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Project 5—Lake and Reservoir Research

Subproject 2: Warmwater Fisheries Investigations
Subproject 3: Angler Exploitation Investigations

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ANNUAL PERFORMANCE REPORT
SUBPROJECT 2: WARMWATER FISHERIES INVESTIGATIONS

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ABSTRACT

We monitored annual variation in year class strength of crappie *Pomoxis spp.* in several water bodies in Idaho during the summers of 2005-2008. Sampling consisted of summer trawling with a neuston net and fall electrofishing and trap netting at Brownlee and C. J. Strike reservoirs in southwest Idaho and Hayden Lake and Mann Creek Reservoir in northern Idaho. Larval crappie catch per unit effort (CPUE) was variable at all water bodies among all years. The period of peak larval CPUE for crappie at Brownlee and C. J. Strike reservoirs was the first week of July during all four years, whereas peak CPUE in the northern Idaho waters was usually in late June. Fall electrofishing was, overall, considerably more effective at capturing warmwater species than was trap netting. Combining collection methods, length frequencies revealed that crappie population structure is dynamic at all water bodies and that following year classes through time is difficult. Average weekly peak inflow (ft^3/s) predicts the CPUE of larval crappie at Brownlee and C. J. Strike reservoirs while comparisons of larval crappie CPUE with reservoir level and zooplankton parameters (ZPR-ZQI) demonstrate no relationship. Unlike previous years, a relationship between larval CPUE and the CPUE of cohorts at age-1 was established; however, sampling of this type will be necessary for the next several years for meaningful patterns to emerge.

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INTRODUCTION

Idaho's warmwater fisheries are receiving increased interest from anglers and the importance for Idaho Department of Fish and Game (IDFG) managers to monitor these populations and understand the factors that influence these fisheries is growing. According to the 1999 angler opinion survey, angler preference for warmwater species has increased from 7% in 1977 to 20% in 1999 (IDFG 2001). Species targeted by anglers include smallmouth bass *Micropterus dolomieu*, largemouth bass *M. salmoides*, black crappie *Pomoxis nigromaculatus*, white crappie *P. annularis*, bluegill *Lepomis macrochirus*, yellow perch *Perca flavescens*, walleye *Sander vitreous*, and channel catfish *Ictalurus punctatus*. These species provide sport fisheries in approximately one-third of the surface waters in Idaho (IDFG 2001).

A benefit of warmwater fisheries is that populations can be self-sustaining, making them relatively simple to create in comparison to other types of fisheries. However, because warmwater fisheries are self-supporting, managers generally know less about the status, characteristics, and factors that influence populations. A better understanding of the factors that affect recruitment, growth, mortality, and thus, year class strength (YCS), in Idaho crappie populations would be beneficial for several reasons. First, a statewide perspective of population characteristics, such as size structure and growth, would help IDFG managers and anglers understand the variation between populations, and set reasonable expectations for a fishery. Second, increased knowledge of the biological and environmental factors that influence these population characteristics would allow managers to determine which combinations of recruitment, growth, and mortality result in desirable fisheries and whether they can be influenced by some form of management practice such as harvest regulations. Furthermore, increased knowledge and understanding of these warmwater fisheries would allow managers to effectively communicate the status of a fishery with anglers, the reasons for changes in a particular fishery, defense for regulation changes, and may provide managers the ability to predict the quality of a fishery.

Although simple to create, warmwater fisheries can be difficult to successfully manage because, for many species, fluctuations in year class strength or body size can occur (Allen 1997; Boxrucker and Irwin 2002; Martin and Maceina 2004). Fluctuations in population structure and growth are likely a result of different environmental characteristics such as temperature, water volume, and lake or reservoir bathymetry, and biological variables such as food supply or fish density (Mitzner 1991; Pope et al. 2004). In fact, many studies exist on the effects of these variables on crappie populations in Midwestern and Southeastern waters in the United States. Investigations on the influences of biotic and abiotic factors on crappie populations have been infrequent in Idaho because the popularity of warmwater fisheries is a relatively recent phenomenon.

Standardized methods to assess population characteristics of crappie populations have been developed by other states (Gablehouse 1984; Hill 1984; Hammers and Miranda 1991; Guy and Willis 1995; Allen et al. 1998; St. John and Black 2004; McInerny and Cross 2005). Notably, Colvin and Vasey (1986) describe a method where information collected during annual fall sampling with trap nets in Missouri allowed biologists to evaluate and qualitatively describe five important parameters, including population density, growth rate, age structure, size structure, and recruitment. These parameters, along with descriptive indices like proportional stock density (PSD), relative stock density (RSD), and relative weight indices (Wr), can be used not only to describe the status of a fishery but also to adequately describe the causes of potential problems such as stunting or poor catch rates. Measuring these parameters on an annual basis can lead to other potential benefits as well. For example, catch rates of age-2 and older crappie during fall collections at four reservoirs were significantly correlated with angler harvest estimates during the following year (Colvin 1991). Such correlation allowed managers to predict when anglers could expect a quality harvest along with the age and size of fish.

Accurately predicting YCS is essential for proper management of warmwater species and understanding the factors that influence YCS allows the implementation of management strategies (Sammons and Bettoli 1998). However, assessing YCS of crappie using standard methods such as trap nets and electrofishing can be problematic. For example, crappie are difficult to successfully sample in steep-sided basins that are often characteristic of Idaho reservoirs. Also, extreme fluctuations in YCS can hinder efforts to effectively sample a population, and weak or missing year classes may not be detected until the fish have already entered the fishery. Because of these problems, some researchers have suggested utilizing larval sampling to index YCS and relate YCS back to abiotic and biotic factors. Sammons and Bettoli (1998) found that although larval crappie were only briefly available to capture by neuston netting, peak larval density accurately predicted the geometric mean density of age-1 crappie ($r^2 = 0.99$, $P = 0.0001$). Under the assumption that YCS is fixed before the end of the first growing season, larval sampling may offer a reliable method in which problems are detected early, offering managers the time and ability to take desired actions. Sampling larval crappie would also allow for a better understanding of factors that influence successful reproduction and recruitment in Idaho waters. Water level, discharge, temperature, wind, and zooplankton abundance have all been linked to successful spawning and growth (Beam 1983; Pope and Willis 1998; Sammons et al. 2002a, 2002b; St. John and Black 2004).

The use of larval sampling as an index of YCS for crappie is beneficial only when YCS is set during the first growing season (Sammons and Bettoli 1998). If, for instance, substantial mortality occurs during the first winter, then YCS estimates based on larval sampling will be misleading. Winter conditions have been demonstrated to be important for largemouth bass in northern Idaho, where fish <50 mm did not survive (Bowles 1985), probably the result of depletion of energy stores or increased risk to predation (Miranda and Hubbard 1994a, 1994b; Garvey et al. 1998). The severity of winter conditions has been shown to have a profound impact on survival of age-0 white crappies through physiological stress when water temperatures drop below 4°C (McCollum et al. 2003).

Because winter may often act as the bottleneck that defines YCS, year classes need to be followed for several years to determine if survival during the first winter is equally as important in determining YCS as reservoir conditions during spawning and the first growing season. Gaining a better understanding of limiting factors in Idaho's crappie fisheries likely requires a commitment to follow a number of year classes for 3-4 years.

MANAGEMENT GOAL

1. Improve warmwater sportfishing and fisheries management in Idaho lakes and reservoirs.

OBJECTIVES

1. Determine if larval abundance of crappie can be used to predict year class strength and fishing quality in Idaho waters.

2. Identify collection techniques (trap netting, gillnetting, and electrofishing) for obtaining adequate samples of crappies across all age groups in Idaho lakes and reservoirs.

3. Examine crappie population characteristics in relation to environmental conditions to gain an understanding of which environmental influence crappie fisheries.

METHODS

Larval Trawling

Larval fish were collected at Hayden Lake in the IDFG Panhandle Region, Mann Creek Reservoir in the Clearwater Region, and C. J. Strike and Brownlee reservoirs in the Southwest Region from 2005 to 2008. We attempted to collect samples on a biweekly basis from late May through August with the goal of identifying peak larval catch-per-unit-effort (CPUE). Fixed sites were randomly selected (see Butts et al. 2007 for locations) and sampled by towing a 1 m x 2 m floating neuston net of 1 mm bar mesh equipped with a flow meter at night (Sammons and Bettoli 1998; St. John and Black 2004). Sites were located using a boat mounted Garmin GPS unit. At Brownlee and C. J. Strike reservoirs and Hayden Lake, where temperature and habitat variation occurred along the longitudinal axes of each water body, sampling was stratified into three strata within each lake (Appendix A). The net was towed for 5 minutes at each station with a 6.4 m boat powered by a 175 hp outboard motor. Mean tow volume was 362.12 m^3 and mean boat speed was 2.6 m/s. Samples were immediately preserved in a 10% formalin solution and later transferred to ethanol (St. John and Black 2004) and larval fish were identified in the laboratory using meristics described by Auer (1982). All larval fish were identified, counted, and measured except when large samples (>200 fish) required subsampling. Larval crappie were not identified to species because the differences in meristic characteristics at that size are unreliable (Sammons and Bettoli 1998). The CPUE for larval crappie was calculated by averaging the number of larval crappie captured from each stratum. The peak larval CPUE are reported as the highest mean number of larval crappie captured in a strata for each year.

Also examined in this report are Idaho Power Company (IPC) larval data collected from April through August from 1994 through 1998 (Richter and Chandler 2007). Larval fish were collected by IPC personnel using oblique tows with paired, 0.5 m diameter, 750 µ-mesh ichthyoplankton nets. Tows were made at five depths (0-4 m) for one minute at each depth for a total of five minutes at a constant speed (for full description, see Richter 2001). Because the IPC data was collected using similar tow times and distances, with the only difference being the net mouth size (0.195 m^2 X 2 nets vs. 2 m^2), IPC larval crappie counts per tow were multiplied by 5 to standardize larval catch to our data. Larval CPUE data were analyzed for differences between IPC and IDFG collections using ANOVA (SAS 2008), and no differences were observed ($df = 1$, $F = 0.01$, $P = 0.92$). Therefore, we pooled larval CPUE data from both sources in the analysis for Brownlee Reservoir.

Fall Index Sampling

Older year classes of crappie and other warmwater species were sampled in October by electrofishing and trap netting in Brownlee Reservoir, C. J. Strike Reservoir, and Hayden Lake. Only trap netting was completed on Hayden Lake in 2006 because of an electrofishing boat malfunction. We did not complete fall sampling at Mann Creek Reservoir in either 2006 or 2007 because of extremely low water levels; however, Mann Creek Reservoir was sampled in 2005 and 2008 while waters levels were adequate to launch the electroshocking boat. All fall sampling followed the Lowland Lakes Standard Survey protocol (IDFG, unpublished data). We used trap nets constructed from 13 mm treated black mesh with a 0.9 x 1.8 m frame and a 22.9 m lead. Shoreline trap net locations were randomly selected and depths ranged from 2 to 10 m. Trap nets were placed in the same locations in all years, with some exceptions due to water level changes in the reservoirs. Electrofishing was conducted at night using a 5.5 m long Smith Root boat equipped with a Smith Root GPP 5.0 electrofisher using pulsed DC. One hour of current-on electrofishing and one net night equaled one unit of effort. Electrofishing was conducted along the shoreline using a combination of short parallel and perpendicular boat movements for any given distance of shoreline. Two persons netted stunned fish from the front of the boat. We calculated CPUE by dividing the number of target fish captured by the effort in hours for electrofishing or the number of net nights for trap nets. The amount of effort varied between water bodies and ranged from 20 to 40 trap net nights and 2 to 3 hours of electrofishing. We identified and measured all fish captured and weighed a subsample from both trap nets and electrofishing. Length frequency histograms were constructed for crappie to characterize populations in each water body.

Factors Affecting Year Class Strength

To assess factors affecting potential differences in CPUE of larval and adult crappie and year class strength zooplankton samples and water quality profiles were collected at fixed sites concurrently during larval trawling (Tables 3-10). Collections were made at three locations at Brownlee and C. J. Strike reservoirs and Hayden Lake and one site at Mann Creek Reservoir. Vertical profiles were collected using a MiniSonde 4a (Hach Environmental) attached by a cable to a Surveyor 4a. We measured temperature, dissolved oxygen, specific conductivity, and pH from the surface to the bottom at 1 m intervals (mean surface measurements are reported in tables 3-10). Two readers also independently measured water clarity with a Secchi disk to get an average reading. Zooplankton samples were collected using the method outlined by Teuscher (1996). Zooplankton nets in three mesh sizes (153 µm, 500 µm, and 750 µm) were each lowered to a depth of 9.9 meters in the water column and slowly pulled back to the surface. Zooplankton samples were weighed and the Zooplankton Ratio (ZPR) and Zooplankton Quality Index (ZQI) measurements were calculated for each sample site (Tables 7-10). Further limnology data is being provided from IPC (T. Richter, unpublished data), including more detailed zooplankton samples, depth profiles, and dam outflow temperatures for Brownlee and C. J. Strike reservoirs; however, data is still forthcoming and therefore is not included in this report.

We also gathered physical water data from other sources (IPC, United States Geological Survey [USGS]), including reservoir inflow rates (ft^3/s), dam outflow rates (ft^3/s), and reservoir elevation (ft), for Brownlee, C. J. Strike and Mann Creek reservoirs; no similar data exists for Hayden Lake. Inflow and outflow rates were practically identical for both Brownlee and C. J. Strike reservoirs, so inflow rates were used for comparisons. Inflow rates for Brownlee Reservoir were measured at the USGS gauge on the Snake River immediately upstream of the slack water to the reservoir. Similar measurements for C. J. Strike Reservoir were collected from both the USGS gauge from the Bliss section of the Snake River approximately 28 k upstream of the slack water of the Snake River Arm and from the Bruneau River, approximately 3 km upstream of the Bruneau Arm. Inflow rates for Mann Creek Reservoir were collected from the canal feeding the reservoir (Bureau of Reclamation). Reservoir elevations for Brownlee and C. J. Strike reservoirs were provided by IPC (T. Richter, unpublished data). Mean, weekly inflow rates and reservoir elevations were calculated to decrease the variability of daily measurements for comparison to the peak CPUE of larval crappie.

We tested the relationship between the peak larval CPUE of crappie with the CPUE of age-1 or greater crappie. We used linear regression (SAS 2008) to identify whether the peak larval CPUE of crappie predicts the CPUE of crappie in subsequent years ($\alpha = 0.05$). The proportion of crappie in different age classes was calculated using length frequencies and length-at-age keys developed for the different water bodies (J. A. Lamansky, unpublished data) to allocate the CPUE to the proper year class. The total CPUE for a given year was then multiplied by the proportion in each year class to obtain the CPUE for the different age classes. The regression includes Brownlee and C. J. Strike reservoirs and Hayden Lake; analysis was not performed for Mann Creek Reservoir. Peak larval crappie CPUE was also compared to inflow and reservoir elevation at Brownlee, C. J. Strike, and Mann Creek reservoirs using linear regression.

RESULTS

Larval Trawling

Brownlee Reservoir

The peak larval CPUE dates were similar in Brownlee reservoir during the four years sampled occurred on July 12, 2005, July 17, 2006, July 10, 2007, and July 1, 2008 (Figure 1) with surface water temperatures of 24, 25, 26 and 23°C, respectively (Table 3). Although peak CPUE was identified in different strata of the reservoir, as a whole these dates reflect the peak CPUE for each year.

C. J. Strike Reservoir

Similar to Brownlee Reservoir, peak crappie CPUE from C. J. Strike Reservoir was identified around similar dates during the four years of sampling with peaks on July 13, 2005, July 6, 2006, July 9, 2007, and July 2, 2008 (Figure 2). Surface water temperatures were also similar to Brownlee Reservoir on peak larval days with 23°C in 2005 and 24°C in both 2006 and 2007 (Table 4). Temperature was not recorded in 2008 on the peak date, but temperatures on surrounding dates were similar to other years. The peak larval CPUE in C. J. Strike Reservoir was identified in the Bruneau Arm in all years.

Hayden Lake

The peak dates for larval crappie CPUE was similar in Hayden Lake to the previous two reservoirs, however, two peaks were observed in 2007 and 2008. The first peak was June 27, 2006, June 19, 2007, and a few weeks later in 2008 on July 9 (Figure 3). However, the second peak in 2007 was on July 30 and was higher than the June 19 peak, suggesting that crappie spawn multiple times in Hayden Lake. Peak larval crappie CPUE revealed an increasing trend from approximately 20 fish/trawl in 2005 to over 400 fish/trawl in 2008 (Figure 3). Surface water temperatures ranged between 19°C and 25°C during larval crappie sampling (Table 5).

Mann Creek Reservoir

Unlike the other three water bodies sampled, dates of peak larval crappie CPUE were variable in Mann Creek Reservoir. Peak CPUE occurred on June 1, 2006, June 5, 2007, and June 25, 2008 (Figure 4). A second peak was also observed in Mann Creek Reservoir in all four years ranging between July 31, 2006 to August 19, 2008. Surface water temperature was 25°C on peak larval days in all four years (Table 6).

Fall Index Sampling

Crappie CPUE from electrofishing was variable among water bodies and years (Table 1). In Brownlee Reservoir, fall electrofishing CPUE for crappie ranged from a low of 20 fish/h in 2005 to a high of 342 fish/h in 2007. In C. J. Strike Reservoir, crappie CPUE ranged between 2 fish/h in 2007 to 185 fish/h in 2006. In Hayden Lake, fall electrofishing CPUE was lowest in 2007 (5 fish/h) and highest in 2008 (113 fish/h). Only two years of fall electrofishing data are available for Mann Creek Reservoir, and electrofishing CPUE for crappie was 77 fish/h in 2005 and 40 fish/h in 2008 (Table 2).

Likewise, trap netting CPUE was variable among years for all water bodies sampled. However, the CPUE with trap nets was considerably less than electrofishing in all water bodies in all years ranging between 4 to 80 times fewer crappie per net night than per hour spent electrofishing (Table 2). Fall crappie CPUE ranges from a low of 1 fish/net night in Hayden Lake in 2005 to a high of 22 fish/net night in Brownlee in 2007 (Table 3).

The length frequencies for crappie from the study waters suggest that either crappie populations are very dynamic from year to year (Figures 5-7) or our sampling methods introduce considerable error. In both Brownlee (Figure 5) and C. J. Strike (Figure 6) reservoirs, the 2006 larval year class has apparently survived well and is the primary year class observed in 2008. Indeed, the 2006 year class is the dominant cohort present in both reservoirs with few or no other year classes represented. In contrast, at Hayden Lake, several year classes were observed in 2008 and it appears that cohorts have survived consistently since 2005 (Figure 7). The population in Mann Creek Reservoir also appears consistent (Figure 8), although data is only available for 2005 and 2008. The CPUE for other species captured during fall electrofishing and trap netting are shown in Tables 1 and 2, respectively

Factors Affecting Year Class Strength

Water quality samples taken at each water body were similar for all years (Tables 6-9). Peak larval crappie CPUE always occurred on days where surface water temperatures were between 23°C and 26°C (Tables 3-6). Other parameters measured (dissolved oxygen, conductivity, pH) were within reasonable limits and did not show any drastic changes during the sampling periods at any water body. Secchi depths ranged between 1-2 m at Brownlee, C. J. Strike, and Mann Creek reservoirs and were between 5-6 m at Hayden Lake.

