.1
65	3665	896	75.6	15.3	3.7
65	3478	893	74.3	12.9	3.3
66	3735	935	75.0	18.3	4.6
66	3483	858	75.4	12.9	3.2
68	4352	1021	76.5	12.3	2.9
68	4324	1019	76.5	18.5	4.4
69	4493	1031	77.1	16.0	3.7
69	4070	1004	75.3	14.8	3.7
69	4482	1029	77.0	17.7	4.1
71	4332	1057	--	--	--
72	5085	1343	--	--	--
74	4778	1205	74.8	10.8	2.7
75	5795	1468	--	--	--
75	5401	1394	74.2	14.5	3.7
76	3910	991	74.7	15.8	4.0
77	5199	1318	74.7	16.2	4.1
79	5933	1399	76.4	12.7	3.0
81	6460	1606	--	--	--
<u>84</u>	<u>7074</u>	<u>1851</u>	<u>73.8</u>	<u>21.3</u>	<u>5.6</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	70.94	4500	1104	75.51	15.48	3.80
SD	5.81	996	269	1.08	2.78	.72
n	16					

APPENDIX F2. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (II) IN 0.2% NaCl AND WFT WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
59						
60		2348	418	82.2	9.0	1.6
61						
63		2714	523	80.7	10.4	2.0
64		2714	465	82.9	10.4	1.8
65						
65						
65						
66						
66						
66		3846	815	78.7	17.4	3.7
67		3470	667	80.8	13.5	2.6
67		4005	770	80.8	13.3	2.6
68		3814	657	82.8	9.5	1.6
68		4122	837	79.7	11.0	2.2
68						
69						
69						
70		4690	901	--	--	--
71		4908	988	79.9	16.4	3.3
71		4729	908	--	--	--
72		4780	988	79.3	13.1	2.7
73		4986	1119	77.6	14.1	3.2
73						
74						
78		6221	1235	80.2	12.4	2.5
80						
<u>84</u>		<u>6849</u>	<u>1371</u>	<u>80.0</u>	<u>11.3</u>	<u>2.3</u>

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	68.83	4156	835	80.44	12.45	2.47
SD	7.07	1373	295	1.53	2.54	.65
n	13					

APPENDIX F3. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (II) IN 0.4% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg).	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
58		2436	495	79.7	14.4	2.9
59		2562	539	79.0	14.5	3.1
61		2645	501	81.1	10.1	1.9
63						
64						
64		3601	810	77.5	16.4	3.7
65		3705	867	76.6	15.6	3.7
66		3542	750	78.8	10.4	2.2
66		3441	774	77.5	16.3	3.7
66						
67						
67						
67		3455	777	77.5	13.6	3.1
67		3638	819	--	--	--
67		3953	869	78.0	15.6	3.4
68						
68						
68						
68						
69						
69						
73		4712	1060	--	--	--
73		4841	1140	76.5	15.5	3.7
76		5349	1200	77.6	15.4	3.5
76		5452	1227	77.5	15.9	3.6
79		5949	1327	77.7	14.3	3.2
81						
82						
85		7216	1645	77.2	14.0	3.2
86		8486	1946	77.1	16.1	3.7

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$	69.87	4442	991	77.95	14.54	3.24
SD	8.86	1760	421	1.23	1.94	.56
n	15					

APPENDIX F4. LENGTH AND SURVIVAL TIME OF LARGEMOUTH BASS (II) IN 0.85% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
56		2009	326	83.8	9.6	1.6
58						
59		2287	471	79.4	11.3	2.3
61		1905	332	82.6	12.4	2.2
61		2764	545	80.3	14.1	2.8
62		2547	518	--	--	--
62						
62						
63						
63						
63		3329	796	76.1	18.0	4.3
63		2878	537	81.3	11.0	2.1
64						
64						
64						
64						
65		3506	844	75.9	17.5	4.2
66		3151	668	78.8	14.8	3.1
66						
67						
67						
67						
67						
67		3825	832	78.3	10.5	2.3
68						
69		3774	902	76.1	14.5	3.5
70		4149	869	79.1	11.7	2.5
70						
73						
76		5361	1134	78.9	12.4	2.6
80		6343	1423	77.6	15.3	3.4
82		6762	1573	76.7	13.7	3.2
84						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	67.00	3717	804	78.92	13.34	2.86
SD	7.76	1505	374	2.44	2.53	.79
n	14					

APPENDIX F5. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CONTROL LARGEMOUTH BASS (II), SACRIFICED THE DAY THE EXPERIMENT ENDED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
68	4492	1047	76.7	17.4	4.1
69	4316	902	79.1	18.0	3.8
70	4015	921	--	--	--
70	4313	959	77.8	10.2	2.3
71	4804	1095	77.2	12.5	2.9
74	5084	1122	77.9	15.3	3.4
75	5568	1271	77.2	16.4	3.7
76	5635	1268	77.5	12.4	2.8
76	5808	1464	74.8	16.0	4.0
78	6409	1501	76.6	15.2	3.6
82	7551	1709	--	--	--
82	8462	2137	74.8	19.8	5.0
83	6563	1543	76.5	14.9	3.5
84	7634	1866	75.6	15.8	3.9
85	7884	1875	76.2	17.7	4.2
88	8674	2182	74.8	18.5	4.7
<u>90</u>	<u>9290</u>	<u>2207</u>	<u>76.2</u>	<u>17.3</u>	<u>4.1</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	77.93	6129	1496	76.59	15.83	3.73
SD	7.06	2022	457	1.25	2.57	.70
n	15					

APPENDIX G1. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF BROOK TROUT FROM ALL SOLUTIONS, SACRIFICED THE DAY FEEDING WAS DISCONTINUED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
65	2626	484	81.6	16.6	3.1
68	3174	611	80.8	11.5	2.2
68	3156	620	80.4	17.0	3.3
72	3422	657	80.8	18.4	3.5
72	3674	641	82.6	18.9	3.3
75	3718	693	--	--	--
75	3842	782	--	--	--
75	3991	808	79.8	20.5	4.2
76	3941	795	--	--	--
76	4472	896	80.0	12.2	2.4
76	4726	889	81.2	18.0	3.4
78	4352	874	--	--	--
78	4743	870	79.5	21.1	4.3
79	4332	916	--	--	--
80	4854	1006	--	--	--
80	5108	1112	78.2	18.9	4.1
80	4417	892	--	--	--
83	5890	1303	77.9	19.0	4.2
86	5844	1182	79.8	20.8	4.2
86	5544	1183	--	--	--
87	6159	1240	--	--	--
87	6383	1371	78.5	13.1	2.8
88	5869	1316	77.6	16.3	3.7
<u>90</u>	<u>6946</u>	<u>1471</u>	<u>78.8</u>	<u>16.8</u>	<u>3.6</u>

AVERAGES APPLY ONLY TO FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	77.60	4635	949	79.83	17.27	3.49
SD	7.90	1324	321	1.45	3.00	0.67
n	15					

APPENDIX G2. LENGTH AND SURVIVAL TIME OF BROOK TROUT IN 90% DISTILLED/10% TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
60		2012	309	84.6	12.5	1.9
66		3000	491	83.6	11.5	1.9
68		3167	551	--	--	--
69		3058	455	85.1	7.7	1.2
71						
72		3649	583	--	--	--
73						
73		3414	562	83.5	14.7	2.4
74		4266	738	82.7	16.4	2.8
75						
77						
77		4507	689	84.7	9.2	1.4
78						
78						
79						
79		5009	941	81.2	15.3	2.9
80		5418	941	82.6	15.8	2.7
81						
82						
82						
82						
83						
83		5048	786	84.4	12.7	2.0
83		5834	1096	--	--	--
83		5391	1050	80.5	19.3	3.8
85						
85						
86						
86		5748	1013	82.4	12.2	2.2
87						
88						
88		7015	1369	80.5	19.0	3.7
90						
90						
92						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	76.50	4490	779	82.98	13.86	2.41
SD	8.44	1408	301	1.62	3.57	.81
n	12					

APPENDIX G3. LENGTH AND SURVIVAL TIME OF BROOK TROUT IN TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>WET</u> <u>WEIGHT</u> <u>(mg)</u>	<u>DRY</u> <u>WEIGHT</u> <u>(mg)</u>	<u>PERCENT</u> <u>BODY</u> <u>WATER</u>	<u>PERCENT</u> <u>FAT</u> <u>(DW)</u>	<u>PERCENT</u> <u>FAT</u> <u>(WW)</u>
52		1275	181	85.5	4.6	0.7
57		1808	268	--	--	--
59		1960	312	84.1	11.0	1.8
64		2440	398	83.7	10.2	1.7
67		2908	545	81.3	15.4	2.9
68		2862	469	--	--	--
68		3179	515	83.8	8.7	1.4
69		3766	726	--	--	--
70		3202	564	--	--	--
71		3745	659	--	--	--
72		3828	678	82.3	9.6	1.7
72		3302	536	83.8	13.1	2.1
72						
73		3631	617	--	--	--
74		4363	762	--	--	--
75		3911	671	82.8	12.2	2.1
75		4235	720	--	--	--
76		4229	774	--	--	--
78		4013	697	82.6	9.8	1.7
78		4544	721	--	--	--
78		4728	908	--	--	--
78		4969	913	--	--	--
81		5058	908	--	--	--
82						
82						
82						
82						
83						
85						
85		5571	981	82.4	14.6	2.6
85		5873	1094	81.4	14.7	2.7
87						
87						
88		6342	1188	81.3	14.6	2.7
90						
90						
92						
94						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	72.08	3717	650	82.94	11.54	2.01
SD	10.93	1564	307	1.35	3.19	.64
n	12					

APPENDIX G4. LENGTH AND SURVIVAL TIME OF BROOK TROUT IN 0.2% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
61		2378	423	82.2	11.4	2.0
66		2805	453	83.9	10.5	1.7
71		3475	533	84.7	11.1	1.7
72		3469	652	--	--	--
72		3133	546	82.6	11.4	2.0
72		3448	581	--	--	--
73						
74						
75						
75						
77		3985	757	31.0	14.3	2.7
79						
79						
80						
80						
80						
80		4425	861	80.5	16.0	3.1
81		4965	954	80.8	12.4	2.4
82		5239	1082	--	--	--
82						
82						
82						
83						
84						
84						
84		5559	1044	81.2	15.4	2.9
85		5556	1033	--	--	--
85		5876	1164	80.2	14.1	2.8
86						
86						
87						
87						
88						
88						
88						
89		6290	1219	80.6	13.9	2.7
90						
90						
92						
92						
93						
98		8411	1736	79.4	15.1	3.1

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	78.54	4664	881	81.55	13.24	2.46
SD	10.65	1789	400	1.63	1.94	.53
n	11					

APPENDIX G5. LENGTH AND SURVIVAL TIME OF BROOK TROUT IN 0.4% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

<u>LENGTH (mm)</u>	<u>SURVIVAL TIME (DAYS)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
63		2200	372	83.1	15.3	2.6
63		2444	395	83.8	7.9	1.3
64		2152	374	82.6	8.8	1.5
66						
70		3173	507	--	--	--
70		3420	570	83.3	9.7	1.6
72		3847	658	--	--	--
72						
72						
73						
73						
73						
74		3832	723	81.1	20.6	3.9
75						
75						
76						
77						
77		3896	719	81.6	14.0	2.6
78						
79						
79						
79		3959	701	82.3	12.0	2.1
81		4383	815	81.4	14.0	2.6
82		4854	897	81.5	12.4	2.3
82						
83						
83						
84						
84						
85						
85						
85						
85						
86						
86						
87						
87						
88						
89		6131	1261	79.4	12.5	2.6
91		6509	1114	82.9	10.6	1.8
92		6792	1291	81.0	10.0	1.9
92						
94						
<u>94</u>		<u> </u>	<u> </u>	<u> </u>	<u> </u>	<u> </u>

