Summary of the Biological Assessments and Angler Satisfaction Surveys for the Evaluation of the Panfish Enhancement Special Regulation Program

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Background

The popularity and importance of panfish fisheries in Pennsylvania has been well documented in a variety of sources. Surveys conducted by the U.S. Fish and Wildlife Service (USFWS) showed that, with the exception of trout, anglers in Pennsylvania spend more time fishing for panfish than any other species. Specifically, USFWS surveys conducted in 1991, 2001, and 2006 found that anglers spent over 8.0, 5.5, and 7.8 million days, respectively, fishing for panfish. Summaries of angler use and harvest surveys conducted statewide on Pennsylvania impoundments by the Pennsylvania Fish and Boat Commission (PFBC) have shown that nearly half of all fishing time in Pennsylvania is spent in pursuit of panfish. Thus, fishing for panfish in Pennsylvania represents one of the most popular forms of recreational angling. This can be attributed to a number of factors including: 1) the widespread occurrence and availability of panfish; 2) panfish are relatively easy to catch; 3) panfish provide great table fare; and 4) panfish play a key role in introducing new and young anglers to the sport.

Historically, the PFBC, like other state fisheries agencies, encouraged and promoted panfishing under the premise that these species were underutilized and could not be overfished. Thus, in most Pennsylvania waters, panfish have been and are currently managed under liberal harvest regulations with a 50 fish/day creel limit and no minimum size limit. During the last two decades, however, fishery managers in Pennsylvania and elsewhere have become concerned that angler harvest has reduced the size structure of panfish populations.

To investigate the potential effects of harvest on panfish population size structure, the Fisheries Management Division proposed Panfish Enhancement Regulations (PERs) in 1994. The overall objectives of the PERs were to (1) improve the size structure of bluegill, pumpkinseed, redear sunfish, black crappie, white crappie, and yellow perch populations in selected waters where it was believed feasible to increase numbers of large panfish given their vulnerability to exploitation and (2) increase the number of satisfied anglers targeting panfish. To accomplish these objectives, a minimum size limit and reduced creel limit were established. To guide the selection of minimum size limits for PERs, historic PFBC trapnet catch rate and species size structure data, expert opinion, and angler preference data was considered. There was broad support among PFBC fisheries managers to apply and evaluate panfish minimum length limits of 175 mm (7 inches) for bluegill, pumpkinseed and redear sunfish; and 225 mm (9 inches) for black crappie, white crappie, and yellow perch. For each species or species group - sunfish (bluegill, pumpkinseed, and redear sunfish), crappie (black crappie and white crappie), and yellow perch, a 20 fish per day creel limit applied. Additionally, the 50 fish combined species creel limit remained when harvesting fish from multiple species groups.

In 1997, the PFBC Board of Commissioners approved the PERs and in 1999 adopted the current version of the regulation. The 1997 meeting identified the program as experimental and included several bench marks and objectives including: 1) increase the number of sunfish over 175 mm (7 inches) and number of crappie and yellow perch over 225 mm (9 inches) available for harvest, as measured in biological assessments; 2) increase the number of satisfied anglers targeting sunfish, crappie, and yellow perch as measured through angler contact surveys; and 3) increase the number of desirable size panfish harvested, as measured by creel surveys on selected waters.

Eleven lakes were included in this study. Six of the lakes were within the PERs program and five were controls. Lakes included in the study were:

Treatment Lakes	**Control Lakes**
F.J. Sayers Lake	Kahle Lake
Lake Chilisquaque	Hills Creek Lake
Blue Marsh Reservoir	Yellow Creek Lake
High Point Lake	Little Buffalo Lake
Cross Creek Lake	Rose Valley Lake
Promised Land Lake (Includes Upper and Lower Promised Land Lake)	

Biological Assessments

Results of biological assessments indicate that of the species and species groups analyzed, crappie catch per 24 hr net set (CPE; including legal-size and total CPE for black crappie, white crappie, and black and white crappie combined) from treatment lakes with experimental PERs significantly increased post-regulation implementation (over a threefold increase) compared to pre-regulation implementation ($p < 0.10$). In addition, crappie CPE in control lakes (lakes with standard, statewide harvest regulations) did not change over the same time period, suggesting that natural fluctuations in CPE was likely not responsible for the observed increase in treatment lakes ($p > 0.10$). For crappie (black and white combined), CPE of legal-size fish increased in treatment waters from an average ($\pm$ standard deviation, SD) of 3.33 $\pm$ 6.36 fish per 24 hr net set before the experimental PERs to an average of 10.27 $\pm$ 21.97 fish per 24 hr net set after PERs were initiated in 1999 or 2000. For control lakes, average CPE before and after PERs was 6.46 $\pm$ 19.30 and 7.32 $\pm$ 20.47 legal-size fish per 24 hr net set, respectively. The fact that catch rates of legal-size crappie tripled in treatment lakes post regulation and remained unchanged in control lakes provides strong evidence that a biologically significant

response may have occurred for this species group in addition to a statistically significant response.

No other species or species group (sunfish and yellow perch) demonstrated a statistically significant response to the enhancement regulations for either the catch of legal-size or the total catch of these species. However, CPE of legal-size sunfish in treatment waters before and after PERs was 12.63 ± 26.89 and 20.52 ± 44.53 fish per 24 hr net set compared to 20.98 ± 31.36 and 20.68 ± 29.86 fish per 24 hr set pre and post treatment, respectively, in control waters. Likewise, CPE of legal-size yellow perch in treatment waters was 8.23 ± 29.04 fish per 24 hr net set prior to PERs implementation in 1999/2000 compared to 18.96 ± 43.80 fish per 24 hr net set after PERs were established, while in control waters there were 32.26 ± 78.49 legal-size fish per 24 hr net set prior to the experimental regulation period compared to 14.43 ± 38.83 legal-size fish per 24 hr net set afterwards. The fact that catch rates of legal-size sunfish and yellow perch nearly doubled in treatment lakes post regulation and remained unchanged or declined in control lakes provides strong evidence that a biologically significant response may have still occurred for these species, as it is likely that the high variability in trapnet catch rates reduced our ability to detect a statistically significant response, despite the doubling in catch rates post-regulation. At a minimum, the PERs had a neutral effect on treatment waters and likely may have had a biological benefit.

Angler Satisfaction Surveys

Overall, the angler satisfaction interview results indicate PERs are in part fulfilling their intention. Between the 1996-1998 (pre-implementation) and 2008 (post-implementation) interview cycles, overall angler opinions of satisfaction increased at both treatment and control

lakes while opinions of dissatisfaction have increased at control lakes. At treatment lakes, dissatisfaction has increased slightly for length of fish but has decreased overall for number of fish. Anglers at treatment lakes were not as satisfied as control lake anglers with the length of fish caught in 2008. They were, however, more satisfied with the number of fish caught in 2008 than control lake anglers. For treatment lakes, it appeared regulations have had little effect on angler effort.

The program appears to have influenced angler preferences between treatment and control lakes. Anglers fishing treatment lakes in 2008 appeared to favor the PERs. Control lake anglers appeared to follow suit, selecting the current limit of 50 fish per day as their preferred limit. Anglers, it appears, are willing to adjust to regulations and limits, and their willingness may have been a function of the fact that the PERs were not too restrictive. Anglers could still harvest a total of 50 fish per day under the PERs, but no more than 20 fish per species/species group. If the PERs were more restrictive, especially to the point that they considerably reduced angler yield, anglers may have been less willing to adjust. Most (81%) anglers at control lakes indicated that they would accept a change from statewide regulations to PERs and most (86%) said this change would have no affect on their angling effort. These results provide additional support for continuation and potential expansion of the PERs program.

Full Reports

The full reports outlining the biological assessments and angler satisfaction surveys are attached. Due to different authors for the biological assessment report and angler satisfaction survey report, each report should be cited separately when referencing.

Management Recommendations

1. Due to the threefold increase in the number of legal-size crappie in treatment waters post-regulation (statistically significant and likely biologically significant) and no change in control waters, along with the overall angler acceptance of the regulation, it is recommended that the PER program be continued at treatment waters for crappie.

2. While not statistically significant, results of biological assessments suggest that there were considerable increases (twofold) in legal-size sunfish and yellow perch numbers in treatment waters and no change in control waters. Thus, it appears that PERs had at least a neutral effect and may have had a biologically significant effect on sunfish and yellow perch in treatment waters. Given these results and overall angler acceptance of the regulation, it is recommended that the PER program be considered for continuation at treatment waters for sunfish and yellow perch as well.

3. Lakes being considered for application of PERs in the future should be carefully considered and should meet minimum program guidelines for trapnet catch rates, lake productivity, and fish growth. Most importantly, angler exploitation must be documented or judged to be sufficiently high for regulations to be biologically effective. If fishing mortality does not comprise a significant proportion of the total annual mortality of a species, it is likely that applying the PERs will not have the desired biological effect of increasing the numbers of larger panfish in the waterway.

4. If the PERs program is approved for continuation, managers should carefully review each individual water currently included in the PER program and be provided with the flexibility to recommend an alternate management strategy including removal of a water from the program if they feel it did not perform as desired.

Biological Assessment of Experimental Panfish Enhancement Regulations on Select Pennsylvania Impoundments

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Introduction

Pennsylvania's man-made impoundments and natural lakes provide a substantial amount of angling opportunities and fishing in these waters contributes in excess of $200 million annually to the state's economy (Weirich 1993). The Pennsylvania Fish and Boat Commission (PFBC) actively manage fishing and boating programs on over 400 publicly accessible impoundments with a combined surface area of over 100,000 acres. These impoundments vary in size, water quality, thermal regimes, and physical characteristics. PFBC fisheries managers are presented with many unique challenges in managing the variety of fish, people, and habitats that comprise these fisheries. From small infertile ponds to large productive reservoirs, the one constant and important fishery in almost all Pennsylvania impoundments involves panfish (e.g., sunfish, crappie, and perch). With very few new impoundments being constructed across the state and with an increasing number of impoundments being dewatered or closed to angling due to aging infrastructure and public liability, the management of panfish populations is important to providing quality angling opportunities at current and future levels of demand.

The popularity and importance of panfish fisheries in Pennsylvania has been well documented in a variety of sources. U.S. Fish and Wildlife Service surveys conducted in 1991, 2001, and 2006 show that in Pennsylvania, with the exception of trout, anglers spend more time

fishing for panfish than any other species with anglers spending over 8.0, 5.5, and 7.8 million days, respectively fishing for panfish (U.S. Department of the Interior 1991, 2001, and 2006). Summaries of angler use and harvest surveys conducted statewide on Pennsylvania impoundments by the PFBC have shown that nearly half of all time spent fishing in Pennsylvania is in pursuit of panfish (Hoopes and Cooper 1984; Hoopes and Kristine 1992). Additionally, many angler use and harvest surveys conducted at individual lakes confirm this level of use and have shown that most of the fish harvested during the survey period were comprised of panfish species (Kristine and Hollender 1992; Lorson and Smith 1997; Kristine and Hollender 1998; Arnold et al. 1999; Kristine and Hollender 1999; Moase et al. 1999; Wilson et al. 2004). A number of factors are responsible for the popularity of panfish fishing in Pennsylvania including: 1) the widespread occurrence and availability of panfish; 2) the relative ease in which panfish are caught; 3) panfish provide great table fare; and 4) the key role panfish play in introducing new and young anglers to the sport (Lorson and Miko 1995b; Lorantas 1998).

Historically, the PFBC like other state fisheries agencies encouraged and promoted panfish fishing under the premise that these species were underutilized and could not be overfished. Thus, in most Pennsylvania waters, panfish have been and are currently managed under liberal harvest regulations with a 50 fish/day creel limit and no minimum size limit (Table 1). During the last two decades, however, fishery managers in Pennsylvania and elsewhere have become concerned over the reduced size structure of bluegill *Lepomis macrochirus*, black crappie *Pomoxis nigromaculatus*, white crappie *Pomoxis annularis*, and yellow perch *Perca flavescens* populations at some waters and the significant effect angling can have on the size structure of their populations either directly or through indirect life history effects (Kempinger et al. 1975; Goedde and Coble 1981; Coble 1988; Miller et al. 1990; Lorson 1994; Lorson and

Miko 1995A; Lorson and Miko 1995B; Beard and Kampa 1999). Examination of long-term trends in Minnesota and Wisconsin showed that numbers of large bluegills, crappies, and yellow perch declined over time in both fish population and angler use and harvest assessments and these changes, in part, were attributed to increased angler exploitation (Olson and Cunningham 1989; Beard and Kampa 1999). While a comparison of the size structure of panfish species in Pennsylvania showed that truncation of size or size structure before 1986 and after was not as evident as has been observed in the data sets from the midwest, it was nonetheless felt that size structure of panfish populations in some Pennsylvania impoundments could be improved through the implementation of more conservative harvest regulations including establishing minimum size limits and decreasing creel limits (Lorson 1994; Lorson and Miko 1995a).

Panfish Enhancement Regulations (PERs) were first formally proposed by the PFBC Fisheries Management Division in 1994 (Lorson 1994; Lorson and Miko 1995b). The overall objectives of the PER program were to 1) increase numbers of large panfish and 2) increase the number of satisfied anglers targeting panfish. These objectives were to be accomplished through the establishment of a minimum size limit and reduced creel limit for bluegill, pumpkinseed, redear sunfish, black crappie, white crappie, and yellow perch in an attempt to improve their size structure in selected waters where it was believed feasible (Table 2). Hereafter, within this report the species to which PERs apply will be referred to collectively as “panfish”, unless otherwise specified, although the term “panfish” often includes other species within Pennsylvania. These other species include: other sunfish, white perch, rock bass, white bass, and other gamefish. When referencing panfish species within the enhancement program along with those additional panfish as defined in Pennsylvania’s Summary of Fishing Regulations and Laws

(as noted above, Table 1), these together will be collectively referred to as “combined panfish” species.

For harvest restrictions associated with the PERs in Pennsylvania, it was presumed that establishing minimum length limit restrictions would serve as the principal feature influencing size structure with reduced creel limits having lesser influence (R. Lorson and D. Miko personal communication 1997). While creel limits have the potential for important biological and social consequences (Cook et al. 2001; Jacobson 2005; Edison et al. 2006), evaluation of a reduced creel limit alone for panfish under a previous set of harvest restrictions known as Conservation Lake Regulations in select Pennsylvania impoundments had been found to be ineffective or insufficient at increasing and maintaining numbers of larger panfish (Billingsley and Johns 1992; Kaufmann et al. 1993; Lorson and Smith 1997). Size limit harvest restrictions have been shown to be effective at improving size structure of *Lepomis* species in both empirical studies (Pauckert et al. 2002) and simulation studies (Beard and Essington 2000). Similarly, size limit harvest restrictions applied to crappie populations have been shown to be effective at improving or maintaining size structure of crappie species or “dampening” fluctuations in abundance of desirable size crappie associated with year class variation (Colvin 1991; Webb and Ott 1991; Bunnell et al. 2006; M. Kaufmann personal communication 2008). There have been instances where panfish size structure has improved, but reduced angler yield was considered too great under an increased minimum size limit. For example, Hale et al. (1999) reported improved crappie size structure but a considerable reduction in yield under a 254 mm (10 inch) minimum size limit and consequently the minimum size limit was adjusted to 229 mm (9 inches) to reduce impact on yield. Depending upon the length limit established, harvest restrictions applied to yellow perch have been shown to exhibit variable effects in terms of size structure improvement

relative to yield loss (Isermann et al. 2007). Panfish populations that exhibited a favorable response to size limit increases were those with above average regional growth rates and where fishing mortality was suspected or measured to be a significant proportion of total annual mortality (Pauckert et al. 2002; Bunnell et al. 2006; Crawford and Allen 2006, Iserman et al. 2007). Favorable response was typically identified as increased availability of larger panfish with limited reduction in yield to anglers.

Although the magnitude of any change in abundance of large panfish due to regulatory change may be expected to be influenced by the magnitude of angling mortality relative to total mortality (Paukert et al. 2002, Crawford and Allen 2006, Iserman et al. 2007), it is also influenced by the duration that the regulatory change has been permitted to act on a population (Lorantas and Burman 1997; Allen and Pine 2000). Additionally, recruitment variability has the ability to influence the magnitude and detectability of change (Allen and Pine 2000). Using vital rates derived from statewide data sets and the fisheries literature, Lorantas and Burman (1997) used a dynamic pool model to simulate regulatory changes proposed in Table 2. Results illustrated that in excess of a 50% increase in population abundance was anticipated for bluegill ≥ age 4 assuming constant recruitment for 11 years following the regulatory change (Table 2). Similarly, an increase in excess of 50% for pumpkinseed ≥ age 4 was anticipated assuming constant recruitment for 9 years following the regulatory change. For black crappie, white crappie, and yellow perch density increases ≥ age 4 in excess of 50% were anticipated 9 years following implementation of harvest restrictions. For all species, simulated changes in abundance reached a peak between 9 and 11 years after implementation of the regulation and in all cases it was assumed that fishing mortality comprised the primary component of total annual mortality. The modeling exercise of Lorantas and Burman (1997) was not intended to mimic a

precise real-world population response to regulation change. Rather, it was intended to provide perspective as to the minimum period of time required for change and the approximate magnitude of population change under a scenario of constant annual recruitment. Although hypothetical, the scenario served to identify a time period necessary to yield maximum difference between pre and post regulation density changes and therefore guided timing of sampling evaluation periods. Not accommodating or allowing adequate time for a population response could lead to incorrect conclusions and inefficient use of agency resources.

To guide the selection of minimum size limits for PERs, historic PFBC trapnet catch rate and species size structure data, total annual mortality estimates from catch curves, expert opinion, and angler preference data was considered (Lorson and Miko 1995b; Lorantas 1998). There was broad support among PFBC fisheries managers to apply and evaluate panfish minimum length limits of 175 mm (7 inches) for bluegill, pumpkinseed, and redear sunfish; and 225 mm (9 inches) for black crappie, white crappie, and yellow perch. For each species or species group - sunfish (bluegill, pumpkinseed, and redear sunfish), crappie (black and white crappie), and yellow perch, a 20 fish per day creel limit applied. Additionally, the 50 fish combined species creel limit remained when harvesting fish from multiple species groups. At the January 1997 quarterly meeting, the PFBC Board of Commissioners approved the PERs and in 1999 adopted the current version of the regulation (Table 2). The 1997 meeting identified the program as experimental and included several bench marks and objectives including: 1) increase the number of sunfish over 175 mm (7 inches) and number of crappie and yellow perch over 225 mm (9 inches) available for harvest, as measured in biological assessments; 2) increase the number of satisfied anglers targeting sunfish, crappie, and yellow perch as measured through angler contact surveys; and 3) increase the number of desirable size panfish harvested, as

measured by creel surveys on selected waters. The focus of this report is on the results of the biological assessments (objective 1); results of the angler satisfaction survey (objective 2) was reported by Weigle et al. (2009) – see attachment; and 3) with the exception of Foster Joseph Sayers Lake, post-treatment creel surveys were not conducted due to funding limitations and therefore objective 3 was not completed.

Methods

Study Area – It was recognized early in discussions among PFBC fisheries management staff that circumstances influencing size structure include: fishing mortality (angler harvest, hooking, and handling mortality), natural mortality, growth (length at age), and recruitment. These primary vital rates can be variously influenced by predator density, water productivity (e.g., total alkalinity, chlorophyll a), prey density, competing fish species' density, biological habitat characteristics (e.g., aquatic plant density), physical habitat characteristics (e.g., average depth, overhead cover, spawning substrate), life history strategy, and other factors (Schneider 1999; Cross and McInerny 2005; Tomcko and Pierce 2005). Given these many variables, fisheries managers carefully identified a group of waters for evaluation of the PERs. Treatment waters were chosen where biological and angler use assessments indicated it may be possible to increase the number of large panfish given their popularity and suspected high rates of exploitation. Control waters were used to account for changes not associated with changes in angling regulations. Following a review of a wide variety of biotic and abiotic characteristics and using best professional judgment, attempts were made to identify control waters that exhibited panfish species population characteristics and other characteristics similar to treatment waters. Evaluation and control water pairings and applicable species are identified in Table 3.

In 1999, PERs were implemented at Foster Joseph Sayers Lake (Centre County) and Lake Chillisquaque (Montour County) for sunfish and crappie. The following year (2000), PERs were applied to crappie at Blue Marsh Reservoir (Berks County), sunfish and yellow perch at Promised Land Lake (Pike County), yellow perch at High Point Lake (Somerset County), and sunfish and crappie at Cross Creek Lake (Washington County). Control waters chosen for evaluation included Yellow Creek Lake (Indiana County), Kahle Lake (Clarion County), Hills Creek Lake (Tioga County), Rose Valley Lake (Lycoming County), and Little Buffalo Lake (Perry County).

Study waters varied in surface area from 36 to 700 ha, ranged in average depth from 1.7 to 8.9 m, and had productivity levels as measured by total alkalinity ranging from 5 to 117 mg/l (Table 4, Figure 1). Fish communities varied in study waters and were typical of publicly accessible impoundments in Pennsylvania where fisheries are managed for a wide range of angler preferences (Table 5). All study waters supported black bass *Micropterus spp.* populations as a top predator where sunfish and crappie fisheries were evaluated and nighttime electrofishing catch rates and size structure over time for black bass populations for these lakes are described in Table 6. In study waters where yellow perch populations were examined, walleye *Sander vitreus* were present and considered as the top predator (Table 7). Esocid populations were also present in all study waters.

Panfish population assessments - Panfish populations were sampled using Pennsylvania style trapnets (Hoopes 1989) to evaluate PERs. The Pennsylvania trapnet is a maze-type gear constructed of 25 mm (1 inch) stretched mesh which consists of a 30 m (100 ft) lead with two wings and a single heart which funnel fish into a 4.9 m^3 (175 ft^3) pot (Figure 2). Trapnets were set perpendicular to the shoreline and allowed to fish overnight and were moved daily. Fish

captured were identified to species and enumerated. For target species, total length was measured, catches enumerated by 25-mm length group, and a scale sample and weight was taken from up to ten individuals per 25-mm length group. Since overnight net sets varied slightly in duration, trapnet catch per effort (CPE) was standardized to catch per 24 hr net set.

It was presumed that trapnet CPE data was proportional to abundance as described by Lester et al. (1995) and that the magnitude of change, if any, that would be detectable statistically, would be influenced by trapnet sampling gear, variability in trapnet catch within years and among years, significance level (α), and power ($1-\beta$). Most pre-regulation data was secured from historic trapnet surveys (e.g., data collected prior to conception of this analysis). That data was used to guide sampling intensity (number of net sets) and to identify the number of years of pre and post regulation trapnet catch data to be used in analyses that would be adequate to detect anticipated levels of change. Analyses using techniques employed by Lester et al. (1995) showed that 40 trapnet sets per water per sample year and six sample years of annual data collection would yield the greatest level of resolution to changes in catch rate. Three years of CPE data would be required prior to establishment of harvest regulations and three years of data following regulation change. In the post application period, paired control and treatment waters were sampled during the same year to better account for some variability in these catch rates not attributable to regulation change. The recommended annual sampling intensity effectively doubled existing levels of annual effort expended per water body and it was not possible for some PFBC fisheries managers to achieve given staffing constraints and other commitments. Therefore, sample sizes varied within and among years.

Statistical Analysis – CPE data was analyzed to determine if PERs resulted in an increase in total CPE and/or CPE of large or legal size fish, on average, across all treatment and control

lakes (see Table 2 for description of large fish ≥ minimum size limit). Total CPE and CPE of legal-size fish for black crappie, white crappie, total crappie (white and black combined), bluegill, pumpkinseed sunfish, total sunfish (bluegill and pumpkinseed combined), and yellow perch were used in the statistical analysis. Because some surveys were performed in early spring and some surveys were performed in late spring, prior to performing the analyses to evaluate PERs, we evaluated whether or not CPE data varied between these two time periods. If there were not differences between early and late surveys, all data would be used to evaluate the PERs, regardless of spring sampling time. To determine if seasonal differences existed in panfish catch rates (e.g., early spring sampling vs. late spring sampling), a one-way ANOVA was used to compare average CPE of early and late spring samples and each observation used in the analysis was weighted by its standard deviation (SD) (i.e., 1/SD). Because average CPE data was used in this analysis, weighting by 1/SD accounted for the uncertainty in those means during the analysis. No statistically significant differences were found in either total catch rates or catch rates of legal-size panfish seasonally; therefore, all spring data was used for analyses. To evaluate the PERs, we fit general linear mixed models. These models addressed the study goal of whether or not the experimental regulations increased, on average, the number of sunfish ≥ 175 mm (7 inches) and number of crappie and yellow perch ≥ 225 mm (9 inches) available for harvest (as measured by CPE) in treatment lakes compared to control lakes. To accommodate the lack of independence among trapnet sets within the same lake and year, we included lake and year as random effects in the models. The fixed main effects included a categorical variable describing if a lake was a “treatment” or “control” lake and a categorical variable designating whether or not the sampling was performed “before” or “after” the experimental regulations were implemented. Because we were interested in the interaction between the two main effects,

this term was also included in the model. The interaction term allows for the comparison of the mean CPE before and after implementation for both treatment and control lakes. A significant interaction, where treatment lake CPE increases while control lake CPE remains unchanged would provide evidence for the PERs having the desired effect. After models were fit, least squares means and 90% confidence intervals (CIs) for CPE before and after the regulation implementation and for both control and treatment lakes were calculated (i.e., means and CIs were calculated for the interaction of the main effects in the models). Models were fitted using the MIXED procedure in the Statistical Analysis System (SAS; SAS Institute 2004). Least-squares means are within-group means adjusted for other effects in the model and are also known as the population marginal means (Searle 1987). Significant differences between least squares means were compared using $\alpha = 0.10$ and using the Tukey–Kramer correction to protect against type I errors. CPE was natural-log transformed after adding a constant to accommodate zero catches (i.e., ln(CPE + 0.1)) prior to analyses. Analyses were performed for each species (e.g., bluegill and black crappie) and species groups (i.e., total sunfish (bluegill + pumpkinseed sunfish) and total crappie (black + white crappies) for legal-size fish CPE and total CPE.

Creel Survey and Human Dimension Surveys – Angler satisfaction is clearly related to components of the angling experience apart from angling success, fish catch, and fish size (Holland and Ditton 1992). However, successful anglers have showed higher levels of satisfaction than unsuccessful anglers in a Minnesota lake (Spencer 1993). Support for restrictive regulations to improve fish catch and size has been related to availability of quality size and numbers of bluegill in Illinois lakes, where anglers expressed greater support for regulations where bluegill were small (Edison and Wahl et al. 2006). Perceived angling success, associated with trout regulation type has the potential to lead to more angling trips to a particular

water-management-type based upon choice modeling (Aas et al. 2000). Ultimately, identifying satisfaction levels attributable to fish catch that maximize angling use and angling trips will provide a basis for identification of concise angling objectives within a fishery management plan.

