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# Correlation of Hook-and-Line Vulnerability of Largemouth Bass (Micropterus salmoides) with Selected Physicochemical Parameters at Ridge Lake

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Correlation of Hook-and-Line Vulnerability of

Largemouth Bass (*Micropterus salmoides*) with

Selected Physicochemical Parameters at Ridge Lake

(TITLE)

BY

Dale P. Burkett

# THESIS

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ABSTRACT

Fluctuation in kilograms of largemouth bass caught per man-hour of fishing pressure (catch rate) in Ridge Lake (a 6.8ha impoundment located in Fox Ridge State Park, Coles County, Illinois) was positively correlated with dissolved oxygen concentration ($r$=0.7490), conductivity ($r$=0.7439), pH ($r$=0.5965), and alkalinity ($r$=0.7531). Negative correlations were found between largemouth bass catch rate and turbidity ($r$=-0.5145), as well as ammonia ($r$=-0.4694). No significant ($p<0.05$) correlations were found between catch rate and column water temperature, air temperature, barometric pressure, water level, maximum water temperature, minimum water temperature, maximum air temperature, or minimum air temperature.

Models describing the relationships of the most significant physico-chemical parameters to catch rate of largemouth bass were chosen to represent the effects of environment on catch rate. These models were generated utilizing two variations on stepwise multiple regression available through the Statistical Analysis System (R-square and Maximum R-square Improvement). Selection of the "best" models from the many produced involved the following criteria: any model containing component independent variables with $p>0.05$ was deleted, any model not agreeing with both the R-square procedure and the Maximum R-square Improvement procedure was deleted, and any model not accounting for a minimum of 50% of catch rate fluctuation was deleted. The best two independent variable model generated was as follows: Kg/man-hour = -0.4377Amm + 0.0020Alk - 0.0301 (Amm = total ionized ammonia, ppm; Alk = total carbonate alkalinity, ppm) with $r^2$=0.7028.

Examination of Pearson product moment correlation results, R-square procedure results, and Maximum R-square Improvement results revealed that

the single most significant factor responsible for catch rate fluctuation was alkalinity; in addition, dissolved oxygen, turbidity, conductivity, column water temperature, ammonia, and maximum air temperature were significant.

## ACKNOWLEDGEMENTS

This study was conducted as a part of a study entitled; Evaluation of Catch-and-Release, Hook-and-Line Vulnerability, and Heredity of Vulnerability of a Largemouth Bass Population (ST ILL CONSERV US COMM FISH REST F-27, 1-47-26-82-363). Funding was provided through Dingell-Johnson monies by the Illinois Department of Conservation. Facilities, equipment, and personnel of the Illinois Natural History Survey were utilized during all portions of the study. Key-punching of data onto IBM cards was carried out by Illinois Geological Survey-Computer Services Center employees. Statistical analysis of the data was accomplished through the Statistical Analysis System of the University of Illinois IBM 4341 computer.

Deep thanks go to Dr. William F. Childers (Ill. Nat. Hist. Surv.) and Dr. David P. Philipp (Ill. Nat. Hist. Surv.) for the many hours of consultation and support which they provided. The services of Dr. Arthur W. Ghent (University of Illinois) were invaluable in designing the study and in determining which data analysis techniques to use. Mr. Donald R. Crebs and Mr. Peter A. Lake (Eastern Illinois University Interns) assisted in data collection and devoted many hours of personal time to the study. Mrs. Ellen Brewer (Illinois Geological Survey-Computer Services Center) was responsible for programming and provided aid in data verification and I am deeply indebted to Mr. Philip C. Mankin for his assistance in managing the vast quantities of data produced by this study. Dr. Leonard Durham deserves special recognition for providing the critical assistance and support so necessary to a working student; without his good humor and advice, this study would not have reached culmination. My appreciation is also extended to the entire Eastern Illinois University Life Sciences Division academic staff for tolerating my tardiness and missed classes. This tolerance allowed the completion of my study.

And to my wife, Virginia K. Burkett, for her long hours spent assisting with data collection, verifying computer printouts, typing the manuscript and putting up with my always exacting and sometimes outrageous demands, I express my most heartfelt gratitude and deepest appreciation.

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# INTRODUCTION

Fluctuations in the catch rate of largemouth bass (*Micropterus salmoides*) during fishing seasons have been well-documented (Bennett 1954, Byrd 1959). These fluctuations have been attributed to learning associated with accumulation of fishing pressure (Bennett 1954) and inverse relationships between angling success and availability of natural forage (Lux and Smith 1960). Variation in catch rate was not correlated with fluctuations in environmental factors such as water temperature, turbidity, pH, dissolved oxygen, and total carbonates (Lux and Smith 1960) although inverse relationships between catch rate and turbidity have been demonstrated (Bennett *et al.* 1940, Buck 1956). The effects of environmental variables on catch rate of largemouth bass have not been adequately expressed.

Much work has been done on physiological and behavioral consequences of environmental variation. Physiological and behavioral effects of various physicochemical parameter fluctuations such as increased metabolic rate with increasing water temperature (Marcus 1932, Molnar and Tolg 1962) and increases in cruising speed associated with increased metabolic rate (Johnson *et al.* 1960), have been demonstrated. Largemouth bass require more oxygen at higher temperatures than at lower temperatures to support increased activity (Beamish 1970). Feeding rate, growth, metabolism and cruising speed maximize between 25.0°C and 30.0°C, provided that sufficient oxygen is present (Johnson *et al.* 1960, Coutant 1975). Largemouth bass prefer and actively seek out temperatures ranging from 26.7°C to 27.8°C (Ferguson 1958).

Water temperature, metabolic rate, and oxygen consumption are interrelated (Clausen 1933). Peak periods of oxygen consumption in largemouth bass occur from 0500 hrs to 0800 hrs and from 1500 hrs to 2000 hrs (Clausen 1936), and as dissolved oxygen concentrations rise from 2.0ppm to 8.0ppm there is an increase in feeding rate (Stewart *et al.* 1967). Energy available for swimming increases with dissolved oxygen concentrations and temperature up to 30.0°C (Beamish 1970). Avoidance reactions of largemouth bass to low oxygen concentrations have been shown to effect spatial relocation of individuals (Whitmore 1960). Decreases in dissolved oxygen concentration below 6.0ppm are associated with decreases in swimming speed (Dahlberg *et al.* 1968) and reductions in growth rate of bass have been attributed to reduction in appetite at low oxygen levels (Bulkley 1975).

Centrarchid distribution and abundance is affected by pond depth and turbidity (Carver 1966). Juvenile largemouth bass activity is significantly higher in waters of low turbidity than in waters of high turbidity (Heimstra *et al.* 1969) possibly because organic and inorganic sediments present in high turbidity conditions absorb and adsorb oxygen, thereby depleting the supply available to fish (Chandler 1942).

Interactions of physicochemical factors with each other may have physiological and behavioral consequences. Ammonia toxicity to centrarchids increases as pH values rise above 7.0 (Bulkley 1975). Increased ammonia toxicity with increased pH was also demonstrated for channel catfish (*Ictalurus punctatus*) (Tomasso *et al.* 1980). High ammonia concentrations may prevent excretion of waste ammonia resulting in damage to the nervous system (Fromm 1970), and sublethal concentrations have been linked to tissue destruction in organs (Flis 1968).

High alkalinity has been associated with mortality in centrarchids (Tiemeier and Elder 1957), but a significant positive correlation has been demonstrated between total alkalinity and standing fish crop (Turner 1960). Increases in total dissolved solids result in increases in standing crop and sport fisheries yield (Jenkins 1967).

The purpose of this study was to determine effects of fluctuations of maximum and minimum air and water temperatures, rainfall, water level, barometric pressure, dissolved oxygen concentration, conductivity, turbidity, pH, total ionized ammonia, and total carbonate alkalinity on catch rate of largemouth bass subjected to a 457.0mm size limit during the 1979 fishing season, and to generate a predictive model based upon the results.

## STUDY AREA

This study was conducted at Ridge Lake, a 6.28 hectare impoundment located in Fox Ridge State Park, Coles County, Illinois. Dry Run Creek, an intermittent stream draining 365.2ha, was dammed in 1940 to form the lake. The dam is 137.2m long and a 21.3m concrete surface spillway is located at the north end of the dam. Three concrete structures are located in the lake basin: the tower spillway (with an intake at its base and a center baffle set to maintain the lake water level at 181.4m above sea level); a mid-lake instrument tower; and an upper lake instrument tower (Fig. 1) (Bennett 1954). A laboratory and boat dock, owned and maintained by the Illinois Natural History Survey and the Illinois Department of Conservation, are situated 243.8m east of the dam on the southern shoreline.

The lake has a maximum depth of 5.49m and lake width varies from 121.9m at the dam to 61.0m at the eastern end. Dry Run Creek ravine walls in the vicinity of Ridge Lake have slopes in excess of 30% (Stall *et al.*

1951). These steep slopes result in a relatively deep lake. Except for vestiges of the creek bed, the basin is featureless and gradually slopes upward from the dam to the eastern end. With the exception of the dam face, the shoreline is both steep and wooded to the water's edge and 90% of the surface area of the lake is observable from the dock. These characteristics ideally suit Ridge Lake to controlled fishing experiments.

Ridge Lake was drained in 1975 and restocked with largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and hybrid sunfish (male *Lepomis macrochirus* × female *Lepomis cyanellus*). The lake was opened to controlled fishing from state-owned boats equipped with live-wells and a complete creel census was conducted for the 1976, 1977, 1978, 1979, and 1980 fishing seasons by research and technical assistants of the Illinois Natural History Survey.

## MATERIALS AND METHODS

### CREEL

Public fishing was permitted at Ridge Lake from 15 April to 14 October 1979. Five days of fishing (Wednesday-Sunday) were allowed per week. Each fishing day was divided into two distinct sessions (AM = 0600-1000 hrs, PM = 1500-2000 hrs). Fishermen were required to sign in with an Illinois Natural History Survey technical or research assistant prior to fishing the lake.

The following data were recorded on a standard creel card for each individual: fisherman's name, city of origin, time of day (to the nearest quarter-hour), fisherman boat number (1-8), and fisherman identification letter (A-C). No more than eight boats, containing a maximum of three fishermen each, were allowed on the lake at any one time. Boats were fitted with a live-well in the center seat and fishermen were instructed to keep all fish caught in the live-well. As fish were caught, fishermen were instructed to note the bait type used to catch them. Fishermen were asked to change approximately one-half of the volume of the water in their live-wells with fresh water dipped from the lake every forty-five minutes. As a precaution against overcrowding, fishermen were instructed to raise a red flag when they had caught six fish. An assistant would then row to the boat and collect the fish.

Collection of fish was conducted every forty-five minutes by a technical assistant or as red flags appeared. Data recorded at the time of collection included the following: boat number (1-8), fisherman identification letter (A-c), bait-type used, species of fish caught, and number caught of each species by each fisherman.

Upon reaching the dock, the technical assistant transferred data collected on the lake to the proper standard creel cards. Fish were then weighed to the nearest hundredth of a pound on a Toledo beam balance scale and measured to the nearest millimeter (total length). Data on length and weight were recorded in the proper spaces on the standard creel card. After processing, all live fish were returned to the lake.

Data from the standard creel cards were transferred to IBM FORTRAN coding forms (GX28-7327-6U/M 050) and a printout of the data for verification against the original standard creel cards was produced. Creel data were then summarized utilizing the Statistical Analysis System of the IBM 4341 computer at the University of Illinois. The program included a segment for the conversion of weight data from pounds to kilograms. Printouts of the kilograms of largemouth bass caught per man-hour of fishing pressure for weekly time intervals inclusive of both AM (0600-1000 hrs) and PM (1500-2000 hrs) sessions were produced. These data were broken down into five size classes (T.L.<200mm, 200<T.L.≤356mm, 356<T.L.≤ 457mm, and T.L.>457mm) as well as a category including all five size classes. These data sets were coded onto FORTRAN coding forms, punched onto IBM cards, and verified against the creel program output. All kg/man-hour data sets represent dependent variables in the regression analysis portion of this study.

## PHYSICOCHEMICAL FACTORS

Fifteen selected physicochemical parameters were monitored at Ridge Lake from 15 April to 14 October 1979 (Wednesday-Sunday each week). Depth-independent factors which were monitored included maximum and minimum air and water temperatures, rainfall, water level, air temperature, and barometric pressure.

Maximum and minimum air and water temperatures, as well as rainfall, were measured at 0600 hrs. Maximum and minimum air temperatures (°C) were measured 1.5m above the boat dock (Fig. 1) using a Taylor (No. 5458) maximum-minimum, self-registering thermometer fitted with a ventilated shade housing. Maximum and minimum water temperatures (°C) were measured 1.0m below the water's surface from the boat dock using a submersed Taylor (No. 5458) maximum-minimum thermometer. Rainfall (mm) was measured 1.5m above the boat dock with a Taylor See-Thru rain gauge. Thermometers were reset and rain gauge emptied after reading.

Water level, air temperature, and barometric pressure were recorded at 0800 and 1700 hrs. Water level was recorded utilizing an arbitrary scale where one unit was equal to the distance between two steps on the tower spillway (values range from 21.0 to 23.0 where 0.1 is approximately equal to 3cm). Air temperature (°C) was determined at the mid-lake instrument tower (Fig. 1) with a 0-50°C (0.2°C readability) mercury thermometer. Barometric pressure (mmHg) was recorded using a Thommen pocket altimeter/barometer (corrected to an altitude of 181.4m above sea level) at the boat dock prior to depth-dependent factor monitoring.

Depth-dependent parameters were monitored at 0.5m, 1.5m, 3.0m, and 3.5m at 0800 and 1700 hrs. Dissolved oxygen, water temperature, conductivity, turbidity, pH, ammonia, and alkalinity constitutde the depth-dependent parameters monitored.