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	77.08	4214	769	82.00	12.32	2.23
SD	10.57	1607	324	1.23	3.44	.70
n	12					

APPENDIX G6. LENGTH AND SURVIVAL TIME OF BROOK TROUT IN 0.85% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
64		2556	442	82.7	10.7	1.9
64		2338	429	81.7	10.8	2.0
65		2294	366	--	--	--
65						
66		2290	423	--	--	--
66		2408	416	82.7	8.5	1.5
68		2984	568	--	--	--
69		2781	484	--	--	--
71		3536	661	81.3	11.6	2.2
72		3255	559	82.8	7.9	1.4
75						
76		3930	661	--	--	--
77		4445	782	82.4	9.9	1.7
77		3939	742	81.2	16.5	3.1
78						
79						
79						
79						
79						
80						
80						
80						
80						
80						
81						
81		4908	918	--	--	--
82		4221	817	80.6	16.5	3.2
82		4953	967	80.5	11.2	2.2
84						
84						
84						
85						
85						
86						
86		5181	960	81.5	16.4	3.0
87						
87		5793	1110	80.8	15.1	2.9
87						
88		5855	1048	82.1	11.2	2.0
90						
90						

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	76.33	4040	744	81.69	12.19	2.26
SD	8.88	1256	247	0.84	3.12	.64
n	12					

APPENDIX G7. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CONTROL BROOK TROUT, SACRIFICED THE DAY THE EXPERIMENT ENDED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
104	12021	2510	79.1	15.2	3.2
108	11672	2560	--	--	--
112	14675	3210	78.1	15.9	3.5
114	14341	3247	--	--	--
121	17705	4004	77.4	15.0	3.4
128	21215	4847	--	--	--
128	19490	4192	--	--	--
129	23045	5379	76.7	17.8	4.2
132	21800	4767	--	--	--
132	23429	5164	78.0	17.9	4.0
135	25533	5812	--	--	--
138	30285	6841	77.4	21.1	4.8
142	30110	6995	76.8	13.9	3.2
146	29455	6879	76.7	19.1	4.5
<u>150</u>	<u>34308</u>	<u>8029</u>	<u>76.6</u>	<u>12.2</u>	<u>2.9</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	130.44	23893	5446	77.42	16.44	3.74
SD	15.61	7779	1899	0.85	2.75	.66
n	9					

APPENDIX H1. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CHANNEL CATFISH FROM ALL SOLUTIONS, SACRIFICED THE DAY FEEDING WAS DISCONTINUED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
51	967	174	82.0	17.0	3.1
54	1304	286	78.1	25.0	5.5
55	1409	247	82.5	11.4	2.0
56	1559	382	--	--	--
57	1742	419	--	--	--
57	1772	412	--	--	--
57	1669	336	--	--	--
57	1466	337	77.0	25.5	5.9
58	1824	436	--	--	--
59	1888	475	74.8	26.4	6.6
59	1636	360	78.0	20.4	4.5
60	1963	466	--	--	--
60	1848	514	--	--	--
60	1787	380	--	--	--
60	1964	439	--	--	--
62	2428	606	75.0	27.9	7.0
66	2740	681	--	--	--
66	2402	502	79.1	20.6	
66	2374	529	77.7	22.5	4.4
67	2584	619	--	--	--
67	2681	576	78.5	18.5	4.0
68	2394	536	77.6	24.8	5.6
68	3090	773	75.0	26.9	6.7
69	2748	619	77.5	25.4	5.7
72	2854	613	78.5	17.6	3.8
74	2888	614	78.7	17.4	3.7
<u>81</u>	<u>4667</u>	<u>1273</u>	<u>72.7</u>	<u>34.2</u>	<u>9.3</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

X	64.25	2325	533	77.67	22.59	5.19
SD	8.08	899	255	2.51	5.52	1.83
n	16					

APPENDIX H2. LENGTH AND SURVIVAL TIME OF CHANNEL CATFISH IN 90% DISTILLED/10% TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED SURVIVORS.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
49		1025	160	84.4	15.6	2.4
52		1266	217	82.9	17.3	3.0
53		1511	238	--	--	--
53		1463	296	--	--	--
54		1463	315	78.5	18.2	3.9
54						
55						
55		1720	304	82.3	16.5	2.9
57						
62		2255	480	--	--	--
62		2358	443	81.2	21.4	4.0
62						
62						
63						
63		2643	490	81.3	22.7	4.2
64		2632	539	--	--	--
64		2498	485	80.6	18.3	3.6
64		2519	487	--	--	--
64						
64						
65		2610	564	--	--	--
65						
65						
65						
66						
67						
67						
68						
68						
68		2736	434	84.1	10.7	1.7
69		3293	795	75.9	26.2	6.3
70		3065	595	80.6	21.3	4.1
70						
71						
72						
72		3785	872	--	--	--
72		3107	471	--	--	--
73		3652	704	80.7	24.2	4.7
75						
76						
<u>81</u>		<u>4825</u>	<u>934</u>	<u>80.6</u>	<u>16.2</u>	<u>3.1</u>

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	63.33	2545	490	81.09	19.05	3.66
SD	9.52	1093	234	2.32	4.29	1.19
n	12					

APPENDIX H3. LENGTH AND SURVIVAL TIME OF CHANNEL CATFISH IN TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
50	12	1019	123	87.9	14.8	1.8
53	33	1512	204	86.5	22.1	3.0
54	--	1255	218	82.6	21.6	3.8
54	--	1310	252	80.8	19.2	3.7
55	63	--	--	--	--	--
57	55	--	--	--	--	--
58	61	--	--	--	--	--
59	27	--	--	--	--	--
59	--	1856	382	79.4	19.8	4.1
59	25	1682	324	80.7	17.2	3.3
60	36	--	--	--	--	--
60	30	--	--	--	--	--
60	27	--	--	--	--	--
62	25	--	--	--	--	--
62	40	--	--	--	--	--
62	--	2165	466	78.5	26.9	5.8
63	23	2466	535	78.3	25.9	5.6
64	26	2927	424	85.5	25.8	3.7
65	102	2581	380	85.3	19.2	2.8
65	22	2396	401	83.3	15.0	2.5
66	22	2491	479	80.8	20.4	3.9
67	--	2595	490	81.1	20.0	3.8
68	--	2877	664	--	--	--
68	29	--	--	--	--	--
69	--	3039	607	80.0	21.9	4.4
69	--	3092	662	78.6	28.7	6.2
70	40	--	--	--	--	--
70	10	--	--	--	--	--
70	23	3103	738	76.2	24.3	5.8
72	45	--	--	--	--	--
76	--	4058	896	77.9	22.3	4.9
76	--	3666	727	80.2	18.7	3.7
78	40	--	--	--	--	--
85	33	6112	969	84.2	20.7	3.3

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$ 65.11	2559	522	79.90	22.12	4.49
SD 8.40	993	222	1.48	3.47	.95
n 9					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

$\bar{X}$ 64.00	2628	458	82.87	20.54	3.57
SD 9.58	1385	247	3.77	4.08	1.27
n 10					

APPENDIX H4. LENGTH AND SURVIVAL TIME OF CHANNEL CATFISH IN 0.2% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
48	12	939	160	--	--	--
55	--	1585	360	77.3	31.1	7.1
55	--	1617	258	84.1	8.9	1.4
55	12	1586	262	83.5	28.4	7.9
55	51	--	--	--	--	--
59	--	1819	364	80.0	18.9	3.8
60	--	1852	421	77.3	21.5	4.9
60	27	--	--	--	--	--
60	29	--	--	--	--	--
61	--	2119	403	81.0	19.0	3.6
61	--	2087	399	80.9	19.0	3.6
61	51	--	--	--	--	--
62	32	--	--	--	--	--
63	74	--	--	--	--	--
63	--	2236	438	80.4	17.6	3.5
64	--	2550	512	79.9	24.0	4.8
64	119	1536	224	85.4	9.2	1.3
65	23	2379	391	83.6	27.3	4.5
65	--	2246	536	76.1	27.0	6.4
66	23	2546	545	78.6	25.7	5.5
66	85	--	--	--	--	--
69	56	--	--	--	--	--
69	--	3010	716	76.2	26.8	6.4
70	--	3096	775	--	--	--
71	50	--	--	--	--	--
71	--	3095	560	81.9	15.0	2.7
72	--	3232	948	70.7	33.1	9.7
74	22	3249	747	77.0	29.9	6.9
75	28	3554	694	80.5	29.2	5.7
75	56	--	--	--	--	--
80	29	--	--	--	--	--

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	62.92	2287	493	78.82	21.83	4.58
SD	5.62	568	185	3.52	6.91	2.14
n	12					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	66.50	2475	477	81.43	24.95	5.30
SD	7.34	831	220	3.26	7.86	2.29
n	6					

APPENDIX H5. LENGTH AND SURVIVAL TIME OF CHANNEL CATFISH IN 0.4% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
48	56	--	--	--	--	--
48	56	--	--	--	--	--
50	--	1137	219	80.7	12.8	2.5
51	--	1133	225	80.1	23.0	4.6
53	--	1136	225	--	--	--
53	77	1290	148	88.5	24.3	2.8
54	109	1263	260	79.4	20.8	4.3
54	--	1434	276	--	--	--
55	--	1455	278	--	--	--
56	--	1444	294	79.6	16.8	3.4
57	--	1576	319	--	--	--
58	--	1591	358	--	--	--
58	--	1639	274	83.3	12.6	2.1
60	113	1581	288	81.8	12.4	2.3
61	--	1970	432	78.1	21.6	4.7
63	--	2455	523	--	--	--
63	--	2513	539	78.6	24.7	5.3
64	--	1943	478	--	--	--
64	--	1973	431	--	--	--
65	--	2539	487	--	--	--
66	--	2591	570	78.0	22.8	5.0
66	--	2360	471	--	--	--
66	--	2780	582	--	--	--
67	--	2675	570	--	--	--
68	--	2638	590	77.6	22.5	5.0
69	--	2941	635	78.4	22.9	4.9
69	--	3076	619	79.9	22.0	4.4
70	--	2303	843	79.1	26.9	9.9
86	--	6206	1500	75.8	21.1	7.5

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	63.92	2466	566	79.10	21.64	4.94
SD	9.84	1354	353	1.95	5.36	2.09
n	12					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	55.67	1378	232	83.23	19.17	3.13
SD	3.79	176	74	4.72	6.12	1.04
n	3					

APPENDIX H6. LENGTH AND SURVIVAL TIME OF CHANNEL CATFISH IN 0.85% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
48	--	882	162	81.6	19.6	3.6
48	--	970	203	79.1	27.1	5.7
50	--	1135	224	--	--	--
51	--	1068	216	79.8	22.7	4.6
51	62	967	192	80.2	19.7	3.9
52	--	1247	277	77.8	22.9	5.1
52	92	956	226	76.4	27.1	6.4
53	77	--	--	--	--	--
53	98	1416	213	85.0	29.3	4.4
53	96	1467	265	81.9	26.0	4.7
53	97	1100	172	84.4	13.9	2.2
54	111	967	231	76.1	22.7	5.4
54	--	1449	281	80.6	15.7	3.1
54	--	1437	311	78.4	23.2	5.0
55	71	1275	276	78.4	26.9	5.8
56	--	1780	422	76.3	25.8	6.1
57	--	1672	361	78.4	19.2	4.2
58	--	1761	442	--	--	--
58	--	2001	525	--	--	--
58	--	1926	373	--	--	--
59	--	1763	404	--	--	--
59	--	1728	327	--	--	--
59	78	1444	224	84.5	9.0	1.4
59	--	1879	428	77.2	20.3	4.6
59	--	1779	391	78.0	18.6	4.1
60	--	1823	418	77.1	22.5	5.2
61	--	2225	607	--	--	--
61	--	2475	633	--	--	--
63	88	2049	459	77.6	20.5	4.6
64	--	2178	537	75.3	24.7	6.1
65	--	2624	653	--	--	--
65	99	2114	442	79.1	25.1	5.3
70	--	2857	737	--	--	--
70	--	3046	717	76.5	23.7	5.6
70	--	2912	654	77.5	23.2	5.2
72	--	3197	799	75.0	28.3	7.1
72	92	2506	509	79.7	22.5	4.6
75	89	2820	609	78.4	19.7	4.3