Prior to application of PERs, creel surveys designed to estimate catch, harvest, and size harvested, were conducted on a select group of control and treatment waters. Additionally, angler preference and satisfaction data were collected prior to application of regulations. This early preference data was used to guide selection of enhanced size and creel limits (Table 2). In the pre-treatment period survey work included sampling both "open water" periods and "ice fishing" periods on selected waters; on other waters, only "open water" periods were included in sampling (Table 3). Due to funding limitations in the post treatment period, a roving creel survey to estimate angler use and harvest was only conducted on Foster Joseph Sayers Lake during open water and ice fishing periods, and provisional angler preference and satisfaction surveys were conducted (Detar and Hollender 2004; Wilson et al. 2004). In the post treatment period for this water and other selected treatment and control waters, comprehensive angler preference and satisfaction surveys were conducted during the spring and summer "open water" fishing periods. Methodology and results of the 2008 angler satisfaction surveys are detailed by Weigle et al. (2009).

Results

Depending on the species of fish sampled, the total number of trapnets set over all lakes and years ranged from 1,119 to 1,154. Although 40 trapnets per sample occasion were recommended as a target level of effort during the post treatment evaluation, sample sizes varied from lake-to-lake and over time. Mean trapnet CPE, standard deviations, sample sizes, and

associated length indices for panfish and combined panfish groups from 1982-2007 at treatment and control waters are presented in Appendix I, Tables A1-A14. Associated length indices included proportional stock density (PSD) using stock and quality length as proposed by Willis et al. (1993), relative stock density (RSD) using stock length provided by Willis et al. (1993), and specified length as the PERs minimum size limit for each species.

Mean CPE over time for all lakes was highly variable among lakes and over time for sunfish, crappie, and yellow perch in study waters (Figures 3-16). For example, mean CPE ($\pm$ standard deviation, SD) for black crappie $\geq$ 225 mm sampled in Kahle Lake ranged from 7.59 $\pm$ 10.66 fish per 24 hr trapnet set in 1993 to 42.39 $\pm$ 54.51 fish per 24 hr trapnet set in 2007, while mean CPE of all size bluegill in Promised Land Lake ranged from 28.93 $\pm$ 34.63 in 1993 to 46.67 $\pm$ 57.93 bluegill per 24 hr trapnet set in 2003. While these study waters only represent a small number of the total impounded resources in Pennsylvania, this observed natural variability is typical and indicative of the wide range of physical, chemical, and biological characteristics influenced by various biotic and abiotic factors forming various fisheries across the state regardless of harvest regulation type.

Of the species and species groups analyzed, crappie CPE (including legal-size and total CPE for black crappie, white crappie, and black and white crappie combined) from treatment lakes with experimental PERs significantly increased post-regulation implementation compared to pre-regulation ($p < 0.10$; Figures 17–22). In addition, control lakes (lakes with standard harvest regulations) did not change over the same time period, suggesting that natural variability in CPE was not responsible for the observed increase in treatment lakes ($p > 0.10$). For total crappie, CPE of legal-size fish increased in treatment waters from an average of 3.33 $\pm$ 6.36 per 24 hr net set before the PERs to an average of 10.27 $\pm$ 21.97per 24 hr net set after PERs were

initiated in 1999 or 2000. For control lakes, average CPE before and after PERs was 6.46 ± 19.30 and 7.32 ± 20.47 legal-size fish per net set, respectively. The fact that catch rates of legal-size crappie tripled in treatment lakes post regulation and remained unchanged in control lakes provides strong evidence that a biologically significant response may have occurred for this species group in addition to a statistically significant response.

No other species or species group demonstrated a statistically significant response to the PERs for either legal-size or all size sunfish and yellow perch (Figures 18–30). However, CPE of legal-size sunfish in treatment waters before and after PERs was 12.63 ± 26.89 and 20.52 ± 44.53 fish per 24 hr net set, respectively, compared to 20.98 ± 31.36 and 20.68 ± 29.86 fish per 24 hr net set pre and post treatment, respectively, in control waters. The considerable increase in catch rate (nearly doubled) of legal-size sunfish in treatment lakes pre vs. post treatment may indicate there was a biologically significant response, even though the response was not statistically detectable. This was especially noteworthy given that the catch rates did not change in control waters pre vs. post treatment. Similarly, CPE of legal-size yellow perch in treatment waters before and after PERs was 8.23 ± 29.04 and 18.96 ± 43.80 fish per 24 hr net set, respectively, compared to 32.26 ± 78.49 and 14.43 ± 38.83 fish per 24 hr net set pre and post treatment, respectively, in control waters. The considerable increase in catch rate (more than doubled) of legal-size perch in treatment lakes pre vs. post treatment may indicate there was a biologically significant response, even though the response was not statistically significant, especially given that the catch rates declined in control waters pre vs. post treatment.

Results from individual evaluation (treatment) waters and applicable paired control waters for relevant species provide further insight. See Appendix 1, Tables A1-A14 for a compilation of all individual water results, including mean CPE and SD.

Blue Marsh Lake crappie (Hills Creek Lake-control) – PERs were applied to crappie at Blue Marsh Lake in 2000. The mean CPE for all and legal-size (≥ 225 mm, 9 in) crappie prior to 2000 was 77.28 and 3.58 crappie per 24 hour set, respectively, in trapnets fished at 134 sites from 1982-1999 (Tables A5 and A6). Following application of PERs mean total and legal-size CPE for crappie was 66.72 and 8.66 crappie per net set, respectively, at 78 sites. Proportional stock density (PSD) and relative stock density for 225 mm and larger fish (RSD_{225}) for crappie increased from 10 and 5, respectively, prior to 2000 to 23 and 15, respectively, following application of PERs. The mean total and ≥ 225 mm catch rate for crappie at the paired control water, Hills Creek Lake, was 33.60 and 9.47 per net set, respectively, prior to 2000 and declined to 8.40 and 6.81 per net set, respectively, from 2000-2007. A total of 60 trapnets were fished at Hills Creek Lake from 1982-1999 while 119 trapnets were fished in 2003, 2005, and 2007. While crappie catch rates declined at Hills Creek Lake, PSD and RSD_{225} for crappie increased from 26 and 23 prior to 2000 to 90 and 81 from 2000-2007.

Cross Creek Lake sunfish and crappie (Kahle Lake-control) – Beginning in 2000, PERs were applied to crappie and sunfish at Cross Creek Lake. Prior to treatment, trapnets were fished at a total of 65 sites between 1986 and 1999. The mean CPE for all and legal size (≥ 225 mm, 9 in) crappie during this time was 10.08 and 2.27 crappie per 24 hour net set, respectively (Tables A5 and A6). PSD and RSD_{225} values prior to PERs were 39 and 24. Post treatment sampling consisted of a total of 60 trapnet sites during 2003, 2005, and 2007. PSD and RSD_{225} values following enactment of PERs increased to 76 and 38, respectively, and mean trapnet catches increased to 69.60 crappies per 24 hr net set for all size fish and 25.36 crappies per set for legal-size fish. A total of 57 trapnets were fished at the paired control water, Kahle Lake, prior to implementation of PERs in 2000 at Cross Creek Lake and 120 trapnets were fished during the

post-treatment period. Mean catch rates of black and white crappie combined at Kahle Lake during the pre-treatment period for all and ≥ 225 mm fish were 12.24 and 9.74 crappie per 24 hour set. Similar to Cross Creek Lake, CPE was higher during the post-treatment period with means of 33.12 for all size crappie per 24 hr net set and 17.96 crappie per net set ≥ 225 mm. PSD and RSD_{225} values for crappie prior to 2000 were 83 and 79, respectively, and declined to 74 and 57, respectively, during the post-treatment period at Kahle Lake.

Combined mean catches of bluegill and pumpkinseed prior to PERs at Cross Creek Lake were 23.76 sunfish per 24 hr net set and 14.74 legal-size fish (≥ 175mm, 7 in) per net set (Tables A11 and A12). Post-treatment catch rates were considerably higher with a catch rate of all size fish of 64.32 sunfish per set and legal-size fish of 40.23 sunfish per 24 hr net set. Mean post treatment catch rates of sunfish on the control water Kahle Lake were 52.32 fish per set for all size sunfish and 34.06 per set for sunfish ≥ 175mm per 24 hr net were considerably higher than pre treatment catch rates of 21.36 fish per set for all size sunfish and 16.15 sunfish ≥ 175mm per 24 hr net set. PSD and RSD_{175} values for sunfish at Cross Creek Lake remained near constant (81 and 65 pre-PERs vs. 80 and 63 post-PERs) and were similar to the control water Kahle Lake (88 and 76 pre-PERs vs. 65 and 65 after 2000).

Foster Joseph Sayers Lake crappie and sunfish (Yellow Creek Lake-control) - Prior to implementation of PERs in 1999, a total of 48 trapnets were fished during 1987, 1995, and 1998 while 97 trapnets were set during the post-treatment period (2000-2007). Trapnets were fished at Yellow Creek Lake (paired control water) at 29 sites prior to 1999 and at 56 total sites in 2002, 2004, and 2006 (post treatment period). The mean CPE for all size and legal-size (≥ 175mm, 7 in) sunfish prior to 1999 at Sayers Lake was 31.92 and 13.09 sunfish per 24 hr net set, respectively, and 27.12 and 5.14 sunfish per net set, respectively, post PERs (Tables A11 and

A12). Lower PSD and RSD_{175} values of 38 and 19 were documented during the post treatment period when compared to 66 and 43 prior to 1999 for sunfish at Sayers Lake. Similar results were documented at Yellow Creek Lake. Mean CPE for all size and fish $\geq$ 175mm before 1999 were 38.64 and 11.51 sunfish per 24 hr net set, respectively, compared to 19.68 and 2.48 sunfish per net set, respectively, post PERs. PSD and RSD_{175} values were 39 and 32 before PERs were implemented at Sayers Lake vs. 35 and 16 afterwards at the control lake.

Combined mean catches of black and white crappie prior to PERs at Foster Joseph Sayers Lake were 81.12 crappie per 24 hr net set and 3.85 legal size fish ($\geq$ 225mm, 9 in) per net set with associated PSD and RSD_{225} length indices of 23 and 8 (Tables A5 and A6). After PERs were applied, mean trapnet catch rates were slightly higher at 85.68 and 5.35 fish per 24 hr net set for total and legal size fish, respectively, while PSD and RSD_{225} length indices were 30 and 8. Yellow Creek Lake mean catch rates for all size crappie and fish $\geq$ 225mm before 1999 were 9.12 and 5.06 crappie per 24 hr net set, respectively, compared to 6.96 and 5.17 crappie per net set, respectively, during the post-treatment period. PSD and RSD_{225} values were 74 and 59 before PERs were implemented at Sayers vs. 94 and 87 afterwards.

Lake Chillisquaque crappie and sunfish (Kahle Lake-control) - Beginning in 1999, PERs were applied to crappie and sunfish at Lake Chillisquaque. Prior to the experimental regulations, trapnets were fished at a total of 60 sites between 1984 and 1998. The mean CPE for all and legal size ($\geq$ 225 mm, 9 in) crappie during this time was 21.12 and 3.50 crappie, respectively, per 24 hour net set (Tables A5 and A6). PSD and RSD_{225} values prior to PERs were 54 and 33. Post treatment sampling consisted of a total of 120 trapnet sites during 2003, 2005, and 2007. PSD and RSD_{225} values following enactment of PERs increased to 84 and 51 and mean trapnet catches increased to 23.76 crappies per 24 hr net set for all size fish and 7.75 crappies per set for

legal-size fish. Mean catch rates of black and white crappie combined at the paired control water, Kahle Lake, during the pre-treatment period for all and ≥ 225 mm size fish were 12.24 and 9.74 crappie per 24 hour net set, respectively. Similar to Lake Chillisquaque, catch rates were higher during the post-treatment period with means of 33.12 for all size crappie per 24 hr net set and 17.96 crappie per net set for fish ≥ 225 mm. PSD and RSD_{225} values for crappie prior to 1999 were 83 and 79 and declined to 74 and 57 during the post-treatment period at Kahle Lake.

Combined mean catches of bluegill and pumpkinseed prior to PERs at Lake Chillisquaque were 21.84 for all size sunfish per 24 hr net set and 4.33 legal size fish (≥ 175mm, 7 in) per net set (Tables A11 and A12). Post-treatment catch rates were found to be lower with legal size fish being caught at an average rate of 1.11 sunfish per 24 hr net set and all size fish catch rates at 8.88 sunfish per set. Mean post PERs catch rates of 52.32 total and 34.06 sunfish ≥ 175mm per 24 hr net set at control water Kahle Lake were higher than the mean pre PERs catch rates of 21.36 and 16.15 sunfish ≥ 175mm per 24 hr net set. While PSD and RSD_{175} values for sunfish at Lake Chillisquaque remained near constant (43 and 23 pre-PERs vs. 37 and 22 post-PERs), these values were somewhat higher at the control water Kahle Lake (88 and 76 pre-PERs vs. 65 and 65 after 1999).

Promised Land Lake yellow perch and sunfish (Hills Creek Lake-control) - PERs were initiated at Promised Land Lake in 2000 for sunfish (bluegill and pumpkinseed) and yellow perch. Mean total catch for all size and legal-size (≥ 175 mm, 7in) sunfish prior to 2000 was 44.64 and 31.50 sunfish per 24 hr net set at 18 total trapnet sites fished in 1993 and 1997 (Tables A11 and A12). Following establishment of PERs, catch rates were found to be higher with a mean 50.64 sunfish of all sizes and 43.86 legal-size sunfish per 24 hr net set captured in 113 total

nets set during 2003, 2005, and 2007 at the lake. PSD and RSD_{175} length indices for sunfish populations before PERs were 98 and 71 compared to 98 and 87 afterwards at Promised Land Lake. A total of 60 and 119 trapnets were set at the paired control water, Hills Creek Lake, during the pre and post treatment periods, respectively. While sunfish populations contained a higher proportion of larger fish at Hills Creek Lake during the post treatment period compared to before 2000 as evidenced by PSD and RSD_{175} values of 90 and 67 vs. 78 and 47, mean trapnet catch rates were lower in the post treatment period (34.80 total and 23.24 sunfish $\geq$ 175mm per 24 hr net set) than in the pre-treatment period (58.32 total and 29.21 sunfish $\geq$ 175mm per 24 hr net set).

The mean CPE for all and legal size ($\geq$ 225mm, 9in) yellow perch at Promised Land Lake prior to PERs was 59.28 and 22.04 fish per 24 hour set with associated PSD and RSD_{225} values of 78 and 37, respectively (Tables A13 and A14). Mean catch rates for the same size groups in the post treatment period were 33.36 total and 27.02 legal-size yellow perch per net set and PSD and RSD_{225} length indices were 92 and 81. At the control water, Hills Creek Lake, yellow perch catch rates pre treatment for all size and $\geq$ 225 mm fish were 43.68 and 6.26 perch per 24 hour net set and 5.04 total perch and 2.11 $\geq$ 225 mm perch per set during post treatment. Hills Creek Lake yellow perch PSD index was 35 prior to 2000 and 77 afterwards while RSD_{225} was 15 before PERs and 44 in the years sampled afterwards.

High Point Lake yellow perch (Kahle Lake-control) - Management of the yellow perch fishery at High Point Lake under the experimental PERs began in 2000. Between 1989 and 1998 before regulations went into effect the lake was sampled during three different years (1989, 1996, and 1998) and trapnets were fished at a total of 46 sites (Tables A13 and A14). Post treatment evaluation at High Point Lake consisted of 51 total trapnet sites sampled during 2003,

2005, and 2007. The mean catch rate for all and legal size (≥ 225mm, 9in) yellow perch at High Point Lake prior to PERs was 34.80 and 2.83 fish per 24 hour set with associated PSD and RSD_{225} values of 14 and 9, respectively (Tables A13 and A14). Mean catch rates for the same size groups in the post treatment period were 57.36 total and 1.12 legal-size yellow perch per set and PSD and RSD_{225} length indices were 11 and 9. At the control water, Kahle Lake, yellow perch catch rates pre treatment for all size and ≥ 225 mm fish were 79.68 and 73.82 perch per 24 hour net set during pre treatment and 34.08 total perch and 12.96 ≥ 225 mm perch per set during post treatment. Kahle Lake yellow perch PSD index was 98 prior to 2000 and 57 afterwards while RSD_{225} was 94 before PERs and 43 in the years sampled afterwards.

Discussion

Once thought of as underused and a common held belief that panfish populations could not be affected by overharvest, anglers and fisheries managers alike have become increasingly aware of the effects of angler exploitation on the quality of panfish populations. The goal of this report was to evaluate the effectiveness of harvest restrictions for improving the size structure of panfish populations in selected waters where biological and angler use assessments indicated it may be feasible to increase numbers of large panfish.

Population assessments

Results of biological assessments through Pennsylvania trapnet surveys suggest that numbers of large or legal-size panfish have increased in treatment waters. It is important to recognize that study results were from data pooled from all treatment and control waters for this analysis, rather than on an individual water basis (i.e., we examined whether or not the PERs were effective, *on average*, at achieving management goals).

The threefold increase in the number of legal-size crappie in treatment waters post-regulation (statistically significant ($p < 0.10$) and likely biologically significant) was likely due to harvest restrictions and not natural variability, as control waters showed no change.

While not statistically significant, results suggest that there were still considerable increases in legal-size sunfish and yellow perch numbers for some individual waters and the treatment group as a whole when compared to paired control waters or the control group as a whole. The fact that catch rates of legal-size sunfish and yellow perch about doubled in treatment lakes post regulation while remained unchanged or declined in control lakes provides strong evidence that a biologically significant response may have still occurred for these species, as it is likely that the high variability in trapnet catch rates reduced our ability to detect a statistically significant response. At a minimum, the PERs had a neutral effect on treatment waters and likely may have had a biological benefit. As with any statistical technique, it is critically important to consider the biological significance of results. Statistically nonsignificant results may be biologically significant, especially if the number of observations is too low to detect the change (Carpenter 1989). Krebs (1999) states, "The greatest mistake any ecologist can make in the use of routine statistics is to confuse the concept of statistical significance with that of biological significance. Biological significance is not a mechanical concept like statistical significance. It refers to the importance of a particular set of measurements in the context of a theoretical hypothesis. To demonstrate a difference statistically is trivial and often gets in the way of the real ecological question: How different are the two populations or communities? And, secondly, are the differences large enough to be ecologically relevant?" The two-threefold increases in catch rates for legal-size crappie, sunfish, and perch in treatment waters post-

regulation and no change in control waters provide considerable evidence that a biologically significant/relevant response likely occurred for all species groups.

Factors affecting population size structure

It was recognized early in discussions among PFBC fisheries management staff that many factors have the ability to influence size structure including: fishing mortality (angler harvest and release mortality), natural mortality, growth (length at age), and recruitment. These primary vital rates can be variously influenced by predator density, water productivity (e.g., total alkalinity, chlorophyll a), prey density, competing fish species' density, biological habitat character (e.g. vascular aquatic plant stem density), physical habitat (e.g., average depth), life history strategy, and other factors (Schneider 1999; Cross and McInerny 2005; Tomcko and Pierce 2005). The potential for some *Lepomis* species to favor life history strategies that could lead to production and recruitment of smaller males was also recognized (Ehlinger et al. 1997) although such life-history strategies (sneakers and satellites) have not been documented in Pennsylvania and have not received attention by agency biologists. In terms of life history strategy versus angling impacts on size structure of *Lepomis* species, simulation work by Beard and Essington (2000) showed that fishing mortality had the greatest influence on size structure, however life history strategies that favored mating with small males tended to slow improvement in size structure once fishing mortality directed to larger parental males was reduced via regulation. Further, a clear relationship between ratio of bluegill cuckholders (small males) and parental males (large males) was not always related to fishing pressure (Tomcko and Pierce 1993; Drake et al. 1997).

A population phenomenon also significantly influencing abundance of *Lepomis* species, *Pomoxis* species, and yellow perch can be broadly characterized as year class variability or

recruitment variability. Year class variability can be influenced by climatic variables that affect annual production of young and other abiotic and biotic influences. Although year class strength or recruitment variability influence ultimate abundance and size structure of many fish populations, many would argue that *Pomoxis* species are most subject to the greatest year class variation (Bunnell et al. 2006). Many attempts to relate seasonal reservoir elevation, storage or exchange to recruitment or year class levels have been successful for *Pomoxis* species (Beam 1983, Maceina and Stempert 1998). However these coarse reservoir changes have fallen short in some cases with other variables also influencing year class strength (Maceina 2003, Mitzner1991, Bunnell et al. 2006). More detailed examination of mechanisms that influence production and survival of young crappies has shown that both biotic and abiotic features (catch per unit effort of adult crappie and chlorophyll a concentration, respectively) have yielded a high level of variance explanation (Bunnell et al. 2006). The latter work suggested that adult stock influenced production of young, an attribute where harvest limitation may benefit annual recruitment.

Beard and Kampa (1999) noted that there tended to be geographically broad similarities in species specific temporal changes in abundance for not only black crappie but bluegill, and yellow perch, perhaps associated with climatic variables. Some analyses suggest that influences of predation and recruitment variation and other non-angling influences were sufficiently great that detecting any change in sunfish vital rates (growth) or abundance and attributing that change to habitat manipulations or other management changes such as changes in angling mortality would be problematic (Carpenter et al. 1995).

Therefore, because there are so many factors that have the ability to affect panfish population size and size structure, it is important to note that not all avenues or potential factors

were investigated as part of this report. The focus remained on evaluating the PER program as a whole, not on an individual water basis. Nonetheless, we included water specific information such as predator density, productivity measurements, physical characteristics, etc., to allow for more in depth analyses for individual waters in the future if this is of interest to fisheries managers. However, it is also important to note that all factors do not need to be evaluated, quantified, or measured to make a management decision. Even if we measured all or some of these factors our ultimate decision regarding program success is likely to remain unchanged. The benefit of investigating these variables is that they may provide insight regarding why some lakes may have performed better than others.

The overall objectives of the PER program were to 1) increase numbers of large panfish and 2) increase the number of satisfied anglers targeting panfish. From a biological standpoint, the PER program as a whole was successful at significantly increasing the numbers of legal-size crappie (black and white combined) in treatment waters, and at a minimum had a neutral effect on and likely biological benefit to the numbers of legal-size sunfish (bluegill and pumpkinseed combined) and yellow perch.

Future Research

Additional evaluation of catch data using methods described by Brenden et al. (2008) or others may provide further insight into the effectiveness of PERs for crappie, sunfish, and yellow perch fisheries and allow better understanding to more precisely ascertain how fish populations changed. The variability among CPE in the study lakes suggests that future research that focuses on elucidating lake characteristics (physical, chemical, and biological) associated with favorable responses to size and creel limits will guide future decisions about which waters to target for using more restrictive harvest regulations to enhance size structure of panfish populations.

Perhaps the most important underlying premise for PERs was that angler exploitation was assumed to be sufficiently high to affect size structure of panfish populations. However, angler exploitation was never directly measured in any treatment or control lake. In addition, with the exception of Foster Joseph Sayers Lake, angler use and harvest studies were not conducted at any other treatment or control waters due to budget restraints and other commitments. A future angler use and harvest survey in conjunction with a study to facilitate the estimation of exploitation at select waters would be very helpful in making future recommendations for waters to be included in the PERs and to establish levels of angler harvest which are limiting quality panfish fisheries.

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Management Recommendations

5. Due to the threefold increase in the number of legal-size crappie in treatment waters post-regulation (statistically significant and likely biologically significant) and no change in control waters, along with the overall angler acceptance of the regulation, it is recommended that the PER program be continued at treatment waters for crappie.

6. While not statistically significant, results of biological assessments suggest that there were considerable increases (twofold) in the number of legal-size sunfish and yellow perch in treatment waters and no change in control waters. Thus, it appears that PERs had at least a neutral effect and may have had a biologically significant effect on sunfish and yellow perch in treatment waters. Given these results and overall angler acceptance of the regulation, it is recommended that the PER program be considered for continuation at treatment waters for sunfish and yellow perch as well.

7. Lakes being considered for application of PERs in the future should be carefully considered and should meet minimum program guidelines for trapnet catch rates, lake productivity, and fish growth. Most importantly, angler exploitation must be documented or judged to be sufficiently high for regulations to be biologically effective. If fishing mortality does not comprise a significant proportion of the total annual mortality of a species, it is likely that applying the PERs will not have the desired biological effect of increasing the numbers of larger panfish in the waterway.

8. If the PERs program is approved for continuation, managers should carefully review each individual water currently included in the PER program and be provided with the flexibility to recommend an alternate management strategy including removal of a water from the program if they feel it did not perform as desired.

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Table 1. For all Commonwealth Inland waters not otherwise designated the following minimum size limit (MSL) and combined species daily creel limit (DCL) applied to panfish.

Species or Species Group	MSL	DCL
Sunfish, yellow perch, white perch, crappies, catfish, rock bass, suckers, carp, white bass, and other game fish not otherwise listed.	none	50

Table 2. For selected waters and species or species groups designated as included in the Panfish Enhancement Regulation (PER) program, harvest restrictions identified below apply. Note that harvest restrictions (minimum size limit, MSL; and daily creel limit, DCL) may be designated to apply to any species or species group combination, however the combined species DCL of 50 applies to all panfish species on all waters regardless of inclusion in the PER program.

Species or Species Group	MSL	DCL
Sunfish (bluegill and pumpkinseed)	7 inches	20
Crappie (black and white)	9 inches	20
Yellow perch	9 inches	20
Combined (includes all "panfish" species regardless of inclusion in PER program)	As designated by PER, otherwise none	50

Table 3. Panfish Enhancement program control and treatment waters where three years pre-treatment and three years post-treatment trapnet data were available. Creel and human dimension survey details are noted by approximate sample seasons

Water Name	AFM	Species	Reason Initiated	Regulation Effective Year	Recommended Control Lake Pairing	Spring/summer Creel Survey	Winter Creel Survey	Preference/ Satisfaction Survey
Hills Creek Lake	4		Control			1998		1998, 2008
Little Buffalo Lake	7		Control (not paired)			1996		1996
Kahle Lake	2		Control			1997	1998	1998, 2008
Rose Valley Lake	3		Control (not paired)			1992		
Yellow Creek Lake	8		Control			1996	1997	1996, 1997, 2008
Foster Joseph Sayers Lake	3	SNF, BWC	Program Evaluation	1999	Yellow Creek Lk	1998, 2002	2003	1998, 2002, 2003, 2008
Lake Chillisquaque	3	SNF, BWC	Program Evaluation	1999	Kahle Lk			1998, 2008
Blue Marsh Lake	6	BWC	Program Evaluation	2000	Hills Ck Lk	1986, 1990		2008
Promised Land Lake	5	SNF, YP	Program Evaluation	2000	Hills Creek Lk	1997	1998	1997, 1998, 2008
High Point Lake	8	YP	Program Evaluation	2000	Kahle Lk	1996		1996, 2008
Cross Creek Lake	8	SNF, BWC	Program Evaluation	2000	Kahle Lk	?		1997, 2008

Table 4. Surface Area, percent littoral area (lake area < 3.0 m deep), maximum depth, average depth, shoreline development index (SDI), and total alkalinity of Panfish Enhancement Study Lakes. NA indicates information not available.