Dissolved oxygen, water temperature, and conductivity were measured in-situ at the mid-lake instrument tower. Dissolved oxygen concentration (ppm) was determined with a Yellow Springs Instrument (YSI Model 51B) dissolved oxygen meter (range: 0-15ppm, accuracy: ±0.2ppm, readability: 0.1ppm) fitted with a 7.62m cable (YSI 5740) and an oxygen temperature probe (YSI 5739). Readings were taken according to methods specified in Instruction Manual YSI Model 51B (Yellow Springs Instrument Co., Yellow Springs, Ohio 45387). Water temperature (°C) was determined with the YSI Model 51B dissolved oxygen meter (range: -5°C to +45°C, accuracy: ±0.7°C including probe, readability: 0.25°C) outfitted as above. Conductivity (μmhos/cm) was determined with a Yellow Springs Instrument (YSI Model 33) salinity-conductivity-temperature meter (ranges: 0-500, 0-5,000, 0-50,000 μmho/cm, accuracy: +4.5% including probe, readability: 2.5 μmhos/cm on 500 μmho/cm range, 25 μmhos/cm on 5,000 μmho/cm range, and 250 μmhos/cm on 50,000 μmho/cm range) fitted with a conductivity/temperature probe (YSI 3300 Series). Readings were taken according to methods outlined in Instructions for YSI Model 33 and 33M S-C-T Meters (available at YSI address listed above).

Turbidity, ammonia, pH, and alkalinity readings were determined in the laboratory from 2.2 liter samples taken with a Wildco alpha-series water sampling bottle (Model 1120-H, Wildlife Supply Co., Saginaw, Michigan 48602) for each sampling depth at the mid-lake instrument tower. One liter Nalgene screw-cap sample bottles were filled to capacity from the 2.2 liter water sample bottle. Turbidity (NTU) was measured with an HF (Model DRT-15) turbidimeter (ranges: 0-1, 0-10, 0-100, 0-200 NTU, linearity: ±1% of full scale, accuracy: ±1% of full scale, sensitivity: 0.02 NTU change) immediately after sampling according to methods outlined in HF DRT-15 series "A" Instruction Manual (Shaban Manufacturing L.T.D., HF Instruments Division, 105 Healey Road, Bolton, Ontario, LOP 1A0). Ammonia, pH, and alkalinity were all determined using an Orion Research specific ion meter (Model 407A/L) fitted with the proper probe (specific ion range: 2 decades with ±0.5% of scale reading relative accuracy, ±0.5% scale reading repeatability, pH range: 0-14pH, with ±0.015pH repeatability, ±0-02pH relative accuracy). Total ionized ammonia (ppm) was measured using an Orion (Model 95-10) ammonia electrode (concentration range: 0.02-17,000ppm, temperature range: 0-50°C, pH range: samples and standards adjusted to above pH 11). All measurements were taken according to methods specified in Model 95-10 Ammonia Electrode Instruction Manual. Measurements of pH were made with an Orion (Model 91-05) gel-filled combination pH electrode (pH range: 0-14pH, temperature range: 0-100°C, 150 potential point: pH 7) according to Model 91-05 Gel-Filled Combination pH Electrode Instruction Sheet. Total carbonate alkalinity (ppm) was determined by potentiometric titration of 50ml samples with

0.02N $H_2SO_4$ standard (standardized by titration against 0.02N $Na_2CO_3$ to pH 8.3, correction factor = $\frac{\text{mls } 0.02N\ Na2CO3}{\text{mls } 0.02N\ H_2CO_4}$ ). Samples were titrated to an endpoint of pH 4.6 utilizing the Orion specific ion meter fitted with the gel-filled combination pH probe and an Ace automatic burette (0-25ml).

All physicochemical data were transferred from field note sheets to IBM FORTRAN coding forms (GX28-7327-6U/M 050), onto IBM cards, and a printout of the data for verification against the original field data sheets was produced. Physicochemical data were then summarized utilizing the Statistical Analysis System of the IBM 4341 computer at the University of Illinois. Program output included the following time categories for weekly time periods: AM (mean of depth-dependent samples taken at 0800 hrs, mean of depth-independent samples taken at 0800 hrs, rainfall, and maximum and minimum air and water temperatures read at 0600 hrs), PM (mean of depth dependent samples taken at 1700 hrs, mean of depth-independent samples taken at 1700 hrs, rainfall, and maximum and minimum air and water temperatures read at 0600 hrs), and weekly collapsed (mean of depth-dependent samples taken at 0800 and 1700 hrs, mean of depth-independent samples taken at 0800 and 1700 hrs, rainfall, and mean of maximum and minimum air and water temperatures read at 0600 hrs). Data on four depth categories (0.5m, 1.5m, 3.0m, and 3.5m below surface) were produced for depth-dependent factors, as well as a category including all four depths (column) for each of the time categories listed above. Weekly collapsed column data sets were coded onto FORTRAN coding forms (GX28-7327-6U/M 050), punched onto IBM cards, and verified against physicochemical program output. All physicochemical data sets represent independent variables in the regression analysis portion of this study.

## RESULTS

During the twenty-six week 1979 Ridge Lake fishing season a total of 6123 largemouth bass weighing 1202.01kg were caught in 6104 man-hours of fishing. Distribution of the largemouth bass catch by size class occurred as follows: 553 bass, T.L.<200mm, weight = 50.02kg; 4716 bass, 200<T.L.≤254, weight = 733.12kg; 449 bass, 254<T.L.≤356mm, weight = 138.82kg; 398 bass, 356<T.L.≤457mm, weight = 269.00kg; and 7 bass, T.L.>457mm, weight = 11.05kg. Weekly catch rate (kilograms/man-hour) fluctuated throughout the season (Fig. 2).

Physicochemical factors monitored at Ridge Lake showed fluctuation on a weekly basis as follows: water column temperatures, 13.21-24.85°C; column dissolved oxygen concentration, 3.90-11.40ppm; column conductivity, 243.9-439.4µmhos/cm; column turbidity, 1.07-65.58NTU; column pH, 7.47-8.60; column total ionized ammonia, 0.05-0.31ppm; column total carbonate alkalinity, 95.0-191.4ppm; air temperature at time of sampling, 10.68-30.0°C; barometric pressure, 750.4-763.2mmHg; water level, 21.7-22.4 (approximately 21.0cm); rainfall, 0.0-45.4mm; maximum water temperature, 17.0-31.3°C at 1.0m below surface; minimum water temperature, 12.8-27.9°C at 1.0m below surface; maximum air temperature, 19.1-35.8°C; and minimum air temperature, 3.1-21.8°C.

Relationships between physicochemical factors were determined by calculation of a Pearson product moment correlation matrix utilizing the Statistical Analysis System of the University of Illinois IBM 4341 computer. Conductivity, alkalinity and dissolved oxygen were all positively correlated with each other and turbidity was positively correlated with rainfall, water level, maximum and minimum water temperatures, and minimum air temperature. As expected, air temperature at time of sampling, water column temperature, maximum and minimum air temperatures and maximum and minimum water temperatures were all positively intercorrelated. Conductivity and pH were positively correlated with water level, but not correlated with each other. Conductivity was, however, positively correlated with maximum air temperature. Water level and rainfall were positively correlated with minimum air temperature but showed no significant correlation with each other. Dissolved oxygen showed negative correlation with maximum water temperature as did ammonia which also showed a negative correlation with air temperature at time of sampling, barometric pressure, water level, and minimum air temperature ($r$ and p values, Table 1).

Relationships between physicochemical factors and catch rate of large-mouth bass were determined in a three step process utilizing the Statistical Analysis System of the University of Illinois IBM 4341 computer for each step.

Step One involved calculation of a Pearson product moment correlation matrix for catch rate of largemouth bass (kilograms/man-hour) on physico-chemical parameters. Catch rate data was analyzed for size classes: T.L.<200mm (hereafter referred to as I), 200<T.L.$\leq$254mm (hereafter referred to as II), 254<T.L.$\leq$356mm (hereafter referred to as III), 356<T.L.$\leq$457mm (hereafter referred to as IV), T.L.>457mm (hereafter referred to as V), and all size classes combined. Column water temperature, barometric pressure, water level, maximum and minimum air temperatures, and maximum and minimum water temperatures were not significantly correlated ($p>0.05$) with any size class catch rate (SCCR) or the combined size class catch rate. Dissolved oxygen was positively correlated with the combined SCCR ($r=0.7490$, $p=0.0001$) and the catch rates for size classes: I ($r=0.7290$, $p=0.0001$), II ($r=0.7253$, $p=0.0001$), and IV ($r=0.5561$, $p=0.0032$).

Conductivity was also positively correlated with the combined SCCR

($r$=0.7439, p=0.0001), as well as the catch rates for size classes: I ($r$=0.5562, p=0.0032), II ($r$=0.7167, p=0.0001), and IV ($r$=0.6021, p= 0.0011). Turbidity was negatively correlated with the combined SCCR ($r$=-0.5145, p=0.0072) and the catch rates for size classes: II ($r$=-0.5343, p=0.0004) and III ($r$=-0.4090, p=0.0380). There was a positive correlation between pH and the combined SCCR ($r$=0.5965, p=0.0013), as well as the catch rates for size classes: I ($r$=0.5753, p-0.0021), II ($r$=0.5887, p=0.0001), and IV ($r$=0.4426, p=0.0236). Ammonia was only negatively correlated with the combined SCCR ($r$=-0.4694, p=0.0155) and size class IV catch rate ($r$=-0.4560, p=0.0192). As with dissolved oxygen, conductivity, and pH, alkalinity was positively correlated with the combined SCCR ($r$=0.7531, p=0.0001), as well as the catch rates for size classes: I ($r$=0.8265, p=0.0001), II ($r$=0.7782, p=0.0001), and IV ($r$=0.4895, p=0.0112). Rainfall was only correlated to the catch rate for size class V ($r$=0.4209, p=0.0323) (Table 2).

In summary, the Pearson product moment correlations for dissolved oxygen, conductivity, pH, and alkalinity (independent variables) on the combined SCCR and catch rates for size classes I, II and IV (dependent variables) were highly significant. Turbidity and ammonia were both negatively related to the combined SCCR, but turbidity was also negatively related to size class II and size class III catch rates, while ammonia was negatively correlated with size class IV catch rate. Rainfall was only correlated with size class V catch rate.

Step two utilized the Statistical Analysis System R-square procedure with limits set at five independent variable models. Best one independent variable R-square regression models included: alkalinity (56.71% catch rate fluctuation (CRF) accounted for) for the combined size class; alkalinity

(68.31% CRF accounted for) for size class I; alkalinity (60.55% CRF accounted for) for size class II; turbidity (16.72% CRF accounted for) for size class III; conductivity (36.26% CRF accounted for) for size class IV; and rainfall (17.71% CRF accounted for) for size class V (Table 3).

Best two independent variable R-square regression models included ammonia-alkalinity (70.28% CRF accounted for) for the combined size class; turbidity-alkalinity (71.86% CRF accounted for) for size class I; ammonia-alkalinity (68.25% CRF accounted for) for size class II; turbidity-ammonia (30.13% CRF accounted for) for size class III; turbidity-water level (61.41% CRF accounted for) for size class IV; and column water temperature-maximum water temperature (29.10% CRF accounted for) for size class V (Table 4).

Best three independent variable R-square regression models included: dissolved oxygen-turbidity-ammonia (74.44% CRF accounted for) for the combined size class; column water temperature-alkalinity-maximum water temperature (72.82% CRF accounted for) for size class I; turbidity-ammonia-alkalinity (70.88% CRF accounted for) for size class II; turbidity-barometric pressure-rainfall (38.26% CRF accounted for) for size class III; turbidity-water level-minimum water temperature (64.31% CRF accounted for) for size class IV; and column water temperature-rainfall-maximum water temperature (36.82% CRF accounted for) for size class V (Table 5).

Best four independent variable R-square regression models included: dissolved oxygen-conductivity-turbidity-ammonia (77.36% CRF accounted for) for combined size class; column water temperature-turbidity-alkalinity-maximum water temperature (75.07% CRF accounted for) for size class I; column water temperature-conductivity-turbidity-maximum water temperature (74.33% CRF accounted for) for size class II; turbidity-barometric pressure-rainfall-maximum water temperature (45.61% CRF accounted for) for size class III; turbidity-water level-maximum water temperature-minimum water temperature (71.35% CRF accounted for) for size class IV; and water temperature-rainfall-maximum water temperature-minimum air temperature (43.03% CRF accounted for) for size class V (Table 6).

Best five independent variable R-square regression models included: column water temperature-conductivity-turbidity-ammonia-maximum water temperature (81.16% CRF accounted for) for the combined size class; column water temperature-turbidity-alkalinity-air temperature at time of sampling-maximum air temperature (76.59% CRF accounted for) for size class I; column water temperature-conductivity-turbidity-ammonia-maximum air temperature (77.62% CRF accounted for) for size class II; turbidity-air temperature at time of sampling-barometric pressure-rainfall-maximum water temperature (54.50% CRF accounted for) for size class III; turbidity-barometric pressure-water level-maximum water temperature-minimum water temperature (74.35% CRF accounted for) for size class IV: and column water temperature-water level-rainfall-maximum water temperature-minimum air temperature (46.70% CRF accounted for) for size class V (Table 6).

In summary, the best R-square regression models for the combined size class with one through five independent variables included: alkalinity (56.71% CRF accounted for); ammonia-alkalinity (70.28% CRF accounted for); dissolved oxygen-turbidity-ammonia (74.44% CRF accounted for); dissolved oxygen-conductivity-turbidity-ammonia (77.36% CRF accounted for); and column water temperature-conductivity-turbidity-ammonia-maximum water temperature (81.16% CRF accounted for).

Best R-square regression models for size class I included: alkalinity (68.31% CRF accounted for); turbidity-alkalinity (71.86% CRF accounted for); column water temperature-alkalinity-maximum water temperature (72.82% CRF accounted for); column water temperature-turbidity-alkalinity-maximum water temperature (75.07% CRF accounted for); and column water temperature-turbidity-alkalinity-air temperature at time of sampling-maximum air temperature (76.59% CRF accounted for).

Best R-square regression models for size class II included: alkalinity (60.55% CRF accounted for); ammonia-alkalinity (68.25% CRF accounted for); turbidity-ammonia-alkalinity (70.88% CRF accounted for); column water temperature-conductivity-turbidity-maximum water temperature (74.33% CRF accounted for); and column water temperature-conductivity-turbidity-ammonia-maximum air temperature (77.62% CRF accounted for).

Best R-square regression models for size class III included: turbidity (16.72% CRF accounted for); turbidity-ammonia (30.13% CRF accounted for); turbidity-barometric pressure-rainfall (38.26% CRF accounted for); turbidity-barometric pressure-rainfall-maximum water temperature (45.61% CRF accounted for); and turbidity-air temperature at time of sampling-barometric pressure-rainfall-maximum water temperature (54.50% CRF accounted for).