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	58.27	1821	412	77.90	22.50	5.02
SD	7.78	733	191	1.84	3.37	1.04
n	15					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	58.75	1590	318	80.14	21.87	4.42
SD	8.19	634	146	3.13	5.85	1.42
n	12					

APPENDIX H7. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CONTROL CHANNEL CATFISH, SACRIFICED THE DAY THE EXPERIMENT ENDED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
55	1632	309	81.1	22.8	4.3
59	1620	358	--	--	--
61	1989	336	83.1	16.5	2.8
65	2400	479	--	--	--
65	2329	491	78.9	24.2	5.1
68	3100	753	75.7	26.9	6.5
71	2611	588	77.5	21.0	4.7
72	3524	859	--	--	--
72	3319	764	77.0	26.9	6.2
78	3827	826	78.4	22.2	4.8
80	4418	812	81.6	19.0	3.5
81	5007	1170	--	--	--
81	4687	1007	78.5	29.6	6.4
85	5307	1403	73.6	29.8	7.9

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	71.60	3322	728	78.54	23.98	5.22
SD	9.57	1222	326	2.84	4.43	1.54
n	10					

APPENDIX II. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF YELLOW PERCH FROM ALL SOLUTIONS, SACRIFICED THE DAY FEEDING WAS DISCONTINUED.

LENGTH (mm)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
35	226	30	86.7	2.8	0.7
39	388	53	86.3	3.7	0.5
40	551	81	85.3	5.8	0.9
40	674	117	82.6	10.0	1.7
40	607	108	82.2	4.2	0.8
40	779	141	81.9	9.3	1.7
41	717	122	83.0	7.6	1.3
41	683	114	83.3	5.5	0.9
41	446	71	84.1	3.9	0.6
41	779	137	82.4	8.0	1.4
41	551	83	84.9	6.5	1.0
42	851	140	83.6	9.9	1.6
42	887	143	83.9	8.3	1.3
42	892	155	82.6	13.1	2.3
42	895	157	82.5	5.6	1.0
42	632	108	82.9	5.6	1.0
43	477	76	84.1	6.2	1.0
45	790	128	83.8	3.4	0.6
45	630	139	83.3	4.1	0.7
45	953	172	82.0	6.7	1.2
45	999	164	83.6	4.1	0.7
46	845	151	82.1	6.5	1.2
46	680	99	85.4	1.3	0.2
46	707	110	84.4	3.9	0.7
46	1012	175	82.7	6.4	1.1
46	688	118	82.9	3.7	0.6
46	781	130	83.4	4.3	0.7
47	914	161	82.4	6.7	1.2
49	1022	160	84.3	4.7	0.7
49	1281	219	82.9	6.0	1.0
49	1233	237	80.8	15.3	2.9
49	1390	267	80.8	11.8	2.3
50	1413	251	82.2	12.8	2.3
50	818	141	82.8	3.2	0.6
51	1510	275	81.8	7.9	1.4
52	1568	265	83.1	12.8	2.2
52	997	160	84.0	3.5	0.6
54	1351	227	83.2	5.1	0.9
57	1202	190	84.2	3.4	0.5

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

X	45.05	872	148	83.29	6.50	1.12
SD	4.72	313	59	1.29	3.28	0.61
n	39					

APPENDIX I2. LENGTH AND SURVIVAL TIME OF YELLOW PERCH IN 90% DISTILLED/10% TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
35	37	364	54	85.2	2.2	0.3
36	28	358	56	84.4	3.7	0.6
40	12	287	52	81.9	4.9	0.9
40	83	--	--	--	--	--
40	--	478	79	83.5	4.9	0.8
41	15	--	--	--	--	--
41	--	415	75	81.9	4.6	0.8
42	--	532	85	84.0	4.5	0.7
42	29	--	--	--	--	--
42	32	--	--	--	--	--
42	32	--	--	--	--	--
42	47	556	93	83.3	4.8	0.8
42	23	416	71	82.9	4.1	0.7
42	67	468	84	82.1	3.3	0.6
42	83	483	83	82.8	3.6	0.6
43	--	542	88	83.8	4.5	0.7
43	--	580	--	--	--	--
43	--	610	--	--	--	--
43	2	517	81	84.3	3.9	0.6
43	65	550	--	--	--	--
43	90	480	83	82.7	--	--
43	67	550	76	86.2	4.1	0.6
43	--	581	--	--	--	--
44	90	497	81	83.7	--	--
44	62	741	117	84.2	--	--
44	--	580	93	84.0	4.0	0.6
45	--	732	--	--	--	--
45	--	673	120	82.2	3.6	0.6
45	--	663	--	--	--	--
45	35	545	102	81.3	3.2	0.6
45	36	680	114	83.3	3.5	0.6
45	71	701	121	82.7	4.4	0.8
45	77	560	92	83.6	3.8	0.6
45	86	607	96	84.2	3.7	0.6
46	13	654	61	90.7	3.8	0.4
46	--	641	109	83.0	3.8	0.7
46	--	687	--	--	--	--
46	--	651	--	--	--	--
46	--	692	108	84.4	4.3	0.7
46	--	640	--	--	--	--
46	--	658	119	81.9	4.3	0.8
47	--	781	146	81.3	4.1	0.8
47	--	853	--	--	--	--
47	--	730	--	--	--	--
47	--	834	--	--	--	--
47	--	828	--	--	--	--
47	--	753	--	--	--	--
47	--	650	116	82.2	--	--
47	95	763	123	83.9	3.6	0.6
48	--	809	141	82.6	3.6	0.6
48	--	782	--	--	--	--
48	--	724	126	82.6	--	--
48	--	886	--	--	--	--
48	--	848	--	--	--	--
48	--	865	137	84.2	4.0	0.6
48	--	820	147	82.1	--	--
49	--	836	153	81.7	--	--
49	--	887	154	82.6	--	--
49	--	868	145	83.3	--	--
49	95	731	123	83.2	3.9	0.7
50	31	767	143	81.4	3.0	0.6
51	22	1090	187	87.8	3.6	0.6

APPENDIX I2. CONTINUED.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>WET</u> <u>WEIGHT</u> <u>(mg)</u>	<u>DRY</u> <u>WEIGHT</u> <u>(mg)</u>	<u>PERCENT</u> <u>BODY</u> <u>WATER</u>	<u>PERCENT</u> <u>FAT</u> <u>(DW)</u>	<u>PERCENT</u> <u>FAT</u> <u>(WW)</u>
51	--	--	--	--	--	--
51	--	--	--	--	--	--
52	--	--	--	--	--	--
52	--	1120	211	81.2	4.8	0.9
52	--	1043	--	--	--	--
52	--	1127	186	83.5	3.8	0.6
53	--	1081	199	81.6	3.9	0.7
54	--	--	--	--	--	--
55	--	--	--	--	--	--
55	--	--	--	--	--	--
55	--	1257	240	80.9	4.3	0.9
56	--	1170	--	--	--	--
<u>52</u>	--	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>	<u>--</u>

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

X	46.75	766	130	82.70	4.20	0.73
SD	4.42	258	51	1.21	.40	.10
n	16					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

X	43.84	584	95	83.96	3.74	0.62
SD	4.13	186	34	2.29	.61	.13
n	22					

APPENDIX I3. LENGTH AND SURVIVAL TIME OF YELLOW PERCH IN TAP WATER AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
33	14	233	40	82.8	5.6	1.0
34	19	323	54	83.3	2.9	0.5
36	28	357	63	82.4	5.8	1.0
36	22	303	47	84.5	3.6	0.6
36	43	356	58	83.7	2.1	0.3
37	26	--	--	--	--	--
38	8	335	58	82.7	--	--
38	48	419	63	85.0	3.4	0.5
39	45	382	67	82.5	3.4	0.6
40	29	--	--	--	--	--
40	20	484	84	82.7	3.1	0.5
40	42	422	71	83.2	2.8	0.5
40	34	466	80	82.8	3.1	0.5
40	22	489	87	82.2	--	--
41	28	478	75	84.3	3.6	0.6
41	13	430	70	83.7	3.8	0.6
41	34	400	74	81.5	3.4	0.6
41	36	482	87	82.0	4.5	0.8
41	22	477	87	81.8	--	--
42	45	469	85	81.9	4.0	0.7
42	65	455	73	84.0	2.7	0.4
42	26	--	--	--	--	--
42	--	476	76	84.0	--	--
42	--	557	85	84.7	3.9	0.6
42	--	476	76	84.0	4.4	0.7
43	3	682	103	84.9	3.6	0.5
43	34	618	114	81.6	--	--
43	45	593	87	85.3	4.2	0.6
43	71	481	81	83.2	3.8	0.6
43	62	559	89	84.1	--	--
44	28	656	106	83.8	2.7	0.4
44	28	565	106	81.2	--	--
44	--	565	90	84.1	3.5	0.6
44	--	634	103	83.8	3.7	0.6
45	--	578	95	83.6	3.7	0.6
45	33	--	--	--	--	--
45	92	480	78	83.8	3.5	0.6
45	89	688	100	85.5	--	--
45	90	500	83	83.4	--	--
46	65	674	108	84.0	2.5	0.4
46	50	571	95	83.4	3.1	0.5
46	90	584	91	84.4	4.3	0.7
46	32	--	--	--	--	--
46	--	672	108	83.9	4.1	0.7
46	--	633	114	82.0	--	--
46	--	650	106	83.7	4.5	0.7
47	92	461	78	83.1	3.6	0.5
47	--	767	119	84.5	3.9	0.7
47	--	681	116	83.0	--	--
47	--	738	--	--	--	--
47	--	658	--	--	--	--
48	--	746	135	81.9	--	--
48	--	771	132	82.9	4.0	0.7
48	--	806	--	--	--	--
48	48	744	130	82.5	--	--
48	43	708	125	82.4	3.0	0.5
48	76	747	116	84.5	--	--
48	--	--	--	--	--	--
49	32	--	--	--	--	--
49	--	--	--	--	--	--
49	43	745	132	82.3	--	--
49	37	693	128	81.5	--	--
49	--	879	160	81.8	3.2	0.6

APPENDIX I3. CONTINUED.

