FISHERY RESEARCH

EFFECTS OF HIGHER WINTER WATER LEVELS ON THE PEND OREILLE RIVER FISH COMMUNITY

LAKE PEND OREILLE FISHERY RECOVERY PROJECT

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2005 Annual Progress Report, Part 2

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ABSTRACT

During 2005, we sampled the fish community in the Pend Oreille River in Idaho to determine if increased winter lake and river levels benefited the largemouth bass, black crappie, yellow perch, and pumpkinseed populations. Species composition and catch-per-unit-effort data suggest that a higher abundance of warmwater game fish and a lower abundance of native cyprinids, catostomids, and salmonids exist now compared to 1991 and 1992. No significant relationships were observed between winter water level and year class strength of largemouth bass, black crappie, yellow perch, or pumpkinseed. There were significant relationships between the year class strength of smallmouth bass, largemouth bass, and black crappie and the timing of spring refill. Yellow perch, black crappie, and pumpkinseed sunfish all exhibited high annual mortality rates (>50%). The annual mortality of largemouth bass was 34%, and survival in 2005 was much better than in 1991 (66% versus 31%). Slow growth rates and longevity of this largemouth bass population (maximum age was 17 years) may benefit from regulations that limit angler harvest. Species composition shifts since the early 1990s may be a response to lake level management, particularly the timing of spring refill. However, smallmouth bass have become well established since previous research, which may also have influenced the shift in species composition. We also captured six walleye (267-605 mm, ages 2-5) and suspect that this population is increasing. Expanding smallmouth bass numbers correlate with declines in the abundance of northern pikeminnow and redside shiner populations, all of which tend to utilize similar habitat. Although smallmouth bass would provide additional recreational opportunities, more research is needed to determine the impacts smallmouth bass may have on other fish populations, particularly salmonids.

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INTRODUCTION

Historically, the Pend Oreille River in Idaho was a productive coldwater fishery that supported native populations of westslope cutthroat trout *Oncorhynchus clarkii*, bull trout *Salvelinus confluentus*, and mountain whitefish *Prosopium williamsoni*. After construction of the Albeni Falls Dam in 1952, the free-flowing river changed to a reservoir, and dam operations fluctuated annual water levels by 3.5 m to increase hydroelectric power production and provide flood control. These changes resulted in a decline in the abundance of native salmonid populations (Dice 1983). Fluctuating river levels have resulted in degraded habitat, particularly increased erosion, sedimentation, and water temperature (Bennett and DuPont 1993). Under these conditions, the Pend Oreille River essentially becomes a warmwater reservoir during the summer and a coldwater river system during the winter. While these altered habitat conditions are not beneficial to native salmonid populations, they may provide increased habitat for nonnative game fish such as largemouth bass *Micropterus salmoides*, smallmouth bass *M. dolomieui*, black crappie *Pomoxis nigromaculatus*, pumpkinseed *Lepomis gibbosus*, and yellow perch *Perca flavescens*.

DuPont (1994) assessed the fish community structure in the Pend Oreille River during 1991 and 1992. He found fish that were the least disturbed by fluctuating lake levels such as yellow perch, peamouth *Mylocheilus caurinus*, and northern pikeminnow *Ptychocheilus oregonensis* to be most abundant (62% of total species composition). By sampling during high pool and drawdown periods, DuPont (1994) documented fish actively selecting off-channel habitats when available. During drawdown, fish were excluded from off-channel habitats and forced into areas with higher velocities and greater depths, indicating that habitat may be limited for species such as largemouth bass that prefer lower velocities and shallow depths. Beginning in 1996, the U.S. Army Corps of Engineers (USACE) began changing winter lake levels to enhance kokanee salmon *O. nerka* spawning habitat. To identify changes in the fish community and population structure after three winters of higher water levels, Karchesky (2002) surveyed the Pend Oreille River during 1999 and 2000. Although overall catch rates did not change between the early 1990s and 2000, Karchesky (2002) attributed the increased abundance of larger and older fish (particularly largemouth bass, black crappie, and pumpkinseed) to improved survival from three winters of higher water levels.

Winter drawdowns of 3.5 m in the Pend Oreille River reduce the amount of suitable overwintering habitat for centrarchids to approximately 45 hectares (Bennett and DuPont 1993). Bennett and DuPont (1993) hypothesized that if lake level drawdowns were limited to 2 m (vs. 3.5 m), the amount of suitable winter habitat for centrarchids in the Pend Oreille River would increase by 7.5 times (325 hectares), possibly increasing their survival and abundance.

OBJECTIVE

1. To increase the warmwater fish populations in the Pend Oreille River seven fold.

STUDY AREA

The Pend Oreille River extends 44.25 km from the outlet of Lake Pend Oreille near Sandpoint, Idaho (Long Bridge) to the Albeni Falls Dam, and covers 3,887 hectares (Figure 1).

The Pend Oreille River is a large system with a drainage area of 62,678 km^2 and flows ranging from 617 m^3/s (average monthly minimum) to 2,044 m^3/s (average monthly maximum). Approximately 161 km of shoreline, including sloughs and islands, have gentle to moderate steepness consisting of mostly fine sediments (<4 mm), while about 16 km of shoreline consists of riprap. The river has an average depth of 7.05 m, a maximum depth of 48.5 m, a maximum width of 3.2 km, and an annual drawdown of 3.51 m. Drawdown starts in mid-September and reaches low pool (625.14 m, lake elevation) by mid-November. Water levels are raised in mid-April and reach high pool (628.65 m, lake elevation) by mid-June (Dice 1983).

METHODS

To evaluate the effect of winter lake levels on the warmwater fish community in the Pend Oreille River, we examined species composition, catch-per-unit-effort (CPUE), and year class strength of largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed. Fish were sampled from three different littoral habitat types and the main Pend Oreille River channel using electrofishing equipment and gill nets. All lake and river level data was acquired from USACE at Albeni Falls Dam (agency files). Species composition and CPUE values calculated in 2005 were compared to values obtained in 1991 and 1992 from Bennett and DuPont (1993) to determine the effects of winter lake levels on the warmwater fish community in the Pend Oreille River. During 2005, we sampled the same littoral habitats and used similar sampling methods as Bennett and DuPont during 1991 and 1992. Data collected in 1991 and 1992 was representative of the Pend Oreille River fish community subjected to consistent full drawdowns during winter (i.e. winter lake level of 625.6 m above mean sea level [MSL]). In 1996, USACE began changing winter water levels to enhance kokanee spawning habitat in Lake Pend Oreille. Since that time, winter lake levels have been at 626.5 MSL for 6 out of 10 years (Figure 2).

Littoral Fish Community Assessment

From June 13 to June 24, 2005, we sampled the littoral fish community of the Pend Oreille River in Idaho. Sample locations were randomly selected within the three shoreline habitat types identified and mapped by Bennett and DuPont (1993) and DuPont (1994). The dominant habitat type, sand, comprised 61% of the shoreline and was characterized by substrates <15 mm. The second most available habitat type, slough, comprised 28% of the shoreline and was characterized by fine sediments with high biomasses of aquatic macrophytes. The least amount of habitat type available, rock, comprised 11% of the shoreline, was characterized by substrates >15 mm, and typically contained large cobble and boulders. Each habitat type was divided into 400 m sections (approximate distance 10 min of electrofishing could effectively sample [Bonar et. al. 2000]). We used All Topo Maps Version 6.6.10.1130 software and randomly chose 19, 19, and 12 sites in sand, slough, and rock habitats, respectively. Cumulatively, these selected sites equated to sampling 10% of the available sand habitat, 20% of the slough habitat, and 30% of the rock habitat within the study area. Each site was sampled for a maximum of 10 min (shocking time) during night with a 4.8 m Smith-Root 5.0 GPP electrofishing boat using DC current of 120 pulses per second at 3 amps power. Two dip netters collected all sizes and species of fish. Captured fish were identified to species and measured for total length (TL) in millimeters (mm); fish not used for aging were released alive.

Ten individual largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed were sacrificed from each 10 mm size group and were weighed to the nearest gram (g). Fish were put on ice while in the field and frozen in the lab for later age, growth, and catch-curve analysis using sagittae otoliths. All sizes of pumpkinseed and black crappie as well as largemouth bass, smallmouth bass, and yellow perch <150 mm were aged using whole otoliths according to Ross et al. (2005). Ages of largemouth bass, smallmouth bass, and yellow perch larger than 150 mm were determined from the transverse cross section of the otolith. The posterior end of the sectioned otolith was mounted in Crystal Bond resin onto a microscope slide, and the cut side was sanded using a series of wet sand paper in sizes grading from 500-grit to 1200-grit to 2000-grit. Otoliths were then viewed under a dissecting microscope with the aid of a fiber optic light source shining into the side of the sectioned otolith, and annuli were read from the nucleus out to either the dorsal or ventral end. All aging was verified by a minimum of two readers.

Data Analysis

Species composition, expressed in percent (%) composition, for all species captured was calculated for all three habitat types (sand, slough, and rock) and then combined for all littoral habitats. Species composition data was compared to similar data from 1991 and 1992 (Bennett and DuPont 1993; DuPont 1994). Catch-per-unit-effort (CPUE) was calculated for all species captured in each habitat type and expressed as number of fish captured per minute of electrofishing (number of fish/min).

We entered age, total length (TL) (mm), and weight (g) data of largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed into the Fisheries Analysis and Simulation Tools (FAST 2.0) model developed by Slipke and Maceina (2001) to determine catch-curve regressions, population parameters (i.e. proportional stock density-PSD and relative stock density-RSD), mean length at age, and weight-length relationships. Relative weight (W_r) for each species was calculated using the following equation from Anderson and Neumann (1996):

$$W_r = (W/W_s) \times 100$$

where W = weight of an individual and W_s = the length-specific standard weight predicted by a weight-length regression for that species. Standard weights for each species were calculated using standard weight equations found in Anderson and Neumann (1996). Length and age frequency histograms using percent frequency captured by electrofishing were used to evaluate length and age structure.

Fish year class strength was determined from catch-curve residuals calculated in FAST. Weak and strong year classes were defined by having residual values less than –0.5 and greater than 0.5, respectively (Maceina 2003). Catch curve residuals (year class strength) for each year class of largemouth bass, smallmouth bass, pumpkinseed, black crappie, and yellow perch were plotted with the lake level elevation for which they lived through their first winter. For example, an age-8 largemouth bass (born in 1997) survived its first winter during 1997-98; this year class had a residual of 1.4. The lake level during 1997-98 was held at 626.5 MSL. We plotted year class strength (1.4) and lake elevation (626.5) and used linear regression to determine the relationship between the two. Catch-curve residuals were also compared to the date of spring refill to determine if the timing of lake level increases influenced centrarchid year class strength. We plotted year class strength of individual species against the date in which

lake levels reached 627, 627.5, 628, and 628.5 m above sea level (MSL). Winter lake level and spring refill date were analyzed with all year class strength data to determine the relationship between these factors.

Population structure for largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed was described using PSD and RSD values and by plotting W_r with fish length. These indices along with annual mortality (AM) were used to compare the population status of fish in the Pend Oreille River to other systems to determine their balance and productivity of the community.

River Channel Fish Community Assessment

From July 31 to August 5, 2005, we sampled the fish community from the main river channel of the Pend Oreille River with gill nets. Sampling took place in water at least 5 m deep to avoid vegetated littoral areas. The river was divided into three pelagic sections (section 4, 5, and 6) as identified by DuPont (1994) (Figure 1). Section 4 started at Albeni Falls Dam and extended upriver 8.9 km to the mouth of the Priest River. Section 5 began at the mouth of the Priest River and extended upriver 30.6 km to the town of Dover, Idaho where the river began to widen. Section 6 began where the river widened and extended 4.8 km upriver to the U.S. Highway 95 Bridge at the Lake Pend Oreille Outlet. Each section was divided into 1 km transects and four, eight, and three sample locations were randomly selected in sections 4, 5, and 6, respectively. On July 29, 2005, we recorded temperature profiles at the deepest location in each section (7 m for section 4, 55 m for section 5, and 6 m for section 6) and temperatures ranged from 22.7°C on the surface to 18.8°C at 50 m and no thermocline was present. However, because we located cooler water below 30 m (19.5°C) we ensured that at least one sample location was in that depth. At each sample location we set replicate gillnet sets on the bottom and perpendicular to shore at sunset and pulled the nets after sunrise. We used experimental gillnets (45.7 m long x 2.4 m deep) that were constructed of eight sinking panels of variable size (1.3, 1.9, 2.5, and 5.1 cm stretched mesh) monofilament. All fish captured were identified and measured for total length (TL) in millimeters.

Data Analysis

Species composition (%) was calculated for each section and compared to similar data from 1991/1992 (Bennett and DuPont 1993; DuPont 1994). Species composition data were also combined for all river channel sections and compared to 1991/1992 data. Warmwater game fish were separated by species (largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed) while other fish species were grouped as native cyprinids and catostomids, salmonids, and other fish (i.e. bullhead and tench).

Juvenile Fish Assessment

To document the abundance of young-of-the-year (YOY) and growth of juvenile largemouth bass, smallmouth bass, yellow perch, black crappie, and pumpkinseed we performed electrofishing surveys in all three littoral habitats of the Pend Oreille River. Sampling occurred between September 26 and October 6. We selected sites that were sampled in June 2005 (see methods under Littoral Fish Community Assessment); however, not all sites were repeated. In total, we sampled 12 of the 19 slough sites, 11 of the 12 rock sites, and 8 of the 19 sand sites. We sampled each site for a maximum of 10 min (shocking time) during night with a

6.0 m Smith-Root 7.5 GPP electrofishing boat using DC current of 120 pulses per second at 3 to 5 amps power. Two dip netters were instructed to pick up only fish smaller than 150 mm. Captured fish were identified to species, all fish were measured for TL (mm), and fish not used for aging were released alive. Ten individuals of largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed were sacrificed for each 10 mm size group. Fish were put on ice while in the field and frozen in the lab for later age analysis using sagittae otoliths. All fish were aged using whole otoliths according to Ross et al. (2005). All aging was verified by a minimum of two readers.

Data Analysis

Catch-per-unit-effort (CPUE) (number of fish/min) was calculated for age-0 to age-2 largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed for each habitat type to establish baseline data for future evaluations. Age frequency histograms (age-0 to age-2) were created for each species from pooled length data from all habitat types to determine size structure of juvenile fish. Mean length at age (mm) was calculated to document growth (in length) from spring to fall for age-0 to age-2 fish.

RESULTS

Littoral Fish Community Assessment

Species composition changes from 1991/1992 to 2005 were notable in all littoral shoreline habitats (Table 1; Figure 3). In sand habitats smallmouth bass, black crappie, mountain whitefish, and redside shiner all showed considerable changes between years while the species composition of all other fish captured remained similar. Smallmouth bass made up 4% of the sand littoral community; no smallmouth bass were captured during electrofishing surveys of the littoral area in 1991 and 1992, although one was captured by gillnet in the sand littoral habitat. Black crappie greatly increased in composition in 2005 (29%) compared to 1991 (1%) and 1992 (0.5%). Alternatively, mountain whitefish and redside shiner abundance decreased in 2005, making up only 1% and 2% of the species composition, respectively. In rock habitats, the largest change in the fish species community was the increase in smallmouth bass and black crappie and the decrease of northern pikeminnow and redside shiner. Smallmouth bass were not documented in rock littoral areas in 1991 or 1992 and comprised 25% of the fish community in rock habitat during 2005. Black crappie made up <3% of the composition in 1991 and 1992 and accounted for 19% of the fish community in 2005. During 1991 and 1992, northern pikeminnow accounted for 55 and 45% of the fish community, respectively, but decreased to 30% in 2005. Redside shiner declined from 11 and 14% in 1991 and 1992 to 1% in 2005. The biggest change in slough habitat was the increase in black crappie composition, from 4% and 3% in 1991 and 1992, respectively, to 22% in 2005. Overall, when all littoral habitats were combined, both smallmouth bass and black crappie had the largest increase in species composition. The biggest decreases in species composition were observed in mountain whitefish, northern pikeminnow, and redside shiner.

Electrofishing CPUE (fish/min) differences were noted in all three littoral habitats between 1991/1992 and 2005 (Table 2). In sand habitat in 2005, catch rates of pumpkinseed and black crappie were higher than 1991/1992, while lower catch rates of mountain whitefish and redside shiner were observed. In rock habitats, smallmouth bass and black crappie had higher catch rates in 2005 but northern pikeminnow and redside shiner catches were lower. In

slough habitats, catch rates for pumpkinseed and black crappie were greater in 2005 than in 1991/1992.

Catch-curve residuals plotted against lake level elevation did not show any significant relationships suggesting that the range of observed winter lake/river levels influenced year class strength (Figure 4). For the centrarchids sampled in the Pend Oreille River, higher winter lake levels did not result in stronger year classes of fish. The strongest relationship found, although not significant, was a negative relationship between winter lake level and year class strength of pumpkinseed (n = 4, P = 0.24, r^2 = 0.57) (Figure 4).

Catch-curve residuals plotted against spring lake refill levels showed some effect of refill date on year class strength (Figures 5-9). Significant relationships between year class strength and spring refill date were observed in largemouth and smallmouth bass and black crappie. Largemouth bass year class strength increased when lake levels reached 628 m earlier in the spring refill period (Figure 5). Smallmouth bass showed a similar relationship between increased year class strength and earlier spring refill levels (Figure 6). Unlike bass populations in the Pend Oreille River, black crappie year class strength was correlated to later spring refill dates (Figure 7). No significant relationships between spring refill dates and year class strength of yellow perch (Figure 8) or pumpkinseed (Figure 9) were observed.

River Channel Fish Community Assessment

Species composition shifts in the main river channel were most notable with yellow perch, northern pikeminnow, peamouth, mountain whitefish, and lake whitefish (Table 3; Figure 3). The largest change was in the yellow perch population, which comprised 48% of the community in 2005 compared to 15% in 1991 and 1992 (data combined). Decrease in species composition was observed with peamouth, northern pikeminnow, and both mountain and lake whitefish. Sampling during 2005 also identified the presence of walleye *Sander vitreus* (n = 6) in the main channel of the Pend Oreille River. Walleye between age-2 and -5 and ranging from 267 to 605 mm TL were captured in gillnets.

Overall, the percentage of warmwater game fish (largemouth bass, yellow perch, black crappie, and pumpkinseed) of the total species composition within the main river channel increased from 14.6% to 54.6% (Figure 3). The percentage of salmonids, as well as the percentage of native cyprinids and catostomids (combined) decreased from 10.6% and 71.9% to 2.3% and 36.8% of the total species composition within the main river channel (Figure 3).

Largemouth Bass Population

In total, we captured 237 largemouth bass ranging in length from 65 mm to 564 mm (Figure 10) and weighed from 3 g to 3400 g. Largemouth bass were predominantly captured in slough habitats and made up 10% of the species composition found in this habitat type. Largemouth bass had a mean W_r of 95% (Figure 11). Fish below 350 mm had lower W_r than fish larger than 350 mm. Largemouth bass PSD and RSD values were high, which depicts a population that is slightly skewed towards larger fish (Table 4). Additionally, 10% of the fish captured were considered a preferred size to catch by anglers (>380 mm) and 44% were of stock length (>200 mm). Pend Oreille River largemouth bass exhibited relatively slow growth rates when compared to other bass populations throughout Idaho (Dillon 1995), and on average they reach 200 mm by age-3, 300 mm by age-5 and 400 mm by age-7 (Figure 12). We captured bass from age-1 to age-17 with most fish being caught at age-2 (Figure 13). Based on catch

curve analysis of largemouth bass age-2 to age-12, total annual mortality was 34% (Figure 14). The length-weight relationship for largemouth bass captured in the Pend Oreille River during 2005 was described by the equation: $\log_{10}$ weight (g) = 3.19 $\log_{10}$ total length (mm) –5.33 (Figure 15).