Best R-square regression models for size class IV included: conductivity ( 36.26% CRF accounted for); turbidity-water level (61.41% CRF accounted for); turbidity-water level-minimum water temperature (64.31% CRF accounted for); turbidity-water level-maximum water temperature-minimum water temperature (71.35% CRF accounted for); and turbidity-barometric pressure-water level-maximum water temperature-minimum water temperature (74.35% CRF accounted for).

Best R-square regression models for size class V included: rainfall (17.71% CRF accounted for); column water temperature-maximum water temperature (29.10% CRF accounted for); column water temperature-rainfall-maximum water temperature (36.82% CRF accounted for); column water temperature-rainfall-maximum water temperature-minimum air temperature (43.03% CRF accounted for); column water temperature-water level-rainfall-maximum water temperature-minimum air temperature (46.70% CRF accounted for).

Step Three utilized the Statistical Analysis System Maximum R-square Improvement stepwise multiple regression procedure which begins by selecting one independent variable model producing the highest R-square. Then another variable, the one yielding the greatest R-square increase, is added. Next, a determination is made whether removing one variable and replacing it with another variable would increase R-square or not. After comparison of all possible combinations, the best two independent variable model is produced and the process continues. A five independent variable limit was set on the procedure. In all of the following equations physico-chemical parameters will be abbreviated as follows: WTemp = column water temperature, DO = dissolved oxygen, Cond = conductivity, Turb = turbidity, Amm = total ammonia, Alk = total carbonate alkalinity, ATemp = air temperature at time of sampling, BPres = barometric pressure, WLev = water level, RFall = rainfall, MaxTW = maximum water temperature, MinTW = minimum water temperature, MaxTA = maximum air temperature, MinTA = minimum air temperature. Abbreviations for kg/man-hour of largemouth bass caught are as follows: KgMH0 = combined size class, KgMH1 = $T.L. < 200$mm, KgMH2 = $200 < T.L. \leq 254$mm, KgMH3 = $254 < T.L. \leq 356$mm, KgMH4 = $356 < T.L. \leq 457$mm, and KgMH5 = $T.L. > 457$mm.

Best one independent variable Maximum R-square Improvement stepwise multiple regression models were described by equations: KgMH0 = 0.0021Alk - 0.1070 ($F=31.44$, $p>F=0.0001$), KgMH1 = 0.0003Alk - 0.0316 ($F=51.74$, $p>F=0.0001$), KgMH2 = 0.0016Alk - 0.1011 ($F=36.84$, $p>F=0.0001$), KgMH3 = -0.0003Turb + 0.0262 ($F=4.82$, $p>F=0.0380$), KgMH4 = 0.0002Cond - 0.0308 ($F=13.65$, $p>F=0.0011$), and KgMH5 = 0.0003RFall + 0.0010 ($F=5.17$, $p>F=0.0323$)

(Table 8). These results are identical to Step Two (R-square procedure) results.

Best two independent variable Maximum R-square Improvement stepwise multiple regression models were described by equations: KgMH0 = 0.4377Amm + 0.0020Alk - 0.0301 (F=27.19 p F=0.0001), KgMH1 = 0.0001Turb + 0.0003Alk - 0.0394 (F=29.37, p>F=0.0001), KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601 (F=24.72, p>F=0.0001), KgMH3 = -0.0003Turb - 0.0502Amm + 0.0328 (F=4.96, p>F=0.0162), KgMH4 = 0.0002Cond + 0.0021BPres - 1.6153 (F=8.78, p>F=0.0051), and KgMH5 = -0.0028WTemp + 0.0029MaxTW - 0.0136 (F=4.72, p>F=0.0192) (Table 9). These results were identical to those produced in Step Two except that Turb-WLev was selected for the 356<T.L.$\leq$457mm size class in Step Two and Cond-BPres was selected for the same size class in Step Three.

Best three independent variable Maximum R-square Improvement stepwise multiple regression models were described by equations: KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828 (F=21.36, p>F=0.0001), KgMH1 = 0.0001Turb - 0.0103Amm + 0.0003Alk - 0.0373 (F=19.21, p>F=0.0001), KgMH2 = -0.0007Turb - 0.2491Amm + 0.0013Alk - 0.0173 (F=17.85, p>F=0.0001), KgMH3 = -0.0005Turb + 0.0013BPres + 0.0006RFall - 0.9646 (F=4.55, p>F=0.0126), KgMH4 = 0.0034DO + 0.0001Cond + 0.0023BPres - 1.7881 (F=6.73, p>F=0.0022), and KgMH5 = -0.0024WTemp + 0.0002RFall + 0.0025MaxTW - 0.0120 (F=4.27, p>F=0.0160) (Table 10). These results varied with those produced in Step Two for the T.L.<200mm size class (Step Two = WTemp-Alk-MaxTW, Step Three = Turb-Amm-Alk) and the 356<T.L.$\leq$457mm size class (Step Two = Turb-WLev-MinTW, Step Three = DO-Cond-BPres).

Best four independent variable Maximum R-square Improvement stepwise multiple regression models were described by equations: KgMH0 = 0.0168DO + 0.0004Cond - 0.0017Turb - 0.2978Amm + 0.0018 (F=17.94, p>F=0.0001), KgMH1 =

-0.0020WTemp + 0.0001Turb + 0.0004Alk + 0.0019MaxTW - 0.0490 (F=15.81, p>F=0.0001), KgMH2 = -0.0010Turb - 0.1784Amm + 0.0013Alk + 0.0023MinTA - 0.0680 (F=14.35, p>F=0.0001), KgMH3 = -0.0006Turb + 0.0011BPres + 0.0068RFall + 0.0007MaxTW - 0.8443 (F=4.40, p>F=0.0097), KgMH4 = 0.0051DO - 0.0012Turb - 0.0004Alk + 0.1261WLev - 2.7023 (F=11.67, p>F=0.0001), and KgMH5 = -0.0021WTemp + 0.0003RFall + 0.0031MaxTW - 0.0008MinTA - 0.0226 (F=3.97, p>F=0.0150) (Table 11). These results varied with those produced in Step Two for the $200 < T.L. \leq 254$mm size class (Step Two = WTemp-Cond-Turb-MaxTW, Step Three = Turb-Amm-Alk-MinTA) and the $356 < T.L. \leq 457$mm size class (Step Two = Turb-WLev-MaxTW-MinTW, Step Three = DO-Turb-Alk-WLev).

Best five independent variable Maximum R-square Improvement stepwise multiple regression models were described by equations: KgMH0 = 0.0151DO + 0.0003Cond - 0.0023Turb - 0.2484Amm + 0.1049WLev - 2.2683 (F=14.65, p>F=0.0001), KgMH1 = -0.0012WTemp + 0.0002Turb + 0.0003Alk - 0.0010ATemp + 0.0017MaxTA - 0.0375 (F=13.09, p>F-0.0001), KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714 (F-13.87, p>F=0.0001), KgMH3 = -0.0007Turb - 0.0015ATemp + 0.0012BPres + 0.0008RFall + 0.0024MaxTW - 0.8950 (F=4.79, p>F=0.0049), KgMH4 = 0.0057DO - 0.0010Turb - 0.0329pH + 0.1099WLev + 0.0019MinTW - 2.1869 (F=10.56, p>F=0.0001), and KgMH5 = -0.0024WTemp + 0.0145WLev + 0.0002RFall + 0.0038MaxTW - 0.0013MinTA - 0.3465 (F=3.50, p>F=0.0195) (Table 12). These results varied with those produced in Step Two for the combined size class (Step Two = WTemp-Cond-Turb-Amm-MaxTW, Step Three = DO-Cond-Turb-Amm-WLev) and the $356 < T.L. \leq 457$mm size class (Step Two = Turb-BPres-WLev-MaxTW-MinTW, Step Three = DO-Turb-pH-WLev-MinTW).

In summary, the best Maximum R-square Improvement stepwise multiple regression models for the combined size class with one through five independent variables included: KgMH0 = 0.0021Alk - 0.1070; KgMH0 = -0.4377Amm + 0.0020Alk - 0.0301; KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828; KgMH0 = 0.0168DO + 0.0004Cond - 0.0017Turb - 0.2978Amm + 0.0018; and KgMH0 = 0.0151DO + 0.0003Cond - 0.0023Turb - 0.2484Amm + 0.1049WLev - 2.2683. These results agreed with one through four independent variable R-square regression models, but not with the five variable model.

Best Maximum R-square Improvement stepwise multiple regression models for size class I with one through five independent variables included: KgMH1 = 0.0003Alk - 0.0316; KgMH1 = 0.0001Turb + 0.0003Alk - 0.0394; KgMH1 = 0.0001Turb - 0.0103Amm + 0.0003Alk - 0.0373; KgMH1 = -0.0020WTemp + 0.0001Turb + 0.0004Alk + 0.0019MaxTW - 0.0490; and KgMH1 = -0.0012WTemp + 0.0002Turb + 0.0003Alk - 0.0010ATemp + 0.0017MaxTA - 0.0375. These results were in agreement with all independent variable R-square regression models.

Best Maximum R-square Improvement stepwise multiple regression models for size class II with one through five independent variables included: KgMH2 = 0.0016Alk - 0.1011; KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601; KgMH2 = -0.0007Turb - 0.2491Amm + 0.0013Alk - 0.0173; KgMH2 = -0.0010Turb - 0.1784Amm + 0.0013Alk + 0.0023MinTA - 0.0680; and KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714. These results were in agreement with all R-square regression models except the four independent variable model.

Best Maximum R-square Improvement stepwise multiple regression models for size class III with one through five independent variables included: KgMH3 = -0.0003Turb + 0.0262; KgMH3 = -0.0003Turb - 0.0502Amm + 0.0328; KgMH3 = -0.0005Turb + 0.0013BPres + 0.0006RFall - 0.9646; KgMH3 = -0.0006Turb + 0.0011BPres + 0.0068RFall + 0.0007MaxTW - 0.8443; and KgMH3 = -0.0007Turb - 0.0015ATemp + 0.0012BPres + 0.0008RFall + 0.0024MaxTW - 0.8950. These results were in agreement with all R-square independent variable models.

Best Maximum R-square Improvement stepwise multiple regression models for size class IV with one through five independent variables included: KgMH4 = 0.0002Cond - 0.0308; KgMH4 = 0.0002Cond + 0.0021BPres - 1.6153; KgMH4 = 0.0034DO + 0.0001Cond + 0.0023BPres - 1.7881; KgMH4 = 0.0051DO - 0.0012Turb - 0.0004Alk + 0.1261WLev - 2.7023; and KgMH4 = 0.0057DO - 0.0010Turb - 0.0329pH + 0.1099WLev + 0.0019MinTW - 2.1869. All R-square independent models except the one independent variable model were in disagreement with these results.

Best Maximum R-square Improvement stepwise multiple regression models for size class V with one through five independent variables included: KgMH5 = 0.0003RFall + 0.0010; KgMH5 = -0.0028WTemp + 0.0029MaxTW - 0.0136; KgMH5 = -0.0024WTemp + 0.0002RFall + 0.0025MaxTW - 0.0120; KgMH5 = -0.0021WTemp + 0.0003RFall + 0.0031MaxTW - 0.0008MinTA - 0.0226; and KgMH5 = -0.0024WTemp + 0.0145WLev + 0.0002RFall + 0.0038MaxTW - 0.0013MinTA - 0.3465. These results were in agreement with all R-square independent variable models.

## DISCUSSION

Results of the Pearson product moment correlation matrix showed turbidity to be inversely related to catch rate for the combined size class, as well as size classes II and III. Heimstra, *et al.* (1969) found that bass activity was significantly higher in waters of low turbidity than in waters of high turbidity. This decreased activity may express itself in decreased catch rate. Negative correlation of turbidity with catch rate is consistent with the results of Bennett, *et al.* (1940) and Buck (1956).

Ammonia was inversely related to the combined SCCR and size class IV catch rate. Flis (1968) demonstrated that sublethal concentrations were linked to tissue destruction in organs and Fromm (1970) related high ammonia concentrations to nervous system damage. Ammonia toxicity to centrarchids increases as pH rises above 7.0 (Bulkley 1975) and the minimum pH of Ridge Lake during the study was 7.47, while the maximum pH value was 8.6. Sublethal concentrations may affect largemouth bass striking performance through irritation, nervous response impairment, or appetite reduction, thereby decreasing catch rate.

Positive correlations of dissolved oxygen, carbonate alkalinity and pH with catch rates for size classes I, II, IV and the combined size class are in disagreement with the results of Lux and Smith (1960), who found that these three parameters, as well as turbidity, were not related to catch rate. The disparity between the results of Lux and Smith and our results may be explained by their use of bi-weekly physicochemical samples and creel estimates, whereas we sampled physicochemical parameters on a daily basis and compared them to the results of a complete creel survey.

Conductivity was also positively related to the catch rate for size classes I, II, and IV, as well as the combined size class catch rate. Catch rate for size class V only showed correlation with rainfall.

Lack of many significant correlations for size class III and V catch rates may be due to their small contributions, 12% and 1% respectively, to the total catch rate of largemouth bass (Fig. 3). Bass in size class II dominated the catch rate (61% of the total catch rate) and the population. These bass were members of the dominant 1976 year class.

Most surprising were the lack of significant correlations of column water temperature, air temperature, barometric pressure, water level, and maximum and minimum air and water temperatures with size class catch rate. Many of these values did become significant in the R-square and Maximum R-square Improvement analyses.

Results from the R-square analyses were compared to results from the Maximum R-square Improvement analyses in order to determine the "best" representative models for catch rate fluctuation on physicochemical factor variation. In order to choose the "best" overall models, the following criteria were used in the selection process: any model containing component independent variables with $p>0.05$ was deleted, any model not agreeing with both the R-square procedure and the Maximum R-square Improvement procedure was deleted, and any model not accounting for a minimum of 50% CRF was deleted. The reader should be cautioned that these are extremely stringent criteria set to specifically severely limit the number of working models to the few most statistically significant "best" models. Exhaustive information has been supplied in the Results section of this study and the Appendices in order to allow the reader flexibility in interpretation of the results.