<u>LENGTH</u> <u>(mm)</u>	<u>SURVIVAL</u> <u>TIME</u> <u>(DAYS)</u>	<u>WET</u> <u>WEIGHT</u> <u>(mg)</u>	<u>DRY</u> <u>WEIGHT</u> <u>(mg)</u>	<u>PERCENT</u> <u>BODY</u> <u>WATER</u>	<u>PERCENT</u> <u>FAT</u> <u>(DW)</u>	<u>PERCENT</u> <u>FAT</u> <u>(WW)</u>
49	--	665	122	81.7	--	--
49	--	849	134	84.2	3.7	0.5
49	--	808	--	--	--	--
49	--	749	--	--	--	--
49	--	706	--	--	--	--
50	--	864	137	84.1	3.6	0.6
51	--	900	159	82.3	4.0	0.7
51	--	1010	166	83.6	--	--
52	--	1009	202	80.0	4.4	0.9
52	--	--	--	--	--	--
52	--	--	--	--	--	--
52	--	--	--	--	--	--
52	--	--	--	--	--	--
52	--	--	--	--	--	--
53	--	--	--	--	--	--
53	--	1041	--	--	--	--
55	--	--	--	--	--	--

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$ 46.78	726	122	83.40	3.90	0.66
SD 3.19	159	35	1.27	.37	.09
n 14					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

$\bar{X}$ 41.12	475	79	83.41	3.54	0.58
SD 4.08	121	19	0.99	.85	.18
n 26					

APPENDIX I4. LENGTH AND SURVIVAL TIME OF YELLOW PERCH IN 0.2% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
32	10	--	--	--	--	--
34	18	258	42	83.7	3.3	0.5
36	20	388	68	82.5	--	--
36	34	323	58	82.0	2.7	0.5
37	31	313	56	82.1	3.1	0.6
38	7	409	52	87.3	2.8	0.4
38	51	--	--	--	--	--
38	51	346	59	83.0	3.0	0.5
38	22	375	63	83.2	4.3	0.7
39	23	306	55	82.0	--	--
39	29	--	--	--	--	--
40	13	357	61	82.9	4.2	0.7
40	36	472	83	82.4	2.8	0.5
40	34	437	73	83.3	3.3	0.6
40	52	425	67	84.2	3.3	0.5
40	29	--	--	--	--	--
41	45	543	85	84.4	3.1	0.5
41	49	457	76	83.4	3.2	0.5
41	36	463	82	82.3	4.4	0.8
41	43	491	73	85.1	2.9	0.4
41	70	480	59	87.7	4.3	0.5
41	--	494	75	84.8	4.7	0.7
41	--	530	77	85.8	4.3	0.6
42	--	--	--	--	--	--
42	29	--	--	--	--	--
42	29	--	--	--	--	--
42	8	496	81	83.7	--	--
42	20	390	69	82.3	--	--
42	14	549	88	84.0	--	--
42	62	549	93	83.1	--	--
42	86	477	74	84.5	3.8	0.6
42	59	438	71	83.8	--	--
43	4	435	68	84.4	--	--
43	2	533	91	82.9	3.2	0.6
43	14	588	84	85.7	3.8	0.5
43	14	522	83	84.1	--	--
43	47	635	102	83.9	--	--
43	51	505	94	81.4	--	--
43	47	546	94	82.8	--	--
43	30	478	87	81.8	2.0	0.4
43	67	571	81	85.8	--	--
44	17	474	79	83.3	4.3	0.7
44	52	633	105	83.4	--	--
44	43	564	94	83.3	--	--
44	52	556	91	83.6	--	--
44	--	587	89	84.8	4.7	0.7
45	--	746	118	84.2	3.5	0.6
45	--	589	87	85.2	4.7	0.7
45	26	--	--	--	--	--
45	--	--	--	--	--	--
45	--	--	--	--	--	--
45	32	--	--	--	--	--
45	32	--	--	--	--	--
45	50	620	111	82.1	3.1	0.6
45	45	597	108	81.9	--	--
45	51	605	110	81.8	--	--
45	85	595	102	82.9	3.8	0.7
45	52	712	121	83.0	--	--
46	50	655	120	81.7	2.5	0.5
46	78	665	122	81.7	--	--
46	73	695	115	83.5	3.4	0.6

APPENDIX I4. CONTINUED.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
46	70	642	--	--	--	--
46	73	707	106	85.0	--	--
46	--	644	99	84.6	3.6	0.6
46	--	719	115	84.0	4.0	0.6
46	--	--	--	--	--	--
46	--	695	107	84.6	4.0	0.6
47	--	--	--	--	--	--
47	--	747	98	86.9	3.2	0.4
47	--	717	109	84.8	4.0	0.6
47	45	740	--	--	--	--
48	59	700	125	82.1	2.6	0.5
48	32	--	--	--	--	--
50	--	--	--	--	--	--
56	--	1094	191	82.5	3.6	0.6
56	--	--	--	--	--	--

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$	45.81	688	106	84.75	4.03	0.61
SD	3.97	161	32	1.09	0.53	.08
n	10					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

$\bar{X}$	41.24	479	79	83.50	3.33	0.56
SD	3.36	118	22	1.58	0.64	.10
n	26					

APPENDIX 15. LENGTH AND SURVIVAL TIME OF YELLOW PERCH IN 0.4% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
35	42	377	61	83.8	--	--
37	30	443	73	83.5	2.1	0.4
37	43	301	52	82.7	4.8	0.8
37	7	255	43	83.1	--	--
37	10	--	--	--	--	--
38	14	394	69	82.5	4.5	0.8
38	31	401	65	83.8	5.4	0.9
39	14	373	53	85.8	5.8	0.8
39	34	405	70	82.7	2.5	0.4
39	36	393	68	82.7	3.0	0.5
39	31	--	--	--	--	--
39	39	--	--	--	--	--
40	62	429	66	84.6	4.1	0.6
40	4	360	56	84.4	5.9	0.9
40	20	319	50	84.3	--	--
40	47	446	76	83.0	--	--
40	52	454	76	83.3	4.8	0.8
40	40	389	64	83.6	--	--
41	14	386	62	83.9	--	--
41	95	426	67	84.3	--	--
41	14	--	--	--	--	--
41	29	511	--	--	--	--
41	29	495	--	--	--	--
42	8	--	--	--	--	--
42	32	--	--	--	--	--
42	14	447	59	86.8	6.8	0.9
42	16	470	71	84.9	--	--
42	45	453	77	83.0	--	--
42	82	459	55	88.0	--	--
42	31	503	89	82.3	--	--
42	78	614	101	83.6	3.8	0.6
43	36	507	87	82.8	--	--
43	89	538	85	84.2	--	--
43	95	488	73	85.0	4.1	0.6
43	15	--	--	--	--	--
43	22	--	--	--	--	--
43	29	567	--	--	--	--
43	50	571	99	82.7	--	--
43	75	607	89	85.3	4.1	0.6
43	67	548	85	84.5	--	--
43	43	545	72	86.8	--	--
43	52	583	101	82.7	--	--
44	48	541	87	83.9	3.3	0.5
44	47	570	98	82.8	--	--
44	5	452	74	83.6	--	--
44	28	508	93	81.7	--	--
44	77	631	85	86.5	3.8	0.5
44	38	523	89	83.0	--	--
44	40	595	98	83.5	--	--
44	32	--	--	--	--	--
44	--	516	92	82.2	4.1	0.7
45	--	535	86	83.9	4.0	0.6
45	39	--	--	--	--	--
45	1	528	58	89.0	--	--
45	21	462	79	82.9	3.2	0.6
45	48	603	112	81.4	1.6	0.3
45	50	546	93	83.0	--	--
45	40	566	92	83.8	--	--
46	48	567	107	81.1	--	--
46	41	555	93	83.2	--	--
46	83	662	88	86.7	3.6	0.5
46	75	596	107	82.1	3.8	0.7
46	82	633	92	85.5	4.1	0.6

APPENDIX I5. CONTINUED.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
46	--	606	95	84.3	3.3	0.5
46	--	653	110	83.2	4.5	0.8
46	29	699	--	--	--	--
46	29	607	--	--	--	--
47	--	--	--	--	--	--
47	50	665	123	81.5	3.1	0.6
47	47	720	121	83.2	--	--
48	34	757	139	81.6	--	--
48	37	708	125	82.4	--	--
48	--	--	--	--	--	--
48	--	900	158	82.4	3.4	0.8
48	--	684	112	83.6	--	--
48	--	797	115	85.6	--	--
49	--	768	126	83.6	--	--
49	--	810	136	83.2	4.2	0.7
49	--	782	122	84.4	--	--
49	39	--	--	--	--	--
49	34	778	139	82.1	2.9	0.5
50	62	997	169	83.1	--	--
50	--	--	--	--	--	--
50	26	--	--	--	--	--
50	--	899	140	84.4	4.5	0.7
50	--	870	140	83.9	--	--
50	--	848	128	84.9	--	--
51	78	827	118	85.7	4.3	0.6
52	--	847	140	83.5	--	--
52	--	979	144	85.3	3.9	0.6
53	45	963	158	83.6	1.2	0.2
55	--	1183	208	82.4	7.6	1.3
56	--	--	--	--	--	--
56	70	1113	145	87.0	--	--
56	67	1534	237	84.6	2.8	0.4
57	--	--	--	--	--	--
57	--	1393	249	82.1	--	--
57	--	1288	214	83.4	3.8	0.6
57	--	1144	159	86.1	4.4	0.6
57	--	1272	195	84.7	3.7	0.6

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$	50.50	899	145	83.79	4.28	0.61
SD	4.96	281	44	1.22	1.12	.18
n	12					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

$\bar{X}$	43.42	577	92	83.97	3.84	0.60
SD	4.96	251	40	1.59	1.26	.18
n	26					

APPENDIX I6.

LENGTH AND SURVIVAL TIME OF YELLOW PERCH IN 0.6% NaCl AND WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER AND BODY FAT (dry weight, DW and wet weight, WW) OF SELECTED FISH DYING DURING THE EXPERIMENT OR SURVIVING.

LENGTH (mm)	SURVIVAL TIME (DAYS)	WET WEIGHT (mg)	DRY WEIGHT (mg)	PERCENT BODY WATER	PERCENT FAT (DW)	PERCENT FAT (WW)
36	12	268	46	82.8	2.2	0.4
38	22	335	57	83.0	2.2	0.4
39	13	314	59	81.2	3.2	0.6
39	26	--	--	--	--	--
40	15	--	--	--	--	--
41	5	335	55	83.6	2.2	0.4
41	14	455	73	84.0	--	--
41	23	379	67	82.3	2.6	0.5
42	5	392	65	83.4	--	--
42	36	560	100	82.1	--	--
42	26	--	--	--	--	--
43	1	684	108	84.2	--	--
43	14	495	90	81.8	3.3	0.6
43	41	492	85	82.7	--	--
43	41	534	92	82.8	--	--
43	82	555	83	85.1	3.3	0.5
43	87	463	73	84.2	4.1	0.7
44	16	576	101	82.5	--	--
44	70	--	--	--	--	--
45	14	601	105	82.5	--	--
45	31	588	93	84.2	--	--
45	36	554	102	81.6	--	--
45	50	535	93	82.6	4.1	0.7
45	15	--	--	--	--	--
45	--	543	79	85.5	5.1	0.7
46	--	643	96	85.1	3.4	0.5
46	26	691	--	--	--	--
46	29	601	--	--	--	--
46	32	--	--	--	--	--
46	70	856	106	87.6	5.0	0.6
47	65	668	120	82.0	4.1	0.7
47	73	769	111	85.6	3.4	0.5
47	44	704	121	82.8	--	--
47	50	690	112	83.8	--	--
47	--	802	117	85.4	4.9	0.7
48	--	880	146	83.4	5.3	0.9
48	--	664	119	82.1	4.1	0.7
48	3	871	108	87.6	--	--
48	7	763	121	84.1	2.4	0.4
48	36	668	115	82.8	3.8	0.7
48	10	--	--	--	--	--
48	29	--	--	--	--	--
48	32	--	--	--	--	--
50	--	1213	199	83.6	4.3	0.7
50	--	969	161	83.4	4.8	0.8
51	--	1040	164	84.2	3.1	0.5
50	12	756	128	83.1	3.1	0.5
50	21	766	138	82.0	3.3	0.6
51	40	1075	168	84.4	3.5	0.6
52	--	911	129	85.8	4.6	0.7
53	40	--	--	--	--	--

AVERAGES FOR SURVIVORS ANALYZED FOR FAT CONTENT.