Smallmouth Bass Population

In total, we captured 305 smallmouth bass ranging from 51 mm to 427 mm in TL (Figure 16) and from 5 g to 1400 g in weight. Smallmouth bass were mostly captured in rock habitat where they made up 25% of the species composition. Overall, more smallmouth bass were captured than largemouth bass; this is the first time this has been documented in the Pend Oreille River system in Idaho. We captured smallmouth bass from ages 1-7 with the age-2 year class being most abundant based on electrofishing (Figure 17). Smallmouth bass mean W_r was lower than 100 (mean = 93%) for all age classes suggesting that forage maybe slightly limited (Figure 18). Smallmouth bass PSD value is moderately high but below 40 (Table 4). Smallmouth bass relative stock density is very low and by examining both PSD and RSD-P values together indicates a high-density population of many small fish ready to be recruited into the population. Smallmouth bass in the Pend Oreille River reach 200 mm by age-3, 300 mm by age-4, and 400 mm by age-7 (Figure 19). Based on catch curve analysis of smallmouth bass age-2 to age-7, total annual mortality was 69% (Figure 20). The length-weight relationship for smallmouth bass captured in the Pend Oreille River during 2005 was described by the equation: $\log_{10}$ weight (g) = 3.00 $\log_{10}$ total length (mm) –4.90 (Figure 21).

Black Crappie Population

We captured 1,086 black crappie ranging from 58 mm to 273 mm in total length (Figure 22) and 2 g to 282 g in weight. Black crappie were found in relatively large numbers in all littoral habitat types, accounting for 19, 29, and 22% of the species composition in rock, slough, and sand habitats, respectively (Table 1). We captured black crappie from ages 1-6 with the age-2 year class being most abundant (Figure 23). Juvenile black crappie (<175 mm; age 1-3) mean W_r was 111%, but declines in mean W_r (92%) after 175 mm (age 3+) suggest that forage maybe limited for adult crappie (Figure 24). Black crappie PSD and RSD are very low and indicated that high-densities of small black crappie were present in the Pend Oreille River system and very few large adults were observed in our sampling. Black crappie in the Pend Oreille River reach 130 mm by age-2, 170 mm by age-3, and 200 mm by age-4 (Figure 25). Based on catch curve analysis of black crappie between age-2 and age-6, total annual mortality was 84% (Figure 26). The length-weight relationship for black crappie captured in the Pend Oreille River during 2005 was described by the equation: $\log_{10}$ weight (g) = 3.06 $\log_{10}$ total length (mm) –4.98 (Figure 27).

Yellow Perch Population

We captured 797 yellow perch ranging from 70 mm to 267 mm in length (Figure 28) and 4 g to 206 g in weight. Yellow perch were most abundant in slough and sand habitats, accounting for 21 and 19% of the species composition in these areas, respectively (Table 1). We captured yellow perch from ages 2-9 with the age-2 year class being most abundant based on electrofishing (Figure 29). Yellow perch mean W_r was 87% (Figure 30). Yellow perch PSD and RSD are very low and indicate that high-densities of small yellow perch are present in the Pend Oreille River system and very few large adults were observed in our sampling (Table 4).

Yellow perch in the Pend Oreille River reach 150 mm by age-3, but growth rate slows considerably beyond age-3 (Figure 31). Based on catch curve analysis of yellow perch age-2 to age-9, total annual mortality was 53% (Figure 32). The length-weight relationship for yellow perch captured in the Pend Oreille River during 2005 was described by the equation: $\log_{10}$ weight (g) = 2.86 $\log_{10}$ total length (mm) –4.65 (Figure 33).

Pumpkinseed Population

We captured 862 pumpkinseed ranging from 48 mm to 165 mm in length (Figure 34) and 2 g to 110 g in weight. Pumpkinseed were most abundant in slough habitats, comprising 32% of the species composition in these habitats (Table 1). We captured pumpkinseed from ages 1-6 with the age-3 year class being most abundant based on electrofishing (Figure 35). Pumpkinseed mean W_r was 109% (Figure 36). The majority of the pumpkinseed population (98%) is greater than stock length (80 mm), but very few fish were at quality or preferred lengths (150 mm and 200 mm, respectively) (Table 4). Age and growth analysis revealed that pumpkinseed in the Pend Oreille River obtain lengths over 100 mm by age-3, but growth slows considerably between age-3 and age-6 (Figure 37). Based on catch curve analysis of pumpkinseed age-3 to age-6, total annual mortality was 75% (Figure 38). The length-weight relationship for pumpkinseed captured in the Pend Oreille River during 2005 was described by the equation: $\log_{10}$ weight (g) = 3.23 $\log_{10}$ total length (mm) –5.13 (Figure 39).

Juvenile Fish Assessment

Age-0 pumpkinseed, largemouth bass, and black crappie were most abundant in slough habitats (Table 5). Age-0 smallmouth bass were most abundant in rock habitats and pumpkinseed were the most abundant species in sand habitats (Table 5). For all species except largemouth bass and yellow perch, more age-1 fish were captured than age-0 fish (Figure 40). Mean total length in September for age-0 largemouth bass was 63.0 mm, 67.2 mm for smallmouth bass, 54.4 mm for black crappie, 62.8 mm for yellow perch, and 34.5 mm for pumpkinseed (Table 6). June to September growth rates of warmwater fish species found in the Pend Oreille River were highly variable (Table 7). Age-1 largemouth and smallmouth bass exhibited the most summer growth of all species sampled, averaging 42.5 and 42.3 mm of growth between June and September, respectively. Pumpkinseed exhibited the least amount of growth, averaging 11.3 mm between June and September. Smallmouth bass exhibited the highest growth rate of age-2 fish sampled, averaging 31.1 mm, while age-2 pumpkinseed showed virtually no growth, averaging only 0.2 mm.

Electrofishing CPUE (fish/min) rates for juvenile fish in the Pend Oreille River varied by both habitat and species (Table 8). Overall, pumpkinseed sunfish and smallmouth bass exhibited the highest catch rates. In slough habitats, pumpkinseed and largemouth bass had the highest catch rates, while smallmouth bass were the most predominant species in rock habitat. In sand habitat, catch rates were highest for pumpkinseed sunfish. For age-0 fish, overall CPUE was highest for largemouth bass; smallmouth bass had the highest CPUE of age-1 captures, while pumpkinseed sunfish had the highest CPUE of age-2 fish captured (Table 8).

DISCUSSION

Pend Oreille River Fish Species Composition

Overall, the species composition within the Pend Oreille River has shifted from native cyprinids and catostomids in the early 1990s to warmwater game fish (largemouth bass, smallmouth bass, yellow perch, black crappie, and pumpkinseed) in 2005. The increase in warmwater game fish abundance was concurrent with the changes in lake level management implemented to enhance kokanee spawning (BPA Project # 199404700). Changes in the winter lake level began in the fall of 1996; therefore, fish species had nine years to respond before our sampling in 2005. This would suggest that the change in lake levels benefited the warmwater fish in the Pend Oreille River.

Bennett and DuPont (1993) suggest that habitat limitations, not fishing pressure, were responsible for the low abundance of warmwater game fish, and indicated that lake level drawdowns severely limit the amount of suitable overwintering habitat for centrarchids. By using catch curve residuals, we failed to find a correlation between year class strength and winter lake elevation. Increased winter lake levels may increase the amount of available habitat within the Pend Oreille River, but this habitat may be prone to freezing or lack the appropriate cover and/or depth to provide suitable winter habitat for centrarchids. Karchesky (2002) identified habitats containing aquatic vegetation and depths from 1-3 m as the primary wintering areas used by largemouth bass during winters with intermediate drawdown levels (2.9 m). Future research in the Pend Oreille River should include monitoring and evaluation of slough and off-channel habitats, particularly water temperature, depth, velocity, and aquatic vegetation, to determine the suitability of this habitat during years with high winter water levels.

While increased winter water levels were not correlated with year class strength of centrarchids in the Pend Oreille River, largemouth and smallmouth bass year class strength improved when spring refill occurred at earlier dates (Figures 5 and 6). When we examined the timing of spring refill, the data suggested that stronger year classes of largemouth bass and smallmouth bass were produced when the lake refilled to 628 MSL in early- to mid-May. The strongest year class of largemouth bass currently in the Pend Oreille River was produced during the 1997-flood year when river levels increased early in the spring, allowing largemouth bass to exploit slough areas early. Similar to largemouth bass, smallmouth bass year classes were also strongest when river levels increased earlier in the spring, possibly providing access to higher quality gravel and rock shorelines for spawning. Raibley et al. (1997) found strong cohorts of largemouth bass were produced in the Illinois River during years when high spring floods allowed access to the floodplain for spawning and nursery habitats.

Contrary to largemouth and smallmouth bass, black crappie had the opposite response to earlier spring refill dates. Black crappie produced stronger year classes when lake refill levels occurred later (late May/early June) (Figure 7). Preferred spawning temperatures likely influenced this analysis, as largemouth bass are believed to spawn at cooler water temperatures than black crappie. Increasing river levels later in the spring may provide both increased quantity and quality of spawning habitat for black crappie, as water temperatures during this period may be optimal.

Changes in the composition of fish species found in the Pend Oreille River were also likely due to the recent establishment of smallmouth bass. Smallmouth bass, which were essentially nonexistent in 1991/1992 (DuPont 1994) and comprised less than 1% of the total catch in 1999/2000 (Karchesky 2002), comprised 25% of the species captured in rock habitats

during 2005, and 7% of the overall species composition. Between 2000 and 2005, smallmouth bass abundance increased dramatically, and other research has shown that smallmouth bass can reduce native small-bodied forage fish and influence species richness (Jackson 2002). Vidergar (2000) documented redside shiner as the primary prey item (40%) found in the diet of smallmouth bass in Lake Pend Oreille. The recently observed shift in species composition in the Pend Oreille River, particularly the reduction in redside shiner, northern pikeminnow, and mountain whitefish, may be related to the increasing population of smallmouth bass.

Largemouth Bass

Largemouth bass below 350 mm had lower W_r than fish larger than 350 mm, suggesting that forage or growing conditions may be less optimal for younger largemouth bass. Additionally, 10% of the fish captured were considered a preferred size to catch by anglers (>380 mm), which suggests that a quality largemouth bass fishery exists in the slough areas of the Pend Oreille River, Idaho. Survival of the largemouth bass population has improved since Bennett and DuPont's research (1993) from 31% in 1991 to 66% in 2005. Given the slow nature of largemouth bass growth in the Pend Oreille River, regulations aimed at protecting larger fish may benefit the population. However, a closer look at angler exploitation is needed before regulation changes can be recommended.

Smallmouth Bass

Previous research on the Pend Oreille River documented very few smallmouth bass. Based on our species composition data smallmouth bass have dramatically increased (particularly in rock habitats), while the abundance of redside shiner and northern pikeminnow have diminished, suggesting that smallmouth bass may be reducing both native species. Whittier et al. (1997) documented the loss of native minnow biodiversity in Northeastern lakes stocked with nonnative predators, especially *Micropterus* spp.

A very small percentage of smallmouth bass captured were considered a preferred size (>350 mm) by anglers. This may be because our sampling methods were inefficient at capturing larger individuals. The length frequency histogram (Figure 7) of smallmouth bass captured in the Pend Oreille River reveals that smallmouth bass >300 mm were either under sampled or were missing from the population. Additionally, smallmouth bass in the Pend Oreille River showed growth rates greater than those in nearby Hayden Lake, Idaho (Davis and Horner 1995). Based on size and growth information for smallmouth bass, three possible scenarios could be happening. The first is that the population is just starting to expand. Based on species composition data collected in 1991 and 1992 (DuPont 1994) and 1999 and 2000 (Karchesky 2002), we know that the population has expanded since previous estimates and strong year classes of younger fish are starting to move through the population. The second may be that high natural and/or fishing mortality is limiting older age classes. The third scenario is that adult smallmouth bass may be immigrating into Lake Pend Oreille in search of suitable habitat and/or forage. Future research is needed to identify critical habitats, particularly spawning locations, as well as the spatial distribution of adult smallmouth bass. It is unknown if adult smallmouth bass migrate into Lake Pend Oreille in search of suitable foraging or spawning habitat or what impacts they may have on native species. As this point, we do not recommend regulations aimed at improving smallmouth bass populations in the Pend Oreille River due to their rapid expansion and potential to impact other fish species.

Black Crappie

The black crappie population in the Pend Oreille River displayed a relatively high abundance of age-2 and age-3 fish, but had a high annual mortality rate (84%). Annual mortality in 1991 and 1992 was 70% and 60%, respectively (Bennett and DuPont 1993). Beyond age-3, the population is severely limited, possibly due to an inadequate food supply. Previous studies have documented a shift in black crappie foraging behavior, from being primarily insectivores to piscivores, although the size and age when this shift occurs is highly variable. Pelham et al. (2001) documented this shift at age-1, while Ellison (1984) observed no shift to piscivory by black crappie. Previous studies of black crappie >200 mm in the Pend Oreille River documented fish as the dominant food source by weight, comprising 83.6% of the diet, with cyprinids representing 82.7% of these fish (Bennett and DuPont 1993). The reduction of cyprinids such as redside shiner and northern pikeminnow may limit the amount of forage available to adult black crappie in the Pend Oreille River, therefore hindering growth rates.

Yellow Perch

Yellow perch in the Pend Oreille River showed poor growth rates and condition factors, indicating that forage may be limited. Hubert and Sandheinrich (1983) observed yellow perch feeding mainly on plankton and suggest that poor growth rates and condition factors may result when benthic invertebrates are limited. Future studies of the yellow perch population in the Pend Oreille River should include diet composition and prey availability.

Pumpkinseed

The slow growth rates and small maximum size (165 mm) of pumpkinseed sunfish in the Pend Oreille River likely makes them an undesirable sport fish for anglers. However, pumpkinseed sunfish may serve as a key forage species for largemouth bass. Olson and Young (2003) documented pumpkinseed and bluegill sunfish as the predominant prey item of largemouth bass greater than 75 mm TL.

Walleye

Prior to our research, walleye were previously undocumented in the Pend Oreille River in Idaho. The timing and method of walleye establishment in the Pend Oreille system is unknown. Establishment of walleye in the Pend Oreille River may have occurred from emigration from upstream reservoirs or illegal angler introductions. The concern with the presence of walleye in this system is the potential impacts they could have on the existing fish community. Research in Lake Roosevelt, Washington showed hatchery-released kokanee and rainbow trout were a significant proportion of walleye diet (Baldwin et al 2003). To evaluate walleye abundance, the impacts they may be having on the fishery, and the potential to reduce their numbers in the Pend Oreille River and Lake system, we recommend using standardized fish sampling gear and methods similar to those used to monitor other walleye populations throughout Idaho.

Juvenile Fish Assessment

Future evaluations of juvenile largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed sunfish will help us better evaluate the effects of winter lake levels on survival. Identification of winter habitat use by juvenile centrarchids in the Pend Oreille River is needed to determine the effects of water level manipulations.

RECOMMENDATIONS

1. Winter lake levels should be managed to maximize kokanee production in Lake Pend Oreille, as higher winter lake levels have not been shown to improve warmwater game fish populations within the Pend Oreille River.

2. Earlier spring refill (early- to mid-May) may provide stronger year classes of largemouth bass, but caution should be used, as this was also correlated with increases in smallmouth bass year class strength.

3. We recommend future sampling of the Pend Oreille River to monitor increases in smallmouth bass abundance.

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Table 1. Species composition (%) of all fish captured during electrofishing surveys of the littoral area of the Pend Oreille River, Idaho. Data from 1991 and 1992 is from DuPont (1994).

	Sand			Rock			Slough			All strata combined		
	1991	**1992**	**2005**	**1991**	**1992**	**2005**	**1991**	**1992**	**2005**	**1991**	**1992**	**2005**
Largemouth bass	1.0	1.5	0.2	1.1	2.5	0.5	2.9	18.2	9.9	1.7	8.4	5.1
Smallmouth bass	0.0	0.0	3.8	0.0	0.0	24.5	0.0	0.0	1.0	0.0	0.0	6.7
Pumpkinseed	0.2	6.7	9.2	0.2	5.3	1.6	6.5	43.2	32.0	2.4	21	19.0
Yellow perch	8.3	9.0	19.2	1.1	7.7	6.3	34.6	21.1	20.8	16	13.5	17.4
Black crappie	1.0	0.5	28.9	0.0	1.7	19.0	3.7	2.7	22.5	1.7	1.7	23.7
Northern pikeminnow	23.4	23.9	19.7	54.5	44.8	30.4	5.4	2.1	1.0	24.2	20.3	12.6
Tench	1.1	0.3	0.1	0.4	0.3	0.0	2.9	5.2	1.4	1.6	2.3	0.7
Peamouth	5.8	0.7	6.3	3.5	1.0	6.4	10.5	0.0	2.0	6.9	0.5	4.2
Rainbow trout	5.2	0.0	0.8	2.2	0.0	0.4	0.4	0.0	0.1	2.8	0.0	0.4
Westslope cutthroat	1.0	0.0	1.8	1.9	0.0	0.2	0.1	0.0	0.1	0.9	0.0	0.6
Brown trout	0.5	0.2	1.0	0.0	0.2	0.7	0.0	0.0	0.2	0.2	0.1	0.5
Mountain whitefish	31.5	27.8	1.1	0.7	4.5	0.0	0.5	0.5	0.0	13.4	11.2	0.3
Redside shiner	7.9	17.8	1.9	10.6	14.0	1.5	1.2	0.2	0.2	6.2	9.8	1.0
Largescale sucker	10.1	9.1	4.0	23.2	16.1	8.7	8.5	0.9	2.9	12.6	7.6	4.4
Longnose sucker	1.0	0.6	1.4	0.2	0.2	0.1	1.3	0.7	0.5	0.9	0.5	0.7
Brown bullhead	1.1	1.8	0.4	0.0	1.7	0.1	21.3	5.1	5.2	8.0	3.1	2.7

Table 2. Electrofishing catch per unit effort (CPUE) (fish/minute) of all species captured from the Pend Oreille River, Idaho. Data from 1991 and 1992 is from DuPont (1994).

	Sand		Rock		Slough	
	91-92	**2005**	**91-92**	**2005**	**91-92**	**2005**
Largemouth bass	0.30	0.03	0.40	0.03	1.90	1.19
Smallmouth bass	NA	0.43	NA	1.24	NA	0.13
Pumpkinseed	0.20	1.05	0.10	0.08	2.50	3.85
Yellow perch	1.10	2.19	0.20	0.32	3.80	2.51
Black crappie	0.07	3.30	0.04	0.96	0.40	2.71
Northern pikeminnow	2.00	2.25	3.20	1.53	1.00	0.13
Tench	0.05	0.02	0.03	0.00	0.32	0.17
Peamouth	0.20	0.72	0.30	0.32	0.40	0.24
Rainbow trout	0.20	0.09	0.05	0.02	0.02	0.01
Westslope cutthroat	0.04	0.20	0.05	0.01	0.01	0.02
Brown trout	NA	0.11	NA	0.04	NA	0.02
Mountain whitefish	1.90	0.13	0.20	0.00	0.10	0.01
Redside shiner	1.00	0.22	1.00	0.07	0.01	0.03
Largescale sucker	0.70	0.45	1.20	0.44	0.30	0.35
Longnose sucker	0.01	0.16	0.08	0.01	0.09	0.06
Brown bullhead	0.09	0.05	0.07	0.01	0.95	0.63

Table 3. Species composition (%) of all species captured in the main river channel of the Pend Oreille River, Idaho. Data from 1991 and 1992 (Bennett and DuPont 1993; DuPont 1994) are combined.