Five independent variable models showed the highest $r^2$ values for each size class, but many contained physicochemical factors which were individually insignificant. The Maximum R-square Improvement stepwise multiple regression model for size class II, however, accounted for 77.62% of CRF with all individual physicochemical factors significant at $p<0.05$ and matched the best five independent variable model predicted by the R-square procedure (Table 7). The regression equation for size class II is as follows: KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714 (Table 12).

Four independent variable models showed the next highest $r^2$ values for each size class, but all equations contained individually insignificant physicochemical factors and Maximum R-square Improvement results varied with R-square procedure results for size class II and size class IV which were both dominant in percent contribution to total catch rate (Fig. 3).

One Maximum R-square Improvement three independent variable model (combined size class), KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828 (74.44% CRF accounted for), contained no individual insignificant physicochemical factors (Table 10) and agreed with R-square procedure results (Table 5).

Four of the two Maximum R-square Improvement two independent variable models contained no individual insignificant physicochemical factors, but the size class III model only accounted for 30.13% of CRF and the size class V model accounted for only 29.10% of CRF. Thus, the combined size class model (KgMH0 = -0.4377Amm + 0.0020Alk - 0.0301, 70.28% CRF accounted for) and the size class II model (KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601, 68.25% CRF accounted for) were selected as the best two independent variable models (Table 9). Both models were in agreement with R-square procedure results (Table 4).

All Maximum R-square Improvement one independent variable models were significant and agreed with R-square procedure results and with best Pearson product moment correlation matrix results, but models for size class III (16.72% CRF accounted for), size class IV (36.26% CRF accounted for), and size class V (17.71% CRF accounted for) failed to explain large percentages of the CRF for their size classes (Table 8). Models for size class I (68.31% CRF accounted for), size class II (60.55% CRF accounted for) and the combined size class (56.71% CRF accounted for) were all based upon alkalinity. Equations for these one independent variable models were as follows: KgMH0 = 0.0021Alk - 0.1070, KgMH1 = 0.0003Alk - 0.0316, and KgMH2 = 0.0016Alk - 0.1011.

The importance of variations in carbonate alkalinity as related to

CRF in size classes I, II and the combined size class is clearly demonstrated in these one variable models. In the two variable model for the combined size class (KgMHO = -0.4377Amm + 0.0020Alk - 0.0301) alkalinity was responsible for 78.03% of the Type II Sum of Squares, while in the two variable model for size class II (KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601) alkalinity accounted for 87.52% of the Type II Sum of Squares. Ammonia was more important to CRF for the combined size class (21.97% contribution to Type II Sum of Squares) than to CRF for size class II (12.48% contribution to Type II Sum of Squares).

In the best three variable model (KgMHO = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828) alkalinity dropped out and was replaced by dissolved oxygen and turbidity whose combined Type II Sum of Squares contribution was 80.88% (dissolved oxygen=55.01%, turbidity=25.87%).

The best five variable model (KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714) replaces dissolved oxygen with column water temperature, conductivity, and maximum air temperature, 26.87%, 35.32% and 12.19% contribution to Type II Sum of Squares respectively (combined Type II Sum of Squares = 74.38%).

These models suggest that the dominant single factor responsible for CRF was alkalinity; in addition, dissolved oxygen, turbidity, conductivity, column water temperature, ammonia, and maximum air temperature were important. These results are consistent with Pearson product moment correlation matrix results with the exception of column water temperature and maximum air temperature which were both shown to have no significant correlation with catch rate. Column water temperature was, however, negatively related to alkalinity ($r$=-0.4096, p=0.0377) and maximum air temperature was positively related to conductivity ($r$=0.3982, p=0.0439), thus raising the possibility of combinatorial effects.

Assuming that results for the combined size class catch rate and size class II catch rate are comparable (size class II = 61.0% of combined size class catch rate), and acknowledging that models KgMH2 = 0.0016Alk - 0.1011 (60.55% CRF accounted for), KgMH0 = -0.4377Amm + 0.0020Alk - 0.0301 (70.28% CRF accounted for), KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828 (74.44% CRF accounted for) and KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714 (77.62% CRF accounted for) represent the "best" models, a single choice to be used as a diagnostic tool in predicting catch rate fluctuation can be made by the investigator after considering the cost/benefit ratio for each model. Fluctuation not accounted for by these models may be due to other physicochemical factors such as light intensity, turbulence resulting from wind action, day length, and instantaneous fluctuations of physicochemical parameters at various points in the lake. Biotic factors such as availability of natural forage, hook-avoidance learning and biorhythmic behavior patterns may also account for some of the catch rate fluctuation. Variation in fishing ability may also have some effect on catch rate fluctuation and should not be discounted.

## CONCLUSIONS

(1) Dissolved oxygen, conductivity, pH, and alkalinity were all significantly positively correlated with catch rate fluctuation in largemouth bass.

(2) Turbidity and ammonia were significantly negatively correlated with catch rate fluctuation in largemouth bass.

(3) Maximum R-square Improvement regression analyses generated the following "best" models for catch rate fluctuation on physicochemical

parameter variation: $KgMH2 = 0.0016Alk - 0.1011$ ($r^2$=0.6055), $KgMH0 = -0.4377Amm + 0.0020Alk - 0.0301$ ($r^2$=0.7028), $KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828$ ($r^2$=0.7444), and $KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714$ ($r^2$=0.7762).

(4) Differences in catch rate fluctuation between size classes as compared to physicochemical parameter fluctuations were obscured due to dominance of the 1976 year class (size class II) in the creel and in the population.

(5) The single most important physicochemical factor correlated with catch rate fluctuation was alkalinity; in addition, dissolved oxygen, turbidity, conductivity, column water temperature, ammonia, and maximum air temperature were important.

(6) Conductivity, pH, and alkalinity were all more strongly positively correlated with catch rate fluctuation than turbidity was negatively correlated with catch rate fluctuation.

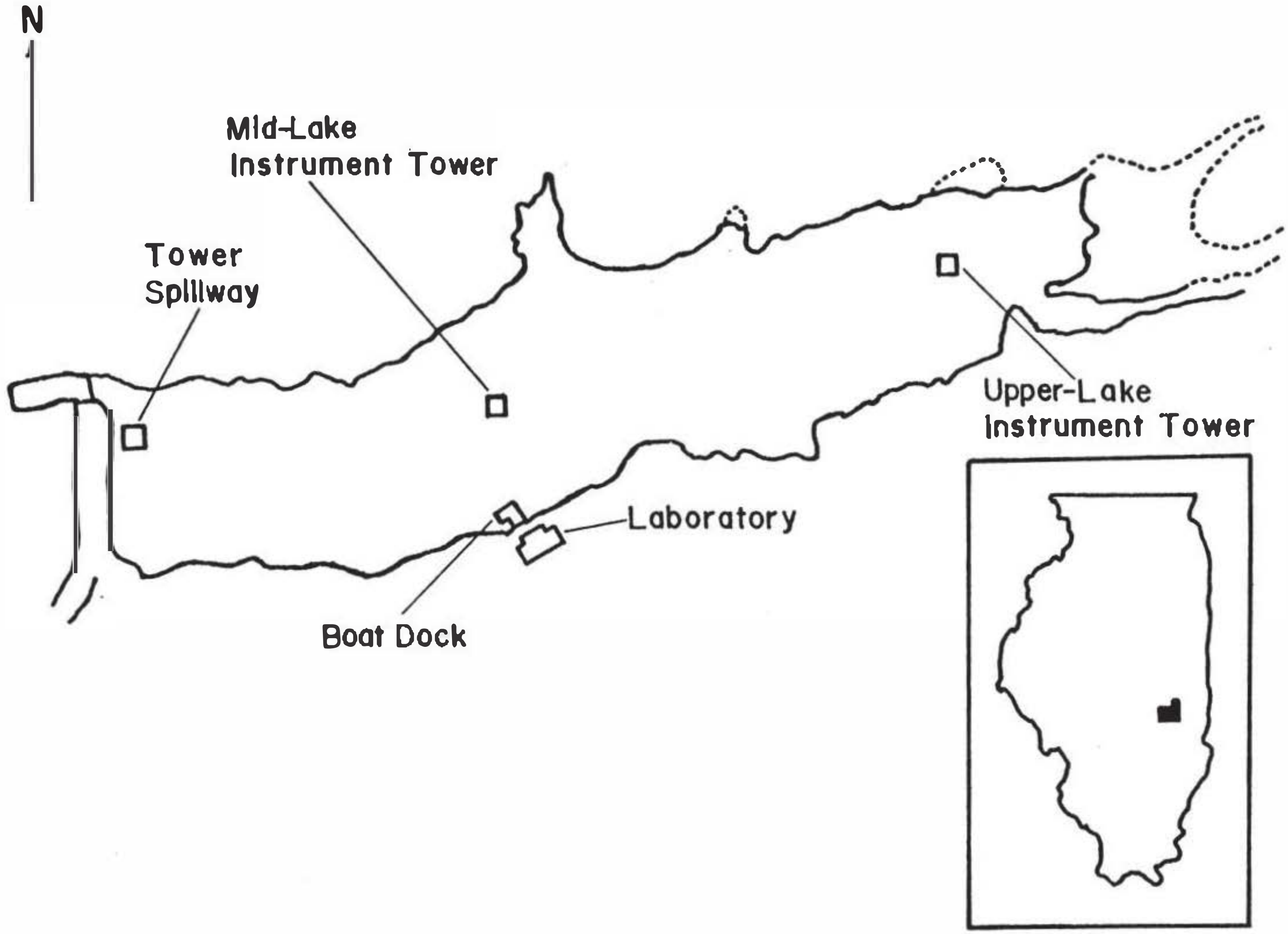


Figure 1. Map of Ridge Lake, a 6.28 hectare impoundment located in Fox Ridge State Park Coles County, Illinois.

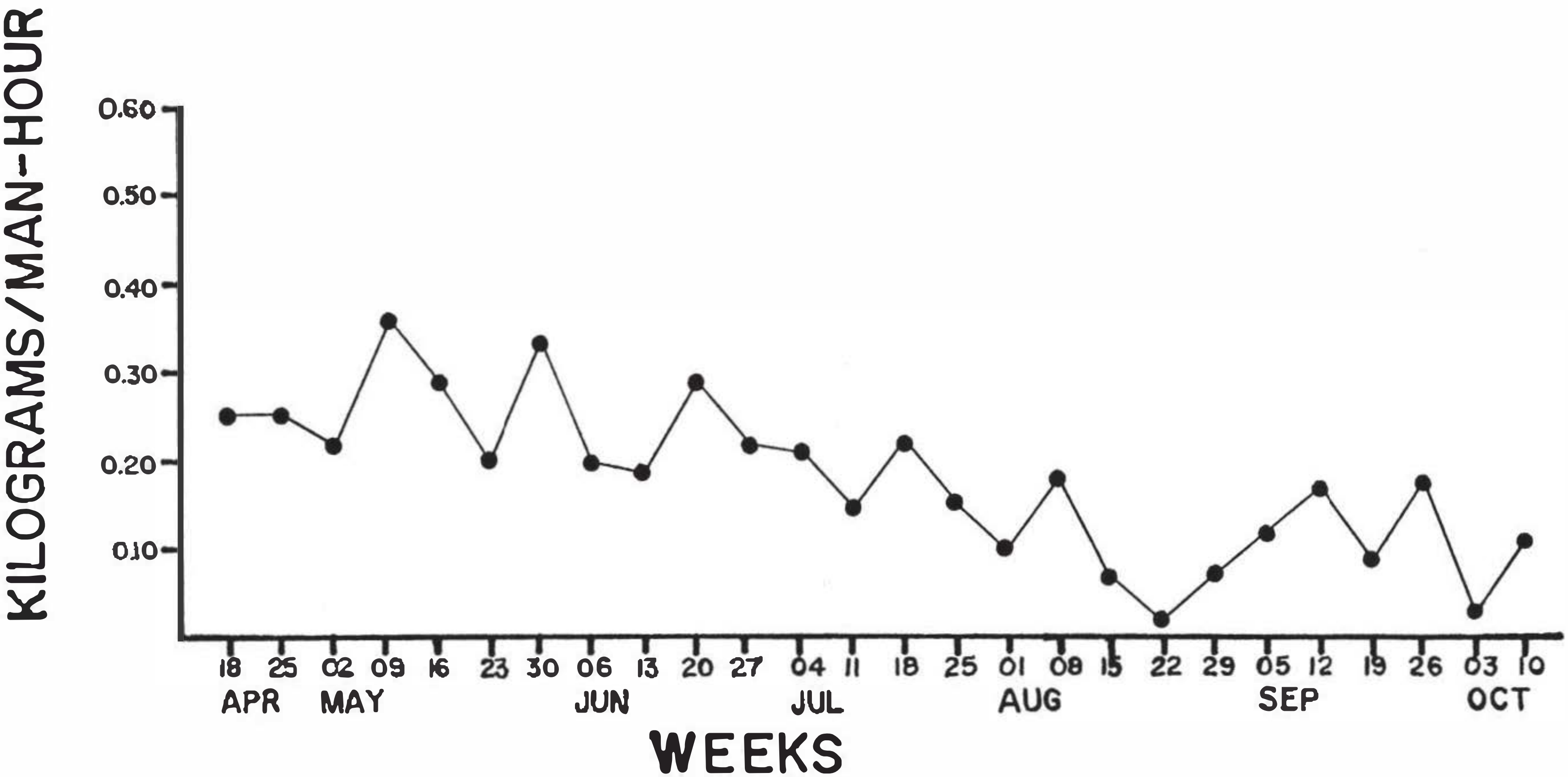


Figure 2. Fluctuations in the catch rate of largemouth bass (*Micropterus salmoides*) during the 1979 Ridge Lake fishing season.