The ZPR and ZQI values ranged widely and were higher early in the summer and averaged <1.0 for most of the sample dates. No pattern of either ZPR or ZQI was obvious when compared to peak larval CPUE for crappie (Tables 7-10).

Regression analysis does suggest a relationship between the number of peak larval crappie and the CPUE of the cohorts at age-1 (df = 5, F = 29.7, p = 0.001, r^2 = 0.81; Figure 9). Thus far, however, data are limited and removal of one point results in an insignificant relationship.

Regression analysis of the combined IPC and IDFG larval crappie data from Brownlee Reservoir suggests that reservoir inflow is a predictor of peak larval crappie CPUE (df = 1, F = 10.21, p = 0.01) with the model explaining 56% of the variation (Figure 10). Observing the effect of inflow on the peak larval CPUE for IDFG data alone is also significant (*df* = 1, F = 55.96, p = 0.02), but the effect of inflow is responsible for 96% of the variation in the model (Figure 11). Interestingly, inflow into the Snake River Arm of C. J. Strike Reservoir also predicts the level of larval crappie CPUE (*df* = 1, F = 58.72, p = 0.02) and explains 97% of the variation in the model (Figure 12), although, in each year to date, the peak larval CPUE has occurred in the Bruneau Arm. However, the mean weekly peak flow from the Bruneau River suggests no relationship with the peak larval crappie CPUE (*df* = 1, F = 0.09, p = 0.79). Unsurprisingly, no relationship was found between inflow and larval crappie CPUE at Mann Creek Reservoir (*df* = 1, F = 0.08, p = 0.81), likely because inflow is determined by agricultural need and is not related to any natural hydrography. None of the other parameters tested (reservoir elevation, surface water temperatures, ZPR-ZQI) demonstrated a relationship with larval crappie CPUE.

DISCUSSION

Larval Trawling

Although the CPUE for larval crappie was variable, the peak timing of larval abundance was similar for all four years within each lake. Dates of peak larval CPUE were similar in Brownlee and C. J. Strike reservoirs, which occurred during the first two weeks of July. Peak larval CPUE was earlier in Hayden Lake and Mann Creek Reservoir (first week of June) indicating earlier spawn timing, although multiple peaks were observed indicating continuing or multiple spawning. Sammons et al. (2001) noted bimodal peaks of larval crappie abundance in a Tennessee reservoir. However, other studies observed a single peak of larval crappie abundance (Travnichek et al. 1996; Mitzner 1991). Peak larval crappie timing in our study was oftentimes 30-60 days later than other studies who noted peak timing from mid-April through late May (Sammons et al. 2001; Travnichek et al. 1996; Mitzner 1991). Such variable timing is probably due to the difference in the climate or hydrology of the water bodies in our study, which are much deeper and, therefore, do not reach temperatures necessary for crappie spawning until later in the year. Water temperatures are important in controlling spawn timing, which is related to when larval fish are present (Travnichek et al. 1996; Mitzner 1991), but is not necessarily related to the availability or recruitment of larval fish to our sampling methods.

Fall Index Sampling

We have experienced difficulty developing an effective fall index for crappie because trap netting catch rates are low, especially when compared to other studies (Sammons et al. 2002b; Colvin and Vasey 1986). The sample size goal for Colvin and Vasey (1986) was 1,500 age-1 and older crappie, which would equate to two weeks of sampling with the highest catch rates we encountered using trap nets in any year. With current catch rates, our use of trap nets will not yield an adequate sample size to allow the analysis described by Colvin and Vasey (1986). In our study, sampling occurred in October when water temperatures were between 15°C and 20°C, which corresponded to the temperatures noted by Colvin and Vasey (1986) when crappie are vulnerable. We need to better discern when crappie become shoreline oriented in the fall and re-evaluate spring sampling when high catch rates of crappie were observed during electrofishing for a separate project in these same water bodies.

The success of this project relies on our ability to sufficiently sample different life stages of crappie. After combining fall collection methods, crappie length frequencies reveal that population structure is dynamic at all water bodies as mentioned in other studies (Sammons et al. 2001; Travnichek et al. 1996; Mitzner 1991; Colvin and Vasey 1986). Although we are able to adequately sample larval crappie, sampling older age classes proved difficult. Sampling indicated that we might be missing year classes, but we were unsure if low catch rates revealed a year class failure, inadequate sampling procedures, or poor sample timing. Regardless, it remains crucial that we are able to accurately follow year classes through time. Therefore, we need to adjust our sampling techniques and continue using trap nets where they are successful, increase the electrofishing effort to make up for low trap net catch rates, and find alternative techniques that will increase sampling efficiency.

The crappie populations in our study water bodies demonstrated different dynamics. At Brownlee and C. J. Strike reservoirs, crappie populations were dominated by a single year class, while at Hayden Lake and Mann Creek Reservoir, the populations consisted of several cohorts (Figures 5-8). In 2007, few larval crappie were encountered at Brownlee or C. J. Strike reservoirs suggesting poor spawning, which was expected due to the lack of spawning age crappie. However, in 2008, with the dominant 2006 cohort old enough to spawn, we encountered a relatively high CPUE of larval crappie. Nevertheless, neither year class was found in later sampling, meaning those year classes probably failed. The difference in population characteristics suggests that, while recruitment appears consistent at Hayden Lake and Mann Creek Reservoir, that year class failure has occurred at Brownlee and C. J. Strike reservoirs, at least over the sampling period. Crappie populations in Brownlee and C. J. Strike reservoirs appear to be cyclic in nature, while those in Hayden Lake and Mann Creek Reservoir demonstrate consistent recruitment. Although the level of larval crappie CPUE appears related to spring inflow, the recruitment of the young-of-year cohort to the next year remains unexplained. Crappie year class failure has been attributed to fluctuations in water level (Beam 1983), reservoir discharge (Sammons et al. 2002a), entrainment (Sorenson et al. 1998), winter water temperatures (McCollum et al. 2003) or turbidity (Ellison 1984; Mitzner 1991). Variable recruitment at different water bodies emphasizes the point that, where crappie are concerned, attention to individual waters is necessary to determine specific characteristics important to populations (Sammons et. al 2002b).

Factors Affecting Year Class Strength

The larval crappie CPUE at all lakes was extremely variable among the four years of sampling. Variability in larval sampling has been noted in most other studies sampling crappie populations (Colvin and Vasey 1986; Beam 1983). However, for the water bodies we studied, inflow rates were significantly, positively related to larval CPUE and explain a majority of the variability (56% combined, 97% IDFG). Studies on Tennessee reservoirs determined that high winter flow patterns resulted in increased crappie recruitment before spawning (Sammons et. al 2002a; Sammons and Bettoli 2001). Likewise, abundance of age-0 black crappie was correlated to high lake levels in Lake Okeechobee, Florida during winter months (Miller et al. 1990). Strong year classes of crappie in Alabama reservoirs were also related to high winter water levels but not reservoir hydrology during or post-spawning. However, the reason or mechanism for such a relationship is unclear.

We have studied several factors, both biotic and abiotic, to explain crappie year class strength and only peak spring inflow rates have provided any relationship. Flow and water levels may be a spawning cue for adult crappie (Maceina and Stimpert 1998), although high discharge during the spawning period appeared to be harmful to crappie recruitment in some Tennessee reservoirs (Sammons et al 2002a). Possibly, the sheer number of spawning crappie was responsible for larval numbers; however, crappie fecundity was not related to crappie recruitment in a Pennsylvania reservoir (Mathur et al. 1979). Larval crappie may also be susceptible to entrainment through dams (Sorenson et al. 1998) because of their pelagic behavior during times of year when dam discharge is highest.

Although our comparisons with ZPR and ZQI do not reveal a relationship to larval crappie CPUE, food availability may be affecting larval crappie survival, especially in Brownlee Reservoir. Further investigation is necessary to determine the effects of food availability on larval crappie. Likewise, predation on larval crappie may be significant, although, from other studies it appears crappie comprise a small proportion of the diet of predator species (Pelham et al. 2001; Bennett and Dunsmoor 1986; Ellison 1984; O'Brien et al. 1984). Regardless, the direct mechanism responsible for larval crappie recruitment or failure remains unclear.

Unlike the previous year (Meyer et al. 2008), peak larval abundance does explain the CPUE of age-1 crappie. However, the sample size is small (n = 10), and as mentioned previously, the removal of a single sample results in an insignificant outcome. We recommend that sampling continue to increase both the sample size and the reliability of this analysis.

RECOMMENDATIONS

1. Include forthcoming zooplankton and temperature data from Idaho Power Company to further refine the relationships with larval crappie CPUE.

2. Continue larval and adult crappie sampling through 2009 including adult sampling in the spring, summer, and fall periods to revisit whether sample timing effects adult crappie CPUE. Consideration should be given to extend this study several more years to allow the observation of crappie cohorts through their lives.

3. Perform age and growth analysis along with basic diet analysis to better understand the number and proportion of cohorts in the populations and to determine if diet or cannibalism may affect the recruitment of larval crappie.

4. Use existing data to examine if a qualitative assessment of crappie population characteristics developed by Colvin and Vasey (1986) can benefit the management of crappie fisheries in Idaho.

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Table 1. The CPUE of fish species captured during spring/fall electrofishing in Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir, Idaho for the years 2005-2008.

			Species					
Water	Year	**Sampling Period**	**Crappie (var sp.)**	**Smallmouth bass**	**Largemouth bass**	**Bluegill**	**Pumpkin-seed**	**Yellow perch**
Brownlee Reservoir	2005	Spring	14.4	117.1	0.4	17.5	0.0	1.5
		Fall	20.2	187.0	2.1	69.5	1.1	9.8
	2006	Fall	114.7	90.0	35.1	0.0	0.0	0.0
	2007	Fall	342.7	189.0	1.7	0.0	0.3	0.0
	2008	Fall	156.1	157.4	1.6	14.9	0.0	0.3
C. J. Strike Reservoir	2005	Spring	8.8	140.3	7.0	45.4	1.5	4.0
		Fall	167.9	129.0	64.2	249.7	10.8	25.6
	2006	Fall	185.3	119.9	52.9	17.0	2.7	0.0
	2007	Fall	1.7	201.0	24.3	63.3	9.3	14.3
	2008	Fall	17.7	75.4	65.5	127.6	21.7	10.9
Hayden Lake	2005	Spring	78.5	119.5	50.5	0.0	112.0	44.5
		Fall	79.4	75.3	24.0	0.0	0.0	0.0
	2006	[a]						
	2007	Fall	5.3	75.3	36.3	0.0	23.0	133.0
	2008	Fall	112.8	19.9	55.8	0.6	48.7	112.2
Mann Creek Reservoir	2005	Fall	77.0	0.0	231.5	201.0	114.5	0.0
	2006	[b]						
	2007	*						
	2008	Fall	39.7	0.0	186.2	39.7	32.8	0.0

[a] Hayden Lake not sampled in 2006 due to boat malfunction.
[b] Mann Creek Reservoir not sampled in 2006 or 2007 due to low water levels.

Table 2. The CPUE of fish species captured during spring/fall trap netting in Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir, Idaho for the years 2005-2008.

			Species					
Water	**Year**	**Sampling Period**	**Crappie (var sp.)**	**Smallmouth bass**	**Largemouth bass**	**Bluegill**	**Pumpkin-seed**	**Yellow perch**
Brownlee Reservoir	2005	Spring	7.7	0.0	0.0	0.5	0.3	0.3
		Fall	2.9	0.1	0.0	1.5	0.0	0.1
	2006	Fall	16.5	0.0	0.0	7.7	0.3	0.0
	2007	Fall	22.3	1.7	0.1	0.0	0.1	0.1
	2008	Fall	20.7	0.2	0.0	0.3	0.0	0.1
C. J. Strike Reservoir	2005	Spring	6.5	1.0	0.0	0.2	0.2	1.7
		Fall	10.5	0.6	0.1	11.8	0.2	4.6
	2006	Fall	9.6	0.6	0.1	2.8	0.2	0.0
	2007	Fall	2.0	1.3	0.3	0.0	0.5	0.0
	2008	Fall	1.5	0.7	0.0	0.7	0.1	0.7
Hayden Lake	2005	Spring	0.0	0.0	0.0	0.0	1.3	0.1
		Fall	1.0	0.0	0.4	0.1	4.4	1.8
	2006	Fall	15.8	0.7	0.2	0.1	2.4	0.0
	2007	Fall	7.4	0.0	0.3	0.2	0.2	4.5
	2008	Fall	2.2	0.0	0.1	0.4	1.9	2.5
Mann Creek Reservoir	2005	Fall	3.5	0.0	2.5	6.9	12.8	0.0
	2006	*						
	2007	*						
	2008	Fall	1.8	0.0	0.2	0.8	10.2	0.0

* Mann Creek Reservoir not sampled in 2006 or 2007 due to low water levels.

Table 3. Surface means of water quality parameters measured at Brownlee Reservoir during the summers of 2005-2008, including temperature (Temp; °C), dissolved oxygen (DO; mg/L), conductivity, pH, and secchi depth (m). N/A-data not available.

Date	Temp (°C)	DO (mg/L)	Conductivity	pH	Secchi Depth (m)
6/21/2005	21.1	7.7	325	9.36	1.15
7/12/2005	24.2	14.8	334	10.29	0.80
7/28/2005	25.2	10.5	373	10.07	1.20
8/15/2005	26.2	N/A	399	10.33	1.29
9/6/2005	23.5	9.3	431	8.46	2.55
5/24/2006	16.1	10.2	201	8.78	0.35
6/5/2006	21.1	10.7	207	9.12	2.00
6/19/2006	19.3	9.9	N/A	N/A	0.73
7/5/2006	26.3	8.4	254	8.79	4.00
7/17/2006	25.5	6.7	356	9.00	1.30
7/31/2006	25.1	6.5	348	9.00	1.08
8/24/2006	23.4	10.2	368	8.93	1.35
5/31/2007	19.4	8.6	309	8.97	3.17
6/12/2007	20.8	7.5	300	8.79	3.50
6/26/2007	24.8	6.6	312	8.72	3.50
7/10/2007	26.1	9.6	335	8.99	3.50
7/24/2007	26.2	8.7	368	8.82	1.75
8/8/2007	25.5	4.6	399	8.24	2.42
8/21/2007	23.6	7.1	406	8.33	2.71
6/17/2008	19.1	11.0	187	8.71	1.83
7/1/2008	23.8	6.5	219	8.90	1.53
7/15/2008	25.2	9.5	294	9.19	1.82
7/29/2008	24.4	9.6	376	8.87	1.63
8/12/2008	25.7	11.1	413	8.88	1.32

Table 4. Surface means of water quality parameters measured at C. J. Strike Reservoir during the summers of 2005-2008, including temperature (Temp; °C), dissolved oxygen (DO; mg/L), conductivity, pH, and secchi depth (m). N/A-data not available.

Date	Temp (°C)	DO (mg/L)	Conductivity	pH	Secchi Depth (m)
6/22/2005	19.5	8.9	369	9.92	1.75
7/13/2005	22.8	10.4	395	10.09	1.85
8/22/2005	25.0	12.5	421	8.77	N/A
9/7/2005	21.5	11.4	439	8.85	2.05
10/12/2005	15.8	11.3	489	8.77	2.05
5/25/2006	20.7	13.8	373	9.09	1.00
6/6/2006	23.8	13.2	190	N/A	0.85
6/20/2006	21.1	9.7	N/A	N/A	0.93
7/6/2006	23.8	8.5	329	8.53	0.81
7/18/2006	24.8	12.4	344	8.85	0.76
10/12/2006	14.8	8.1	321	8.89	1.45
6/25/2007	22.5	7.4	340	8.67	1.59
7/9/2007	25.2	8.0	344	8.88	1.30
7/23/2007	26.0	12.2	353	8.97	1.25
8/7/2007	24.1	6.9	405	8.50	1.68
8/20/2007	24.2	7.2	412	8.55	1.40
6/18/2008	21.0	10.7	241	8.88	1.28
7/2/2008	N/A	N/A	N/A	N/A	1.65
7/16/2008	23.4	10.5	389	9.00	1.08
7/30/2008	23.7	8.7	419	8.77	1.24
8/13/2008	23.8	10.1	442	8.81	1.32

Table 5. Surface means of water quality parameters measured at Hayden Lake during the summers of 2005-2008, temperature (Temp; °C), dissolved oxygen (DO; mg/L), conductivity, pH, and secchi depth (m). N/A-data not available.

Date	Temp (°C)	DO (mg/L)	Conductivity	pH	Secchi Depth (m)
7/19/2005	22.5	8.1	52	9.12	8.50
8/11/2005	24.3	N/A	52	9.20	6.05
9/1/2005	21.5	8.0	52	7.97	6.50
9/17/2005	17.7	8.3	52	7.92	N/A
5/16/2006	17.1	9.7	51	7.81	5.85
5/31/2006	17.9	8.9	52	8.04	5.18
6/13/2006	18.4	8.0	N/A	N/A	5.53
6/27/2006	23.4	7.3	50	7.68	6.47
7/11/2006	23.3	6.9	49	7.86	6.67
8/2/2006	22.7	6.7	49	8.01	5.53
10/17/2006	14.1	8.6	49	8.56	7.83
6/5/2007	23.1	6.2	49	7.77	6.50
7/1/2007	20.5	7.3	48	7.76	N/A
7/18/2007	24.1	7.5	38	7.69	7.59
7/30/2007	24.3	6.7	48	7.65	5.80
8/14/2007	23.1	6.2	49	7.77	6.46
8/28/2007	20.8	6.6	49	8.08	9.29
9/11/2007	20.5	6.9	49	7.97	7.74
6/24/2008	16.9	7.0	42	7.85	6.35
7/8/2008	21.9	7.7	59	8.04	7.38
7/22/2008	21.8	7.4	60	8.19	6.68
8/5/2008	23.0	7.5	61	8.11	6.08
8/18/2008	23.6	7.1	62	8.16	6.00
10/9/2008	14.9	8.3	61	8.39	6.33

Table 6. Surface means of water quality parameters measured at Mann Creek Reservoir during the summers of 2005-2008, including: temperature (Temp; °C), dissolved oxygen (DO; mg/L), conductivity, pH, and secchi depth (m). N/A-data not available.