Water	AFM	Assessment Study	Surface Area (ha)	Littoral Area (%)	Maximum Depth (m)	Average Depth (m)	SDI	Total Alkalinity (mg/l)
Blue Marsh Lake	6	Treatment	465	NA	15.5	8.9	7.09	104
Cross Creek Lake	8	Treatment	99	70	17.7	6.4	4.22	117
Foster Joseph Sayers Lake	3	Treatment	700	28	20.7	5.5	4.02	101
High Point Lake	8	Treatment	137	NA	9	3.6	2.05	28
Hills Creek Lake	4	Control	55	80	5.5	2.9	1.78	44
Kahle Lake	2	Control	102	69	11.9	5	1.79	36
Lake Chillisquaque	3	Treatment	67	40	12.2	6	2.35	40
Little Buffalo Lake	7	Control	36	NA	9	3.1	2.41	51
Promised Land Lake	5	Treatment	171	71	3.5	1.7	3.41	5
Rose Valley Lake	3	Control	157	NA	5.5	3.1	2.2	18
Yellow Creek Lake	8	Control	291	NA	11	4.2	2.86	20

Table 5. Fish species occurrence at study lakes captured by all gear over time. Does not include wild or hatchery trout (multiple page table).

Common Name	Scientific Name	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	High Point Lake	Hills Creek Lake	Kahle Lake	Lake Chillisquaque	Little Buffalo Lake	Promised Land Lake	Rose Valley Lake	Yellow Creek Lake
American Eel	*Anguilla rostrata*	X							X			
Alewife	*Alosa pseudoharengus*	X										X
Gizzard Shad	*Dorosoma cepedianum*								X			X
Banded Killifish	*Fundulus diaphanus*				X			X	X			X
Chain Pickerel	*Exox niger*			X	X	X		X	X	X	X	
Northern Pike	*Esox lucius*		X		X			X	X	X		X
Muskellunge	*Esox masquinongy*				X	X			X	X	X	X
Tiger Muskellunge	*Esox lucius x E. masquinongy*	X		X	X		X		X	X		X
Goldfish	*Carassius auratus*	X		X					X			
Common Carp	*Cyprinus carpio*	X	X	X	X	X	X	X	X	X		X
Golden Shiner	*Notemigonus crysoleucas*	X	X	X	X	X	X	X	X	X	X	X
Satinfin Shiner	*Cyprinella analostana*	X							X			
Common Shiner	*Luxilus cornutus*	X	X					X	X	X		
Spottail Shiner	*Notropis hudsonius*	X		X				X	X	X		
Emerald Shiner	*Notropis atherinoides*						X					
Rosyface Shiner	*Notropis rubellus*									X		X
Swallowtail Shiner	*Notropis procne*									X		
Spotfin Shiner	*Cyprinella spiloptera*	X		X				X	X	X		
Blacknose Dace	*Rhinichthys atratulus*		X						X	X		
Longnose Dace	*Rhinichthys cataractae*								X	X		
Redside Dace	*Clinostomus elongatus*									X		

Table 5. Fish species occurrence at study lakes captured by all gear over time. Does not include wild or hatchery trout (multiple page table).

Common Name	Scientific Name	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	High Point Lake	Hills Creek Lake	Kahle Lake	Lake Chillisquaque	Little Buffalo Lake	Promised Land Lake	Rose Valley Lake	Yellow Creek Lake
Central Stoneroller	*Campastoma anomalum*		X				X		X	X		
Bluntnose Minnow	*Pimephales notatus*	X	X		X			X	X	X		X
Fathead Minnow	*Pimephales promelas*							X		X		
Cutlips Minnow	*Exoglossum maxillingua*								X	X		
Eastern Mudminnow	*Umbra pygmaea*									X		
Creek Chub	*Semotilus atromaculatus*		X				X		X	X	X	
Fallfish	*Semotilus corporalis*			X					X	X	X	
River Chub	*Nocomis micropogon*									X		
Quillback	*Carpiodes cyprinus*	X						X		X		
River Carpsucker	*Carpiodes carpio*	X										
White Sucker	*Catastomus commersoni*	X	X	X	X	X	X	X	X	X	X	X
Northern Hog Sucker	*Hypentelium nigricans*		X		X				X	X		
Golden Redhorse	*Moxostoma erythrurum*				X		X					X
Lake Chubsucker	*Erimyzon sucetta*									X		X
Creek Chubsucker	*Erimyzon oblongus*									X		
Margined Madtom	*Noturus insignis*								X	X		
White Catfish	*Ameiurus catus*	X								X		
Yellow Bullhead	*Ameiurus natalis*	X	X	X	X	X	X	X	X	X	X	X
Brown Bullhead	*Ameiurus nebulosus*	X	X	X	X	X	X	X	X	X	X	X
Channel Catfish	*Ictalurus punctatus*	X	X	X		X	X	X	X	X		X
Flathead Catfish	*Pylodictis olivaris*	X	X				X					

Table 5. Fish species occurrence at study lakes captured by all gear over time. Does not include wild or hatchery trout (multiple page table).

Common Name	Scientific Name	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	High Point Lake	Hills Creek Lake	Kahle Lake	Lake Chillisquaque	Little Buffalo Lake	Promised Land Lake	Rose Valley Lake	Yellow Creek Lake
Mottled Sculpin	*Cottus bairdii*		X						X	X		
Slimy Sculpin	*Cottus cognatus*								X	X		
White x Striped Bass	*Morone chrysops x M. saxatilis*	X										
Striped Bass	*Morone saxatilis*	X										
White Perch	*Morone americana*	X										
Rock Bass	*Ambloplites rupestris*	X	X	X	X	X	X	X	X	X	X	X
Green Sunfish	*Lepomis cyanellus*	X	X		X	X		X	X	X		
Pumpkinseed	*Lepomis gibbosus*	X	X	X	X	X	X	X	X	X	X	X
Bluegill	*Lepomis macrochirus*	X	X	X	X	X	X	X	X	X	X	X
Redbreast Sunfish	*Lepomis auritus*	X							X	X		
Redear Sunfish	*Lepomis microlophus*		X									
Hybrid Sunfish	*Lepomis hybrids*	X	X					X		X	X	X
Longear Sunfish	*Lepomis megalotis*									X		
Smallmouth Bass	*Micropterus dolomieu*	X	X	X	X				X	X	X	X
Largemouth Bass	*Micropterus salmoides*	X	X	X	X	X	X	X	X	X	X	X
White Crappie	*Pomoxis annularis*	X	X	X	X		X		X		X	X
Black Crappie	*Pomoxis nigromaculatus*	X	X	X	X	X	X	X	X	X	X	X
Bluespotted Sunfish	*Enneacanthus gloriosus*			X						X	X	
Tessellated Darter	*Etheostoma olmstedi*	X				X			X	X	X	
Johnny Darter	*Etheostoma nigurm*		X		X							X
Fantial Darter	*Etheostoma flabellare*		X						X			X

Table 5. Fish species occurrence at study lakes captured by all gear over time. Does not include wild or hatchery trout (multiple page table).

Common Name	Scientific Name	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	High Point Lake	Hills Creek Lake	Kahle Lake	Lake Chillisquaque	Little Buffalo Lake	Promised Land Lake	Rose Valley Lake	Yellow Creek Lake
Banded Darter	*Etheostoma zonale*								X	X		
Greenside Darter	*Etheostoma blennoides*		X						X	X		
Rainbow Darter	*Etheostoma caeruleum*											X
Blackside Darter	*Percina maculata*								X			
Shield Darter	*Percina peltata*									X		
Log Perch	*Percina caprodes*											X
Walleye	*Sander vitreus*	X	X	X	X	X	X	X	X	X	X	X
Saugeye	*Sander canadensis x S. vitreus*		X									
Yellow Perch	*Perca flavescens*	X	X	X	X	X	X	X	X	X	X	X
	Total Species	36	32	23	25	18	21	25	46	52	21	31

Table 6. Total, ≥ 300 mm, and ≥ 375 mm mean night electrofishing catch rates (catch/hour) of black bass with associated length indices at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total Cue	≥300 mm Mean CUE	≥375mm Mean CUE	PSD	RSD_{375}
Blue Marsh Lake	6	Treatment	1982	2	57.8	11.3	4.9	21	9
			1983	2	29.5	1.4	0.3	12	2
			1985	1	17.2	4.5	1.3	35	10
			1986	9	8.4	2.1	1.1	31	19
			1987	1	15.0	6.9	2.9	55	23
			1988	1	15.3	9.4	4.1	64	28
			1989	4	8.8	4.3	2.5	55	31
			1990	7	1.7	0.5	0.0	50	n/a
			1991	4	6.3	2.9	1.4	62	31
			1992	1	57.7	20.9	11.9	42	24
			1993	1	42.7	24.8	10.4	61	25
			1994	1	49.6	12.0	27.2	62	27
			1995	1	35.9	17.4	10.8	51	31
			1996	2	22.7	14.7	6.7	66	30
			1997	1	36.3	18.5	7.6	60	25
			1998	1	24.5	6.5	2.6	40	16
			1999	1	25.0	10.1	0.6	49	3
			2000	3	12.3	6.4	2.5	80	27
			2001	1	17.8	8.3	3.9	52	24
			Average		25.5	9.6	5.4	50	21
Cross Creek Lake	8	Treatment	1986	1	112.8	9.3	1.5	11	2
			1987	1	146.3	10.7	0.7	10	1
			1988	1	134.2	47.1	5.5	39	5
			1989	1	130.6	40.2	4.6	32	4
			1994	1	201.2	101.5	26.5	58	15
			2007	8	174.6	72.5	31.2	47	20
			Average		150.0	46.9	11.7	33	8
Foster Joseph Sayers Lake	3	Treatment	1990	3	95.9	30.0	5.2	25	6
			1995	5	64.9	17.9	5.7	42	13
			1998	3	31.2	9.3	2.1	65	17
			1999	4	76.5	17.1	10.3	49	30

Table 6. Total, ≥ 300 mm, and ≥ 375 mm mean night electrofishing catch rates (catch/hour) of black bass with associated length indices at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total Cue	≥300 mm Mean CUE	≥375mm Mean CUE	PSD	RSD_{375}
Foster Joseph Sayers Lake	3	Treatment	2002	11	39.6	28.4	8.2	72	21
			Average		61.6	20.5	6.3	51	17
High Point Lake	8	Treatment	1978	1	6.7	1.7	0.0	50	n/a
			1989	1	21.9	7.4	1.7	40	9
			1996	6	23.2	8.9	2.9	47	16
			2007	5	34.4	27.3	16.9	88	54
			Average		21.6	11.3	5.4	56	26
Hills Creek Lake	4	Control	1982	2	63.9	9.5	1.3	19	3
			1988	4	33.7	15.9	3.4	54	13
			1994	6	108.1	38.3	16.1	38	16
			Average		68.6	21.2	6.9	37	11
Kahle Lake	2	Control	1990	1	150.2	36.4	0.2	37	0
			1991	1	197.5	23.5	2.3	48	5
			1992	1	56.5	17.3	4.8	75	21
			1993	1	123.8	22.5	4.9	61	13
			1994	1	166.6	32.2	4.1	43	6
			1995	1	193.5	43.2	7.0	45	7
			1996	1	132.3	47.6	4.6	57	6
			1997	1	170.4	83.7	4.8	81	5
			1998	1	73.8	36.7	9.0	65	16
			1999	1	219.7	21.9	6.1	33	9
			2000	1	192.0	32.7	8.0	26	6
			2001	1	137.4	40.8	5.2	43	6
			2002	1	109.6	53.8	5.1	82	8
			2003	1	115.0	38.7	8.5	57	12
			2004	1	108.1	37.9	14.0	46	17
			2005	1	205.1	35.8	7.7	59	13
			2006	1	263.6	34.4	6.4	26	5
			2007	1	225.2	32.8	8.2	42	11
			2008	1	133.3	36.0	2.6	40	3
			Average		156.5	37.3	6.0	51	9

Table 6. Total, ≥ 300 mm, and ≥ 375 mm mean night electrofishing catch rates (catch/hour) of black bass with associated length indices at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total Cue	≥300 mm Mean CUE	≥375mm Mean CUE	PSD	RSD_{375}
Lake Chillisquaque	3	Treatment	1984	2	41.7	9.2	4.7	24	13
			1985	2	85.6	19.8	2.3	36	4
			1986	1	84.7	20.0	4.0	38	8
			1994	2	151.7	64.5	8.0	52	6
			1998	2	129.8	79.6	11.6	79	12
			2003	2	52.4	30.9	25.0	70	57
			2005	2	70.6	61.8	44.1	88	62
			Average		88.1	40.8	14.2	55	23
Little Buffalo Lake	7	Control	1984	1	75.4	6.3	1.7	10	3
			1989	1	110.7	6.6	0.3	8	0
			1992	4	212.4	24.1	2.5	18	2
			1995	3	251.9	64.5	3.3	28	1
			1996	3	309.0	39.9	5.0	18	3
			1998	2	319.3	184.0	10.1	60	3
			2003	3	270.7	64.5	12.2	28	1
			Average		221.3	55.7	5.0	24	2
Promised Land Lake	5	Treatment	1980	1	24.0	0.7	0.0	20	n/a
			1987	1	22.1	0.5	0.0	6	n/a
			1993	1	33.3	1.5	0.0	6	n/a
			1997	8	36.8	3.4	0.0	9	n/a
			2003	3	26.0	8.4	0.0	39	n/a
			2007	3	3.0	1.7	0.0	55	9
			Average		24.2	2.7	0.0	23	9
Rose Valley Lake	3	Control	1978	1	33.3	10.0	0.7	39	3
			1984	1	83.8	46.3	8.1	58	10
			1991	2	72.6	10.0	0.7	16	1
			1992	1	192.5	79.6	2.0	44	1
			1997	6	87.7	61.6	5.6	75	7
			2003	4	121.7	89.0	7.0	75	6
			2005	3	151.3	93.1	16.9	71	13
			Average		106.1	55.7	5.9	54	6

Table 6. Total, ≥ 300 mm, and ≥ 375 mm mean night electrofishing catch rates (catch/hour) of black bass with associated length indices at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total Cue	≥300 mm Mean CUE	≥375mm Mean CUE	PSD	RSD_{375}
Yellow Creek Lake	8	Control	1989	1	52.9	28.2	1.9	72	5
			1993	9	27.3	10.9	2.9	53	14
			1996	15	40.0	22.3	11.0	74	37
			2006	8	56.2	17.4	3.4	53	11
			Average		44.1	19.7	4.8	63	17

Table 7. Total mean trapnet catch rate (catch/hour) of walleye at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total CUE
High Point Lake	8	Treatment	1989	8	0.89
			1996	16	0.67
			1998	16	0.46
			2003	20	0.02
			2005	15	0.04
			2007	16	0.02
			Average		0.35
Hills Creek Lake	4	Control	1982	24	0.07
			1988	12	0.07
			1994	12	0.1
			1998	12	0.04
			2003	40	0.05
			2005	39	0.03
			Average		0.06
Kahle Lake	2	Control	1993	9	0.05
			1996	16	0.15
			1997	16	0.05
			1998	16	0.05
			2003	40	0.02
			2005	40	0.01
			2007	40	0.02
			Average		0.05
Little Buffalo Lake	7	Control	1984	23	0.04
			1989	12	0.11
			1995	16	0.08
			1998	16	0.02
			2004	22	0

Table 7. Total mean trapnet catch rate (catch/hour) of walleye at Panfish Enhancement Evaluation waters through time (multiple page table).

Water	AFM	Assessment Study	Year	Number Sites	Mean Total CUE
Little Buffalo Lake	7	Control	Average		0.05
Rose Valley Lake	3	Control	1984	15	0.28
			1991	12	0.18
			1997	16	0.3
			2003	40	0.16
			Average		0.23

Figure 1. Location of treatment (closed circle) and control (open circle) waters across Pennsylvania identified for study in Panfish Enhancement Regulation fish population evaluation.

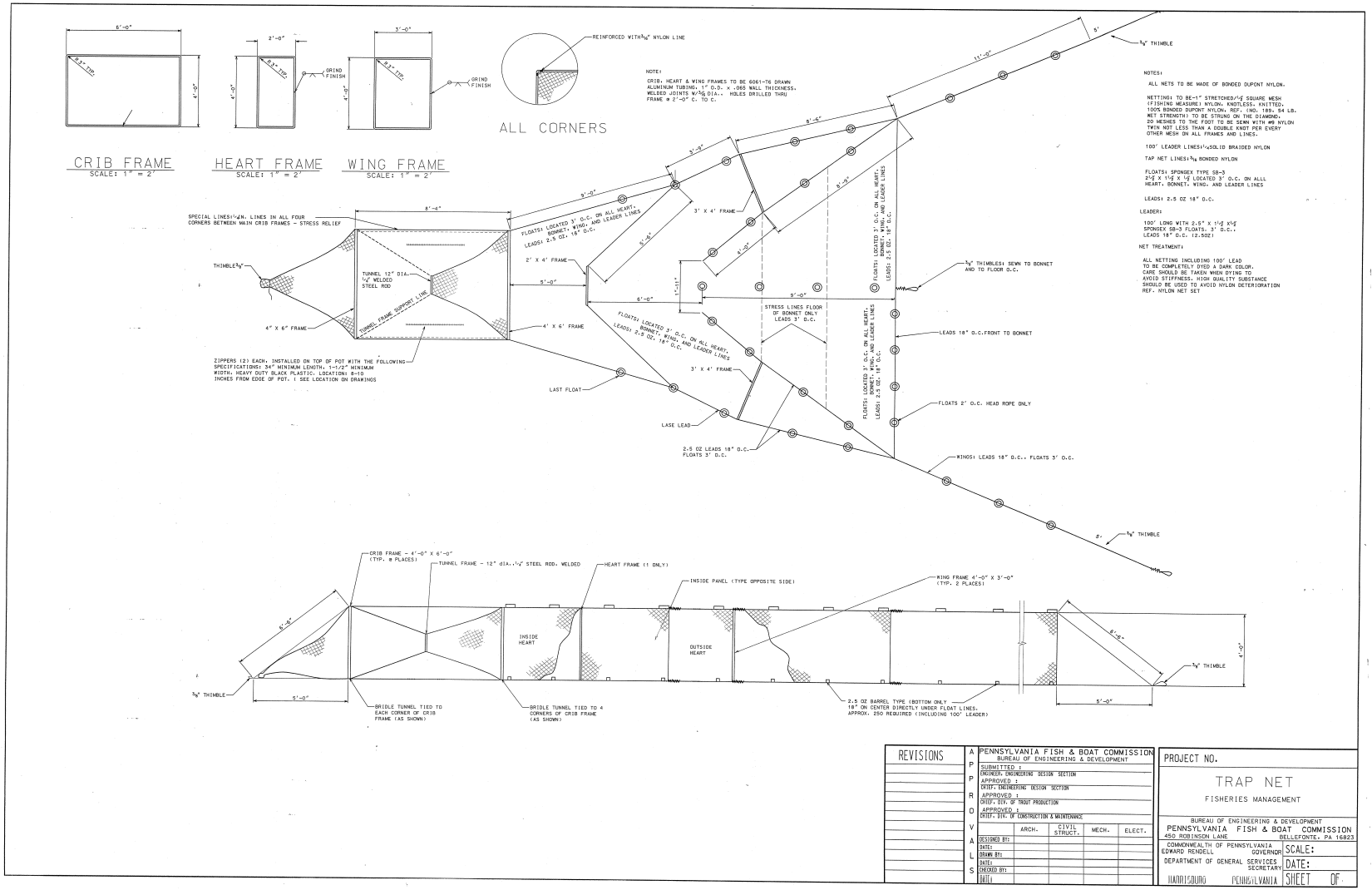

Figure 2. Diagram of a Pennylvania-style trapnet.

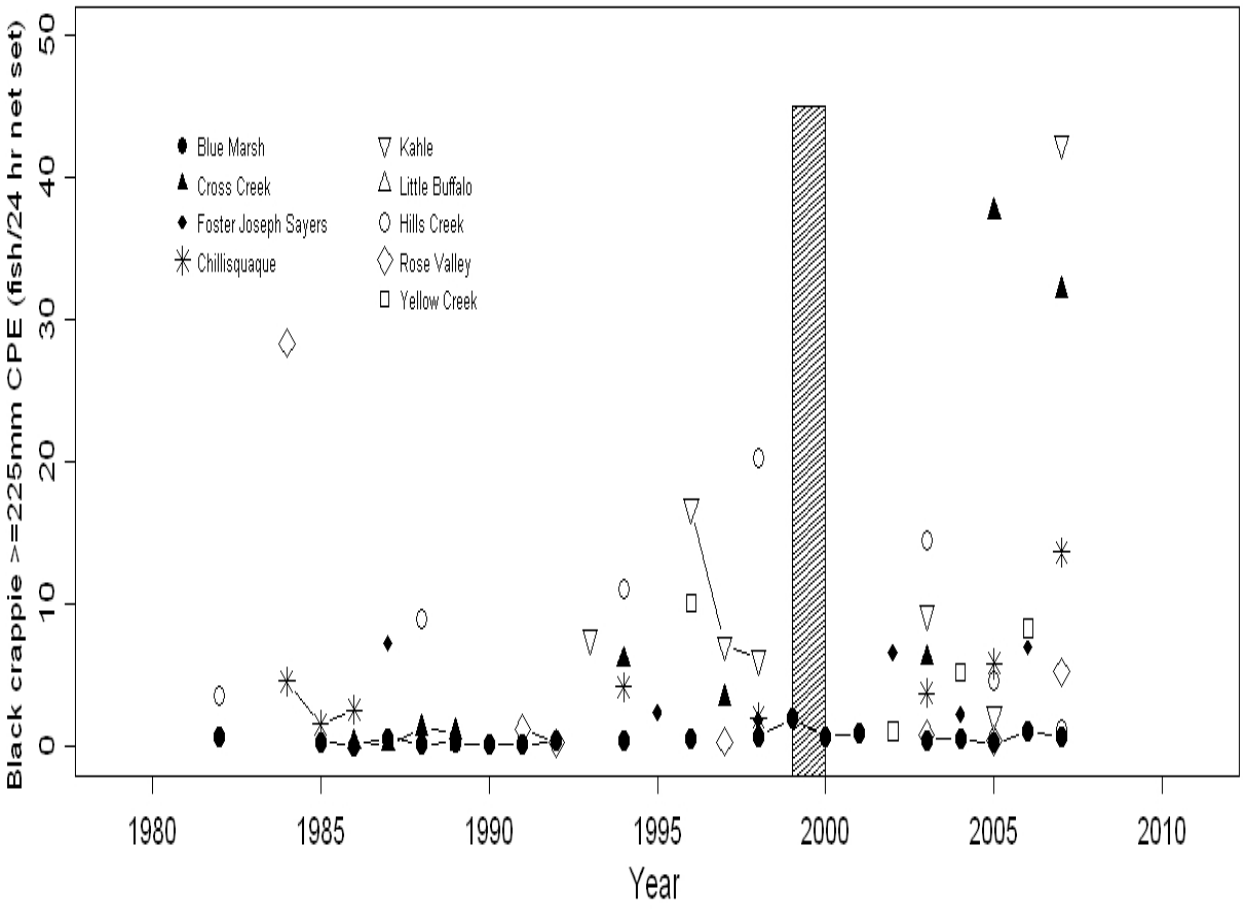

Figure 3. Mean catch per 24 hr net set for black crappie ≥ 225 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

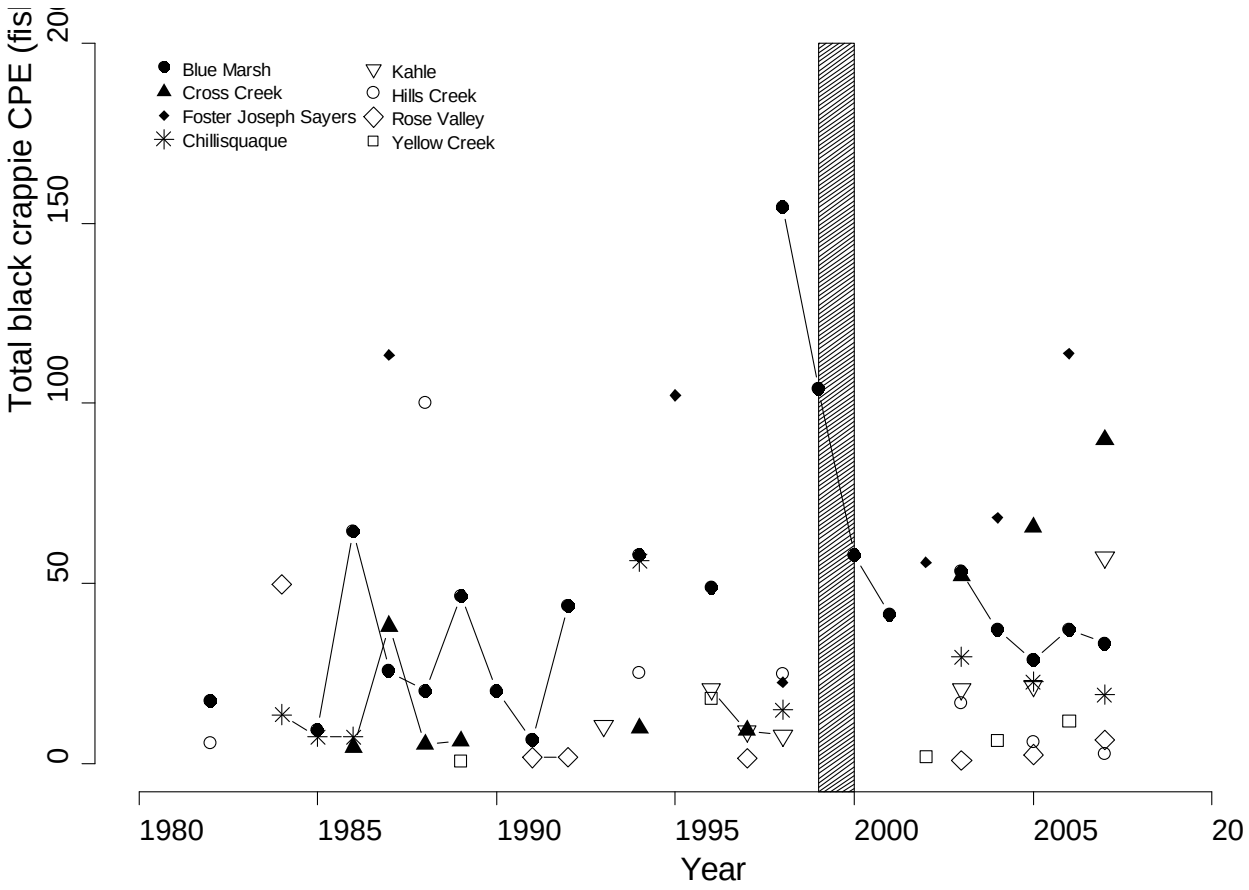

Figure 4. Mean catch per 24 hr net set for all black crappie. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