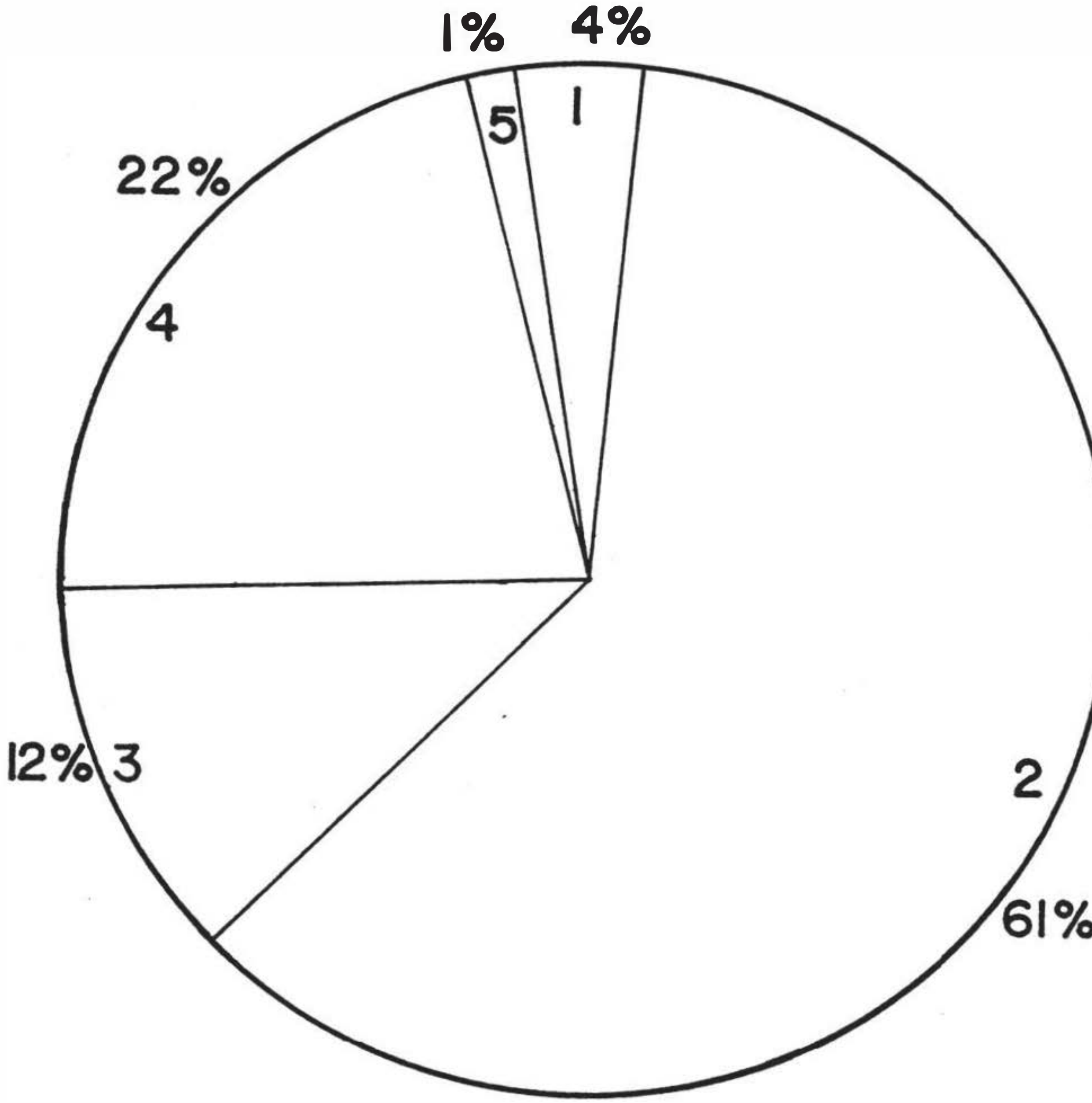


Figure 3. Percent contribution, by size class, to the total catch rate of largemouth bass (*Micropterus salmoides*) during the 1979 Ridge Lake fishing season. 1 = T.L.≤200mm, 2 = 200<T.L.≤254mm, 3 = 254<T.L.≤356mm, 4 = 356<T.L.≤457mm, 5 = T.L.>457mm.

Table 1. Pearson correlation matrix for 1979 weekly Ridge Lake physico-chemical data collapsed over sessions and depths: WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPress = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C), MinTA = minimum air temperature (°C). Correlation coefficients/Prob > !R! under HO:RHO=0, N=26. Correlations not meeting p>0.05 deleted.

| | WTemp | DO | Cond | Turb | pH | Amm | Alk | ATemp |
|---|---|---|---|---|---|---|---|---|
| WTemp | 1.0000<br>0.0000 | -- | -- | -- | -- | -- | -- | -- |
| DO | -- | 1.0000<br>0.0000 | -- | -- | -- | -- | -- | -- |
| Cond | -- | 0.7205<br>0.0001 | 1.0000<br>0.0000 | -- | -- | -- | -- | -- |
| Turb | -- | -- | -- | 1.0000<br>0.0000 | -- | -- | -- | -- |
| pH | -- | -- | -- | -- | 1.0000<br>0.0000 | -- | -- | -- |
| Amm | -- | -- | -- | -- | -- | 1.0000<br>0.0000 | -- | -- |
| Alk | -0.4096<br>0.0377 | 0.8235<br>0.0001 | 0.7043<br>0.0001 | -0.5478<br>0.0038 | 0.6597<br>0.0002 | -- | 1.0000<br>0.0000 | -- |
| ATemp | 0.8898<br>0.0001 | -- | -- | -- | -- | -0.4488<br>0.0215 | -- | 1.0000<br>0.0000 |
| BPress | -- | -- | -- | -- | -- | -0.4365<br>0.0258 | -- | -- |
| WLev | -- | -- | 0.4257<br>0.0301 | 0.4492<br>0.0213 | 0.5822<br>0.0018 | -0.4600<br>0.0180 | -- | -- |
| RFall | -- | -- | -- | 0.7919<br>0.0001 | -- | -- | -- | -- |
| MaxTW | 0.9609<br>0.0001 | -0.3897<br>0.0491 | -- | 0.4113<br>0.0369 | -- | -- | -0.5264<br>0.0057 | 0.9031<br>0.0001 |
| MinTW | 0.9545<br>0.0001 | -- | -- | 0.4407<br>0.0425 | -- | -- | -0.4587<br>0.0184 | 0.9125<br>0.0001 |
| MaxTA | 0.8942<br>0.0001 | -- | 0.3982<br>0.0439 | -- | -- | -- | -- | 0.9517<br>0.0001 |
| MinTA | 0.8660<br>0.0001 | -- | -- | 0.4840<br>0.0122 | -- | -0.4009<br>0.0424 | --<br>-- | 0.9429<br>0.0001 |

Table 1. Pearson correlation matrix for 1979 weekly Ridge Lake physico-chemical data collapsed over sessions and depths: WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (μmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPress = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C). Correlation coefficients/Prob > !R! under HO:RHO=0, N=26. Correlations not meeting p>0.05 deleted. (continued)

| | BPres | WLev | RFall | MaxTW | MinTW | MaxTW | MinTA |
|---|---|---|---|---|---|---|---|
| WTemp | -- | -- | -- | -- | -- | -- | -- |
| DO | -- | -- | -- | -- | -- | -- | -- |
| Cond | -- | -- | -- | -- | -- | -- | -- |
| Turb | -- | -- | -- | -- | -- | -- | -- |
| pH | -- | -- | -- | -- | -- | -- | -- |
| Amm | -- | -- | -- | -- | -- | -- | -- |
| Alk | -- | -- | -- | -- | -- | -- | -- |
| ATemp | -- | -- | -- | -- | -- | -- | -- |
| BPress | 1.0000<br>0.0000 | -- | -- | -- | -- | -- | -- |
| WLev | -- | 1.0000<br>0.0000 | -- | -- | -- | -- | -- |
| RFall | -- | -- | 1.0000<br>0.0000 | -- | -- | -- | -- |
| MaxTW | -- | -- | -- | 1.0000<br>0.0000 | -- | -- | -- |
| MinTW | -- | -- | -- | 0.9732<br>0.0001 | 1.0000<br>0.0000 | -- | -- |
| MaxTA | -- | -- | -- | 0.8763<br>0.0001 | 0.8782<br>0.0001 | 1.0000<br>0.0000 | -- |
| MinTA | -- | 0.5111<br>0.0076 | 0.3961<br>0.0452 | 0.8921<br>0.0001 | 0.9210<br>0.0001 | 0.8806<br>0.0001 | 1.0000<br>0.0000 |

Table 2. Pearson correlation matrix for 1979 weekly Ridge Lake physico-chemical data collapsed over sessions and depths: WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPress = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C); and for kilograms of largemouth bass caught per man-hour of fishing data collapsed over sessions, by size class: KgMH0 = all size classes combined, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤254mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.≥457mm. Correlation coefficients/ Prob > !R! under HO:RHO=0, N=26. Correlations not meeting p>0.05 deleted.

| | WTemp | DO | Cond | Turb | pH | Amm | Alk | ATemp |
|---|---|---|---|---|---|---|---|---|
| KgMH0 | -- | 0.7490<br>0.0001 | 0.7439<br>0.0001 | -0.5145<br>0.0072 | 0.5965<br>0.0013 | -0.4694<br>0.0155 | 0.7531<br>0.0001 | -- |
| KgMH1 | -- | 0.7290<br>0.0001 | 0.5562<br>0.0032 | -- | 0.5753<br>0.0021 | -- | 0.8265<br>0.0001 | -- |
| KgMH2 | -- | 0.7253<br>0.0001 | 0.7167<br>0.0001 | -0.5343<br>0.0049 | 0.5887<br>0.0016 | -- | 0.7782<br>0.0001 | -- |
| KgMH3 | -- | -- | -- | -0.4090<br>0.0380 | -- | -- | -- | -- |
| KgMH4 | -- | 0.5561<br>0.0032 | 0.6021<br>0.0011 | -- | 0.4426<br>0.0236 | -0.4560<br>0.0192 | 0.4895<br>0.0112 | -- |
| KgMH5 | -- | -- | -- | -- | -- | -- | -- | -- |

Table 2. Pearson correlation matrix for 1979 weekly Ridge Lake physico-chemical data collapsed over sessions and depths: WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPress = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C); and for kilograms of largemouth bass caught per man-hour of fishing data collapsed over sessions, by size class: KgMH0 = all size classes combined, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤254mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm. Correlation coefficients/ Prob > !R! under HO:RHO=0, N=26. Correlations not meeting p>0.05 deleted. (continued)

| | BPress | WLev | RFall | MaxTW | MinTW | MaxTA | MinTA |
|---|---|---|---|---|---|---|---|
| KgMH0 | -- | -- | -- | -- | -- | -- | -- |
| KgMH1 | -- | -- | -- | -- | -- | -- | -- |
| KgMH2 | -- | -- | -- | -- | -- | -- | -- |
| KgMH3 | -- | -- | -- | -- | -- | -- | -- |
| KgMH4 | -- | -- | -- | -- | -- | -- | -- |
| KgMH5 | -- | -- | 0.4209<br>0.0323 | -- | -- | -- | -- |

Table 3. Best one independent variable R-square regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) on weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Size Class[1] | Variable(s) in Model | R-square |
|---|---|---|
| KgMH0 | Alk | 0.5671 |
| KgMH1 | Alk | 0.6831 |
| KgMH2 | Alk | 0.6055 |
| KgMH3 | Turb | 0.1672 |
| KgMH4 | Cond | 0.3626 |
| KgMH5 | RFall | 0.1771 |

[1]KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2]Alk = meter titrated alkalinity (ppm), Turb = turbidity (NTU), Cond = conductivity (μmhos), RFall = rainfall (mm).

Table 4. Best two independent variable R-square regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) on weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Size Class[1] | Variable(s) in Model[2] | | R-square |
|---|---|---|---|
| KgMH0 | Amm | Alk | 0.7028 |
| KgMH1 | Turb | Alk | 0.7186 |
| KgMH2 | Amm | Alk | 0.6825 |
| KgMH3 | Turb | Amm | 0.3013 |
| KgMH4 | Turb | WLev | 0.6141 |
| KgMH5 | WTemp | MaxTW | 0.2910 |

[1]KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2]WTemp = water temperature (°C), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), WLev = water level (arbitrary units), MaxTW = maximum water temperature (°C).

Table 5. Best three independent variable R-square regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) on weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Size Class[1] | Variable(s) in Model[2] | | | R-square |
|---|---|---|---|---|
| KgMH0 | DO | Turb | Amm | 0.7444 |
| KgMH1 | WTemp | Alk | MaxTW | 0.7282 |
| KgMH2 | Turb | Amm | Alk | 0.7088 |
| KgMH3 | Turb | BPres | RFall | 0.3826 |
| KgMH4 | Turb | WLev | MinTW | 0.6431 |
| KgMH5 | WTemp | RFall | MaxTW | 0.3682 |

[1]KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2]WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity, BPress = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (oC), MinTW = minimum water temperature (oC), MaxTW = maximum water temperature (oC).

Table 6. Best four independent variable R-square regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) on weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Size Class[1] | Variable(s) in Model[2] | | | | R-square |
|---|---|---|---|---|---|
| KgMH0 | DO | Cond | Turb | Amm | 0.7736 |
| KgMH1 | WTemp | Turb | Alk | MaxTW | 0.7507 |
| KgMH2 | WTemp | Cond | Turb | MaxTW | 0.7433 |
| KgMH3 | Turb | BPres | RFall | MaxTW | 0.4561 |
| KgMH4 | Turb | WLev | MaxTW | MinTW | 0.7135 |
| KgMH5 | WTemp | RFall | MaxTW | MinTA | 0.4303 |

[1] KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (μmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MinTA = minimum air temperature (°C).

Table 7. Best five independent variable R-square regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) on weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Size Class[1] | Variable(s) in Model[2] | | | | | R-square |
|---|---|---|---|---|---|---|
| KgMH0 | WTemp | Cond | Turb | Amm | MaxTW | 0.8116 |
| KgMH1 | WTemp | Turb | Alk | ATemp | MaxTA | 0.7659 |
| KgMH2 | WTemp | Cond | Turb | Amm | MaxTA | 0.7762 |
| KgMH3 | Turb | ATemp | BPres | RFall | MaxTW | 0.5450 |
| KgMH4 | Turb | BPres | WLev | MaxTW | MinTW | 0.7435 |
| KgMH5 | WTemp | WLev | RFall | MaxTW | MinTA | 0.4670 |

[1] KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2] WTemp = water temperature (°C), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C), MinTA = minimum air temperature (°C).