Date	Temp (°C)	DO (mg/L)	Conductivity	pH	Secchi Depth (m)
6/29/2005	25.4	12.3	96	10.78	1.25
7/20/2005	25.9	N/A	84	10.13	1.90
8/9/2005	20.4	9.0	79	8.83	0.85
8/30/2005	19.5	7.9	77	8.80	5.50
5/17/2006	28.1	7.7	89	8.29	2.50
6/1/2006	21.9	9.1	92	8.80	1.15
6/14/2006	19.1	7.6			1.45
6/28/2006	27.4	7.7	85	8.67	1.25
7/10/2006	25.0	7.4	9	81.80	1.25
7/17/2007	25.9	7.8	78	8.94	1.66
7/31/2007	25.2	7.6	74	9.05	1.30
8/15/2007	24.5	8.1	72	8.95	0.80
8/29/2007	23.8	6.9	68	8.70	1.40
9/12/2007	20.6	6.2	67	8.52	1.00
7/9/2008	25.7	7.7	90	9.05	1.34
7/23/2008	22.9	7.8	89	8.90	1.10
8/6/2008	26.1	10.8	93	9.37	0.09
8/19/2008	23.6	7.3	90	9.47	0.61
8/6/2008	26.1	10.8	93	9.37	N/A
8/19/2008	23.6	7.3	90	9.47	N/A

Table 7. Mean biomass (g/m) of zooplankton collected with three different mesh size nets (153, 500, and 750 µm) and the Zooplankton Ratio (ZPR; 750 µm /500 µm) and Zooplankton Quality Index (ZQI; (500 µm + 700 µm)*ZPR) at different sample sites from Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir sampled during the summer of 2005.

			Mean biomass (g/m)				
Water	**Date**	**Sample Site**	**153 µm**	**500 µm**	**750 µm**	**ZPR**	**ZQI**
Brownlee	6/21/2005	BR LIM 3	3.42	3.30	1.75	0.53	2.68
Reservoir	7/12/2005	BR LIM 1	ND[a]	9.13	9.03	0.99	17.96
	7/28/2005	BR LIM 3	ND[a]	4.96	2.98	0.60	4.77
		BR LIM 1	2.15	1.40	0.93	0.66	1.55
	8/15/2005	BR LIM 1	ND[a]	10.90	5.71	0.52	8.70
		BR LIM 3	ND[a]	5.35	4.47	0.84	8.20
	9/6/2005	BR LIM 1	ND[a]	12.37	11.42	0.92	21.96
		BR LIM 3	15.35	9.86	11.43	1.16	24.68
	10/5/2005	BR LIM 3	ND[a]	0.30	0.18	0.60	0.29
C. J. Strike	6/16/2005	CJ LIM 3	7.83	2.67	2.40	0.90	4.56
Reservoir	6/22/2005	CJ LIM 3	15.50	8.91	6.80	0.76	11.99
	7/13/2005	CJ LIM 3	5.46	2.38	1.31	0.55	2.03
	8/2/2005	CJ LIM 3	ND[a]	ND[a]	7.85	ND[b]	ND[b]
	8/22/2005	CJ LIM 3	ND[a]	3.80	3.47	0.91	6.64
	9/7/2005	CJ LIM 3	ND[a]	0.65	0.46	0.71	0.79
	10/12/2005	CJ LIM 3	ND[a]	0.94	0.42	0.45	0.61
Hayden Lake	7/19/2005	HYLIM 1	2.36	1.20	1.09	0.91	2.08
		HYLIM 2	1.50	1.11	0.77	0.69	1.30
	8/11/2005	HYLIM 1	0.59	0.40	0.12	0.30	0.16
		HYLIM 2	0.60	0.34	0.16	0.47	0.24
	9/1/2005	HYLIM 1	0.40	0.17	0.02	0.12	0.02
		HYLIM 2	0.77	0.52	0.31	0.60	0.49
	9/21/2005	HYLIM 1	0.63	0.55	0.20	0.36	0.27
		HYLIM 2	1.30	0.79	0.41	0.52	0.62
Mann Creek	7/21/2005	MNLIM 1	4.82	1.98	0.02	0.01	0.02
Reservoir	8/9/2005	MNLIM 1	16.40	4.25	0.30	0.07	0.32
	8/30/2005	MNLIM 1	6.20	1.12	0.41	0.37	0.56
	9/13/2005	MNLIM 1	7.00	0.90	0.10	0.11	0.11

[a] No data. Samples not preserved.
[b] No data. Unable to calculate.

Table 8. Mean biomass (g/m) of zooplankton collected with three different mesh size nets (153, 500, and 750 µm) and the Zooplankton Ratio (ZPR; 750 µm /500 µm) and Zooplankton Quality Index (ZQI; (500 µm + 700 µm)*ZPR) at different sample sites from Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir sampled during the summer of 2006.

			Mean biomass (g/m)				
Water	**Date**	**Sample Site**	**153 µm**	**500 µm**	**750 µm**	**ZPR**	**ZQI**
Brownlee Reservoir	5/24/2006	BR LIM 3	4.76	0.51	0.33	0.65	0.54
	6/5/2006	BR LIM 3	15.19	14.6	17.81	1.22	39.54
	6/19/2006	BR LIM 1	6.56	6.82	12.40	1.82	34.95
	7/5/2006	BR LIM 3	21.23	15.12	9.29	0.61	15.00
		BR LIM 1	2.82	0.48	0.13	0.27	0.17
	7/17/2006	BR LIM 3	28.88	30.05	26.21	0.87	49.07
		BR LIM 1	43.74	31.65	11.37	0.36	15.45
	7/31/2006	BR LIM 3	18.13	16.11	35.32	2.19	112.76
		BR LIM 1	0.83	0.13	0.06	0.46	0.09
	8/24/2006	BR LIM 3	10.96	4.81	5.40	1.12	11.46
		BR LIM 1	3.78	0.10	0.06	0.60	0.10
	10/4/2006	BR LIM 1	17.15	0.03	0.02	0.67	0.03
C. J. Strike Reservoir	5/25/2006	CJ LIM 3	8.68	1.02	1.20	1.18	2.61
	6/6/2006	CJ LIM 3	21.13	10.71	8.26	0.77	14.63
		CJ LIM 1	6.50	2.57	2.40	0.93	4.64
		CJ LIM 2	2.27	0.33	0.31	0.94	0.60
	6/20/2006	CJ LIM 3	7.80	3.43	2.69	0.78	4.80
		CJ LIM 1	16.19	19.81	8.49	0.43	12.13
		CJ LIM 2	5.90	0.15	0.20	1.33	0.47
	7/6/2006	CJ LIM 3	18.5	1.84	1.22	0.66	2.03
		CJ LIM 1	15.07	5.27	5.09	0.97	10.01
		CJ LIM 2	2.70	3.31	2.60	0.79	4.64
	7/18/2006	CJ LIM 3	8.89	0.35	0.21	0.60	0.34
		CJ LIM 1	16.67	12.8	5.57	0.44	7.99
		CJ LIM 2	1.35	0.26	0.32	1.23	0.71
	10/12/2006	CJ LIM 3	16.30	5.17	5.20	1.01	10.43
		CJ LIM 1	9.75	3.15	2.15	0.68	3.62
		CJ LIM 2	6.01	0.04	0.02	0.50	0.03
Hayden Lake	5/16/2006	HYLIM 1	0.59	0.07	0.09	1.29	0.21
		HYLIM 2	0.80	0.04	0.01	0.25	0.01
		HYLIM 3	0.85	0.12	0.34	2.83	1.30
	5/31/2006	HYLIM 1	0.97	0.32	0.01	0.03	0.01
		HYLIM 2	0.42	0.02	0.01	0.50	0.02
	6/13/2006	HYLIM 1	2.37	0.08	0.01	0.13	0.01
		HYLIM 2	1.61	0.22	0.07	0.32	0.09
		HYLIM 3	0.94	0.05	0.01	0.20	0.01
	6/27/2006	HYLIM 1	2.67	1.70	1.06	0.62	1.72
		HYLIM 2	1.48	0.28	0.10	0.36	0.14
		HYLIM 3	0.65	1.50	3.52	2.35	11.78
	7/11/2006	HYLIM 1	0.78	0.46	0.32	0.70	0.54
		HYLIM 2	1.52	1.33	0.61	0.46	0.89
		HYLIM 3	2.09	2.16	1.47	0.68	2.47
	8/2/2006	HYLIM 1	0.41	0.35	0.18	0.51	0.27
		HYLIM 2	1.74	1.20	0.91	0.76	1.60
		HYLIM 3	4.44	4.58	2.40	0.52	3.66

Table 8. Continued.

Water	Date	Sample Site	Mean biomass (g/m)			ZPR	ZQI
			153 µm	500 µm	750 µm		
Mann Creek Reservoir	5/17/2006	MNLIM 1	10.58	7.52	5.92	0.79	10.58
	6/1/2006	MNLIM 1	2.97	0.84	0.09	0.11	0.10
	6/14/2006	MNLIM 1	4.97	2.46	0.46	0.19	0.55
	6/28/2006	MNLIM 1	7.25	6.05	0.89	0.15	1.02
	7/10/2006	MNLIM 1	4.04	1.42	0.27	0.19	0.32

Table 9. Mean biomass (g/m) of zooplankton collected with three different mesh size nets (153, 500, and 750 µm) and the Zooplankton Ratio (ZPR; 750 µm /500 µm) and Zooplankton Quality Index (ZQI; (500 µm + 700 µm)*ZPR) at different sample sites from Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir sampled during the summer of 2007.

			Mean biomass (g/m)				
Water	**Date**	**Sample Site**	**153 µm**	**500 µm**	**750 µm**	**ZPR**	**ZQI**
Brownlee Reservoir	5/31/2007	BRLIM3	6.09	6.19	4.78	0.77	8.46
	6/12/2007	BRLIM3	1.98	1.05	1.39	1.33	3.24
	6/26/2007	BRLIM3	0.50	0.27	0.21	0.78	0.38
	7/10/2007	BRLIM3	0.64	0.47	0.72	1.53	1.82
	7/24/2007	BRLIM3	0.98	0.51	0.37	0.73	0.64
	8/8/2007	BRLIM1	0.44	0.18	0.00	0.01	0.00
		BRLIM2	0.23	0.06	0.01	0.12	0.01
		BRLIM3	0.57	0.49	0.27	0.55	0.42
	8/21/2007	BRLIM1	0.09	0.02	0.01	0.31	0.01
		BRLIM3	1.53	1.23	0.78	0.64	1.28
C. J. Strike Reservoir	6/25/2007	CJLIM1	0.43	0.28	0.23	0.83	0.42
		CJLIM2	0.16	0.07	0.04	0.52	0.06
	7/9/2007	CJLIM1	0.18	0.22	0.04	0.20	0.05
		CJLIM2	0.58	0.18	0.16	0.90	0.31
	7/23/2007	CJLIM1	0.60	0.28	0.14	0.51	0.22
		CJLIM2	0.16	0.10	0.00	0.00	0.00
	8/7/2007	CJLIM1	1.44	0.72	0.22	0.31	0.29
		CJLIM2	0.53	0.10	0.05	0.52	0.08
		CJLIM3	1.28	0.89	0.00	0.00	0.00
	8/20/2007	CJLIM1	4.55	0.95	0.01	0.01	0.01
		CJLIM2	0.64	0.17	0.00	0.00	0.00
		CJLIM3	1.33	0.41	0.12	0.30	0.16
Hayden Lake	7/1/2007	HYLIM2	0.24	0.11	0.03	0.23	0.03
	7/18/2007	HYLIM1	0.09	0.06	0.01	0.16	0.01
		HYLIM2	0.03	0.05	0.03	0.65	0.05
		HYLIM3	0.10	0.07	0.05	0.71	0.08
	7/30/2007	HYLIM3	0.13	0.06	0.10	1.69	0.28
	8/14/2007	HYLIM1	0.18	0.15	0.06	0.38	0.08
		HYLIM2	0.07	0.05	0.04	0.86	0.08
		HYLIM3	0.13	0.01	0.01	1.30	0.03
	8/28/2007	HYLIM1	0.05	0.01	0.01	0.69	0.02
		HYLIM2	0.07	0.04	0.01	0.18	0.01
		HYLIM3	0.09	0.04	0.00	0.05	0.00
	9/11/2007	HYLIM1	0.03	0.01	0.00	0.80	0.01
		HYLIM2	0.02	0.01	0.01	1.71	0.03
		HYLIM3	0.11	0.06	0.03	0.58	0.05
Mann Creek Reservoir	7/17/2007	MNLIM	0.19	0.05	0.01	0.12	0.01
	7/31/2007	MNLIM	0.26	0.05	0.00	0.08	0.00
	8/15/2007	MNLIM	0.18	0.09	0.04	0.40	0.05
	8/29/2007	MNLIM	0.71	0.15	0.02	0.15	0.03
	9/12/2007	MNLIM	0.18	0.09	0.05	0.52	0.07

Table 10. Mean biomass (g/m) of zooplankton collected with three different mesh size nets (153, 500, and 750 µm) and the Zooplankton Ratio (ZPR; 750 µm /500 µm) and Zooplankton Quality Index (ZQI; (500 µm + 700 µm)*ZPR) at different sample sites from Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir sampled during the summer of 2008.

			Mean biomass (g/m)				
Water	**Date**	**Sample Site**	**153 µm**	**500 µm**	**750 µm**	**ZPR**	**ZQI**
Brownlee Reservoir	7/1/2008	BRLIM1	5.05	1.78	0.75	0.42	1.07
		BRLIM2	0.87	0.22	0.08	0.37	0.11
		BRLIM3	1.59	0.26	0.25	0.96	0.49
	7/15/2008	BRLIM1	3.14	2.65	0.44	0.17	0.51
		BRLIM2	0.34	0.08	0.03	0.41	0.04
		BRLIM3	0.91	0.37	0.20	0.55	0.31
	7/29/2008	BRLIM1	2.14	0.72	0.05	0.07	0.06
		BRLIM2	1.17	0.29	0.06	0.23	0.08
		BRLIM3	1.11	0.18	0.08	0.42	0.11
	8/12/2008	BRLIM1	0.13	0.09	0.02	0.18	0.02
		BRLIM2	0.86	0.34	0.09	0.26	0.11
		BRLIM3	2.23	0.82	0.29	0.36	0.39
C. J. Strike Reservoir	6/5/2008	CJLIM3	1.14	0.20	0.08	0.39	0.11
	6/18/2008	CJLIM1	0.63	0.29	0.22	0.76	0.38
		CJLIM3	2.07	1.48	0.76	0.51	1.15
	7/2/2008	CJLIM1	0.41	0.23	0.15	0.65	0.25
		CJLIM2	0.78	0.41	0.51	1.24	1.15
		CJLIM3	2.49	2.66	1.60	0.60	2.57
	7/16/2008	CJLIM1	1.65	0.12	0.17	1.39	0.41
		CJLIM2	0.76	0.28	0.34	1.21	0.76
		CJLIM3	1.67	1.29	0.94	0.73	1.62
	7/30/2008	CJLIM1	2.48	0.14	0.18	1.29	0.41
		CJLIM2	0.95	0.04	0.04	0.93	0.08
		CJLIM3	0.86	0.15	0.25	1.64	0.65
	8/13/2008	CJLIM1	0.96	0.28	0.13	0.46	0.19
		CJLIM2	0.53	0.04	0.02	0.59	0.04
		CJLIM3	1.31	0.69	0.33	0.48	0.49
Hayden Lake	6/10/2008	HYLIM1	0.04	0.04	0.00	0.03	0.00
	6/24/2008	HYLIM1	0.21	0.06	0.01	0.15	0.01
		HYLIM2	0.09	0.01	0.00	0.31	0.01
		HYLIM3	0.09	0.01	0.00	0.20	0.00
	7/8/2008	HYLIM1	0.37	0.22	0.06	0.25	0.07
		HYLIM2	0.06	0.02	0.01	0.45	0.01
		HYLIM3	0.08	0.05	0.03	0.67	0.06
	7/22/2008	HYLIM1	0.03	0.01	0.00	0.33	0.01
		HYLIM2	0.08	0.01	0.01	0.62	0.01
		HYLIM3	0.04	0.01	0.01	0.62	0.01
	8/5/2008	HYLIM1	0.12	0.05	0.04	0.70	0.06
		HYLIM2	0.04	0.00	0.00	0.00	0.00
		HYLIM3	0.05	0.00	0.00	0.00	0.00
	8/18/2008	HYLIM1	0.00	0.02	0.00	0.00	0.00
		HYLIM2	0.07	0.00	0.00	0.00	0.00
		HYLIM3	0.00	0.00	0.00	0.00	0.00
	10/9/2008	HYLIM1	0.03	0.00	0.00	0.00	0.00
		HYLIM2	0.03	0.00	0.00	0.00	0.00
		HYLIM3	0.03	0.00	0.00	0.00	0.00

Table 10. Continued.

Water	Date	Sample Site	Mean biomass (g/m) 153 µm	500 µm	750 µm	ZPR	ZQI
Mann Creek Reservoir	7/9/2008	MNLIM	0.57	0.38	0.36	0.95	0.70
	7/23/2008	MNLIM	0.03	0.01	0.01	1.10	0.02
	8/6/2008	MNLIM	0.09	0.04	0.00	0.00	0.00
	8/19/2008	MNLIM	0.10	0.06	0.00	0.02	0.00

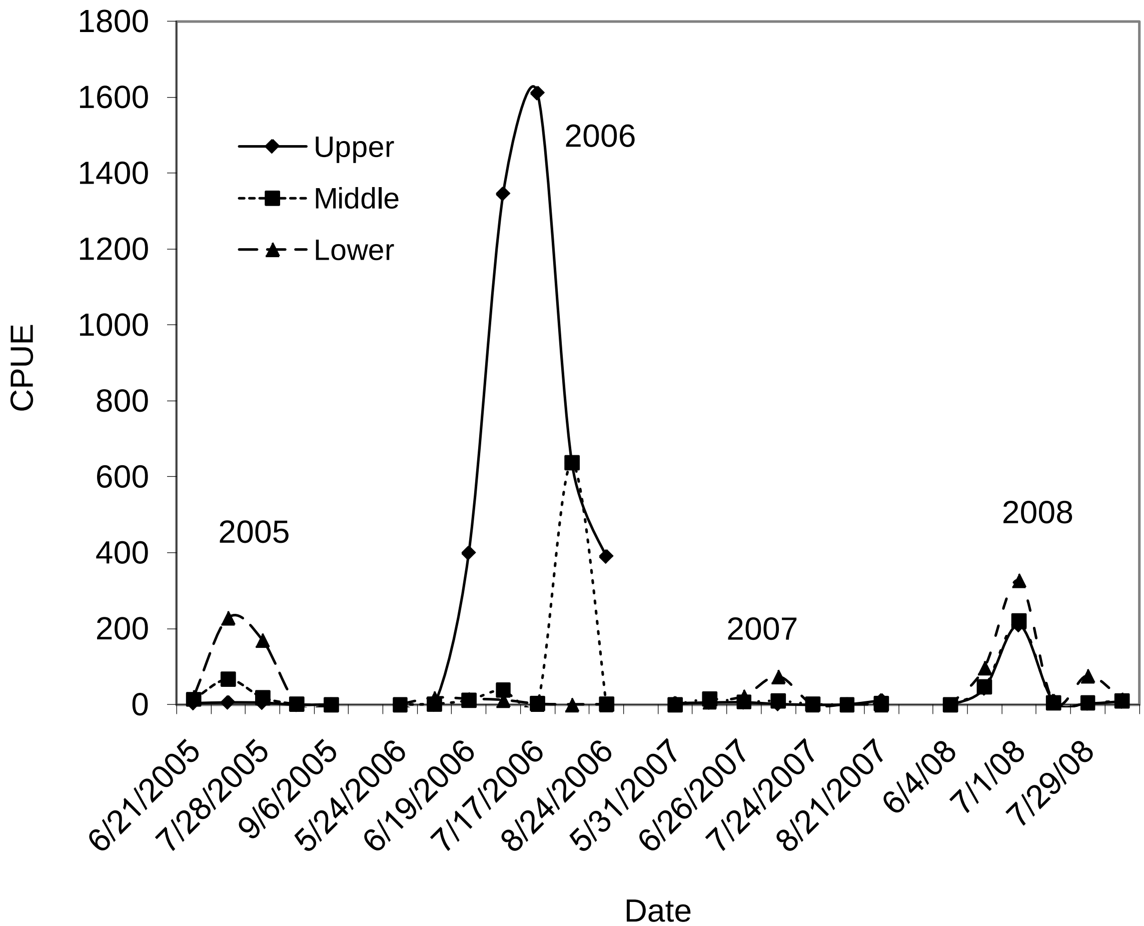

Figure 1. Estimated CPUE of larval crappie captured using neuston net trawls from three strata (Upper, Middle, and Lower) in Brownlee Reservoir for 2005-2008.