$\bar{X}$	48.55	852	134	84.28	4.40	0.69
SD	2.35	212	37	1.25	0.75	0.13
n	9					

AVERAGES FOR THOSE THAT DIED AND WERE ANALYZED FOR FAT CONTENT.

$\bar{X}$	44.47	588	96	83.42	3.28	0.55
SD	4.45	227	34	1.61	0.79	0.11
n	17					

APPENDIX I7. LENGTH, WET WEIGHT, DRY WEIGHT, PERCENT TOTAL BODY WATER, PERCENT FAT (dry weight, DW and wet weight, WW) OF A SAMPLE OF CONTROL YELLOW PERCH, SACRIFICED THE DAY THE EXPERIMENT ENDED.

<u>LENGTH (mm)</u>	<u>WET WEIGHT (mg)</u>	<u>DRY WEIGHT (mg)</u>	<u>PERCENT BODY WATER</u>	<u>PERCENT FAT (DW)</u>	<u>PERCENT FAT (WW)</u>
64	1143	371	78.7	8.5	2.8
76	3802	936	75.4	11.9	2.9
77	3605	789	78.1	6.9	1.5
78	3904	966	--	--	--
79	3961	1022	--	--	--
80	3939	946	76.0	11.1	2.7
82	4439	1089	75.5	10.7	2.6
83	5113	1234	75.9	11.7	2.8
88	6073	1513	75.1	12.0	3.0
88	6023	1481	75.4	9.9	2.4
89	5730	1411	75.4	10.3	2.5
93	6625	1623	75.5	11.1	2.7
97	9507	2397	74.8	11.8	3.0
<u>101</u>	<u>8423</u>	<u>2144</u>	<u>74.6</u>	<u>11.4</u>	<u>2.9</u>

AVERAGES FOR FISH ANALYZED FOR FAT CONTENT.

$\bar{X}$	84.83	5368	1327	75.87	10.61	2.65
SD	10.10	2245	567	1.25	1.54	.41
n	12					

APPENDIX J1. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF CONTROL LARGE-MOUTH BASS (I).

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	60	37.0	301.1	90
5-X-75	60	42.0	284.9	86
(21°C)	63	37.0	306.5	105
	57	36.0	311.8	85
	<u>52</u>	<u>42.6</u>	<u>301.1</u>	<u>90</u>
$\bar{X}$	58.4	38.9	301.1	91.2
SD	4.2	3.1	10.1	8.0
40 DAYS AFTER START (21°C)	67	30.0	301.1	100
	69	33.0	317.2	112
	61	27.0	311.8	---
	65	31.0	311.8	98
	<u>70</u>	<u>29.0</u>	<u>317.2</u>	<u>104</u>
$\bar{X}$	66.4	30.0	311.8	103.5
SD	3.6	2.2	6.6	6.2
62 DAYS AFTER START (15°C)	59	25.0	306.5	112
	65	24.0	290.3	109
	65	30.0	306.5	84
	58	19.0	311.8	83
	<u>66</u>	<u>24.0</u>	<u>322.6</u>	<u>112</u>
$\bar{X}$	62.6	24.4	307.5	100
SD	3.8	3.9	11.7	15.1
END	66	34.0	311.8	110
31-I-76	73	33.0	306.5	116
(21°C)	60	36.0	301.1	122
	72	39.5	317.2	116
	<u>65</u>	<u>39.5</u>	<u>306.5</u>	<u>118</u>
$\bar{X}$	67.2	36.4	308.6	116.4
SD	5.4	3.0	6.1	4.3

APPENDIX J2. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF LARGEMOUTH BASS IN 90% DISTILLED/10% TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	62	34.0	306.5	88
5-X-75	56	34.0	301.1	105
(21°C)	62	38.0	290.3	90
	57	37.0	290.3	98
	<u>64</u>	<u>38.5</u>	<u>295.7</u>	<u>94</u>
$\bar{X}$	60.2	36.3	296.8	95.0
SD	3.5	2.2	7.0	6.8
40 DAYS AFTER START (4°C)	61	19.0	290.3	92
	65	17.0	290.3	78
	61	15.0	317.2	74
	60	12.0	295.7	83
	<u>62</u>	<u>20.0</u>	<u>311.8</u>	<u>71</u>
$\bar{X}$	61.8	16.6	301.1	79.6
SD	1.9	3.2	12.6	8.3
62 DAYS AFTER START (2°C)	68	26.0	285.0	86
	62	24.0	290.3	94
	63	15.0	285.6	82
	57	25.0	306.5	81
	<u>62</u>	<u>12.0</u>	<u>301.1</u>	<u>79</u>
$\bar{X}$	62.4	20.4	293.7	84.4
SD	3.9	6.4	9.6	5.9
END	63	18.0	311.8	78
31-I-76	60	24.0	301.1	66
(2°C)	65	25.0	311.8	86
	62	31.0	295.7	82
	<u>63</u>	<u>29.0</u>	<u>306.5</u>	<u>80</u>
$\bar{X}$	62.6	25.4	305.4	78.4
SD	1.8	5.0	7.0	7.5

APPENDIX J3. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF LARGEMOUTH BASS IN TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	58	34.2	317.2	104
5-X-75	61	33.0	306.5	98
(21°C)	62	43.0	311.8	110
	63	44.0	295.7	84
	<u>64</u>	<u>28.0</u>	<u>311.8</u>	<u>98</u>
$\bar{X}$	61.6	36.4	308.6	98.8
SD	2.3	6.9	8.1	9.7
40 DAYS AFTER START (4°C)	65	13.0	284.9	81
	56	8.0	290.3	76
	64	12.0	279.6	88
	<u>62</u>	<u>12.0</u>	<u>306.5</u>	<u>85</u>
$\bar{X}$	61.8	11.3	290.3	82.5
SD	4.0	2.2	11.6	5.2
62 DAYS AFTER START (2°C)	55	22.0	279.6	78
	60	21.0	285.0	82
	60	14.0	306.5	98
	54	32.0	290.3	73
	<u>53</u>	<u>23.0</u>	<u>290.3</u>	<u>75</u>
$\bar{X}$	56.4	22.4	290.3	81.2
SD	3.4	6.4	10.1	10.0
END	57	25.0	306.5	105
31-I-76	60	29.0	311.8	105
(2°C)	63	22.0	311.8	100
	65	19.0	290.3	85
	<u>58</u>	<u>20.0</u>	<u>322.6</u>	<u>90</u>
$\bar{X}$	60.6	23.0	308.6	97.0
SD	3.4	4.1	11.8	9.1

APPENDIX J4. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF LARGEMOUTH BASS IN 0.1% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	58	43.0	290.3	83
5-X-75	59	38.0	328.0	75
(21°C)	63	38.0	301.1	94
	57	39.5	306.5	109
	64	36.0	311.8	85
$\bar{X}$	60.2	38.9	307.5	89.2
SD	3.1	2.6	13.9	13.0
40 DAYS AFTER START (4°C)	70	22.0	322.5	106
	64	18.0	317.2	74
	56	16.0	---	---
	59	13.0	328.0	83
	69	15.0	301.1	107
$\bar{X}$	63.6	16.8	317.2	92.5
SD	6.1	3.4	11.6	16.6
62 DAYS AFTER START (2°C)	68	18.0	317.2	85
	58	22.0	328.0	88
	62	15.0	338.7	104
	63	19.0	344.1	110
	60	19.0	333.3	98
$\bar{X}$	62.2	18.6	332.3	97.0
SD	3.8	2.5	10.3	10.5
END	57	24.0	317.2	90.5
31-I-76	73	18.5	338.7	110
(2°C)	54	18.0	322.6	119
	61	18.0	322.6	117
	59	18.0	311.8	104
$\bar{X}$	60.8	19.3	322.6	108.1
SD	7.3	2.6	10.1	11.5

APPENDIX J5. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF HEALTHY LARGE-MOUTH BASS AND OF LARGEMOUTH BASS APPARENTLY NEAR DEATH IN 0.5% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	SURVIVAL TIME (DAYS)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	58	--	36.0	285.0	107
5-X-75	59	--	38.0	301.1	95
(21°C)	64	--	35.0	301.1	115
	63	--	38.0	311.8	107
	66	--	36.0	301.1	106
$\bar{X}$	62.0		36.6	300.0	106.0
SD	3.4		1.3	9.6	7.1
40 DAYS AFTER START (4°C)	65	--	16.0	344.0	123
	62	--	25.0	333.3	126
	64	--	20.0	306.5	105
$\bar{X}$	63.7		20.3	327.9	118.0
SD	1.5		4.5	19.3	11.4
62 DAYS AFTER START (2°C)	62	--	17.0	328.0	108
	61	--	20.0	338.7	89
	61	--	19.0	311.8	91
	61	--	21.0	344.1	110
	65	--	17.0	338.7	100
$\bar{X}$	62.0		18.8	332.3	99.6
SD	1.7		1.8	12.8	9.6
(2°C)	62	92	25.0	344.1	88
(2°C)	56	97	36.5	360.2	95
$\bar{X}$	59		30.8	352.2	91.5
SD	4.2		8.1	11.4	5.0
END	65	--	32.0	392.4	134
31-I-76	65	--	20.0	365.6	113
(2°C)	60	--	23.0	371.1	103
	61	--	27.0	338.7	78
	65	--	28.0	360.2	116
$\bar{X}$	63.2		26.0	365.6	108.8
SD	2.5		4.6	19.4	20.5

APPENDIX J6. MEAN LENGTH, HEMATOCRIT, OSMOLALITY AND CHLORIDE ION CONCENTRATION OF HEALTHY LARGEMOUTH BASS AND OF LARGEMOUTH BASS APPARENTLY NEAR DEATH IN 1.0% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	SURVIVAL TIME (DAYS)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)
START	64	--	35.0	311.8	103
5-X-75 (21°C)	56	--	34.0	311.8	114
	62	--	34.0	333.3	125
	61	--	27.0	311.8	85
	<u>61</u>	--	<u>26.0</u>	<u>344.1</u>	<u>135</u>
X	60.8		31.2	322.6	112.4
SD	3.0		4.3	15.2	19.4
40 DAYS AFTER START (4°C)	62	--	19.0	333.3	--
	63	--	19.0	349.5	89
	64	--	20.0	354.8	115
	<u>62</u>	--	<u>17.0</u>	<u>338.7</u>	<u>110</u>
X	62.8		18.8	344.1	104.7
SD	1.0		1.3	9.8	13.8
62 DAYS AFTER START (2°C)	60	--	27.0	360.2	140
	66	--	29.0	371.0	148
	58	--	22.0	349.5	136
	61	--	25.0	360.2	152
	<u>65</u>	--	<u>26.6</u>	<u>354.8</u>	<u>144</u>
X	62.0		25.9	359.1	144.0
SD	3.4		2.6	8.0	6.3
(2°C)	66	64	33.0	392.5	151
(2°C)	59	71	22.0	381.7	144
(2°C)	59	73	27.0	365.6	131
(2°C)	60	88	23.0	414.0	116
(2°C)	63	89	22.0	403.2	155
(2°C)	<u>58</u>	<u>92</u>	<u>30.0</u>	<u>376.3</u>	<u>109</u>
X	60.8		26.2	388.9	134.3
SD	3.1		4.6	17.9	18.9
END	69	--	13.0	381.7	141
31-I-76	65	--	25.0	392.5	156.5
(2°C)	<u>66</u>	--	<u>22.0</u>	<u>419.4</u>	<u>121.5</u>
X	66.7		20.0	397.9	139.7
SD	2.1		6.3	19.4	17.6

APPENDIX K1. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CONTROL LARGEMOUTH BASS (II).