Table 8. Best one independent variable Maximum R-square Improvement stepwise multiple regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) against weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Model | Regression Equation[1,2] | $r$ | $r^2$ | F | Prob>F |
|---|---|---|---|---|---|
| KgMH0 | KgMH0 = 0.0021Alk - 0.1070 | 0.7531 | 0.5671 | 31.44 | 0.0001 |
| KgMH1 | KgMH1 = 0.0003Alk - 0.0316 | 0.8265 | 0.6831 | 51.74 | 0.0001 |
| KgMH2 | KgMH2 = 0.0016Alk - 0.1011 | 0.7781 | 0.6055 | 36.84 | 0.0001 |
| KgMH3 | KgMH3 = -0.0003Turb + 0.0262 | 0.4089 | 0.1672 | 4.82 | 0.0380 |
| KgMH4 | KgMH4 = 0.0002Cond - 0.0308 | 0.6022 | 0.3626 | 13.65 | 0.0011 |
| KgMH5 | KgMH5 = 0.0003RFall + 0.0010 | 0.4208 | 0.1771 | 5.17 | 0.0323 |

[1] KgMH0 = all size classes, KgMH1 = T.L.$<$200mm, KgMH2 = 200$<$T.L.$\leq$245mm, KgMH3 = 254$<$T.L.$\leq$356mm, KgMH4 = 356$<$T.L.$\leq$457mm, KgMH5 = T.L.$>$457mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C).

Table 9. Best two independent variable Maximum R-square Improvement stepwise multiple regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) against weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Model | Regression Equation[1,2] | $r$ | $r^2$ | F | Prob>F |
|---|---|---|---|---|---|
| KgMH0 | KgMH0 = -0.4377Amm + 0.0020Alk - 0.0301 | 0.8383 | 0.7028 | 27.19 | 0.0001 |
| KgMH1 | KgMH1 = 0.0001Turb + 0.0003Alk - 0.0394 | 0.8477 | 0.7186 | 29.37 | 0.0001 |
| KgMH2 | KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601 | 0.8261 | 0.6825 | 24.72 | 0.0001 |
| KgMH3 | KgMH3 = -0.0003Turb - 0.0502Amm + 0.0328 | 0.5489 | 0.3013 | 4.96 | 0.0162 |
| KgMH4 | KgMH4 = 0.0002Cond + 0.0021BPres - 1.6153 | 0.6580 | 0.4330 | 8.78 | 0.0015 |
| KgMH5 | KgMH5 = -0.0028WTemp + 0.0029MaxTW - 0.0136 | 0.5394 | 0.2910 | 4.72 | 0.0192 |

[1] KgMH0 = all size classes, KgMH1 = $T.L. < 200$mm, KgMH2 = $200 < T.L. \le 245$mm, KgMH3 = $254 < T.L. \le 356$mm, KgMH4 = $356 < T.L. \le 457$mm, KgMH5 = $T.L. > 457$mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C).

Table 10. Best three independent variable Maximum R-square Improvement stepwise multiple regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) against weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Model | Regression Equation[1,2] | $r$ | $r^2$ | F | Prob>F |
|---|---|---|---|---|---|
| KgMH0 | KgMH0 = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828 | 0.8628 | 0.7444 | 21.36 | 0.0001 |
| KgMH1 | KgMH1 = 0.0001Turb - 0.0103Amm + 0.0003Alk - 0.0373 | 0.8507 | 0.7237 | 19.21 | 0.0001 |
| KgMH2 | KgMH2 = -0.0007Turb - 0.2491Amm + 0.0013Alk - 0.0173 | 0.8419 | 0.7088 | 17.85 | 0.0001 |
| KgMH3 | KgMH3 = -0.0005Turb + 0.0013BPres + 0.0006RFall - 0.9646 | 0.6185 | 0.3826 | 4.55 | 0.0126 |
| KgMH4 | KgMH4 = 0.0034DO + 0.0001Cond + 0.0023BPres - 1.7881 | 0.6919 | 0.4787 | 6.73 | 0.0022 |
| KgMH5 | KgMH5 = -0.0024WTemp + 0.0002RFall + 0.0025MaxTW - 0.0120 | 0.6068 | 0.3682 | 4.27 | 0.0160 |

[1] KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (µmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C).

Table 11. Best four independent variable Maximum R-square Improvement stepwise multiple regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) against weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Model | Regression Equation[1,2] | $r$ | $r^2$ | F | Prob>F |
|---|---|---|---|---|---|
| KgMH0 | KgMH0 = 0.0168DO + 0.0004Cond - 0.0017Turb - 0.2978Amm + 0.0018 | 0.8628 | 0.7736 | 19.94 | 0.0001 |
| KgMH1 | KgMH1 = -0.0020WTemp + 0.0001Turb + 0.0004Alk + 0.0019MaxTW - 0.0490 | 0.8664 | 0.7507 | 15.81 | 0.0001 |
| KgMH2 | KgMH2 = -0.0010Turb - 0.1784Amm + 0.0013Alk + 0.0023MinTA - 0.0680 | 0.8557 | 0.7322 | 14.35 | 0.0001 |
| KgMH3 | KgMH3 = -0.0006Turb + 0.0011BPres + 0.0068RFall + 0.0007MaxTW - 0.8443 | 0.6754 | 0.4561 | 4.40 | 0.0097 |
| KgMH4 | KgMH4 = 0.0051DO - 0.0012Turb - 0.0004Alk + 0.1261WLev - 2.7023 | 0.8304 | 0.6896 | 11.67 | 0.0001 |
| KgMH5 | KgMH5 = -0.0021WTemp + 0.0003RFall + 0.0031MaxTW - 0.0008MinTA - 0.0226 | 0.6560 | 0.4303 | 3.97 | 0.0150 |

[1] KgMH0 = all size classes, KgMH1 = T.L. $<$ 200mm, KgMH2 = 200 $<$ T.L. $\leq$ 245mm, KgMH3 = 254 $<$ T.L. $\leq$ 356mm, KgMH4 = 356 $<$ T.L. $\leq$ 457mm, KgMH5 = T.L. $>$ 457mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (μmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C), MinTA = minimum air temperature (°C).

Table 12. Best five independent variable Maximum R-square Improvement stepwise multiple regression models for weekly kilograms of largemouth bass (*Micropterus salmoides*) caught per man-hour of fishing collapsed over sessions, by size classes (dependent variables) against weekly physicochemical parameter values collapsed over sessions and depths (independent variables). N=26.

| Model | Regression Equation[1,2] | $r$ | $r^2$ | F | Prob>F |
|---|---|---|---|---|---|
| KgMH0 | KgMH0 = 0.0151DO + 0.0003Cond - 0.0023Turb - 0.2484Amm + 0.1049WLev - 2.2683 | 0.8863 | 0.7855 | 14.65 | 0.0001 |
| KgMH1 | KgMH1 = -0.0012WTemp + 0.0002Turb + 0.0003Alk - 0.0010ATemp + 0.0017MaxTA - 0.0375 | 0.8752 | 0.7659 | 13.09 | 0.0001 |
| KgMH2 | KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714 | 0.8810 | 0.7762 | 13.87 | 0.0001 |
| KgMH3 | KgMH3 = -0.0007Turb - 0.0015ATemp + 0.0012BPres + 0.0008RFall + 0.0024MaxTW - 0.8950 | 0.7382 | 0.5450 | 4.79 | 0.0049 |
| KgMH4 | KgMH4 = 0.0057DO - 0.0010Turb - 0.0329pH + 0.1099WLev + 0.0019MinTW - 2.1869 | 0.8516 | 0.7253 | 10.56 | 0.0001 |
| KgMH5 | KgMH5 = -0.0024WTemp + 0.0145WLev + 0.0002RFall + 0.0038MaxTW - 0.0013MinTA - 0.3465 | 0.6834 | 0.4670 | 3.50 | 0.0195 |

[1] KgMH0 = all size classes, KgMH1 = T.L.<200mm, KgMH2 = 200<T.L.≤245mm, KgMH3 = 254<T.L.≤356mm, KgMH4 = 356<T.L.≤457mm, KgMH5 = T.L.>457mm.

[2] WTemp = water temperature (°C), DO = dissolved oxygen (ppm), Cond = conductivity (μmhos), Turb = turbidity (NTU), Amm = total ammonia (ppm), Alk = meter titrated alkalinity (ppm), ATemp = air temperature (°C), BPres = barometric pressure (mm Hg), WLev = water level (arbitrary units), RFall = rainfall (mm), MaxTW = maximum water temperature (°C), MinTW = minimum water temperature (°C), MaxTA = maximum air temperature (°C), MinTA = minimum air temperature (°C).

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# APPENDIX A-1

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHO = 0.0021Alk - 0.1070 (Table 8).

KgMHO = 0.0021Alk - 0.1070

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.1070 | | | | |
| Alk | 0.0021 | 0.0004 | 0.1110 | 31.44 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.1110 | 0.1110 | 31.44 | 0.0001 |
| Error | 24 | 0.0848 | 0.0035 | | |
| Total | 25 | 0.1958 | | | |

[1]B=slope

APPENDIX A-2

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHl = 0.0003Alk - 0.0316 (Table 8).

KgMHl = 0.0003Alk - 0.0316

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0316 | | | | |
| Alk | 0.0003 | 0.0000 | 0.0019 | 51.74 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.0019 | 0.0019 | 51.74 | 0.0001 |
| Error | 24 | 0.0009 | 0.0000 | | |
| Total | 25 | 0.0028 | | | |

[1] B=slope

# APPENDIX A-3

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH2 = 0.0016Alk - 0.1011 (Table 8).

KgMH2 = 0.0016Alk - 0.1011

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.1011 | | | | |
| Alk | 0.0016 | 0.0003 | 0.0594 | 36.84 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.0594 | 0.0594 | 36.84 | 0.0001 |
| Error | 24 | 0.0387 | 0.0016 | | |
| Total | 25 | 0.0981 | | | |

[1] B=slope

APPENDIX A-4

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH3 = -0.0003Turb + 0.0262 (Table 8).

KgMH3 = -0.0003Turb + 0.0262

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0262 | | | | |
| Turb | -0.0002 | 0.0001 | 0.0004 | 4.82 | 0.0380 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.0004 | 0.0004 | 4.82 | 0.0380 |
| Error | 24 | 0.0022 | 0.0001 | | |
| Total | 25 | 0.0027 | | | |

[1]B=slope

APPENDIX A-5

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH4 = 0.0002Cond - 0.0308 (Table 8).

KgMH4 = 0.0002Cond - 0.0308

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0308 | | | | |
| Cond | 0.0002 | 0.0001 | 0.0046 | 13.65 | 0.0011 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.0047 | 0.0046 | 13.65 | 0.0011 |
| Error | 24 | 0.0082 | 0.0003 | | |
| Total | 25 | 0.0128 | | | |

[1]B=slope

# APPENDIX A-6

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH5 = 0.0003RFall + 0.0010 (Table 8).

KgMH5 = 0.0003RFall + 0.0010

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0010 | | | | |
| RFall | 0.0003 | 0.0001 | 0.0002 | 5.17 | 0.0323 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 1 | 0.0002 | 0.0002 | 5.17 | 0.0323 |
| Error | 24 | 0.0011 | 0.0000 | | |
| Total | 25 | 0.0013 | | | |

[1]B=slope

## APPENDIX B-1

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHO = -0.4377Amm + 0.0020Alk - 0.0301 (Table 9).

KgMHO = -0.4377Amm + 0.0020Alk - 0.0301

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0301 | | | | |
| Amm | -0.4377 | 0.1351 | 0.0266 | 10.50 | 0.0036 |
| Alk | 0.0020 | 0.0003 | 0.0945 | 37.33 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.1376 | 0.0688 | 27.19 | 0.0001 |
| Error | 23 | 0.0582 | 0.0025 | | |
| Total | 25 | 0.1958 | | | |

[1] B=slope

APPENDIX B-2

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHl = 0.0001Turb + 0.0003Alk - 0.0394 (Table 9).

KgMHl = 0.0001Turb + 0.0003Alk - 0.0394

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0394 | | | | |
| Turb | 0.0001 | 0.0001 | 0.0001 | 2.90 | 0.1021 |
| Alk | 0.0003 | 0.0000 | 0.0018 | 51.61 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.0020 | 0.0010 | 29.37 | 0.0001 |
| Error | 23 | 0.0008 | 0.0000 | | |
| Total | 25 | 0.0028 | | | |

[1]B=slope

APPENDIX B-3

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601 (Table 9).

KgMH2 = -0.2333Amm + 0.0015Alk - 0.0601

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0601 | | | | |
| Amm | -0.2333 | 0.0988 | 0.0075 | 5.57 | 0.0271 |
| Alk | 0.0014 | 0.0002 | 0.0526 | 38.82 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.0669 | 0.0335 | 24.72 | 0.0001 |
| Error | 23 | 0.0311 | 0.0014 | | |
| Total | 25 | 0.0981 | | | |

[1]B=slope

# APPENDIX B-4

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH3 = -0.0003Turb - 0.0502Amm + 0.0328 (Table 9).

KgMH3 = -0.0003Turb - 0.0502Amm + 0.0328

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0328 | | | | |
| Turb | -0.0003 | 0.0001 | 0.0005 | 5.70 | 0.0256 |
| Amm | -0.0502 | 0.0239 | 0.0004 | 4.41 | 0.0469 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.0008 | 0.0004 | 4.96 | 0.0162 |
| Error | 23 | 0.0019 | 0.0001 | | |
| Total | 25 | 0.0027 | | | |

[1] B=slope

# APPENDIX B-5

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH4 = 0.0002Cond + 0.0021BPres - 1.6153 (Table 9).

KgMH4 = 0.0002Cond + 0.0021BPres - 1.6153

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -1.6153 | | | | |
| Cond | 0.0002 | 0.0001 | 0.0048 | 15.23 | 0.0007 |
| BPres | 0.0021 | 0.0023 | 0.0009 | 2.85 | 0.1047 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.0055 | 0.0028 | 8.78 | 0.0015 |
| Error | 23 | 0.0073 | 0.0003 | | |
| Total | 25 | 0.0128 | | | |

[1] B=slope

APPENDIX B-6

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH5 = -0.0028WTemp + 0.0029MaxTW - 0.0136 (Table 9).