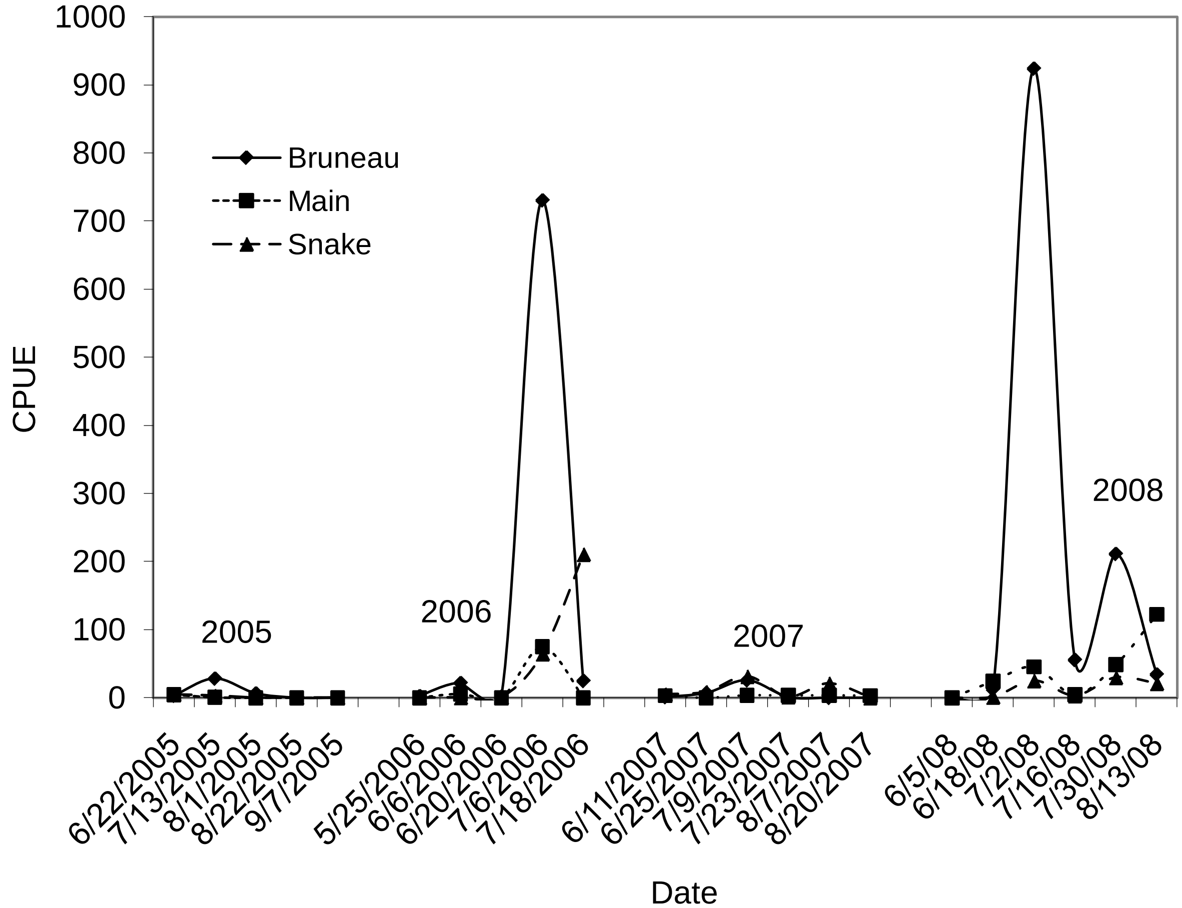

Figure 2. Estimated CPUE of larval crappie captured using neuston net trawls from three strata (Bruneau, Main, and Snake arms) in C. J. Strike Reservoir for 2005-2008.

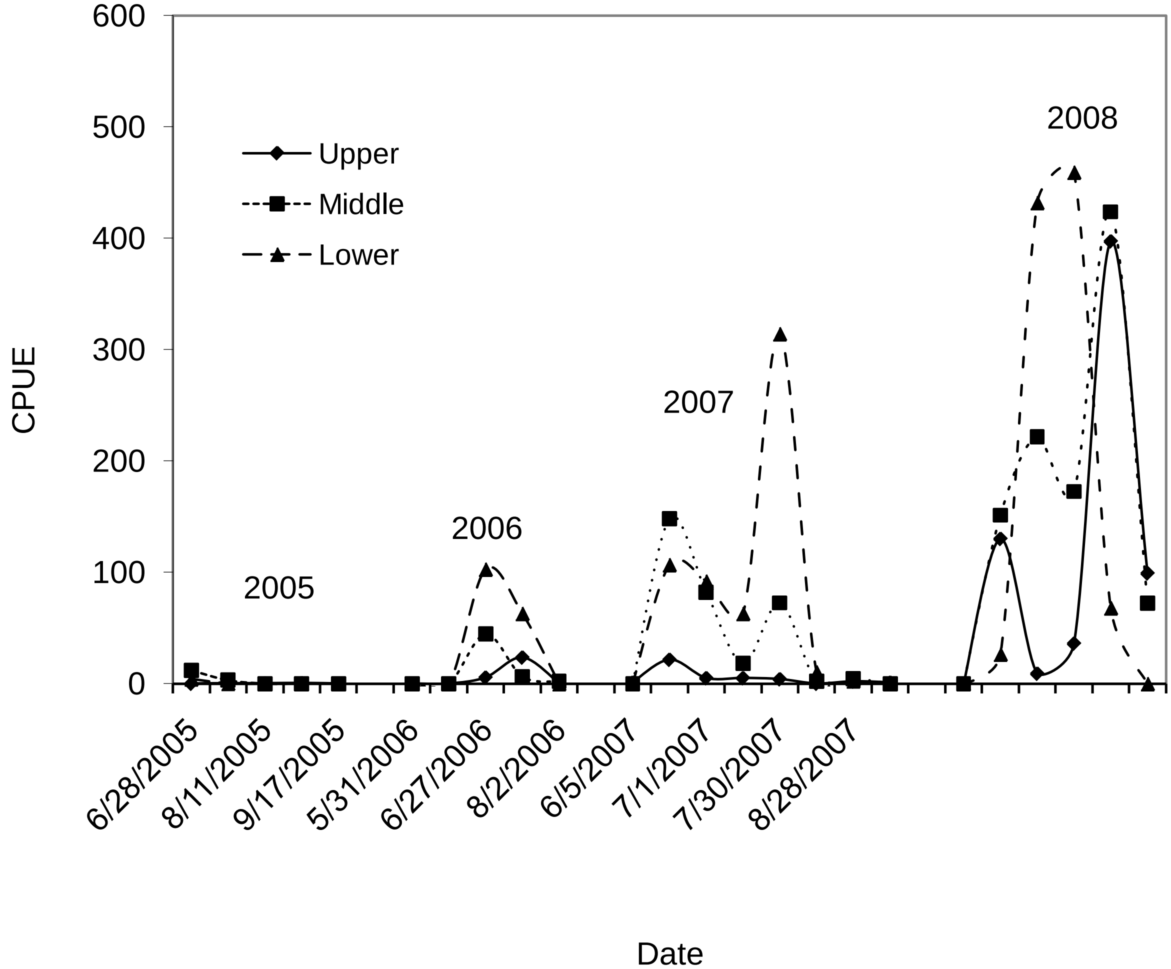

Figure 3. Estimated CPUE of larval crappie captured using neuston net trawls from three strata (Upper, Middle, and Lower) in Hayden Lake for 2005-2008.

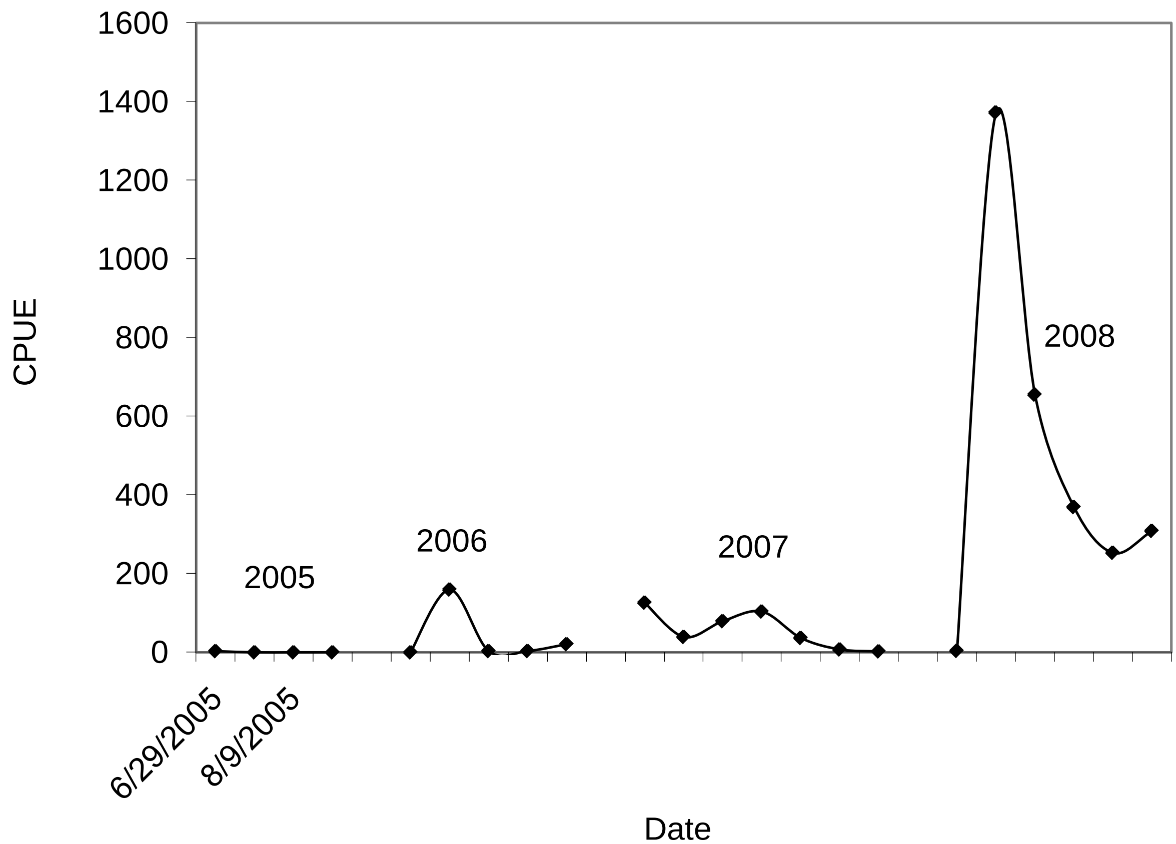

Figure 4. Estimated CPUE of larval crappie captured using neuston net trawls in Mann Creek Reservoir for 2005-2008.

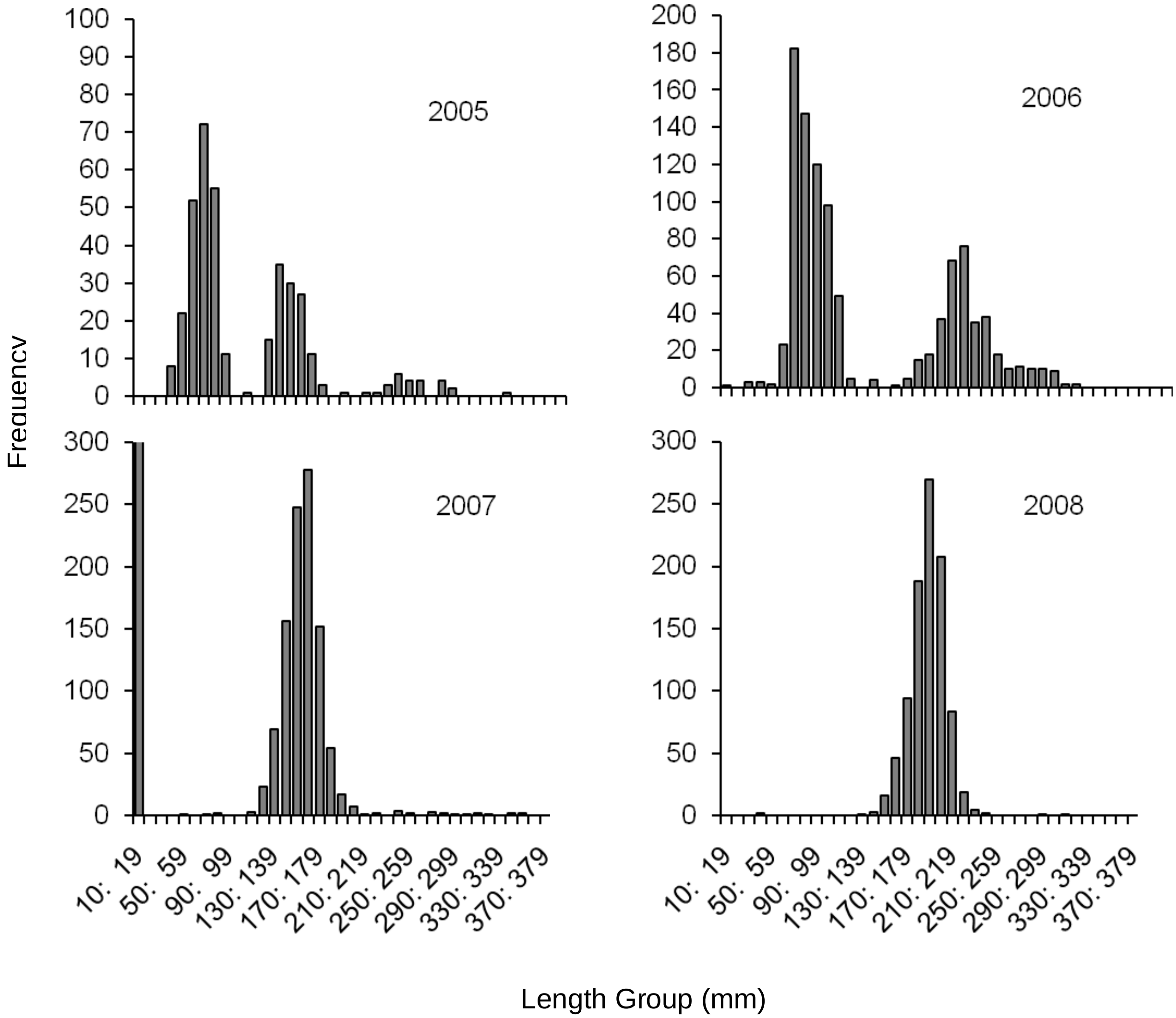

Figure 5. Length frequency histograms of crappie sampled from Brownlee Reservoir with electrofishing and trap nets in the fall of 2005-2008.

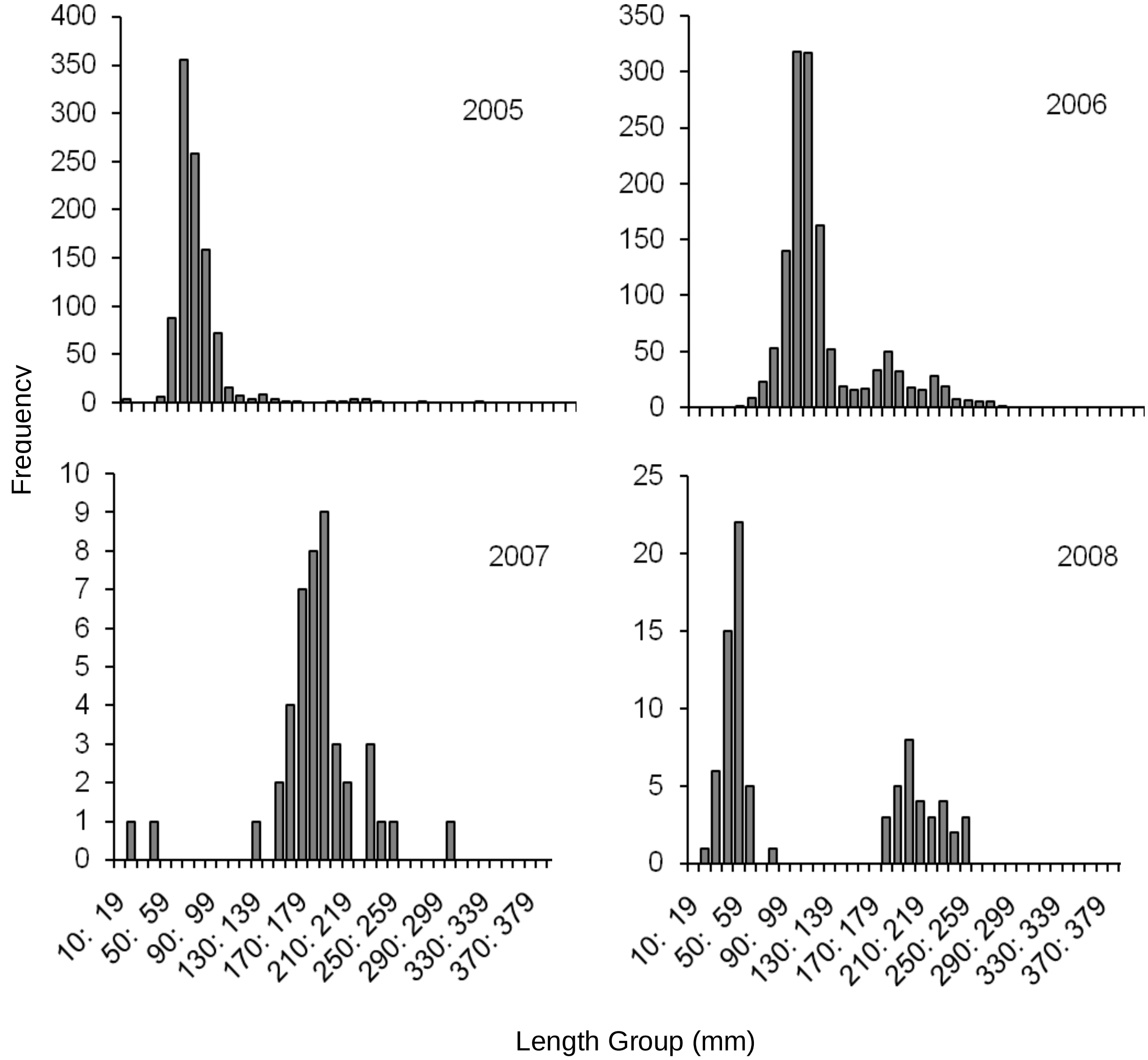

Figure 6. Length frequency histograms of crappie sampled from C. J. Strike Reservoir with electrofishing and trap nets in the fall of 2005-2008.

