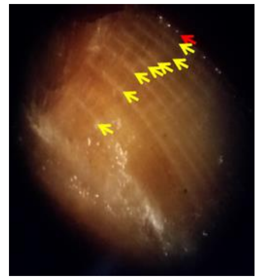


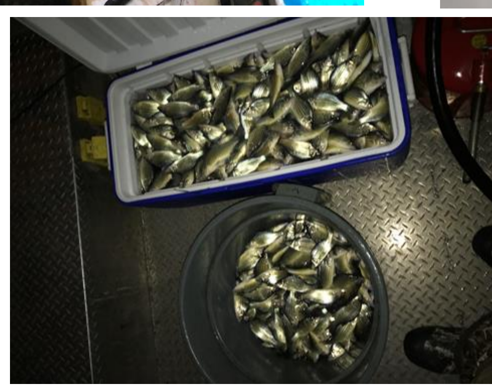
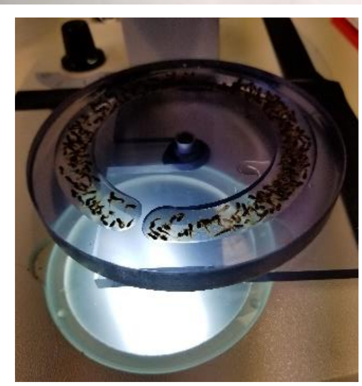



Distribution, population dynamics, and interspecific competition of Yellow Bass in Iowa's shallow natural lakes

Study 7052 Completion Report
Federal Aid to Sport Fish Restoration
Iowa Fisheries Research





Jonathan R. Meerbeek

Period Covered: 1 July 2017 - 30 June 2022

Iowa Department of Natural Resources
Kayla Lyon, Director

WILDLIFE & SPORT FISH RESTORATION

This publication was funded under the Federal Aid in Sport Fish Restoration Program utilizing state fishing license money and federal grant funds derived from federal excise taxes on fishing tackle and other fishing related expenditures. Funds from the Sport Fish Restoration Program (also known as the Dingell-Johnson or D-J Programs) are used for aquatic education, fisheries research and management, and other activities that enhance sport fishing opportunities. The program is administered cooperatively by the Iowa Department of Natural Resources and the US Fish and Wildlife Service.

Equal Opportunity

Federal and State laws prohibit employment and/or public accommodation (such as access to services or physical facilities) discrimination on the basis of age, color, creed, disability (mental and/or physical), gender identity, national origin, pregnancy, race, religion, sex, or sexual orientation. If you believe you have been discriminated against in any program, activity or facility as described above, or if you desire further information, contact the Iowa Civil Rights Commission, 1-800-457-4416 or write to: Director, Iowa Department of Natural Resources, Wallace State Office Building, 502 East 9th Street, Des Moines, Iowa 50319-0034

Alternative Formats

This information is available in alternative formats upon request by contacting the DNR at 515-725-8200. TTY users: Contact Relay Iowa at 800-735-2942

Table of Contents

Executive Summary

Yellow Bass *Morone mississippiensis* populations have expanded their range to include several northwest Iowa and southwest Minnesota natural lakes since the turn of the century, yet little is known regarding the mechanisms regulating their expansion, nor their impacts to native fish communities. In small impoundments, Yellow Bass overpopulate and stunt, causing cascading negative effects to the fishery. At Clear Lake, a natural lake where Yellow Bass were introduced in the 1920s, Yellow Bass populations widely fluctuate, but periods of overabundance have not caused significant declines in the fishery. It is largely unknown how natural lakes of varying physical and biological characteristics will respond to introduced populations of Yellow Bass. Thus, the objectives of this project were to: 1) determine the distribution of Yellow Bass in Iowa's shallow natural lakes; 2) evaluate population dynamics of Yellow Bass in infested natural lakes; 3) evaluate and identify interspecific diet interactions in lakes with Yellow Bass; and 4) evaluate short and long-term changes in fish population size structure, density, and growth with varying Yellow Bass densities.

Targeted fisheries surveys conducted from 2017-2018 found that new Yellow Bass populations existed in two of the twenty-five sampled natural lakes of unknown Yellow Bass status, and that as many as twenty-one natural lakes in Iowa have established populations of non-native Yellow Bass. Multiple gear types were used throughout the course of this study; however, Yellow Bass detection probability was substantially improved via fall night electrofishing compared to day electrofishing or other passive and active gear types. Thus, managers interested in surveying lakes for presence/absence of Yellow Bass can focus their effort via fall night electrofishing investigations at water temperatures ranging from 45 to 58˚F to monitor Yellow Bass population dynamics and densities.

This is the first study that evaluated Yellow Bass population dynamics concurrently in multiple shallow natural lakes for up to three consecutive years and we observed extreme variation in growth, condition, and mortality among, and within natural lakes sampled. Unlike small impoundments, the physical characteristics of the lake, such as lake size, lake depth, and habitat complexity, as well as fish community complexity and lake productivity may play a more important role in structuring Yellow Bass population characteristics than Yellow Bass density alone. We also observed substantial recruitment variability and that single year-classes can persist and dominate a fishery for up to ten years; however, recruitment patterns were rather similar amongst lakes. These findings suggest that regional environmental conditions may be influencing Yellow Bass recruitment, similar to what has been observed with other species in the family Moronidae.

We evaluated the diets of 1,340 Yellow Bass collected from eight natural lakes in Iowa and found that Yellow Bass consume mostly either benthic invertebrates and/or zooplankton throughout the open water season. Evidence to support that Yellow Bass may influence native population via piscivory or egg predations was limited. Most piscivory occurred in two of the eight lakes examined and their tendency to switch to piscivory appears to be related more to food availability and fish size rather than food preference. Also, egg predation via Yellow Bass in natural lakes was infrequently observed and suppression of native fish recruitment by Yellow Bass may be more influenced via direct competition of food and habitat resources than predation. However, dietary overlap comparisons were examined at multiple systems, during multiple seasons, and among multiple species and significant overlap was not consistently observed. Significant overlap was more common in lakes where food item breadth was limited or where both Yellow Bass and White Bass *Morone chrysops* cohabitated.

Few significant differences among fisheries statistics between pre and post Yellow Bass introduction were observed and no consistent pattern of species prevalence or demise due solely to Yellow Bass was detected at lakes identified as either established or recently established Yellow Bass lakes. Our attempts to normalize biotic and abiotic values to summarize patterns in large and small natural lakes was useful to view trends in lakes with differing Yellow Bass population characteristics. However, Yellow Bass populations were generally unpredictable, especially in shallow natural lakes. In Iowa, we have observed a few scenarios that may happen after Yellow Bass introductions: (1) an extremely large year-class develops and persists up to 10 years, dominates the fishery resulting in poor growth and competition with other species; (2) populations increase rapidly, then subside to a more moderate density, growth rates of Yellow Bass and other species remain good; (3) large recruitment events are absent, resulting in low initial densities, Yellow Bass exhibit extremely high growth rates; (4) large recruitment events are absent, growth rates of fish are extremely variable; and (5) Yellow Bass detected, but recruitment events are absent.

It is anticipated that Yellow Bass expansion will continue as both their popularity as a sport-fish increases and pathways for introduction improve. This study provided a valuable framework on Yellow Bass diet composition and dietary overlap with native conspecifics, as well as provided valuable information on the erratic nature of fishery trends post-establishment of a Yellow Bass population in natural lakes. This study found that Yellow Bass generally do not have significant negative effects in natural lakes that have a diverse fishery and are deeper (>15 ft). However, since many natural lakes in Iowa and southern Minnesota are shallow and lack fish diversity, the impacts of Yellow Bass expansion could take many forms. Thus, it is important that fisheries managers routinely evaluate the expansion of Yellow Bass via fisheries surveys and continue education programs that inform anglers on the negative consequences Yellow Bass may have on natural lakes.

Recommended best management practices from this research were as follows:

- Fall night electrofishing provided the best assessment tool to detect of the presence/absence of Yellow Bass and collect sufficient sample sizes of Yellow Bass for adequate population dynamics information.
- Yellow Bass recruitment is variable and detection of successful Yellow Bass recruitment events is critical in understanding potential fishery impacts to native fish communities in shallow natural lakes.
- Yellow Bass consume mostly either benthic invertebrates and/or zooplankton throughout the open water season and do not substantially impact native fish population via predation of young or eggs.
- Yellow Bass did not have consistent significant overlap with any one fish species, except where young White Bass were present or limited food resources were available.
- This study found little evidence to support that fish communities have changed substantially pre and post-Yellow Bass introductions. Several patterns of Yellow Bass population dynamics were observed among natural lakes, with fishery impacts more likely observed in lakes that were shallow and had less fishery diversity.

Suggested citation format, American Fisheries Society Style Guide:

Meerbeek, JR. 2022. Distribution, population dynamics, and interspecific competition of Yellow Bass in Iowa's shallow natural lakes. Federal Aid in Sport Fish Restoration, Completion Report, Des Moines.

Introduction

Yellow Bass *Morone mississippiensis* are native to Lake Michigan and the Mississippi River tributaries from Minnesota to Louisiana and western Iowa to eastern Tennessee (Page and Burr 1991). Yellow Bass have colonized lentic and lotic environments across the Mississippi River drainage basin, primarily through either intentional or unintentional stockings or from connectivity to introduced waters (Carlander et al. 1953; Wright 1968). Many of these introductions in the Midwest were likely the result of “fish rescue” operations that occurred when the Mississippi River receded during drought periods (Helm 1964). In Iowa, the first documentation of Yellow Bass expanding past its’ native range was in 1932 during an angler creel survey in Clear Lake (Bailey and Harrison 1945). Yellow Bass were probably introduced in Clear Lake between 1910 and 1921 with mixed shipments of fish from the Mississippi River (Atchison 1967), and by the late 1940s and early 1950s, comprised as much as 46% of the anglers catch in May and June (Rose 1951). Yellow Bass have thrived in introduced waters, often displacing popular sport fish communities and hybridizing with native White Bass *Morone chrysops* (Wright 1968; Fries and Harvey 1989). In many southern Iowa’s small impoundments, Yellow Bass tend to overpopulate and stunt, causing cascading negative effects to the entire fishery that become difficult to overcome with traditional management practices (Hudson and Larson 2002; Sobotka 2005). Thus, managers have often utilized complete fish renovations or have experimented with targeted rotenone applications with the intent to remove undesirable species such as Yellow Bass and Gizzard Shad *Dorosoma cepedianum* (Flammang and Sobotka 2014).

Little is known regarding Yellow Bass impacts on existing fish communities in shallow natural lakes. Several studies were conducted in Clear Lake from 1953 to 1970 by the Iowa Cooperative Fishery Research Unit that sought to understand the age, growth, diet, and spawning characteristics of an established Yellow Bass population in a shallow, euthophic, natural lake (Carlander et al. 1953; Bulkley 1969a, 1969b, 1970a, 1970b; Buckholtz 1960; Kraus 1963; Ridenhour 1960; Atchinson 1967). Like many small impoundments, Yellow Bass population densities in Clear Lake fluctuate widely and have resulted in stunted populations (Carlander et al. 1953). Seasonally, Yellow Bass consume many of the same organisms as other species and their young provide forage for many of the piscivores (Ridenhour 1960; Buckholtz 1960; Atchinson 1967; Bulkley 1970b). Hence, the abundance of Yellow Bass in Clear Lake has a profound impact on other fish species. In addition to direct competition of food resources, Yellow Bass also have been found to consume eggs or larval fish and may impact recruitment of other species (Fose 2013; Montgomery 2015). However, no studies have thoroughly examined changes in fish community structure both pre and post Yellow Bass introductions. Understanding the effects of introduced predators on existing fish communities is crucial for determining lake specific management strategies (Moyle et al. 1986).

Historic records indicate that Yellow Bass were initially established in three of Iowa’s shallow natural lakes (Clear Lake, North/South Twin Lakes, and Black Hawk Lake) and would periodically contribute to a substantial proportion of the recreational creel (Carlander et al. 1953; Collier 1959; McWilliams 1987). Recently, new Yellow Bass populations have been discovered in several of Iowa’s natural lakes. In 2005, Yellow Bass were found in East Okoboji, part of a chain of lakes that supports one of Iowa’s most utilized fisheries and recreational areas. Yellow Bass have become one of the most abundant fish species in East and West Okoboji lakes and are often targeted by anglers for both their ease of catch and value as a food fish. Yellow Bass were discovered in Lost Island Lake in 2008 and by 2012 were the most harvested fish in the summer creel (Meerbeek and Hawkins 2012). Since many of the shallow lakes in Iowa have simple fish communities that are dependent on fluctuations in Yellow Perch *Perca flavescens* reproductive cycles, angling success is often either “boom or bust” and voids in shallow lakes fisheries can occur. Due to the recent success of Yellow Bass in several of Iowa’s larger natural lakes, the rate of introduction into other natural lake systems has substantially increased presumably to fill these voids in fishing success. For example, since 2012, Yellow Bass have been captured in five more natural lakes in Iowa and in two of southern Minnesota’s natural lakes (Nate Hodgins, MN DNR, personal communication). Yellow Bass introductions are occurring at an alarming rate and there is a need to understand, evaluate, and communicate the potential impacts of these introductions in shallow natural lakes. Specific objectives of this study were to: 1) determine the distribution of Yellow Bass in Iowa’s shallow natural lakes; 2) evaluate population dynamics of Yellow Bass in infested natural lakes; 3) evaluate and identify interspecific diet interactions in lakes with Yellow Bass; and 4) evaluate short and long-term changes in fish population size structure, density, and growth with varying Yellow Bass densities. By addressing these objectives, managers can make informed decisions regarding the potential impacts of Yellow Bass in shallow lake ecosystems.

Methods

Inventory of Natural Lakes with Yellow Bass - Periodic or annual fisheries survey data collected at natural lakes managed for sport fisheries (n = 42; Table 1) by the Iowa DNR prior to 2017 were examined to determine the current distribution of Yellow Bass in Iowa's natural lakes. Yellow Bass were considered to be established in interconnected natural lakes that had known populations of Yellow Bass in one or more of the connected lakes (e.g., East Okoboji, West Okoboji, Upper and Lower Gar, Minnewashta; North and South Twin; Table 1) regardless of prior fisheries survey capture history. Natural lakes where Yellow Bass had previously not been detected (n = 30) were surveyed on at least two separate dates from March 2017 to May 2018 to account for temporal and spatial differences in species catch (Table 2). Each fisheries survey consisted of one or more of the following gear types: day or night pulsed DC electrofishing (lakes with Secchi disk ≥ 0.9 m were sampled at night), modified-fyke nets (frame size of 0.61 x 1.22 m or 0.91 x 1.83 m), experimental gill nets (minimum of two nets; 76.2 m x 1.83 m - five 15.2 panels ranging from 0.635 cm to 3.810 cm bar mesh]), 152.4 m bag seine (minimum of 8 hauls), and baited hoop nets (series of three nets in tandem; Table 2). An electrofishing survey was defined as a minimum of 2-hr of electrofishing on-time or a complete survey of the lakes shoreline, whichever occurred first. Experimental gill nets and modified-fyke nets were set for 24-hr; whereas hoop net series were set for 72-hr. Targeted Yellow Bass sampling (day or night electrofishing) also occurred in 2017 at natural lakes that were identified to have an established population of Yellow Bass to obtain basic population demographic information. In lakes where Yellow Bass were captured, Yellow Bass were measured (total length [TL]; nearest mm) and a subsample of 10 fish per 25-mm length group per lake were placed in a cooler with ice for later examination in the laboratory. Each lake sampled (including lakes with existing populations) was categorized using catch, size, and age structure data (see *Fish Processing* below) as either: 1) no Yellow Bass population detected; 2) recently established Yellow Bass population (predominately age-0 to age-2 fish); and 3) established Yellow Bass population (several age classes sampled; Table 2).

Yellow Bass Relative Abundance - Targeted night electrofishing surveys for Yellow Bass were conducted in the fall 2018 at each natural lake identified as having an established, recently established, or suspected (reported via anglers) Yellow Bass population (n = 15; Elm Lake was excluded due to scheduled fishery renovation). At least four 15-min electrofishing runs were conducted at each lake along the periphery of the shoreline at water temperatures < 60˚F. For each electrofishing survey, water conductivity was measured with an Oakton conductivity meter (model ECTestr low) and anode electrode exposure was modified to achieve between 15-20 amperage outputs. Electrofishing surveys were repeated during the fall of 2019 and 2020 in lakes that had confirmed recently established Yellow Bass populations and two lakes that had established Yellow Bass populations (e.g., reference lakes; Lost Island Lake and Lake Cornelia) to monitor annual variation in Yellow Bass relative abundance. Electrofishing crew consisted of a boat operator and one netter that was instructed to net all Yellow Bass encountered. Captured Yellow Bass were measured for TL and a subsample (10 fish per 25-mm length group per lake) of Yellow Bass were placed on ice and brought back to the laboratory for later examination (see *Fish Processing* below). Yellow Bass (age-1 and older) relative abundance for each lake and year was expressed as electrofishing catch-per-hour (CPH) and recruitment was examined via changes in catches (CPH) of age-0 Yellow Bass in each lake from 2018-2020.

Interspecific Competition of Food Resources - A minimum of four natural lakes identified as having recent and two natural lakes with established Yellow Bass populations were sampled each year from 2018-2020 to evaluate diet characteristics between Yellow Bass and native fish communities. More specifically, Yellow Bass (≥ age-1) and at least one keystone species (e.g., Black Crappie *Pomoxis nigromaculatus*, Bluegill *Lepomis macrochirus*, Walleye *Sander vitreus* White Bass *Morone chrysops*, and Yellow Perch *Perca flavescens*; ≥ age-1) were sampled from each lake at bi-monthly intervals from April to November (April and May = Late Spring; June and July = Early Summer; August and September = Late Summer; October and November = Fall). For each lake, Yellow Perch was the target keystone species, but other fish species that were frequently encountered during sampling events were also collected to evaluate diet characteristics among multiple fish species. Sampling for Yellow Bass and keystone species consisted of any combination of the aforementioned gear types; however, day/night electrofishing and short-term (1-2 hr sets) daytime gill net sets (multifilament or monofilament, range of mesh sizes between 0.635 cm to 3.810 cm) were the most common techniques used to collect fish for diet analysis. Nets and electrofishing typically consisted of sampling various locations around the lake periphery or offshore structure to collect desired sample sizes for each species. Attempts were made to collect at least 15 individuals during each interval for each species and lake sampled. All fish that were collected for the diet analysis were immediately placed on ice in a cooler and later taken to the laboratory for dissection.

Fishery Response to Yellow Bass Introduction - Changes in the relative abundance (catch-per-effort; CPE), size structure (proportional stock density and mean TLs), and condition (relative weights) of sport fishes in two lakes (Lost Island Lake and Lake Cornelia) that have an established Yellow Bass population and six lakes (Center Lake, Five Island Lake, Ingham Lake, Pleasant Lake, Rice Lake, Silver Lake) that have recent infestations of Yellow Bass were evaluated using standardized spring electrofishing and fall fyke netting (see Schultz 2008) data collected by Iowa DNR staff prior to the start of this study (i.e. 2018), surveys conducted from 2018-2020 as part of Research Study 7027, and surveys conducted as part of this study. More specifically, spring (May 1 - June 30) electrofishing occurred at fixed locations sampled for a minimum of 15 minutes (on-time) when water temperatures were between 60 ˚F and 75 ˚F. Sampling effort (number of 15 minute stations) was determined by lake size (acres) and ranged from 4 to 8 stations per lake. Fall (mid-August to mid-October) fyke netting surveys (fixed stations) were conducted in water temperatures between 75 ˚F and 60 ˚F and the number of net nights for each lake were also determined by lake size (n = 4-20 net nights; Schultz 2009). At Lake Cornelia, spring fyke netting was conducted in conjunction with spring electrofishing. Iowa's standard gear for modified fyke nets had recently changed from a 0.61 m x 1.22 m frame to a 0.91 m x 1.83 m frame (both with 1.905 cm mesh and 12.2 m lead), thus net effort was described by the number of net nights set multiplied by the respective net opening width (0.7442 m^2 for nets prior to 2018; 1.6653 m^2 for nets after 2018). For example, if eight fyke nets nights were completed during a survey prior to 2018, net effort would be 5.9536 (e.g., 8 x 0.7442). The number of fish for each species captured during that survey would be divided by net effort to calculate a standardized fyke net metric, in this case, number of fish captured per square-meter of fyke net frame used during the survey. For each survey, TLs were collected from a subsample of fish captured. For surveys conducted as part of this project, a subsample (10 fish per 25-mm length group per lake) of weights and aging structures were collected from each major sportfish species. Subsamples of fish weights and aging structures were infrequently taken for surveys conducted by IA DNR staff prior to 2018; however, these data were obtained for surveys conducted as part of Research Study 7027. Trends in mean length-at-age for each lake were compared by pooling age data collected from surveys conducted from 2017-2020 (spring and fall pooled separately) for Yellow Perch, Bluegill, and Black Crappie and comparing growth curves to 25th and 75th growth percentiles for natural lakes in Iowa (spring and fall comparisons; J. Meerbeek, unpublished data).

Fish Processing - At the laboratory, sacrificed Yellow Bass and keystone species were measured (TL) and weighed (Wt; g) and sex was determined by examination of reproductive organs (male, female, immature, or unknown; sex was not determined for fish collected as part of a standardized survey). If the fish was collected as part of the bimonthly diet sample, stomachs were then removed and placed in a numbered 125 ml plastic bottle containing a solution of 99% isopropyl alcohol and stored for later examination. Sagittal otoliths were removed from each fish, cleaned via a paper towel, and placed in a number vial and stored for ≤ 6 months. Otoliths were placed in a black Ohaus aluminum scoop (10.16 cm x 8.89 cm) containing a small amount of water and viewed under a dissecting microscope. Annuli were counted and recorded for each fish. If the otolith was determined to be ≥ age-5 or unreadable due to extensive calcification of the outer surface (e.g., all Yellow Bass experienced poor whole-view readability), then otoliths were cracked along the lateral axis and examined as a cross-section (Soupir et al. 1997). To improve cross-section clarity and accentuate the annuli, otolith cross-sections were held via a forceps and exposed to a flame to lightly burn the lateral axis of the otolith until it appeared golden-brown. The otolith was then placed in modeling clay and mineral oil was finely brushed on the surface of the otolith via an artist brush. The cross-section was viewed under a dissecting microscope and side illumination was provided by a 150-W halogen illuminator light box and was transmitted across the proximal end of the otolith with a 45° fiber optic light guide. All structures were read by one experienced worker (≥ 15 years of age and growth work experience).

Stomach Content Analysis - Stomach samples were removed from the bottle and a surgical scissors was used to carefully cut along the entire length of the outer stomach wall, starting at the esophageal opening and ending near the basal end of the stomach. Pressure was then applied to the outer lining of the stomach to invert the stomach wall, exposing the stomach contents. A plastic squeeze medical wash bottle was then used to rinse the exposed stomach wall and all food items were collected in a 50-250 ml plastic beaker (beaker size dependent on stomach fullness). Stomach content biomass (g) was obtained by pouring the contents of the plastic beaker in a homemade funnel containing a small (approximately 10 cm x 10 cm) section of a 63 µm cloth-nitex filter. To account for weight associated with water saturating the 63 µm cloth filter post filtration, prior to using, the filter section was wetted with the wash bottle, quickly dried with a paper towel, placed on a Mettler Toledo AB204-SRS scale, and then the scale was set to tare. The same 63 µm cloth filter section containing the stomach contents was also dried via a paper towel by applying slight pressure to the filter section contents in attempt to remove as much water weight as possible. The filter section was then weighed on the same scale that was set to tare, total biomass weight was recorded (nearest 0.0001 g), and the stomach contents were then rinsed into in a Ward Counting Wheel. Food items were viewed under a dissecting microscope and identified to lowest possible taxonomic classification, enumerated, and recorded for each stomach sample. If no food items were found, the stomach was classified as being empty. Food items were later separated into one of 16 major taxonomic classifications (adult insect - winged; Amphipoda; Bivalve/Ostracod; Chironomidae larvae; Chironomidae pupae; Cladoceran; Copepoda; Ephemeropteran; fish; Gastropoda; Hemipteran; Hydracarnia; Leptodora; Odonatan; Tricopteran; other/unidentifiable). Further classification of food items into either zooplankton, benthic invertebrates, fish, or other was also performed to evaluate broad characteristics in seasonal diet patterns for Yellow Bass and keystone species for each lake and year. Finally, broad classification of food items were also pooled by species and lake from 2018-2020 to generalize seasonal trends in diet throughout the duration of the project.

Statistical Procedures - Basic population demographic information (i.e., length-weight relationships, growth, and mortality) was estimated collectively for each lake where Yellow Bass were sampled between July-October from 2017-2020 (limited to lakes where ≥ 75 individuals were collectively captured; Kritzer et al. 2001). First, pooled length-weight relationships for Yellow Bass were examined using simple linear regression (SAS Institute, Gary, North Carolina) and studentized residuals exceeding ± 3 were reviewed for data accuracy and omitted if determined to be an outlier. Then, Program AGEKEY was used to assign ages to unaged Yellow Bass using subsampled year specific age data obtained from each lake (Isermann and Knight 2005). Growth was assessed via the von Bertalanffy growth equation (von Bertalanffy 1938; Van den Avyle and Hayward 1999) and compared between lakes with the least squares model to determine if von Bertalanffy growth parameters differed between lakes (SAS Institute). Due to extreme recruitment variability, reliable mortality rates calculated via catch-curve models could not be estimated annually. Therefore, combined mean length-at-age data from surveys conducted between 2017-2020 (July-October) were used to estimate lake specific Yellow Bass instantaneous natural mortality rates (M) and the associated conditional natural mortality rate (cm) via Fisheries Analysis and Modeling Simulator (FAMS; Slipke and Maciena 2014). Yellow Bass mean length-at-age was compared among lakes using analysis of variance (ANOVA) followed by Tukey's post hoc test.

Length frequency distributions from Yellow Bass captured during fall night electrofishing surveys were compared within and among lakes using a Kolmogorov-Smirnov two-sample test (fish ≥ stock size; SAS Institute). Length frequencies, proportional size distribution (PSD, 102 mm), and relative stock density preferred (PSD-P, 229 mm) were calculated to assess annual changes in size distribution within each lake as well as size distribution differences among lakes each year (Anderson 1976; Neumann et al. 2012). Condition (i.e., relative weight; *Wr*) was assessed by pooling annual Yellow Bass captures between July and October (to increase sample size; fish ≥ stock size) and was calculated as described by Wege and Anderson (1978) using standard weight (*Ws*) values reported by Murphy et al. (1991; a = -5.142 and b = 3.133). Yellow Bass mean *Wr* were compared among years and lakes using analysis of variance (ANOVA) followed by Tukey's post hoc test.

Fish data (TL and Wt) collected during standardized surveys was also reviewed for data accuracy via linear regression models and program AGEKEY (Isermann and Knight 2005) was used to assign ages to unaged fish as describe above. Relative weight (*Wr*) was calculated for each major fish species collected as described by Wege and Anderson (1978) using standard weight (*Ws*) values reported by Murphy et al. (1991; fish ≥ stock-length). Trends in mean *Wr* and mean TL were evaluated by comparing pooled *Wr* values pre and post Yellow Bass infestation for each major species (≥ stock-length) via ANOVA followed by Tukey's post hoc test. Size structure of major fish species for each survey was indexed with PSD (Anderson 1976) and a t-test was used to detect differences in size indices among gear types and years. Comparisons of major fish species captured via fyke nets (e.g., CPE as describe above) or electrofishing (catch-per-hour CPH) were evaluated pre and post Yellow Bass infestation for each lake via a two-tailed t-tests (alpha = 0.05). Approximate t-tests and Satterthwaite's approximation for df were used if the folded form of the F-statistic indicated heterogeneous variances ($P < 0.05$).

Natural lakes that were identified as lakes with a recent and established Yellow Bass population were used to evaluate trends in lake size, mean lake depth, mean chlorophyll a, mean Cladocera density, Yellow Bass density (expressed as mean CPH electrofishing), mean July-October condition (*Wr*), and Yellow Bass instantaneous natural mortality rates. More specifically, data collected during this study was normalized for each metric using the formula:

$$z_i = \left[\frac{x_i - \min(\mathrm{x})}{\max(\mathrm{x}) - \min(\mathrm{x})}\right] * 100$$

where x_i is the lake specific metric, min(x) is the minimum of the range of values for that metric, max(x) is the maximum of the range of values for that metric, and z_i is the normalized value ranging from 0-100. Natural lakes were categorized as either large (> 972 acres) natural lakes or small (< 500 acres) lakes and trends in mean lake depth, mean chlorophyll a, mean Cladocera density, Yellow Bass density, Yellow Bass condition, and Yellow Bass mortality were examined.

Frequency of occurrence and percent occurrence of major prey items in the stomachs of Yellow Bass and keystone species collected from each lake were calculated for each bi-monthly interval and year to evaluate seasonal and annual differences in dietary food consumption among lakes and species. Frequency of occurrence was calculated using the formula:

$$\%F_i = \frac{N_i}{N} x\ 100$$

where $\%F_i$ is the frequency of occurrence of given item *i*, N_i is the number of stomachs in which food item *i* occurs and N is the total number of stomachs examined. Percent occurrence for each species and interval was calculated by summing the total number of food item *i* divided by the total number of food items times 100. Trends in frequency and percent occurrence were also examined by pooling bi-monthly diet data for each species, lake, and year. Index of fullness was calculated for each stomach examined by taking the total weight of the stomach contents x 10,000 and dividing by the weight of the fish. Food items were partitioned into one of 16 major taxonomic groups and diet overlap was used to compare prey consumption between each fish species for each lake across the different seasons. I calculated diet overlap using Schoener's index α (Schoener 1970, Hurlbert 1978),

$$Schoener's\ \alpha = 1 - 0.5\left(\sum_{i=1}^{n} \left|P_{x,i} - P_{y,i}\right|\right)$$

where $P_{x,i}$ is the proportion of food item *i* used by fish species *x*; $P_{y,i}$ is the proportion of food item *i* used by fish species y; and n is the total number of diet categories. Schoener's Index ranges from 0 (no overlap) to 1 (complete overlap) and overlap values > 0.6 were considered to be biologically significant (Wallace and Ramsey 1983). A minimum sample size of 10 fish per species per bimonthly period was used for overlap analysis. A significance level α of 0.05 was established a priori for all tests.

Results

Thirty-six natural lakes were sampled in 2017-2018 via day or night electrofishing (114.4 hr on-time), experimental gillnets (n = 9 net nights), seines (n = 14 hauls), hoop nets (n = 36 net nights), fyke nets (n = 102 net nights) or angling (3 hr) to determine Yellow Bass distribution (Table 2). Comprehensive (spring daytime electrofishing, summer tandem hoop netting, and fall fyke netting) or general surveys (spring daytime electrofishing and fall fyke netting; Schultz 2009) were conducted by IA DNR staff on Storm, Center, Five Island, Black Hawk, Rice and Silver (Worth Co) lakes in 2017 (Table 1). In addition to day electrofishing conducted in summer of 2017 by IA DNR staff, the Minnesota DNR conducted comprehensive fisheries surveys (summer experimental gill nets and spring fyke nets) in Iowa and Tuttle lakes (i.e, Minnesota-Iowa border water lakes) in 2017. No fisheries survey was conducted in Little Swan Lake due to a scheduled fisheries renovation project. Similarly, a second fisheries survey was not completed for Diamond or Elm lakes due to a scheduled complete fisheries renovations. Other lakes where targeted Yellow Bass sampling did not occur (n = 5) had connectivity to known infested lakes (e.g., West Okoboji, Upper Gar, Minnewashta, Lower Gar, South Twin; Table 2). Aquatic vegetation density in Burt, Virgin, and Little Clear lakes prevented targeted sampling in 2017, but all lakes were sampled in 2018 via spring day electrofishing (Table 2). Of the 36 sampled lakes, twelve (33%) were verified to have either an established or a recently established Yellow Bass population (Table 2). New Yellow Bass populations were discovered in two natural lakes (Pleasant and Elm lakes) in 2017. Other natural lakes where Yellow Bass were collected in 2017 were known to have either recently established (< 5 years) or established (≥ 5 years) Yellow Bass populations (Table 3). Although Yellow Bass were not detected in Spirit Lake and Ingham Lake during spring and fall day electrofishing in 2017, night electrofishing surveys in the fall of 2016 and surveys conducted after 2018 detected at least one Yellow Bass in each of those lakes. Therefore, both of these lakes were classified as having recently established Yellow Bass populations. Likewise, Yellow Bass were not sampled in Rice, Storm, or Tuttle lakes in 2017, however anglers reported Yellow Bass from these lakes from 2017-2018. Subsequent sampling has verified their presence at Storm Lake (Table 3). Including those observations, Yellow Bass are known to exist in 19 natural lakes (including those with connectivity to infested waters) in Iowa and may be established in 21 natural lakes (angler reported catches at Rice and Tuttle lakes; Table 3).

Fall night electrofishing surveys were conducted at 15 natural lakes in 2018 and catch rates for age-0 and adults/juveniles combined ranged from 0.0 fish/hr at Rice, Spirit, Storm, Tuttle lakes to 693.0 fish/hr at Five Island Lake (Figure 1). Successful recruitment (i.e., age-0 catch > 0) was observed at all lakes where Yellow Bass were captured in 2018 and ranged from 1.0 fish/hr at Ingham Lake to 205.0 fish/hr at North Twin Lake. In 2019, eight natural lakes were sampled and Yellow Bass catch rates (all age groups) ranged from 0.0 fish/hr at Tuttle and Ingham lakes to 544.0 fish/hr at Lake Cornelia. No age-0 Yellow Bass were collected at Center Lake and Lake Cornelia, and age-0 catch rates in all other lakes except Five Island Lake were poor (≤ 9.0 fish/hr). Six natural lakes were sampled in 2020 via fall night electrofishing and catch rates ranged from 150.0 fish/hr at Pleasant Lake to 1,204.0 fish/hr at Five Island Lake. Successful recruitment (≥ 37.0 age-0 fish/hr) was observed at all lakes with the highest catch rate (874.0 age-0 fish/hr) observed at Five Island Lake.

Large variation was observed in the range (all sexes) of Yellow Bass TL's collected from 10 natural lakes in Iowa from 2017-2020, with larger (> 900 acres) natural lakes and lakes with recent infestations of Yellow Bass having a wider range of fish sizes (Table 4). Yellow Bass (all sexes) mean total length ranged from 139 mm (Little Wall Lake) to 211 mm (Clear Lake; Table 4) and sexual dimorphism in growth was rarely observed (except Pleasant Lake; Table 4). Individual lake Yellow Bass total length-weight regressions were all significant and explained between 93-99% of the variation. Yellow Bass maximum age determined via sectioned otoliths was 10, and ranged from age 0-5 in lakes identified as recent Yellow Bass infestations (i.e., Center, Five Island, Ingham, and Silver lakes; Table 5) to age 6-10 in natural lakes with established Yellow Bass populations (Table 5). Similar to what was observed via fall night electrofishing Yellow Bass age-0 CPE, based off the age frequency distribution of adult Yellow Bass in Iowa's natural lakes, Yellow Bass recruitment was also variable; however, recruitment patterns were similar amongst lakes. For example, the 2014 year-class was absent from eight natural lakes and only 1-4 individuals in that year class were observed in the remaining two lakes. In lakes where Yellow Bass were sampled for at least 4 consecutive years, strong year-classes often persisted for multiple years (i.e., 2013 year-class at Lake Cornelia; 2017 year-class at Five Island Lake; 2015 year-class at Lost-Island; 2016 year-class at Pleasant Lake; Table 5). Pooled mean TL's at age varied significantly among lakes. In general, Yellow Bass residing in larger natural lakes (> 900 acres) and those with recent infestations observed significantly higher mean TL-at-age (ages 1-6) compared to smaller, established Yellow Bass natural lakes (Table 5).

Yellow Bass growth rates estimated via von Bertalanffy growth equation (combined 2017-2020 data) ranged from 0.136 (Little Wall Lake) to 0.634 (Silver Lake; Table 6). Comparison of von Bertalanffy growth functions (Clear Lake was not included in this analysis due to insufficient age data) found significant differences in growth among all lakes except comparisons among Five Island and East Okoboji, Pleasant and Little Wall, and Center and Silver lakes (Table 7). Estimates of M (sexes combined) ranged from 0.34 in Lake Cornelia to 0.73 in Silver Lake; whereas estimates of cm (sexes combined) ranged from 0.28 in Lake Cornelia and Little Wall lakes to 0.51 in Silver Lake (Table 6). Condition varied significantly among and within lakes between 2017-2020 (Table 8; Figure 2). In 2017, condition was poorest in Little Wall Lake (mean *Wr* of 79), and highest in Center Lake (Figure 2). Similarly, in 2018, condition was poorest in Little Wall Lake and Lake Cornelia and highest in Silver Lake. In both 2019 and 2020, condition was highest in Silver and Lost Island Lakes and lowest in Lake Cornelia and Pleasant Lake. Length-frequency comparison among lakes were also significantly different for each year sampled from 2018-2020 except Silver and North Twin lakes in 2018 and Lost Island and Center Lake in 2019 (Table 9). Length-frequency data combined from 2018-2020 found no similarities among lakes (Table 9). Length-frequency comparisons within lakes often differed from year to year, with the exception of Center Lake (2018*2019), Pleasant Lake (2018*2019), and Silver Lake (2018*2019; 2019*2020; Table 8). With these changes in length-frequencies, fluctuations in PSD and PSD-P within and among lakes were also observed from 2018-2020 fall electrofishing investigations (Figure 3).