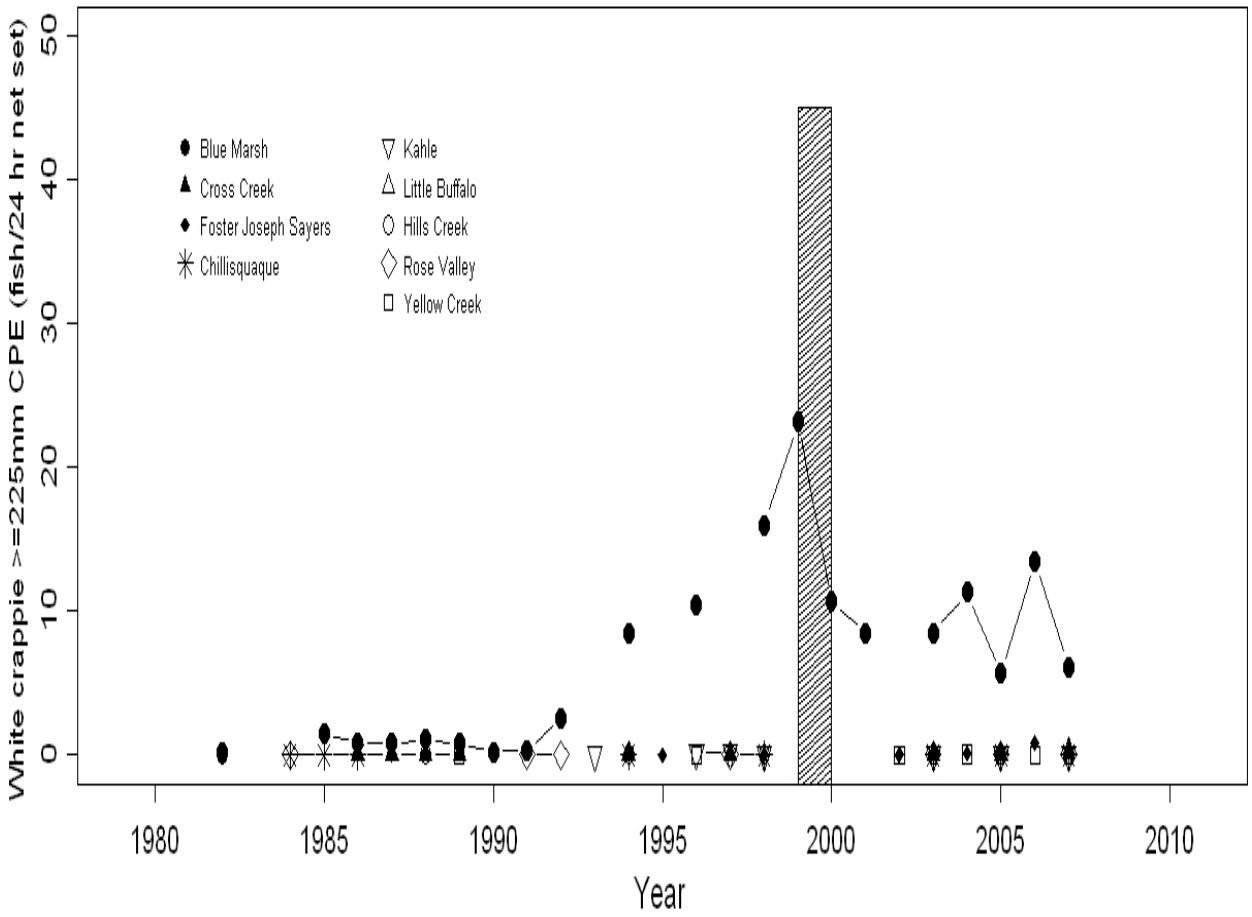

Figure 5. Mean catch per 24 hr net set for white crappie ≥ 225 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

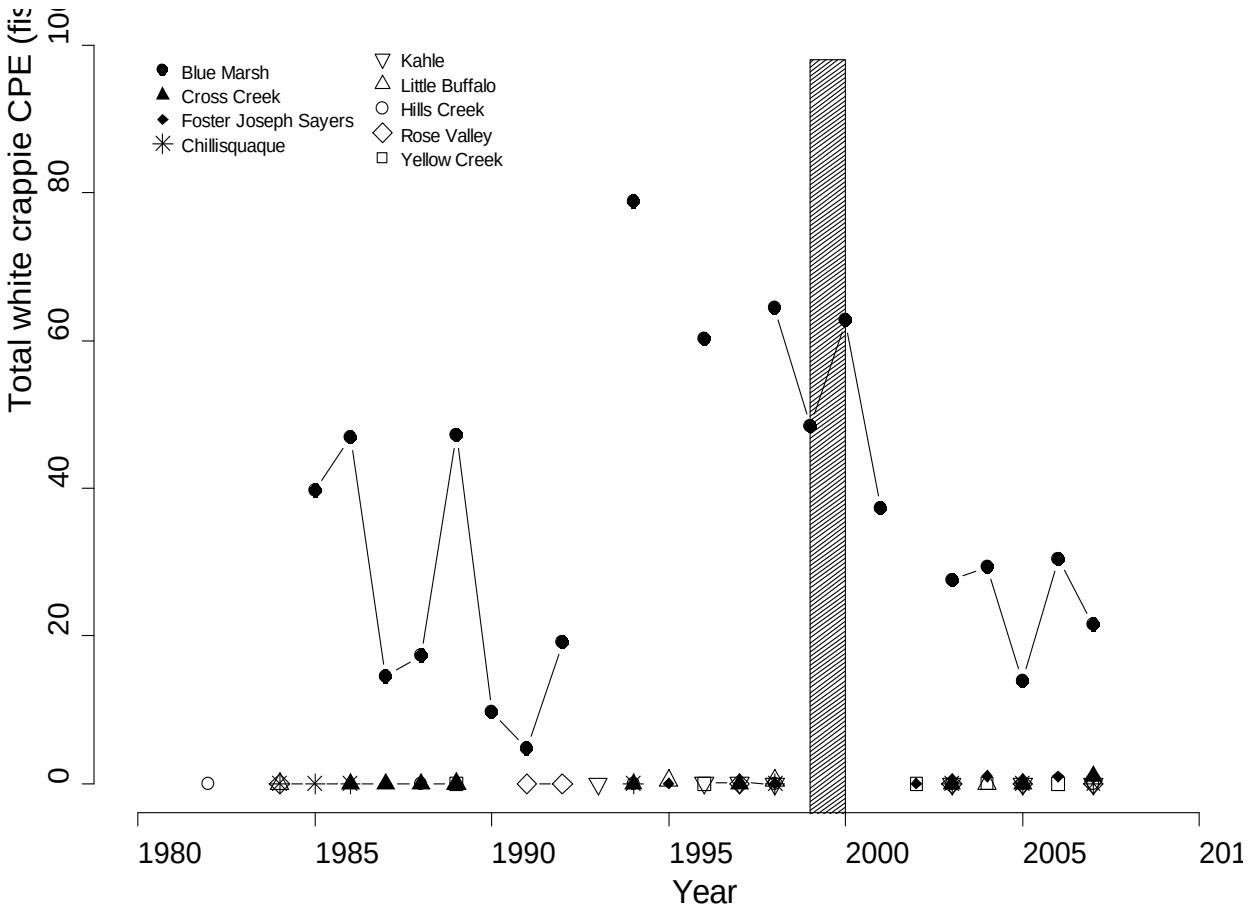

Figure 6. Mean catch per 24 hr net set for all white crappie. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

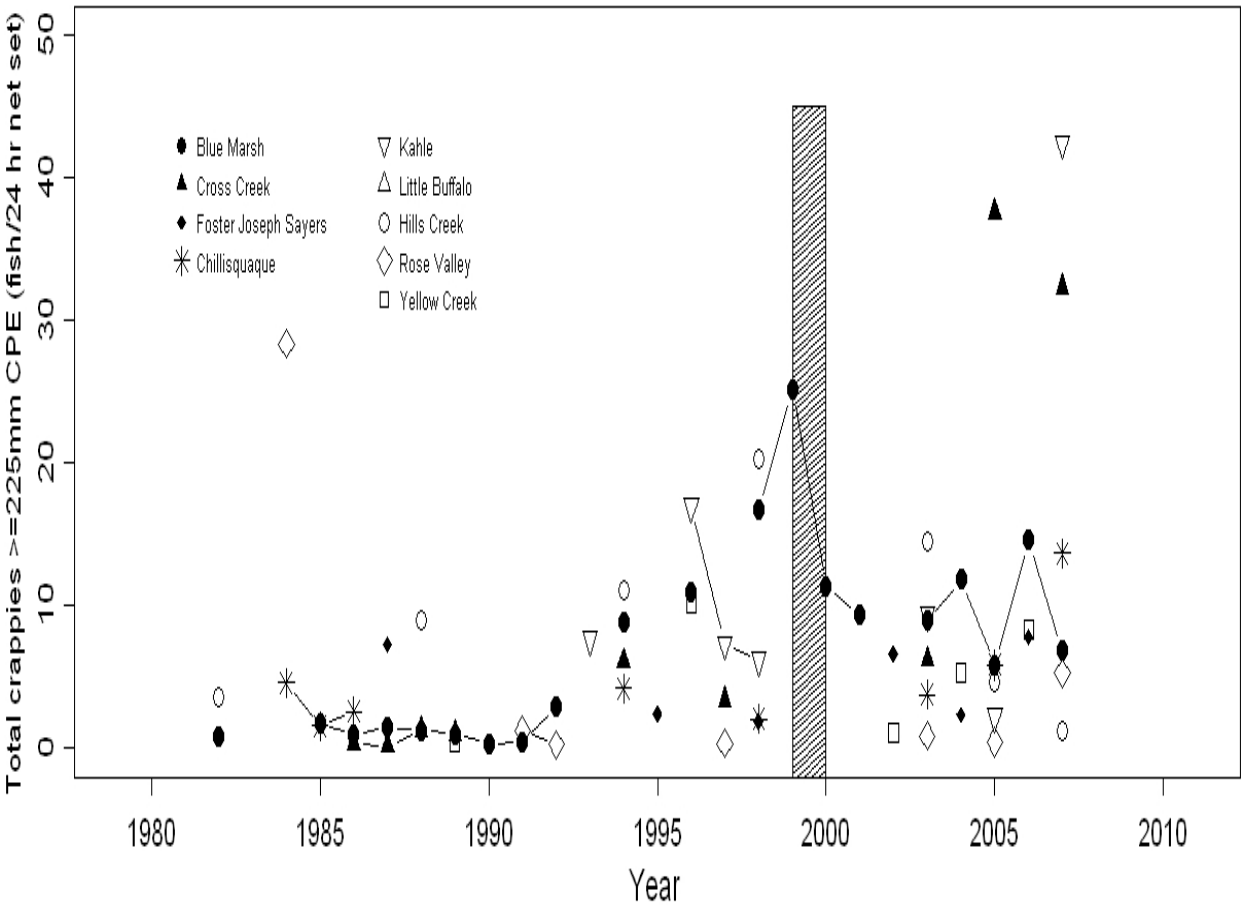

Figure 7. Mean catch per 24 hr net set for crappie (black and white combined) ≥ 225 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

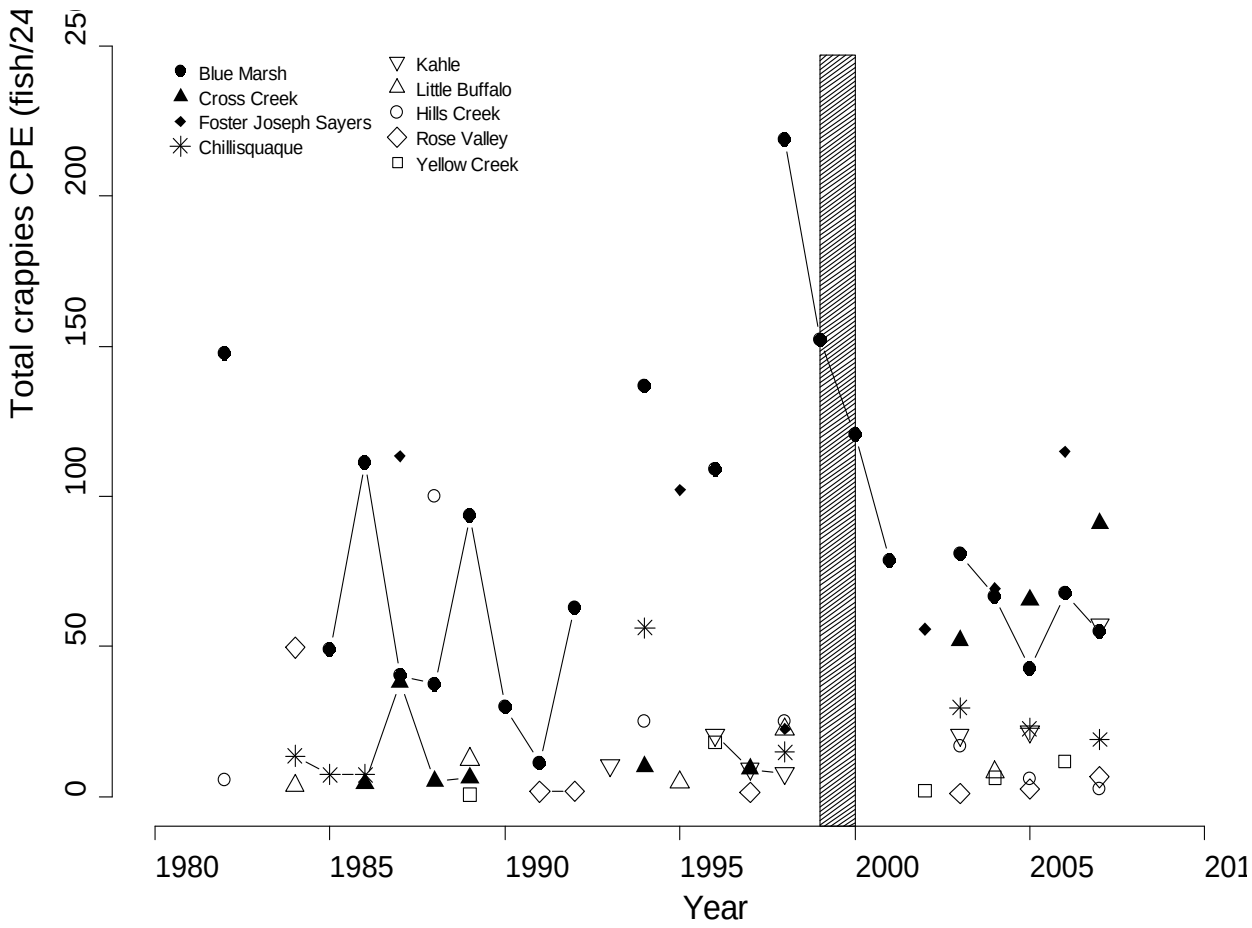

Figure 8. Mean catch per 24 hr net set for all crappie (black and white combined). Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

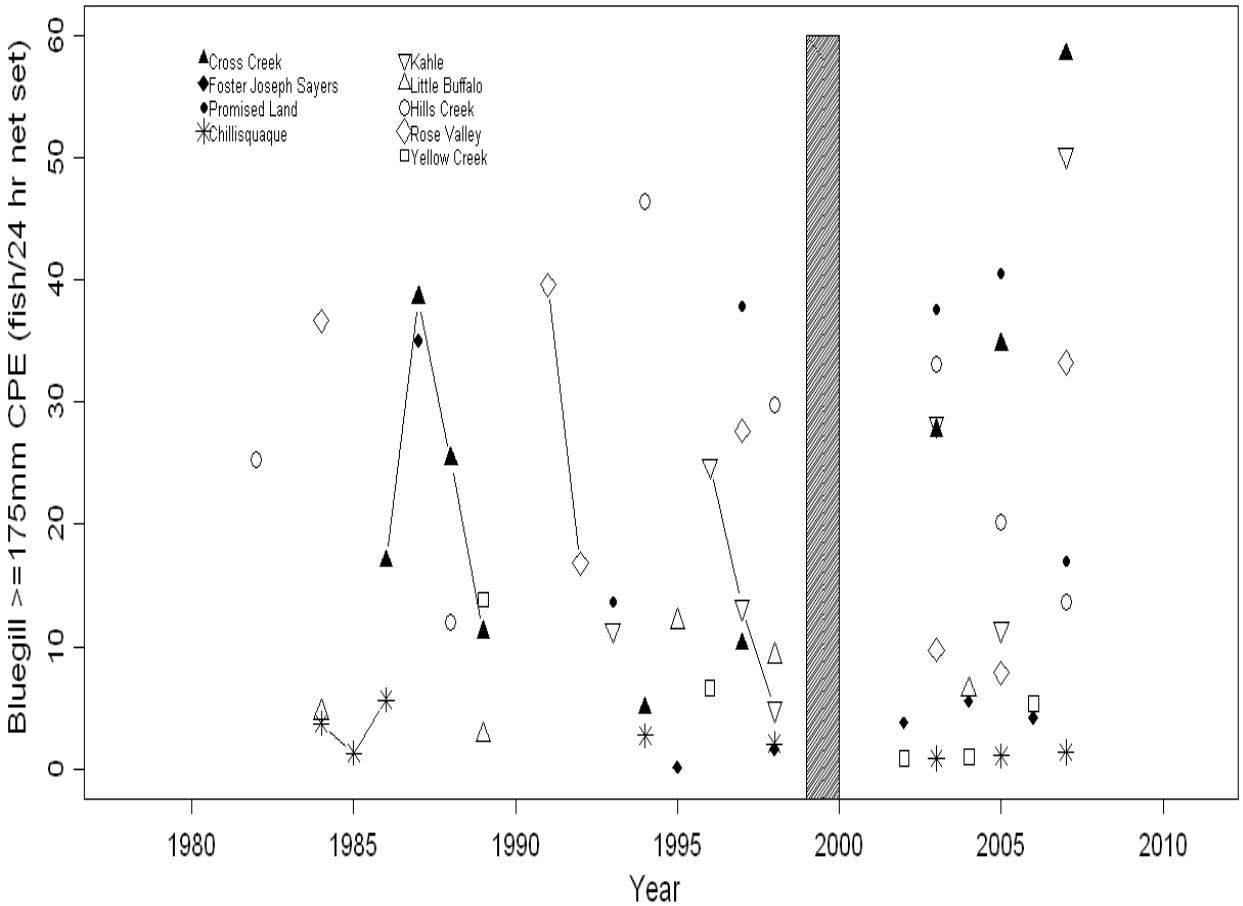

Figure 9. Mean catch per 24 hr net set for bluegill ≥ 175 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

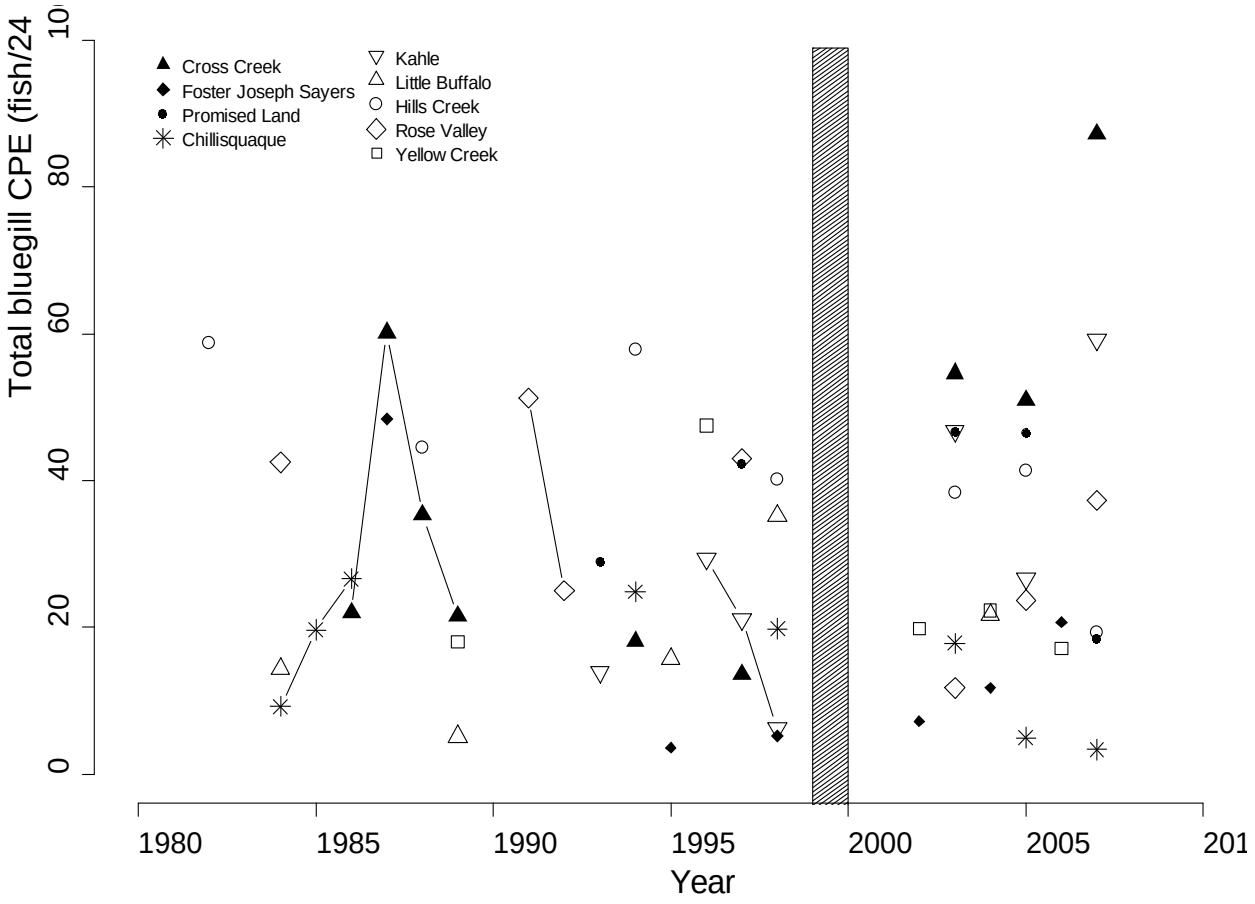

Figure 10. Mean catch per 24 hr net set for all bluegill. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

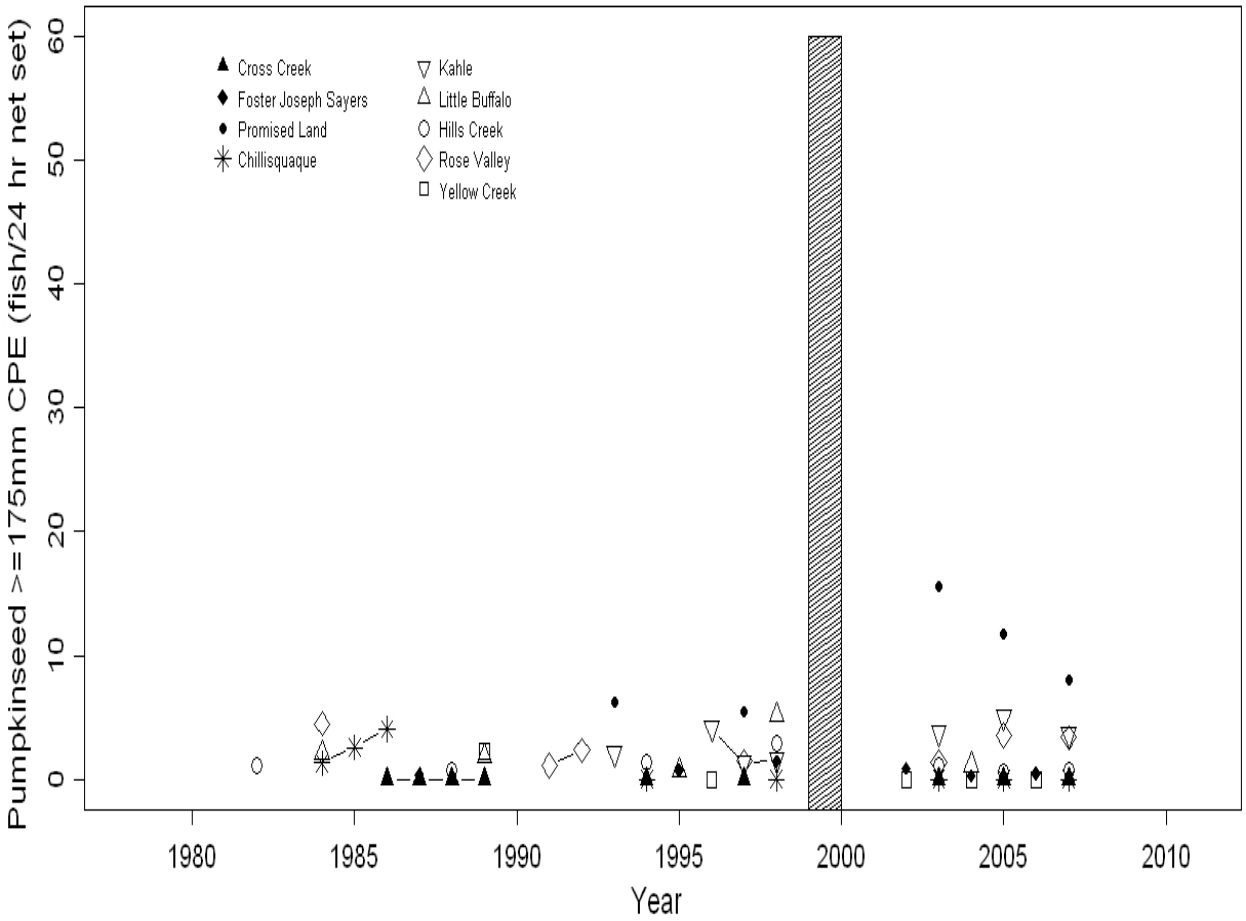

Figure 11. Mean catch per 24 hr net set for pumpkinseed sunfish ≥ 175 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

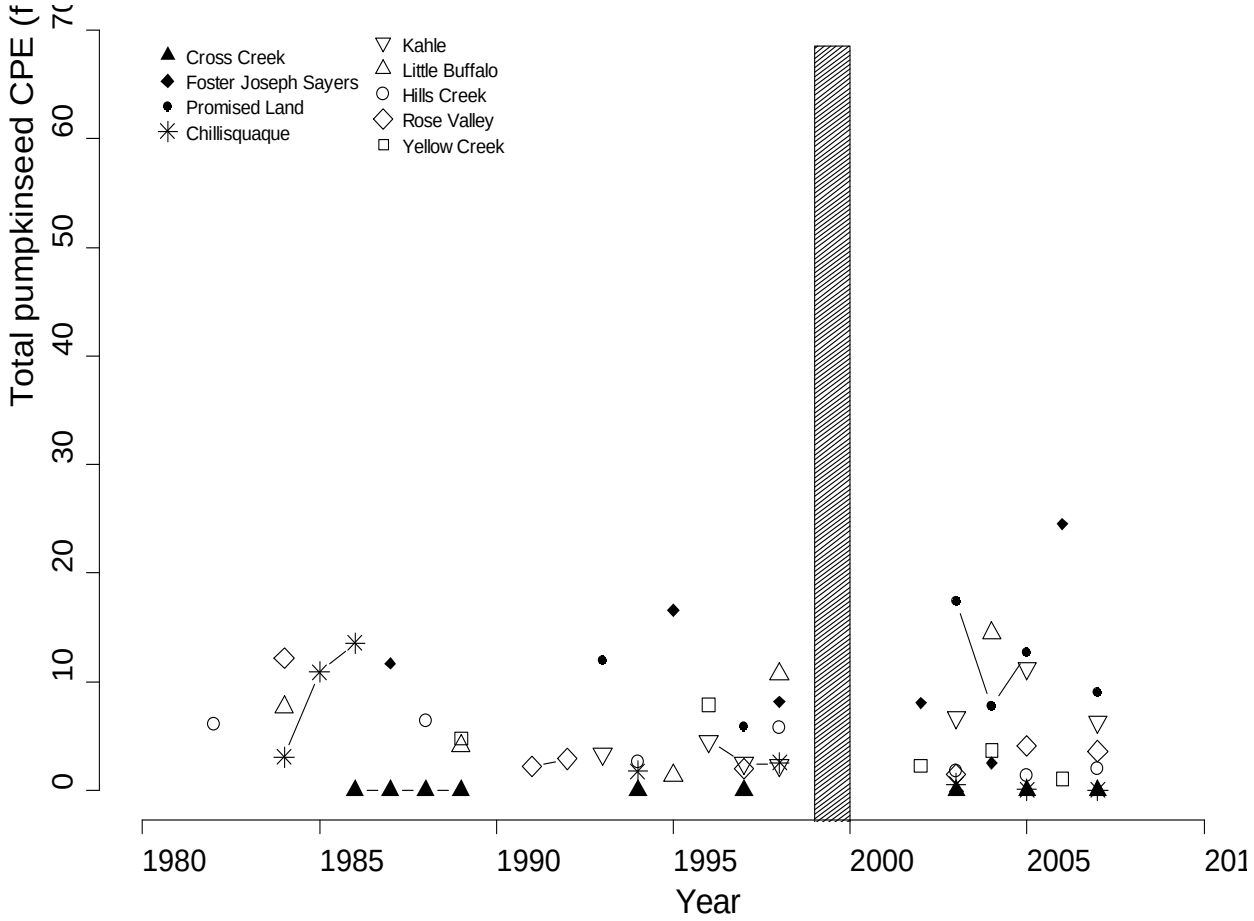

Figure 12. Mean catch per 24 hr net set for all pumpkinseed sunfish. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