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	68	34.5	344.1	133	146.7
19-I-76	81	33.0	322.6	137	134.5
(13.5°C)	74	37.0	333.3	112	146.7
	72	37.5	328.0	125	125.8
	62	36.5	333.3	126	131.0
$\bar{X}$	71.4	35.7	332.3	126.6	136.9
SD	7.1	1.9	8.0	9.6	9.4
36 DAYS AFTER START (21.0°C)	88	30.0	295.7	119	125.8
	66	46.0	317.2	121	118.8
	74	41.0	322.6	122	148.5
	67	47.5	317.2	124	155.5
	76	42.0	322.6	128	138.0
$\bar{X}$	74.2	41.3	315.1	122.8	137.3
SD	8.8	6.9	11.2	3.4	15.3
58 DAYS AFTER START (21.0°C)	82	26.3	301.1	116	148.5
	67	30.7	301.1	120	146.7
	95	34.8	311.8	122	124.0
	78	34.3	338.7	118	145.0
	69	38.0	317.2	113	148.5
$\bar{X}$	78.2	32.8	314.0	117.8	142.5
SD	11.3	4.5	15.5	3.5	10.5
END	87	30.0	311.8	105	127.5
19-V-76	71	30.0	317.2	104	124.0
(21.0°C)	85	33.0	317.2	118	136.2
	83	40.0	311.8	117	138.0
	78	45.0	322.6	124	139.7
$\bar{X}$	80.8	35.6	316.1	113.6	133.1
SD	6.4	6.7	4.5	8.7	6.9

APPENDIX K2. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF LARGEMOUTH BASS IN 0.2% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	70	28.0	301.1	98	157.2
19-I-76	65	43.0	306.5	110	165.9
(13.5°C)	74	48.5	349.5	124	143.2
	69	39.0	338.7	107	136.2
	71	46.0	328.0	112	---
$\bar{X}$	69.8	40.9	324.8	110.2	150.6
SD	3.3	8.0	20.7	9.4	13.4
36 DAYS AFTER START (4.0°C)	65	27.0	322.6	105	157.2
	80	25.5	317.2	104	143.2
	67	23.0	322.6	117	134.5
	66	26.5	322.6	114	118.8
	80	33.0	328.0	122	---
$\bar{X}$	71.6	27.0	322.6	112.4	138.4
SD	7.7	3.7	3.8	7.8	16.1
58 DAYS AFTER START (2.0°C)	64	23.0	328.0	116	146.7
	72	26.3	317.2	108	148.5
	72	21.0	317.2	117	115.3
	68	28.5	311.8	107	141.5
	76	25.5	317.2	110	127.5
$\bar{X}$	70.4	24.9	318.3	111.6	135.9
SD	4.6	2.9	5.9	4.6	14.2
END	65	15.7	338.7	131	136.2
19-V-76	66	20.5	328.0	111	143.2
(2.0°C)	57	23.0	333.3	117	141.5
	70	24.0	344.1	133	143.2
	60	21.5	338.7	131	---
$\bar{X}$	63.6	20.9	336.6	124.6	141.0
SD	5.1	3.2	6.1	9.9	3.3

APPENDIX K3. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF LARGEMOUTH BASS IN 0.4% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	78	40.5	360.2	144	139.7
19-I-76	87	49.0	333.3	129	148.5
(13.5°C)	72	48.5	322.6	122	131.0
	73	49.5	338.7	107	106.6
	<u>71</u>	<u>37.5</u>	<u>344.1</u>	<u>127</u>	<u>---</u>
$\bar{X}$	76.2	45.0	339.8	125.8	131.5
SD	6.6	5.6	13.9	13.3	18.0
36 DAYS AFTER START (4.0°C)	72	31.0	317.2	111	153.7
	71	29.0	317.2	104	143.2
	89	30.0	311.8	106	164.2
	62	23.0	306.5	112	148.5
	<u>61</u>	<u>21.5</u>	<u>317.2</u>	<u>113</u>	<u>145.0</u>
$\bar{X}$	71.0	26.9	314.0	109.2	150.9
SD	11.2	4.3	4.8	4.0	8.4
58 DAYS AFTER START (2.0°C)	65	25.0	333.3	119	150.2
	69	22.7	338.7	135	153.7
	72	26.0	344.1	129	141.5
	70	31.5	344.1	113	145.0
	<u>76</u>	<u>27.5</u>	<u>333.3</u>	<u>102</u>	<u>---</u>
$\bar{X}$	70.4	26.5	338.7	119.6	147.6
SD	4.0	3.3	5.4	13.0	5.4
END	64	19.7	338.7	150	139.7
19-V-76	69	20.5	344.1	123	136.2
(2.0°C)	68	21.0	333.3	115	132.8
	63	17.0	349.5	147	143.2
	<u>68</u>	<u>20.5</u>	<u>344.1</u>	<u>140</u>	<u>---</u>
$\bar{X}$	66.4	19.7	341.9	135.0	138.0
SD	2.7	1.6	6.2	15.3	4.5

APPENDIX K4. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF LARGEMOUTH BASS IN 0.85% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	64	38.0	328.0	118	124.0
19-I-76	69	29.5	349.5	124	132.7
(13.5°C)	84	41.5	328.0	104	---
	69	28.0	371.0	157	153.7
	70	26.5	360.2	149	157.2
$\bar{X}$	71.2	32.7	347.3	130.4	141.9
SD	7.5	6.6	19.2	22.1	16.1
36 DAYS AFTER START (4.0°C)	73	21.0	317.2	130	153.7
	71	20.0	301.1	94	148.5
	85	26.5	317.2	138	145.0
	65	22.5	333.3	132	162.5
	65	23.0	338.7	105	153.7
$\bar{X}$	71.8	22.6	321.5	119.8	152.7
SD	8.2	2.5	14.9	19.2	6.6
58 DAYS AFTER START (2.0°C)	70	23.0	360.2	124	157.2
	64	28.5	376.3	139	153.7
	78	28.7	381.7	140	157.2
	67	22.5	376.3	141	159.0
	78	23.5	371.0	131	---
$\bar{X}$	73.3	25.2	373.1	135.0	156.8
SD	5.6	3.1	8.1	7.3	2.2
END	73	20.7	285.0	88	99.6
19-V-76	84	23.0	328.0	109	136.2
(2.0°C)	62	25.0	263.4	74	115.3
	68	18.0	322.6	117	---
	67	19.0	392.5	155	146.7
$\bar{X}$	70.8	21.1	318.3	108.6	124.5
SD	8.4	2.9	49.3	31.0	21.1

APPENDIX L1. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CONTROL BROOK TROUT.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	82	37.5	354.8	127	145.0
12-III-76	85	37.7	344.1	105	150.2
(14°C)	83	44.7	333.3	121	148.5
	77	32.0	328.0	128	122.3
	72	32.0	328.0	119	129.3
$\bar{X}$	79.8	36.8	337.6	120.0	139.1
SD	5.3	5.2	11.6	9.2	12.5
23 DAYS AFTER START (15.5°C)	103	40.0	306.5	125	125.8
	90	36.3	317.2	118	143.2
	81	35.0	311.8	122	131.0
	85	42.0	344.1	112	115.3
	95	33.3	333.3	124	153.7
$\bar{X}$	85.3	37.3	322.6	120.2	133.8
SD	8.8	3.6	15.7	5.3	15.0
55 DAYS AFTER START (15.5°C)	103	30.0	349.5	135	132.8
	89	27.5	338.7	125	111.8
	93	34.0	349.5	118	141.5
	110	33.5	333.3	130	141.5
	109	33.5	322.6	136	148.5
$\bar{X}$	91.3	34.5	338.7	128.8	135.2
SD	11.6	4.3	11.4	7.5	14.2
END	117	30.8	317.2	137	157.2
9-VII-76	123	35.8	322.6	136	141.5
(15.5°C)	125	35.5	311.8	130	138.0
	116	34.8	322.6	135	150.2
	128	35.8	317.2	121	122.3
$\bar{X}$	98.5	34.5	318.3	131.8	141.8
SD	16.9	3.6	4.5	6.6	13.3

APPENDIX L2. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF BROOK TROUT IN 90% DISTILLED/10% TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	82	40.0	338.7	125	138.0
12-III-76	71	33.5	349.5	130	153.7
(14.0°C)	70	34.0	354.8	119	148.5
	80	38.0	328.0	135	153.7
	<u>77</u>	<u>30.5</u>	<u>365.6</u>	<u>124</u>	<u>145.0</u>
$\bar{X}$	76.0	35.2	347.3	126.6	147.8
SD	5.3	3.8	14.5	6.1	6.6
23 DAYS AFTER START (4.0°C)	88	32.7	317.2	107	120.5
	73	26.0	317.2	93	110.0
	90	24.3	333.3	126	111.8
	83	25.5	354.8	127	113.5
	<u>80</u>	<u>27.5</u>	<u>338.7</u>	<u>120</u>	<u>108.3</u>
$\bar{X}$	82.8	27.2	332.2	114.6	112.8
SD	6.8	3.3	15.9	14.5	4.7
55 DAYS AFTER START (2.0°C)	85	21.3	333.3	87	174.7
	65	20.5	322.6	103	143.2
	78	24.0	338.7	132	122.3
	81	26.0	344.1	131	108.3
	<u>88</u>	<u>25.8</u>	<u>349.5</u>	<u>142</u>	<u>145.0</u>
$\bar{X}$	79.4	23.5	337.6	119.0	138.7
SD	8.9	2.5	10.4	23.0	25.2
END	88	18.7	306.5	137	148.5
9-VII-76	77	20.0	322.5	133	141.5
(2.0°C)	83	27.5	344.1	138	141.5
	86	23.3	317.2	130	138.0
	<u>75</u>	<u>27.0</u>	<u>328.0</u>	<u>131</u>	<u>118.8</u>
$\bar{X}$	81.8	23.3	323.7	133.8	137.7
SD	5.6	4.0	13.9	3.6	11.2

APPENDIX L3. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF BROOK TROUT IN TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	75	37.0	328.0	102	113.5
12-III-76	81	31.0	338.7	135	124.4
(14.0°C)	76	30.5	338.7	127	134.5
	87	35.7	381.7	130	122.3
	68	30.5	376.3	119	134.5
$\bar{X}$	77.4	32.9	352.7	122.6	125.8
SD	7.1	3.2	24.5	12.9	8.9
23 DAYS AFTER START (4.0°C)	73	26.0	349.5	128	113.5
	89	25.7	338.7	107	113.5
	82	28.0	333.3	115	101.3
	65	23.0	328.8	117	111.8
	83	18.0	360.2	125	134.5
$\bar{X}$	78.4	24.1	342.1	118.4	114.9
SD	9.4	3.9	12.7	8.4	12.1
55 DAYS AFTER START (2.0°C)	70	31.0	349.5	132	106.6
	79	26.0	338.7	132	125.8
	65	24.5	354.8	121	134.5
	83	29.3	328.0	135	157.2
	78	26.5	344.1	141	139.7
$\bar{X}$	75.0	27.5	343.0	132.2	132.8
SD	7.3	2.6	10.3	7.3	18.6
END	92	16.0	344.1	144	139.7
9-VII-76	94	23.0	317.2	143	136.2
(2.0°C)	72	22.0	322.6	122	---
	85	12.0	333.3	123	141.5
	90	25.0	349.5	100	118.8
$\bar{X}$	86.6	19.6	333.3	126.4	134.1
SD	8.8	5.4	13.7	18.1	10.4