KgMH5 = -0.0028WTemp + 0.0029MaxTW - 0.0136

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0136 | | | | |
| WTemp | -0.0028 | 0.0012 | 0.0002 | 4.93 | 0.0366 |
| MaxTW | 0.0029 | 0.0011 | 0.0003 | 7.40 | 0.0122 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 2 | 0.0004 | 0.0002 | 4.72 | 0.0192 |
| Error | 23 | 0.0009 | 0.0000 | | |
| Total | 25 | 0.0013 | | | |

[1]B=slope

# APPENDIX C-1

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHO = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828 (Table 10).

KgMHO = 0.0238DO - 0.0019Turb - 0.3661Amm + 0.0828

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0828 | | | | |
| DO | 0.0238 | 0.0051 | 0.0489 | 21.50 | 0.0001 |
| Turb | -0.0019 | 0.0006 | 0.0230 | 10.13 | 0.0043 |
| Amm | -0.3661 | 0.1339 | 0.0170 | 7.48 | 0.0121 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.1458 | 0.0486 | 21.36 | 0.0001 |
| Error | 22 | 0.0500 | 0.0023 | | |
| Total | 25 | 0.1958 | | | |

[1]B=slope

APPENDIX C-2

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHl = 0.0001Turb - 0.0103Amm + 0.0003Alk - 0.0373 (Table 10).

KgMHl = 0.0001Turb - 0.0103Amm + 0.0003Alk - 0.0373

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0373 | | | | |
| Turb | 0.0001 | 0.0000 | 0.0000 | 2.55 | 0.1248 |
| Amm | -0.01025 | 0.0161 | 0.0000 | 0.41 | 0.5303 |
| Alk | 0.0003 | 0.0000 | 0.0017 | 47.09 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0020 | 0.0007 | 19.21 | 0.0001 |
| Error | 22 | 0.0008 | 0.0000 | | |
| Total | 25 | 0.0028 | | | |

[1]B=slope

# APPENDIX C-3

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH2 = -0.0007Turb - 0.2491Amm + 0.0013Alk - 0.0173 (Table 10).

KgMH2 = -0.0007Turb - 0.2491Amm + 0.0013Alk - 0.0173

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0173 | | | | |
| Turb | -0.0007 | 0.0005 | 0.0026 | 1.99 | 0.1726 |
| Amm | -0.2491 | 0.0974 | 0.0085 | 6.54 | 0.0180 |
| Alk | 0.0013 | 0.0003 | 0.0263 | 20.29 | 0.0002 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0695 | 0.0232 | 17.85 | 0.0001 |
| Error | 22 | 0.0286 | 0.0013 | | |
| Total | 25 | 0.0981 | | | |

[1] B=slope

## APPENDIX C-4

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH3 = -0.0005Turb + 0.0031BPres + 0.0006RFall - 0.9646 (Table 10).

KgMH3 = -0.0005Turb + 0.0013BPres + 0.0006RFall - 0.9646

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.9646 | | | | |
| Turb | -0.0005 | 0.0002 | 0.0007 | 9.74 | 0.0050 |
| BPres | 0.0013 | 0.0006 | 0.0003 | 4.66 | 0.0421 |
| RFall | 0.0006 | 0.0003 | 0.0003 | 3.92 | 0.0604 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0010 | 0.0003 | 4.55 | 0.0126 |
| Error | 22 | 0.0016 | 0.0001 | | |
| Total | 25 | 0.0027 | | | |

[1]B=slope

# APPENDIX C-5

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH4 = 0.0034DO + 0.0001Cond + 0.0023BPres - 1.7881 (Table 10).

KgMH4 = 0.0034DO + 0.0001Cond + 0.0023BPres - 1.7881

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -1.7881 | | | | |
| DO | 0.0034 | 0.0025 | 0.0006 | 1.93 | 0.1784 |
| Cond | 0.0001 | 0.0001 | 0.0009 | 3.08 | 0.0934 |
| BPres | 0.0023 | 0.0012 | 0.0011 | 3.59 | 0.0713 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0061 | 0.0020 | 6.73 | 0.0022 |
| Error | 22 | 0.0067 | 0.0003 | | |
| Total | 25 | 0.0128 | | | |

[1] B=slope

APPENDIX C-6

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH5 = -0.0024WTemp + 0.0002RFall + 0.0025MaxTW - 0.0120 (Table 10).

KgMH5 = -0.0024WTemp + 0.0002RFall + 0.0025MaxTW - 0.0210

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0120 | | | | |
| WTemp | -0.0024 | 0.0012 | 0.0001 | 3.81 | 0.0637 |
| RFall | 0.0002 | 0.0001 | 0.0001 | 2.69 | 0.1152 |
| MaxTW | 0.0025 | 0.0011 | 0.0002 | 5.48 | 0.0286 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0005 | 0.0002 | 4.27 | 0.0160 |
| Error | 22 | 0.0008 | 0.0000 | | |
| Total | 25 | 0.0013 | | | |

[1]B=slope

# APPENDIX D-1

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHO = 0.0168DO + 0.0004Cond - 0.0017Turb - 0.2978Amm + 0.0018 (Table 11).

KgMHO = 0.0168DO + 0.0004Cond - 0.0017Turb - 0.2978Amm + 0.0018

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0018 | | | | |
| DO | 0.0168 | 0.0065 | 0.0141 | 6.69 | 0.0172 |
| Cond | 0.0004 | 0.0002 | 0.0057 | 2.71 | 0.1148 |
| Turb | -0.0017 | 0.0006 | 0.0183 | 8.67 | 0.0078 |
| Amm | -0.2978 | 0.1355 | 0.0102 | 4.83 | 0.0393 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 4 | 0.1515 | 0.0379 | 17.94 | 0.0001 |
| Error | 21 | 0.0443 | 0.0021 | | |
| Total | 25 | 0.1958 | | | |

[1] B=slope

# APPENDIX D-2

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHl = -0.0020WTemp + 0.0001Turb + 0.0004Alk + 0.0019MaxTW - 0.0490 (Table 11).

KgMHl = -0.0020WTemp + 0.0001Turb + 0.0004Alk + 0.0019MaxTW - 0.0490

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0490 | | | | |
| WTemp | -0.0020 | 0.0013 | 0.0001 | 2.65 | 0.1183 |
| Turb | 0.0001 | 0.0001 | 0.0001 | 1.90 | 0.1830 |
| Alk | 0.0004 | 0.0001 | 0.0016 | 48.41 | 0.0001 |
| MaxTW | 0.0019 | 0.0012 | 0.0001 | 2.66 | 0.1178 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 4 | 0.0021 | 0.0005 | 15.81 | 0.0001 |
| Error | 21 | 0.0007 | 0.0000 | | |
| Total | 25 | 0.0028 | | | |

[1] B=slope

# APPENDIX D-3

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH2 = -0.0010Turb - 0.1784Amm + 0.0013Alk + 010023MinTA - 0.0680 (Table 11).

KgMH2 = -0.0010Turb - 0.1784Amm + 0.0013Alk + 0.0023MinTA - 0.0680

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0680 | | | | |
| Turb | -0.0010 | 0.0005 | 010042 | 3.35 | 0.0812 |
| Amm | -0.1784 | 0.1089 | 0.0034 | 2.68 | 0.1163 |
| Alk | 0.0013 | 0.0003 | 0.0285 | 22.81 | 0.0001 |
| MinTA | 0.0023 | 0.0017 | 0.0023 | 1.83 | 0.1900 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 4 | 0.0718 | 0.0180 | 14.35 | 0.0001 |
| Error | 21 | 0.0263 | 0.0013 | | |
| Total | 25 | 0.0981 | | | |

[1] B=slope

# APPENDIX D-4

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH3 = -0.0006Turb + 0.0011BPres + 0.0068RFall + 0.0007MaxTW - 0.8443 (Table 11).

KgMH3 = -0.0006Turb + 0.0011BPres + 0.0068RFall + 0.0007MaxTW - 0.8443

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.8443 | | | | |
| Turb | -0.0006 | 0.0002 | 0.0009 | 13.28 | 0.0015 |
| BPres | 0.0011 | 0.0006 | 0.0002 | 3.62 | 0.0709 |
| RFall | 0.0007 | 0.0003 | 0.0004 | 5.32 | 0.0314 |
| MaxTW | 0.0007 | 0.0004 | 0.0002 | 2.84 | 0.1068 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 3 | 0.0010 | 0.0003 | 4.55 | 0.0126 |
| Error | 22 | 0.0016 | 0.0001 | | |
| Total | 25 | 0.0027 | | | |

[1] B=slope

APPENDIX D-5

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH4 = 0.0051DO - 0.0012Turb - 0.0004Alk + 0.1261WLev - 2.7023 (Table 11).

KgMH4 = 0.0051DO - 0.0012Turb - 0.0004Alk + 0.1261WLev - 2.7023

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -2.7023 | | | | |
| DO | 0.0051 | 0.0025 | 0.0008 | 4.08 | 0.0562 |
| Turb | -0.0012 | 0.0003 | 0.0039 | 20.52 | 0.0002 |
| Alk | -0.0.0004 | 0.0002 | 0.0009 | 4.71 | 0.0416 |
| WLev | 0.1261 | 0.0269 | 0.0042 | 21.97 | 0.0001 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 4 | 0.0089 | 0.0022 | 11.67 | 0.0001 |
| Error | 21 | 0.0040 | 0.0002 | | |
| Total | 25 | 0.0128 | | | |

[1]B=slope

# APPENDIX D-6

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH5 = -0.0021WTemp + 0.0003RFall + 0.0031MaxTW - 0.0008MinTA - 0.0226 (Table 11).

KgMH5 = -0.0021WTemp + 0.0003RFall + 0.0031MaxTW - 0.0008MinTA - 0.0226

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0226 | | | | |
| WTemp | -0.0021 | 0.0012 | 0.0002 | 2.94 | 0.1013 |
| RFall | 0.0003 | 0.0001 | 0.0002 | 4.83 | 0.0393 |
| MaxTW | 0.0031 | 0.0011 | 0.0003 | 7.83 | 0.0108 |
| MinTA | -0.0008 | 0.0006 | 0.0001 | 2.29 | 0.1453 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 4 | 0.0006 | 0.0001 | 3.97 | 0.0150 |
| Error | 21 | 0.0007 | 0.0000 | | |
| Total | 25 | 0.0013 | | | |

[1] B=slope

APPENDIX E-1

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMHO = 0.0151DO + 0.0003Cond - 0.0023Turb - 0.2484Amm + 0.1049WLev - 2.2683 (Table 12).

KgMHO = 0.0151DO + 0.0003Cond - 0.0023Turb - 0.2484Amm + 0.1049WLev - 2.2683

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -2.2683 | | | | |
| DO | 0.0151 | 0.0067 | 0.0107 | 5.10 | 0.0353 |
| Cond | 0.0003 | 0.0002 | 0.0029 | 1.37 | 0.2549 |
| Turb | -0.0023 | 0.0008 | 0.0173 | 8.26 | 0.0094 |
| Amm | -0.2484 | 0.1431 | 0.0063 | 3.01 | 0.0979 |
| WLev | 0.1049 | 0.0996 | 0.0023 | 1.11 | 0.3050 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.1538 | 0.0308 | 14.65 | 0.0001 |
| Error | 20 | 0.0420 | 0.0021 | | |
| Total | 25 | 0.1958 | | | |

[1] B=slope

APPENDIX E-2

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH1 = -0.0012WTemp + 0.0002Turb + 0.0003Alk - 0.0010ATemp + 0.0017MaxTA - 0.0375 (Table 12).

KgMH1 = -0.0012WTemp + 0.0002Turb + 0.0003Alk - 0.0010ATemp + 0.0017MaxTA - 0.0375

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.0375 | | | | |
| WTemp | -0.0012 | 0.0008 | 0.0001 | 2.17 | 0.1560 |
| Turb | 0.0002 | 0.0001 | 0.0001 | 3.51 | 0.0757 |
| Alk | 0.0003 | 0.0001 | 0.0009 | 28.16 | 0.0001 |
| ATemp | -0.0010 | 0.0008 | 0.0000 | 1.32 | 0.2633 |
| MaxTA | 0.0017 | 0.0009 | 0.0001 | 3.65 | 0.0707 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.0022 | 0.0004 | 13.09 | 0.0001 |
| Error | 20 | 0.0007 | 0.0000 | | |
| Total | 25 | 0.0028 | | | |

[1]B=slope

# APPENDIX E-3

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714 (Table 12).

KgMH2 = -0.0134WTemp + 0.0005Cond - 0.0010Turb - 0.2245Amm + 0.0068MaxTA + 0.0714

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | 0.0714 | | | | |
| WTemp | -0.0134 | 0.0043 | 0.0108 | 9.80 | 0.0053 |
| Cond | 0.0005 | 0.0001 | 0.0142 | 12.95 | 0.0018 |
| Turb | -0.0010 | 0.0004 | 0.0049 | 4.48 | 0.0471 |
| Amm | -0.2245 | 0.1011 | 0.0054 | 4.93 | 0.0381 |
| MaxTA | 0.0068 | 0.0032 | 0.0049 | 4.49 | 0.0467 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.0761 | 0.0152 | 13.87 | 0.0001 |
| Error | 20 | 0.0219 | 0.0011 | | |
| Total | 25 | 0.0981 | | | |

[1] B=slope

APPENDIX E-4

Analysis of variance for Maximum R-square Improvement stepwise muptiple regression model KgMH3 = -0.0007Turb - 0.0015ATemp + 0.0012BPres + 0.0008RFall + 0.0024MaxTW - 0,8950 (Table 12).

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.8949 | | | | |
| Turb | -0.0007 | 0.0002 | 0.0011 | 18.15 | 0.0004 |
| ATemp | -0.0015 | 0.0007 | 0.0002 | 3.91 | 0.0621 |
| BPres | 0.0012 | 0.0006 | 0.0003 | 4.53 | 0.0460 |
| RFall | 0.0008 | 0.0003 | 0.0005 | 8.41 | 0.0089 |
| MaxTW | 0.0024 | 0.0009 | 0.0004 | 6.62 | 0.0182 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.0015 | 0.0003 | 4.79 | 0.0049 |
| Error | 20 | 0.0012 | 0.0001 | | |
| Total | 25 | 0.0027 | | | |

[1]B=slope

# APPENDIX E-5

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH4 = 0.0057DO - 0.0010Turb - 0.0329pH + 0.1099WLev + 0.0019MinTW - 2.1869 (Table 12).