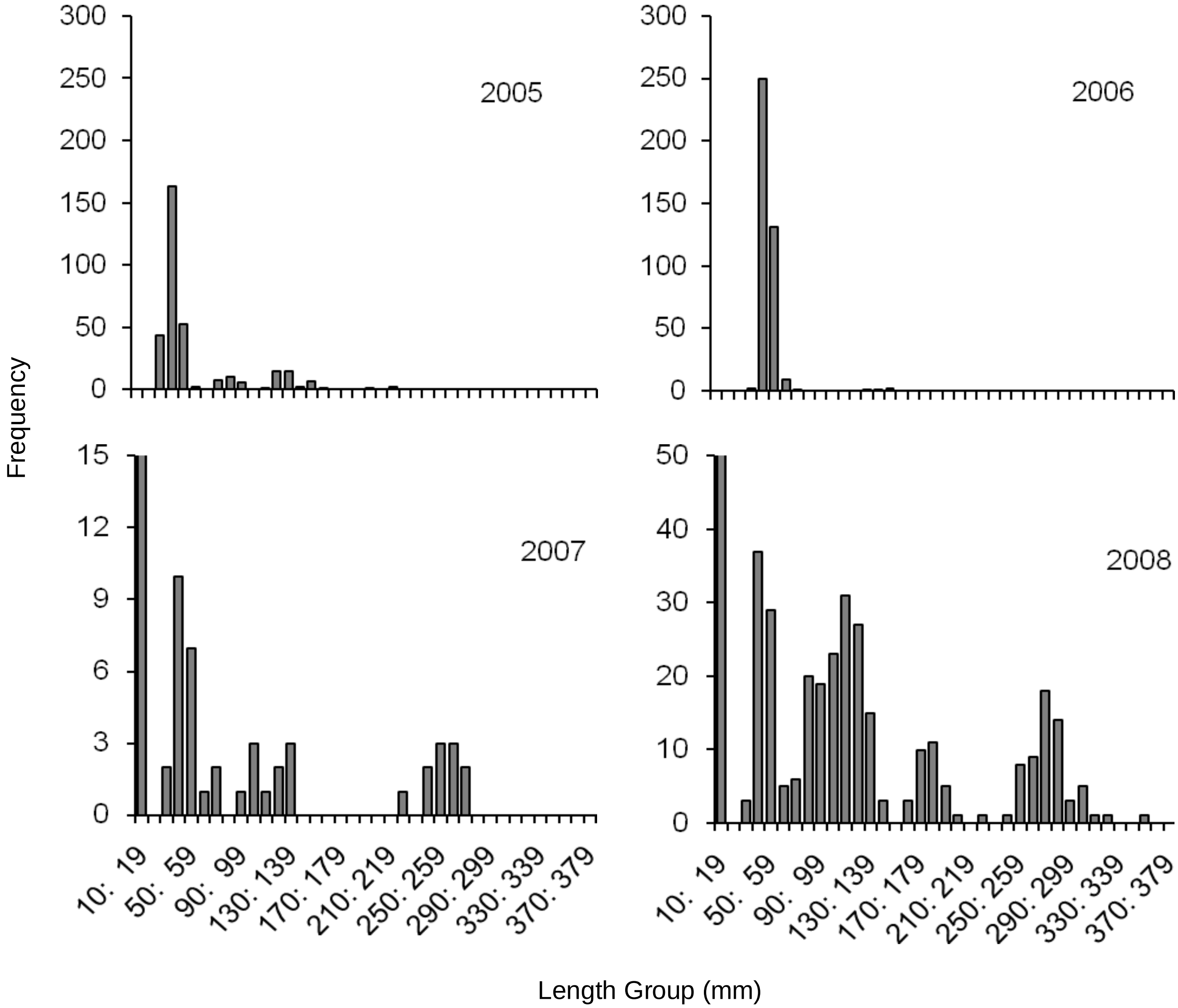

Figure 7. Length frequency histograms of crappie sampled from Hayden Lake with electrofishing and trap nets in the fall of 2005-2008. Note: Hayden Lake was not electrofished in 2006 because of a boat malfunction.

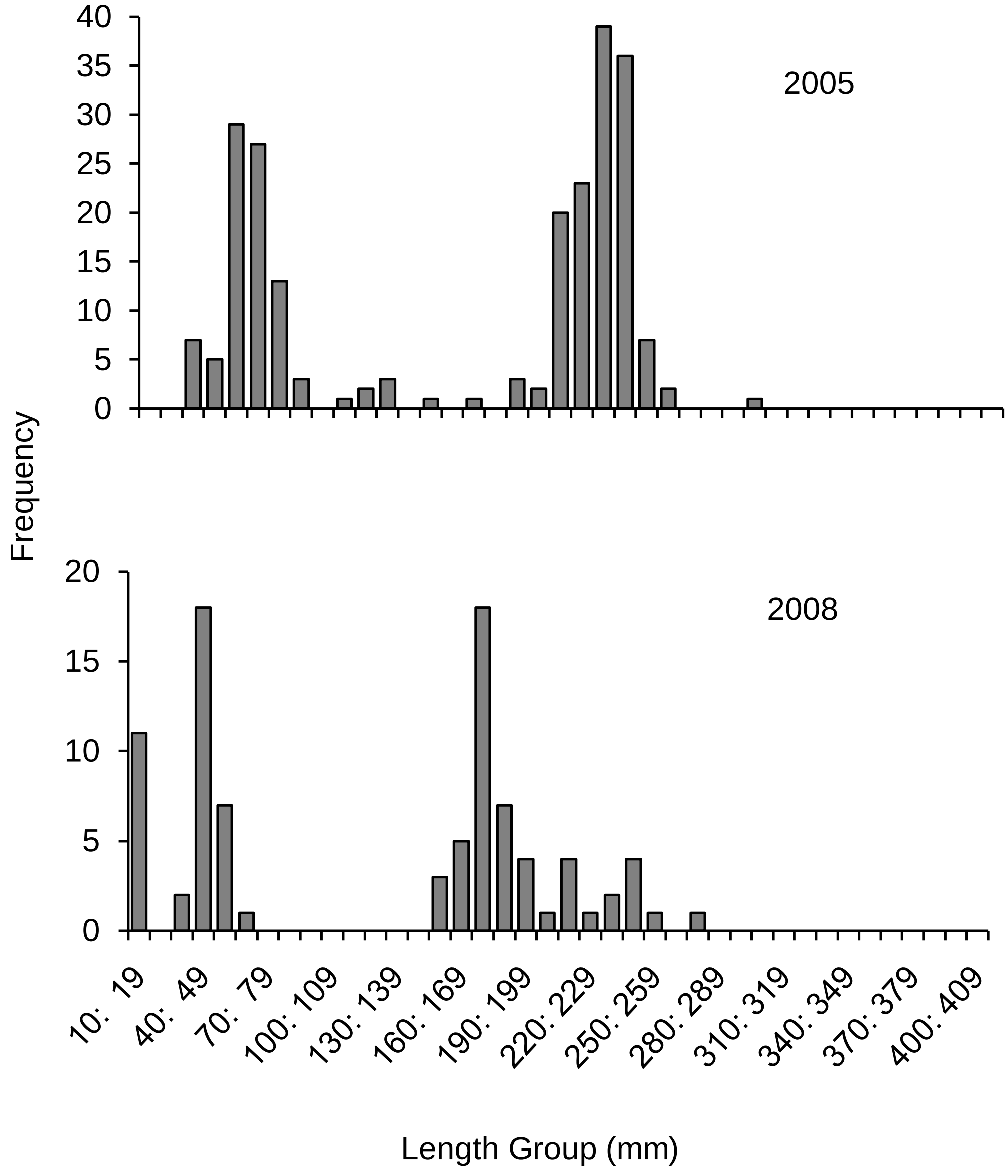

Figure 8. Length frequency histograms of crappie sampled from Mann Creek Reservoir with electrofishing and trap nets in the fall of 2008.

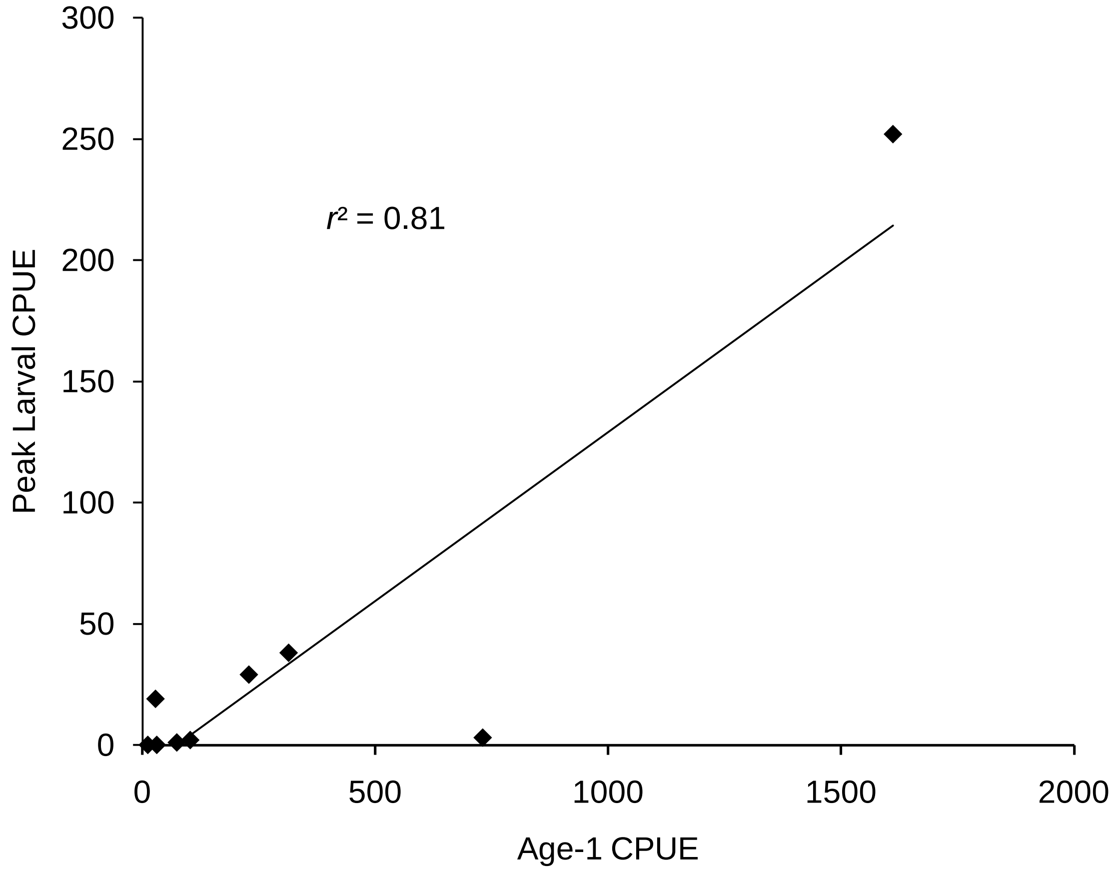

Figure 9. Regression comparison of peak larval crappie CPUE and the CPUE of the crappie cohort at age-1 sampled during the fall from Brownlee Reservoir, C. J. Strike Reservoir, and Hayden Lake for the years 2005-2008.

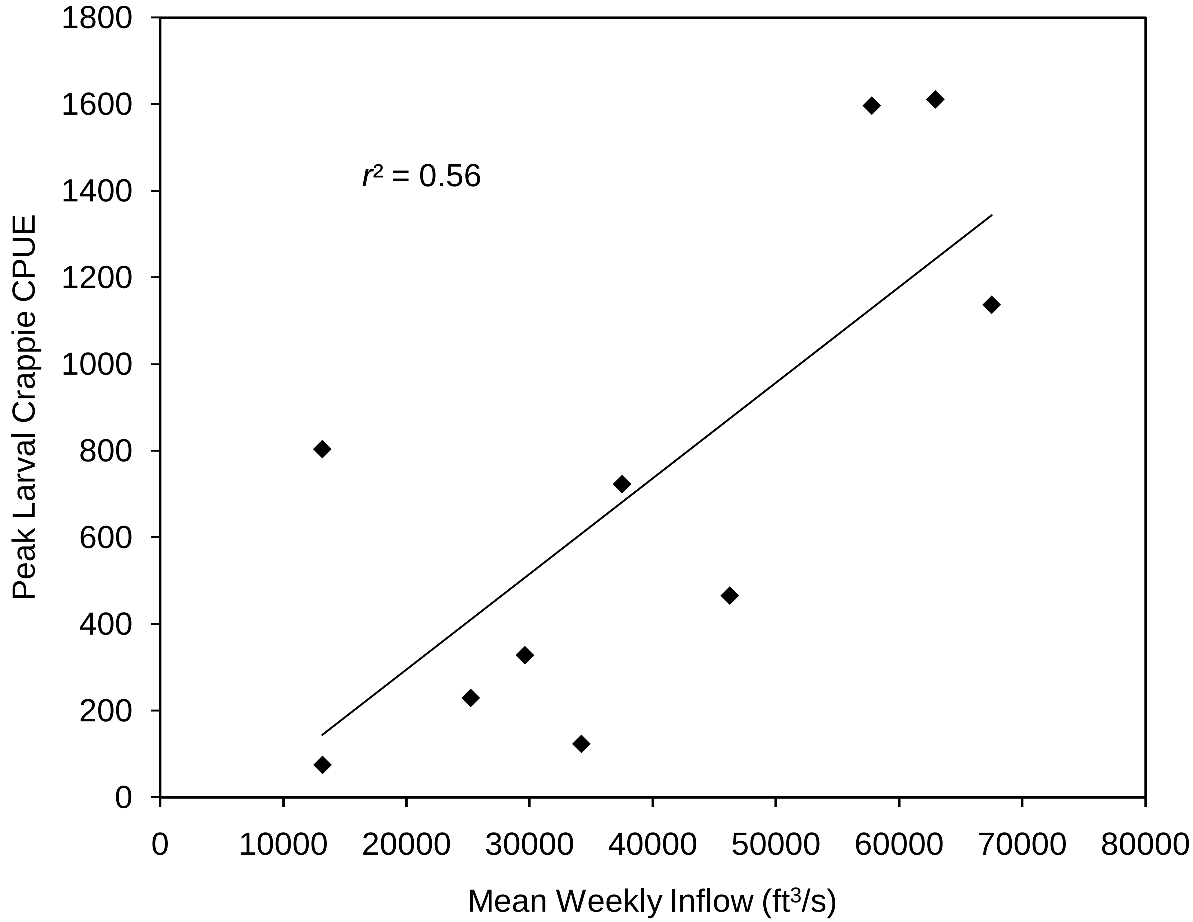

Figure 10. Regression comparison between peak larval crappie CPUE (data pooled from Idaho Power Company for the years 1994-1998 and from the Idaho Department of Fish and Game for the years 2005-2008) and mean peak inflow rates (ft^3/s) at Brownlee Reservoir.

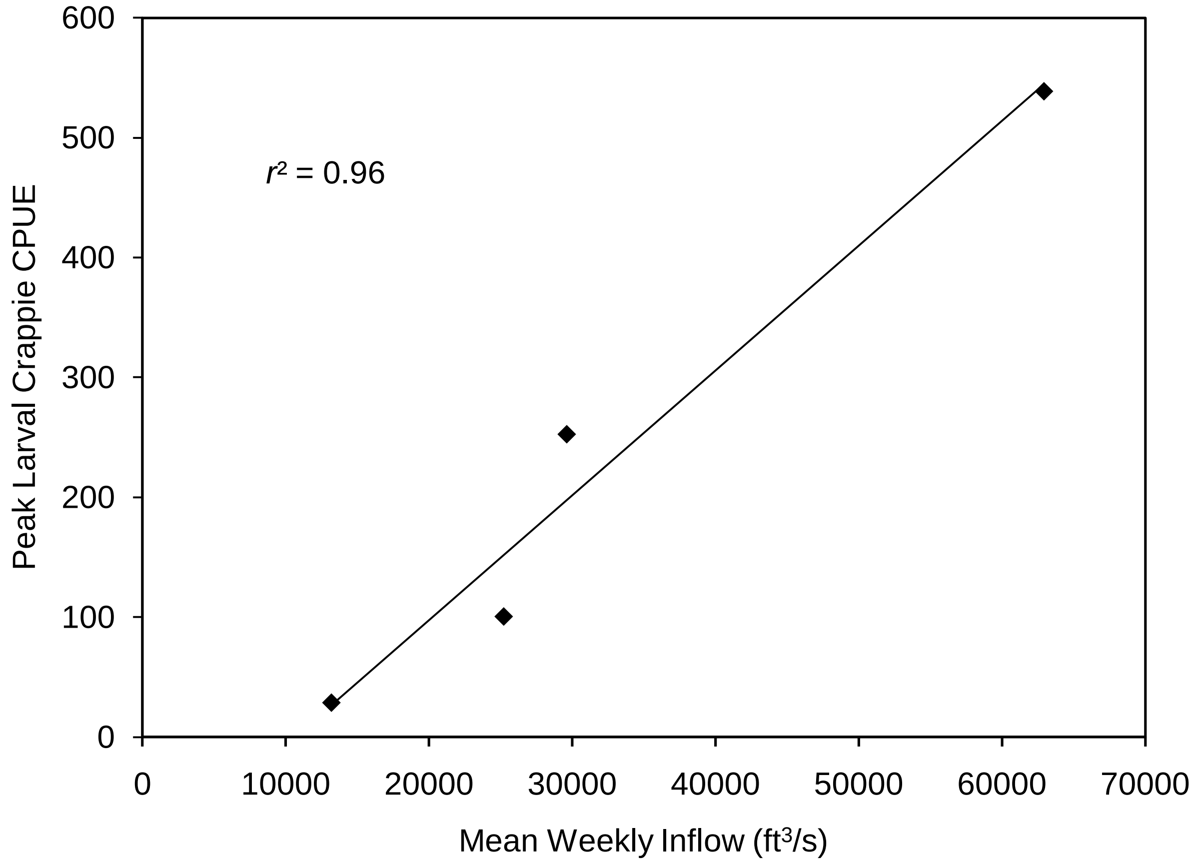

Figure 11. Regression comparison between peak larval crappie CPUE and mean peak inflow rates (ft^3/s) at Brownlee Reservoir collected by the Idaho Department of Fish and Game for the years 2005-2008.