On occasion, it was not practical to capture enough Yellow Bass during a bi-monthly period due to the abundance of Yellow Bass in the lake system (i.e., recent introduction and lack of sufficient individuals). In those instances, we captured keystone species to identify seasonal diet characteristics of selected species in lieu of an abundant Yellow Bass population (e.g., Rice Lake and Ingham Lake). In addition, there were bimonthly periods where we were unable to capture a sample of 15 fish per species due to time constraints, gear limitations, species density, weather, etc. In those instances, diet and fish data were reported, but diet overlap comparisons were limited to those with sample sizes ≥ 10. Collectively, 3,427 stomach samples were obtained from 2018-2020 representing six species and 403 of those (12%) were classified as empty (Table 10; Table 11; Table 12). Diet samples from a total of 258 Black Crappie (5.8% empty), 273 Bluegill (13.9% empty), 92 Crappie spp. (1.1% empty), 1,297 Yellow Perch (16.3% empty), 1,340 Yellow Bass (9.6% empty) and 50 Walleye (2.0% empty) were collected from all lakes during all seasons combined (Table 10; Table 11; Table 12). Over 600,000 food items were identified and separated into 16 different taxa/groups. Collectively, Cladocera (372,000), Chironomidae larvae (80,000), Leptodora (47,000), Chironomidae pupae (41,000), and Copepoda (39,000) were the most consumed food items during the study. Other taxa groups that contributed to fish diets in significant numbers included Amphipoda (6,000), Ephemeropteran (4,000), Hemiptera (4,000), Hydracarnia (3,700), and Tricopteran (2,700). Approximately 1,000 fish were found in the diets of sampled fish.

Diet samples from adult/juvenile Black Crappie (n = 135), Bluegill (n = 88), Yellow Perch (n = 153), Yellow Bass (n = 226), and Walleye (n = 29) were collected from Center Lake from 2018-2020 (Table 10; Table 11; Table 12). Comparative to other species sampled in 2018 and 2019, Yellow Perch had the highest proportion of empty stomachs as well as substantially lower mean number of food items, mean stomach biomass, and mean stomach fullness values (Table 10; Table 11). In 2020, all Yellow Perch sampled had at least one food item in their stomach, yet mean stomach indices were consistently lower than other all species sampled (Table 12). In 2018, Yellow Perch more frequently consumed Chironomidae larvae, Hemiptera, and fish from June-November and less frequently consumed Cladocera and Leptodora, food taxa often consumed by Black Crappie, Bluegill, and Yellow Bass (Table 13). In 2019, Yellow Perch consumed many of the same items as their fish counterparts, but amount consumed was substantially less (Table 14). Yellow Bass, on the other hand, consumed a wide variety of prey taxa throughout the open water season. Periods of high frequency and percent occurrence of Chironomidae larvae, Chironomidae pupae, Cladocera, Hemiptera, and Leptodora were often observed from April to November (Table 13; Table 14; Table 15). Cumulatively, twenty-two diet overlap comparisons were conducted for Center Lake, of which, thirteen included bimonthly comparisons of Yellow Bass and either Black Crappie (n = 4), Bluegill (n = 2), or Yellow Perch (n = 7; Table 16; Table 17; Table 18). Yellow Bass had high diet overlap with Bluegill during the April-May period in both 2018 and 2019 (Table 16; Table 17). Yellow Bass had high diet overlap with Black Crappie for April-May and October-November bimonthly intervals in 2019 (Table 17). Of the 7 observations of diet overlap comparison for Yellow Bass and Yellow Perch, significant diet overlap was observed once, during the August-September sample in 2018 (Table 16). Broad classification of pooled diet data for Black Crappie, Bluegill, Yellow Perch, and Yellow Bass found that Yellow Bass in Center Lake fed primarily on zooplankton throughout year; whereas both benthic invertebrates and zooplankton were seasonally a major diet item for other species (Figure 4).

Diet samples from adult/juvenile Black Crappie (n = 30), Bluegill (n = 72), Yellow Perch (n = 160), and Yellow Bass (n = 259) were collected from Lake Cornelia from 2018-2020 (Table 10; Table 11; Table 12). The quality and quantity of food items found within fish species collected from Lake Cornelia were generally the poorest amongst all lakes where fish diet was evaluated, regardless of season. In 2018, 26 of 27 Bluegill and 26 of 33 Yellow Bass collected in April-May had empty stomachs (Table 10). Similarly, 10 of the 15 Yellow Perch collected in April-May of 2019 had stomachs that were empty, but Yellow Bass and Bluegill consumed Cladocera among a variety of other food items (Table 11). Although empty stomachs were rare during other years and seasons at Lake Cornelia, mean stomach biomass was rarely > 0.1 g for species examined, regardless of the number of food items consumed (Table 10; Table 11; Table 12). Although all 16 major prey items were found in at least one fish throughout the duration of the study, Cladocera, Chironomidae larvae, and Hydracarnia were the most frequently observed during the open water period from 2018-2020 (Table 13; Table 14; Table 15). Cumulatively, sixteen diet overlap comparisons were conducted for Lake Cornelia, of which, fourteen included bimonthly comparisons of Yellow Bass and either Black Crappie (n = 1), Bluegill (n = 3), or Yellow Perch (n = 12; Table 16; Table 17; Table 18). High diet overlap was observed for Yellow Bass and Bluegill in June-July 2018 and Yellow Bass and Yellow Perch in 3 of 10 bimonthly comparisons (Table 16; Table 17; Table 18). Broad classification of pooled diet data for Black Crappie, Bluegill, Yellow Perch, and Yellow Bass found that Yellow Bass in Lake Cornelia fed primarily on zooplankton throughout year, with benthic invertebrates being consumed more frequently during August-September.

Whereas, for Yellow Perch, benthic invertebrates were more frequent in the diets seasonally. Bluegill from April-June fed on both zooplankton and benthic invertebrates. Insufficient samples sizes for Black Crappie limited broad classification of major prey items throughout the season (Figure 5).

Diet samples from adult/juvenile Yellow Perch (n = 21) and Yellow Bass (n = 37) were collected from East Okoboji Lake in April-May 2018 (Table 10). Yellow Perch mean stomach biomass, mean stomach fullness, and mean number of food items was substantially higher than Yellow Bass even though Yellow Bass were on average larger (Table 10). Yellow Perch diet consisted of more Amphipods; whereas, Yellow Bass consumed more Cladocera (Table 13). Diet overlap between Yellow Perch and Yellow Bass was similar (0.58), but not considered to be biologically significant (Table 16).

Diet samples from adult/juvenile Bluegill (n = 15), Yellow Perch (n = 77), and Yellow Bass (n = 126) were collected from Five Island Lake from 2019-2020 (Table 11; Table 12). Yellow Bass, on average, consumed more prey items then Yellow Perch during all bimonthly diet periods, yet mean stomach biomass and stomach fullness did not consistently differ substantially (Table 11; Table 12). Yellow Bass consumed a variety of prey items in Five Island Lake during the open water period, but Cladocera, Chironomidae larvae, Leptodora, Ephemeroptera were the most frequently consumed (Table 14; Table 15). Yellow Perch diet in Five Island Lake was predominantly Chironomidae larvae and pupae, as well as Ephemeroptera, Hydracarnia, and Tricoptera (Table 14; Table 15). Sufficient sample sizes of Yellow Perch were not obtained during five of the bimonthly periods combined to conduct diet overlap comparisons. Diet overlap for observations where sufficient samples sizes were available (n = 5 observations) found no overlap among species in Five Island Lake (Table 17; Table 18). Similarly, broad classification of pooled diet data for Yellow Perch and Yellow Bass found little similarities in diet among the two species. Yellow Perch seasonal diet consisted mainly of benthic invertebrates; whereas, Yellow Bass consumed zooplankton seasonally, with benthic invertebrates becoming more commonly consumed from April-July (Figure 6).

Diet samples from adult/juvenile Crappie spp. (n = 92), Yellow Perch (n = 177), and Yellow Bass (n = 3) were collected from Ingham Lake from 2018-2019 (Table 10; Table 11). Too few Yellow Bass were collected to make comparative generalizations between Yellow Bass and keystone species. Substantial differences were observed in mean number, stomach biomass, and stomach fullness between Yellow Perch and Crappie spp. from April to September 2018 (Table 10). During these samples, a similar range of food prey was consumed, but Crappie spp. had a higher proportion of Cladocera in their diet than did Yellow Perch and Yellow Perch consumed more Chironomidae larvae/pupae (Table 13). Yellow Perch diet in 2019 was not as diverse, but a majority of the prey items were Chironomidae larvae/pupae (Table 14). Significant diet overlap between Yellow Perch and Crappie spp. was observed only during the April-May sample, 2018 (Table 16). Broad classification of pooled diet data for Yellow Perch found that benthic invertebrates are the primary food item consumed, with zooplankton being consumed less frequently. Conversely, Black Crappie fed primarily on zooplankton throughout year, with benthic invertebrates consumed less frequently (Figure 7).

Diet samples from adult/juvenile Black Crappie (n = 83), Bluegill (n = 57), Yellow Perch (n = 223), Yellow Bass (n = 240), and White Bass (n = 26) were collected from Lost Island Lake from 2018-2020 (Table 10; Table 11; Table 12). During the April-May 2018 sample, all fish species collected either had a high proportion of empty stomach or low (< 0.2g) stomach biomass estimates (Table 10). During all other collection events from 2018-2020, mean stomach biomass estimates were always > 0.1 g except Yellow Perch in June-July of 2018 and Yellow Bass in April-May of 2020 (Table 10; Table 11; Table 12). Similarly, mean stomach fullness values were consistently high during all seasons and years for each species collected. A wide range of food items were consumed seasonally by all species with Chironomidae larvae, Chironomidae pupae, Cladocera, Amphipoda, Ephemeroptera, and Tricoptera having the highest frequency and percent occurrence (Table 13; Table 14; Table 15). Annual differences in seasonal Yellow Bass diet composition was observed; however, similar patterns of diet selectivity were observed seasonally. In general, Yellow Bass diet during April-May consisted of Copepods and Cladocera, followed by a higher proportion of Chironomidae larvae and pupae from June to October. Fish were a common diet item for Yellow Bass from August-November. Yellow Perch generally consumed a wider variety of prey items and had higher proportions of high-quality benthic invertebrates then did Yellow Bass (Table 13; Table 14; Table 15). Nineteen observations of Yellow Bass and keystone species diet overlap were calculated for Lost Island Lake from 2018-2020. Of those, four were found to have significant overlap among Yellow Bass and Yellow Perch (3 of 12 observations) and Yellow Bass and Black Crappie (1 of 4 observations; Table 16; Table 17; Table 18). Of those, no observations of diet overlap occurred in April-May, two occurred in June-July and the remaining two seasons each had one observation of overlap among Yellow Bass and a keystone species (Table 16; Table 17; Table 18). Broad classification of pooled diet data found that Yellow Perch in Lost Island Lake fed primarily on benthic invertebrates from April-September, and zooplankton in October-November (Figure 8). Yellow Bass consumed zooplankton throughout the open water period, but also consumed high proportions of benthic invertebrates throughout the year. Similarly, diets of Bluegill and Black Crappie collected from April-July were primarily benthic invertebrates and zooplankton (Figure 8).

Diet samples from adult/juvenile Yellow Perch (n = 262) and Yellow Bass (n = 231) were collected from Pleasant Lake from 2018-2020 (Table 10; Table 11; Table 12). Of the 242 fish sampled throughout the entire open water period in 2018, 43% (n = 104) of stomachs were found to be empty at Pleasant Lake (Table 10). Those that contained food, had consumed predominantly Cladocera or Copepods (Table 13). Empty stomachs were also observed in 2019, but at a lower rate (Table 11). In 2020, only one fish was found to have an empty stomach (Table 12). During these two years, both Yellow Perch and Yellow Bass consumed a higher proportion of Chironomidae larvae/pupae than observed in 2018. Both Yellow Perch and Yellow Bass collected from Pleasant Lake consumed lower numbers of prey items, on average, than these same species collected at other natural lakes during the respective bimonthly interval (Table 10; Table 11; Table 12). Pleasant Lake was also the only lake in which fish was a major component of the food items consumed by both Yellow Perch and Yellow Bass during all seasons (Table 13; Table 14; Table 15), which resulted in highly variable seasonal indices of mean stomach biomass and stomach fullness (Table 10; Table 11; Table 12). Because of the low availability of quality prey items, diet overlap among Yellow Perch and Yellow Bass was observed in 5 of the 10 comparison, spanning all four seasons sampled (Table 16; Table 17; Table 18). Broad classification of pooled diet data found similar seasonal trends in Yellow Bass and Yellow Perch diet in Pleasant Lake (Figure 9). Zooplankton was the most consumed prey item for both species from June-November. During the April-May period, many Yellow Bass had empty stomachs, but those that did not, fish was the major food item consumed. Conversely, Yellow Perch during this time period had consumed mostly zooplankton (Copepoda; Figure 9).

Diet samples from adult/juvenile Bluegill (n = 41) and Yellow Perch (n = 51) were collected from Rice Lake in April-May 2018 (Table 10). No Yellow Bass were detected during subsequent surveys; thus, Rice Lake was removed from the diet study in 2018. Ten of the 51 Yellow Perch collected in April-May 2018 were found to have empty stomachs, yet mean number of food items, mean stomach biomass, and mean stomach fullness was higher than what was observed for Bluegill, of which no stomachs were found to be empty (Table 10). Bluegill consumed a higher proportion of Chironomidae larvae; whereas, Yellow Perch consumed more Chironomidae pupae (Table 13). Although the extent of food items consumed was similar among the two species in April-May 2018, no diet overlap was detected (Table 16).

Diet samples from adult/juvenile Yellow Perch (n = 174), Yellow Bass (n = 213), Walleye (n = 21), and White Bass (n = 101) were collected from Silver Lake from 2018-2020 (Table 10; Table 11; Table 12). Silver Lake was added as a diet study lake in lieu of Rice Lake early in 2018 after unsuccessfully collecting Yellow Bass at Rice Lake during a comprehensive spring survey (i.e., no April-May samples during 2018). Only 10 of the 509 stomach samples (1.9%) were found to be empty throughout the duration of the study. Mean number of food items, mean stomach biomass, and mean stomach fullness was consistently high for all species sampled in 2018 (Table 10). In 2019 and 2020, periods of poor (<0.2 g) mean stomach biomass were observed for multiple species, but these observations were infrequent (5 of 28 seasonal observations; Table 11; Table 12). In 2018, Cladocera and Leptodora were a major prey items for Yellow Perch, Yellow Bass, and White Bass from June-November (Table 13). In 2019, Cladocera continued to be the most frequently consumed prey item by these species in most bimonthly periods; however, Chironomidae pupae and Chironomidae larvae also contributed substantial to the diet (Table 14). In 2020, Cladocera were consumed at high proportions during the April-May period for White Bass and Yellow Bass, but were less frequent throughout the remainder of the year. A more diverse diet, including Chironomidae larvae/pupae, Ephemeroptera, fish, Hemiptera, and Leptodora was more seasonally important for fish species examined (Table 15). Cumulatively, twenty-four diet overlap comparisons were conducted for Silver Lake, of which, sixteen included bimonthly comparisons of Yellow Bass and either White Bass (n = 5), Walleye (n = 1), or Yellow Perch (n = 7; Table 16; Table 17; Table 18). Four of the five diet overlap indices for Yellow Bass and White Bass indicated high diet overlap. High diet overlap for Yellow Perch and Yellow Bass was also documented in 50% of the diet comparisons and occurred during a wide range of bimonthly intervals. No significant diet overlap was observed in 2020, but for 4 of the 9 comparisons, overlap indices were very close to the level considered biologically significant (0.57; Table 18). Consequently, broad classification of pooled diet data among Yellow Perch, White Bass and Yellow Bass found strong similarities in seasonal diet composition (Figure 10). All species besides

Walleye consumed a high proportion of zooplankton throughout the year. Yellow Perch consumed a higher proportion of benthic invertebrates from April-July than did other panfish species. Walleye rarely fed heavily on zooplankton and their diets were more seasonally diverse (Figure 10).

For all lakes except Lake Cornelia, sample sizes of fishes collected via spring electrofishing were insufficient for pre and post Yellow Bass infestation comparisons. Thus, fall fyke netting was the primary gear used to compare mean CPE, mean TLs, mean Wr, and mean PSD’s pre and post Yellow Bass introductions. Comprehensive fisheries surveys were conducted at Ingham (2018-2019) and Rice lakes (2018) with the expectation that a recent Yellow Bass population would emerge, however none were detected during these surveys and a winterkill during 2019-2020 at Ingham Lake likely further limited Yellow Bass expansion (Appendix 10; Appendix 11). Pleasant Lake was also identified as a natural lake with a recent Yellow Bass infestation and comprehensive fisheries surveys occurred at Pleasant Lake each year between 2018-2020 (Appendix 10; Appendix 11; Appendix 12; Appendix 13). However, fisheries data mining conducted as part of this project found no prior fishery survey data for Pleasant Lake. Consequently, comparisons of pre and post Yellow Bass infestation were not conducted at these three lakes. Rather, fishery comparisons were limited to two lakes identified as having an existing Yellow Bass population (Lost Island Lake and Lake Cornelia) and three lakes with an emerging Yellow Bass population (Center Lake, Five Island Lake, and Silver Lake). At Center Lake, six fyke net surveys totaling 53 fyke net nights were conducted between 1999-2008 (pre-Yellow Bass) and four fyke net surveys (N = 24 net nights) were conducted from 2017-2020 (post-Yellow Bass). Six fyke net surveys (N = 77 net nights) were conducted at Five Island Lake from 1999-2012 (pre-Yellow Bass) and three surveys from 2017-2020 were completed (post-Yellow Bass; N = 38 net nights). At Silver Lake, eight fyke net surveys were conducted from 1996-2011 totaling 122 net nights (pre) compared to four surveys conducted from 2014-2020 (post; N = 41 net nights). A total of fourteen (7 pre and 7 post) fyke net surveys were conducted at Lost Island (N = 59 net nights from 1995-2005; N = 90 net nights from 2008-2020). At Lake Cornelia, five spring fyke net surveys were conducted pre-Yellow Bass infestation (1997-2005; N = 28 net nights) and twelve spring surveys were conducted after Yellow Bass were detected (2006-2020; N = 75 net nights). In addition to fyke netting, spring electrofishing occurred six times pre-Yellow Bass (3.97 hr of on-time) and fifteen times post-Yellow Bass infestation (13.02 hr of on-time).

Few significant differences in fishery statistics among pre and post-Yellow Bass infestation were observed at Center Lake (Figure 11). Mean catch per fyke net effort decreased significantly for one of the eight species evaluated (Black Bullhead) and mean total length significantly increased in two species post Yellow Bass infestation (Black Bullhead and Black Crappie). No statistical comparisons were conducted for Wr due to insufficient fish weight data pre-Yellow Bass infestation. Although differences were observed in mean TLs, no significant differences were detected via PSD comparison pre and post-Yellow Bass infestation.

Common Carp was the only fish species (of eight examined) that had significant declines in catch per fyke net effort at Five Island Lake, pre and post-Yellow Bass infestation (Figure 12). No other significant trends were observed in CPE even though Bluegill increased nearly 8-fold. Mean TLs significantly increased for Black Crappie and Walleye after Yellow Bass were documented within Five Island Lake; whereas Bluegill and Channel Catfish experienced significant declines in TL. Relative weight significantly declined for Black Crappie and Bluegill, but no differences were detected in mean PSD for any species pre and post-Yellow Bass infestation.

Extreme variation in fyke net CPE was observed for Black Crappie and Freshwater Drum post-Yellow Bass infestation at Silver Lake, thus no significant differences were detected (Figure 13). Channel Catfish, however, observed significant declines in fyke net CPE post-Yellow Bass infestation. No consistent trends in mean TL comparisons were observed among the ten species evaluated via fyke net data, even though four of the species observed either significant increases (Black Bullhead, Black Crappie) or decreases in mean TL (Whit Bass, Yellow Perch). For most species, comparisons of Wr were not possible due to lack of fish weight data pre-Yellow Bass infestation, but of the four species where sufficient sample sizes were available, only Bluegill had significant increases in Wr post-Yellow Bass infestation. Either insufficient data or no difference in PSD was observed between pre and post-Yellow Bass survey data.

At Lost Island Lake, significant decreases in Black Bullhead and Common Carp were observed among pre and post-Yellow Bass infestation fyke net surveys. In addition to those decreases, a significant increase was detected in Bluegill CPE, whereas other species CPE remained similar (Figure 14). All of the eight fish species except Bluegill and Common Carp had higher mean TLs post-Yellow Bass infestation, and significant increases were observed for Black Bullhead, Black Crappie, Channel Catfish and Yellow Bullhead. Likewise, Wr for the five species with sufficient pre and post data either was similar (Black Crappie), increased (Walleye and Yellow Bullhead), or significantly increased (Black Bullhead and Channel Catfish). Proportional stock density significantly increased for Black Bullhead and was either not statistically different or lacked sufficient data for other fish species.

For electrofishing and fyke netting surveys conducted at Lake Cornelia, significant differences were detected for three of the six species via electrofishing, but no difference detected via fyke netting surveys pre and post-Yellow Bass infestation (Figure 15). Bluegill CPH electrofishing increased significantly, whereas, both Largemouth Bass and Yellow Perch had significant declines in CPH pre and post-Yellow Bass infestation. All species except Largemouth Bass had either a significant increase (Black Bullhead and Channel Catfish) or decrease (Black Crappie, Bluegill, and Yellow Perch) in mean TLs pre and post-Yellow Bass infestation. Bluegill also had a significant decrease in mean Wr. Ictalurids species had either an increase (Channel Catfish) or decrease in mean Wr following Yellow Bass invasion. Black Bullhead PSD increased significantly post-Yellow Bass. Other species PSD's were similar or significantly decreased (Black Crappie and Yellow Perch) post-Yellow Bass infestation.

Yellow Perch observed TL at age was extremely variable in both spring and fall samples collected from seven natural lakes from 2017-2020 and observations fell substantially above and below the interquartile ranges for natural lakes in Iowa (Figure 16; Figure 19). No trend in Yellow Bass density and Yellow Perch growth was observed. For example, both lakes classified as having high Yellow Bass populations either experienced poor Yellow Perch growth (Lake Cornelia) or moderate/good growth (Lost Island Lake; Figure 16; Figure 19). Ingham Lake (control) and Rice (control) had Yellow Perch growth rates mostly within the interquartile range as did Yellow Perch in Center Lake (recent) and Five Island Lake (recent). Two lakes had growth rates that were consistently below the interquartile range (Pleasant Lake and Lake Cornelia). In Pleasant Lake, growth was extremely slow for young fish (age 1-4), but once Yellow Perch were large enough to consume a wider variety of prey items (i.e., fish), their growth rates increased to within the interquartile range (Figure 16; Figure 19). Yellow Perch at Silver Lake (recent) had the highest mean TL at age for all age classes except age-2 (Figure 16).

Black Crappie observed TL at age was also variable among study lakes, especially for fall sampled fish (Figure 17; Figure 20). Growth at Ingham Lake (control) was consistently within the interquartile range. Other study lakes had periods of growth above or below the interquartile range. Lakes with abundant Yellow Bass (i.e., Lost Island Lake) had consistently good growth rates for Black Crappie and those with recent infestations (i.e., Center and Silver Lakes) had more variable growth rates at age 1-6 (Figure 17; Figure 20). Black Crappie growth rates at Five Island Lake were substantially below the interquartile range for age 1-5 fish (Figure 17).

Bluegill observed mean TL at age data was collected for five study lakes during both seasons combined (Center Lake, Lake Cornelia, Lost Island Lake, Rice Lake, Five Island Lake and Silver Lake; Figure 18; Figure 21). At Rice Lake (control), Bluegill growth was within or above the interquartile range. Most observations of Bluegill growth for lakes with abundant or recent infestations of Yellow Bass were also within the interquartile range except for older (age 4-5) Bluegill at Lake Cornelia (below; Figure 18) and most Bluegill age classes at Center Lake (below; Figure 21).

In large natural lakes where Yellow Bass were classified as established, normalized values for mean lake depth, mean Chlorophyll a, mean Cladocera density, and mean Yellow Bass density, growth, Wr, and cm followed a similar pattern when compared among all study lakes (Figure 22). At Silver Lake (recent), normalized Yellow Bass density was the lowest among all lakes and resulted in highest growth, highest Wr, and highest Yellow Bass cm. In addition, Silver Lake had the highest Chlorophyll a and Cladocera density among all study lakes. At Five Island Lake (recent), normalized values for Yellow Bass generally followed a similar pattern as other large lakes with established Yellow Bass populations, but physical characteristics of the lake were different. Normalized values of depth, Chlorophyll a, Cladocera density, and Yellow Bass population characteristics in shallow natural lakes were extremely variable for lakes with both established and recent infestations of Yellow Bass (Figure 23). Established Yellow Bass shallow natural lakes such as North Twin Lake and Little Wall Lake had similar physical characteristics and Cladocera densities, yet Yellow Bass population characteristics normalized values were largely different. At Lake Cornelia (established), where Yellow Bass densities were the highest, Yellow Bass growth was poorest and cm was the lowest among all lakes evaluated. Extreme variation among normalized values was also detected for shallow natural lakes with recent infestations of Yellow Bass (i.e., Center and Pleasant lakes).

Discussion

This is the first study that has sought to understand the distribution, population dynamics, and diets of Yellow Bass in natural lakes since studies completed on Clear Lake and North Twin Lake from 1950-1970. Targeted fisheries surveys conducted from 2017-2018 found that new Yellow Bass populations existed in two of the twenty-five sampled natural lakes of unknown Yellow Bass status, and that as many as twenty-one natural lakes in Iowa have established populations of non-native Yellow Bass. Only three natural lakes were known to have existing populations of Yellow Bass prior to the turn of the century. Similar trends in increased distribution of Yellow Bass in natural lakes exist in southern Minnesota (Nate Hodgins, MN DNR, personal communication) and at least one record of Yellow Bass in natural lakes exists in Wisconsin (Nathan Nye, WI DNR, personal communication). The sudden increase in the rate of expansion throughout the glacial lakes region is largely unknown. Many scientists believe that global climate change will alter pathways in which non-native species may enter aquatic systems (Hellmann et al. 2008; Rahel and Olden 2008). For example, increased variability and intensity of rainfall events have modified flow regimes in many areas of the Midwest (Villarini et al. 2013) that may increase connectivity and expansion of non-native species. In several Northwest Iowa natural lakes, the invasion of Asian Carps *(Hypophthalmichthys* spp) was documented during extreme flooding conditions of the Missouri River in 2011 and it cannot be excluded that many of the new introductions of Yellow Bass may have occurred via a similar pathway. However, in Iowa and elsewhere, it is also speculated that many of these unwanted introductions originated via angler distribution (Rahel 2004; Johnson et al. 2009), as Yellow Bass have become a more desirable species to harvest in natural lakes due to their ease of catch and size potential. In addition to the potential increased rate of Yellow Bass introduction, in many natural lakes, Black Bullhead populations have been precipitously declining, presumably due to improved water quality conditions (Meerbeek 2013; Meerbeek and Hawkins 2021). Currently, limited data exist on the potential interactions among Black Bullhead and Yellow Bass in natural lakes, thus overlapping niches (see Kutkuhn 1955 and Welker 1963) may have reduced Yellow Bass invasion success in natural lakes in the past. Regardless of the pathways for introduction, Yellow Bass have become a staple species in many natural lake fish communities and understanding their role is vital to managing these complex ecosystems.

Throughout the course of this study, we found that Yellow Bass detection probability was substantially improved via fall night electrofishing compared to day electrofishing or other passive and active gear types. For example, during our initial survey of Yellow Bass population dynamics at known established Yellow Bass lakes, daytime fall electrofishing for Yellow Bass at East Okoboji Lake (high Yellow Bass density) yielded 207 fish in 3 hr of electrofishing on-time (69 fish/hr). Night electrofishing was conducted subsequently and 167 Yellow Bass were collected in 11 min of electrofishing on-time (910 fish/hr). Likewise, electrofishing transects conducted prior to dusk at Lake Cornelia (high density lake) resulted in few Yellow Bass collected and daytime experimental gillnet sets were necessary to collect adequate samples of diet fish, whereas night electrofishing investigations yielded catch rates exceeding 380 fish/hr. Others have also noted that Yellow Bass are rarely in shallow water during the day (Carlander and Cleary 1949; Helm 1958a), but move to shallow water during crepuscular periods when movement activity is heightened (Sieh 1950; Helm 1958b). Thus, managers interested in surveying lakes for presence/absence of Yellow Bass can focus their effort via fall night electrofishing investigations in lieu of other passive or active gear types. In addition, we found that standard fall night electrofishing surveys conducted at water temperatures ranging from 45 to 58˚F was an adequate technique to monitor Yellow Bass population dynamics and densities. Since Yellow Bass exhibit fluctuations in reproduction success, periodic sampling can provide managers with necessary data to make informed decisions regarding Yellow Bass population characteristics and potential interactions with native fish species and anglers.

To my knowledge, this is the first study that evaluated Yellow Bass population dynamics concurrently in multiple shallow natural lakes for up to three consecutive years. We observed extreme variation in growth, condition, and mortality among, and within natural lakes sampled. Some of the variation in population dynamics among lakes can be explained by Yellow Bass densities, where natural lakes with high populations of Yellow Bass (e.g., Little Wall Lake and Lake Cornelia) had poorer growth, poorer condition, lower rates of mortality, and higher longevity. However, other natural lakes that were also classified as high density also had population dynamics more closely related to balanced populations (e.g., East Okoboji, Clear Lake, and Lost Island Lake). Thus, it appears that the physical characteristics of the lake, such as lake size, lake depth, and habitat complexity, as well as fish community complexity and lake productivity may play a more important role in structuring Yellow Bass population characteristics than Yellow Bass density alone. However, all lakes did exhibit recruitment variability, but recruitment patterns were rather similar amongst lakes. These findings suggest that regional environmental conditions may be influencing Yellow Bass recruitment. Although the reproductive cycle of Yellow Bass has been studied in natural lakes (Atchison 1967; Bulkley 1970a) and elsewhere (Fox 2016), few studies have examined the environmental or biological variables that influence successful recruitment of Yellow Bass. Bulkley (1970b) suggested that adult Yellow Bass prey heavily on their young and may cause fluctuations in year-class strength in Clear Lake, Iowa. However, successful reproduction of Yellow Bass was observed at Lake Cornelia in both 2018 and 2020, at the same time when adult Yellow Bass dominated the fishery. Thus it is likely that Yellow Bass recruitment is more closely related to environmental conditions than Yellow Bass density. Related species, such as White Bass and White Perch, have reproductive cycles that are more closely related to timing and duration of water inflows (DiCenzo and Duval 2002; North and Houde 2003). Although many natural lakes in Iowa do not have significant sources of inflow tributaries, other intrinsic factors such as high water, wind conditions, or available forage may facilitate improved survival of Yellow Bass eggs/larvae. Since successful year-classes of Yellow Bass can dominate a fishery for up to 10 years, more information regarding the individual factors influencing recruitment is necessary to understand future impacts of Yellow Bass on native fish communities in natural lakes.

We evaluated the diets of 1,340 Yellow Bass collected from eight natural lakes in Iowa and found that Yellow Bass consume mostly either benthic invertebrates and/or zooplankton throughout the open water season. Other studies conducted at Clear Lake and North Twin Lake from 1952-1968 found similar diet composition of juvenile and adult Yellow Bass collected from June to August (Kutkuhn 1955; Collier 1959; Buchholz 1960; Kraus 1963; Welker 1963). For most lakes, the breadth of food items consumed during this study did not differ substantially among bimonthly intervals and between 5-13 of the 16 food taxa groups were observed during each bimonthly sample. Breadth of food items was substantially lower at Lake Cornelia during spring (April-May) and fish almost exclusively consumed Cladocera. At Pleasant Lake, breadth of food items was also low during spring and Yellow Bass consumed mostly fish. Other fish species sampled during the spring at these two lakes also had similar diet composition, suggesting that food resources during the ice-out to spring transitional period may be limited in some natural lakes in Iowa and could promote piscivory. Increased rates of piscivory via non-native fish introductions could hinder recruitment and management of more desirable native species and are a major concern regarding the spread of non-indigenous species (Madenjian et al. 2000). However, piscivory was rarely observed at Lake Cornelia, but common during all open water periods at Pleasant Lake. This was likely a result of Yellow Bass gape limitations and prey availability as fish collected from Pleasant Lake throughout the open water period were significantly larger than what was sampled from Lake Cornelia. In other lakes sampled, Yellow Bass never consumed fish during April-May regardless of fish TL, but occasionally did consume age-0 fish from June-November as these became a more readily available food item. Cumulatively, 158 of the Yellow Bass stomachs examined contained fish (11.8%; mean TL of 230 mm; range of 129-318 mm); 63 of these observations were from Pleasant Lake and 42 were from Center Lake. Piscivory at other lakes was much less frequent. Other studies have documented variability in percent frequency of occurrence of fish in Yellow Bass diet among lakes. For example, 70% of adult Yellow Bass at North Twin had fish in their diet during summer (Kutkuhn 1955); whereas 0-5% of adult Yellow Bass at Clear Lake consumed fish (Collier 1959; Buchholz 1960; Kraus 1963; Welker 1963). Although this study did document periods of high Yellow Bass piscivory, Yellow Bass in Iowa's natural lakes generally consume zooplankton and benthic invertebrates throughout the open water period and their tendency to switch to piscivory appears to be related more to food availability and fish size rather than food preference. Similar results have been documented for Yellow Bass in natural lakes (Bulkley 1970b) and impoundments (Zervas 2010; Snow and Porta 2020), thus providing limited evidence that Yellow Bass may impact native populations via piscivory.

Besides predation of age-0 and yearling native fishes, Yellow Bass may negatively impact fish populations via egg predation. Driscoll and Miranda (1999) found that fish eggs made up the largest proportion of Yellow Bass diet by number and weight and occurred in 32% of fish that were collected from a Mississippi River oxbow. Egg predation has been found to be effective for limiting the abundance of some species. For example, Bajer et al. (2012) found that Bluegills may exert extremely high predatory pressure on Common Carp eggs and suppress year-class formation. However, it is unclear if Yellow Bass egg predation is substantial enough to suppress recruitment of native species. In more recent diet studies, the percent by number and frequency of eggs found within Yellow Bass diets have been generally inconsequential (0-2.5%; Stein 2001; Zervas 2010; Snow and Porta 2020). However, Fose (2013) detected fish eggs in 20.5% of Yellow Bass stomachs collected from April to June at a Kentucky impoundment and suggested that

Yellow Bass were directly impacting White Bass reproductive success. Similar hypotheses have been made regarding early life history competition among species of the same genus (Madenjian et al. 2000). In this study, only five of the 539 (<1%) Yellow Bass collected in May or June were found to contain fish eggs within their stomachs (mean of 224 eggs; range of 14-593 eggs) and all five were captured from the same lake, on two separate dates (May 17, 2018; May 26, 2020). Our findings suggest that egg predation via Yellow Bass in natural lakes in Iowa is not substantial and that suppression of native fish recruitment by Yellow Bass may be more influenced via direct competition of food and habitat resources than predation.

Interspecific competition of food resources is a key consideration for the potential of non-native species to displace native species. Dietary overlap is a common tool used by fisheries managers to detect if intense food resource competition exists. In my review, only a few studies have evaluated Yellow Bass dietary overlap with conspecifics and overlap was negligible (Driscoll and Miranda 1999) except for closely related species (Stein 2001; Montgomery 2015). To my knowledge, this is the only study that has evaluated dietary overlap in multiple systems, during multiple seasons, and among multiple species. Here, we reported 77 overlap comparison among Yellow Bass and five native fish species commonly found in Iowa's natural lakes and significant overlap was detected only 27 times (35%; 17 of 53 Yellow Perch comparisons; 4 of 6 White Bass comparisons; 3 of 9 Black Crappie comparisons; 3 of 8 Bluegill comparisons; 0 of 1 Walleye comparisons). Overlap was more common in lakes where food item breadth was limited (Pleasant Lake and Lake Cornelia; 9 of 27) or where both Yellow Bass and White Bass cohabitated (Silver Lake; 4 of 27). Other instances of high overlap among species within a lake, among seasons, or among years was inconsistent. For example, high overlap between Yellow Bass and Yellow Perch was observed at Lost Island Lake in June-July and October-November 2020, but was 0.17 and 0.38 in April-May and August-September, respectively. No significant overlap was observed with these two species at Lost Island Lake in 2018, and only the August-September period was considered to have significant overlap in 2019. The inability to detect consistent patterns of dietary overlap suggests that Yellow Bass can periodically compete against native fishes for food resources, but food selectively is variable and rarely is any one species competitively targeted. However, we did document considerable overlap between Yellow Bass and young (age 1-2) White Bass, which may need be a focus of future studies.

Introductions of Yellow Bass have been speculated to be detrimental to other game fishes and cause declines in a lake's recreational fishery (Bernstein and Olson 2001; Stein 2001), yet few have evaluated short and long-term changes in fish communities pre and post introduction. Our initial attempts to document a natural lake with a recent Yellow Bass introduction and sample the fish community to detect short-term changes in sport fish population dynamics was largely unsuccessful. At both Rice Lake and Ingham Lake, Yellow Bass expansions were expected, but a winterkill presumably eliminated Yellow Bass at Ingham Lake and an expansion never occurred at Rice Lake. Thus, we used long-term fisheries datasets to compare fall/spring fyke net and spring electrofishing catches at established and recently infested Yellow Bass lakes in attempt to determine the impact of Yellow Bass on the fish community. Although this was an acceptable approach, some comparisons (e.g., spring electrofishing) could not be included due to insufficient sample sizes or inability to sample multiple species during the investigation. Therefore, comparisons were limited to fall fyke net datasets for most lakes. However, these survey's typically target Crappie spp., Bluegill, Green Sunfish, Redear Sunfish, Common Carp, and Walleye (Schultz 2009), thus potentially underestimating the prevalence of other important fish species. Hence, comparisons for this study were carefully reviewed before inclusion, yet it was often impractical to conduct analyses due to insufficient sample sizes. Nevertheless, few significant differences among fisheries statistics between pre and post Yellow Bass introduction were observed and no consistent pattern of species prevalence or demise due solely to Yellow Bass was detected at lakes identified as either established or recently established Yellow Bass lakes. Reduced densities of Black Bullhead populations have been documented previously (Meerbeek 2013; Meerbeek and Hawkins 2021) and in this study, but all of these populations were decreasing prior to the introduction of Yellow Bass. However, it cannot be excluded that the large decreases in Black Bullhead populations facilitated the expansions of Yellow Bass in many natural lakes. Voids in fish biomass are often quickly filled (e.g., winterkill or fish renovations) and expansion of native and non-native invasive species can be accelerated when natural declines in native populations occurs. However, it is also possible that those observations are circumstantial, as Yellow Bass and Black Bullhead populations at both Clear Lake and North Twin Lake have existed concurrently at high densities in the past (Collier 1959; Grummer and Dekoster 2017). Thus, it is relatively unknown if Yellow Bass introductions in natural lakes thrive by: occupying a void left by Black Bullhead, moderately displacing one or more native species, or a combination of the two are occurring.