APPENDIX L4. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF BROOK TROUT IN 0.2% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	84	38.0	330.1	120	152
12-III-76	77	34.0	373.1	134	132.8
(14.0°C)	82	35.0	346.2	135	124.0
	67	34.0	340.9	131	131.0
	<u>81</u>	<u>30.3</u>	<u>357.0</u>	<u>130</u>	<u>146.7</u>
$\bar{X}$	78.2	34.3	349.5	130.0	137.3
SD	6.8	2.8	16.4	6.0	11.6
23 DAYS AFTER START (4.0°C)	86	28.5	333.3	137	122.3
	78	29.0	349.5	110	108.3
	73	24.5	328.0	112	124.0
	79	25.0	338.7	128	118.8
	<u>90</u>	<u>26.0</u>	<u>354.8</u>	<u>141</u>	<u>120.5</u>
$\bar{X}$	81.2	26.6	340.9	125.6	118.8
SD	6.8	2.0	11.1	14.2	6.2
55 DAYS AFTER START (2.0°C)	74	21.7	344.1	132	134.5
	75	27.0	349.5	142	124.0
	71	26.0	322.6	---	127.5
	93	24.8	333.3	140	---
	<u>67</u>	<u>24.5</u>	<u>344.1</u>	<u>137</u>	<u>146.7</u>
$\bar{X}$	76.0	24.8	338.7	137.8	133.2
SD	0.0	2.0	10.8	4.4	10.0
END	87	19.5	365.6	137	---
9-VII-76	73	15.0	371.0	144	136.2
(2.0°C)	83	13.0	344.1	138	127.5
	90	14.0	338.7	136	118.8
	<u>92</u>	<u>14.3</u>	<u>360.2</u>	<u>142</u>	<u>125.8</u>
$\bar{X}$	85.0	15.2	355.9	138.7	127.1
SD	7.5	2.5	13.9	3.7	7.2

APPENDIX L5. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF BROOK TROUT IN 0.4 % NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	82	37.3	335.5	128	132.8
12-III-76	77	33.7	319.4	137	139.7
(14.0°C)	93	35.3	346.2	125	145.0
	78	33.0	351.0	112	139.7
	<u>72</u>	<u>28.5</u>	<u>314.0</u>	<u>125</u>	<u>127.5</u>
$\bar{X}$	80.4	33.6	333.2	125.4	136.9
SD	7.9	3.3	16.2	9.0	6.8
23 DAYS AFTER START (4.0°C)	73	22.0	333.3	103	106.6
	89	24.3	349.5	122	138.0
	83	25.0	338.7	138	139.7
	84	23.0	344.1	97	---
	<u>79</u>	<u>23.0</u>	<u>344.1</u>	<u>134</u>	<u>125.8</u>
$\bar{X}$	81.6	23.5	341.9	118.8	127.5
SD	6.0	1.2	6.2	18.3	15.3
55 DAYS AFTER START (2.0°C)	77	25.7	349.5	168	108.3
	77	25.7	370.0	151	120.5
	68	23.5	354.8	136	157.2
	90	25.3	360.2	140	150.2
	<u>81</u>	<u>22.0</u>	<u>354.8</u>	<u>149</u>	<u>124.0</u>
$\bar{X}$	78.6	24.4	357.9	148.8	132.0
SD	8.0	1.6	7.8	12.4	20.8
END	88	13.7	360.2	152	131.0
9-VII-76	72	10.5	344.1	132	124.0
(2.0°C)	79	14.0	301.1	86	122.3
	85	15.5	338.7	130	138.0
	<u>92</u>	<u>16.7</u>	<u>349.5</u>	<u>132</u>	<u>118.8</u>
$\bar{X}$	83.2	14.1	338.7	126.4	126.8
SD	7.9	2.3	22.5	24.3	7.7

APPENDIX L6. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF BROOK TROUT IN 0.85% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	72	37.0	303.2	106	152.0
12-III-76	80	34.0	308.6	125	125.8
(14.0°C)	73	29.0	335.5	146	118.8
	80	31.0	346.2	137	132.8
	<u>63</u>	<u>31.0</u>	<u>340.9</u>	<u>143</u>	<u>---</u>
$\bar{X}$	73.6	32.4	326.9	131.4	132.2
SD	7.0	3.1	19.6	16.3	14.1
23 DAYS AFTER START (4.0°C)	81	28.3	354.8	150	131.0
	81	28.0	344.1	117	139.7
	85	25.5	360.2	146	148.5
	69	29.0	333.3	147	---
	<u>85</u>	<u>24.7</u>	<u>349.5</u>	<u>140</u>	<u>139.7</u>
$\bar{X}$	80.2	27.1	348.4	140.0	139.7
SD	6.6	1.9	10.3	13.4	7.1
55 DAYS AFTER START (2.0°C)	80	25.0	371.0	134	125.8
	86	22.7	360.2	135	131.0
	70	26.0	365.6	132	159.0
	77	29.0	344.1	114	150.2
	<u>76</u>	<u>32.3</u>	<u>349.5</u>	<u>144</u>	<u>---</u>
$\bar{X}$	77.8	27.0	358.1	131.8	141.5
SD	5.9	3.7	11.2	11.0	15.7
END	81	17.0	376.3	163	165.9
9-VII-76	84	15.7	360.2	164	192.1
(2.0°C)	65	16.0	371.0	158	---
	79	16.0	381.7	164	139.7
	<u>80</u>	<u>21.0</u>	<u>376.3</u>	<u>160</u>	<u>150.2</u>
$\bar{X}$	77.6	17.1	373.1	161.8	162.0
SD	7.8	2.2	8.1	2.7	22.8

APPENDIX M1. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CONTROL CHANNEL CATFISH.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	67	16.0	263.4	123	129.3
12-III-76	62	19.3	279.6	118	138.0
(14.0°C)	52	21.0	268.8	106	132.8
	59	18.3	268.8	119	129.3
	<u>60</u>	<u>20.5</u>	<u>263.4</u>	<u>113</u>	<u>131.0</u>
$\bar{X}$	60	19.0	268.8	115.8	132.1
SD	5.4	2.0	6.6	6.5	3.6
55 DAYS AFTER START (18.0°C)	68	20.0	241.9	112	157.2
	70	15.3	252.7	118	122.3
	60	15.5	241.9	112	113.5
	67	15.0	258.1	126	141.5
	<u>81</u>	<u>16.5</u>	<u>268.8</u>	<u>130</u>	<u>125.8</u>
$\bar{X}$	69.2	16.5	252.7	119.6	132.1
SD	7.6	2.1	11.4	8.2	17.3
END	75	13.5	225.8	125	125.8
9-VII-76	70	18.0	268.8	105	132.8
(18.0°C)	85	16.6	241.9	124	125.8
	75	16.8	236.6	104	129.3
	<u>76</u>	<u>15.7</u>	<u>231.2</u>	<u>118</u>	<u>122.3</u>
$\bar{X}$	76.2	16.1	240.9	115.2	127.2
SD	5.5	1.7	16.7	10.1	4.0

APPENDIX M2. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CHANNEL CATFISH IN 90% DISTILLED/10% TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	55	11.5	225.8	124	111.8
12-III-76	69	19.0	231.2	126	143.2
(14.0°C)	50	12.0	241.9	128	124.0
	57	14.5	231.2	131	125.8
	<u>67</u>	<u>22.7</u>	<u>247.3</u>	<u>129</u>	<u>122.3</u>
$\bar{X}$	59.6	15.9	235.5	127.6	125.4
SD	8.1	4.8	8.8	2.7	11.3
55 DAYS AFTER START (2°C)	75	9.7	198.9	121	127.5
	60	6.0	193.5	119	132.8
	57	7.0	209.7	111	--
	72	7.8	209.7	120	124.0
	<u>66</u>	<u>8.0</u>	<u>198.9</u>	<u>120</u>	<u>120.5</u>
$\bar{X}$	66.0	7.7	202.1	118.2	126.2
SD	7.7	1.4	7.3	3.9	5.3
END	75	3.3	295.7	125	131.0
9-VII-76	65	4.7	285.0	106	118.8
(2°C)	64	4.0	263.4	107	124.0
	68	5.0	263.4	90	117.0
	<u>54</u>	<u>5.0</u>	<u>258.1</u>	<u>116</u>	<u>104.8</u>
$\bar{X}$	65.2	4.4	273.1	108.8	119.1
SD	7.6	0.7	16.3	13.0	9.7

APPENDIX M3. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CHANNEL CATFISH IN TAP WATER.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	57	10.5	263.4	127	110.0
12-III-76	73	15.0	274.2	136	125.8
(14.0°C)	62	12.7	263.4	123	131.0
	62	16.7	263.4	131	131.0
	52	17.0	290.3	132	139.7
$\bar{X}$	61.2	14.4	270.9	129.8	127.5
SD	7.8	2.8	11.8	5.0	11.0
55 DAYS AFTER START (2°C)	57	7.0	215.1	112	115.3
	66	9.3	225.8	101	113.5
	64	10.0	209.7	105	110.0
	62	9.7	204.3	106	106.6
	66	13.5	215.1	94	124.0
$\bar{X}$	63.0	9.9	214.0	103.6	113.9
SD	3.7	2.3	8.0	6.7	6.6
END	54	5.5	252.7	114	101.3
9-VII-76	76	5.3	247.3	110	127.5
(2°C)	76	4.8	311.8	125	120.5
	54	3.0	295.7	130	110.0
	59	4.7	290.3	125	117.0
$\bar{X}$	63.8	4.7	279.6	120.8	115.3
SD	11.3	1.0	28.2	8.4	10.0

APPENDIX M4. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CHANNEL CATFISH IN 0.2% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	59	12.7	263.4	126	132.8
12-III-76	67	14.3	268.8	127	150.2
(14.0°C)	72	20.3	268.8	125	125.8
	70	18.0	274.2	132	136.2
	<u>53</u>	<u>14.0</u>	<u>306.5</u>	<u>139</u>	<u>134.5</u>
$\bar{X}$	64.2	15.9	276.3	129.8	135.9
SD	8.0	3.2	17.3	5.8	8.9
55 DAYS AFTER START (2°C)	67	10.5	231.2	116	---
	70	9.7	225.8	104	132.8
	65	12.0	225.8	142	125.8
	74	10.0	209.7	124	120.5
	<u>67</u>	<u>8.3</u>	<u>220.4</u>	<u>113</u>	<u>129.3</u>
$\bar{X}$	68.6	10.1	222.6	119.8	127.1
SD	3.5	1.3	8.2	14.3	5.3
END	72	3.8	258.1	115	138.0
9-VII-76	63	5.0	274.2	121	129.3
(2°C)	61	5.3	285.0	117	110.0
	55	4.0	290.3	110	127.5
	<u>61</u>	<u>4.7</u>	<u>252.7</u>	<u>121</u>	<u>124.0</u>
$\bar{X}$	62.4	4.6	272.1	116.8	125.8
SD	6.2	0.6	16.4	4.6	10.2

APPENDIX M5. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CHANNEL CATFISH IN 0.4% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	72	14.5	284.9	141	139.7
12-III-76	62	16.7	279.6	129	139.7
(14.0°C)	62	14.5	268.8	102	129.3
	59	13.0	258.1	126	141.5
	<u>59</u>	<u>17.5</u>	<u>258.1</u>	<u>129</u>	<u>138.0</u>
$\bar{X}$	62.8	15.2	269.9	125.4	137.6
SD	5.4	1.8	12.2	14.3	4.8
55 DAYS AFTER START (2°C)	72	7.3	225.8	103	124.0
	55	6.0	247.3	117	115.3
	67	10.7	258.1	131	132.8
	76	8.0	285.0	131	136.2
	<u>57</u>	<u>11.0</u>	<u>263.4</u>	<u>141</u>	<u>139.7</u>
$\bar{X}$	65.4	8.6	255.9	124.6	129.6
SD	9.2	2.2	21.7	14.8	9.9
END	86	4.2	322.6	115	125.8
9-VII-76	61	6.5	274.2	136	124.0
(2°C)	68	5.0	285.0	142	139.7
	71	4.0	274.2	122	113.5
	<u>64</u>	<u>5.0</u>	<u>247.3</u>	<u>126</u>	<u>111.8</u>
$\bar{X}$	70.0	4.9	280.7	128.2	123.0
SD	9.7	1.0	27.3	10.8	11.2