	Section 4		Section 5		Section 6		Totals	
	91-92	**2005**	**91-92**	**2005**	**91-92**	**2005**	**91-92**	**2005**
Largemouth bass	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Smallmouth bass	0.0	5.1	0.0	1.6	0.0	1.1	0.0	1.7
Pumpkinseed	0.0	1.0	0.1	8.1	0.0	1.1	0.0	4.9
Yellow perch	10.3	2.0	26.3	53.5	9.8	49.7	15.0	48.4
Black crappie	0.0	0.0	0.1	0.7	0.0	2.1	0.0	1.2
Northern pikeminnow	55.2	32.7	23.6	9.6	9.6	1.3	16.0	8.0
Tench	0.6	5.1	1.4	3.9	2.2	2.3	2.0	3.3
Peamouth	15.2	48.0	30.6	13.0	57.5	35.3	47.0	24.1
Rainbow trout	0.2	0.0	0.0	0.0	0.1	0.2	0.0	0.1
Cutthroat trout	0.0	0.0	0.0	0.3	0.3	0.2	0.0	0.2
Brown trout	0.0	0.0	0.3	0.5	0.1	0.4	0.0	0.4
Mountain whitefish	1.4	1.0	2.4	2.3	6.6	0.0	5.0	1.3
Redside shiner	2.8	0.0	0.1	0.0	0.1	0.0	0.0	0.0
Largescale sucker	12.1	2.0	6.4	4.5	2.7	5.1	4.0	4.6
Longnose sucker	1.0	0.0	2.2	0.0	4.7	0.4	4.0	0.1
Brown bullhead	0.2	2.0	0.8	1.2	1.1	0.8	1.0	1.1
Kokanee	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.2
Walleye	0.0	1.0	0.0	0.7	0.0	0.0	0.0	0.4
Lake whitefish	0.4	0.0	5.6	0.0	4.9	0.0	5.0	0.0
Lake trout	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0

Table 4. Traditional stock density indices, including 95% confidence intervals, of largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed, collected from the Pend Oreille River, Idaho during June 2005 using boat electrofishing in littoral areas.

	# Stock Length (% of population)	**Proportional Stock Density**	**Relative Stock Density-P**	**Relative Stock Density-M**	**Relative Stock Density-T**
Largemouth bass	105 (44%)	37.1 (± 9.2)	21.9 (± 7.9)	1.0 (± 1.9)	0
Smallmouth bass	65 (21%)	36.9 (± 11.7)	3.1 (± 4.1)	0	0
Black crappie	770 (71%)	2.2 (±1.0)	0.3 (±0.4)	0	0
Yellow perch	665 (83%)	4.0 (± 1.5)	0.3 (±0.4)	0	0
Pumpkinseed	851 (98%)	1.2 (±0.7)	0	0	0

Table 5. Mean number of YOY fish captured in each electrofishing sample site within slough, sand, and rock habitat types within the Pend Oreille River, Idaho, during September 2005.

	Slough	Sand	Rock	Average (all habitat types)
Largemouth bass	22.4	2.9	0.1	9.5
Smallmouth bass	0.0	3.3	26.8	10.4
Yellow perch	10.4	2.5	0.0	4.7
Black crappie	11.0	2.1	2.1	5.5
Pumpkinseed	36.4	8.1	6.4	18.5
Largescale sucker	0.1	0.0	0.0	0.0
Mountain whitefish	0.0	0.0	0.1	0.0
Northern pikeminnow	0.1	0.3	0.7	0.4
Redside shiner	0.0	0.4	0.3	0.2
Peamouth	0.0	0.3	0.1	0.1
Westslope cutthroat	0.0	0.6	0.4	0.3
Rainbow trout	0.0	0.4	0.1	0.1
Brown bullhead	0.2	0.0	0.0	0.1
Tench	0.1	0.0	0.0	0.0

Table 6. Mean total length (mm) at age of juvenile largemouth bass, smallmouth bass, black crappie, yellow perch, and pumpkinseed sampled from the Pend Oreille River, Idaho during September 2005.

	Mean total length (mm) at Age		
	Age-0	Age-1	Age-2
Largemouth bass	63.0	128.4	169.0
Smallmouth bass	67.2	114.6	160.6
Black crappie	54.4	103.4	NA
Yellow perch	62.8	121.8	148.3
Pumpkinseed	34.5	66.3	94.2

Table 7. June to September growth rates of largemouth bass, smallmouth bass, black crappie, pumpkinseed, and yellow perch from the Pend Oreille River, Idaho during 2005.

	Age-1			Age-2		
	June TL	September TL	Growth (mm)	June TL	September TL	Growth (mm)
Largemouth bass	85.9	128.4	42.5	151.7	169.0	17.3
Smallmouth bass	72.3	114.6	42.3	129.5	160.6	31.1
Black crappie	79.6	103.4	23.8	133.0	NA	NA
Pumpkinseed	55.0	66.3	11.3	94.0	94.2	0.2
Yellow perch	85.0	121.8	36.0	133.8	148.3	14.2

Table 8. Electrofishing catch per unit effort (CPUE) (fish/minute) of age-0, age-1, and age-2 largemouth bass, smallmouth bass, black crappie, pumpkinseed sunfish, and yellow perch from littoral habitats sampled in the Pend Oreille River, Idaho during September and October 2005.

Age-0

Habitat type	Largemouth bass	Smallmouth bass	Black Crappie	Pumpkinseed sunfish	Yellow perch
Slough	1.68	0.00	0.18	0.97	0.10
Rock	0.00	0.48	0.04	0.03	0.00
Sand	0.27	0.27	0.03	0.39	0.17
Total Age-0 CPUE	0.70	0.24	0.09	0.47	0.08

Age-1

Habitat type	Largemouth bass	Smallmouth bass	Black Crappie	Pumpkinseed sunfish	Yellow perch
Slough	0.46	0.00	0.77	0.63	0.14
Rock	0.01	1.69	0.15	0.10	0.00
Sand	0.03	0.04	0.05	0.08	0.05
Total Age-1 CPUE	0.19	0.59	0.36	0.27	0.06

Age-2

Habitat type	Largemouth bass	Smallmouth bass	Black Crappie	Pumpkinseed sunfish	Yellow perch
Slough	0.13	0.00	0.00	0.88	0.58
Rock	0.00	0.48	0.00	0.34	0.00
Sand	0.00	0.03	0.00	0.21	0.04
Total Age-2 CPUE	0.05	0.20	0.00	1.10	0.23

Combined Age-0 – Age-2

Habitat type	Largemouth bass	Smallmouth bass	Black Crappie	Pumpkinseed sunfish	Yellow perch
Slough	2.23	0.00	0.95	2.43	0.80
Rock	0.01	2.65	0.19	0.46	0.00
Sand	0.30	0.33	0.08	0.65	0.25
Total CPUE	0.95	1.03	0.45	1.85	0.37

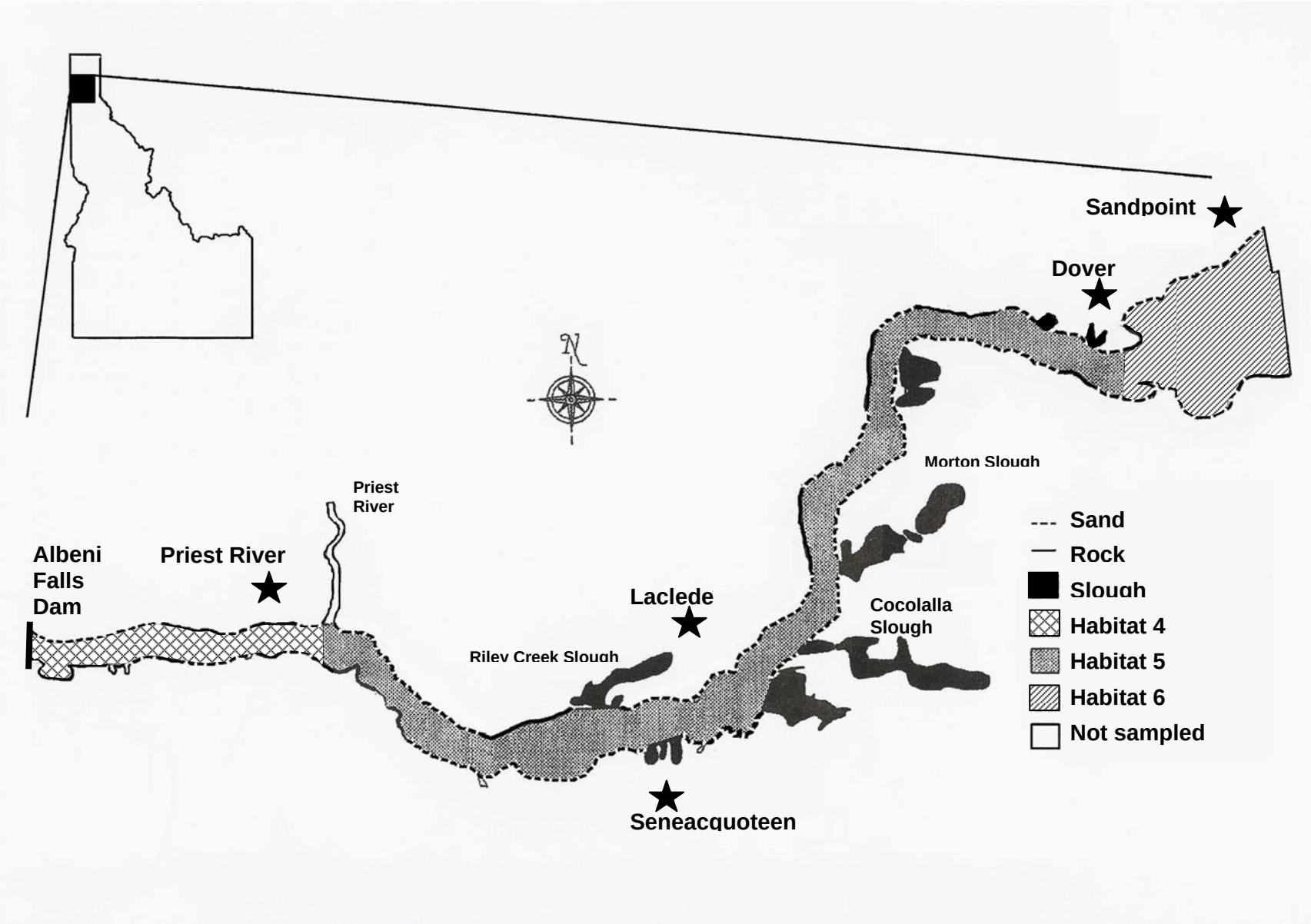

Figure 1. Pend Oreille River, Idaho study area during 2005.

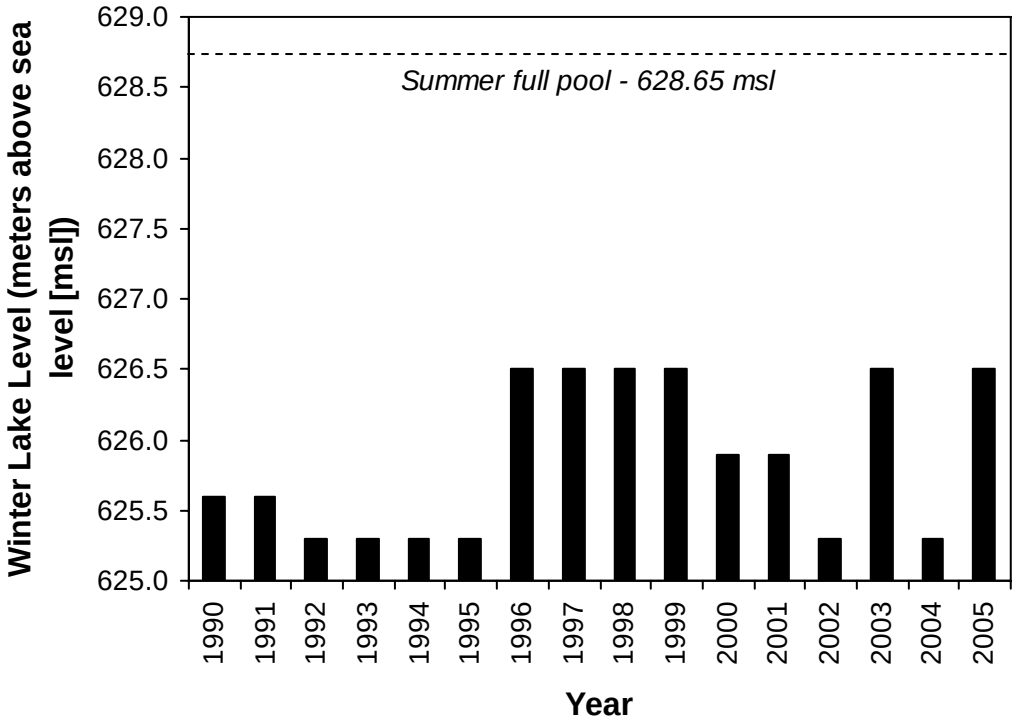

Figure 2. Winter lake levels of Lake Pend Oreille between 1990 and 2005 (data from U.S. Army Corp of Engineers).

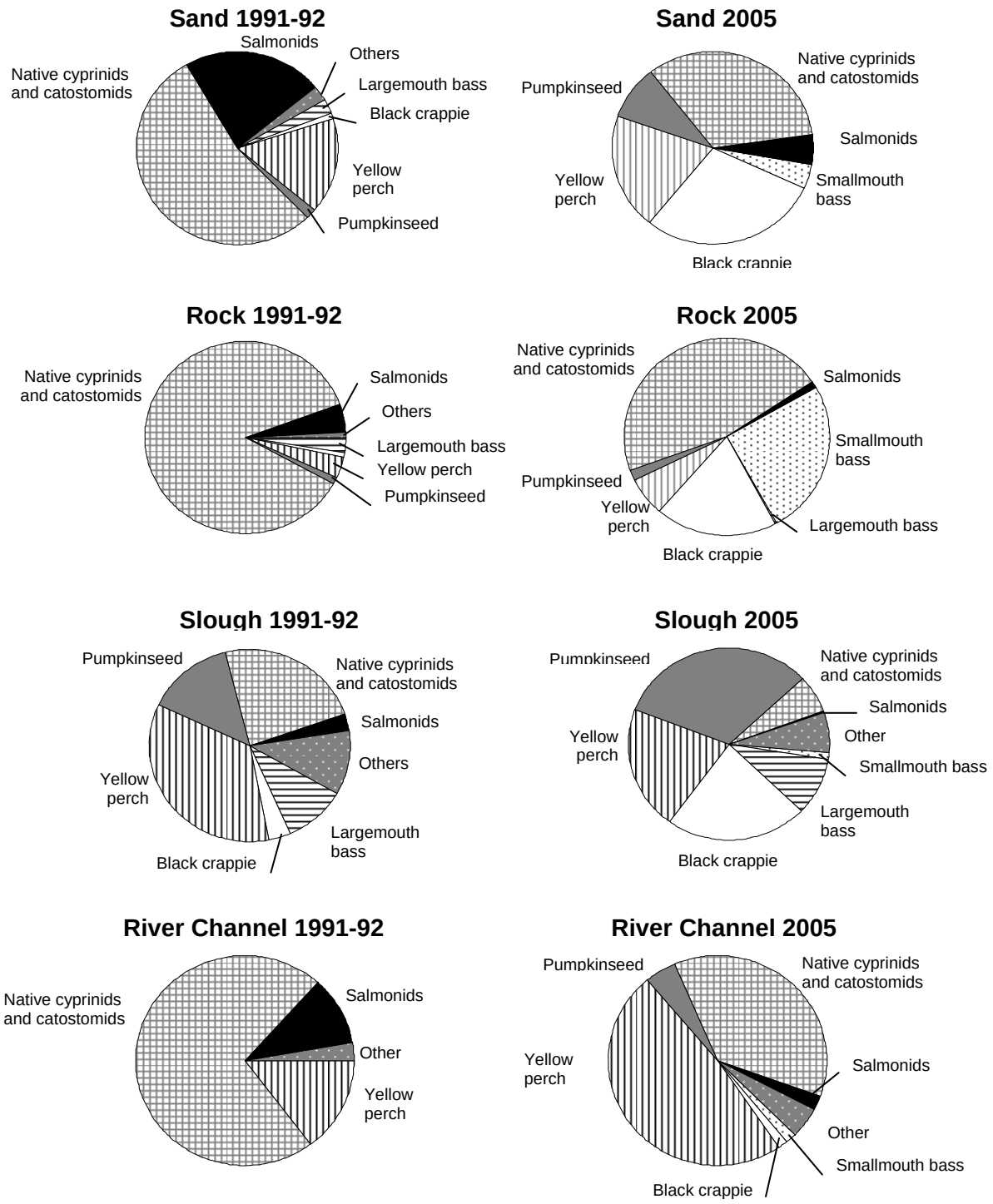

Figure 3. Species composition (by littoral habitat type and main river channel) of the fish community in the Pend Oreille River, Idaho. Data from 1991-1992 are from Bennett and DuPont (1993).

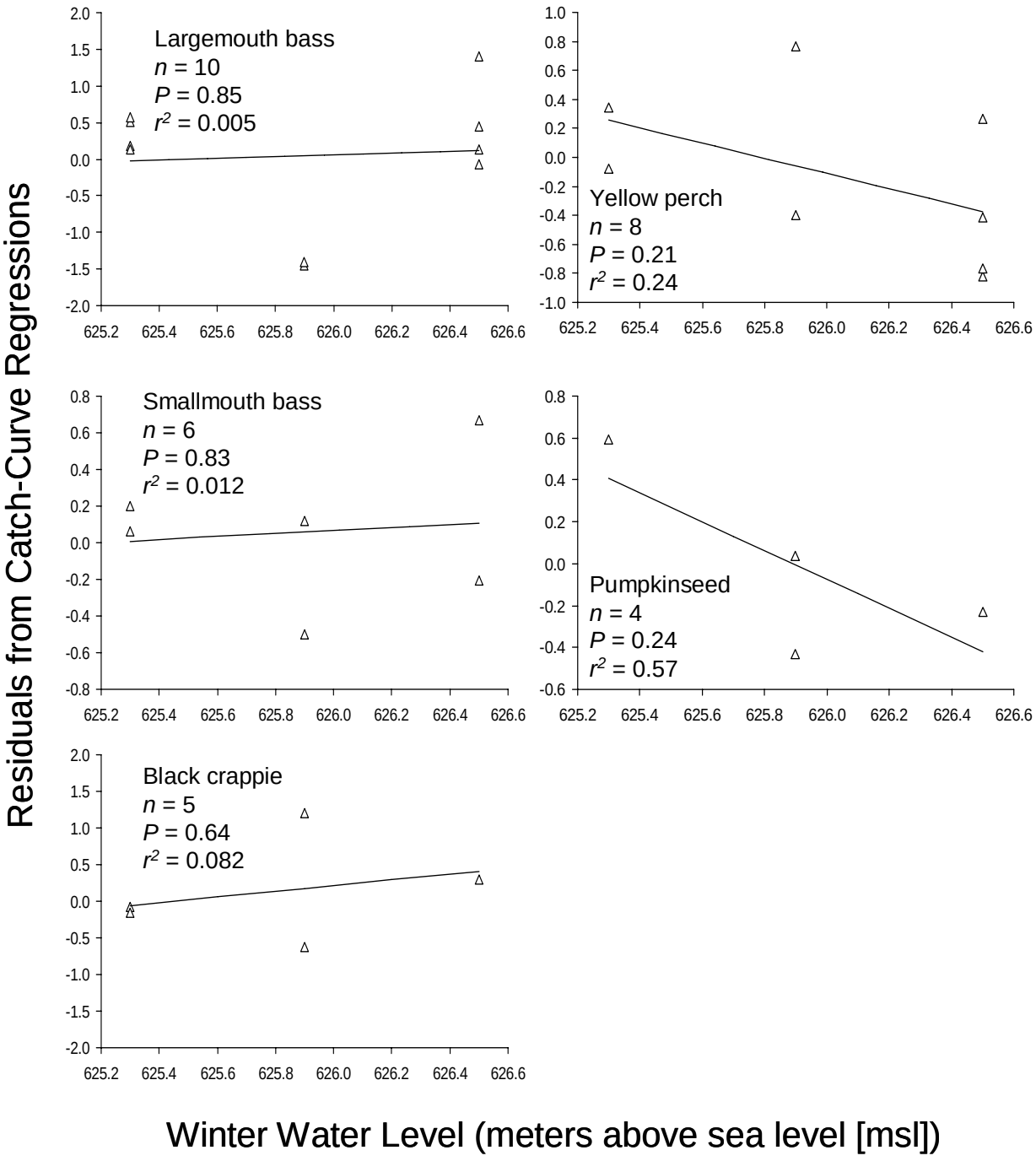

Figure 4. Residual values derived from catch-curve regressions plotted against winter water level (meters above sea level [MSL]) for various fish species in the Pend Oreille River, Idaho.