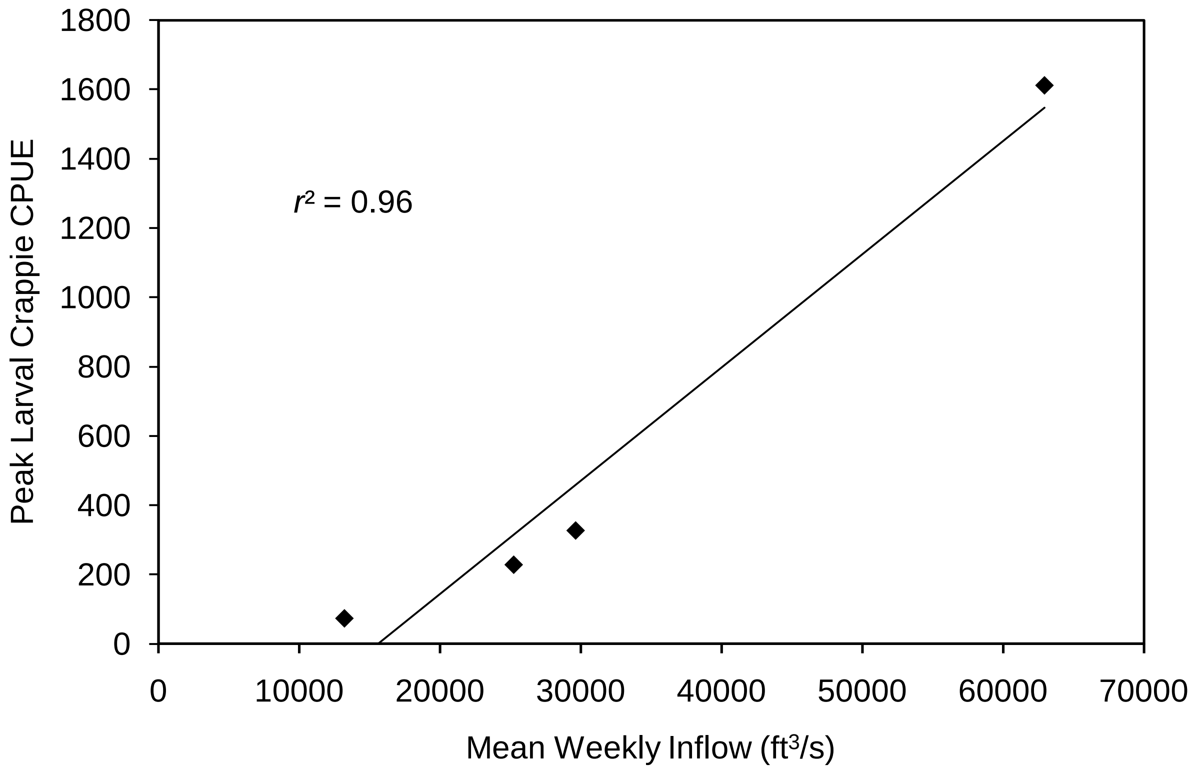

Figure 12. Regression comparison between peak larval crappie CPUE and mean peak inflow rates (ft^3/s) from the Snake River Arm of C. J. Strike Reservoir collected by the Idaho Department of Fish and Game for the years 2005-2008.

APPENDICES

Appendix A. Locations (UTM, NAD83, Zone 11), strata, and nomenclature of sites sampled by larval trawling and for water quality measurements in Brownlee Reservoir, C. J. Strike Reservoir, Hayden Lake, and Mann Creek Reservoir, Idaho for the years 2005-2008.

Water Body	**Strata**	**Larval Trawl Site**	**Water Quality Site**	**UTM Easting**	**UTM Northing**
Brownlee Reservoir	Upper	BL01	BR LIM 1	482909	4922286
		BL02		484003	4926717
		BL03		484575	4928341
		BL04		490802	4940607
	Middle	BL05	BR LIM 2	491672	4942248
		BL06		492384	4944880
		BL07		492969	4946345
		BL08		493909	4948181
	Lower	BL09		498598	4955528
		BL10		503455	4957931
		BL11		507404	4964524
			BR LIM 3	506283	4962798
C. J. Strike Reservoir	Bruneau Arm	CJ01		592019	4752101
		CL02	CJ LIM 1	590515	4752311
		CJ03		590226	4752872
		CJ04		590281	4752714
	Snake Arm	CJ05		584855	4754605
			CJ LIM 2	583871	4755376
		CJ06		585653	4755710
		CJ07		584046	4755832
	Main Pool	CJ08		584140	4758235
		CJ09		584357	4759244
		CJ10	CJ LIM 3	587220	4761523
Hayden Lake	Upper	HY03	HYLIM 1	522783	5293705
		HY04		522853	5293522
	Middle	HY05		523347	5291489
		HY06		524107	5290804
		HY07		523824	5291403
		HY08		522059	5290848
	Lower	HY09	HYLIM 2	522987	5288607
		HY10		523338	5289319
		HY11		521200	5289112
		HY12	HYLIM 3	518954	5289228
Mann Creek Reservoir	Only	MN01		511448	5135810
		MN02		511285	5135593
		MN03		511486	5135482
		MN04		511452	5135284
		MN05		511340	5135353
		MN06		511383	5135495
		MN07		511182	5135489
		MN08	MNLIM 1	511275	5135235
		MN09		511248	5135110
		MN10		511346	5135197

ANNUAL PERFORMANCE REPORT
SUBPROJECT 3: ANGLER EXPLOITATION EVALUATIONS

State of: Idaho | Grant No.: F-73-R-29 Fishery Research

Project No.: 5 | Title: Lake and Reservoir Research

Subproject #3: Angler Tag-reporting Evaluations

Contract Period: July 1, 2008 to June 30, 2009

ABSTRACT

From 2006 to 2008, we tagged and released 20,513 fish in 26 water bodies across Idaho to assess angler tag reporting rates and estimate angler exploitation. We used T-bar anchor tags using the high-reward tag method to estimate tag reporting rates, where tags with various dollar values ($0 to $200) were released, and the reporting rate was estimated as the relative return rate of non-reward tags to the return rate of high reward (≥$100) tags. Tagged fish primarily included crappie *Pomoxis spp.*, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, and hatchery and wild rainbow trout *Oncorhynchus mykiss*. Through February 10, 2009, 3,614 tags have been reported by anglers, with 3,526 of these reports containing enough information (i.e. disposition of the tag and fish) to include in our analyses. Non-reward reporting rate for species with multiple years of data was highest for crappie (mean = 0.65) and lowest for hatchery trout (mean = 0.46). There appeared to be no difference between $100 and $200 rewards regarding reporting rates. Site-specific angler tag reporting rates within one year of tag release varied from 19% for smallmouth bass at Cascade Reservoir in 2006 to essentially 100% for several sites, although estimates at some locations suffer from low sample size. Tag loss, estimated by double tagging a large proportion of fish, was lowest for crappie (2.5 ± 0.8%) and highest for walleye *Stizostedion vitreum* (11.9 ± 3.7%). Correcting annual exploitation for tag reporting rates, tag loss, and tagging mortality (assumed to be <5% based on preliminary results) resulted in estimates of exploitation ranging from less than 5% to over 50%. On average, exploitation was highest for crappie (30%) and smallmouth bass (26%) and lowest and most variable for wild trout (10%, range 2-27%) and hatchery trout (18%, range 5-53%). Our results suggest that anglers report about half the Floy tags they encounter and that reporting rates are higher for species with higher exploitation.

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INTRODUCTION

Angler exploitation can have an important influence on the structure of sport fish communities through effects on recruitment, mortality, and growth. Even when it is considered negligible, knowing the exploitation rate of a fishery is often useful for fishery managers to address public concerns and to track changes over time. However, estimating exploitation can be extremely difficult and labor intensive (Miranda et al. 2002). Furthermore, techniques to estimate exploitation include numerous assumptions that, when violated, render a great deal of uncertainty to estimates.

The most common technique for estimating exploitation consists of releasing a known number of marked fish with tags and relying on angler tag returns to estimate the proportion harvested. This method requires that the actual tag reporting rate be estimated, which can be problematic because the number of tags encountered by anglers and not reported is typically unknown. Thus, the willingness of an angler to report a tag from a harvested fish is often the most important facet of an exploitation study, although it is generally the variable with the highest uncertainty.

There are a number of methods to estimate tag reporting rates, including: 1) estimating the reporting rate from tagging data alone when natural mortality is assumed to be constant (Youngs 1974; Hoenig et al. 1998); 2) using high-reward tagging programs (Pollock et al. 2001); 3) surreptitiously planting tags into the creel of anglers (Green et al. 1983); and 4) using angler surveys (Pollock et al. 1991). Estimating reporting rates solely from tagging data generally yields imprecise estimates and requires multiple years or more than one tagging event each year (Hearn et al. 1998; Pollock et al. 2001). Using the planted tag method, where tags are secretly planted in fish while creel clerks examine the creel, is problematic because of the need for secrecy, which may cause situations of confusion, distrust, or other biases among recreational anglers. Angler surveys, where a clerk monitors angler creel at an access point, often require a great deal of sampling effort to encounter tags, and anglers may assume that a tag has already been reported after the creel was examined, thus biasing reporting rate estimates.

Perhaps the most accurate method of estimating angler reporting rate is the use of a high-reward tag program, where both non-reward and high reward tags are released, and the reporting rate is estimated as the relative recovery rate of non-reward tags to that of high reward tags (Nichols et al. 1991; Pollock et al. 2001). The primary assumption of the high-reward methodology is that the high reward achieves 100% return rates for the high reward tags. Numerous investigations, conducted over a broad spectrum of species, systems, and geographic ranges, have estimated the reward amount needed to elicit a 100% response rate (Conroy and Blandin 1984; Weaver and England 1986; Eder 1990; Haas 1990; Murphy and Taylor 1991; Nichols et al. 1991; Jenkins et al. 2000; Schultz and Robinson 2002). However, nearly all of these studies have some type of inherent limitations, such as small sample sizes, incorrectly assuming the high-reward tags achieved a 100% return rate, or violations of other assumptions. In addition, many studies used various combinations of either nonmonetary rewards (e.g., hats, shirts, patches, beer) or lottery-type programs where one or more large rewards were randomly chosen at the end of the study from all the tags that were reported, while the remaining tags received either no reward or a minimal value reward. While there is evidence that these types of reward programs may increase the tag reporting rate, it is difficult to assess the degree that return rates increased. Numerous other reasons to avoid lottery type programs or nonmonetary reward programs can be found in Pollock et al. (2001).

Tag return rates reported within the literature are quite variable and in many cases, unreliable. Estimates of tag return rates include 31-61% for three warmwater species in a California reservoir (Rawstron 1971), 18-52% for rainbow trout *Oncorhynchus mykiss* in an Oregon stream (Moring 1980), 15-36% for various saltwater species in Texas bays (Green et al. 1983), 67-92% for crappie *Pomoxis spp.* in Missouri reservoirs (Colvin 1991), 29-71% for crappies in Georgia reservoirs (Larson et al. 1991), 27-85% for sauger *Stizostedion canadense* in Alabama (Maceina et al. 1998), 24-62% for crappie in five southeastern U.S. reservoirs (Miranda et al. 2002), and 20-54% in Kansas reservoirs (Schultz and Robinson 2002). Post card returns ranged from 24-66% even when rewards were offered for post cards.

To date, one of the most robust studies that estimate tag return rates is that of Nichols et al. (1991), where variable reward-response curves were developed for reporting of bands on mallard ducks *Anas platyrhynchus*. This study reported a 32% reporting rate for non-reward bands, and determined that the reward amount needed to generate a 100% reporting rate was approximately $100 (1989 dollars). This information has since been used extensively in fisheries investigations (Zale and Bain 1994), but the uncertainty of applying tag reporting rates from wildlife to fisheries studies still exists.

MANAGEMENT GOAL

1. Improve warmwater sportfishing and fisheries management in Idaho lakes and reservoirs.

OBJECTIVES

1. Determine the exploitation rates for crappie, largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieu*, and hatchery and wild trout in multiple waters across Idaho.

2. Develop reward–response curves to estimate angler tag reporting rate based on the high-reward methodology for tag returns.

3. Evaluate the variation in exploitation rates and angler tag reporting rates across species, years, water types, and geographical areas to assess implications for fisheries management.

METHODS

From 2006 to 2008, Idaho Department of Fish and Game (IDFG) personnel tagged 20,513 fish distributed between 26 statewide waters (Table 11) with Floy FD-68BC T-bar anchor tags. Tags were fluorescent orange, 70 mm in total length with 51 mm tubing, and were treated with algaecide. Tags were labeled on two sides with one side stating the agency and phone number (i.e. “IDFG 1-866-258-0338”) and the other side listing a tag number and reward amount if applicable. Non-reward tags only contained the tag number. A toll-free automated hotline and website were established through which anglers could report tags, although some tags were mailed in or dropped off at IDFG offices. In addition, posters (Appendix A) and stickers (Appendix B) were distributed to IDFG license vendors, regional offices, and sporting goods stores that publicized the tagging efforts and explained what the information was used for and how to return the tags. No other information was provided to anglers, and individual water bodies were not signed so that exploitation estimates in the future will not require this labor-intensive work.

The primary species tagged were white crappie *Pomoxis annularis* and black crappie *Pomoxis nigromaculatus*, largemouth bass, smallmouth bass, and hatchery and wild rainbow trout; a complete list of tagged fish can be found in Table 11. White crappie and black crappie often occur in sympatry in Idaho waters, and anglers generally do not distinguish between the species, so they were lumped during analyses.

Wild fish and holdover hatchery fish were typically collected using a boat-mounted electrofisher (settings of 300-600 volts, ~60 Hz, and 4-8 millisecond pulse width for ~40% duty cycle and an output of about 1-5 amps). During electrofishing, fish were captured and placed in a live well in small quantities until they were tagged and released near where the fish were captured to ensure good distribution of tags. Wild trout were also captured at weirs. Hatchery trout that were used in this study were netted out of the raceway, anesthetized with CO_2, tagged, and held in a pen within the raceway until stocking. All species were tagged below the dorsal fin.

Tags consisted of five reward levels: $0 (non-reward), $10, $50, $100, and $200, which were generally applied at rates of 76%, 8%, 8%, 4%, and 4%, respectively (Table 11). These efforts resulted in IDFG deploying $14,950 in $10 rewards, $75,500 in $50 rewards, $75,900 in $100 rewards, and $153,600 in $200 rewards for a total of $319,950. We anticipated paying out much less than this amount in reward money, as assumptions were made concerning angler encounter and return rates, tag loss, and mortality in determining reward-tag sample size.

Angler tag reporting rate (λ) was estimated using the high-reward methodology, using the relative return rate of standard (non-rewards) tags to the return rate of high-reward tags (Pollock et al. 2001):

$$\lambda = \frac{R_r / R_t}{N_r / N_t}$$

where R_r is the number of standard tags returned, R_t is the number of standard tags released, N_r is the number of high-reward tags returned, and N_t is the number of high-reward tags released.

Nearly all reward-tagged fish and about 1/3 of the non-reward-tagged fish were double tagged with an additional non-reward tag, for a total of about 48% of the tagged fish being double tagged. Tag loss (Tag_l) was estimated as the number of double-tagged fish for which only a single tag was reported, divided by twice the total number of double-tagged fish reported, whether by one or both tags. Sample size was usually not adequate to estimate tag loss at each water body, so data were pooled to develop a tag loss rate grouped by species.

Estimates of tagging mortality (Tag_m) from the literature is generally about 15% for centrarchids (Muoneke 1992; Hayes et al. 1997; Miranda et al. 2002; Schultz and Robinson 2002) but is generally unknown for most other species. To estimate tagging mortality, we captured wild smallmouth bass, crappie, and trout at several water bodies and held them in the water body in 1 m x 1 m x 1 m wire-mesh cages suspended at the surface. Half of the fish were tagged while the other half were held without tagging. Short-term mortality was estimated for tagged and untagged fish by calculating the proportion of fish alive 1 day and 7 days after initial capture. For hatchery catchables, short-term mortality was estimated by tagging fish in the raceways and holding them in 1.5 m x 1.5 m x 3.0 m pens for 1 to 33 days.

The unadjusted exploitation rate (*u*) was calculated according to Ricker (1975) as the number of non-reward tags recovered from fish that were harvested divided by the number of fish released with non-reward tags. Adjusted exploitation rate (*u'*) incorporated angler tag reporting rate, tag loss, and tag mortality, using the following formula:

$$u' = \frac{u}{\lambda(1 - Tag_l)(1 - Tag_m)}$$

where the terms are defined as before. Because site-specific reporting rates were often less reliable due to limited sample size, we calculated adjusted exploitation rates using site-specific reporting rates as well as mean reporting rates for each species.

RESULTS

Through February 10, 2009, 3,614 tags have been reported by anglers, with 3,526 of these reports containing enough information (i.e. disposition of the tag and fish) to include in tag reporting rate and exploitation analyses. Tags were primarily returned using the tag return hotline (56%) or website (29%; Table 13). Over the three years of the study, tag reports via the hotline have decreased from 62% to 47% whereas tag reports via the website have increased from 21% to 44%. To date, we have awarded approximately $89,180 in rewards, and a few tags continue to arrive.

Of the 3,526 complete returns, 67% were reported as harvested, 27% as released without any tags, and 6% as released with one or both tags (Table 14). On average, hatchery and wild trout have been returned at the lowest percentage of the initial number tagged (7.1 and 6.8%, respectively) whereas smallmouth bass and crappie were returned at much higher percentages of the initial number tagged (23.2 and 24.1%, respectively; Table 15).