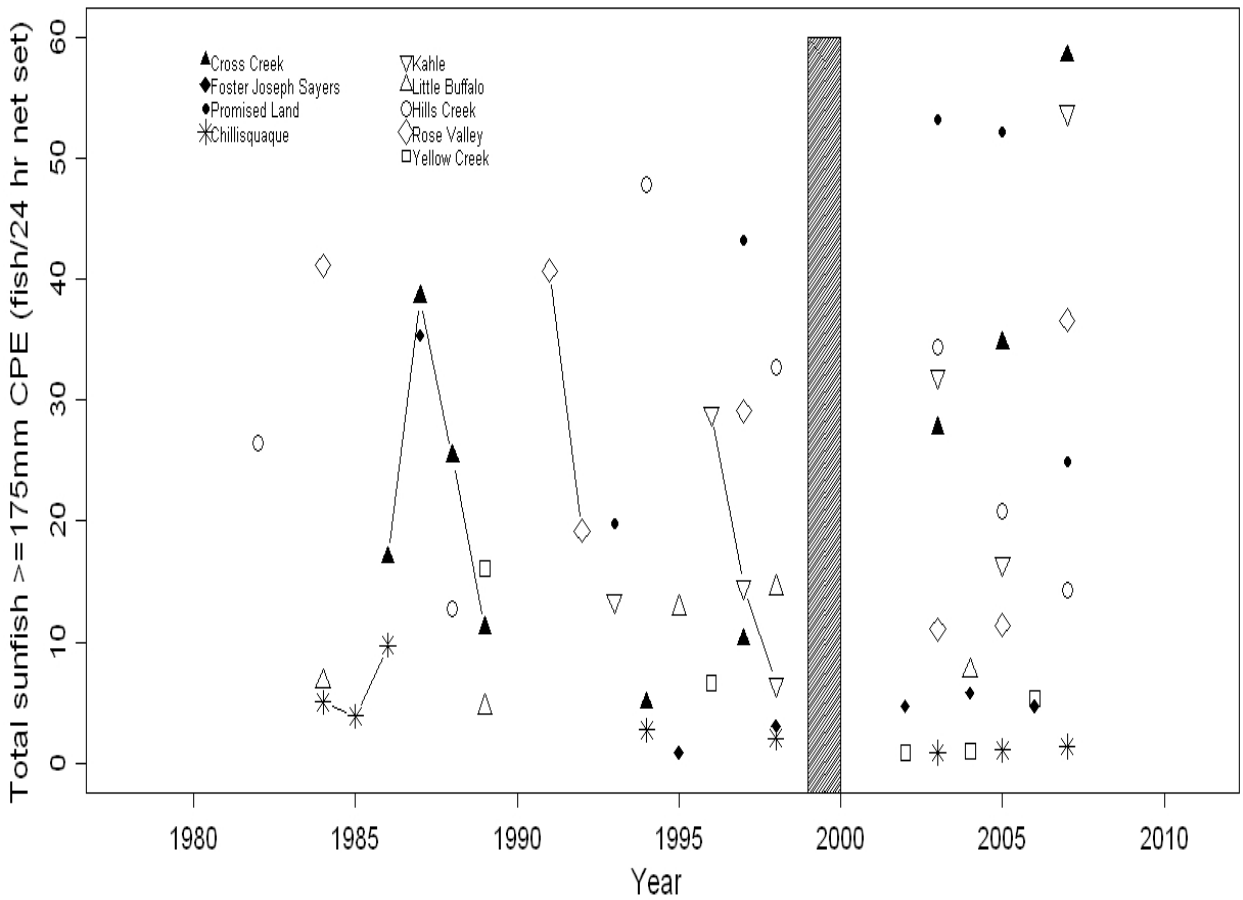

Figure 13. Mean catch per 24 hr net set for sunfish (bluegill and pumpkinseed combined) ≥ 175 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

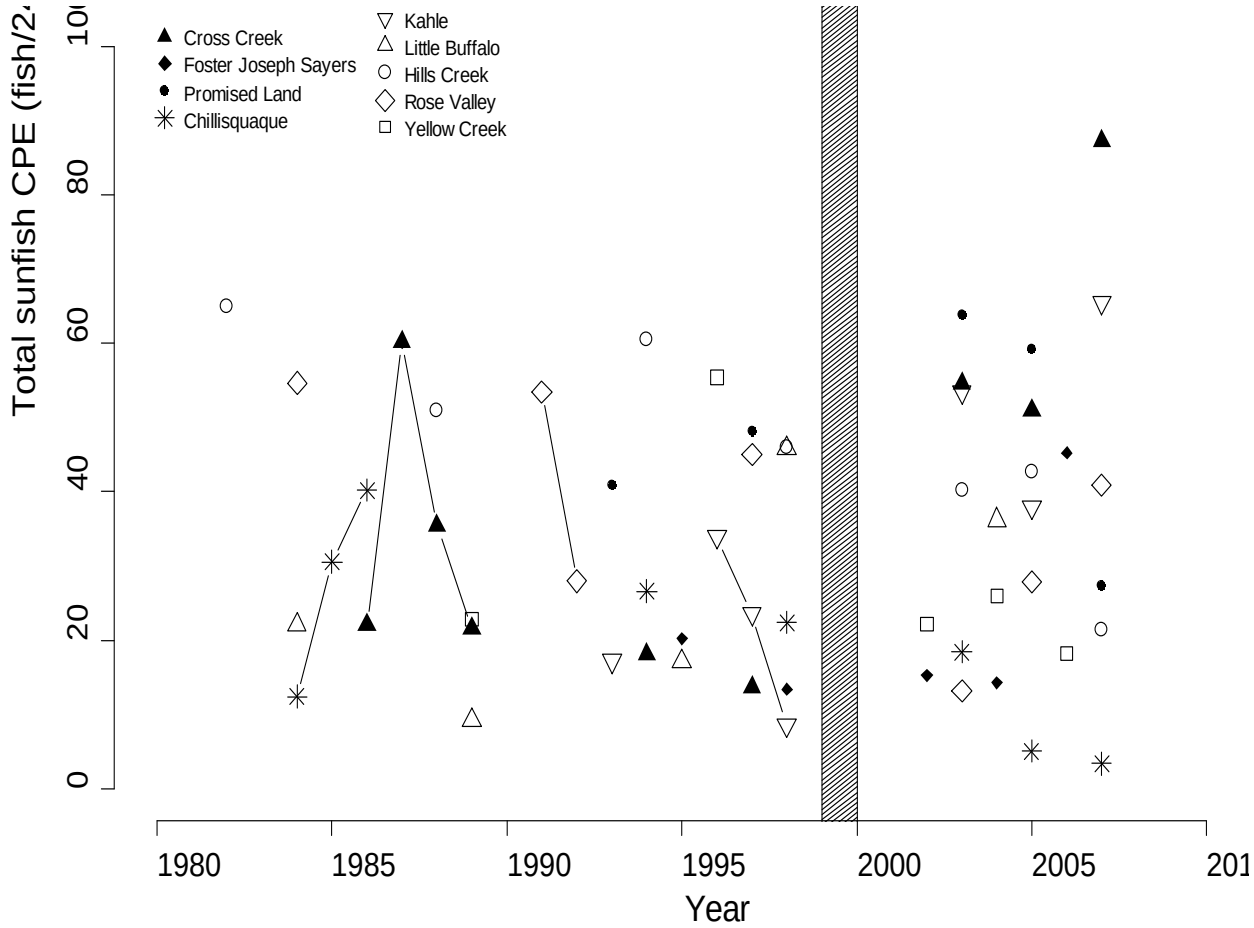

Figure 14. Mean catch per 24 hr net set for all sunfish (bluegill and pumpkinseed combined). Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

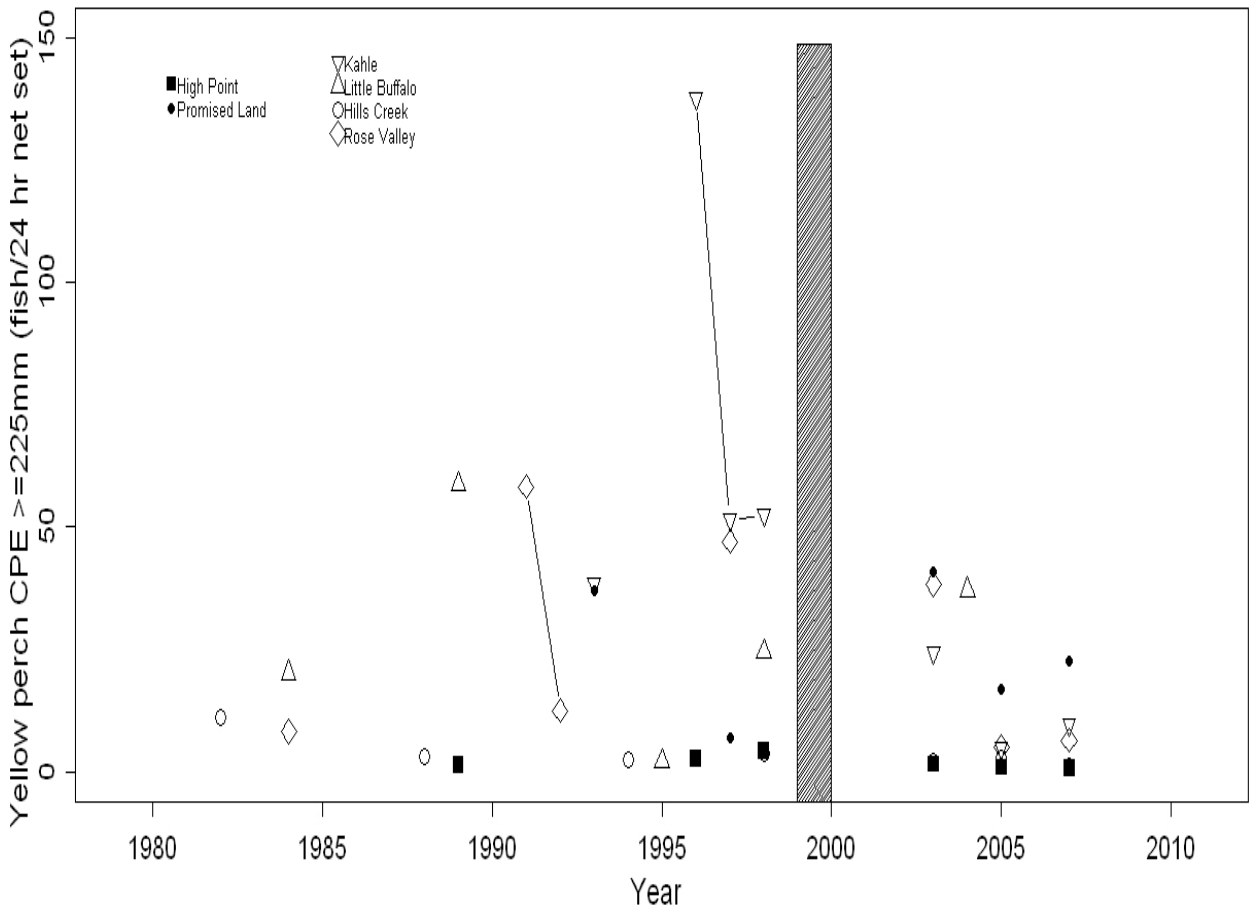

Figure 15. Mean catch per 24 hr net set for yellow perch ≥ 225 mm. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

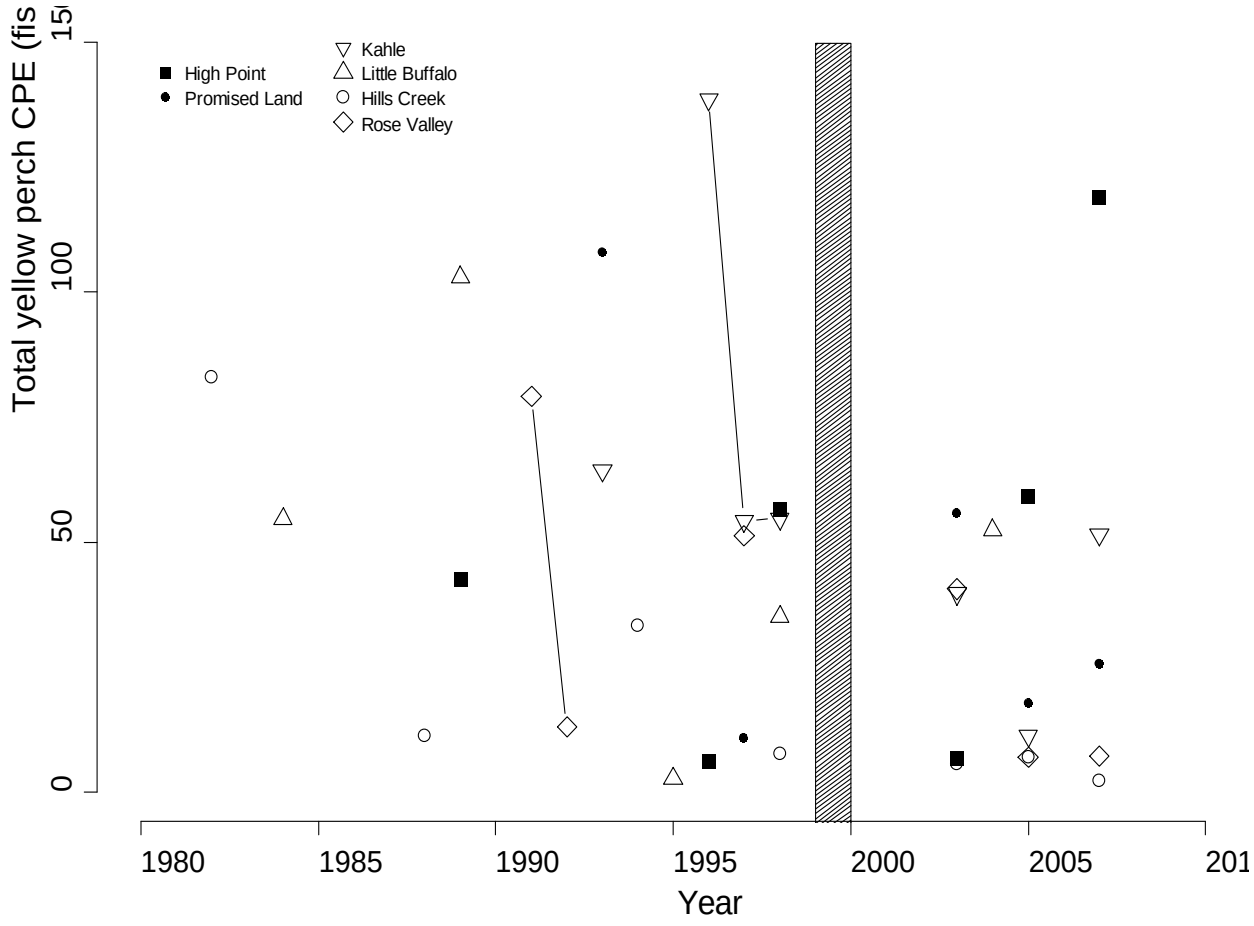

Figure 16. Mean catch per 24 hr net set for all yellow perch. Solid symbols illustrate treatment lakes and open symbols are control lakes. Lines connect consecutive sampling occasions. Vertical bar illustrates year when experimental regulations were implemented on treatment lakes. See Appendix I for standard deviations and sample sizes for each lake/year.

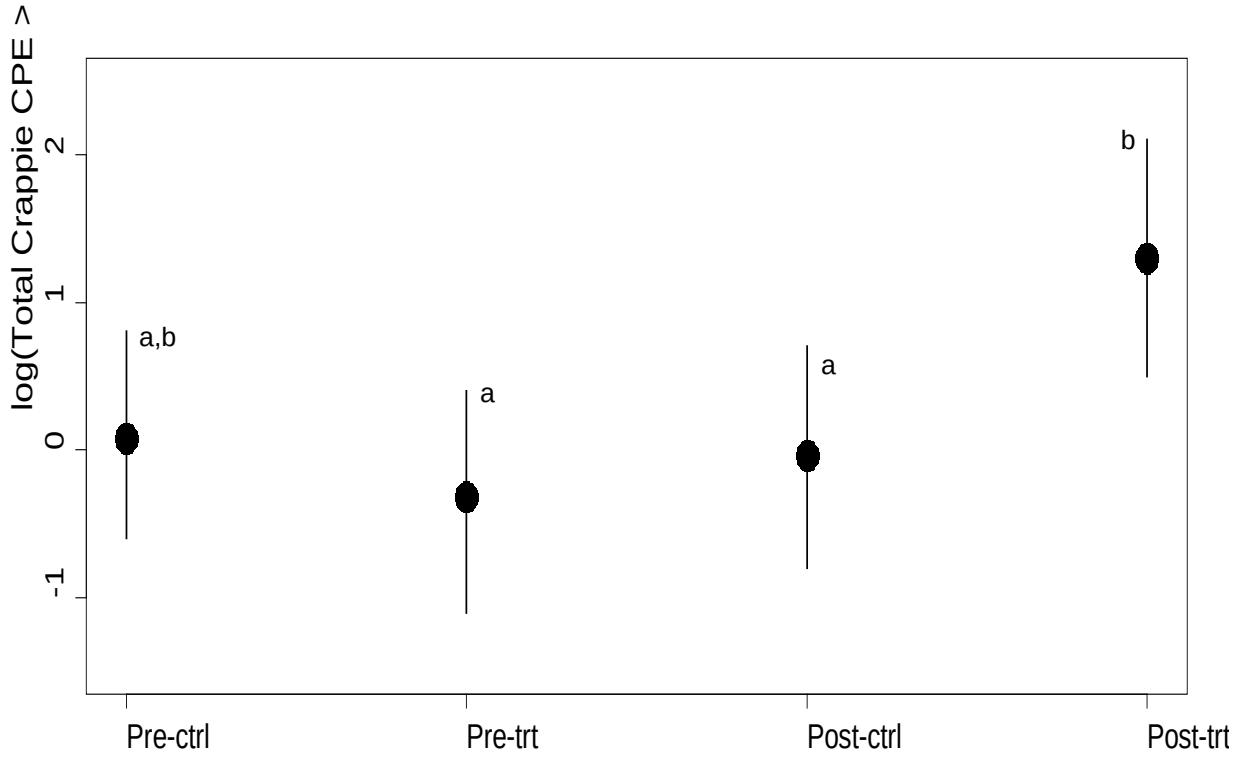

Figure 17. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size crappie (black and white combined). CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

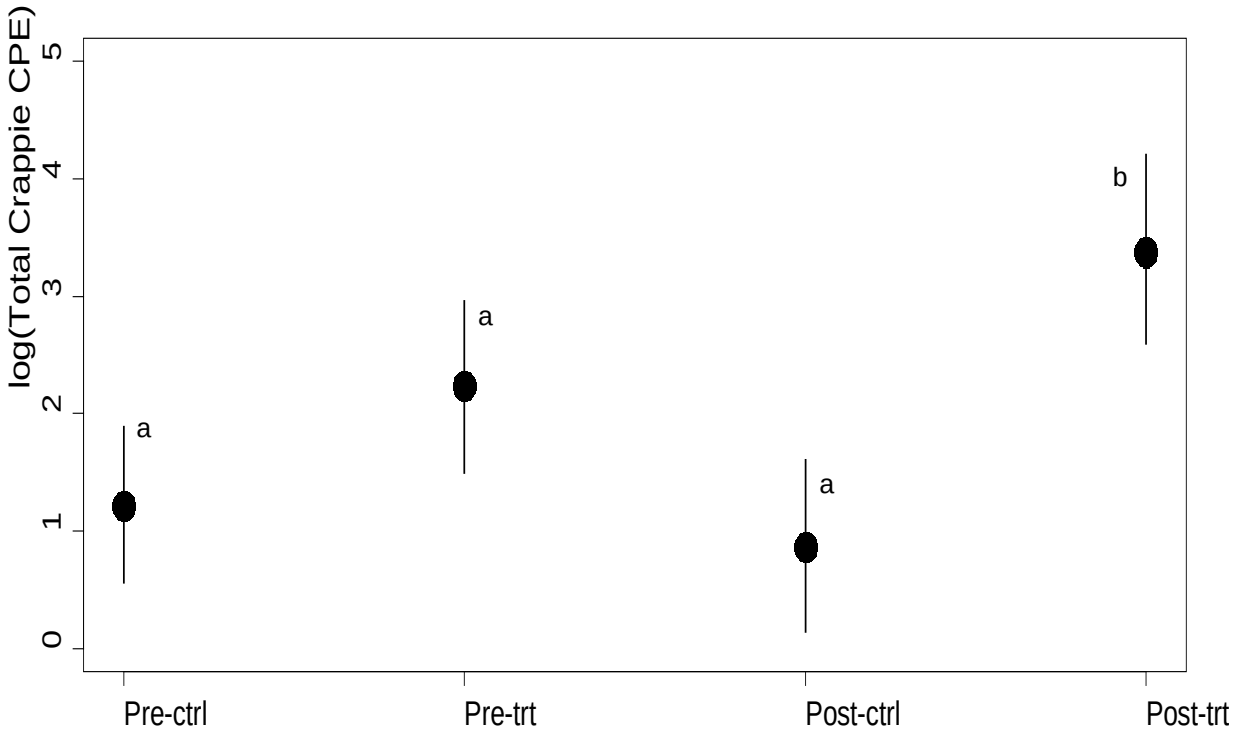

Figure 18. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size crappie (black and white combined). CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

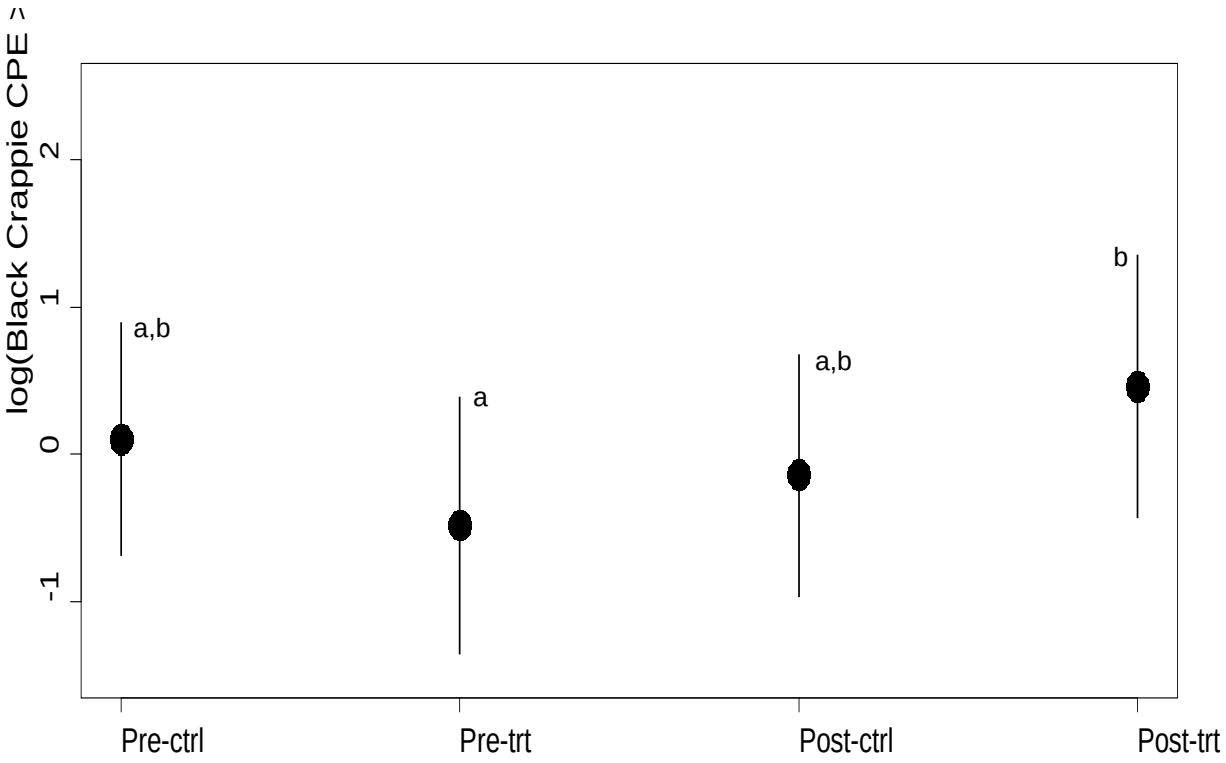

Figure 19. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size black crappie. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