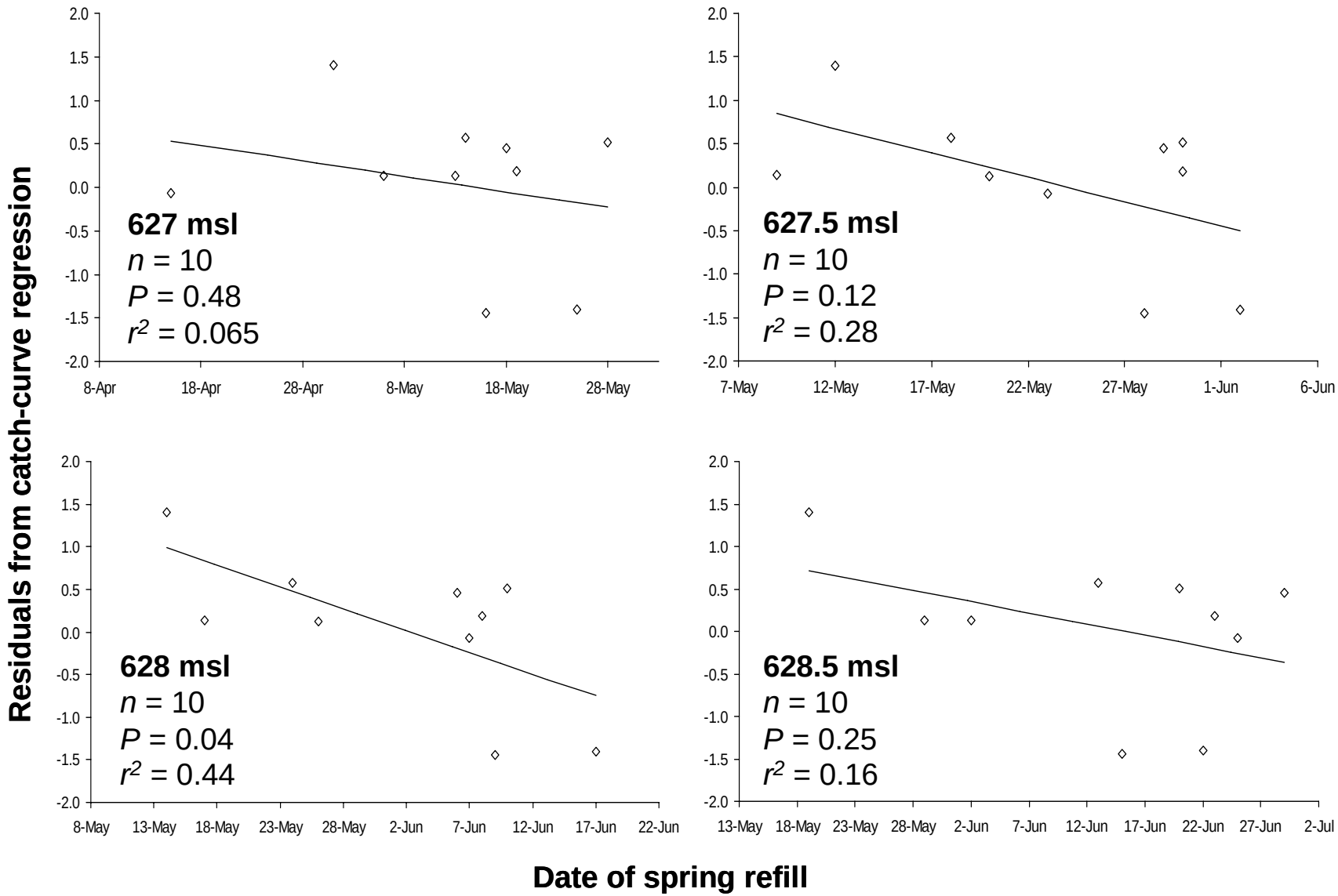

Figure 5. Residual values derived from largemouth bass catch-curve regressions plotted against date of four refill levels (in meters above sea level [MSL]) of Lake Pend Oreille.

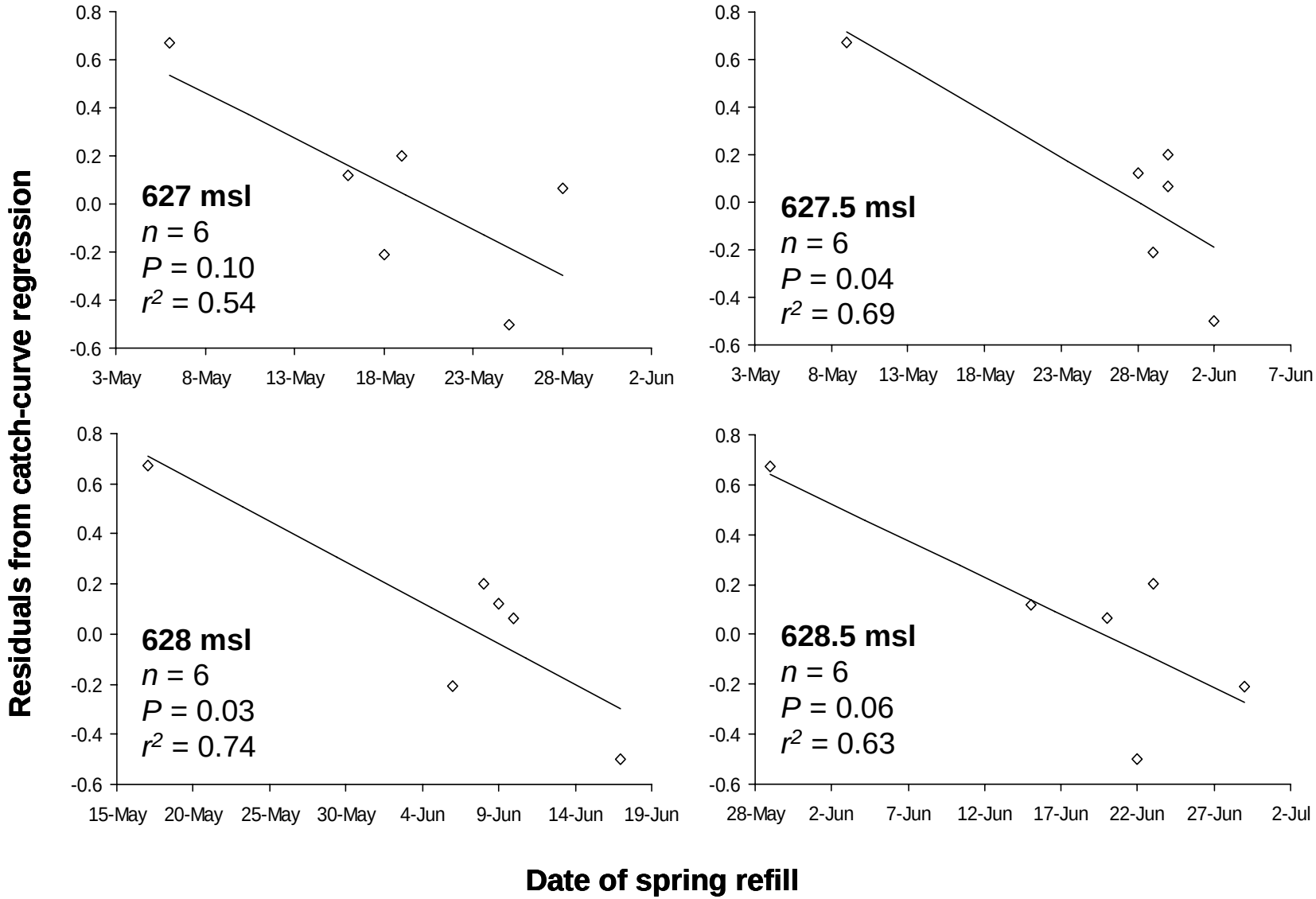

Figure 6. Residual values derived from smallmouth bass catch-curve regressions plotted against date of four refill levels (in meters above sea level [MSL]) of Lake Pend Oreille.

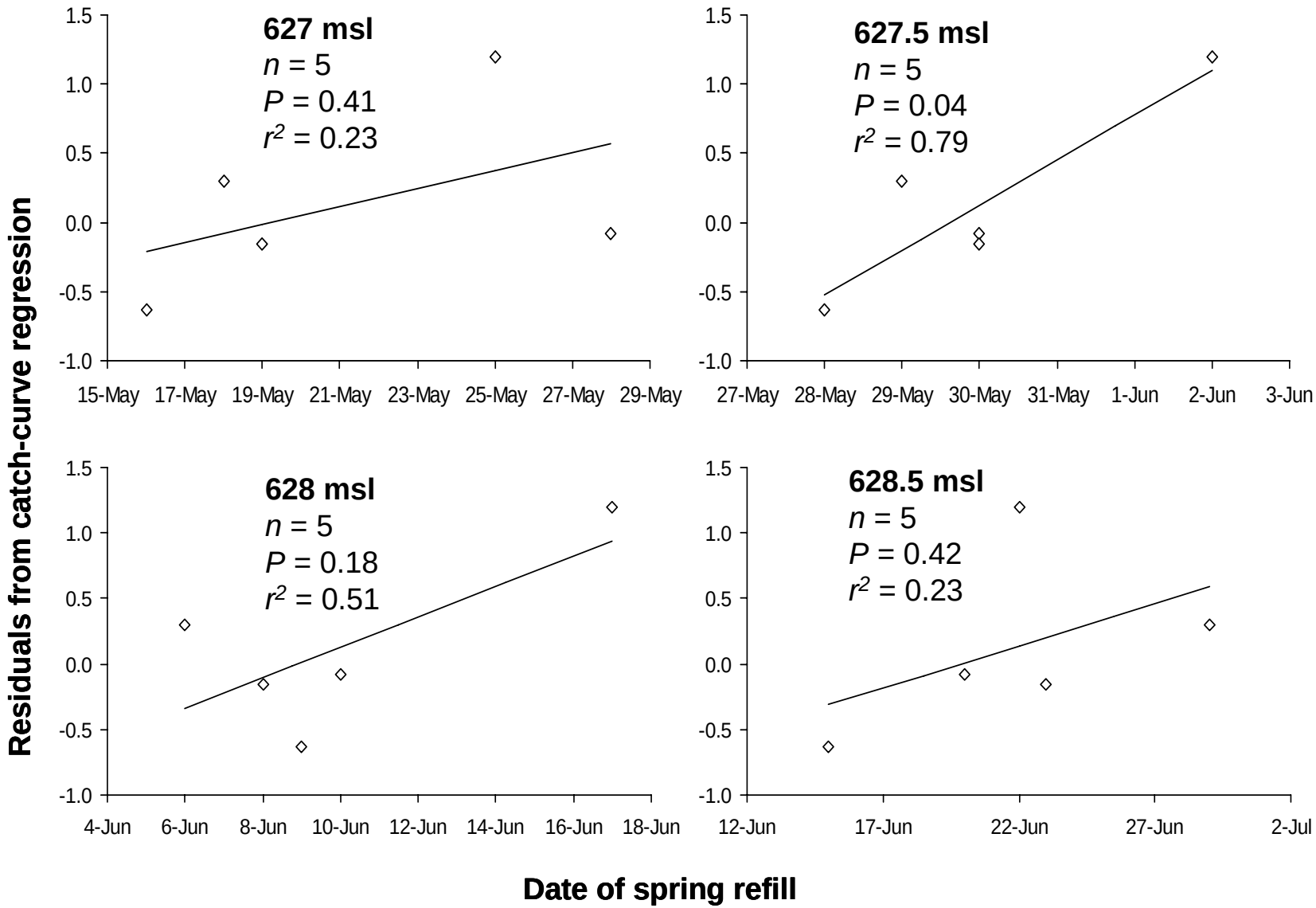

Figure 7. Residual values derived from black crappie catch-curve regressions plotted against date of four refill levels (in meters above sea level [MSL]) of Lake Pend Oreille.

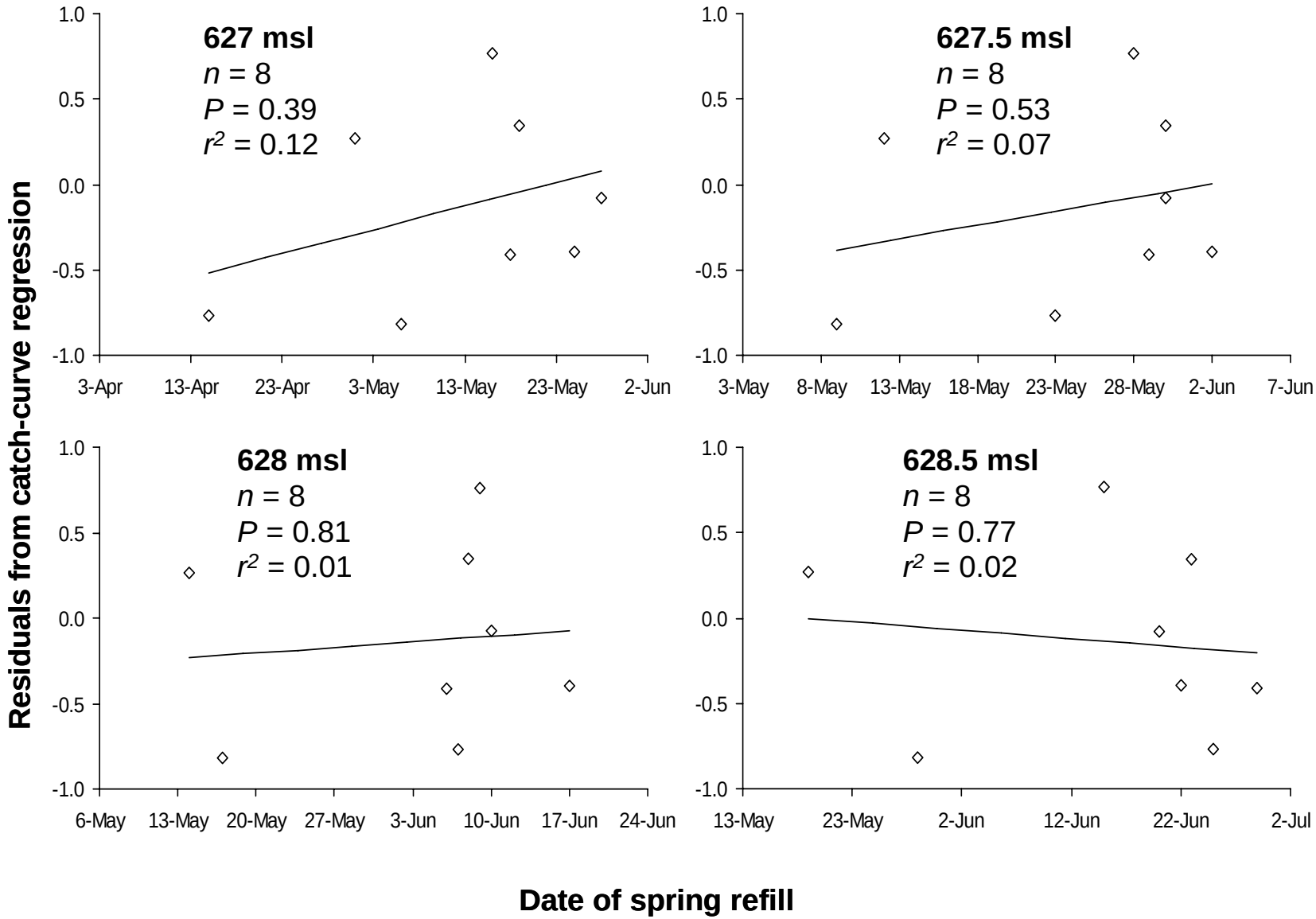

Figure 8. Residual values derived from yellow perch catch-curve regressions plotted against date of four refill levels (in meters above sea level [MSL]) of Lake Pend Oreille.