APPENDIX M6. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CHANNEL CATFISH IN 0.85% NaCl.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	69	15.8	311.8	124	131.0
12-III-76	64	21.3	301.1	131	148.5
(14.0°C)	69	22.0	306.5	147	165.9
	80	19.0	311.8	134	134.5
	<u>65</u>	<u>19.7</u>	<u>295.7</u>	<u>128</u>	<u>143.2</u>
$\bar{X}$	69.4	19.6	305.4	132.8	144.6
SD	6.3	2.4	7.0	8.8	13.8
55 DAYS AFTER START (2°C)	61	9.0	301.1	156	---
	61	9.0	290.3	151	157.2
	67	8.5	295.7	174	143.2
	59	10.7	225.8	120	159.0
	<u>57</u>	<u>8.7</u>	<u>263.4</u>	<u>138</u>	<u>164.2</u>
$\bar{X}$	61.0	9.2	275.3	147.8	155.9
SD	3.7	0.9	31.2	20.2	9.0
END	62	5.7	231.2	105	150.2
9-VII-76	61	3.5	290.3	142	152.0
(2°C)	59	5.2	285.0	154	150.2
	70	5.0	279.6	148	176.4
	<u>70</u>	<u>5.0</u>	<u>268.8</u>	<u>146</u>	<u>157.2</u>
$\bar{X}$	64.4	4.9	271.0	139.0	157.2
SD	5.2	0.8	23.6	19.5	11.1

APPENDIX N1. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF CONTROL YELLOW PERCH. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na⁺ and Cl⁻.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	54	47	322.6	98	134.5
18-VIII-76	60	33	317.2	108	152.0
(18°C)	59	33	284.9	108	97.8
	64	40	274.2	105	103.1
	52	48	295.7	113	107.3
	58	48			
$\bar{X}$	57.8	41.5	298.9	106.4	118.9
SD	4.3	7.2	20.6	5.5	23.3
23 DAYS AFTER START (18°C)	65	35	258.1	--	150.2
	55	30	306.5	--	136.3
	56	32	258.1	--	150.2
	50	31	290.3	--	136.3
	64	31	284.9	--	129.3
	60	30			
$\bar{X}$	58.3	31.5	279.6		140.5
SD	5.8	1.9	21.2		9.3
45 DAYS AFTER START (18°C)	67	29	290.3	--	129.3
	68	33	279.6	--	117.0
	58	32	268.8	--	167.7
	72	35.5	290.3	--	146.7
	62	37	279.6	--	134.5
	65	33.5			
$\bar{X}$	65.3	33.3	281.2		139.0
SD	4.9	2.8	9.0		19.2
END	120	27	328.0	111	129.3
5-XII-76	92	27	344.1	107	136.3
(18°C)	100	30	317.2	109	139.7
	110	23.5	311.8	114	131.0
	104	28.5	328.0	105	134.5
$\bar{X}$	105.2	27.2	325.8	109.2	134.2
SD	10.6	2.4	12.4	3.5	4.2

APPENDIX N2. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF YELLOW PERCH IN 90% DISTILLED/10% TAP WATER. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na^+ AND Cl^- .

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl^- (meq/l)	Na^+ (meq/l)
START	50	32	295.7	125	143.2
18-VIII-76	55	32	371.0	114	146.7
(18°C)	48	34	295.7	113	106.6
	50	36	381.7	109	97.8
	52	34	258.1	109	138.0
	<u>51</u>	<u>38</u>			
$\bar{X}$	51.0	34.3	320.4	114.0	126.5
SD	2.4	2.3	53.4	6.6	22.6
23 DAYS AFTER START (4°C)	56	27	204.3	--	125.8
	45	29	188.2	--	120.5
	53	27	193.6	--	129.3
	48	31	188.2	--	104.8
	<u>56</u>	<u>29</u>	<u>204.3</u>	--	<u>97.8</u>
$\bar{X}$	51.6	28.6	195.7		115.6
SD	4.9	1.7	8.1		13.7
45 DAYS AFTER START (2°C)	55	29	199.0	--	101.3
	49	31	209.7	--	101.3
	47	28	215.1	--	75.1
	51	31	236.6	--	101.3
	47	37	231.2	--	110.0
	<u>48</u>	<u>32</u>			
$\bar{X}$	49.5	31.3	218.3		97.8
SD	3.1	3.1	15.5		13.2
END	52	26	333.3	100	122.3
5-XII-76	55	15	301.1	94	117.0
(2°C)	51	23	328.0	104	106.6
	54	32	322.6	102	122.3
	53	24	338.7	100	115.3
	55	26			
	51	27			
	<u>59</u>	<u>22</u>			
$\bar{X}$	53.8	24.4	324.7	100.0	116.7
SD	2.7	4.9	14.5	3.7	6.5

APPENDIX N3. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF YELLOW PERCH IN TAP WATER. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na^+ and Cl^- .

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl^- (meq/l)	Na^+ (meq/l)
START	50	30	371.0	113	141.5
18-VIII-76	52	36	317.2	108	120.5
(18°C)	56	32	365.6	109	125.8
	51	28	392.5	110	117.0
	48	36	306.5	112	159.0
	69	31			
$\bar{X}$	54.3	32.2	350.5	110.4	132.8
SD	7.7	3.3	37.0	2.1	17.4
23 DAYS AFTER START (4°C)	58	26	199.0	--	120.5
	48	20	188.2	--	111.8
	52	23	220.4	--	115.3
	50	28	204.3	--	117.0
	48	26	225.8	--	106.6
$\bar{X}$	51.2	24.6	207.5		114.2
SD	4.2	3.1	15.5		5.3
45 DAYS AFTER START (2°C)	46	33	204.3	--	118.8
	48	28	220.4	--	120.5
	49	31	236.6	--	131.0
	48	30	241.9	--	103.1
	50	28	225.8	--	118.8
$\bar{X}$	48.2	30.0	225.8		118.4
SD	1.5	2.1	14.7		10.0
END	52	17	311.8	93	125.8
5-XII-76	55	20	311.8	101	125.8
(2°C)	52	30	344.1	78	118.8
	52	18	322.6	88	118.8
	52	24	338.7	86	132.8
	49	20			
	52	24			
	53	24			
$\bar{X}$	52.1	22.1	325.8	89.2	124.4
SD	1.6	4.2	15.0	8.5	5.9

APPENDIX N4. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF YELLOW PERCH IN 0.2% NaCl. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na⁺ and Cl⁻.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	55	42	371.0	130	129.3
18-VIII-76	52	38	338.7	127	129.3
(18°C)	48	33	333.3	110	136.3
	52	36	338.7	123	124.0
	50	38	349.5	134	145.0
	<u>51</u>	<u>32</u>			
$\bar{X}$	51.3	36.5	346.2	124.8	132.8
SD	2.3	3.7	15.0	9.2	8.1
23 DAYS AFTER START (4°C)	56	27	215.1	--	110.0
	51	29	209.7	--	103.1
	48	28	204.3	--	120.5
	49	32	215.1	--	110.0
	46	26	204.3	--	87.3
	<u>47</u>	<u>26</u>			
$\bar{X}$	49.5	28.0	209.7		106.2
SD	3.6	2.3	5.4		12.3
45 DAYS AFTER START (2°C)	38	20	231.2	--	97.8
	49	33	236.6	--	106.6
	52	20	225.8	--	106.6
	41	20	220.4	--	117.0
	51	23	274.2	--	117.0
	<u>54</u>	<u>20</u>			
$\bar{X}$	47.5	22.7	237.6		109.0
SD	6.5	5.2	21.3		8.1
END	45	14	306.5	89	125.8
5-XII-76	50	25	338.7	87	127.5
(2°C)	47	23	349.5	94	131.0
	45	25	328.0	92	118.8
	46	32	338.7	84	118.8
	56	34			
	<u>42</u>	<u>26</u>			
$\bar{X}$	47.3	25.6	332.3	89.2	124.4
SD	4.5	6.5	16.3	4.0	5.4

APPENDIX N5. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF YELLOW PERCH IN 0.4% NaCl. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na⁺ and Cl⁻.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	56	34	311.8	130	101.3
18-VIII-76	48	26	338.7	131	104.8
(18°C)	53	27	328.0	115	103.1
	48	33	365.6	122	124.0
	51	33	317.2	118	138.0
	51	32			
$\bar{X}$	51.2	30.8	332.3	123.2	114.2
SD	3.1	3.4	21.3	7.1	16.1
23 DAYS AFTER START (4°C)	55	34	199.0	--	129.3
	53	31	204.3	--	124.0
	47	30	188.2	--	125.8
	48	30	188.2	--	122.3
	50	34	193.6	--	125.8
	48	33			
	51	33			
$\bar{X}$	50.3	32.1	194.7		125.4
SD	2.9	1.8	7.0		2.6
45 DAYS AFTER START (2°C)	64	29	236.6	--	113.5
	60	29	247.3	--	129.3
	50	32	263.4	--	152.0
	47	40	204.3	--	139.7
	52	26	220.4	--	103.1
$\bar{X}$	54.6	31.2	234.4		127.5
SD	7.1	5.4	23.0		19.7
END	57	18.5	317.2	104	122.3
5-XII-76	48	18	306.5	110	129.3
(2°C)	56	21	301.1	95	113.5
	46	16	290.3	102	132.8
	50	19	306.5	92	103.1
	47	20			
	55	16			
$\bar{X}$	51.3	18.4	304.3	100.6	120.2
SD	4.6	1.9	9.8	7.2	12.1

APPENDIX N6. MEAN LENGTH, HEMATOCRIT, OSMOLALITY, CHLORIDE AND SODIUM ION CONCENTRATIONS OF YELLOW PERCH IN 0.6% NaCl. BLOOD WAS POOLED FOR DETERMINATION OF OSMOLALITY, Na⁺ and Cl⁻.

TIME AND WATER TEMP. (°C)	LENGTH (mm)	HEMATO- CRIT (%)	OSMOLALITY (mosm/l)	Cl ⁻ (meq/l)	Na ⁺ (meq/l)
START	57	33	284.9	140	103.1
25-VIII-76	53	34	306.5	135	167.7
(18°C)	58	33	290.3	112	129.3
	58	41	274.2	114	152.0
	56	26	365.6	143	139.7
	49	27			
$\bar{X}$	55.2	32.3	304.3	128.8	138.4
SD	3.6	5.4	36.2	14.7	24.4
16 DAYS AFTER START (4°C)	51	33	209.7	--	127.5
	47	38	231.2	--	101.3
	48	43	204.3	--	125.8
	48	28	241.9	--	145.0
	52	44	225.8	--	115.3
	47	33			
$\bar{X}$	48.8	36.5	222.6		123.0
SD	2.1	6.3	15.5		16.1
38 DAYS AFTER START (2°C)	52	29	204.3	--	125.8
	45	28	193.6	--	143.2
	43	30	284.9	--	136.3
	48	30	225.8	--	127.5
	62	38	215.1	--	92.6
	51	28			
$\bar{X}$	50.2	30.5	224.7		125.1
SD	6.7	3.8	35.7		19.5
END	47	21	344.1	100	136.3
5-XII-76	50	35	365.6	130	143.2
(2°C)	51	19	371.0	100	118.8
	52	22	365.6	118	146.7
	48	19			
$\bar{X}$	49.6	23.2	361.6	112.0	136.3
SD	2.1	6.7	11.9	14.7	12.4