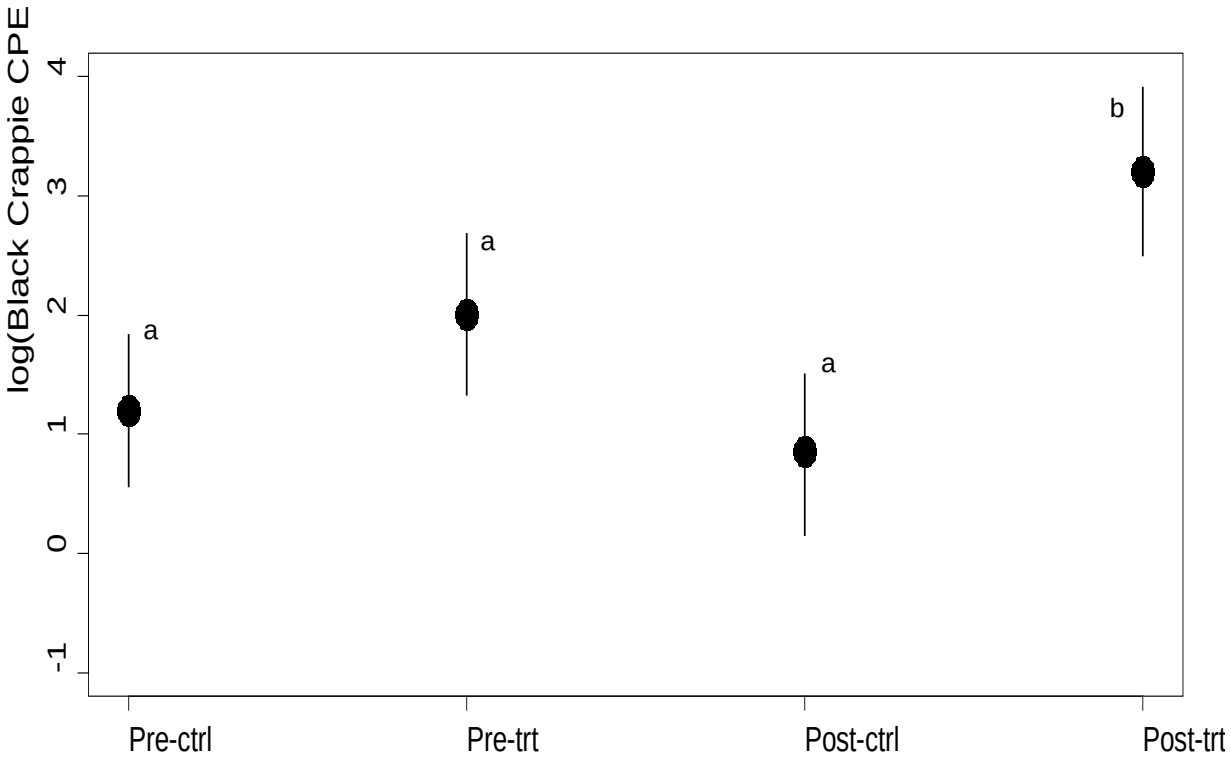

Figure 20. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size black crappie. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

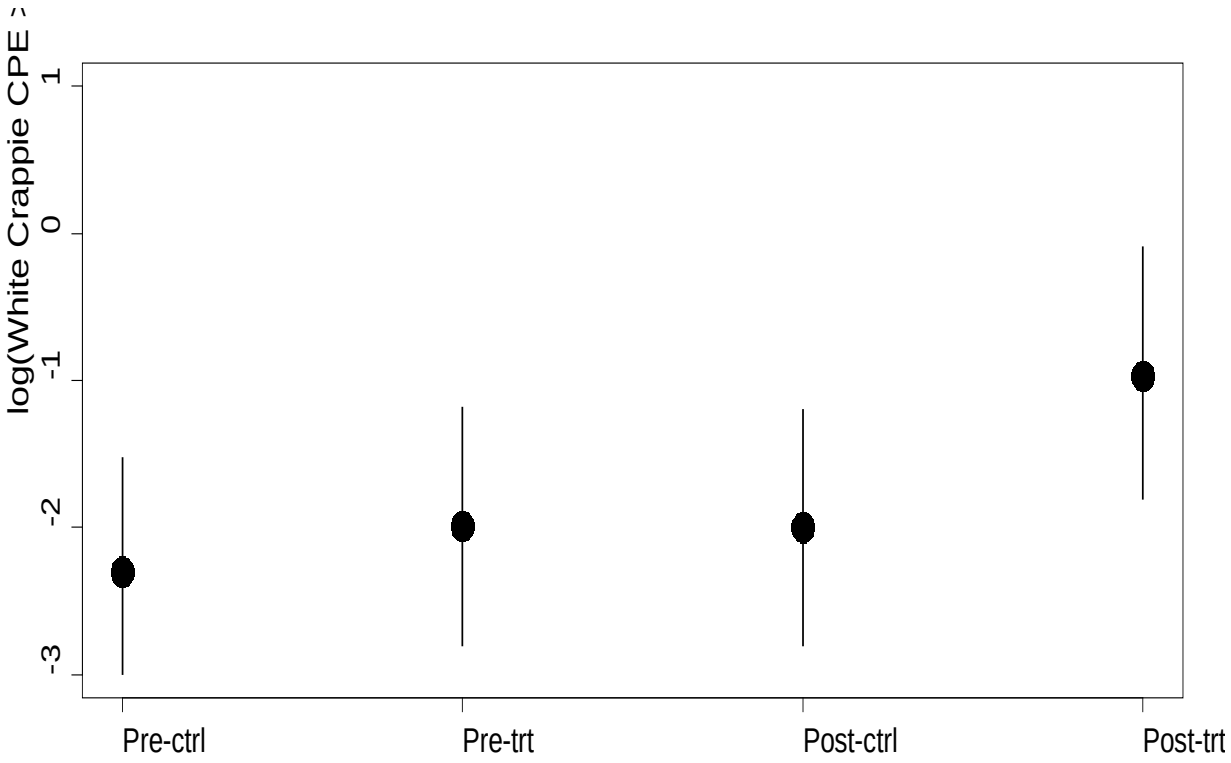

Figure 21. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size white crappie. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

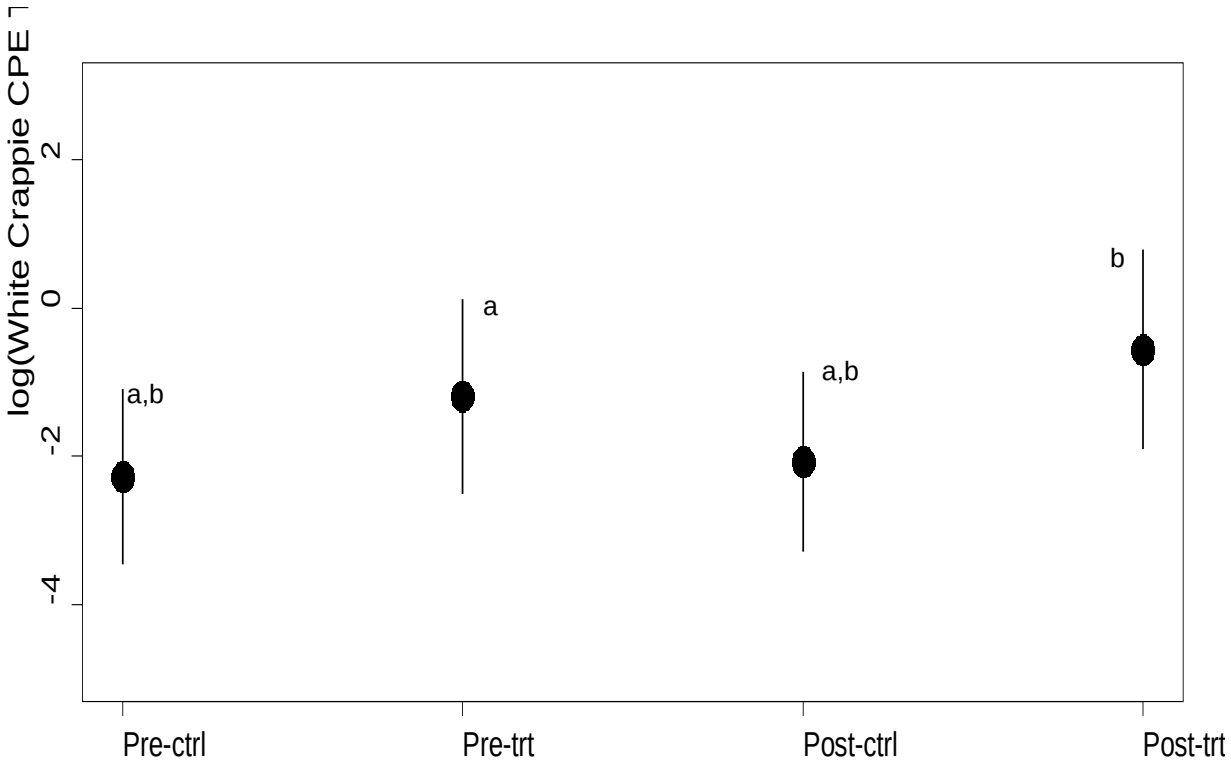

Figure 22. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size white crappie. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

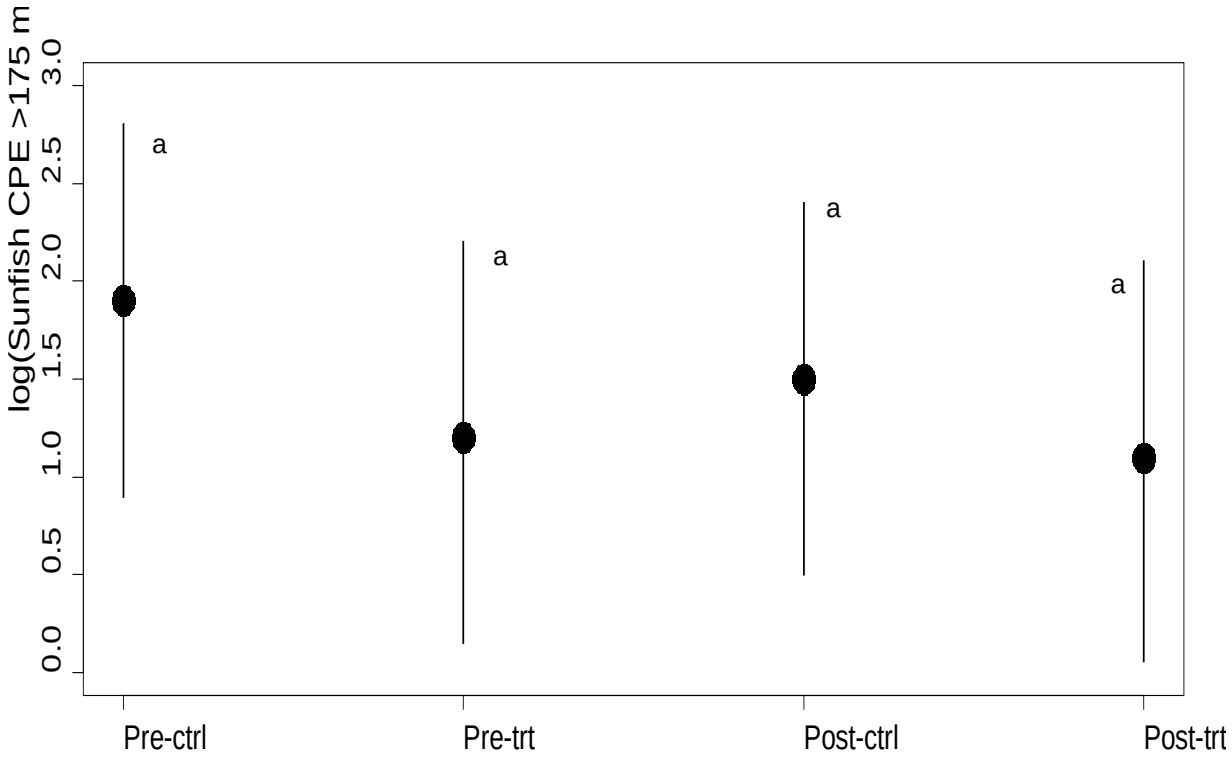

Figure 23. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size sunfish (bluegill and pumpkinseed combined). CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

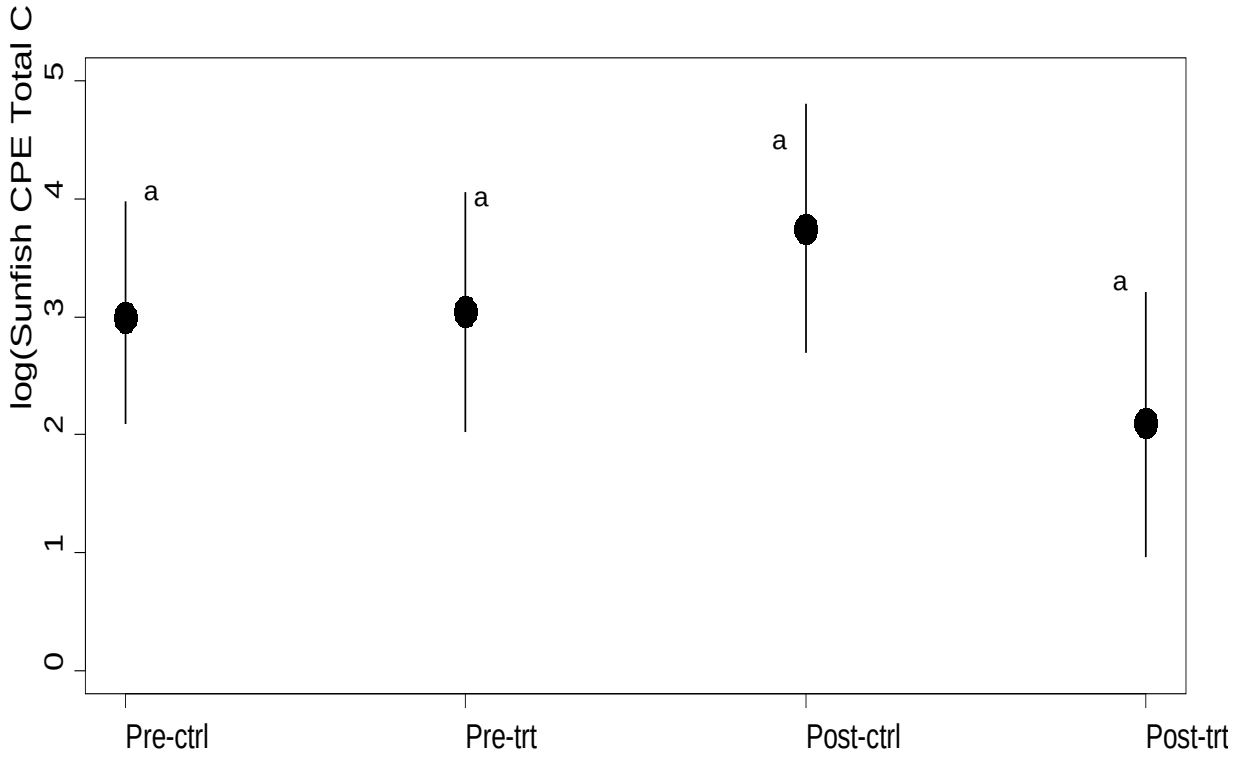

Figure 24. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size sunfish (bluegill and pumpkinseed combined). CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

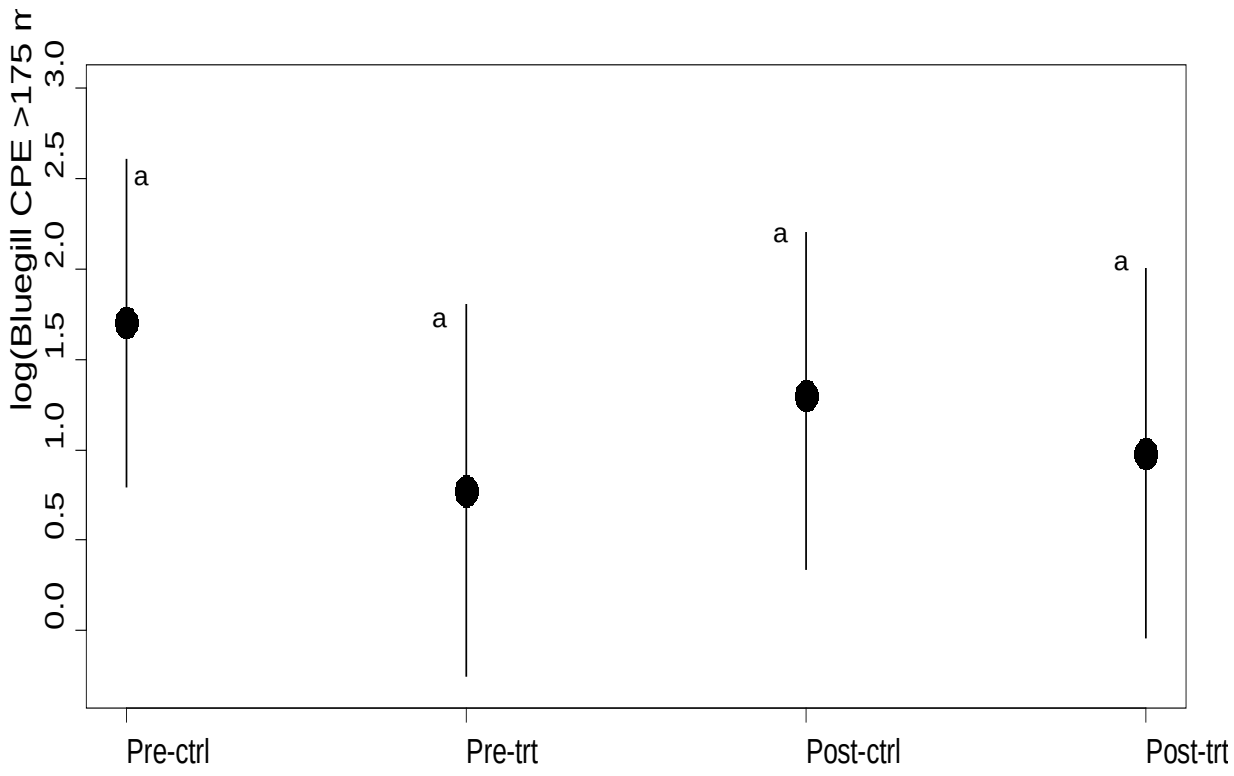

Figure 25. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all legal size bluegill. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

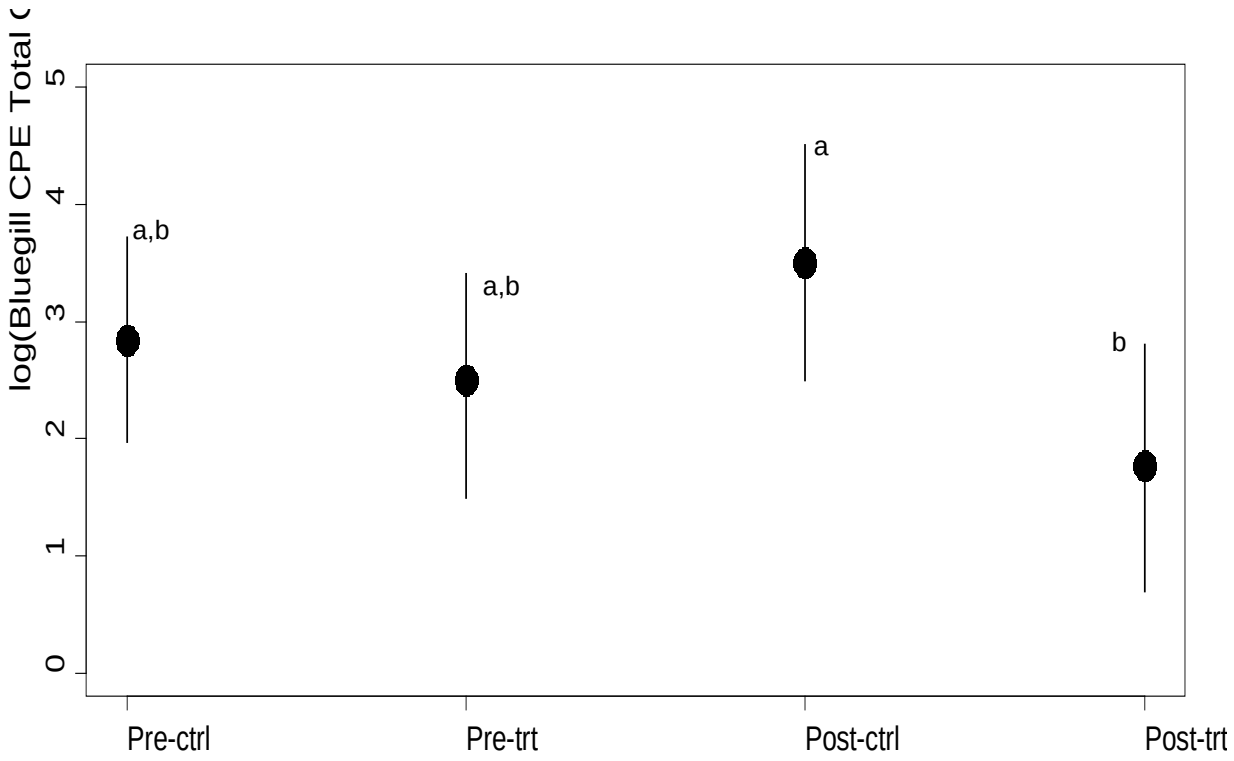

Figure 26. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size bluegill. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

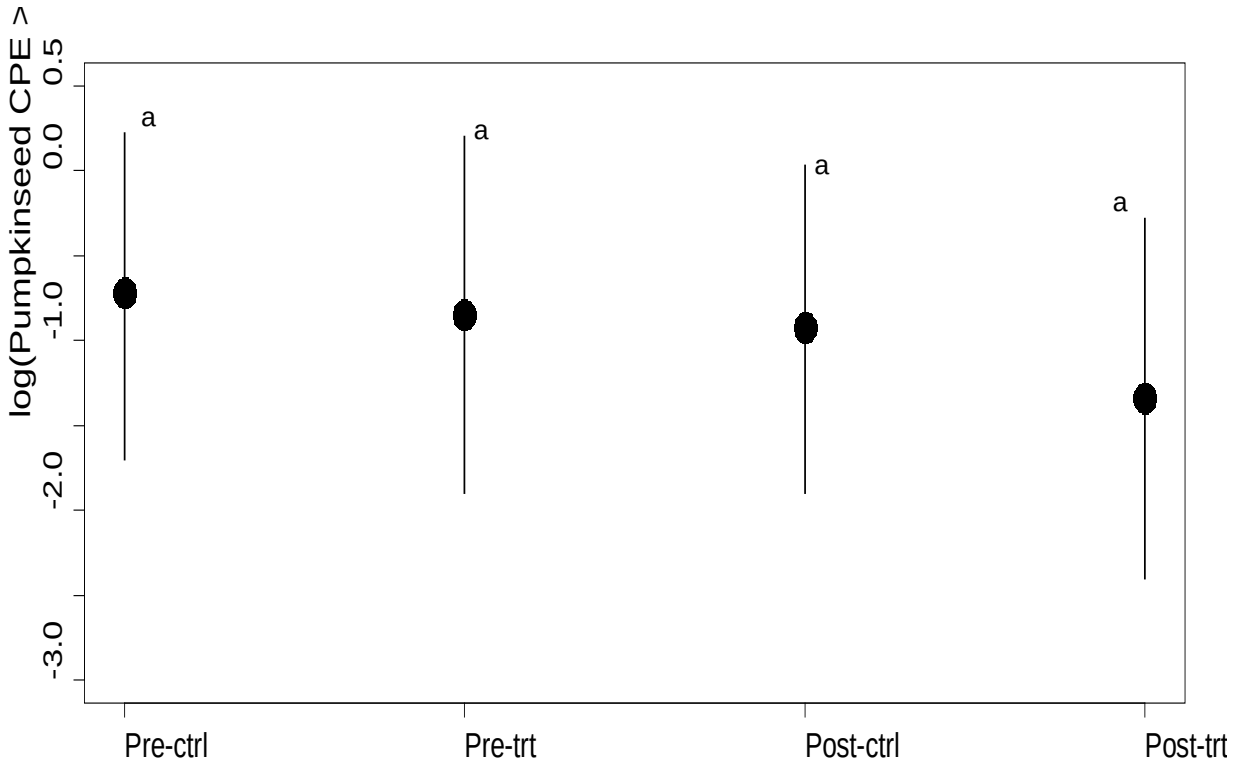

Figure 27. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size pumpkinseed. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

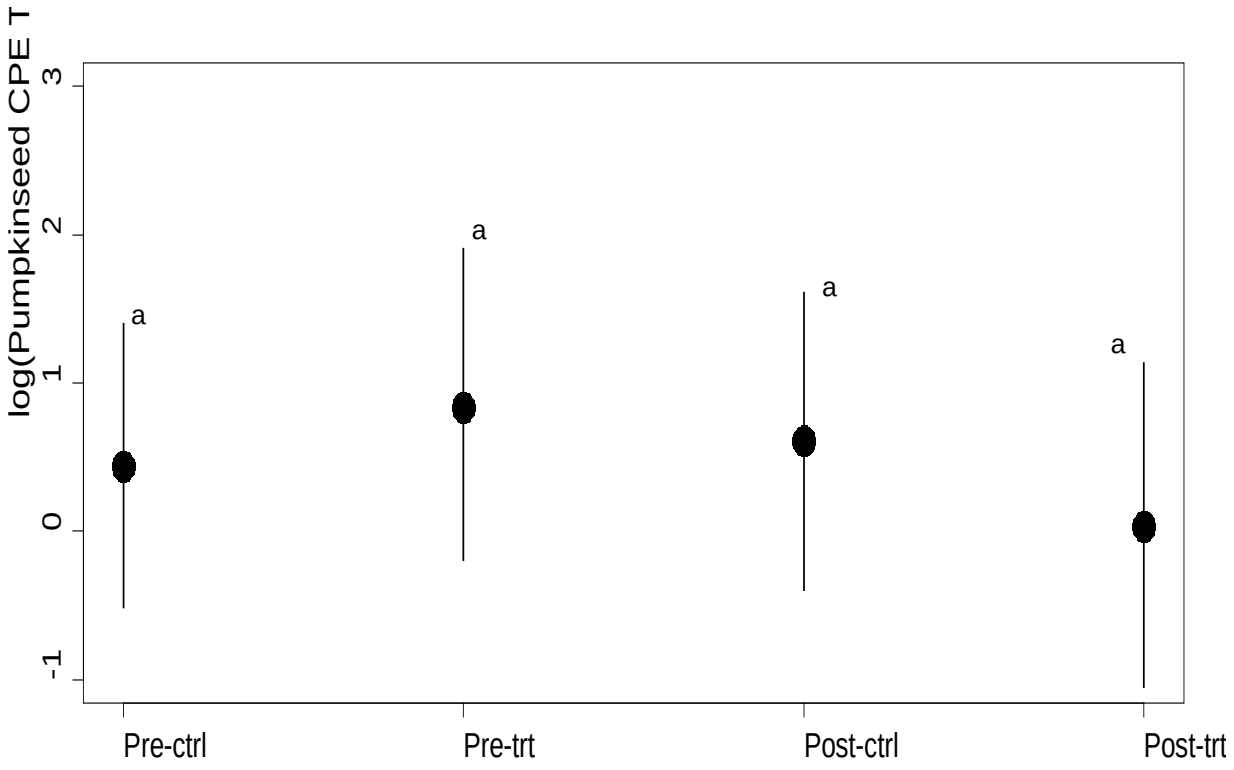

Figure 28. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size pumpkinseed. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