Although beyond the scope of the project, the results of this study were not conclusive enough to develop predictive equations that could model the fishery impacts from Yellow Bass introductions within natural lakes of glacial origin. Our attempts to normalize biotic and abiotic values to summarize patterns in large and small natural lakes was useful to view trends in lakes with differing Yellow Bass population characteristics. For example, large, deeper natural lakes with established Yellow Bass populations had similar trends in Yellow Bass population characteristics (moderate density, moderate growth, moderate/good condition; moderate mortality rates) when compared to other deep and shallow natural lake systems. Larger, shallower natural lakes that had recent populations of Yellow Bass detected had more variable biotic and Yellow Bass population patterns. However, this trend was not observed for smaller natural lakes, regardless of mean depth, as both biotic and abiotic patterns were extremely variable. Thus, it is realized that Yellow Bass introductions into natural lakes may undertake many forms and short and long-term impacts may not be well understood. In Iowa, we have observed a few scenarios that may happen after Yellow Bass introductions: (1) an extremely large year-class develops and persists up to 10 years, dominates the fishery resulting in poor growth and competition with other species (Cornelia, Little Wall Lake, North/South Twin lakes); (2) populations increase rapidly, then subside to a more moderate density, growth rates of Yellow Bass and other species remain good (Okoboji's, Clear Lake, Five Island, Lost Island); (3) large recruitment events are absent, resulting in low initial densities, Yellow Bass exhibit extremely high growth rates (Silver Lake, Dickinson Co.); (4) large recruitment events are absent, growth rates of fish are extremely variable (some fish grow to 12 in by age-5, where others are 6 in at age-5; Pleasant Lake); and (5) Yellow Bass detected, but recruitment events are absent (Spirit, Ingham, and Rice lakes).

This study was Iowa's first attempt at understanding the distribution and short/long-term impacts of non-native Yellow Bass expansion to natural lakes. During the course of this study, new Yellow Bass populations were detected via fisheries surveys conducted as part of federal aid project independent of Project 7052 (i.e., Storm Lake) and even more infestations have been detected in Minnesota's southern natural lakes region (Nate Hodgins, MN DNR, personal communication). It is anticipated that Yellow Bass expansion will continue as both their popularity as a sport-fish increases and pathways for introduction improve (e.g., via global climate change). This study provided a valuable framework on Yellow Bass diet composition and dietary overlap with native conspecifics, as well as provided valuable information on the erratic nature of fishery trends post-establishment of a Yellow Bass population in natural lakes. Although it was not possible to detect significant changes in fishery characteristics post-establishment of Yellow Bass within natural lakes, this study did find that Yellow Bass generally do not have significant negative effects in natural lakes that have a diverse fishery and are deeper (>15 ft). However, since many natural lakes in Iowa and southern Minnesota are shallow and lack fish diversity, the impacts of Yellow Bass expansion could take many forms (as describe above). Thus, it is important that fisheries managers routinely evaluate the expansion of Yellow Bass via fisheries surveys (fall night electrofishing) and continue education programs that inform anglers on the negative consequences Yellow Bass may have on natural lakes. Managers may also consider the use of fish toxicants, such as rotenone, to reduce or eliminate Yellow Bass in natural lakes where they have caused significant fishery impacts. For example, the Yellow Bass population at Lake Cornelia was estimated to be 390 lb/ac and a low-dose rotenone treatment has been scheduled for fall 2022 in attempt to significantly reduce the population. Others have used top-level predators control Yellow Bass densities, yet these results are largely inconclusive (Sobotka 2005; Wamboldt et al. 2020). However, a more comprehensive approach, as being experimented with at Lake Cornelia (see Research Project 7070), may be more appropriate in lakes where fishery characteristics are not conducive to create a balanced fishery once Yellow Bass become established. Regardless of management action taken, managers need to document Yellow Bass introductions, communicate the potential effects of Yellow Bass introductions, and investigate innovative techniques that may slow the spread of Yellow Bass in natural lakes.

Acknowledgements

This study was funded through the Federal Aid in Sport Fish Restoration Program. I thank Iowa DNR staff at the Spirit Lake Fish Hatchery for assisting with project sampling and for the use of historic field sampling data. DJ Vogeler, D Foley and V Wassink conducted a majority of the fish sampling, fish processing, and diet analysis used for this project. I thank G Griffin for volunteering for both field and laboratory work. Iowa Lakeside Laboratory provided employment of seasonal technicians that allowed diet analysis to be completed. This manuscript was improved with comments from George Scholten.

Literature Cited

Anderson, RO. 1976. Management of small warm water impoundments. Fisheries 1:5-7, 26-28.

Atchison, GJ. 1967. Contributions to the life history of the Yellow Bass, *Roccus mississippiensis* (Jordan and Eigenmann). Clear Lake, Iowa. MS thesis. Iowa State University, Ames.

Bailey, RM and HM Harrison Jr. 1945. The fishes of Clear Lake, Iowa. Iowa State College Journal of Science 20:57-77.

Bajer, PG, CJ Chizinski, JJ Silbernagel, and PW Sorensen. 2012. Variation in native micro-predator abundance explains recruitment of a mobile invasive fish, the Common Carp, in a naturally unstable environment. Biological Invasions 14:1919-1929.

Bernstein, NP and JR Olson. 2001. Ecological problems with Iowa's invasive and introduced fishes. Journal of the Iowa Academy of Science 108:185-209.

Buchholz, MM. 1960. Ecological relationships associated with decreasing growth rate of Clear Lake Yellow Bass. PhD Dissertation. Iowa State University, Ames.

Bulkley, RV. 1969a. A furunculosis epizootic in Clear Lake Yellow Bass. Bulletin of the Wildlife Disease Association, 5:322-327.

Bulkley, RV. 1969b. The reproductive cycle of Yellow Bass, *Morone mississippiensis*, in Clear Lake, Iowa. PhD Dissertation. Iowa State University, Ames.

Bulkley, RV. 1970a. Changes in Yellow Bass reproduction associated with environmental conditions. Iowa State Journal of Science 45:137-180.

Bulkley, RV. 1970b. Feeding interaction between adult bass and their offspring. Transactions of the American Fisheries Society 99:732-738.

Carlander, KD and RE Cleary. 1949. The daily activity patterns of some freshwater fishes. American Midland Naturalist 41:447-452

Carlander, KD, WM Lewis, CE Ruhr, and RE Cleary. 1953. Abundance, Growth, and Condition of Yellow Bass, *Morone Interrupta Gill*, in Clear Lake, Iowa, 1941 to 1951. Transactions of the American Fisheries Society 82:91-103.

Collier, JE. 1959. Changes in fish populations and food habits of Yellow Bass in North Twin Lake, 1956-1958. Proceedings of the Iowa Academy of Science 66:518-522.

DiCenzo, VJ and MC Duval. 2002. Importance of reservoir inflow in determining White Bass year-class strength in three Virginia reservoirs. North American Journal of Fisheries Management 22:620-626.

Driscoll, MP, and LE Miranda. 1999. Diet ecology of Yellow Bass (*Morone mississippiensis*) in an oxbow of the Mississippi River. Journal of Freshwater Ecology 14:477-486.

Flammang, M and G Sobotka. 2014. Use of low-concentration rotenone for biomanipulation of Iowa lakes. Iowa Department of Natural Resources, Fisheries Management Section 2014 Completion Report, Des Moines, Iowa.

Fose, JF. 2013. Interference in White Bass reproduction by two introduced predators in Barren River Lake, Kentucky. MS Thesis, Western Kentucky University.

Fox, CN, AM Ferrara, A Fischer, and QC Fontenot. 2016. Seasonal abundance, age structure, GSI, and gonad histology of Yellow Bass in the Upper Barataria Estuary, Louisiana. Journal of the Southeastern Association of Fish and Wildlife Agencies 3:71-79.

Fries, LT and WD Harvey. 1989. Notes: Natural Hybridization of White Bass with Yellow Bass in Texas. Transactions of the American Fisheries Society 118:87-89.

Grummer, S and T Dekoster. 2018. Clear Lake creel survey, 2017. Iowa Department of Natural Resources. Des Moines, Iowa.

Helm, WT. 1958a. Yellow bass, *Roccus mississippiensis* (Jordan and Eigenmann). Material for Handbook of Biological Data, 6 pp.

Helm, WT, 1958b. Notes on the ecology of panfish in Lake Wingra with special reference to the Yellow Bass. PhD. Thesis, University of Wisconsin, Madison

Helm, WT. 1964. Yellow Bass in Wisconsin. Transactions of the Wisconsin Academy of Science 53:109-125.

Hellmann, JJ, JE Byers, BG Bierwagon and JS Dukes. 2008. Five potential consequences of climate change for invasive species. Conservation Biology 22:534-543.

Hudson, J and C Larson. 2002. Impacts of Yellow Bass on a small impoundment fishery. Iowa Department of Natural Resources, Fisheries Management Section 2002 Completion Report, Des Moines, Iowa.

Hurlbert, SH. 1978. The measurement of niche overlap and some relatives. Ecology 59:67-77.

Isermann, DA and CT Knight. 2005. A computer program for age-length keys incorporating age assignment to individual fish. North American Journal of Fisheries Management 25:1153-1160.

Johnson, BM, R Arlinghaus, and PJ Martinez. 2009. Are we doing all we can to stem the tide of illegal fish stocking. Fisheries 34:389-394.

Kraus, R. 1963. Food habits of the Yellow Bass, *Roccus mississippiensis*, Clear Lake, Iowa, summer 1962. Iowa Academy of Science, 70:209-215.

Kritzer, JP, CR Davies, and BD Mapstone. 2001. Characterizing fish populations: effects of sample size an population structure on the precision of demographic parameter estimates. Canadian Journal of Fisheries and Aquatic Science 58:1557-1568.

Kutkuhn, JH. 1955. Food and feeding habits of some fishes in a dredge Iowa lake. Iowa Academy of Science 62:576-588.

Madenjian, CP, RL Knight, MT Bur, and JL Forney. 2000. Reduction in recruitment of White Bass in Lake Erie after invasion of White Perch. Transactions of the American Fisheries Society 129:1340-1353.

McWilliams, RH. 1987. Natural winterkill lakes. Iowa Department of Natural Resources Fisheries Bureau, Federal Aid Completion Report No. F-95-R, Des Moines, Iowa.

Meerbeek, JR. 2013. Population densities, biomass, and age-growth of Common Carp and Black Bullheads in Clear Lake and Ventura Marsh. Iowa Department of Natural Resources. Federal Aid in Sport Fish Restoration, Project F-160-R, Completion Report, Des Moines.

Meerbeek, JR and K Hawkins. 2012. Lost Island Creel Survey, 2012 Summer Angling Season. Project Completion Report, Spirit Lake, Iowa.

Meerbeek, JR and MJ Hawkins. 2021. The Lost Island Lake renovation project - design, implementation, and adaptive management. Iowa Department of Natural Resources. Special Publication 21-02, Des Moines.

Montgomery, ML. 2015. Dietary overlap of native White Bass and introduced Yellow Bass in Barren River. Honors College Capstone Experience Thesis Project, Western Kentucky University, Bowling Green.

Moyle, PB, HW Li, and BA Barton. 1986. The Frankenstein effect: impact of introduced fishes on native fishes in North America. Pages 415-426 in RH Stroud, editor. Fish culture in fisheries management. American Fisheries Society, Bethesda, Maryland

Murphy, BR, DW Willis, and TA Springer. 1991. The relative weight index in fisheries management: status and need. Fisheries 16:30-38.

Neumann, RM, CS Guy, and DW Willis. 2012. Length, weight, and associated indices. Pages 637-676 in AV Zale, DL Parrish, and TM Sutton, editors. Fisheries techniques, 3rd edition. American Fisheries Society, Bethesda, Maryland.

North, EW and ED Houde. 2003. Linking ETM physics, zooplankton prey, and fish early-life histories to Striped Bass *Morone saxatilis* and White Perch *M. americana* recruitment. Marine Ecology Progress Series 260:219-236.

Page, LM, and BM Burr. 1991. A field guide to freshwater fishes of North America north of Mexico. The Peterson Field Guide Series, volume 42. Houghton Mifflin, Boston.

Rahel, FJ. 2004. Unauthorized fish introductions: Fisheries management of the people, for the people, or by the people? American Fisheries Society Symposium 44:431-443.

Rahel, FJ and JD Olden. 2008. Assessing the effects of climate change on aquatic invasive species. Conservation Biology 22:521-533.

Ridenhour, RL. 1960. Abundance, growth and food of young game fish in Clear Lake, Iowa, 1949 to 1957. Iowa State College Journal of Science, 35:1-23.

Rose, ET. 1951. The 1951 Iowa lakes creel census. Iowa State Conservation Commission, Quarterly Biological Report. Vol 3, No. 2, pp. 8.

Schoener, TW. 1970. Non-synchronous spatial overlap of lizards in patchy habitats. Ecology 51:408-418.

Schultz, RD, editor. 2009. Standard gear and techniques for fisheries surveys in Iowa. Iowa Department of Natural Resources, Job Completion Report, Des Moines.

Sieh, JG, 1950. Activity patterns of some Clear Lake, Iowa fishes. Proc. Iowa Acad. Sci. 57:511-518

Slipke, JW, and MJ Maceina. 2014. Fisheries analysis and modeling simulator (FAMS), version 1.64. American Fisheries Society, Bethesda, Maryland.

Snow, RA and MJ Porta. 2020. Population dynamics and diets of Yellow Bass in New Spiro Reservoir, Oklahoma. Proceedings of the Oklahoma Academy of Science 100:54-61.

Sobotka, GL. 2005. Evaluation of Walleye and Largemouth Bass in controlling Yellow Bass at Twelve Mile Lake. Iowa Department of Natural Resources, Fisheries Management Section 2005 Completion Report, Des Moines, Iowa.

Soupir, CA, BB Blackwell, and ML Brown. 1997. Relative precision among calcified structures for White Bass age and growth assessment. Journal of Freshwater Ecology 12:531-538.

Stein, JE. 2001. Biology of nonindigenous White Perch and Yellow Bass in an oxbow of the Missouri River. MS Thesis. Emporia State University, Emporia, Kansas.

Van Den Avyle, MJ, and RS Hayward. 1999. Dynamics of exploited fish populations. Pages 127-166. in CC Kohler and WA Hubert, editors. Inland fisheries management in North America, second edition. American Fisheries Society, Bethesda, Maryland.

Villarini, G, JA Smith and GA Vecchi. 2013. Changing frequency of heavy rainfall over the Central United States. Journal of Climate 26:351-357.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Human Biology 19:181-213.

Wallace, RK, and JS Ramsey. 1983. Reliability in measuring diet overlap. Canadian Journal of Fisheries and Aquatic Sciences 40:347-351.

Wamboldt, JJ, AD Wanamaker, HM Carroll, RD Schultz, and JE Morris. 2020. Trophic dynamics of a reservoir fishery following an introduction of a top predator: insights from stable carbon and nitrogen isotopes. Fisheries Management and Ecology 00:1-9.

Wege, GJ, and RO Anderson. 1978. Relative weight (Wr): a new index of condition for largemouth bass. Pages 79-91 in GD Novinger and JG Dillard, editors. New approaches to the management of small impoundments. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.

Welker, BD. 1963. Summer food habits of Yellow Bass and Black Bullhead in Clear Lake. Iowa Academy of Science 69:286-295.

Wright, TD. 1968. Changes in Abundance of Yellow Bass (*Morone mississippiensis*) and White Bass (*M. chrysops*) in Madison, Wisconsin, Lakes. Copeia 1:183-185.

Zervas, PG. 2010. Age, reproduction, growth, condition and diet of the introduced Yellow Bass, Morone mississippiensis, in Barren River Lake, Kentucky. Master’s Thesis, Western Kentucky University, Bowling Green.

Table 1. Physical and chemical properties of 42 natural lakes in Iowa. ft = feet; SDI = shoreline development index; WS:Area = watershed to area ratio; CHL-a = Chlorophyll-a (µg/L); TDS = total dissolved solids (mg/L); KN = total Kjeldahl nitrogen (mg/L); TP = total phosphorous (mg/L); TSS = total suspended solids (mg/L); TURB = turbidity (NTU).

Lake	County	Acres	Maximum Depth (ft)	Mean Depth (ft)	SDI	WS:Area	CHL-a	TDS	KN	TP	TSS	TURB
Pickeral*	Buena Vista	170			1.2		82	426	2.8	300	62	42
Storm	Buena Vista	3,097	20.4	8.2	1.7	4.7	16	305	0.8	88	30	46
North Twin	Calhoun	453	12.0	8.7	1.9	4.6	49	300	1.8	80	24	27
South Twin*	Calhoun	600					36	335	3.0	167	63	41
Clear	Cerro Gordo	3,684	19.2	9.6	1.6	2.6	31		1.6	73	19	
Elk	Clay	263	6.3	3.8	1.3		70	241	3.6	250	95	91
Trumbull	Clay	1,183	5.0	2.9	1.9	40.0	90	320	1.8	201	70	144
Center	Dickinson	220	17.9	12.2	1.7	2.2	60	365	2.1	93	11	27
Diamond*	Dickinson	143	7.0			27.8	219	285	2.6	180	33	28
East Okoboji	Dickinson	1,835	22.0	10.0	2.8	6.4	41	287	1.3	82	10	17
Little Spirit	Dickinson	604	10.0	6.0	2.9	2.4	75	286	2.2	205	21	61
Little Swan	Dickinson	371	14.0	5.6	1.8	6.1		300	2.2	262	93	58
Lower Gar	Dickinson	251	8.1	4.1	1.8	40.0	53	283	1.4	90	21	23
Minnewashta	Dickinson	118	16.5	10.2	1.4	2.4	37	284	1.3	97	11	17
Pleasant*	Dickinson	77					25	701	2.4	132	36	22
Prairie*	Dickinson	100					36	672	1.8	99	26	12
Silver	Dickinson	1,041	10.6	7.4	1.8	14.2	72	362	1.7	160	20	34
Spirit	Dickinson	5,684	24.0	17.0	1.6	3.2	24	270	1.1	45	8	15
Upper Gar	Dickinson	36	5.0	3.3	1.5	5.7	34	281	1.3	85	13	13
West Okoboji	Dickinson	3,847	136.0	38.0	2.3	3.9	5	289	0.7	24	4	4
High	Emmet	467	7.5	3.2	2.2		61	374	3.0	190	44	30
Ingham	Emmet	357	12.0	6.0	1.6	2.6	105	264	3.3	148	40	44
Iowa	Emmet	802	9.4	4.0		1.7	101	196	3.7	142	37	141
Tuttle	Emmet	2,268	6.0	4.0	1.8	54.1	80	336	2.4	199	50	103
West Swan	Emmet	379					55	334	3.3	170	43	27
Little Wall	Hamilton	249	13.9	7.2	1.4	0.8	46	300	3.9	107	41	34
Crystal	Hancock	264	18.4	7.5	1.3	7.5	80	209	2.2	236	28	53
West Twin	Hancock	93	6.0	4.0			118	390	3.8	241	79	80
Burt*	Kossuth	200										
Iowa*	Osceola	116										
Five Island	Palo Alto	973	24.9	5.6	3.6	8.0	45	267	1.8	100	25	34
Lost Island	Palo Alto	1,162	15.7	11.3	1.5	4.0	25	256	1.3	74	18	25
Silver	Palo Alto	648	7.2	4.5	1.6	12.8	79	256	1.9	196	43	75
Virgin	Palo Alto	222	6.7	4.3	2.3		99	309	3.7	373	157	64
Little Clear*	Pocahontas	187						258	2.6	132	21	4
Lizard	Pocahontas	275	6.1	3.7	1.4		119	434	2.8	233	70	78
Black Hawk	Sac	745	15.1	6.0	2.0	14.3	49	297	1.8	200	27	57
Rice	Winnebago	1,000	10.0	4.4	3.9		100	270	2.7	312	46	44
Silver	Worth	343	7.3	4.8	1.5	5.5	71	331	2.3	173	36	50
Cornelia	Wright	245	20.6	9.5	1.1	2.0	24	227	1.6	66	21	19
Elm*	Wright	458					16	251	3.4	294	79	67
Morse*	Wright	90					84	238	2.8	201	39	82

*maximum depth < 8 ft; mean depth < 5 ft

Table 2. Fish population survey's conducted in 2017 and 2018 to determine distribution of Yellow Bass in Iowa's shallow natural lakes. Exp GN = experimental gillnet; EF = electrofishing survey; Comp Survey = comprehensive survey.

Lake	Survey 1			Survey 2			Yellow Bass Status
	Date	Gear	Effort	Date	Gear	Effort	
Pickeral	5/2/2017	Exp GN/Fyke	2-5 net nights	4/12/2018	Day EF	52 min	None Detected
Storm	Multiple	General Survey*		10/17/2017	Night EF	90 min	None Detected***
North Twin	9/14/2017	Day EF	120 min				Established
South Twin	No Targeted Sample - Connected to North Twin						Established
Clear	10/13/2017	Day EF	118 min				Established
Elk	6/7/2017	Day EF	110 min	9/28/2017	Day EF	82 min	None Detected
Trumbull	4/20/2017	Fyke Net	13 net nights	9/6/2017	Day EF	120 min	None Detected
Center	Multiple	General Survey*		Multiple	Day EF/Angling	188 min	Recent
Diamond	3/28/2017	Fyke Net	13 net nights	Scheduled for Lake Renovation			None Detected
East Okoboji	10/3/2017	Day EF	180 min	10/25/2017	Night EF	11 min	Established
Little Spirit	8/14/2017	Day EF	120 min	9/11/2017	Day EF	120 min	None Detected
Little Swan	No Targeted Sample - Scheduled for Renovation						
Lower Gar	No Targeted Sample - Connected to East Okoboji						Established
Minnewashta	No Targeted Sample - Connected to East Okoboji						Established
Pleasant	5/12/2017	Day EF	103 min	9/12/2017	Day EF	80 min	Recent
Prairie	5/3/2017	Day EF	75 min	10/17/2017	Day EF	120 min	None Detected
Silver	Multiple	Day EF	90 min	Multiple	Day EF	141 min	Recent
Spirit	Multiple	152.4 m Seine	8 hauls	10/18/2017	Night EF	120 min	Recent**
Upper Gar	No Targeted Sample - Connected to East Okoboji						Established
West Okoboji	No Targeted Sample - Connected to East Okoboji						Established
High	6/7/2017	Day EF	120 min	9/19/2017	Day EF	120 min	None Detected
Ingham	6/8/2017	Day EF	120 min	9/19/2017	Day EF	120 min	Recent**
Iowa	8/10/2017	Day EF	120 min	Multiple	Comp Survey*		None Detected
Tuttle	8/8/2017	Day EF	120 min	Multiple	Comp Survey*		None Detected****
West Swan	6/8/2017	Day EF	120 min	9/29/2017	Day EF	120 min	None Detected
Little Wall	9/26/2017	Day EF	80 min				Established
Crystal	8/15/2017	Day EF	72 min	9/27/2017	Day EF	74 min	None Detected
West Twin	8/15/2017	Day EF	54 min	9/27/2017	Day EF	54 min	None Detected
Burt	No Sample due to vegetation density			5/2/2018	Day EF	60 min	None Detected
Iowa	5/4/2017	Day EF	120 min	9/13/2017	Day EF	120 min	None Detected
Five Island	Multiple	General Survey*		Multiple	Day EF	95 min	Established
Lost Island	9/22/2017	Day EF	122 min				Established
Silver	5/12/2017	Day EF	75 min	9/28/2017	Day EF	120 min	None Detected
Virgin	No Sample due to vegetation density			4/23/2018	Day EF	80 min	None Detected
Little Clear	No Sample due to vegetation density			4/12/2018	Day EF	60 min	None Detected
Lizard	4/24/2017	Exp GN	2 net nights	4/12/2018	Day EF	60 min	None Detected
Black Hawk	Multiple	General Survey*		10/18/2017	Night EF	90 min	None Detected
Rice	Multiple	General Survey*		10/4/2017	Day EF	120 min	None Detected****
Silver	Multiple	Comp Survey*		10/4/2017	Day EF	90 min	None Detected
Elm	8/16/2017	Day EF	120 min	Scheduled for Lake Renovation			Recent
Cornelia	9/26/2017	Day EF	46 min				Established
Morse	Multiple	Day EF	30 min	10/11/2017	Day EF	73 min	None Detected

*Sampled via Iowa or Minnesota (Iowa and Tuttle) DNR staff as part of a standard general or comprehensive survey
**Yellow Bass verified in 2016, none captured in 2017
***Yellow Bass reported by anglers in 2017; subsequent sampling in 2020 verified established Yellow Bass population
****Yellow Bass reported by angler in 2017 or 2018

Table 3. Natural lakes in Iowa where Yellow Bass have been detected, year detected, population status (recent or established), and estimated population density for each sampled lake.

Lake	County	Year Detected	Yellow Bass Status	Population Density
Storm	Buena Vista	2020	Recent	Low
North Twin	Calhoun	Unknown	Established	High
South Twin*	Calhoun		Established	
Clear Lake	Cerro Gordo	1930s	Established	High
Center	Dickinson	2016	Recent	Moderate
East Okoboji	Dickinson	2005	Established	High
Lower Gar*	Dickinson		Established	
Minnewashta*	Dickinson		Established	
Upper Gar*	Dickinson		Established	
West Okoboji*	Dickinson		Established	
Pleasant	Dickinson	2017	Recent	Moderate
Silver	Dickinson	2013	Recent	Moderate
Spirit	Dickinson	2016	Recent	Low
Ingham	Emmet	2016	Recent	Low
Tuttle**	Emmet	2018	Non-verified	Low
Little Wall	Hamilton	Unknown	Established	High
Five Island	Palo Alto	2016	Recent	High
Lost Island	Palo Alto	2008	Established	High
Rice**	Winnebago	2017	Non-verified	Low
Cornelia	Wright	2006	Established	High
Elm	Wright	2017	Recent	Low

*Classified as established via connectivity to infested waterbody

**Yellow Bass reported via anglers

Table 4. Yellow Bass length-weight statistics (n = number; TL = total length [mm]; Max wt [g] = maximum weight) and length-weight relationships estimated from 10 shallow natural lakes in Iowa from 2017-2020 (July-October sampling). An asterisks indicates sampling that occurred only in 2017-2018.

Lake	Sex	n	Length-Weight Statistics			Length-Weight Relationship			
			Range TL	Mean TL	Max wt	Intercept	Slope	P-value	r^2
	All	383	74-275	181	332	-5.6869	3.3655	0.0001	0.9935
Center	Male	147	131-273	203	332	-5.0726	3.1007	0.0001	0.9610
	Female	139	125-275	205	328	-5.3777	3.2313	0.0001	0.9767
	All	155	85-286	211	400	-5.5907	3.3318	0.0001	0.9980
Clear*	Male	63	217-285	244	392	-5.2763	3.2010	0.0001	0.9185
	Female	55	218-286	246	400	-4.7284	2.9704	0.0001	0.9068
	All	754	80-239	165	234	-5.3552	3.2167	0.0001	0.9928
Cornelia	Male	191	99-239	177	234	-5.5409	3.2979	0.0001	0.9839
	Female	240	98-222	176	164	-5.2736	3.1774	0.0001	0.9802
	All	509	88-287	181	360	-5.5341	3.2940	0.0001	0.9953
East Okoboji*	Male	153	136-287	203	360	-5.5373	3.2990	0.0001	0.9946
	Female	137	137-271	202	318	-5.4249	3.2493	0.0001	0.9945
	All	961	77-307	160	413	-5.4429	3.2654	0.0001	0.9960
Five Island	Male	227	91-307	196	413	-5.5803	3.3283	0.0001	0.9920
	Female	215	93-268	194	330	-5.6282	3.3473	0.0001	0.9937
	All	165	96-203	139	89	-4.3578	2.7147	0.0001	0.9315
Little Wall*	Male	14	143-187	164	85				
	Female	15	144-182	161	81				
	All	763	78-306	203	484	-5.6682	3.3689	0.0001	0.9940
Lost Island	Male	182	161-297	227	484	-5.4905	3.2948	0.0001	0.9819
	Female	197	157-306	218	478	-5.4843	3.2921	0.0001	0.9808
	All	219	71-244	161	240	-5.2339	3.1655	0.0001	0.9964
North Twin*	Male	84	144-234	190	210	-5.7396	3.3886	0.0001	0.9840
	Female	79	132-244	184	240	-5.6794	3.3598	0.0001	0.9859
	All	540	68-322	156	620	-5.0109	3.0292	0.0001	0.9789
Pleasant	Male	90	102-296	166	352	-4.9871	3.0237	0.0001	0.9892
	Female	143	105-322	180	620	-5.3928	3.2082	0.0001	0.9842
	All	192	75-317	173	564	-5.5619	3.3260	0.0001	0.9968
Silver	Male	36	96-300	228	478	-5.3169	3.2200	0.0001	0.9972
	Female	54	95-317	226	564	-5.3566	3.2386	0.0001	0.9969

Table 5. Yellow Bass mean total length (TL; mm) at age estimated via sectioned otoliths for age classes 0-10 sampled at eleven shallow natural lakes in Iowa from 2017-2020 (July-October sampling). “All” refers to pooled annual July-October data for each lake. Number of fish is provided in parentheses. Superscript denotes significant difference in pooled mean TL-at-age among lakes. Comparisons limited to sample sizes ≥ 10 fish.

Lake	Year	Age										
		0	1	2	3	4	5	6	7	8	9	10
	2017		195(40)		249(2)							
	2018	98(4)	188(93)	238(10)	268(1)							
Center	2019		181(37)	229(26)	255(4)	275(1)						
	2020	95(277)	183(35)	232(26)	255(26)	265(2)						
	All	95(281)^{bc}	187(205)^{b}	232(62)^{b}	255(33)^{b}	268(3)						
	2017	69(24)			226(2)	226(9)	239(21)	230(1)	251(8)			
Clear	2018	98(125)		222(1)	237(2)	246(1)	243(8)	248(50)		260(15)		
	All	93(149)^{c}		222(1)	231(4)	228(10)^{b}	240(29)^{c}	247(51)^{a}	251(8)	260(15)^{a}		
	2017	92(1)		156(1)		163(146)			193(26)			
	2018	111(150)					180(264)			204(11)		
Cornelia	2019		142(184)		178(7)	182(13)		184(355)			210(15)	
	2020	95(100)	137(2)	164(445)					196(248)			213(8)
	All	104(251)^{a}	142(186)^{e}	164(446)^{f}	178(7)	164(159)^{e}	180(264)^{d}	184(355)^{b}	195(274)	204(11)^{b}	210(15)	213(8)
	2017	89(1)	157(144)	206(124)	221(1)	248(102)	287(1)	285(1)				
East Okoboji	2018	98(76)	151(136)	192(93)	223(5)		255(15)					
	All	98(77)^{b}	154(280)^{d}	200(217)^{e}	223(6)	248(102)^{a}	257(16)^{b}	285(1)				
	2017	93(201)	169(57)	206(26)		260(3)	307(1)					
	2018	103(54)	166(550)	203(73)	223(16)							
Five Island	2019	107(465)	180(3)	214(82)	231(21)	246(4)						
	2020	102(874)	174(333)	225(8)	239(41)	260(6)	256(2)					
	All	103(1594)^{a}	169(943)^{c}	209(189)^{d}	234(78)^{c}	256(13)^{a}	273(3)					
Ingham	2018	110(1)										
	2017		111(2)	121(63)	132(3)	152(52)	160(11)	170(26)	198(5)			
Little Wall	2018	104(173)	147(11)	160(1)	173(17)							
	All	104(173)^{a}	141(13)^{e}	121(64)^{h}	167(20)^{e}	152(52)^{e}	160(11)^{e}	170(26)^{c}	198(5)			
	2017	89(5)	167(6)	196(108)		236(12)						
	2018	108(89)	170(7)	219(65)	241(113)		270(7)					
Lost Island	2019	106(13)	187(127)	228(6)	247(31)	261(25)						
	2020	91(37)	186(100)	237(219)	262(14)	271(25)	277(39)					
	All	103(144)^{a}	185(240)^{b}	223(398)^{c}	244(158)^{c}	260(62)^{a}	276(46)^{a}					
	2017		138(8)	168(131)	193(68)	202(53)	206(2)	212(2)				
North Twin	2018	85(205)	161(12)	194(4)	211(22)	228(4)	234(5)	240(1)				
	All	85(205)^{d}	152(20)^{d}	169(135)^{f}	197(90)^{d}	204(57)^{c}	226(7)	221(3)				
	2017		144(19)	271(7)								
	2018	85(2)	137(24)	160(88)	284(13)		306(2)					
Pleasant	2019	76(4)	123(10)	148(12)	175(67)	273(3)	288(2)	288(2)				
	2020	82(60)	113(42)	136(66)	159(21)	180(57)	253(1)		296(1)			
	All	82(66)^{e}	126(95)^{f}	155(173)^{g}	186(101)^{d}	185(60)^{d}	288(5)	288(2)	296(1)			
	2017	104(18)		269(1)								
	2018	115(9)	211(54)		282(1)							
Silver	2019	105(8)		261(16)								
	2020	93(182)		267(2)	291(33)							
	All	95(217)^{bc}	211(54)^{a}	262(19)^{a}	291(34)^{a}							

Table 6. Yellow Bass von Bertalanffy parameters (n = number; L∞ = length infinity; k = brody growth coefficient; To = time at 0), mortality (M = instantaneous natural mortality; cm = conditional natural mortality), and maximum age (Max Age) estimated from 10 shallow natural lakes in Iowa from 2017-2020 (July-October sampling events).

Lake	Sex	von Bertalanffy parameters n	L∞	k	To	P-value	Mortality M	cm	Max Age
Center*	All	584	300	0.526	-0.756	<0.0001	0.62	0.46	4
	Male	148	299	0.427	-1.339	<0.0001	0.56	0.43	4
	Female	140	294	0.492	-1.117	<0.0001	0.61	0.45	4
Clear	All	267	300	0.257	-1.783	<0.0001	0.62	0.46	8
Cornelia	All	1,976	250	0.131	-4.985	<0.0001	0.34	0.28	10
	Male	410	250	0.128	-5.403	<0.0001	0.33	0.28	10
	Female	526	250	0.115	-6.344	<0.0001	0.32	0.27	9
East Okoboji	All	779	300	0.341	-1.149	<0.0001	0.50	0.39	6
Five Island*	All	2,820	325	0.297	-1.344	<0.0001	0.47	0.37	5
	Male	233	325	0.302	-1.298	<0.0001	0.47	0.38	5
	Female	227	325	0.291	-1.406	<0.0001	0.47	0.37	5
Little Wall	All	364	230	0.136	-4.751	<0.0001	0.35	0.28	7
Lost Island	All	1,048	325	0.330	-1.281	<0.0001	0.49	0.39	5
	Male	225	325	0.314	-1.334	<0.0001	0.48	0.38	5
	Female	256	325	0.337	-1.223	<0.0001	0.50	0.39	5
North Twin	All	517	250	0.346	-1.335	<0.0001	0.52	0.40	6
	Male	160	250	0.486	-1.023	<0.0001	0.62	0.46	6
	Female	152	250	0.501	-0.940	<0.0001	0.62	0.46	6
Pleasant	All	503	325	0.246	-0.969	<0.0001	0.43	0.35	7
	Male	88	325	0.262	-0.100	<0.0001	0.45	0.36	7
	Female	142	325	0.247	-1.088	<0.0001	0.43	0.35	6
Silver*	All	324	325	0.660	-0.535	<0.0001	0.73	0.51	3
	Male	38	325	0.573	-0.795	<0.0001	0.68	0.49	3
	Female	59	325	0.634	-0.655	<0.0001	0.71	0.50	3

*newly established population, age frequency biased low

Table 7. Comparison of Yellow Bass von Bertalanffy growth functions among 9 natural lakes in Iowa. Clear Lake was not compared due to underrepresentation of age-classes.

	Center	Cornelia	East Okoboji	Five Island	Little Wall	Lost Island	North Twin	Pleasant	Silver
Center	-	<0.0001	<0.0001	<0.0001	<0.0001	0.0386	<0.0001	<0.0001	0.0823
Cornelia	<0.0001	-	<0.0001	0.0001	<0.0001	<0.0001	0.7023	<0.0001	<0.0001
East Okoboji	<0.0001	<0.0001	-	0.4074	<0.0001	<0.0001	0.0051	<0.0001	<0.0001
Five Island	<0.0001	0.0001	0.4074	-	<0.0001	<0.0001	0.0378	<0.0001	<0.0001
Little Wall	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	0.1944	<0.0001
Lost Island	0.0386	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.0001	<0.0001	0.0002
North Twin	<0.0001	0.7023	0.0051	0.0378	<0.0001	<0.0001	-	<0.0001	<0.0001
Pleasant	<0.0001	<0.0001	<0.0001	<0.0001	0.1944	<0.0001	<0.0001	-	<0.0001
Silver	0.0823	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	<0.0001	<0.0001	-

Table 8. Mean relative weight of Yellow Bass captured in ten of Iowa's natural lakes between July-October in 2017, 2018, 2019, and 2020. Differences in superscript represent significant differences in mean annual relative weights for each lake (P < 0.05). Annual differences in Yellow Bass length-frequency from 2018-2020 were compared via Kolmogorov-Smirnov two-sample test and KSa and p-values (parentheses) for within lake comparisons are also provided.