Initial estimates of angler tag reporting rates were higher than anticipated using both $100 and $200 as the high-reward correction (Table 15). In general, there appeared to be no difference between $100 and $200 rewards regarding reporting rates, and because sample sizes were generally low, returns were pooled to estimate site-specific angler tag reporting rate. In addition, there did not appear to be any pattern to differences in reporting rates between years. Crappie reporting rates were highest in year two and lowest in year three, smallmouth bass reporting rates were highest in year two and lowest in year 1, and hatchery trout reporting rates were highest in year 1 and lowest in year three. Average reporting rate for all species combined was 57, 52, and 51% in 2006, 2007, and 2008, respectively.

Site-specific angler tag reporting rate in 2006 varied from 19% for smallmouth bass at Cascade Reservoir to essentially 100% for hatchery rainbow trout at Lucky Peak Reservoir (Table 16). In 2007, reporting rate ranged from 40% for hatchery rainbow x cutthroat trout in Glendale Reservoir to essentially 100% for wild rainbow trout in Williams Lake and crappie in CJ

Strike Reservoir. And in 2008, reporting rates ranged from 21% for hatchery rainbow trout in Anderson Ranch Reservoir to 65% for smallmouth bass in Brownlee Reservoir.

Tag loss ranged from a low of 1.3% for crappie in 2008 to a high of 22.7% for walleye in 2008 (Table 17). On average, percent tag loss was less than 10% for all species except walleye. Tagging mortality was generally zero or very low (i.e., <5%) for all estimates (Table 18), and based on this data we assumed tagging mortality was 5%.

Taking into account angler reporting rate, tag loss, and tagging mortality, adjusted exploitation in 2006 ranged from a low of 7% for hatchery rainbow trout at Cascade Reservoir to a high of 64% for crappie at Mann Creek Reservoir (Table 16). In 2007, exploitation ranged from a low of 3% for wild hybrid trout at Henrys Lake to a high of 67% for hatchery hybrid trout at Glendale Reservoir.

Angler reporting rates were higher for species with higher rates of exploitation, but this pattern was only apparent using mean reporting and exploitation rates for each species across all years (Figure 8, lower panel). Using each estimate as the sampling unit, no pattern between angler reporting rate and exploitation rate was discernible (Figure 8, upper panel).

DISCUSSION

Angler tag return rates across all water bodies and species have to date averaged about 55%. This is higher than we expected, and is at the upper end of most values found in the fisheries literature. Previous estimates have ranged from a low of 15% to a high of 92%, but generally have been between 20 and 65% (Rawstron 1971; Moring 1980; Green et al. 1983; Colvin 1991; Larson et al. 1991; Maceina et al. 1998; Miranda et al. 2002; Schultz and Robinson 2002). Our overall average was almost double the estimate of 32% from Nichols et al. (1991), which has been used widely in Idaho and elsewhere in fisheries studies.

In many instances, reporting rates we present may have been influenced by the low number of returns of high-reward tags. For 11 of the 39 estimates, five or fewer high reward tags were returned. At such low numbers, estimates of reporting rate can be changed by 25-50% or more by the addition or subtraction of only one returned high-reward tag. This is also true of estimates for some species; for example, if high-reward tags for largemouth bass in 2007 had been returned with one less or one more tag, tag reporting rate would have changed ± 6%. Estimates for 2008 will be improved as more tags are reported and as the one-year date from original tagging is approached.

Another factor that may have artificially inflated estimates of angler tag reporting rate was that the assumption that the reward tagging study does not change angler behavior might have been violated. In some cases, such as Milner Reservoir, many anglers reported that people were fishing because of the reward program. In addition, reward fish were reported as having been targeted by some anglers. Initial enthusiasm by anglers for the tagging program may also have elevated return rates, although we avoided advertising of the program and did not disclose tagging locations in order to minimize any such enthusiasm. We will test whether return rates decrease over time by tagging crappie and smallmouth bass in Brownlee Reservoir in four consecutive years, culminating in 2008.

We were also concerned that tag reporting rate was affected by how many tags were particular angler encountered, and whether any of them were rewards. For example, it is possible that the higher tag return rates we have found, compared to much of the literature, and the mallard duck reporting rate in particular, is in part due to the fact that many anglers are turning in more than one tag, and that anglers with reward tags may be more likely to turn in non-reward tags at the same time. Such analyses have not been done to date, but could be used to adjust the estimates of angler reporting rate in waters where fewer or no reward tags are released. Finally, there may have been some confusion by anglers as to whether or not non-reward tags would result in a reward after the report was made. Further analysis is needed to assess whether reporting rates differ between anglers reporting multiple tags or only one tag, or between anglers reporting non-reward and reward tags compared to those who only have non-reward tags to report; to date these analyses have not been possible. We attempted to control for this potential source of bias by not advertising tag releases at any water bodies, and instead used statewide education to draw attention to the overall program without identifying any specific study waters where tags were released. Another potential bias was that the presence of a tag could influence the decision to harvest a fish. We controlled for this by asking whether anglers harvested the fish only because of the tag, or because they planned to harvest the fish anyway. All of these factors may have artificially inflated angler reporting rates beyond that which would be normal.

It appears that, in general, reporting rates were higher for fish with higher exploitation rates (Figure 8). However, there was much variation in exploitation and tag reporting rates for each individual species at each water body, which obscured this relationship except when using mean exploitation and tag reporting rates for each species. Nevertheless, the fact that anglers are more likely to report tags attached to species for which exploitation is higher is not surprising considering that anglers may find tag removal a nuisance if they plan to release the fish.

RECOMMENDATIONS

1. Assess whether angler tag reporting rates were influenced by whether anglers caught more than one tag, or by whether they caught reward tags as well as non-reward tags.

2. Assess whether return rates decrease over time by tagging crappie and smallmouth bass in Brownlee Reservoir and C. J. Strike Reservoir in four consecutive years.

3. Use results from this study for future IDFG exploitation studies by releasing non-reward T-bar anchor tags and using the estimated tag reporting rates herein to estimate angler harvest. In next year’s final report we will what level of reward tags are needed to into the future to maintain current angler willingness to return tags.

4. Application of these results to species not included in this study (especially those not similar to any of the species already studied) may be inappropriate and may warrant small-scale replication of this study to estimate tag reporting rates for the new species in question.

5. Calibration of these tag return rates by replicating this study on a few fish species in some water bodies will probably be necessary every 5-10 years to assess whether angler tag return rates have changed. Such calibration should be carried out by fish management staff in the course of routine work, with planning and coordination from research staff.

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Table 11. Location, species, and initial number of fish tagged and released by Idaho Department of Fish and Game (IDFG) from 2006 to 2008.

				Reward Value					
Year	Water body	Region	Species	$0	$10	$50	$100	$200	Total
2006	Ben Ross Reservoir	3M	Largemouth bass	108	12	7	7	9	143
2006	Brownlee Reservoir	3N	Crappie	449	34	40	19	22	564
2006	Brownlee Reservoir	3N	Smallmouth bass	392	33	45	19	19	508
2006	Cascade Reservoir	3M	Rainbow trout (hatchery)	755	80	80	40	40	995
2006	Cascade Reservoir	3M	Smallmouth bass	106	2	2	1	1	112
2006	Chesterfield Reservoir	5	Rainbow trout (hatchery)	231	24	24	12	13	304
2006	Chesterfield Reservoir	5	Rainbow trout (holdovers)	147	12	13	8	7	187
2006	C.J. Strike Reservoir	3N	Crappie	210	22	16	9	9	266
2006	C.J. Strike Reservoir	3N	Smallmouth bass	292	31	31	15	14	383
2006	Coeur d'Alene River	1	WCT/HYB/RBT (wild)	78	9	9	5	5	106
2006	Lucky Peak Reservoir	3N	Rainbow trout (hatchery)	381	38	38	20	20	497
2006	Manns Lake	2	Crappie	252	24	24	12	13	325
2006	Manns Lake	2	Rainbow trout (hatchery)	343	40	40	20	20	463
2006	Milner Reservoir	4	Smallmouth bass	401	40	40	20	20	521
2006	Moyie River	1	Brook trout (wild)	166	2	5	3	1	177
2006	Moyie River	1	Rainbow trout (wild)	208	23	21	14	11	277
2006	Pend Oreille River	1	Largemouth bass	332	36	37	17	16	438
2006	Pend Oreille River	1	Smallmouth bass	36	6	5	3	5	55
2006	SF Snake River	6	Rainbow trout (wild)	243	26	27	12	13	321
2006	Williams Lake	7	Rainbow trout (holdovers)	226	26	25	12	12	301
2006	Total			5,356	520	529	268	270	6,943
2007	Ben Ross Reservoir	3M	Largemouth bass	227	23	25	12	12	299
2007	Boise River	3N	Rainbow trout (hatchery)	228	24	24	12	12	300
2007	Boise River (In Boise)	3N	Rainbow trout (hatchery)	152	16	16	8	8	200
2007	Brownlee Reservoir	3N	Crappie	399	42	42	21	21	525
2007	Brownlee Reservoir	3N	Smallmouth bass	399	42	42	21	21	525
2007	C.J. Strike Reservoir	3N	Crappie	366	38	38	20	20	482
2007	C.J. Strike Reservoir	3N	Smallmouth bass	379	40	40	20	20	499
2007	Cascade Reservoir	3M	Hybrid (RT/CT; hatchery)	472	10	10	5	3	500
2007	Devil Creek Reservoir	5	Hybrid (RT/CT; hatchery)	560	37	40	19	20	676
2007	Dworshak Reservoir	2	Smallmouth bass	384	40	40	20	20	504
2007	Glendale Reservoir	5	Hybrid (RT/CT; hatchery)	382	39	40	20	19	500
2007	Henry's Lake	6	YCT/HYB (Wild)	669	74	73	37	38	891
2007	Manns Creek Reservoir	3N	Rainbow trout (hatchery)	380	40	41	20	20	501
2007	NF Payette River	3M	Rainbow trout (hatchery)	670	72	67	36	36	881
2007	Salmon Falls Creek Reservoir	4	Walleye	558	42	42	21	21	684
2007	South Fork Snake River	6	RBT/HYB (wild)	456	48	48	24	24	600
2007	Williams Lake	7	Rainbow trout (holdovers)	228	24	24	12	19	307
2007	Total			6,909	651	652	328	334	8,874
2008	Anderson Ranch Reservoir	4	Rainbow trout (Hagerman Hatchery)	303	28	32	15	16	394
2008	Anderson Ranch Reservoir	4	Rainbow trout (Nampa Hatchery)	303	32	33	16	16	400
2008	Brownlee Reservoir	3N	Crappie	379	40	40	20	20	499
2008	Brownlee Reservoir	3N	Smallmouth bass	382	40	40	20	20	502
2008	C J Strike Reservoir	3N	Crappie	381	40	40	20	20	501
2008	C J Strike Reservoir	3N	Smallmouth bass	381	40	39	20	20	500
2008	Cascade Reservoir	3M	Rainbow trout (Nampa Hatchery)	304	32	32	16	16	400
2008	Cascade Reservoir	3M	Rainbow trout (Hagerman Hatchery)	304	32	32	16	16	400
2008	Lake Pend O'reille	1	Lake trout	38					38
2008	Mann Creek Reservoir	3N	Redband trout (wild)	289					289
2008	Mann Lake	2	Largemouth bass	68					68
2008	Oakley Reservoir	4	Walleye	72					72
2008	Ririe Reservoir	6	Cutthroat trout (hatchery)	380	40	41	20	20	501
2008	Spring Valley Reservoir	2	Largemouth bass	77					77
2008	Winchester Lake	2	Largemouth bass	55					55
2008	Total			3,716	324	329	163	164	4,696
	Grand Total			15,981	1,495	1,510	759	768	20,513

Table 12. Total number of released tags by reward levels for each species from 2006 to 2008.

		Reward Value					
Year	Species	$0	$10	$50	$100	$200	Grand Total
2006	Crappie	911	80	80	40	44	1,155
2006	Smallmouth Bass	1,227	112	123	58	59	1,579
2006	Largemouth Bass	440	48	44	24	25	581
2006	Wild/holdover trout	1,068	98	100	54	49	1,369
2006	Hatchery trout	1,710	182	182	92	93	2,259
2006	Total	5,356	520	529	268	270	6,943
2007	Crappie	765	80	80	41	41	1,007
2007	Smallmouth Bass	1,162	122	122	61	61	1,528
2007	Largemouth Bass	227	23	25	12	12	299
2007	Walleye	558	42	42	21	21	684
2007	Wild trout	1,353	146	145	73	81	1,798
2007	Hatchery trout	2,844	238	238	120	118	3,558
2007	Total	6,909	651	652	328	334	8,874
2008	Crappie	760	80	80	40	40	1,000
2008	Smallmouth Bass	763	80	79	40	40	1,002
2008	Largemouth Bass	200	0	0	0	0	200
2008	Walleye	72	0	0	0	0	72
2008	Wild trout	327	0	0	0	0	327
2008	Hatchery trout	1,594	164	170	83	84	2,095
2008	Total	3,716	324	329	163	164	4,696
	Grand total	15,981	1,495	1,510	759	768	20,513

Table 13. Summary of reporting method for tag reports received by Idaho Department of Fish and Game as of February 22, 2008.

		Reward Value						
Year	Report method	$0	$10	$50	$100	$200	Total	Percent
2006	Hotline	628	72	76	56	50	882	62
2006	Mail	13	16	23	7	10	69	5
2006	Regional Office	44	3	11	8	9	75	5
2006	Website	203	27	41	16	15	302	21
2006	Other	87	7	2	4	3	103	7
2006	Total	975	125	153	91	87	1,431	100
2007	Hotline	608	67	97	47	51	870	55
2007	Mail	54	13	12	9	10	98	6
2007	Regional Office	36	8	11	4	10	69	4
2007	Website	354	37	56	26	25	498	31
2007	Other	31	4	10	10	5	60	4
2007	Total	1,083	129	186	96	101	1,595	100
2008	Hotline	198	16	29	17	18	278	47
2008	Mail	5	2	9		2	18	3
2008	Regional Office	16	2	6	3	1	28	5
2008	Website	182	23	24	18	11	258	44
2008	Other	3	0	2	1	0	6	1
2008	Total	404	43	70	39	32	588	100

Table 14. Summary of all tags reported and fish disposition information by year, water body, species, and reward amount as of February 10, 2009.

					Harvested						Released with tag						Released without tag						Relaeased with one tag					
Year	Water body	Region	Species	Origin	$0	$10	$50	$100	$200	Total	$0	$10	$50	$100	$200	Total	$0	$10	$50	$100	$200	Total	$0	$10	$50	$100	$200	Total
2006	Ben Ross Reservoir	3M	Largemouth bass	Wild	5	1	0	1	2	9	2					2	6	1	2	1		10						0
2006	Brownlee Reservoir	3N	Crappie	Wild	99	9	14	9	4	135	1					1	6	3				9	1		1			2
2006	Brownlee Reservoir	3N	Smallmouth bass	Wild	41	7	6	6	4	64	19	2	1		1	23	24	4	9	4	6	47	1	1				2
2006	Cascade Reservoir	3M	Rainbow trout	Hatchery	25	1	5	2	0	33						0	2		3	2		7						0
2006	Cascade Reservoir	3M	Smallmouth bass	Wild	8	0	0	0	0	8						0	3		1	1		5	1					1
2006	Chesterfield Reservoir	5	Rainbow trout	Hatchery	14		2	1	3	20	2		1			3	4	1		1		6	1					1
2006	Chesterfield Reservoir	5	Rainbow trout	Holdover	15	1	3	1	5	25	1					1	1					1						0
2006	C.J. Strike Reservoir	3N	Crappie	Wild	41	9	5	1	2	58	2					2	6		1	1	1	9						0
2006	C.J. Strike Reservoir	3N	Smallmouth bass	Wild	41	3	8	5	1	58	14	1	1	1	1	18	31	5	6	2	4	48	1		1			2
2006	Coeur d'Alene River	1	Cutthroat/rainbow/hybrid trout	Wild	6	0	0	0	0	6	1					1	2			2	2	6	1					1
2006	Lucky Peak Reservoir	3N	Rainbow trout	Hatchery	39	2	5	3	1	50						0	2					2			1			1
2006	Manns Lake	2	Crappie	Wild	92	14	12	4	13	135	1					1	12	1	3	1		17	1					1
2006	Manns Lake	2	Rainbow trout	Hatchery	41	4	4	4	4	57	2					2	12	1	2	1		16						0
2006	Milner Reservoir	4	Smallmouth bass	Wild	33	5	6	2	2	48	16					16	76	11	10	10	8	115	1	1	1			3
2006	Moyie River	1	Brook Trout (Wild)	Wild	6		1			7						0	3					3						0
2006	Moyie River	1	Rainbow trout	Wild	6	2	1	2		11						0	1	1		1		3						0
2006	Pend Oreille River	1	Largemouth bass	Wild	43	8	8	2	3	64	10		3			13	36	6	10	7	7	66		1	1	1	1	4
2006	Pend Oreille River	1	Smallmouth bass	Wild	3	1		1		5						0	3	1	1	1		6						0
2006	SF Snake River	6	Rainbow trout	Wild	23	3	5	1	1	33	3					3	16	3			1	20	1	1				2
2006	Williams Lake	7	Rainbow trout	Wild	30	4	3	6	4	47						0	7		1		1	9						0
2006	Total				611	74	88	51	49	873	74	3	6	1	2	86	253	38	49	35	30	405	9	4	5	1	1	20
2007	Ben Ross Reservoir	3M	Largemouth bass	Wild	7	1	2	2	1	13	15					15	21	6	9	2	3	41			1	1		2
2007	Boise River	3N	Rainbow trout	Hatchery	52	4	9	6	1	72	2				1	3	30	8	6	5	5	54	3		2			5
2007	Brownlee Reservoir	3N	Crappie	Wild	97	7	19	7	10	140						0	6	3	1	2		12	1					1
2007	Brownlee Reservoir	3N	Smallmouth bass	Wild	49	3	5	2	6	65	9	1				10	20	3	5	3	4	35	1					1
2007	CJ Strike Reservoir	3N	Crappie	Wild	82	10	9	3	5	109	3					3	15	3	2	1	1	22		1				1
2007	CJ Strike Reservoir	3N	Smallmouth bass	Wild	75	6	10	3	6	100	7			1		8	56	6	11	4	2	79	1	1	1	1		4
2007	Dworshak Reservoir	2	Smallmouth bass	Wild	55	6	14	5	6	86	11	1		1		13	27	4	6	2	3	42	1	1	1	1		4
2007	Glendale Reservoir	5	Hybrid (RTCT)	Hatchery	74	11	17	9	7	118	1					1	9	1		2	3	15	1	1		1		3
2007	Henry's Lake	6	Cutthroat trout	Wild	10		4		2	16						0	4					4						0
2007	Little Wood Reservoir	4	Hybrid (RTCT)	Hatchery	5	1	2	1	2	11						0						0						0
2007	Manns Creek Reservoir	3N	Rainbow trout	Hatchery	73	8	14	2	10	107						0	1	2	2			5	1					1
2007	North Fork Payette River	3M	Rainbow trout	Hatchery	40	3	3	4	4	54						0	13	5	2	2	2	24			1	1		2
2007	Salmon Falls Creek Reservoir	4	Walleye	Wild	80	4	9	4	6	103	4					4	25	1	1	2		29	1					1
2007	South Fork Snake River	6	Rainbow trout/hybrids	Wild	40	6	9	4	5	64	1					1	19	3	3	2	1	28	1	1				2
2007	Williams Lake	7	Rainbow trout	Wild	12	1	3	1	2	19		1				1	2	1		1	1	5						0
2007	Total				751	71	129	53	73	1,077	53	3	0	2	1	59	248	46	48	28	25	395	11	5	6	5	0	27
2008	Anderson Ranch Reservoir	4	Rainbow trout	Hagerman Hat.	4	1				5						0	1					1						0
2008	Anderson Ranch Reservoir	4	Rainbow trout	Nampa Hat.	8		3	3	2	16	2					2			1			1						0
2008	Brownlee Reservoir	3N	Crappie	Wild	52	6	9	7	5	79	1					1	6		1		1	8						0
2008	Brownlee Reservoir	3N	Smallmouth bass	Wild	60	11	14	4	5	94	8	1			1	10	36	5	9	4	3	57	1	1	1			3
2008	CJ Strike Reservoir	3N	Crappie	Wild	58	8	9	9	2	86						0	11	1	1	1		14					1	1
2008	CJ Strike Reservoir	3N	Smallmouth bass	Wild	47	3	6	6	6	68	6				2	8	35	4	6	2	2	49	1		1			2
2008	Cascade Reservoir	3M	Rainbow Trout	Hagerman Hat.						0						0						0						0
2008	Cascade Reservoir	3M	Rainbow Trout	Nampa Hat.		1			1	2						0						0						0
2008	Lake Pend O'reille	1	Lake Trout	Wild	1					1						0						0						0
2008	Mann Creek Reservoir	3N	Rainbow Trout	Wild	9					9						0						0						0
2008	Mann Lake	2	Largemouth Bass	Wild	5					5						0	3					3						0
2008	Oakley Reservoir	4	Walleye	Wild	10					10						0	1					1						0
2008	Ririe Reservoir	6	Cutthroat trout	Hatchery	13	2	5	3	3	26	2					2	3		1			4						0
2008	Spring Valley Reservoir	2	Largemouth Bass	Wild	6					6						0	1					1						0
2008	Winchester Lake	2	Largemouth Bass	Wild	5					5						0	4					4						0
2008	Total				278	32	46	32	24	412	19	1	0	0	3	23	101	10	19	7	6	143	2	1	2	0	1	6
	Grand total				1,640	177	263	136	146	2,362	146	7	6	3	6	168	602	94	116	70	61	943	22	10	13	6	2	53