KgMH4 = 0.0057DO - 0.0010Turb - 0.0329pH + 0.1099WLev + 0.0019MinTW - 2.1869

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -2.1869 | | | | |
| DO | 0.0057 | 0.0024 | 0.0010 | 5.53 | 0.0291 |
| Turb | -0.0010 | 0.0002 | 0.0036 | 20.64 | 0.0002 |
| pH | -0.0329 | 0.0158 | 0.0008 | 4.33 | 0.0506 |
| WLev | 0.1099 | 0.0283 | 0.0027 | 15.11 | 0.0009 |
| MinTW | 0.0019 | 0.0008 | 0.0010 | 5.75 | 0.0264 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.0093 | 0.0019 | 10.56 | 0.0001 |
| Error | 20 | 0.0035 | 0.0002 | | |
| Total | 25 | 0.0128 | | | |

[1] B=slope

APPENDIX E-6

Analysis of variance for Maximum R-square Improvement stepwise multiple regression model KgMH5 = -0.0024WTemp + 0.0145WLev + 0.0002RFall + 0.0038MaxTW - 0.0013MinTA - 0.3465 (Table 12).

KgMH5 = -0.0024WTemp + 0.0145WLev + 0.0002RFall + 0.0038MaxTW - 0.0013MinTA - 0.3465

| | B[1] | SE | Type II Sum of Squares | F | Prob>F |
|---|---|---|---|---|---|
| Intercept | -0.3465 | | | | |
| WTemp | -0.0024 | 0.0012 | 0.0001 | 3.74 | 0.0675 |
| WLev | 0.0145 | 0.0124 | 0.0000 | 1.38 | 0.2545 |
| RFall | 0.0002 | 0.0002 | 0.0001 | 2.03 | 0.1697 |
| MaxTW | 0.0038 | 0.0012 | 0.0003 | 9.32 | 0.0063 |
| MinTA | -0.0013 | 0.0007 | 0.0002 | 3.68 | 0.0695 |

Analysis of Variance

| | DF | Sum of Squares | Mean Square | F | Prob>F |
|---|---|---|---|---|---|
| Regression | 5 | 0.0006 | 0.0001 | 3.50 | 0.0195 |
| Error | 20 | 0.0007 | 0.0000 | | |
| Total | 25 | 0.0013 | | | |

[1] B=slope

Appendix F. 1979 Ridge Lake weekly physicochemical data: WTemp = water temperature (°C)[1], DO = dissolved oxygen (ppm)[1], Cond = conductivity (mhos)[1], Turb = turbidity (NTU)[1], Amm = total ammonia (ppm)[1], Alk = meter titrated alkalinity (ppm)[2], ATemp = air temperature (°C)[3], BPress = barometric pressure (mm Hg)[3], WLev = water level (arbitrary units)[4], RFall = rainfall (mm)[5], MaxTW = maximum water temperature (°C)[6], MinTW = minimum water temperature (°C)[6], MaxTA = maximum air temperature (°C)[7], MinTA = minimum air temperature (°C)[7].

| Week | WTemp | DO | Cond | Turb | pH | Amm | Alk | ATemp | BPres | WLev | RFall | MaxTW | MinTW | MaxTA | MinTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 790418 | 13.54 | 9.58 | 324.9 | 6.95 | 8.06 | 0.08 | 144.6 | 16.74 | 763.2 | 22.1 | 0.2 | 17.7 | 13.5 | 22.4 | 9.7 |
| 790425 | 14.80 | 8.95 | 343.8 | 13.86 | 8.13 | 0.14 | 170.8 | 13.19 | 754.5 | 22.3 | 9.2 | 17.1 | 14.9 | 19.1 | 7.1 |
| 790502 | 14.52 | 8.98 | 356.0 | 2.25 | 8.18 | 0.18 | 180.5 | 14.65 | 755.8 | 22.1 | 2.2 | 17.0 | 13.2 | 20.6 | 7.6 |
| 790509 | 18.13 | 9.58 | 403.3 | 4.26 | 8.25 | 0.10 | 187.5 | 21.01 | 757.1 | 22.1 | 3.8 | 23.4 | 19.3 | 29.5 | 13.7 |
| 790516 | 19.65 | 10.24 | 430.4 | 6.23 | 8.35 | 0.08 | 191.4 | 21.54 | 754.1 | 22.1 | 2.8 | 23.0 | 18.9 | 32.7 | 12.4 |
| 790523 | 18.75 | 9.84 | 427.7 | 4.16 | 8.50 | 0.06 | 188.3 | 16.47 | 757.6 | 22.1 | 4.2 | 20.8 | 15.8 | 25.1 | 8.3 |
| 790530 | 20.91 | 11.40 | 434.8 | 2.00 | 8.60 | 0.08 | 181.8 | 24.75 | 752.9 | 22.1 | 1.8 | 25.0 | 19.9 | 31.7 | 16.3 |
| 790606 | 23.34 | 9.57 | 423.0 | 31.39 | 8.41 | 0.17 | 141.6 | 26.79 | 755.4 | 22.3 | 13.0 | 27.9 | 23.7 | 35.4 | 21.0 |
| 790613 | 23.47 | 7.21 | 439.4 | 3.19 | 8.28 | 0.21 | 157.8 | 26.83 | 752.0 | 22.1 | 0.0 | 26.9 | 22.8 | 35.8 | 18.3 |
| 790620 | 24.82 | 8.52 | 422.7 | 1.07 | 8.34 | 0.13 | 152.0 | 26.87 | 759.1 | 22.1 | 2.4 | 28.9 | 24.2 | 35.5 | 19.0 |
| 790627 | 24.15 | 8.34 | 375.9 | 3.78 | 8.01 | 0.11 | 126.3 | 24.73 | 756.9 | 22.0 | 0.2 | 27.3 | 23.7 | 32.3 | 16.8 |
| 790704 | 24.18 | 7.27 | 366.5 | 2.78 | 8.05 | 0.08 | 124.0 | 22.73 | 761.6 | 22.0 | 0.0 | 27.5 | 23.2 | 31.8 | 15.3 |
| 790711 | 24.85 | 5.85 | 408.7 | 31.26 | 7.74 | 0.08 | 106.5 | 25.92 | 755.8 | 22.0 | 10.6 | 28.3 | 24.4 | 32.0 | 20.2 |

Appendix F. 1979 Ridge Lake weekly physicochemical data: WTemp = water temperature (°C)[1], DO = dissolved oxygen (ppm)[1], Cond = conductivity (mhos)[1], Turb = turbidity (NTU)[1], Amm = total ammonia (ppm)[1], Alk = meter titrated alkalinity (ppm)[2], ATemp = air temperature (°C)[3], BPress = barometric pressure (mm Hg)[3], WLev = water level (arbitrary units)[4], RFall = rainfall (mm)[5], MaxTW = maximum water temperature (°C)[6], MinTW = minimum water temperature (°C)[6], MaxTA = maximum air temperature (°C)[7], MinTA = minimum air temperature (°C)[7]. (continued)

| Week | WTemp | DO | Cond | Turb | pH | Amm | Alk | ATemp | BPres | WLev | RFall | MaxTW | MinTW | MaxTA | MinTA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 790718 | 24.70 | 6.07 | 366.8 | 4.82 | 7.76 | 0.05 | 121.5 | 26.72 | 760.8 | 22.1 | 0.0 | 28.9 | 25.0 | 33.8 | 16.4 |
| 790725 | 23.22 | 7.39 | 323.9 | 65.58 | 8.06 | 0.05 | 95.0 | 25.17 | 756.9 | 22.4 | 45.4 | 29.1 | 24.9 | 31.3 | 21.8 |
| 790801 | 22.18 | 6.81 | 305.1 | 34.54 | 7.74 | 0.05 | 122.4 | 30.00 | 757.4 | 22.2 | 18.0 | 28.7 | 24.5 | 33.3 | 20.1 |
| 790808 | 24.39 | 6.78 | 309.2 | 13.92 | 8.07 | 0.06 | 110.0 | 26.07 | 755.8 | 22.1 | 0.0 | 31.3 | 27.9 | 32.5 | 21.7 |
| 790815 | 22.21 | 6.82 | 292.5 | 24.18 | 8.23 | 0.08 | 110.4 | 24.41 | 756.1 | 22.0 | 4.7 | 26.1 | 21.7 | 31.0 | 15.1 |
| 790822 | 23.10 | 5.48 | 263.5 | 59.54 | 8.10 | 0.26 | 100.8 | 24.19 | 758.7 | 22.1 | 8.6 | 28.5 | 23.0 | 31.4 | 17.4 |
| 790829 | 22.87 | 3.94 | 273.0 | 24.68 | 7.89 | 0.18 | 99.8 | 26.33 | 755.8 | 22.1 | 5.4 | 28.3 | 22.6 | 32.4 | 21.7 |
| 790905 | 23.11 | 4.77 | 279.2 | 14.80 | 7.88 | 0.15 | 107.5 | 23.29 | 756.2 | 22.0 | 0.0 | 28.9 | 22.5 | 30.6 | 14.5 |
| 790912 | 21.51 | 5.14 | 274.1 | 18.92 | 7.81 | 0.07 | 112.8 | 21.21 | 758.2 | 22.0 | 0.0 | 26.4 | 19.9 | 27.0 | 12.4 |
| 790919 | 19.51 | 3.90 | 271.4 | 10.15 | 7.56 | 0.23 | 116.0 | 18.41 | 758.9 | 22.0 | 0.0 | 24.6 | 18.3 | 27.5 | 10.6 |
| 790926 | 18.64 | 4.68 | 271.7 | 5.98 | 7.58 | 0.15 | 112.1 | 22.08 | 756.6 | 21.8 | 3.0 | 23.8 | 18.5 | 29.6 | 11.5 |
| 791003 | 16.85 | 6.22 | 260.9 | 6.07 | 7.47 | 0.27 | 121.5 | 13.50 | 753.3 | 21.8 | 0.0 | 21.3 | 16.3 | 20.5 | 6.2 |
| 791010 | 13.21 | 7.14 | 243.9 | 8.27 | 7.49 | 0.31 | 118.5 | 10.68 | 750.4 | 21.7 | 2.2 | 17.2 | 12.8 | 19.3 | 3.1 |

[1]These data were collected at 0800 hrs and at 1700 hrs on a daily basis at 0.5, 1.5, 3.0 and 3.5 meters below the surface of the lake. Data in the above table represents means of the daily values across the above depths for weekly time intervals.

[2]Alkalinity data were collected at 0800 hrs and at 1700 hrs at 0.5, 1.5, 3.0 and 3.5 meters below the surface on Sunday of each of the indicated weeks.

[3]These data were collected at 0800 hrs and at 1700 hrs on a daily basis at 0.5 meter above the water at the mid-lake sampling station. Data in the above table represents means of the daily values for weekly time intervals.

[4]These data were taken from the scale on the drain tower at 0800 hrs and at 1700 hrs on a daily basis. Data in the above table represents means of the daily values for weekly time intervals.

[5]These data were collected at 0600 hrs each day 1.5 meters above the dock.

[6]These data were collected at 0600 hrs each day 1.0 meter below the surface of the lake at the dock.

[7]These data were collected at 0600 hrs each day 1.5 meters above the dock.

Appendix G. 1979 Ridge Lake weekly largemouth bass (*Micropterus salmoides*) creel data, by size class, expressed as kilograms/man-hour of fishing pressure.

| Week | Kilograms of largemouth bass/man-hour of fishing pressure | | | | | |
|---|---|---|---|---|---|---|
| | T.L.<=200 mm | 200<T.L.<=254 mm | 254<T.L.<=356 mm | 356<T.L.<=457 mm | T.L.>457mm | All Size Classes |
| 790418 | 0.01 | 0.16 | 0.03 | 0.05 | 0.00 | 0.25 |
| 790425 | 0.02 | 0.16 | 0.01 | 0.06 | 0.00 | 0.25 |
| 790502 | 0.01 | 0.13 | 0.02 | 0.06 | 0.00 | 0.22 |
| 790509 | 0.03 | 0.23 | 0.03 | 0.07 | 0.00 | 0.36 |
| 790516 | 0.04 | 0.21 | 0.02 | 0.03 | 0.00 | 0.30 |
| 790523 | 0.01 | 0.12 | 0.02 | 0.05 | 0.00 | 0.20 |
| 790530 | 0.02 | 0.24 | 0.03 | 0.05 | 0.00 | 0.34 |
| 790606 | 0.01 | 0.12 | 0.02 | 0.05 | 0.00 | 0.20 |
| 790613 | 0.00 | 0.12 | 0.02 | 0.05 | 0.00 | 0.19 |
| 790620 | 0.01 | 0.18 | 0.04 | 0.06 | 0.00 | 0.29 |
| 790627 | 0.00 | 0.13 | 0.03 | 0.06 | 0.00 | 0.22 |
| 790704 | 0.00 | 0.10 | 0.03 | 0.07 | 0.00 | 0.20 |
| 790711 | 0.00 | 0.10 | 0.02 | 0.02 | 0.00 | 0.14 |
| 790718 | 0.00 | 0.11 | 0.03 | 0.08 | 0.00 | 0.22 |
| 790725 | 0.00 | 0.06 | 0.03 | 0.04 | 0.02 | 0.15 |
| 790801 | 0.00 | 0.04 | 0.01 | 0.05 | 0.01 | 0.11 |
| 790808 | 0.00 | 0.09 | 0.03 | 0.05 | 0.01 | 0.18 |
| 790815 | 0.00 | 0.04 | 0.01 | 0.01 | 0.00 | 0.06 |
| 790822 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 |
| 790829 | 0.00 | 0.04 | 0.00 | 0.03 | 0.00 | 0.07 |
| 790905 | 0.00 | 0.08 | 0.02 | 0.03 | 0.00 | 0.13 |
| 790912 | 0.00 | 0.10 | 0.04 | 0.02 | 0.00 | 0.16 |
| 790919 | 0.00 | 0.05 | 0.03 | 0.01 | 0.00 | 0.09 |
| 790926 | 0.00 | 0.14 | 0.02 | 0.01 | 0.00 | 0.17 |
| 791003 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 | 0.03 |
| 791010 | 0.00 | 0.06 | 0.02 | 0.03 | 0.00 | 0.11 |