Lake	Relative Weight				Length Frequency		
	2017	2018	2019	2020	2018*2019	2018*2020	2019*2020
Center	112^{a}	96^{bc}	98^{b}	94^{c}	0.58(0.88)	2.58(<0.01)	3.99(<0.01)
Clear	108^{a}	103^{b}					
Cornelia	88^{c}	95^{ab}	93^{b}	96^{a}	5.36(<0.01)	5.75(<0.01)	5.69(<0.01)
East Okoboji	97^{a}	89^{b}					
Five Island	94^{b}	99^{a}	99^{a}	98^{a}	13.44(<0.01)	10.36(<0.01)	4.91(<0.01)
Little Wall	70^{b}	92^{a}					
Lost Island	97^{b}	98^{b}	111^{a}	109^{a}	3.93(<0.01)	4.20(<0.01)	5.29(<0.01)
North Twin	93^{b}	102^{a}					
Pleasant	86^{a}	83^{a}	78^{b}	78^{b}	1.19(0.12)	3.19(<0.01)	3.70(<0.01)
Silver	102^{a}	108^{a}	107^{a}	107^{a}	1.32(0.06)	2.62(<0.01)	1.30(0.07)

Table 9. Comparison of length frequencies of Yellow Bass captured via fall night electrofishing from 2018-2020 in ten natural lakes in Iowa. KSa value and p-value (parentheses) for each among lake comparison are provided for 2018, 2019, 2020, and pooled length data from 2018-2020 (all years).

	Center	Clear	Cornelia	East Okoboji	Five Island	Little Wall	Lost Island	North Twin	Pleasant	Silver
					2018					
Center	-	1.14(<0.01)	2.49(<0.01)	1.82(<0.01)	2.78(<0.01)	3.18(<0.01)	1.64(<0.01)	1.65(<0.01)	2.61(<0.01)	1.90(<0.01)
Clear	1.14(<0.01)	-	6.46(<0.01)	5.63(<0.01)	6.71(<0.01)	5.64(<0.01)	3.69(<0.01)	3.63(<0.01)	4.48(<0.01)	3.16(<0.01)
Cornelia	2.49(<0.01)	6.46(<0.01)	-	3.62(<0.01)	5.15(<0.01)	6.07(<0.01)	7.89(<0.01)	4.63(<0.01)	3.30(<0.01)	4.61(<0.01)
East Okoboji	1.82(<0.01)	5.63(<0.01)	3.62(<0.01)	-	5.33(<0.01)	7.33(<0.01)	6.46(<0.01)	3.71(<0.01)	2.18(<0.01)	3.61(<0.01)
Five Island	2.78(<0.01)	6.71(<0.01)	5.15(<0.01)	5.33(<0.01)	-	9.11(<0.01)	8.18(<0.01)	4.10(<0.01)	3.89(<0.01)	4.19(<0.01)
Little Wall	3.18(<0.01)	5.64(<0.01)	6.07(<0.01)	7.33(<0.01)	9.11(<0.01)	-	6.32(<0.01)	5.34(<0.01)	5.72(<0.01)	4.51(<0.01)
Lost Island	1.64(<0.01)	3.69(<0.01)	7.89(<0.01)	6.46(<0.01)	8.18(<0.01)	6.32(<0.01)	-	2.22(<0.01)	4.60(<0.01)	1.97(<0.01)
North Twin	1.65(<0.01)	3.63(<0.01)	4.63(<0.01)	3.71(<0.01)	4.10(<0.01)	5.34(<0.01)	2.22(<0.01)	-	3.68(<0.01)	0.73(0.65)
Pleasant	2.61(<0.01)	4.48(<0.01)	3.30(<0.01)	2.18(<0.01)	3.89(<0.01)	5.72(<0.01)	4.60(<0.01)	3.68(<0.01)	-	3.94(<0.01)
Silver	1.90(<0.01)	3.16(<0.01)	4.61(<0.01)	3.61(<0.01)	4.19(<0.01)	4.51(<0.01)	1.97(<0.01)	0.73(0.65)	3.94(<0.01)	-
					2019					
Center	-	-	2.13(<0.01)	-	5.17(<0.01)	-	1.13(0.16)	-	4.24(<0.01)	-
Cornelia	2.13(<0.01)	-	-	-	13.62(<0.01)	-	4.71(<0.01)	-	3.96(<0.01)	-
Five Island	5.17(<0.01)	-	13.62(<0.01)	-	-	-	9.25(<0.01)	-	6.17(<0.01)	-
Lost Island	1.13(0.16)	-	4.71(<0.01)	-	9.25(<0.01)	-	-	-	5.39(<0.01)	-
Pleasant	4.24(<0.01)	-	3.96(<0.01)	-	6.17(<0.01)	-	5.39(<0.01)	-	-	-
					2020					
Center	-	-	5.93(<0.01)	-	2.00(<0.01)	-	5.69(<0.01)	-	3.84(<0.01)	-
Cornelia	5.93(<0.01)	-	-	-	11.26(<0.01)	-	11.32(<0.01)	-	7.28(<0.01)	-
Five Island	2.00(<0.01)	-	11.26(<0.01)	-	-	-	13.28(<0.01)	-	3.43(<0.01)	-
Lost Island	5.69(<0.01)	-	11.32(<0.01)	-	13.28(<0.01)	-	-	-	7.74(<0.01)	-
Pleasant	3.84(<0.01)	-	7.28(<0.01)	-	3.43(<0.01)	-	7.74(<0.01)	-	-	-
					All Years					
Center	-	4.43(<0.01)	3.55(<0.01)	3.25(<0.01)	3.79(<0.01)	4.06(<0.01)	4.47(<0.01)	3.22(<0.01)	3.78(<0.01)	3.69(<0.01)
Clear	4.43(<0.01)	-	7.10(<0.01)	5.63(<0.01)	6.88(<0.01)	5.64(<0.01)	3.07(<0.01)	4.63(<0.01)	5.87(<0.01)	2.13(<0.01)
Cornelia	3.55(<0.01)	7.10(<0.01)	-	4.52(<0.01)	11.24(<0.01)	8.66(<0.01)	13.55(<0.01)	4.35(<0.01)	7.29(<0.01)	5.02(<0.01)
East Okoboji	3.25(<0.01)	5.63(<0.01)	4.52(<0.01)	-	6.06(<0.01)	7.33(<0.01)	7.39(<0.01)	3.71(<0.01)	3.72(<0.01)	4.11(<0.01)
Five Island	3.79(<0.01)	6.88(<0.01)	11.24(<0.01)	6.06(<0.01)	-	4.92(<0.01)	16.56(<0.01)	4.40(<0.01)	4.37(<0.01)	5.15(<0.01)
Little Wall	4.06(<0.01)	5.64(<0.01)	8.66(<0.01)	7.33(<0.01)	4.92(<0.01)	-	9.32(<0.01)	5.34(<0.01)	6.81(<0.01)	5.04(<0.01)
Lost Island	4.47(<0.01)	3.07(<0.01)	13.55(<0.01)	7.39(<0.01)	16.56(<0.01)	9.32(<0.01)	-	2.46(<0.01)	9.89(<0.01)	1.49(0.02)
North Twin	3.22(<0.01)	4.63(<0.01)	4.35(<0.01)	3.71(<0.01)	4.40(<0.01)	5.34(<0.01)	2.46(<0.01)	-	4.34(<0.01)	1.49(0.02)
Pleasant	3.78(<0.01)	5.87(<0.01)	7.29(<0.01)	3.72(<0.01)	4.37(<0.01)	6.81(<0.01)	9.89(<0.01)	4.34(<0.01)	-	4.99(<0.01)
Silver	3.69(<0.01)	2.13(<0.01)	5.02(<0.01)	4.11(<0.01)	5.15(<0.01)	5.04(<0.01)	1.49(0.02)	1.49(0.02)	4.99(<0.01)	-

Table 10. Number, number empty, mean total length (TL; mm), mean stomach fullness (% of weight [wt]), mean stomach biomass (g), and mean number of food items for five species collected from six lakes during bimonthly intervals in 2018. Standard error is provided in parentheses.

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
Center	Black Crappie	April-May	30	2	259.8(8.4)	2.1(1.4)	0.6(0.4)	110.6(89.2)
		June-July	34	5	208.0(35.0)	2.2(2.5)	0.3(0.4)	472.2(554.4)
		August-Sept	14	0	209.2(52.5)	1.2(1.1)	0.2(0.2)	270.7(270.1)
		October-Nov	19	2	242.2(27.3)	2.1(1.3)	0.4(0.2)	401.3(206.3)
	Bluegill	April-May	30	0	173.5(14.8)	6.8(3.3)	0.9(0.4)	285.2(181.4)
		June-July	37	2	169.3(17.2)	1.6(2.1)	0.2(0.2)	117.5(218.8)
	Yellow Perch	June-July	18	6	208.5(33.0)	0.5(0.9)	0.0(0.1)	7.3(10.8)
		August-Sept	17	3	204.3(34.4)	1.0(1.2)	0.1(0.1)	40.2(57.5)
		October-Nov	13	2	233.2(19.4)	2.4(4.1)	0.5(0.9)	1.9(2.5)
	Yellow Bass	April-May	28	0	208.0(21.3)	6.1(3.7)	0.9(0.5)	428.3(360.7)
		June-July	7	0	174.1(32.9)	6.4(3.3)	0.5(0.2)	503.3(336.3)
		August-Sept	15	0	173.2(17.0)	9.8(3.1)	0.7(0.2)	833.5(276.7)
		October-Nov	27	5	193.5(48.0)	2.4(2.7)	0.4(0.6)	105.1(107.8)
Cornelia	Bluegill	April-May	27	26	159.0(13.1)	0.0(0.1)	0.0(0.0)	0.0(0.2)
		June-July	30	0	154.6(20.0)	4.8(2.9)	0.4(0.3)	373.7(482.3)
	Black Crappie	April-May	30	4	189.8(7.9)	0.7(0.8)	0.1(0.1)	656.7(960.4)
	Yellow Perch	August-Sept	18	0	169.4(12.5)	2.1(1.6)	0.1(0.1)	18.7(14.1)
		October-Nov	16	0	112.3(3.7)	2.8(3.4)	0.0(0.1)	178.9(168.1)
	Yellow Bass	April-May	33	26	171.3(15.1)	0.0(0.1)	0.0(0.0)	0.2(0.6)
		June-July	32	0	160.0(12.4)	2.5(1.3)	0.1(0.1)	816.8(655.2)
		August-Sept	44	0	179.4(6.2)	0.9(0.8)	0.1(0.1)	64.3(77.3)
		October-Nov	26	0	149.9(33.2)	1.3(1.2)	0.1(0.1)	320.7(203.2)
East Okoboji	Yellow Perch	April-May	21	3	166.4(25.4)	4.2(3.9)	0.3(0.3)	127.6(193.2)
	Yellow Bass	April-May	37	10	183.7(43.3)	1.2(1.9)	0.1(0.1)	71.8(145.9)
Ingham	Crappie spp.	April-May	30	0	224.7(18.6)	1.9(1.2)	0.4(0.2)	129.2(278.3)
		June-July	32	0	199.3(49.0)	2.1(1.6)	0.3(0.3)	697.8(724.3)
		August-Sept	30	1	163.4(24.3)	1.4(0.7)	0.1(0.0)	271.6(194)
	Yellow Perch	April-May	30	2	124.3(33.6)	6.5(6.1)	0.2(0.2)	42.4(31.9)
		June-July	30	5	129.2(22.9)	2.3(2.1)	0.1(0.1)	19.8(22.3)
		August-Sept	15	7	157.9(19.7)	0.1(0.2)	0.0(0.0)	2.1(4.8)
		October-Nov	30	0	182.9(25.3)	2.8(3.1)	0.2(0.3)	16.0(15.9)
	Yellow Bass	April-May	2	0	267.5(3.5)	0.3(0.3)	0.1(0.1)	10.0(12.7)
		October-Nov	1	0	110	2	0	49
Lost Island	Black Crappie	April-May	30	1	162.8(45.4)	1.5(2.3)	0.1(0.3)	237.9(319.8)
		June-July	18	0	208.8(13.7)	5.2(7.9)	0.7(1.1)	299.8(400.3)
	Bluegill	April-May	30	4	149.0(33.8)	1.3(2.0)	0.1(0.3)	65.5(142.2)
	Yellow Perch	April-May	26	14	140.2(51.3)	0.4(0.7)	0.0(0.0)	1.3(4.1)
		June-July	12	2	154.3(33.2)	3.7(2.7)	0.1(0.1)	39.0(30.7)
		August-Sept	38	2	182.7(20.3)	4.4(3.0)	0.3(0.2)	33.8(36.7)
		October-Nov	25	2	200.8(22.6)	9.1(9.8)	1.1(1.5)	7.0(11.2)
	Yellow Bass	April-May	45	15	180.7(20.5)	0.6(0.7)	0.0(0.0)	36.4(96.5)
		June-July	27	2	191.7(11.2)	4.7(6.4)	0.5(0.7)	310.6(434.5)
		August-Sept	14	1	206.1(29.1)	5.6(5.4)	0.8(1.0)	117.7(149.7)
		October-Nov	26	1	243.4(17.9)	6.3(6.5)	1.7(1.9)	97.3(134.5)
Pleasant	Yellow Perch	April-May	38	12	158.1(81.7)	3.9(4.9)	0.2(1.1)	159.1(237.8)
		June-July	27	23	266.5(55.4)	0.4(1.4)	0.1(0.4)	11.1(50.1)
		August-Sept	59	41	229.4(61.0)	2.2(9.4)	0.3(1.4)	8.2(33.2)
		October-Nov	15	4	196.5(69.9)	3.1(5.5)	0.5(1.3)	11.0(22.0)
	Yellow Bass	April-May	17	9	268.6(31.9)	3.0(6.3)	0.8(1.8)	0.6(0.7)

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
		June-July	22	4	245.2(74.3)	5.8(8.2)	1.6(2.0)	144.1(316.3)
		August-Sept	49	9	179.3(59.2)	1.4(2.7)	0.1(0.4)	48.9(132.1)
		October-Nov	15	2	184.8(45.6)	5.2(7.2)	0.5(0.9)	72.1(250.9)
Rice	Bluegill	April-May	41	0	164.4(34.2)	2.6(2.7)	0.3(0.4)	58.4(86.1)
	Yellow Perch	April-May	51	10	187.3(64.2)	4.7(5.3)	0.5(0.8)	76.7(102.1)
	White Bass	June-July	16	1	219.3(8.2)	2.0(2.2)	0.3(0.3)	129.6(192.7)
		August-Sept	18	1	311.4(43.3)	4.3(4.7)	1.8(2.5)	668.9(441.2)
		October-Nov	12	0	181.6(8.3)	4.8(2.2)	0.4(0.2)	327.2(174.5)
Silver	Yellow Perch	August-Sept	20	1	288.7(22.1)	1.3(0.9)	0.4(0.3)	373.7(288.4)
		October-Nov	17	0	255.8(57.6)	1.7(1.3)	0.5(0.3)	120.9(174.2)
	Yellow Bass	June-July	58	0	136.2(16.4)	7.0(4.3)	0.3(0.2)	361.6(284.3)
		August-Sept	18	0	189.6(39.1)	7.4(5.6)	0.7(0.5)	587.7(519.2)
		October-Nov	34	0	207.2(32.9)	2.7(1.8)	0.4(0.4)	189.3(179.9)

Table 11. Number, number empty, mean total length (TL; mm), mean stomach fullness (% of weight [wt]), mean stomach biomass (g), and mean number of food items for five species collected from seven lakes during bimonthly intervals in 2019. Standard error is provided in parentheses.

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
Center	Black Crappie	April-May	10	0	227.5(44.6)	1.6(0.6)	0.3(0.2)	173.1(144.1)
		June-July	5	1	220.8(49.3)	1.5(1.5)	0.2(0.2)	428.6(416.8)
		August-Sept	4	0	279.3(17.1)	1.4(0.8)	0.5(0.2)	12.3(2.6)
		October-Nov	7	0	216.1(55.7)	2.6(1.1)	0.5(0.4)	87.3(54.8)
	Bluegill	April-May	12	5	182.3(15)	0.8(1.2)	0.1(0.1)	101.3(269.7)
		June-July	5	0	170(48.2)	3.3(2.5)	0.4(0.3)	289(272)
		August-Sept	4	0	184.5(21.4)	0.8(0.9)	0.1(0.1)	14.3(13.1)
	Yellow Perch	April-May	17	10	217.4(30)	0.2(0.6)	0(0.1)	11.1(36.7)
		June-July	23	1	219.6(25.5)	1(0.7)	0.1(0.1)	47.1(48.4)
		August-Sept	12	5	214(31.3)	0.3(0.6)	0(0)	2.2(3.9)
		October-Nov	16	1	225.6(20.9)	1(2.2)	0.1(0.2)	12.3(23.3)
	Yellow Bass	April-May	19	0	209.8(23.2)	4.7(2)	0.6(0.2)	1461.1(693.6)
		June-July	21	2	199.2(6.5)	1.9(2.2)	0.2(0.2)	363.8(505.8)
		August-Sept	20	1	213.4(36.6)	5.1(5.4)	0.5(0.5)	8.9(11.8)
		October-Nov	20	0	214.6(27.6)	2.9(3.4)	0.6(0.8)	70.4(57.9)
Cornelia	Bluegill	April-May	15	1	151.7(27.7)	2.2(2.3)	0.2(0.4)	73.9(81.1)
	Yellow Perch	April-May	15	10	118(4.9)	0.2(0.3)	0(0)	1.7(3.3)
		June-July	15	0	142.9(11.4)	1.1(1)	0(0)	24.9(16.3)
		August-Sept	15	0	152.2(17.8)	2.9(2.5)	0.2(0.3)	30.5(40.3)
		October-Nov	20	3	158.4(9.7)	1(1.5)	0(0.1)	28.2(39.9)
	Yellow Bass	April-May	15	0	178.7(3.8)	1.3(1.2)	0.1(0.1)	601.5(757.1)
		June-July	15	3	173.7(25.4)	0.8(0.8)	0.1(0.1)	30.6(61.3)
		August-Sept	15	0	175.7(19.6)	0.9(0.6)	0.1(0.1)	57.9(91.5)
		October-Nov	20	3	181.8(19.1)	0.6(0.7)	0(0.1)	63.5(63.8)
Five Island	Bluegill	April-May	15	0	171.1(24.6)	5.9(3.2)	0.7(0.4)	163.9(91.5)
	Yellow Perch	April-May	4	0	129(28.8)	3.1(3.1)	0.1(0.2)	58.5(103.7)
		June-July	9	0	184.2(25.1)	1.6(0.9)	0.1(0.1)	30.4(40.4)
		August-Sept	15	2	190.3(18.2)	1.3(1.4)	0.1(0.1)	14.6(16.2)
		October-Nov	8	4	202.1(24.9)	0.6(0.9)	0.1(0.1)	1.5(2.7)
	Yellow Bass	April-May	15	0	184.3(17.9)	2.7(1.1)	0.2(0.1)	204.9(188.9)
		June-July	20	0	214.3(16.4)	1.2(0.8)	0.2(0.1)	42.2(31.7)
		August-Sept	15	2	216.1(7.1)	0.4(0.4)	0.1(0.1)	218.8(329.9)
		October-Nov	20	1	224.5(8.2)	0.8(0.7)	0.1(0.1)	230.7(210.6)

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
Ingham	Yellow Perch	April-May	11	0	165.2(19.4)	4.7(2.7)	0.3(0.2)	34.1(22.3)
		June-July	24	0	190.3(31)	4.3(2.9)	0.4(0.4)	114.8(76)
		August-Sept	17	1	200.9(35)	0.6(0.6)	0(0)	10.2(9.9)
		October-Nov	20	3	233.7(20.2)	8.8(14.3)	1.7(2.7)	1.2(2.4)
Lost Island	Black Crappie	April-May	11	0	237.6(22.2)	3(2.3)	0.7(0.6)	68.7(95.8)
		October-Nov	3	0	255.3(14.3)	6.2(0.8)	1.8(0.5)	265.7(11)
	Bluegill	April-May	10	0	186.7(30.2)	4(2.7)	0.7(0.5)	114.6(118.5)
		June-July	9	0	162.9(38.8)	3.9(3.5)	0.4(0.3)	144.3(114.7)
	White Bass	June-July	18	2	358.2(22.9)	2.7(2.9)	1.4(1.4)	33.6(87.8)
	Yellow Perch	April-May	15	3	174.1(27.9)	4.8(6.5)	0.3(0.5)	16.5(21.1)
		June-July	16	1	192.1(41.2)	9(6.6)	1(0.9)	54(59.4)
		August-Sept	15	3	196.1(30.7)	5(6)	0.5(0.6)	200.8(235.5)
		October-Nov	15	4	201.9(33.3)	2(3.3)	0.2(0.3)	89.4(125.5)
	Yellow Bass	April-May	15	1	184(57.4)	2.3(1.9)	0.3(0.3)	114.9(164.3)
		June-July	20	1	228(15.8)	1.2(1.1)	0.2(0.2)	331(277.5)
		August-Sept	15	1	232.2(25.3)	9.4(4.3)	1.9(1.1)	547.7(338.7)
		October-Nov	19	4	224.1(66.3)	2.2(2.3)	0.4(0.5)	166.5(241.9)
Pleasant	Yellow Perch	April-May	15	3	226.3(62.5)	25.9(39.9)	2.8(4)	1(0.8)
		June-July	22	0	255.1(57.5)	3.8(8.7)	0.9(2.2)	1.1(0.5)
		August-Sept	18	9	150.9(57.4)	0.7(1.1)	0(0.1)	2.1(3.6)
		October-Nov	5	3	242.2(56.2)	4.8(9.2)	0.8(1.5)	0.4(0.5)
	Yellow Bass	April-May	15	9	294.3(14.9)	3.3(5.9)	1.5(2.7)	0.5(0.7)
		June-July	21	4	246.9(57.7)	0.3(0.6)	0(0.1)	1.6(4.5)
		August-Sept	18	4	184.8(62.2)	0.3(0.5)	0(0)	8.2(14)
		October-Nov	20	4	202.1(51.9)	3.2(4.9)	0.5(1.3)	3.9(6)
	White Bass	April-May	3	0	295(8.2)	0.9(1.3)	0.3(0.4)	139.3(68.5)
		June-July	1	0	294	3	1	7
		August-Sept	16	0	246.6(100.8)	9.4(8.7)	1.6(2.3)	692.1(767.8)
		October-Nov	12	1	179.4(8.5)	1.2(1.1)	0.1(0.1)	52.3(52.9)
Silver	Yellow Perch	April-May	15	2	260.8(62.2)	1(0.9)	0.3(0.4)	174.2(412.8)
		June-July	18	0	289.3(24.5)	1.7(1.3)	0.6(0.4)	162.1(212.4)
		August-Sept	24	0	234.3(47.8)	3.1(3.1)	0.5(0.5)	366.7(295.8)
		October-Nov	20	1	249.6(49.8)	1.8(2.4)	0.5(1)	29.4(55)
	Yellow Bass	April-May	17	1	223.4(24.2)	0.9(1.4)	0.2(0.3)	66.8(138.8)
		June-July	17	0	222(8.3)	3.6(3)	0.6(0.6)	330.8(284.5)
		August-Sept	12	0	228.3(65.4)	4.5(3.6)	0.7(0.4)	701.3(384.6)
		October-Nov	3	0	268.3(4.5)	0.3(0.2)	0.1(0.1)	10.7(2.1)

Table 12. Number, number empty, mean total length (TL; mm), mean stomach fullness (% of weight [wt]), mean stomach biomass (g), and mean number of food items for five species collected from six lakes during bimonthly intervals in 2020. Standard error is provided in parentheses.

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
	Black Crappie	June-July	5	0	236(54.1)	5.6(4.7)	1.0(0.6)	342.2(596.2)
		August-Sept	6	0	233(36.2)	3.7(2.3)	0.7(0.5)	32.3(34.0)
		Oct-Nov	1	0	176	10.1	0.9	8.0
	Walleye	April-May	6	1	312(85.8)	7.0(15.3)	1.7(3.8)	19.8(24.2)
		June-July	8	0	281(57.0)	3.8(4.6)	0.6(0.7)	73.6(161.8)
		August-Sept	8	0	334(40.0)	17.6(21.1)	4.2(3.7)	2.6(1.2)
		Oct-Nov	7	0	341(8.3)	9.4(5.2)	3.4(1.9)	6.1(11.5)
Center	Yellow Perch	April-May	6	0	185(13.4)	5.2(1.5)	0.5(0.1)	68.5(51.1)
		June-July	14	0	228(30.0)	1.7(1.2)	0.3(0.2)	73.7(107.1)
		August-Sept	9	0	241(15.4)	0.5(0.3)	0.1(0.1)	1.2(1.5)
		Oct-Nov	8	0	241(17.3)	0.9(1.5)	0.1(0.2)	12.0(28.8)
	Yellow Bass	April-May	15	1	238(8.6)	6.5(4.5)	1.3(0.9)	2109.1(2153.1)
		June-July	19	0	225(21.5)	4.5(3.0)	0.8(0.6)	388.1(281.7)
		August-Sept	20	0	229(31.6)	2.8(3.2)	0.4(0.4)	26.1(65.3)
		Oct-Nov	15	0	226(42.2)	2.0(2.8)	0.5(1.0)	44.3(58.9)
	Yellow Perch	April-May	15	0	172(10.3)	5.9(2.0)	0.3(0.1)	181.4(90.3)
		June-July	15	0	176(5.9)	4.2(1.3)	0.3(0.1)	98.6(36.6)
		August-Sept	15	0	179(8.6)	1.2(0.8)	0.1(0.1)	5.7(12.0)
		Oct-Nov	16	0	194(19.7)		0.1(0.3)	2.8(10.5)
Cornelia	Yellow Bass	April-May	15	0	187(2.5)	0.9(1.7)	0.1(0.1)	411.9(424.2)
		June-July	15	0	191(9.7)	2.3(1.6)	0.2(0.2)	192.5(378.7)
		August-Sept	15	0	191(9.8)	0.4(0.3)	0.0(0.0)	8.3(11.3)
		Oct-Nov	14	0	194(30.4)	3.3(5.5)	0.6(1.3)	39.2(48.6)
	Yellow Perch	April-May	2	0	176(59.4)	7.3(1.0)	0.7(0.7)	121.5(71.4)
		June-July	15	0	174(8.2)	1.8(1.2)	0.1(0.1)	17.6(13.5)
		August-Sept	15	0	184(16.0)	0.8(0.6)	0.1(0.0)	8.5(9.2)
		Oct-Nov	9	0	176(28.1)	0.9(0.6)	0.1(0.0)	2.3(2.5)
Five Island	Yellow Bass	April-May	16	1	236(8.9)	3.2(3.1)	0.6(0.7)	229.4(244.5)
		June-July	15	0	214(35.3)	0.9(0.7)	0.1(0.1)	119.5(84.4)
		August-Sept	15	0	198(36.1)	2.3(1.9)	0.3(0.4)	70.5(76.8)
		Oct-Nov	15	0	191(32.8)	4.2(7.0)	0.8(1.7)	208.6(727.7)
	Black Crappie	April-May	7	0	253(30.4)	3.9(1.5)	1.1(0.6)	487.3(1049.4)
		June-July	10	0	196(4.9)	5.6(2.0)	0.8(0.3)	2659.9(921.2)
		Oct-Nov	4	0	221(19.0)	3.7(0.2)	0.7(0.1)	674.3(307.9)
	Bluegill	April-May	5	0	211(11.4)	1.8(2.1)	0.5(0.5)	19.0(19.0)
		Oct-Nov	3	0	184(27.0)	3.4(1.5)	0.6(0.5)	1138.7(851.0)
	White Bass	April-May	6	2	377(17.4)	1.3(2.4)	0.8(1.5)	48.2(101.1)
		Oct-Nov	2	0	239(92.6)	4.7(3.6)	1.4(1.7)	50.5(67.2)
Lost Island	Yellow Perch	April-May	15	1	221(26.5)	7.3(4.5)	1.2(0.7)	212.3(159)
		June-July	15	0	219(8.5)	3.3(1.3)	0.6(0.2)	60.9(43.7)
		August-Sept	15	0	240(10.3)	1.6(1.8)	0.3(0.3)	22.3(20.8)
		Oct-Nov	15	0	235(20.0)	5.6(6.8)	1.0(1.4)	276.8(781)
	Yellow Bass	April-May	15	2	255(9.3)	0.3(0.4)	0.1(0.1)	31.2(48.2)
		June-July	15	0	224(25.5)	4.6(2.4)	0.8(0.3)	954.5(560.9)
		August-Sept	14	0	249(21.8)	3.2(3.8)	0.8(1.2)	41.0(38.9)
		Oct-Nov	15	0	243(43.4)	2.5(2.8)	0.6(0.9)	120.1(223.8)
Pleasant	Yellow Perch	April-May	15	0	269(34.6)	24.3(14.5)	6.0(3.4)	1.5(0.7)
		June-July	18	0	274(35.8)	2.7(8.9)	0.6(1.5)	0.3(0.7)
		August-Sept	15	0	286(33.4)	9.3(16.1)	2.2(3.2)	0.4(0.6)
		Oct-Nov	15	0	140(18.0)	2.8(2.1)	0.1(0.0)	47.7(106.6)

Lake	Species	Period	N	N empty	Mean TL	Mean Stomach Fullness (% of wt)	Mean Stomach Biomass (g)	Mean N food Items
Silver	Yellow Bass	April-May	8	1	280(20.3)	3.1(5.6)	0.9(1.6)	0.3(0.5)
		June-July	16	0	211(65.7)	7.6(12.0)	1.9(3.9)	19.3(56.8)
		August-Sept	15	0	203(75.4)	2.8(4.2)	0.4(1.0)	24.1(35.8)
		Oct-Nov	15	0	164(23.7)	7.2(9.7)	0.4(0.5)	151.5(506.8)
	Walleye	April-May	1	0	380	0.5	0.2	71.0
		June-July	5	0	357(31.0)	0.8(0.7)	0.3(0.3)	35.2(34.0)
		August-Sept	10	0	306(68.9)	4.1(3.6)	1.2(1.1)	1.9(1.3)
		Oct-Nov	5	0	344(69.3)		1.7(1.7)	1.6(1.1)
	White Bass	April-May	1	0	171	2.7	0.2	258.0
		June-July	6	0	270(82.7)	6.8(3.3)	2.3(2.9)	739.2(1050.6)
		August-Sept	10	0	241(82.3)	29.0(23.5)	3.9(2.9)	1.5(0.7)
		Oct-Nov	6	0	181(4.3)		3.3(2.2)	1.0(0.6)
	Yellow Perch	April-May	15	2	235(36.9)	5.1(3.2)	0.9(1.0)	172.7(161.3)
		June-July	15	0	267(48.3)	2.1(1.2)	0.6(0.3)	87.3(67.7)
		August-Sept	15	0	259(44.9)	1.0(1.3)	0.2(0.3)	0.5(0.8)
		Oct-Nov	15	0	218(51.0)		0.1(0.1)	61.4(163.1)
	Yellow Bass	April-May	12	0	270(9.0)	0.4(0.5)	0.1(0.1)	101.2(130.4)
		June-July	15	0	269(8.8)	2.8(1.6)	0.9(0.5)	289.3(221.7)
		August-Sept	15	0	288(9.3)	0.2(0.3)	0.1(0.1)	0.5(0.9)
		Oct-Nov	12	0	291(13.3)	0.9(0.6)	0.2(0.2)	1.8(1.9)

Table 13. Frequency and percent occurrence (parentheses) of 16 major prey items found in Black Crappie, Bluegill, Crappie spp. (Black and White Crappie combined), White Bass, Yellow Perch, and Yellow Bass from eight natural lakes in Iowa taken at bimonthly periods from April to November, 2018.

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Center	Black Crappie	April-May	3.3(0.3)	0(0)	0(0)	86.7(9.1)	93.3(88.4)	6.7(0.1)	0(0)	23.3(0.4)	0(0)	0(0)	53.3(1.5)	10(0.1)	0(0)	3.3(0)	6.7(0.1)	0(0)
		June-July	0(0)	0(0)	0(0)	70.6(2.9)	44.1(1.4)	82.4(88.8)	32.4(0.2)	20.6(0.1)	2.9(0.1)	0(0)	29.4(0.2)	0(0)	8.8(6.2)	5.9(0)	2.9(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	64.3(4.2)	28.6(0.8)	57.1(70.2)	28.6(0.6)	7.1(0.1)	0(0)	0(0)	50(0.6)	0(0)	35.7(23.6)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	10.5(0)	0(0)	10.5(0.2)	21.1(0.1)	94.7(65.9)	52.6(0.8)	10.5(0)	0(0)	0(0)	26.3(0.1)	0(0)	100(32.8)	0(0)	0(0)	0(0)
	Bluegill	April-May	23.3(1.4)	3.3(0)	0(0)	90(31.4)	100(61.9)	46.7(2.9)	3.3(0)	63.3(1)	0(0)	23.3(0.2)	56.7(0.4)	10(0.1)	0(0)	6.7(0)	6.7(0)	63.3(0.6)
		June-July	2.7(0.1)	10.8(0.2)	0(0)	75.7(5.4)	48.6(1.5)	78.4(78.3)	24.3(0.7)	18.9(11.1)	2.7(0)	16.2(0.4)	16.2(0.5)	32.4(0.4)	0(0)	2.7(0.2)	2.7(0)	16.2(1)
	Yellow Perch	June-July	5.6(0.8)	0(0)	0(0)	38.9(64.4)	11.1(4.5)	11.1(10.6)	0(0)	5.6(5.3)	0(0)	0(0)	27.8(10.6)	0(0)	0(0)	16.7(2.3)	5.6(0.8)	5.6(0.8)
		Aug-Sep	0(0)	0(0)	0(0)	70.6(18.6)	17.6(0.4)	11.8(5.4)	0(0)	5.9(0.7)	0(0)	0(0)	23.5(22)	0(0)	29.4(52.9)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	23.1(36)	0(0)	0(0)	0(0)	0(0)	30.8(36)	0(0)	0(0)	0(0)	0(0)	0(0)	23.1(28)	0(0)
	Yellow Bass	April-May	7.1(0)	32.1(0.8)	0(0)	60.7(0.3)	100(68.8)	28.6(24.8)	0(0)	35.7(0.2)	0(0)	0(0)	64.3(5)	0(0)	0(0)	0(0)	0(0)	7.1(0)
		June-July	0(0)	0(0)	0(0)	0(0)	14.3(0)	0(0)	14.3(0)	28.6(0.2)	28.6(0.1)	0(0)	42.9(0.2)	0(0)	100(99.5)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	33.3(2)	6.7(0.2)	86.7(22.2)	13.3(0)	0(0)	0(0)	0(0)	66.7(0.2)	0(0)	100(75.4)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	3.7(0)	0(0)	59.3(28.6)	37(9.2)	7.4(0.1)	18.5(0.4)	3.7(0)	22.2(5.8)	0(0)	48.1(56)	0(0)	0(0)	0(0)
Cornelia	Black Crappie	April-May	3.3(0)	30(0.2)	0(0)	0(0)	0(0)	26.7(1.2)	86.7(98.5)	0(0)	3.3(0)	0(0)	3.3(0)	0(0)	0(0)	0(0)	0(0)	3.3(0)
	Bluegill	April-May	3.7(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	43.3(1.3)	43.3(0.4)	0(0)	83.3(2.3)	40(0.4)	90(80)	13.3(2.1)	10(0)	0(0)	13.3(0.1)	0(0)	80(11.6)	0(0)	3.3(0)	3.3(0)	50(1.6)
	Yellow Perch	Aug-Sep	16.7(0.9)	5.6(0.3)	11.1(0.6)	44.4(10.7)	44.4(31.5)	22.2(3)	0(0)	0(0)	0(0)	16.7(3.3)	0(0)	50(6.8)	0(0)	0(0)	0(0)	66.7(43)
		Oct-Nov	0(0)	0(0)	6.3(0.2)	31.3(0.5)	12.5(0.1)	100(85)	87.5(14.2)	0(0)	0(0)	0(0)	0(0)	6.3(0)	0(0)	6.3(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	0(0)	0(0)	0(0)	0(0)	9.1(50)	6.1(50)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	3.1(0)	3.1(0)	0(0)	53.1(1.6)	37.5(0.1)	100(98.2)	15.6(0.1)	3.1(0)	0(0)	6.3(0)	0(0)	3.1(0)	0(0)	3.1(0)	0(0)	12.5(0)
		Aug-Sep	0(0)	2.3(0)	11.4(0.4)	95.5(28.8)	40.9(1.4)	84.1(51.9)	50(2.4)	2.3(0)	0(0)	2.3(0)	0(0)	45.5(12.8)	9.1(1.6)	0(0)	0(0)	11.4(0.6)
		Oct-Nov	0(0)	38.5(2.1)	3.8(0)	30.8(0.4)	19.2(0.7)	100(92.9)	65.4(2.2)	0(0)	0(0)	0(0)	3.8(0)	0(0)	30.8(1.7)	7.7(0)	0(0)	3.8(0)
Ingham	Crappie spp.	April-May	0(0)	0(0)	0(0)	70(1.4)	90(15.9)	60(77.6)	10(0.1)	0(0)	0(0)	3.3(0)	70(4.7)	13.3(0.3)	0(0)	3.3(0)	0(0)	0(0)
		June-July	15.6(0)	6.3(0)	0(0)	81.3(7.7)	71.9(0.5)	93.8(89.6)	68.8(0.5)	6.3(0)	3.1(0)	12.5(0.3)	62.5(1.3)	12.5(0.1)	0(0)	0(0)	21.9(0)	3.1(0)
		Aug-Sep	6.7(0)	0(0)	0(0)	26.7(0.2)	73.3(1.2)	96.7(92.2)	90(3.2)	0(0)	0(0)	0(0)	13.3(0)	3.3(0)	83.3(3)	0(0)	3.3(0)	0(0)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	66.7(16.6)	83.3(21.4)	76.7(45)	6.7(0.4)	0(0)	0(0)	0(0)	66.7(16.5)	3.3(0.1)	0(0)	0(0)	0(0)	3.3(0.1)
		June-July	6.7(0.7)	6.7(0.3)	0(0)	63.3(48.7)	46.7(12.3)	36.7(20.1)	10(1)	3.3(0.2)	0(0)	16.7(7.6)	46.7(8.6)	3.3(0.3)	0(0)	3.3(0.2)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	33.3(56.3)	26.7(34.4)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	13.3(6.3)	0(0)	0(0)	0(0)	6.7(3.1)
		Oct-Nov	0(0)	0(0)	3.3(1)	86.7(71.1)	46.7(11.2)	3.3(15)	13.3(0.8)	0(0)	3.3(0.6)	0(0)	3.3(0.2)	0(0)	0(0)	0(0)	0(0)	0(0)
	Black Crappie	April-May	3.3(0)	43.3(1.2)	40(12.9)	76.7(11.9)	3.3(0)	26.7(2.9)	86.7(69.5)	40(1.2)	3.3(0)	0(0)	0(0)	6.7(0.1)	0(0)	23.3(0.2)	0(0)	0(0)