Table 15. Number of fish initially tagged (*N*), reported (*R*), percent returned by reward (%), and estimated non-reward reporting rate for all species from 2006 to 2008 as of February 10, 2009.

		Reward amount																	
		Nonreward			$10			$50			$100			$200			Nonreward reporting rate		
Year	Species	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	*N*	*R*	%	$100	$200	Combined
2006	Crappie	911	262	28.8	80	36	45.0	80	36	45.0	40	16	40.0	44	20	45.5	0.72	0.63	0.67
2006	Smallmouth Bass	1,227	310	25.3	112	40	35.7	123	50	40.7	58	31	53.4	59	27	45.8	0.47	0.55	0.51
2006	Largemouth Bass	440	102	23.2	48	17	35.4	44	24	54.5	24	12	50.0	25	13	52.0	0.46	0.45	0.45
2006	Wild/holdover trout	1,068	113	10.6	98	15	15.3	100	14	14.0	54	11	20.4	49	12	24.5	0.52	0.43	0.47
2006	Hatchery trout	1,710	144	8.4	182	9	4.9	182	23	12.6	92	14	15.2	93	8	8.6	0.55	0.98	0.71
2006	Total	5,356	931	17.4	520	117	22.5	529	147	27.8	268	84	31.3	270	80	29.6	0.55	0.59	0.57
2007	Crappie	765	204	26.7	80	24	30.0	80	31	38.8	41	13	31.7	41	16	39.0	0.84	0.68	0.75
2007	Smallmouth Bass	1,162	218	18.8	122	20	16.4	122	32	26.2	61	14	23.0	61	18	29.5	0.82	0.64	0.72
2007	Largemouth Bass	227	43	18.9	23	7	30.4	25	12	48.0	12	5	41.7	12	4	33.3	0.45	0.57	0.51
2007	Walleye	558	110	19.7	42	5	11.9	42	10	23.8	21	6	28.6	21	6	28.6	0.69	0.69	0.69
2007	Wild trout	1,353	89	6.6	146	13	8.9	145	19	13.1	73	8	11.0	81	11	13.6	0.60	0.48	0.53
2007	Hatchery trout	2,844	305	10.7	238	44	18.5	238	58	24.4	120	33	27.5	118	35	29.7	0.39	0.36	0.38
2007	Total	6,909	765	11.1	651	89	13.7	652	131	20.1	328	66	20.1	334	74	22.2	0.55	0.50	0.52
2008	Crappie	760	128	16.8	80	15	18.8	80	20	25.0	40	17	42.5	40	9	22.5	0.40	0.75	0.52
2008	Smallmouth Bass	763	194	25.4	80	25	31.3	79	37	46.8	40	16	40.0	40	19	47.5	0.64	0.54	0.58
2008	Largemouth Bass	200	24	12.0	0	0	-	0	0	-	0	0	-	0	0	-	-	-	-
2008	Walleye	72	11	15.3	0	0	-	0	0	-	0	0	-	0	0	-	-	-	-
2008	Wild trout	327	10	3.1	0	0	-	0	0	-	0	0	-	0	0	-	-	-	-
2008	Hatchery trout	1,594	33	2.1	164	4	2.4	170	10	5.9	83	6	7.2	84	6	7.1	0.29	0.29	0.29
2008	Total	3,716	400	10.8	324	44	13.6	329	67	20.4	163	39	23.9	164	34	20.7	0.45	0.52	0.48
	Grand total	15,981	2,096	13.1	1,495	250	16.7	1,510	345	22.8	759	189	24.9	768	188	24.5	0.53	0.54	0.53

Table 16. Number of non-reward and high dollar (i.e. $100 and $200) tags released, returned, and harvested within one year of the release date, from which tag reporting rate and exploitation estimates were derived.

Year	Water body	Species	Origin	Nonreward tags			High reward tags		Tag reporting rate	Annual Unadjusted exploitation	Adjusted exploitation using site-specific reporting rates	Adjusted exploitation using mean reporting rates
				Returned	Harvested	Released	Returned	Released				
2006	Ben Ross Reservoir	Largemouth Bass	Wild	9	5	108	5	16	0.27	4.6	19.7	11.5
2006	Brownlee Reservoir	Crappie	Wild	77	71	449	9	41	0.78	15.8	22.1	25.7
2006	Brownlee Reservoir	Smallmouth Bass	Wild	88	41	392	21	38	0.41	10.5	29.6	23.4
2006	Cascade Reservoir	Rainbow Trout	Hatchery	25	23	755	4	80	0.66	3.0	5.2	4.9
2006	Cascade Reservoir	Smallmouth Bass	Wild	10	7	106	1	2	0.19	6.6	40.2	14.8
2006	Chesterfield Reservoir	Rainbow Trout	Hatchery	18	12	231	3	25	0.65	5.2	9.1	8.3
2006	Chesterfield Reservoir	Rainbow Trout	Hatchery holdovers	11	9	147	4	15	0.28	6.1	24.8	14.7
2006	CJ Strike Reservoir	Crappie	Wild	42	35	210	5	18	0.72	16.7	25.3	27.1
2006	CJ Strike Reservoir	Smallmouth Bass	Wild	87	41	292	14	29	0.62	14.0	26.1	31.5
2006	Coeur d'Alene River	Cutthroat trout	Wild	10	6	73	3	10	0.46	8.2	20.5	19.7
2006	Lucky Peak Reservoir	Rainbow Trout	Hatchery	40	37	381	4	40	1.05	9.7	10.5	15.6
2006	Manns Lake	Crappie	Wild	82	68	252	14	25	0.58	27.0	50.7	43.9
2006	Manns Lake	Rainbow Trout	Hatchery	56	41	343	9	40	0.73	12.0	18.7	19.1
2006	Milner Reservoir	Smallmouth Bass	Wild	130	32	401	22	40	0.59	8.0	15.6	17.9
2006	Moyie River	Brook Trout	Wild	14	10	374	3	29	0.36	2.7	8.4	6.4
2006	Pend Oreille River	Largemouth Bass	Wild	75	38	332	19	33	0.39	11.4	33.1	28.5
2006	Pend Oreille River	Smallmouth Bass	Wild	4	2	36	2	8	0.44	5.6	14.4	12.5
2006	SF Snake River	Rainbow Trout	Wild	35	15	243	2	25	1.80	6.2	3.9	14.8
2006	Williams Lake	Rainbow Trout	Wild	27	22	226	7	24	0.41	9.7	27.0	23.4
2007	Ben Ross Reservoir	Largemouth Bass	Wild	36	7	227	9	24	0.42	3.1	8.6	7.2
2007	Boise River	Rainbow Trout	Hatchery	89	52	380	17	39	0.54	13.7	28.1	40.2
2007	Brownlee Reservoir	Crappie	Wild	96	88	399	15	42	0.67	22.1	35.1	31.4
2007	Brownlee Reservoir	Smallmouth Bass	Wild	79	49	399	15	42	0.55	12.3	25.1	19.5
2007	CJ Strike Reservoir	Crappie	Wild	71	55	366	8	40	0.97	15.0	16.6	21.4
2007	CJ Strike Reservoir	Smallmouth Bass	Wild	142	75	379	19	40	0.79	19.8	28.5	31.4
2007	Dworshak Reservoir	Smallmouth Bass	Wild	86	49	383	18	40	0.50	12.8	29.1	20.3
2007	Glendale Reservoir	Hybrid (RTCT)	Hatchery	85	73	379	22	39	0.40	19.3	53.4	56.6
2007	Henry's Lake	Cutthroat trout	Wild	12	6	669	3	75	0.45	0.9	2.2	1.9
2007	Little Wood Reservoir	Hybrid (RTCT)	Hatchery	5	5	378	3	40	0.18	1.3	8.3	3.9
2007	Manns Creek Reservoir	Rainbow Trout	Hatchery	70	68	380	11	40	0.67	17.9	29.4	52.5
2007	North Fork Payette River	Rainbow Trout	Hatchery	53	40	670	13	72	0.44	6.0	15.0	17.5
2007	Salmon Falls Creek Reservoir	Walleye	Wild	72	49	559	7	42	0.77	8.8	13.4	15.0
2007	SF Snake River	Hybrid (RTCT)	Wild	55	35	456	12	48	0.48	7.7	17.7	16.0
2007	Williams Lake	Rainbow Trout	Wild	15	10	228	2	31	1.02	4.4	4.8	9.2
2008	Anderson Ranch Reservoir	Rainbow Trout	Hagerman Hatchery	5	4	303	0	31	-	1.3	-	5.1
2008	Anderson Ranch Reservoir	Rainbow Trout	Nampa Hatchery	10	8	303	5	32	0.21	2.6	14.1	10.3
2008	Brownlee Reservoir	Crappie	Wild	59	52	379	13	40	0.48	13.7	30.5	28.2
2008	Brownlee Reservoir	Smallmouth Bass	Wild	105	60	382	17	40	0.65	15.7	27.4	30.5
2008	CJ Strike Reservoir	Crappie	Wild	68	57	381	13	40	0.55	15.0	29.1	30.8
2008	CJ Strike Reservoir	Smallmouth Bass	Wild	90	47	381	18	40	0.52	12.3	26.5	24.0
2008	Lake Pend O'reille	Lake Trout	Wild	1	1	38	0	0	-	2.6	-	5.7
2008	Mann Creek Reservoir	Rainbow Trout	Wild	9	9	288	0	0	-	3.1	-	6.8
2008	Mann Lake	Largemouth Bass	Wild	8	5	68	0	0	-	7.4	-	18.1
2008	Oakley Reservoir	Walleye	Wild	11	10	72	0	0	-	13.9	-	27.4
2008	Ririe Reservoir	Cutthroat trout	Hatchery	18	13	380	6	40	0.32	3.4	12.2	13.3
2008	Spring Valley Reservoir	Largemouth Bass	Wild	7	6	77	0	0	-	7.8	-	19.2
2008	Winchester Lake	Largemouth Bass	Wild	9	5	55	0	0	-	9.1	-	22.4

Table 17. Estimates of annual percent tag loss by year for all species as of February 22, 2008.

		Annual tag loss			Combined	
Species	*n*	2006	2007	2008	Estimate	95% CI
Crappie	1710	3.6	1.9	1.3	2.5	0.8
Smallmouth bass	2,480	8.4	7.2	6.6	7.5	1.1
Largemouth bass	558	7.1	11.1	-	7.5	2.2
Walleye	302	-	11.1	22.7	11.9	3.7
Wild trout	778	7.4	5.4	-	6.0	1.7
Hatchery trout	1,378	7.2	4.5	6.9	5.6	1.2

Table 18. Estimates of short-term mortality for tagged and untagged fish held in cages to estimate tagging mortality.

			Tagged fish					Untagged fish				
			Fish length (mm)			Percent mortality		Fish length (mm)			Percent mortality	
Water body	Species	Origin	*n*	Mean	Range	1 day	7 day	*n*	Mean	Range	1 day	7 day
Brownlee Reservoir	Crappie	Wild	20	193	185-225	0	5	20	193	180-215	0	0
Brownlee Reservoir	Smallmouth Bass	Wild	14	395	205-465	0	0	14	381	310-470	0	0
CJ Strike Reservoir	Crappie	Wild	40	200	190-239	-	7.5[a]	40	199	195-215	-	5[a]
CJ Strike Reservoir	Smallmouth Bass	Wild	15	318	305-347	6.7	6.7	15	329	306-395	0	6.7
SF Snake River	Rainbow Trout	Wild	20	477	380-605	-	0	20	459	368-520	-	0
Ririe Reservoir	Cutthroat trout	Mackay Hatchery	500	285	-	0	-					
Glendale Reservoir	Rainbow trout	Grace Hatchery	500	280	-	0	1.0[c]					
Cascade Reservoir	Rainbow trout	American Falls Hatchery	500	250	-	0	0.4[c]					
Little Wood Reservoir	Rainbow trout	Nampa Hatchery	500	260	-	0	1.8[c]					

[a]Sampled 8 days after release

[b]Held in the hatchery

[c]Held for 22-33 days in the hatchery.

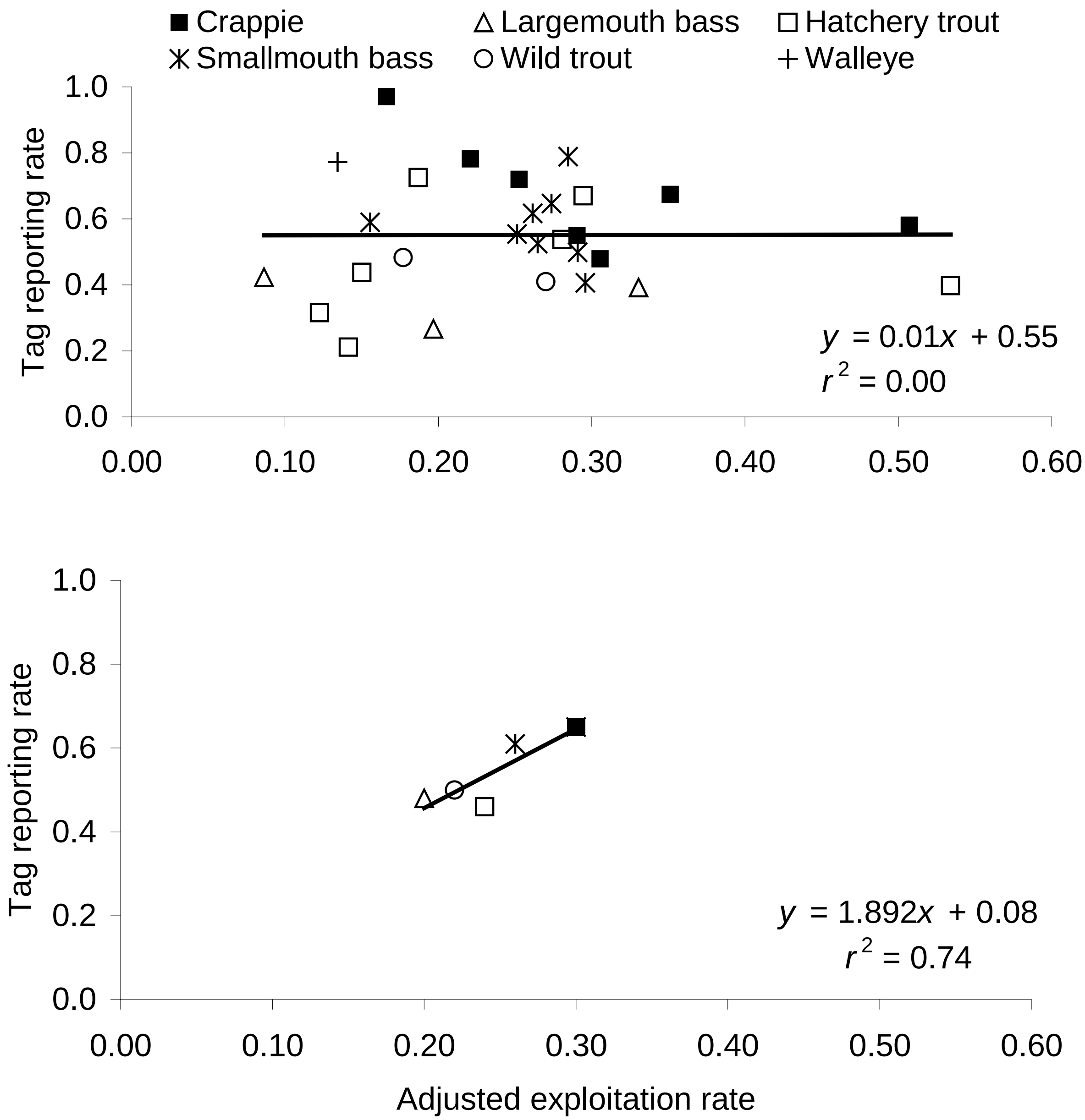

Figure 13. The relationship between angler tag reporting rate and exploitation rate for several species across Idaho, showing individual estimates (upper panel) and averages (lower panel).

APPENDICES

Appendix B. Posters distributed to IDFG regional offices, license vendors, and sporting goods shops publicizing the tagging program.

Appendix C. Business card-sized stickers distributed to IDFG regional offices, license vendors, and sporting goods shops publicizing the tagging program.

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