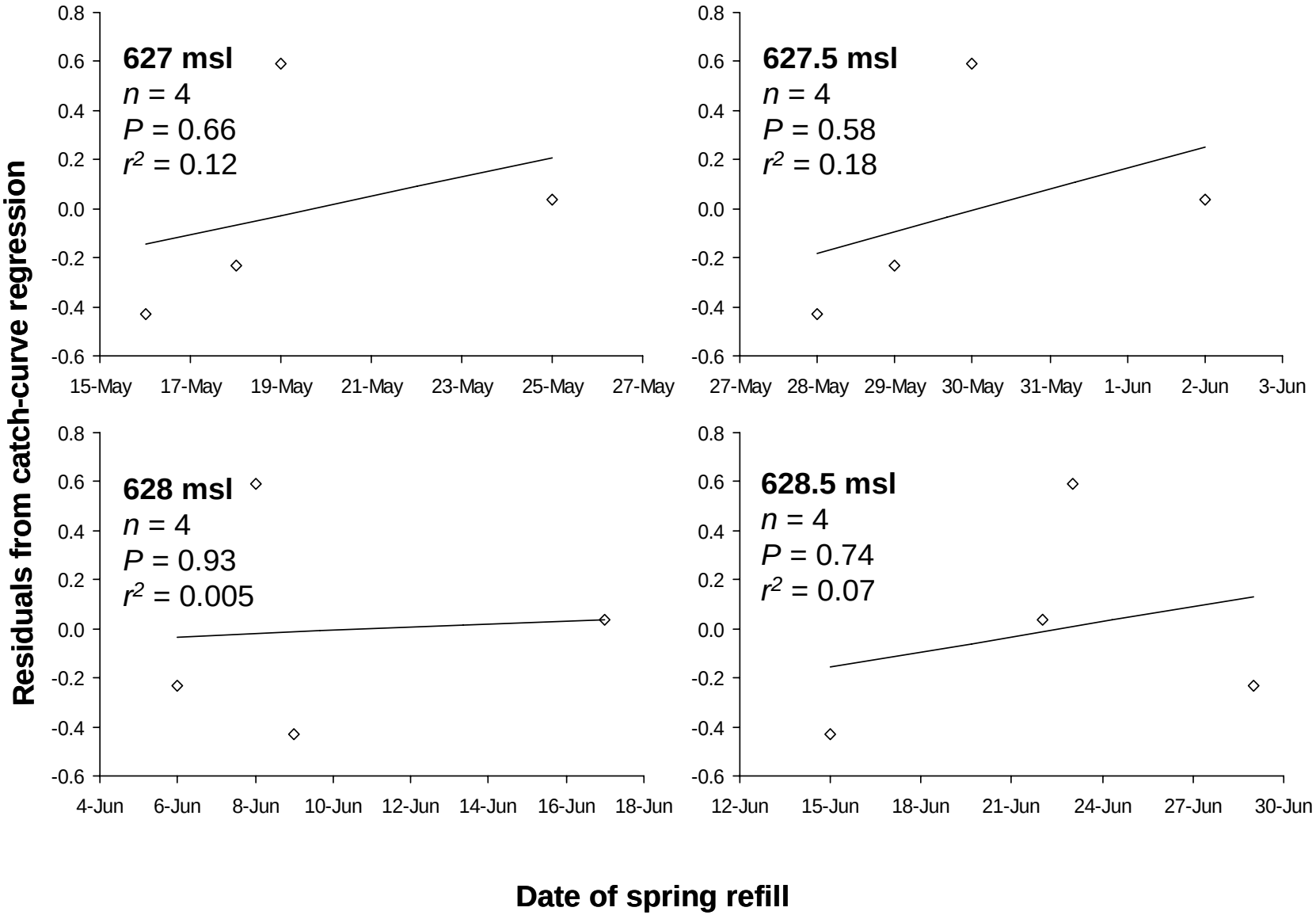

Figure 9. Residual values derived from pumpkinseed catch-curve regressions plotted against date of four refill levels (in meters above sea level [MSL]) of Lake Pend Oreille.

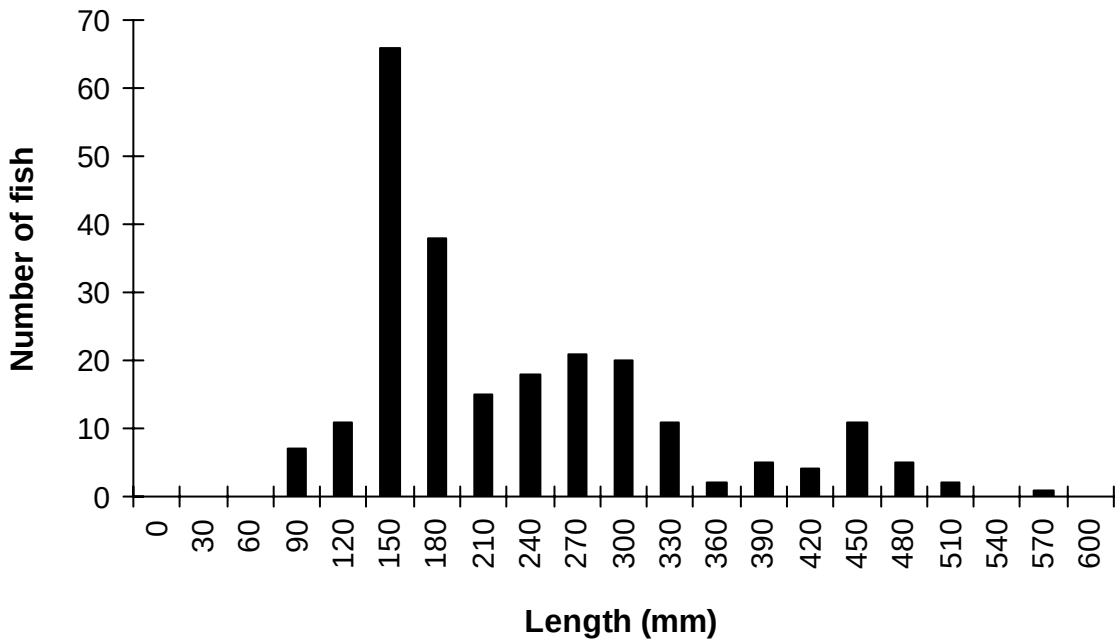

Figure 10. Length-frequency of largemouth bass captured (*n* = 237; mean total length = 216 mm) during 2005 in the Pend Oreille River, Idaho.

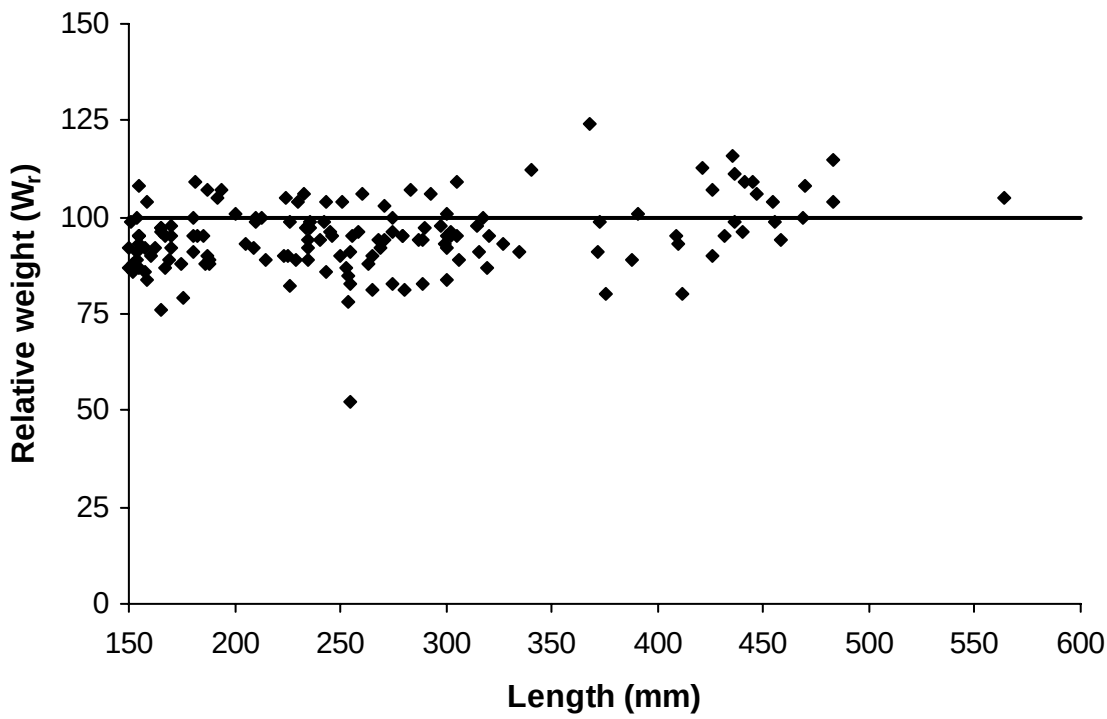

Figure 11. Relative weights (W_r) of largemouth bass (n = 150, mean = 95%) in the Pend Oreille River, Idaho, 2005.

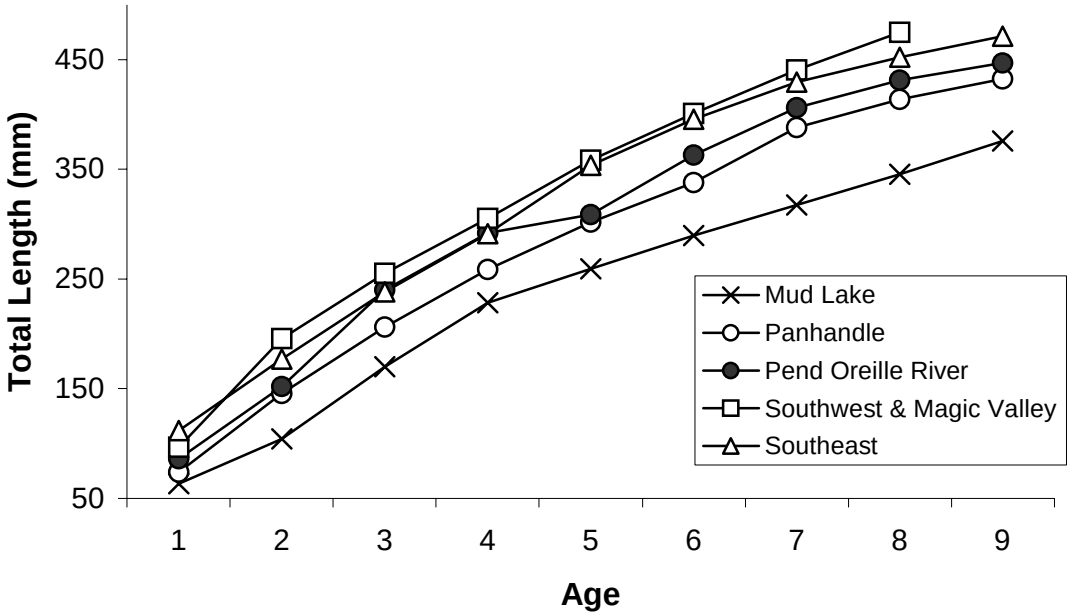

Figure 12. Average largemouth bass growth for five locations throughout Idaho. The black circles represent growth rates from the Pend Oreille River in 2005. Statewide data is from Dillon (1995); open squares represent average growth rates from the Southwest and Magic Valley Regions, open triangles represent data from the Southeast Region, open circles represent the Panhandle and Clearwater Regions, and X's represent data from Mud Lake (Upper Snake Region).

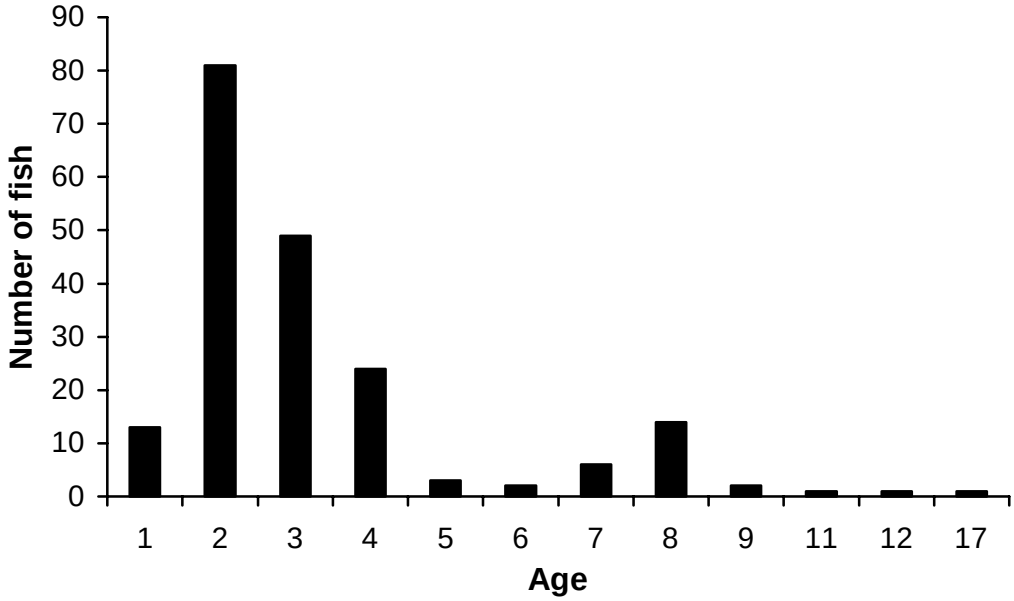

Figure 13. Age frequency distribution of largemouth bass in the Pend Oreille River, Idaho, collected by electrofishing during June 2005.

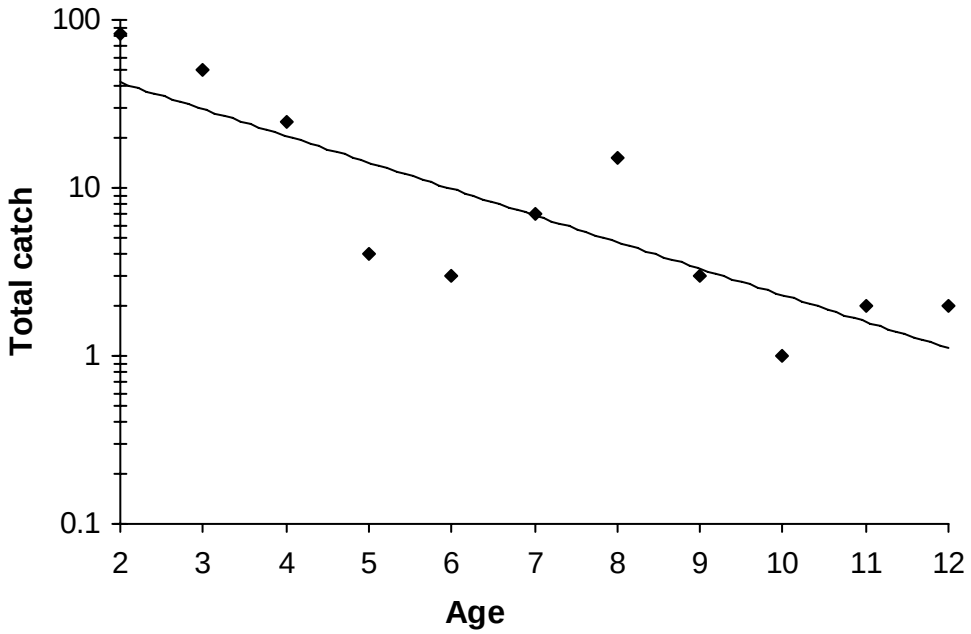

Figure 14. Catch curve analysis of largemouth bass, age-2 to age-12, in the Pend Oreille River, Idaho, 2005. Total annual mortality was 34% (r^2 = 0.71).

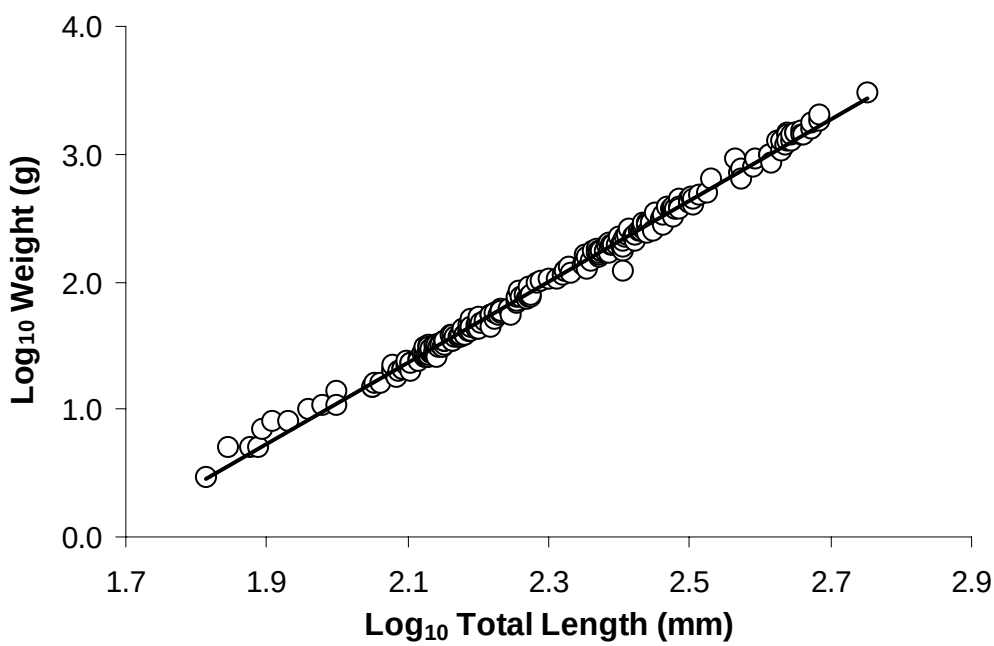

Figure 15. The relationship between weight (g) and total length (mm) of largemouth bass in the Pend Oreille River, Idaho, during 2005. The equation of the line is: $\log_{10}$ weight (g) = 3.19 $\log_{10}$ total length (mm) – 5.33, (r^2 = 0.99; n = 219).

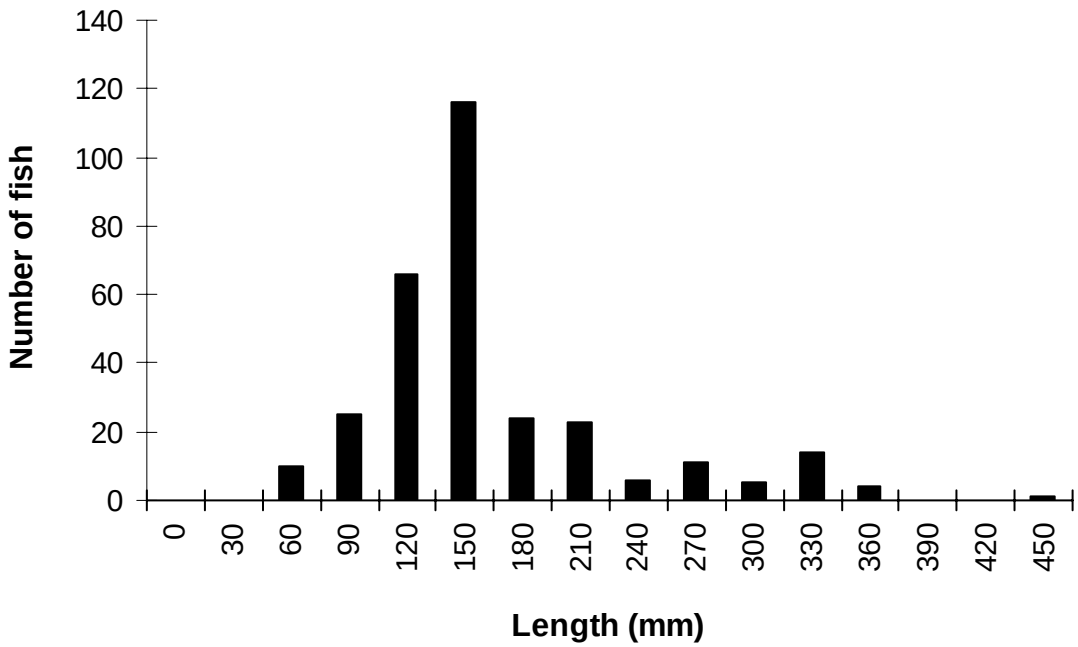

Figure 16. Length-frequency of smallmouth bass captured (*n* = 305; mean total length = 148 mm) during 2005 in the Pend Oreille River, Idaho.