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Lost Island	Bluegill	June-July	5.6(0)	16.7(0.1)	0(0)	100(49.1)	22.2(2.3)	50(48)	11.1(0.1)	0(0)	0(0)	0(0)	5.6(0)	38.9(0.3)	0(0)	11.1(0.1)	5.6(0)	5.6(0)
		April-May	3.3(0.1)	13.3(0.3)	20(0.8)	70(96.2)	33.3(1)	3.3(0.1)	6.7(0.5)	3.3(0.1)	0(0)	6.7(0.1)	0(0)	0(0)	0(0)	26.7(0.5)	0(0)	16.7(0.5)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	15.4(65.7)	15.4(11.4)	0(0)	11.5(14.3)	0(0)	3.8(2.9)	3.8(2.9)	3.8(2.9)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	66.7(37.2)	0(0)	58.3(40.8)	50(6.8)	8.3(1.9)	0(0)	50(10.3)	0(0)	8.3(0.4)	0(0)	0(0)	0(0)	25(1.9)	16.7(0.6)	0(0)
		Aug-Sep	2.6(0.1)	28.9(12.7)	21.1(1.2)	89.5(62.2)	65.8(8.8)	13.2(1)	2.6(0.2)	18.4(9)	7.9(0.2)	10.5(0.5)	0(0)	13.2(1.6)	0(0)	0(0)	2.6(0.1)	7.9(2.5)
		Oct-Nov	0(0)	4(0.6)	0(0)	8(1.7)	0(0)	4(2.3)	4(0.6)	0(0)	56(27.4)	0(0)	24(60.6)	0(0)	0(0)	12(4.6)	8(1.1)	8(1.1)
	Yellow Bass	April-May	4.4(0.1)	8.9(0.4)	6.7(0.2)	48.9(24.7)	15.6(0.8)	17.8(73.4)	2.2(0.1)	0(0)	0(0)	0(0)	2.2(0.1)	0(0)	0(0)	6.7(0.2)	2.2(0.1)	0(0)
		June-July	22.2(1.3)	14.8(1.8)	0(0)	66.7(52.7)	44.4(24.6)	40.7(17.9)	11.1(0.6)	29.6(1)	0(0)	0(0)	7.4(0)	3.7(0)	0(0)	7.4(0)	0(0)	0(0)
		Aug-Sep	0(0)	14.3(0.1)	0(0)	50(6.6)	28.6(0.4)	14.3(4.3)	0(0)	0(0)	28.6(0.4)	0(0)	0(0)	0(0)	64.3(88.2)	0(0)	0(0)	7.1(0.1)
		Oct-Nov	0(0)	11.5(0.1)	3.8(0.1)	69.2(65.5)	11.5(0.1)	19.2(31.7)	0(0)	11.5(0.1)	46.2(1.9)	0(0)	0(0)	0(0)	3.8(0.1)	15.4(0.2)	3.8(0)	3.8(0)
Pleasant	Yellow Perch	April-May	2.6(0)	2.6(0.1)	0(0)	31.6(10)	2.6(0)	0(0)	47.4(89.8)	2.6(0)	5.3(0)	2.6(0)	0(0)	0(0)	0(0)	0(0)	2.6(0)	0(0)
		June-July	0(0)	0(0)	0(0)	3.7(11.3)	3.7(2)	3.7(26.2)	3.7(59.8)	0(0)	7.4(0.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	1.7(1.2)	0(0)	8.5(67.2)	10.2(30.5)	0(0)	8.5(1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	6.7(1.2)	20(2.4)	6.7(0.6)	46.7(30.3)	13.3(5.5)	20(54.5)	20(4.2)	0(0)	0(0)	0(0)	0(0)	0(0)	6.7(0.6)	6.7(0.6)
	Yellow Bass	April-May	0(0)	0(0)	0(0)	11.8(30)	0(0)	0(0)	0(0)	0(0)	35.3(70)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	4.5(0.1)	0(0)	18.2(45.8)	22.7(53.6)	0(0)	54.5(0.5)	0(0)	4.5(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	32.7(6.2)	22.4(1.5)	44.9(78.2)	34.7(13.2)	0(0)	24.5(0.8)	0(0)	4.1(0.1)	0(0)	0(0)	0(0)	2(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	6.7(0.1)	0(0)	26.7(96.9)	20(2.4)	0(0)	40(0.6)	6.7(0.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Silver	White Bass	June-July	0(0)	6.3(0)	0(0)	12.5(0.1)	6.3(0)	81.3(97.3)	0(0)	0(0)	25(0.2)	6.3(0)	81.3(2.2)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	11.1(0)	0(0)	0(0)	16.7(0)	22.2(0.1)	94.4(50.5)	0(0)	0(0)	16.7(0)	0(0)	5.6(0)	0(0)	88.9(49.3)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	41.7(0.1)	8.3(0)	100(74.9)	0(0)	0(0)	0(0)	0(0)	41.7(0.2)	0(0)	83.3(24.7)	0(0)	0(0)	0(0)
	Yellow Perch	Aug-Sep	5(0)	0(0)	0(0)	40(0.9)	50(0.9)	95(90.8)	0(0)	0(0)	5(0)	0(0)	10(0)	0(0)	55(7.3)	0(0)	0(0)	15(0.1)
		Oct-Nov	0(0)	5.9(0)	0(0)	76.5(21.4)	0(0)	64.7(76.4)	0(0)	0(0)	0(0)	0(0)	11.8(0.1)	0(0)	11.8(2)	0(0)	11.8(0.1)	0(0)
	Yellow Bass	June-July	6.9(0)	3.4(0)	0(0)	60.3(11.3)	46.6(0.5)	94.8(86.6)	43.1(0.7)	6.9(0)	6.9(0)	0(0)	53.4(0.7)	0(0)	0(0)	1.7(0)	3.4(0)	10.3(0.1)
		Aug-Sep	0(0)	0(0)	0(0)	77.8(7)	50(0.7)	83.3(56.5)	0(0)	5.6(0.1)	0(0)	0(0)	33.3(0.1)	0(0)	66.7(35.6)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	8.8(0.1)	0(0)	79.4(6.5)	8.8(0.3)	73.5(54.6)	8.8(4.3)	8.8(0)	0(0)	0(0)	35.3(1.7)	0(0)	67.6(32.4)	2.9(0)	5.9(0)	2.9(0)
Rice	Bluegill	April-May	0(0)	85.4(19.3)	4.9(0.1)	87.8(68)	51.2(5.7)	4.9(0.5)	7.3(0.2)	19.5(1.4)	0(0)	0(0)	29.3(1)	17.1(0.7)	0(0)	36.6(3)	0(0)	2.4(0)
	Yellow Perch	April-May	0(0)	56.9(20)	2(0.2)	74.5(19.4)	49(49.1)	2(0)	9.8(0.3)	29.4(3.9)	0(0)	9.8(0.4)	11.8(0.3)	2(0)	0(0)	27.5(6.2)	0(0)	3.9(0.1)
East Okoboji	Yellow Perch	April-May	0(0)	66.7(54.4)	4.8(0)	33.3(0.5)	14.3(0.5)	9.5(42.8)	0(0)	4.8(0)	0(0)	33.3(1.3)	14.3(0.4)	0(0)	0(0)	4.8(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	37.8(14.6)	2.7(0.1)	29.7(1.2)	10.8(0.2)	40.5(82.1)	16.2(0.9)	5.4(0.3)	0(0)	5.4(0.1)	5.4(0.1)	5.4(0.1)	0(0)	5.4(0.1)	2.7(0.2)	10.8(0.3)

Table 14. Frequency and percent occurrence (parentheses) of 16 major prey items found in Black Crappie, Bluegill, White Bass, Yellow Perch, and Yellow Bass from seven natural lakes in Iowa taken at bimonthly periods from April to November, 2019.

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Center	Black Crappie	April-May	0(0)	30(0.2)	0(0)	100(21.1)	30(0.2)	30(24.7)	20(0.7)	100(51.3)	0(0)	0(0)	70(1)	0(0)	0(0)	30(0.8)	20(0.1)	0(0)
		June-July	0(0)	0(0)	0(0)	80(3.4)	80(1.2)	80(91.7)	40(2)	60(1.6)	0(0)	0(0)	60(0.2)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	25(6.1)	0(0)	0(0)	50(10.2)	100(22.4)	0(0)	0(0)	0(0)	75(32.7)	0(0)	100(24.5)	0(0)	0(0)	50(4.1)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	42.9(10.8)	14.3(0.2)	14.3(17.2)	28.6(5.7)	14.3(0.3)	0(0)	0(0)	71.4(7.5)	0(0)	85.7(57.8)	28.6(0.5)	0(0)	0(0)
	Bluegill	April-May	0(0)	0(0)	0(0)	41.7(10.7)	16.7(0.4)	16.7(84.3)	16.7(0.2)	25(4.1)	0(0)	8.3(0.1)	8.3(0.2)	0(0)	0(0)	0(0)	8.3(0.1)	0(0)
		June-July	0(0)	20(0.1)	0(0)	100(24.8)	100(1.3)	40(72.7)	20(0.1)	60(0.8)	0(0)	0(0)	0(0)	20(0.1)	0(0)	0(0)	0(0)	20(0.1)
		Aug-Sep	0(0)	0(0)	0(0)	75(49.1)	50(15.8)	0(0)	0(0)	0(0)	0(0)	0(0)	50(35.1)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	23.5(35.1)	17.6(51.9)	5.9(11.7)	5.9(0.4)	0(0)	0(0)	0(0)	5.9(0.8)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	95.7(42)	82.6(11.4)	60.9(33.4)	17.4(0.8)	21.7(11.6)	0(0)	0(0)	4.3(0.1)	8.7(0.2)	0(0)	0(0)	4.3(0.1)	8.7(0.3)
		Aug-Sep	0(0)	0(0)	0(0)	0(0)	4.8(3.8)	0(0)	0(0)	0(0)	9.5(15.4)	0(0)	23.8(38.5)	4.8(3.8)	0(0)	4.8(15.4)	0(0)	9.5(23.1)
		Oct-Nov	0(0)	6.3(0.5)	0(0)	68.8(37.1)	25(2)	6.3(0.5)	6.3(0.5)	6.3(1)	6.3(0.5)	0(0)	31.3(52.3)	0(0)	0(0)	6.3(5.6)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	26.3(0.1)	0(0)	100(1.2)	84.2(0.5)	100(97.1)	36.8(0.1)	84.2(0.9)	0(0)	5.3(0)	57.9(0.2)	5.3(0)	0(0)	10.5(0)	5.3(0)	0(0)
		June-July	0(0)	4.8(0)	0(0)	57.1(3.5)	42.9(0.8)	81(93.5)	57.1(2)	4.8(0)	0(0)	0(0)	23.8(0.1)	0(0)	0(0)	0(0)	0(0)	9.5(0.1)
		Aug-Sep	0(0)	0(0)	0(0)	10(25.3)	15(6.2)	0(0)	0(0)	5(0.6)	80(61.2)	0(0)	30(5.1)	0(0)	0(0)	0(0)	0(0)	5(1.7)
		Oct-Nov	10(0.1)	5(0.1)	0(0)	10(2.7)	5(0.2)	35(8.5)	20(0.4)	15(0.2)	15(3.2)	0(0)	55(12.7)	0(0)	75(71.7)	0(0)	0(0)	5(0.1)
Cornelia	Bluegill	April-May	13.3(0.2)	53.3(6.6)	13.3(1.9)	60(6.2)	60(4.1)	13.3(20.5)	0(0)	6.7(0.1)	0(0)	40(1.6)	46.7(0.8)	53.3(56)	0(0)	13.3(0.3)	26.7(1.5)	20(0.4)
	Yellow Perch	April-May	0(0)	6.7(4)	0(0)	13.3(16)	20(32)	13.3(48)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	13.3(5.4)	93.3(47)	46.7(4.3)	73.3(31.3)	20(2.7)	0(0)	0(0)	26.7(6.5)	0(0)	53.3(2.7)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	20(2.5)	0(0)	80(17.1)	93.3(18.8)	13.3(29.6)	0(0)	0(0)	0(0)	60(22.1)	0(0)	33.3(2.5)	0(0)	0(0)	6.7(0.2)	46.7(7.1)
		Oct-Nov	0(0)	40(14.7)	5(1.1)	45(13.3)	5(0.2)	75(66.1)	0(0)	0(0)	0(0)	25(1.2)	5(0.2)	10(0.4)	0(0)	5(2.7)	5(0.2)	0(0)
	Yellow Bass	April-May	0(0)	46.7(0.1)	0(0)	40(0.3)	86.7(1)	100(97.8)	73.3(0.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	73.3(34.6)	13.3(3.9)	20(22.6)	13.3(37)	0(0)	0(0)	0(0)	0(0)	6.7(0.2)	13.3(1.6)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	6.7(0.2)	0(0)	93.3(33.8)	33.3(1.6)	20(58.8)	20(5.4)	6.7(0.1)	0(0)	0(0)	0(0)	6.7(0.1)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	35(2.5)	10(0.2)	75(36.5)	5(0.1)	70(59.5)	20(0.6)	5(0.1)	5(0.1)	0(0)	0(0)	0(0)	5(0.5)	0(0)	0(0)	0(0)
Five Island	Bluegill	April-May	0(0)	53.3(0.9)	0(0)	100(38.8)	100(40.6)	53.3(2)	6.7(0.1)	53.3(9.3)	0(0)	13.3(0.2)	0(0)	73.3(4)	0(0)	0(0)	6.7(0)	100(4.1)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	50(16.7)	75(82.9)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	25(0.4)
		June-July	0(0)	0(0)	0(0)	88.9(35.6)	100(51)	0(0)	0(0)	44.4(5.8)	0(0)	0(0)	0(0)	11.1(1)	0(0)	0(0)	0(0)	44.4(6.7)
		Aug-Sep	0(0)	0(0)	6.7(0.5)	86.7(37.4)	73.3(22.4)	6.7(0.5)	0(0)	6.7(0.5)	0(0)	0(0)	0(0)	20(38.8)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	37.5(83.3)	12.5(8.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	12.5(8.3)	0(0)
	Yellow Bass	April-May	0(0)	0(0)	0(0)	93.3(3.3)	80(8)	80(72.2)	46.7(3.2)	60(9.9)	0(0)	0(0)	26.7(0.6)	0(0)	0(0)	0(0)	0(0)	80(2.7)

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Ingham		June-July	0(0)	0(0)	0(0)	75(45.2)	55(2.7)	60(10.8)	25(2.3)	30(1.2)	0(0)	0(0)	0(0)	0(0)	55(36.8)	0(0)	0(0)	10(1.1)
		Aug-Sep	0(0)	0(0)	0(0)	26.7(0.2)	13.3(0.1)	86.7(97.5)	40(0.5)	6.7(0)	0(0)	0(0)	0(0)	0(0)	46.7(1.6)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	40(1.3)	5(0)	90(94.9)	35(0.3)	20(0.1)	0(0)	0(0)	0(0)	0(0)	70(3.3)	0(0)	0(0)	0(0)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	63.6(6.9)	100(92.3)	9.1(0.3)	0(0)	9.1(0.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	9.1(0.3)	0(0)
		June-July	0(0)	29.2(0.4)	0(0)	100(85.8)	91.7(5.8)	79.2(8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	94.1(94.3)	23.5(4)	5.9(1.1)	0(0)	0(0)	0(0)	0(0)	0(0)	5.9(0.6)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	15(58.3)	0(0)	0(0)	0(0)	0(0)	45(37.5)	0(0)	0(0)	0(0)	0(0)	0(0)	5(4.2)	0(0)
	Black Crappie	April-May	0(0)	63.6(13.1)	0(0)	36.4(1.4)	81.8(69.9)	18.2(0.5)	0(0)	36.4(4.8)	0(0)	0(0)	9.1(0.1)	0(0)	0(0)	63.6(10.1)	0(0)	0(0)
	Bluegill	April-May	0(0)	80(65.9)	10(0.1)	80(7.8)	60(9.8)	0(0)	0(0)	40(0.3)	0(0)	70(11.9)	0(0)	50(3.3)	0(0)	10(0.1)	0(0)	30(0.8)
		June-July	33.3(1.6)	22.2(0.6)	0(0)	66.7(2.2)	44.4(0.6)	66.7(44.7)	0(0)	44.4(4.1)	11.1(0.1)	33.3(0.7)	11.1(3.2)	55.6(40.1)	0(0)	11.1(0.1)	11.1(0.1)	66.7(1.9)
	White Bass	June-July	0(0)	16.7(3.3)	0(0)	22.2(5.9)	33.3(53.9)	0(0)	0(0)	5.6(0.7)	66.7(21.1)	0(0)	22.2(3.3)	0(0)	0(0)	5.6(0.7)	27.8(11.2)	0(0)
Lost Island	Yellow Perch	April-May	0(0)	6.7(0.2)	0(0)	60(48.7)	46.7(42.5)	0(0)	0(0)	13.3(0.5)	0(0)	26.7(1.2)	6.7(0.2)	13.3(0.7)	0(0)	0(0)	0(0)	20(6)
		June-July	43.8(5.1)	25(7.7)	0(0)	62.5(10.3)	43.8(2.8)	12.5(4.9)	0(0)	56.3(1.3)	0(0)	6.3(0.1)	0(0)	12.5(5.6)	0(0)	18.8(4.3)	0(0)	68.8(58)
		Aug-Sep	0(0)	0(0)	6.7(0)	46.7(81.4)	33.3(0.4)	6.7(16.9)	6.7(0)	0(0)	6.7(0)	6.7(0)	6.7(0)	0(0)	6.7(0)	0(0)	13.3(0.2)	13.3(0.9)
		Oct-Nov	0(0)	20(4)	6.7(0.1)	13.3(0.3)	0(0)	73.3(95)	0(0)	13.3(0.1)	6.7(0.1)	0(0)	0(0)	6.7(0.1)	0(0)	0(0)	0(0)	13.3(0.2)
	Yellow Bass	April-May	0(0)	26.7(6.6)	0(0)	93.3(17.1)	6.7(0.1)	0(0)	26.7(75.3)	13.3(0.2)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	13.3(0.7)
		June-July	0(0)	15(0.6)	0(0)	35(4.2)	45(0.5)	85(94.3)	30(0.3)	0(0)	0(0)	5(0)	0(0)	5(0)	0(0)	5(0)	0(0)	10(0.1)
		Aug-Sep	0(0)	0(0)	6.7(0)	86.7(61.2)	60(18.8)	13.3(0)	0(0)	0(0)	6.7(0)	0(0)	0(0)	0(0)	86.7(20)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	31.6(0.6)	0(0)	42.1(12.5)	47.4(1.4)	31.6(0.8)	21.1(70)	0(0)	5.3(0)	0(0)	0(0)	0(0)	15.8(14.6)	5.3(0)	0(0)	0(0)
Pleasant	Yellow Perch	April-May	0(0)	0(0)	0(0)	6.7(7.1)	0(0)	0(0)	0(0)	0(0)	60(92.9)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	22.7(71.4)	4.5(14.3)	4.5(14.3)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	16.7(48.6)	11.1(5.7)	0(0)	5.6(2.9)	5.6(5.7)	5.6(2.9)	11.1(5.7)	0(0)	5.6(2.9)	0(0)	5.6(20)	0(0)	11.1(5.7)
		Oct-Nov	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	20(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	26.7(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	4.8(21.7)	9.5(65.2)	0(0)	0(0)	0(0)	0(0)	0(0)	9.5(13)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	27.8(66)	16.7(9.7)	16.7(10.4)	22.2(8.3)	0(0)	11.1(2.1)	0(0)	5.6(0.7)	0(0)	5.6(0.7)	5.6(0.7)	11.1(1.4)	0(0)
		Oct-Nov	0(0)	5(1.5)	0(0)	25(47.8)	0(0)	5(4.5)	5(3)	5(16.4)	30(10.4)	0(0)	10(3)	0(0)	0(0)	0(0)	20(13.4)	0(0)
Silver	White Bass	April-May	0(0)	0(0)	0(0)	66.7(11)	100(57.2)	100(30.3)	0(0)	33.3(0.4)	0(0)	0(0)	66.7(1.1)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	6.3(0)	0(0)	37.5(0.1)	12.5(0.1)	93.8(87.8)	6.3(0)	12.5(0)	18.8(0.1)	0(0)	12.5(0)	0(0)	81.3(11.9)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	41.7(8)	0(0)	66.7(91.4)	0(0)	16.7(0.3)	0(0)	0(0)	8.3(0.3)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	80(7.6)	46.7(10)	53.3(81.8)	6.7(0)	20(0.1)	0(0)	0(0)	20(0.4)	6.7(0)	0(0)	0(0)	0(0)	6.7(0)
		June-July	27.8(0.2)	38.9(0.6)	0(0)	77.8(1.9)	61.1(1.7)	61.1(88.5)	0(0)	16.7(0.1)	0(0)	5.6(0)	27.8(0.4)	5.6(0)	0(0)	38.9(2.2)	16.7(0.2)	83.3(4.2)

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
		Aug-Sep	0(0)	4.2(0)	0(0)	75(1.1)	58.3(0.8)	91.7(96.5)	0(0)	33.3(0.1)	0(0)	0(0)	37.5(0.3)	0(0)	0(0)	0(0)	0(0)	29.2(1.1)
		Oct-Nov	0(0)	10(0.3)	0(0)	85(92.3)	0(0)	20(6.5)	0(0)	10(0.5)	5(0.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	17.6(9.4)	0(0)	64.7(17.7)	17.6(8.8)	88.2(63.2)	5.9(0.2)	17.6(0.2)	0(0)	0(0)	11.8(0.3)	0(0)	0(0)	0(0)	11.8(0.2)	0(0)
		June-July	0(0)	17.6(0.3)	5.9(0)	35.3(1.5)	41.2(0.2)	94.1(85)	5.9(0)	11.8(0)	11.8(1)	0(0)	94.1(5.5)	0(0)	29.4(6.3)	5.9(0)	0(0)	17.6(0.1)
		Aug-Sep	0(0)	16.7(0)	0(0)	91.7(1.1)	66.7(0.5)	100(92.5)	16.7(2.2)	33.3(0)	8.3(0)	0(0)	83.3(0.7)	0(0)	50(2.9)	0(0)	0(0)	8.3(0.1)
		Oct-Nov	0(0)	0(0)	0(0)	66.7(50)	0(0)	33.3(12.5)	33.3(3.1)	33.3(3.1)	0(0)	0(0)	100(31.3)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 15. Frequency and percent occurrence (parentheses) of 16 major prey items found in Black Crappie, Bluegill, Walleye, White Bass, Yellow Perch, and Yellow Bass from six natural lakes in Iowa taken at bimonthly periods from April to November, 2020.

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Center	Black Crappie	June-July	0(0)	0(0)	0(0)	100(10.9)	80(3.9)	20(70.8)	20(3.9)	20(0.5)	80(1.9)	0(0)	80(0.8)	0(0)	20(7.2)	0(0)	20(0.1)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	50(28.4)	66.7(55.6)	0(0)	16.7(0.4)	16.7(0.4)	83.3(8.6)	0(0)	16.7(1.2)	0(0)	16.7(5.3)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	100(75)	0(0)	0(0)	0(0)	0(0)	100(12.5)	0(0)	100(12.5)	0(0)	0(0)	0(0)	0(0)	0(0)
	Walleye	April-May	0(0)	16.7(32.8)	0(0)	33.3(5)	66.7(27.7)	16.7(28.6)	0(0)	16.7(4.2)	16.7(0.8)	0(0)	16.7(0.8)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	12.5(0.2)	0(0)	75(84.7)	50(3.4)	12.5(4.1)	0(0)	25(0.3)	37.5(1.9)	0(0)	0(0)	0(0)	25(5.3)	0(0)	12.5(0.2)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	87.5(95.2)	0(0)	0(0)	12.5(4.8)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	0(0)	0(0)	28.6(80)	0(0)	0(0)	100(20)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	April-May	0(0)	0(0)	0(0)	83.3(61.1)	100(33.1)	0(0)	0(0)	33.3(5.4)	0(0)	0(0)	16.7(0.5)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	85.7(37.4)	85.7(53.8)	0(0)	0(0)	50(7.3)	7.1(0.2)	7.1(0.1)	21.4(1.2)	0(0)	0(0)	14.3(0.2)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	22.2(36.4)	11.1(9.1)	0(0)	11.1(9.1)	0(0)	22.2(27.3)	0(0)	0(0)	0(0)	22.2(18.2)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	25(11.5)	12.5(1)	25(83.3)	0(0)	0(0)	12.5(1)	0(0)	25(2.1)	0(0)	12.5(1)	0(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	33.3(0)	0(0)	46.7(0)	86.7(0.2)	93.3(99.5)	0(0)	13.3(0)	0(0)	6.7(0)	73.3(0.2)	0(0)	0(0)	6.7(0)	0(0)	6.7(0)
		June-July	0(0)	5.3(0.1)	0(0)	94.7(83.8)	57.9(0.5)	36.8(2)	5.3(0)	57.9(0.3)	15.8(0.2)	5.3(0)	21.1(1.7)	0(0)	10.5(11.4)	5.3(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	30(26.3)	25(66.3)	5(0.1)	0(0)	0(0)	55(3.6)	0(0)	25(0.9)	0(0)	10(2.8)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	6.7(0.8)	0(0)	60(36.8)	6.7(0.1)	40(34.2)	0(0)	20(1.1)	13.3(0.6)	0(0)	73.3(20.4)	0(0)	33.3(5.7)	6.7(0.3)	0(0)	0(0)
Cornelia	Yellow Perch	April-May	0(0)	13.3(0.6)	20(0.1)	100(92.7)	80(1)	13.3(0.3)	0(0)	6.7(0)	0(0)	0(0)	0(0)	33.3(0.5)	0(0)	0(0)	0(0)	40(4.8)
		June-July	0(0)	0(0)	26.7(0.3)	100(94.9)	93.3(2.8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	26.7(0.3)	0(0)	0(0)	0(0)	73.3(1.7)
		Aug-Sep	0(0)	0(0)	6.7(0.8)	60(89.5)	26.7(6.5)	0(0)	0(0)	0(0)	0(0)	13.3(2.4)	0(0)	0(0)	0(0)	0(0)	6.7(0.8)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	6.3(3.5)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	18.8(1.2)	6.3(91.8)	0(0)	0(0)	12.5(3.5)	0(0)

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
		April-May	0(0)	0(0)	0(0)	60(1.1)	40(1)	100(97.8)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Bass	June-July	0(0)	0(0)	26.7(0.2)	93.3(45.2)	20(0.1)	13.3(54.3)	0(0)	0(0)	13.3(0.1)	0(0)	0(0)	6.7(0)	6.7(0.1)	0(0)	0(0)	6.7(0)
		Aug-Sep	0(0)	0(0)	13.3(1.6)	46.7(50.4)	0(0)	26.7(23.2)	20(8.8)	0(0)	0(0)	6.7(0.8)	0(0)	6.7(5.6)	20(9.6)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	21.4(10.2)	0(0)	42.9(41.9)	7.1(0.2)	28.6(45.2)	7.1(0.4)	0(0)	14.3(1.3)	0(0)	0(0)	7.1(0.2)	7.1(0.2)	0(0)	21.4(0.5)	0(0)
		April-May	0(0)	0(0)	0(0)	50(24.7)	100(47.3)	0(0)	0(0)	50(28)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	June-July	0(0)	0(0)	0(0)	100(42.4)	86.7(11.4)	0(0)	0(0)	80(27.7)	6.7(0.8)	0(0)	0(0)	13.3(1.1)	0(0)	0(0)	0(0)	40(16.7)
		Aug-Sep	0(0)	0(0)	0(0)	80(45.3)	20(7)	20(13.3)	6.7(0.8)	6.7(0.8)	0(0)	0(0)	0(0)	46.7(21.9)	0(0)	0(0)	6.7(0.8)	20(10.2)
Five Island		Oct-Nov	0(0)	0(0)	0(0)	22.2(47.4)	0(0)	11.1(31.6)	0(0)	22.2(10.5)	0(0)	0(0)	11.1(5.3)	0(0)	0(0)	0(0)	0(0)	11.1(5.3)
		April-May	0(0)	0(0)	0(0)	43.8(0.8)	93.8(53.9)	56.3(40.6)	0(0)	50(0.6)	0(0)	0(0)	18.8(0.7)	0(0)	0(0)	6.3(0.1)	0(0)	50(3.4)
	Yellow Bass	June-July	0(0)	0(0)	0(0)	73.3(53.2)	66.7(15.1)	46.7(25.8)	0(0)	53.3(2.6)	20(0.6)	0(0)	20(0.6)	0(0)	26.7(0.6)	0(0)	20(0.7)	33.3(0.9)
		Aug-Sep	0(0)	0(0)	0(0)	93.3(12.6)	66.7(13)	93.3(60.6)	46.7(0.8)	33.3(0.5)	6.7(0)	0(0)	6.7(0.1)	13.3(0.1)	66.7(12)	0(0)	6.7(0)	6.7(0.1)
		Oct-Nov	0(0)	6.7(0)	0(0)	13.3(0.6)	0(0)	60(98.3)	13.3(0.1)	26.7(0.3)	26.7(0.1)	0(0)	6.7(0)	0(0)	6.7(0.1)	0(0)	0(0)	13.3(0.5)
		April-May	0(0)	71.4(0.5)	28.6(0.2)	71.4(4)	100(9)	85.7(84.9)	0(0)	100(0.5)	0(0)	0(0)	42.9(0.1)	0(0)	0(0)	14.3(0.1)	28.6(0.6)	0(0)
	Black Crappie	June-July	10(0)	40(0)	10(0)	80(0.1)	100(4.9)	100(94.8)	10(0)	40(0)	20(0)	10(0)	0(0)	20(0)	0(0)	20(0)	0(0)	0(0)
		Oct-Nov	25(0)	100(9.6)	0(0)	100(0.5)	25(0.2)	100(87.8)	0(0)	100(1.5)	0(0)	0(0)	50(0.4)	0(0)	0(0)	0(0)	0(0)	0(0)
	Bluegill	April-May	0(0)	0(0)	0(0)	60(50.5)	60(11.6)	0(0)	0(0)	40(4.2)	0(0)	20(1.1)	0(0)	0(0)	0(0)	20(1.1)	20(0)	80(31.6)
		Oct-Nov	0(0)	33.3(0)	0(0)	66.7(0.4)	33.3(0)	100(98.5)	33.3(0)	0(0)	0(0)	66.7(0.5)	0(0)	33.3(0.1)	0(0)	0(0)	0(0)	66.7(0.5)
	White Bass	April-May	0(0)	0(0)	16.7(1.4)	50(88.6)	50(10)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	100(2.9)	0(0)	0(0)	0(0)	50(95.1)	50(1.9)	0(0)	0(0)
Lost Island		April-May	0(0)	13.3(0.1)	33.3(0.2)	86.7(17.8)	86.7(80.2)	0(0)	0(0)	6.7(0)	0(0)	13.3(0.1)	6.7(0)	0(0)	0(0)	6.7(1.5)	0(0)	6.7(0)
	Yellow Perch	June-July	0(0)	26.7(0.8)	46.7(1.4)	100(78.8)	100(14.3)	6.7(0.3)	6.7(0.1)	13.3(0.2)	13.3(0.2)	40(3.4)	0(0)	6.7(0.2)	0(0)	0(0)	0(0)	20(0.4)
		Aug-Sep	0(0)	6.7(0.5)	13.3(0.5)	80(37)	13.3(1)	0(0)	0(0)	0(0)	0(0)	6.7(0.3)	0(0)	0(0)	0(0)	0(0)	0(0)	53.3(60.8)
		Oct-Nov	0(0)	26.7(1.5)	6.7(0)	20(0.1)	6.7(0)	66.7(97.5)	6.7(0)	13.3(0.1)	40(0.4)	6.7(0.1)	6.7(0.1)	0(0)	6.7(0)	0(0)	6.7(0)	26.7(0.1)
		April-May	0(0)	26.7(1.9)	0(0)	40(10.7)	60(6)	46.7(80.1)	6.7(0.2)	13.3(0.4)	0(0)	0(0)	0(0)	6.7(0.2)	0(0)	6.7(0.2)	0(0)	6.7(0.2)
	Yellow Bass	June-July	0(0)	13.3(0)	53.3(0.1)	100(94.5)	100(5.4)	13.3(0)	0(0)	0(0)	13.3(0)	6.7(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	14.3(0.3)	85.7(98.6)	7.1(0.2)	0(0)	0(0)	7.1(0.2)	21.4(0.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	6.7(0)	40(16.5)	0(0)	26.7(8)	0(0)	80(74.2)	0(0)	26.7(0.2)	33.3(0.3)	6.7(0)	0(0)	0(0)	6.7(0)	0(0)	20(0.5)	6.7(0)
		April-May	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	93.3(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	June-July	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	16.7(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
Pleasant		Aug-Sep	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	33.3(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	6.7(0.7)	0(0)	40(2.1)	0(0)	46.7(81.8)	0(0)	26.7(1.2)	0(0)	6.7(0.1)	33.3(11.8)	0(0)	13.3(0.4)	40(1.8)	6.7(0)	6.7(0.1)
		April-May	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	25(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)

Lake	Species		Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
Silver	Yellow Bass	June-July	0(0)	0(0)	0(0)	43.8(13.3)	37.5(9.1)	6.3(0.6)	18.8(73.5)	0(0)	31.3(2.3)	18.8(1.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	53.3(43.8)	33.3(26.3)	6.7(7.8)	13.3(21.3)	0(0)	13.3(0.6)	0(0)	6.7(0.3)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	26.7(0.4)	13.3(0.1)	40(1.9)	0(0)	26.7(90.4)	0(0)	0(0)	40(0.4)	6.7(0)	66.7(6.7)	0(0)	0(0)	6.7(0)	0(0)	0(0)
	Walleye	April-May	0(0)	100(9.9)	0(0)	100(2.8)	100(73.2)	100(12.7)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	100(1.4)	0(0)	0(0)
		June-July	0(0)	0(0)	0(0)	100(93)	40(2.3)	20(0.6)	0(0)	20(0.6)	20(1.2)	0(0)	0(0)	0(0)	20(2.3)	0(0)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	0(0)	20(33.3)	10(5.6)	0(0)	0(0)	0(0)	70(61.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	80(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	White Bass	April-May	0(0)	100(1.2)	0(0)	100(0.4)	100(1.2)	100(96.1)	0(0)	0(0)	0(0)	0(0)	100(1.2)	0(0)	0(0)	0(0)	0(0)	0(0)
		June-July	0(0)	33.3(0.2)	0(0)	66.7(27.4)	50(6.5)	100(6.6)	33.3(0.1)	50(0.2)	100(3.7)	0(0)	33.3(0.2)	16.7(0)	100(55)	33.3(0.1)	0(0)	0(0)
		Aug-Sep	0(0)	0(0)	10(6.7)	0(0)	0(0)	0(0)	0(0)	0(0)	100(93.3)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	83.3(100)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
	Yellow Perch	April-May	0(0)	6.7(2)	6.7(0)	60(2.4)	86.7(82.2)	6.7(0)	0(0)	46.7(0.5)	0(0)	0(0)	20(0.2)	0(0)	0(0)	73.3(2.8)	26.7(0.4)	73.3(9.5)
		June-July	0(0)	80(38.5)	6.7(0.1)	100(40.2)	86.7(7.1)	33.3(2.6)	0(0)	86.7(7.8)	6.7(0.2)	6.7(0.1)	26.7(0.4)	6.7(0.1)	0(0)	20(0.2)	0(0)	53.3(2.8)
		Aug-Sep	0(0)	0(0)	0(0)	6.7(14.3)	13.3(28.6)	0(0)	0(0)	0(0)	26.7(57.1)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	0(0)	0(0)	6.7(0.2)	0(0)	6.7(38.3)	13.3(61.4)	6.7(0.1)	0(0)	0(0)	0(0)	0(0)	6.7(0.1)	0(0)	0(0)	0(0)
	Yellow Bass	April-May	0(0)	16.7(5.9)	0(0)	25(0.7)	66.7(2.4)	66.7(87.1)	0(0)	16.7(0.9)	0(0)	0(0)	75(2.6)	0(0)	0(0)	0(0)	8.3(0.1)	16.7(0.2)
		June-July	13.3(0.1)	53.3(0.7)	20(0.1)	73.3(13)	73.3(12.6)	80(5.3)	6.7(0)	66.7(3.3)	0(0)	0(0)	20(0.2)	0(0)	93.3(64.3)	6.7(0.2)	20(0.1)	6.7(0)
		Aug-Sep	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	20(57.1)	0(0)	0(0)	0(0)	6.7(42.9)	0(0)	0(0)	0(0)
		Oct-Nov	0(0)	16.7(8.3)	0(0)	16.7(12.5)	0(0)	0(0)	0(0)	16.7(29.2)	16.7(16.7)	0(0)	33.3(33.3)	0(0)	0(0)	0(0)	0(0)	0(0)

Table 16. Lake, period, number of prey taxon observed, species being compared (BLG = Bluegill; BLC = Black Crappie; CRP = crappie species combined; YEP = Yellow Perch; YLB = Yellow Bass; WHB = White Bass), and Schoener's index values for diet data collected from eight natural lakes in Iowa between April and September, 2018. Schoener's index overlap values > 0.6 were considered to be biologically significant.