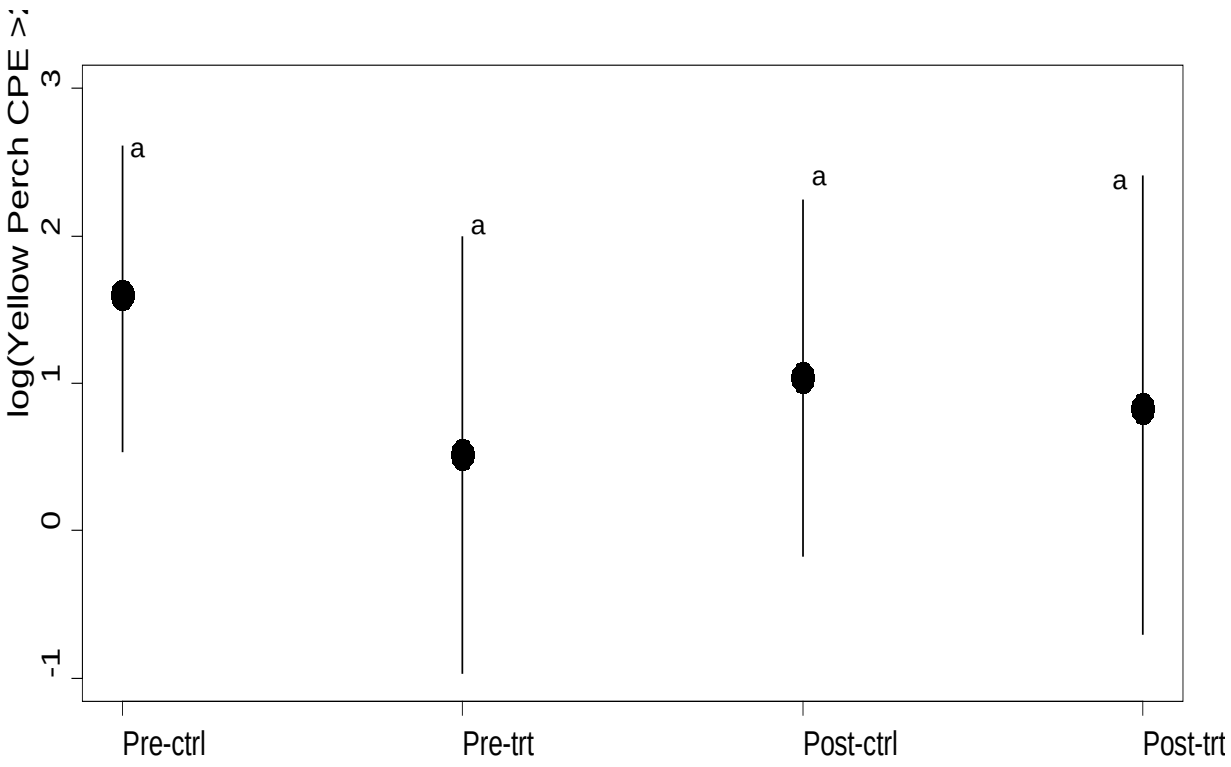

Figure 29. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for legal size yellow perch. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

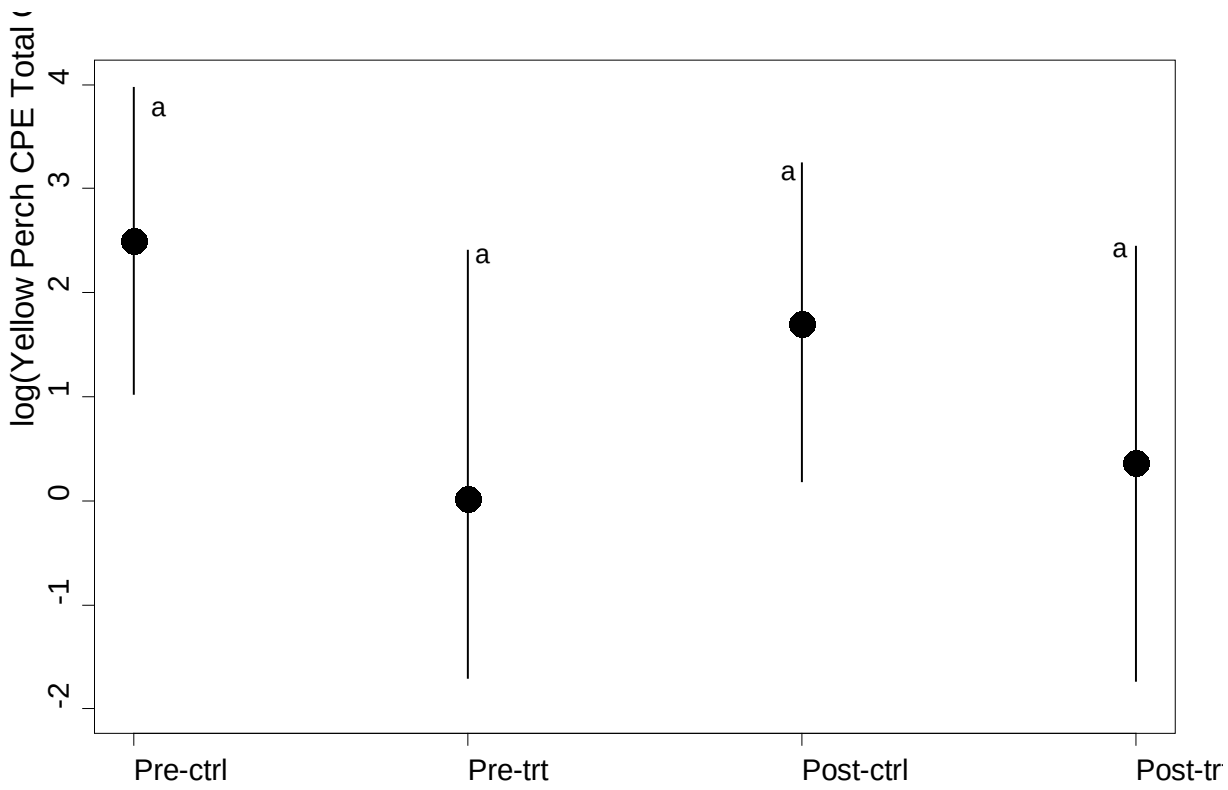

Figure 30. Least squares mean log(catch per effort (CPE)) and 90% confidence intervals for treatment (trt) and control (ctrl) lakes sampled before (Pre) and after (Post) implementation of experimental regulations for all size yellow perch. CPE is measured as CPE per 24 hr net set. Categories with different superscripted letters are significantly different ($\alpha = 0.10$).

Appendix I.

Mean catch per 24 hr net set, standard deviations, and sample sizes (number of trapnets set) for each lake from 1982 – 2007.

Table A1. Mean catch per 24 hr net set of black crappie ≥ 225 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	0.70 (1.32,16)	NS	NS	NS	3.54 (2.95,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	4.59 (6.79,24)	NS	NS	0.77 (1.47,35)	28.35 (53.47,31)	NS
1985	0.31 (0.62,4)	NS	NS	1.58 (3.02,6)	NS	NS	NS	NS	NS
1986	0.09 (0.32,14)	0.28 (0.48,15)	NS	2.57 (4.01,6)	NS	NS	NS	NS	NS
1987	0.63 (1.54,6)	0.18 (0.44,6)	7.26 (7.27,16)	NS	NS	NS	NS	NS	NS
1988	0.22 (0.50,11)	1.25 (1.18,5)	NS	NS	8.93 (7.70,12)	NS	NS	NS	NS
1989	0.26 (0.56,20)	1.05 (1.35,12)	NS	NS	NS	NS	1.38 (2.81,25)	NS	0.37 (0.71,15)
1990	0.12 (0.41,24)	NS	NS	NS	NS	NS	NS	NS	NS
1991	0.15 (0.43,8)	NS	NS	NS	NS	NS	NS	1.21 (2.14,28)	NS
1992	0.40 (0.71,7)	NS	NS	NS	NS	NS	NS	0.26 (0.60,16)	NS
1993	NS	NS	NS	NS	NS	7.59 (10.66,9)	NS	NS	NS
1994	0.44 (1.07,6)	6.08 (6.93,12)	NS	4.21 (4.30,12)	11.05 (7.78,12)	NS	NS	NS	NS
1995	NS	NS	2.42 (2.74,16)	NS	NS	NS	0.07 (0.26,32)	NS	NS
1996	0.53 (0.86,6)	NS	NS	NS	NS	16.82 (29.15,16)	NS	NS	10.09 (15.34,14)
1997	NS	3.37 (5.24,15)	NS	NS	NS	7.16 (7.90,16)	NS	0.36 (0.85,32)	NS
1998	0.69 (0.85,6)	NS	1.88 (2.49,16)	2.05 (2.57,12)	20.27 (21.03,12)	6.19 (7.46,16)	5.10 (7.38,28)	NS	NS

1999	2.01 (2.67,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	0.72 (0.90,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	0.94 (1.88,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	6.63 (6.52,17)	NS	NS	NS	NS	NS	1.10 (1.22,16)
2003	0.49 (1.03,18)	6.22 (7.61,20)	NS	3.74 (4.11,40)	14.47 (17.64,40)	9.29 (10.99,40)	NS	0.87 (3.01,81)	NS
2004	0.54 (0.90,6)	NS	2.29 (3.41,40)	NS	NS	NS	0.73 (1.18,22)	NS	5.24 (6.64,20)
2005	0.24 (0.46,18)	37.58 (55.70,20)	NS	5.84 (4.60,40)	4.64 (6.87,40)	2.21 (3.92,40)	NS	0.42 (1.17,50)	NS
2006	1.11 (1.18,6)	NS	6.96 (13.07,40)	NS	NS	NS	NS	NS	8.31 (13.34,20)
2007	0.75 (1.09,18)	32.06 (55.97,20)	NS	13.66 (12.20,40)	1.17 (1.84,39)	42.39 (54.51,40)	NS	5.24 (7.57,40)	NS
Pre-Treatment	0.40 (0.98,134)	2.27 (4.41,65)	3.85 (5022,48)	3.50 (5.12,60)	9.47 (12.11,60)	9.67 (17.20,57)	1.72 (4.28,120)	8.67 (31.15,107)	5.06 (11.57,29)
Post-Treatment	0.60 (1.02,78)	25.29 (47.08,60)	4.98 (9.29,97)	7.75 (8.92,120)	6.81 (12.31,119)	17.96 (36.44,120)	0.73 (1.18,22)	1.76 (4.64,171)	5.15 (9.24,56)
Pre-RSD_{225}	1	24	8	33	23	79	26	57	59
Post-RSD_{225}	2	38	7	51	81	57	9	67	87

Table A2. Mean catch per 24 hr net set of all black crappie. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	17.39 (15.31,16)	NS	NS	NS	5.59 (4.14,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	13.58 (13.67,24)	NS	NS	3.75 (4.70,35)	49.66 (92.13,31)	NS
1985	9.40 (12.04,4)	NS	NS	7.36 (7.73,6)	NS	NS	NS	NS	NS
1986	64.41 (65.28,14)	4.60 (4.78,15)	NS	7.41 (10.71,6)	NS	NS	NS	NS	NS
1987	25.75 (39.53,6)	38.19 (32.09,6)	113.50 (149.99,17)	NS	NS	NS	NS	NS	NS
1988	20.13 (20.91,11)	5.32 (3.94,5)	NS	NS	100.16 (64.69,12)	NS	NS	NS	NS
1989	46.58 (65.63,20)	6.17 (8.98,12)	NS	NS	NS	NS	12.50 (19.16,25)	NS	0.75 (1.59,15)
1990	20.05 (29.55,24)	NS	NS	NS	NS	NS	NS	NS	NS
1991	6.53 (8.18,8)	NS	NS	NS	NS	NS	NS	1.63 (2.42,28)	NS
1992	43.75 (36.59,7)	NS	NS	NS	NS	NS	NS	1.78 (1.76,16)	NS
1993	NS	NS	NS	NS	NS	10.47 (12.06,9)	NS	NS	NS
1994	57.87 (31.28,6)	9.95 (9.14,12)	NS	56.21 (60.00,12)	25.19 (15.27,12)	NS	NS	NS	NS
1995	NS	NS	102.27 (105.50,16)	NS	NS	NS	4.44 (7.88,32)	NS	NS
1996	48.85 (22.89,6)	NS	NS	NS	NS	20.60 (32.46,16)	NS	NS	18.15 (23.15,14)
1997	NS	9.22 (15.93,15)	NS	NS	NS	9.08 (9.04,16)	NS	1.46 (2.63,32)	NS
1998	154.54 (120.73,6)	NS	22.53 (34.01,16)	14.89 (9.22,12)	24.92 (25.47,12)	7.85 (8.83,16)	22.15 (22.55,28)	NS	NS

1999	103.98 (67.44,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	57.86 (29.87,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	41.34 (22.81,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	55.85 (47.68,17)	NS	NS	NS	NS	NS	1.91 (2.02,16)
2003	53.23 (59.85,18)	52.19 (45.24,20)	NS	29.59 (56.21,40)	16.69 (17.47,40)	20.56 (18.45,40)	NS	0.94 (3.12,81)	NS
2004	37.21 (24.55,6)	NS	68.27 (91.28,40)	NS	NS	NS	8.07 (11.33,22)	NS	6.34 (7.59,20)
2005	28.62 (25.51,18)	65.54 (93.89,20)	NS	22.68 (17.78,40)	5.87 (8.43,40)	21.64 (35.61,40)	NS	2.48 (4.39,50)	NS
2006	37.26 (26.36,6)	NS	113.87 (132.77,40)	NS	NS	NS	NS	NS	11.74 (13.75,20)
2007	33.39 (33.97,18)	89.93 (138.98,20)	NS	19.07 (14.16,40)	2.60 (3.67,39)	57.16 (66.28,40)	NS	6.55 (8.13,40)	NS
Pre-Treatment	35.52 (52.98,134)	10.08 (15.48,65)	81.12 (114.73,48)	21.12 (33.46,60)	33.60 (46.47,60)	12.24 (19.93,57)	10.32 (15.77,120)	15.60 (54.62,107)	9.12 (18.09,29)
Post-Treatment	39.84 (38.15,78)	69.12 (100.38,60)	84.96 (106.36,97)	23.76 (34.18,120)	8.40 (13.09,119)	33.12 (47.32,120)	8.16 (11.26,22)	2.64 (6.28,171)	6.96 (10.78,56)
Pre-PSD	5	39	23	54	26	83	48	94	74
Post-PSD	3	76	29	84	90	74	13	73	94

Table A3. Mean catch per 24 hr net set of white crappie ≥ 225 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	0.19 (0.41,16)	NS	NS	NS	0 (0,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	0 (0,24)	NS	NS	0 (0,35)	0 (0,31)	NS
1985	1.44 (1.13,4)	NS	NS	0 (0,6)	NS	NS	NS	NS	NS
1986	0.88 (1.53,14)	0 (0,15)	NS	0 (0,6)	NS	NS	NS	NS	NS
1987	0.81 (1.51,6)	0 (0,6)	0 (0,17)	NS	NS	NS	NS	NS	NS
1988	1.03 (1.90,11)	0 (0,5)	NS	NS	0 (0,12)	NS	NS	NS	NS
1989	0.76 (1.28,20)	0 (0,12)	NS	NS	NS	NS	0 (0,25)	NS	0 (0,15)
1990	0.23 (0.49,24)	NS	NS	NS	NS	NS	NS	NS	NS
1991	0.25 (0.70,8)	NS	NS	NS	NS	NS	NS	0 (0,28)	NS
1992	2.59 (2.16,7)	NS	NS	NS	NS	NS	NS	0 (0,16)	NS
1993	NS	NS	NS	NS	NS	0 (0,9)	NS	NS	NS
1994	8.46 (6.59,6)	0 (0,12)	NS	0 (0,12)	0 (0,12)	NS	NS	NS	NS
1995	NS	NS	0 (0,16)	NS	NS	NS	0.14 (0.47,32)	NS	NS
1996	10.43 (7.65,6)	NS	NS	NS	NS	0.13 (0.53,16)	NS	NS	0 (0,14)
1997	NS	0 (0,15)	NS	NS	NS	0.13 (0.51,16)	NS	0 (0,32)	NS
1998	16.00 (13.59,6)	NS	0 (0,16)	0 (0,12)	0 (0,12)	0 (0,16)	0.07 (0.26,28)	NS	NS

1999	23.15 (16.31,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	10.64 (9.40,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	8.49 (7.08,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	0 (0,17)	NS	NS	NS	NS	NS	0 (0,16)
2003	8.52 (7.32,18)	0 (0,20)	NS	0 (0,40)	0 (0,40)	0 (0,40)	NS	0 (0,81)	NS
2004	11.30 (10.35,6)	NS	0.08 (0.35,40)	NS	NS	NS	0 (0,22)	NS	0.05 (0.23,20)
2005	5.65 (5.02,18)	0 (0,20)	NS	0 (0,40)	0 (0,40)	0 (0,40)	NS	0 (0,50)	NS
2006	13.50 (11.82,6)	NS	0.83 (2.06,40)	NS	NS	NS	NS	NS	0 (0,20)
2007	6.12 (5.71,18)	0.21 (0.55,20)	NS	0 (0,40)	0 (0,39)	0 (0,40)	NS	0 (0,40)	NS
Pre-Treatment	3.18 (7.51,134)	0 (0,65)	0 (0,48)	0 (0,60)	0 (0,60)	0.07 (0.39,57)	0.05 (0.27,120)	0 (0,107)	0 (0,29)
Post-Treatment	8.06 (7.45,78)	0.07 (0.33,60)	0.38 (1.39,97)	0 (0,120)	0 (0,119)	0 (0,120)	0 (0,22)	0 (0,171)	0.02 (0.14,56)
Pre-RSD_{225}	8	-	-	-	-	100	27	-	-
Post-RSD_{225}	31	27	48	-	-	-	-	-	100

Table A4. Mean catch per 24 hr net set of all white crappie. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	130.26 (142.83,16)	NS	NS	NS	0 (0,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	0 (0,24)	NS	NS	0 (0,35)	0 (0,31)	NS
1985	39.68 (20.96,4)	NS	NS	0 (0,6)	NS	NS	NS	NS	NS
1986	46.88 (49.48,14)	0 (0,15)	NS	0 (0,6)	NS	NS	NS	NS	NS
1987	14.51 (21.19,6)	0 (0,6)	0 (0,17)	NS	NS	NS	NS	NS	NS
1988	17.35 (33.81,11)	0 (0,5)	NS	NS	0 (0,12)	NS	NS	NS	NS
1989	47.16 (68.56,20)	0 (0,12)	NS	NS	NS	NS	0 (0,25)	NS	0 (0,15)
1990	9.71 (22.16,24	NS	NS	NS	NS	NS	NS	NS	NS
1991	4.78 (6.73,8)	NS	NS	NS	NS	NS	NS	0 (0,28)	NS
1992	19.21 (16.50,7)	NS	NS	NS	NS	NS	NS	0 (0,16)	NS
1993	NS	NS	NS	NS	NS	0 (0,9)	NS	NS	NS
1994	78.88 (25.61,6)	0 (0,12)	NS	0 (0,12)	0 (0,12)	NS	NS	NS	NS
1995	NS	NS	0 (0,16)	NS	NS	NS	0.47 (1.44,32)	NS	NS
1996	60.35 (14.38,6)	NS	NS	NS	NS	0.13 (0.53,16)	NS	NS	0 (0,14)
1997	NS	0 (0,15)	NS	NS	NS	0.13 (0.51,16)	NS	0 (0,32)	NS
1998	64.45 (39.29,6)	NS	0 (0,16)	0 (0,12)	0 (0,12)	0 (0,16)	0.36 (0.73,28)	NS	NS

1999	48.38 (28.73,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	62.79 (26.83,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	37.35 (33.19,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	0 (0,17)	NS	NS	NS	NS	NS	0 (0,16)
2003	27.65 (17.42,18)	0 (0,20)	NS	0 (0,40)	0 (0,40)	0 (0,40)	NS	0 (0,81)	NS
2004	29.40 (30.35,6)	NS	1.03 (2.07,40)	NS	NS	NS	0.05 (0.21,22)	NS	0.05 (0.23,20)
2005	13.91 (8.62,18)	0 (0,20)	NS	0 (0,40)	0 (0,40)	0 (0,40)	NS	0 (0,50)	NS
2006	30.37 (22.94,6)	NS	1.01 (2.49,40)	NS	NS	NS	NS	NS	0 (0,20)
2007	21.51 (16.62,18)	1.00 (2.20,20)	NS	0 (0,40)	0 (0,39)	0 (0,40)	NS	0 (0,40)	NS
Pre-Treatment	69.61 (69.45,134)	0 (0,65)	0 (0,48)	0 (0,60)	0 (0,60)	< 0.01 (0.02, 57)	0.24 (2.62,120)	0 (0,107)	0 (0,29)
Post-Treatment	26.88 (23.31,78)	0.24 (0.24, 60)	0.72 (2.36,97)	0 (0,120)	0 (0,119)	0 (0,120)	0 (0,22)	0 (0,171)	0.02 (0.14,56)
Pre-PSD	13	-	-	-	-	100	73	-	-
Post-PSD	48	100	68	-	-	-	-	-	100

Table A5. Mean catch per 24 hr net set of crappie (black and white combined) ≥ 225 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	0.89 (1.55,16)	NS	NS	NS	3.54 (2.95,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	4.59 (6.79,24)	NS	NS	0.77 (1.47,35)	28.35 (53.47,31)	NS
1985	1.75 (0.69,4)	NS	NS	1.58 (3.02,6)	NS	NS	NS	NS	NS
1986	0.97 (1.58,14)	0.28 (0.48,15)	NS	2.57 (4.01,6)	NS	NS	NS	NS	NS
1987	1.44 (3.02,6)	0.18 (0.44,6)	7.26 (7.27,16)	NS	NS	NS	NS	NS	NS
1988	1.25 (2.60,11)	1.25 (1.18,5)	NS	NS	8.93 (7.70,12)	NS	NS	NS	NS
1989	1.02 (1.71,20)	1.05 (1.35,12)	NS	NS	NS	NS	1.38 (2.81,25)	NS	0.37 (0.71,15)
1990	0.35 (0.84,24)	NS	NS	NS	NS	NS	NS	NS	NS
1991	0.40 (0.77,8)	NS	NS	NS	NS	NS	NS	1.21 (2.14,28)	NS
1992	2.99 (2.27,7)	NS	NS	NS	NS	NS	NS	0.26 (0.60,16)	NS
1993	NS	NS	NS	NS	NS	7.59 (10.66,9)	NS	NS	NS
1994	8.90 (6.90,6)	6.08 (6.93,12)	NS	4.21 (4.30,12)	11.05 (7.78,12)	NS	NS	NS	NS
1995	NS	NS	2.42 (2.74,16)	NS	NS	NS	0.21 (0.58,32)	NS	NS
1996	10.96 (7.97,6)	NS	NS	NS	NS	16.95 (29.63,16)	NS	NS	10.09 (15.34,14)
1997	NS	3.37 (5.24,15)	NS	NS	NS	7.29 (8.25,16)	NS	0.36 (0.85,32)	NS
1998	16.69 (13.42,6)	NS	1.88 (2.49,16)	2.05 (2.57,12)	20.27 (21.03,12)	6.19 (7.46,16)	5.17 (7.51,28)	NS	NS

1999	25.15 (16.71,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	11.35 (10.16,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	9.43 (7.40,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	6.63 (6.52,17)	NS	NS	NS	NS	NS	1.10 (1.22,16)
2003	9.01 (8.09,18)	6.22 (7.61,20)	NS	3.74 (4.11,40)	14.47 (17.64,40)	9.29 (10.99,40)	NS	0.87 (3.01,81)	NS
2004	11.84 (10.59,6)	NS	2.37 (3.39,40)	NS	NS	NS	0.73 (1.18,22)	NS	5.29 (6.60,20)
2005	5.89 (5.27,18)	37.58 (55.70,20)	NS	5.84 (4.60,40)	4.64 (6.87,40)	2.21 (3.92,40)	NS	0.42 (1.17,50)	NS
2006	14.62 (12.07,6)	NS	7.79 (13.35,40)	NS	NS	NS	NS	NS	8.31 (13.34,20)
2007	6.87 (6.42,18)	32.28 (56.22,20)	NS	13.66 (12.20,40)	1.17 (1.84,39)	42.39 (54.51,40)	NS	5.24 (7.57,40)	NS
Pre-Treatment	3.58 (7.87,134)	2.27 (4.41,65)	3.85 (5.22,48)	3.50 (5.12,60)	9.47 (12.11,60)	9.74 (17.48,57)	1.77 (4.33,120)	8.67 (31.15,107)	5.06 (11.57,29)
Post-Treatment	8.66 (7.96,78)	25.36 (47.19,60)	5.35 (9.52,97)	7.75 (8.92,120)	6.81 (12.31,119)	17.96 (36.44,120)	0.73 (1.18,22)	1.76 (4.64,171)	5.17 (9.23,56)
Pre-RSD_{225}	5	24	8	33	23	79	26	57	59
Post-RSD_{225}	15	38	8	51	81	57	9	67	87

Table A6. Mean catch per 24 hr net set of all crappie (black and white combined). Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Blue Marsh Lake	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	147.64 (154.31,16)	NS	NS	NS	5.59 (4.14,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	13.58 (13.67,24)	NS	NS	3.75 (4.70,35)	49.66 (92.13,31)	NS
1985	49.08 (30.67,4)	NS	NS	7.36 (7.73,6)	NS	NS	NS	NS	NS
1986	111.28 (98.35,14)	4.60 (4.78,15)	NS	7.41 (10.71,6)	NS	NS	NS	NS	NS
1987	40.26 (60.51,6)	38.19 (32.09,6)	113.50 (149.99,17)	NS	NS	NS	NS	NS	NS
1988	37.48 (46.27,11)	5.32 (3.94,5)	NS	NS	100.16 (64.69,12)	NS	NS	NS	NS
1989	93.74 (119.26,20)	6.17 (8.98,12)	NS	NS	NS	NS	12.50 (19.16,25)	NS	0.75 (1.59,15)
1990	29.76 (46.29,24)	NS	NS	NS	NS	NS	NS	NS	NS
1991	11.30 (13.85,8)	NS	NS	NS	NS	NS	NS	1.63 (2.42,28)	NS
1992	62.96 (50.03,7)	NS	NS	NS	NS	NS	NS	1.78 (1.76,16)	NS
1993	NS	NS	NS	NS	NS	10.47 (12.06,9)	NS	NS	NS
1994	136.75 (41.71,6)	9.95 (9.14,12)	NS	56.21 (60.00,12)	25.19 (15.27,12)	NS	NS	NS	NS
1995	NS	NS	102.27 (105.50,16)	NS	NS	NS	4.92 (7.86,32)	NS	NS
1996	109.19 (23.67,6)	NS	NS	NS	NS	20.74 (32.94,16)	NS	NS	18.15 (23.15,14)
1997	NS	9.22 (15.93,15)	NS	NS	NS	9.21 (9.38,16)	NS	1.46 (2.63,32)	NS
1998	218.99 (151.72,6)	NS	22.53 (34.01,16)	14.89 (9.22,12)	24.92 (25.47,12)	7.85 (8.83,16)	22.51 (22.58,28)	NS	NS