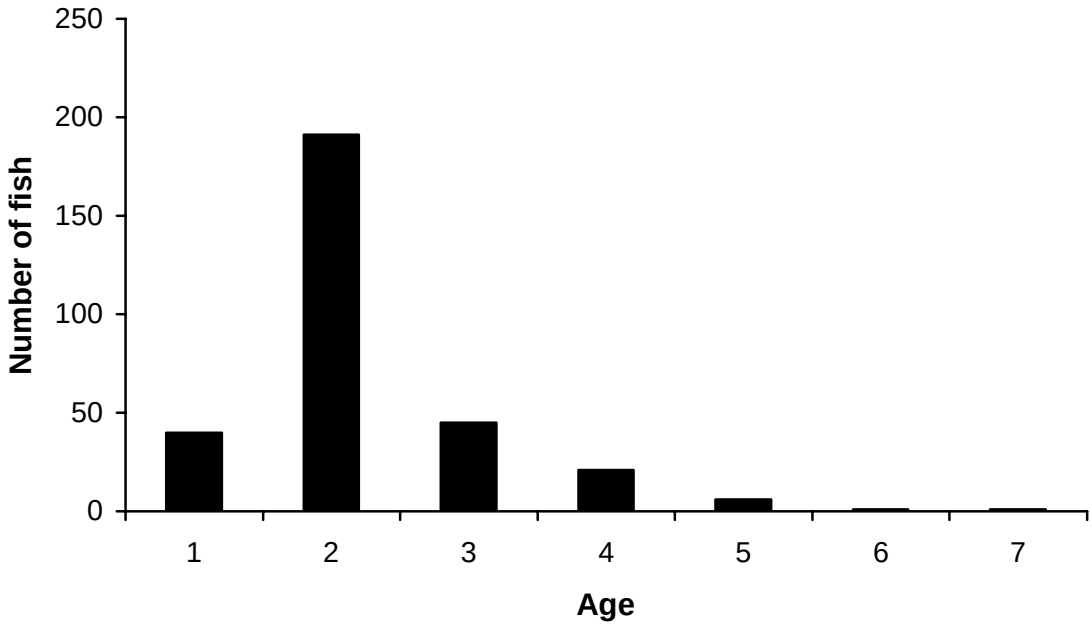

Figure 17. Age frequency distribution of smallmouth bass in the Pend Oreille River, Idaho collected by electrofishing during June 2005.

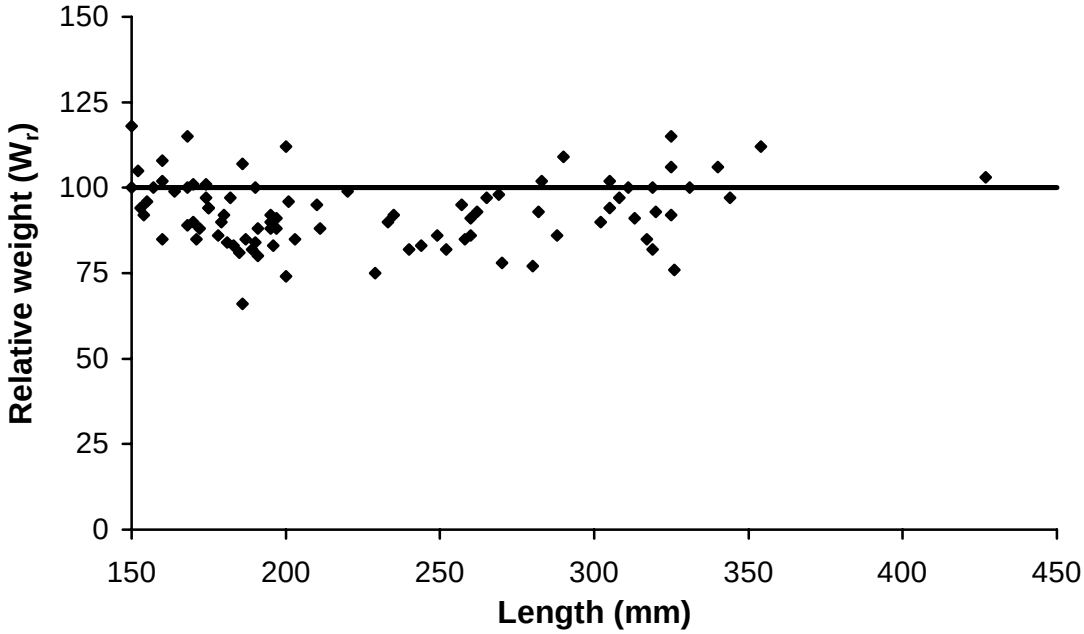

Figure 18. Relative weights (W_r) of smallmouth bass (n = 89, mean = 93%) in the Pend Oreille River, Idaho, 2005.

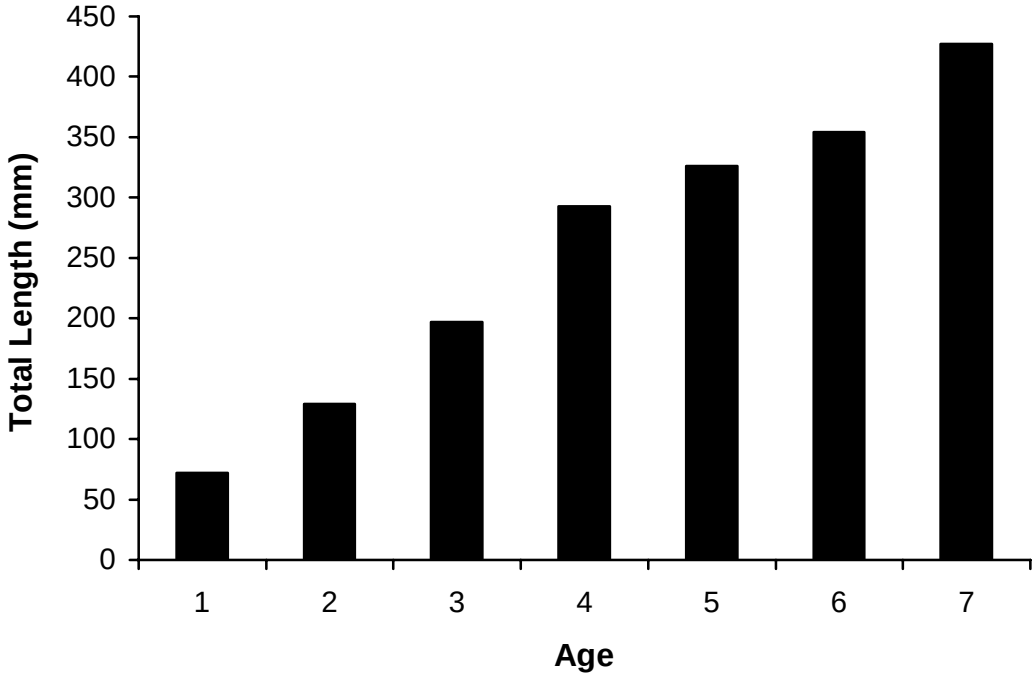

Figure 19. Mean length at age of smallmouth bass in the Pend Oreille River, Idaho, captured by electrofishing in 2005.

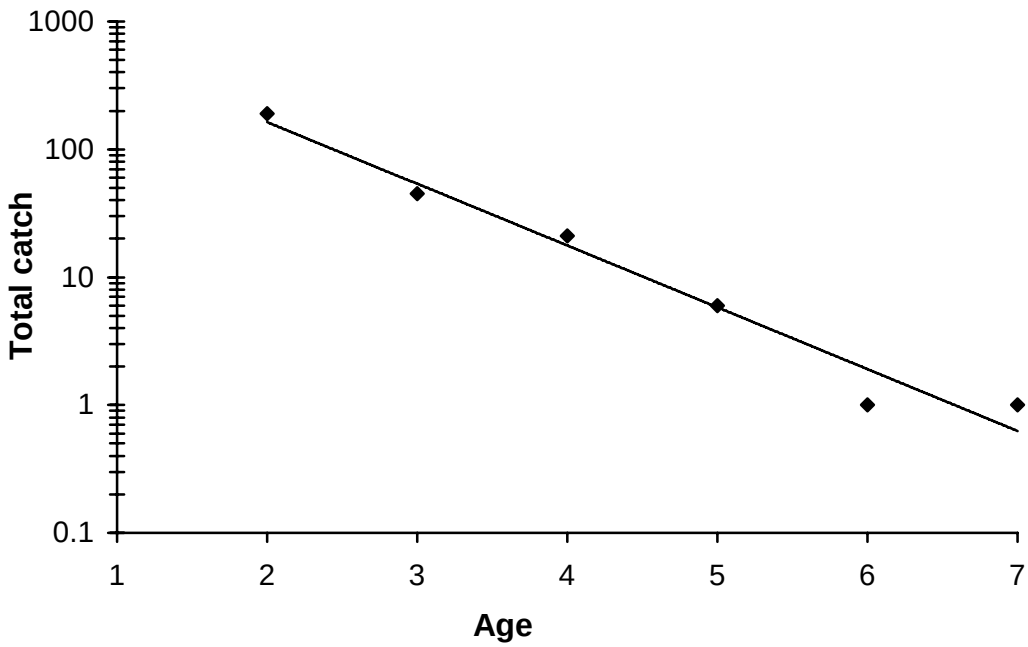

Figure 20. Catch curve analysis of smallmouth bass, age-2 to age-7, in the Pend Oreille River, Idaho, 2005. Total annual mortality was 69% (r^2 = 0.97).

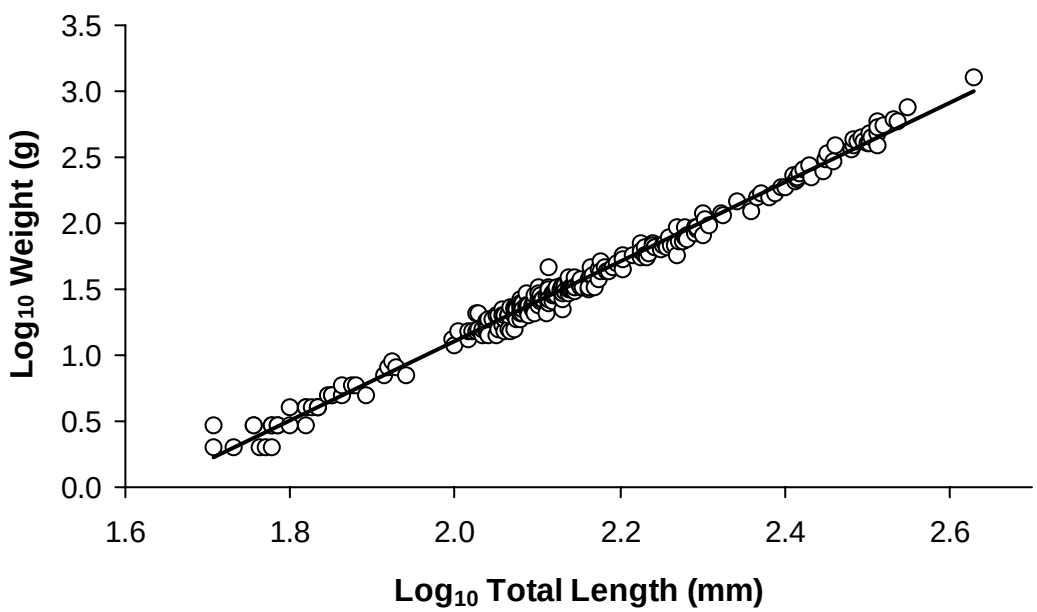

Figure 21. The relationship between weight (g) and total length (mm) of smallmouth bass in the Pend Oreille River, Idaho, during 2005. The equation of the line is: $\log_{10}$ weight (g) = 3.00 $\log_{10}$ total length (mm) – 4.90, (r^2 = 0.99; n = 291).

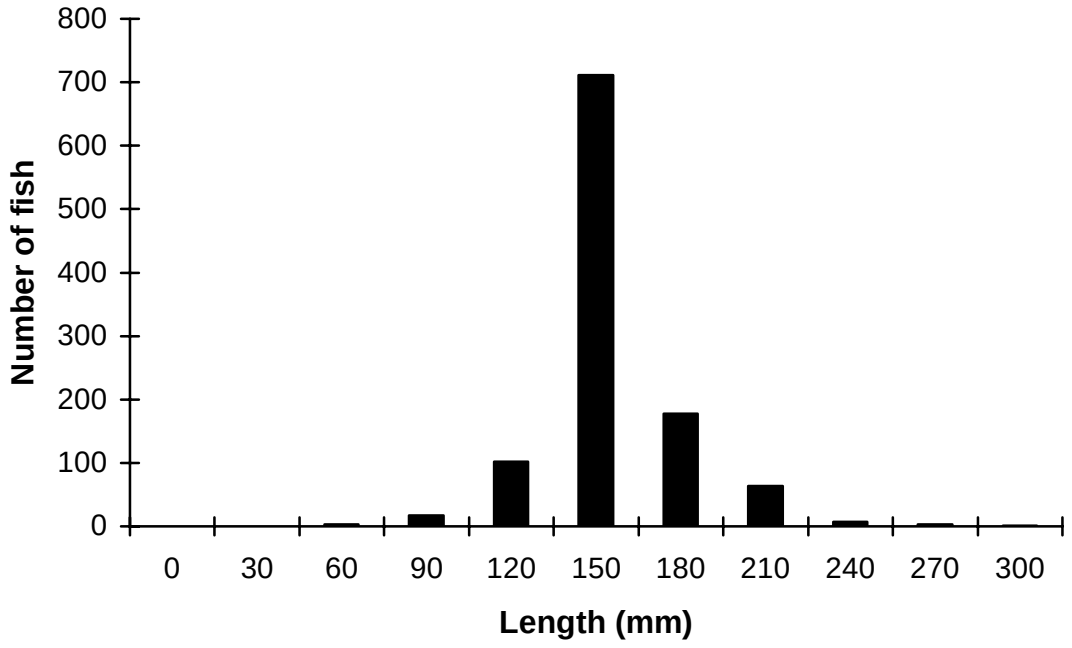

Figure 22. Length-frequency of black crappie captured (*n* = 1,086; mean total length = 141 mm) during 2005 in the Pend Oreille River, Idaho.

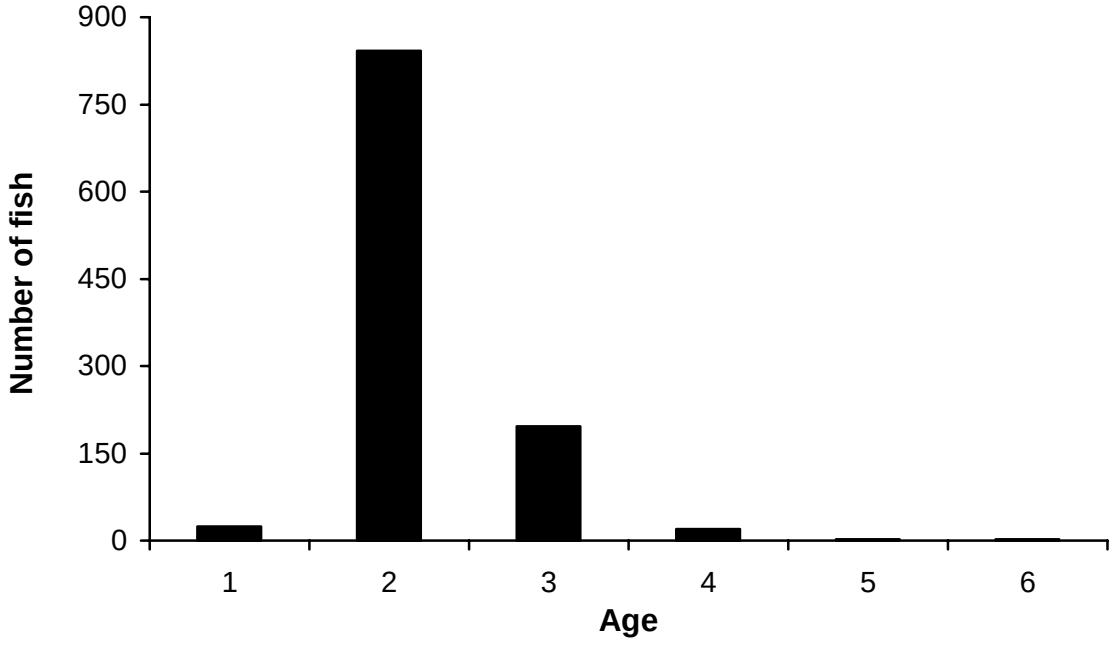

Figure 23. Age frequency distribution of black crappie in the Pend Oreille River, Idaho, collected by electrofishing during June 2005.

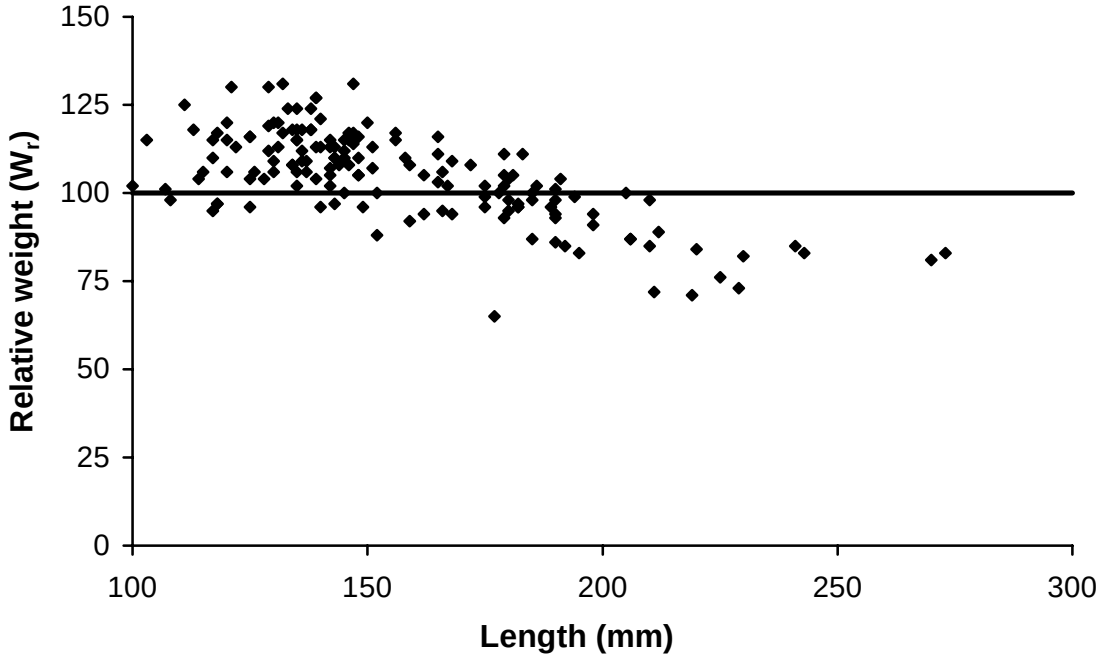

Figure 24. Relative weights (W_r) of black crappie (n = 155, mean = 104%) in the Pend Oreille River, Idaho, 2005.

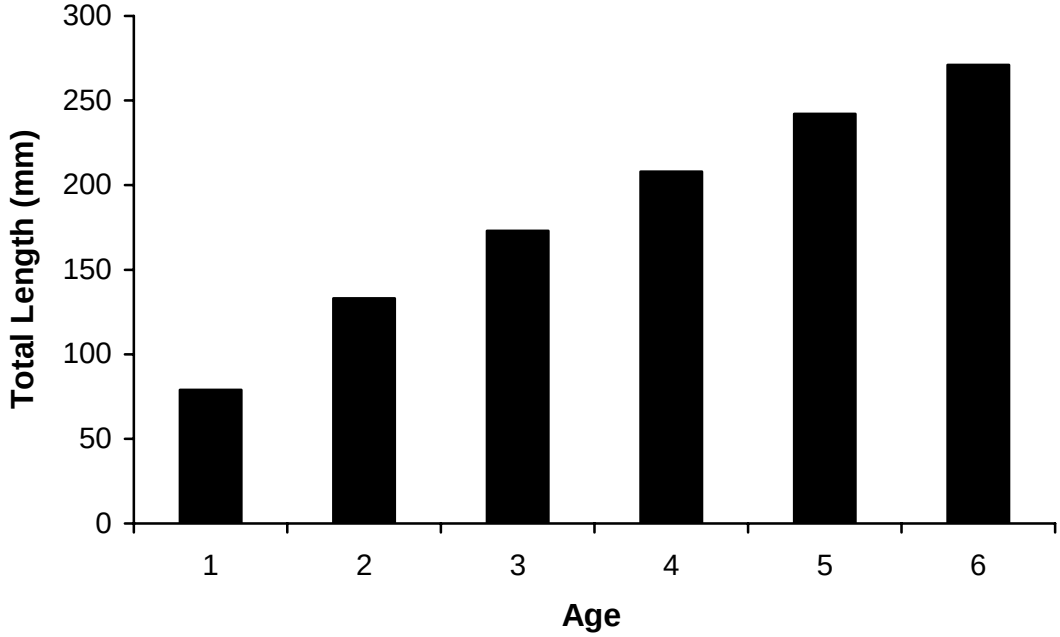

Figure 25. Mean length at age of black crappie in the Pend Oreille River, Idaho, captured by electrofishing in 2005.