Lake	Period	Number of Prey Taxon	Species	Schoener's
Center	April-May	13	BLC*BLG	0.72
Center	April-May	11	BLC*YLB	0.71
Center	April-May	13	BLG*YLB	0.66
Center	June-July	15	BLC*BLG	0.83
Center	June-July	12	BLC*YEP	0.15
Center	June-July	14	BLG*YEP	0.24
Center	August-September	7	BLC*YEP	0.34
Center	August-September	7	BLC*YLB	0.48
Center	August-September	7	YEP*YLB	0.61
Center	October-November	10	BLC*YEP	0.00
Center	October-November	10	BLC*YLB	0.62
Center	October-November	9	YEP*YLB	0.00
Cornelia	April-May	7	BLG*BLC	0.00
Cornelia	April-May	3	BLG*YLB	0.00
Cornelia	April-May	7	BLC*YLB	0.51
Cornelia	June-July	12	BLG*YLB	0.82
Cornelia	August-September	12	YEP*YLB	0.23
Cornelia	October-November	11	YEP*YLB	0.88
Ingham	April-May	9	CRP*YEP	0.67
Ingham	June-July	14	CRP*YEP	0.30
Ingham	August-September	10	CRP*YEP	0.01
Lost Island	April-May	13	BLC*BLG	0.14
Lost Island	April-May	13	BLC*YEP	0.26
Lost Island	April-May	13	BLC*YLB	0.16
Lost Island	April-May	13	BLG*YEP	0.67
Lost Island	April-May	13	BLG*YLB	0.26
Lost Island	April-May	12	YEP*YLB	0.26
Lost Island	June-July	13	BLC*YEP	0.45
Lost Island	June-July	12	BLC*YLB	0.70
Lost Island	June-July	12	YEP*YLB	0.52
Lost Island	August-September	14	YEP*YLB	0.08
Lost Island	October-November	13	YEP*YLB	0.06
Pleasant	April-May	9	YEP*YLB	0.10
Pleasant	June-July	6	YEP*YLB	0.80
Pleasant	August-September	7	YEP*YLB	0.82
Pleasant	October-November	10	YEP*YLB	0.33
Silver	June-July	13	WHB*YLB	0.88
Silver	August-September	8	WHB*YEP	0.58
Silver	August-September	8	WHB*YLB	0.86
Silver	August-September	9	YEP*YLB	0.65
Silver	October-November	7	WHB*YEP	0.77
Silver	October-November	11	WHB*YLB	0.80
Silver	October-November	11	YEP*YLB	0.63
East Okoboji	April-May	13	YEP*YLB	0.58
Rice	April-May	12	BLG*YEP	0.50

Table 17. Lake, period, number of prey taxon observed, species being compared (BLG = Bluegill; BLC = Black Crappie; YEP = Yellow Perch; YLB = Yellow Bass; WHB = White Bass), and Schoener's index values for diet data collected from six natural lakes in Iowa between April and September, 2019. Schoener's index overlap values > 0.6 were considered to be biologically significant.

Lake	Period	Number of Prey Taxon	Species	Schoener's
Center	April-May	10	BLC*BLG	0.40
Center	April-May	9	BLC*YEP	0.34
Center	April-May	11	BLC*YLB	0.27
Center	April-May	8	BLG*YEP	0.23
Center	April-May	11	BLG*YLB	0.87
Center	April-May	11	YEP*YLB	0.14
Center	June-July	10	YEP*YLB	0.39
Center	August-September	8	YEP*YLB	0.26
Center	October-November	12	YEP*YLB	0.17
Cornelia	April-May	13	BLG*YEP	0.35
Cornelia	April-May	14	BLG*YLB	0.22
Cornelia	April-May	5	YEP*YLB	0.50
Cornelia	June-July	8	YEP*YLB	0.64
Cornelia	August-September	10	YEP*YLB	0.49
Cornelia	October-November	14	YEP*YLB	0.76
Five Island	April-May	11	BLG*YLB	0.25
Five Island	April-May	7	YEP*YLB	0.12
Five Island	August-September	8	YEP*YLB	0.01
Lost Island	April-May	11	BLC*BLG	0.25
Lost Island	April-May	10	BLC*YEP	0.45
Lost Island	April-May	9	BLC*YLB	0.08
Lost Island	April-May	10	BLG*YEP	0.21
Lost Island	April-May	10	BLG*YLB	0.15
Lost Island	April-May	9	YEP*YLB	0.18
Lost Island	June-July	13	WHB*YEP	0.13
Lost Island	June-July	13	WHB*YLB	0.05
Lost Island	June-July	11	YEP*YLB	0.10
Lost Island	August-September	11	YEP*YLB	0.62
Lost Island	October-November	12	YEP*YLB	0.02
Pleasant	April-May	2	YEP*YLB	0.93
Pleasant	June-July	5	YEP*YLB	0.13
Pleasant	August-September	13	YEP*YLB	0.60
Silver	April-May	10	YEP*YLB	0.80
Silver	June-July	16	YEP*YLB	0.88
Silver	August-September	10	WHB*YEP	0.88
Silver	August-September	10	WHB*YLB	0.91
Silver	August-September	10	YEP*YLB	0.94
Silver	October-November	6	WHB*YEP	0.15

Table 18. Lake, period, number of prey taxon observed, species being compared (BLG = Bluegill; BLC = Black Crappie; YEP = Yellow Perch; YLB = Yellow Bass; WAE = Walleye; WHB = White Bass), and Schoener's index values for diet data collected from six natural lakes in Iowa between April and September, 2020. Schoener's index overlap values > 0.6 were considered to be biologically significant.

Lake	Period	Number of Prey Taxon	Species	Schoener's
Center	June-July	11	YEP*YLB	0.40
Cornelia	April-May	8	YEP*YLB	0.02
Cornelia	June-July	8	YEP*YLB	0.45
Cornelia	August-September	9	YEP*YLB	0.52
Cornelia	October-November	10	YEP*YLB	0.04
Five Island	June-July	10	YEP*YLB	0.58
Five Island	August-September	11	YEP*YLB	0.35
Lost Island	April-May	12	YEP*YLB	0.17
Lost Island	June-July	13	BLC*YEP	0.05
Lost Island	June-July	12	BLC*YLB	0.05
Lost Island	June-July	11	YEP*YLB	0.84
Lost Island	August-September	8	YEP*YLB	0.38
Lost Island	October-November	14	YEP*YLB	0.76
Pleasant	June-July	6	YEP*YLB	0.02
Pleasant	August-September	6	YEP*YLB	0.01
Pleasant	October-November	11	YEP*YLB	0.91
Silver	April-May	10	YEP*YLB	0.06
Silver	June-July	16	YEP*YLB	0.27
Silver	August-September	4	WAE*WHB	0.61
Silver	August-September	3	WAE*YEP	0.77
Silver	August-September	4	WAE*YLB	0.57
Silver	August-September	4	WHB*YEP	0.57
Silver	August-September	3	WHB*YLB	0.57
Silver	August-September	4	YEP*YLB	0.57
Silver	October-November	8	YEP*YLB	0.00

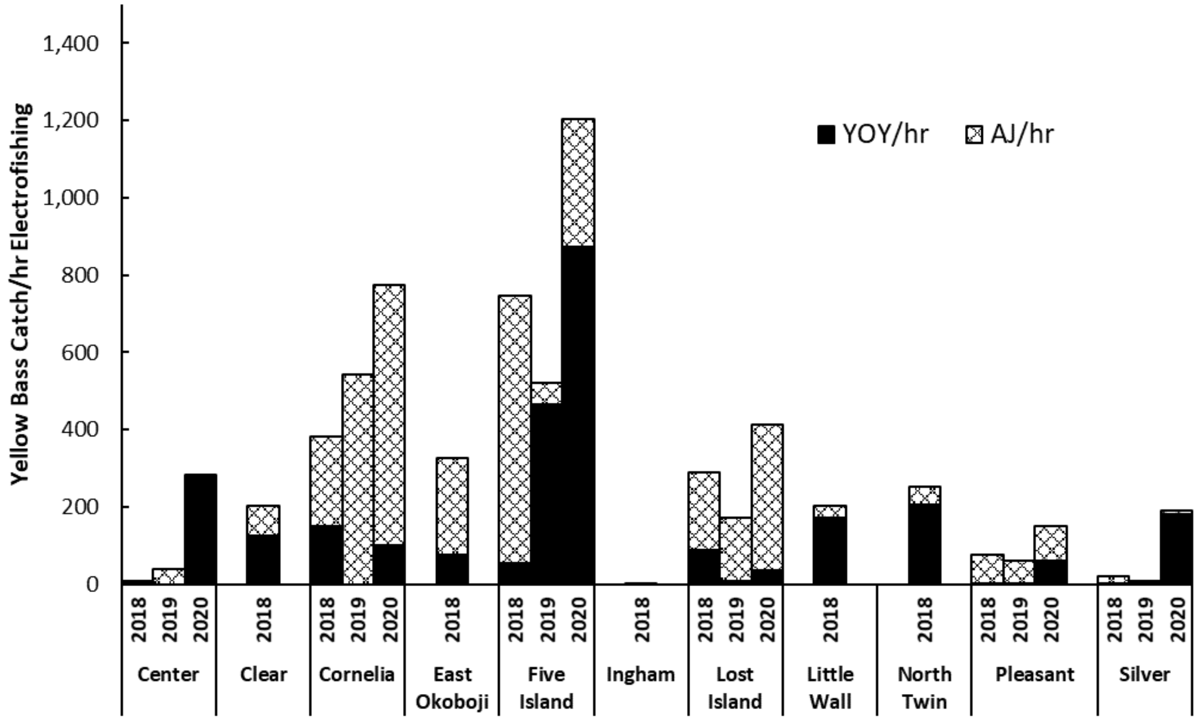


Figure 1. Number of age-0 and adult/juvenile (AJ) Yellow Bass caught per hour electrofishing (night) at eleven natural lakes in Iowa, fall 2018-2020. No Yellow Bass were captured in Rice, Spirit, Storm, or Tuttle lakes during electrofishing investigations in 2018 and no Yellow Bass were captured in Ingham and Tuttle lakes during electrofishing surveys in 2019.

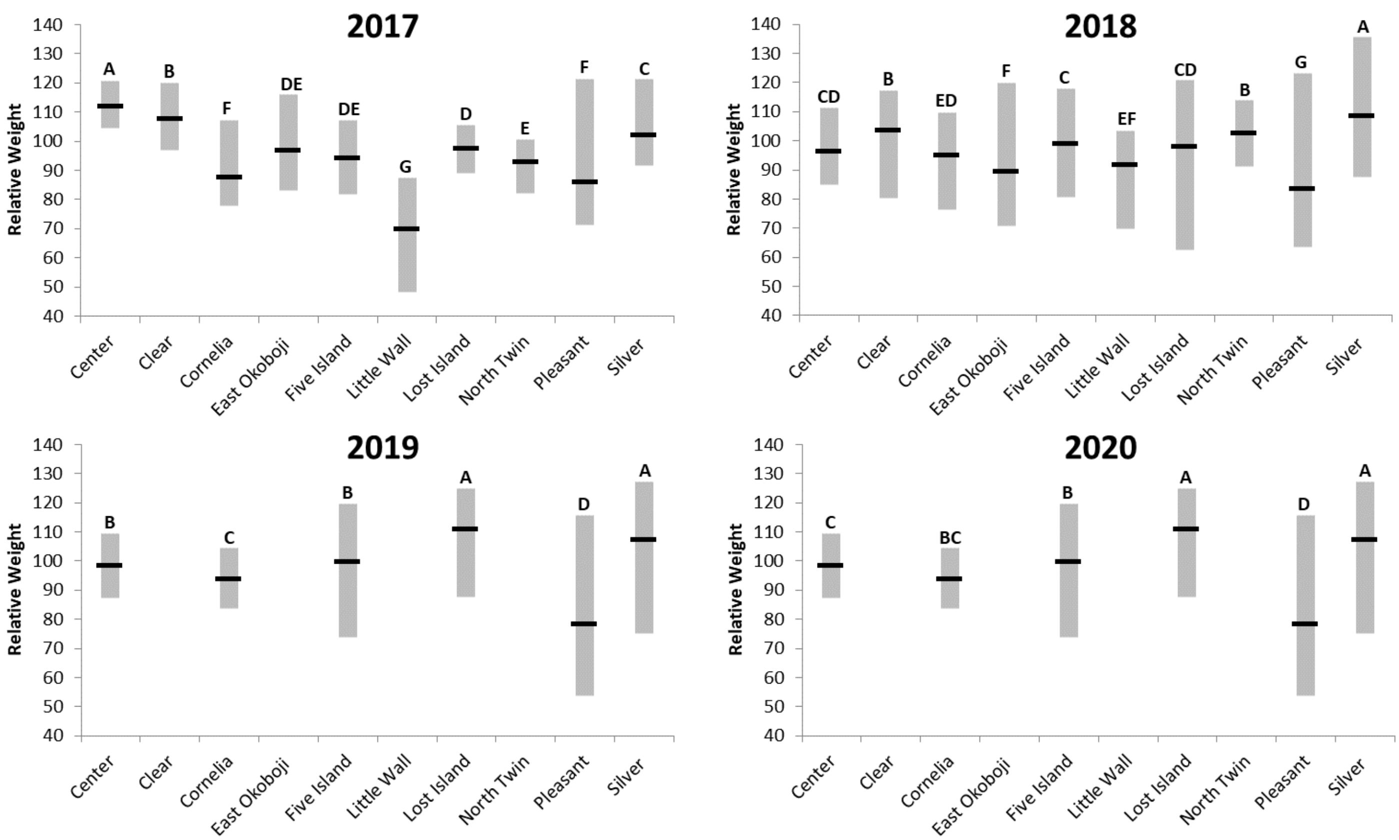


Figure 2. Mean relative weights of Yellow Bass collected between July and October for ten natural lakes in Iowa, 2017-2020. Different letters denote significant differences among lakes for each year sampled (P < 0.05).

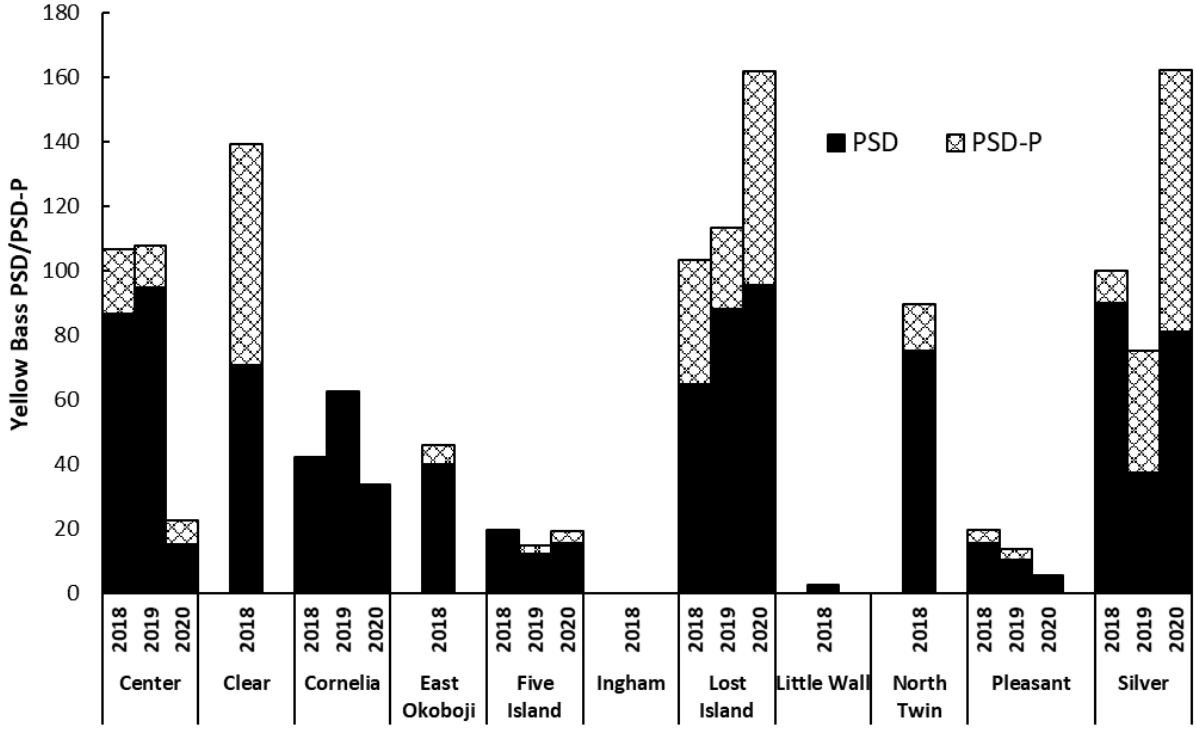


Figure 3. Yellow Bass proportional stock density (PSD) and proportional stock density-preferred (PSD-P) from fall electrofishing survey conducted during 2018-2020 at eleven natural lakes where Yellow Bass populations were previously detected. No stock-size fish were captured at Ingham Lake.

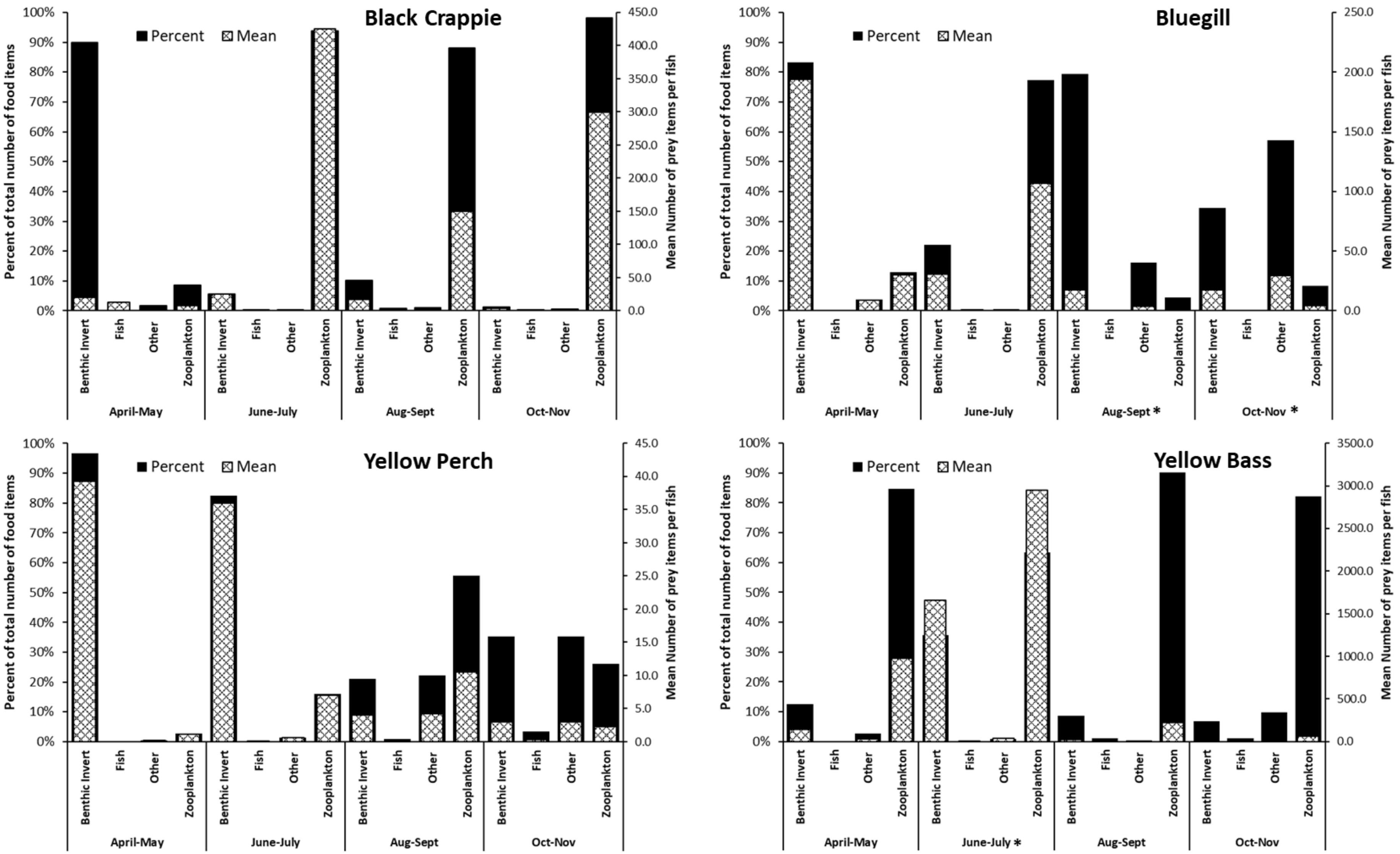


Figure 4. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Black Crappie (upper left), Bluegill (upper right), Yellow Perch (lower left) and Yellow Bass (lower right) collected during four open-water periods at Center Lake, 2018-2020 (cumulative by species; asterisks by period indicates <10 sample).

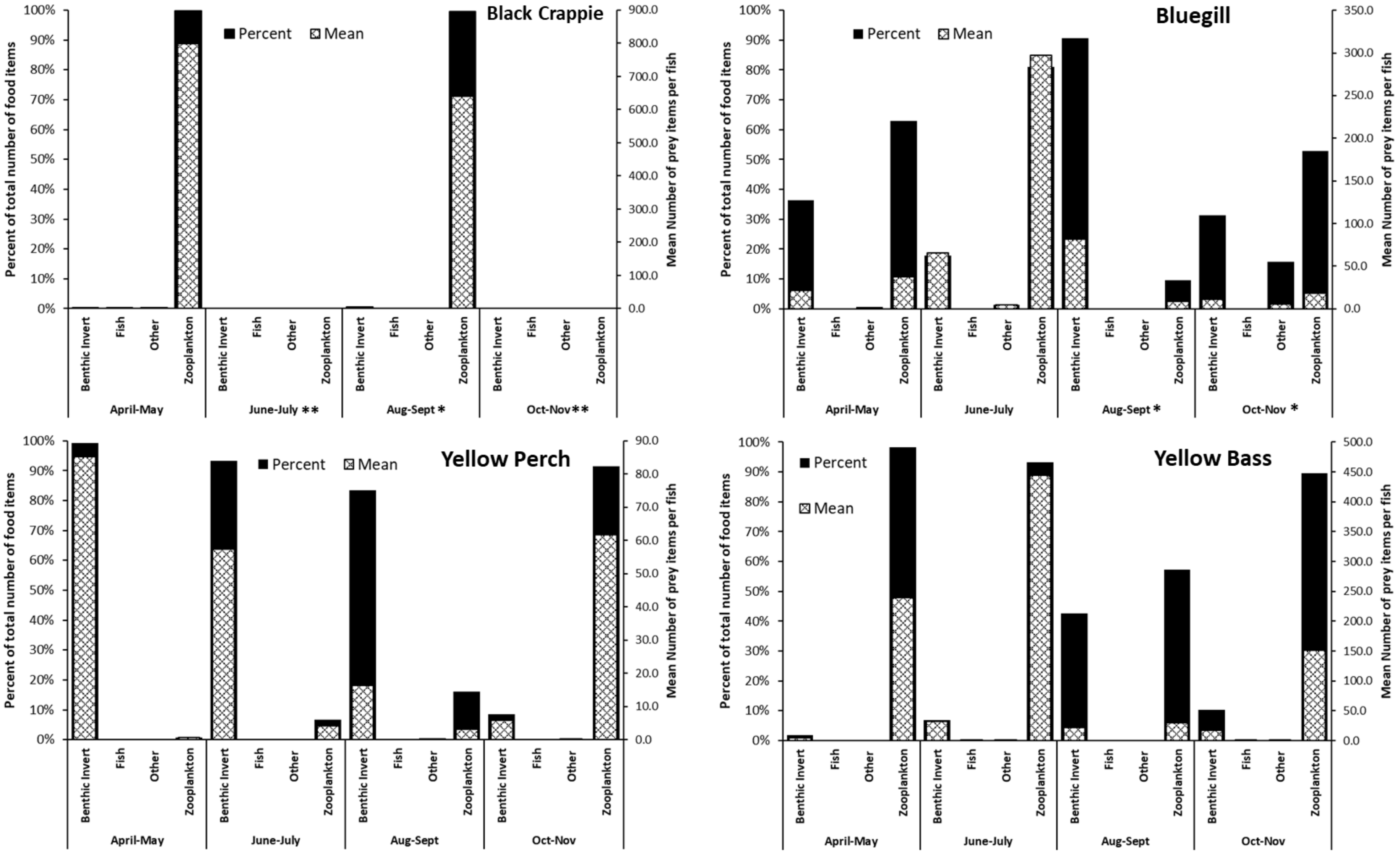


Figure 5. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Black Crappie (upper left), Bluegill (upper right), Yellow Perch (lower left) and Yellow Bass (lower right) collected during four open-water periods at Lake Cornelia, 2018-2020 (cumulative by species; asterisks by period indicates <10 sample; double asterisks by period indicates no sample).

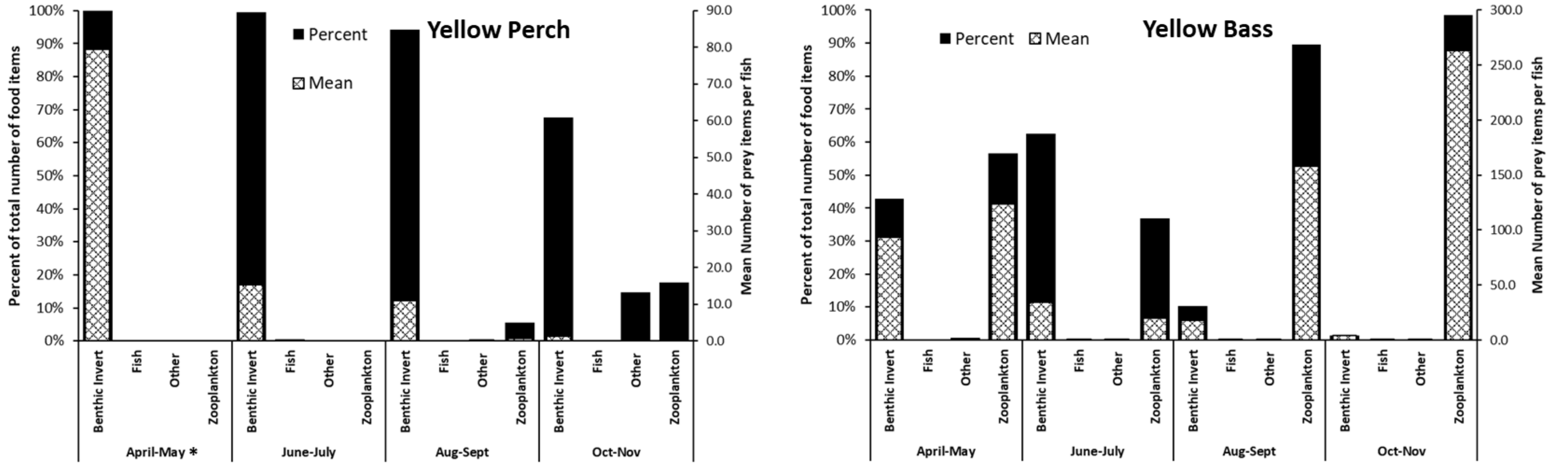


Figure 6. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Yellow Perch (left) and Yellow Bass (right) collected during four open-water periods at Five Island Lake, 2019-2020 (cumulative by species; asterisks by period indicates <10 sample).

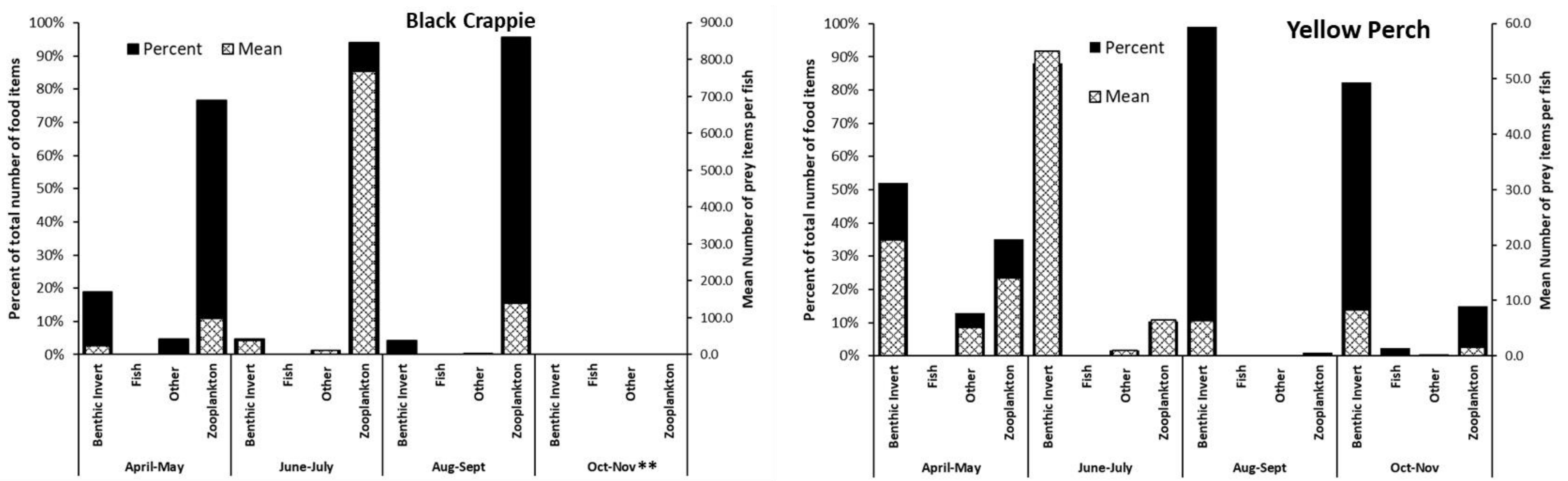


Figure 7. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Black Crappie (left) and Yellow Perch (right) collected during four open-water periods at Ingham Lake, 2018-2019 (cumulative by species; double asterisks by period indicates no sample).

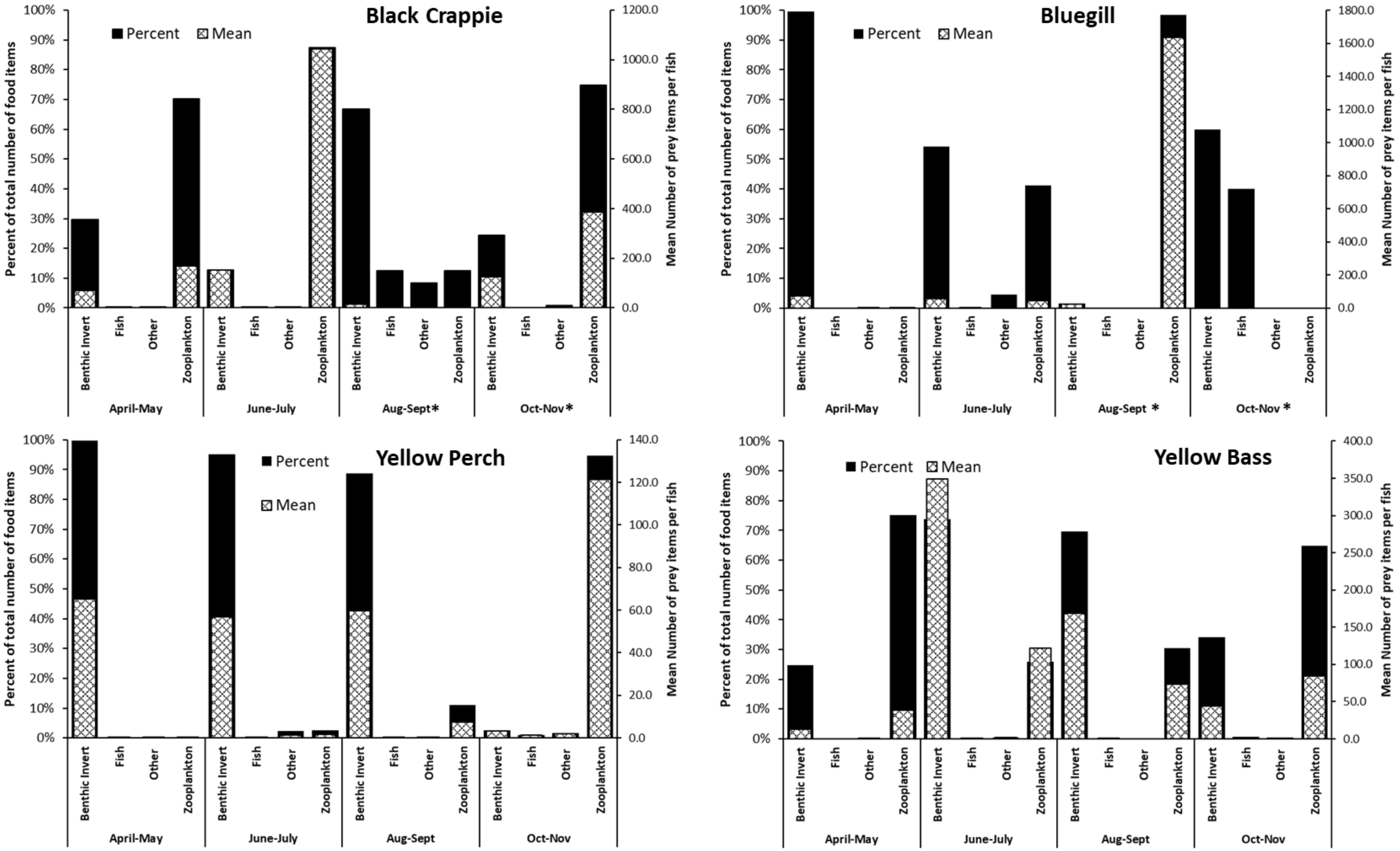


Figure 8. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Black Crappie (upper left), Bluegill (upper right), Yellow Perch (lower left) and Yellow Bass (lower right) collected during four open-water periods at Lost Island Lake, 2018-2020 (cumulative by species; asterisks by period indicates <10 sample).

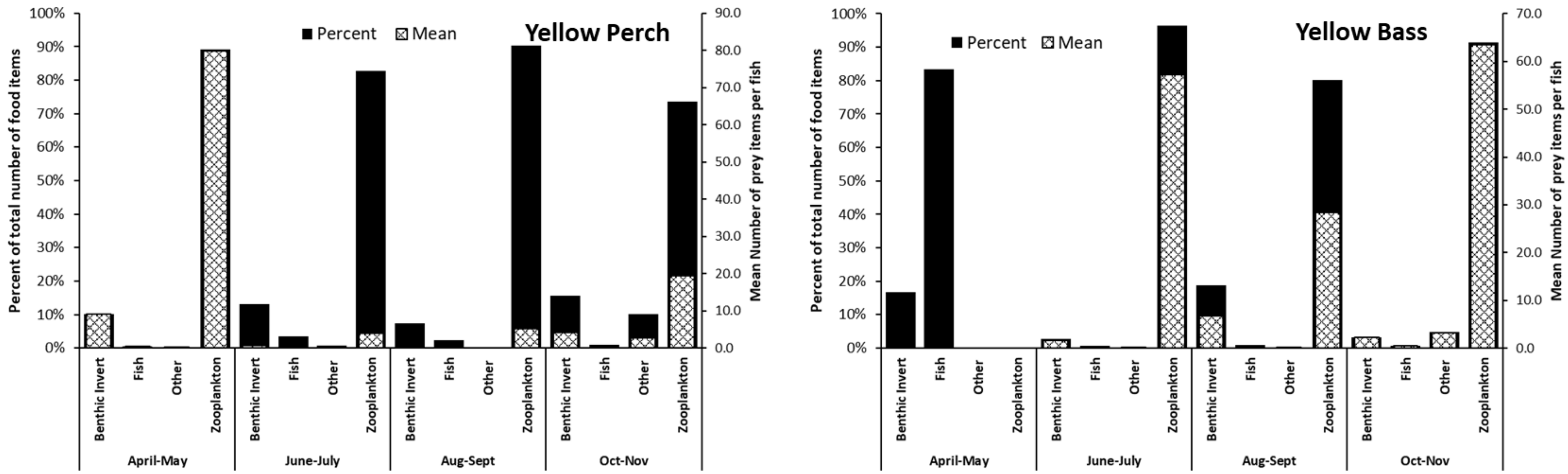


Figure 9. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Yellow Perch (left) and Yellow Bass (right) collected during four open-water periods at Pleasant Lake, 2018-2020 (cumulative by species).