1999	152.35 (84.19,6)	NS	NS	NS	NS	NS	NS	NS	NS
2000	120.65 (39.13,6)	NS	NS	NS	NS	NS	NS	NS	NS
2001	78.69 (46.74,6)	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	NS	55.85 (47.68,17)	NS	NS	NS	NS	NS	1.91 (2.02,16)
2003	80.88 (67.56,18)	52.19 (45.24,20)	NS	29.59 (56.21,40)	16.69 (17.47,40)	20.56 (18.45,40)	NS	0.94 (3.12,81)	NS
2004	66.61 (51.20,6)	NS	69.30 (91.07,40)	NS	NS	NS	8.12 (11.31,22)	NS	6.40 (7.55,20)
2005	42.54 (31.69,18)	65.54 (93.89,20)	NS	22.68 (17.78,40)	5.87 (8.43,40)	21.64 (35.61,40)	NS	2.48 (4.39,50)	NS
2006	67.63 (43.42,6)	NS	114.88 (113.26,40)	NS	NS	NS	NS	NS	11.74 (13.75,20)
2007	54.90 (44.50,18)	90.93 (140.01,20)	NS	19.07 (14.16,40)	2.60 (3.67,39)	57.16 (66.28,40)	NS	6.55 (8.13,40)	NS
Pre-Treatment	77.28 (100.01,134)	10.08 (15.48,65)	81.12 (114.73,48)	21.12 (33.46,60)	33.60 (46.47,60)	12.24 (19.93,57)	10.56 (15.77,120)	15.60 (54.62,107)	9.12 (18.09,29)
Post-Treatment	66.72 (50.87,78)	69.60 (100.39,60)	85.68 (108.73,97)	23.76 (34.18,120)	8.40 (13.09,119)	33.12 (47.32,120)	8.16 (11.26,22)	2.64 (6.28,171)	6.96 (10.78,56)
Pre-PSD	10	39	23	54	26	83	49	94	74
Post-PSD	23	76	30	84	90	74	13	73	94

Table A7. Mean catch per 24hr net set of bluegill ≥ 175 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	25.28 (17.77,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	3.70 (4.09,24)	NS	NS	NS	4.63 (7.51,35)	36.63 (64.65,31)	NS
1985	NS	NS	1.29 (1.45,6)	NS	NS	NS	NS	NS	NS
1986	16.99 (27.42,15)	NS	5.64 (4.05,6)	NS	NS	NS	NS	NS	NS
1987	39.49 (53.98,6)	35.00 (57.92,16)	NS	NS	NS	NS	NS	NS	NS
1988	25.33 (24.45,5)	NS	NS	NS	12.04 (7.25,12)	NS	NS	NS	NS
1989	11.14 (13.88,12)	NS	NS	NS	NS	NS	2.77 (5.46,25)	NS	13.87 (16.22,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	39.58 (39.37,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	16.83 (18.92,16)	NS
1993	NS	NS	NS	13.60 (18.11,9)	NS	11.34 (14.47,9)	NS	NS	NS
1994	4.92 (5.37,12)	NS	2.74 (2.07,12)	NS	46.37 (33.64,12)	NS	NS	NS	NS
1995	NS	0.13 (0.35,16)	NS	NS	NS	NS	12.05 (17.23,32)	NS	NS
1996	NS	NS	NS	NS	NS	24.81 (29.05,16)	NS	NS	6.58 (7.39,14)
1997	10.18 (11.68,15)	NS	NS	37.78 (40.20,9)	NS	13.24 (14.26,16)	NS	27.63 (26.24,32)	NS
1998	NS	1.63 (3.24,16)	2.06 (2.59,12)	NS	29.77 (39.45,12)	4.90 (5.17,16)	9.23 (16.06,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS

2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	3.77 (5.58,17)	NS	NS	NS	NS	NS	NS	0.83 (1.14,16)
2003	27.61 (26.44,20)	NS	0.87 (1.48,40)	37.61 (47.20,39)	33.16 (22.07,40)	28.22 (22.46,40)	NS	9.71 (15.44,81)	NS
2004	NS	5.54 (7.48,40)	NS	NS	NS	NS	6.48 (7.92,22)	NS	0.96 (1.38,20)
2005	34.66 (66.23,20)	NS	1.10 (1.83,40)	40.47 (45.08,38)	20.23 (15.25,40)	11.40 (28.09,40)	NS	7.86 (8.03,50)	NS
2006	NS	4.20 (6.93,40)	NS	NS	NS	NS	NS	NS	5.33 (5.14,20)
2007	58.42 (90.98,20)	NS	1.36 (1.85,40)	17.00 (29.17,36)	13.67 (30.27,39)	50.16 (57.18,40)	NS	33.24 (32.54,40)	NS
Pre-Treatment	14.74 (24.20,65)	12.26 (36.59,48)	3.13 (3.39,60)	25.69 (32.71,18)	27.75 (27.53,60)	13.84 (19.39,57)	7.29 (13.09,120)	31.75 (43.50,107)	10.35 (13.06,29)
Post-Treatment	40.23 (66.93,60)	4.68 (6.93)	1.11 (1.73,120)	32.01 (42.44,113)	22.42 (24.47,119)	29.92 (41.83,120)	6.48 (7.92,22)	14.67 (21.91,171)	2.48 (3.84,56)
Pre-RSD_{175}	65	65	21	72	50	76	43	77	35
Post-RSD_{175}	63	32	23	85	68	68	33	73	16

Table A8. Mean catch per 24 hr net set of all bluegill. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	58.79 (37.90,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	9.23 (7.53,24)	NS	NS	NS	14.37 (16.21,35)	42.51 (75.65,31)	NS
1985	NS	NS	19.68 (22.20,6)	NS	NS	NS	NS	NS	NS
1986	22.08 (28.92,15)	NS	26.63 (13.56,6)	NS	NS	NS	NS	NS	NS
1987	60.20 (61.22,6)	48.44 (90.80,17)	NS	NS	NS	NS	NS	NS	NS
1988	35.42 (34.97,5)	NS	NS	NS	44.55 (31.60,12)	NS	NS	NS	NS
1989	21.53 (21.74,12)	NS	NS	NS	NS	NS	5.15 (7.90,25)	NS	18.03 (20.54,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	51.32 (48.09,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	25.08 (23.83,16)	NS
1993	NS	NS	NS	28.93 (34.63,9)	NS	13.91 (13.66,9)	NS	NS	NS
1994	18.15 (14.69,12)	NS	24.88 (27.75,12)	NS	57.81 (38.49,12)	NS	NS	NS	NS
1995	NS	3.65 (6.27,16)	NS	NS	NS	NS	15.73 (18.91,32)	NS	NS
1996	NS	NS	NS	NS	NS	29.36 (30.50,16)	NS	NS	47.54 (33.88,14)
1997	13.60 (16.48,15)	NS	NS	42.22 (48.54,9)	NS	21.10 (17.50,16)	NS	42.99 (34.43,32)	NS
1998	NS	5.21 (8.38,16)	19.85 (18.37,12)	NS	40.16 (49.84,12)	6.25 (5.93,16)	35.22 (51.42,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS

2000	NS	NS	NS	NS	NS	NS	NS	NS	NS
2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	7.24 (9.17,17)	NS	NS	NS	NS	NS	NS	19.88 (17.79,16)
2003	54.65 (36.33,20)	NS	17.86 (26.57,40)	46.67 (57.93,39)	38.44 (23.22,40)	46.75 (27.15,40)	NS	11.77 (16.14,81)	NS
2004	NS	11.80 (14.56,40)	NS	NS	NS	NS	21.77 (24.78,22)	NS	22.33 (20.70,20)
2005	50.92 (82.04,20)	NS	4.99 (7.37,40)	46.55 (50.57,38)	41.30 (31.20,40)	26.73 (43.26,40)	NS	23.74 (22.54,50)	NS
2006	NS	20.72 (25.93,40)	NS	NS	NS	NS	NS	NS	17.17 (14.28,20)
2007	87.29 (117.26,20)	NS	3.36 (2.96,40)	18.35 (31.57,36)	19.37 (31.48,39)	59.26 (61.85,40)	NS	37.29 (33.56,40)	NS
Pre-Treatment	23.76 (29.02,65)	19.44 (56.53,48)	17.28 (18.59,60)	35.52 (41.74,18)	52.8 (39.03,60)	18.00 (21.74,57)	18.24 (28.92,120)	42.72 (52.13,107)	32.16 (31.02,29)
Post-Treatment	64.32 (85.52,60)	14.64 (18.91,97)	8.64 (13.01,120)	37.68 (48.47,113)	33.12 (31.41,119)	44.16 (47.32,120)	21.84 (24.77,22)	21.12 (25.11,171)	19.68 (17.96,56)
Pre-PSD	81	84	37	99	79	89	64	93	42
Post-PSD	80	57	38	97	91	79	58	81	35

Table A9. Mean catch per 24 hr net set of pumpkinseed sunfish ≥ 175 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	1.11 (1.12,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	1.33 (1.92,24)	NS	NS	NS	2.11 (4.13,35)	4.47 (4.18,31)	NS
1985	NS	NS	2.58 (3.21,6)	NS	NS	NS	NS	NS	NS
1986	0 (0,15)	NS	4.07 (4.33,6)	NS	NS	NS	NS	NS	NS
1987	0 (0,6)	0.33 (0.65,16)	NS	NS	NS	NS	NS	NS	NS
1988	0 (0,5)	NS	NS	NS	0.76 (1.18,12)	NS	NS	NS	NS
1989	0 (0,12)	NS	NS	NS	NS	NS	1.85 (2.59,25)	NS	2.25 (3.11,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	1.12 (1.69,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	2.38 (3.23,16)	NS
1993	NS	NS	NS	6.17 (8.68,9)	NS	2.05 (2.44,9)	NS	NS	NS
1994	0 (0,12)	NS	0 (0,12)	NS	1.41 (2.55,12)	NS	NS	NS	NS
1995	NS	0.72 (0.90,16)	NS	NS	NS	NS	0.73 (1.11,32)	NS	NS
1996	NS	NS	NS	NS	NS	4.10 (5.90,16)	NS	NS	0 (0,14)
1997	0 (0,15)	NS	NS	5.44 (6.84,9)	NS	1.34 (2.19,16)	NS	1.47 (2.05,32)	NS
1998	NS	1.46 (3.40,16)	0 (0,12)	NS	2.95 (3.99,12)	1.61 (2.55,16)	5.21 (10.85,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS

2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	0.92 (2.83,17)	NS	NS	NS	NS	NS	NS	0 (0,16)
2003	0 (0,20)	NS	0 (0,40)	15.59 (25.90,39)	1.16 (1.60,40)	3.72 (5.96,40)	NS	1.37 (2.24,81)	NS
2004	NS	0.25 (0.68,40)	NS	NS	NS	NS	1.16 (2.49,22)	NS	0 (0,20)
2005	0 (0,20)	NS	0 (0,40)	11.71 (14.07,38)	0.61 (0.94,40)	5.06 (5.79,40)	NS	3.55 (3.35,50)	NS
2006	NS	0.48 (1.05,40)	NS	NS	NS	NS	NS	NS	0 (0,20)
2007	0 (0,20)	NS	0 (0,40)	7.96 (11.48,36)	0.67 (1.16,39)	3.62 (4.29,40)	NS	3.37 (5.07,40)	NS
Pre-Treatment	0 (0,65)	0.84 (2.08,48)	1.20 (2.35,60)	5.81 (7.59,18)	1.47 (2.35,60)	2.30 (3.81,57)	2.41 (5.99,120)	2.47 (3.55,107)	1.16 (2.48,29)
Post-Treatment	0 (0,60)	0.46 (1.42,97)	0 (0,120)	11.85 (18.54,113)	0.81 (1.28,119)	4.14 (5.39,120)	1.16 (2.49,22)	5.81 (7.59,171)	0 (0,56)
Pre-RSD_{175}	-	7	28	65	25	73	42	47	19
Post-RSD_{175}	-	4	-	91	47	52	8	92	-

Table A10. Mean catch per 24 hr net set of all pumpkinseed sunfish. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	6.11 (6.60,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	3.18 (3.01,24)	NS	NS	NS	7.69 (13.89,35)	12.14 (13.34,31)	NS
1985	NS	NS	10.88 (11.76,6)	NS	NS	NS	NS	NS	NS
1986	0 (0,15)	NS	13.56 (11.27,6)	NS	NS	NS	NS	NS	NS
1987	0 (0,6)	11.67 (28.18,17)	NS	NS	NS	NS	NS	NS	NS
1988	0 (0,5)	NS	NS	NS	6.41 (5.33,12)	NS	NS	NS	NS
1989	0 (0,12)	NS	NS	NS	NS	NS	4.10 (4.87,25)	NS	4.77 (4.14,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	2.16 (3.31,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	2.88 (3.54,16)	NS
1993	NS	NS	NS	12.00 (14.36,9)	NS	3.31 (3.75,9)	NS	NS	NS
1994	0 (0,12)	NS	1.72 (4.41,12)	NS	2.64 (4.14,12)	NS	NS	NS	NS
1995	NS	16.58 (14.20,16)	NS	NS	NS	NS	1.37 (1.27,32)	NS	NS
1996	NS	NS	NS	NS	NS	4.54 (6.19,16)	NS	NS	7.85 (14.73,14)
1997	0 (0,15)	NS	NS	5.89 (6.88,9)	NS	2.49 (3.32,16)	NS	2.00 (2.39,32)	NS
1998	NS	8.16 (12.35,16)	2.53 (2.51,12)	NS	5.81 (7.42,12)	2.30 (3.14,16)	10.66 (20.07,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS

2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	8.04 (10.27,17)	NS	NS	NS	NS	NS	NS	2.26 (3.03,16)
2003	0 (0,20)	NS	0.56 (1.40,40)	17.12 (28.58,39)	1.80 (2.24,40)	6.66 (6.69,40)	NS	1.42 (2.31,81)	NS
2004	NS	2.51 (3.60,40)	NS	NS	NS	NS	14.42 (28.18,22)	NS	3.64 (6.55,20)
2005	0 (0,20)	NS	0.05 (0.31,40)	12.67 (14.63,38)	1.40 (1.73,40)	11.18 (11.56,40)	NS	4.10 (3.95,50)	NS
2006	NS	24.54 (32.98,40)	NS	NS	NS	NS	NS	NS	1.04 (2.80,20)
2007	0 (0,20)	NS	0 (0,40)	9.00 (12.78,36)	1.99 (2.17,39)	6.25 (5.95,40)	NS	3.59 (5.68,40)	NS
Pre-Treatment	0 (0,65)	12.48 (19.95,48)	4.56 (7.44,60)	8.88 (11.20,18)	5.52 (5.58,60)	3.12 (3.62,57)	6.00 (13.15,120)	5.04 (9.93,107)	6.24 (10.34,29)
Post-Treatment	0 (0,60)	12.48 (23.64,97)	0 (0,120)	12.96 (20.41,113)	1.68 (2.62,119)	7.92 (7.89,120)	14.40 (28.14,22)	2.64 (3.14,171)	0 (0,56)
Pre-PSD	-	37	65	97	63	85	81	92	27
Post-PSD	-	17	-	99	74	88	36	97	-

Table A11. Mean catch per 24 hr net set of sunfish (bluegill and pumpkinseed combined) ≥ 175 mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	26.39 (17.98,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	5.03 (4.33,24)	NS	NS	NS	6.74 (9.74,35)	41.10 (66.80,31)	NS
1985	NS	NS	3.87 (4.60,6)	NS	NS	NS	NS	NS	NS
1986	16.99 (27.42,15)	NS	9.71 (5.70,6)	NS	NS	NS	NS	NS	NS
1987	38.49 (53.98,6)	35.34 (58.04,16)	NS	NS	NS	NS	NS	NS	NS
1988	25.33 (24.45,5)	NS	NS	NS	12.80 (7.73,12)	NS	NS	NS	NS
1989	11.14 (13.88,12)	NS	NS	NS	NS	NS	4.62 (7.79,25)	NS	16.12 (18.13,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	40.70 (39.97,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	19.21 (19.08,16)	NS
1993	NS	NS	NS	19.77 (25.23,9)	NS	13.39 (14.63,9)	NS	NS	NS
1994	4.92 (5.37,12)	NS	2.74 (2.07,12)	NS	47.78 (35.09,12)	NS	NS	NS	NS
1995	NS	0.85 (0.94,16)	NS	NS	NS	NS	12.78 (17.77,32)	NS	NS
1996	NS	NS	NS	NS	NS	28.91 (32.35,16)	NS	NS	6.58 (7.39,14)
1997	10.18 (11.68,15)	NS	NS	43.22 (46.52,9)	NS	14.58 (14.67,16)	NS	29.10 (26.64,32)	NS
1998	NS	3.09 (6.45,16)	2.06 (2.59,12)	NS	32.71 (40.19,12)	6.51 (6.57,16)	14.45 (21.98,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS

2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	4.68 (8.25,17)	NS	NS	NS	NS	NS	NS	0.83 (1.14,16)
2003	27.61 (26.44,20)	NS	0.87 (1.48,40)	53.19 (68.98,39)	34.32 (22.53,40)	31.94 (26.18,40)	NS	11.08 (15.90,81)	NS
2004	NS	5.79 (7.67,40)	NS	NS	NS	NS	7.64 (9.79,22)	NS	0.96 (1.38,20)
2005	34.66 (66.23,20)	NS	1.10 (1.83,40)	52.18 (52.56,38)	20.84 (15.54,40)	16.46 (29.71,40)	NS	11.41 (9.33,50)	NS
2006	NS	4.68 (7.29,40)	NS	NS	NS	NS	NS	NS	5.33 (5.14,20)
2007	58.42 (90.98,20)	NS	1.36 (1.85,40)	24.97 (36.32,36)	14.34 (30.50,39)	53.78 (59.29,40)	NS	36.60 (32.51,40)	NS
Pre-Treatment	14.74 (24.20,65)	13.09 (36.64,48)	4.33 (4.32,60)	31.50 (38.26,18)	29.21 (28.26,60)	16.15 (21.33,57)	9.71 (15.72,120)	34.13 (44.67,107)	11.51 (14.61,29)
Post-Treatment	40.23 (66.93,60)	5.14 (7.56,97)	1.11 (1.73,120)	43.86 (55.75,113)	23.24 (24.84,119)	34.06 (43.61,120)	7.64 (9.79,22)	17.14 (22.42,171)	2.48 (3.84,56)
Pre-RSD_{175}	65	43	23	71	47	76	43	73	32
Post-RSD_{175}	63	19	22	87	67	65	23	76	16

Table A12. Mean catch per 24 hr net set of all sunfish (bluegill and pumpkinseed combined). Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	Cross Creek Lake	Foster Joseph Sayers Lake	Lake Chillisquaque	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake	Yellow Creek Lake
1982	NS	NS	NS	NS	64.90 (40.30,24)	NS	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS	NS	NS	NS
1984	NS	NS	12.41 (9.16,24)	NS	NS	NS	22.06 (26.51,35)	54.66 (84.77,31)	NS
1985	NS	NS	30.56 (33.65,6)	NS	NS	NS	NS	NS	NS
1986	22.08 (28.92,15)	NS	40.19 (20.20,6)	NS	NS	NS	NS	NS	NS
1987	60.20 (61.22,6)	60.11 (117.90,17)	NS	NS	NS	NS	NS	NS	NS
1988	35.42 (34.97,5)	NS	NS	NS	50.96 (36.26,12)	NS	NS	NS	NS
1989	21.53 (21.74,12)	NS	NS	NS	NS	NS	9.24 (11.57,25)	NS	22.80 (22.66,15)
1990	NS	NS	NS	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	NS	NS	53.48 (49.67,28)	NS
1992	NS	NS	NS	NS	NS	NS	NS	27.96 (24.30,16)	NS
1993	NS	NS	NS	40.93 (48.10,9)	NS	17.22 (13.36,9)	NS	NS	NS
1994	18.15 (14.69,12)	NS	26.60 (30.82,12)	NS	60.45 (41.02,12)	NS	NS	NS	NS
1995	NS	20.23 (19.42,16)	NS	NS	NS	NS	17.10 (19.27,32)	NS	NS
1996	NS	NS	NS	NS	NS	33.91 (33.47,16)	NS	NS	55.39 (46.54,14)
1997	13.60 (16.48,15)	NS	NS	48.11 (55.05,9)	NS	23.59 (19.05,16)	NS	44.99 (34.54,32)	NS
1998	NS	13.37 (20.01,16)	22.38 (20.06,12)	NS	45.97 (51.49,12)	8.55 (8.27,16)	45.88 (62.69,28)	NS	NS
1999	NS	NS	NS	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS	NS	NS	NS

2001	NS	NS	NS	NS	NS	NS	NS	NS	NS
2002	NS	15.28 (17.42,17)	NS	NS	NS	NS	NS	NS	22.13 (18.97,16)
2003	54.65 (36.33,20)	NS	18.41 (27.39,40)	63.79 (82.82,39)	40.24 (24.08,40)	53.42 (30.03,40)	NS	13.19 (16.75,81)	NS
2004	NS	14.31 (16.85,40)	NS	NS	NS	NS	36.19 (50.16,22)	NS	25.97 (24.50,20)
2005	50.92 (82.04,20)	NS	5.04 (7.56,40)	59.21 (58.51,38)	42.70 (32.28,40)	37.91 (48.94,40)	NS	27.84 (23.68,50)	NS
2006	NS	45.26 (50.76,40)	NS	NS	NS	NS	NS	NS	18.21 (14.38,20)
2007	87.29 (117.26,20)	NS	3.36 (2.96,40)	27.35 (39.90,36)	21.35 (31.65,39)	65.52 (64.87,40)	NS	40.88 (34.06,40)	NS
Pre-Treatment	23.76 (29.02,65)	31.92 (73.16,48)	21.84 (22.31,60)	44.64 (49.89,18)	58.32 (40.90,60)	21.36 (23.56,57)	24.24 (36.81,120)	48.00 (57.01,107)	38.64 (38.77,29)
Post-Treatment	64.32 (85.52,60)	27.12 (37.82,97)	8.88 (18.40,120)	50.64 (63.78,113)	34.80 (31.42,119)	52.32 (49.95,120)	36.24 (50.66,22)	24.00 (25.11,171)	19.68 (17.96,56)
Pre-PSD	81	66	43	98	78	88	68	93	39
Post-PSD	80	38	37	98	90	65	49	83	35

Table A13. Mean catch per 24 hr net set of yellow perch ≥225mm. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	High Point Lake	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake
1982	NS	NS	10.97 (13.26,24)	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	NS	20.11 (46.87,35)	8.22 (16.10,31)
1985	NS	NS	NS	NS	NS	NS
1986	NS	NS	NS	NS	NS	NS
1987	NS	NS	NS	NS	NS	NS
1988	NS	NS	3.11 (2.57,12)	NS	NS	NS
1989	1.43 (2.18,14)	NS	NS	NS	58.67 (86.40,25)	NS
1990	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	58.23 (137.51,28)
1992	NS	NS	NS	NS	NS	12.45 (17.49,16)
1993	NS	37.07 (72.62,9)	NS	38.31 (35.95,9)	NS	NS
1994	NS	NS	2.44 (2.49,12)	NS	NS	NS
1995	NS	NS	NS	NS	2.13 (3.50,32)	NS
1996	2.64 (2.71,16)	NS	NS	137.49 (170.17,16)	NS	NS
1997	NS	7.00 (9.99,9)	NS	51.56 (116.72,16)	NS	47.03 (95.07,32)
1998	4.24 (8.38,16)	NS	3.83 (7.66,12)	52.40 (34.80,16)	24.50 (42.62,28)	NS
1999	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS
2001	NS	NS	NS	NS	NS	NS
2002	NS	NS	NS	NS	NS	NS

2003	1.52 (1.59,20)	40.97 (69.92,39)	2.10 (2.45,40)	24.39 (20.17,40)	NS	38.32 (75.43,81)
2004	NS	NS	NS	NS	37.05 (57.69,22)	NS
2005	0.89 (2.33,15)	16.76 (27.18,38)	2.94 (2.97,40)	4.80 (6.37,40)	NS	5.10 (10.00,50)
2006	NS	NS	NS	NS	NS	NS
2007	0.84 (1.00,16)	22.73 (42.63,36)	1.28 (1.49,39)	9.70 (15.19,40)	NS	6.39 (6.69,40)
Pre-Treatment	2.83 (5.34,46)	22.04 (52.61,18)	6.26 (9.85,60)	73.82 (116.40,57)	24.37 (54.17,120)	33.55 (89.70,107)
Post-Treatment	1.12 (1.70,51)	27.02 (50.80,113)	2.11 (2.46,119)	12.96 (17.09,120)	37.05 (57.69,22)	21.14 (54.63,171)
Pre-RSD_{225}	9	37	15	94	56	34
Post-RSD_{225}	9	81	44	43	71	96

Table A14. Mean catch per 24 hr net set of all yellow perch. Means are followed by standard deviation and sample size (number of trapnets set) in parentheses. NS = not sampled.

Year	High Point Lake	Promised Land Lake	Hills Creek Lake	Kahle Lake	Little Buffalo Lake	Rose Valley Lake
1982	NS	NS	82.98 (66.01,24)	NS	NS	NS
1983	NS	NS	NS	NS	NS	NS
1984	NS	NS	NS	NS	54.67 (112.65,35)	225.02 (563.09,31)
1985	NS	NS	NS	NS	NS	NS
1986	NS	NS	NS	NS	NS	NS
1987	NS	NS	NS	NS	NS	NS
1988	NS	NS	11.11 (8.98,12)	NS	NS	NS
1989	42.69 (88.31,14)	NS	NS	NS	103.11 (149.59,25)	NS
1990	NS	NS	NS	NS	NS	NS
1991	NS	NS	NS	NS	NS	79.15 (169.74,28)
1992	NS	NS	NS	NS	NS	13.07 (17.68,16)
1993	NS	107.93 (225.41,9)	NS	64.37 (60.98,9)	NS	NS
1994	NS	NS	33.21 (40.04,12)	NS	NS	NS
1995	NS	NS	NS	NS	2.70 (3.91,32)	NS
1996	6.15 (7.76,16)	NS	NS	138.60 (170.21,16)	NS	NS
1997	NS	10.78 (16.35,9)	NS	54.23 (117.07,16)	NS	51.31 (101.14,32)
1998	56.49 (106.08,16)	NS	7.63 (15.13,12)	54.70 (36.65,16)	35.07 (61.91,28)	NS
1999	NS	NS	NS	NS	NS	NS
2000	NS	NS	NS	NS	NS	NS
2001	NS	NS	NS	NS	NS	NS
2002	NS	NS	NS	NS	NS	NS

2003	6.62 (6.49,20)	55.85 (103.18,39)	5.68 (9.78,40)	39.68 (34.52,40)	NS	40.60 (76.69,81)
2004	NS	NS	NS	NS	52.38 (78.41,22)	NS
2005	59.09 (177.60,15)	17.84 (28.54,38)	6.91 (6.06,40)	11.25 (13.64,40)	NS	6.99 (11.67,50)
2006	NS	NS	NS	NS	NS	NS
2007	118.94 (177.93,16)	25.59 (45.49,36)	2.17 (2.04,39)	51.57 (109.90,40)	NS	7.21 (6.80,40)
Pre-Treatment	34.8 (81.39,46)	59.28 (162.92,18)	43.68 (55.78,60)	79.68 (117.78,57)	46.80 (102.53,120)	104.16 (330.18,107)
Post-Treatment	57.36 (143.97,51)	33.36 (68.88,113)	5.04 (7.85,119)	34.08 (68.36,120)	52.32 (78.80,22)	23.04 (56.49,171)
Pre-PSD	14	78	35	98	79	69
Post-PSD	11	92	77	57	81	98