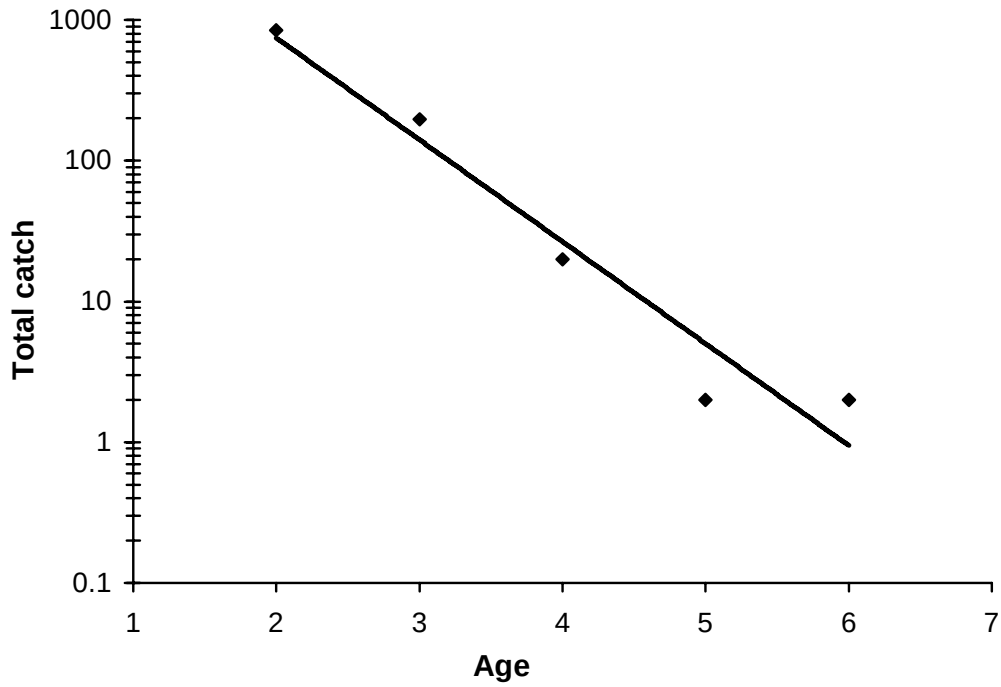

Figure 26. Catch curve analysis of black crappie, age-2 to age-6, in the Pend Oreille River, Idaho, 2005. Total annual mortality was 84% (r^2 = 0.97).

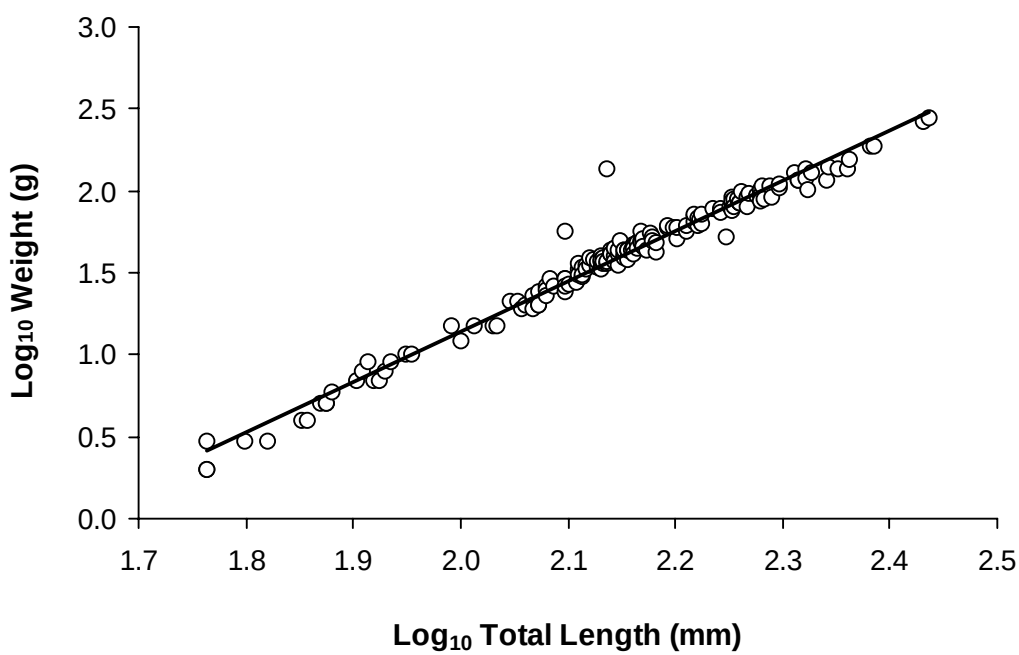

Figure 27. The relationship between weight (g) and total length (mm) of black crappie in the Pend Oreille River, Idaho during 2005. The equation of the line is: $\log_{10}$ weight (g) = 3.06 $\log_{10}$ total length (mm) – 4.98, (r^2 = 0.97; n = 179).

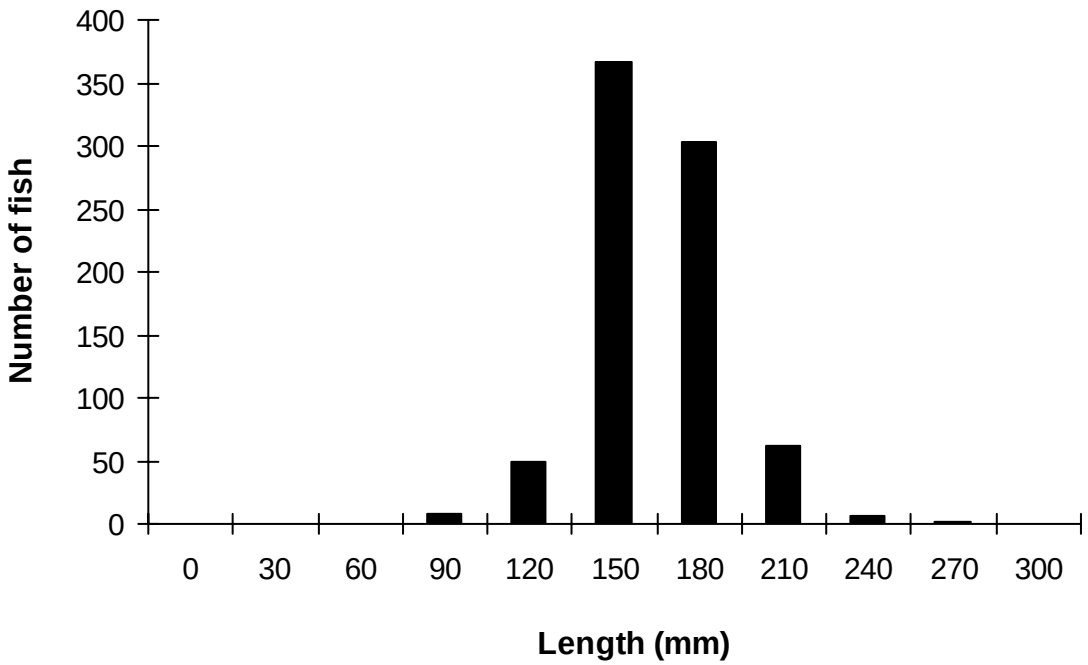

Figure 28. Length-frequency of yellow perch captured (*n* = 797; mean total length = 151 mm) during 2005 in the Pend Oreille River, Idaho.

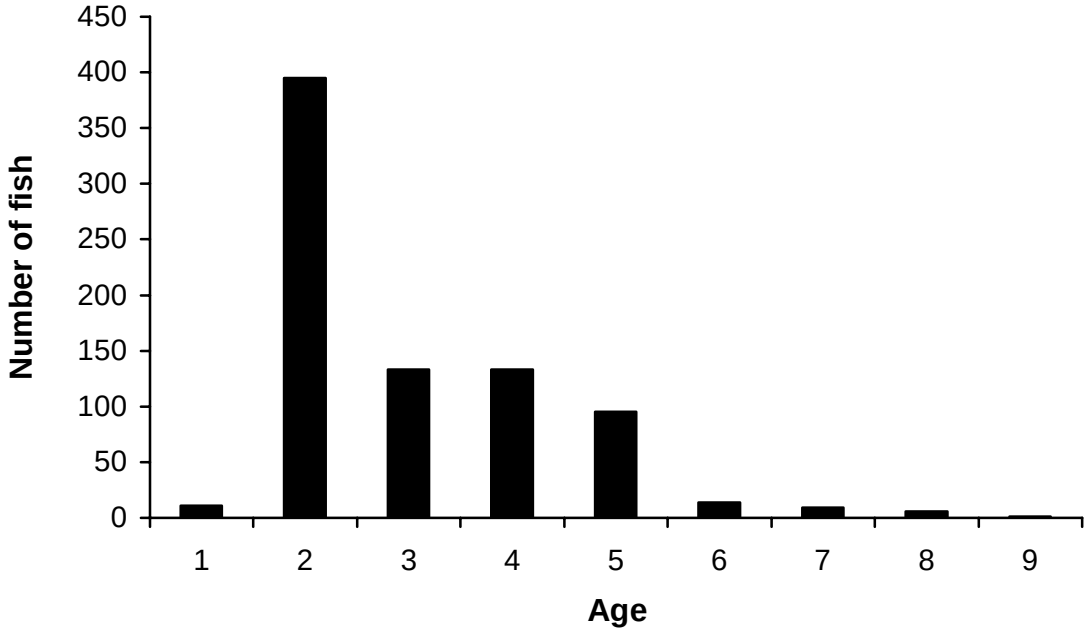

Figure 29. Age frequency distribution of yellow perch in the Pend Oreille River, Idaho collected by electrofishing during June 2005.

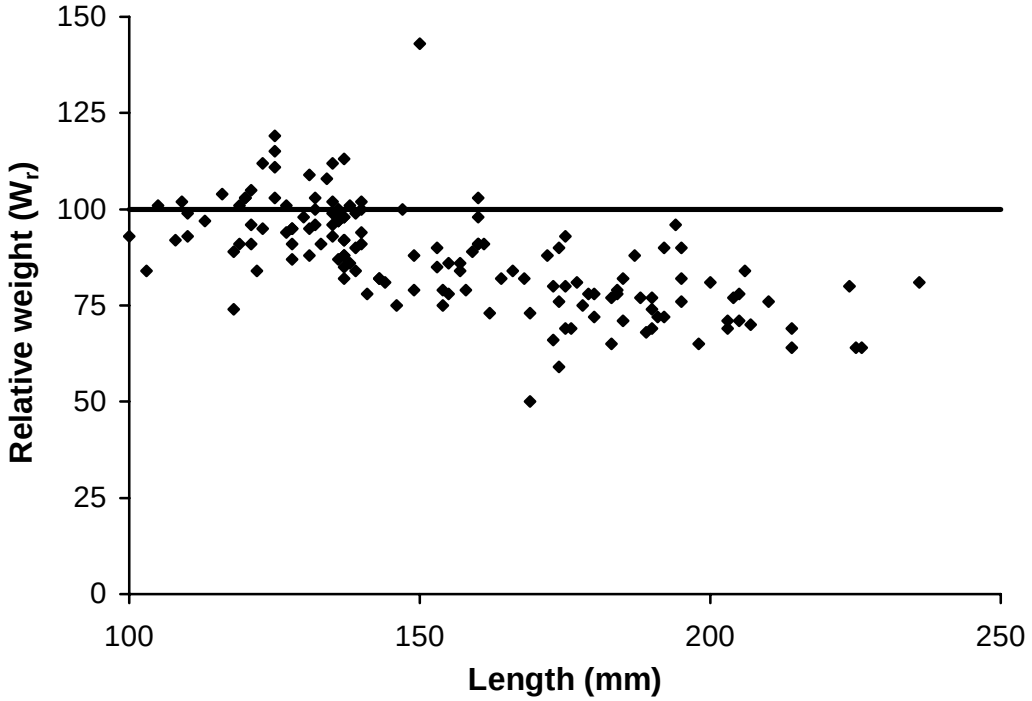

Figure 30. Relative weights (W_r) of yellow perch (n = 150, mean = 87%) in the Pend Oreille River, Idaho, 2005.

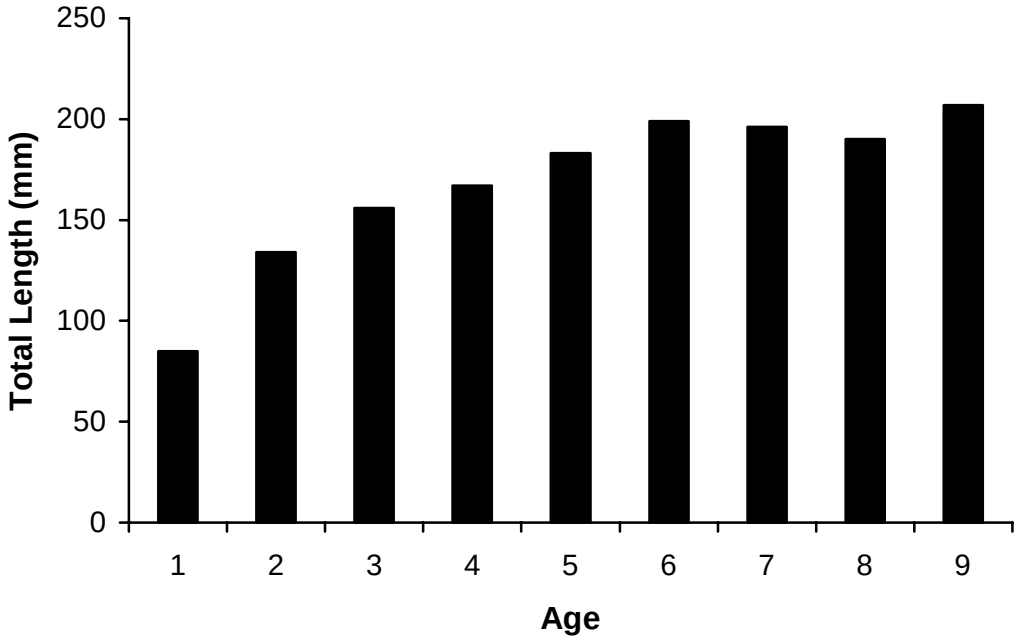

Figure 31. Mean length at age of yellow perch in the Pend Oreille River, Idaho captured by electrofishing in 2005.

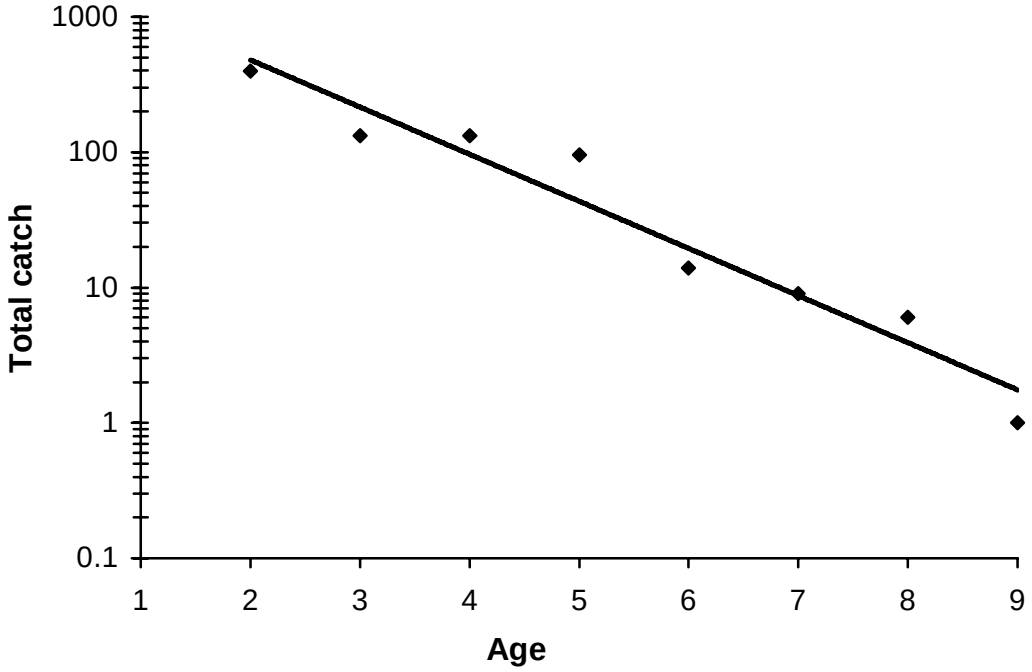

Figure 32. Catch curve analysis of yellow perch, age-2 to age-9, in the Pend Oreille River, Idaho, 2005. Total annual mortality was 53% (r^2 = 0.93).

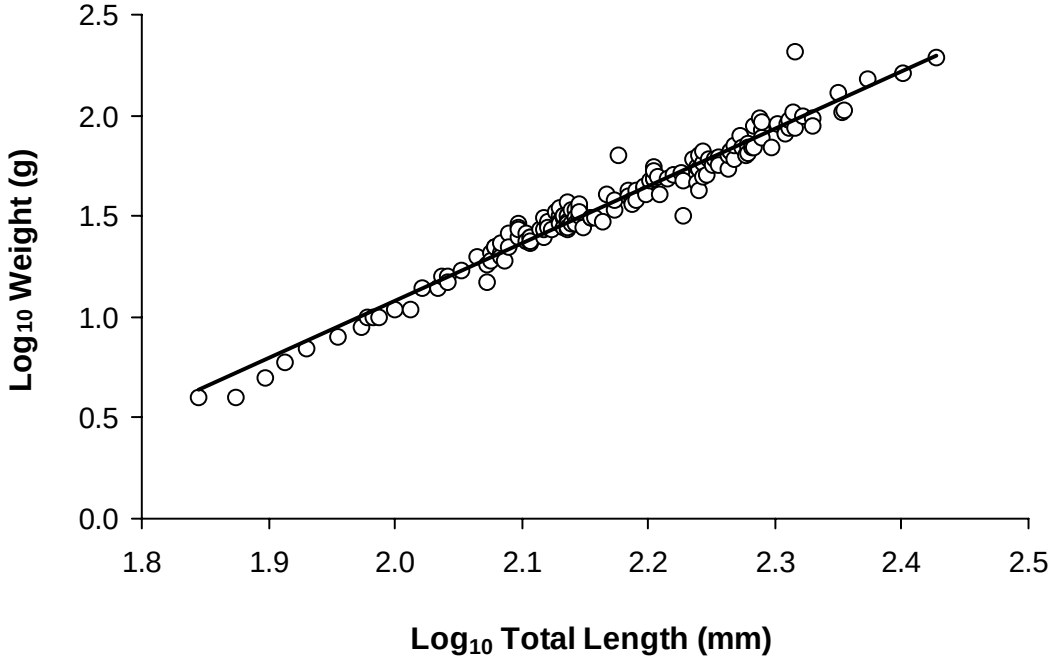

Figure 33. The relationship between weight (g) and total length (mm) of yellow perch in the Pend Oreille River, Idaho during 2005. The equation of the line is: $\log_{10}$ weight (g) = 2.86 $\log_{10}$ total length (mm) – 4.65, (r^2 = 0.96; n = 161).