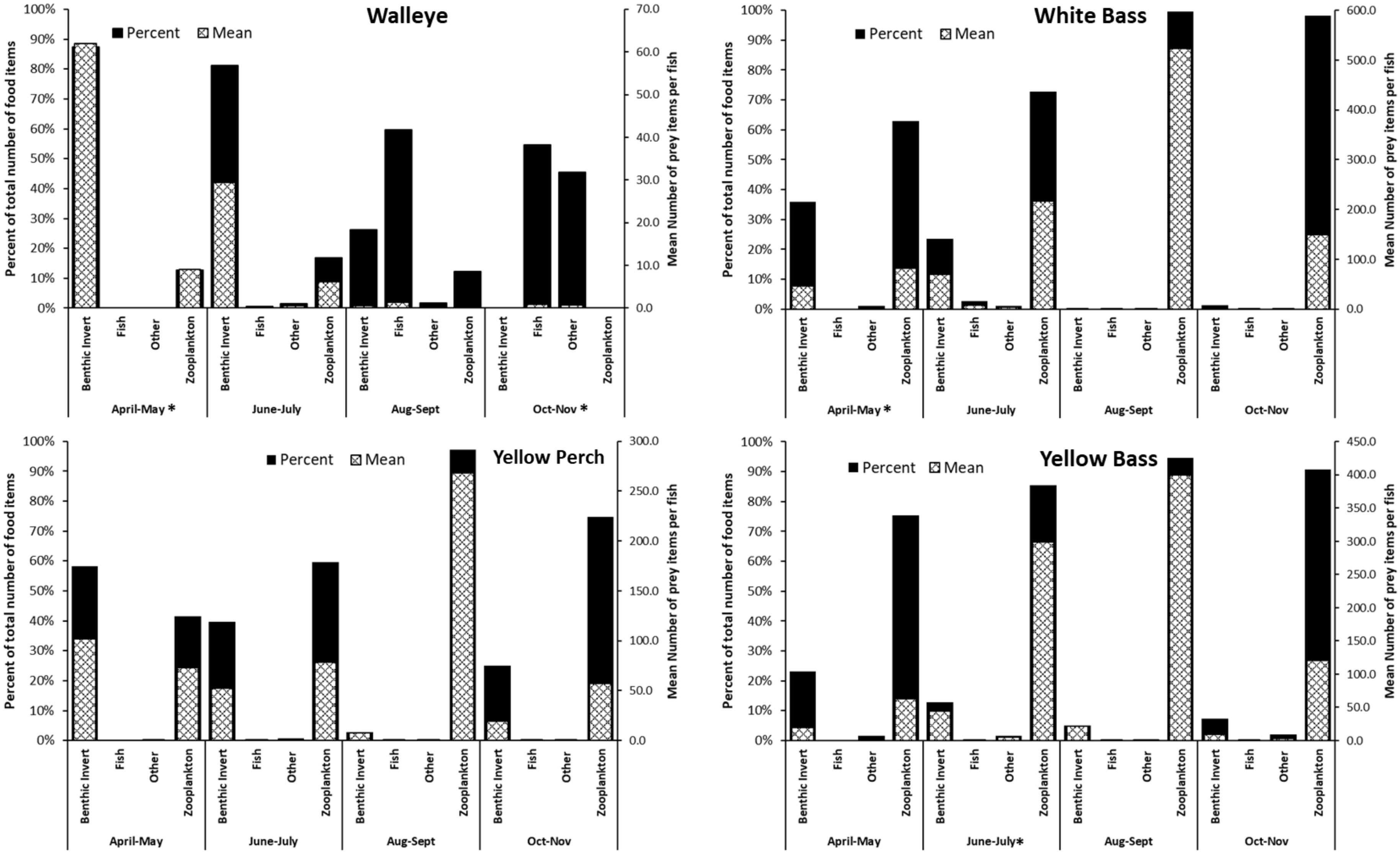


Figure 10. Percent of total number of food items (benthic invertebrates, fish, other, and zooplankton; primary axis) and mean number of food items (secondary axis) consumed by Walleye (upper left), White Bass (upper right), Yellow Perch (lower left) and Yellow Bass (lower right) collected during four open-water periods at Silver Lake, 2019-2020 (cumulative by species; asterisks by period indicates <10 sample).

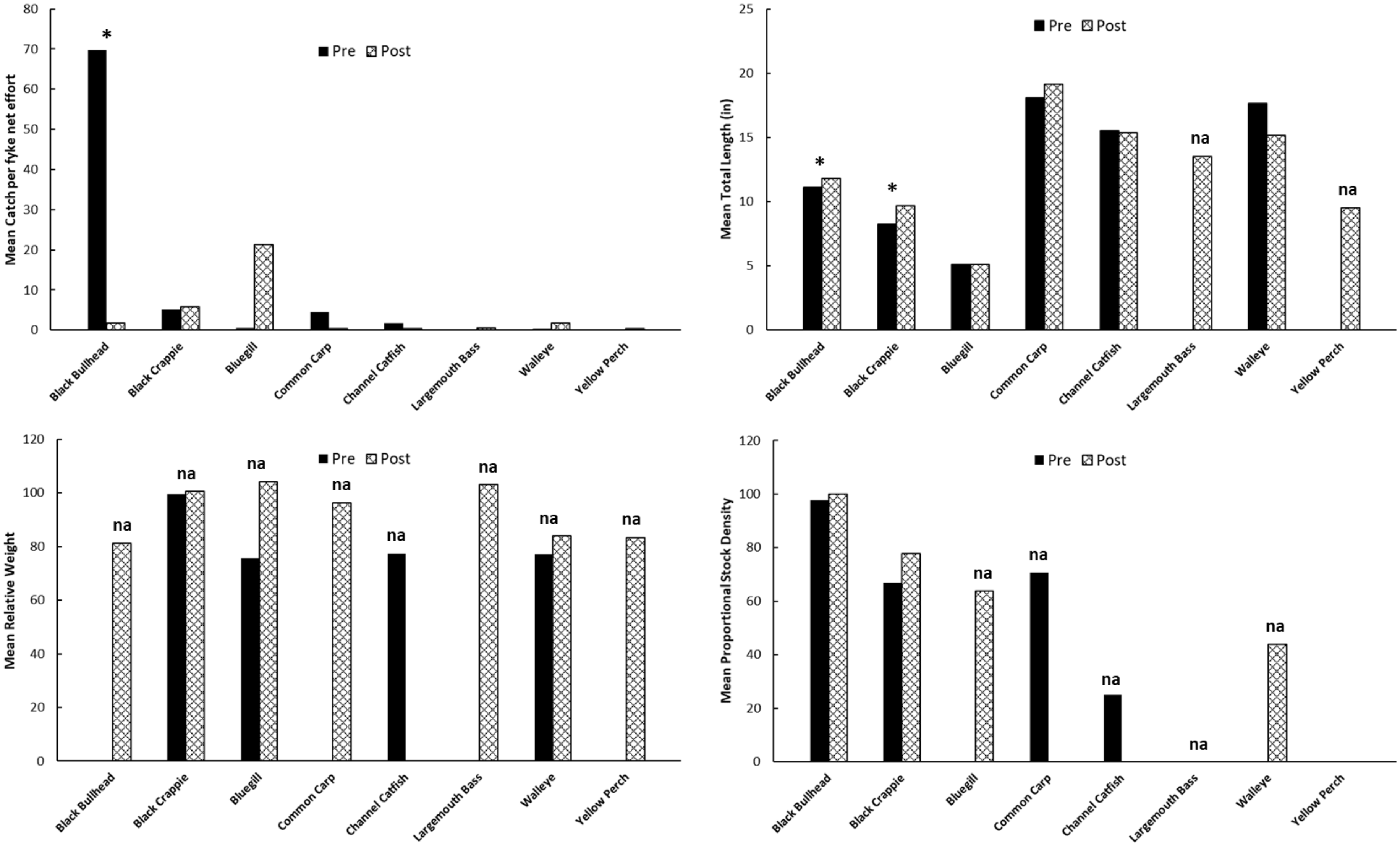


Figure 11. Mean catch per fyke net effort, mean total length, mean relative weight, and mean proportional stock density for eight fish species captured during standard fall fyke net surveys conducted at Center Lake both pre (1999-2008) and post (2017-2020) Yellow Bass infestation. na = insufficient sample size or no data; asterisks indicates significant difference among pre and post fishery statistic for a species; no asterisks indicates no significant difference among (P > 0.05).

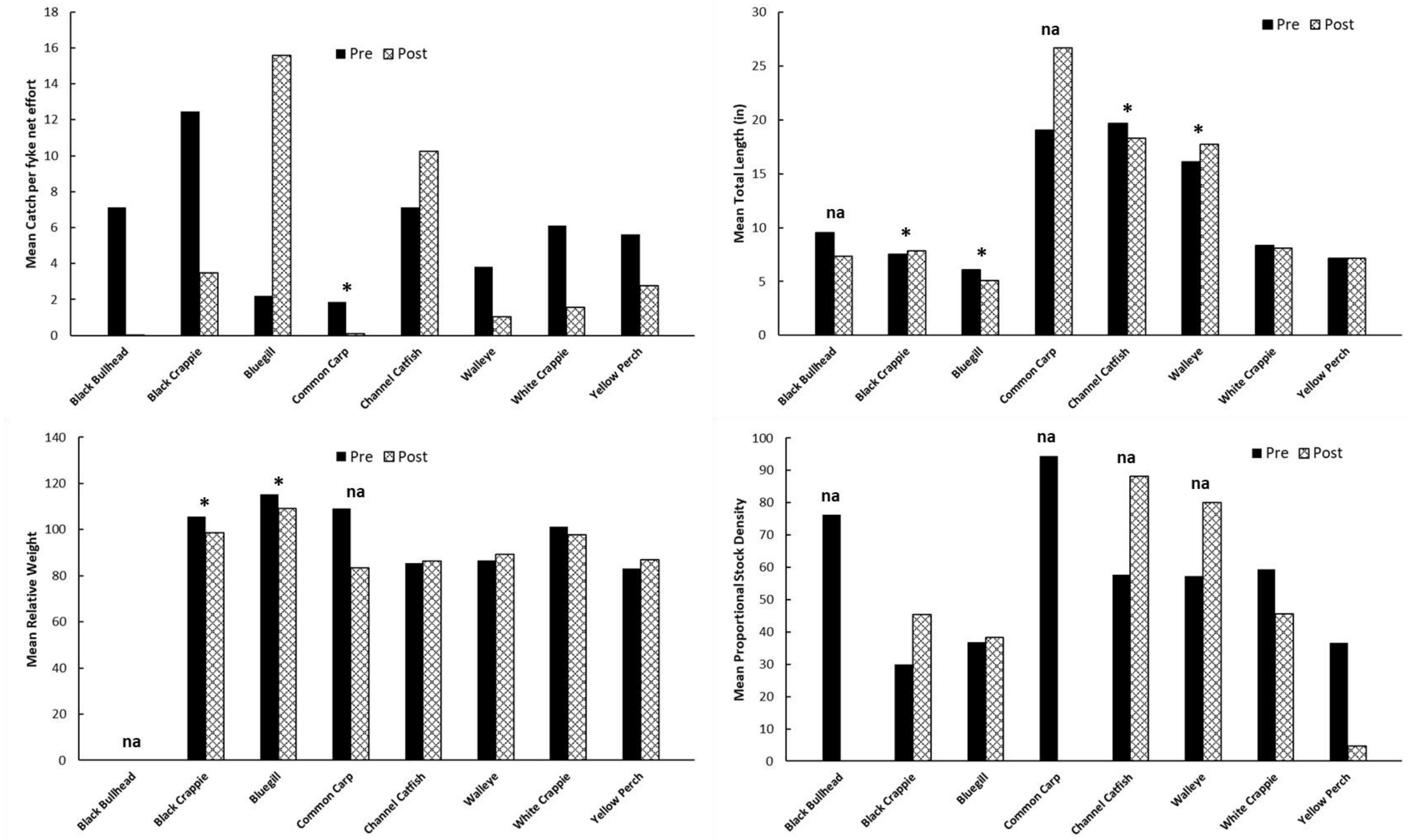


Figure 12. Mean catch per fyke net effort, mean total length, mean relative weight, and mean proportional stock density for eight fish species captured during standard fall fyke net surveys conducted at Five Island Lake both pre (1999-2012) and post (2017-2020) Yellow Bass infestation. na = insufficient sample size or no data; asterisks indicates significant difference among pre and post fishery statistic for a species; no asterisks indicates no significant difference among (P > 0.05).

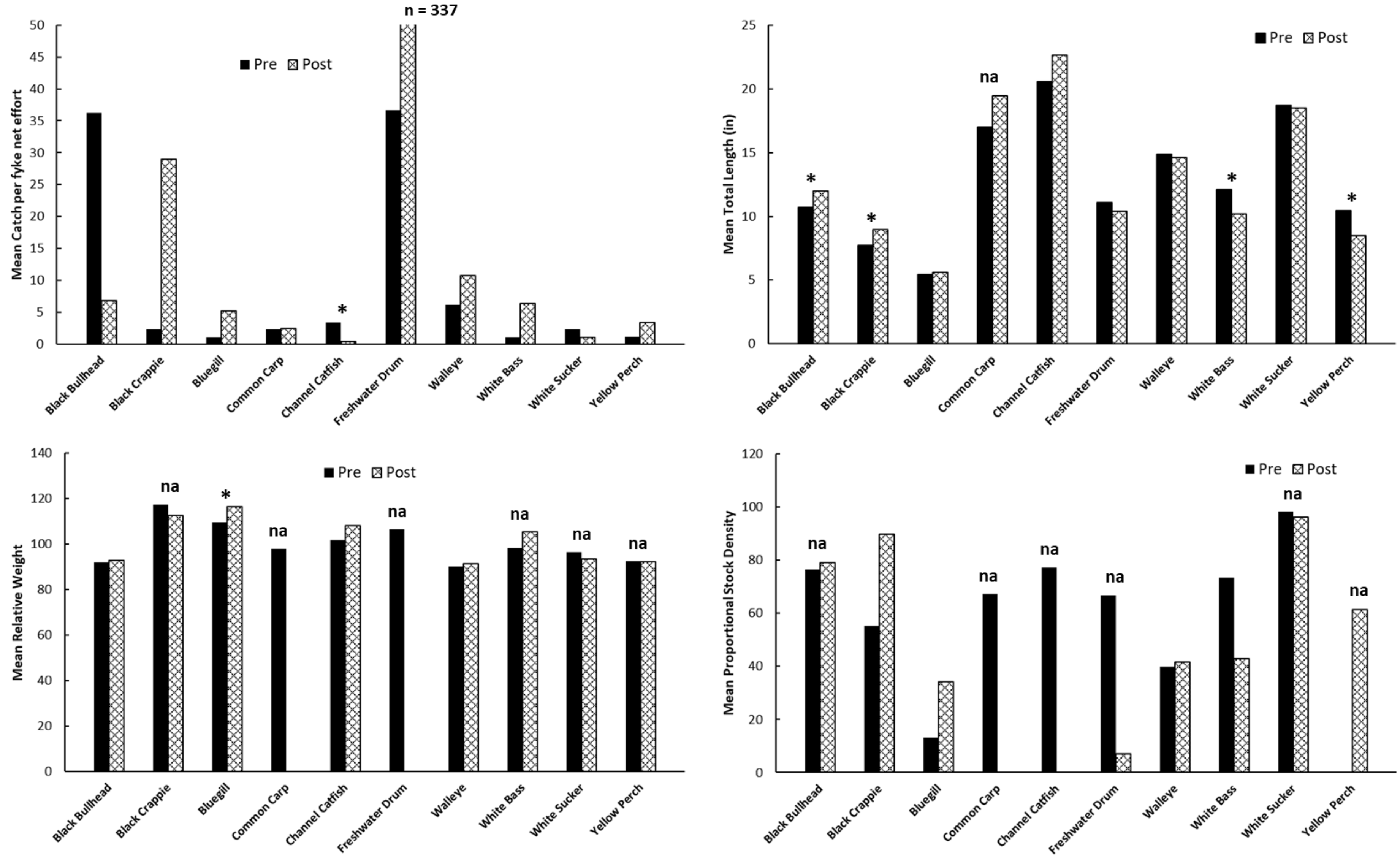


Figure 13. Mean catch per fyke net effort, mean total length, mean relative weight, and mean proportional stock density for ten fish species captured during standard fall fyke net surveys conducted at Silver Lake both pre (1996-2011) and post (2014-2020) Yellow Bass infestation. na = insufficient sample size or no data; asterisks indicates significant difference among pre and post fishery statistic for a species; no asterisks indicates no significant difference among (P > 0.05).

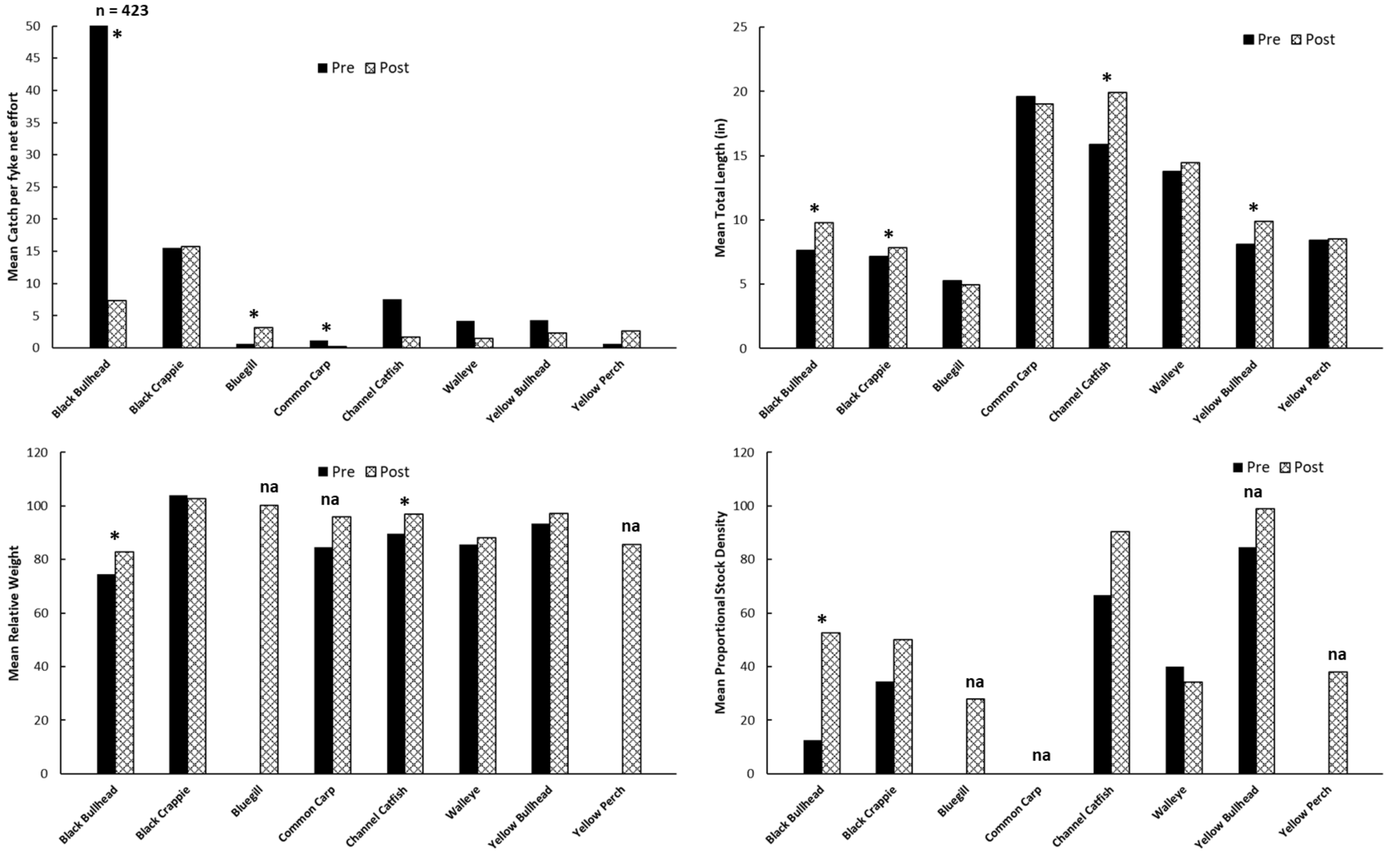


Figure 14. Mean catch per fyke net effort, mean total length, mean relative weight, and mean proportional stock density for eight fish species captured during standard fall fyke net surveys conducted at Lost Island Lake both pre (1995-2005) and post (2008-2020) Yellow Bass infestation. na = insufficient sample size or no data; asterisks indicates significant difference among pre and post fishery statistic for a species; no asterisks indicates no significant difference among (P > 0.05).

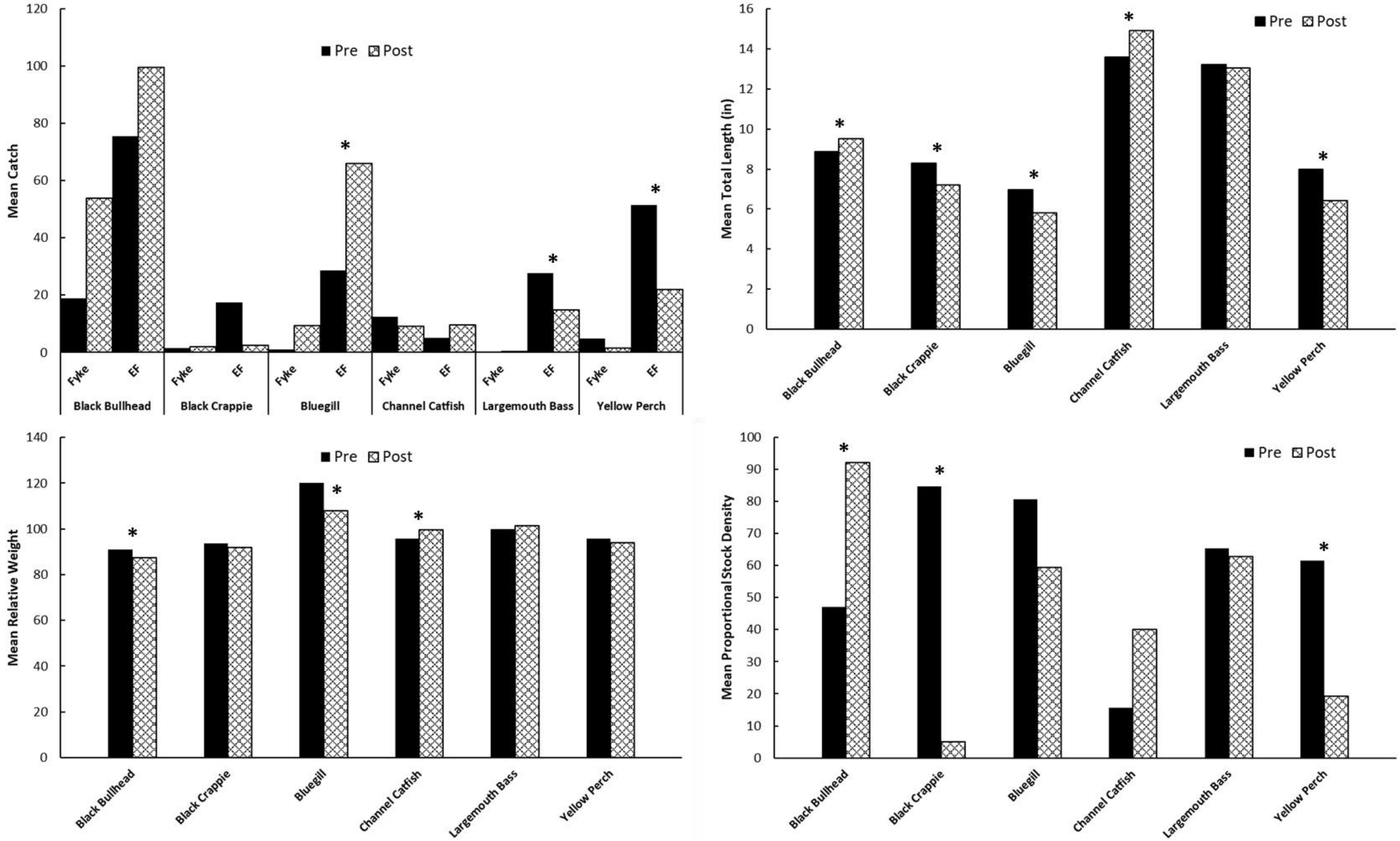


Figure 15. Mean catch per fyke net effort and electrofishing catch-per-hour, mean total length, mean relative weight, and mean proportional stock density for six fish species captured during standard spring fyke net and electrofishing surveys conducted at Lake Cornelia both pre (1997-2005) and post (2006-2020) Yellow Bass infestation. na = insufficient sample size or no data; asterisks indicates significant difference among pre and post fishery statistic for a species; no asterisks indicates no significant difference among (P > 0.05).

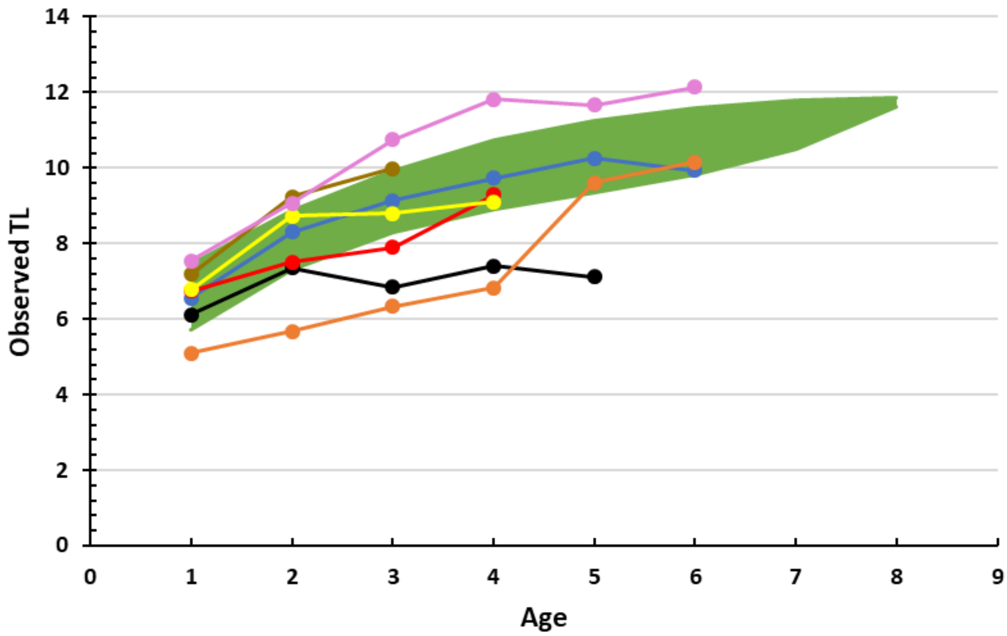


Figure 16. Yellow Perch observed total length (TL) at age (ages 1-6; otolith only) for seven lakes collected during fall investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Yellow Perch growth (shaded green) within natural lakes in Iowa (fall observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Black = Lake Cornelia; Red = Five Island Lake; Yellow = Ingham Lake (control); Brown = Lost Island Lake; Orange = Pleasant Lake; Pink = Silver Lake.

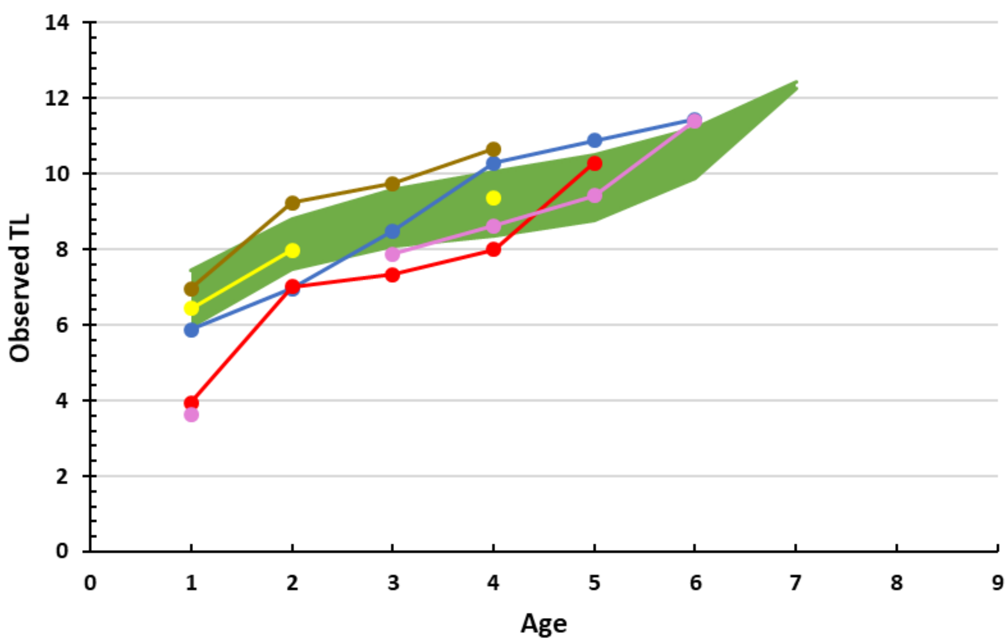


Figure 17. Black Crappie observed total length (TL) at age (ages 1-6; otolith only) for five lakes collected during fall investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Black Crappie growth (shaded green) within natural lakes in Iowa (fall observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Red = Five Island Lake; Yellow = Ingham Lake (control); Brown = Lost Island Lake; Pink = Silver Lake.

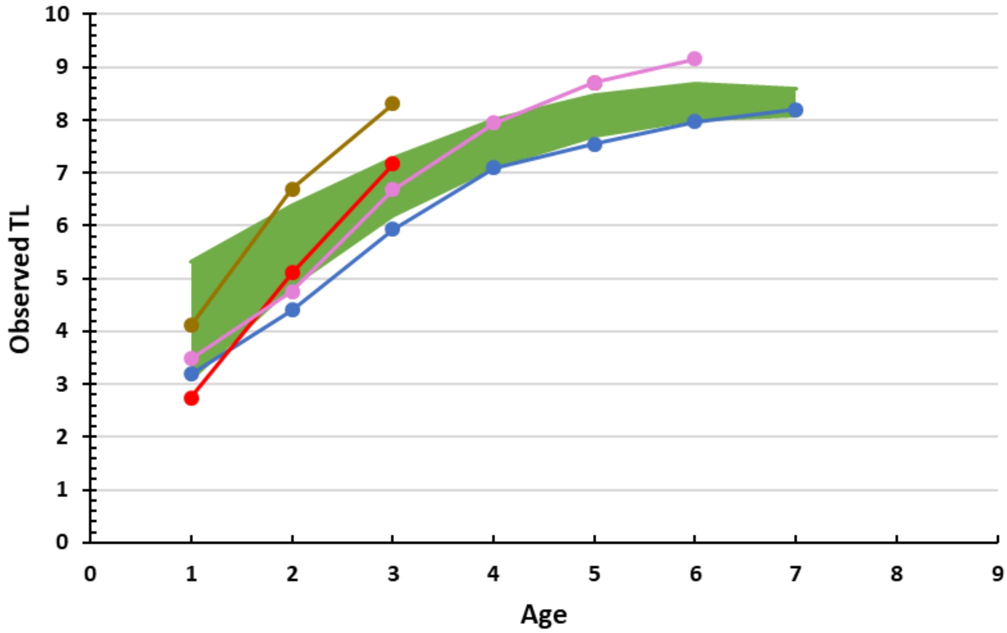


Figure 18. Bluegill observed total length (TL) at age (ages 1-7; otolith only) for four lakes collected during fall investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Bluegill growth (shaded green) within natural lakes in Iowa (fall observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Red = Five Island Lake; Brown = Lost Island Lake; Pink = Silver Lake.

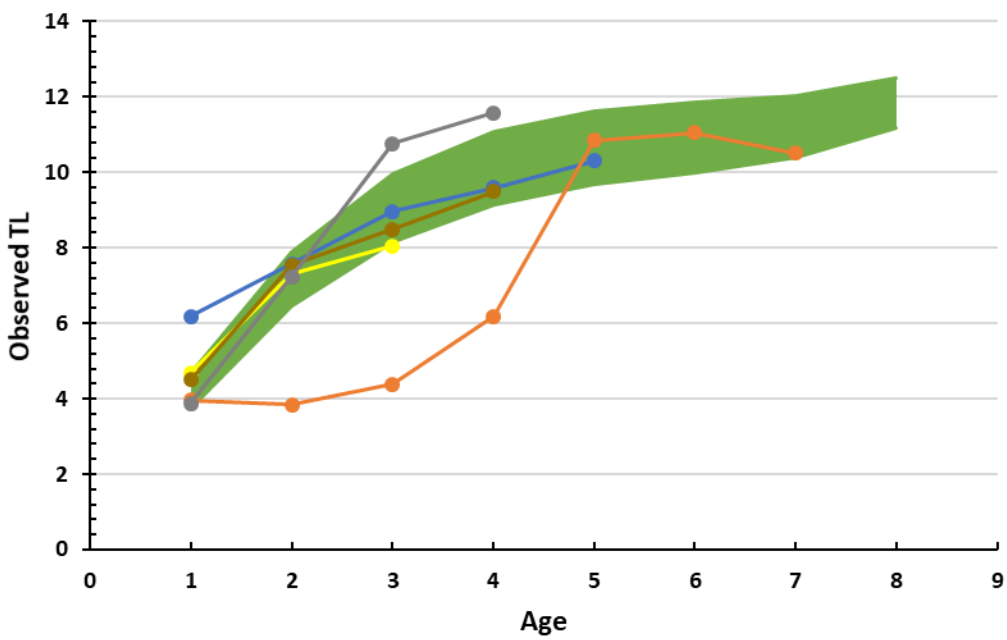


Figure 19. Yellow Perch observed total length (TL) at age (ages 1-7; otolith only) for five lakes collected during spring investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Yellow Perch growth (shaded green) within natural lakes in Iowa (fall observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Yellow = Ingham Lake (control); Brown = Lost Island Lake; Orange = Pleasant Lake; Grey = Rice Lake.

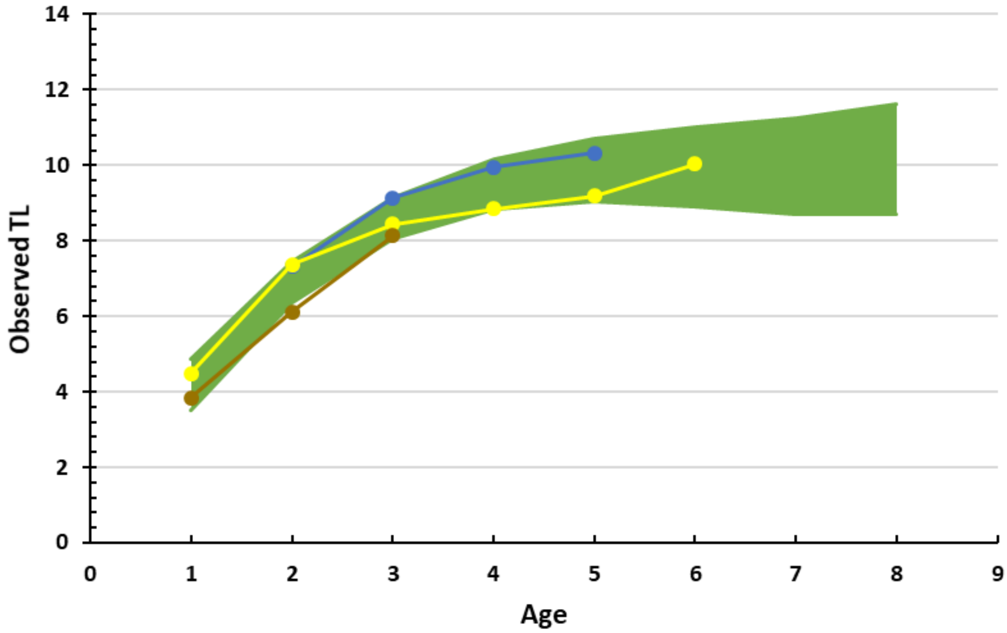


Figure 20. Black Crappie mean observed total length (TL) at age (ages 1-6; otolith only) for three lakes collected during spring investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Black Crappie growth (shaded green) within natural lakes in Iowa (spring observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Yellow = Ingham Lake (control); Brown = Lost Island Lake.