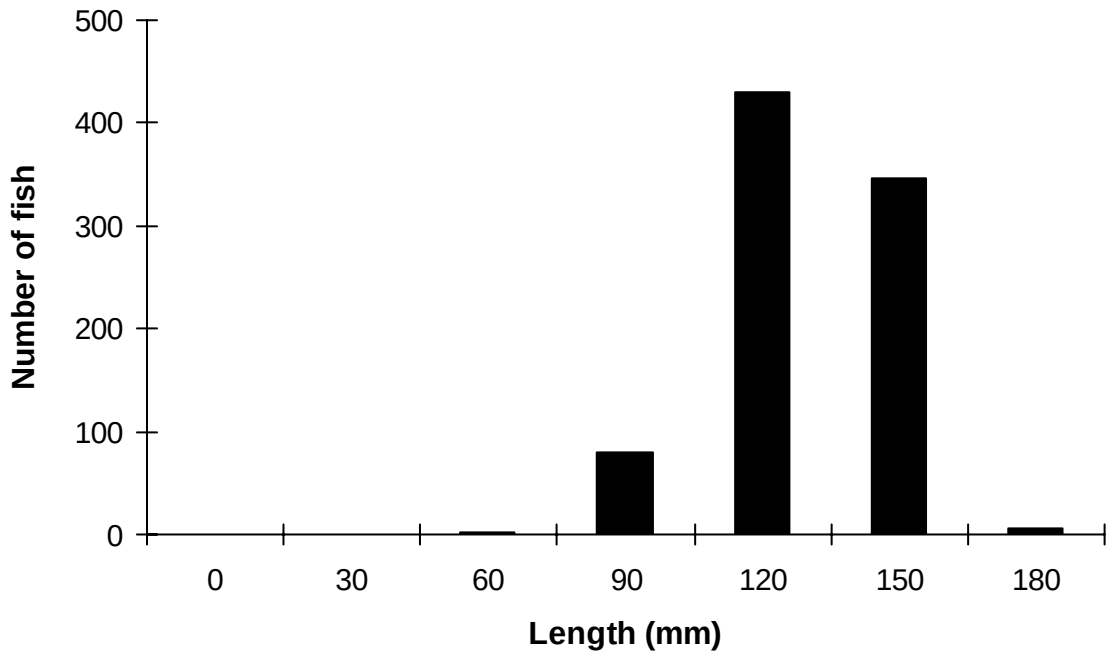

Figure 34. Length-frequency of pumpkinseed captured (*n* = 862; mean total length = 116 mm) during 2005 in the Pend Oreille River, Idaho.

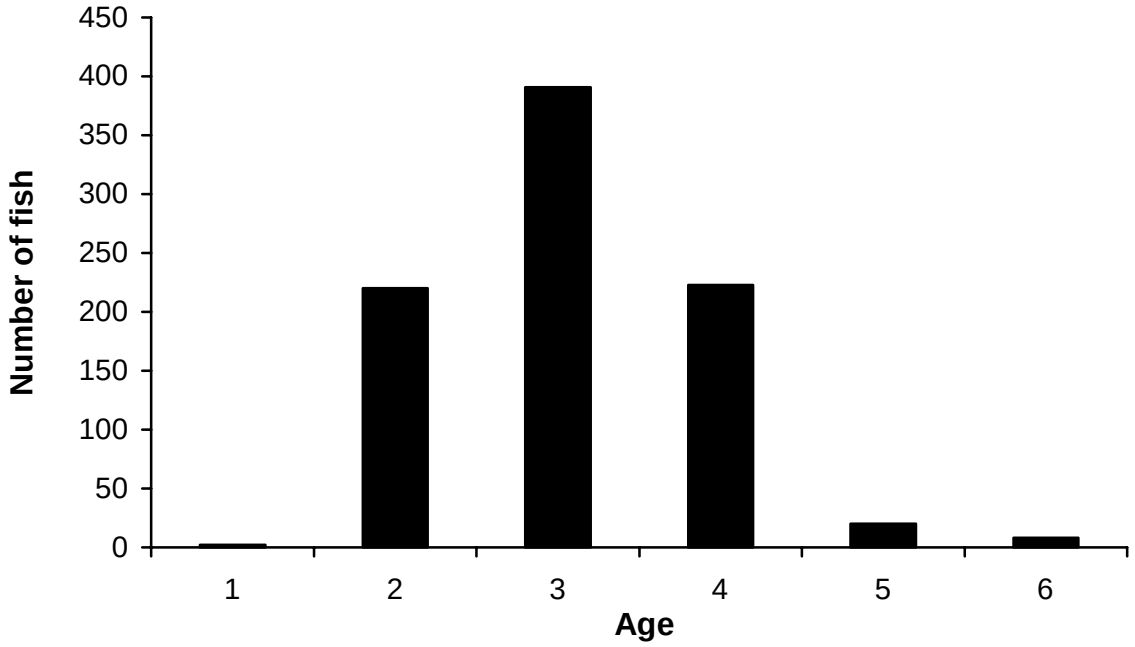

Figure 35. Age frequency distribution of pumpkinseed in the Pend Oreille River, Idaho collected by electrofishing during June 2005.

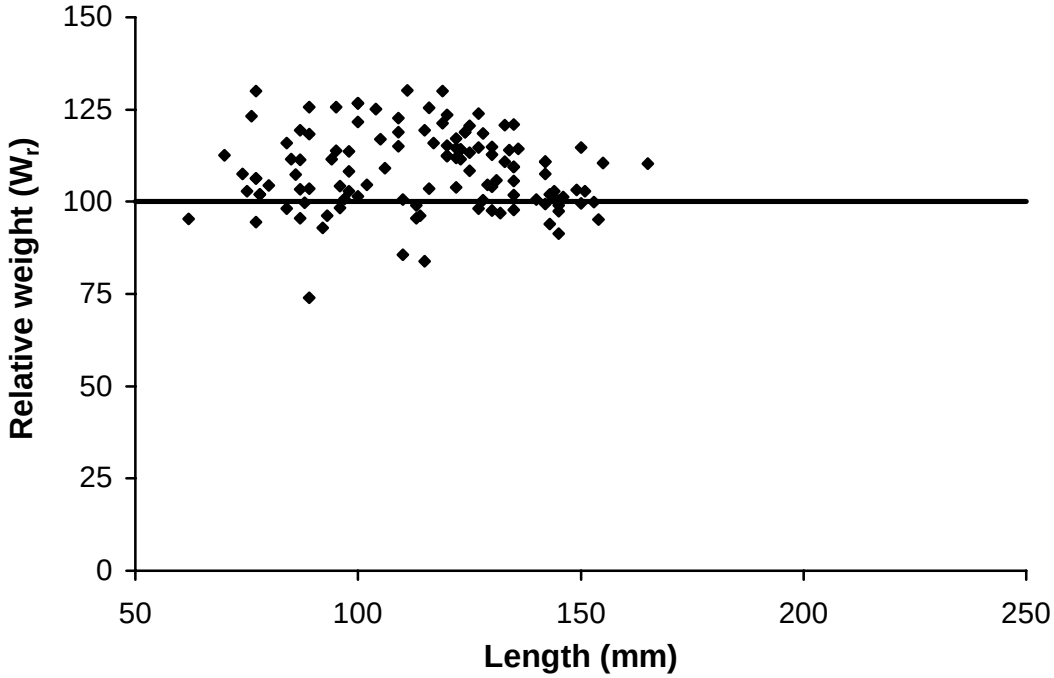

Figure 36. Relative weights (W_r) of pumpkinseed (n = 119, mean = 109%) in the Pend Oreille River, Idaho, 2005.

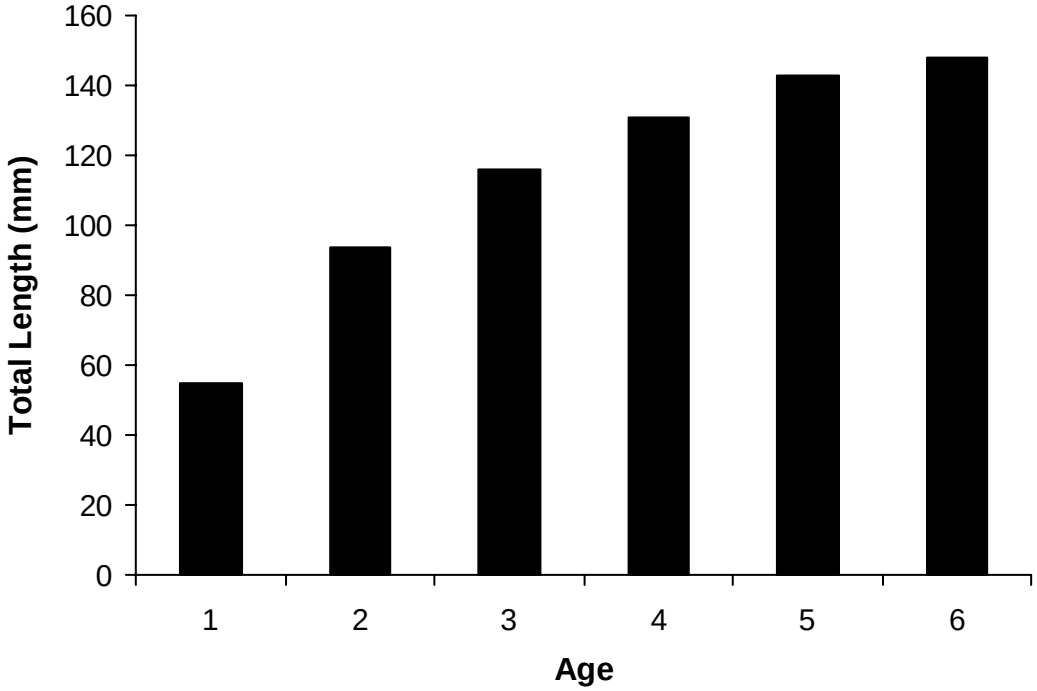

Figure 37. Mean length at age of pumpkinseed in the Pend Oreille River, Idaho captured by electrofishing in 2005.

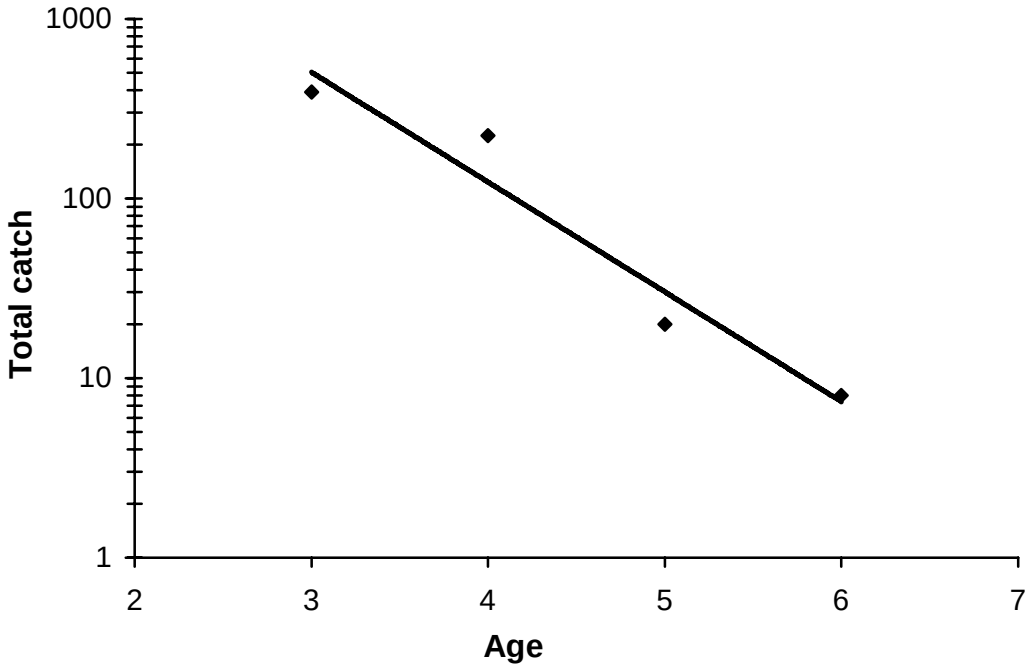

Figure 38. Catch curve analysis of pumpkinseed, age-3 to age-6, in the Pend Oreille River, Idaho, 2005. Total annual mortality was 75% (r^2 = 0.93).

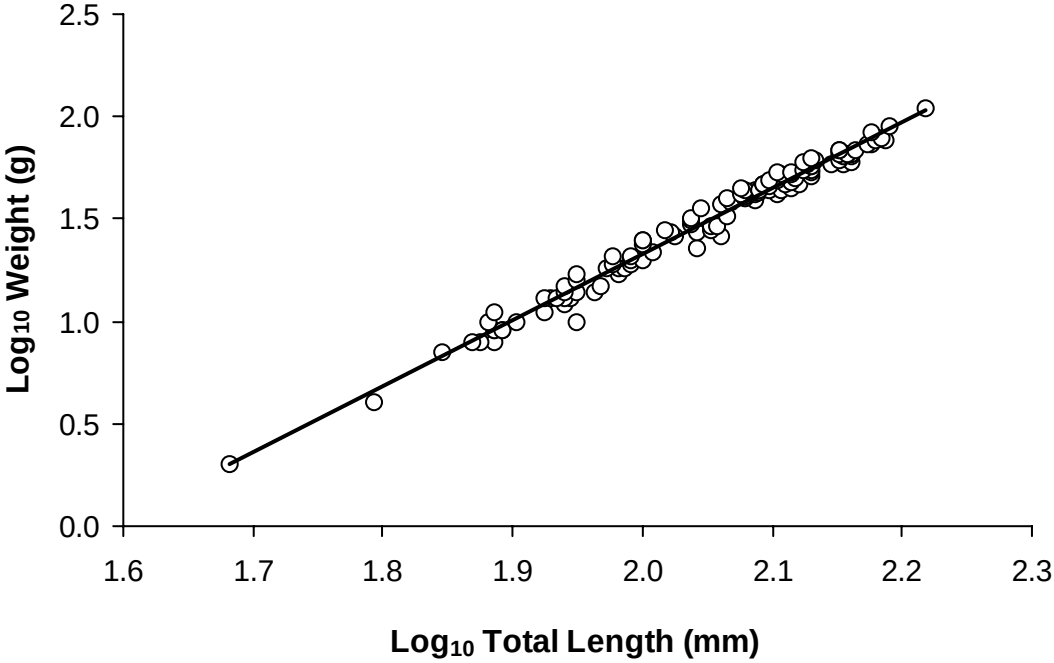

Figure 39. The relationship between weight (g) and total length (mm) of pumpkinseed in the Pend Oreille River, Idaho during 2005. The equation of the line is: $\log_{10}$ weight (g) = 3.23 $\log_{10}$ total length (mm) – 5.13, (r^2 = 0.98; n = 120).

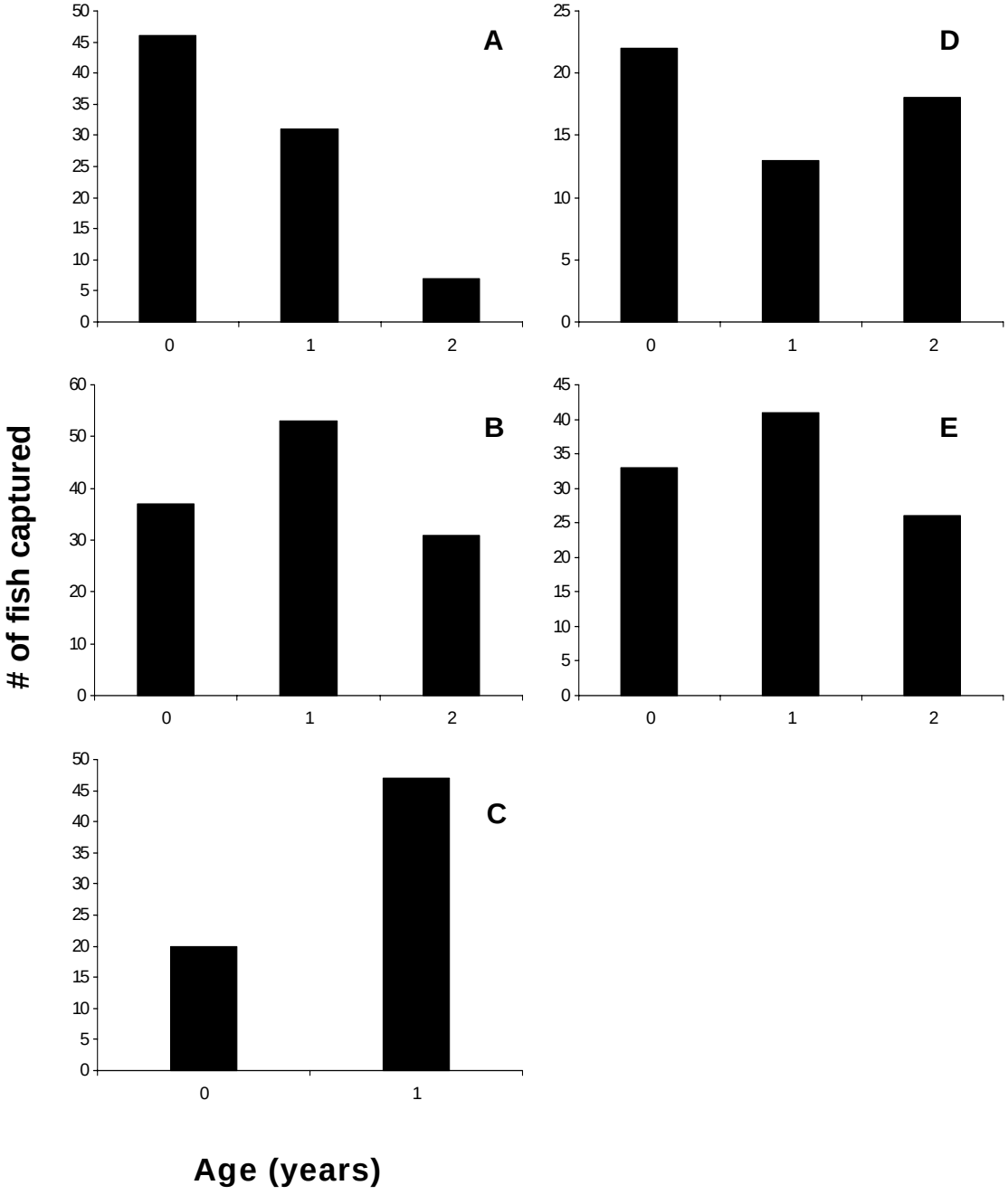

Figure 40. Frequency distribution of Age-0, Age-1, and Age-2 largemouth bass (A), smallmouth bass (B), black crappie (C), yellow perch (D), and pumpkinseed (E) in the Pend Oreille River, Idaho during 2005 electrofishing.

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