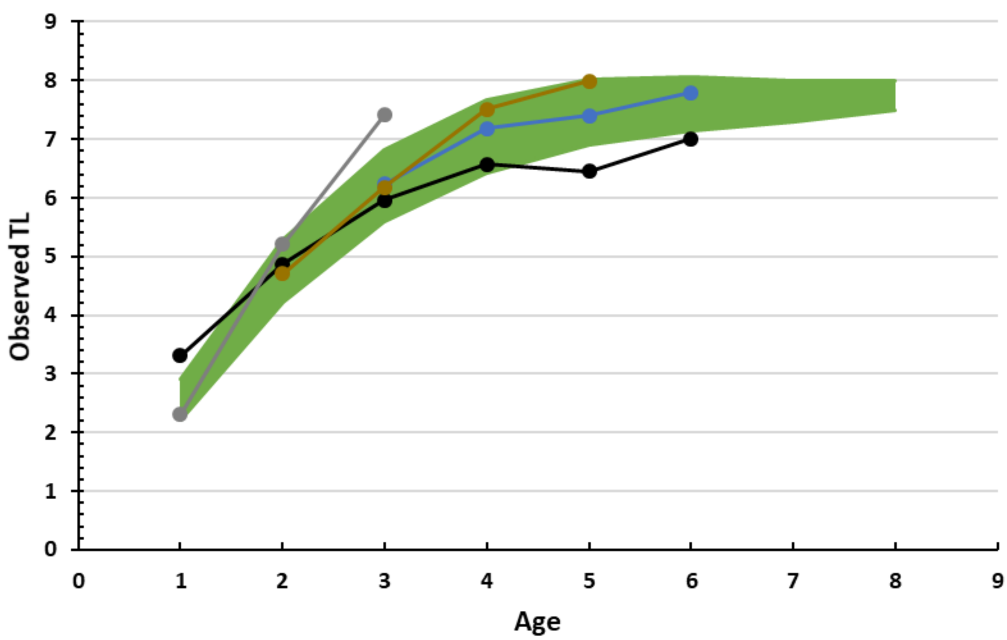
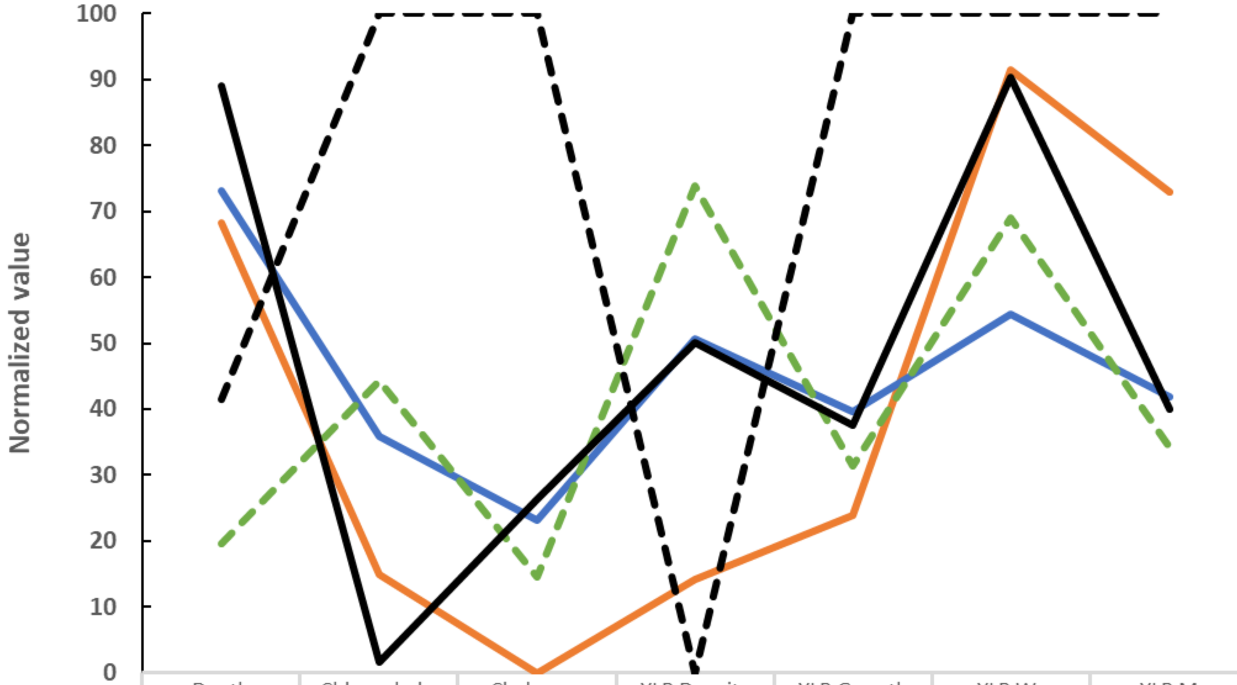
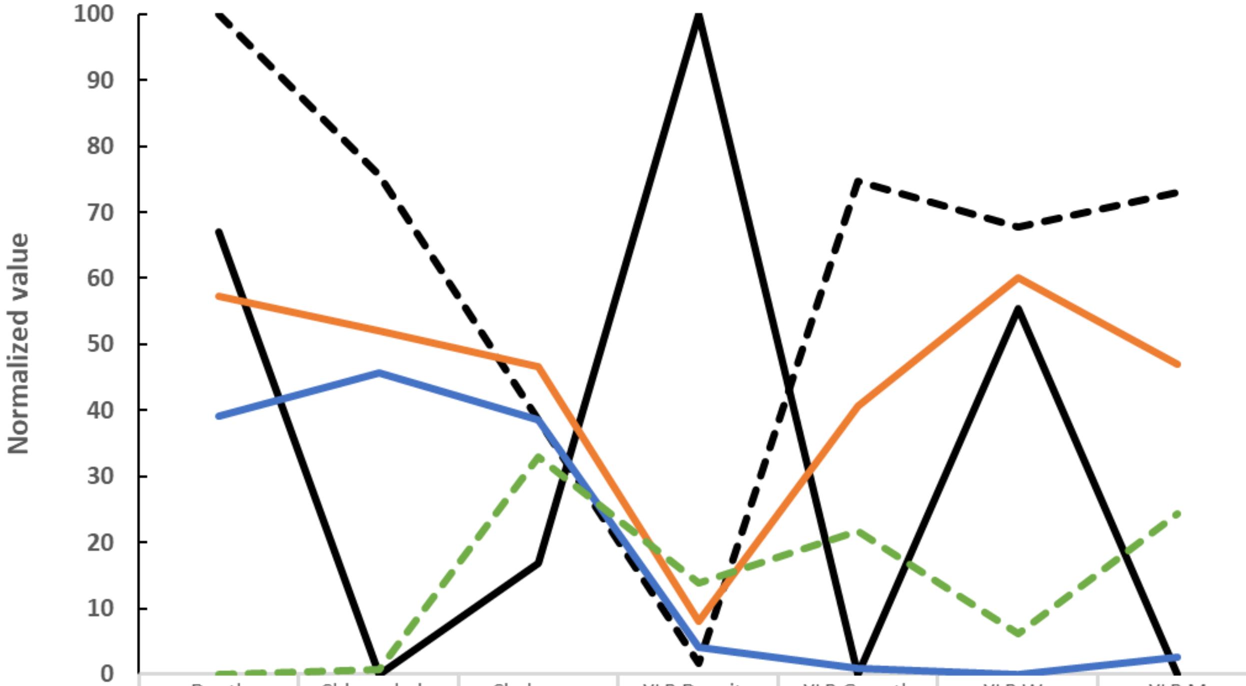


Figure 21. Bluegill mean observed total length (TL) at age (ages 1-6; otolith only) for four lakes collected during spring investigations from 2017-2020 with varying densities of Yellow Bass populations compared to the interquartile range for Bluegill growth (shaded green) within natural lakes in Iowa (spring observations only; J. Meerbeek, unpublished data). Blue = Center Lake; Black = Lake Cornelia; Brown = Lost Island Lake; Grey = Rice Lake.



	Depth	Chlorophyl a	Cladocera	YLB Density	YLB Growth	YLB Wr	YLB M
Clear	68	15	0	14	24	91	73
East Okoboji	73	36	23	51	40	54	42
Five Island	20	44	14	74	31	69	34
Lost Island	89	2	26	50	38	90	40
Silver	41	100	100	0	100	100	100

Figure 22. Normalized values (0-100) for lake mean depth, mean Chlorophyll a, Cladocera density, mean Yellow Bass (YLB) catch-per-hour electrofishing (e.g., density), Yellow Bass growth (k coefficient), mean relative weight (Wr), and Yellow Bass instantaneous mortality rates estimated during this study for large (≥ 973 acres) natural lakes in Iowa. Dashed lines represent natural lakes where a recent population of Yellow Bass was detected (i.e., Five Island Lake and Silver Lake). Yellow Bass were detected in the mid-to-late 2000s for both East Okoboji Lake and Lost Island Lake. Yellow Bass have been in Clear Lake since the 1930s.



	Depth	Chlorophyl a	Cladocera	YLB Density	YLB Growth	YLB Wr	YLB M
Center	100	76	39	2	75	68	73
Cornelia	67	0	17	100	0	55	0
Little Wall	39	46	39	4	1	0	3
North Twin	57	52	47	8	41	60	47
Pleasant	0	1	33	14	22	6	24

Figure 23. Normalized values (0-100) for lake mean depth, mean Chlorophyll a, Cladocera density, mean Yellow Bass (YLB) catch-per-hour electrofishing (e.g., density), Yellow Bass growth (k coefficient), mean relative weight (Wr), and Yellow Bass instantaneous mortality rates estimated during this study for small (< 500 acres) natural lakes in Iowa. Dashed lines represent natural lakes where a recent population of Yellow Bass was detected (i.e., Center Lake and Pleasant Lake). Yellow Bass were detected in the mid-to-late 2000s for both Lake Cornelia and Little Wall Lake. Yellow Bass have been in North Twin Lake since the 1950s.

Appendices

Appendix 1. Mean number of major prey taxa for Black Crappie (BLC), Bluegill (BLG), Yellow Perch (YEP), Yellow Bass (YLB), and Walleye (WAE) collected from Center Lake during four bimonthly diet intervals from 2018-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
	30	A-M	2018	0.3			10.1	97.8	0.1		0.4			1.7	0.1		0.0	0.1	
	10	A-M	2019		0.3		35.1	0.4	41.1	1.1	85.4			1.6			1.3	0.1	
	34	J-J	2018				13.9	6.6	419.5	0.8	0.7	0.5		0.9		29.3	0.1	0.0	
	5	J-J	2019				14.6	5.0	393.0	8.4	6.8			0.8					
	5	J-J	2020				37.4	13.2	242.4	13.2	1.8	6.6		2.8		24.6		0.2	
BLC	14	A-S	2018				11.4	2.1	190.0	1.5	0.1			1.6		64.0			
	4	A-S	2019	0.8			1.3	2.8				4.0		3.0			0.5		
	6	A-S	2020				11.5	22.5		0.2	0.2	3.5		0.5		2.2			
	19	O-N	2018		0.1		0.7	0.5	264.4	3.4	0.1			0.4		131.8			
	7	O-N	2019				9.4	0.1	15.0	5.0	0.3			6.6		50.4	0.4		
	1	O-N	2020				6.0					1.0		1.0					
	30	A-M	2018	4.0	0.0		87.2	172.3	8.1	0.0	2.7		0.6	1.0	0.2		0.1	0.1	1.8
	12	A-M	2019				10.8	0.4	84.8	0.2	4.2		0.1	0.2				0.2	
BLG	37	J-J	2018	0.1	0.2		6.4	1.8	91.9	0.8	13.1	0.1	0.5	0.6	0.5		0.2	0.0	1.2
	5	J-J	2019		0.4		71.8	3.8	210.0	0.2	2.2				0.2				0.4
	4	A-S	2019				7.0	2.3						5.0					
	17	A-M	2019				4.9	7.3	1.6	0.1				0.1					
	6	A-M	2020				41.8	22.7			3.7			0.3					
	18	J-J	2018	0.1			4.7	0.3	0.8		0.4			0.8			0.2	0.1	0.1
	23	J-J	2019				19.8	5.4	15.7	0.4	5.5			0.0	0.1			0.0	0.1
	14	J-J	2020				31.6	45.4			6.1	0.1	0.1	1.0			0.1		
YEP	17	A-S	2018				7.5	0.2	2.2		0.3			8.8		21.2			
	12	A-S	2019					0.1				0.3		0.8	0.1		0.3		0.5
	9	A-S	2020				0.4	0.1		0.1		0.3				0.2			
	13	O-N	2018				0.7					0.7						0.5	
	16	O-N	2019		0.1		4.6	0.3	0.1	0.1	0.1	0.1		6.4			0.7		
	8	O-N	2020				1.4	0.1	10.0			0.1		0.3		0.1			
	28	A-M	2018	0.1	3.5		1.1	283.4	102.0		1.0			20.5					0.2
	19	A-M	2019		0.7		17.1	7.5	1423.7	1.5	13.3		0.1	2.7	0.2		0.1		
	15	A-M	2020		0.7		0.7	4.8	2045.0		0.3		0.1	3.5			0.1		0.1
	7	J-J	2018					0.1		0.1	1.0	0.3		1.0		500.7			
	21	J-J	2019		0.0		12.7	3.0	340.1	7.3	0.1			0.2					0.2
YLB	19	J-J	2020		0.2		326.9	2.0	7.6	0.1	1.1	0.8	0.1	6.6		44.5	0.1		
	15	A-S	2018				16.8	1.5	185.0	0.4				1.5		628.3			
	20	A-S	2019				2.3	0.6			0.1	5.5		0.5					0.2
	20	A-S	2020				11.7	29.5	0.1			1.6		0.4		1.3			
	27	O-N	2018				0.0		30.0	9.6	0.1	0.4	0.0	6.1		58.8			
	20	O-N	2019	0.1	0.1		1.9	0.2	5.8	0.3	0.2	2.2		8.6		48.5			0.1
	15	O-N	2020		0.4		17.7	0.1	16.5		0.5	0.3		9.8		2.7	0.1		
	6	A-M	2020		6.5		1.0	5.5	5.7		0.8	0.2		0.2					
WAE	8	J-J	2020		0.1		62.3	2.5	3.0		0.3	1.4				3.9		0.1	
	8	A-S	2020									2.5			0.1				
	7	O-N	2020						4.6			1.1							

Appendix 2. Mean number of major prey taxa for Black Crappie (BLC), Bluegill (BLG), Yellow Perch (YEP), and Yellow Bass (YLB), collected from Lake Cornelia during four bimonthly diet intervals from 2018-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
BLC	30	A-M	2018	0.0	1.3				8.2	647.1		0.0		0.0					0.0
	27	A-M	2018	0.0															
BLG	15	A-M	2019	0.1	5.0	1.5	4.7	3.1	15.5		0.1		1.2	0.6	42.5		0.2	1.1	0.3
	30	J-J	2018	5.0	1.7		8.7	1.3	298.9	7.9	0.2		0.5		43.3		0.1	0.0	6.1
	15	A-M	2019		0.1		0.3	0.5	0.8										
	15	A-M	2020		1.1	0.2	168.1	1.8	0.5		0.1				0.9				8.7
	15	J-J	2019			1.3	11.5	1.1	7.7	0.7			1.6		0.7				
	15	J-J	2020			0.3	93.5	2.8							0.3				1.7
YEP	18	A-S	2018	0.2	0.1	0.1	2.0	5.9	0.6				0.6		1.3				8.1
	15	A-S	2019		0.8		5.5	6.0	9.5				7.1		0.8			0.1	2.3
	15	A-S	2020			0.1	7.4	0.5					0.2					0.1	
	16	O-N	2018			0.3	0.9	0.3	152.0	25.3					0.1		0.1		
	20	O-N	2019		4.2	0.3	3.8	0.1	18.7				0.4	0.1	0.1		0.8	0.1	
	14	O-N	2020				0.2							0.1	5.6			0.2	
	33	A-M	2018						0.1	0.1									
	15	A-M	2019		0.8		2.1	6.3	598.0	4.3									
	15	A-M	2020				4.7	4.3	402.9										
	32	J-J	2018	0.0	0.0		13.1	0.8	801.8	0.7	0.1		0.1		0.0		0.0		0.2
	15	J-J	2019				10.0	1.1	6.5	10.7					0.1	0.5			
YLB	15	J-J	2020			0.3	90.9	0.2	109.2			0.2			0.1	0.3			0.1
	44	A-S	2018		0.0	0.3	18.5	0.9	33.3	1.5	0.0		0.0		8.3	1.0			0.4
	15	A-S	2019		0.1		20.1	0.9	34.9	3.2	0.1				0.1				
	15	A-S	2020			0.1	4.2		1.9	0.7			0.1		0.5	0.8			
	26	O-N	2018		6.6	0.1	1.2	2.1	297.8	7.1				0.1		5.5	0.1		0.1
	20	O-N	2019		1.6	0.1	23.2	0.1	37.8	0.4	0.1	0.1				0.3			
	14	O-N	2020		4.0		16.4	0.1	17.6	0.1		0.5			0.1	0.1		0.2	

Appendix 3. Mean number of major prey taxa for Yellow Perch (YEP) and Yellow Bass (YLB) collected from East Okoboji Lake during April-May (A-M) in 2018. Number (N) of fish collected is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
YEP	21	A-M	2019		69.4	0.0	0.7	0.7	54.6		0.0		1.6	0.5			0.0		
YLB	37	A-M	2018		10.5	0.1	0.8	0.1	58.9	0.6	0.2		0.1	0.1	0.1		0.1	0.1	0.2

Appendix 4. Mean number of major prey taxa for Bluegill (BLG), Yellow Perch (YEP), and Yellow Bass (YLB) collected from Five Island Lake during four bimonthly diet intervals from 2019-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
BLG	15	A-M	2019		1.5		65.9	69.1	3.4	0.2	15.8		0.3		6.8				7.0
YEP	4	A-M	2019				9.8	48.5											0.3
	2	A-M	2020				30.0	57.5			34.0								
	9	J-J	2019				4.1	5.9			0.7				0.1				0.8
	15	J-J	2020				7.5	2.0			4.9	0.1			0.2				2.9
	15	A-S	2019			0.1	5.5	3.3	0.1		0.1				5.7				
	15	A-S	2020				3.9	0.6	1.1	0.1	0.1				1.9			0.1	0.9
	8	O-N	2019				1.3	0.1										0.1	
	9	O-N	2020				1.0		0.7		0.2			0.1					0.1
YLB	15	A-M	2019				6.9	16.5	149.5	6.6	20.5			1.3					5.7
	16	A-M	2020				1.9	123.7	93.1		1.4			1.5			0.2		7.8
	20	J-J	2019				19.1	1.2	4.6	1.0	0.5					15.5			0.5
	15	J-J	2020				37.5	10.7	18.2		1.8	0.4		0.4		0.4		0.5	0.7
	15	A-S	2019				0.5	0.3	213.4	1.1	0.1					3.5			
	15	A-S	2020				16.9	17.4	81.5	1.1	0.7	0.1		0.1	0.2	16.1		0.1	0.1
	20	O-N	2019				3.1	0.1	218.9	0.8	0.3					7.7			
	15	O-N	2020		0.1		1.9		310.1	0.3	0.9	0.3		0.1		0.3			1.6

Appendix 5. Mean number of major prey taxa for Crappie spp. (CRP), Yellow Perch (YEP), and Yellow Bass (YLB) collected from Ingham Lake during four bimonthly diet intervals from 2018-2019 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
CRP	30	A-M	2018				1.8	20.6	100.3	0.1			0.0	6.1	0.3		0.0		
	32	J-J	2018	0.2	0.1		53.7	3.7	625.0	3.2	0.1	0.0	1.9	9.4	0.4			0.3	0.0
	30	A-S	2018	0.1			0.5	3.4	250.5	8.8				0.1	0.1	8.1		0.0	
YEP	30	A-M	2018				7.0	9.1	19.1	0.2				7.0	0.0				0.0
	11	A-M	2019				2.4	31.5	0.1		0.1								
	30	J-J	2018	0.1	0.1		9.6	2.4	4.0	0.2	0.0		1.5	1.7	0.1		0.0		
	24	J-J	2019		0.5		99.5	6.7	9.3										
	15	A-S	2018				1.2	0.7							0.1				0.1
	17	A-S	2019				9.6	0.4	0.1						0.1				
	30	O-N	2018			0.2	11.4	1.8	2.4	0.1		0.1		0.0					
	20	O-N	2019				0.7					0.5						0.1	
YLB	2	A-M	2018				4.5	3.0	2.0					0.5					
	1	O-N	2018					1.0	42.0	6.0									

Appendix 6. Mean number of major prey taxa for Black Crappie (BLC), Bluegill (BLG), Yellow Perch (YEP), Yellow Bass (YLB), and Walleye (WAE) collected from Lost Island Lake during four bimonthly diet intervals from 2018-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
	30	A-M	2018	0.0	2.8	30.7	28.4	0.0	7.0	165.4	2.8	0.1			0.1		0.5		
	11	A-M	2019		11.2		1.2	59.5	0.5		4.1			0.1			8.6		
	7	A-M	2020		2.4	1.0	19.7	44.0	413.9		2.4			0.4			0.4	3.0	
BLC	18	J-J	2018	0.1	0.2		147.3	7.0	143.8	0.2				0.1	0.8		0.2	0.1	0.1
	10	J-J	2020	0.1	0.8	0.2	3.7	137.9	2665.3	0.1	0.4	0.3	0.8		0.4		0.2		
	3	O-N	2019		0.3		182.3	1.0								81.0			1.0
	4	O-N	2020	0.3	67.3		3.3	1.5	614.8		10.5			2.5					
	30	A-M	2018	0.0	0.2	0.5	63.0	0.7	0.0	0.3	0.0		0.1				0.3		0.3
	10	A-M	2019		77.5	0.1	9.2	11.5			0.4		14.0		3.9		0.1		0.9
BLG	5	A-M	2020				9.6	2.2			0.8		0.2				0.2		6.0
	9	J-J	2019	2.2	0.9		3.0	0.9	62.0		5.7	0.1	1.0	4.4	55.7		0.1		2.7
	3	O-N	2020		0.7		6.0	0.3	1634.0	0.7			7.7		1.3				9.0
	26	A-M	2018				0.9	0.2		0.2		0.0	0.0	0.0					
	15	A-M	2019		0.1		14.0	12.2			0.1		0.3	0.1	0.2				1.7
	15	A-M	2020		0.1	0.5	37.9	170.3			0.1		0.1	0.1			3.3		0.1
	12	J-J	2018		14.5		15.9	2.7	0.8		4.0		0.2				0.8	0.3	
	16	J-J	2019	3.4	5.2		6.9	1.9	3.3		0.9		0.1		3.8		2.9		39.2
	15	J-J	2020		0.5	0.9	53.7	9.7	0.2	0.1	0.1	0.1	2.3		0.1				0.3
YEP	38	A-S	2018	0.0	4.3	0.4	21.0	3.0	0.3	0.1	3.1	0.1	0.2		0.5			0.0	0.8
	15	A-S	2019			0.1	157.1	0.8	32.7	0.1		0.1	0.1	0.1		0.1		0.1	1.7
	15	A-S	2020		0.1	0.1	9.9	0.3					0.1						16.2
	25	O-N	2018		0.0		0.1		0.2	0.0		1.9		4.2			0.3	0.1	0.1
	15	O-N	2019		3.6	0.1	0.3		84.9		0.1	0.1			0.1				0.2
	15	O-N	2020		5.6	0.1	0.5	0.1	359.7	0.1	0.3	1.5	0.2	0.3		0.1		0.1	0.5
	45	A-M	2018	0.0	0.1	0.1	9.0	0.3	26.7	0.0				0.0			0.1	0.0	
	15	A-M	2019		7.8		20.1	0.1		88.9	0.3								0.9
	15	A-M	2020		0.6		3.3	1.9	25.0	0.1	0.1				0.1		0.1		0.1
	27	J-J	2018	4.1	5.5		163.9	76.6	55.6	1.9	3.0			0.1	0.0		0.1		
	20	J-J	2019		1.8		13.4	1.6	299.4	0.9			0.1		0.1		0.1		0.2
	15	J-J	2020		0.3	0.9	901.7	51.1	0.1			0.3	0.1						
YLB	14	A-S	2018		0.1		7.7	0.5	5.1			0.4				103.8			0.1
	15	A-S	2019			0.1	335.2	102.7	0.3			0.1				109.4			
	14	A-S	2020			0.1	40.4	0.1			0.1	0.3							
	26	O-N	2018		0.1	0.1	63.7	0.1	30.8		0.1	1.8				0.1	0.2		0.0
	19	O-N	2019		1.1		20.8	2.4	1.3	116.6		0.1				24.3	0.1		
	15	O-N	2020	0.1	22.7		11.1		102.1		0.3	0.5	0.1			0.1		0.7	0.1
	6	A-M	2020			0.7	42.7	4.8											
WHB	18	J-J	2019		0.3		0.5	4.6			0.1	1.8		0.3			0.1	0.1	
	2	O-N	2020									1.5				49.0	1.0		

Appendix 7. Mean number of major prey taxa for Yellow Perch (YEP) and Yellow Bass (YLB) collected from Pleasant Lake during four bimonthly diet intervals from 2018-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
YEP	38	A-M	2018	0.1	0.1		15.9	0.0		142.9	0.0	0.1	0.0					0.0	
	15	A-M	2019				0.1					0.9							
	15	A-M	2020									1.5							
	27	J-J	2018				1.3	0.2	2.9	6.7		0.1							
	22	J-J	2019									0.2	0.0	0.0					
	18	J-J	2020									0.2							
	59	A-S	2018				0.1		5.5	2.5		0.1							
	18	A-S	2019				0.9	0.1		0.1	0.1	0.1	0.1		0.1		0.4		0.1
	15	A-S	2020									0.4							
	15	O-N	2018			0.1	0.3	0.1	3.3	0.6	6.0	0.5							0.1
	5	O-N	2019									0.2						0.2	
	15	O-N	2020		0.3		1.1		41.3		0.6		0.1	5.9		0.2	0.9		0.1
YLB	17	A-M	2018				0.2					0.4							
	15	A-M	2019									0.4							
	8	A-M	2020									0.3							
	22	J-J	2018				0.1		66.0	77.2		0.7		0.0					
	21	J-J	2019				0.2	0.7						0.1					
	16	J-J	2020				2.6	1.8	0.1	14.2		0.4	0.3						
	49	A-S	2018				3.0	0.7	38.3	6.4		0.4		0.0				0.0	
	18	A-S	2019				5.3	0.8	0.8	0.7		0.2		0.1		0.1	0.1	0.1	
	15	A-S	2020				10.5	6.3	1.9	5.1		0.1		0.1					
	15	O-N	2018				0.1		69.7	1.7		0.4	0.1						
	20	O-N	2019		0.1		1.6		0.2	0.1	0.6	0.4		0.1				0.5	
	15	O-N	2020		0.7	0.2	3.0		140.1			0.6	0.1	10.3			0.1		

Appendix 8. Mean number of major prey taxa for Bluegill (BLG) and Yellow Perch (YEP) collected from Rice Lake during April-May (A-M) in 2018. Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
BLG	41	A-M	2018		11.3	0.0	39.7	3.3	0.3	0.1	0.8			0.6	0.4		1.8		0.0
YEP	51	A-M	2018		10.4	0.1	10.1	25.5	0.0	0.2	2.0		0.2	0.1	0.0		3.2		0.0

Appendix 9. Mean number of major prey taxa for Yellow Perch (YEP), Yellow Bass (YLB), White Bass (WHB) and Walleye (WAE) collected from Silver Lake during four bimonthly diet intervals from 2018-2020 (A-M = April to May; J-J = June to July; A-S = August to September; O-N = October to November). Number (N) of fish collected each period is also provided.

Species	N	Period	Year	Adult - winged	Amphipoda	Bivalve	Chiro. Larvae	Chiro. Pupae	Cladoceran	Copepoda	Ephemeropteran	Fish	Gastropoda	Hemiptera	Hydracarnia	Leptodora	Odonata	Other	Tricopteran
YEP	15	A-M	2019				13.5	17.7	145.3	0.1	0.2			0.7	0.1				0.1
	15	A-M	2020		3.5	0.1	4.2	141.9	0.1		0.9			0.3			4.8	0.7	16.3
	18	J-J	2019	0.3	0.9		3.3	2.9	150.4		0.2		0.1	0.7	0.1		3.7	0.3	7.1
	15	J-J	2020		39.9	0.1	41.7	7.4	2.7		8.1	0.2	0.1	0.4	0.1		0.2		2.9
	20	A-S	2018	0.1			3.2	3.4	339.3			0.1		0.1		27.4			0.3
	24	A-S	2019		0.0		4.1	2.8	353.2		0.5			1.1					4.2
	15	A-S	2020				0.1	0.1				0.3							
	17	O-N	2018		0.1		25.8		92.3					0.1		2.5		0.1	
	20	O-N	2019		0.1		27.1		1.9		0.2	0.1							
	15	O-N	2020				0.2		33.6	53.9	0.1					0.1			
YLB	17	A-M	2019		6.7		12.6	6.3	45.1	0.1	0.2			0.2				0.1	
	12	A-M	2020		6.0		0.8	2.4	88.2		0.9			2.7				0.1	0.2
	58	J-J	2018	0.1	0.0		40.9	1.9	313.1	2.6	0.1	0.1		2.6			0.0	0.0	0.2
	17	J-J	2019		1.2	0.1	5.4	0.8	294.4	0.1	0.1	3.4		18.9		21.8	0.1		0.4
	15	J-J	2020	0.2	2.3	0.3	40.0	38.7	16.4	0.1	10.1			0.6		197.1	0.7	0.3	0.1
	18	A-S	2018				41.1	4.1	332.2		0.3			0.6		209.3			
	12	A-S	2019		0.2		8.0	3.3	650.8	15.4	0.3	0.1		4.6		20.7			0.4
	15	A-S	2020									0.3				0.2			
	34	O-N	2018		0.1		12.3	0.5	103.3	8.2	0.1			3.2		61.4	0.0	0.0	0.0
	3	O-N	2019				5.3		1.3	0.3	0.3			3.3					
	12	O-N	2020		0.2		0.3				0.6	0.3		0.7					
WHB	3	A-M	2019				9.7	50.3	26.7		0.3			1.0					
	1	A-M	2020		3.0		1.0	3.0	248.0					3.0					
	16	J-J	2018		0.1		0.2	0.1	126.1			0.3	0.1	2.8					
	1	J-J	2019		1.0				5.0		1.0			29.0		90.0			
	6	J-J	2020		1.7		213.8	50.3	51.5	0.8	1.7	29.0		1.3	0.2	428.3	0.5		
	18	A-S	2018	0.1			0.2	0.9	337.7			0.2		0.1		329.8			
	16	A-S	2019		0.1		0.8	0.8	607.5	0.1	0.1	0.4		0.1		82.2			
	10	A-S	2020			0.1						1.4							
	12	O-N	2018				0.4	0.1	245.0					0.8		80.9			
	12	O-N	2019				4.2		47.8		0.2			0.2					
	6	O-N	2020									1.5							
WAE	1	A-M	2020		7.0		2.0	52.0	9.0								1.0		
	5	J-J	2020				31.8	0.8	0.2		0.2	0.4				0.8			
	10	A-S	2020				0.6	0.1				1.1							
	5	O-N	2020									1.0							

Appendix 10. Catch rate (number per net night or number per hr) of fish species collected during standard electrofishing, fyke netting, and hoop netting surveys in Rice, Ingham, and Pleasant lakes. Mean total length (mm) is provided in parentheses.

Species	Rice	Ingham	Pleasant	Rice	Ingham	Pleasant	Rice	Ingham	Pleasant
		Electrofishing			Fyke Netting			Hoop Netting	
Bigmouth Buffalo		11(506)			0.4(425)			0.2(311)	
Black Bullhead		49(205)	134(160)	0.1(269)	1.4(171)	6.3(163)	0.7(290)	79(203)	0.3(185)
Black Crappie		58(153)			97(154)			16.4(181)	
Bluegill	15.3(157)		1(203)	17.5(180)			14.7(160)		0.3(162)
Brown Bullhead						2.5(211)		3(256)	32.8(220)
Bullhead Spp.									17.5(230)
Common Carp		24(565)				0.3(142)		2.3(585)	0.5(215)
Channel Catfish								6(397)	
Fathead Minnow			8(87)						
Golden Shiner		1(94)	17(133)		0.2(132)	0.3(140)			0.5(173)
Green Sunfish		2(131)	2(136)		0(58)	0.8(127)	0.1(0)		0.8(158)
Hybrid Sunfish				0.2(206)					
Largemouth Bass	112(292)			1.1(310)			0.3(325)		
Orangespotted Sunfish		5(80)	2(76)		0.2(330)	35.3(82)			
Walleye	28(404)	11(338)	2(603)	0.6(440)	0.2(172)		0.8(415)	0.7(358)	
White Crappie		2(319)			78.6(145)			13.2(150)	
Yellow Bass			18(194)			0.3(221)			1.5(295)
Yellow Bullhead		8(180)			4.2(210)			1.1(260)	
Yellow Perch	52.7(128)	67(121)	43(147)	15.2(127)	0.8(163)	9.3(158)	24.7(215)	9.6(200)	6.8(263)

Appendix 11. Catch rate (number per net night or number per hr) of fish species collected during standard electrofishing, fyke netting, and hoop netting surveys in Ingham, and Pleasant lakes from 2018-2019. Mean total length (mm) is provided in parentheses.

	Ingham		Pleasant		Ingham		Pleasant		Ingham		Pleasant	
Species	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
	Electrofishing				Fyke Netting				Hoop Netting			
Bigmouth Buffalo	11(506)	24(430)			0.4(425)				0.2(311)	0.3(387)		
Black Bullhead	49(205)	73(200)	134(160)	186(170)	1.4(171)	110.2(106)	6.3(163)	16(165)	79(203)	980.3(210)	0.3(185)	9.8(192)
Black Crappie	58(153)				97(154)	8.6(186)			16.4(181)	2.8(148)		
Bluegill		6(56)	1(203)			2.2(130)		1.2(175)			0.3(162)	
Brown Bullhead		1(239)		14(197)		1.2(270)	2.5(211)	11(178)	3(256)	2.8(239)	32.8(220)	50.8(205)
Bullhead Spp.											17.5(230)	
Common Carp	24(565)	10(607)		2(380)			0.3(142)	0.2(370)	2.3(585)	0.5(585)	0.5(215)	0.5(295)
Channel Catfish									6(397)			
Fathead Minnow			8(87)	15(79)								
Golden Shiner	1(94)		17(133)	126(130)	0.2(132)		0.3(140)	37.4(140)			0.5(173)	
Green Sunfish	2(131)	1(115)	2(136)	6(128)	0(58)		0.8(127)	7.2(138)			0.8(158)	0.3(174)
Orangespotted Sunfish	5(80)	1(68)	2(76)	26(84)	0.2(330)	0.6(99)	35.3(82)	103.8(86)				0.3(83)
Walleye	11(338)		2(603)		0.2(172)	0.6(151)			0.7(358)			
White Crappie	2(319)				78.6(145)	5.4(213)			13.2(150)			
Yellow Bass			18(194)	96(165)			0.3(221)	8.4(169)			1.5(295)	1.3(237)
Yellow Bullhead	8(180)				4.2(210)	33(136)			1.1(260)	1.8(216)		
Yellow Perch	67(121)		43(147)	26(166)	0.8(163)	19.2(159)	9.3(158)	54.6(137)	9.6(200)	6.5(193)	6.8(263)	1.8(275)

Appendix 12. Catch rate (number per hr) of fish species collected during standard electrofishing surveys in Pleasant, Cornelia, Center, Five Island, Lost Island, and Silver lakes in 2020. Mean total length (mm) is provided in parentheses.

Species	Center	Cornelia	Five Island	Lost Island	Pleasant	Silver
Bigmouth Buffalo	0.8(26.5)		2.4(24.3)			
Black Bullhead				2.9(11.6)	114(7.2)	
Black Crappie	8.8(10.6)		0.8(10.3)	17.3(7.6)		
Bluegill	7.2(7.6)	39(5.4)	3.2(6.5)	27.5(4.9)	1(8.1)	2.7(6.3)
Brown Bullhead					2(6.8)	
Channel Catfish		1(16.0)	4.8(17.9)			
Common Carp	2.4(21.2)	14.0	4(26.4)	0.7(33.3)	10(15.0)	0.7(33.1)
Common Shiner						
Emerald Shiner						
Fathead Minnow					4(2.8)	
Freshwater Drum	5.6(15.8)					
Golden Shiner					39(5.5)	
Green Sunfish		4(5.6)		8.7(5.3)	24(4.6)	
Hybrid Sunfish		8(5.6)				
Largemouth Bass	11.2(12.9)	14(13.2)	3.2(14.8)	2.2(8.8)		
Northern Pike			0.8(19.5)	3.6(28.7)		
Orangespotted Sunfish					22(3.1)	
Pumpkinseed						
Smallmouth Bass	2.4(11.2)					
Spottail Shiner						
Walleye	2.4(20.2)	1(9.7)	0.8(15.5)		1(23.5)	2.6(18.6)
White Bass		2(13.6)		7.2(14.6)		
White Crappie	14.3					
White Sucker				3.6(19.8)		
Yellow Bass	17.5(8.8)	432(6.5)	33.4(8.3)	33.3(9.1)	95(5.7)	
Yellow Bullhead				2.2(9)		
Yellow Perch		17(6.3)	4(4.5)	8(6.2)	19(5.2)	1.3(8.4)

Appendix 13. Catch rate (number per net night) of fish species collected during standard fyke netting surveys in Pleasant, Cornelia, Center, Five Island, Lost Island, and Silver lakes in 2020. Mean total length (mm) is provided in parentheses.

Species	Center	Cornelia	Five Island	Lost Island	Pleasant	Silver
Bigmouth Buffalo			0.1(25.2)			220.2(10.7)
Black Bullhead	0.5(12.5)			5.9(3.4)	88.1(6.4)	
Black Crappie	9.8(4.9)	8.7(7.6)	2.7(6.7)	95.1(4.2)		185.6(4.4)
Bluegill	85(4.4)	13(5.8)	68(3)	13.2(3)	0.1(7.6)	16.3(4.7)
Brown Bullhead	0.5(12.4)				1.6(6.4)	1160.1(5.1)
Channel Catfish			0.3(11.1)			0.1(8.6)
Common Carp	0.2(19)	0.2(9.3)	0.1(30)		7.6(5.5)	15.6(10.3)
Common Shiner	0.2(5.1)					0.2(4.5)
Emerald Shiner	0.2(4.4)					0.1(4.7)
Fathead Minnow						
Freshwater Drum				0.9(5.9)		448.8(5.1)
Golden Shiner	0.3(6)				7.6(5.5)	0.1(5)
Green Sunfish	0.2(5)	0.2(5.5)	0.3(4.9)	1.6(5)	8(5)	0.6(4.7)
Hybrid Sunfish				0.1(4.2)		
Largemouth Bass	0.2(14.6)	0.2(5.8)	0.4(4.4)	0.2(3.5)		3.2(5.7)
Northern Pike			0.1(26.9)		0.1(35.5)	2.2(28.4)
Orangespotted Sunfish					68.6(3.2)	
Pumpkinseed	0.2(4.6)		0.2(3.3)			0.1(6.8)
Smallmouth Bass						
Spottail Shiner				0.1(5)		1.2(4.2)
Walleye	3(11.9)		0.3(17.5)	0.2(16.6)	0.5(25.9)	5.6(11.1)
White Bass						40.6(6.2)
White Crappie			0.4(7.8)			12.7(4.3)
White Sucker						0.3(20.6)
Yellow Bass	0.7(6.7)	8(7.7)	14.2(5.1)	0.7(4.4)	9.3(6)	59.8(4.4)
Yellow Bullhead	3.5(10.6)		1.1(7.6)	1.3(10.3)		1.5(8)
Yellow Perch	0.3(9.7)	22.2(7.4)	9.2(7.1)	18(7.5)	25.4(5.4)	7.3(6.1)